Selective Synthesis of Organosilicon Scaffolds

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Declaration

This thesis has not been submitted in support of an application for another degree at this or any other university. It is the result of my own work and includes nothing that is the outcome of work done in collaboration except where specifically indicated. Any section of this thesis which has been published will be clearly identified.

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Abstract

Chapter 1 outlines the fundamental reactivity of silicon and the resulting synthetic advantages in organic chemistry. It highlights the growing role of silicon-containing motifs in medicinal chemistry while addressing limitations due to restricted access to diverse organosilane building blocks. Particular focus is given to the utility of vinyl and allylsilanes and the ongoing challenges in achieving their regio- and stereoselective synthesis.

Chapter 2 details the optimisation of triflimide-catalysed activation of vinylsilanes to achieve the regioselective synthesis of linear allylsilanes from various silyl hydrides. It also examines limitations related to functional group compatibility, catalyst loading, and side reactions.

Chapter 3 builds on the work in Chapter 2, employing triflimide-catalysed allylations to synthesise allylsilanes in high regio- and stereoselectivity. It outlines the optimisation process, examines key limitations, and explores the reactivity of the resulting allylsilanes, including attempts to generate allylic alcohols and the successful formation of 1,5-dienes through protodesilylation.

Chapter 4 describes the development of a platinum-catalysed hydrosilylation method for the regioselective synthesis of α-silyl-α,β-unsaturated amides. This transformation proceeds with complete regiocontrol, providing access to synthetically valuable silyl-substituted acrylamides. Their reactivity and synthetic potential were also explored.

Chapter 5 builds on the work of Chapter 4, further developing hydrosilylation methodology to access β-(*E*)-silyl acrylamides with high regio- and stereoselectivity. These β-silyl acrylamides complement the previously described vinylsilanes, broadening the structural diversity of accessible silylated amides. Their reactivity and potential applications were also investigated.

Chapter 6 presents the overall conclusions and places the research within the wider field of organosilicon chemistry. It emphasizes the importance of regio- and stereoselectivity in allyl and vinylsilane synthesis and highlights the contributions of the developed methods. Finally, it proposes potential directions for future research.

Chapter 7 provides the experimental and characterisation data for the compounds listed in the thesis.

Acknowledgements

First and foremost, I would like to express my deepest appreciation to my supervisor, Mark. Your unwavering support, encouragement, and belief in my abilities have meant the world to me. Thank you for always pushing me to grow as a scientist and for being a source of calm and reason throughout the highs and lows of this journey. Your kindness, both in and out of the lab, has made this experience all the more meaningful.

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Contents

Abbreviations

γ	gamma
δ	chemical shift (NMR)
Ă	angstrom
µ	micro
α	alpha
β	beta
π	pi
Ac	acetyl
ADMET	absorption, distribution, metabolism, excretion and toxicity
AO	atomic orbital
APCI	atmospheric pressure chemical ionisation
Ar	unspecified aryl group
Asn	asparagine
Aq	aqueous
b	branched
BBA	Brønsted acid-assisted chiral Brønsted acid (catalysis)
BBB	blood brain barrier
BINAP	(2,2’-bis(diphenylphosphino)-1,1’-binaphthyl
BINOL	1,1’-bi-2-naphthol
B	unspecified base
Bn	benzyl
Boc	*tert*-butoxy carbonyl
BOP	benzotriazol-1-yloxytris(dimethylamino)phosphonium hexafluorophosphate
Bpin	pinacolborane
Bpy	2,2’-bipyridine
br	broad
BTK	Bruton’s tyrosine kinase
Bu	butyl
BuLi	butyllithium
C	Celsius
Cat	catalyst

CNS	central nervous system
COSY	correlated spectroscopy (NMR)
Cy	cyclohexane
Cys	cysteine
d	distance
dba	dibenzylideneacetone
DCC	*N*,*N*'-dicyclohexylcarbodiimide
DCE	1,2-dichloroethane
DCM	dichloromethane
DCU	dicyclohexylurea
d.e	diastereomeric excess
DEPT-135	distortionless enhancement by polarisation transfer
DIBAL-H	diisobutylaluminium hydride
DIPEA	*N*,*N*-diisopropylethylamine
DMAP	2-(dimethylamino)pyridine
DMF	*N,N'*-dimethylformamide
DNA	deoxyribonucleic acid
Dppf	1,1'-bis(diphenylphosphino)ferrocene
Dppb	1,4-bis(diphenylphosphino)butane
Dppe	1,2-bis(diphenylphosphino)ethane
Dppp	1,3-bis(diphenylphosphino)propane
DMSO	dimethyl sulfoxide
DTBP	2,6-di(*t*-butyl)-pyridine
dr	diastereomeric ratio
DVDS	1,3-divinyl-1,1,3,3-tetramethyldisiloxane
E	unspecified electrophile
ee	enantiomeric excess
EDCI	1-ethyl-3-(3-dimethylaminopropyl)carbodiimide
EGFR	epidermal growth factor receptor
ESI	electrospray ionisation
Et	ethyl
EtOAc	ethyl acetate
Eq.	equivalent(s)
EWG	electron withdrawing group

FDA	food and drug administration
Fmoc	fluorenylmethyloxycarbonyl
FTIR	fourier-transform infrared spectroscopy
h	hour(s)
H_0	Hammet acidity function
HATU	hexafluorophosphate azabenzotriazole tetramethyl uronium
HFIP	hexafluoro-2-propanol
His	histidine
HMBC	heteronuclear multiple bond correlation (NMR)
HOBt	hydroxybenzotriazole
HOMO	highest occupied molecular orbital
HRMS	high-resolution mass spectrometry
HSQC	heteronuclear single quantum coherence (NMR)
HSQMBC	heteronuclear single quantum multiple bond correlation
Hz	hertz
i	*iso*
IPAP	in-phase, anti-phase
IR	infrared
J	coupling constant
k	equilibrium constant
KJ	kilojoules
l	linear
LA	Lewis acid
LBA	Lewis acid assisted chiral Brønsted acid (catalysis)
LBBA	chiral Lewis base assisted Brønsted acid (catalysis)
LBD	Lewy body dementia
LC-MS	liquid chromatography-mass spectrometry
L_n	ligand
LUMO	lowest occupied molecular orbital
Lys	lysine
m	*meta*
M	molar
Me	methyl
MeCN	acetonitrile

MeOH	methanol
Min	minute(s)
MO	molecular orbital
Mol	mole
mmol	millimole
Ms	methanesulfonyl
m/z	mass/charge
NBS	*N*-bromosuccinimide
NHC	*N*-heterocyclic carbene (ligand)
NIS	*N*-iodosuccinimide
NOESY	nuclear Overhauser effect spectroscopy
NMP	*N*-methyl-2-pyrrolidone
NMR	nuclear magnetic resonance
NTf_2	bis(trifluoromethylsulfonyl)imide
NTPA	*N*-triflylphosphoramides
Nu	unspecified nucleophile
n.r	no reaction
o	*ortho*
p	*para*
Ph	phenyl
PPARα	peroxisome proliferator activated receptor agonist
PPTS	pyridinium *p*-toluenesulfonate
Pr	propyl
Pro	proline
PTS	polyoxyethanyl-α-tocopheryl sebacate
Py	pyridine
R	unspecified alkyl group
R_f	retention factor
RT	room temperature
S_E	electrophilic substitution
Ser	serine
S_N	nucleophilic substitution
SNTPA	spinol-*N*-triflylphosphoramides
SPINOL	1,1′-spirobiindane-7,7′-diol

TAS	trialkylsilyl
TBAF	tetrabutylammonium fluoride
TBS	*tert*-butyldimethylsilyl
TBDPS	*tert*-butyldiphenylsilyl
TEA	triethylamine
Temp	temperature
tert	tertiary
TES	triethylsilane
Tf	trifluoromethanesulfonyl
THF	tetrahydrofuran
TIPS	triisopropylsilane
TLC	thin layer chromatography
TMDS	tetramethyldisiloxane
TMS	trimethylsilyl
Trp	tryptophan
Ts	toluenesulfonyl
Tyr	tyrosine
US	united states
VT	variable temperature (NMR)

1 Chapter 1 – Introduction into Organosilicon Chemistry

Organosilicon reagents are highly valued in the synthesis of fine chemicals, agrochemicals, and pharmaceutically relevant compounds.[1-3] Their unique combination of low toxicity and enhanced stability toward air and moisture distinguishes them from other organometallic reagents.[4, 5] The broad utility and versatility of silicon-based compounds stem from their advantageous properties, which are often emphasised in contrast to their carbon analogues.[6] Due to silicon's significantly greater electropositivity compared to carbon (**Table 1**),[7] bonds such as Si-C and Si-H are highly polarised, imparting increased electrophilic character to the silicon centre. This polarisation renders silicon more susceptible to nucleophilic attack; a feature extensively leveraged in the use of silyl protecting groups and in Si-H bond activation during hydrosilylation reactions.[8-12]

Table 1: Pauling scale of electronegativities of selected elements[7]

	C	Si	H	O	F
Electronegativities	2.5	1.8	2.1	3.5	4.0

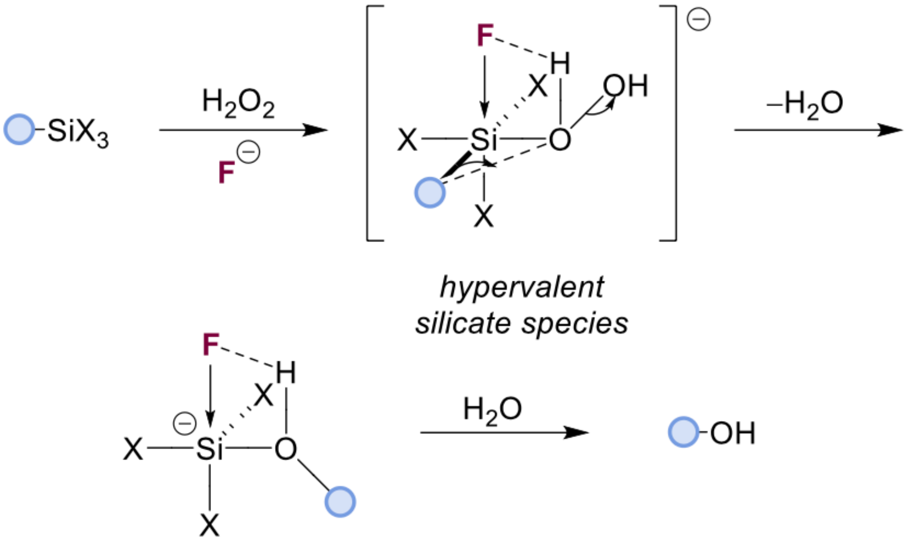
$$\overset{\delta+}{\mathrm{Si}}-\overset{\delta-}{\mathrm{C}} \qquad \overset{\delta+}{\mathrm{Si}}-\overset{\delta-}{\mathrm{H}}$$

Another key distinction between silicon and carbon lies in bond length. Silicon-containing bonds are notably longer than their carbon analogues. For instance, the C-C bond length is approximately 1.54 Å, whereas the C-Si bond measures around 1.85 Å (**Table 2**).[13] A popular example demonstrating this is seen in that a trimethylsilane (TMS) group is less sterically demanding than its carbon counterpart (in terms of A values).[14] The longer bond to the TMS group decreases steric interactions even though the whole size of the group is indeed larger. Additionally, silicon exhibits a high affinity towards oxygen and halogens, forming significantly stronger Si-O and Si-X bonds, resulting in higher relative bond dissociation energies.[15] On the other hand, Si-C and Si-H bonds are weaker than the respective C-C and C-H bonds. The crux of modern organosilicon chemistry hinges on the generation of exceptionally stable Si-O or Si-F bonds, whilst at the same time cleaving weaker silicon bonds (Si-C or Si-H). This has led to the use of silicon as part of strategic planning during natural product synthesis as protecting groups.[16] In contrast to the strength of σ-silicon bonds, π-silicon bonds are generally weak.[17] For this reason, normally no stable silyl equivalents exist for olefins or carbonyl functional groups. However, there are a few exceptions for compounds with sterically or electronically stabilised Si=C and Si=O bonds which can be isolated.[18, 19]

Table 2: Bond lengths and dissociation energies of selected bonds[13]

	C-C	**C-H**	**C-O**	**C-F**	**C-Si**	**Si-Si**	**Si-H**	**Si-O**	**Si-F**
Bond Dissociation Energies (kJ/mol)	346	413	358	485	318	221	318	452	565
Bond Length (Å)	1.54	1.09	1.43	1.35	1.85	2.34	1.48	1.63	1.60

Silicon also possesses the ability to have an 'expanded valency' owed to having access to a low lying 3d orbital. This gives silicon the ability to form hypervalent species like pentacoordinate (e.g. in silicates, SiF_5^-) and hexacoordinate complexes.[20, 21] The hypervalent intermediates allow organosilanes to undergo oxidation under a variety of conditions, illustrated by the Fleming-Tamao oxidations (**Scheme 1**).[22, 23]



SiX_3 = $SiMe_2F$, $SiMe_2F$, $SiMe_2Cl$, $SiMe_2(OR)$ etc.

Scheme 1: Fleming-Tamao oxidation mechanism via hypervalent silicon species[23]

1.1 The Alpha (α) and Beta (β) Silicon Effect

Silyl groups possess the ability to stabilise charges within the vicinity of the group, which is considered the fundamental phenomenon that underpins silicon's unique reactivity. Silicon's ability to stabilise neighbouring negative charges is known as the α-effect.[24, 25] The α-silicon effect is due to two main factors (**Figure 1**), the overlap of the α-carbon-metal bond with a silicon d orbital and the overlap of the α-carbon-metal bond with the σ* orbital of the adjacent Si-C bond. The α-effect is frequently exhibited in the α-metalation of silanes using strong bases, which is a key step of the Peterson olefination.[26, 27]

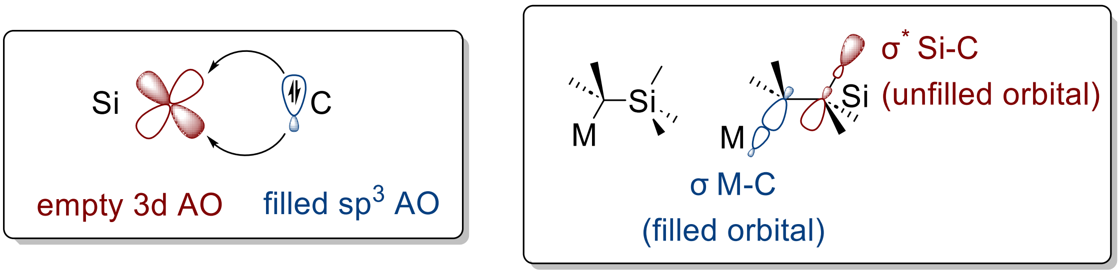


Figure 1: α-carbanion stabilised by hyperconjugation between the filled p orbital and the empty d orbital of silicon

Silicon can also stabilise β-carbocations and β-carboradicals to varying degrees and is described as the β-effect.[28, 29] The origin of the β-effect of β-carboradicals is still subject to controversy. However, the stabilisation has been theorised to be due to homoconjugation [$(p\text{-}d)_\pi$] between the single electron and the 3d orbitals of the silicon atom (**Figure 2**).[30]

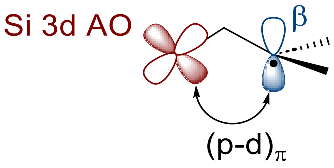


Figure 2: Stabilisation of β-carboradicals via the β-silicon effect

Whereas σ-π hyperconjugation is generally used to describe the stabilisation of β-carbocations (**Figure 3**).[28] The stabilisation results from the overlap between the vacant p orbital on the β-carbon atom and the σ-orbital between the silicon atom and the α-carbon atom. The higher energy C-Si σ molecular orbital (MO) and the higher coefficient (as a result of silicon being more electropositive) leads to more effective orbital overlap and increased stabilisation. It is important to note that the vacant p orbital and the C-Si bond must be in the same plane for maximum stabilisation to occur, but this may not always be possible in cyclic systems.

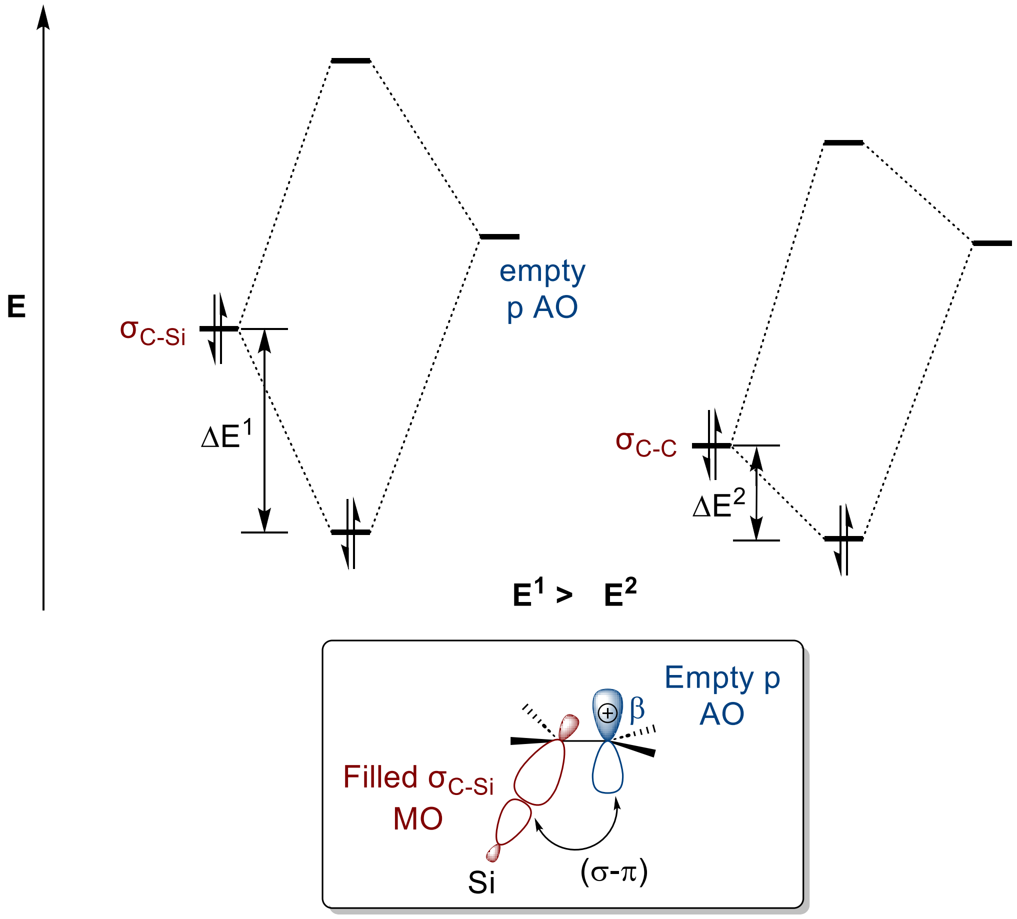
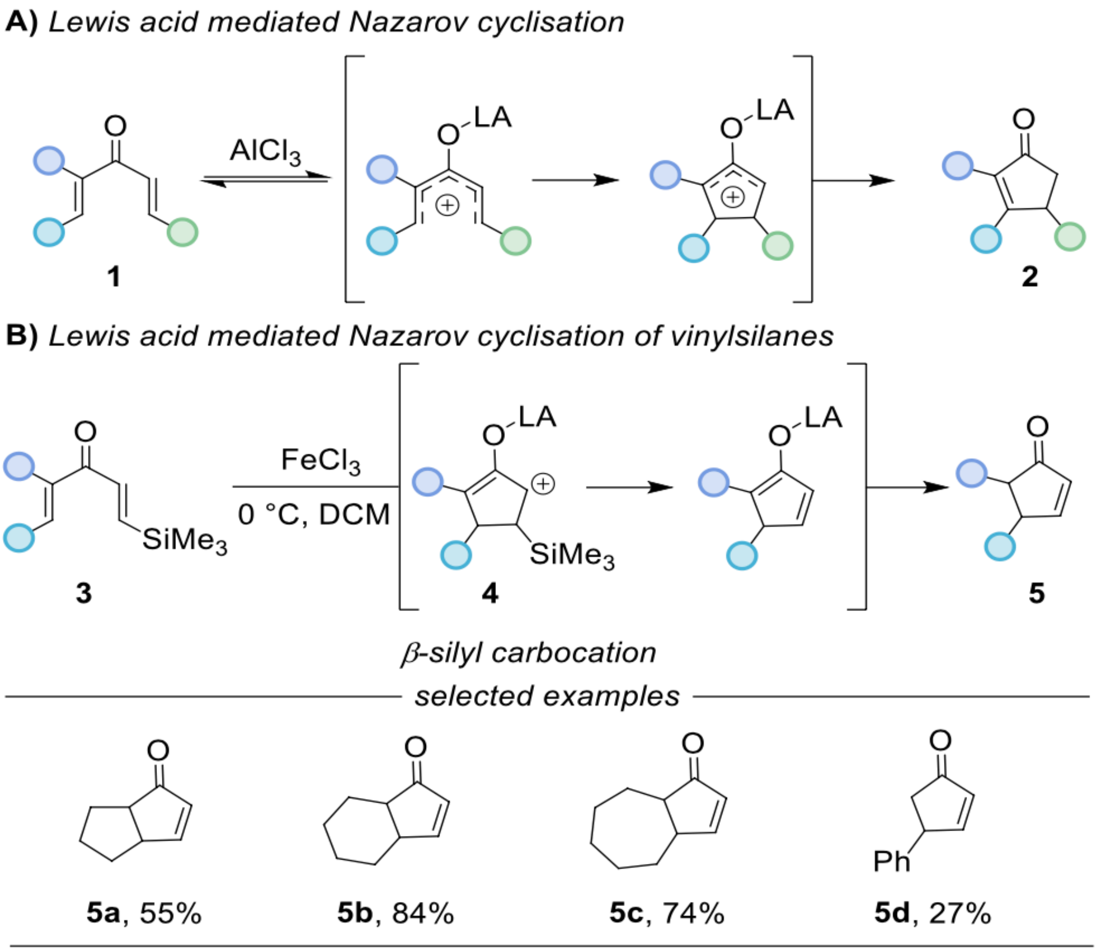


Figure 3: Stabilisation of β-carbocations via hyperconjugation compared to carbon analogue

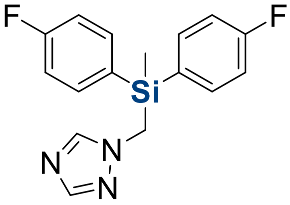
Denmark and co-workers elegantly demonstrated how the stable β-silyl carbocation intermediate (**4**) can be used as directing groups in transition states in order to predict outcomes of the reaction.[31] The authors reported a Lewis acid catalysed Nazarov cyclisation via vinylsilanes (**3**), in order to overcome the lack of control over the position of the double bond in the cyclopentanone moiety (**Scheme 2**). Normally, the double bond resides in the most thermodynamically stable position (i.e. highest degree of substitution) giving rise to favoured regioisomer (**2**). However, with strategic positioning of the silyl group, the reaction proceeds via the stabilised intermediate (**4**), giving rise to the product (**5**) with the double bond in the least substituted position. Hence inducing high selectively to form products (**5a** – **d**) which their carbon analogues would of not.



Scheme 2: Silicon directed Nazarov cyclisation

1.2 Silicon's Role in Medicinal Chemistry

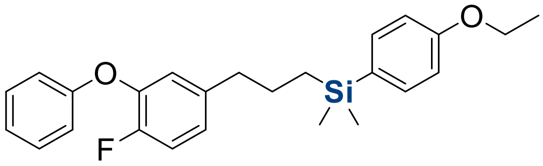
Silicon's unique and diverse reactivity has led to a growing role in drug discovery, which has attracted significant attention in the last decade.[2, 32, 33] It is generally accepted there are no naturally occurring organosilicon compounds within nature, i.e. compounds containing at least one C-Si bond. There has however been some notable success in the agrochemical industry, with the synthesis and application of Flusilazole (**6**) and Silafluofen (**7**) (**Figure 4**).[34, 35] Despite the increasing interest, currently there are no silicon-containing drugs which have been approved in any United States (US) or Western European market. There is one example marketed a steroid Silabolin (**8**), in which silicon exists as a silyl ether in a prodrug capacity.[36] The pharmaceutical underuse of silicon is primarily attributed to an absence in general accessible methods for construction of diverse silicon-containing molecules.



Flusilazole

broad spectrum fungicide

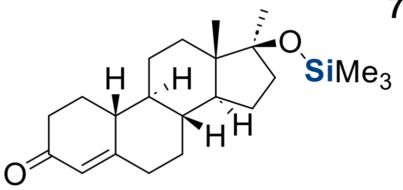
6



Silafluofen

insecticide

7



Silabolin

anabolic steriod

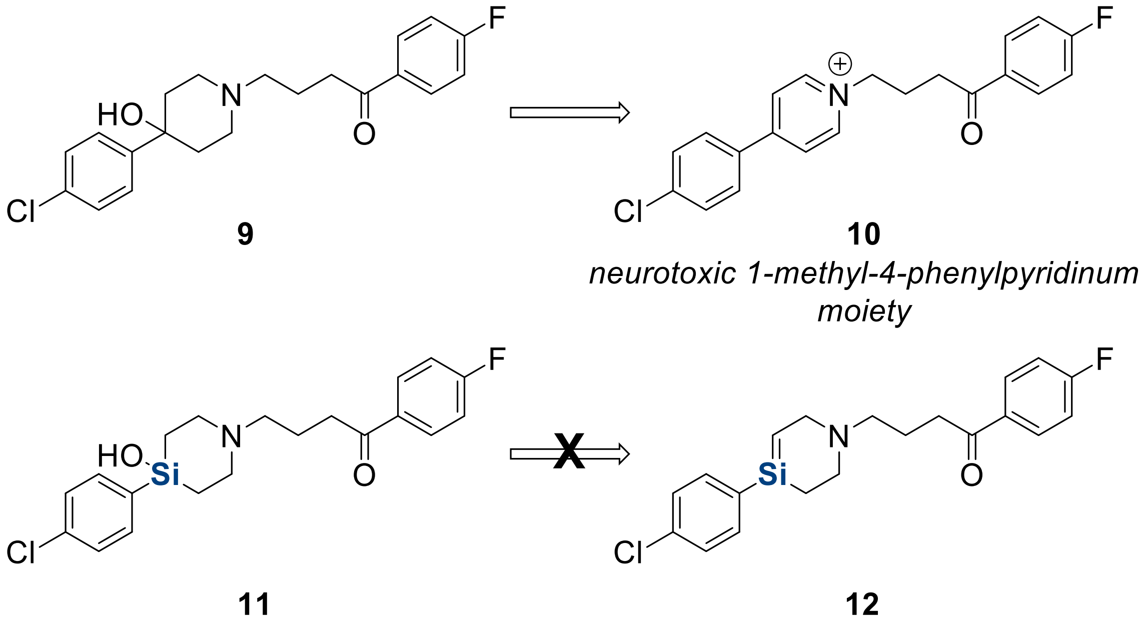
8

Figure 4: Selected examples of bioactive organosilicon compounds

1.2.1 The "Silicon Switch"

In recent years, significant attention has been directed toward the use of silicon as a carbon bioisostere, aiming to modulate pharmacokinetically relevant parameters in drug discovery. This is attributed to the unique physiochemical properties of silicon which render ideal characteristics in medicinal applications.[1] These attributes have arisen from the fundamental dichotomy between carbon and silicon and as such has been dubbed as the "silicon switch".[37] This strategy was first exemplified by the pioneering work of Tacke and co-workers, who designed silicon analogues of bioactive molecules by substituting one or more carbon atoms with silicon atoms (or silicon-containing groups).[38] Employing silane-based bioisosteres has proven to be a strategic approach for mitigating the formation of toxic metabolites and enhancing the ADMET (absorption, distribution, metabolism, excretion, and toxicity) profile of drug candidates.[37] A key example involves the antipsychotic drug haloperidol (**9**),[39, 40] whose neurotoxic side effects are linked to the formation of a harmful pyridinium metabolite (**10**), known to damage dopamine-producing neurons and induce symptoms associated with Parkinson's disease (**Scheme 3**).[41] Tacke *et al.* addressed this issue by synthesising a sila-haloperidol analogue (**11**), in which a silicon atom replaced a carbon within the pharmacophore.[42] This analogue was unable to produce the toxic metabolite (**12**) due to the enhanced stability of the

Si-O bond and silicon's inherent inability to form stable Si=C bonds, thus demonstrating a clear therapeutic advantage.

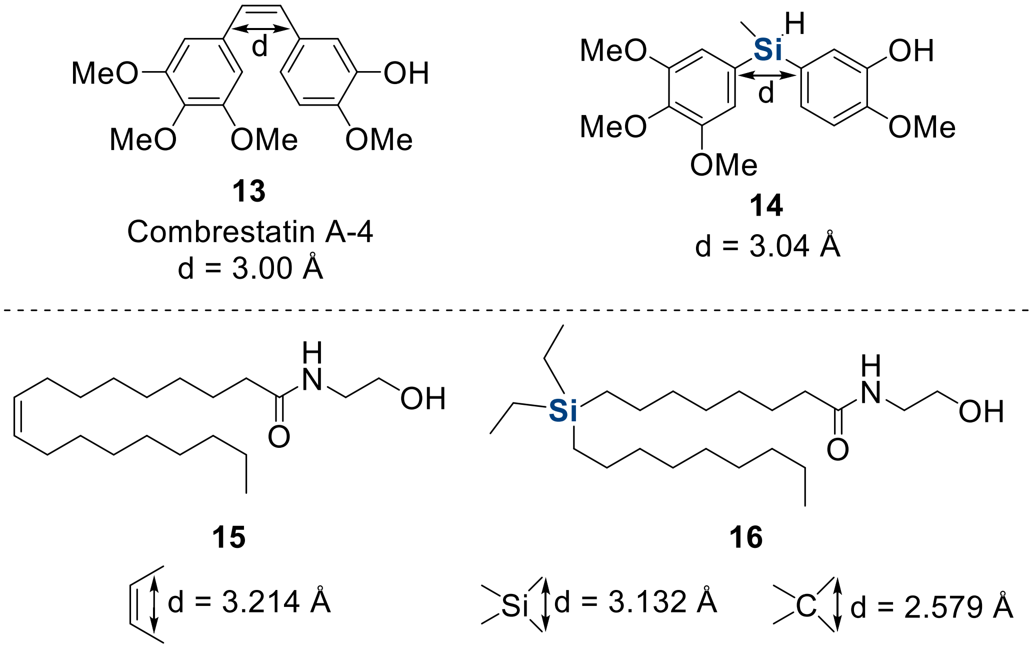


neurotoxic 1-methyl-4-phenylpyridinum moiety

Scheme 3: Metabolic pathway of haloperidol comparison to its silyl-analogue

Members of the combretastatin family have demonstrated potent inhibition of cell growth and proliferation.[43] One representative compound (**13**), exhibited strong anti-tumour activity and functioned as a vascular-disrupting agent by reducing tumour blood flow, ultimately leading to cell death.[44] Nakamura *et al.* reported the synthesis of a silyl-containing analogue (**14**), in which the central ethene linkage was replaced with a silicon-based bridge, maintaining an almost identical inter-ring distance (**Figure 5**).[45] The introduction of the silyl group enhanced the compound's chemical stability, prompting the authors to propose that the silicon bridge could serve as a bioisostere of a *cis*-alkene.

Extending this concept, Fujii and co-workers further explored whether silane groups could functionally replace aliphatic *cis*-olefins. An endogenous peroxisome proliferator-activated receptor agonist (PPARα) (**15**) with insulin-sensitising and anti-proliferative properties, was used as a model.[46] Molecular orbital calculations revealed that the distance between carbon atoms bridged by a silicon atom closely resembled that of the corresponding *cis*-alkene, although the direct C–Si–C bridging distance was slightly shorter. Despite this, the replacement of the ethene moiety with a silicon atom did not significantly perturb the geometry or spatial orientation of the molecule, and importantly, the biological activity of the resulting analogue (**16**) remained comparable to the parent compound.



13
Combrestatin A-4
d = 3.00 Å

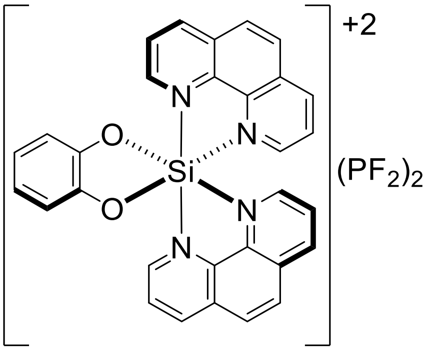
14
d = 3.04 Å

15
d = 3.214 Å

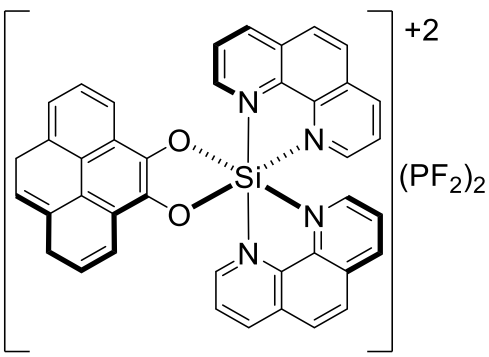
16
d = 3.132 Å
d = 2.579 Å

Figure 5: Silyl analogues mimicking *cis*-olefins

As previously discussed, silicon can also form hypervalent complexes, which are inaccessible with carbon.[21] Meggers and co-workers reported the biological activity of hydrolytically stable silicon containing octahedral polypyridyl complexes (**17** and **18**) (**Figure 6**).[47] Studies showed that the complexes can intercalate between DNA base pairs. DNA intercalators have a variety of therapeutic applications, mainly in the area of cancer therapy.[48] Here, silicon's non-toxicity and natural abundance is deemed advantageous over commonly used transition metals in designing complexes with such pharmaceutical applications.



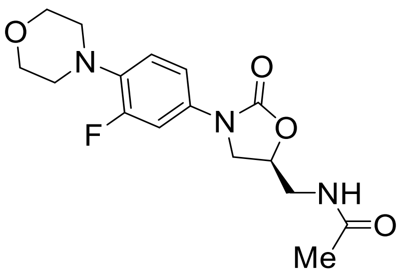
17



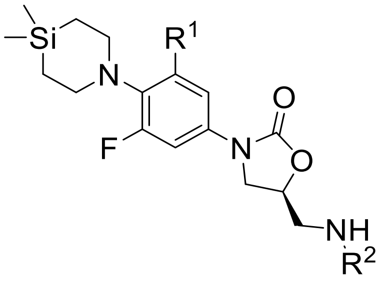
18

Figure 6: Hypervalent silicon complexes as DNA intercalators

The blood-brain-barrier (BBB) allows passage of certain molecules to the brain, with small lipophilic molecules diffusing through more readily.[49] The incorporation of silicon into a molecule can increase the lipophilicity, which may increase the BBB penetration of a drug. Linezolid (**19**) is a marketed antibiotic with a clog P of 0.17 (**Figure 7**).[50] Several compounds have been developed from this molecule surrounding the adaption of the morpholine ring in order to improve ADMET properties and potency. Reddy and co-workers designed and synthesised silicon analogues (**20a** – **c**) and evaluated their biological activity (**Figure 7**).[51] The pharmacokinetics revealed that the silicon incorporation caused a significant increase in brain to plasma ratio. **20c** demonstrated a 29-fold increase in brain/plasma ratio with respect to **19**. This increase in central nervous system (CNS) exposure is due to the increase in lipophilicity of the compounds which is evident from the increasing cLog P values.



19
Linezolid, clog P = 0.17



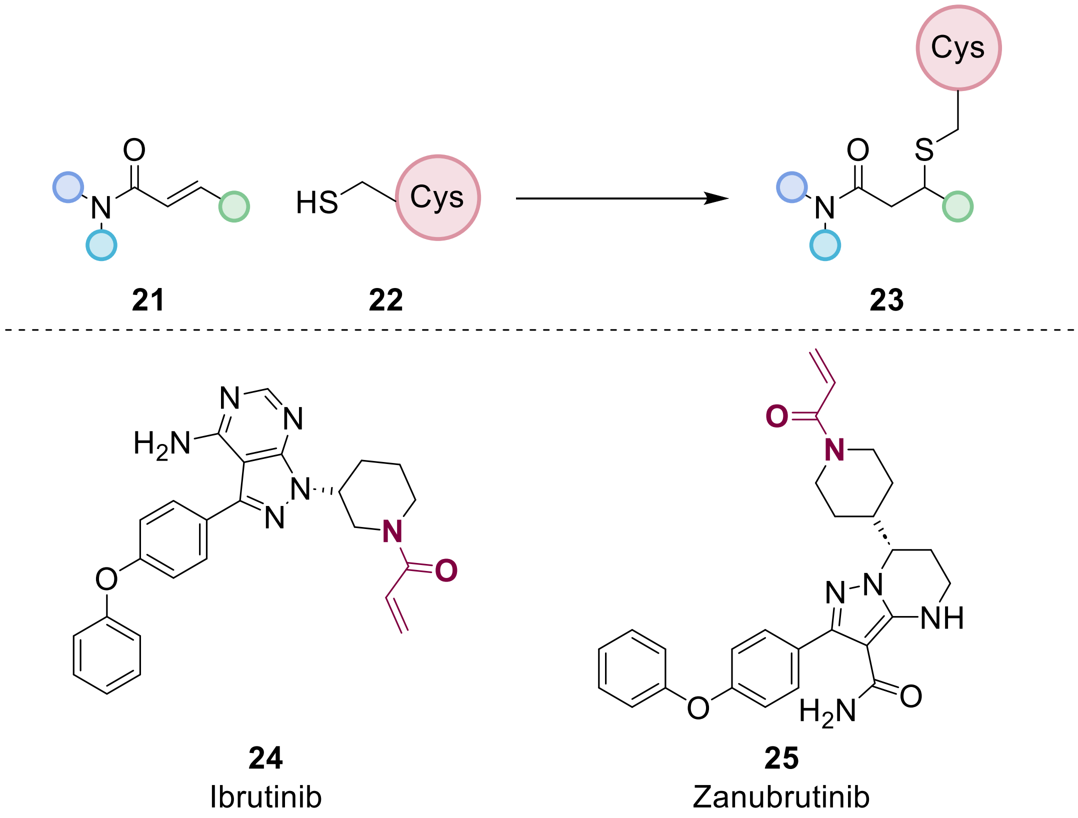
Compound	R^1	R^2	clog P
20a	H	C(O)Me	4.15
20b	F	C(O)Me	4.36
20c	H	C(S)OMe	5.55

Figure 7: Silicon incorporation into Linezolid

It has been demonstrated that the incorporation of silicon in the scaffold of a drug can not only markedly improve the ADMET profile but also biological activity. However, a major difficulty lies in general methodology in order to form libraries of silicon compounds with increased medicinally relevant functionalities.

1.2.2 Silicon-Based Covalent Warheads

A huge staple within medicinal chemistry are acrylamides which typically target non-catalytic cysteine residues.[52, 53] The acrylamide warheads (**21**) can react irreversibly with the thiol group of a cysteine residue (**22**) via a Michael addition to form conjugated adducts (**23**) (**Scheme 4**). There has been much success for the development of such irreversible covalent inhibitors. For example, Ibrutinib (**24**) was approved for marketing in 2013 as a drug for the treatment in B-cell malignancy and Zanubrutinib (**25**), was approved by the Food and Drug Administration (FDA) in 2019 to inhibit Bruton’s tyrosine kinase (BTK) activity.[54, 55]



21 **22** **23**

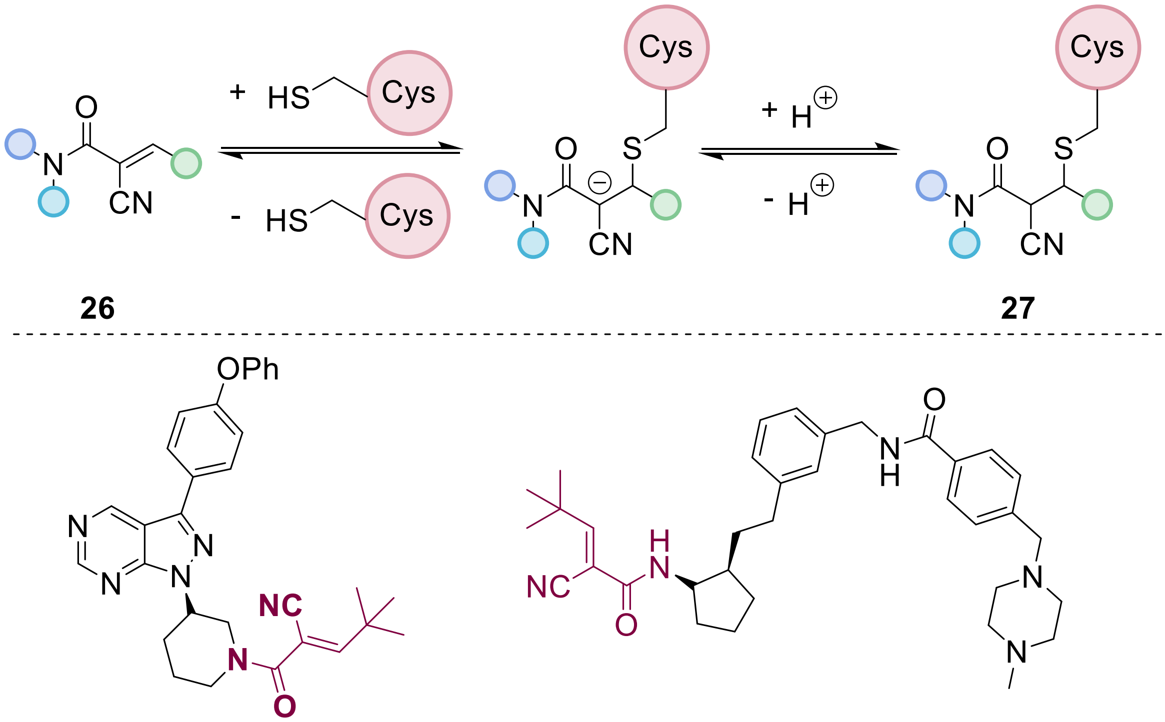
24
Ibrutinib

25
Zanubrutinib

Scheme 4: Acrylamide as irreversible inhibitors by reacting via Michael addition to cysteine residues

However off-target side effects of covalently bound drugs are still problematic and limiting their use within medicinal chemistry. The selectivity and potency investigation of inhibitors is of significant importance. One method of investigating potential biological reactivity is the fine-tuning of substitution patterns around the reactive site.

Taunton *et al.* proposed a reversible covalent inhibitor of the synthetic p90 ribosomal protein S6 kinase RSK2 by introducing an electron-withdrawing cyano group at the α-position of acrylamides (**26**) (**Scheme 5**).[56] This was shown to accelerate the Michael addition to cysteine thiols and forms a reversible covalent bond (**27**). It was shown **28**, can not only increase electrophilicity and reactivity with cysteine residues but also greatly enhance the acidity of α-H, so the reverse reaction can biologically occur *in vivo*. On the other hand, by adjusting the steric hindrance of the β-group, the removal rate of α-H can be regulated, thereby modulating the rate of the reverse reaction. The greater the steric hindrance of the β-group, the more difficult the α-H on the drug molecule in the enzymatic pocket is to be removed by the base, and the lower the rate of the reverse reaction will be, thus increasing the action time of the drug. This was also shown in 2019 by Jang *et al*. who applied the cyanoacrylamide **29** to a PPARγ phosphorylation inhibitor that induced reversible covalent bond with Cys285 of the PPARγ Lewy body dementia (LBD).[57]



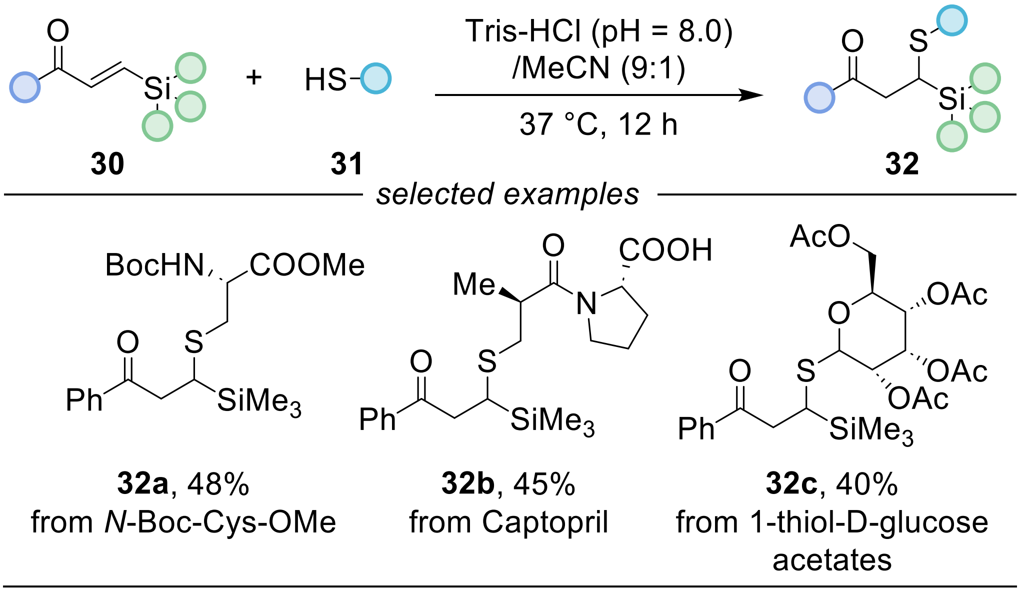
26 **27**

28 **29**

Scheme 5: Irreversible binding of α-cyano substituted acrylamides with cysteine residues via Michael addition

This demonstrates the potential chemical space to explore selective binding of amino acids in order to reduce off target effects and increase potency. In 2024, Zhang *et al.* reported a new bioconjugation agent (**32**) containing silicon to be developed for the selective reaction with thiols under biocompatible conditions (**Table 3**).[58] The methodology was applied to a large substrate scope with a range of functionalities with variation of the silane moiety, α,β-unsaturated compound (**30**) and sulphur nucleophile (**31**). The methodology was notably applied to biologically relevant structures such as **32a** derived from *N*-Boc protected cysteine methyl ester, **32b** derived from the antihypertensive drug Captopril and also 1-thio-D-glucose derivative **32c**, albeit in a lower yield. This showcased the methodology to be highly tolerant of variety of functionalities and highlighted its biocompatibility to different potential targets.

Table 3: β-silyl-α,β-unsaturated compounds as bio-conjugating reagents

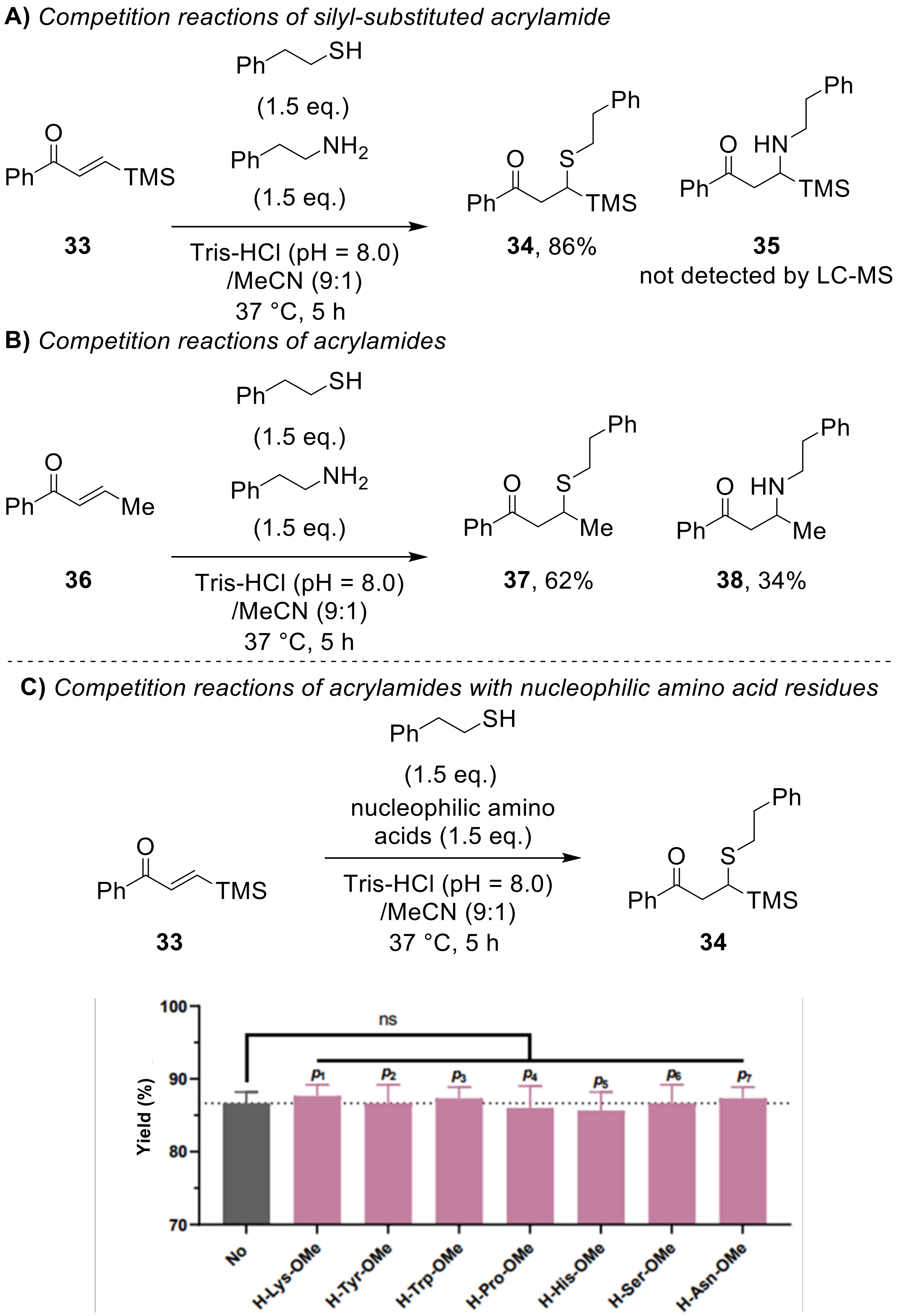


32a, 48%
from *N*-Boc-Cys-OMe

32b, 45%
from Captopril

32c, 40%
from 1-thiol-D-glucose acetates

The authors also conducted a series of experiments to establish the effect of the silyl group on the chemoselectivity of the reaction. The silyl-substituted acrylamide (**33**) proved to outperform it's carbon counterpart (**36**), with increased chemoselectivity towards sulphur nucleophiles in the presence of nitrogen nucleophiles (**Scheme 6** – **A** and **B**). In addition to this, the reaction was also investigated in the presence of several nucleophilic amino acids residues (**Scheme 6** – **C**). This resulted in similar yield of **34** being obtained in each case demonstrating the high chemoselectivity of the reaction in the presence of other amino acid residues.


A) *Competition reactions of silyl-substituted acrylamide*

B) *Competition reactions of acrylamides*

C) *Competition reactions of acrylamides with nucleophilic amino acid residues*

Scheme 6: Chemoselectivity experiments of silyl-substituted acrylamides[58]

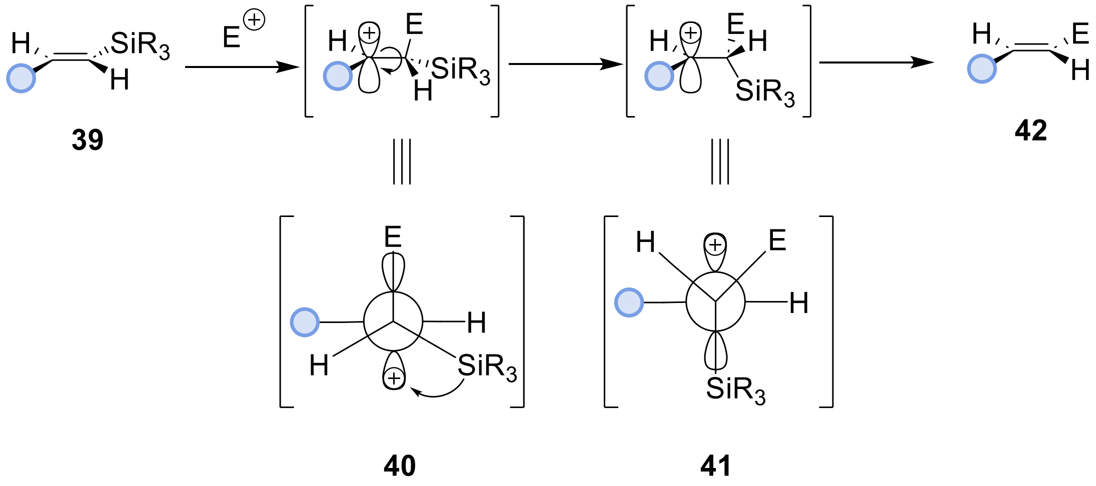
Although this report is a promising result for organosilanes being used to invoke higher stability and selectively as covalent warheads, this area is largely underdeveloped and may benefit from different substitution patterns being explored. In addition to this, there is still a need within the chemical industry for further exploration and investigation into the role of silicon and its biological implications. This is evident from the scarcity of successful drugs to pass through clinical trials containing silyl functional groups. A big drawback to this research stems for the lack of methodology to access highly functionalised, diverse organosilicon scaffolds. Although there has been significant research into their synthesis, methodologies still suffer from limited accessibility and selectivity issues.

1.3 Olefinic Silanes

1.3.1 Vinylsilanes

1.3.1.1 The Applications and Reactivity of Vinylsilanes

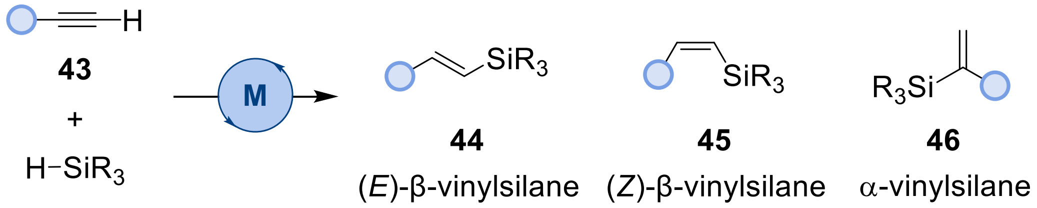
Among the highly valued organosilicon compounds are vinylsilanes which have high versatility with much interest being focused on their use in low cost, non-toxic routes to the formation of C-C and C-O bonds.[29, 59] The versatility of vinylsilanes can be seen by their participation in a wide variety of reactions including, olefin metathesis, cross couplings, and cycloadditions.[29, 60-65] Vinylsilanes (**39**) may also undergo electrophilic substitution reactions otherwise known as protodesilylations, where the silicon is replaced by the electrophile at the *ispo*-carbon atom. [55] The stereochemistry of the vinylsilane is significant because this exchange usually occurs with complete stereochemical retention (**Scheme 7**). This regioselectivity is governed by the formation of a stable β-carbocation intermediate. The transition states (**40** and **41**) illustrate how the silyl group aligns to give increased orbital overlap to achieve maximum stabilisation of the resulting cation. Elimination of the silyl group then occurs forming the olefin (**42**). This stereospecific elimination of silicon makes vinylsilanes useful reagents that can be regarded as stable vinylic organometallic compounds that will react with powerful electrophiles while preserving the double bond location and geometry.[66]



Scheme 7: Stereoretentive electrophilic substitution of vinylsilanes

1.3.1.2 Synthesis of Vinylsilanes via Hydrosilylation

The preparation of vinylsilanes has been well-documented with hydrosilylation of alkynes (**43**) being one of the most direct and efficient methods for their synthesis.[8-10, 67, 68] The main difficulty in the preparation of vinylsilanes is the regio- and stereoselectivity of the reaction, as numerous isomers (**44** – **46**) can be generated (**Scheme 8**). The delivery of a hydrosilanes to the same face of the triple bond (*syn*-addition) results in the formation of (*E*)-β-vinylsilane (**44**), while *trans*-addition (*anti*-addition) provides the respective (*Z*)-β-vinylsilane (**45**). The addition of a hydrosilanes to alkynes can also give rise to the α-vinylsilane regioisomer (**46**).

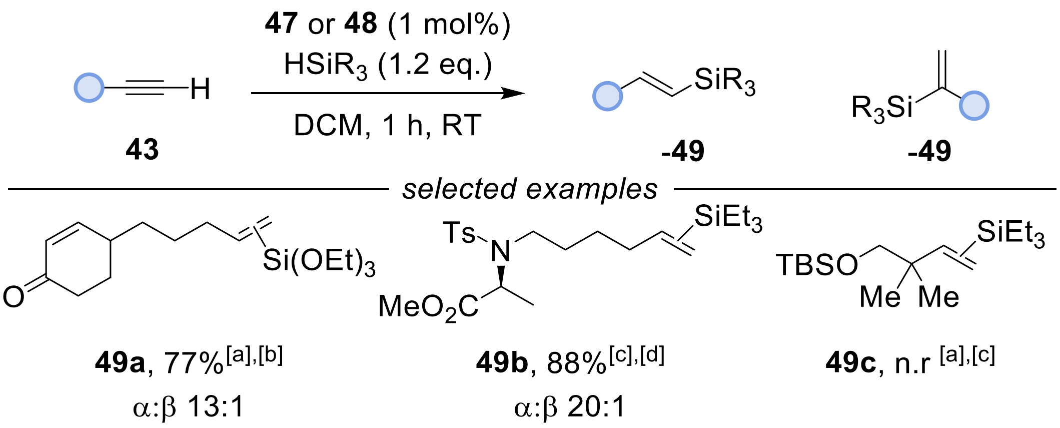


Scheme 8: Hydrosilylation of terminal alkynes synthesising stereo- and regioisomers of vinylsilanes

The ratio of products is ultimately dependant on the metal catalyst, ligand, alkyne, and the silane employed. However, the majority of transition metal catalysed hydrosilylation reactions favour the formation of the β-isomer, while α-vinylsilanes accessibility is more limited.

Markovnikov favoured hydrosilylations have been investigated by Trost and co-workers extensively, firstly using cyclopentadienyl ruthenium complex **47** (**Table 4**).[64, 69-73] The reactions proceeded in high yield and high regioselectivity in favour of the α-vinylsilane as shown in **49a**. Further investigation led to the development of a highly active catalyst – [Cp*Ru(MeCN)$_3$]PF$_6$ (**48**).[71] This resulted in a significant increase in the observed regioselectivity. As shown with α-vinylsilane **49b** being formed in a >20:1 α:β ratio. However, the methodology was limited by substrates with increased steric hinderance as seen with α-quaternary **49c** and bulkier silanes used, resulting in no reaction taking place.

Table 4: Ruthenium catalysed Markovnikov hydrosilylation

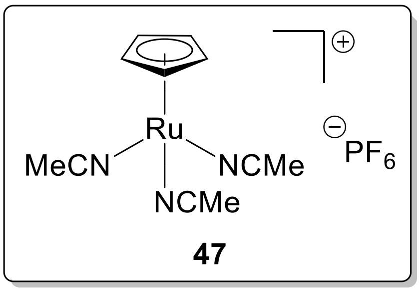


49a, 77%[a],[b]
α:β 13:1

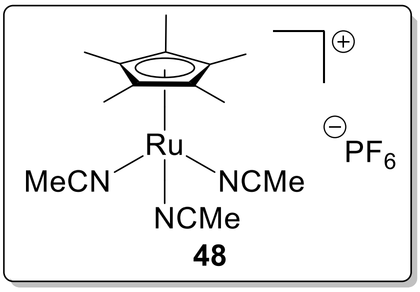
49b, 88%[c],[d]
α:β 20:1

49c, n.r [a],[c]

[a] **47** 1 mol% used, [b] isolated yield of both regioisomers, [c] **48** 1 mol% used, [d] isolated yield of solely α-isomer



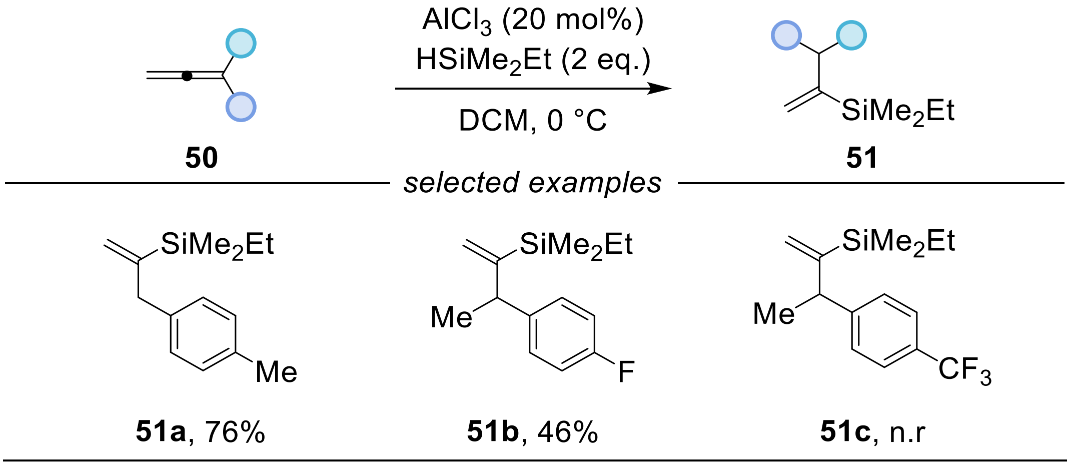
47



48

Yamamoto and co-workers also reported high regiochemical control providing α-vinylsilanes (**51**).[74] The authors utilised the Lewis acid AlCl$_3$ for the hydrosilylation of simple allenes (**50**) (**Table 5**). Although the methodology lacked functional diversity among substrates with no examples of electron rich groups, the reaction did however provide the products as single regioisomers as seen with **51a** and **51b**. However, the reaction was not tolerant to strongly electron-withdrawing substrates such as *p*-CF$_3$ substituted phenyl **51c**, resulting in recovery of the starting material.

Table 5: Lewis acid catalysed hydrosilylation for the synthesis of α-vinylsilanes



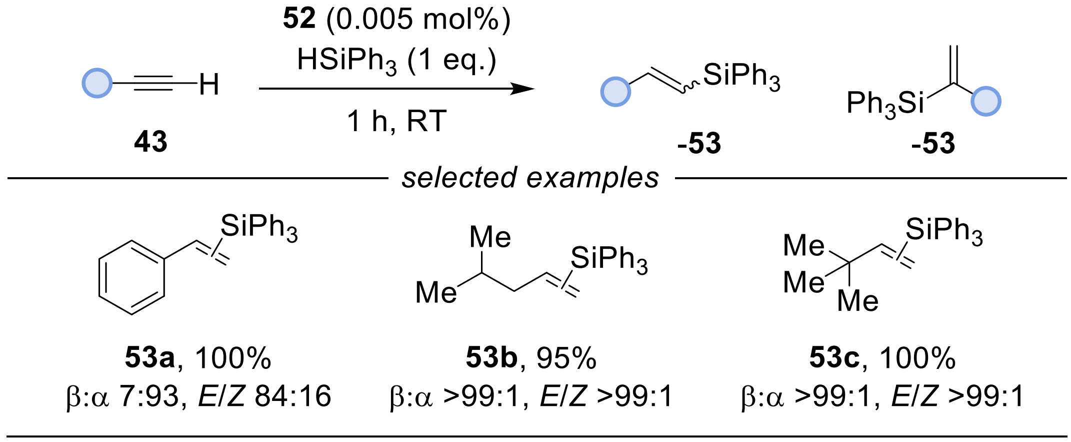
51a, 76% **51b**, 46% **51c**, n.r

This regioselectivity has been extensively studied and there are many catalysts that promote hydrosilylation reactions with late transition metal catalysts showing to be especially efficient.[68, 75] Owing to their unparalleled catalytic activity, industry is largely dominated by platinum-based systems.[76]

1.3.1.2.1 Platinum Catalysed Hydrosilylations

In the 1950s, Speier first reported the application of platinum-based catalysts for the hydrosilylation of olefins using hexachloroplatinic acid (H_2PtCl_6) and dichloromethylsilane.[77] This breakthrough resulted in the platinum complex being appropriately named "Speier's catalyst" and set the foundation for further developments within the field. Later in the 1970s, Karstedt's catalyst (platinum(0)-1,3-divinyl-1,1,3,3-tetramethyldisiloxane) (**52**) was developed and was reported to show higher selectivity and activity as a hydrosilylation catalyst, along with the elimination of corrosive by-products (HCl).[78] This resulted in widespread use within industrial settings for the synthesis of organosilanes, albeit not without difficulty in consideration to the regio and stereochemical control. Lewis *et al.* studied the selectivity using **52** with a range of simple terminal alkynes (**43**) (**Table 6**).[79] It was shown the reaction shows high stereochemical control almost exclusively forming the (*E*)-isomer, following a *syn*-addition pathway of the silyl hydride. The authors also demonstrated the regiochemical control is highly dependent on the alkyne, with higher regiochemical control observed with higher steric substitution (**53b** and **53c**), favouring the β-isomer.

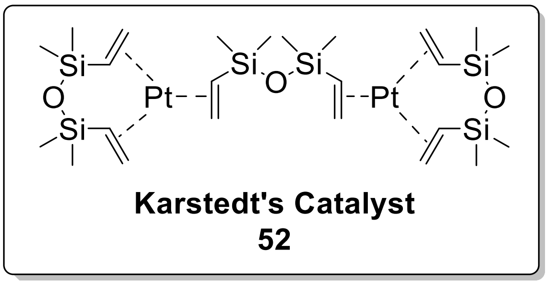
Table 6: Hydrosilylation of terminal alkynes using Karstedt's catalyst



53a, 100%
β:α 7:93, *E*/*Z* 84:16

53b, 95%
β:α >99:1, *E*/*Z* >99:1

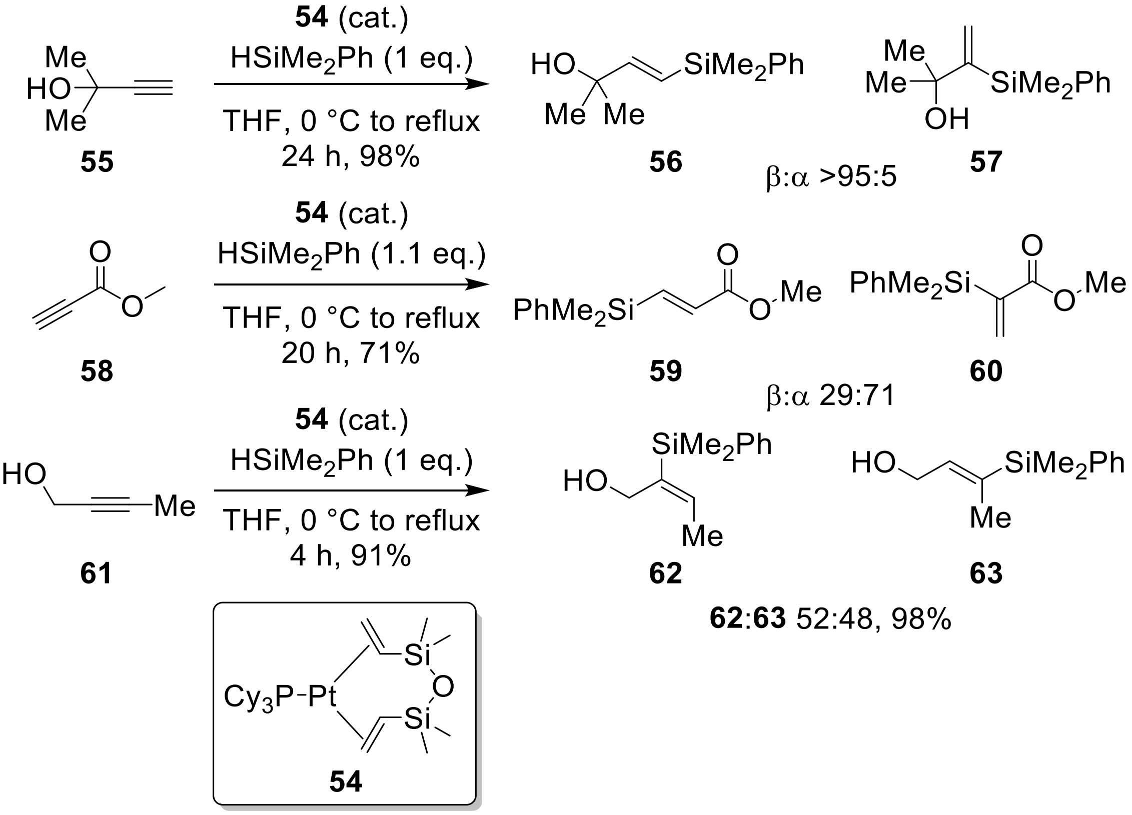
53c, 100%
β:α >99:1, *E*/*Z* >99:1



Karstedt's Catalyst
52

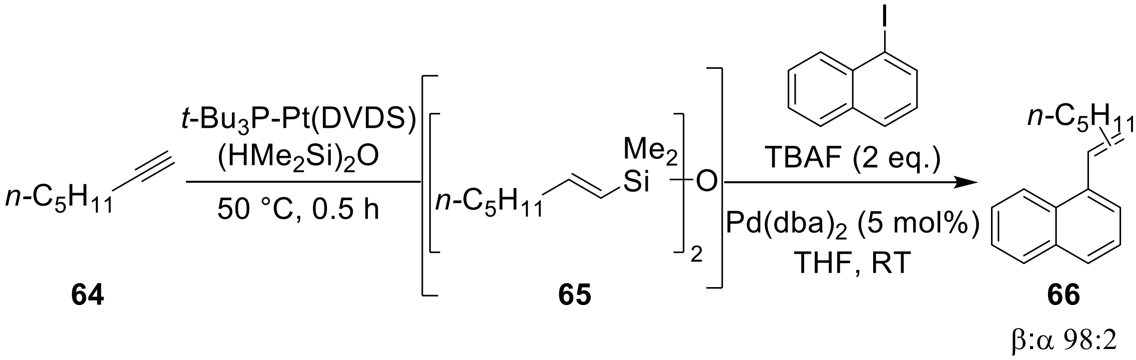
Since these classical methods there has been a great effort to fine-tune the regio- and stereoselectivity for the synthesis of vinylsilanes, as well as the chemoselectivity to avoid over reduction (alkyl silane formation) or isomerisation side reactions, in which classical methods were limited.

Procter and co-workers demonstrated through the use of bulky phosphine ligands could facilitate higher regiochemical control during the hydrosilylation of simple acetylenes (**Scheme 9**).[80] In general, the reaction provides overall *syn*-addition of H-SiR_3 to the least hindered position of the alkyne, providing high stereo- and regioselectivity towards the β-(*E*)-vinylsilanes such as **56**. However, deviation from simple substrates shows a significant decrease in regioselectivity such as demonstrated with use of electron deficient alkynes such as **58** resulted in a reversal of regiochemical control favouring the α-isomer (**60**). In addition to this, poor regioselectivity was reported with internal alkynes (**61**) resulting in near 1:1 ratio of regioisomers (**62** and **63**).



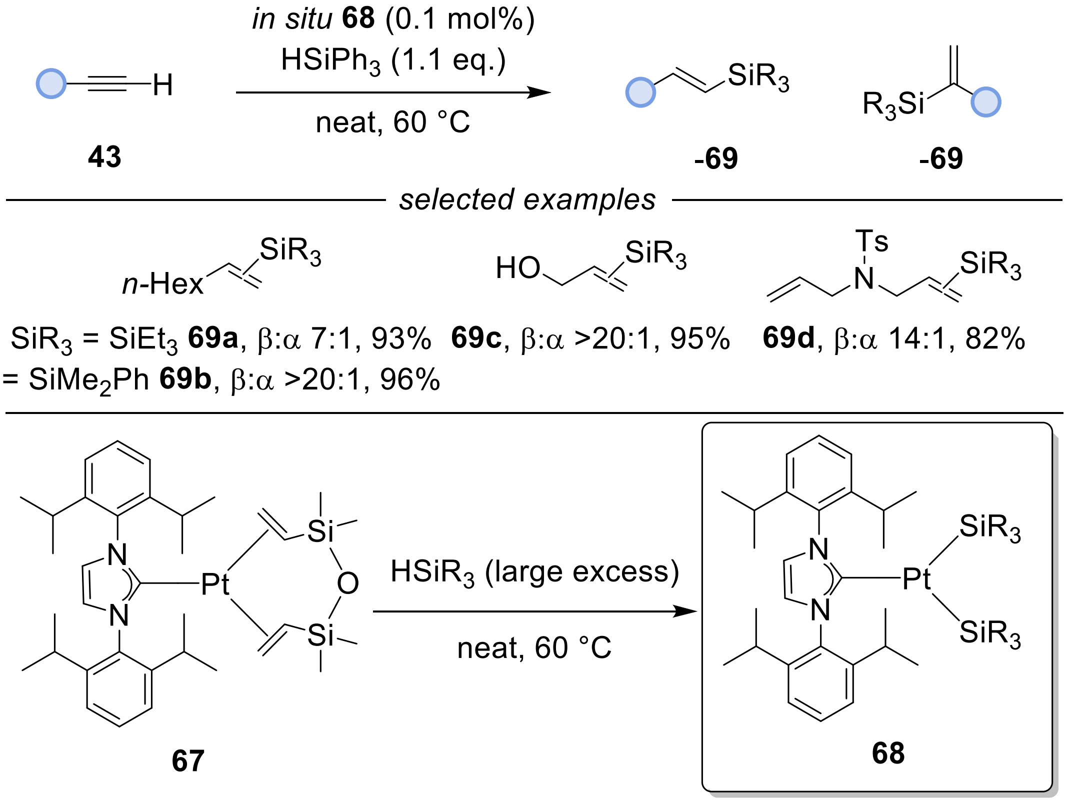
Scheme 9: Platinum catalysed hydrosilylations of simple acetylenes

Later, in agreement with Proctor's work, Denmark and co-workers reported the use of ^{t}Bu$_3$-P-Pt(DVDS) complex in an elegant one-pot sequential hydrosilylation/cross-coupling methodology.[81] The strategy demonstrated high regioselectivity towards β-(*E*)-vinylsilanes (**65**), outperforming Speier's catalyst which resulted in β:α ratio of 84:16 in the same reaction conditions (**Scheme 10**).



Scheme 10: Hydrosilylation/cross coupling methodology

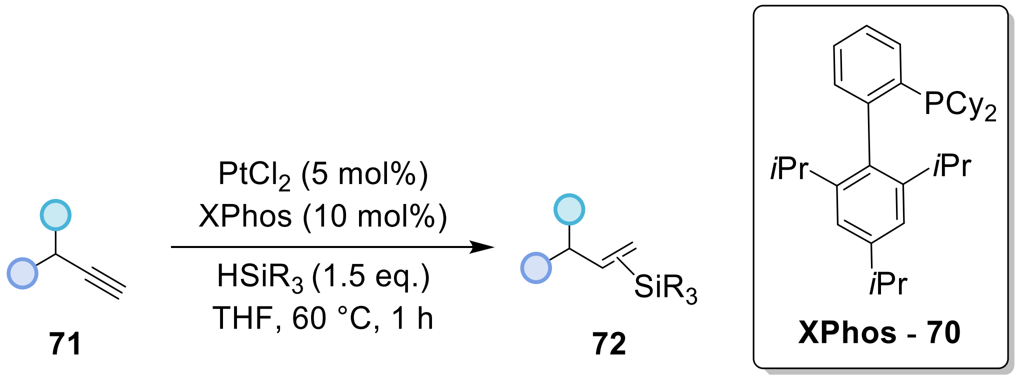
Markὸ *et al.* also reported a significant advancement based of Karstedt's catalyst through the use of *N*-heterocyclic carbene (NHC) platinum (0) complexes.[82] In 2015, the authors demonstrated the use of further developed NHC platinum complexes **68** which are formed *in situ* by reacting **67** with the corresponding silane in large excess. This resulted in β-(*E*)-vinylsilanes (**69a – d**) being obtained in excellent yields and higher regiochemical control operating under low catalyst loadings of 0.1 mol%.[76]



Although these reports represent a significant advancement on the catalyst system developed by Karstedt, they still do not give full regiochemical control and the use of highly air-sensitive ligands is not ideal.

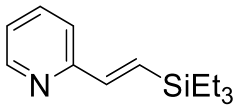
In 2008, Alami *et al.* reported the high activity and selectivity afforded by the use of Pt(II) salts – PtO_2/$PtCl_2$ and the bulky dialkylphosphine – XPhos (**70**) (**Table 7**).[83] Substrates proceeded via a *syn*-addition favouring the formation of the β-(*E*)-vinylsilane (**72**) in high regio and stereochemical control as seen in **72a**, which was formed in excellent yield. The author did however report the *ortho*-substituted ester **72b**, resulted in a decrease in regioselectivity (81:19 β:α). This was reported to be likely suffered from an *ortho* directing effect of the ester moiety favouring a rise in the formation of the α-isomer. The methodology was also tolerated well during variation of the silyl group, as shown with **72c** which was formed in good yield and excellent regioselectivity.

Table 7: Platinum/XPhos catalysed hydrosilylation of alkynes

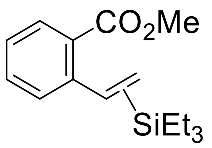


71 **72** **XPhos - 70**

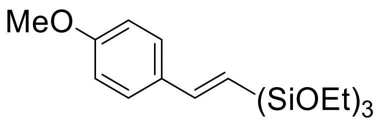
selected examples



72a, β:α >99:1, 98%[a]



72b, β:α 81:19, 83%[b]

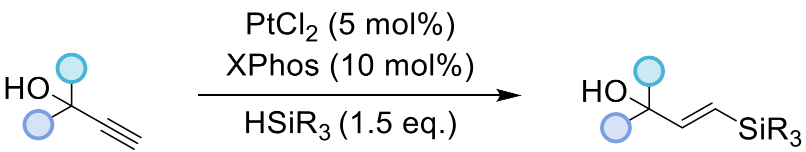


72c, β:α 98:2, 65%

[a] 10 mol% of $PtCl_2$ and 20 mol% of XPhos used, [b] Isolated yield of the regioisomeric mixture

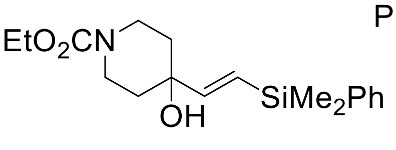
More recently, McLaughlin *et al.* further expanded on the use of platinum (II) chloride/XPhos catalytic system for the synthesis of β-silyl allylic alcohols (**74**) from propargylic alcohols (**73**) (**Table 8**).[84, 85] This method provided β-(*E*)-vinylsilanes in complete stereo- and regiochemical control. The methodology uses a low catalytic loading, while tolerating a wide range of functional groups, increasing on the diversity not seen with previous systems such as the heterocycles (**74a** – **c**).

Table 8: Pt/XPhos catalyst system for the synthesis of β-(*E*)-vinylsilanes

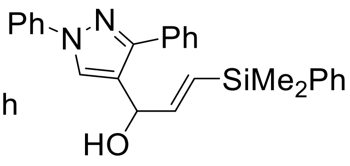


73 **74**

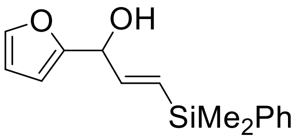
selected examples



74a, β:α >99:1, 84%

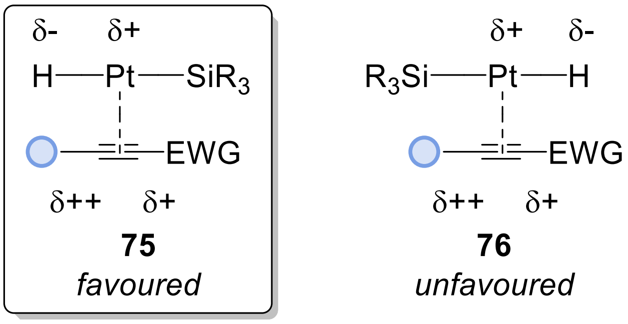


74b, β:α >99:1, 71%



74c, β:α >99:1, 81%

Platinum catalysis has been invaluable in the methodologies towards β-vinylsilanes affording high regiochemical control. Conversely, there has been limited success in forming the α-vinylsilane, with only limited reports.[86, 87] Among them, Ferrerira and co-workers reported the use of electron-withdrawing groups in order to favour the formation of α-vinylsilanes (**Figure 8**).[88] The alkyne-coordinated Pt^{II} complex **75** delivers the hydride to the more electron-deficient alkyne carbon atom, favouring the formation of the α-vinylsilane upon reductive elimination.



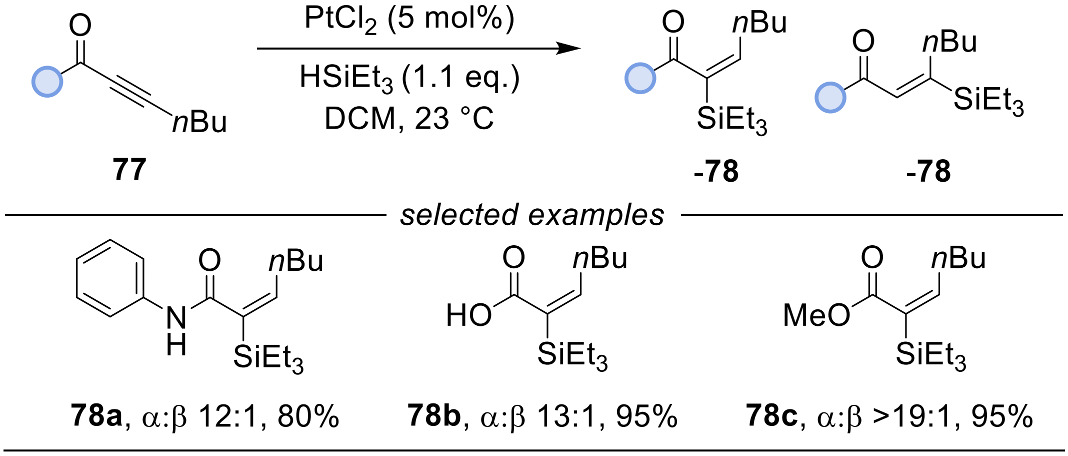
75
favoured

76
unfavoured

Figure 8: Electron-withdrawing effects on hydride insertion

The authors demonstrated the methodology to be tolerant towards amide **78a**, carboxylic acid **78b** and esters such as **78c**, providing the corresponding α-vinylsilane in excellent yields and high regiochemical control using un-ligated platinum catalyst (**Table 9**).

Table 9: Platinum catalysed hydrosilylation of electron-deficient alkynes



77

-78

-78

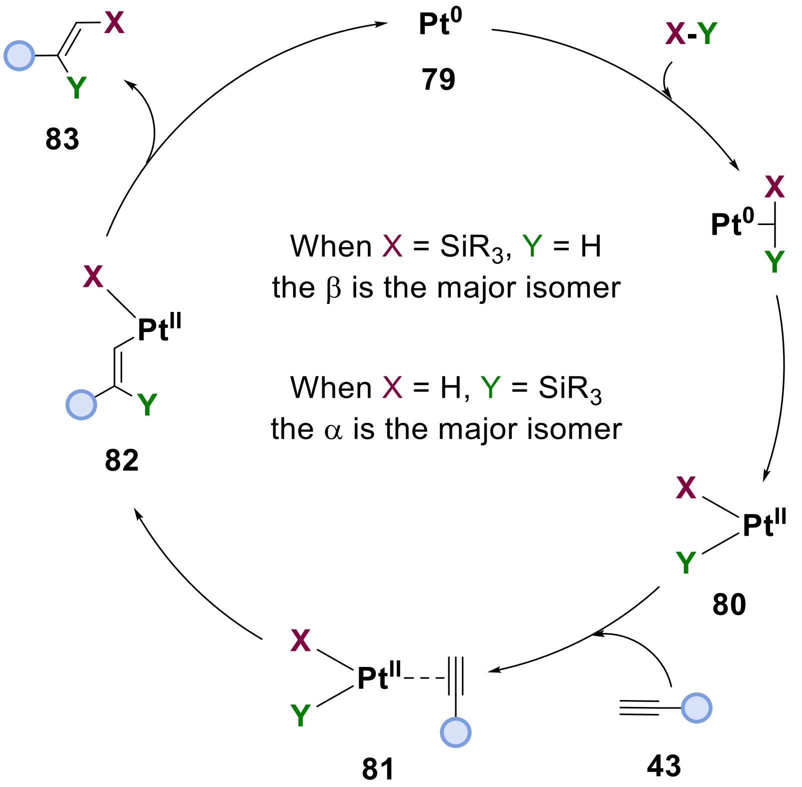
78a, α:β 12:1, 80%

78b, α:β 13:1, 95%

78c, α:β >19:1, 95%

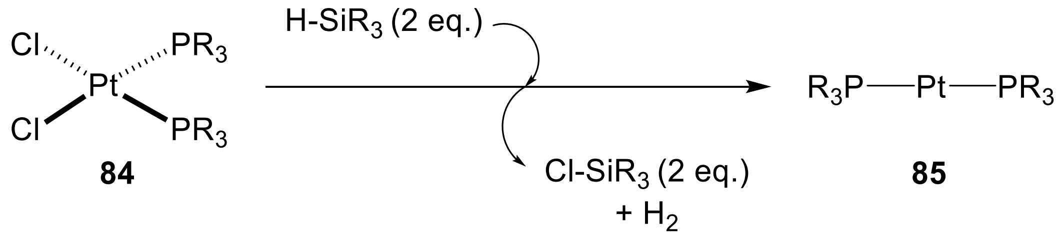
1.3.1.2.2 Mechanism of Platinum Catalysed Hydrosilylations

To understand the origin of selectivity in platinum-catalysed hydrosilylation reactions, numerous mechanistic studies have been conducted. The generally accepted mechanism for most platinum-catalysed *syn*-hydrosilylations, is either via the Chalk-Harrod or modified Chalk-Harrod mechanisms (**Scheme 11**).[89] The mechanism proceeds by oxidative addition of the Pt(0) species (**79**) into the Si-H bond affording a Pt(II) complex (**80**), which subsequently undergoes π-complexation in this case with an alkyne (**43**). Following migratory insertion of the alkyne into either the Pt-H or Pt-Si bond forms the complex (**82**). Insertion into the Pt-H bond follows the Chalk-Harrod mechanism while insertion into the Pt-Si bond follows the modified Chalk-Harrod mechanism. Reductive elimination furnishes either the α- or β-vinylsilane (**83**), while regenerating Pt(0) species (**79**). While this general mechanism accounts for the observed *syn*-hydrosilylations, it is important to note that specific catalyst systems may follow mechanistic variations, depending on ligand environment, substrate, and reaction conditions.



Scheme 11: Chalk-Harrod and modified Chalk-Harrod platinum catalysed hydrosilylation mechanism

While the proposed mechanism generally assumes the use of a Pt(0) species, work by Pregosin *et al*. demonstrated that Pt(II) complexes of the general formula $PtCl_2(PR_3)_3$ (**84**) can be readily reduced *in situ* by silyl hydrides. This reduction proceeds via formation of chlorosilane by-products ($ClSiR_3$) and liberation of hydrogen gas, yielding the active Pt(0) species, $Pt(PR_3)_2$ (**85**) (**Scheme 12**).[90] This accounts for the ability of Pt(II) complexes, such as those employed by Alami *et al.*, to function effectively as precatalysts in hydrosilylation reactions.[83]



Scheme 12: Reduction of platinum catalysts by silyl hydrides

A key step of the described mechanisms in **Scheme 11** is the interaction between the π-electrons of the alkyne and the metal centre resulting in the formation of a π-complex (**81**). The general bonding description of complexes of this type can be described by the Dewar-Duncanson-Chatt model (**Figure 9**).[91, 92] The substrate donates electron density from the filled π-orbital into a vacant d-orbital of the π-acid metal centre (**86**). Simultaneously, metal-ligand backdonation from a filled d-orbital into the π* antibonding orbital of the substrate takes place (**87**). The combination of these effects results in a reduced bond order of the π-bond, resulting in increased reactivity towards nucleophilic attack or, as in the case of hydrosilylation, migratory insertion.

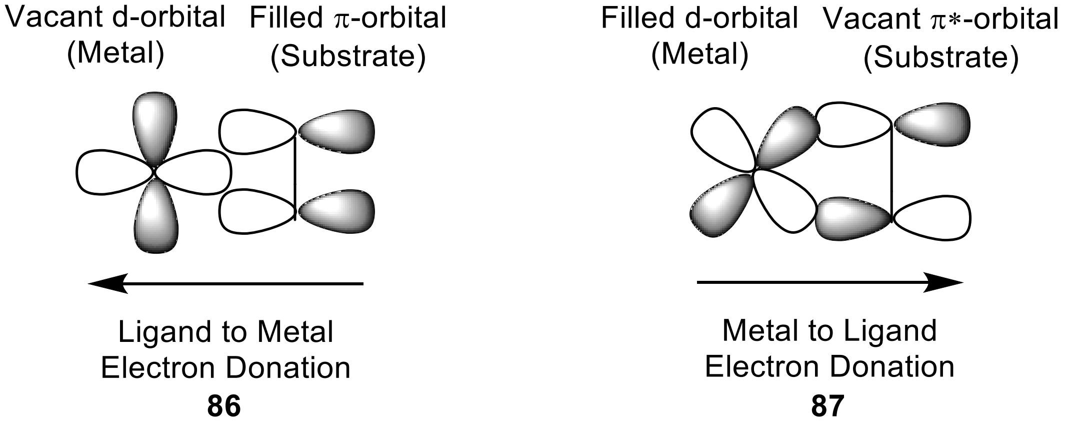


Figure 9: Dewar-Duncanson-Chatt bonding model

The resultant π-complex can be represented by two models, depending on the electronic nature of the metal centre. Late transition metals or metals in higher oxidation states possess reduced electron density and consequently exhibit weaker backdonation. In such cases, the C=C bond retains more of its original character, and the complex is more accurately depicted using the Dewar–Duncanson–Chatt model (**88**). The diminished backdonation in these complexes results in increased cationic character at the vinylic carbons, enhancing their electrophilicity relative to complexes with greater metal-to-ligand backdonation. In contrast, complexes involving early transition metals or metals in low oxidation states, which are typically more electron-rich, favour substantial π-backdonation into the alkene π* orbital. This reduces the C=C bond order significantly, and the complex is best described as a metallacyclopropane (**89**).[93]

Dewar-Duncanson-Chatt Model
88

Metallacyclopropane Model
89

Figure 10: Bonding models for transition metal π-complexes

The high levels of regioselectivity observed in hydrosilylations catalysed by $PtCl_2$/XPhos system can be rationalised through the classical Chalk–Harrod mechanism, as demonstrated by Cook and co-workers.[84, 85] The authors proposed that regioselectivity arises from steric interactions, resulting in the alkyne orientating itself to minimise repulsion between its substituents and the bulky XPhos ligand, thereby favouring insertion into the Pt–H bond (**90**) (**Figure 11**). In addition, deuterium-labelling studies further supported this by identifying the rate-determining step is alkyne hydroplatination. These findings are consistent with previous mechanistic insights into platinum-catalysed hydrosilylation reactions involving Karstedt's catalyst.[94]

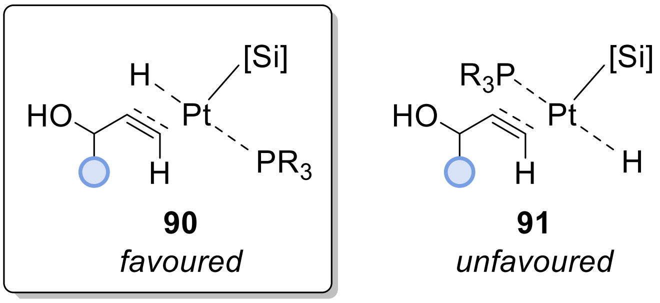


Figure 11: Regioselectivity model determined via steric bulk

1.3.1.2.3 Platinum Catalysed Hydrosilylation of Nitrogen-Containing Compounds

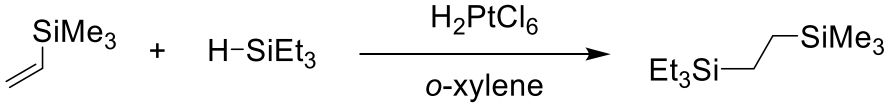
The development of medicinally relevant organosilicon compounds is of growing interest, and the incorporation of nitrogen-containing functionalities within these structures is considered particularly valuable due to their prevalence in bioactive molecules. However, platinum hydrosilylation chemistry has not been without difficulties in trying to incorporate nitrogen functionalities such as amines and amides. Speier and co-workers first disclosed the attempted hydrosilylation of allyl amines, resulting in the formation of an isomeric mixture of regioisomers.[95] The authors reported TMS-protected amine does minimise this, although no data on the regio or stereoselectivity afforded by the reaction was reported.

Storlie and co-workers demonstrated potential modes of deactivation of Pt(II)-olefin complexes with nucleophiles such as triphenylphosphine and pyridine.[96] The authors then went on to further demonstrate that with a large excess of pyridine, olefins can be irreversibly displaced from platinum centres to afford the corresponding platinumamino complex. This work was corroborated by Pregosin and co-workers who also documented that both aliphatic and aromatic amines can preferentially displace olefinic ligands in the complex formed by $PtCl_2$ and styrene (**92**) (**Scheme 13**).[90] The displacement can occur with much lower loadings of amine relative to platinum as well as additionally occurring with amines of much lower nucleophilicity such as aniline (**93**).

92 **93** **94** **95**

Scheme 13: Displacement of ligands by nitrogen compounds on platinum

Endo and co-workers investigated the effect of nitrogen donors present within the hydrosilylation reaction between TMS-vinylsilane (**96**) and triethylsilane (**97**) (**Scheme 14**).[97] The authors observed a strong correlation between polymers with an increasing number of amine moieties and increasing inhibition of the hydrosilylation reaction. Even at amine/platinum ratios as low as 1:1, there was over 40% reduction of catalyst efficiency, suggesting nitrogen poisoning of the platinum catalyst via chelation is taking place. It was also worth noting sterically hindered amines were unable to coordinate to the platinum catalyst as efficiently and therefore reduced inhibition of the reaction was observed.

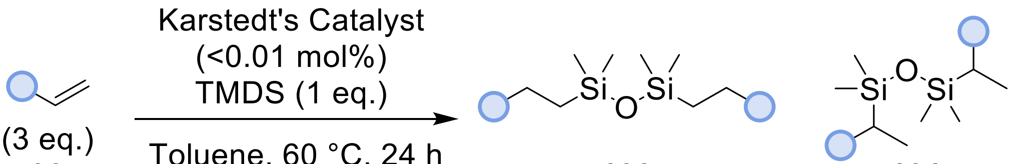


96 **97** **98**

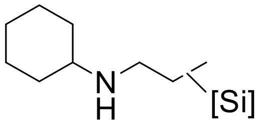
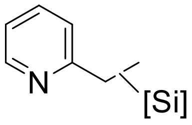
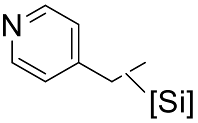
Scheme 14: Platinum catalysed hydrosilylation of TMS-vinylsilane and triethylsilane

Chechelska-Noworyta *et al.* demonstrated the limitations of platinum complexes in catalysing the hydrosilylation of olefins (**99**) with amine functionalities.[98] The authors noted poor regioselectivity in the case of allyl amine (**102**) and little to no conversion in the cases of pyridine substituted substrates (**103**) and (**104**) (**Table 10**). However, the authors did not report the regioisomeric ratios or yields of the products obtained. Interestingly, they observed higher reactivity with less nucleophilic amines, such as aniline derivatives. Furthermore, the study noted that catalytic activity could be enhanced by increasing the steric bulk around the nitrogen donor, presumably to minimise undesired interactions between the substrate and the catalyst.

Table 10: Hydrosilylation of nitrogen-containing olefin compounds

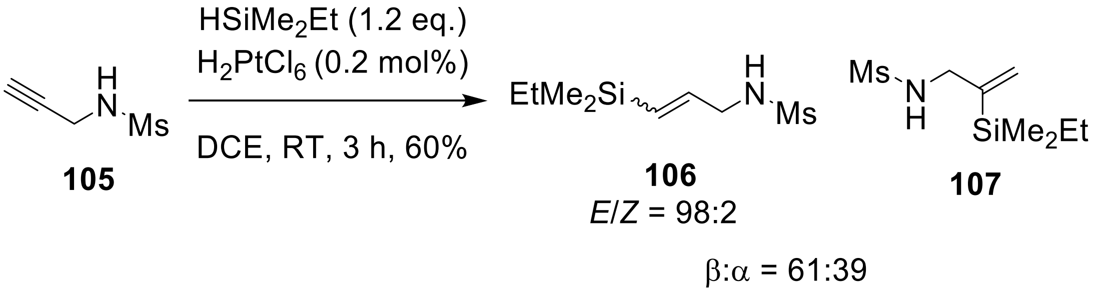


99 **100** **101**

 **102**	 **103**, trace	 **104**, n.r

It has been noted since the inception of Speier’s and Karstedt’s catalyst that due the increased coordinative ability of nitrogen, platinum catalysed hydrosilylations containing amine results in catalyst poisoning and limited catalytic turnover, and therefore these transformations are scarcely reported in literature. These investigations show hydrosilylations of nitrogen containing compounds is not trivial in nature and represents an unmet need within synthetic community.

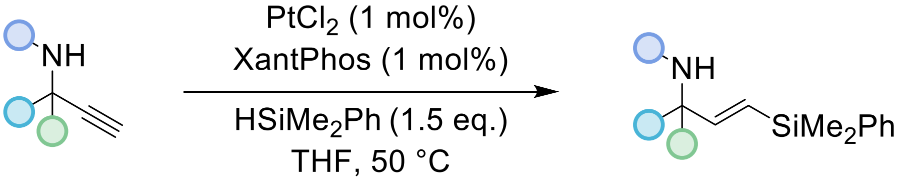
That said, several recent strategies have seen some improvement when employing platinum catalysts to mediate the hydrosilylation of vinylsilanes bearing nitrogen-containing functional groups. Ebata and Takeuchi reported the platinum catalysed hydrosilylation of *N*-sulfonylpropargyl amines.[99] The authors report that when treated with hexachloroplatinic acid, sulfonamide **105** undergoes hydrosilylation to afford **106** and **107** as a mixture of regioisomers, in 60% yield. Although poor regioselectivity was observed, the use of a sulfonyl group was noted to significantly enhance the reactivity of the reaction (**Scheme 15**).



Scheme 15: Platinum catalysed hydrosilylation of *N*-sulfonylpropargyl amine

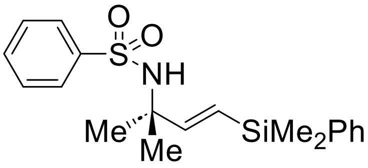
More recently, Roberts *et al.* reported an efficient methodology towards the hydrosilylation of propargylic amines (**108**) in high yields and with full regiochemical control (**Table 11**).[100] The methodology was applied to sulfonamides (**109a**), amides (**109b**) and carbamates (**109c**) in good to excellent yields. The regio- and stereoselectivity is governed by the bulkiness of the bidentate ligand XantPhos (**110**), favouring the formation of the thermodynamic β-(*E*)-vinylsilane products.

Table 11: Platinum catalysed hydrosilylation of allylic amines

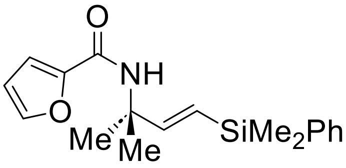


108 **109**

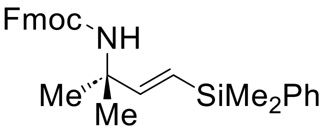
selected examples



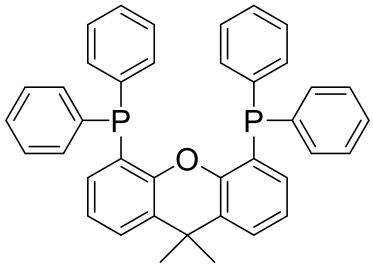
109a, β:α >99:1, 92%



109b, β:α >99:1, 84%



109c, β:α >99:1, 79%



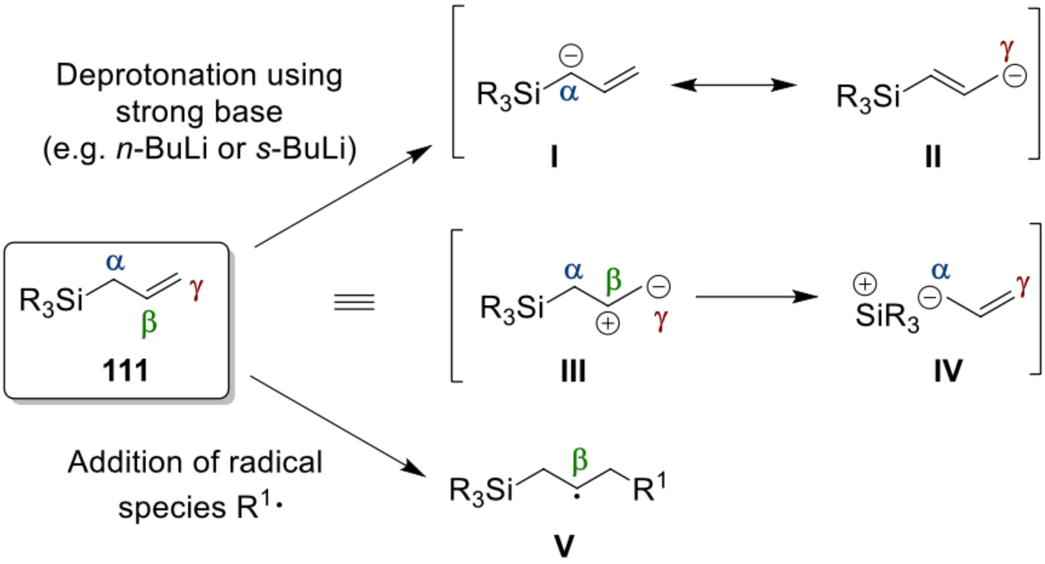
110
XantPhos

It is noticeable that while there are relatively few examples of hydrosilylation of propargyl amines, the hydrosilylation of amides has received more attention,[88] particularly those mediated by various transition metals such as nickel,[101] and palladium.[86, 87, 102] The increased prevalence of work on these substrates can likely be attributed to the deactivated nature of the amide moiety in comparison to amines. Although, there have been significant advancements made within platinum catalysed hydrosilylation chemistry, there is still a need for the incorporation of nitrogen-containing functionalities within vinylsilanes to be accessed under high regio- and stereochemical control.

1.3.2 Allylsilanes

1.3.2.1 The Applications and Reactivity of Allylsilanes

Another important class of organosilicon compound are allylsilanes which react as olefins and metal-allyl species, making them of special interest in organic synthesis.[24, 66] This reactivity may be explained by the aforementioned silyl group's ability to stabilise charges by the α-effect and β-effect.[29, 103] Allylsilanes (**111**) may be summarised as the synthetic equivalents (**I** – **V**), which can be adopted depending on the nature of the process in which they are involved (**Scheme 16**). The adaptability of allylsilanes as synthetic equivalents (**I** – **V**) illustrates the diversity of functionalisation which can be envisioned, starting from a simple allylsilane (**111**).



Scheme 16: Allylsilanes as synthetic equivalents

Allylsilanes typically react as π-nucleophiles through the γ-position with a variety of electrophiles in a stepwise process via a β-silyl carbocation.[24, 60, 66] Silicon stabilises the β-carbocation by hyperconjugation interactions with the low energy C-Si σ orbital which is subsequently quenched via loss of the silane resulting in a formal allylation of the electrophile. Allylsilanes typically adopt the preferred conformation (**112**), where the small substituent (H) eclipses the double bond. The electrophile can approach the double bond in two ways; either from the same side as the silyl group (*syn*-S_E') (**113**) or from the side opposite the silyl group (*anti*-S_E') (**114**). The configuration of the newly formed stereogenic centre is therefore dependent upon the directionality of the attack. The attack of an electrophile to an allylsilane, however, generally occurs through an *anti*-S_E2' pathway, although in cases of extreme steric bias, *syn*-S_E2' reactions are known (**Figure 12**).[29]

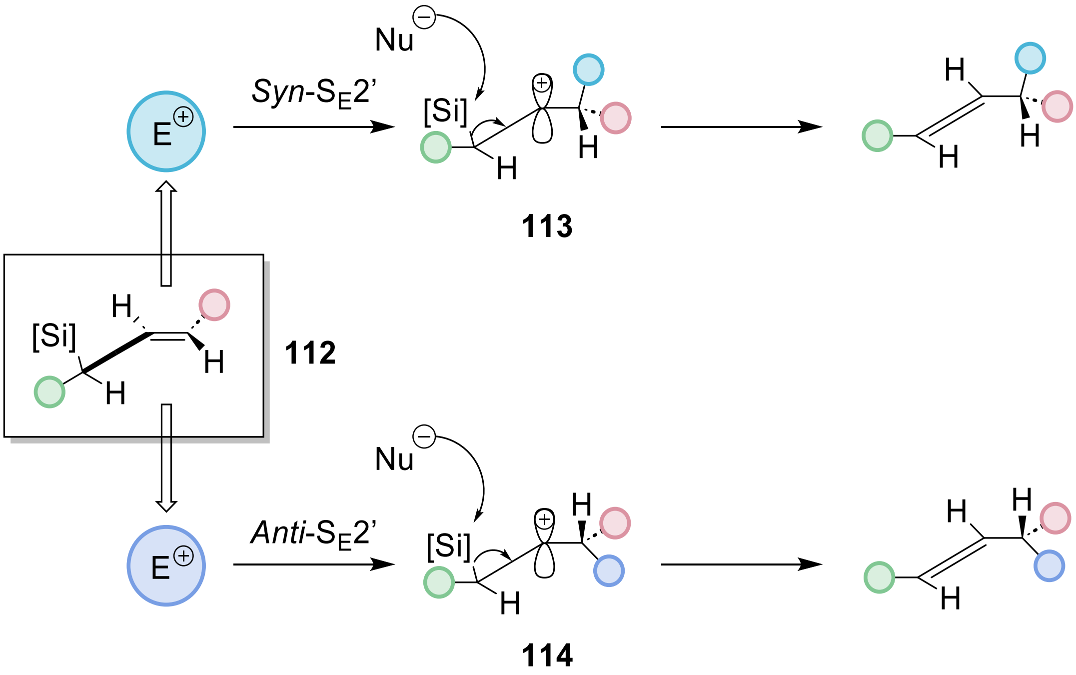
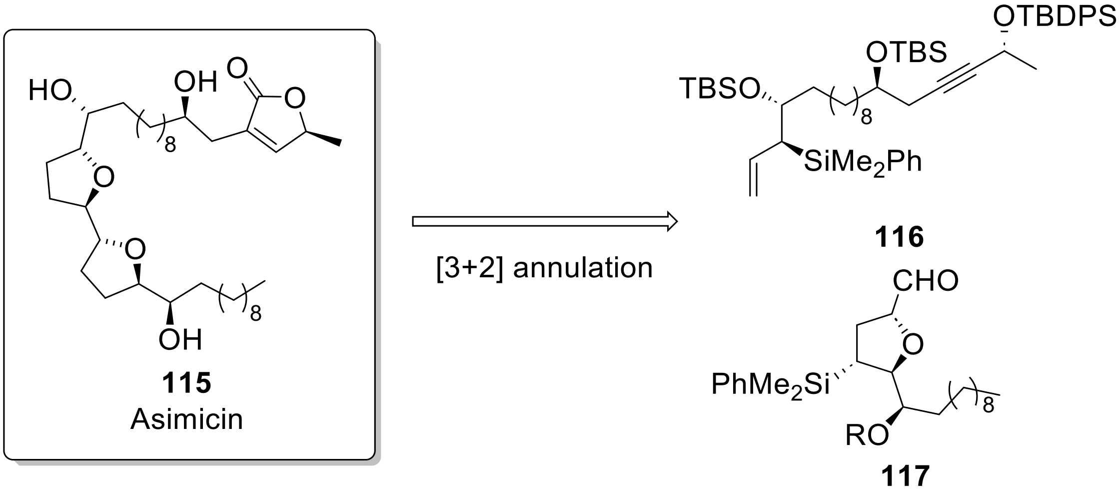


Figure 12: Different stereochemical routes for the electrophilic substitution of allylsilanes

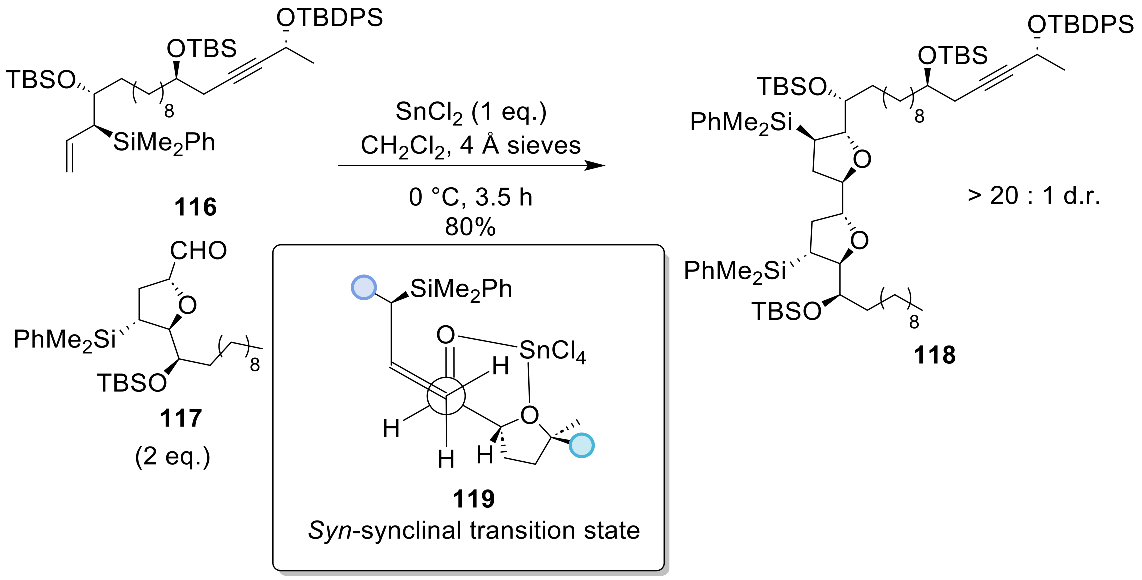
Many electrophiles in these reactions are carbon centres, with the most well-studied being the Hosomi-Sakurai allylation of carbonyl compounds.[104, 105] While the initial report employed a carbonyl electrophile utilising titanium tetrachloride, in more recent studies a variety of other Lewis and Brønsted acids have been shown to mediate the reaction.[106, 107] This has led to a plethora of catalysts being developed and employed such as organosilicon compounds, boron derivatives, transition metal salts and complexes, alkali earth metals and main group superacids.[108] These have subsequently been applied to a variety of electrophiles including α,β-unsaturated compounds, imines/iminium ions, epoxides, acyl halides, and oxocarbenium ions.[109, 102] In particular, the use of allylsilanes in enantioselective allylations for the formation of chiral homoallylic alcohols and amines have been especially important within the synthesis of complex natural products.[109-111]

Although loss of silane is the most common reaction pathway for these nucleophiles, loss of other groups, or nucleophilic trapping of the cation are also viable pathways. Roush and co-workers demonstrated elegantly the trapping of this carbocation intermediate in a highly stereoselective [3+2] annulation reaction.[112] Allylsilane **116** and aldehyde **117** were applied as an indispensable method for creating the core substituted tetrahydrofuran that is found in Asimicin (**115**), a bioactive molecule recognised for its antitumor and pesticidal properties (**Scheme 17**).[113]



Scheme 17: Retrosynthesis analysis of asimicin

The treatment of **116** with aldehyde **117** mediated by $SnCl_4$ afforded the bis-tetrahydrofuran **118** as a single diastereoisomer in 80% yield (**Scheme 18**). The high diastereoselectivity of this reaction is attributed to the matched facial selectivity of the chiral allylsilane (*anti*-S_E2') and the $SnCl_4$-chelated chiral aldehyde in the favoured *syn*-synclinal transition state (**119**).



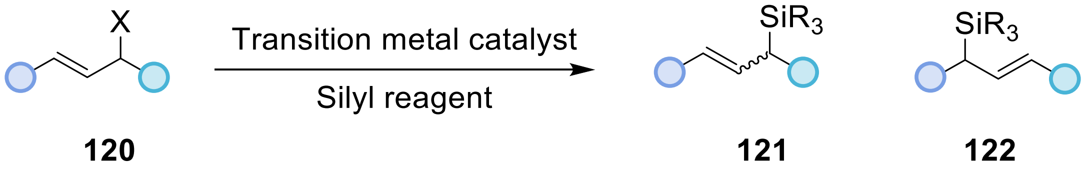
Scheme 18: [3+2] annulation of allylsilanes mediated by $SnCl_4$ for the synthesis of the bis-tetrahydrofuran core of asimicin

1.3.2.2 Synthesis of Allylsilanes

The extensive applications in which allylsilanes participate including, electrophilic substitution reactions and the construction of natural products has led to the demand for the development of novel and sustainable methods for their synthesis.[66, 109] Traditionally, synthesis of allylsilanes has typically relied on the silylation of allylic organometallics, hydrosilylations and Wittig reactions.[114-116] Despite the fact that allylsilanes can be prepared in several ways and their synthesis has been investigated in depth, there is still a sustained effort to develop a regio- and stereoselective protocol to these reagents.

1.3.2.2.1 Transition Metal Catalysed Silylations of Allylic Electrophiles

In recent years, transition metal catalysed silylation of allylic electrophiles (**120**) with a variety of silicon sources have proven to be promising protocols for the construction of allylsilanes (**121**/**122**) (**Scheme 19**). However, establishing high regiochemical control has not been trivial due to the nature of the allyl group leading to the formation of linear (**121**) and branched regioisomers (**122**). In addition, to this, many of the methodologies allylic precursors have been confined to functionalised allylic compounds such as allyl -halides, -esters, -carbonates and -phosphonates.[117-121]

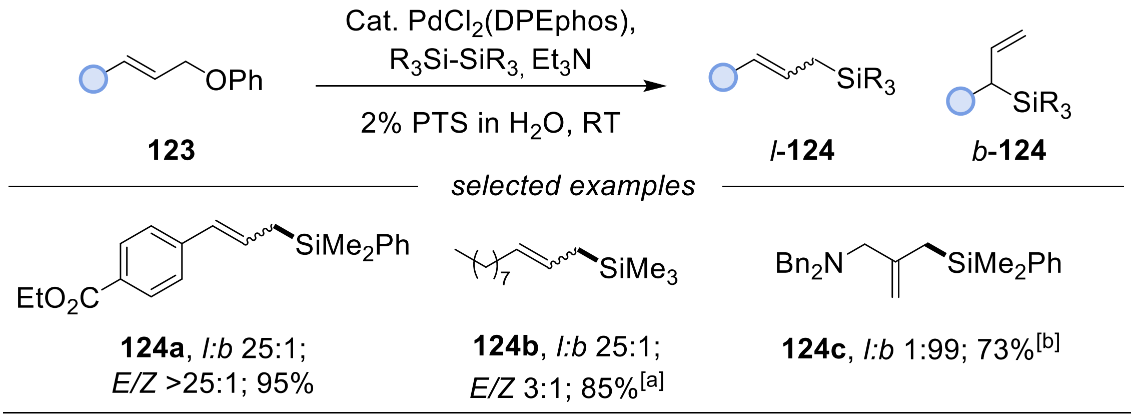


X = Esters, ethers, halides, phosphates, alcohols

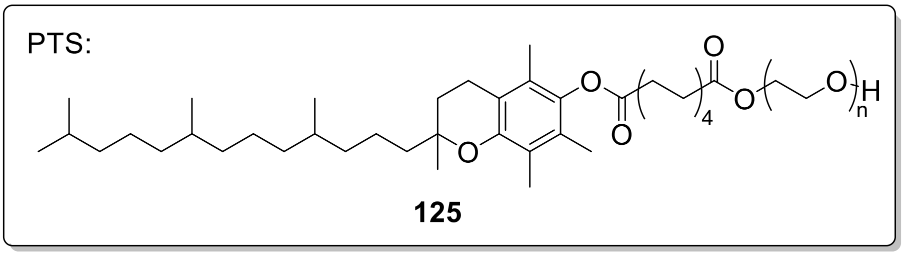
Scheme 19: General scheme for transition metal catalysed silylation of allylic electrophiles

Moser and co-workers described a method using a palladium catalyst to silylate allylic ethers (**123**) with organodisilanes (**Table 12**).[122] Their method uses micellar catalysis in water at room temperature. Although it is thought to be considerably milder than previous anhydrous transition metal pathways, the required use of a non-commercial surfactant – polyoxyethanyl-α-tocopheryl sebacate (PTS) (**125**) is vital for the reaction to be successful. The method does however provide good regioselectivity in examples **124a** and **124b** (linear vs branched, >25:1, l:b) and forming a single regioisomer in the case of **124c**. The stereoselectivity was also relatively high generally, with substrates forming the (*E*)-olefin preferentially. It is noted the dimethylphenylsilyl derivatives had increased stereoselectivity compared to the TMS equivalents.

Table 12: Palladium catalysed silylation of allylic phenyl ethers

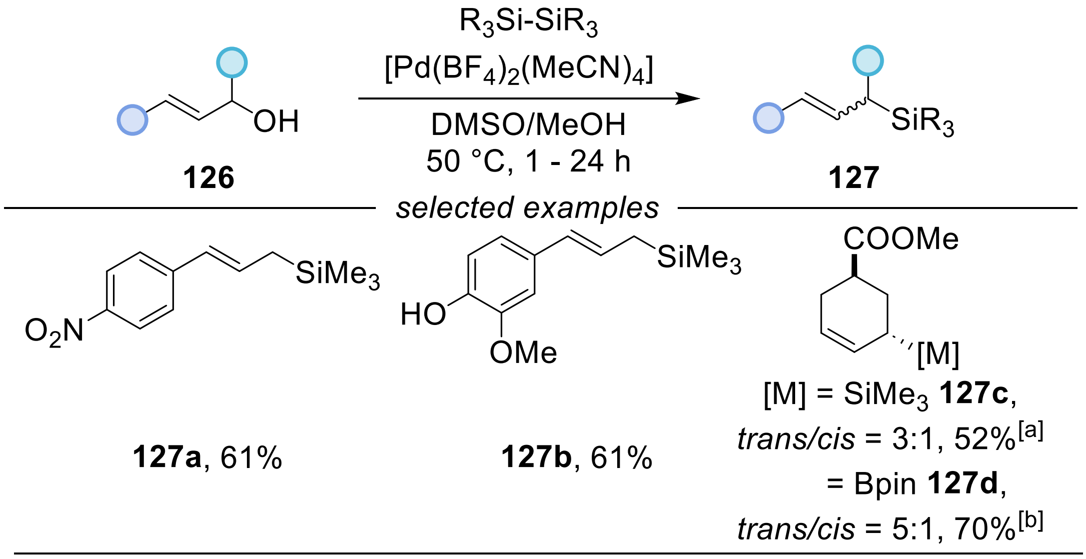


[a] $PdCl_2(PPh_3)_2$ (1.5 mol%), $PdCl_2$(DPEphos) (1.5 mol%), [b] 10 mol% catalyst



It has been documented for synthetic efficiency it is much more desirable to generate allylsilanes directly from allylic alcohols. Although this has not been without difficulty due to the poor leaving group ability of the hydroxy group. Selander and co-workers reported a palladium-catalysed silylation of allylic alcohols (**126**) utilising disilanes precursors (**Table 13**).[123] This method resulted in substantial improvement in tolerance to a wider variety of functional groups, with noticeable improvement in the *E*/*Z* and regioselectivity, giving single isomers in the majority of cases (**127a** and **127b**). They also expanded the substrate scope to include a range of allylboranes derivatives such as the cyclic species **127d**, which was formed in high regioselectivity and moderate enantioselectivity.

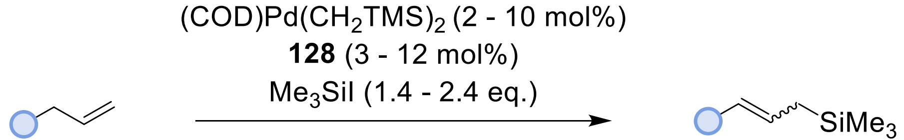
Table 13: Palladium catalysed silylation of allylic alcohols using disilanes



[a] 60 °C, [b] 20 °C

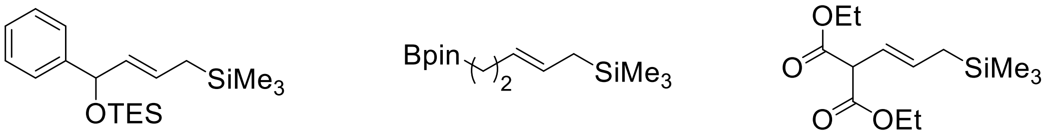
McAtee and co-workers employed a second-generation ligand, bis(3,5-di-*tert*-butylphenyl)(*tert*-butyl)phosphine (**128**) in a palladium-catalysed silyl-Heck reaction (**Table 14**).[124] In general, this procedure produced high yields with high stereoselectivity, preferentially forming solely (*E*)-allylsilane in many cases. The group also demonstrated the high-yielding synthesis of **130b** which has two useful organometallic handles on either end. However, the regioselectivity did suffer, with many substrates containing 10% of the regioisomer as seen with vinylsilane **130a** and in the case of **130c** the homoallylsilane regioisomer in 8-11%. In addition, the use of a toxic and highly active silicon donor, silyl iodide and non-commercially available ligand (**128**) requires the use of strict anhydrous and inert conditions.

Table 14: Palladium catalysed silyl-Heck reaction for the synthesis of allylsilanes



129 **130**

selected examples

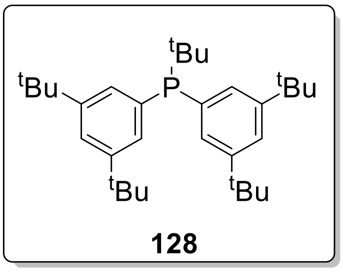


130a, *E*/*Z* >99:1, 55:45[a], 92%

130b, *E*/*Z* 78:22, ~90:10[a], 89%[b]

130c, *E*/*Z* >99:1, ~90:10[a], 74%[b],[c]

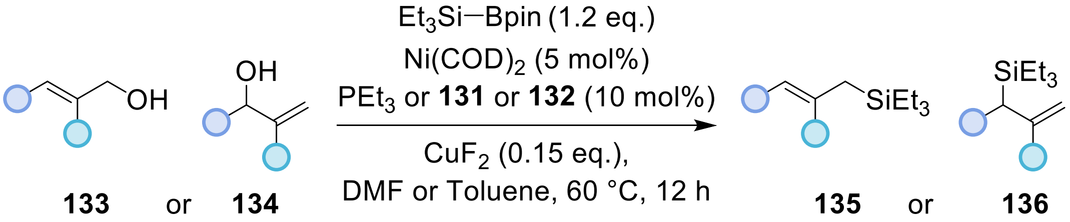
[a] *E*-allyl:*E*-vinyl regioisomer ratio, [b] 10 mol% catalyst, 10 mol% **128**, [c] Contains 8-11% homoallylsilane



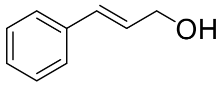
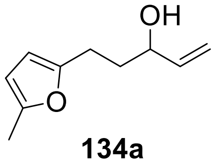
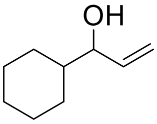
128

Although advancements had been made, protocols primarily favoured the formation of linear (*E*)-allylsilanes, with regioselective synthesis of branched allylsilanes still remaining a challenge, since the silylation tends to occur at the less-hindered terminus of the allyl group. In 2019, Gan *et al.* reported a nickel-copper catalysed regiodivergent methodology employing allylic alcohols (**133**/**134**) (**Table 15**).[125] By manipulation of the steric and electronic environment of the ligands on the nickel catalyst, the regioselectivity of silylation may be controlled, enabling the C-Si bonds to be formed to either end of the allyl terminus. It was noted less-hindered ligands such as PEt$_3$ favoured the formation of branched products (**136**), while bulkier ligands like dcype (**131**) or **132** favoured the formation of linear products (**135**), both pathways afforded high yields and regiochemical control. It was also found the use of silyl boranes and CuF$_2$ to activate the allylic alcohol was crucial for the success of the reaction, proceeding via the corresponding boronate ester derivative.

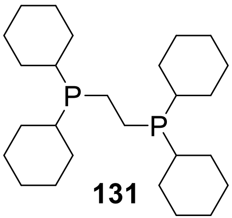
Table 15: Nickel-Copper catalysed regiodivergent synthesis of allylsilanes from allylic alcohols



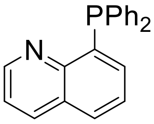
selected examples

Substrate	Ligand	Yield (%)	**135**(l):**136**(b)	*E*/*Z*
 **133a**	PEt_3	79	24:76	-
	dcype	86	>99:1	-
 **134a**	PEt_3	92	3:97	-
	8-(Ph_2P)-quinoline	85	30:1	14:1
 **134b**	PEt_3	82	3:97	-
	dcype[a]	80	30:1	10:1

[a] 5 mol% dcype used



131
dcype

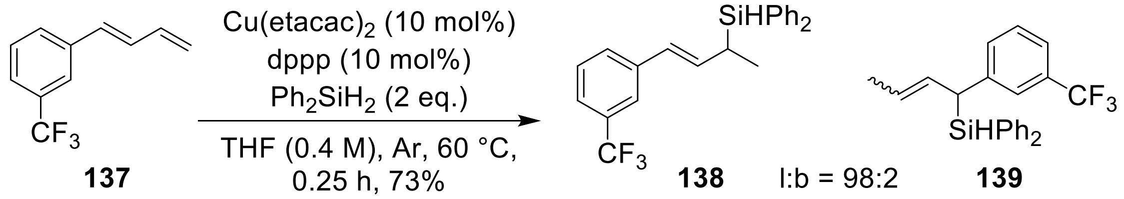


132
8-(Ph_2P)-quinoline

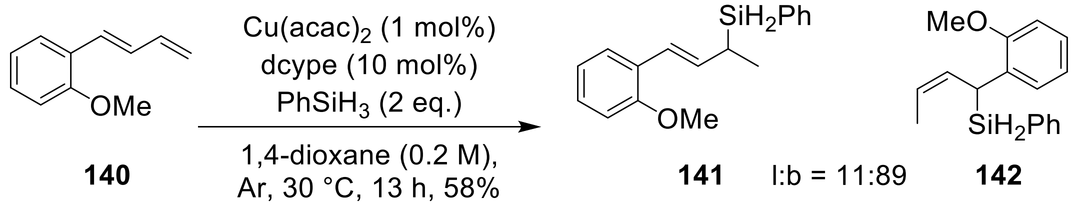
1.3.2.2.2 Hydrosilylation of Dienes and Allenes

Another strategy towards allylsilanes is via the hydrosilylation of dienes.[126] Xu and co-workers have worked extensively within this area and have developed several hydrosilylations of 1,3-dienes utilising copper catalysis (**Scheme 20**).[127] They first demonstrated the use of Cu(etacac)$_2$ with dppp as a ligand facilitating 1,2-hydrosilylation of 1-substituted 1,3-dienes (**137**), favouring linear allylsilanes (**138**) in excellent regioselectivity (**Scheme 20** – **a**). Equally, they demonstrated Cu(acac)$_2$ with dcype promoting 1,4-hydrosilylation, with high regioselectivity towards the branched regioisomer (**142**) (**Scheme 20** – **b**). The method was also expanded to incorporate the 1,4-hydrosilylation of 2-aryl-substituted 1,3-dienes (**143**), with preference towards linear allylsilanes (**144**) in good regiochemical control (**Scheme 20** – **c**). Later, the authors also reported a highly Markovnikov selective 3,4-hydrosilylation of 2-substituted 1,3-dienes (**146**) utilising a copper/ XantPhos catalyst system (**Scheme 20** – **d**).[128] In all cases the methods produced allylsilanes in high regiochemical control.

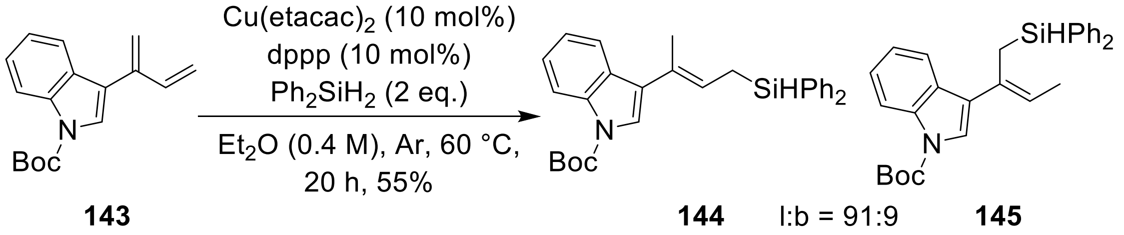
a) *1,2-hydrosilylation of 1-substituted-1,3-dienes*



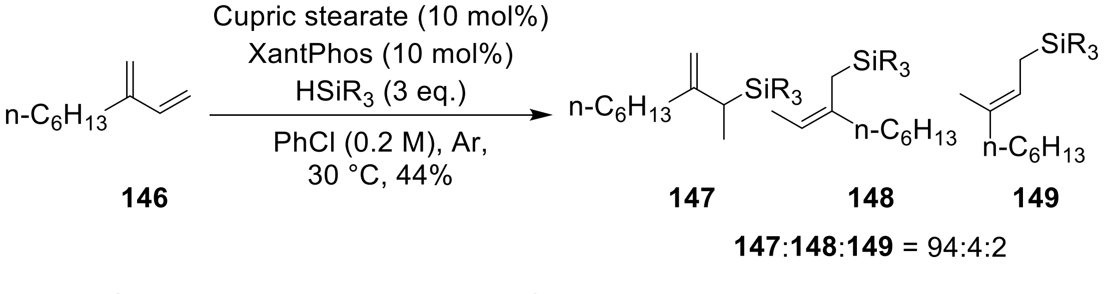
b) *1,4-hydrosilylation of 1-substituted-1,3-dienes*



c) *1,4-hydrosilylation of 2-substituted-1,3-dienes*

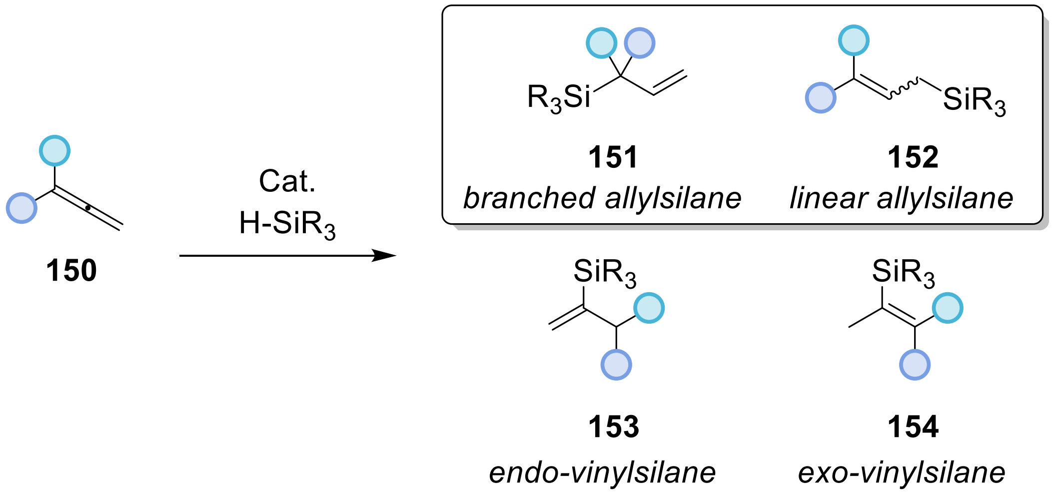


d) *3,4-hydrosilylation of 2-substituted-1,3-dienes*



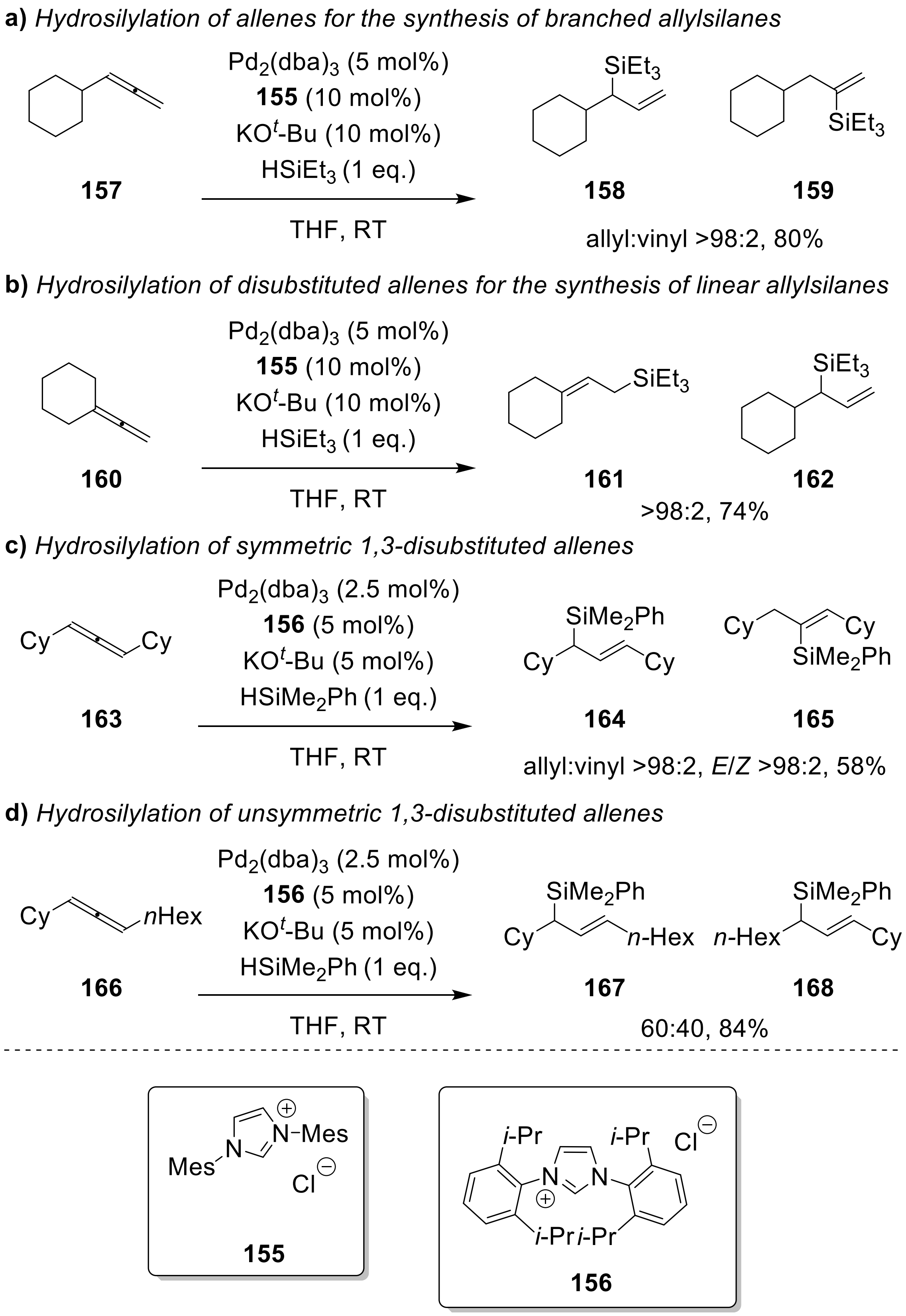
Scheme 20: Hydrosilylation of 1,3-dienes using copper catalysis

Hydrosilylation protocols have also employed allenes (**150**) as starting materials, as with previous methods presents considerable challenges in selectivity. This is due to 1,2 or 2,1-addition to either of the two contiguous π-systems, potentially leading to allyl (**151** and **152**) and vinylsilane isomers (**153** and **154**) (**Scheme 21**).



Scheme 21: Possible isomers in allene hydrosilylation

However, some examples have resulted in highly stereo- and regioselective routes to access allylsilanes. Montogomery and co-workers demonstrated a palladium catalysed hydrosilylation utilising a smaller NHC ligand (**155**) forming the branched allylsilane regioisomer (**158**) in excellent regiochemical control (**Scheme 22** – **a**).[129] They then applied this route to a single example of the 1,1-disubstsituted allene (**160**), however due to the increased steric bulk formed the linear regioisomer (**161**), though in high regioselectivity (**Scheme 22** – **b**). With this result they further expanded their work to incorporate 1,3-disubstituted allenes for the synthesis of linear allylsilanes, utilising a larger bulkier NHC ligand (**156**) (**Scheme 22** – **c**).[130] The symmetrical allene (**163**) formed the corresponding allylsilanes (**164**) in excellent stereo- and regioselectivity. However, when subjecting unsymmetrical allenes (**166**) to the same procedure resulted in poor regioselectivity in slight favour of silyl addition towards the more hindered carbon atom (**167**) (**Scheme 22** – **d**).


a) *Hydrosilylation of allenes for the synthesis of branched allylsilanes*

b) *Hydrosilylation of disubstituted allenes for the synthesis of linear allylsilanes*

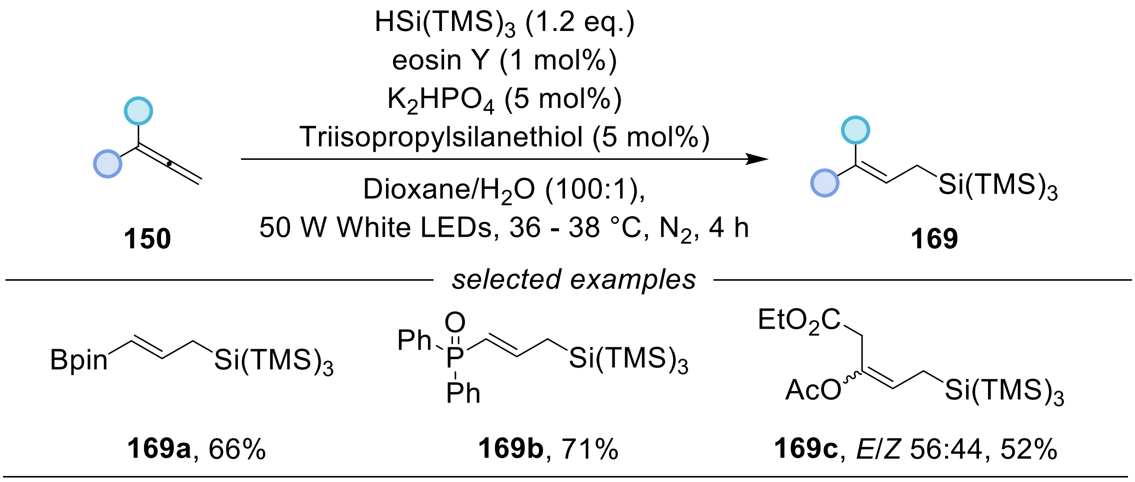
c) *Hydrosilylation of symmetric 1,3-disubstituted allenes*

d) *Hydrosilylation of unsymmetric 1,3-disubstituted allenes*

Scheme 22: Palladium catalysed hydrosilylation of allenes

More recent work from Yao and co-workers developed a visible-light driven radical hydrosilylation of allenes (**150**) (**Table 16**).[131] The method was subjected to monosubstituted allenes giving a single isomer in almost all cases. The method was tolerant to esters, amides and gave access to bi-organometallic products **169a** and **169b** in good yields. The reaction however is limited to the use of the very reactive super-silyl reagent (($(TMS)_3SiH$) and monoalkyl substituted allenes. In addition to this, there was a loss in stereocontrol when the methodology was applied to disubstituted allenes, giving rise the *E/Z* mixtures as seen with **169c**.

Table 16: Radical based hydrosilylation of allenes



150

169

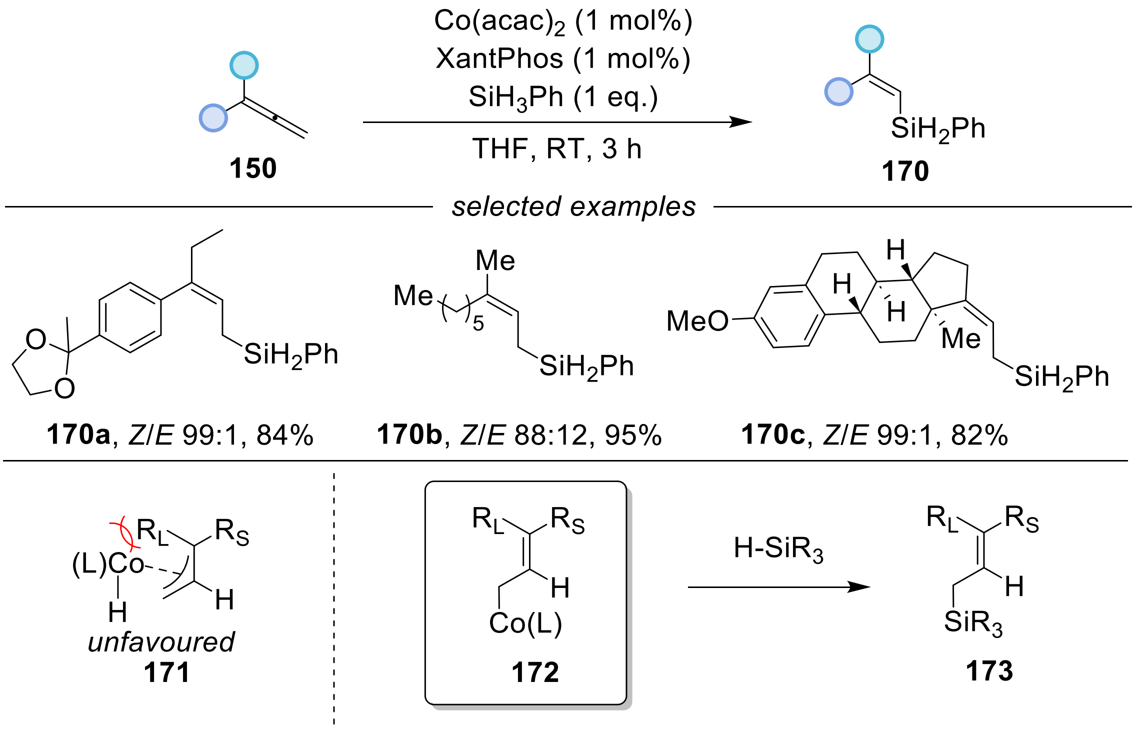
169a, 66%

169b, 71%

169c, *E/Z* 56:44, 52%

It was noted tri-substituted allylsilanes are of increasing difficulty due to the steric hinderance in which renders most systems to form products in poor selectivity or yield. However more recently, Wang *et al.* provided an elegant strategy for the synthesis of the less common tri-substituted (*Z*)-allylsilanes (**170**) (**Table 17**).[132] The method employed a cobalt catalyst with XantPhos as the ligand in low loadings at room temperature, offering a milder alternative. The method displayed a diverse substrate scope with high regio and stereochemical control, providing solely the (*Z*)-allylsilane in most cases (**170a** – **c**). The authors through mechanistic studies determined the steric repulsion between R_L of the allyl group and the cobalt catalyst makes the formation of the η^3-bound allyl cobalt intermediate (**171**) unfavourable. Therefore, the mechanism proceeds via the η^1-bound allyl cobalt intermediate (**172**) and subsequent σ-bond metathesis with the hydrosilane takes place. It is the minimising of the steric interaction in intermediate **172**, which accounts of the observed (*Z*)-stereoselectivity (**173**).

Table 17: Cobalt catalysed hydrosilylation of disubstituted allenes



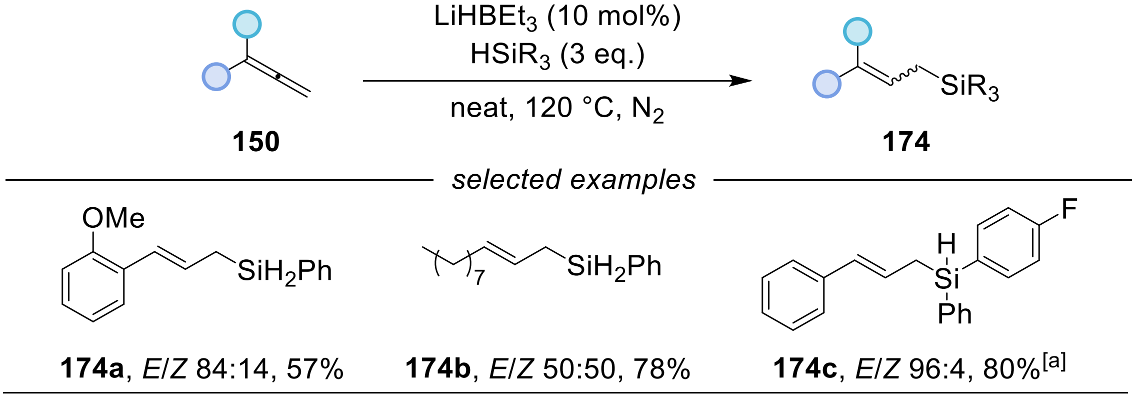
170a, *Z*/*E* 99:1, 84%

170b, *Z*/*E* 88:12, 95%

170c, *Z*/*E* 99:1, 82%

More recently, through a drive for more sustainable methodology, Liu *et al*, reported a hydrosilylation of allenes (**150**) for the formation of allylsilanes (**174**). Here they report the use of commercially available, lithium triethyl borohydride (LiHBEt$_3$) as a catalyst, eliminating the need for transition metals (**Table 18**).[133] This method is effective for monosubstituted allenes with primary or secondary silanes, yielding linear (*E*)-allylsilanes with good selectivity in the cases of **174a** and **174c**. However, there was seen a drop in stereoselectivity with aliphatic substrates such as **174b**.

Table 18: Lewis acid catalysed hydrosilylation of allenes



174a, *E*/*Z* 84:14, 57%

174b, *E*/*Z* 50:50, 78%

174c, *E*/*Z* 96:4, 80%[a]

[a] 2 eq. of silane used

While there are many transition metal-based methodologies for synthesising allylsilanes in commendable yields and control, they are often hindered by significant limitations. These include the formation of regioisomeric mixtures, ligand divergence, and a reliance on complex, non-commercial catalysts, or highly reactive silicon donors. Additionally, many protocols demand strictly anhydrous and inert conditions, as well as specialised equipment, limiting their operational practicality. Harsh reaction conditions can further restrict the incorporation of structurally complex or sensitive functional groups and often result in the generation of undesirable by-products.

Although some existing methods achieve high levels of regiochemical and stereochemical control, they frequently fall short – especially for substrates lacking pronounced steric or electronic bias. Consequently, despite advances in the field, truly sustainable and broadly applicable catalytic strategies remain underdeveloped. Addressing these limitations from an environmental and economic point of view, the development of metal-free catalytic approaches under mild conditions for the synthesis of highly functionalised allylsilanes is highly desirable.

1.4 Conclusions

The incorporation of silicon into biologically active scaffolds fundamentally depends on the formation of robust Si-C bonds. Despite over six decades of research and growing interest from numerous research groups, it remains striking that, although several organosilicon compounds have advanced to clinical evaluation, no silicon-containing drug has yet been approved for the treatment of human diseases. This persistent gap highlights the synthetic challenges associated with constructing silicon-containing frameworks and underscores a significantly underexplored opportunity in medicinal chemistry.

Of particular interest are olefinic silanes which serve as versatile building blocks due to their rich and tuneable reactivity. However, methodologies for accessing vinyl and allylsilanes with high structural complexity and substitution remain limited, particularly those that offer selectivity, scalability, and functional group tolerance. The development of new, broadly applicable synthetic routes to these scaffolds is therefore a critical need in the field. To this end, our work aims to refine and establish more selective, accessible strategies for the synthesis of allyl and vinylsilanes in order to expand their potential applications across medicinal and industrial domains.

2 Chapter 2 – Synthesis of Allylsilanes via Superacid Catalysed Reduction

2.1 Brønsted Superacid Chemistry

Transition metals have dominated as catalysts for many years in C-C bond-forming reactions.[134, 135] More recently, metal-free catalytic systems have been developed to achieve efficient and environmentally friendly alternatives.[136] Brønsted acids have shown potential as catalysts in this area but have not proceeded without difficulties.[137, 138] Such limitations are generally centred around Brønsted acid catalysis having limited control over selectivity and reactivity. This ultimately results in poor functional group tolerance and unexpected side reactions. However, Brønsted acids have been shown to activate hydroxy groups but typically require much higher catalyst loadings or stoichiometric amounts.[139] In such cases, the use of superacids may be the solution to achieve the greater reactivity required in more demanding transformations.

2.1.1 The Acidity Function

Louis Plack Hammet proposed what is now known as the Hammett acidity function (H_0) in order to measure the acidity for very concentrated solutions of strong acids, such as superacids.[140, 141] In highly concentrated solutions, simple approximations such as the Henderson-Hasselbalch equation (Equation **1**) are no longer valid due to the variations of the activity coefficient.[142]

$$pH = pK_a + log\left[\frac{[A^-]}{[HA]}\right] \quad (for\ dilute\ aqueous\ solutions) \quad \textbf{(Equation 1)}$$

Therefore, the Hammet acidity function replaces the pH for concentrated solutions. It is defined using equations analogous to the Henderson-Hasselbalch equation (Equation **2**).[140]

$$H_0 = pK_{ion} - log\left[\frac{[BH^+]}{[B]}\right] \qquad \textbf{(Equation 2)}$$

From this it is apparent H_0 represents an acid's ability to donate a proton, as measured in terms of its ability to shift the equilibrium between B and BH^+ towards BH^+. More negative values of H_0 correspond to stronger Brønsted acids with greater proton transferring ability, while less negative indicates weaker Brønsted acidity.

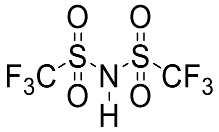
In 1971, Gillespie defined a superacid as an acid with a greater acidity than that of 100% pure sulphuric acid (H_2SO_4).[140] On this scale sulphuric acid's $H_0 = -12$. Therefore, superacids are defined with a Hammett acidity function <-12.

Table 19: Selected Hammet acidity functions of known superacids[140]

	Sulphuric acid **H_2SO_4**	**Triflic acid** **CF_3SO_3H**	**Magic acid** **$F_5Sb\text{-}FSO_3H$**
Hammet Acidity Function (H_0)	−12	−14.6	−24 to −21

2.1.2 Triflimide in Organic Synthesis

Among the superacid family is bis(trifluoromethanesulfonyl)imide, also known as triflimide (**175**) (**Figure 13**). Triflimide is characterised by two strongly electron-withdrawing trifluoromethanesulfonyl groups and a pK_a value of −12.3 in dichloroethane (DCE). Triflimide also benefits from the low nucleophilicity and non-coordinating properties of its conjugate base ($^-NTf_2$). This superacid catalyst has shown its versatility in organic synthesis, assisting as an exceptional catalyst, precatalyst, promoter or additive in a broad range of organic reactions.[143, 144] It is also worth noting that triflimide has been used to prepare cationic metal complexes, which have been employed as successful catalysts.[145, 146]



175

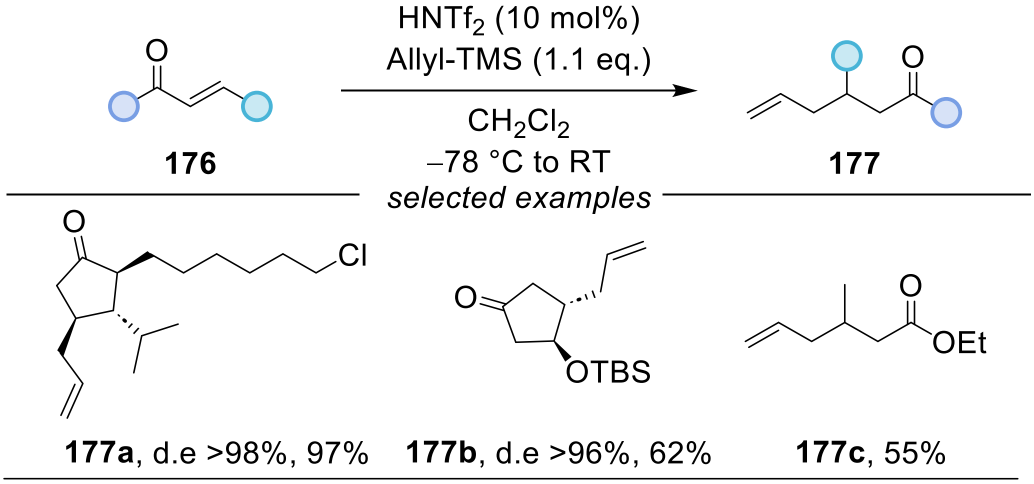
Figure 13: Triflimide

Triflimide's strong acidity as well as good compatibility with organic solvents makes it a competitive choice in comparison to other popular superacids such as triflic acid, which has been developed and used as a catalyst in more recent years.[143, 144] In comparison, triflimide allows for easier handling (solid vs viscous oil), and triflimide's pK_a is 1 unit lower than that of triflic acid (−12.3 vs −11.4 in DCE), which allows for potentially milder activation conditions.[147]

2.1.2.1 Triflimide Catalysed Reactions with Silyl Nucleophiles

Notably, triflimide has been employed as a catalyst in many reactions with silyl-based nucleophiles. Robertson and co-workers reported a pioneering example of using triflimide to catalyse the allylation of enones (**176**) with allyl-TMS in a 1,4-addition reaction (**Table 20**).[148] This method proceeded under relatively mild conditions gave rise to cyclic enones such as **177a** in high diastereoselectivity and yield. Significantly, **177b** was formed via *anti*-allylation giving the opposite stereochemistry to that which would be obtained from the classical Sakurai conditions. The method was also able to provide the desired product **177c** when the conventional method using titanium tetrachloride had failed.

Table 20: Triflimide catalysed allylation of α,β-unsaturated compounds



176

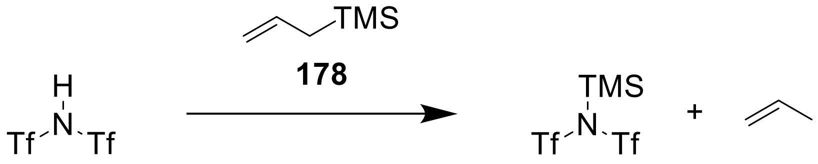
177

177a, d.e >98%, 97%

177b, d.e >96%, 62%

177c, 55%

During NMR studies they demonstrated the catalyst was a Lewis/Brønsted acid cooperative system. At −78 °C they reacted allyl-TMS (**178**) with triflimide (**175**) forming the Lewis superacid – **179** (**Scheme 23**). **179** subsequently catalysed the allylation when warmed to room temperature. Although the real catalyst in this scheme is not a Brønsted acid but the Lewis superacid (**179**), the high reactivity of this acid catalyst originated from the high reactivity of triflimide. It was shown in later studies, **179** can be readily formed by reacting triflimide with allyl-TMS at room temperature within 1 hour giving 93% yield.



178

175

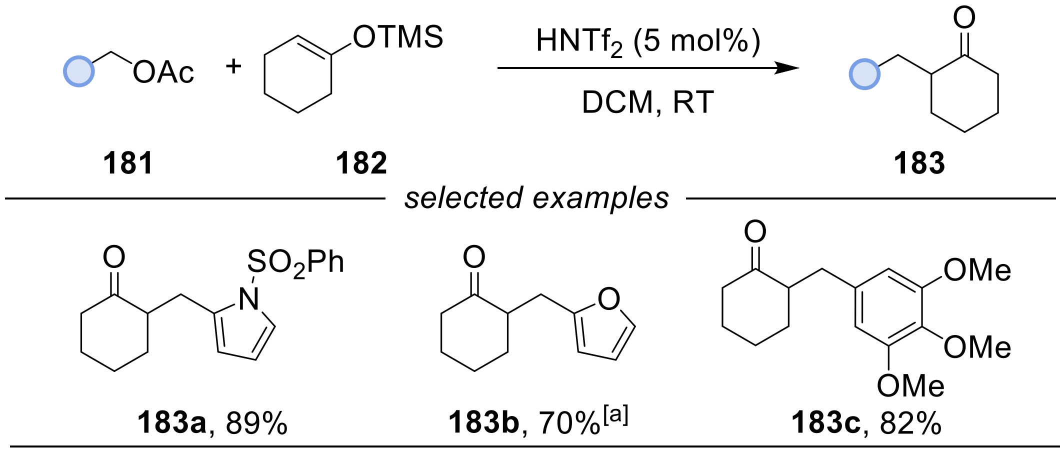
179

180

Scheme 23: Reaction of triflimide with allyl-TMS forming a Lewis superacid

Similar catalytic systems of combining TMS-substituted nucleophiles and triflimide have also been established by many reports. For example, Ghosez and co-workers reported a benzylation reaction using the silyl enol ether **182** and employing acetates (**181**) as leaving groups (**Table 21**).[149] The reaction proceeded under relatively mild conditions forming a range of substituted cyclohexanone derivatives (**183a – c**) in good to excellent yields.

Table 21: Triflimide catalysed benzylation using organosilicon-based nucleophiles forming cyclic ketones

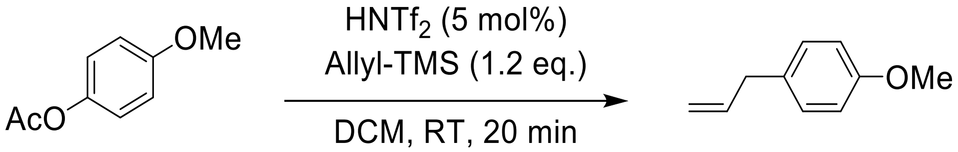


181 **182** **183**

183a, 89% **183b**, 70%[a] **183c**, 82%

[a] 1.0 mol% HNTf$_2$

In addition to this they demonstrated the reaction of *p*-methoxybenzyl acetate (**184**) with allyl-TMS to produce 1-allyl-4-methoxybenzene (**185**) in excellent yields under mild reaction conditions (**Scheme 24**). However, when conditions were subjected to the other substrates no allylation products were formed and resulted in decomposition and complex mixtures.

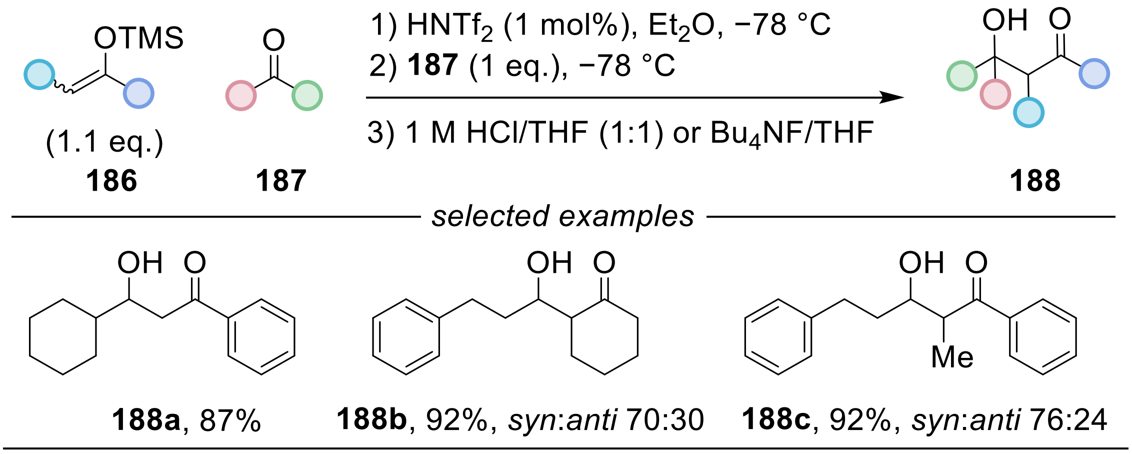


184 **185**, 90%

Scheme 24: Triflimide catalysed allylation of benzyl acetates with allyl-TMS

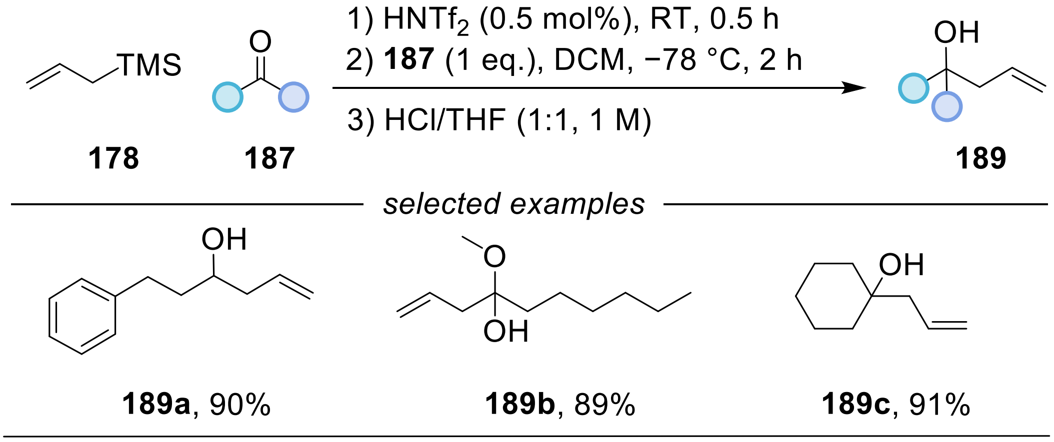
Yamamoto and co-workers demonstrated a Mukaiyama aldol reaction of carbonyl compounds (**187**) using silyl enol ethers (**186**) (**Table 22**).[150] They observed the addition order was important to control unwanted side reactions due to the catalyst's high reactivity. Additionally, *syn*-products (**188b** and **188c**) were obtained as major diastereoisomers independent of the stereochemistry of the silyl enol ethers. Although products were formed in high yields, the scope of the reaction is limited to simple aliphatic chains, with no examples of substrates with more complex electronics.

Table 22: Mukaiyama aldol reaction of carbonyl compounds catalysed by TMS-triflimide



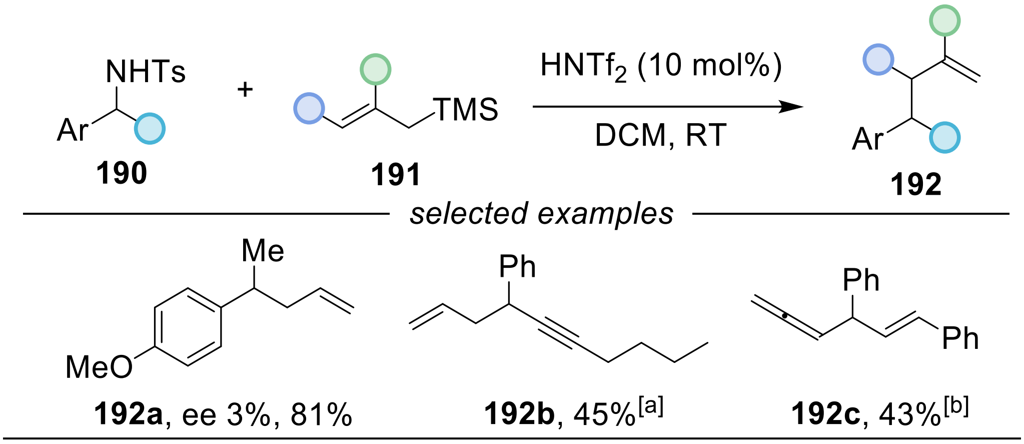
The authors also expanded this to include triflimide catalysed Hosomi-Sakurai reaction of carbonyl compounds (**187**) (**Table 23**). All homoallylic alcohols were formed in excellent yields (89 – 92%). However, again the substrate scope is limited to only a few substrates (**189a** – **b**), with only minimal electronic diversity displayed.

Table 23: Hosomi-Sakurai allylation into various electrophiles



In 2010, Tian and co-workers reported a triflimide-catalysed allylation using allylsilanes (**191**) and *N*-benzyl sulfonamides (**190**) to form the corresponding olefins (**Table 24**).[151] Triflimide was demonstrated in this reaction to show high catalytic activity, in comparison to triflic acid and many other catalysts which were unsuccessful in forming the product. The reaction of an optically active *N*-benzylic sulfonamide with 95% ee afforded **192a** however with complete loss in stereochemistry to 3% ee. This was determined to mean the benzyl cation is generated from the corresponding *N*-benzylic sulfonamide through catalytic cleavage of C-N bond and the coupling reaction proceeds via a S_N1 mechanism. Additionally, the method was also shown to be successful employing varied silyl nucleophiles such as propargylic silane to give **192c**, albeit in lower yield.

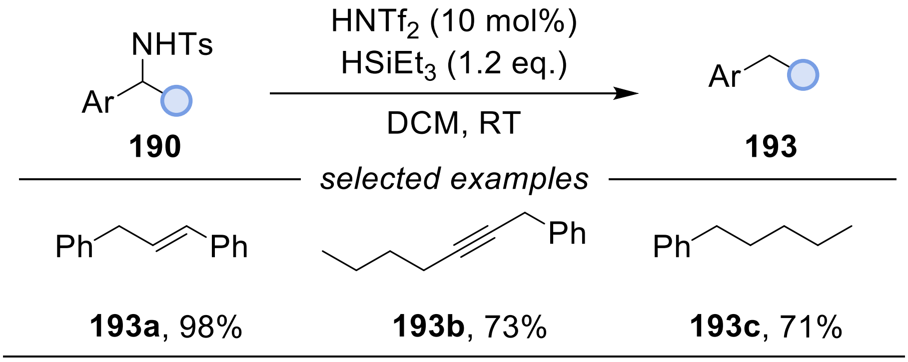
Table 24: Triflimide catalysed coupling of *N*-benzylic sulfonamides with allylsilanes



[a] 2 mol% $NHTf_2$, [b] propargylic silane used

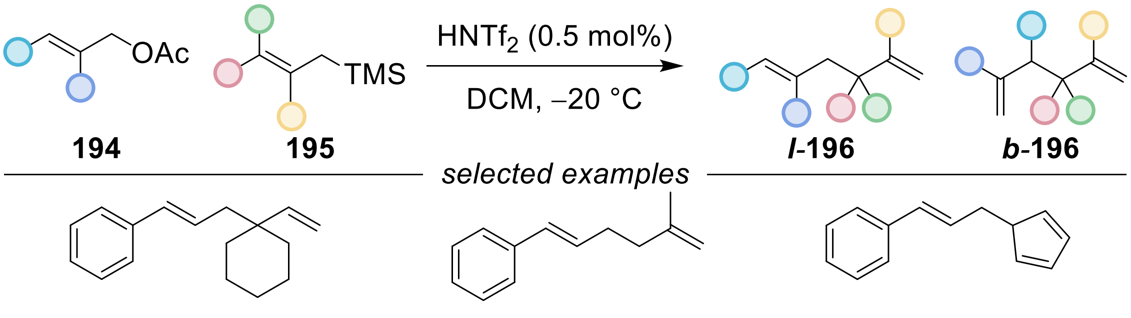
The authors also reported a reduction of *N*-sulfonamides (**190**) by triethylsilane proceeding with high regio- and chemoselectivity (**Table 25**). They noted the sulfonamide groups were removed cleanly without reduction of the C-C multiple bonds present in the *N*-sulfonamides (**193a** and **b**), resulting in high yields being obtained.

Table 25: Triflimide catalysed reduction of *N*-benzylic sulfonamides



Liu and co-workers reported the allylation of allylic acetates (**194**) using substituted allylsilanes (**195**) (**Table 26**).[152] The corresponding allylation products were formed in good yield, favouring the formation of the linear regioisomer ***l*-196**. The authors noted the reaction tolerates more sterically hindered allylsilanes as coupling partners. The cyclohexyl allylsilane formed **196a**, albeit with low conversion. There was also lower selectivity seen with branched allylsilanes (**196b**). Additionally, the use of TMS-cyclopentadiene worked efficiently forming **196c** in good yield and reasonable selectivity. They also noted the reaction was unsuccessful with other common Brønsted acids (TsOH, HCl and AcOH) and with strongly electron-withdrawing groups. They proposed the mechanism proceeds via a triflimide mediated activation of the acetate group to form the stable benzylic β-carbocation intermediate (**198**) and triflate anion. Subsequent, nucleophilic attack of the allylsilane (**195**) occurs with following desilylation. Coupling at the terminal end of the allylic acetate affords the linear isomer (**197**) via path **A**. On the other hand, an alternative attack via path **B** affords the branched regioisomer (**199**). The branched isomer (**199**) is seen as a minor product because of the increased steric hindrance.

Table 26: Triflimide catalysed allylation reaction of allyl acetates

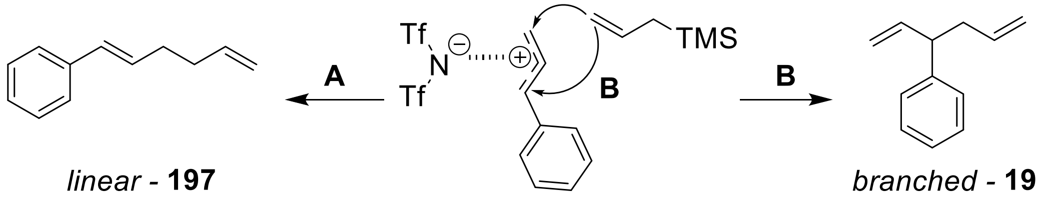


196a, 36%, 77:23[a]

196b, 66%, 60:40[a]

196c, 63%, 78:22[a]

[a] *l*-**196**:*b*-**196** regioisomeric ratio



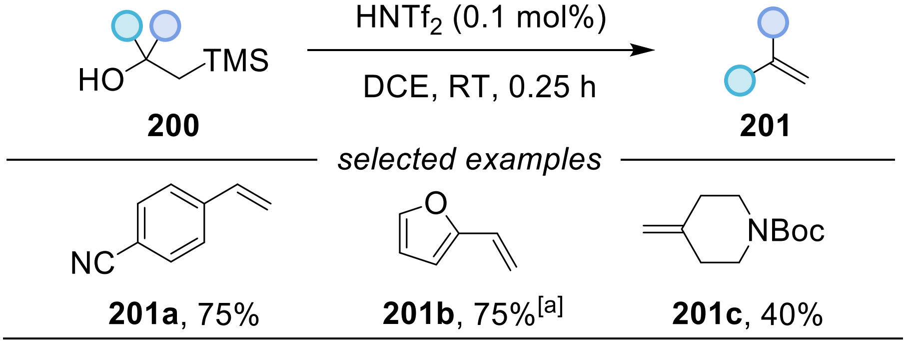
linear - **197**

198

branched - **199**

McLaughlin and co-workers demonstrated a triflimide catalysed Peterson olefination to access functionalised olefins (**201**) (**Table 27**).[153] The protocol utilises low catalytic loadings compared to what is usually employed in these reactions. This has enabled a milder alternative to catalyse Peterson olefinations with short reaction times at room temperature, taking place in a one-pot fashion. The substrate scope tolerated a diverse substrate scope including heterocycles (**201b** and **201c**), although a slightly higher catalyst loading was required to facilitate the formation of **201b**. Although high yields were obtained, it should be noted that not all products could be isolated; in these cases, NMR yields were calculated.

Table 27: Synthesis of olefins via a triflimide catalysed elimination of β-hydroxysilanes



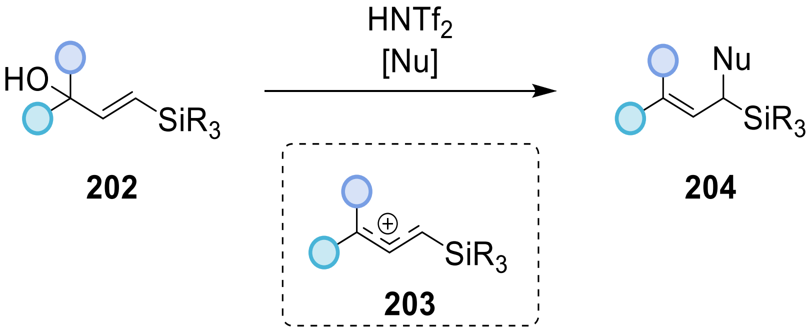
[a] Reaction performed in $CDCl_3$, yield was determined through ^1H NMR spectroscopy of the reaction mixture using 1,3,5-trimethoxybenzene as an internal standard, [b] 0.5 mol% $HNTf_2$ used.

It has been demonstrated within literature the Brønsted superacid triflimide has already played many important roles in organic synthesis and of note is its success with reactions involving silyl nucleophiles. The high acidity combined with a weakly nucleophilic and non-coordinating counter anion has given this compound unique versatility as a catalyst in C-C bond formations. Triflimide is particularly well-suited for those reactions requiring strong Brønsted acid promotion and involving highly electrophilic cationic intermediates. In many cases, triflimide has been demonstrated to outperform triflic acid in terms of reaction efficiency or other aspects, such as catalyst loading, reaction time and temperature. Taking advantage of this powerful Brønsted superacid, there is potential to develop a general metal-free procedure employing lower catalyst loadings.

2.2 Aims

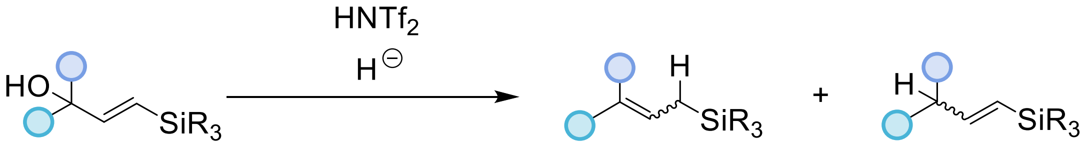
Allylsilanes are highly versatile organometallic reagents however stereo- and regioselective access to these compounds is not trivial. In addition, their synthesis has heavily relied upon the use of highly active silicon donors and strictly anhydrous/inert conditions. The work in this chapter aims to address these limitations by developing a strategy which utilises the commercially available superacid triflimide. Although triflimide has been proven to be a particularly useful catalyst, the highly reactive nature of triflimide can be seen as problematic. Nevertheless, the synthetic utility of Brønsted superacids has resulted in several alternatives being reported, many of these only requiring low catalytic amounts and have shown great promise as new, sustainable catalysts.

The methodology will employ β-silyl alcohols (**202**), which gives the added benefit of the silicon functional handle already being pre-installed, allowing circumvention of the use of highly active silicon donors. The β-silyl alcohols (**202**) will then be subjected to dehydrative nucleophilic addition, which in turn may trigger a double bond transposition via the intermediate carbocation **203** (**Scheme 25**). This provides a metal-free catalysed pathway for the synthesis of allylsilanes (**204**).



Scheme 25: Synthesis of allylsilanes via nucleophilic addition to vinylsilanes

The feasibility of using hydrides as the chosen nucleophile to access linear allylsilanes will be investigated. As well as an in-depth investigation of the methodology with careful consideration of the regio- and stereoselectivity as multiple isomers (**205** and **206**) may be formed (**Scheme 26**).



202 **205** **206**

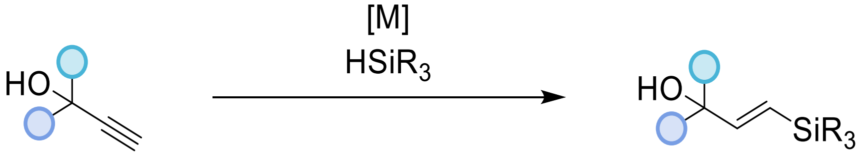
Scheme 26: Triflimide catalysed nucleophilic addition to vinylsilanes

2.3 Results and Discussion

The work presented in this section has been published in part as: Leonard, E. Akien, G., Britten, T., Kazi, N., Roberts, D. and McLaughlin, M., *Adv. Synth. Catal.*, 2023, **365**, 3872-3875.[154]

2.3.1 Hydrosilylation of Propargylic Alcohols

As the work in this chapter requires a range of diverse β-silyl allylic alcohols (**202**), the initial focus was accessing these scaffolds with complete regio- and stereochemical control. After in-depth survey of the literature, hydrosilylation of alkynes presented itself as the most direct and efficient method for the synthesis of vinylsilanes. Therefore, it was deemed practical to access **202** from readily accessible propargylic alcohols (**207**) (**Scheme 27**).



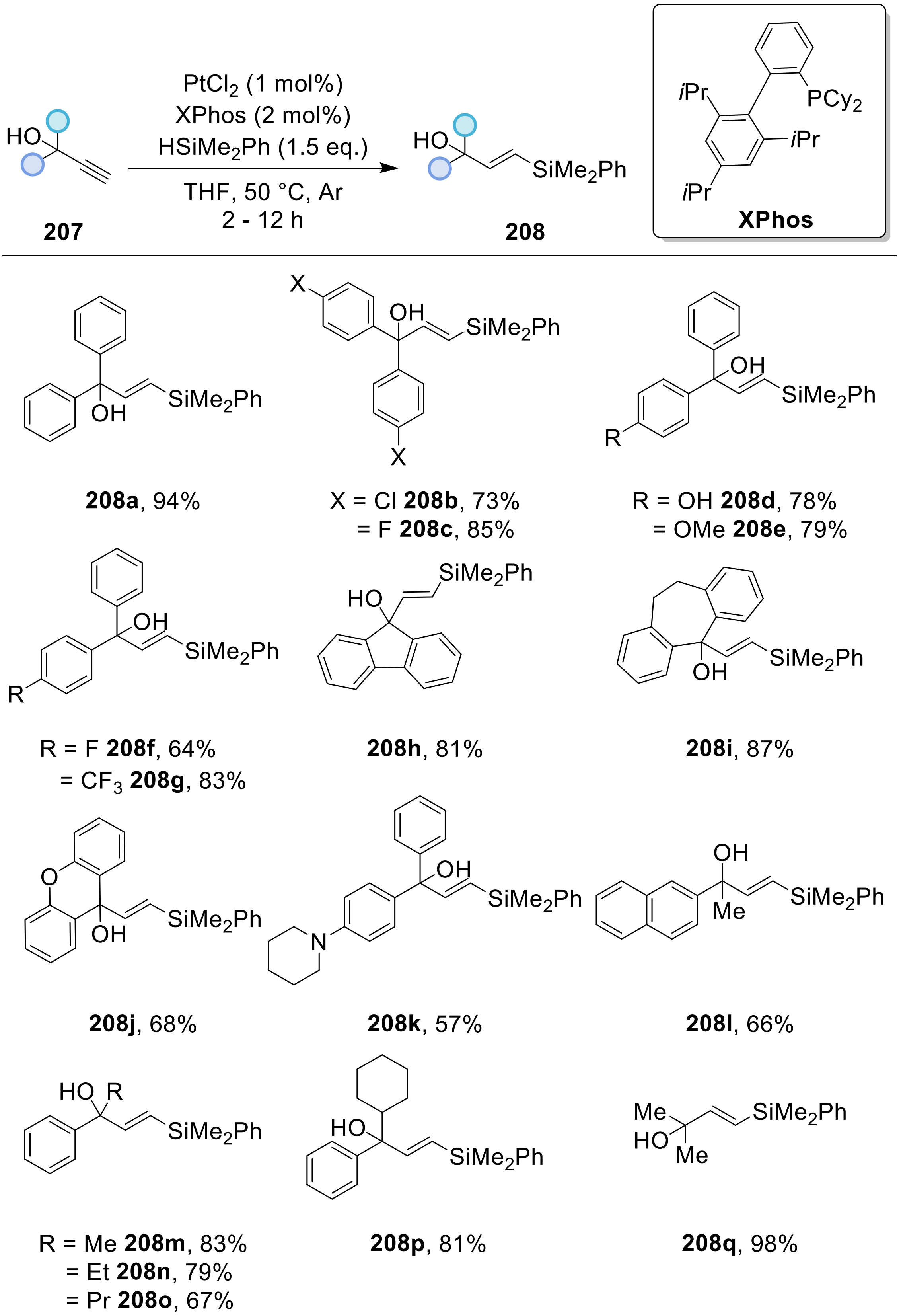
207 **202**

Scheme 27: Synthesis of β-(*E*)-silyl allylic alcohols via hydrosilylation of propargylic alcohols

Employing the methodology developed by McLaughlin *et al.*, enabled access to β-(*E*)-silyl allylic alcohols (**208**) with complete regio- and stereochemical control (**Table 28**).[84, 85] Biaryl substrates furnished the corresponding β-(*E*)-vinylsilanes (**203a – g**) in good to excellent yields, exclusively as a single isomer. The methodology was also effective in synthesising sterically demanding cyclic derivatives (**208h** and **208i**), which were obtained in excellent yields with complete regio- and stereoselectivity. A more hindered cyclic alcohol was well tolerated under the reaction conditions, affording the desired vinylsilane (**208j**) in

68% yield. Furthermore, the reaction exhibited functional group tolerance to basic nitrogen-containing substituents; for instance, a piperidine-containing substrate yielded the desired vinylsilane (**208k**), albeit in reduced yield. A variety of alkyl-substituted substrates also underwent efficient hydrosilylation, furnishing the corresponding vinylsilanes (**208l** – **q**) in good to excellent yields (66 – 98%). In all cases, the products were obtained with excellent regio- and stereoselectivity, providing exclusively the β-(*E*)-isomer.

Table 28: Substrate scope of hydrosilylation of tertiary propargylic alcohols



208a, 94%

X = Cl **208b**, 73%
= F **208c**, 85%

R = OH **208d**, 78%
= OMe **208e**, 79%

R = F **208f**, 64%
= CF_3 **208g**, 83%

208h, 81%

208i, 87%

208j, 68%

208k, 57%

208l, 66%

R = Me **208m**, 83%
= Et **208n**, 79%
= Pr **208o**, 67%

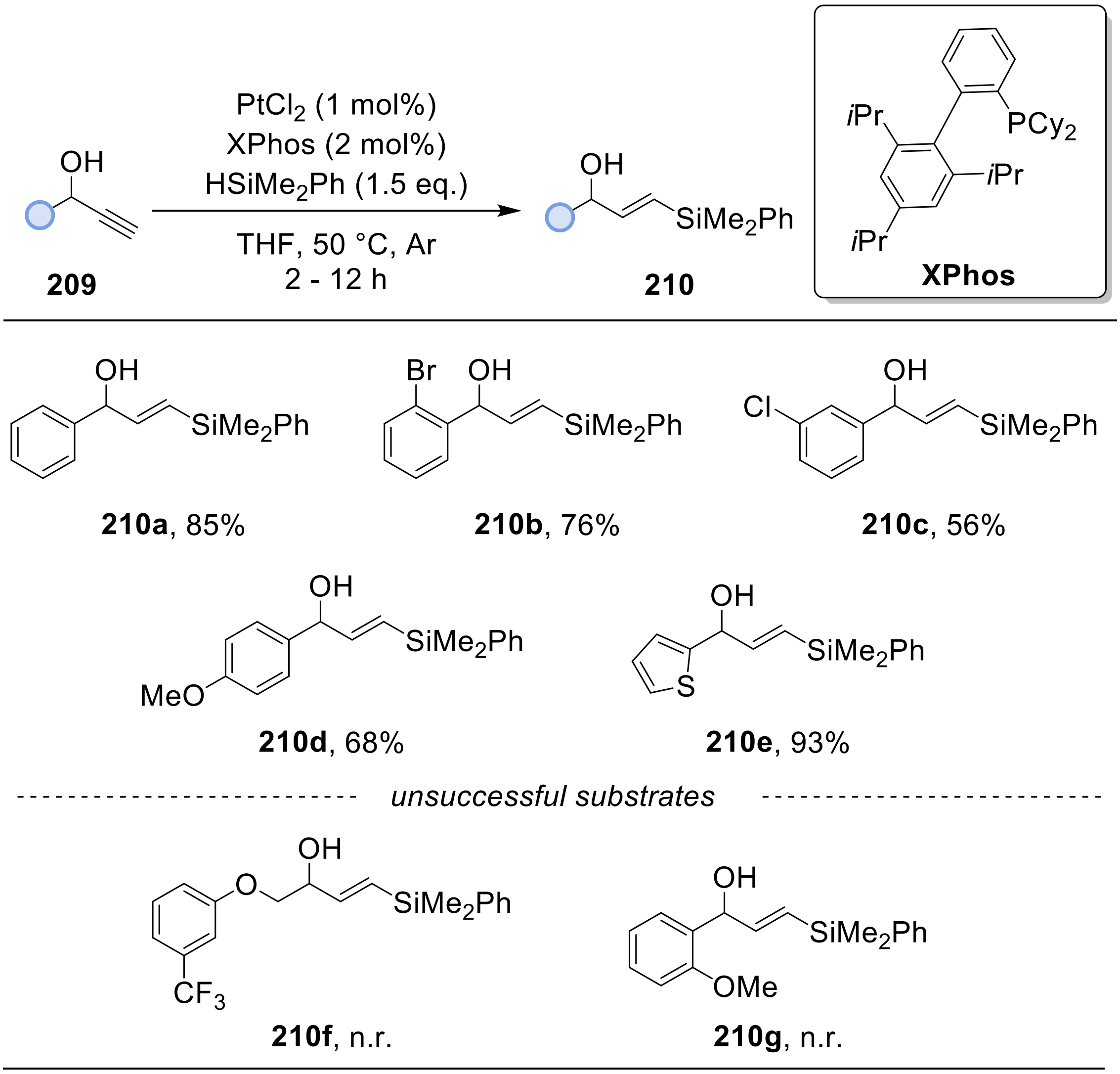
208p, 81%

208q, 98%

Note: only β-(*E*)-isomer formed

To further demonstrate the scope of the methodology, we expanded our vinylsilane library to include a range of secondary propargylic alcohol substrates (**209**) (**Table 29**). These transformations generally afforded the corresponding hydrosilylated vinylsilanes (**210**) in moderate to high yields. For example, the phenyl-substrate underwent smooth conversion to the corresponding vinylsilane **210a** in an excellent yield of 85% within 2 hours. The reaction conditions were found to tolerate a variety of substituents. An *ortho*-brominated aryl substrate afforded the desired product (**210b**) in 76% yield, whereas a *meta*-chlorinated analogue (**210c**) resulted in a somewhat diminished yield of 56%. A substrate bearing an electron-donating methoxy group was also well tolerated, providing the product (**210d**) in 68% yield. In the case of the thiophene-derived substrate (**210e**), prolonged reaction times (12 hours) were required compared to the standard 2-hour protocol, however, an excellent yield of 93% was still obtained. Notably, no product formation was observed for substrates **210f** and **210g** under the optimised conditions. In all successful cases, the corresponding vinylsilanes were obtained as a single regio- and stereoisomer.

Table 29: Substrate scope of hydrosilylation of secondary propargylic alcohols



210a, 85%

210b, 76%

210c, 56%

210d, 68%

210e, 93%

unsuccessful substrates

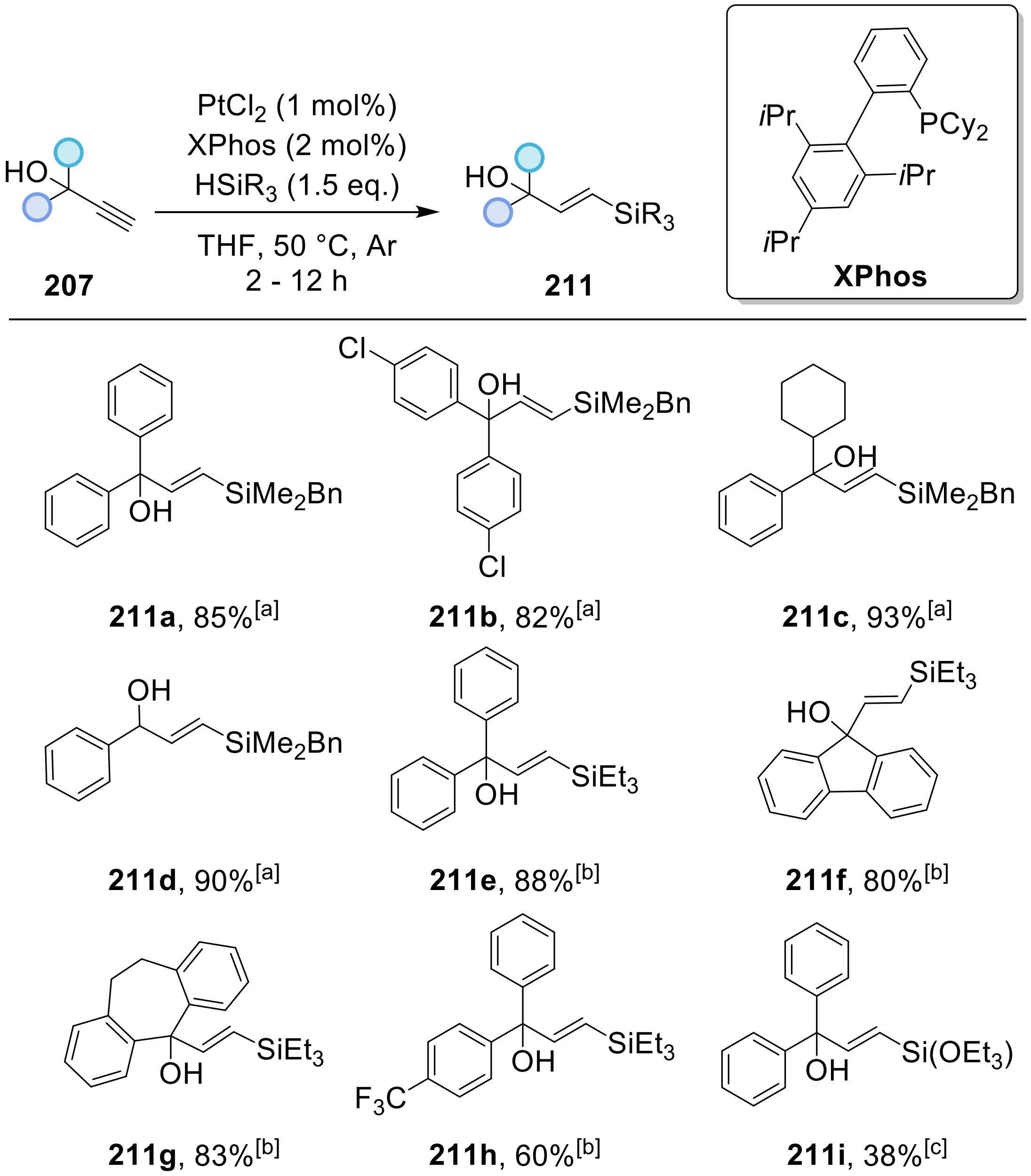
210f, n.r.

210g, n.r.

Note: only β-(*E*)-isomer formed

To expand the generality of the transformation, a range of alternative silane reagents were employed such as triethylsilane, dimethylbenzylsilane and triethoxysilane (**Table 30**). These reactions proceeded as anticipated, displaying complete regio- and stereochemical control. Hydrosilylation reactions utilising dimethylbenzylsilane underwent smooth hydrosilylation, affording the corresponding vinylsilanes (**211a** – **d**) in good to excellent yields (82 – 93%). Similarly, triethylsilane derivatives (**211e** – **h**) were obtained in moderate to good yields ranging from 60 – 88%. In the case of triethoxysilane, the corresponding vinylsilane (**211i**) was obtained in a comparatively lower yield of 38%; however, still synthetically useful.

Table 30: Variation of the silyl group in the hydrosilylation of propargylic alcohols



211a, 85%[a] **211b**, 82%[a] **211c**, 93%[a]

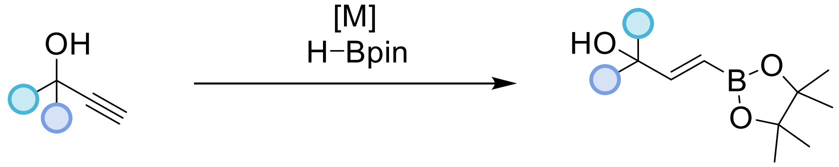
211d, 90%[a] **211e**, 88%[b] **211f**, 80%[b]

211g, 83%[b] **211h**, 60%[b] **211i**, 38%[c]

Note: only β-(*E*)-isomer formed, [a] Benzyldimethylsilane was used, [b] Triethylsilane was used, [c] Triethoxysilane was used.

2.3.2 Hydroboration of Propargylic Alcohols

To broaden the substrate scope and investigate the applicability of alternative organometallic reagents, we explored the synthesis of β-(*E*)-boryl allylic alcohols (**212**) via hydroboration of propargylic alcohols (**207**) (**Scheme 28**).

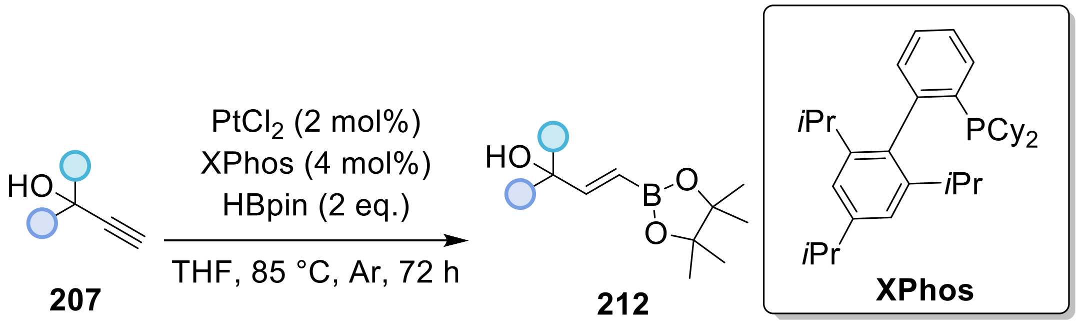


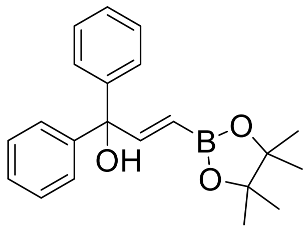
207 **212**

Scheme 28: Hydroboration of propargylic alcohols

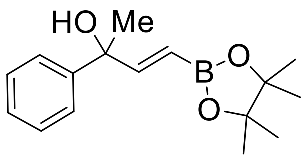
Building on the successful β-(*E*)-silyl allylic alcohol substrate scope, we initially investigated the hydroboration of propargylic alcohols using the platinum/XPhos catalytic system developed by McLaughlin *et al.* (**Table 31**).[84, 85] The biaryl propargylic alcohol was subjected to these conditions, affording the β-(*E*)-boryl allylic alcohol **213** with excellent regio- and stereoselectivity, albeit in a low yield of 25%. Similarly, substrate **214** yielded the desired product with complete regio- and stereochemical control, though in an even lower yield of 10%. Attempts to hydroborate the secondary propargylic alcohol **215** was unsuccessful under the same conditions. Prolonging the reaction time (up to 72 hours), increasing the temperature, and varying the catalyst and ligand loadings failed to improve yield.

Table 31: Hydroboration of propargylic catalysed using platinum (II)/XPhos catalytic system

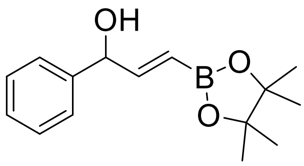




213, 25%



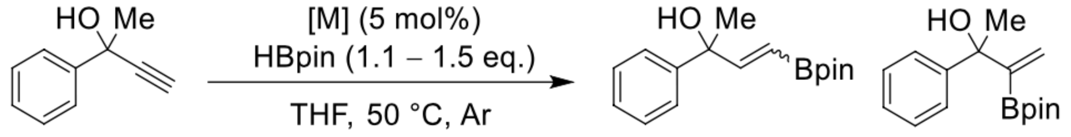
214, 10%



215, n.r

Therefore, the investigation into the hydroboration of propargylic alcohols was conducted, subjecting **207a** to optimisation (**Table 32**). However, deviations from the conditions outlined in entry **1** consistently resulted in complex reaction mixtures, with no detectable formation of β-(*E*)-boryl allylic alcohols (**β-214**) or the regioisomer (**α-214**). Variations in temperature, reaction time, and catalyst and ligand loadings were explored; however, all modifications proved unsuccessful. Additionally, a copper-catalysed approach was examined based on previous reports of successful vinylborane synthesis with good yields and selectivity.[155, 156] Despite these efforts, the copper system also failed to deliver any improvement.

Table 32: Optimisation of hydroboration of propargylic alcohols to form vinylboranes

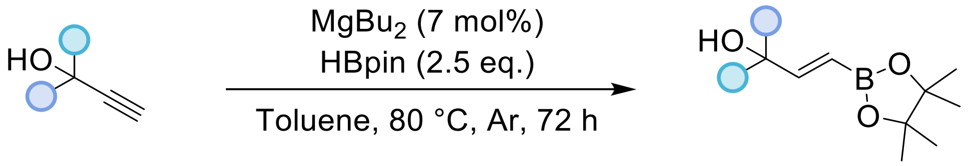


207a **β-214** **α-214**

Entry	Catalyst	Ligand	HBpin (eq.)	β:α[a]	Yield (%)
1	$PtCl_2$	XPhos (10 mol%)	1.1	>99:1	10
2	$PtCl_2$	XantPhos/ 5mol%)	1.1	-	n.r
3	$PtCl_2$	dppf (5 mol%)	1.1	-	n.r
4	$PtCl_2$	DavePhos (10 mol%)	1.1	-	n.r
5	$PtCl_2$	JohnPhos (10 mol%)	1.1	-	n.r
6	$PtCl_2$	SPhos (10 mol%)	1.1	-	n.r
7	$Cu(OTf)_2$	XPhos (10 mol%)	1.5	-	n.r
8	$Cu(OTf)_2$	XantPhos (5mol%)	1.5	-	n.r
9	$Cu(OTf)_2$	dppf (5 mol%)	1.5	-	n.r
10	$Cu(OTf)_2$	DavePhos (10 mol%)	1.5	-	n.r
11	$Cu(OTf)_2$	JohnPhos (10 mol%)	1.5	-	n.r
12	$Cu(OTf)_2$	SPhos (10 mol%)	1.5	-	n.r

[a] β:α regioisomeric ratio determined via analysis of ^1H NMR of the crude reaction.

A method developed by Rueping and co-workers employing dibutylmagnesium as a catalyst had achieved hydroboration of propargylic alcohols in high yielding and selective synthesis of β-(*E*)-boryl allylic alcohols **216** and **217** (**Scheme 29**).[157]



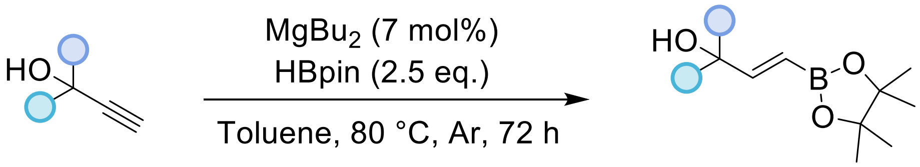
207

○ = ○ = Cyclohexyl **216**, 83%
○ = Me, ○ = Ph **217**, 80%

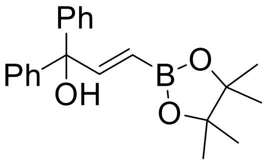
Scheme 29: Magnesium catalysed hydroboration of propargylic alcohols

The bisphenyl propargylic alcohol was subjected to the reaction conditions, affording the desired product **213** as a single isomer in a modestly improved yield of 30% (**Table 33**). However, this method proved unsuccessful when applied to other substrates (**214**, **215**, **218** and **219**), with significant recovery of unreacted starting material observed. Attempts to enhance reactivity through variations in reaction time, temperature, and catalyst and ligand loadings were also explored but failed to deliver any further successful transformations.

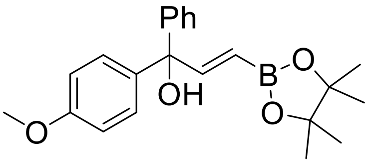
Table 33: Hydroboration of propargylic alcohols using a dibutylmagnesium catalyst



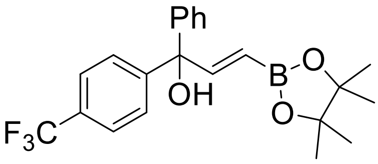
207 **212**



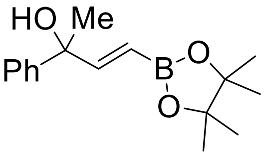
213, 30%



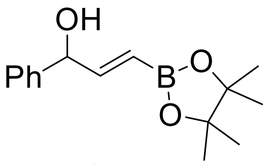
218, n.r



219, n.r



214, n.r



215, n.r

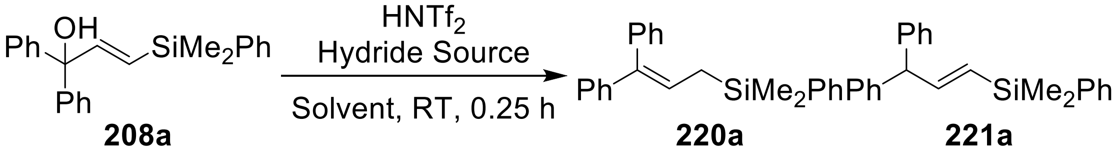
The reaction was ultimately deemed unsuitable for propargylic alcohol substrates due to the presence of the hydroxy functional group. The pronounced oxophilicity of magnesium and boron may facilitate strong coordination with the alcohol, thereby providing a pathway for catalyst inhibition. Consequently, this interaction results in low or negligible product yields. Subsequently, owing to these inherent limitations and limited overall success, further investigation into the synthesis of β-(*E*)-boryl allylic alcohols was abandoned.

2.3.3 Synthesis of Allylsilanes via Triflimide Catalysed Reduction of Vinylsilanes

2.3.3.1 Optimisation of Dehydrative Reduction of Vinylsilanes

Efforts were next directed toward the synthesis of allylsilanes (**220**) via Brønsted superacid-catalysed dehydrative reduction of vinylsilanes (**208**). Initial studies commenced with the optimisation of reaction conditions using substrate **208a**. (**Table 34**).

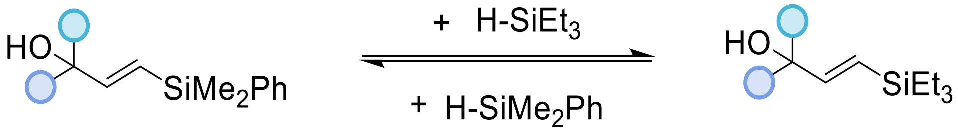
Table 34: Triflimide catalysed reduction of vinylsilanes



Entry	Solvent[a]	Hydride	$HNTf_2$ (mol%)	**220**:**221**	Yield (%)[b]
1	DCM	$NaBH_4$ (3 eq.)	5	-	-
2	DCM	HBpin (3 eq.)	5	-	n.r
3	DCM	Hantzsch Ester (3 eq.)	5	-	n.r
4	DCM	$HSiEt_3$ (3 eq.)	5	-	20
5	DCM	$HSiMe_2Ph$ (3 eq.)	5	>99:1	86
6	DCM	$HSiMe_2Ph$ (3 eq.)	1	>99:1	51
7	DCM	$HSiMe_2Ph$ (3 eq.)	2	>99:1	54
8	DCM	$HSiMe_2Ph$ (1.1 eq.)	5	>99:1	31
9	DCM	$HSiMe_2Ph$ (1.5 eq.)	5	>99:1	36
10	Toluene	$HSiMe_2Ph$ (3 eq.)	5	>99:1	43
11	DCM	None	5	-	-

[a] Solvent 0.5 M, [b] Yield calculated based of ^1H NMR of the crude reaction using 1,3,5-trimethoxybenzene as an internal standard.

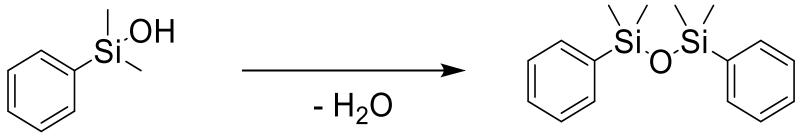
The use of reducing agents such as sodium borohydride led to a complex mixture, as well full reduction of the double bond being observed (Entry **1**). The reaction was also unsuccessful using pinacol borane and Hantzsch ester with no formation of the desired product (Entries **2** and **3**). When **208a** was subjected to 3 equivalents of triethylsilane with 5 mol% catalyst loading, the desired product was obtained in 20% yield (Entry **4**). The low yield was attributed to the formation of multiple organosilane side products, originating from both the starting material and the silyl hydride source. This observation suggests that transsilylation side reactions (**Scheme 30**), may occur via silicon exchange between the hydride reagent and the starting material (**208**).



208 **222**

Scheme 30: Transsilylation reaction between silicon hydride and vinylsilanes

To suppress this side reaction from occurring the silicon functionality of the hydride source was matched to that of the parent silane (**208a**). Therefore, dimethylphenylsilane was subsequently employed, resulting in a significantly improved yield of 86% of the allylsilane (**220a**) as a single regioisomer (Entry **5**). However, it was also observed that reduction of the double bond continued to occur, accompanied by the formation of disiloxane by-products within the reaction mixture. These disiloxanes (**224**) arise from the condensation of the by-product dimethylphenylsilanol (**223**) (**Scheme 31**). Furthermore, the disiloxane (**224**) co-eluted with the allylsilane product, complicating purification and thus problematic to obtain isolated yields.



223 (2 eq.) **224**

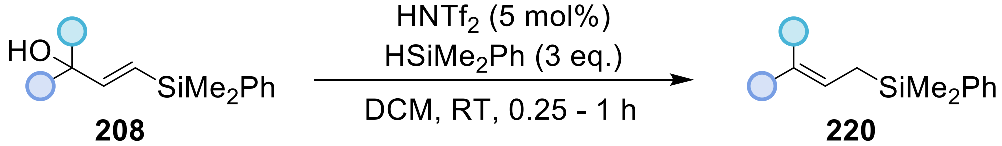
Scheme 31: Dimerisation of silanol derivative forming siloxanes

To suppress the reduction of the double bond and minimise disiloxane formation, reactions employing lower equivalents of both the silane and catalyst were investigated (Entries **6** – **9**). While regioselectivity remained unchanged under these conditions, a significant decrease in product yield was observed. Furthermore, switching the solvent to toluene resulted in a further reduction in yield (Entry **10**). Despite these challenges, the regioselective formation of allylsilane (**220a**) in good yield represents a promising outcome.

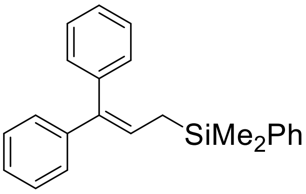
2.3.3.2 *Substrate Scope of Linear Allylsilanes*

Initial investigation of the substrate scope focused on tri-substituted vinylsilanes (**208**) (**Table 35**). Biaryl substrates (**220a** – **d**) afforded a single regioisomer in good yields ranging from 86 to 66%, successfully tolerating larger cyclic ring systems. While the allylsilane **220e** was obtained in a good yield of 89%, the reaction lacked stereochemical control, resulting in an *E*/*Z* ratio of 58:42. Additionally, the methoxy-substituted substrate **220f** failed to yield any product due to reduction of the double bond, and alkyl substrates (**220g** and **220h**) similarly showed no product formation for the same reason.

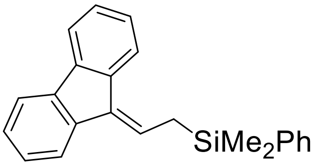
Table 35: Substrate scope of allylsilanes



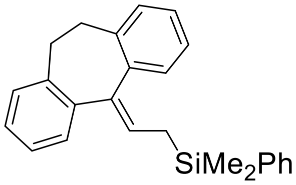
208 → **220**



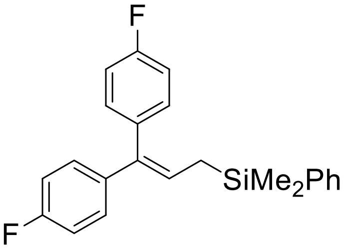
220a, 86%[a]



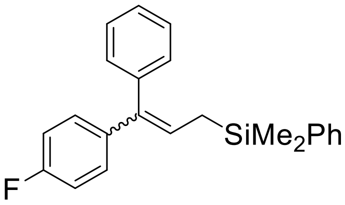
220b, 71%



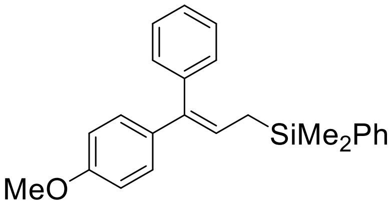
220c, 66%



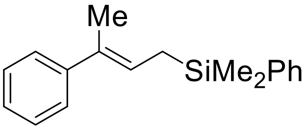
220d, 70%



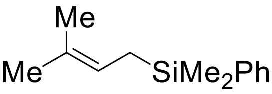
220e, 89%[a], *E*/*Z* 58:42[b]



220f, n.r.



220g, n.r.

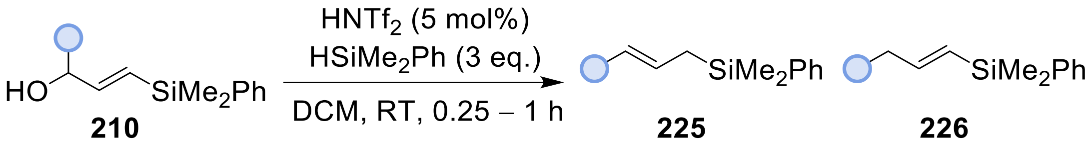


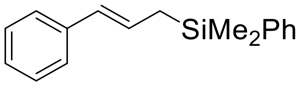
220h, n.r.

[a] NMR yield calculated based ^{1}H NMR of the crude reaction using 1,3,5-trimethoxybenzene as an internal standard, [b] *E*/*Z* ratio determined by NMR NOESY and selHSQMBC analysis of crude reaction mixture

Next, the disubstituted vinylsilanes (**210**) were subjected to optimised conditions yielding the corresponding (*E*)-allylsilanes **225a** – **c** (**Table 36**). As with previous examples, the electron-donating substrate **225c** resulted in a significantly lower yield, attributed to reduction of the double bond. Furthermore, regioselectivity was diminished in these cases, leading to mixtures of regioisomers. Nonetheless, the stereochemical outcome remained highly selective, favouring the (*E*)-isomer for both vinyl (**226**) and allyl (**225**) regioisomers.

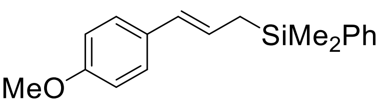
Table 36: Substrate scope of allylsilanes





225a, 93:7[a], 49%[b]

225b, 80:20[a], 55%[b]

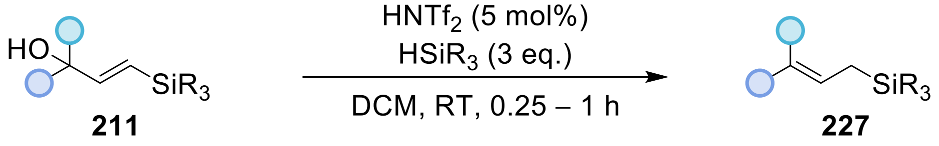


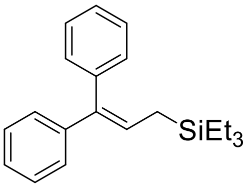
225c, 78:22[a], 22%[b]

Note: only (*E*)-allylsilane and (*E*)-vinylsilane isomers formed, [a] **225**:**226** regioisomeric ratio, [b] NMR yield calculated based ^{1}H NMR of the crude reaction using 1,3,5-trimethoxybenzene as an internal standard of only (*E*)-allylsilane

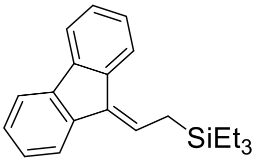
To expand the scope of the reaction, variation of the hydride source was investigated (**Table 37**). The use of triethylsilane afforded allylsilanes (**227a** – **c**) in good yields (76 – 89%) with excellent regioselectivity. Substrate **227d** also formed the desired product in high yield and with full regioselectivity; however, a mixture of stereoisomers was observed (*E*/*Z* 38:62), favouring the formation of the (*Z*)-isomer. Additionally, the use of dimethylbenzylsilane and pinacol borane furnished the corresponding allyl derivatives (**227e** and **227f**) with complete regiochemical control.

Table 37: Variation of the silyl group substrate scope

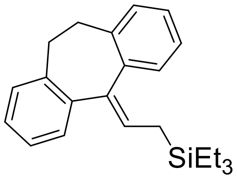




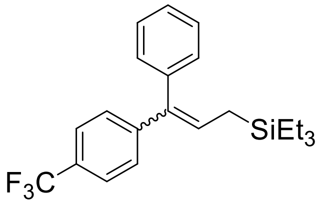
227a, 63%[a]



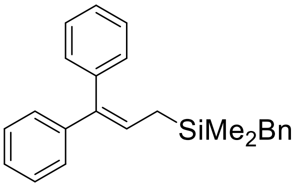
227b, 76%[a]



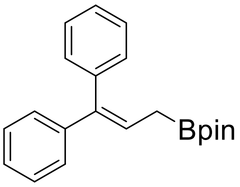
227c, 89%[a]



227d, 86%, *E*/*Z* 38:62[b]



227e, 72%[d]



227f, 40%[a],[d]

[a] $HSiEt_3$ was used instead, [b] *E*/*Z* ratio determined by NMR NOESY and selHSQMBC analysis of crude reaction mixture, [c] $HSiMe_2Bn$ was used, [d] NMR yield calculated based of ^{1}H NMR of the crude reaction using mestiylene as an internal standard.

2.3.3.3 E/Z Assignments of Trisubstituted Alkenes

This NMR study was conducted in collaboration with Dr Geoffrey Aiken at Lancaster University. While the *E*/*Z* assignment of 1,2-disubstituted alkenes is readily achieved by extracting the $^3J_{HH}$ coupling constant across the double bond from the 1D ^{1}H NMR spectrum (i.e. $^3J_{HH,trans} > {}^3J_{HH,cis}$), this approach is not applicable to tri-substituted alkenes due to the absence of a vicinal proton across the double bond. In such systems, the typical proton–proton coupling analysis cannot be performed, as one side of the alkene is substituted with a non-proton-bearing group. Instead, the use of $^3J_{CH}$ coupling constants may be used in a directly comparable manner (i.e. $^3J_{CH,trans} > {}^3J_{CH,cis}$).[158]

To obtain these couplings, 2D proton-selective HSQMBC (heteronuclear single quantum multiple bond correlation) NMR experiments were employed.[159] This technique detects long-range (^{2}J and ^{3}J) heteronuclear couplings, typically between ^{1}H and ^{13}C nuclei, across two or three bonds. In the proton-selective variant, a specific proton signal is selectively excited, enhancing spectral resolution by suppressing overlap and isolating correlations from a defined spin system. This method enables the indirect measurement of $^3J_{CH}$ coupling constants across the alkene, specifically between the olefinic carbon and adjacent allylic or vinylic protons. These couplings are sensitive to the stereochemistry of the alkene, in (*E*)-alkenes, the relevant $^3J_{CH}$ values are generally larger due to antiperiplanar alignment, whereas in (*Z*)-alkenes, the values are typically smaller owing to gauche or synclinal geometries.

Accordingly, to accurately assign the *E*/*Z* geometry of allylsilanes **220e** and **227d**, 2D proton-selective HSQMBC experiments were performed. Where applicable, 1D selective NOESY experiments were used to validate these assignments (**Figure 14**). The corresponding data was collected with structural determination carried out by Dr Geoffrey Aiken. In compounds **220e** and **227d**, where the olefinic proton is adjacent to a CH_2 group, a quartet is observed due to coupling with both ^1H and ^{13}C. However, due to overlap or insufficient resolution in the standard HSQMBC spectrum, IPAP-HSQMBC was employed to accurately determine the $^3J_{CH}$ value.[160] The IPAP variant experiment allows for higher precision in long-range coupling by collecting two spectra; one where the coupling appears in-phase (IP) and one where it appears anti-phase (AP). By taking the difference in chemical shift between the IP and AP, the $^3J_{CH}$ value can be extracted with higher accuracy for congested regions or in systems where signals overlap in conventional spectra such as seen in **220e** and **227d**.

The extracted couplings of $^3J_{CH,\mathit{trans}}$ were observed in the range 9.1 – 9.3 Hz, whereas $^3J_{CH,\mathit{cis}}$ values ranged from 5.9 – 6.3 Hz. This corresponded to *trans* and *cis*-configurations, respectively, thereby enabling definitive *E*/*Z* assignment.

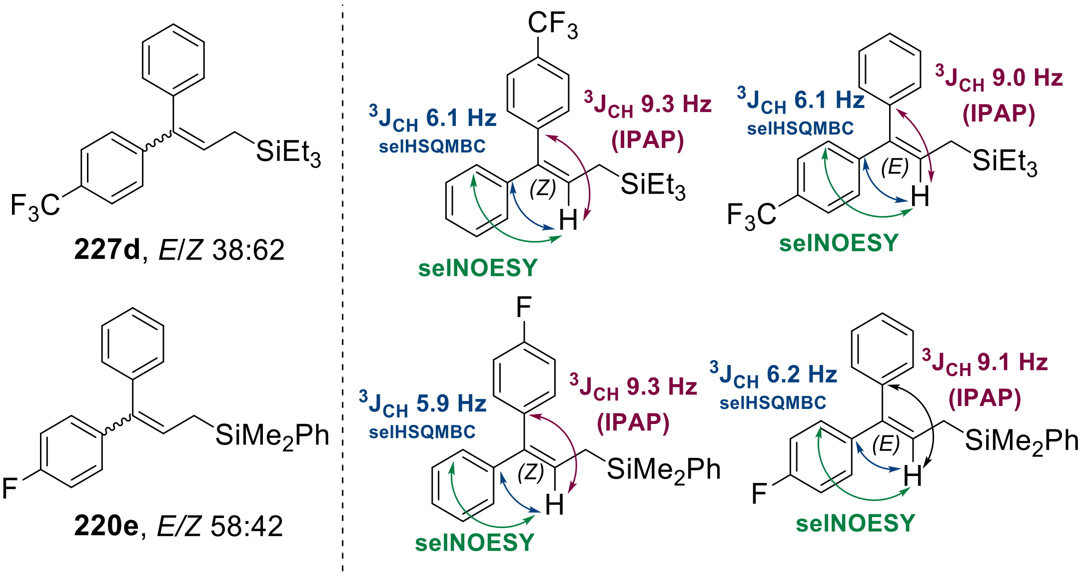
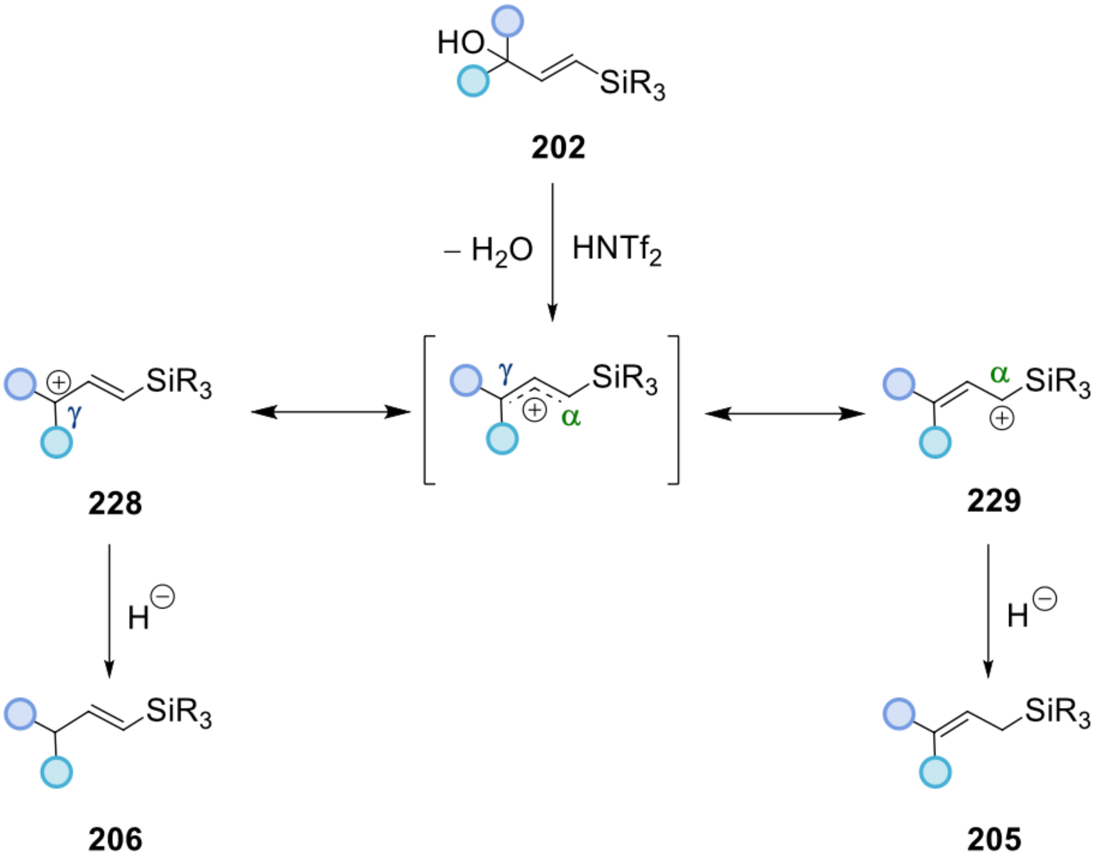


Figure 14: *E*/*Z* assignment of trisubstituted alkenes

2.3.3.4 Mechanistic Discussion

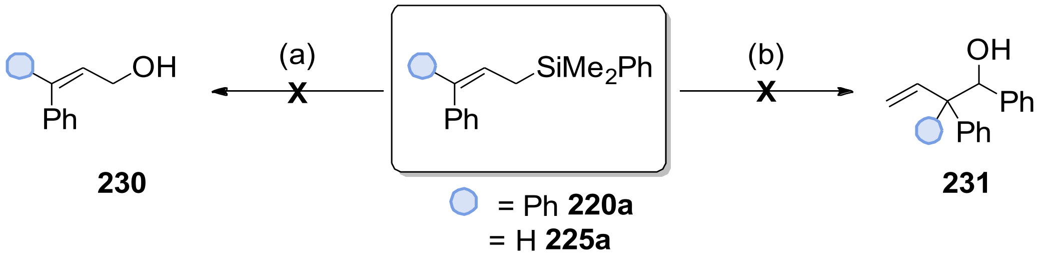
The vinylic nature of the stating material (**202**) upon dehydration leads to two prevalent electrophilic sites – α-**228** and γ-**229** (**Scheme 32**). It is believed the addition of the hydride proceeds via an S_N1 or S_N1' mechanism due to the formation of these stable allylic carbocation intermediates. In addition, these carbocations are further stabilised via conjugation with a substituted aryl ring at the γ-position. It was noted that substitution at the γ-position influences the site of nucleophile attack, which in turn affects the regioselectivity of the reaction. A higher substitution at the γ-position favours direct addition at the least hindered α position, giving rise to the desired allylsilane (**205**). However, substrates with lower substitution at the γ-position resulted in an increased formation of the vinyl regioisomer (**206**).



Scheme 32: Brønsted acid catalysed the formation of allylic and vinylic silanes via triflimide catalysed dehydrative reduction

2.3.4 Attempted Synthesis of Allylic Alcohols

To demonstrate the applicability of allylsilanes, we subjected them to diversification to form useful and medicinal relevant structures such as allylic alcohols. Therefore, **220a** was subjected to Sakurai allylation conditions.[104] However, all attempts were unsuccessful and led to complex mixtures (**Scheme 33**). The reaction was also attempted with **225a**, which has a lower substitution at the γ-position (relative to the silicon moiety) however this made negligible difference in the result of the reaction. Attention was next turned to subjecting allylsilanes **220a** and **225a** to Fleming-Tamao oxidation conditions.[22, 59, 161] However, ultimately led to a similar outcome of forming complex mixtures and no product being formed.



Scheme 33: Attempted synthesis of allylic alcohols: (a) TBAF (1.2 eq.), 30% H_2O_2 (20 eq.), MeOH, $KHCO_3$ (4 eq.), THF, (b) $BF_3{\cdot}OEt_2$, benzaldehyde, DCM

2.4 Conclusions

Hydrosilylation of propargylic alcohols using an XPhos/platinum(II) chloride system enabled the synthesis of a range of sterically and electronically diverse β-(*E*)-vinylsilanes. The reactions proceeded with complete regio- and stereochemical control, affording 30 examples in yields ranging from 38 – 98%, thereby providing a broad library of starting materials.

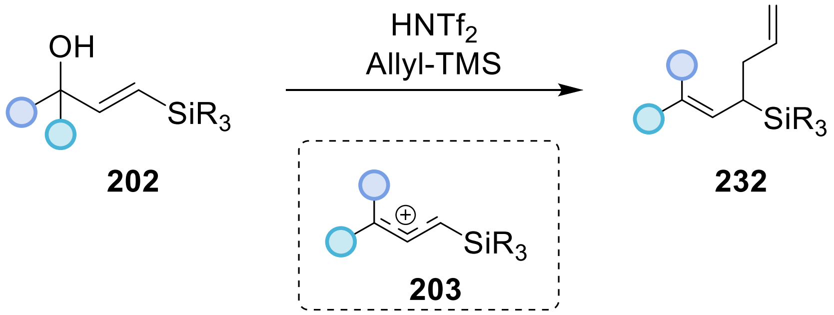
In addition, although the hydroboration of propargylic alcohols is known to be non-trivial, two examples were successfully synthesised with high regio- and stereoselectivity, albeit in low but synthetically useful yields. The low efficiency of these transformations was attributed to catalytic inhibition pathways, likely arising from the high oxophilicity of magnesium and boron species.

Triflimide demonstrated utility in catalysing the regioselective synthesis of linear allylsilanes under metal-free conditions. The reduction methodology was sufficiently optimised, with a range of conditions investigated. Overall, the reaction tolerated a variety of vinylsilanes, delivering allylsilanes in high yields up to 89%. However, limitations of the methodology were observed, including a loss of regioselectivity with less hindered substrates. Additionally, the substrate scope was restricted due to the requirement for matched silanes, and further challenges were encountered due to side reactions such as oligomerisation and reduction of the double bond.

3 Chapter 3 – Synthesis of Allylsilanes via Superacid Catalysed Allylations

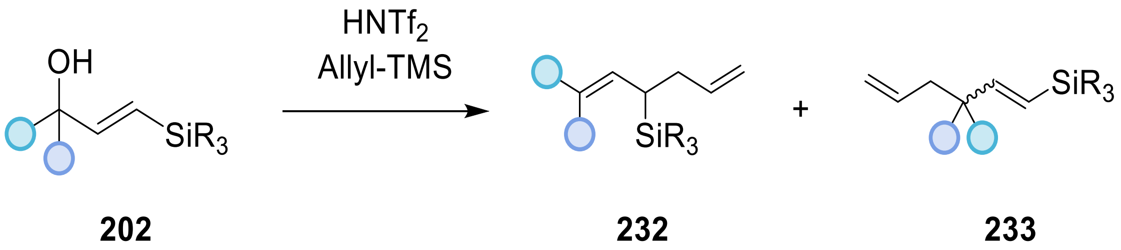
3.1 Aims

The methodology presented in Chapter 2 provides an ideal strategy towards linear allylsilanes, however there are significant limitations that has led to limited substrate scope and difficulties with purification. These limitations are based on the methodologies restriction to use matched silanes and additionally side reactions such as oligomerisation and reduction of the double bond. Therefore, we began to look at the possibility of different nucleophiles and whilst considering our superacid catalyst, it was deemed basic nucleophiles would be unsuitable. We therefore probed the idea of using allyl-TMS as a method to access allylsilanes (**232**). Our methodology will employ β-silyl alcohols (**202**) to undergo dehydrative nucleophilic addition, thereby triggering a double bond transposition via the intermediate carbocation **203** to realise the efficient and mild synthesis of allylsilanes (**Scheme 34**).



Scheme 34: Synthesis of allylsilanes via nucleophilic addition to vinylsilanes

An in-depth investigation of the methodology will take place with careful consideration of the regio- and stereoselectivity of the reaction as multiple isomers (**232** and **233**) may be formed (**Scheme 35**).



Scheme 35: Triflimide catalysed nucleophilic addition to vinylsilanes

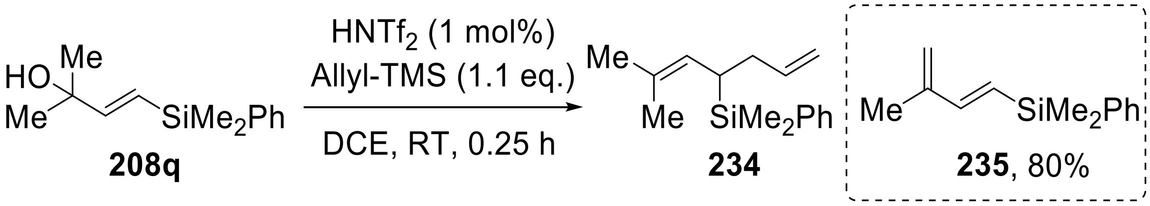
3.2 Results and Discussion

The work presented in this section has been published in part as: Leonard, E. Akien, G., Britten, T., Kazi, N., Roberts, D. and McLaughlin, M., *Adv. Synth. Catal.*, 2023, **365**, 3872-3875.[154]

3.2.1 Synthesis of Allylsilanes via Triflimide Catalysed Allylations

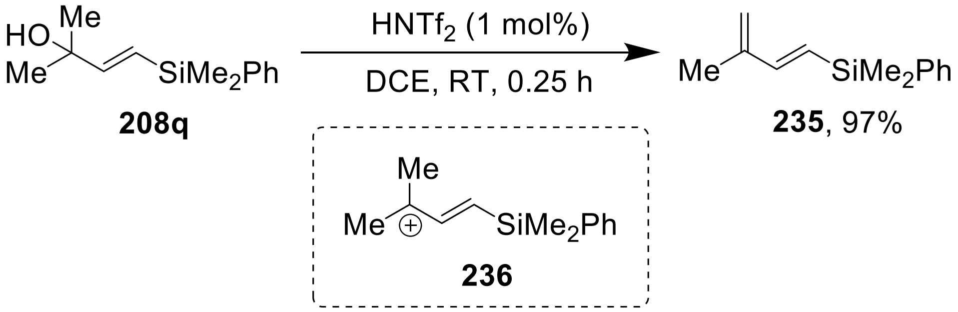
3.2.1.1 Optimisation Studies

Optimisation studies began with vinylsilane **208q**, using 1 mol% $HNTf_2$ and 2 equivalents of allyl-TMS (**Scheme 36**). Within 15 minutes there was complete consumption of the starting material, however no allylation product (**234**) was observed. Instead, 1,3-diene **235** was recovered after column chromatography in 80% yield.



Scheme 36: Attempted triflimide catalysed allylation of alkyl-substituted β-silyl-allylic alcohol

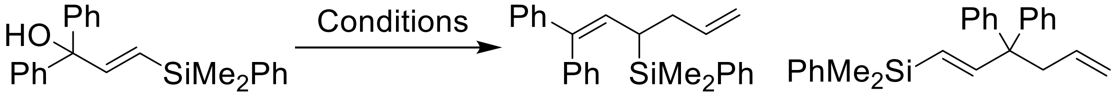
This reaction was repeated without allyl-TMS, resulting in the formation of the 1,3-diene (**235**) in 97% yield within 15 minutes (**Scheme 37**). This made it apparent the presence of terminal alkyl groups at the γ-position (relative to the silicon group) can readily undergo a Brønsted acid catalysed elimination pathway via a stable tertiary allylic carbocation **236**.



Scheme 37: Brønsted acid catalysed elimination of β-silyl-allylic alcohol

We therefore began the optimisation of the allylation of the β-silyl-allylic alcohol **208a**, which would be unable to undergo the elimination side reaction (**Table 38**).

Table 38: Optimisation of the Sakurai allylation of β-silyl-allylic alcohol



208a **237a** **238a**

Entry	Solvent[a]	$HNTf_2$ (mol%)	Temp (°C)	Silane (eq.)	**237**:**238**	Yield (%)
1	DCM	10.0	Room	1.5	-	-
2	DCM	1.0	Room	1.5	>99:1	53
3	DCE	1.0	Room	1.5	>99:1	90
4	HFIP	1.0	Room	1.5	-	-
5	THF	1.0	Room	1.5	-	-
6	Toluene	1.0	Room	1.5	-	-
7	DCE	1.0	0	1.5	>99:1	86
8	MeCN	1.0	–40	1.5	-	n.r
9	DCE	1.0	Room	1.1	>99:1	93
10	DCE	1.0	Room	0	-	-
11	DCE	0.1	Room	1.1	>99:1	77
12	DCE	0.2	Room	1.1	>99:1	80
13	DCE	0.5	Room	1.1	>99:1	89
14	DCE	0	Room	1.1	-	n.r

[a] 0.5 M

Firstly, investigations began with the conditions outlined in entry **1**, with 10 mol% triflimide and 1.5 equivalents allyl-TMS at room temperature in DCM. However, this resulted in degradation and no observable allylation products being observed in the ^{1}H NMR of the crude reaction. The reaction was however successful with a much lower catalyst loading of 1 mol%, giving **237a** in moderate yield (53%), with complete regiochemical control (Entry **2**). The effect of solvent was investigated next, as triflimide is known to have a differential pK_a in different solvents and therefore a difference in the catalytic reactivity (**Table 39**). The yield was found to be significantly higher in halogenated solvents such as DCE and DCM, with DCE being the optimal solvent of choice giving the desired product in 90% yield with complete regiochemical control (Entry **3**). This was attributed to the effect of the solvents on the pK_a with $HNTf_2$ having a much higher acidity and therefore higher catalytic activity in DCM and DCE.[162]

Table 39: pK_a values of triflimide in different media[162]

Acid	**H_2O pK_a**	**MeCN pK_a**	**DCE pK_a**	**DCM pK_a**
Triflimide	<–2	–0.1	–11.4	–12.3

The reaction was not successful in THF and toluene leading to degradation of **208a** (Entry **5** and **6**, respectively). The literature suggests that HFIP can stabilise carbocations, and so, could stabilise the possible carbocation intermediates involved in this reaction. However, when using HFIP, a mildly acidic solvent (pK_a of 9.3) in combination with triflimide, complete degradation of the **208a** was observed (Entry **4**).[163]

Next, the effect of temperature was investigated; when the temperature was decreased, a decrease in yield was observed and no reaction occurred at −40 ˚C (Entries **7** and **8**). However, acetonitrile may also result in lower catalyst turnover due to a much higher pK_a value, resulting in lower catalytic activity.

The yield also suffered slightly with the decrease in catalyst loading from 1.0 to 0.1 – 0.2 mol% (Entries **11** and **12**), although the product could still be isolated in good yields as a single regioisomer (77% and 80%, respectively). It was also noted the reaction worked with negligible difference in yield when the catalyst loading was decreased to 0.5 mol% (Entry **13**), with the starting material **208a** still being consumed within 15 minutes. There was also trivial difference in yield in reducing the allyl-TMS loading to 1.1 from 1.5 equivalents which enabled a cleaner reaction profile (Entry **9**).

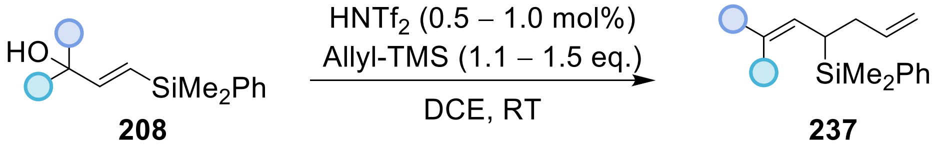
During our control experiments, no reaction occurred without the silane and resulted in the degradation of **208a** (Entry **10**). No reaction occurred without the acid catalyst, resulting in complete recovery of the starting material (Entry **14**). Therefore, the optimised reaction conditions are outlined in entry **13**, with 0.5 mol% catalyst loading and 1.1 equivalents of allyl-TMS, proceeding at room temperature with full conversion within 15 minutes. The reaction mixture was worked up with potassium carbonate and filtered to provide a single regioisomer **237a** in 89% isolated yield, with the added benefit of requiring no column chromatography to obtain a spectroscopically pure product.

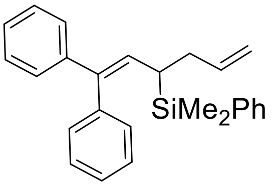
3.2.1.2 Investigation of the Allylsilane Substrate Scope

With the optimised allylation in hand, a library of β-(*E*)-silyl-allylic alcohols (**208**) were subjected to the optimised conditions to generate a range of allylsilanes

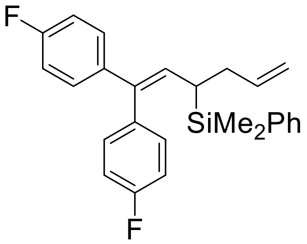
(**237**) (**Table 40**). The biaryl-substituted substrates worked particularly well giving the desired products (**237a** – **c**) in excellent yields, without the need of further purification by column chromatography and as single regioisomers. The electron-withdrawing substituted biaryl substrates produced the corresponding allylsilanes **237d** and **237e** in excellent yields (93% and 85%, respectively). Electron donating substituted biaryl substrates **237f** and **237g** were formed in good yields (82% and 70% respectively). It was observed during analysis of the ^{1}H NMR of the crude reactions of substrates **237d** – **g**, where there is a substitution at the *para* position on one of the aryl groups at the γ-position (relative to the silicon moiety) the products were obtained in a stereoisomeric mixture. This enabled us to realise a trend illustrating electron-withdrawing (**237d** and **237e**) showing preference to higher formation of the (*Z*)-olefin and electron donating (**237f** and **237g**) showing preference to the formation of the (*E*)-olefin. Exploring alkyl group tolerance resulted in the formation of **237h** – **l** in good to excellent yields (57 – 92%), as a single stereo and regio-isomer, with the (*E*)-allylsilane being formed as the sole product, except in the case of **237l**, where the (*Z*)-allylsilane is the sole product.

Table 40: Allylation of β-(*E*)-silyl-allylic alcohols substrate scope

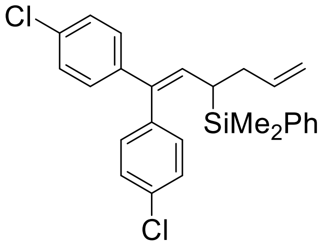




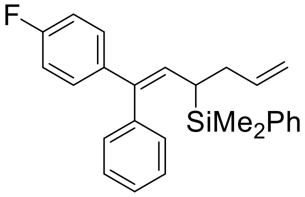
237a, 89%



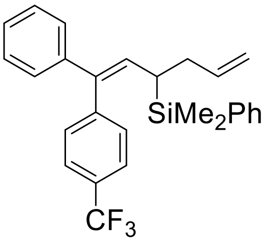
237b, 98%



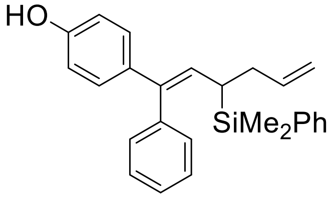
237c, 87%



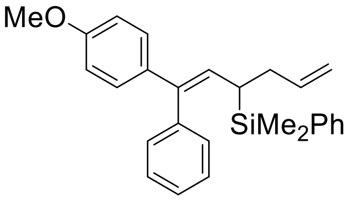
237d, 93%, *E*/*Z* 62:38[b]



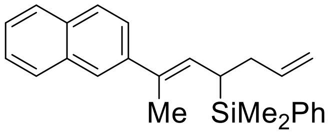
237e, 85%, *E*/*Z* 12:88[b]



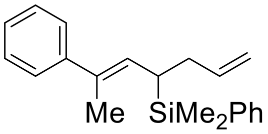
237f, 82%, *E*/*Z* 75:25[b]



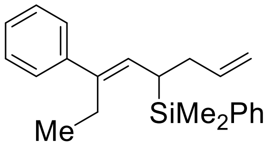
237g, 70%, *E*/*Z* 80:20[b]



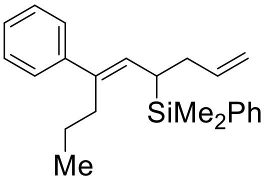
237h, 82%, *E*/*Z* >99:1[b]



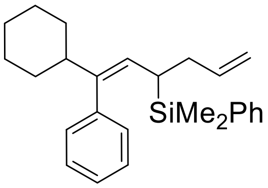
237i, 67%, *E*/*Z* >99:1[b]



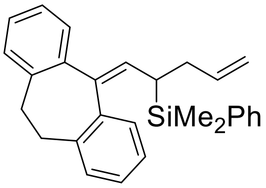
237j, 57%, *E*/*Z* >99:1[b]



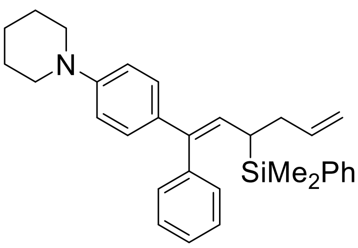
237k, 63%, *E*/*Z* >99:1[b]



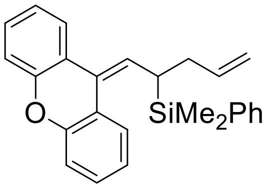
237l, 92%, *E*/*Z* <1:99[a],[b]



237m, n.r.



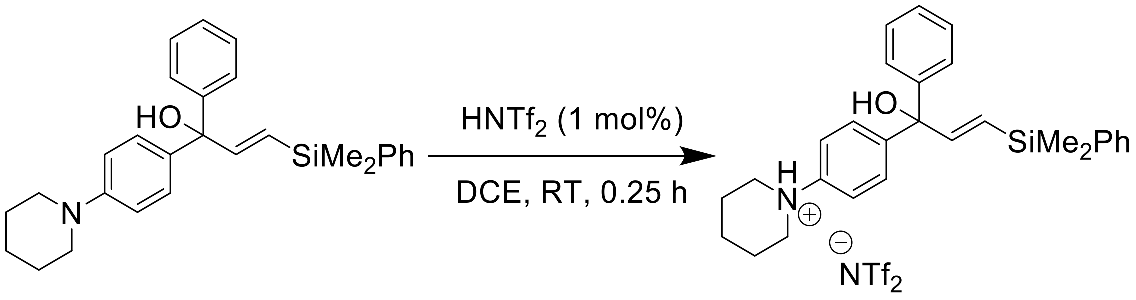
237n, n.r.



237o, n.r.

[a] 1 mol% $HNTf_2$, 1.5 eq. allyl-TMS, [b] *E*/*Z* ratio determined by NMR NOESY and selHSQMBC analysis of crude reaction

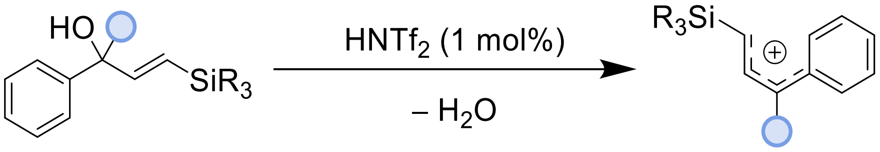
In addition, **237m** was not successful and resulted in degradation of the starting material when subjected to the reaction conditions. Heterocyclic rings (**237n** and **237o**) were unsuccessful, most likely due to the basic properties of the functional groups. Instead, they resulted in formation of a salt such as (**239**) by protonation of the basic functional group by the acid catalyst, providing a pathway for catalyst inhibition (**Scheme 38**).



208k **239**

Scheme 38: Catalyst inhibition via basic functional group presence

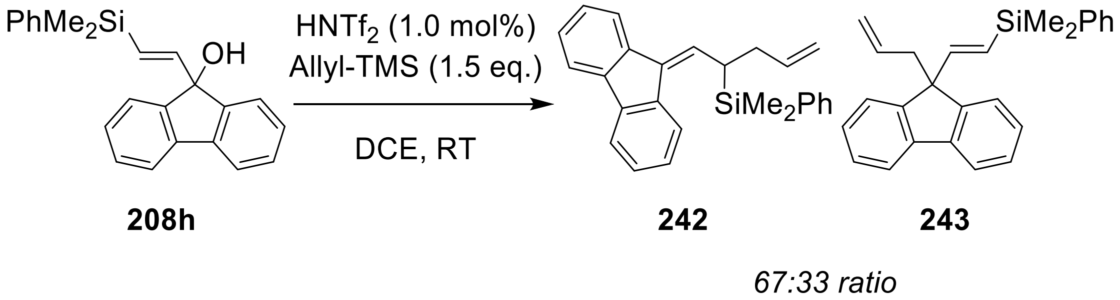
As previously investigated **234** was not formed, due to the formation of a 1,3 diene (**235**) in 97% yield. In addition to this, alkyl substituted derivatives (**237i** – **k**) did see a decrease in yield due to the competing elimination pathway. However, it is thought the aryl ring can stabilise the formation of a very stable benzylic and allylic carbocation intermediate **241** through conjugation (**Scheme 39**). This stabilisation ultimately may favour the formation of the allylsilane (**237**) via the allylation reaction.



240 **241**

Scheme 39: Triflimide catalysed dehydration of β-(*E*)-silyl-allylic alcohols

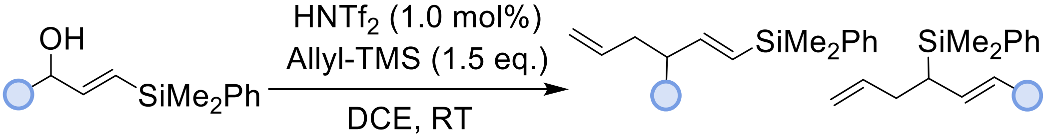
During the scope of disubstituted β-(*E*)-silyl-allylic alcohols, **208h** was subjected to the optimised conditions which resulted in a 67:33 (**242**:**243**) regioisomeric ratio (**Scheme 40**). This is attributed its planar structure reducing steric congestion, in comparison to the two freely rotating aryl groups, such as **237a** which was formed as a single regioisomer. This may increase the likelihood of nucleophilic attack at the γ-position, giving rise to the regioisomer vinylsilane (**243**).



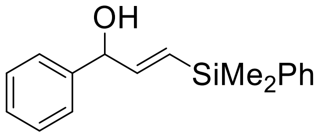
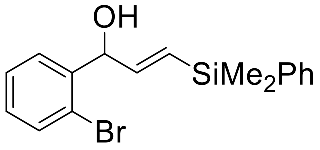
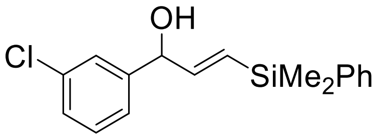
Scheme 40: Allylation of fluorenone derived β-(*E*)-silyl-allylic alcohol

To investigate this further, the methodology was subjected to monosubstituted substrates (**210**) (**Table 41**). The allylation was successful in forming the allylsilanes **245a** – **c**. However, these substrates as expected formed a mixture of regioisomers, favouring the formation of the vinylsilanes **244a** – **c**. Substitution around the aromatic ring in the *ortho* and *meta* positions, had negligible effect on the regiochemical outcome of the reaction. It is evident the sterics around the γ-position (relative to the silicon moiety) heavily influence the regiochemical outcome of the allylation, with less hindered substrates giving rise to reduced regioselectivity.

Table 41: Allylation of monosubstituted β-(*E*)-silyl-allylic alcohols



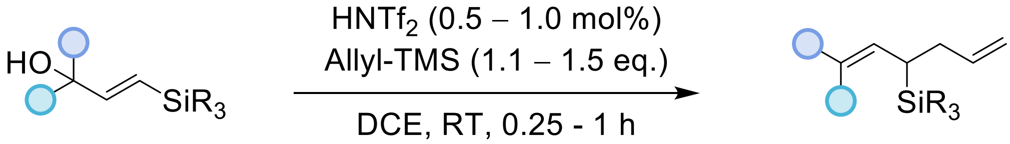
210 **244** **245**

Entry	Substrate	**244**:**245**[a]	Yield (%)[b]
1	 **210a**	70:30	77
2	 **210b**	75:25	67
3	 **210c**	72:28	55

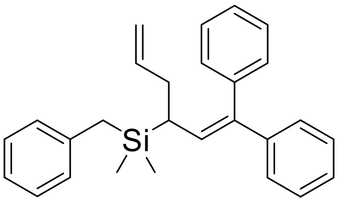
Note: *E*/*Z* ratio determined by analysis of ^{1}H NMR of the crude reaction, only the (*E)*-allylsilane and (*E*)-vinylsilane was formed in all cases, [a] Vinyl:allyl regioisomer ratio determined by NMR analysis of crude reaction, [b] isolated yield of regioisomeric mixture

The use of different silyl and boron derivatives was subsequently investigated (**Table 42**). Substrates bearing various silyl groups (**247a** – **d**) were obtained in excellent yields without the need for chromatographic purification. These substrates were formed with complete regiocontrol, and the (*Z*)-configured compound **247c** was also generated with complete stereochemical fidelity. Substrate **247e** proved unsuccessful, which was attributed to the presence of a basic ethoxy functionality that likely inhibited the superacid catalyst. In addition, the methodology enabled access to the allylborane derivative **247f** in excellent yield, with complete regiochemical control and no requirement for chromatographic purification.

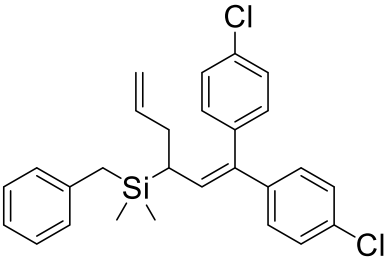
Table 42: Substrate scope of varying vinyl organometallic functionality



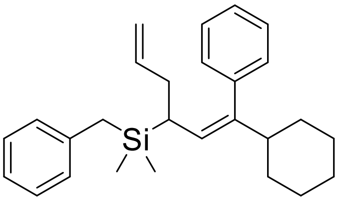
246 → **247**



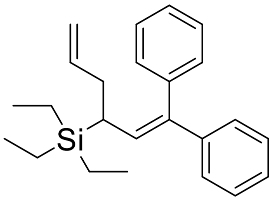
247a, 98%



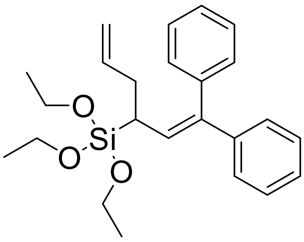
247b, 98%



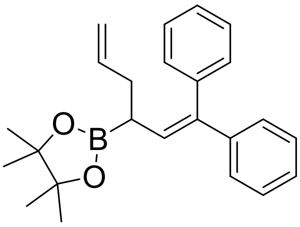
247c, 86%, *Z/E* >99:1[a],[b]



247d, 91%



247e, n.r.

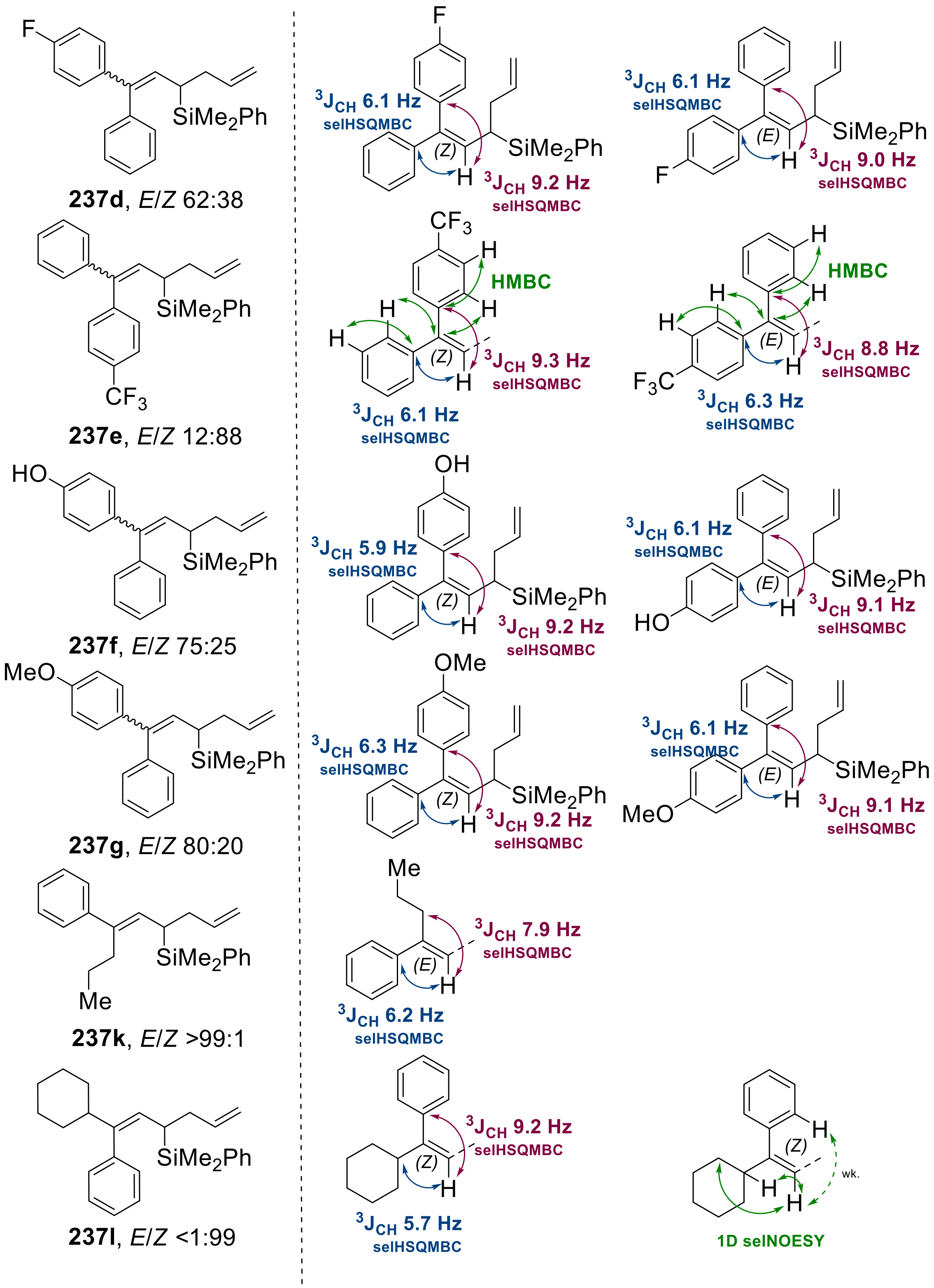


247f, 98%

[a] 1 mol% HNTf$_2$, 1.5 eq. allyl-TMS, [b] *E/Z* ratio determined by NMR NOESY and selHSQMBC analysis of crude reaction

3.2.1.3 E/Z Assignments via ^{1}H NMR Experiments

This NMR study was conducted in collaboration with Dr Geoffrey Aiken at Lancaster University. As described in section **2.3.3.3**, it was necessary to conduct 2D proton-selective HSQMBC experiments and, where possible, 1D selective NOESY experiments to validate the stereochemical assignment of the allylsilanes (**237d** – **g**, **237k** and **237l**) (**Figure 15**).[158, 159] The corresponding data was collected with structural determination carried out by Dr Geoffrey Aiken. In line with previous studies, the measured $^3J_{CH,trans}$ coupling constants were found to be in the range of 7.9 – 9.3 Hz, while the corresponding $^3J_{CH,cis}$ values were observed between 5.7 – 6.3 Hz, consistent with *trans* and *cis* configurations, respectively.



237d, *E*/*Z* 62:38

237e, *E*/*Z* 12:88

237f, *E*/*Z* 75:25

237g, *E*/*Z* 80:20

237k, *E*/*Z* >99:1

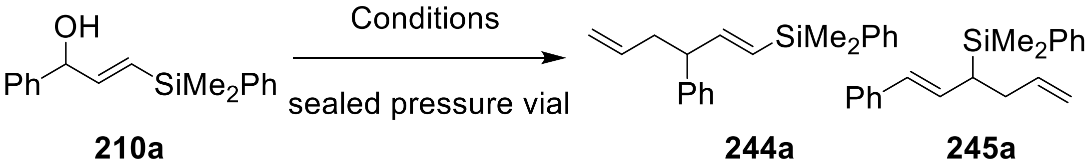
237l, *E*/*Z* <1:99

Figure 15: 2D ^{1}H-selective HSQMBC and NOESY couplings for tri-substituted alkenes

3.2.1.4 Regioselectivity Investigation and Optimisation

To establish higher regioselectivity for less sterically hindered β-(*E*)-silyl-allylic alcohols (**208h** and **210a** – **c**), an investigation into the conditions required for the allylation of model substrate **210a** took place (**Table 43**).

Table 43: Regioselectivity optimisation of monosubstituted β-(*E*)-silyl-allylic alcohols



Entry	Solvent[a]	Catalyst[b]	Temp (°C)	**178** (eq.)	*E*/*Z* [c]	**245**:**244**[d]	Yield (%)[e]
1	DCE	$HNTf_2$	Room	1.1	>99:1	30:70	77
2	DCE	$HNTf_2$	0	1.1	>99:1	31:69	65
3	MeCN	$HNTf_2$	–40	1.1	>99:1	-	n.r
4	DCE	$HNTf_2$	40	1.5	>99:1	29:71	69
5	DCE	$HNTf_2$	60	1.5	>99:1	30:70	63
6	DCE	$HNTf_2$	80	1.5	>99:1	30:70	52
7	DCE	$Ca(NTf_2)_2$	40	1.5	>99:1	30:70	65
8	DCE	$Ca(NTf_2)_2$	60	1.5	>99:1	30:70	46
9	DCE	$Ca(NTf_2)_2$	80	1.5	>99:1	29:71	40

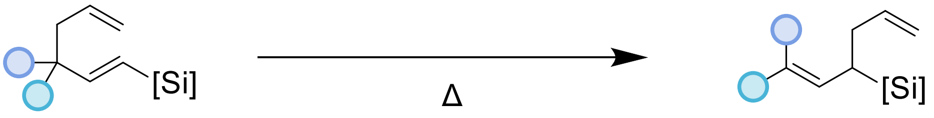
[a] Solvent 0.5 M, [b] Catalyst loading 5 mol%, [c] *E*/*Z* ratio of both allylsilane and vinylsilane determined via analysis of ^{1}H NMR of the crude reaction, [d] **245**:**244** ratio was determined via analysis of ^{1}H NMR of the crude reaction, [e] total isolated yield of the regioisomeric mixture

The reaction resulted in a slightly lower yield at lower temperatures (Entry **2**), which is in line with previous optimisation. However, changing the temperature did not change the regioselectivity. As shown in entry **3**, the reaction did not proceed at –40 ˚C, resulting in no formation of products (**244a** or **245a**). At higher temperatures we unsurprisingly noted the formation of multiple side products, leading to a slight decrease in yield and with no gain in regioselectivity (Entries **4** – **6**).

An investigation to see the feasibility of promoting a Lewis acid catalyst pathway instead of the Brønsted acid pathway, was undertaken in the hope for more regiocontrol. Hence, the Lewis acid catalyst – $Ca(NTf_2)_2$ was employed in entries **7** – **9**. It is worth noting the reaction mixture requires heating for the formation of the active catalyst, due to poor solubility in lower temperatures. In each case, the reaction proceeded producing the desired allylsilane (**245a**). However, due to the higher temperatures, this similarly led to unwanted side products, dramatically decreasing the yield and with no gain in regioselectivity. It was therefore concluded, variation of the reaction conditions of the current catalytic system unable to improve the regioselectivity of the reaction. Hence, reasoning the regioselectivity of the reaction is highly dependent on the nature of the starting material. It is also worth noting there was no loss in stereoselectivity in the synthesis of the (*E*)-allylsilane (**245a**) and (*E*)-vinylsilane (**244a**), throughout the optimisation.

3.2.1.5 Cope Rearrangement of Vinylsilane Regioisomers

With minimal success in improving the regioselectivity from varying the reaction conditions of the allylation, attention was next turned to an alternative method in the hope that it could circumvent this issue. This was to involve the use of the Cope rearrangement, converting the regioisomers **243**/**244** into desired products **242**/**245** (**Scheme 41**).

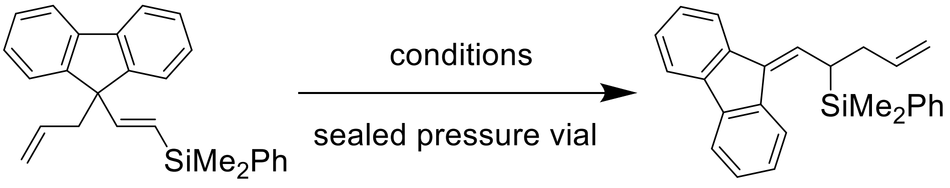


243/244 **242/245**

Scheme 41: Cope rearrangement of vinylsilane regioisomer

Therefore, **243** was subjected to elevated temperatures to facilitate a Cope rearrangement (**Table 44**). The solvent was changed to toluene to reach higher temperatures that could match the potential activation energy needed for this rearrangement. However, the reaction resulted in poor conversion of the starting material, even at elevated temperature of 150 °C and prolonged reaction times (Entry **1**). The mixture was heated proceeded to heat the mixture in a sealed pressure vial in DCE for 4 hours and a significant increase in conversion was observed leading to 83:17 (**242**:**243**) regioisomeric ratio (Entry **3**), enabling a significantly higher isolated yield of **242** (63%). With this promising result in hand, the reaction was monitored by ^{1}H NMR and the time of the reaction mixture being heated was increased to achieve full conversion.

Table 44: Cope optimisation of fluorenone derived β-(*E*)-vinylsilane



243 **242**

Entry	Solvent[a]	Temp (°C)	Time (h)	*E*/*Z* [b]	**242:243**[c]	Yield (%)[c]
1	Toluene	150	36	>99:1	67:33	27
2	DCE	85	4	>99:1	83:17	63
3	DCE	85	12	>99:1	97:3	80

[a] Solvent 0.5 M, [b] *E*/*Z* of **243** determined via analysis of the ^{1}H NMR of the crude reaction, [c] **242**:**243** ratio determined via analysis of the ^{1}H NMR of the crude reaction, [c] isolated yield of (*E*)-allylsilane only

Figure 16 shows the ^{1}H NMR of each stage of the reaction. Spectrum **1** shows the reaction after 30 minutes at room temperature. This showed the β-(*E*)-silyl-allylic alcohol (**208h**) was still present but also evidence of the simultaneous formation of both regioisomers (**242** and **243**). Spectrum **2** shows the reaction after 1 hour at room temperature. The β-(*E*)-silyl-allylic alcohol (**208h**) had been fully consumed which resulted in a 67:33 ratio (**242**:**243**). It is also worth noting only the (*E*)-allyl and (*E*)-vinyl products were observed. The reaction was then heated for 4 hours at 85 °C. Encouragingly, a dramatic increase in conversion of **243** into **242** was observed (Spectrum **3**). After 12 hours at 85 ˚C, the observed ratio of regioisomers was 97:3 (**242**:**243**) (Spectrum **4**). This resulted in a total isolated yield of 80% of **242**.

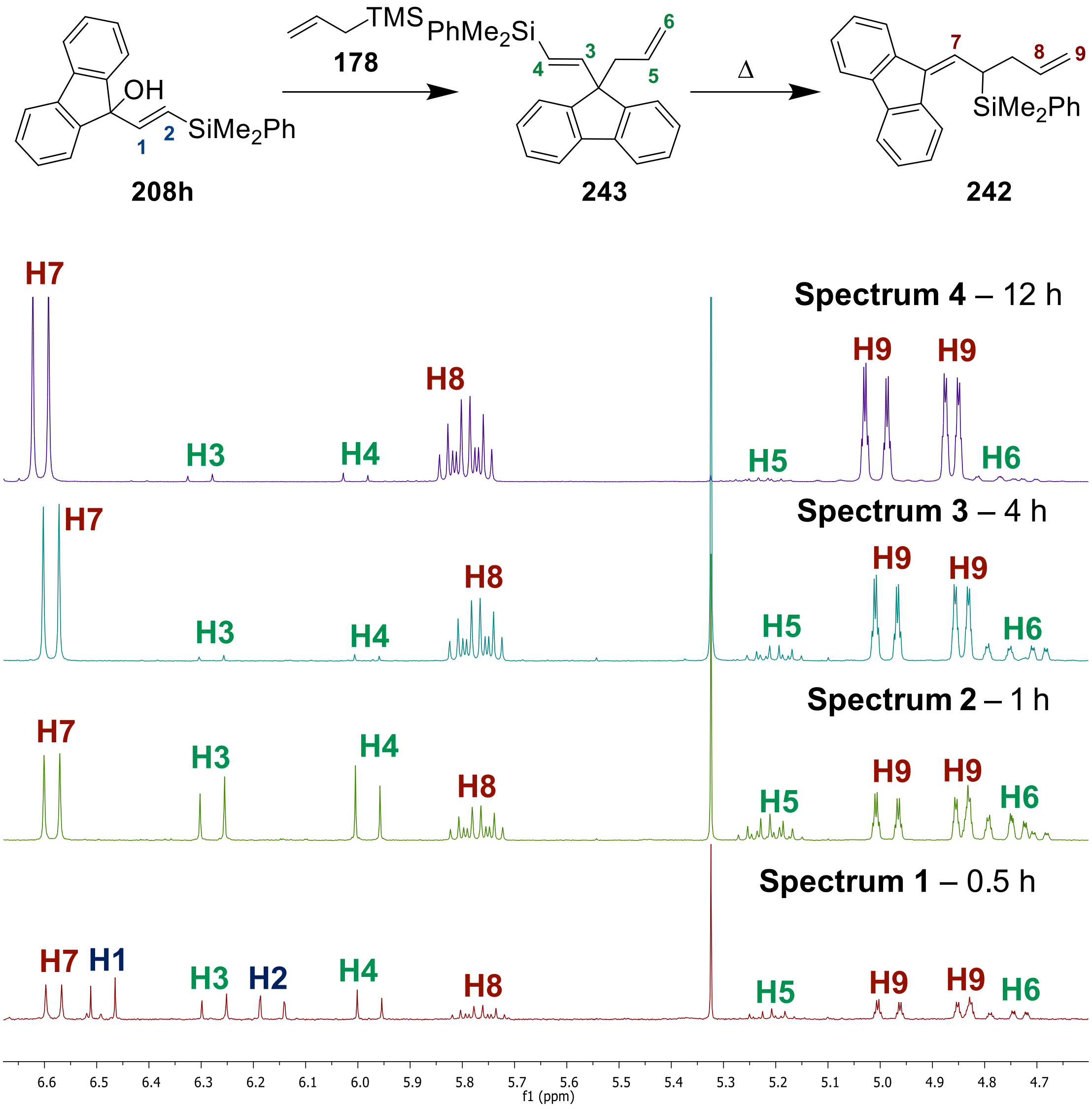
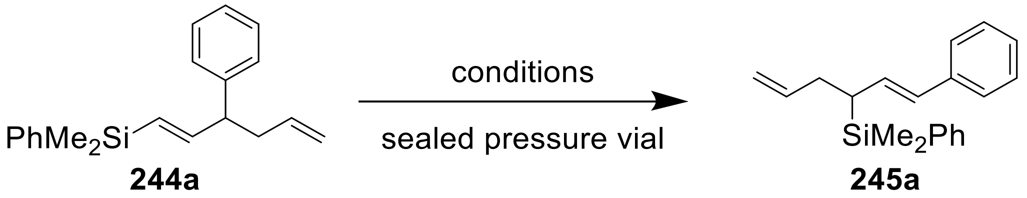


Figure 16: Stacked partial ^{1}H NMR of the crude reaction for Cope rearrangement of vinylsilane regioisomer ($CDCl_3$, 400 MHz, 298 K)

With this success, exploration of the Cope rearrangement of the monosubstituted substrates began, starting with **244a** (**Table 45**). The regioisomeric mixture was heated in DCE, in a sealed pressure vial at 85 °C and 100 °C, however even with prolonged reaction times, no conversion was observed (Entries **1** – **3**). The solvent was therefore changed the chlorobenzene, to accommodate heating to higher temperatures. Heating the mixture up to 140 °C led to minimal conversion of the regioisomer **244a** (Entries **4** – **5**). However, increasing the temperature to 150 °C led to a slight increase in conversion after 24 hours (Entry **6**). A further increase to 175 °C resulted in a 67:33 (**245a**:**244a**) ratio of regioisomers after 72 hours (Entry **7**). The highest conversion was achieved from heating **244a** at

175 °C for 144 hours in chlorobenzene affording a ratio of 71:29 (**245a**:**244a**) (Entry **9**). Increased reaction time did not result in an improvement in conversion. However, in attempt to lower the reaction time the temperature was increased to 200 °C and although this led to a faster rate of conversion, there was also a concomitant increase in the number of impurities observed and no further improvement was observed after 12 hours (Entry **8**).

Table 45: Optimisation of allylation-Cope reaction of monosubstituted vinylsilanes



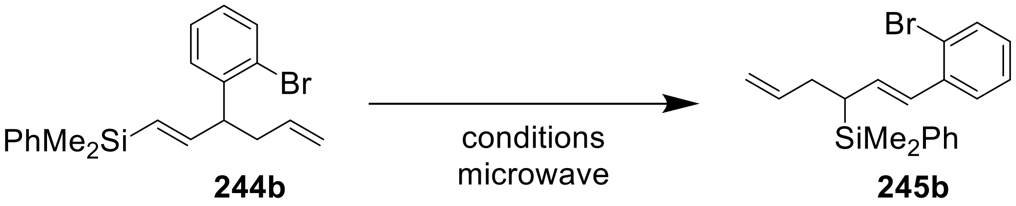
Entry	Solvent[a]	Temperature (°C)	Time (h)	*E*/*Z*[b]	**245:244**[c]
1	DCE	85	12	>99:1	31:69
2	DCE	100	2	>99:1	31:69
3	DCE	100	12	>99:1	31:69
4	Chlorobenzene	100	12	>99:1	31:69
5	Chlorobenzene	140	12	>99:1	31:69
6	Chlorobenzene	150	24	>99:1	36:64
7	Chlorobenzene	175	72	>99:1	67:33
8	Chlorobenzene	200	12	>99:1	67:33
9	Chlorobenzene	175	144	>99:1	71:29

[a] Solvent 0.5 M, [b] *E*/*Z* ratio of **244a** was determined via analysis of ^{1}H NMR of the crude reaction, [c] **245**:**244** ratio determined via analysis of the ^{1}H NMR of the crude reaction

Although conversion was significantly improved to increase the yield of the allylsilane **245a**, impractical reaction times and the use of toxic chlorobenzene is not ideal. In addition to this, the potential of higher temperatures being required to overcome the high activation energy needed for this Cope reaction to take place meant further optimisation of the monosubstituted substrates (**244a** – **c**) was required.

Therefore, to gain better conversion, the optimisation of the Cope methodology was continued employing a microwave reactor. This permits shorter reaction times with additional benefits to use solvents with lower toxicity. Therefore, **244b**:**245b** mixture (75:25) was subjected to elevated temperatures (**Table 46**).

Table 46: Microwave-assisted Cope rearrangement of monosubstituted vinylsilanes



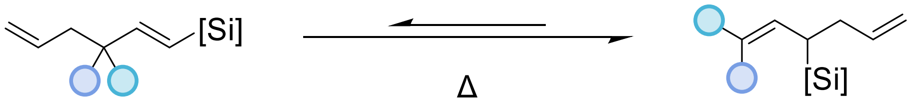
Entry	Solvent[a]	Temperature (°C)	Time (h)	*E*/*Z*[b]	**245b:244b**[b]
1	DCE	175	2	>99:1	71:29
2	DCE	175	6	>99:1	77:23
3	DCE	175	8	>99:1	77:23

[a] Solvent 0.75 M, [b] *E*/*Z* and **245b**:**244b** ratio determined via analysis of the ^{1}H NMR of the crude reaction

After just two hours at 175 °C, there was significant conversion resulting in a regioisomeric ratio of 71:29 (**245b**:**244b**) (Entry **1**). However, prolonged reaction times did not cause any significant increase in conversion to the desired allylsilane **245b**. The plateau of conversion may have resulted from reaching an equilibrium between the regioisomers (**245b** and **244b**), due to reversibility of the Cope rearrangement.

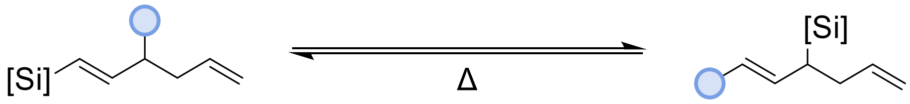
From the results above it can be deduced the Cope rearrangement of olefins such as **248** furnishes trisubstituted olefins (**249**), which are significantly more stable thermodynamic products due to increased alkene substitution. This is due to higher substituted alkenes being generally lower in energy (**Scheme 42** – **A**). In contrast, rearrangement of **250** leads to a disubstituted olefin (**251**), with no net increase in alkene substitution (**Scheme 42** – **B**). As a result, there is less thermodynamic driving force for the rearrangement to proceed, necessitating higher reaction temperatures and extended reaction times. Nevertheless, the resulting allylsilane (**251**) is still the thermodynamic product, likely due to conjugation between the olefin and the aromatic ring, which provides additional stabilisation and directs the rearrangement toward this major product.

A) Cope rearrangment of disubstituted vinylsilanes



248 **249**

B) Cope rearrangment of monosubstituted vinylsilanes

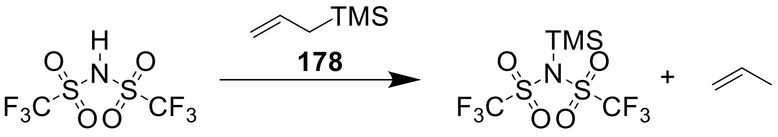


250 **251**

Scheme 42: Cope rearrangement of monosubstituted vs disubstituted vinylsilanes

3.2.2 Mechanistic Discussion

Literature has shown that when triflimide (**175**) and allyl-TMS (**178**) are reacted *in situ,* following protodesilylation results in the production of propene (**180**) and the formation of a Lewis-acid catalyst system (**179**) (**Scheme 43**). The Lewis acid (**179**) is deemed to be much more Lewis acidic than the Brønsted superacid (**175**), which acts as a pre-catalyst in this pathway.[149]



175 **179** **180**

Scheme 43: Reaction of allyl-TMS and triflimide forming a Lewis superacid

Thus, there is potentially more than one active catalyst within the allylation reaction – the TMS-triflimide Lewis acid (**179**) or the Brønsted triflimide superacid (**175**), enabling two different modes of activation of β-(*E*)-silyl-allylic alcohols (**202**) (**Figure 17**).

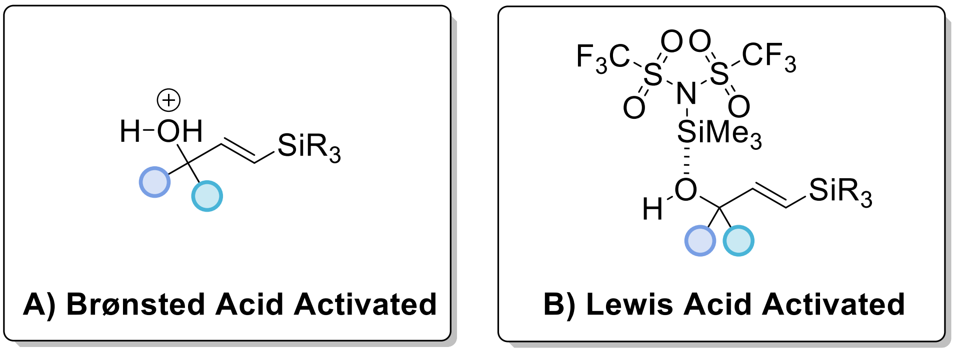
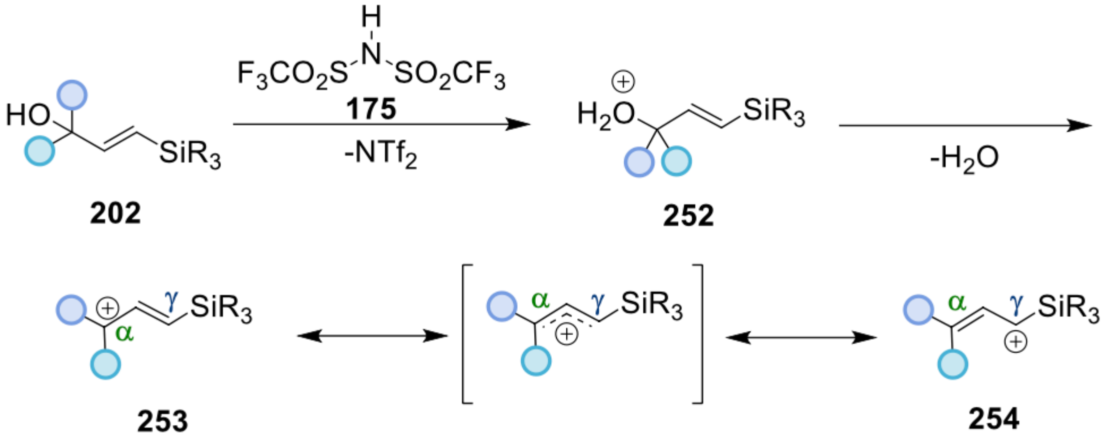


Figure 17: Modes of activation of β-(*E*)-silyl-allylic alcohols

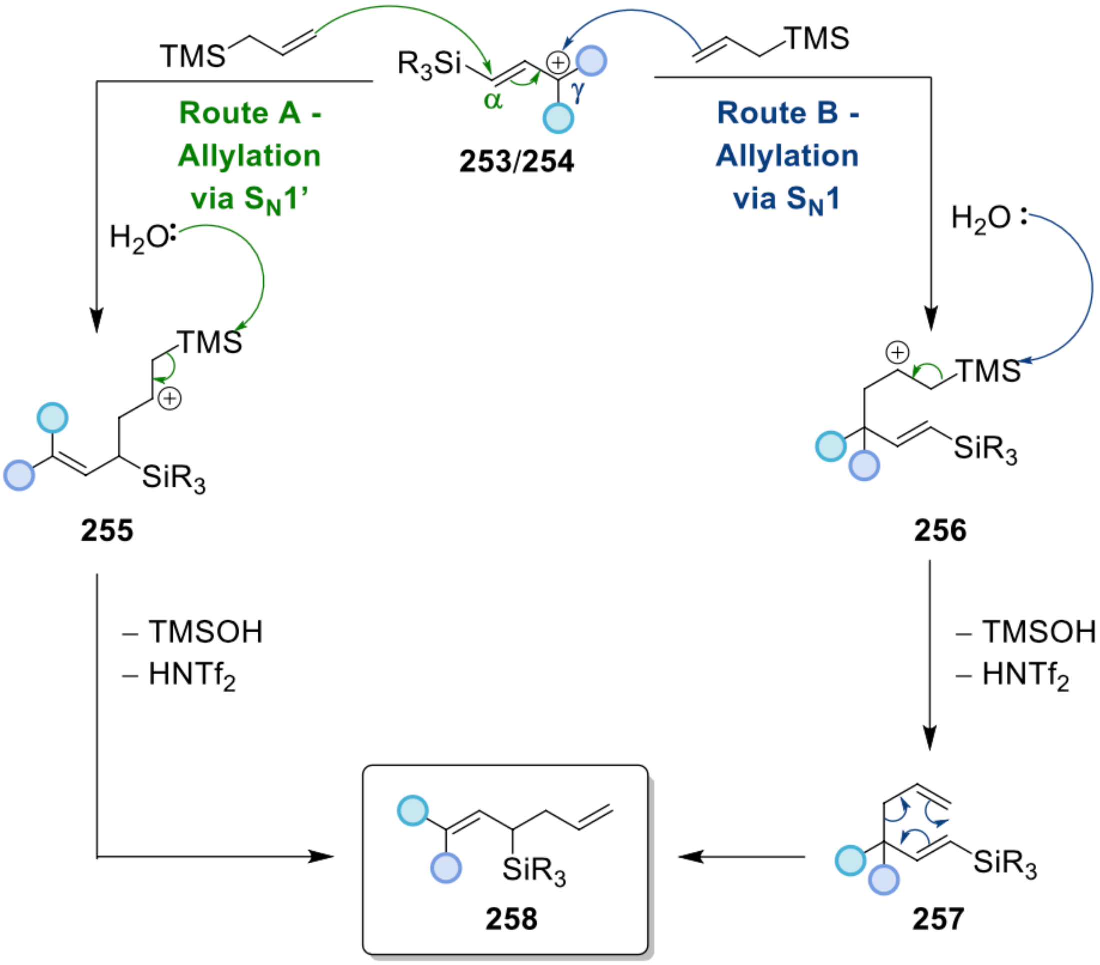
The first activation mode **A** is a Brønsted acid pathway, where triflimide behaves as a typical Brønsted acid, protonating the hydroxyl group and releasing water. On the other hand, it can behave as a pre-catalyst to form the Lewis acid TMS-triflimide catalyst (**175**). The *in situ* generated Lewis acid can coordinate with the oxygen atom of the hydroxy group within the vinylsilane substrate activating the C-O bond (activation mode **B**), thereby decreasing the LUMO energy of this carbon-oxygen bond and promoting nucleophilic addition. To determine the active catalyst, the allylation was repeated with 2,6-di-*tert*-butyl pyridine (DTBP), a Brønsted acid inhibitor. This resulted in no reaction taking place, therefore the allylation must be catalysed by a Brønsted acid. This is also supported by the little tolerance of basic functional groups during substrate scope investigations.

There are two potential electrophilic sites which are subject to nucleophilic attack evident from the formation of regioisomeric mixtures in some cases. It was shown the steric environment around the electrophilic sites influences the site of nucleophile attack heavily, which in turn affects the regioselectivity of the reaction. It is believed the allylation proceeds via an S_N1/S_N1' mechanism due to the formation of stable allylic carbocation intermediates **253** and **254** (**Scheme 44**). In addition, these carbocations are also stabilised via conjugation with the substituted aryl ring at the γ-position.



Scheme 44: Brønsted acid catalysed the formation of allylic carbocations from vinylsilanes

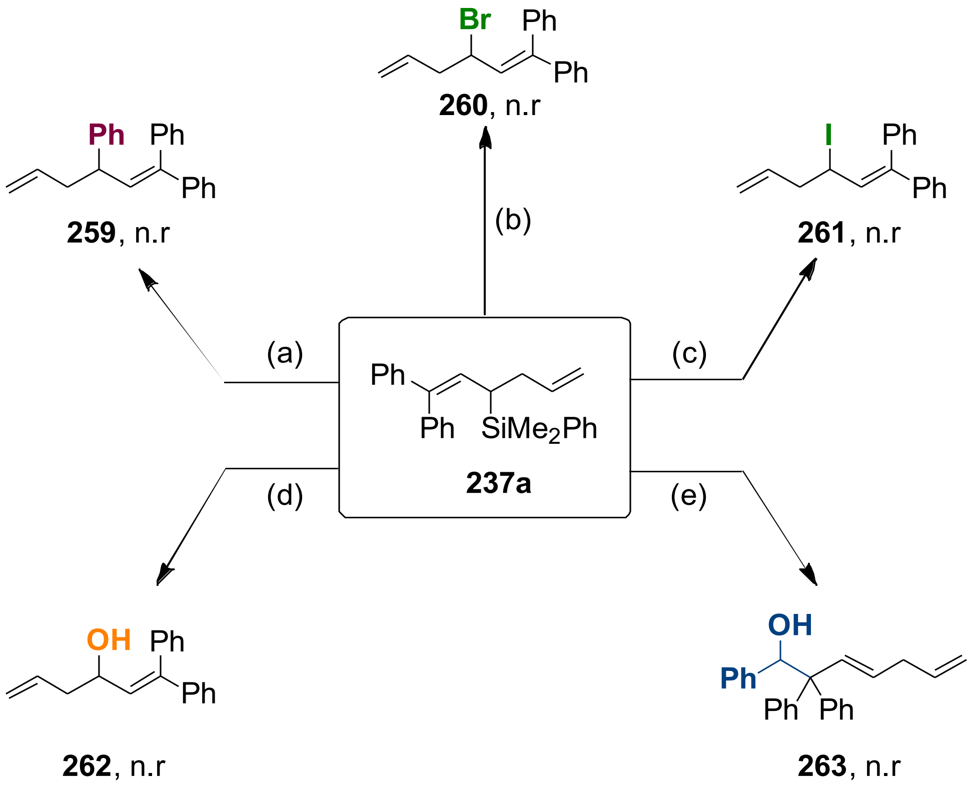
Therefore, the allylation can proceed via two pathways and is substrate dependant (**Scheme 45**). A higher substitution on the γ-position favours direct allylation at the α-position derived from the nucleophilic attack at the least hindered position (kinetic). With lower substitution at the γ-position there is less steric hindrance which facilitates attack at the γ-position. In this case, this γ-position is now the least hindered site as opposed to the α-position being adjacent to the bulky silane moiety. Both allylations lead to β-silylcarbocation intermediates **255** and **256**. TMS elimination is achieved through nucleophilic addition of water – forming a strong Si-O bond, which helps drive this step and generates the terminal allylic olefin. This results in the formation of the regioisomers **257** and **258**, the by-product; silanol and regeneration of the active catalyst **175**. The regioisomer (**257**), can then undergo a Cope rearrangement to afford the desired allylsilane (**258**).



Scheme 45: Allylation mechanism pathways for the synthesis of allylsilanes

3.2.3 Attempted Diversification of Allylsilanes and the Synthesis of 1,5-Dienes

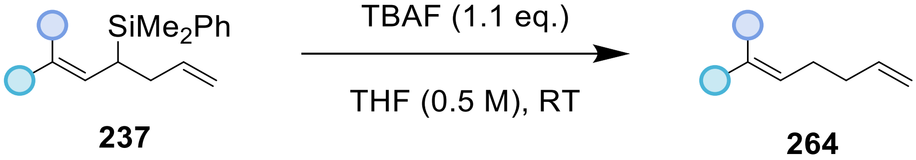
Efforts to diversify the allylsilane scaffolds were undertaken, as illustrated in **Scheme 46**. Initial attempts focused on Hiyama cross-coupling of compound **237a** to generate derivative **259**; however, all optimisation strategies failed, consistently yielding complex mixtures with no identifiable target product. Subsequently, halogenation strategies employing *N*-iodosuccinimide (NIS) and *N*-bromosuccinimide (NBS) were explored, with the intention of generating halogenated intermediates (**260** and **261**) amenable to further cross-coupling transformations. These reactions, however, also proved unsuccessful, similarly resulting in decomposition or the formation of non-isolable product mixtures. Attempts to achieve a Fleming–Tamao-type oxidation of **237a**, with the goal of accessing the corresponding allylic alcohols (**262**), were likewise unsuccessful. Furthermore, multiple attempts at Sakurai allylation failed to deliver the anticipated products (**263**) under a variety of conditions.

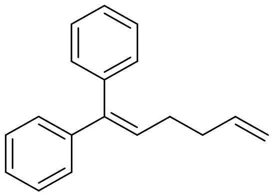
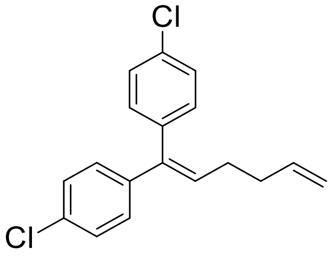
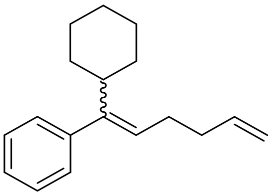


Scheme 46: Attempted diversification of allylsilanes: (a) TBAF, iodobenzene, $Pd_2(dba)_3 \cdot CHCl_3$, THF, RT (b) NBS, MeCN, 50 °C (c) NIS, MeCN, RT (d) TBAF, THF, 0 °C, 10 min then H_2O_2, MeOH, $KHCO_3$, THF, 0 °C to RT. (e) benzaldehyde, $BF_3 \cdot OEt_2$, DCM 0 °C to RT.

Many of the reactions require elimination of the silane moiety to activate the allylsilanes towards functionalisation. Therefore, we began to investigate the feasibility of the silyl-elimination via protodesilylation reactions mediated by TBAF (**Table 47**). 1,5-dienes **264a** and **264b** were formed in good yields of 70% and 87%, respectively. (*Z*)-**264l** was also subjected to protodesilylation and although resulted in good yield, led to the product **264c** being formed in a mixture of stereoisomers with a 44:56 *E*/*Z* ratio.

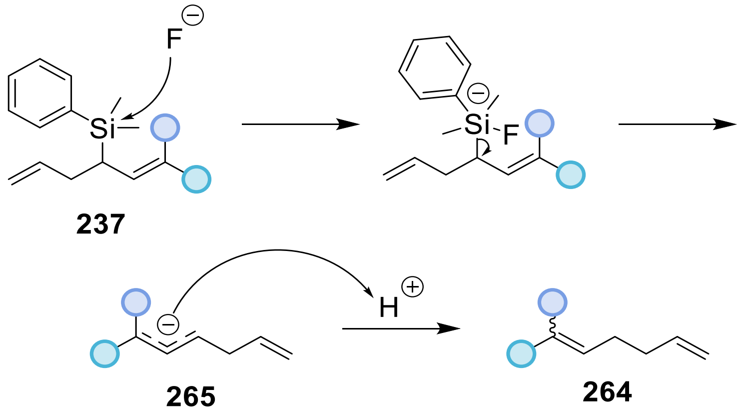
Table 47: Protodesilylation of allylsilanes forming 1,5-dienes



		
264a, 70%	**264b**, 87%	**264c**, 73%, *E*/*Z* 44:56[a]

[a] *E*/*Z* ratio determined via analysis of ^{1}H NMR of the crude reaction

Within the literature, it is suggested that this protodesilylation follows a concerted mechanistic pathway, in which it proceeds via a pentacoordinate silicon anion species.[60, 61] However, in this case it is believed the reaction proceeds via a stepwise mechanism, where the silicon moiety leaves forming an allylic stabilised anion (**265**) (**Scheme 47**). This means the intermediate can lead to multiple sites of attack and accounts for the formation of *E*/*Z* isomers and complex mixtures that may be formed during diversification attempts. It was noted that regioisomers were not observed and this was reasoned to be due to the reaction favouring the formation of the more stable thermodynamic product due to conjugation and being the higher substituted olefin.



Scheme 47: Reaction mechanism of the protodesilylation of allylsilanes

3.3 Conclusions

The metal-free catalysed allylation has been sufficiently optimised, with a range of conditions studied. Overall, the reaction tolerates varied vinylsilanes well, giving varied substituted allylsilanes in moderate to excellent yields (55 – 97%). The reaction however was shown to be less tolerant to alkyl substituents in the γ-position relative to the silane group, which resulted in lower yields. This is due to a competing elimination reaction producing 1,3-dienes. The methodology also highlights limitations towards basic functional groups, such as amines, as it provides a pathway to inhibit the catalytic pathway.

Additional optimisation studies took place of the Brønsted superacid triflimide to improve the regioselectivity of less hindered substrates. Whilst we were unable to find a suitable set of conditions to increase the level of regioselectivity, we did note that steric interactions around the reactive site proved to be a crucial factor in determining the levels of regioselectivity in the reaction. This gave insight into the mechanistic theories, in which both allylation pathways are participating simultaneously.

Subsequent investigations in to the Cope rearrangement of vinylsilane regioisomer took place. This allowed access to the desired allylsilanes and evidence in support of the feasibility of the rearrangement being used to be able to circumvent regioselectivity issues from less hindered substrates. Although complete conversion could not be achieved in all substrates, improvement of conversion led to much higher yields of the desired product.

Several diversification methods were attempted to further diversify the allylsilanes, however, were unsuccessful. However, 1,5-dienes were successfully formed in high yield via protodesilylations. Although accompanied by a loss of stereochemistry, potentially accounting for the complex mixtures formed during diversification attempts, as multiple addition products may be formed.

Collectively, this methodology offers a rare metal-free route to novel allylsilanes with operational simplicity. Whereas most reported syntheses rely heavily on transition-metal catalysis under strict inert and anhydrous conditions, this reaction proceeds without such requirements and still delivers efficient, and highly selective synthesis, setting it as a complementary alternative to metal-catalysed strategies.

4 Chapter 4 – Synthesis of α-Silyl Acrylamides

4.1 Introduction

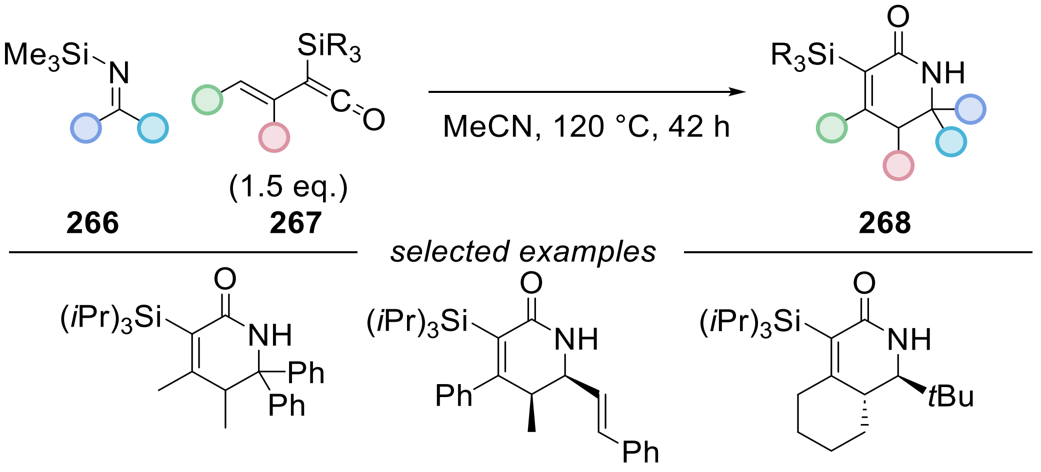
As outlined in Chapter 1, silyl-substituted medicinal compounds remain highly desirable yet underexplored in medicinal chemistry. These motifs offer significant potential as innovative alternatives to their carbon-based analogues, with the capacity to improve ADMET properties and enhance biological activity and selectivity. Acrylamides, in particular, are of notable interest due to their widespread use as covalent warheads. The substitution pattern around the acrylamide moiety plays a crucial role in modulating both potency and target selectivity. Accordingly, the development of silyl-substituted acrylamides could represent a valuable advancement in the design of next-generation therapeutics. However, progress in this area has been limited, primarily due to the synthetic challenges associated with accessing these motifs through selective and reliable methodologies.

4.1.1 Previous Synthesis of α-Silyl-Acrylamides

As previously discussed, there is limited literature on the synthesis of silyl-substituted amines or amides via hydrosilylation chemistry. However, a few reports describe elegant non-hydrosilylation methodologies for accessing silyl-α,β-unsaturated amides.

Notably, several methodologies for the synthesis of α-silyl acrylamides involve the use of isocyanates or ketenes. In 1999, Danheiser and co-workers reported a hetero Diels–Alder reaction involving (trialkylsilyl)vinylketenes (TAS-vinylketenes, **267**) and imino dienophiles (**266**), yielding a series of α,β-unsaturated δ-valerolactams (**268**) (**Table 48**).[164] The authors proposed that the transformation proceeds via either a concerted or stepwise [2+2] cycloaddition mechanism, resulting in the formation of cyclic α-silyl-α,β-unsaturated amides (**268**). While this methodology offers an elegant route to these motifs, its scope is limited to substrates bearing basic aryl and alkyl groups, with no electron-rich or electron-deficient substituents explored.

Table 48: Cycloadditions of TAS-vinylketenes with *N*-(TMS)imines

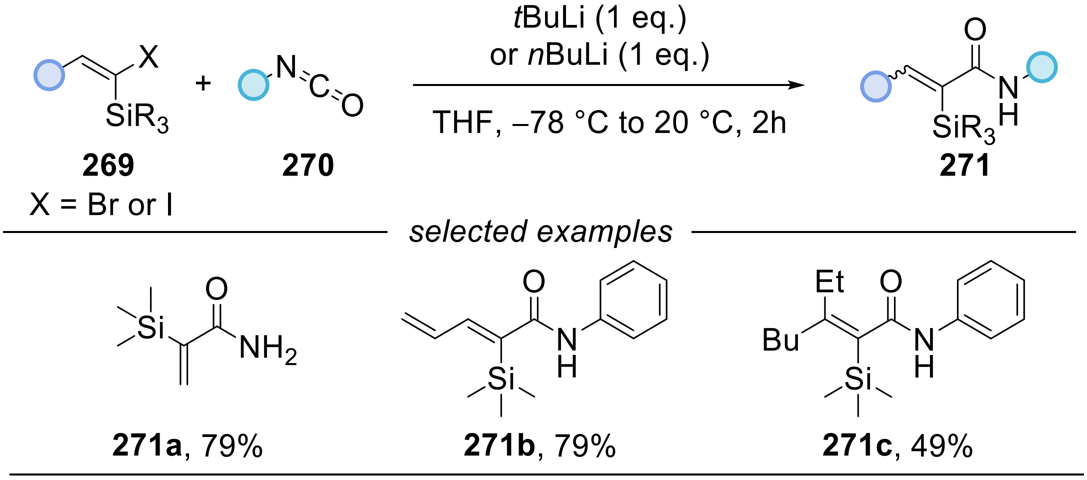


268a, 79%[a] **268b**, 78%[b] **268c**, 56%[c]

[a] Reflux in MeCN for 1 - 25 h, [b] no solvent, 5 min to 2 h at RT, [c] 3 eq. of **266** at 110 °C in MeCN (sealed tube) for 90 h.

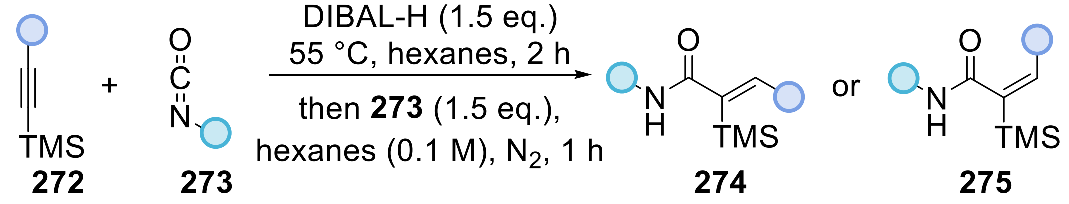
Cooke *et al.* reported an efficient approach in which nucleophilic α-silylvinyl reagents (**269**) were added to isocyanates (**270**) to furnish α-silyl-α,β-unsaturated amides (**271**) (**Table 49**).[103] The methodology enabled access to these targets in moderate to good yields. For example, hydrolytic removal of the *N*-TMS protecting group furnished the free amine product (**271a**) in 79% yield. Substrates bearing higher substitution at the β-position (relative to the silyl group) were also well tolerated, although with slightly reduced efficiency, giving product **271c** in 49% yield. Despite its merits, the methodology is limited by a narrow substrate scope, with minimal investigation of electron-rich or electron-poor systems, thereby restricting its synthetic generality and diversity.

Table 49: Addition of nucleophilic α-silylvinyl reagents to isocyanates

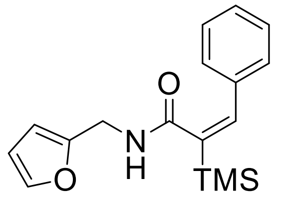


Jung and co-workers reported a hydroalumination strategy for the synthesis of α-silyl-α,β-unsaturated amides (**274** or **275**) via the reaction of TMS-substituted alkynes (**272**) with diisobutylaluminium hydride (**Table 50**).[165] The authors demonstrated that stereoselectivity could be modulated through solvent choice; reactions conducted in hexanes afforded the corresponding (*E*)-alkenes with high stereoselectivity across a range of isocyanate and alkyne substitutions. Conversely, the use of a 5:1 hexanes/THF solvent mixture favoured the formation of (*Z*)-alkenes, again with high stereoselectivity and good yields. The influence of electronic substituents on stereoselectivity was also investigated. Substrates bearing an electron-donating *p*-methoxy group resulted in reduced stereoselectivity (*E*/*Z* = 87:13). This was attributed to isomerisation of a silyl-substituted alkenylaluminium intermediate (**276**), where the *p*-methoxy substituent stabilises the intermediate **277** via resonance, increasing the rate constant k_{-2}. In contrast, substrates bearing an electron-withdrawing *p*-trifluoromethyl group were proposed to destabilise the intermediate **277** via inductive effects, thereby decreasing k_1, which similarly led to a reduction in stereoselectivity.

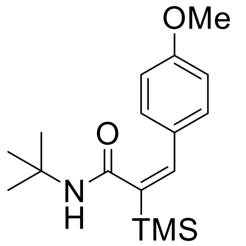
Table 50: Hydroalumination of TMS-substituted alkynes



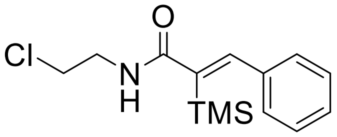
selected examples



275a, *E*/*Z* >99:1, 89%

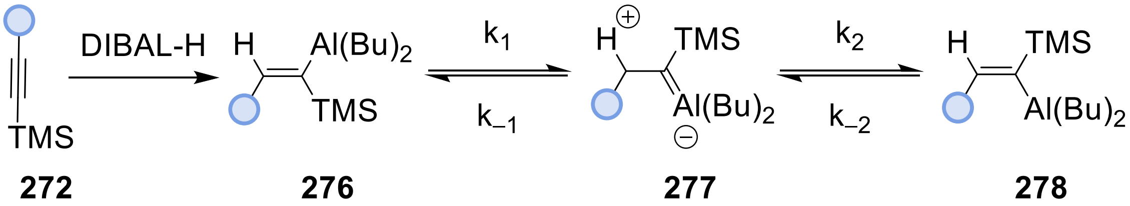


275b, *E*/*Z* 87:13, 90%



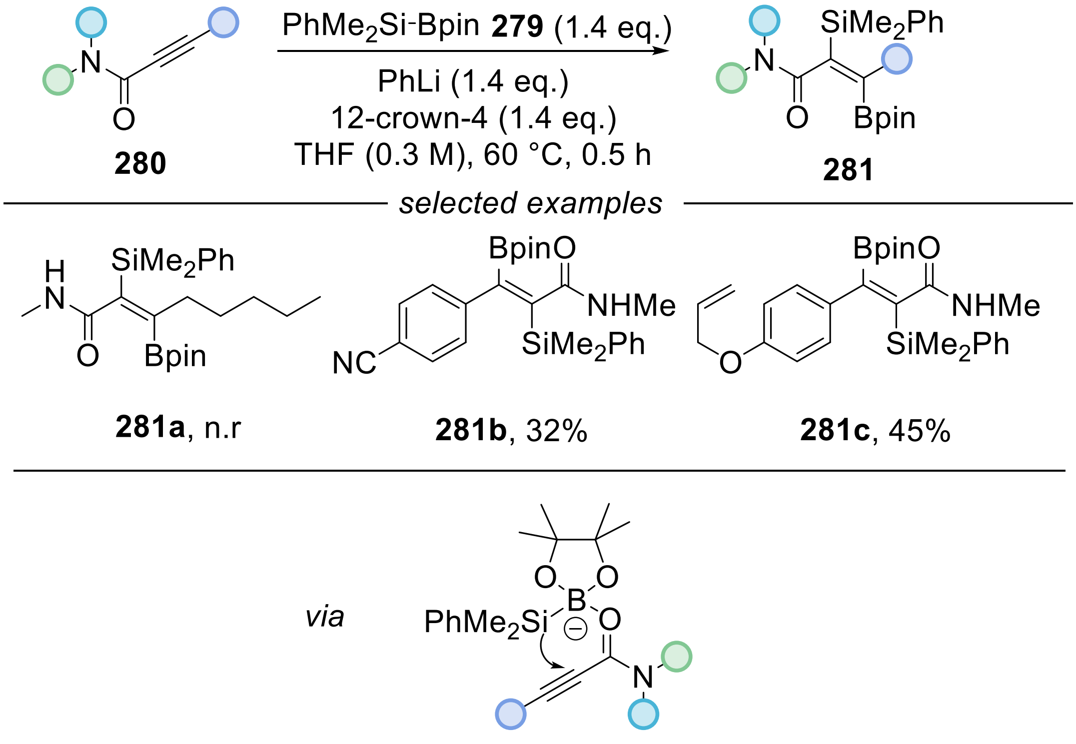
274a, *E*/*Z* >1:99, 95%[a]

[a] hexanes/THF (5:1)



More recently, Santos and co-workers reported a Brønsted base mediated silaboration to give (*Z*)-α-silyl-β-boryl-aryl acrylamides (**281**) (**Table 51**).[166] The reaction proceeds in a *trans*-fashion which is achieved through the formation of the Lewis acid-base adduct **282**, followed by sequential intramolecular α-silyl-β-borylation. This methodology provides excellent stereoselectivity favouring the (*Z*)-olefin. The method tolerated protecting groups and strongly electron withdrawing groups such as cyano moieties **281b**, albeit in lower yields. The lower yield was accounted for as a likely complication from butyllithium reacting with the benzonitrile. Also, alkyl-substituted propiolamide resulted in no product formation as a result of the lack of delocalisation of electrons from the resulting carbonic intermediate.

Table 51: Synthesis of (*Z*)-α-silyl-β-boryl-aryl acrylamides



280 → **281**

281a, n.r

281b, 32%

281c, 45%

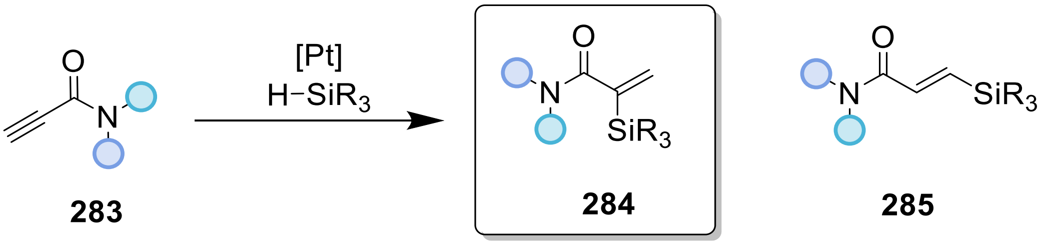
282

There have also been other single entries within substrate scopes incorporating a selected few silyl-α,β-unsaturated amides.[86, 87, 167, 168] However, the precedent for a general synthesis of these compounds as discussed is limited. In addition, although these examples formed the α-isomer in high regioselectivity. There are several drawbacks including the use of strictly anhydrous conditions and highly toxic isocyanates somewhat limits the reactions uptake beyond what is commercially available. Furthermore, the lack of Lewis basic functional groups in many of these methods limits their usefulness in terms of complex target synthesis and medicinal chemistry.

4.2 Aims

As discussed, vinylsilanes which incorporate new functionality can be easily applied within the growing interest in pharmaceutical chemistry. The work in this chapter aims to form simple silicon-containing building blocks which can be amenable to synthetic manipulation and hence find applications within drug discovery. However, the general lack of silicon-containing pharmaceutical products has come from the of lack of general methods for their accessibility. In addition to this, the commonly seen amide/amine functionality which is highly sought after within many medicinally relevant structures has been difficult to achieve.

As such, the feasibility of designing a catalyst system that would allow access synthesis of silyl-α,β-unsaturated amides via platinum catalysed hydrosilylations will be explored. This would allow the existence of simple silicon-containing building blocks that are amenable to synthetic manipulation and potential further applications within drug discovery. Another main consideration is the selective synthesis towards vinylsilanes due to the potential of many isomers being formed. Here careful consideration will be taken into catalyst design from choice of ligands. This is evidenced by the lack of suitability and tolerance to nitrogen containing compounds in platinum catalysis. Therefore, the aim of this work will be the development of regioselective hydrosilylation reactions of propynamides **283** to synthesise α-silyl-α,β-unsaturated amides **284** (**Scheme 48**).



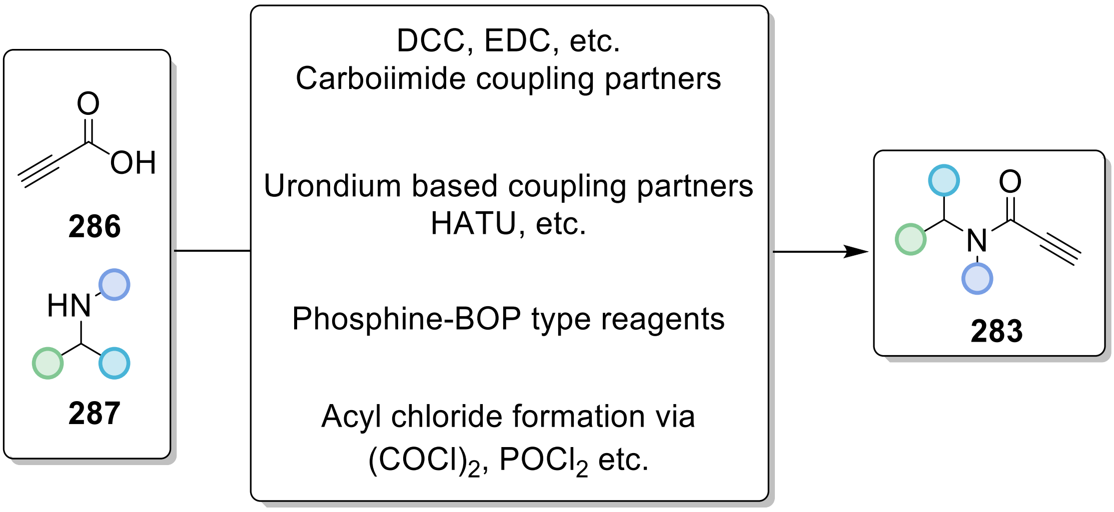
Scheme 48: Platinum catalysed hydrosilylation of propargylic amides

4.3 Results and Discussion

The work presented in this section has been published in part as: Leonard, E., Boyd, M., Akien, G. and McLaughlin, M., *Chem. Commun.,* 2025, **61**, 14121-14124.[169]

4.3.1 Synthesis of Propynamides

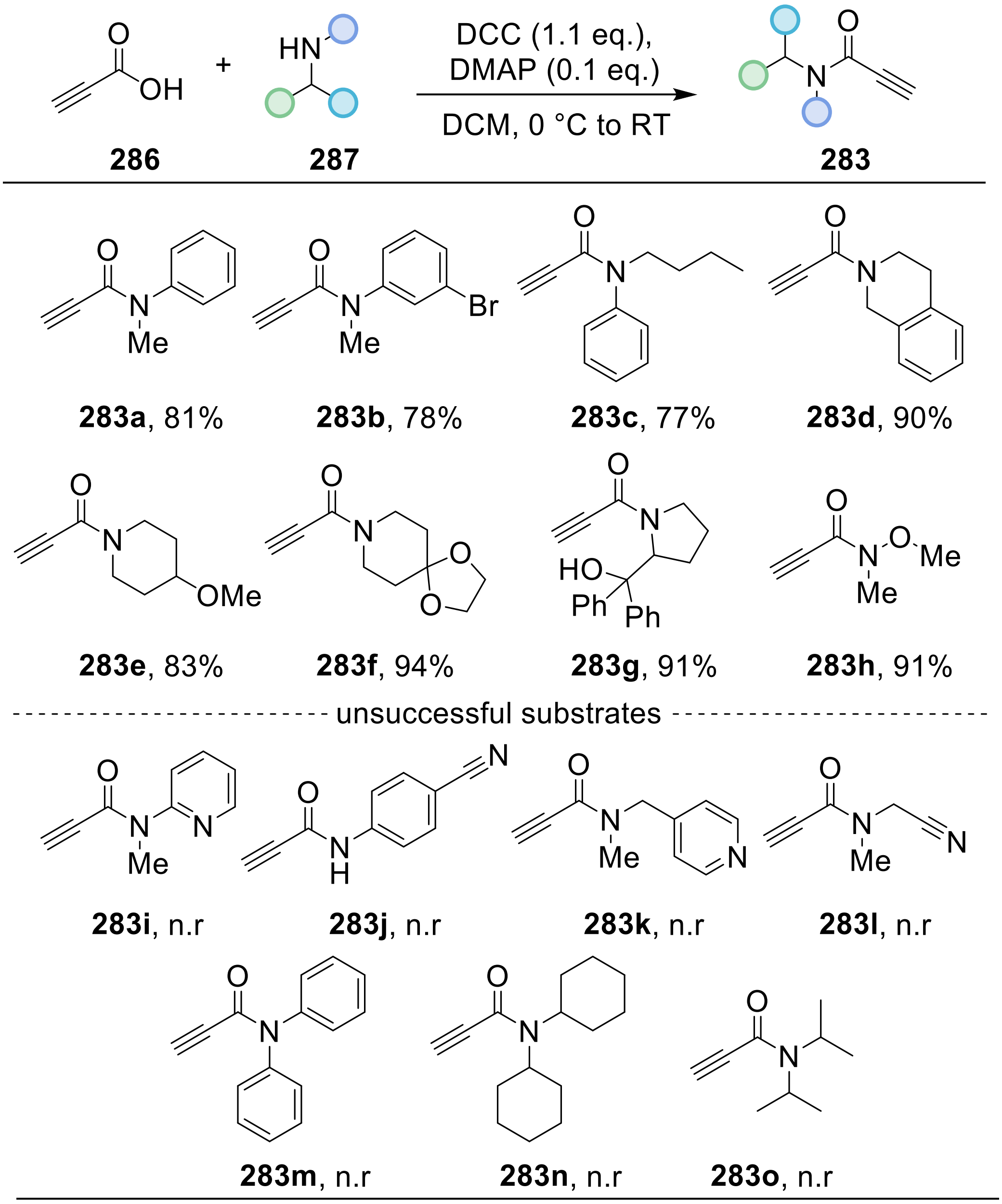
As the methodology requires access to a range of diverse propynamides (**283**), the synthesis of these substrates was initially undertaken. Typically, amide formation involves the coupling of a carboxylic acid (**286**) and an amine (**287**) using a variety of coupling partners (**Scheme 49**). Alternatively, amides can be synthesised via acyl chlorides derived from the corresponding carboxylic acids.



Scheme 49: Synthetic routes towards propynamides

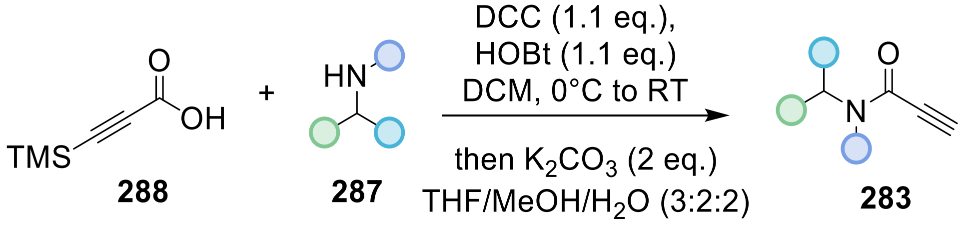
Initial efforts focused on the use of carbodiimide coupling partners, following the literature procedure reported by Chen *et al*. The reaction of propiolic acid with a range of amines was facilitated by DCC in the presence of DMAP as a catalyst (**Table 52**).[170] Substrates **283a** – **f** were obtained in good to excellent yields (77 – 94%), with the reaction showing good tolerance toward electron-donating, electron-withdrawing, and alkyl substituents. The sterically hindered substrate **283g** was isolated in excellent yield (91%), attributed to the careful control of the addition sequence, which avoided undesired esterification arising from the free alcohol group. A Weinreb amide derivative (**283h**) was also successfully formed in 91% yield, providing a valuable functional handle for further diversification. In contrast, substrates **283i** and **283j** proved significantly more challenging, with no product formation observed. The lack of reactivity was attributed to diminished nucleophilicity of the amines, likely due to strongly electron-withdrawing nitrogen substituents on the aromatic ring. Benzyl and simple alkyl derivatives also failed to afford the desired products (**283k** and **283l**) under the tested conditions. The bisphenyl-substituted substrate **283m** similarly failed to react, likely due to electronic deactivation of the aromatic system. Additionally, substrates **283n** and **283n** bearing bulky aliphatic groups were unreactive, and no successful coupling was achieved.

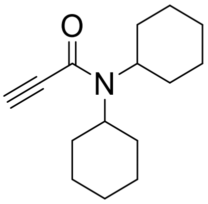
Table 52: DCC and DMAP mediated synthesis of propynamides



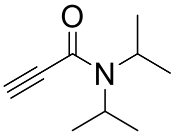
The literature procedure reported by Oakdale and co-workers was therefore adopted, employing a TMS protected alkyne (**288**) and HOBt as an additive (**Table 53**).[171] This method involves the formation of a TMS protected propynamide intermediate, followed by subsequent TMS deprotection to afford the corresponding free propynamide (**283**). Using this approach, substrates **283n** and **283o**, which were previously inaccessible via the earlier synthetic route, were obtained in moderate to good yields. The methodology also enabled the synthesis of secondary propynamides (**283p** – **r**), although these were generally isolated in lower yields. The reduced yields were attributed to purification challenges, specifically coelution with the urea byproduct (DCU) formed during the reaction. Attempts to synthesise **283k** and **283l** under these conditions again proved unsuccessful.

Table 53: DCC and HOBt mediated synthesis of propynamides

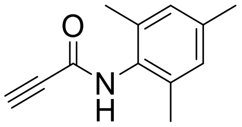




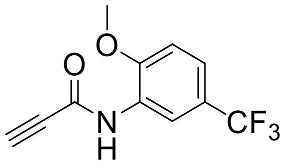
283n, 51%



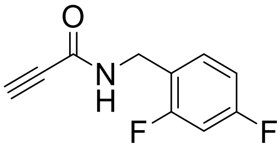
283o, 63%



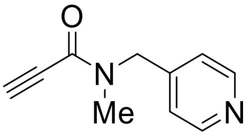
283p, 64%



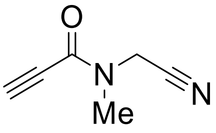
283q, 17%



283r, 50%



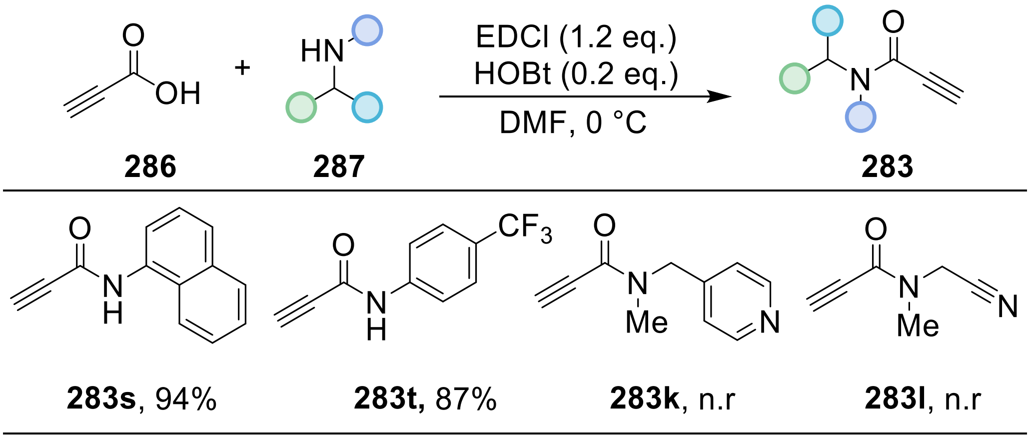
283k, n.r



283l, n.r

Although many examples gave good results, challenges associated with the presence of DCU, along with unsuccessful attempts to form substrates containing strongly electron withdrawing and pyridine functionalities, indicated that DCC was insufficient. As an alternative, the derivative carbodiimide reagent EDCI was employed. Unlike DCC, EDCI generates a water-soluble urea byproduct that can be readily removed during aqueous workup, simplifying purification. As a result, secondary alkynes **283s** and **283t** were obtained in excellent yields of 94% and 87%, respectively (**Table 54**). However, substrates **283k** and **283l** again failed to undergo successful coupling under these conditions.

Table 54: EDCI and HOBt mediated synthesis of propynamides

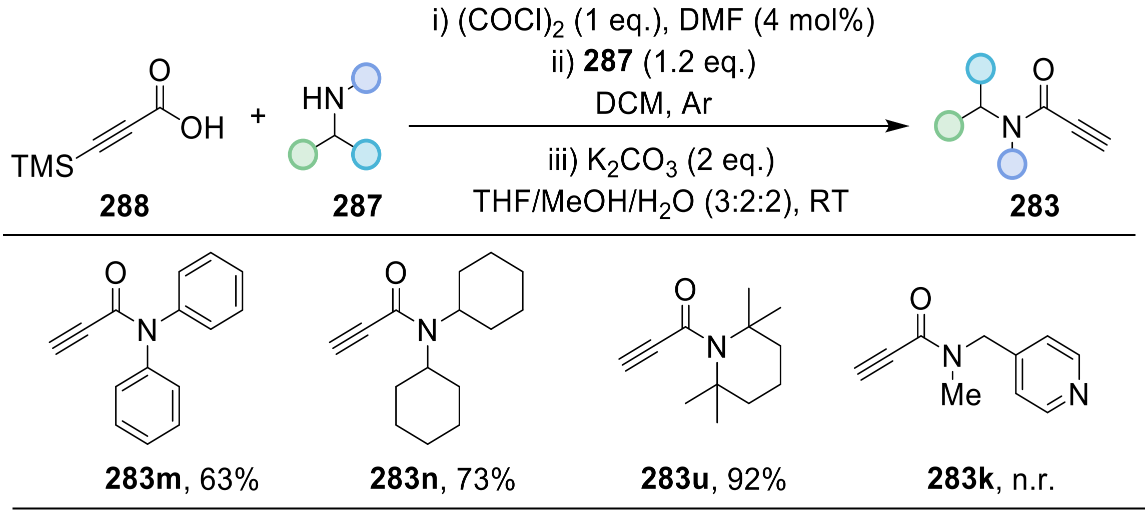


286 **287** **283**

283s, 94% **283t,** 87% **283k**, n.r **283l**, n.r

Another effective synthetic route for amide formation involved generating the acyl chloride derivative of propiolic acid. This method proved successful in synthesising compounds that had previously been inaccessible using earlier approaches, such as **283m**, and led to improved yields for the formation of **283n** (**Table 55**). The bulky piperidine substituted substrate **283u** was also obtained in excellent yield using this method. However, substrate **283k** once again failed to react, even under these modified conditions.

Table 55: Synthesis of propynamides via acyl chloride formation

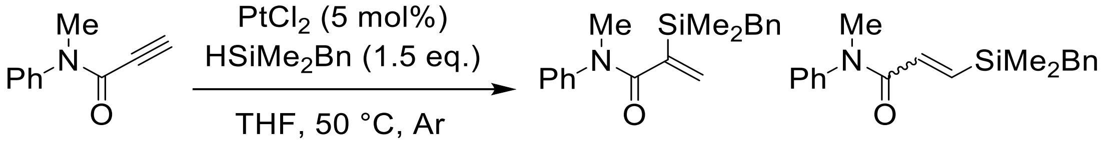


288 **287** **283**

283m, 63% **283n**, 73% **283u**, 92% **283k**, n.r.

4.3.2 Synthesis of α-Silyl-Acrylamides

Following the preparation of a library of diverse propynamides, the synthesis of silyl-substituted acrylamides was investigated. Initial studies focused on the hydrosilylation of *N*-methyl-*N*-phenylpropynamide **283a** as the prototypical amide. Using non-ligated platinum(II) chloride, the reaction afforded a regioisomeric mixture (67:33 α:β), with the β-isomer (**285a**) additionally formed as an 81:19 *E/Z* mixture (**Scheme 50**). Although the reaction showed preferential formation of the α-isomer **284a**, the level of regioselectivity was insufficient, highlighting the need for further optimisation through ligand screening.



283a **284a** **285a** (E/Z = 81:19)

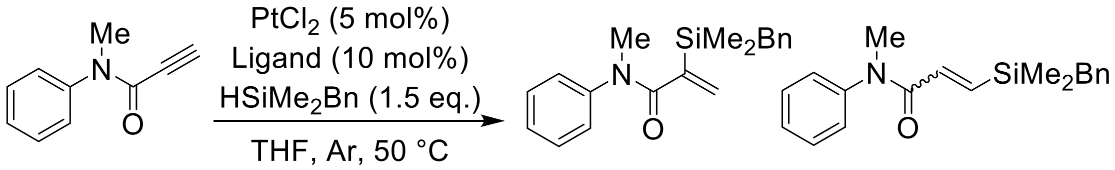
α:β = 67:33

Scheme 50: Platinum catalysed hydrosilylation of propynamides

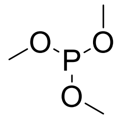
4.3.2.1 Ligand Screen Optimisation Studies

Attention was therefore directed toward an in-depth ligand study, initially focusing on monodentate phosphine ligands (**Table 56**). The reactions were monitored via ^{1}H NMR using 1,3,5-trimethoxybenzene as an internal standard to calculate the consumption of the starting material and the relative selectivity. Trimethylphosphite resulted in the formation of the β-isomer **285a** in high regioselectivity (19:81, α:β) and excellent stereoselectivity (>99:1 *E*/*Z*). However, with low consumption of the starting material (39%). Similarly, tripropan-2-ylphosphine gave poor conversion (44%) and a significant loss of regioselectivity, resulting in a near 1:1 ratio of α- and β-isomers. Triphenylphosphine failed to promote the reaction, with no detectable formation of either isomer. The use of the bulky ligand CataXium A led to improved conversion and enhanced regioselectivity, favouring formation of the β-isomer (21:79, α:β). Conversely, tricyclohexylphosphine resulted in the formation of the α-isomer as the major product in moderate regioselectivity (73:27 α:β), with complete consumption of the starting material alkyne **283a**. Notably, the electron-deficient tris(pentafluorophenyl)phosphine ligand resulted in complete regioselective transformation forming the product as a single isomer **284a**, with complete consumption of the starting material. In contrast, tri(*o*-tolyl)phosphine resulted in decreased regioselectivity and preferential formation of the β-isomer, along with a slight reduction in stereoselectivity (93:7, *E/Z*). It was noted during optimisation studies the reaction needed to be performed under anhydrous and inert conditions. Exposure to air and moisture significantly reduced product formation and adversely affected the regioselectivity.

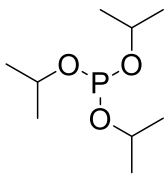
Table 56: Monodentate phosphine ligand screen



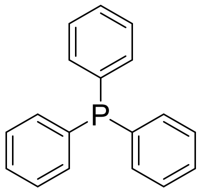
283a **284a** **285a**



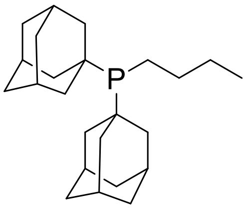
Trimethyl-phosphite
α:β ratio = 18:82
E:*Z* ratio = >99:1
Conversion = 39%



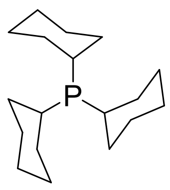
Tripropan-2-yl-phosphite
α:β ratio = 50:50
E:*Z* ratio = >99:1
Conversion = 44%



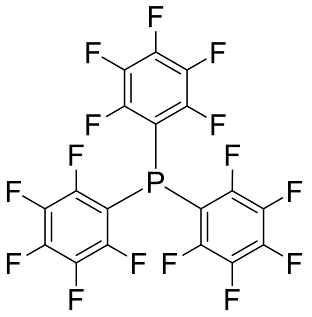
Triphenyl-phosphine
n.r.



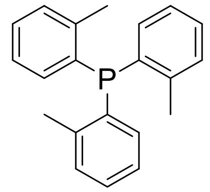
CataCXium A
α:β ratio = 21:79
E:*Z* ratio = >99:1
Conversion = 67%



Tricyclohexyl-phosphine
α:β ratio = 73:27
E:*Z* ratio = >99:1
Conversion = 99%



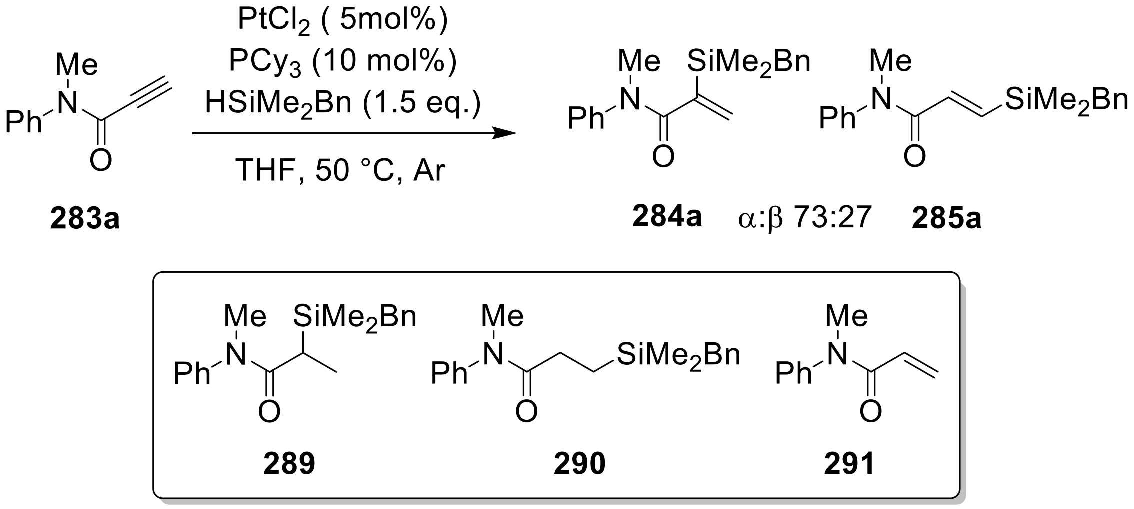
Tris(pentafluorophenyl)-phosphine
α:β ratio = >99:1
Conversion = >99%



Tri(*o*-tolyl)phosphine
α:β ratio = 36:64
E:*Z* ratio = 93:7
Conversion = 88%

[a] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [b] *E*/*Z* ratio of **285a** was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [c] Conversion % was based on consumption of **283a** and was determined using analysis from the ^{1}H NMR of the crude reaction mixture with internal standard 1,3,5-trimethoxybenzene

It is also worth noting that three side products (**289**, **290** and **291**) were observed during the ligand screen studies (**Scheme 51**). The origin of these by-products remains unclear, though it is proposed that cleavage of the silane moiety may account for the formation of **291**, while reduction of the double bond in α- or β-isomer may be responsible for the formation of **289** and **290**, respectively.



Scheme 51: Possible side products formed during non-selective hydrosilylation of propynamides

In attempt to establish the origin of the side products (**289** – **291**) a time experiment monitored by quantitative ^1H NMR was conducted (**Figure 18**). The reaction was referenced with 1,3,5-trimethoxybenzene as an internal NMR standard to calculate the standardised amounts of **284a** and **285a** and **289** – **91** as the reaction progressed. The hydrosilylation was performed with tricyclohexylphosphine as the ligand as all possible products may be formed during the reaction. It became clear that the side products were formed simultaneously alongside the α-**284a** and β-**285a** vinylsilanes. The reactions were conducted at prolonged reaction times, and no significant decrease was observed of the α-**284a** nor the β-**285a** vinylsilane which correlated to an increase in formation of the side products.

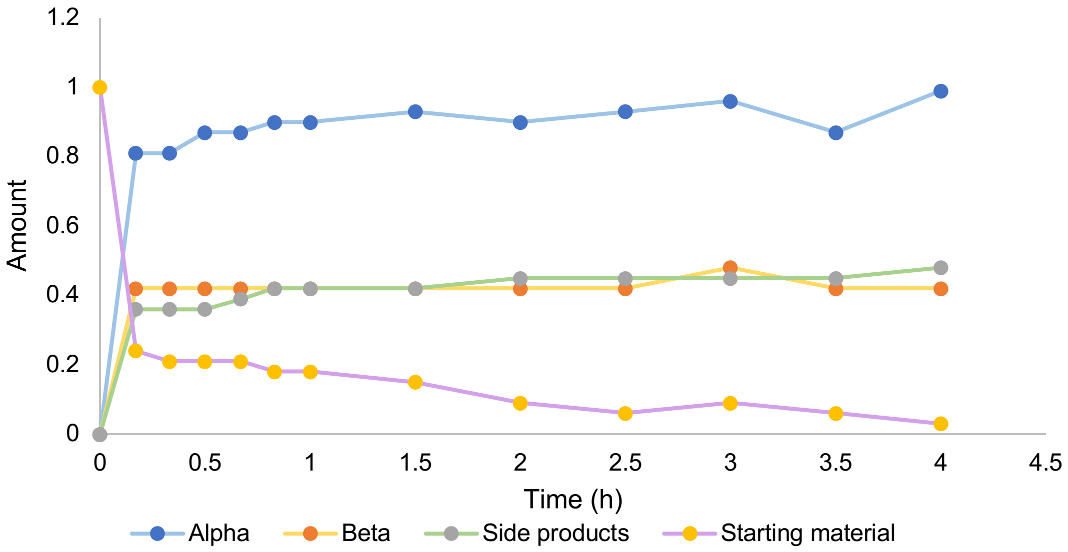
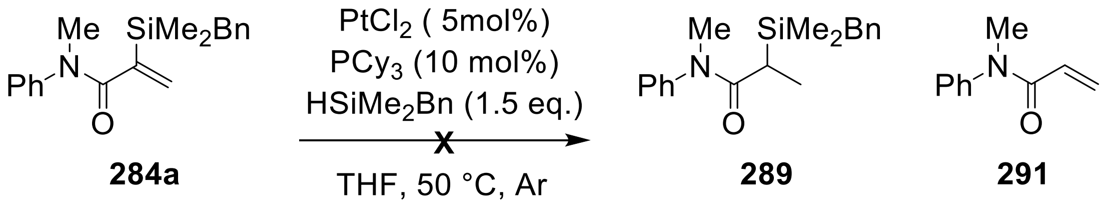


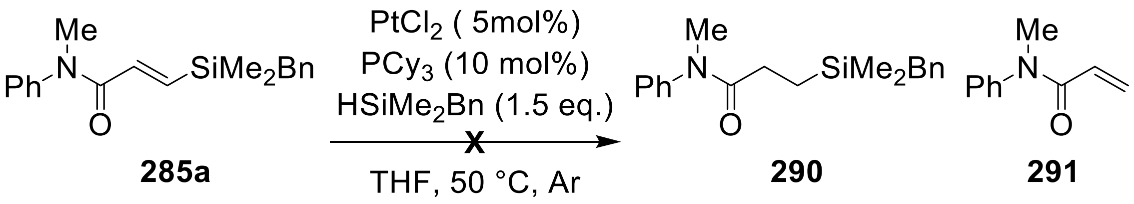
Figure 18: Hydrosilylation of propynamides monitored over time

Additionally, as a control experiment each isomer was individually isolated and subjected to hydrosilylation reaction conditions (**Scheme 52**). In each case, no evidence of side products was seen, and the starting material remained unchanged and was recovered quantitatively. This suggested the side products may have been formed via hydrogenation or desilylative-type side reactions of the starting alkyne **283**.

a) α-silyl-α,β-unsaturated amides subjected to hydrosilylation conditions



b) β-(*E*)-silyl-α,β-unsaturated amides subjected to hydrosilylation conditions



Scheme 52: Silyl-α,β-unsaturated amides subjected to hydrosilylation reaction conditions

4.3.2.2 Optimisation of Regioselective Synthesis of α-Silyl-α,β-Unsaturated Amides

Since tris(pentafluorophenyl)phosphine (**L1**) exclusively formed the α-isomer **284a**, it was selected as the ligand for subsequent screening of solvents, temperature, catalyst loading, and silane equivalents (**Table 57**). Firstly, various solvents were screened to optimise the reaction. THF resulted in a poor yield of 17%, attributed to increased formation of side products **289** and **291** (Entry **1**). Ethyl acetate improved the yield to 58%, although the reaction time was significantly prolonged to 24 hours (Entry **2**). The reaction proceeded well in toluene and acetonitrile, delivering good yields of 63% and 62%, respectively (Entries **3** and **6**). The highest yield was achieved using dichloromethane (DCM) as the solvent, with a 67% yield (Entry **4**). As expected, the reaction was unsuccessful in protic solvents such as methanol (Entry **7**), likely due to the silophilic nature of methanol providing a pathway for reaction inhibition.

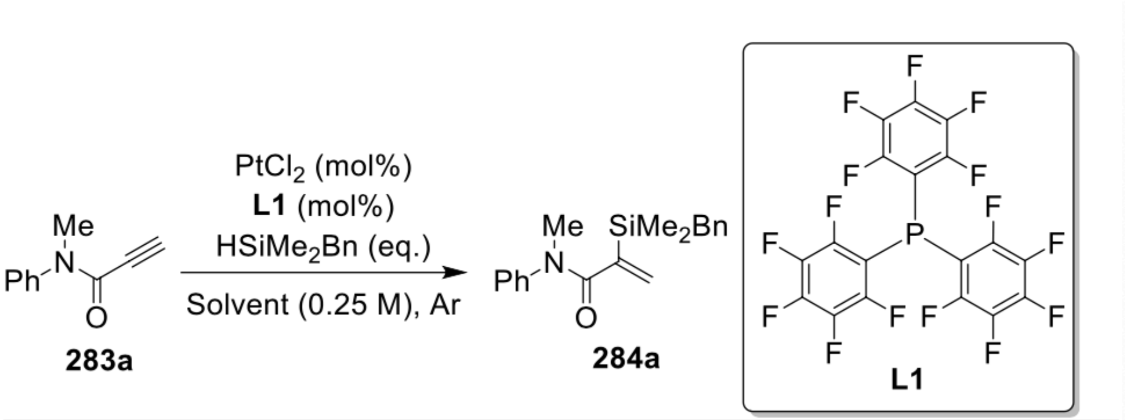
The effect of lowering the reaction temperature was also investigated. Although catalyst and ligand pre-mixing was performed at 50 °C to ensure catalyst formation before adding the starting material and silane. Conducting the reaction at room temperature resulted in a significantly reduced yield of 38% and increased formation of side products (**289** and **291**). Additionally, the reaction time was substantially prolonged to 72 hours (vs 2 hours) (Entry **7**).

Reducing the catalyst loading to 2 mol% led to a decreased yield of 55% and an extended reaction time of 48 hours (Entry **8**). Increasing the catalyst loading to 10 mol% accelerated the reaction but resulted in only a marginal improvement in yield, reaching 65% (Entry **9**).

The effect of silane loading on the reaction outcome was also examined, where increasing the amount of silane to 2 equivalents led to only a slight improvement in yield, achieving 64% (Entry **10**). Conversely, reducing the silane loading to 1.1 equivalents caused a marked decrease in product formation, resulting in a significantly lower yield of just 29% (Entry **11**).

It was observed that the regioselectivity remained consistent throughout the optimisation studies, providing full regiochemical control towards the α-isomer. The optimum conditions are therefore outlined in entry **4**, yielding a single regioisomer **284a** in 67% isolated yield. Attempts to deviate from these optimal parameters did not yield improvements, as efforts to suppress side reactions and further increase the yield proved unsuccessful.

Table 57: Optimisation for the synthesis of α-silyl-α,β-unsaturated amides



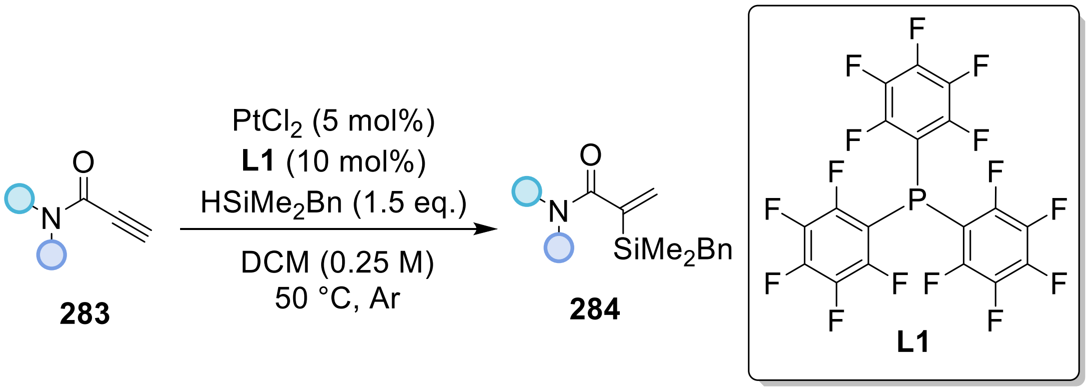
Entry	Solvent	Silane (eq.)	$PtCl_2$ (mol%)	L1 (mol%)	Temp (°C)	α:β[b]	Yield (%)
1	THF	1.5	5	10	50	>99:1	17
2	EtOAc	1.5	5	10	50	>99:1	58
3	Toluene	1.5	5	10	50	>99:1	63
4	DCM	1.5	5	10	50	>99:1	67
5	MeOH	1.5	5	10	50	-	n.r
6	MeCN	1.5	5	10	50	>99:1	62
7	DCM	1.5	5	10	25[a]	>99:1	38
8	DCM	1.5	2	4	50	>99:1	55
9	DCM	1.5	10	20	50	>99:1	65
10	DCM	2	5	10	50	>99:1	64
11	DCM	1.1	5	10	50	>99:1	29

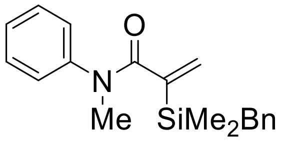
[a] Premixing of the ligand and $PtCl_2$ was conducted at 50 °C for 0.5 h before cooling to 25 °C, [b] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture

4.3.2.3 Substrate Scope of α-Silyl-Acrylamides

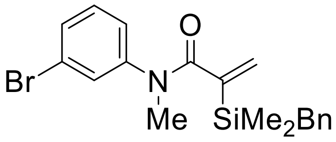
With the optimised conditions in hand, the methodology was subjected to a varied range of propynamide substrates (**Table 58**). The reaction was found to be tolerant of mixed aryl functionality (**284a** – **c**), affording good yields and delivering the products as single regioisomers. It also accommodated bulky alkyl groups (**284e**, **284g** and **284h**), providing moderate to good yields with excellent regioselectivity. Substrate **284i**, featuring a bulky pyrrolidine moiety, was also formed in excellent yield and with high regioselectivity Nitrogen-containing heterocycles including those bearing electron-donating substituents (**284j**), were well tolerated, affording the α-isomer exclusively. Similarly, oxygen-containing heterocycles (**284k**) were compatible, giving good yields with complete regiochemical control. In addition, a Weinreb amide was employed and formed corresponding α-isomer **284l** in excellent regioselectivity and good yield. This substrate gives increased functionality as a general reagent that could be used as a vinylsilane lynchpin, facilitating installation of this high value functional group into a range of motifs. In contrast, the reaction did not tolerate simple bisphenyl systems (**284d**) or sterically demanding piperidines (**284f**).

Table 58: Substrate scope of α-silyl-α,β-unsaturated amides

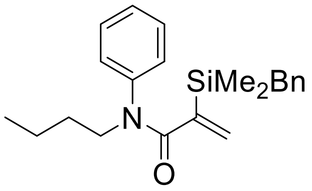




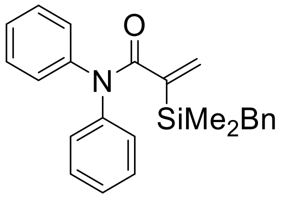
284a, 67%, >99:1



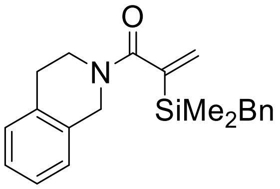
284b, 56%, >99:1



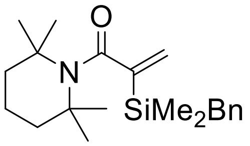
284c, 65%, >99:1



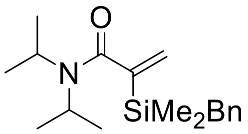
284d, n.r.



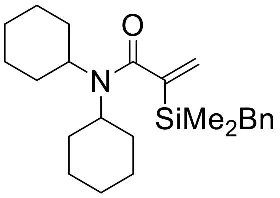
284e, 57%, >99:1



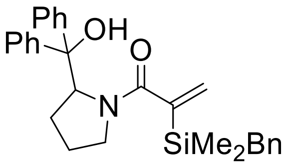
284f, n.r.



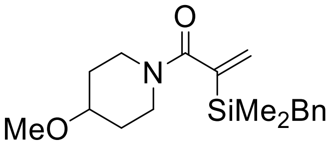
284g, 49%, >99:1



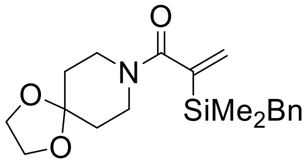
284h, 64%, >99:1



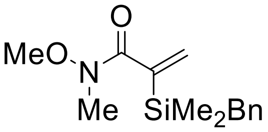
284i, 74%, >99:1



284j, 65%, >99:1



284k, 60%, >99:1



284l, 65%, >99:1

Note: α:β ratio determined via analysis of ^{1}H NMR of the crude reaction

Additional NMR data was necessary from nominal temperatures of 25 °C in the case **284e**. *This NMR study was conducted in collaboration with Dr Geoffrey Aiken at Lancaster University*. The 1D ^{1}H spectrum at 21.8 °C (**Figure 19** – Spectrum **A**) contained more peaks than the expected given structure, and many of them being broad. During variable temperature NMR experiment, as the temperature increased, the peaks merged and sharpened to gives spectrum consistent with the structure. In particular, the cleanest spectra were obtained at 125.8 °C (**Figure 19** – Spectrum **B**), while further temperature increases to 146.0 °C gave negligible reductions in linewidth and the appearance of new peaks due to degradation. On cooling back to 21.8 °C (**Figure 19** – Spectrum **C**), the same broad peaks were observed again, confirming the reversibility of the process, with the exception of the decomposition products.

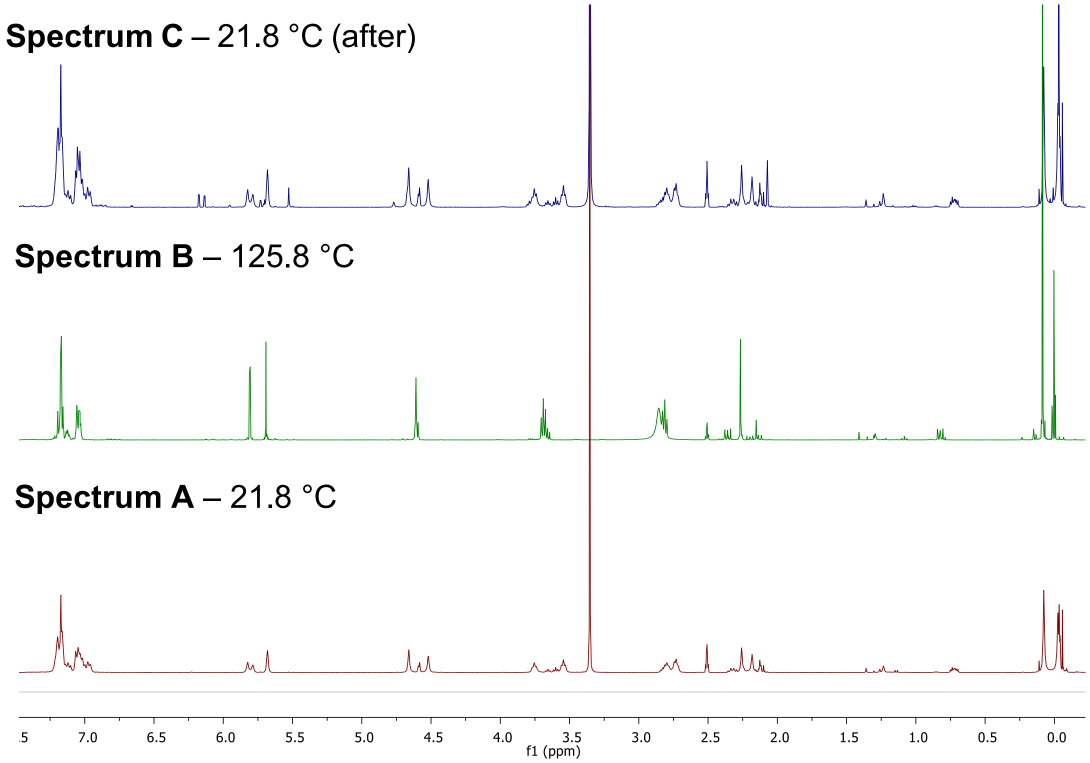
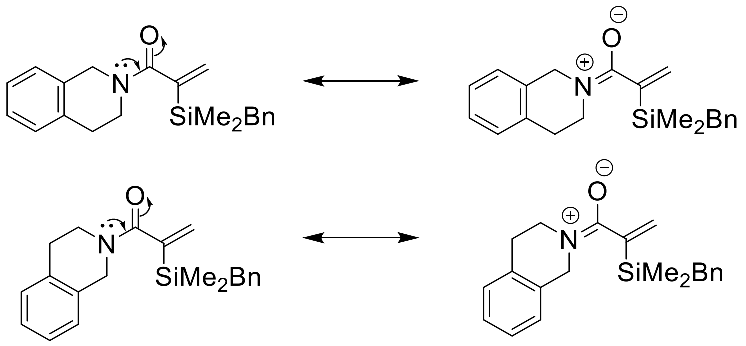


Figure 19: Stacked partial ^{1}H NMR at variable temperatures (ethylene glycol-d$_6$, 400 MHz)

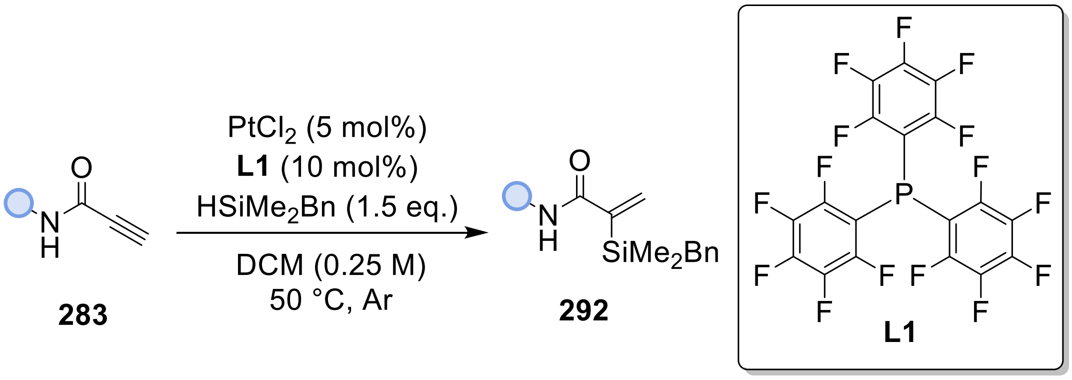
All of these observations are consistent with chemical exchange between rotamers on the NMR timescale, with restricted rotation around the C-N bond being the most probable cause (**Scheme 53**).

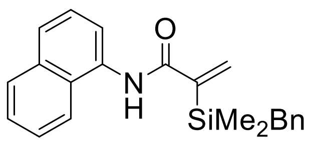


Scheme 53: Resonance of α-silyl-α,β-unsaturated amides

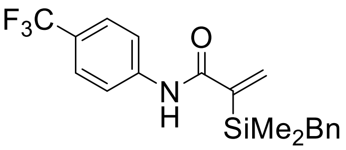
The secondary propynamides (**283**) were next explored, however, observed no reaction occur in any substrate (**292a** – **e**) (**Table 59**). This was attributed to a potential catalyst deactivation pathway, in which a free amine bears more nucleophilicity than previous tried substrates. This ultimately enables strong coordination towards the platinum catalyst, along with potential ligand displacement. This led to almost complete recovery of the starting material alkynes **283**.

Table 59: Substrate scope of secondary α-silyl-α,β-unsaturated amides

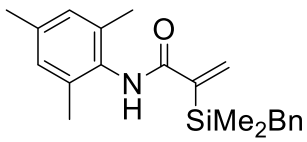




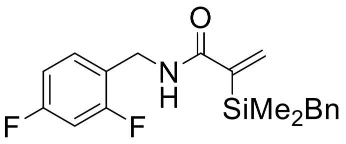
292a, n.r



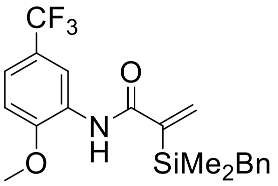
292b, n.r



292c, n.r



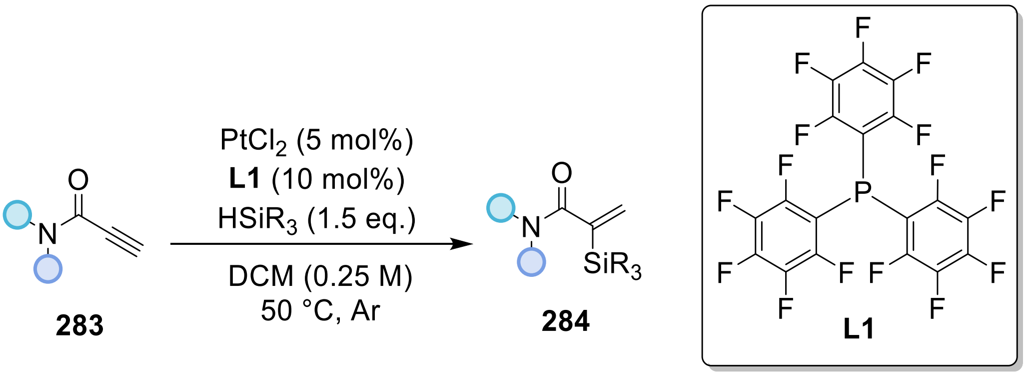
292d, n.r

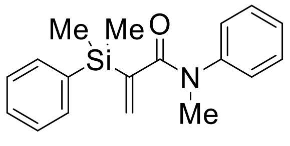


292e, n.r

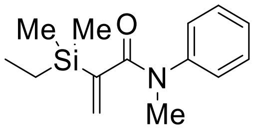
An investigation into the effect of silane structure on the reaction was subsequently undertaken (**Table 60**). Dimethylphenylsilane delivered the corresponding α-vinylsilane **284m** in slightly lower yield, however still remained with full regiochemical control. The dimethylethylsilane derivative **284n** was formed in excellent yield, albeit with a slight erosion in regioselectivity. However, more reactive silanes and those with increased steric bulk (**284o** – **q**) failed to afford the desired products, resulting instead in complete recovery of starting material.

Table 60: Variation of the silyl group of α-silyl-acrylamides

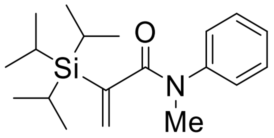




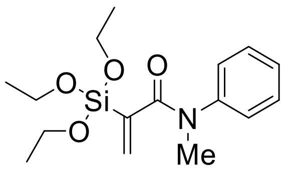
284m, 49%, >99:1[a]



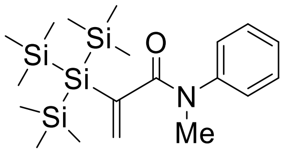
284n, 91%[b], 86:14[c]



284o, n.r[d]



284p, n.r[e]

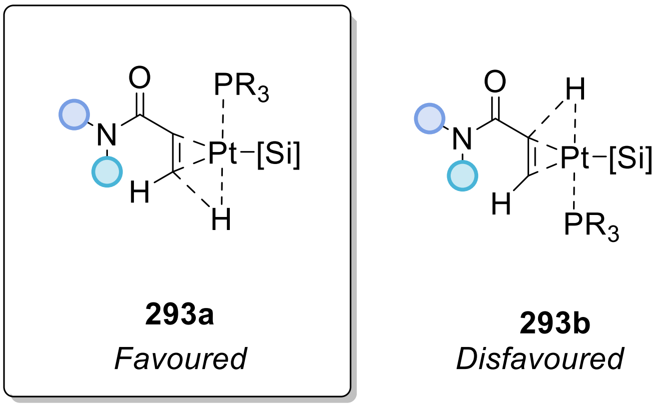


284q, n.r[f]

Note: α:β ratio determined via analysis of ^{1}H NMR of the crude reaction, [a] $HSiMe_2Ph$ was used, [b] Isolated yield of both regioisomers combined, [c] $HSiMe_2Et$ was used, [d] HSi(*i*-Pr)$_3$ was used, [e] $HSi(OEt)_3$ was used, [f] $HSi(TMS)_3$ was used.

4.3.2.4 *Mechanistic Discussion*

It is predicted the hydrosilylation proceeds via a modified Chalk-Harrod pathway in-line with previously reported platinum-catalysed hydrosilylations. The observed regioselectivity within this methodology is comparable with the known platinum catalysed hydrosilylations of electron-deficient alkynes which favour the formation of the α-isomer.[86, 167] The hydride is favoured to be delivered to the electron-deficient alkyne carbon atom (**293a**) (**Figure 20**). In addition to this the steric hinderance is lessened due to the susceptibility of sp^2 hybridisation of the nitrogen atom and delocalisation of electrons within propynamides giving overall a more planar structure. This ultimately favours a Markovnikov addition where the silicon group is delivered to the more substituted position.



293a
Favoured

293b
Disfavoured

Figure 20: π-coordination of platinum ligand towards electron-deficient alkynes

4.3.3 Investigation of the Reactivity of α-Silyl-Acrylamides

To probe the reactivity of the vinylsilanes as Michael acceptors nucleophilic additions were investigated using simple sulphur, oxygen, and nitrogen nucleophiles (**Table 61**). All efforts to promote the reaction were unsuccessful, with no conversion observed and complete recovery of the starting material.

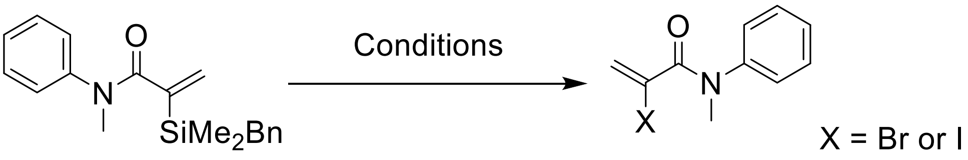
Table 61: Attempted Michael additions into α-silyl-α,β-unsaturated amides

284a **294**

Entry	Reagent (1.5 eq.)	Solvent (0.05 M)	Temperature (°C)	Yield (%)
1	BnOH	MeCN	Room	n.r
2	BnSH	MeCN	Room	n.r
3	$BnNH_2$	MeCN	Room	n.r

α-Halogenated acrylamides were considered as potentially valuable intermediates for cross-coupling reactions, offering access to diverse substitution patterns at the α-position. Initially, a literature procedure reported by Lee *et al.* was followed using *N*-iodosuccinimide (NIS) as the halogenating agent in excess, at both ambient and elevated temperatures (**Table 62** – Entry **1** and **2**).[165] However, in all cases, no reaction was observed, and the starting material was fully recovered. Subsequently, investigations employed *N*-bromosuccinimide (NBS) at elevated temperature was also investigated to promote higher reactivity. Nevertheless, this approach also proved unsuccessful, with complete recovery of the unreacted starting material (**Table 62** – Entry **3**).

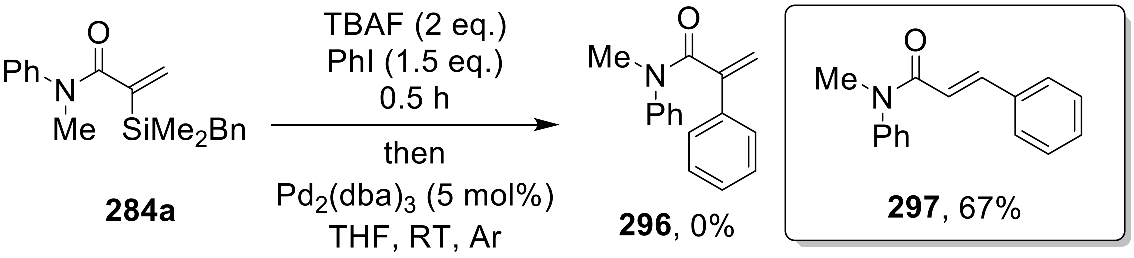
Table 62: Attempted halogenation investigation of α-silyl-α,β-unsaturated amides



284a **295**

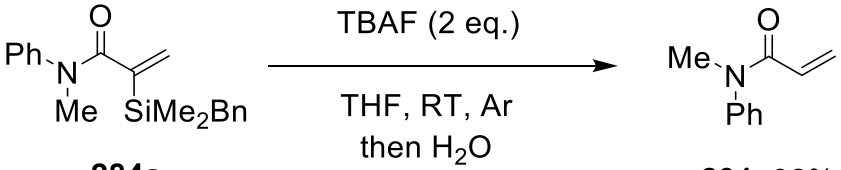
Entry	Reagent	Solvent (0.05 M)	Temperature (°C)	Yield (%)
1	NIS / 2 eq.	MeCN	Room	n.r
2	NIS / 2 eq.	MeCN	50	n.r
3	NBS / 0.9 eq.	MeCN	100	n.r

Attention was next directed toward the investigation of cross-coupling reactions of the α-vinylsilanes. Compound **284a** was subjected to a literature procedure reported by Cook and co-workers to facilitate a Hiyama-type cross-coupling.[172] Although full consumption of the starting material was observed, the expected cross-coupling product (**296**) was not formed. Instead, compound **297** was obtained in 67% yield with complete stereochemical control, delivering the (*E*)-alkene as the sole product. (**Scheme 54**).



Scheme 54: Cross coupling of α-silyl-α,β-unsaturated amides

This suggests that a Heck-type coupling occurred at the terminal end of the alkene, followed by protodesilylation facilitated by TBAF. To investigate this, a TBAF-mediated protodesilylation control experiment was conducted, which provided the corresponding acrylamide **291** in near-quantitative yield (92%) (**Scheme 55**).

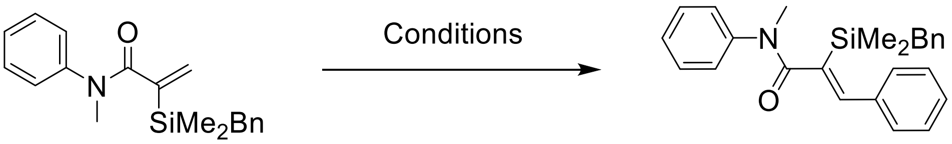


284a **291**, 92%

Scheme 55: TBAF mediated protodesilylation of α-silyl-α,β-unsaturated amides

The replacement of the additive TBAF was explored to achieve cross-coupling without loss of the silane group (**Table 63**). Since base typically mediates formation of the active catalyst via reductive elimination during a Heck coupling, a variety of commonly used bases were screened. However, in the absence of TBAF, no reaction occurred, and the starting material was completely recovered.

Table 63: Attempted optimisation of Heck cross coupling of phenyl iodide with α-silyl-acrylamides



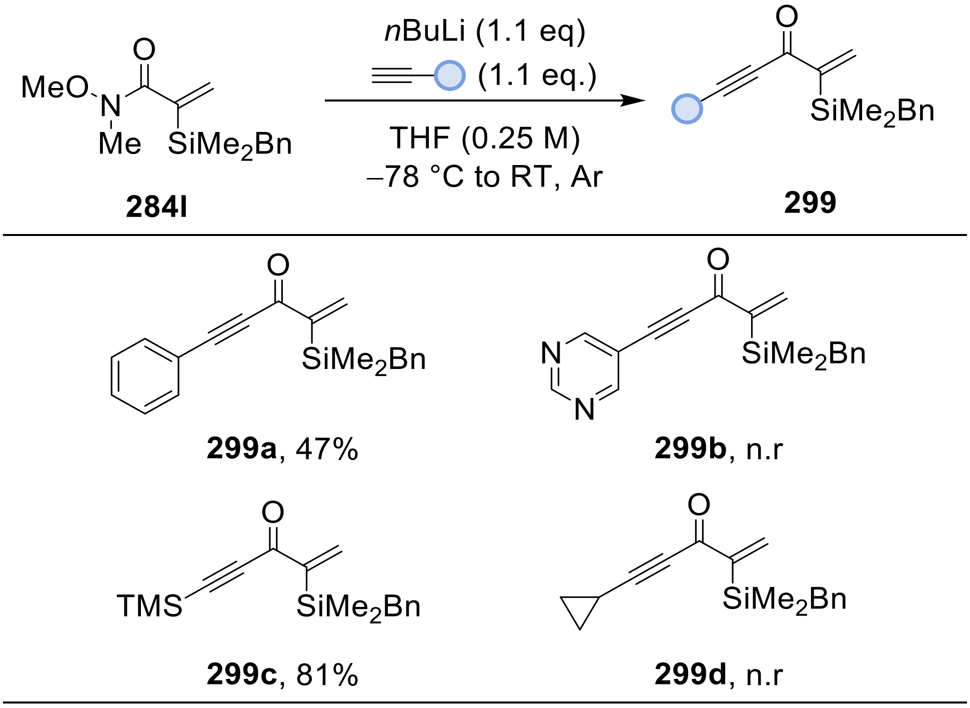
284a **298**

Entry	Catalyst (5 mol%)	Additive (eq.)	Solvent (0.5 M)	Temp (°C)	Yield (%)
1	$Pd_2(dba)_3$	K_2CO_3 / 2 eq.	THF	Room	n.r
2	$Pd_2(dba)_3$	K_2CO_3 / 2 eq.	THF	50	n.r
3	$Pd_2(dba)_3$	TBAI / 2 eq.	THF	Room	n.r
4	$Pd_2(dba)_3$	Cs_2CO_3 / 2 eq.	THF	Room	n.r
5	$Pd_2(dba)_3$	-	THF	Room	n.r
6	$Pd_2(dba)_3$	-	THF	50	n.r

4.3.3.1 Applications of Weinreb Amide Derivative

The synthetic utility of α-silyl-acrylamides was explored using the Weinreb amide derivative **284l**, which can be readily functionalised due to its inherent reactivity towards organolithium and organomagnesium reagents. This approach offers the opportunity to access novel α-vinylsilane derivatives that are otherwise currently inaccessible. The reaction of lithiated acetylenes was investigated to afford the corresponding α-silyl-substituted enynones (**299**) (**Table 64**). Substitution with phenylacetylene and trimethylsilylacetylene proceeded efficiently, yielding the corresponding enynones **299a** and **299c** in 47% and 81% yield, respectively. However, substrates **299b** and **299d** were deemed unsuccessful due to degradation, with no recoverable starting material. The successful reactions were noted to proceed exclusively via the 1,2-addition pathway, with no 1,4-addition products observed in the ^{1}H NMR spectra of the crude reaction mixtures.

Table 64: Acylation of Weinreb amides to form α-silyl-substituted enynones



4.4 Conclusions

A method for the selective and efficient hydrosilylation of propynamides has been developed, addressing key limitations associated with conventional hydrosilylation catalysts. The starting alkynes were prepared via multiple synthetic routes from commercially available amines and propiolic acid derivatives. These included carbodiimide-mediated couplings using DCC or EDC in the presence of HOBt and DMAP, as well as an alternative route involving the formation of acyl chlorides from propiolic acid using oxalyl chloride, followed by coupling with a variety of amines. These strategies enabled access to a structurally diverse library of propynamides.

Hydrosilylation of the synthesised propynamides using a $PtCl_2$/tris(pentafluorophenyl)phosphine catalyst system proceeded with complete regiocontrol, affording exclusively the α-vinylsilane products. The reaction demonstrated broad substrate scope, tolerating a wide range of aryl, alkyl, and heterocyclic substituents, and generally provided good yields. Although the secondary propynamides were unsuccessful. This was attributed to a potential catalyst deactivation pathway via coordination towards the platinum catalyst, along with potential ligand displacement. The influence of silane structure on reaction outcome was systematically explored, with higher reactive and bulkier silanes deemed unsuccessful. The observed Markovnikov selectivity is proposed to arise from the electron-deficient nature of the substituted alkyne, consistent with precedent in the literature.

The reactivity of the resulting α-silyl-acrylamides was further explored. Although attempts at halogenation were unsuccessful, the substrates showed promising reactivity under Heck-type cross-coupling conditions and underwent efficient protodesilylation. Furthermore, Weinreb amide derivatives were successfully employed and further transformed into enynone derivatives.

5 Chapter 5 – Synthesis of β-(*E*)-Acrylamides

5.1 Introduction

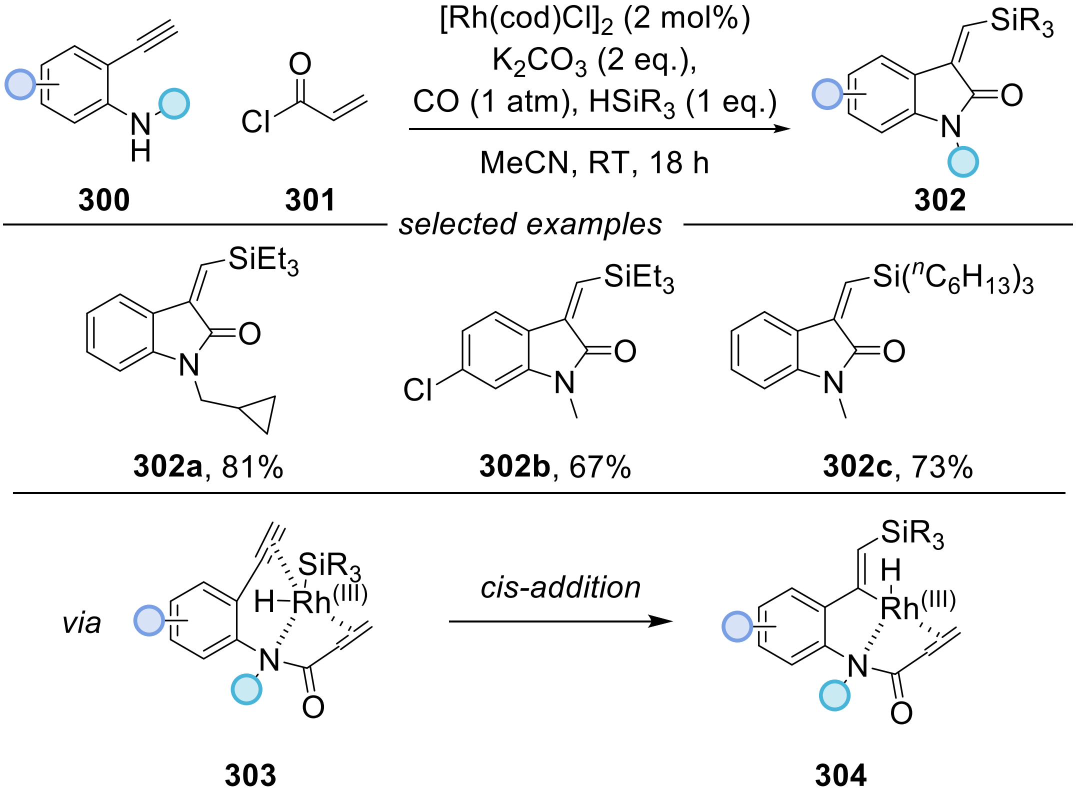
Building on the work presented in Chapter 4, this chapter examines a different variation of silyl substituted acrylamides. These structural motifs hold significant promise due to their potential to enhance ADMET properties and improve both biological activity and target selectivity. There is increasing interest in accessing acrylamide derivatives with varied substitution patterns, as these modifications play a crucial role in influencing potency and selectivity. However, progress in this area has been limited, largely due to the synthetic challenges involved in obtaining these motifs through selective and reliable methods. Addressing these challenges is essential for expanding the chemical space of acrylamide derivatives available for medicinal applications.

5.1.1 Previous Synthesis of β-Silyl-α,β-Unsaturated Amides

As noted earlier, the literature on synthesising silyl-substituted amines or amides via hydrosilylation remains limited. Nevertheless, several reports describe alternative methodologies, primarily using isocyanates or carbonylation-type reactions, for the preparation of β-silyl-acrylamides.

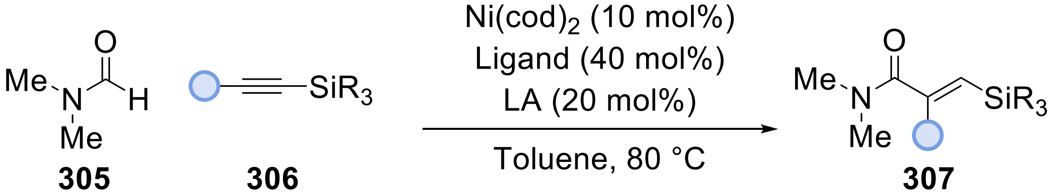
Hang *et al.* reported a Rh(I)-catalysed silylative carbonylation of 2-alkynylanilines (**300**), enabling the synthesis of (*Z*)-3-(silylmethylene)indolin-2-ones (**302**) in good yields and with excellent stereoselectivity (**Table 65**).[173] The reaction proceeds via an *in situ* generated acryl moiety, which serves as a transient chelating group to coordinate the activated Rh(I) species (**303**). This facilitates a *cis*-silylrhodation across the alkyne to generate the corresponding *cis*-silyl vinyl-Rh(III) intermediate (**304**). Subsequent aminocarbonylation then furnishes the desired (*Z*)-isomer exclusively in all cases. Notably, the authors did observe side reactions such as silylation of the alkyne or C–N bond decomposition. The methodology was further extended to the silylative aminocarbonylation of *N*-acrylanilines, thereby eliminating the need for *in situ* acrylamide formation.

Table 65: Silylative carbonylation of 2-alkynylanilines

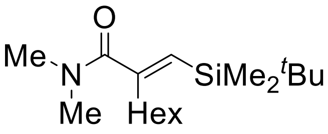


Hiyama and co-workers reported a nickel and Lewis acid co-catalyst system that promoted stereo- and regioselective intermolecular hydrocarbamoylation reactions of alkynes (**306**), affording silyl-substituted unsaturated amides (**307**) in good yields (**Table 66**).[168] The reaction displayed high regio- and stereoselectivity, particularly with alkynes bearing sterically biased substituents. The presence of a bulky silyl substituent was found to be crucial for the formation of the *cis*-adducts. Despite the promising selectivity, the substrate scope and functional group tolerance of the methodology remained limited, with only a small number of examples successfully demonstrated.

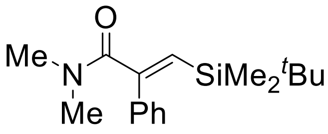
Table 66: Hydrocarbamoylation of alkynes with DMF



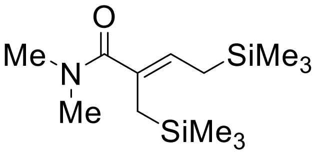
selected examples



307a, 58%[a],[c]



307b, *E*/*Z* 96:4, 63%[a],[c]

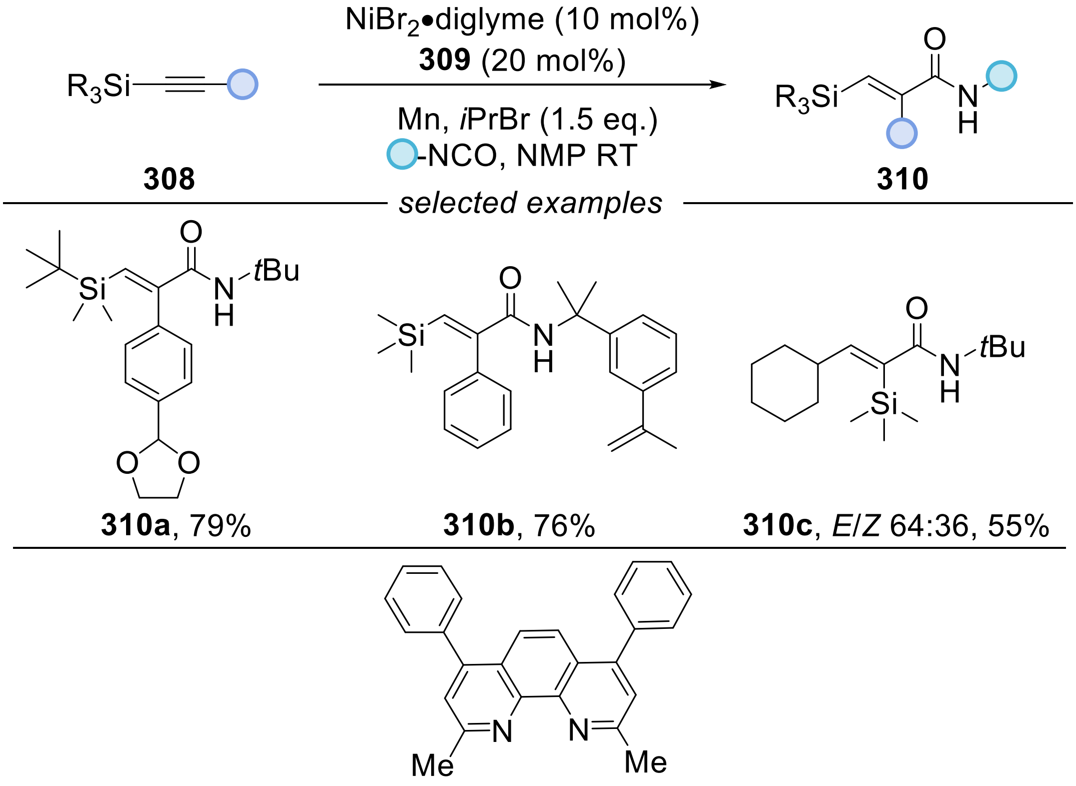


307b, 55%[b],[c]

[a] P(*t*-Bu$_3$)$_3$ as the ligand and AlMe$_3$ as the Lewis acid used, [b] PCyp$_3$ as the ligand and BPh$_3$ as the Lewis acid used, [c] Isolated yields based on **306**

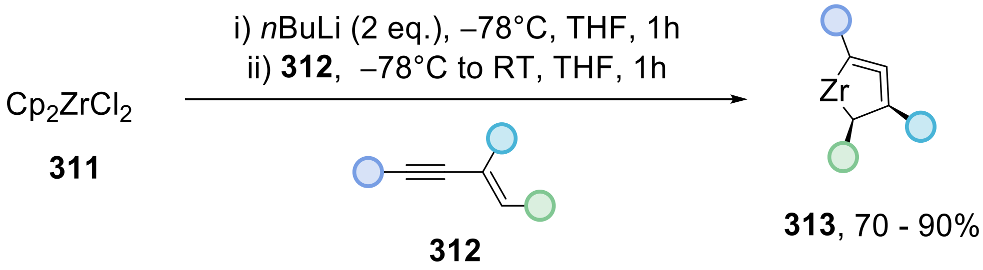
Wang *et al*. reported a nickel catalysed hydroamidation of alkynes (**308**) with isocyanates using alkyl bromides as hydride source (**Table 67**). [174] This enabled access to a diverse range of β-silyl-acrylamides (**310**) in excellent stereo and regioselectivity. The authors did note the absence of a π-component on the alkyne (**310c**) terminus resulted in switch in regioselectivity to favour the α-isomer, along with a diminished stereoselectivity observed.

Table 67: Hydroamidation of alkynes with isocyanates



309

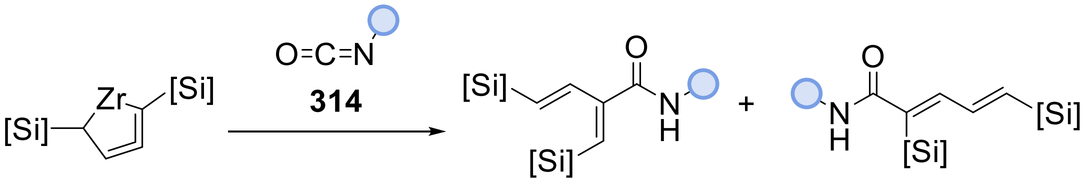
More recently, Suzuki *et al* reported the formation of **313** complexes which may be formed from via the formation of Negishi's reagent (**311**) and 1,3-enynes **312** (**Scheme 56**).[175]



	🔵	🩵	🟢
313a	SiMe$_3$	SiMe$_3$	H
313b	SiMe$_3$	H	SiMe$_3$
313c	SiMe$_2$(*t*Bu)	H	SiMe$_2$(*t*Bu)

Scheme 56: Formation of zirconaycloallenes

Zirconacycloallene complexes **313** can be employed to react with isocyanates **314**, affording silyl-α,β-unsaturated amides (**315/316**) (**Scheme 57**).[175] However, this methodology delivered only a limited number of substrates, typically in moderate yields and as regioisomeric mixtures, with a preference for formation of the β-isomer **315**. Notably, improved regioselectivity was observed for substrate **315c** (98:2), attributed to the increased steric bulk of the silyl group, which favoured selective formation of the β-isomer.



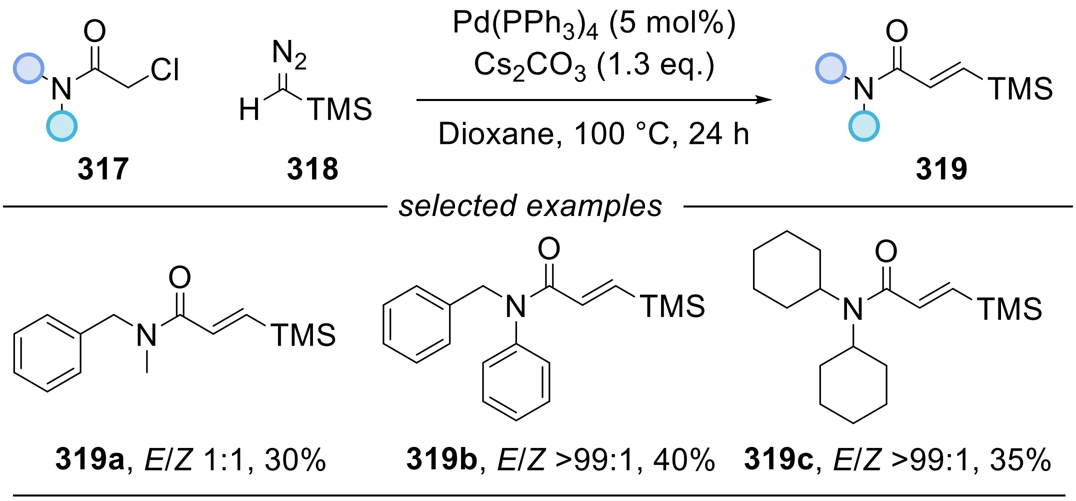
313 **315** **316**

Product	○	[Si]	**315**:**316**	Yield (%)
a	Ph	$SiMe_3$	78:22	38
b	Et	$SiMe_3$	78:22	48
c	Ph	$SiMe_2tBu$	92:8	58

Scheme 57: Zirconium mediated synthesis of silyl-substituted unsaturated amides

Alternatively, avoiding the use of isocyanates or carbonylation methods, Xu and co-workers reported a palladium-catalysed olefination of alkyl halides (**317**) with TMS-diazomethane (**318**), proceeding via a carbene migratory insertion mechanism (**Table 68**). The method enabled the formation of β-(*E*)-vinylsilanes (**319**), with stereochemical outcomes highly influenced by the steric environment. Excellent (*E*)-selectivity (>99:1 *E*/*Z*) was achieved with increased steric bulk around the nitrogen, as demonstrated in substrates **319b** and **319c**, whereas a 1:1 *E*/*Z* ratio was observed for **319a**, indicating significant loss of stereocontrol in less hindered systems. Despite the high stereoselectivity observed in selected cases, the overall yields were moderate, and the method showed limited functional group tolerance, with relatively narrow substrate scope.

Table 68: Palladium catalysed olefination of alkyl halides with TMS-diazomethane



There have also been several methodologies which have included isolated examples of β-silyl substituted acrylamides within their substrate scopes, often with high regioselectivity.[156, 176-182]

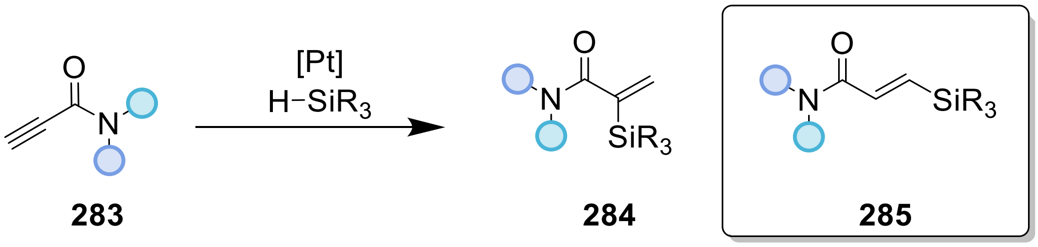
In summary, while several methodologies have demonstrated access to β-isomer products with good stereo- and regioselectivity, they are often constrained by low catalyst turnover, limited functional group tolerance, and narrow substrate scopes. General and reliable synthetic strategies for these compounds remain underdeveloped. Moreover, the reliance on isocyanates, which are highly toxic and moisture sensitive, and the need for specialised equipment in carbonylation reactions further limit their practicality and broader uptake. These challenges underscore the need for more selective, functionally tolerant, and widely applicable approaches.

5.2 Aims

Building upon the findings presented in Chapter 4 and the growing interest in accessing acrylamide derivatives with varied substitution patterns, the work in this chapter focuses on evaluating the feasibility of designing a catalytic system capable of delivering β-(*E*)-silyl-acrylamides via a platinum-catalysed hydrosilylation methodology. This is of particular relevance to efforts aimed at broadening the substrate scope to include nitrogen-containing compounds, which are known to pose challenges in platinum catalysis due to their tendency to coordinate to the metal centre, leading to catalyst deactivation.

A key focus was placed on achieving both regio- and stereoselective formation of the desired β-(*E*)-vinylsilane products. Careful consideration should be undertaken in relation to catalyst design, particularly the selection of ligands, to overcome the inherent preference for α-vinylsilane formation typically observed with electron-deficient alkynes.

Accordingly, the objective is to develop a robust platinum-catalysed hydrosilylation protocol for the regio- and stereoselective synthesis of β-(*E*)-silyl-α,β-unsaturated amides (**285**) from readily accessible propynamide substrates (**283**) (**Scheme 58**).



Scheme 58: Platinum catalysed hydrosilylation of propargylic amides

5.3 Results and Discussion

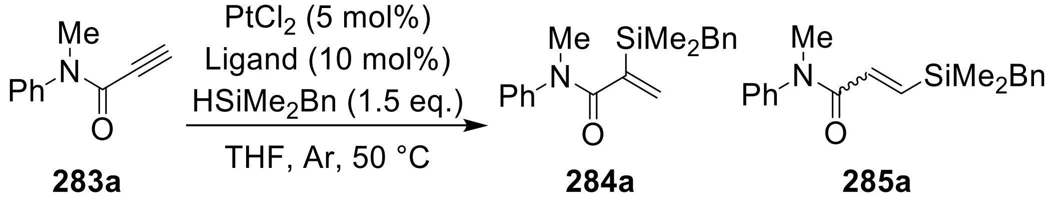
The work presented in this section has been published in part as: Leonard, E., Boyd, M., Akien, G. and McLaughlin, M., *Chem. Commun.,* 2025, **61**, 14121-14124.[169]

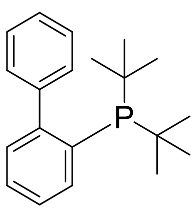
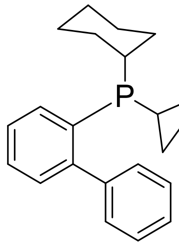
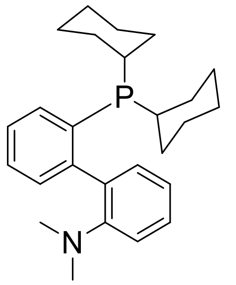
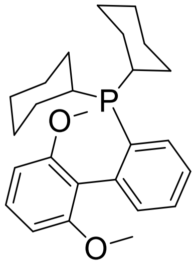
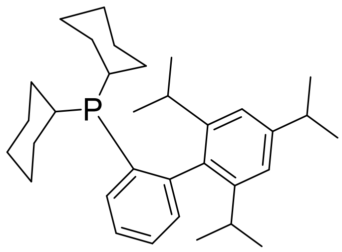
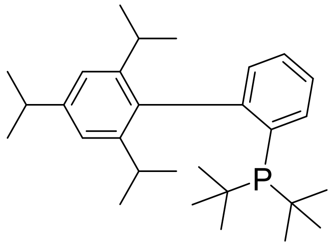
5.3.1 Synthesis of β-(*E*)-Silyl-Acrylamides

5.3.1.1 Ligand Screen Optimisation Studies

The investigation commenced using *N*-methyl-*N*-phenylpropynamide (**283a**) as the model substrate. Reactions were monitored by ^{1}H NMR spectroscopy, employing 1,3,5-trimethoxybenzene as an internal standard to quantify both the consumption of starting material and the relative selectivity of the transformation. Initial studies focused on evaluating a range of Buchwald-type phosphine ligands to determine their effect on reactivity and selectivity (**Table 69**). Among these, JohnPhos afforded high regioselectivity in favour of the β-isomer (14:86, α:β), with excellent stereoselectivity and complete consumption of the starting alkyne. In contrast, CyJohnPhos led to diminished regioselectivity (36:64, α:β) and incomplete conversion. DavePhos maintained similar regioselectivity but resulted in lower conversion and reduced stereoselectivity. SPhos provided full conversion and reasonable stereocontrol but exhibited further erosion in regioselectivity (43:57, α:β). XPhos delivered complete stereochemical control and formed the β-isomer as the major product; however, this was accompanied by poor regioselectivity and reduced overall conversion. Notably, *tert*-butyl-XPhos was the only Buchwald-type ligand to favour formation of the α-isomer as the major product (71:29, α:β), achieving full conversion but with significant erosion in the stereoselectivity of the β-isomer.

Table 69: Buckwald type ligand screen



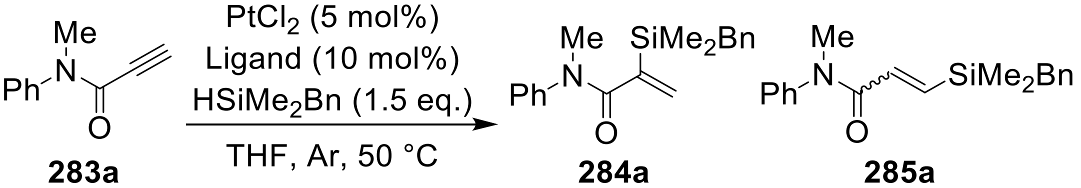
		
JohnPhos α:β ratio = 14:86 *E*/*Z* ratio = >99:1 Conversion = >99%	**CyJohnPhos** α:β ratio = 38:62 *E*/*Z* ratio = >99:1 Conversion = >36%	**DavePhos** α:β ratio = 38:62 *E*/*Z* ratio = 86:14 Conversion = 85%
		
SPhos α:β ratio = 43:57 *E*/*Z* ratio = 85:15 Conversion = >99%	**XPhos** α:β ratio = 33:67 *E*/*Z* ratio = >99:1 Conversion = 63%	**^{t}BuXPhos** α:β ratio = 71:29 *E*/*Z* ratio = 77:23 Conversion = >99%

[a] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [b] *E*/*Z* ratio of **285a** was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [c] Conversion % was based on consumption of **283a** and was determined using analysis from the ^{1}H NMR of the crude reaction mixture with internal standard 1,3,5-trimethoxybenzene

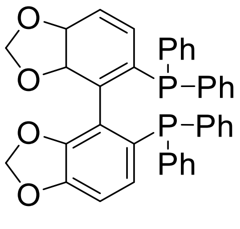
The investigation was further expanded to explore bidentate phosphine ligands (**Table 70**). Based on previous precedent within the group, it was hypothesised that bidentate ligands, particularly XantPhos, might provide enhanced regiocontrol for the synthesis of nitrogen-containing β-(*E*)-vinylsilanes.[100] However, contrary to expectations, XantPhos afforded poor regioselectivity, producing an approximately 1:1 mixture of α- and β-isomers.

Similar results were observed with other bidentate phosphine ligands. Both SegPhos and *rac*-BINAP, delivered poor regioselectivity with near equimolar regioisomeric mixtures and reduced conversion of the starting material. Ligands featuring a ferrocene backbone, such as dppf, increased regioselectivity towards the α-isomer, albeit at the expense of stereoselectivity. In contrast, the bulkier JosiPhos ligand enhanced regioselectivity towards the β-isomer but suffered from poor conversion. An investigation into the influence of bite angle was conducted using dppe, dppp, and dppb; however, no clear trend emerged. All three ligands exhibited similar stereoselectivity and conversion, with only minor differences in regioselectivity, which remained poor overall (~1:1 α:β).

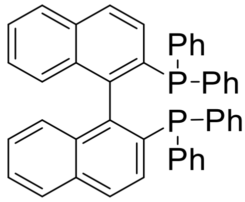
Table 70: Ligand screen of bidentate phosphine ligands



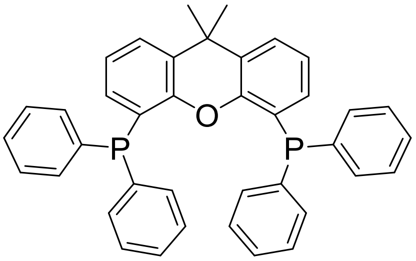
283a **284a** **285a**



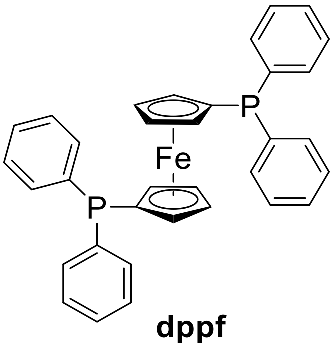
SegPhos
α:β ratio = 50:50
E/*Z* ratio = >99:1
Conversion = 83%



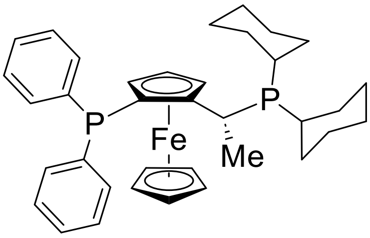
rac-BINAP
α:β ratio = 42:58
E/*Z* ratio = >99:1
Conversion = 65%



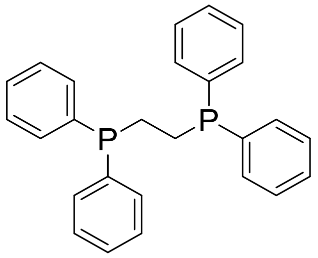
XantPhos
α:β ratio = 50:50
E/*Z* ratio = >99:1
Conversion = 85%



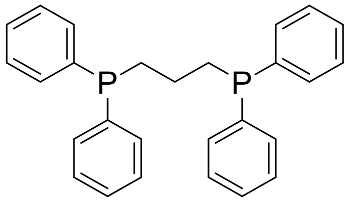
dppf
α:β ratio = 62:38
E/*Z* ratio = 82:18
Conversion = 85%



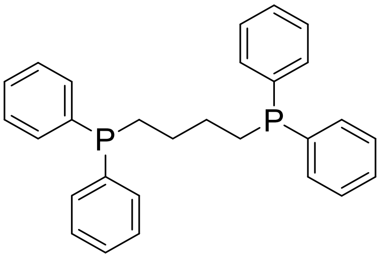
JosiPhos
α:β ratio = 38:62
E/*Z* ratio = >99:1
Conversion = 41%



dppe
α:β ratio = 45:55
E/*Z* ratio = 84:16
Conversion = 78%



dppp
α:β ratio = 66:34
E/*Z* ratio = 84:16
Conversion = 85%

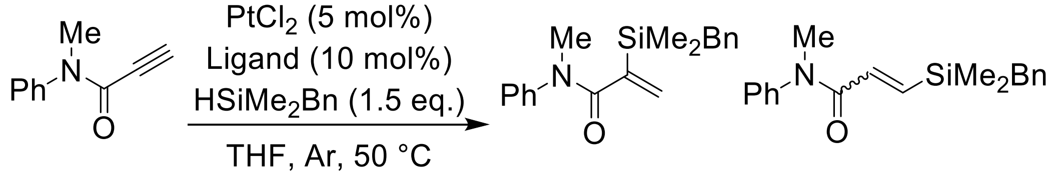


dppb
α:β ratio = 52:48
E/*Z* ratio = 85:15
Conversion = 81%

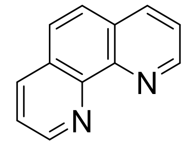
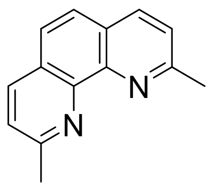
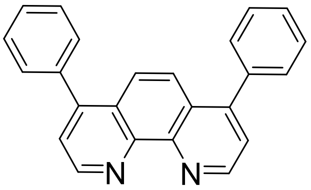
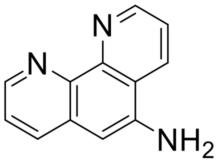
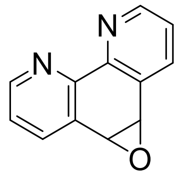
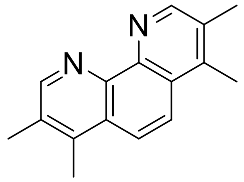
[a] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [b] *E*/*Z* ratio of **285a** was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [c] Conversion % was based on consumption of **283a** and was determined using analysis from the ^{1}H NMR of the crude reaction mixture with internal standard 1,3,5-trimethoxybenzene

Next, nitrogen-containing ligands were investigated, beginning with phenanthroline derivatives (**Table 71**). Phenanthroline itself afforded excellent conversion of the starting material and high stereoselectivity; however, regioselectivity favoured the α-isomer with a ratio of 77:23 (α:β). Other phenanthroline-based ligands also failed to improve regioselectivity, consistently favouring the formation of the α-isomer. Additionally, decreases in both conversion and stereoselectivity were observed with these derivatives. As expected, 1,10-phenanthroline amine resulted in no reaction, with complete recovery of the starting alkyne (**283a**). This lack of reactivity is attributed to catalyst inhibition, likely caused by coordination of the free amine group.

Table 71: Phenanthroline derived ligand screen



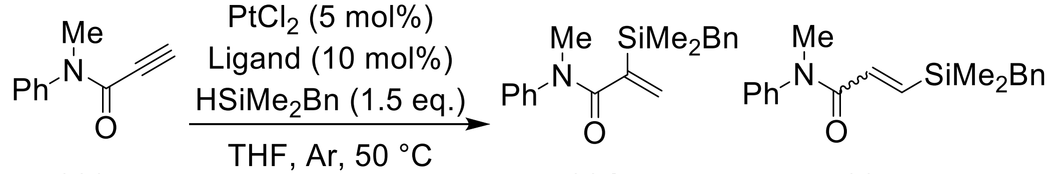
283a **284a** **285a**

 **1,10-Phenanthroline** α:β ratio = 77:23 *E*/*Z* ratio = >99:1 Conversion = >99%	 **Neocuproine** α:β ratio = 71:29 *E*/*Z* ratio = 78:22 Conversion = 79%	 **4,7-Diphenyl-1,10-phenanthroline** α:β ratio = 60:40 *E*/*Z* ratio = 85:15 Conversion = 62%
 **1,10-Phenanthrolin-5-amine** n.r	 **5,6-Epoxy-5,6-dihydro-[1,10]phenanthroline** α:β ratio = 77:23 *E*/*Z* ratio = 80:20 Conversion = 77%	 **3,4,7,8-Tetramethyl-1,10-phenanthroline** α:β ratio = 67:33 *E*/*Z* ratio = 89:11 Conversion = >99%

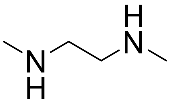
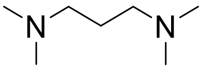
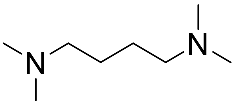
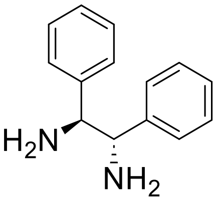
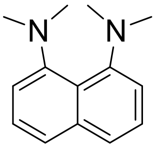
[a] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [b] *E*/*Z* ratio of **285a** was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [c] Conversion % was based on consumption of **283a** and was determined using analysis from the ^{1}H NMR of the crude reaction mixture with internal standard 1,3,5-trimethoxybenzene

Next, bidentate amine ligands were investigated (**Table 72**). In parallel with the studies on bidentate phosphine ligands, the influence of bite angle on regioselectivity was examined. Both *N,N'*-dimethylethylenediamine and *N,N,N',N'*-tetramethyl-1,4-butanediamine afforded approximately 1:1 mixtures of α:β isomers. However, the use of *N,N,N',N'*-tetramethyl-1,3-propanediamine resulted in a marked increase in regioselectivity favouring the α-isomer. These trends mirrored those observed with the bidentate phosphine ligands. Overall, the bidentate amine ligands led to diminished *E*/*Z* stereoselectivity and poor regioselectivity for the formation of the desired β-isomer.

Table 72: Bidentate amine ligand screen



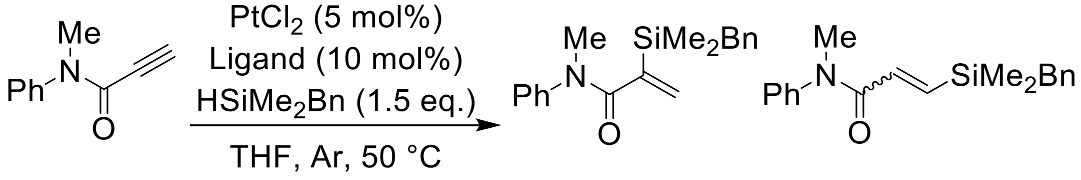
283a **284a** **285a**

 **N,N'-Dimethyl-ethylenediamine** α:β ratio = 50:50 *E*/*Z* ratio = >99:1 Conversion = 80%	 ***N,N, N',N'*-Tetramethyl-1,3-propanediamine** α:β ratio = 80:20 *E*/*Z* ratio = 78:22 Conversion = >99%	 ***N,N, N',N'*-Tetramethyl-1,4-butanediamine** α:β ratio = 54:46 *E*/*Z* ratio = 82:18 Conversion = 85%
 **(1S,2S)-1,1-Diphenylethane-1,2-diamine** α:β ratio = 71:29 *E*/*Z* ratio = 87:13 Conversion = 86%	 **1,8-Bis(dimethylamino)-naphthalene** α:β ratio = 76:24 *E*/*Z* ratio = 81:19 Conversion = 79%	

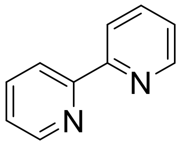
[a] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [b] *E*/*Z* ratio of **285a** was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [c] Conversion % was based on consumption of **283a** and was determined using analysis from the ^{1}H NMR of the crude reaction mixture with internal standard 1,3,5-trimethoxybenzene

Finally, bpy derived ligands were explored (**Table 73**). In the case of unsubstituted bpy, no reaction was observed. However, with substituted bpy derivatives, the reaction proceeded, albeit with limited improvement in regioselectivity. Variations in steric bulk and electronic properties, ranging from electron donating to electron withdrawing substituents, had minimal impact on the regioselectivity of the transformation. Nevertheless, an increase in overall conversion was noted compared to other bidentate ligand classes. Notably, bpy ligands bearing strongly electron withdrawing substituents afforded products with complete stereochemical control, in contrast to electron donating analogues, which showed diminished stereoselectivity.

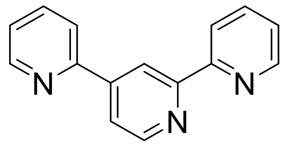
Table 73: Bpy derived ligand screen



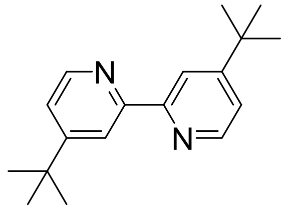
283a **284a** **285a**



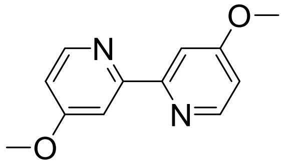
Bipyridine
Conversion = 30%



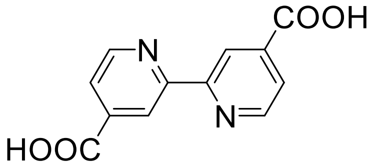
2,2':6',2"-Terpyridine
α:β ratio = 71:29
E/*Z* ratio = 91:9
Conversion = 80%



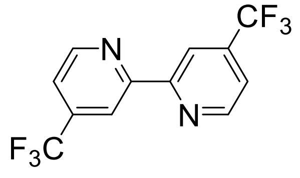
2,2'-Bipyridine-4,4'-dicarboxylic acid
α:β ratio = 71:29
E/*Z* ratio = 87:13
Conversion = 95%



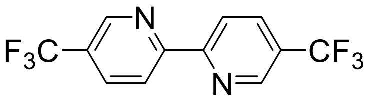
4,4'-Bis(trifluoromethyl)-2,2'-bipyridine
α:β ratio = 69:31
E/*Z* ratio = 86:14
Conversion = >99%



4,4'-Di-*tert*-butyl-2,2'-bipyridine
α:β ratio = 69:31
E/*Z* ratio = 84:16
Conversion = >99%



4,4'-Dimethoxy-2,2'-bipyridine
α:β ratio = 70:30
E/*Z* ratio = >99:1
Conversion = >99%



5,5'-Bis(trifluoromethyl)-2,2'-bipyridine
α:β ratio = 72:28
E/*Z* ratio = >99:1
Conversion = 88%

[a] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [b] *E*/*Z* ratio of **285a** was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [c] Conversion % was based on consumption of **283a** and was determined using analysis from the ^{1}H NMR of the crude reaction mixture with internal standard 1,3,5-trimethoxybenzene

Overall, for all nitrogen-based ligands examined, regioselectivity remained poor, with non-negligible amounts of the β-isomer (**285a**) formed and a general loss of stereochemical control. This is attributed to potential ligand displacement, with selectivities being comparable of that with un-ligated $PtCl_2$ as the catalyst system.

5.3.1.2 Optimisation of Regioselective Synthesis of β-(E)-Silyl-Acrylamides

Following an extensive ligand screening to identify conditions favouring selective formation of the (*E*)-β-isomer **285a**, JohnPhos (**L2**) emerged as the most effective ligand, providing the highest β-selectivity. As a result, it was selected for use in subsequent optimisation studies. These included evaluation of solvent, temperature, catalyst loading, and silane equivalents (**Table 74**). Solvent effects were examined first, with the aim of further increasing the yield and regioselectivity. When the reaction was performed in THF, the desired product **285a** was obtained in only 23% yield, accompanied by increased formation of side products (**290** and **291**, previously discussed in section **4.3.2.1**). A reduction in regioselectivity was also observed (α:β = 18:82, Entry **1**). Switching to ethyl acetate resulted in a significant improvement, affording the β-isomer in 50% yield and improved regioselectivity (α:β = 10:90, Entry **2**). Entry **3** demonstrates that toluene was the optimal solvent, affording the highest yield of the desired β-isomer **285a** (62%) while maintaining high regioselectivity. The reaction also proceeded effectively in dichloromethane, delivering **285a** in 57% yield (Entry **4**). As anticipated, the hydrosilylation was unsuccessful in methanol (Entry **5**). A moderate yield was obtained in acetonitrile, with the desired product formed in 38% yield, although regioselectivity remained comparable (Entry **6**).

The effect of reaction temperature on yield and regioselectivity was also examined. Although pre-mixing of $PtCl_2$ and JohnPhos were carried out at 50 °C to ensure complex formation prior to substrate and silane addition. However, subsequent reduction of the reaction temperature led to diminished performance, resulting in a reduced yield of 40%, though regioselectivity remained high (α:β = 9:91, Entry **7**).

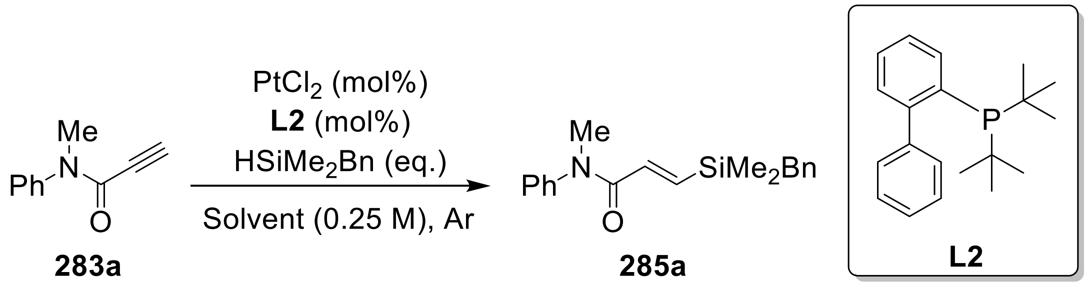
The impact of catalyst loading on the reaction outcome was subsequently evaluated. Reducing the catalyst loading to 2 mol% resulted in a moderate decrease in yield (52%), while regioselectivity remained largely unaffected (Entry

8). However, increasing the loading to 10 mol% led to only a marginal improvement in yield (56%, Entry **9**).

Increasing the silane equivalent to 2.0 resulted in only a modest increase in yield (59%, Entry **10**) but was accompanied by a reduction in regioselectivity (α:β = 17:83). In contrast, lowering the silane loading led to an increased formation of side products, ultimately affording the desired product in only 46% yield (Entry **11**).

Throughout the optimisation studies, regioselectivity remained relatively consistent, with all conditions affording complete stereochemical control towards the (*E*)-isomer. The optimal conditions were established in Entry **3**, delivering the desired product **285a** in 62% isolated yield with high regio- and stereoselectivity. Attempts to deviate from these optimal parameters did not yield improvements, as efforts to suppress side reactions and further increase the yield proved unsuccessful.

Table 74: Optimisation of the synthesis of β-(*E*)-silyl-acrylamides



Entry	Solvent	Silane (eq.)	$PtCl_2$ (mol%)	L2 (mol%)	Temp (°C)	**285:284**[b]	β(*E*):β(*Z*)[c]	Yield[d] (%)
1	THF	1.5	5	10	50	82:18	>99:1	23
2	EtOAc	1.5	5	10	50	90:10	>99:1	50
3	Toluene	1.5	5	10	50	88:12	>99:1	62
4	DCM	1.5	5	10	50	86:14	>99:1	57
5	MeOH	1.5	5	10	50	-	-	n.r
6	MeCN	1.5	5	10	50	90:10	>99:1	38
7	Toluene	1.5	5	10	25[a]	91:9	>99:1	40
8	Toluene	1.5	2	4	50	87:13	>99:1	52
9	Toluene	1.5	10	20	50	90:10	>99:1	56
10	Toluene	2	5	10	50	83:17	>99:1	59
11	Toluene	1.1	5	10	50	88:12	>99:1	46

[a] Premixing of the ligand and $PtCl_2$ was conducted at 50 °C for 0.5 h before cooling to 25°C, [b] α:β ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture, [c] *E*/*Z* ratio was determined using analysis from the ^{1}H NMR of the crude reaction mixture,[d] Isolated yield of solely β-(*E*)-isomer **285a**

5.3.1.3 Substrate Scope of β-(E)-Silyl-Acrylamides

With the optimised conditions in hand, the substrate scope was explored using a range of propynamides synthesised in Chapter **4.3.1**. The reaction demonstrated broad functional group tolerance across various substrates (**Table 75**). Mixed aryl amides (**285a** – **c**) were well tolerated, affording the desired products in good to excellent yields while maintaining high regioselectivity. An exception was observed with the bisphenyl substrate **285d**, which failed to undergo hydrosilylation under the standard conditions.

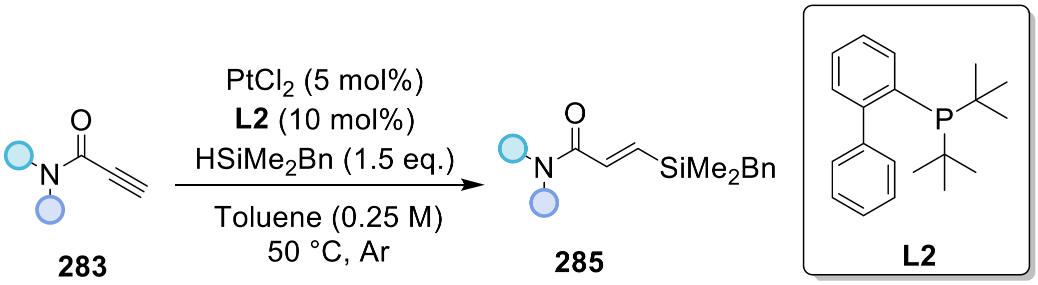
Amides bearing bulky alkyl substituents also performed well, with product **285e** obtained in excellent yield. Notably, the sterically hindered piperidine-derived amide **285f** was converted with complete regiochemical control, though the yield was diminished due to increased side products (previously discussed in section

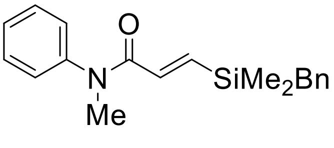
4.3.2.1). Similar side-product formation was also observed for substrates **285g** and **285h**, resulting in reduced yields.

Substrate **285h** also exhibited a moderate drop in regioselectivity (β:α = 67:33), in contrast to **285i**, which was formed in 79% yield with excellent selectivity (β:α, 88:12). In addition, nitrogen- and oxygen-containing heterocycles (**285j** and **285k**) were compatible with the reaction conditions, delivering the corresponding products in good yields and excellent regioselectivities (β:α, 93:7 and 94:6, respectively).

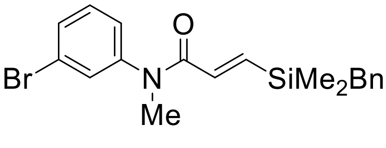
The Weinreb amide substrate **285l** also performed well, providing the product in good yield with excellent regioselectivity. Importantly, across all substrates evaluated, the reaction proceeded with complete stereocontrol, affording only the (*E*)-isomer in all cases.

Table 75: Substrate scope of β-(*E*)-silyl-acrylamides

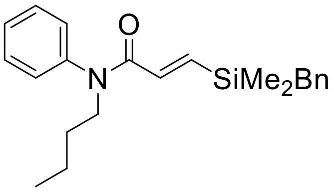




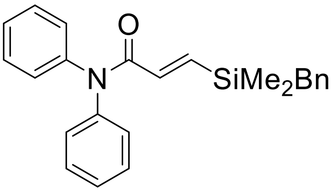
285a, 62%, 88:12



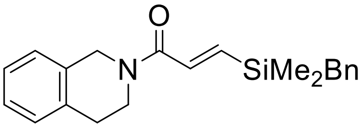
285b, 70%, 85:15



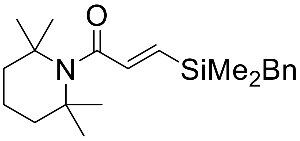
285c, 82%, 90:10



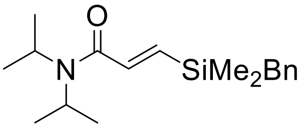
285d, n.r



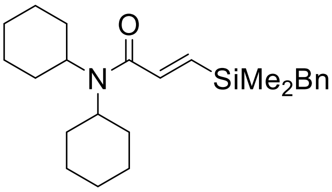
285e, 80%, 94:6



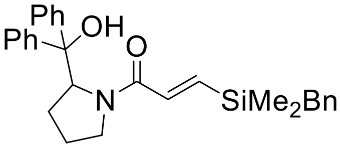
285f, 49%, >99:1



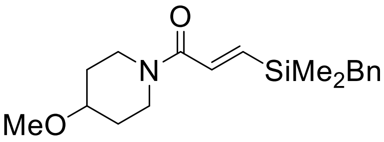
285g, 56%, 88;11



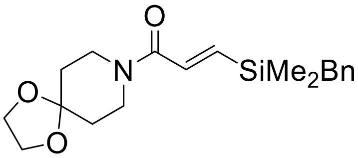
285h, 47%, 67:33[a]



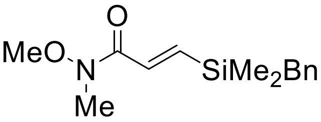
285i, 79%, 88:12



285j, 63%, 93:7



285k, 72%, 94:6

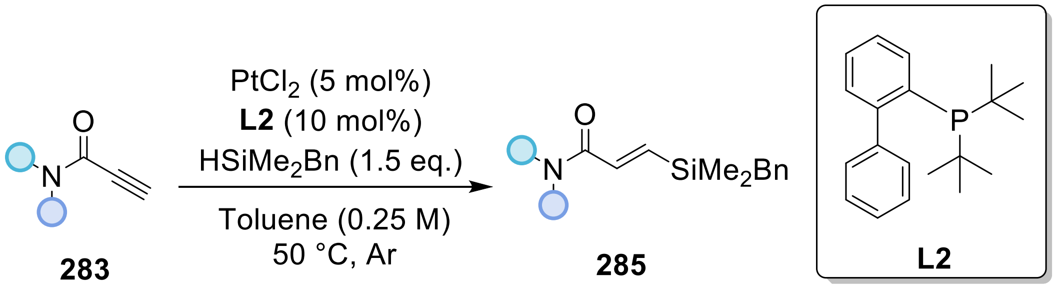


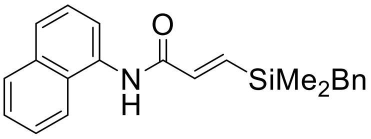
285l, 51%, 93:7

Note: β:α ratio determined via analysis of ^{1}H NMR of the crude reaction, (*Z*)-isomer was not observed, isolated yields are of only β-(*E*)-vinyl silane unless otherwise stated, [a] isolated yield of α and β-(*E*)-isomer

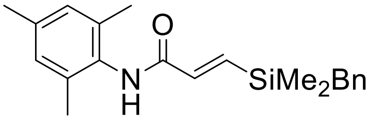
Attention was then turned to investigate the tolerance of secondary amide substrates with this platinum system (**Table 76**). However, to no prevail were any successful reactions, leading to complete recovery of the starting materials. This was suggested due to potential inhibition of the catalyst pathway due to the nitrogen poisoning of the catalyst.

Table 76: Substrate scope of β-(*E*)-silyl-acrylamides

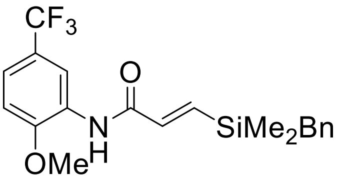




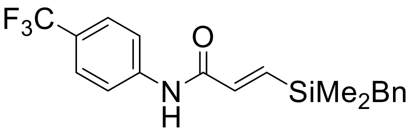
285m, n.r



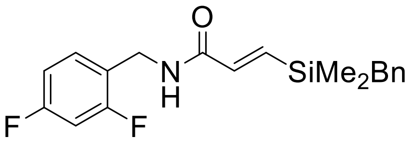
285n, n.r



285o, n.r



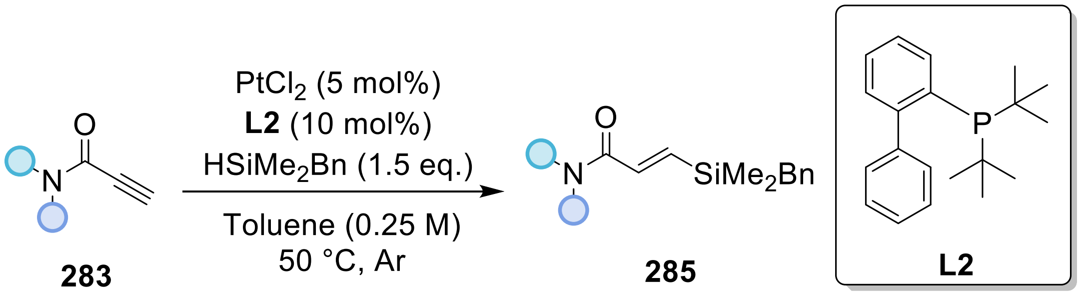
285p, n.r

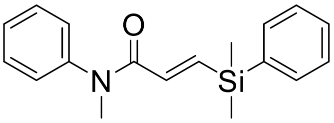


285q, n.r

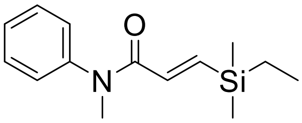
Next, the influence of the silyl group on the reaction outcome was investigated (**Table 77**). Dimethylphenylsilane afforded the desired product **285r** in good yield with high regiochemical control. In contrast, the use of dimethylethylsilane resulted in significantly reduced regioselectivity, with a marked preference for formation of the α-isomer (**285s**). This decrease in selectivity is likely attributable to the lower steric bulk of the ethyl-substituted silane, which may reduce the steric bias required for effective β-selectivity. Attempts to employ more reactive or sterically demanding silanes (**285t** – **285v**) were unsuccessful, with no product formation observed under the standard reaction conditions.

Table 77: Silyl substrate scope of β-(*E*)-silyl-acrylamides

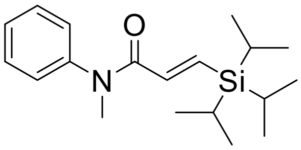




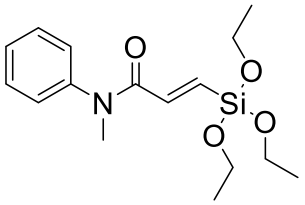
285r, 51%, 84:16[a]



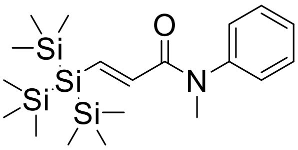
285s, 59%[b], 27:73[c]



285t, n.r[d]



285u, n.r[e]

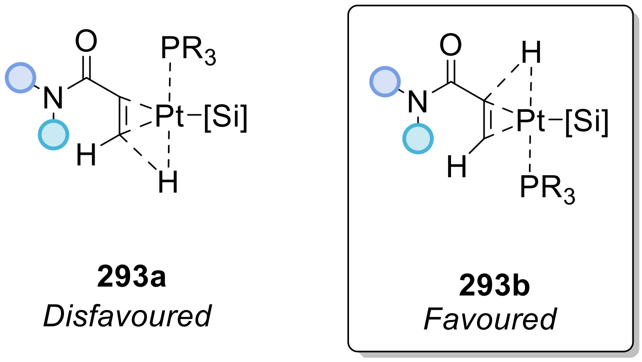


285v, n.r[f]

Note: β:α ratio determined via analysis of ^{1}H NMR of the crude reaction, (*Z*)-isomer was not observed, isolated yields are of only β-(*E*)-vinylsilane, unless otherwise stated, [a] HSiMe$_2$Ph was used, [b] Isolated yield of α and β-(*E*)-isomer, [c] HSiMe$_2$Et was used, [d] HSi(*i*-Pr)$_3$ was used, [e] HSi(OEt)$_3$ was used, [f] HSi(TMS)$_3$ was used.

5.3.1.4 Mechanistic Discussion

The reaction is proposed to proceed via a combination of the Chalk–Harrod and modified Chalk–Harrod mechanisms. During the substrate scope investigation, it was observed that the steric bulk of the amide substituent plays a key role in directing regioselectivity. Bulkier substrates favoured formation of the β-isomer and resulted in higher regioselectivity. This effect is believed to offset the electron-withdrawing nature of the amide group, which would otherwise favour α-selectivity (as discussed in Chapter **4.3.2.4**). However, the use of bulky JohnPhos ligand, overrides this preference, instead promoting formation of the β-isomer through steric control (**293b**) (**Figure 21**). This steric influence was further supported by silane variation studies, where less hindered silanes led to a decrease in the regioselectivity, favouring the α-isomer.



293a
Disfavoured

293b
Favoured

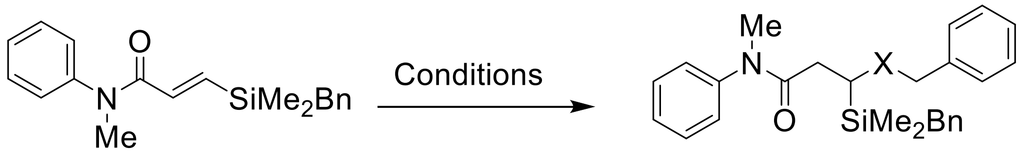
Figure 21: Favoured transition state for hydrosilylation of propynamides

Moreover, the reaction is believed to proceed via a *syn*-addition pathway, as no evidence of (*Z*)-olefin formation was observed in any of the successful reactions, affording exclusive formation of the (*E*)-isomer under the conditions employed.

5.3.2 Investigation of the Reactivity of β-(*E*)-Silyl-Acrylamides

To probe the reactivity of the vinylsilanes as Michael acceptors nucleophilic additions were investigated using simple sulphur, oxygen, and nitrogen nucleophiles (**Table 78**). All efforts to promote the reaction were unsuccessful, with no conversion observed and complete recovery of the starting material.

Table 78: Attempted Michael additions into β-(*E*)-silyl-acrylamides



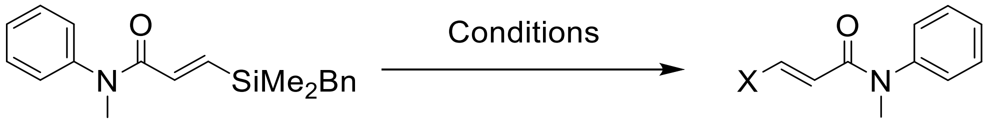
285a

320

Entry	Reagent (1.5 eq.)	Solvent (0.05 M)	Temperature (°C)	Yield (%)
1	BnOH	MeCN	Room	n.r
2	BnSH	MeCN	Room	n.r
3	$BnNH_2$	MeCN	Room	n.r

β-Halogenated acrylamides (**321**) were considered attractive intermediates for cross-coupling reactions, offering a route to diversify substitution at the β-position. Initially, a literature procedure reported by Lee *et al.* was followed, employing NIS in excess at both ambient and elevated temperatures (**Table 79**).[165] However, in all cases, no reaction occurred, and the starting material was fully recovered. Subsequently, investigations employed NBS at elevated temperature was also explored to promote higher reactivity. Despite these efforts, this approach also failed to afford the desired product, and the starting material was again recovered unreacted.

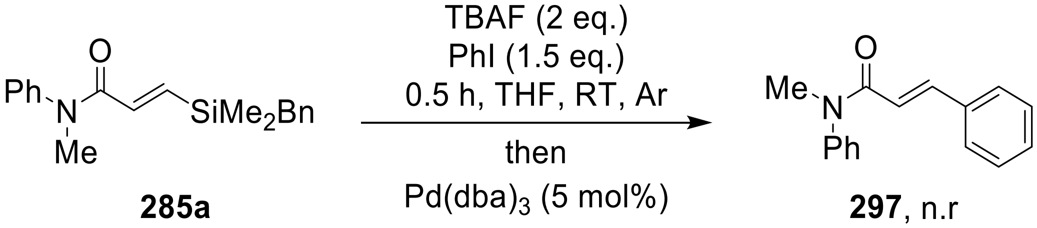
Table 79: Attempted halogenation investigation of β-(*E*)-silyl- acrylamides



285a **321** X = Br or I

Entry	Reagent	Solvent (0.05 M)	Temperature (°C)	Yield (%)
1	NIS / 2 eq.	MeCN	Room	n.r
2	NIS / 2 eq.	MeCN	50	n.r
3	NBS / 0.9 eq.	MeCN	100	n.r

The cross-coupling reactivity of the β-vinylsilanes was next explore, beginning with attempts at a Hiyama-type coupling. However, under the conditions employed, no cross-coupled product (**297**) was observed (**Scheme 59**). Additionally, under these conditions no Heck-type coupling was observed either, which was seen during investigation of the α-isomers in Chapter **4.3.4**. This lack of reactivity may be attributed to the increased steric hindrance around the β-silane compared to its α-isomer, potentially inhibiting the coupling process.



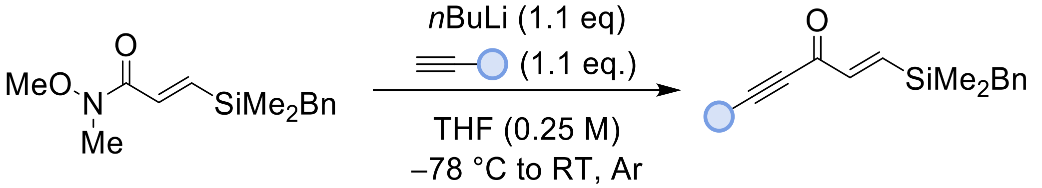
285a **297**, n.r

Scheme 59: Cross coupling of β-(*E*)-silyl-acrylamides

5.3.2.1 Applications of Weinreb Amide Derivative

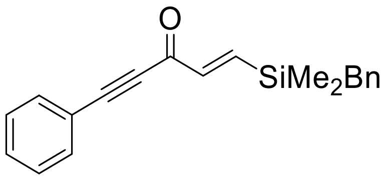
To explore the synthetic utility of β-(*E*)-silyl-acrylamides, the Weinreb amide derivative **285l** was employed, owing to its well-established reactivity towards organolithium and organomagnesium reagents. This approach offers the opportunity to introduce diverse functionalities, enabling access to novel β-(*E*)-vinylsilane derivatives that are otherwise difficult to obtain. The study began with the substitution of TMS-acetylene, which proceeded efficiently to afford the corresponding ynone **322c** in 67% yield (**Table 80**). This methodology was also applied to the phenyl derivative **322a**, resulting in a 68% yield. In contrast, attempts to functionalise substrates **322b** and **322c** were unsuccessful, leading to complex mixtures attributed to degradation. Notably, the reactions proceeded exclusively through the 1,2-addition pathway, with no evidence of 1,4-addition products observed.

Table 80: Acylation of Weinreb amide to form internal alkynes

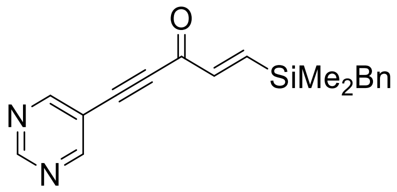


285l

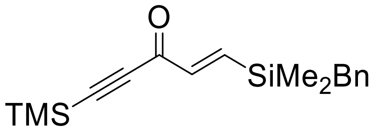
322



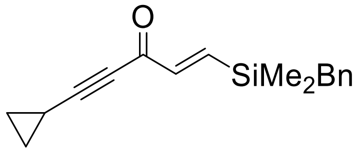
322a, 68%



322b, n.r



322c, 67%



322d, n.r

5.4 Conclusions

Hydrosilylation of the synthesised propynamides using a $PtCl_2$/JohnPhos catalyst system proceeded with high regioselectivity and complete stereochemical control, affording the β-(*E*)-vinylsilane products in high yield and selectivity. The reaction exhibited broad substrate scope, tolerating a variety of aryl, alkyl, and heterocyclic substituents, and generally delivered good yields. In contrast, secondary propynamides were found to be unreactive under these conditions, which was attributed to potential catalyst deactivation via coordination of the amide nitrogen to the platinum centre, as well as possible ligand displacement.

The influence of silane structure on reaction outcome was systematically examined. Bulky or highly reactive silanes were generally unsuccessful, likely due to steric or electronic incompatibility with the catalytic system. The observed β-selectivity is proposed to arise from the steric bulk of the JohnPhos ligand, which may override the electronic bias that would typically favour α-isomer formation.

The reactivity of the resulting β-silyl-substituted acrylamides was further investigated. Attempts at halogenation and cross-coupling were unsuccessful. However, Weinreb amide derivatives were successfully incorporated and subsequently transformed into enynone derivatives.

6 Chapter 6 – Overall Conclusions and Future Work

6.1 Overall Conclusions

This thesis has explored the development of novel, selective strategies for the synthesis of structurally diverse vinyl and allylsilane derivatives. As highlighted in Chapter 1, silicon-containing olefinic motifs, despite their extensive applications in industrial and synthetic chemistry, remain underutilised in medicinal chemistry. This is surprising as they hold significant potential to improve ADMET properties and biological activity. However, a key limitation in this area arises due to the lack of reliable, general synthetic methods that provide defined regio- and stereocontrol. The work presented in this thesis directly addresses these challenges through the advancement of selective hydrosilylation and metal free allylation methodologies.

Hydrosilylation of propargylic alcohols using a $PtCl_2$/XPhos system enabled the efficient synthesis of a library of β-(*E*)-vinylsilanes with complete regio- and stereocontrol. These transformations exhibited broad substrate scope, accommodating a range of sterically and electronically diverse aryl and alkyl substituents, and consistently delivered high yields.

To access linear allylsilanes, a metal-free triflimide catalysed reduction of vinylsilanes was developed and optimised. However, challenges such as oligomerisation, over reduction, and limited functional group tolerance prompted the exploration of alternative strategies. This led to the development of a Brønsted superacid catalysed allylation methodology. The reaction tolerated a range of vinylsilanes and furnished substituted allylsilanes in moderate to excellent yields. Nevertheless, several limitations were encountered, including diminished regioselectivity with less hindered substrates, incompatibility with alkyl substituents at the γ-position (relative to the silicon group) due to competing elimination pathways leading to 1,3 dienes, and poor tolerance of basic functional groups such as amines, which inhibited catalytic turnover. Although optimal selectivity for less hindered substrates could not be achieved, the influence of steric factors on reaction outcome provided valuable mechanistic insight and supported the operation of multiple allylation pathways. To overcome regioselectivity issues, a Cope rearrangement strategy was successfully employed, converting vinylsilane regioisomers into the desired allylsilanes and highlighting the utility of this complementary approach.

Attempts to diversify the allylsilane products were largely unsuccessful. However, protodesilylation proved effective, affording 1,5 dienes in high yields. While partial loss of stereochemical fidelity was observed, likely due to the formation of multiple addition products, the transformation remains synthetically valuable.

In parallel, a robust platform was established for the synthesis of both α- and β-silyl-substituted acrylamides via hydrosilylation of propynamides. Hydrosilylation using a $PtCl_2$/tris(pentafluorophenyl)phosphine system afforded α-vinylsilanes with high regioselectivity and broad substrate tolerance. However, secondary propynamides were unreactive, likely due to catalyst deactivation through nitrogen coordination and possible ligand displacement. The observed Markovnikov selectivity aligned with literature precedent and was attributed to the electron-deficient nature of the amide substituted alkyne. Functionalisation of these α-silyl acrylamides showed promising reactivity under Heck-type cross-coupling and protodesilylation conditions, although attempts at halogenation were unsuccessful. Nonetheless, Weinreb amide derivatives were successfully incorporated and transformed into enynone products, demonstrating the synthetic versatility of this motif.

Also, the $PtCl_2$/JohnPhos system enabled the synthesis of β-(*E*)-silyl-substituted acrylamides with high regio- and stereochemical control. This transformation accommodated a wide array of aryl, alkyl, and heterocyclic substituents and generally provided high yields. Secondary propynamides remained unreactive, likely due to catalyst deactivation caused by coordination of nitrogen-containing groups. Additionally, bulky or highly reactive silanes were unsuccessful. The observed β-selectivity is proposed to originate from the steric demands of the JohnPhos ligand, which may override the electronic bias that typically favours α-addition. While functionalisation of these β-silyl acrylamides proved limited, as with the α-series Weinreb amide derivatives were successfully incorporated and converted to novel enynone products.

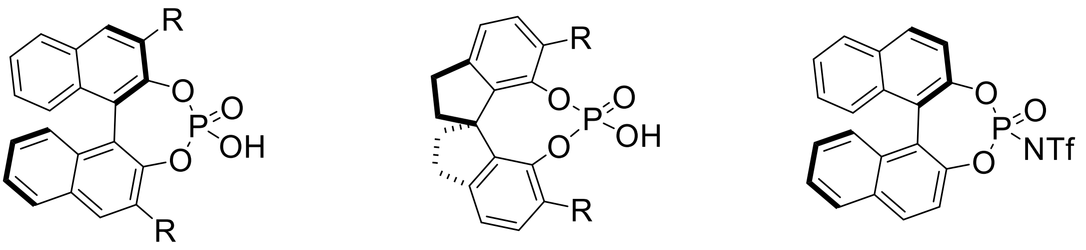
Collectively, the methodologies developed in this thesis provide high selectivity, scalable, and broadly applicable routes to both α- and β-silyl-substituted acrylamides and allylsilanes. These findings represent a significant contribution to the field of organosilicon chemistry and provide a strong foundation for the continued exploration of silicon-containing motifs in medicinal chemistry and beyond.

6.2 Future Work

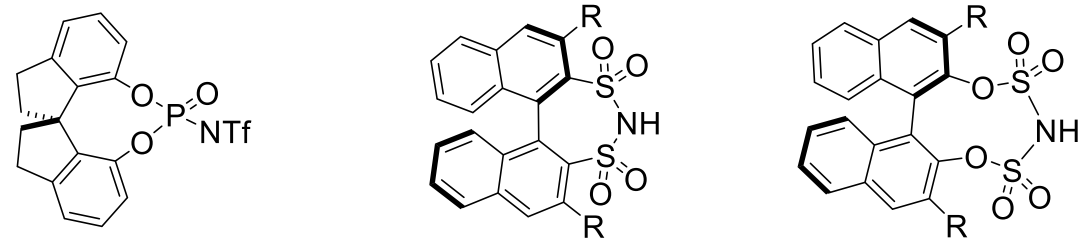
6.2.1 Enantioselective Brønsted Superacid Catalysed Synthesis of Allylsilanes

Building upon the work presented in Chapters 2 and 3, several avenues offer promising directions for further investigation. Chiral allylsilanes are highly valuable organosilicon reagents that enable stereocontrolled transformations in cross coupling, allylation, and other C-C bond forming reactions.[24, 60] Importantly, the ability to access optically pure allylsilanes is not only synthetically desirable but would also be highly advantageous for the development of medicinal targets, where precise control over stereochemistry can directly influence biological activity, selectivity, and pharmacokinetic properties.

One promising direction would be the introduction of chiral Brønsted acid catalysts to enable enantioselective allylsilane formation. In particular, the use of chiral superacid organocatalysts inspired by BINAP or SPINOL derived phosphoric acids represents a compelling approach (**Figure 22**).[183, 184] These catalysts incorporate strongly electron-withdrawing sulfonyl functionalities, which enhance their Brønsted acidity to superacid levels, while the BINAP or SPINOL backbone provides a defined chiral environment. Such systems could thus combine the catalytic efficiency of superacids with the stereocontrol necessary for asymmetric induction.



BINOL-phosphoric acids **SPINOL-phosphoric acids** ***N*-Phosphoramides**



SNTPA-1 **Bis(sulfonyl)imides** **Bis(sulfuryl)imides**

Figure 22: Lewis assisted Brønsted chiral superacids catalysts

Furthermore, this strategy could be extended through cooperative catalysis frameworks, such as:

- LBA (Lewis acid assisted Brønsted acid catalysis)
- LBBA (chiral Lewis base assisted Brønsted acid catalysis)
- BBA (Brønsted acid assisted Brønsted acid catalysis)

These hybrid approaches offer attractive alternatives to traditional Brønsted acid catalysis and can expand the range of activation modes and substrate compatibility.[141, 184, 185] Applying such cooperative catalysis to the current methodology may not only invoke enantioselectivity but also help overcome current limitations, such as the poor tolerance of basic functional groups like amines and diminished regioselectivity with less hindered substrates.

Ultimately, the development of an enantioselective Brønsted superacid catalysed method would represent a significant advancement, providing access to optically active allylsilanes with defined absolute stereochemistry. These compounds would offer great potential in asymmetric synthesis and expand their utility in medicinal chemistry, particularly in the design of stereochemically complex, biologically active molecules.

6.2.2 Evaluation of Silyl-Substituted Acrylamides as Covalent Warheads

Building upon the findings presented in Chapters 4 and 5, silyl substituted acrylamides represent a compelling scaffold for the development of next generation electrophilic warheads. While cysteine targeting covalent inhibitors have demonstrated significant clinical success, particularly against proteins such as BTK and EGFR, the relatively low proteome wide abundance of cysteine, coupled with concerns over off target reactivity and acquired resistance, has prompted growing interest in alternative nucleophilic residues as viable targets.[53, 186-189]

Future studies should therefore prioritise the evaluation of current silyl substituted acrylamides and the development of new analogues capable of selectively engaging non cysteine nucleophilic residues such as histidine, lysine, and serine. These emerging electrophilic motifs offer the potential for improved chemoselectivity and tuneable reactivity, thereby broadening the scope of covalent inhibition strategies.

Systematic chemoselectivity studies using amino acid panels, in conjunction with competitive labelling experiments and mass spectrometry based proteomic analyses, will be essential for guiding optimisation of both warhead and linker architecture. Complementary NMR titration studies may also provide valuable insight into the nature of reversible and irreversible protein ligand interactions. Candidates demonstrating favourable reactivity profiles should subsequently be evaluated in disease relevant cellular models to assess target engagement, functional activity, and metabolic stability.

Overall, future work should aim to expand the utility of silyl substituted acrylamides beyond their traditional role as synthetic intermediates, positioning them as functionally versatile covalent warheads. Through a combination of chemical biology and proteomic approaches, these emerging electrophiles may ultimately contribute to the discovery of next generation covalent drugs with improved selectivity, broader residue coverage, and enhanced therapeutic potential.

7 Chapter 7 - Experimental

7.1 General Considerations

7.1.1 Solvents and Reagents

Reagents were purchased in the highest purity available from Acros Organics, Alfa Aesar, Fluorochem, TCI, Fischer Scientific or Sigma Aldrich. All solvents were purchased from commercial sources and used without purification (reagent grade). Metal salts and ligands were stored in a desiccator when not in use. Anhydrous solvent was prepared by storing solvent over activated 4 Å MS for 72 hours. Standard vacuum line techniques were used, and glassware was oven dried at 220 °C prior to use. Organic solvents were dried during workup using anhydrous Na_2SO_4 or $MgSO_4$. All reactions were performed using DrySyn heating mantles and pressure regulated vials or round bottom flasks.

7.1.2 Purification and Chromatography

Thin Layer Chromatography (TLC) was carried out using aluminium plates coated with 60 F254 silica gel. Plates were visualised using UV light (254 or 365 nm) and developed with iodine and basic permanganate solution. Flash chromatography was performed on VWR Silica gel 60, 40–63 microns RE as the stationary phase and the solvents employed were of reagent grade.

7.1.3 Characterisation

NMR spectroscopic data were obtained using a Bruker AVANCE III 400 equipped with a BBFO probe at 298 K. The chemical shifts are reported in parts per million (δ) relative to residual $CHCl_3$ (δH = 7.26 ppm) and $CDCl_3$ (δC = 77.16 ppm, central line). ^{19}F spectra were indirectly referenced to the deuterium lock shift. The assignment of the signals in the ^{1}H and ^{13}C NMR spectra was achieved through 2D-NMR techniques: COSY, HSQC and HMBC. Coupling constants (J) are quoted in Hertz. Infrared spectra were recorded on an Agilent Technologies Cary 630 FTIR spectrometer. High resolution mass spectrometry data were recorded using electron spray ionisation (ESI) or atmospheric pressure chemical ionisation (APCI) on a Shimadzu LCMS-IT-TOF mass spectrometer at Lancaster

University or by Analytical Services and Environmental Projects (ASEP) at Queen's University Belfast on a Waters LCT Premier ToF mass spectrometer.

7.2 Chapter 2 – Experimental

7.2.1 Structural Assignment of Isomers

Assignment of the *E*/*Z* 1,2-substituted alkenes is readily done by extracting the $^3J_{HH}$ across the double bond from the corresponding 1D proton NMR spectrum. While the exact same method cannot be used for tri-substituted alkenes, the $^3J_{CH}$ couplings can be used in a comparable manner i.e. $^3J_{CH,trans} > {}^3J_{CH,cis}$.[158]

In particular, 2D proton-selective HSQMBC experiments were used using a literature sequence employing a Zero Quantum Filter (ZQF).[159] Generally, a 100-200 Hz Rsnob pulse was sufficient to achieve the required proton selectivity, and acquisition times of 1 s in the direct dimension to ensure the signals were properly defined.

Olefinic protons adjacent to CH_2's (**220e** and **227d**) gave apparent quartets for one of the isomers since $^3J_{HH} \approx {}^3J_{CH,trans}$, so in this case the IPAP methodology was used to more-precisely measure the $^3J_{CH}$ value. For the compounds measured here, $^3J_{CH,trans}$ was in the range 7.9 – 9.3 Hz, while $^3J_{CH,cis}$ was 5.7 – 6.3 Hz. Where possible, 1D selective NOESY experiments were used to validate the *E*/*Z* assignments from $^3J_{CH}$ measurements.

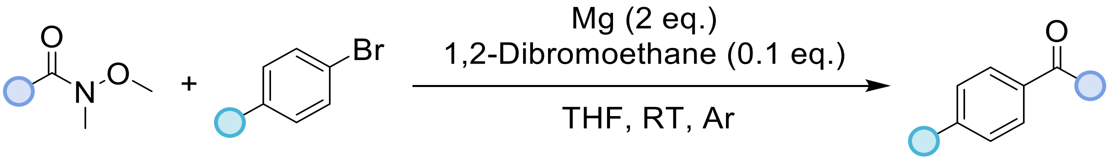
Many of the tri-substituted alkenes formed inseparable mixtures of *E*/*Z* isomers with very similar ^1H and ^{13}C chemical shifts. For this reason, it was necessary to use acquisition times in the indirect dimension of up to 200 ms, or a nominal resolution of 5 Hz prior to further processing. Various combinations of aliasing, F1 band-selection and increased numbers of increments were used to achieve the required resolution without the need to run excessively long experiments. In addition, $^1H,^{19}F$-HMBC and $^1H,^{29}Si$-HMBC experiments were used to aid in assignments as required.

7.2.2 General Procedures

7.2.2.1 General Procedure A – Synthesis of Weinreb Amides

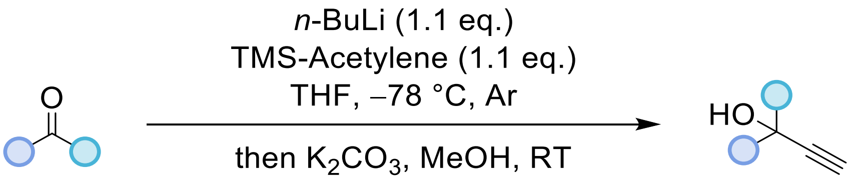
To a stirred suspension of *N*-methoxymethylamine hydrochloride salt (1 eq.) in DCM (0.5 M) at 0 °C was slowly added triethylamine (2 eq.). The acid chloride (1 eq.) was then added dropwise to the solution. The solution was allowed to warm to room temperature and stirred for 1 hour before quenching with saturated aqueous $NaHCO_3$ solution (15 mL). The organic layer was separated and washed with 1 M HCl (5 ml) and brine (5 ml) and dried over Na_2SO_4 before being concentrated in *vacuo*. The crude product was purified via column chromatography to afford the corresponding Weinreb amide.

7.2.2.2 General Procedure B – Synthesis of Dibenzophenones



To an oven dried flask under an argon atmosphere was added magnesium turnings (2.0 eq.) followed by THF (0.5 M) and 1,2-dibromoethane (0.1 eq.) with the resulting suspension then stirred for 20 minutes at room temperature. After this time, aryl bromide (1.5 eq.) was added to the suspension, and the mixture left for 1 hour to form the Grignard reagent. During this time, a separate oven dried flask was charged with the Weinreb amide and placed under a nitrogen atmosphere at 0 °C. Once formed, the Grignard reagent was added dropwise to the Weinreb amide (1 eq.), warmed to room temperature, and stirred. Next, the reaction was quenched via addition of HCl (10 mL, 1 M) and extracted into DCM (3 × 10 mL) before being dried over $MgSO_4$. Volatiles were then removed under vacuum, and the resultant residue purified by flash column chromatography to afford the corresponding dibenzophenone.

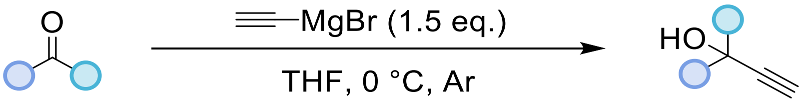
7.2.2.3 General Procedure C – Synthesis of Propargyl Alcohols



To a solution of trimethylsilylacetylene (1.1 eq.) in THF (0.5 M) under an argon atmosphere, *n*-BuLi (1.1 eq., 2.5 M in hexane) was added dropwise at −78 °C. The mixture was stirred for 30 minutes before the requisite aldehyde was added, and the mixture was slowly warmed to room temperature before stirring for 2 hours. After this time, the reaction was quenched with NH_4Cl and extracted with DCM (3 x 10 mL) and dried over $MgSO_4$ before the solvent was removed under pressure to yield the corresponding TMS protected propargyl alcohol.

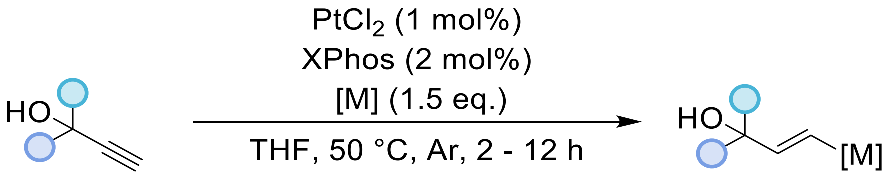
To a solution of TMS protected propargyl alcohol in methanol (0.5 M) was added K_2CO_3 (3 eq.). This solution was stirred at room temperature for 2 hours. After this time, the reaction was quenched with H_2O (10 mL) and EtOAc (10 mL), before extracted into EtOAc (3 x 10 mL). The extract was dried with $MgSO_4$ before removal of solvent in vacuo. The residue was then purified via column chromatography to afford the corresponding propargyl alcohol.

7.2.2.4 General Procedure D – Synthesis of Propargyl Alcohols



A 0.5 M THF solution of ethynylmagnesium bromide (1.1 eq., 0.5 M in THF) under argon was cooled to 0 °C. The aldehyde/ketone was then added dropwise. After the addition was complete, the reaction mixture was warmed to room temperature and allowed to stir overnight. The reaction was quenched with saturated aqueous NH_4Cl (20 mL) and extracted with Et_2O (3 x 10 mL), dried over $MgSO_4$, and concentrated under reduced pressure. Crude product was purified via column chromatography to afford corresponding propargyl alcohol.

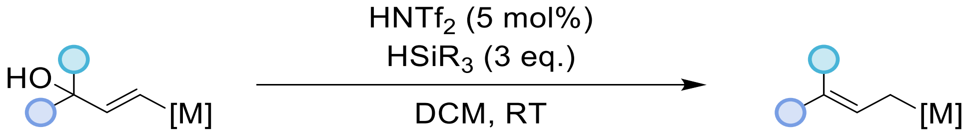
7.2.2.5 General Procedure E – Synthesis of Vinylsilanes/boranes



[M] = SiR_3 or Bpin

To an oven dried vial was added $PtCl_2$ (1 mol%) and 2-dicyclohexylphosphino-2′,4′,6′-triisopropylbiphenyl (2 mol%) (XPhos). The flask was then flushed quickly with argon and dry THF (0.5 M) was added. The mixture was then stirred at 50 °C for 30 minutes until a yellow homogeneous mixture was obtained. The corresponding propargyl alcohol (1 eq.) was added followed by the silane or borane (1.5 eq.) via syringe (CAUTION: Rapid evolution of hydrogen gas) and the solution was stirred at 50 °C overnight. The solvent was evaporated, and the crude mixture was applied to the top of a column and chromatographed to afford the requisite (*E*)-vinylsilane/borane.

7.2.2.6 General Procedure F – Synthesis of Allylsilanes/boranes

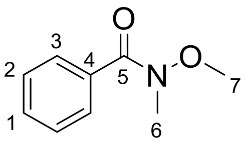


[M] = SiR_3 or Bpin
$HSiR_3$ = $SiMe_2Ph$, $SiMe_2Bn$, $SiEt_3$

To a solution of vinylsilane/borane in DCM (0.5 M) was added $HSiR_3$ (3.0 eq.) and triflimide (5.0 mol%, 0.05 M solution in DCM). This solution was stirred at room temperature for 15 minutes. After this time, the reaction was quenched with K_2CO_3 (1 eq.) and reduced under vacuum. The residue was then purified via column chromatography to afford the corresponding (*E*)–allylsilane/borane.

7.2.3 Weinreb Amides

***N*-methoxy-*N*-methylbenzamide – 323**



The title compound was prepared according to general procedure **A**, from benzoyl chloride (5 g, 35.6 mmol) and *N*-methoxymethylamine hydrochloride salt (3.47 g, 35.6 mmol) and triethylamine (9.92 mL, 71.1 mmol). Following the conversion to product and column chromatography [SiO_2; 3:1 pentane:EtOAc] afforded **323** (5.90 g, 99%) as a colourless oil.

R$_f$ = 0.12 [9:1 Hexane:EtOAc].

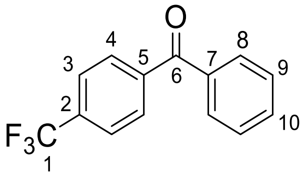
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.68 – 7.65 (m, 2H (**H3**)), 7.45 – 7.37 (m, 3H (**H1** and **H2**)), 3.55 (s, 3H (**H7**)), 3.36 (s, 3H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 171.0 (**C5**), 134.3 (**C4**), 130.7 (**C1**), 128.3 (**C3**), 128.1 (**C2**), 61.2 (**C7**), 33.9 (**C6**).

All spectral data in accordance with literature.[190]

7.2.4 Dibenzophenones

Phenyl-[4-(trifluoromethyl)phenyl]methanone – 324



The title compound was prepared according to general procedure **B**, from 4-bromobenzotrifluoride (1.02 g, 4.54 mmol) and *N*-methoxy-*N*-methylbenzamide (500 mg, 3.03 mmol) using magnesium turnings (147 mg, 6.05 mmol) and 1,2-dibromoethane (13.0 µL, 151 µmol, 5 mol%). Following the conversion to product and column chromatography [SiO_2; 9:1 pentane:EtOAc] afforded **324** (180 mg, 24%) as a white solid.

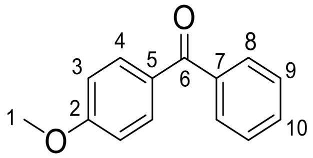
R$_f$ = 0.49 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.0 Hz, 2H (**H3**)), 7.83 (dd, *J* = 8.4, 1.3, 2H (**H8**)), 7.78 (d, *J* = 8.1 Hz, 2H (**H4**)), 7.69 – 7.64 (m, 1H (**H10**)), 7.56 – 7.52 (m, 2H (**H9**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 195.7 (**C6**), 140.9 (**C5**), 136.9 (**C7**), 133.9 (q, *J* = 32.7 Hz (**C2**)) , 133.2 (**C10**), 130.3 (**C8** or **C9**), 130.3 (**C8** or **C9**), 128.7 (**C4**), 125.5 (q, *J* = 3.8 Hz (**C3**)), 123.8 (q, *J* = 272.6 Hz (**C1**)).

All spectral data in accordance with literature.[191]

(4-Methoxyphenyl)-phenyl-methanone – 325



The title compound was prepared according to general procedure **B**, from 4-bromoanisole (849 mg, 4.54 mmol) and *N*-methoxy-*N*-methylbenzamide (500 mg, 3.03 mmol) using magnesium turnings (147 mg, 6.05 mmol) and 1,2-dibromoethane (13.0 µL, 151 µmol, 5 mol%). Following the conversion to product and column chromatography [SiO_2; 9:1 pentane: EtOAc] afforded **325** (280 mg, 44%) as a white solid.

R_f

R_f = 0.39 [9:1 Hexane:EtOAc].

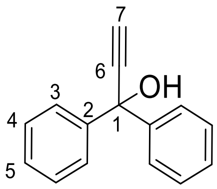
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 9.0 Hz, 2H (**H4**)), 7.76 (dd, *J* = 8.3, 1.4 Hz, 2H (**H8**)), 7.57 (t, *J* = 7.4 Hz, 1H (**H10**)), 7.47 (t, *J* = 7.5 Hz, 2H (**H9**)), 6.97 (d, *J* = 8.9 Hz, 2H (**H3**)), 3.89 (s, 3H (**H1**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 195.7 (**C6**), 163.4 (**C2**), 138.5 (**C7**), 132.7 (**C4**), 132.0 (**C10**), 130.3 (**C5**), 129.8 (**C8**), 128.3 (**C9**), 113.7 (**C3**), 55.7 (**C1**).

All spectral data in accordance with literature.[191]

7.2.5 Propargylic Alcohols

1,1-Diphenyl-2-propyn-1-ol – 207a



The title compound was prepared according to general procedure **D**, from benzophenone (490 µL, 2.74 mmol) and ethynylmagnesium bromide (8.23 mL, 0.5 M in THF, 4.12 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207a** (436 mg, 76%) as a white solid.

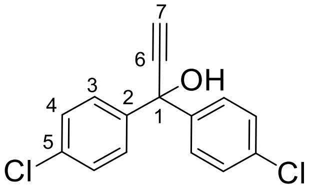
R_f = 0.17 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.61 (dd, *J* = 8.4, 1.3 Hz, 4H (**H3**)), 7.34 (t, *J* = 7.3 Hz, 4H (**H4**)), 7.30 – 7.26 (m, 2H (**H5**)), 2.88 (s, 1H (**H7**)), 2.77 (s, 1H (**O**-**H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 144.5 (**C2**), 128.5 (**C3**), 128.0 (**C5**), 126.1 (**C4**), 86.5 (**C6**), 75.7 (**C7**), 74.5 (**C1**).

All spectral data in accordance with literature.[192]

1,1-Bis(4-chlorophenyl)-2-propyn-1-ol – 207b



The title compound was prepared according to general procedure **D**, from 4,4'-dichlorobenzophenone (250 mg, 996 μmol) and ethynylmagnesium bromide (3.98 mL, 0.5 M in THF, 1.99 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207b** (246 mg, 89%) as a yellow oil.

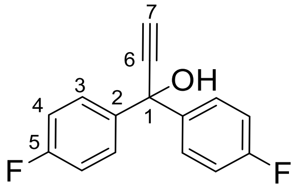
R_f = 0.10 [9:1 Hexane/EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.53 – 7.50 (m, 4H (**H4**)), 7.32 – 7.29 (m, 4H (**H3**)), 2.91 (s, 1H (**H7**)), 2.80 (s, 1H (**O**-**H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 142.7 (**C2**), 134.2 (**C5**), 128.7 (**C4**), 127.5 (**C3**), 85.6 (**C6**), 76.4 (**C7**), 73.5 (**C1**).

All spectral data in accordance with literature.[193]

1,1-Bis(4-fluorophenyl)-2-propyn-1-ol – 207c



The title compound was prepared according to general procedure **D**, from 4,4'-difluorobenzophenone (250 mg, 1.02 mmol) and ethynylmagnesium bromide (3.44 mL, 0.5 M in THF, 1.54 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207c** (216 mg, 77%) as a yellow oil.

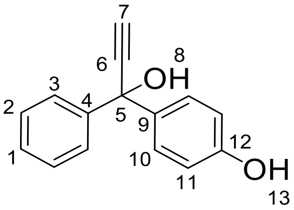
R_f = 0.14 [9:1 Hexane/EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.58 – 7.53 (m, 4H (**H4**)), 7.05 – 6.99 (m, 4H (**H3**)), 2.90 (s, 1H (**H7**)), 2.84 (s, 1H (**O**-**H**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 162.5 (d, *J* = 247.1 Hz (**C5**)), 140.3 (d, *J* = 3.1 Hz **C2**), 128.0 (d, *J* = 8.3 Hz (**C3**)), 115.3 (d, *J* = 21.6 Hz (**C4**)), 86.1 (**C6**), 76.1 (**C7**), 73.5 (**C1**).

All spectral data in accordance with literature.[194]

1-Phenyl-1-(4-hydroxyphenyl)prop-2-yn-1-ol – 207d



The title compound was prepared according to general procedure **C**, from 4-hydroxybenophenone (500 mg, 2.22 mmol), *n*-BuLi (3.13 mL, 2.5 M in hexane, 2.45 mmol) and trimethylsilylacetylene (350 µL, 2.45 mmol). Following the conversion to product and column chromatography [SiO$_2$; 1:1 Hexane:EtOAc] afforded **207d** (434 mg, 77%) as a white solid.

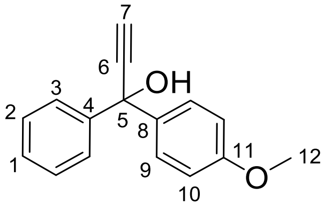
R$_f$ = 0.35 [1:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, DMSO) δ 9.36 (s, 1H (**H13**)), 7.49 (dd, *J* = 8.1, 1.2 Hz, 1H (**H3**)), 7.32 – 7. 28 (m, 4H (**H2** and **H10**)), 7.23 – 7.19 (m, 1H (**H1**)), 6.68 (d, *J* = 8.7 Hz, 1H (**H11**)), 6.59 (s, 1H (**H8**)), 3.73 (s, 1H (**H7**)).

^{13}C NMR: (101 MHz, DMSO) δ 156.4 (**C12**), 146.5 (**C9**), 136.5 (**C4**), 127.8 (**C2** or **C10**), 126.9 (**C2** or **C10**), 126.9 (**C1**), 125.6 (**C3**), 114.5 (**C11**), 87.9 (**C6**), 76.4 (**C7**), 72.4 (**C5**).

All spectral data in accordance with literature.[195]

1-(4-Methoxyphenyl)-1-phenyl-prop-2-yn-1-ol – 207e



The title compound was prepared according to general procedure **D**, (4-methoxyphenyl)-phenyl-methanone (1 g, 4.20 mmol) and ethynylmagnesium bromide (18.8 mL, 0.5 M in THF, 6.30 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207e** (923 mg, 82%) as a white solid.

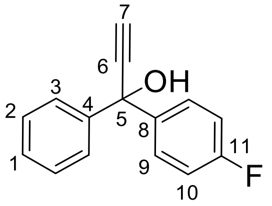
R$_f$ = 0.15 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.61 (dd, *J* = 8.1, 1.3 Hz, 2H (**H3**)), 7.52 (d, *J* = 8.9 Hz, 2H (**H9**)), 7.34 (t, *J* = 7.3 Hz, 2H (**H2**)), 7.30 – 7.26 (m, 1H (**H1**)), 6.86 (d, *J* = 8.9 Hz, 2H (**H10**)), 3.79 (s, 3H (**H12**)), 2.87 (s, 1H (**H7**)), 2.86 (s, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 159.3 (**C11**), 144.7 (**C4**), 136.9 (**C8**), 128.4 (**C3**), 127.9 (**C1**), 127.5 (**C9**), 126.1 (**C2**), 113.7 (**C10**), 86.7 (**C6**), 75.4 (**C7**), 74.1 (**C5**), 55.4 (**C12**).

All spectral data in accordance with literature.[196]

1-Phenyl-1-(4-fluorophenyl)prop-2-yn-1-ol – 207f



The title compound was prepared according to general procedure **D**, 4-fluorobenzophenone (1 g, 4.41 mmol) and ethynylmagnesium bromide (30 mL, 0.5 M in THF, 8.82 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207f** (1.09 g, 96%) as a yellow oil.

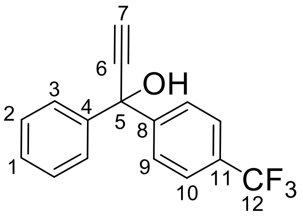
R$_f$ = 0.72 [2:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.61 – 7.56 (m, 4H (**H3** and **H10**)), 7.37 – 7.35 (m, 2H (**H2**)), 7.29 (t, *J* = 7.2 Hz, 1H (**H1**)), 7.10 (d, *J* = 8.7 Hz, 2H (**H9**)), 2.89 (s, 1H (**H7**)), 2.80 (s, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 162.5 (d, *J* = 246.8 Hz (**C11**)), 144.4 (**C4**), 140.4 (d, *J* = 3.1 Hz (**C8**)), 128.5 (**C3**), 128.2 (**C1**), 128.0 (d, *J* = 8.3 Hz (**C9**)), 126.0 (**C2**), 115.2 (d, *J* = 21.6 Hz (**C10**)), 86.3 (**C6**), 75.9 (**C7**), 74.0 (**C5**).

All spectral data in accordance with literature.[193]

1-Phenyl-1-[4-(trifluoromethyl)phenyl]prop-2-yn-1-ol – 207g



The title compound was prepared according to general procedure **D**, phenyl-[4-(trifluoromethyl)phenyl]methanone (750 mg, 2.71 mmol) and ethynylmagnesium bromide (12 mL, 0.5 M in THF, 4.07 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207g** (811 mg, 98%) as a yellow solid.

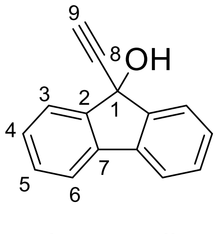
R R_f = 0.22 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 8.2 Hz, 2H (**H10**)), 7.62 – 7.60 (m, 2H (**H3**)), 7.60 (d, *J* = 8.2 Hz (**H9**)), 7.38 – 7.29 (m, 2H (**H2**)), 7.33 (m, 1H (**H1**)), 2.94 (s, 1H (**H7**)), 2.92 (s, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 148.3 (**C4**), 143.9 (**C8**), 130.1 (q, *J* = 32.4 Hz (**C11**)), 128.7 (**C3**), 128.4 (**C1**), 126.5 (**C9**), 126.1 (**C2**), 125.5 (q, *J* = 3.8 Hz (**C10**)), 122.8 (q, *J* = 272.2 Hz (**C12**)), 85.8 (**C6**), 76.4 (**C7**), 74.1 (**C5**).

All spectral data in accordance with literature.[193]

9-Ethynylfluoren-9-ol – 207h



The title compound was prepared according to general procedure **D**, from fluorenone (440 µL, 2.77 mmol) and ethynylmagnesium bromide (8.32 mL, 0.5 M in THF, 4.16 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207h** (514 mg, 90%) as a white solid.

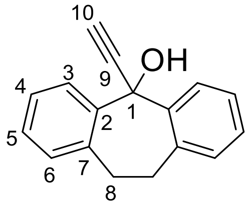
R_f = 0.10 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.72 (ddd, *J* = 7.3, 1.3, 0.7 Hz, 2H (**H3**)), 7.63 (ddd, *J* = 7.5, 1.2, 0.7 Hz, 2H (**H6**)), 7.42 (td, *J* = 7.5, 1.3 Hz, 2H (**H4** or **H5**)), 7.36 (td, *J* = 7.4, 1.3 Hz, 2H (**H4** or **H5**)), 2.50 (s, 1H (**H9**)), 2.48 (s, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 146.8 (**C2**), 139.3 (**C7**), 130.0 (**C5**), 128.8 (**C4**), 124.4 (**C3**), 120.4 (**C6**), 84.0 (**C8**), 74.8 (**C1**), 71.5 (**C9**).

All spectral data in accordance with literature.[197]

5-Ethynyl-10,11-dihydro-5H-dibenzo[a,d]cyclohepten-5-ol – 207i



The title compound was prepared according to general procedure **D**, from dibenzosuberone (500 mg, 2.40 mmol) and ethynylmagnesium bromide (7.20 mL, 0.5 M in THF, 3.60 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207i** (482 mg, 86%) as a white solid.

R

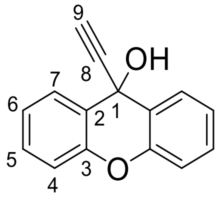
R_f = 0.15 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 8.02 – 7.99 (m, 2H (**H3**)), 7.24 – 7.18 (m, 4H (**H4** and **H5**)), 7.15 – 7.13 (m, 2H (**H6**)), 3.57 – 3.49 (m, 2H (**H8**)), 3.42 – 3.33 (m, 2H (**H8**)), 2.95 (s, 1H (**H10**)), 2.87 (s, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 140.9 (**C2**), 138.5 (**C7**), 131.1 (**C5**), 128.5 (**C4**), 126.2 (**C3**), 125.3 (**C6**), 86.6 (**C9**), 76.5 (**C10**), 73.4 (**C1**), 32.6 (**C8**).

All spectral data in accordance with literature.[197]

9-Ethynylxanthen-9-ol – 207j



The title compound was prepared according to general procedure **D**, from xanthone (400 mg, 2.04 mmol) and ethynylmagnesium bromide (6.12 mL, 0.5 M in THF, 3.06 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207j** (388 mg, 85%) as a red solid.

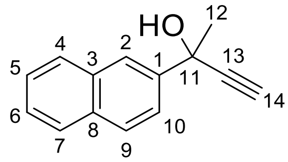
R_f = 0.13 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.97 (dd, *J* = 7.8, 1.5 Hz, 2H (**H7**)), 7.40 (ddd, *J* = 8.2, 7.3, 1.7 Hz, 2H (**H5**)), 7.24 (ddd, *J* = 7.8, 7.3, 1.2 Hz, 2H (**H6**)), 7.20 (dd, *J* = 8.3, 1.0 Hz, 2H (**H4**)), 2.92 (s, 1H (**H9**)), 2.62 (s, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 149.7 (**C3**), 130.4 (**C5**), 128.7 (**C6**), 123.9 (**C7**), 123.4 (**C2**), 117.0 (**C4**), 85.2 (**C8**), 75.9 (**C9**), 64.2 (**C1**).

All spectral data in accordance with literature.[198]

α-Ethynyl-α-methyl-2-naphthalenemethanol – 207l



The title compound was prepared according to general procedure **D**, from 22-acetonaphthone (500 mg, 2.55 mmol) and ethynylmagnesium bromide (8.81 mL, 0.5 M in THF, 3.82 mmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **207l** (401 mg, 70%) as a yellow oil.

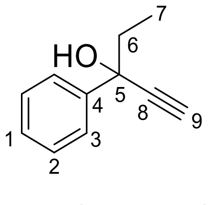
R_f = 0.31 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 8.14 (d, *J* = 1.5 Hz, 1H (**H2**)), 7.89 – 7.83 (m, 3H (**H4**, **H9** and **H10**)), 7.75 (dd, *J* = 8.6, 1.9 Hz, 1H (**H7**)), 7.53 – 7.47 (m, 2H (**H5** and **H6**)), 2.74 (s, 1H (**H14**)), 2.52 (s, 1H (**O-H**)), 1.89 (s, 3H (**H12**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 142.4 (**C1**), 133.1 (**C3** or **C8**), 133.1 (**C3** or **C8**), 128.5 (**$C_{Aromatic}$**), 128.4 (**$C_{Aromatic}$**), 127.7 (**$C_{Aromatic}$**), 126.4 (**$C_{Aromatic}$**), 126.4 (**$C_{Aromatic}$**), 123.6 (**C5** or **C6**), 123.4 (**C5** or **C6**), 87.4 (**C13**), 73.5 (**C14**), 70.1 (**C11**), 33.1 (**C12**).

All spectral data in accordance with literature.[199]

1-Ethynyl-1-phenyl-1-propanol – 207n



The title compound was prepared according to general procedure **D**, propiophenone (250 mg, 1.86 mmol) and ethynylmagnesium bromide (5.6 mL, 0.5 M in THF, 2.69 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207n** (208 mg, 70%) as a colourless oil.

R

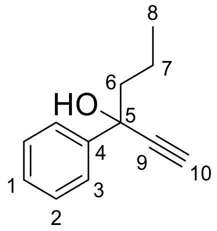
R_f = 0.26 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 7.9 Hz, 2H (**H3**)), 7.37 (t, *J* = 7.4 Hz, 2H (**H2**)), 7.32 – 7.28 (m, 1H (**H1**)), 2.69 (s, 1H (**H9**)), 2.41 (s, 1H (**O-H**)), 2.06 – 1.88 (m, 2H (**H6**)), 0.97 (t, *J* = 7.4 Hz, 3H (**H7**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.9 (**C4**), 128.2 (**C3**), 127.8 (**C1**), 125.5 (**C2**), 86.1 (**C8**), 74.2 (**C9**), 73.8 (**C5**), 38.2 (**C6**), 8.9 (**C7**).

All spectral data in accordance with literature.[200]

α-Ethynyl-α-propylbenzenemethanol – 207o



The title compound was prepared according to general procedure **D**, from butyrophenone (500 mg, 2.87 mmol) and ethynylmagnesium bromide (6.75 mL, 0.5 M in THF, 4.30 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **207o** (346 mg, 59%) as a yellow oil.

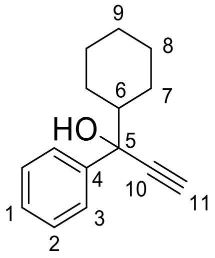
R_f = 0.31 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.64 – 7.61 (m, 2H (**H3**)), 7.39 – 7.34 (m, 2H (**H2**)), 7.32 – 7.28 (m, 1H (**H1**)), 2.69 (s, 1H (**H10**)), 2.37 (s, 1H (**O-H**)), 1.99 – 1.83 (m, 2H (**H6**)), 1.52 – 1.35 (m, 2H (**H7**)), 0.90 (t, *J* = 7.4 Hz, 3H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 144.4 (**C4**), 128.3 (**C3**), 127.9 (**C1**), 125.5 (**C2**), 86.5 (**C9**), 74.2 (**C10**), 73.4 (**C5**), 47.5 (**C6**), 18.1 (**C7**), 14.1 (**C8**).

All spectral data in accordance with literature.[200]

1-Cyclohexyl-1-phenylprop-2-yn-1-ol – 207p



The title compound was prepared according to general procedure **D**, from benzoylcyclohexane (1 g, 4.67 mmol) and ethynylmagnesium bromide (15.9 mL, 0.5 M in THF, 7.00 mmol). Following the conversion to product and column chromatography [SiO_2; [9:1 Hexane:EtOAc] afforded **207p** (1.03 g, 91%) as a yellow oil.

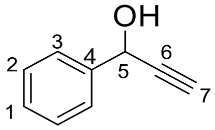
Rf = 0.54 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.62 – 7.59 (m, 2H (**H3**)), 7.38 – 7.34 (m, 2H (**H2**)), 7.32 – 7.28 (m, 1H (**H1**)), 2.69 (s, 1H (**H11**)), 2.36 – 2.35 (m, 1H (**O-H**)), 2.00 – 1.96 (m, 1H (**H6**)), 1.80 – 1.62 (m, 4H ((**H$_{Cyclohhexyl}$**)), 1.51 – 1.47 (m, 1H (**H$_{Cyclohhexyl}$**)), 1.30 – 1.02 (m, 5H (**H$_{Cyclohhexyl}$**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.4 (**C4**), 128.0 (**C3**), 127.8 (**C1**), 126.3 (**C2**), 85.6 (**C10**), 76.7 (**C5**), 75.0 (**C11**) 49.9 (**C6**), 27.9 (**C$_{Cyclohhexyl}$**), 27.4 (**C$_{Cyclohhexyl}$**), 26.4 (**C$_{Cyclohhexyl}$**), 26.3 (**C$_{Cyclohhexyl}$**).

All spectral data in accordance with literature.[201]

1-Phenylprop-2-yn-1-ol – 209a



The title compound was prepared according to general procedure **C**, from benzaldehyde (750 mg, 7.07 mmol), *n*-BuLi (25.0 mL, 2.5 M in hexane, 7.78 mmol) and trimethylsilylacetylene (1.10 mL, 7.78 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **209a** (556 mg, 60%) as a yellow oil.

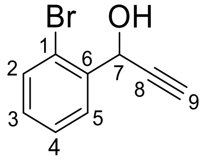
Rf = 0.17 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.56 (dd, *J* = 8.2, 1.2 Hz, 2H (**H3**)), 7.43 – 7.32 (m, 3H (**H1** and **H2**)), 5.38 (dd, *J* = 5.9, 1.8 Hz, 1H (**H5**)), 2.68 (d, J = 2.2 Hz, 1H (**H7**)), 2.21 (s, 1H (**O-H**)).

^{13}C NMR: (100 MHz, $CDCl_3$) δ 140.2 (**C4**), 128.8 (**C3**), 128.7 (**C1**), 126.7 (**C2**), 83.6 (**C6**), 75.0 (**C7**), 64.6 (**C5**).

All spectral data in accordance with literature.[199]

1-(2-Bromophenyl)prop-2-yn-1-ol – 209b



The title compound was prepared according to general procedure **D**, from 2-bromobenzaldehyde (500 mg, 2.70 mmol) and ethynylmagnesium bromide (8.11 mL, 0.5 M in THF, 4.05 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **209b** (546 mg, 96%) as a yellow oil.

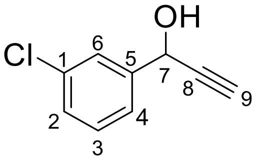
R_f = 0.13 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.79 (dd, *J* = 7.8, 1.7 Hz, 1H (**H2**)), 7.57 (dd, *J* = 8.0, 1.2 Hz, 1H (**H5**)), 7.38 (td, *J* = 7.6, 1.1 Hz, 1H (**H3**)), 7.21 (td, *J* = 7.7, 1.7 Hz, 1H (**H4**)), 5.80 (dd, *J* = 5.5, 2.2 Hz, 1H (**H7**)), 2.67 (d, *J* = 2.3 Hz, 1H (**H9**)), 2.56 - 2.55 (m, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 139.0 (**C6**), 133.2 (**C2**), 130.3 (**C5**), 128.6 (**C3**), 128.1 (**C4**), 122.8 (**C1**), 82.5 (**C8**), 75.2 (**C9**), 64.1 (**C7**).

All spectral data in accordance with literature.[202]

1-(3-Chlorophenyl)-2-propyn-1-ol – 209c



The title compound was prepared according to general procedure **D**, from 3-chlorobenzaldehyde (500 mg, 3.56 mmol) and ethynylmagnesium bromide (14.2 mL, 0.5 M in THF, 7.11 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **209c** (454 mg, 77%) as a yellow oil.

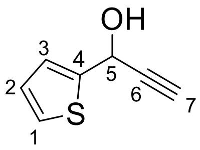
R_f = 0.39 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.56 (m, 1H (**H6**)), 7.44 – 7.41 (m, 1H (**H3**)), 7.32 – 7.31 (m, 2H (**H2** and **H4**)), 5.44 (dd, *J* = 6.2, 2.1 Hz, 1H (**H7**)), 2.69 (d, *J* = 2.3 Hz, 1H (**H9**)), 2.45 – 2.43 (m, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 142.0 (**C5**), 134.7 (**C1**), 130.1 (**C6**), 128.8 (**C2** or **C4**), 126.9 (**C2** or **C4**), 124.9 (**C3**), 83.0 (**C8**), 75.5 (**C9**), 63.8 (**C7**).

All spectral data in accordance with literature.[203]

1-(Thiophen-2-yl)prop-2-yn-1-ol – 209e



The title compound was prepared according to general procedure **C**, from 2-thiophenecarboxaldehyde (250 mg, 2.23 mmol) *n*-BuLi (3.13 mL, 2.5 M in hexane, 2.45 mmol) and trimethylsilylacetylene (350 μL, 2.45 mmol). Following the conversion to product and column chromatography (9:1 Hexane/EtOAc) afforded **209e** (215 mg, 70%) as an orange oil.

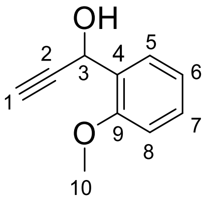
R$_f$ = 0.37 [2:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.32 (dd, *J* = 5.1, 1.3 Hz, 1H (**H1**)), 7.21 - 7.20 (m, 1H (**H2**)), 6.99 (dd, *J* = 5.1, 3.6 Hz, 1H (**H3**)), 5.67 (dd, *J* = 6.9, 1.6 Hz, 1H (**H5**)), 2.69 (d, *J* = 2.2 Hz, 1H (**H7**)), 2.35 (d, *J* = 7.0 Hz, 1H (**O-H**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 144.0 (**C4**), 127.0 (**C1**), 126.5 (**C3**), 126.0 (**C2**), 82.9 (**C6**), 74.5 (**C7**), 60.3 (**C5**).

All spectral data in accordance with literature.[204]

1-(2-Methoxyphenyl)-2-propyn-1-ol – 209g



The title compound was prepared according to general procedure **C**, from 2-methoxybenzaldehyde (444 μL, 3.67 mmol) *n*-BuLi (12.1 mL, 2.5 M in hexane, 4.04 mmol) and trimethylsilylacetylene (570 μL, 4.04 mmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **209g** (371 mg, 73%) as a yellow oil.

R_f = 0.10 [9:1 Hexane:EtOAc].

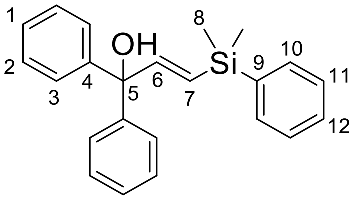
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.57 (dd, *J* = 7.5, 1.7 Hz, 1H (**H5**)), 7.33 (ddd, *J* = 8.2, 7.6, 1.7 Hz, 1H (**H7**)), 6.99 (td, *J* = 7.5, 1.0 Hz, 1H (**H6**)), 6.93 (dd, *J* = 8.2, 0.8 Hz, 1H (**H8**)), 5.70 (dd, *J* = 6.5, 2.3 Hz, 1H (**H3**)), 3.91 (s, 3H (**H10**)), 3.00 (d, *J* = 6.5 Hz, 1H (**O-H**)), 2.62 (d, *J* = 2.3 Hz, 1H (**H1**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 156.9 (**C9**), 130.0 (**C5**), 128.4 (**C4**), 128.0 (**C6**), 121.1 (**C7**), 111.0 (**C8**), 83.2 (**C2**), 74.3 (**C1**), 61.3 (**C3**), 55.7 (**C10**).

All spectral data in accordance with literature.[204]

7.2.6 β-(*E*)-Silyl/boryl Allylic Alcohols

(*E*)-3-(Dimethyl(phenyl)silyl)-1,1-diphenylprop-2-en-1-ol – 208a



The title compound was prepared according to general procedure **E**, from 1,1-diphenyl-2-propyn-1-ol (500 mg, 2.40 mmol) and dimethylphenylsilane (550 µL, 3.60 mmol) using $PtCl_2$ (6 mg, 24.0 µmol) and XPhos (23 mg, 48.0 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **208a** (780 mg, 94%) as yellow oil.

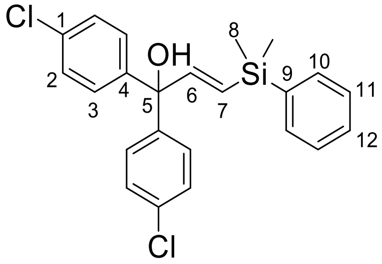
R_f = 0.45 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.53 (dd, *J* = 6.7, 3.2 Hz, 2H (**H1**)), 7.38 – 7.34 (m, 8H (**H2** and **H3**)), 7.33 – 7.31 (m, 3H ((**H11** and **H12**)), 7.29 – 7.25 (m, 2H (**H10**)), 6.74 (d, *J* = 18.7 Hz, 1H (**H6**)), 6.15 (d, *J* = 18.7 Hz, 1H (**H7**)), 2.34 (s, 1H (**O-H**)), 0.39 (s, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 152.2 (**C6**), 145.9 (**C4**), 138.6 (**C9**), 134.0 (**C1**), 129.2 (**C12**), 128.3 (**C2**), 128.0 (**C11**), 127.4 (**C10**), 127.1 (**C3**), 126.0 (**C7**), 80.4 (**C5**), −2.3 (**C8**).

All spectral data in accordance with literature.[85]

(*E*)-1,1-Bis(4-chlorophenyl)-3-[dimethyl(phenyl)silyl]prop-2-en-1-ol – 208b



The title compound was prepared according to general procedure **E**, from 1,1-bis(4-chlorophenyl)-2-propyn-1-ol (150 mg, 541 µmol) and dimethylphenylsilane (120 µL, 812 µmol) using $PtCl_2$ (1 mg, 5.41 µmol) and XPhos (5 mg, 10.8 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208b** (164 mg, 73 %) as a colourless oil.

R_f = 0.70 [9:1 Hexane:EtOAc].

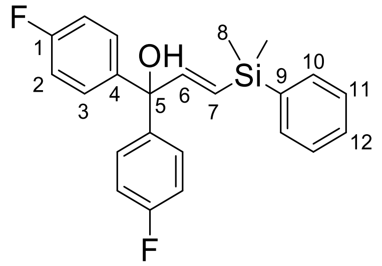
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.51 – 7.49 (m, 2H (**H11**)), 7.38 – 7.36 (m, 3H (**H10** and **H12**)), 7.31 - 7.25 (m, 8H (**H2** and **H3**)), 6.61 (d, *J* = 18.7 Hz, 1H (**H6**)), 6.12 (d, *J* = 18.7 Hz, 1H (**H7**)), 2.33 (s, 1H (**O-H**), 0.39 (s, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 151.1 (**C6**), 143.9 (**C4**), 138.2 (**C9**), 133.9 (**C11**), 133.5 (**C12**), 129.4 (**C1**), 128.6 (**C2** or **C3**), 128.5 (**C2** or **C3**), 128.0 (**C10**), 127.4 (**C7**), 79.7 (**C5**), −2.4 (**C8**).

IR: ν_{max} (neat/cm^{-1}) 3554 (O-H), 3067 (C-H), 2953 (C-H), 1627 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M-H]^-$ Calcd for $C_{23}H_{21}Cl_2OSi$ 411.0744; found 411.0756.

(*E*)-3-[Dimethyl(phenyl)silyl]-1,1-bis(4-flurophenyl)prop-2-en-1-ol – 208c



The title compound was prepared according to general procedure **E**, from 1,1-bis(4-fluorophenyl)prop-2-yn-1-ol (200 mg, 819 µmol) and dimethylphenylsilane (188 µL, 1.23 mmol) using $PtCl_2$ (2 mg, 8.19 µmol) and XPhos (8 mg, 16.4 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208c** (266 mg, 85%) as colourless oil.

R_f = 0.73 [1:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.51 – 7.49 (m, 2H (**H11**)), 7.37 – 7.35 (m, 3H (**H10** and **H12**)), 7.31 – 7.28 (m, 4H (**H2**)), 7.03 – 6.97 (m, 4H (**H3**)), 6.63 (d, *J* = 18.7 Hz, 1H (**H6**)), 6.10 (d, *J* = 18.7 Hz, 1H (**H7**)), 2.33 (s, 1H (**O-H**)), 0.39 (s, 6H (**H8**)).

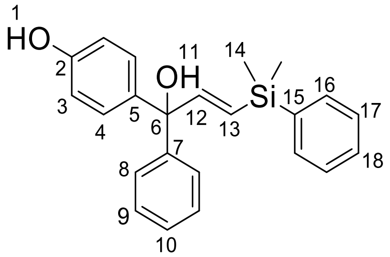
^{13}C NMR: (101 MHz, $CDCl_3$) δ 162.14 (d, *J* = 246.5 Hz (**C1**)), 151.7 (**C6**), 141.5 (d, *J* = 3.1 Hz (**C4**)), 138.3 (**C9**), 133.9 (**C11**), 129.3 (**C12**), 128.8 (d, *J* = 8.1 Hz (**C3**)), 128.0 (**C10**), 126.7 (**C7**), 115.7 (d, *J* = 21.3 Hz (**C2**)), 79.7 (**C5**), −2.3 (**C8**).

^{19}F NMR: (376 MHz, $CDCl_3$) δ −115.20.

IR: ν_{max} (neat/cm^{-1}) 3567 (O-H), 3069 (C-H), 2955 (C-H), 1897 (C=C), 1600 (C=C), 1504 (C=C).

HRMS: (APCI-TOF) *m/z*: [M+H]$^{+}$ Calcd for $C_{23}H_{23}F_2OSi$ 381.1404; found 381.1442.

4-[(*E*)-3-Dimethyl(phenyl)silyl-1-hydroxy-1-phenyl-allyl]phenol – 208d



The title compound was prepared according to general procedure **E**, from 4-(1-hydroxy-1-phenyl-prop-2-ynyl)phenol (200 mg, 892 µmol) and dimethylphenylsilane (205 µL, 1.34 mmol) using $PtCl_2$ (2 mg, 8.92 µmol) and XPhos (9 mg, 17.8 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208d** (250 mg, 78%) as colourless oil.

***R**$_f$* = 0.58 [2:1 Hexane:EtOAc].

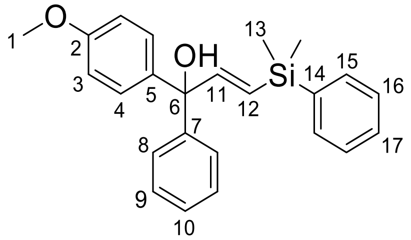
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 6.5, 3.2 Hz, 2H (**H$_{\text{Aromatic}}$**)), 7.36 – 7.27 (m, 8H (**H$_{\text{Aromatic}}$**)), 7.20 (d, *J* = 8.7 Hz, 2H (**H4**)), 6.76 (d, *J* = 8.7 Hz, 2H (**H3**)), 6.68 (d, *J* = 18.7 Hz, 1H (**H12**)), 6.11 (d, *J* = 18.7 Hz, 1H (**H13**)), 4.81 (br s, 1H (**H1**)), 2.29 (br s, 1H (**H11**)), 0.37 (s, 6H (**H14**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 154.9 (**C2**), 152.3 (**C12**), 145.9 (**C5**), 138.7 (**C7** or **C15**), 134.0 (**C4**), 129.2 (**C10**), 128.7 (**C$_{\text{Aromatic}}$**), 128.3 (**C$_{\text{Aromatic}}$**), 128.0 (**C$_{\text{Aromatic}}$**), 127.3 (**C18**), 127.0 (**C$_{\text{Aromatic}}$**), 125.7 (**C13**), 115.1 (**C3**), 80.1 (**C6**), −2.3 (**C14**).

IR: ν_{max} (neat/cm^{-1}) 3326 (O-H), 3065 (C-H), 2955 (C-H), 1608 (C=C), 1220 (C-O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for; $C_{23}H_{25}O_2Si$ 361.1541; found 361.1579.

(*E*)-3-[Dimethyl(phenyl)silyl]-1-(4-methoxyphenyl)-1-phenyl-prop-2-en-1-ol – 208e



The title compound was prepared according to general procedure **E**, from 1-(4-methoxyphenyl)-1-phenyl-prop-2-yn-1-ol (295 mg, 1.24 mmol) and dimethylphenylsilane (285 µL, 1.86 mmol) using $PtCl_2$ (3 mg, 12.4 µmol) and XPhos (12 mg, 24.8 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208e** (338 mg, 73%) as colourless oil.

$\boldsymbol{R_f}$ = 0.20 [9:1 Hexane:EtOAc].

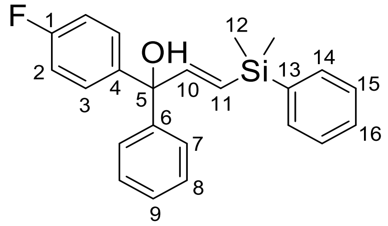
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.53 (dd, *J* = 6.4, 3.2 Hz, 2H ($\mathbf{H_{Aromatic}}$)), 7.41 – 7.30 (m, 8H ($\mathbf{H_{Aromatic}}$)), 7.25 (d, *J* = 8.9 Hz, 2H (**H4**)), 6.85 (d, *J* = 8.9 Hz, 2H (**H3**)), 6.70 (d, *J* = 18.7 Hz, 1H (**H11**), 6.13 (d, *J* = 18.7 Hz, 1H (**H12**), 3.80 (s, 3H (**H1**)), 2.29 (s, 1H (**O-H**), 0.38 (s, 6H (**H13**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 158.9 (**C2**), 152.4 (**C11**), 146.0 (**C7**), 138.2 (**C5**), 134.0 (**C4**), 129.8 (**C14**), 129.2 (**C10**), 128.5 ($\mathbf{C_{Aromatic}}$), 128.3 ($\mathbf{C_{Aromatic}}$), 128.0 ($\mathbf{C_{Aromatic}}$), 127.3 (**C17**), 127.0 ($\mathbf{C_{Aromatic}}$), 125.6 (**C12**), 113.6 (**C3**), 80.1 (**C6**), 55.4 (**C1**), −2.3 (**C13**).

IR: υ_{max} (neat/cm^{-1}) 3416 (O-H), 2953 (C-H), 1614 (C=C), 1247 (C-O).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{24}H_{25}OSi$ 357.1670; found 357.1667.

(*E*)-3-[Dimethyl(phenyl)silyl]-1-(4-fluorophenyl)-1-phenyl-prop-2-en-1-ol – 208f



The title compound was prepared according to general procedure **E**, from 1-(4-fluorophenyl)-1-phenyl-prop-2-yn-1-ol (500 mg, 2.21 mmol) and dimethylphenylsilane (508 µL, 3.31 mmol) using $PtCl_2$ (6 mg, 22.1 µmol) and XPhos (21 mg, 44.2 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208f** (391 mg, 49%) as colourless oil.

R_f = 0.26 [19:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 – 7.50 (m, 2H (**H14**)), 7.36 – 7.28 (m, 10H (**H2** and **H$_{Aromatic}$**)), 7.00 (d, *J* = 8.6 Hz, 2H (**H3**)), 6.68 (dd, *J* = 18.7, 0.9 Hz, 1H (**H10**)), 6.12 (dd, *J* = 18.7, 0.9 Hz, 1H (**H11**)), 2.33 (d, *J* = 2.1 Hz, 1H (**O-H**)), 0.38 (s, 3H (**H12**)), 0.38 (s, 3H (**H12**)).

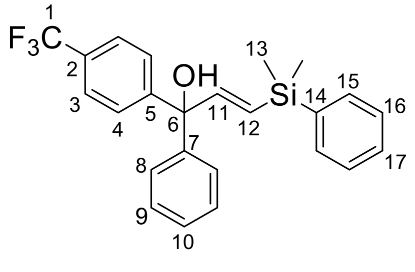
^{13}C NMR: (101 MHz, $CDCl_3$) δ 162.1 (d, *J* = 246.2 Hz (**C1**)), 151.9 (**C10**), 145.7 (**C6**), 141.6 (d, *J* = 3.0 Hz (**C4**)), 138.5 (**C13**), 134.0 (**C$_{Aromatic}$**), 129.3 (**C$_{Aromatic}$**), 128.9 (d, *J* = 8.0 Hz (**C3**)), 128.4 (**C$_{Aromatic}$**), 128.0 (**C$_{Aromatic}$**), 127.6 (**C$_{Aromatic}$**), 127.0 (**C$_{Aromatic}$**), 126.3 (**C11**), 115.1 (d, *J* = 21.3 Hz (**C2**)), 80.0 (**C5**), −2.4 (**C12**).

^{19}F NMR: (376 MHz, $CDCl_3$) δ −115.5.

IR: ν_{max} (neat/cm^{-1}) 3554 (O-H), 3067 (C-H), 2955 (C-H), 1600 (C=C), 1505 (C=C).

HRMS: (ACPI-TOF) *m/z*: $[M-H]^-$ Calcd for $C_{23}H_{22}FOSi$ 363.1498; found 363.1536.

(*E*)-3-[Dimethyl(phenyl)silyl-1-phenyl-1-[4-(trifluoromethyl)phenyl]prop-2-en-1-ol – 208g



The title compound was prepared according to general procedure **E**, from 1-phenyl-1-[4-(trifluoromethyl)phenyl]prop-2-yn-1-ol (300 mg, 1.09 mmol) and dimethylphenylsilane (250 µL, 1.63 mmol) using $PtCl_2$ (3 mg, 10.9 µmol) and XPhos (10 mg, 21.7 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208g** (373 mg, 83%) as colourless oil.

R_f = 0.30 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.4 Hz, 2H (**H3**)), 7.53 – 7.46 (m, 2H, **H$_{\mathbf{Aromatic}}$**)), 7.49 (d, *J* = 8.7 Hz, 2H (**H4**)), 7.38 – 7.28 (m, 8H (**H$_{\mathbf{Aromatic}}$**)), 6.69 (d, *J* = 18.7 Hz, 1H (**H11**)), 6.16 (d, *J* = 18.7 Hz, 1H (**H12**)), 2.38 (s, 1H (**O-H**)), 0.39 (s, 6H (**H13**)).

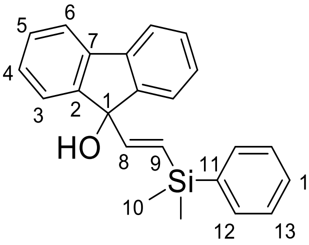
^{13}C NMR: (101 MHz, $CDCl_3$) δ 151.2 (**C11**), 149.6 (**C5** or **C7**), 145.4 (**C5** or **C7**), 138.3 (**C15**), 137.3 (q, *J* = 257.8 Hz (**C1**)), 134.0 (**C4**), 129.3 (**C10** or **C17**), 129.11 (q, *J* = 31.3 Hz (**C2**)), 128.6 (**C$_{\mathbf{Aromatic}}$**), 128.0 (**C$_{\mathbf{Aromatic}}$**), 127.9 (**C10** or **C17**), 127.3 (**C$_{\mathbf{Aromatic}}$**), 127.1 (**C12**), 126.2 (**C$_{\mathbf{Aromatic}}$**), 125.2 (q, *J* = 3.9 Hz (**C3**)), 80.1 (**C6**), −2.4 (**C13**).

^{19}F NMR: (376 MHz, $CDCl_3$) δ −62.5.

IR: υ_{max} (neat/cm^{-1}) 3392 (O-H), 3064 (C-H), 2833 (C-H), 1608 (C=C), 1245 (C-O).

HRMS: (APCI-TOF) *m/z*: $[M-H]^-$ Calcd for $C_{24}H_{22}F_3OSi$ 411.1387; found 411.1373.

9H-Fluoren-9-ol, 9-[(1*E*)-2-(dimethylphenylsilyl)ethenyl] – 208h



The title compound was prepared according to general procedure **E**, from 9-ethynylfluoren-9-ol (50 mg, 242 µmol) and dimethylphenylsilane (60 µL, 364 µmol) using $PtCl_2$ (1 mg, 2.42 µmol) and XPhos (2 mg, 4.44 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **208h** (67 mg, 81%) as an orange oil.

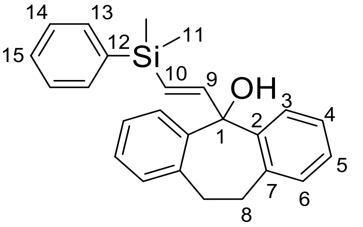
R_f = 0.71 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.4 Hz, 2H (**H$_{Aromatic}$**)), 7.51 (dd, *J* = 6.5, 3.0 Hz, 2H (**H$_{Aromatic}$**)), 7.43 (d, *J* = 7.5 Hz, 2H (**H$_{Aromatic}$**)), 7.41 – 7.37 (m, 3H (**H$_{Aromatic}$**)), 7.35 – 7.31 (m, 4H (**H$_{Aromatic}$**)), 6.47 (d, *J* = 18.6 Hz, 1H (**H8**)), 6.14 (d, *J* = 18.6 Hz, 1H (**H9**)), 2.23 (s, 1H (**O-H**)), 0.33 (s, 6H (**H10**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 148.2 (**C2**), 147.6 (**C8**), 139.8 (**C$_{Aromatic}$**), 134.0 (**C$_{Aromatic}$**), 129.3 (**C$_{Aromatic}$**), 129.1 (**C14**), 128.4 (**C$_{Aromatic}$**), 127.9 (**C$_{Aromatic}$**), 125.4 (**C9**), 124.6 (**C$_{Aromatic}$**), 120.3 (**C$_{Aromatic}$**), 83.5 (**C1**), −2.4 (**C10**).

All spectral data in accordance with literature.[205]

2-(*E*)-2-[Dimethyl(phenyl)silyl]vinyltricyclo[9.4.0.03,8]pentadeca-1(11),3(8),4,6,12,14-hexaen-2-ol – 208i



The title compound was prepared according to general procedure **E**, from 5-ethynyl-10,11-dihydro-5H-dibenzo[a,d]cyclohepten-5-ol (200 mg, 854 µmol) and dimethylphenylsilane (200 µL, 1.28 mmol) using $PtCl_2$ (2 mg, 8.54 µmol) and XPhos (8 mg, 17.1 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208i** (275 mg, 87%) as a yellow oil.

R$_f$ = 0.22 [9:1 Hexane:EtOAc].

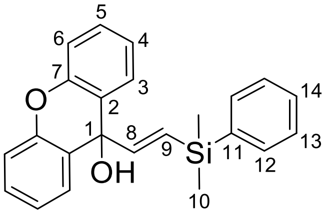
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.87 (dd, *J* = 7.7, 1.7 Hz, 2H (**H3**)), 7.45 (m, 2H (**H14**)), 7.33 – 7.31 (m, 3H (**H13** and **H15**)), 7.23 (td, *J* = 7.3, 1.7 Hz, 4H (**H4** and **H5**)), 7.09 (dd, *J* = 7.2, 1.8 Hz, 2H (**H6**)), 6.60 (d, *J* = 18.7 Hz, 1H (**H9**)), 5.71 (d, *J* = 18.7 Hz, 1H (**H10**)), 3.40 (td, *J* = 8.3, 4.3 Hz, 2H (**H8**)), 2.89 (td, *J* = 8.3, 4.3 Hz, 2H (**H8**)), 2.19 (s, 1H (**O-H**)), 0.31 (s, 6H (**H11**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 153.5 (**C9**), 142.9 (**C2**), 138.2 (**C7** or **C12**), 133.9 (**C14**), 130.5 (**C6**), 129.3 (**C10**), 129.0 (**C15**), 128.0 (**C13**), 127.6 (**C4** or **C5**), 126.2 (**C4** or **C5**), 125.6 (**C3**), 78.8 (**C1**), 32.8 (**C8**), −2.6 (**C11**).

IR: ν_{max} (neat/cm^{-1}) 3512 (O-H), 3060 (C-H), 2948 (C-H), 1602 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{25}Si$ 353.1720; found 353.1694.

9-[(*E*)-2-[Dimethyl(phenyl)silyl]vinyl]xanthen-9-ol – 208j



The title compound was prepared according to general procedure **E**, from 9-ethynylxanthen-9-ol (120 mg, 540 µmol) and dimethylphenylsilane (120 µL, 810 µmol) using $PtCl_2$ (1 mg, 5.40 µmol) and XPhos (5 mg, 10.8 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **208j** (131 mg, 68 %) as an orange oil.

R_f = 0.59 [9:1 Hexane:EtOAc].

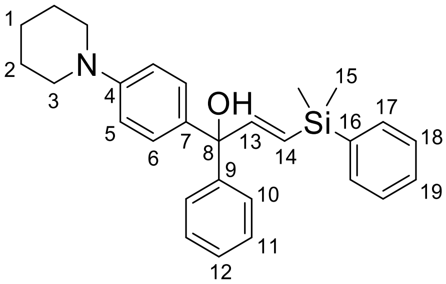
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.54 (dd, *J* = 8.1, 1.6 Hz, 2H (**H$_{Aromatic}$**)), 7.49 (dd, *J* = 6.2, 3.3 Hz, 2H (**H$_{Aromatic}$**)), 7.36 – 7.31 (m, 5H (**H$_{Aromatic}$**)), 7.17 – 7.13 (m, 4H (**H$_{Aromatic}$**)), 6.35 (d, *J* = 18.6 Hz, 1H (**H8**)), 6.13 (d, *J* = 18.6 Hz, 1H (**H9**)), 2.41 (s, 1H (**O-H**)), 0.34 (s, 6H (**H10**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 151.2 (**C8**), 150.2 (**C7**), 150.1 (**C7**), 134.0 (**C$_{Aromatic}$**), 133.8 (**C$_{Aromatic}$**), 129.6 (**C2**), 129.4 (**C$_{Aromatic}$**), 129.2 (**C2**), 128.5 (**C$_{Aromatic}$**), 128.2 (**C$_{Aromatic}$**), 128.1 (**C$_{Aromatic}$**), 127.9 (**C$_{Aromatic}$**), 125.9 (**C$_{Aromatic}$**), 125.0 (**C$_{Aromatic}$**), 123.6 (**C$_{Aromatic}$**), 123.5 (**C$_{Aromatic}$**), 117.6 (**C11**), 116.8 (**C$_{Aromatic}$**), 116.7 (**C$_{Aromatic}$**), 93.9, (**C9**) 70.2 (**C1**), −1.9 (**C10**), −2.4 (**C10**).

IR: ν_{max} (neat/cm^{-1}) 3457 (O-H), 3017 (C-H), 2948 (C-H), 1634 (C=C), 1230 (C-O).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{21}OSi$ 341.1357; found 341.1355.

(E)-3-[Dimethyl(phenyl)silyl]-1-phenyl-1-[4-(1-piperidyl)phenyl]prop-2-en-1-ol – 208k



The title compound was prepared according to general procedure **E**, from 1-phenyl-1-[4-(1-piperidinyl)phenyl]-2-propyn-1-ol (250 mg, 858 µmol) and dimethylphenylsilane (200 µL, 1.29 mmol) using $PtCl_2$ (2 mg, 8.58 µmol) and XPhos (8 mg, 17.2 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **208k** (208 mg, 57%) as a green solid.

R_f = 0.54 [9:1 Hexane:EtOAc].

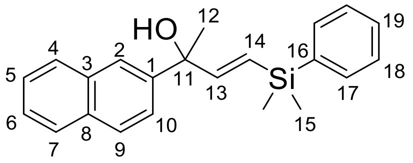
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.51 (dd, J = 6.4, 3.1 Hz, 2H (**$H_{Aromatic}$**)), 7.37 – 7.27 (m, 8H (**$H_{Aromatic}$**)), 7.18 (d, J = 8.9 Hz, 2H (**H6**)), 6.86 (d, J = 8.9 Hz, 2H (**H5**)), 6.69 (d, J = 18.7 Hz, 1H (**H13**)), 6.12 (d, J = 18.7 Hz, 1H (**H14**)), 3.16 (t, J = 5.4 Hz, 4H (**H3**)), 2.25 (s, 1H (**O-H**)), 1.72 – 1.67 (m, 4H (**H2**)), 1.60 – 1.54 (m, 2H (**H1**)), 0.37 (s, 6H (**H15**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 152.6 (**C13**), 151.3 (**C4**), 146.1 (**C9**), 138.8 (**C7**), 136.1 (**C16**), 134.0 (**$C_{Aromatic}$**), 129.1 (**$C_{Aromatic}$**), 128.2 (**$C_{Aromatic}$**), 128.0 (**$C_{Aromatic}$**), 127.9 (**$C_{Aromatic}$**), 127.1 (**$C_{Aromatic}$**), 127.0 (**$C_{Aromatic}$**), 125.2 (**C14**), 115.8 (**C5**), 80.2 (**C8**), 50.4 (**C3**), 26.0 (**C2**), 24.4 (**C1**), −2.3 (**C15**).

IR: υ_{max} (neat/cm^{-1}) 3546 (O-H), 3054 (C-H), 2931 (C-H), 1606 (C=C).

HRMS: (ESI-TOF) m/z: $[M+H]^+$ Calcd for $C_{28}H_{34}NOSi$ 428.2410; Found 428.2398.

(*E*)-4-[Dimethyl(phenyl)silyl]-2-(2-naphthyl)but-3-en-2-ol – 208l



The title compound was prepared according to general procedure **E**, from 2-(2-naphthyl)but-3-yn-2-ol (200 mg, 1.02 mmol) and dimethylphenylsilane (234 µL, 1.53 mmol) using $PtCl_2$ (3 mg, 10.2 µmol) and XPhos (10 mg, 20.4 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208l** (225 mg, 66%) as colourless oil.

R_f = 0.51 [9:1 Hexane:EtOAc].

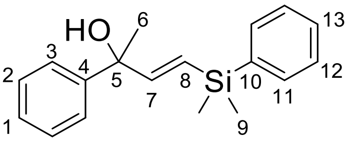
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.93 (m, *J* = 1.9 Hz, 1H (**H2**)), 7.85 – 7.81 (m, 3H (**$H_{Aromatic}$**)), 7.56 – 7.51 (m, 3H (**$H_{Aromatic}$**)), 7.49 – 7.46 (m, 2H (**$H_{Aromatic}$**)), 7.36 (m, 3H (**$H_{Aromatic}$**)), 6.48 (d, *J* =18.8 Hz, 1H (**H13**)), 6.13 (d, *J* = 18.8 Hz, 1H (**H14**)), 2.05 (s, 1H (**O-H**), 1.75 (s, 3H (**H12**)), 0.37 (s, 3H (**H15**)), 0.37 (s, 3H (**H15**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 153.5 (**C13**), 143.8 (**C1**), 138.6 (**C16**), 134.0 (**C18**), 133.3 (**C3** or **C8**), 132.6 (**C3** or **C8**), 129.2 (**C$_{\text{Aromatic}}$**), 128.3 (**C$_{\text{Aromatic}}$**), 128.1 (**C$_{\text{Aromatic}}$**), 128.0 (**C17**), 127.6 (**C$_{\text{Aromatic}}$**), 126.2 (**C$_{\text{Aromatic}}$**), 126.0 (**C$_{\text{Aromatic}}$**), 124.8 (**C$_{\text{Aromatic}}$**), 124.3 (**C$_{\text{Aromatic}}$**), 123.6 (**C14**), 76.0 (**C11**), 29.4 (**C12**), −2.42 (**C15**), −2.43 (**C15**).

IR: ν_{max} (neat/cm^{-1}) 3567 (O-H), 3050 (C-H), 2957 (C-H), 1599 (C=C), 1246 (C-O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for C$_{22}$H$_{25}$OSi 333.1592; found 333.1630.

***(E)*-4-(Dimethyl(phenyl)silyl)-2-phenylbut-3-en-2-ol – 208m**



The title compound was prepared according to general procedure **E**, from 2-phenyl-3-butyn-2-ol (286 µL, 1.71 mmol) and dimethylphenylsilane (390 µL, 2.57 mmol) using PtCl$_2$ (5 mg, 17.1 µmol) and XPhos (16 mg, 34.2 µmol). Following the conversion to product and column chromatography [SiO$_2$; 9:1 Hexane:EtOAc] afforded **208m** (399 mg, 83%) as yellow oil.

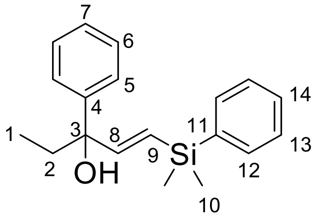
R_f = 0.58 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.51 (dd, J = 6.5, 3.1 Hz, 2H (**H2**)), 7.46 (dd, J = 8.4, 1.2 Hz, 2H (**H3**)), 7.37 – 7.27 (m, 6H (**H1**, **H11**, **H12** and **H13**)), 6.41 (d, J = 18.8 Hz, 1H (**H7**)), 6.09 (d, J = 18.8 Hz, 1H (**H8**)), 1.91 (s, 1H (**O-H**)), 1.66 (s, 3H (**H6**)), 0.36 (s, 6H (**H9**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 153.6 (**C7**), 146.5 (**C4**), 138.7 (**C10**), 134.0 (**C5**), 129.2 (**C1**), 128.4 (**C12**), 128.0 (**C11**), 127.1 (**C13**), 125.4 (**C3**), 124.3 (**C8**), 75.8 (**C5**), 29.5 (**C6**), −2.4 (**C9**), −2.4 (**C9**).

All spectral data in accordance with literature.[85]

(*E*)-1-[Dimethyl(phenyl)silyl]-3-phenyl-pent-1-en-3-ol – 208n



The title compound was prepared according to general procedure **E**, from 1-ethynyl-1-phenyl-1-propanol (100 mg, 624 µmol) and dimethylphenylsilane (144 µL, 936 µmol) using $PtCl_2$ (2 mg, 6.24 µmol) and XPhos (6 mg, 12.5 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208n** (145 mg, 78%) as colourless oil.

Rf = 0.39 [9:1 Hexane:EtOAc].

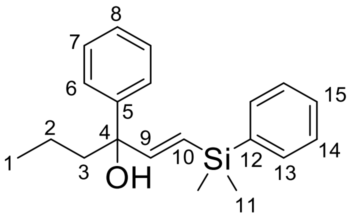
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 – 7.49 (dd, *J* = 6.2, 3.3 Hz, 2H (**H5**)), 7.43 (dd, *J* = 8.4, 1.3 Hz, 2H (**H6**)), 7.36 – 7.31 (m, 6H (**H1**, **H12**, **H13** and **H14**)), 6.42 (d, *J* = 18.9 Hz, 1H (**H8**), 6.08 (d, *J* = 18.9 Hz, 1H (**H9**), 2.00 – 1.87 (m, 2H (**H2**)), 1.88 (s, 1H (**O-H**), 0.84 (t, *J* = 7.4 Hz, 3H (**H1**), 0.35 (s, 6H (**H10**).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 153.0 (**C8**), 145.6 (**C4**), 138.8 (**C11**), 134.0 (**C5**), 129.1 (**C7**), 128.3 (**C13**), 127.9 (**C12**), 126.9 (**C14**), 125.6 (**C6**), 124.6 (**C9**), 78.2 (**C3**), 34.8 (**C2**), 8.1 (**C1**), −2.3 (**C10**), −2.4 (**C10**).

IR: ν_{max} (neat/cm^{-1}) 3568 (O-H), 3065 (C-H), 2879 (C-H), 1600 (C=C), 1246 (C-O).

HRMS: (ACPI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{19}H_{25}OSi$ 297.1630; found 297.1669.

(*E*)-1-[Dimethyl(phenyl)silyl]-3-phenyl-hex-1-en-3-ol – 208o



The title compound was prepared according to general procedure **E**, from 3-phenylhex-1-yn-3-ol (200 mg, 1.15 mmol) and dimethylphenylsilane (264 µL, 1.72 mmol) using $PtCl_2$ (3 mg, 11.5 µmol) and XPhos (11 mg, 23.5 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208o** (235 mg, 67%) as colourless oil.

Rf = 0.49 [9:1 Hexane:EtOAc].

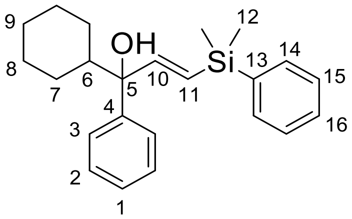
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 – 7.49 (m, 2H (**H7**)), 7.44 – 7.42 (m, 2H (**H6**)), 7.36 – 7.31 (m, 5H (**H8**, **H13** and **H14**), 7.27 – 7.23 (m, 1H (**H15**), 6.44 (d, *J* = 18.8 Hz, 1H (**H9**)), 6.08 (d, *J* = 18.9 Hz, 1H (**H10**)), 1.96 – 1.79 (m, 2H (**H2**)), 1.89 (s, 1H (**O-H**), 1.38 – 1.30 (m, 1H (**H3**)), 1.23 – 1.18 (m, 1H (**H3**)), 0.89 (t, *J* = 7.4 Hz, 3H (**H1**)), 0.35 (s, 6H (**H11**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 153.3 (**C9**), 145.8 (**C5**), 138.8 (**C12**), 134.0 (**C6**), 129.1 (**C8**), 128.3 (**C13**), 127.9 (**C14**), 126.9 (**C15**), 125.5 (**C7**), 124.3 (**C10**), 78.0 (**C4**), 44.6 (**C3**), 17.1 (**C2**), 14.5 (**C1**), −2.3 (**C11**), −2.4 (**C11**).

IR: ν_{max} (neat/cm^{-1}) 3568 (O-H), 3022 (C-H), 2871 (C-H), 1600 (C=C), 1246 (C-O).

HRMS: (ACPI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{20}H_{27}OSi$ 311.1826; found 311.1831.

(*E*)-1-Cyclohexyl-3-[dimethyl(phenyl)silyl-1-phenyl-prop-2-en-1-ol – 208p



The title compound was prepared according to general procedure **E**, from 1-cyclohexyl-1-phenyl-prop-2-yn-1-ol (250 mg, 1.17 mmol) and dimethylphenylsilane (268 µL, 1.75 mmol) using $PtCl_2$ (16 mg, 58.3 µmol) and XPhos (56 mg, 117 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **208p** (331 mg, 81%) as colourless oil.

R_f = 0.29 [20:1 Hexane:EtOAc].

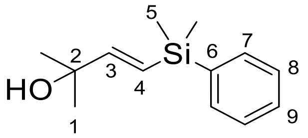
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.51 – 7.49 (m, 2H (**H2**)), 7.42 (dd, *J* = 8.3, 1.2 Hz, 2H (**H3**)), 7.37 – 7.32 (m, 5H (**H1**, **H14** and **H15**), 7.26 – 7.23 (m, 1H (**H16**)), 6.53 (d, *J* = 18.9 Hz, 1H (**H10**)), 6.08 (d, *J* = 18.9 Hz, 1H (**H11**)), 1.88 (s, 1H (**O-H**), 1.82 – 1.62 (m, 5H (**H$_{Cyclohexyl}$**)), 1.25 – 0.98 (m, 6H (**H$_{Cyclohexyl}$**)), 0.36 (s, 3H (**H12**)), 0.36 (s, 3H (**H12**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 152.6 (**C10**), 145.7 (**C4**), 138.9 (**C13**), 134.0 (**C3**), 129.1 (**C1**), 128.2 (**C14**), 127.9 (**C15**), 126.6 (**C16**), 125.7 (**C2**), 124.3 (**C11**), 80.1 (**C5**), 47.8 (**C6**), 27.4 (**C$_{Cylohexyl}$**), 26.9 (**C$_{Cylohexyl}$**), 26.8 (**C$_{Cylohexyl}$**), 26.7 (**C$_{Cylohexyl}$**), 26.6 (**C$_{Cylohexyl}$**), −2.2 (**C12**), −2.2 (**C12**).

IR: ν_{max} (neat/cm^{-1}) 3587 (O-H), 3065 (C-H), 2851 (C-H), 1599 (C=C), 1246 (C-O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{23}H_{31}OSi$ 351.2062; found 351.2099.

(E)-4-(Dimethyl(phenyl)silyl)-2-methylbut-3-en-2-ol – 208q



The title compound was prepared according to general procedure **E**, from 2-methylbut-3-yn-2-ol (500 mg, 5.94 mmol) and dimethylphenylsilane (1.37 mL, 9.92 mmol) using $PtCl_2$ (16 mg, 59.4 μmol) and XPhos (57 mg, 119 μmol). Following the conversion to product and column chromatography (9:1 Hexane/EtOAc) afforded **208q** (1.28 g, 98%) as yellow oil.

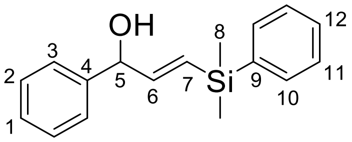
R$_f$ = 0.28 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.53 – 7.50 (dd, J = 6.4, 3.1 Hz, 2H (**H8**)), 7.37 – 7.34 (m, 3H (**H7** and **H9**)), 6.24 (d, J = 18.9 Hz, 1H (**H3**)), 5.96 (d, J = 18.9 Hz, 1H (**H4**)), 1.47 (s, 1H (**O-H**)), 1.32 (s, 6H (**H1**)), 0.35 (s, 6H (**H5**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 155.2 (**C3**), 138.9 (**C6**), 134.0 (**C8**), 129.1 (**C9**), 127.9 (**C7**), 122.7 (**C4**), 72.4 (**C2**), 29.5 (**C1**), −2.4 (**C5**).

All spectral data in accordance with literature.[85]

(*E*)-3-(Dimethyl(phenyl)silyl)-1-phenylprop-2-en-1-ol – 210a



The title compound was prepared according to general procedure **E**, from 1-phenylprop-2-yn-1-ol (320 mg, 242 mmol) and dimethylphenylsilane (560 µL, 3.63 mmol) using $PtCl_2$ (6 mg, 24.2 µmol) and XPhos (23 mg, 48.4 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **210a** (550 mg, 85%) as a yellow oil.

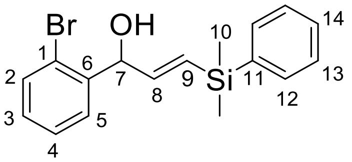
R$_f$ = 0.42 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 (dd, *J* = 6.4, 3.1 Hz, 2H (**H2**)), 7.42 – 7.27 (m, 8H (**H$_{Aromatic}$**)), 6.30 (dd, *J* = 18.6, 5.0 Hz, 1H (**H6**)), 6.15 (dd, *J* = 18.6, 1.4 Hz, 1H (**H7**)), 5.23 (t, *J* = 3.8 Hz, 1H (**H5**)), 1.98 (d, *J* = 3.9 Hz, 1H (**O-H**)), 0.36 (s, 3H (**H8**)), 0.36 (s, 3H (**H8**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 149.0 (**C6**), 142.6 (**C4**), 138.5 (**C9**), 134.0 (**C2**), 129.2 (**C1**), 128.8 (**C11**), 128.0 (**C10**), 127.9 (**C7**), 127.8 (**C12**), 126.7 (**C3**), 76.8 (**C5**), −2.5 (**C8**).

All spectral data in accordance with literature.[85]

(*E*)-1-(2-bromophenyl)-3-[dimethyl(phenyl)silyl]prop-2-en-1-ol – 210b



The title compound was prepared according to general procedure **E**, from 1-(2-bromophenyl)prop-2-yn-1-ol (528 mg, 2.50 mmol) and dimethylphenylsilane (580 µL, 3.75 mmol) using PtCl$_2$ (7 mg, 25.0 µmol) and XPhos (24 mg, 50.0 µmol). Following the conversion to product and column chromatography [SiO$_2$; 9:1 Hexane:EtOAc] afforded **210b** (657 mg, 76 %) as yellow oil.

R$_f$ = 0.50 [9:1 Hexane:EtOAc].

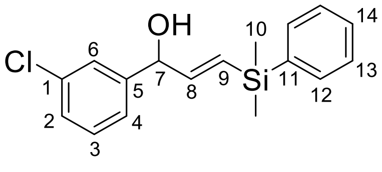
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.55 (d, *J* = 8.0 Hz, 2H (**H2**)), 7.52 – 7.47 (m, 3H (**H$_{Aromatic}$**)), 7.36 – 7.32 (m, 4H (**H$_{Aromatic}$**)), 7.15 (td, *J* = 7.7, 1.7 Hz, 1H (**H5**)), 6.28 (ddd, *J* = 18.7, 3.8, 1.3 Hz, 1H (**H8**)), 6.21 (dd, *J* = 18.7, 0.6 Hz, 1H (**H9**)), 5.63 (t, *J* = 4.0 Hz, 1H (**H7**)), 2.17 (dd, *J* = 11.8, 4.2 Hz, 1H (**O-H**)), 0.35 (s, 3H (**H10**)), 0.35 (s, 3H (**H10**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 147.0 (**C8**), 141.5 (**C6**), 138.5 (**C11**), 134.0 (**C$_{Aromatic}$**), 133.0 (**C$_{Aromatic}$**), 129.3 (**C$_{Aromatic}$**), 129.2 (**C9**), 128.4 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 128.0 (**C$_{Aromatic}$**), 127.9 (**C$_{Aromatic}$**), 122.9 (**C1**), 75.0 (**C7**), −2.5 (**C10**).

IR: ν_{max} (neat/cm^{-1}) 3349 (O-H), 3067 (C-H), 2953 (C-H), 1615 (C=C).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for C$_{17}$H$_{19}$BrOSi 347.0462; found 347.0271.

(*E*)-1-(3-Chlorophenyl)-3-[dimethyl(phenyl)silyl]prop-2-en-1-ol – 210c



The title compound was prepared according to general procedure **E**, from 1-(3-chlorophenyl)-2-propyn-1-ol (200 mg, 1.20 mmol) and dimethylphenylsilane (280 µL, 1.80 mmol) using $PtCl_2$ (3 mg, 12.0 µmol) and XPhos (11 mg, 24.0 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **210c** (204 mg, 56 %) as a yellow oil.

R_f = 0.80 [9:1 Hexane/EtOAc].

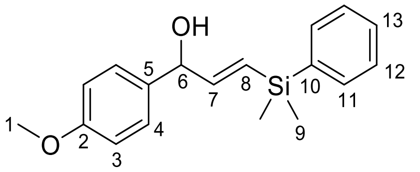
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.50 (dd, *J* = 6.4, 3.1 Hz, 2H (**H$_{\text{Aromatic}}$**)), 7.37 – 7.34 (m, 4H (**H$_{\text{Aromatic}}$**)), 7.31 – 7.26 (m, 2H (**H$_{\text{Aromatic}}$**)), 7.26 – 7.22 (m, 1H (**H$_{\text{Aromatic}}$**)), 6.23 (dd, *J* = 18.6, 4.9 Hz, 1H (**H8**)), 6.14 (dd, *J* = 18.6, 0.9 Hz, 1H (**H9**)), 5.20 (t, *J* = 4.3 Hz, 1H (**H7**)), 2.00 (d, *J* = 3.9 Hz, 1H (**O-H**)), 0.36 (s, 3H (**H10**)), 0.36 (s, 3H (**H10**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 148.3 (**C8**), 144.5 (**C5**), 138.3 (**C11**), 134.6 (**C1**), 134.0 (**C13**), 130.0 (**C$_{\text{Aromatic}}$**), 129.3 (**C$_{\text{Aromatic}}$**), 128.8 (**C$_{\text{Aromatic}}$**), 128.0 (**C12**), 128.0 (**C$_{\text{Aromatic}}$**), 126.7 (**C$_{\text{Aromatic}}$**), 124.7 (**C9**), 76.4 (**C7**), −2.6 (**C10**).

IR: ν_{max} (cm^{-1}) 3467 (O-H), 3008 (C-H), 2921 (C-H), 1603 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{17}H_{20}ClOSi$ 303.0967; found 303.0789.

(*E*)-3-(Dimethyl(phenyl)silyl)-1-(4-methoxyphenyl)prop-2-en-1-ol – 210d



The title compound was prepared according to general procedure **E**, from 1-(methoxyphenyl)-2-propyn-1-ol (100 mg, 617 μmol) and dimethylphenylsilane (140 μL, 925 μmol) using $PtCl_2$ (2 mg, 6.17 μmol) and XPhos (6 mg, 12.3 μmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **210d** (125 mg, 68%) as a yellow oil.

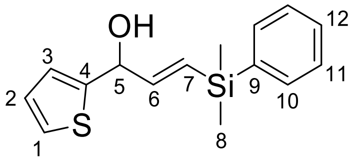
R_f = 0.19 [9:1 Hexane/EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.55 – 7.50 (m, 2H (**H12**), 7.38 – 7.35 (m, 3H (**H11** and **H13**)), 7.31 – 7.27 (m, 2H (**H4**)), 6.92 – 6.89 (m, 2H (**H3**)), 6.30 (dd, *J* = 18.6, 4.8 Hz, 1H (**H7**)), 6.14 (dd, *J* = 18.8, 1.5 Hz, 1H (**H8**)), 5.19 (t, *J* = 3.5 Hz, 1H (**H6**)), 3.82, (s, 3H (**H1**)), 1.95 (d, *J* = 4.0 Hz, 1H (**O-H**)), 0.37 (s, 3H (**H9**)) 0.37 (s, 3H (**H9**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 159.2 (**C2**), 149.1 (**C7**), 138.4 (**C10**), 134.7 (**C5**), 133.8 (**C11**), 129.0 (**C4**), 127.9 (**C12**), 127.8 (**C13**), 114.0 (**C3**), 76.3 (**C6**), 55.3 (**C1**), −2.6 (**C9**).

All spectral data in accordance with literature.[84]

(*E*)-3-[Dimethyl(phenyl)silyl]-1-(2-thienyl)prop-2-en-1-ol – 210e



The title compound was prepared according to general procedure **E**, from 1-(thiophen-2-yl)prop-2-yn-1-ol (50 mg, 362 μmol) and dimethylphenylsilane (80 μL, 543 μmol) using $PtCl_2$ (1 mg, 3.62 μmol) and XPhos (3 mg, 7.24 μmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **210e** (92 mg, 93 %) as an orange oil.

R_f = 0.20 [9:1 Hexane/EtOAc].

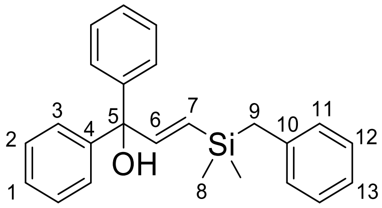
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.65 – 7.57 (m, 1H (**H$_{Aromatic}$**)), 7.54 – 7.52 (m, 2H (**H$_{Aromatic}$**)), 7.43 – 7.33 (m, 2H (**H$_{Aromatic}$**)), 7.31 – 7.27 (m, 1H, (**H$_{Aromatic}$**)), 7.01 – 6.96 (m, 2H (**H$_{Aromatic}$**)), 6.36 (dd, *J* = 18.6, 5.0 Hz, 1H (**H6**)), 6.20 (dd, *J* = 18.6, 1.4 Hz, 1H (**H7**)), 5.46 (td, *J* = 4.9, 1.1 Hz, 1H (**H5**)), 2.10 – 2.08 (m, 1H (**O-H**)), 0.38 (s, 3H (**H8**)), 0.38 (s, 3H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 147.9 (**C6**), 146.6 (**C4**), 134.0 (**C9**), 133.7 (**C$_{Aromatic}$**), 133.2 (**C$_{Aromatic}$**), 128.5 (**C$_{Aromatic}$**), 128.1 (**C$_{Aromatic}$**), 127.0 (**C$_{Aromatic}$**), 125.6 (**C$_{Aromatic}$**), 124.8 (**C7**), 72.4 (**C5**), −2.5 (**C8**).

IR: ν_{max} (neat/cm^{-1}) 3352 (O-H), 2955 (C-H), 2924 (C-H), 1625 (C=C).

HRMS: molecular ion not detected for $C_{15}H_{18}OSSi$.

(*E*)-3-[Benzyl(dimethyl)silyl]-1,1-diphenyl-prop-2-en-1-ol – 211a



The title compound was prepared according to general procedure **E**, from 1,1-diphenyl-2-propyn-1-ol (200 mg, 960 mol) and benzyldimethylsilane (230 μL, 1.44

mmol) using $PtCl_2$ (3 mg, 9.60 µmol) and XPhos (9 mg, 19.2 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **211a** (292 mg, 85%) as yellow oil.

R_f = 0.12 [9:1 Hexane:EtOAc].

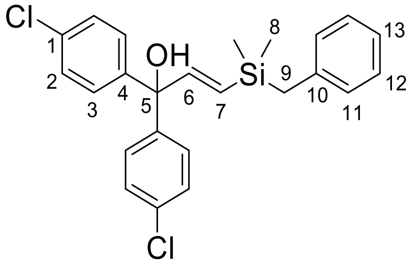
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.32 – 7.26 (m, 10H (**H1**, **H2** and **H3**)), 7.19 – 7.14 (m, 2H (**H12**)), 7.09 – 7.04 (m, 1H (**H13**)), 6.96 – 6.93 (m, 2H (**H11**)), 6.55 (d, *J* = 18.8 Hz, 1H (**H6**)), 5.93 (d, *J* = 18.8 Hz, 1H (**H7**)), 2.25 (s, 1H (**O-H**)), 2.15 (s, 2H (**H9**)), 0.10 (s, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 151.6 (**C6**), 145.8 (**C4**), 139.9 (**C10**), 128.4 (**C12**), 128.3 (**C1**), 128.3 (**C3**), 127.3 (**C11**), 127.1 (**C2**), 126.1 (**C13**), 124.2 (**C7**), 80.3 (**C5**), 26.2 (**C9**), −3.2 (**C8**).

IR: ν_{max} (neat/cm^{-1}) 3457 (O-H), 3058 (C-H), 2953 (C-H), 1599 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M-H]^-$ Calcd for $C_{24}H_{25}OSi$ 357.1680; found 357.1650.

(*E*)-3-[Benzyl(dimethyl)silyl]-1,1-bis(4-chlorophenyl)prop-2-en-1-ol – 211b



The title compound was prepared according to general procedure **E**, from 1,1-bis(4-chlorophenyl)-2-propyn-1-ol (500 mg, 1.80 mmol) and dimethylbenzylsilane (429 µL, 2.71 mmol) using $PtCl_2$ (5 mg, 18.0 µmol) and XPhos (17 mg, 36.1 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **211b** (635 mg, 82 %) as a colourless oil.

R_f = 0.23 [19:1 Hexane:EtOAc].

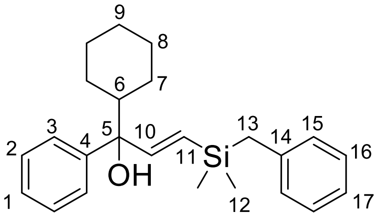
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.27 (d, *J* = 8.7 Hz, 4H (**H2**)), 7.20 – 7.15 (m, 2H (**H12**)), 7.16 (d, *J* = 8.7 Hz, 4H (**H3**)), 7.11 – 7.07 (m, 1H (**H13**)), 6.93 (dd, *J* = 7.9, 0.9 Hz, 2H (**H11**)), 6.40 (d, *J* = 18.8 Hz, 1H (**H6**)), 5.87 (d, *J* = 18.8 Hz, 1H (**H7**)), 2.21 (s, 1H (**O-H**)), 2.15 (s, 1H (**H9**)), 0.11 (s, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 150.6 (**C6**), 143.9 (**C4**), 139.8 (**C10**), 133.5 (**C1**), 128.5 (**C2** or **C3**), 128.5 (**C2** or **C3**), 128.4 (**C11** or **C12**), 128.3 (**C11** or **C12**), 127.4 (**C13**), 124.3 (**C7**), 79.6 (**C5**), 26.1 (**C9**), −3.2 (**C8**).

IR: ν_{max} (neat/cm^{-1}) 3555 (O-H), 3022 (C-H), 2914 (C-H), 1593 (C=C), 1250 (C-O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{24}H_{23}Cl_2OSi$ 414.0785; found 414.0787.

(*E*)-1-Cyclohexyl-3-[dimethyl(benzyl)silyl-1-phenyl-prop-2-en-1-ol – 211c



The title compound was prepared according to general procedure **E**, from 1-cyclohexyl-1-phenyl-prop-2-yn-1-ol (300 mg, 1.40 mmol) and dimethylbenzylsilane (333 µL, 2.10 mmol) using $PtCl_2$ (4 mg, 14.0 µmol) and XPhos (13 mg, 28.0 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **211c** (475 mg, 93%) as colourless oil.

R$_f$ = 0.25 [19:1 Hexane:EtOAc].

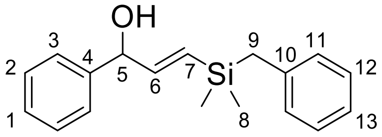
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.38 (dd, *J* = 8.5, 1.4 Hz, 2H (**H3**)), 7.33 (t, *J* = 7.7 Hz, 2H (**H2**)), 7.25 – 7.21 (m, 1H (**H1**)), 7.16 (t, 7.4 Hz, 2H (**H16**)), 7.06 – 7.02 (m, 1H (**H17**)), 6.94 (dd, *J* = 8.1, 1.2 Hz, 2H (**H15**)), 6.35 (d, *J* = 18.9 Hz,1H (**H10**)), 5.87 (d, *J* = 18.9 Hz, 1H (**H11**)), 2.1 (s, 2H (**H13**)), 1.78 – 1.60 (m, 5H (**H$_{Cyclohexyl}$**)), 1.40- 1.37 (m, 1H (**H$_{Cyclohexyl}$**)), 1.22 – 1.04 (m, 3H (**H$_{Cyclohexyl}$**)), 1.01 – 0.90 (m, 2H (**H$_{Cyclohexyl}$**)). 0.07 (s, 3H (**H12**)), 0.06 (s, 3H (**H12**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 152.1 (**C10**), 145.6 (**C4**), 140.0 (**C14**), 128.4 (**C16**), 128.2 (**C15**), 128.2 (**C1**), 126.6 (**C17**), 125.7 (**C4**), 124.3 (**C3**), 124.1 (**C11**), 80.0 (**C5**), 47.6 (**C6**), 27.3 (**C$_{Cyclohexyl}$**), 26.9 (**C$_{Cyclohexyl}$**), 26.8 (**C$_{Cyclohexyl}$**), 26.7 (**C$_{Cyclohexyl}$**), 26.6 (**C$_{Cyclohexyl}$**), 26.3 (**C13**), −2.9 (**C12**), −3.1 (**C12**).

IR: ν_{max} (neat/cm^{-1}) 3587 (O-H), 3060 (C-H), 2853 (C-H), 1599 (C=C), 1246 (C-O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{24}H_{33}OSi$ 365.2295; found 365.2296.

(*E*)-3-[Benzyl(dimethyl)silyl]-1-phenyl-prop-2-en-1-ol – 211d



The title compound was prepared according to general procedure **E**, from 1-phenylprop-2-yn-1-ol (50 mg, 378 µmol) and benzyldimethylsilane (70 µL, 416 µmol) using $PtCl_2$ (2 mg, 5.67 µmol) and XPhos (5 mg, 11.3 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **211d** (96 mg, 90%) as a yellow oil.

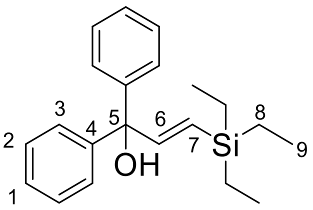
Rf = 0.19 [9:1 Hexane/EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.39 – 7.28 (m, 5H (**H$_{Aromatic}$**)), 7.18 (t, *J* = 7.5 Hz, 2H (**H$_{Aromatic}$**)), 7.06 (t, *J* = 7.4 Hz, 1H (**H$_{Aromatic}$**)), 6.96 (dd, *J* = 7.9, 0.9 Hz, 2H (**H$_{Aromatic}$**)), 6.16 (dd, *J* = 18.7, 5.2 Hz, 1H (**H8**)), 5.96 (dd, *J* = 18.7, 1.4 Hz, 1H (**H7**)), 5.17 (t, *J* = 3.9 Hz, 1H (**H5**)), 2.14 (s, 2H (**H9**)), 1.92 (d, *J* = 3.9 Hz, 1H (**O-H**)), 0.06 (s, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 148.5 (**C6**), 142.6 (**C4**), 139.9 (**C10**), 128.7 (**C$_{Aromatic}$**), 128.4 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 127.9 (**C1**), 127.9 (**C13**), 126.6 (**C$_{Aromatic}$**), 124.2 (**C7**), 76.9 (**C5**), 26.1 (**C9**), −3.3 (**C8**), −3.3 (**C8**).

All spectral data in accordance with literature.[85]

(*E*)-1,1-Diphenyl-3-triethylsilyl-prop-2-en-1-ol – 211e



The title compound was prepared according to general procedure **E**, from 1,1-diphenyl-2-propyn-1-ol (100 mg, 480 µmol) and triethylsilane (115 µL, 720 µmol) using $PtCl_2$ (1 mg, 4.80 µmol) and XPhos (5 mg, 9.60 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **211e** (137 mg, 88%) as colourless oil.

Rf = 0.26 [19:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.38 – 7.33 (m, 5H (**H$_{Aromatic}$**)), 7.33 – 7.32 (m, 2H (**H$_{Aromatic}$**)), 7.30 (m, 1H (**H1**)), 7.28 – 7.27 (m, 1H (**H1**)), 7.26 – 7.23 (m, 1H

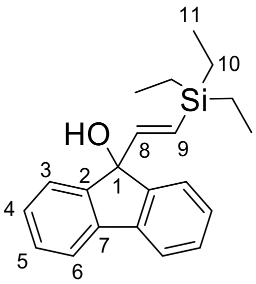
(**H**$_{\textbf{Aromatic}}$)), 6.67 (d, *J* = 18.9 Hz, 1H (**H6**)), 5.93 (d, *J* = 18.9 Hz, 1H (**H7**)), 2.34 (s, 1H (**O-H**)), 0.94 (t, *J* = 7.9 Hz, 9H (**H9**)), 0.61 (q, *J* = 7.7 Hz, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 151.7 (**C6**), 146.1 (**C4**), 128.3 (**C3**), 127.3 (**C1**), 127.1 (**C2**), 124.4 (**C7**), 80.5 (**C5**), 7.5 (**C9**), 3.6 (**C8**).

IR: ν_{max} (neat/cm^{-1}) 3556 (O-H), 3024 (C-H), 2949 (C-H), 1617 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{29}OSi$ 325.1905; found 325.1943.

9-[(*E*)-2-Triethylsilylvinyl]fluoren-9-ol – 211f



The title compound was prepared according to general procedure **E**, from 9-ethynylfluoren-9-ol (500 mg, 2.42 mmol) and triethylsilane (581 µL, 3.64 mmol) using $PtCl_2$ (7 mg, 24.2 µmol) and XPhos (23 mg, 48.5 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **211f** (627 mg, 80%) as a yellow oil.

R$_f$ = 0.21 [19:1 Hexane:EtOAc].

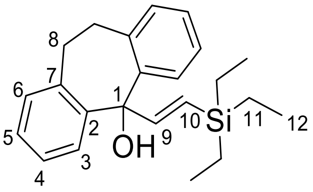
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.5 Hz, 2H (**H**$_{\textbf{Aromatic}}$)), 7.40 (dt, *J* = 7.3, 1.1 Hz, 2H (**H**$_{\textbf{Aromatic}}$)), 7.37 (dd, *J* = 7.4, 1.3 Hz, 2H (**H**$_{\textbf{Aromatic}}$)), 7.30 (td, *J* = 7.4, 1.1 Hz, 2H (**H**$_{\textbf{Aromatic}}$)), 6.29 (d, *J* = 18.9 Hz, 1H (**H8**)), 6.03 (d, *J* = 18.9 Hz, 1H (**H9**)), 2.24 (s, 1H (**O-H**)), 0.92 (t, *J* = 7.9 Hz, 9H (**H11**)), 0.57 (q, *J* = 7.9 Hz, 6H (**H10**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 148.4 (**C2**), 147.1 (**C8**), 139.8 (**C7**), 129.2 (**C**$_{\textbf{Aromatic}}$), 128.3 (**C**$_{\textbf{Aromatic}}$), 124.5 (**C**$_{\textbf{Aromatic}}$), 123.4 (**C9**), 120.2 (**C**$_{\textbf{Aromatic}}$), 83.5 (**C1**), 7.5 (**C10**), 3.6 (**C11**).

IR: ν_{max} (neat/cm^{-1}) 3436 (O-H), 2950 (C-H), 2871 (C-H), 1617 (C=O), 1233 (C-O).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{27}OSi$ 323.1749; found 323.1786.

2-[(*E*)-2-Triethylsilylvinyl]tricyclo[9.4.0.03,8]pentadeca-1(11),3,5,7,12,14-hexaen-2-ol – 211g



The title compound was prepared according to general procedure **E**, from 5-ethynyl-10,11-dihydro-5H-dibenzo[a,d]cyclohepten-5-ol (150 mg, 640 µmol) and triethylsilane (153 µL, 960 µmol) using $PtCl_2$ (2 mg, 6.4 µmol) and XPhos (6 mg, 12.8 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **211g** (224 mg, 83%) as a yellow oil.

R_f = 0.26 [9:1 Hexane:EtOAc].

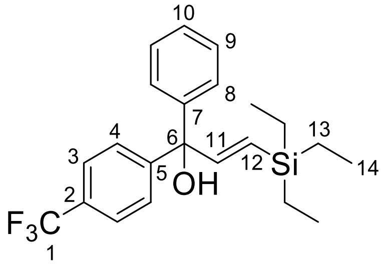
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 7.6 Hz, 2H (**H3**)), 7.25 – 7.17 (m, 4H (**H4** and **H6**)), 7.10 (d, *J* = 7.1 Hz, 2H (**H6**)), 6.57 (d, *J* = 18.9 Hz, 1H (**H9**)), 5.53 (d, *J* = 18.9 Hz, 1H (**H10**)), 3.48 – 3.39 (m, 2H (**H8**)), 2.93 – 2.84 (m, 2H (**H8**)), 2.13 (d, *J* = 0.7 Hz, 1H (**O-H**)), 0.88 (t, *J* = 7.9 Hz, 9H (**H12**)), 0.55 (q, *J* = 7.9 Hz, 6H (**H11**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 153.5 (**C9**), 143.1 (**C2**), 138.2 (**C7**), 130.4 (**C6**), 127.8 (**C10**), 127.6 (**C4** or **C6**), 126.1 (**C4** or **C6**), 125.6 (**C5**), 78.8 (**C1**) , 32.8 (**C8**), 7.5 (**C12**), 3.5 (**C11**).

IR: ν_{max} (neat/cm^{-1}) 3548 (O-H), 3062 (C-H), 2909 (C-H), 1611 (C=C), 1222 (C-O).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{31}OSi$ 351.2099; found 351.2062.

(*E*)-1-Phenyl-3-triethyl-1-[4-(trifluoromethyl)phenyl]prop-2-en-1-ol – 211h



The title compound was prepared according to general procedure **E**, from 1-phenyl-1-[4-(trifluoromethyl)phenyl]prop-2-yn-1-ol (100 mg, 362 µmol) and triethylsilane (86.7 µL, 543 µmol) using $PtCl_2$ (1 mg, 3.62 µmol) and XPhos (4 mg, 7.24 µmol). Following the conversion to product and column chromatography [SiO_2; 20:1 Hexane:EtOAc] afforded **211h** (85 mg, 60%) as colourless oil.

***R*$_f$** = 0.29 [20:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.58 (d, *J* = 8.4 Hz, 2H (**H3**)), 7.50 (d, *J* = 8.2 Hz, 2H (**H4**)), 7.35 – 7.28 (m, 5H (**H8**, **H9** and **H10**), 6.65 (d, *J* = 18.9 Hz, 1H (**H11**)), 5.96 (d, *J* = 18.9 Hz, 1H (**H12**)), 2.38 (d, *J* = 1.8 Hz, 1H (**O-H**)), 0.94 (t, *J* = 7.9 Hz, 9H (**H14**)), 0.62 (q, *J* = 7.9 Hz, 6H (**H13**)).

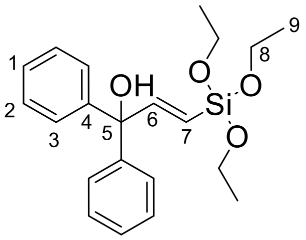
^{13}C NMR: (101 MHz, CDCl$_3$) δ 150.8 (**C11**), 149.9 (**C5**), 145.5 (**C7**), 129.4, (q, *J* = 32.4 Hz (**C2**)), 128.5 (**C4**), 127.8 (**C10**), 127.3 (**C8** or **C9**), 127.1 (**C8** or **C9**), 125.7 (**C12**), 125.2 (q, *J* = 3.8 Hz (**C3**)), 124.3 (q, *J* = 271.9 Hz (**C1**)), 80.3 (**C6**), 7.5 (**C14**), 3.6 (**C13**).

^{19}F NMR: (376 MHz, CDCl$_3$) δ −62.5.

IR: ν_{max} (neat/cm^{-1}) 3546 (O-H), 2953 (C-H), 2875 (C-H), 1617 (C=C), 1323 (C-O).

HRMS: (ACPI-TOF) *m/z*: [M-H]$^-$ Calcd for $C_{24}H_{24}F_3OSi$ 413.1504; found 413.1543.

(*E*)-1,1-Diphenyl-3-triethoxysilylprop-2-en-ol – 211i



The title compound was prepared according to general procedure **E**, from 1,1-diphenyl-2-propyn-1-ol (80 mg, 384 µmol) and triethoxysilane (100 µL, 576 µmol) using PtCl$_2$ (1 mg, 3.84 µmol) and XPhos (4 mg, 7.68 µmol). Following the conversion to product and column chromatography [SiO$_2$; 9:1 Hexane:EtOAc] afforded **211i** (54 mg, 38%) as yellow oil.

***R*$_f$** = 0.21 [1:1 Hexane:EtOAc].

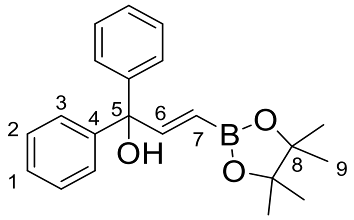
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.37 – 7.30 (m, 8H (**H$_{Aromatic}$**)), 7.28 – 7.27 (m, 2H (**H$_{Aromatic}$**)), 7.03 (d, *J* = 18.8 Hz, 1H (**H6**)), 5.83 (d, *J* = 18.8 Hz, 1H (**H7**)), 3.82 (q, *J* = 7.0 Hz, 6H (**H8**)), 2.33 (s, 1H (**O-H**)), 1.21 (t, *J* = 7.0 Hz, 9H (**H9**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 156.2 (**C6**), 145.4 (**C4**), 128.4 (**C2**), 127.5 (**C3**), 127.1, 117.4 (**C7**), 80.4 (**C5**), 58.7 (**C8**), 18.4 (**C9**).

IR: ν_{max} (neat/cm^{-1}) 3465 (O-H), 3056 (C-H), 2923 (C-H), 1611 (C=C), 1067 (C-O).

HRMS: molecular ion not detected for $C_{21}H_{28}O_4Si$.

(*E*)-1,1-Diphenyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)prop-2-en-ol – 213



The title compound was prepared according to general procedure **E**, from 1,1-diphenyl-2-propyn-1-ol (200 mg, 960 µmol) and pinacol borane (139 µL, 960 µmol) using $PtCl_2$ (1 mg, 4.80 µmol) and XPhos (5 mg, 9.60 µmol). Following the conversion to product and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **213** (81 mg, 25%) as white solid.

R$_f$ = 0.36 [2:1 EtOAc/Hexane].

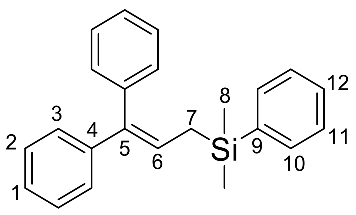
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.41 – 7.38 (m, 4H, (**H$_{Aromatic}$**)), 7.36 – 7.31 (m, 4H (**H$_{Aromatic}$**)), 7.30 - 7.29 (m, 1H (**H1**)), 7.28 -7.25 (m, 1H (**H1**)), 7.23 (d, *J* = 18.0 Hz, 1H (**H6**), 5.80 (d, *J* = 18.0 Hz, 1H (**H7**), 2.34 (s, 1H (**O-H**), 1.29 (s, 12H (**H9**).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 156.5 (**C6**), 145.5 (**C4**), 128.3 (**C3**), 127.5 (**C1**), 127.2 (**C2**), 83.5 (**C5**), 25.0 (**C9**).

All spectral data in accordance with literature.[206]

7.2.7 Allylsilanes/boranes

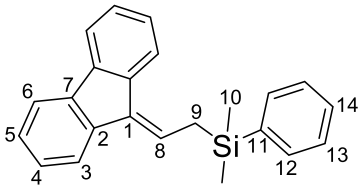
3,3-Diphenylallyl-dimethyl-phenyl-silane – 220a



The title compound was prepared according to general procedure **F**, from (*E*)-3-(dimethyl(phenyl)silyl)-1,1-diphenylprop-2-en-1-ol (50 mg, 145 µmol), dimethylphenylsilane (66.7 µL, 435 µmol) using triflimide (726 µL, 0.01 M in DCM, 5.0 mol%) and 1,3,5-trimethoxybenzene (7 mg, 41.6 µmol) afforded **220a** (86%, NMR yield).

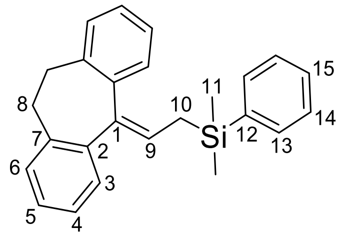
^{1}**H NMR**: (400 MHz, $CDCl_3$) δ 7.58 – 7.56 (m, 2H (**H**$_{\textbf{Aromatic}}$)), 7.41 – 7.24 (m, 11H (**H**$_{\textbf{Aromatic}}$)), 7.19 – 7.17 (m, 2H (**H**$_{\textbf{Aromatic}}$)), 6.25 (t, *J* = 8.7 Hz, 1H (**H6**)), 1.98 (d, *J* = 8.7 Hz, 2H (**H7**)), 0.40 (s, 6H (**H8**)).
All spectral data in accordance with literature.[207]

2-Fluoren-9-ylideneethyl-dimethyl-phenyl-silane – 220b



The title compound was prepared according to general procedure **F,** from 9*H*-fluoren-9-ol, 9-[(1*E*)-2-(dimethylphenylsilyl)ethenyl] (50 mg, 146 µmol) and dimethylphenylsilane (67.1 µL, 438 µmol) using triflimide (146 µL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% Petroleum ether] afforded **220b** (34 mg, 71%) as a yellow oil.
R$_{\boldsymbol{f}}$ = 0.68 [100% Hexane].
^{1}**H NMR**: (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 7.6 Hz, 1H (**H**$_{\textbf{Aromatic}}$)), 7.78 (dd, *J* = 7.4, 0.4 Hz, 1H (**H**$_{\textbf{Aromatic}}$)), 7.74 (dd, *J* = 6.3, 1.1 Hz, 1H (**H**$_{\textbf{Aromatic}}$)), 7.61 – 7.58 (m, 3H (**H**$_{\textbf{Aromatic}}$)), 7.41 – 7.32 (m, 5H (**H**$_{\textbf{Aromatic}}$)), 7.30 – 7.28 (m, 2H (**H**$_{\textbf{Aromatic}}$)), 6.88 (t, *J* = 9.8 Hz, 1H (**H9**)), 2.64 (d, *J* = 9.8 Hz, 2H (**H9**)), 0.38 (s, 6H (**H10**)).
^{13}**C NMR**: (101 MHz, $CDCl_3$) δ 140.7 (**C1**), 139.9 (**C2**), 138.2 (**C2**), 138.0 (**C7**), 137.9 (**C11**), 133.7 (**C12**), 133.4 (**C7**), 129.6 (**C8**), 128.8 (**C**$_{\textbf{Aromatic}}$), 128.1 (**C13**), 127.2 (**C**$_{\textbf{Aromatic}}$), 126.9 (**C**$_{\textbf{Aromatic}}$), 126.8 (**C**$_{\textbf{Aromatic}}$), 126.7 (**C**$_{\textbf{Aromatic}}$), 124.6 (**C**$_{\textbf{Aromatic}}$), 119.9 (**C**$_{\textbf{Aromatic}}$), 119.5 (**C**$_{\textbf{Aromatic}}$), 119.3 (**C**$_{\textbf{Aromatic}}$), 22.1 (**C9**), −2.8 (**C10**).
IR: ν_{max} (neat/cm^{-1}) 3058 (C-H), 3011 (C-H), 2953 (C-H), 2853 (C-H), 1634 (C=C).
HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{23}Si$ 327.1564; found 327.1524.

Dimethyl-phenyl-[2-(2-tricyclo[9.4.0.0^^{208}]pentadeca-1(15),3(8),4,6,11,13-hexaenylidene)ethyl]silane – 220c



The title compound was prepared according to general procedure **F**, from 2-(*E*)-2-[dimethyl(phenyl)silyl]vinyltricyclo[9.4.0.03,8]pentadeca-1(11),3(8),4,6,12,14-hexaen-2-ol (67 mg, 181 μmol) and dimethylphenylsilane (83.1 μL, 542 μmol) using triflimide (181 μL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product and column chromatography [SiO$_2$; 100% Petroleum ether] afforded **220c** (42 mg, 66%) as a yellow oil.

R_f = 0.58 [100% Hexane].

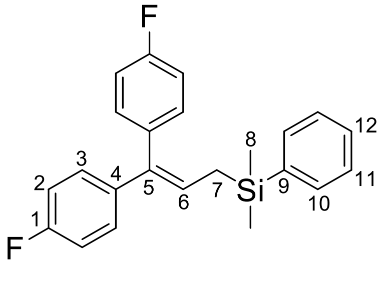
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.44 (dd, *J* = 7.6, 1.8 Hz, 2H (**H**$_{\mathbf{Aromatic}}$)), 7.36 – 7.30 (m, 3H (**H**$_{\mathbf{Aromatic}}$)), 7.24 (dd, *J* = 5.5, 3.6 Hz, 1H (**H**$_{\mathbf{Aromatic}}$)), 7.17 (d, *J* = 3.8 Hz, 2H (**H**$_{\mathbf{Aromatic}}$)), 7.11 (dd, *J* = 5.7, 3.4 Hz, 3H (**H**$_{\mathbf{Aromatic}}$)), 7.02 (dd, *J* = 8.2, 4.6 Hz, 2H (**H**$_{\mathbf{Aromatic}}$)), 5.92 (t, *J* = 8.6 Hz,1H (**H9**)), 3.25 – 3.20 (m, 2H (**H8**)), 2.92 – 2.85 (m, 1H (**H8**)), 2.67 – 2.64 (m, 1H (**H8**)), 2.01 – 1.95 (m, 1H (**H10**)), 1.82 – 1.77 (m, 1H (**H10**)), 0.30 (s, 6H (**H11**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 142.0 (**C1**), 141.0 (**C2**), 140.2 (**C2**), 139.9 (**C7**), 138.7 (**C7**), 137.3 (**C12**), 133.7 (**C13**), 130.0 (**C**$_{\mathbf{Aromatic}}$), 129.2 (**C**$_{\mathbf{Aromatic}}$), 128.8 (**C**$_{\mathbf{Aromatic}}$), 128.7 (**C**$_{\mathbf{Aromatic}}$), 128.2 (**C**$_{\mathbf{Aromatic}}$), 127.9 (**C14**), 127.5 (**C**$_{\mathbf{Aromatic}}$), 127.2 (**C**$_{\mathbf{Aromatic}}$), 126.8 (**C**$_{\mathbf{Aromatic}}$), 126.0 (**C**$_{\mathbf{Aromatic}}$), 125.7 (**C**$_{\mathbf{Aromatic}}$), 33.9 (**C8**), 32.1 (**C8**), 19.7 (**C10**), 1.2 (**C11**).

IR: ν_{max} (neat/cm^{-1}) 3065 (C-H), 2953 (C-H), 2922 (C-H), 2853 (C-H), 1485 (C=C).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for C$_{25}$H$_{27}$Si 355.1837; found 355.1877.

3,3-Bis(4-fluorophenyl)allyl-dimethyl-phenyl-silane – 220d



The title compound was prepared according to general procedure **F**, from (*E*)-3-[dimethyl(phenyl)silyl]-1,1-bis(4-flurophenyl)prop-2-en-1-ol (60 mg, 158 μmol) and dimethylphenylsilane (72.5 µL, 473 µmol) using triflimide (158 µL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% Petroleum ether] afforded **220d** (40 mg, 70%) as a yellow oil.

R_f = 0.53 [100% Hexane].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.44 (dd, *J* = 7.5, 1.9 Hz, 2H (**H11**)), 7.38 – 7.32 (m, 3H (**H10** and **H12**), 7.06 – 6.88 (m, 8H (**H2** and **H3**)), 6.03 (t, *J* = 8.7 Hz, 1H (**H6**)), 1.82 (d, *J* = 8.7 Hz, 2H (**H7**)), 0.28 (s, 6H (**H8**)).

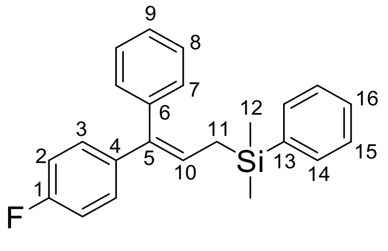
^{13}C NMR: (101 MHz, $CDCl_3$) δ 161.8 (d, *J* = 245.7 Hz, **C1**), 161.7 (d, *J* = 245.5 Hz, **C1**), 139.2 (d, *J* = 3.5 Hz (**C4**)), 138.1 (d, *J* = 8.0 Hz, **C3**), 135.9 (d, *J* = 3.4 Hz (**C4**)), 133.6 (**C11**), 133.0 (**C5**), 131.7 (d, *J* = 7.9 Hz, **C2**), 129.2 (**C12**), 128.3 (d, *J* = 7.8 Hz, **C3**), 127.8 (**C10**), 126.0 (**C6**), 115.2 (d, *J* = 21.2 Hz, **C2**), 114.9 (d, *J* = 21.3 Hz, **C3**), 20.3 (**C7**), −3.0 (**C8**).

^{19}F NMR: (376 MHz, $CDCl_3$) δ −115.5, −116.0.

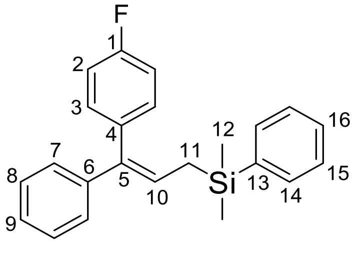
IR: ν_{max} (neat/cm^{-1}) 3069 (C-H), 2957 (C-H), 1600 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{23}F_2Si$ 365.1455; found 365.1492.

Triethyl-[3-(4-fluorophenyl)-3-phenyl-allyl]silane – 220e



(*E*)-220



(*Z*)-220

The title compound was prepared according to general procedure **F**, from (*E*)-3-[dimethyl(phenyl)silyl]-1-(4-fluorophenyl)-1-phenyl-prop-2-en-1-ol (100 mg, 276 µmol) and dimethylphenylsilane (127 µL, 828 µmol) using triflimide (276 µL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product as a stereoisomeric mixture (*E*/*Z* 58:42) and column chromatography [SiO_2; 100% Petroleum ether] afforded (*E*)-**220e** and (*Z*)-**220e** as a mixture in a (85 mg, 89%) as a yellow oil.

R_f = 0.56 [100% Hexane].

Major (*E*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.48 – 7.07 (m, 14H (**$H_{Aromatic}$**)), 6.07 (t, *J* = 8.7 Hz, 1H (**H10**)), 1.89 (d, *J* = 8.9 Hz, 2H (**H11**)), 0.28 (s, 6H (**H12**)).

Major (*E*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 161.7 (d, *J* = 245.5 Hz (**C1**), 140.1 (**C6**), 139.4 (d, *J* = 3.0 Hz (**C4**), 139.2 (**C5**), 138.4 (**C13**), 133.6 (**C14**), 130.1 (**C7**), 129.1 (**C16**), 128.3 (**C8**), 128.3 (d, *J* = 7.8 Hz (**C3**), 127.8 (**C15**), 126.7 (**C9**), 125.6 (**C10**), 114.8 (d, *J* = 21.1 Hz (**C2**)), 20.4 (**C11**), −3.0 (**C12**).

Major (*E*) ^{19}F NMR: (376 MHz, $CDCl_3$) δ −116.8.

Minor (*Z*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.48 – 7.07 (m, 14H (**H**$_{\mathbf{Aromatic}}$)), 6.13 (t, *J* = 8.7 Hz, 1H (**C10**)), 1.87 (d, *J* = 8.9 Hz, 2H (**C11**)), 0.30 (s, 6H (**C12**)).

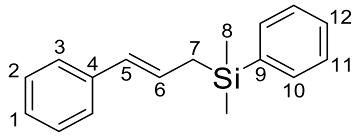
Minor (*Z*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 161.7 (d, *J* = 245.3 Hz (**C1**), 143.1 (**C6**), 139.1 (**C5**), 138.3 (**C13**), 136.1 (d, *J* = 3.1 Hz (**C4**)), 133.6 (**C14**), 131.8 (d, *J* = 7.8 Hz (**C3**)), 129.1 (**C16**), 128.1 (**C8**), 127.8 (**C15**), 126.8 (**C7**), 126.5 (**C9**), 126.1 (**C10**), 115.1 (d, *J* = 21.2 Hz (**C2**)), 20.2 (**C11**), −3.0 (**C12**).

Minor (*Z*) ^{19}F NMR: (376 MHz, $CDCl_3$) δ −116.0.

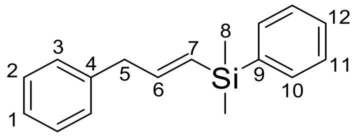
IR: ν_{max} (neat/cm^{-1}) 3050 (C-H), 3021 (C-H), 2953 (C-H), 1600 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{24}FSi$ 347.1549; found 347.1587.

[(*E*)-Cinnamyl]-dimethyl-phenyl-silane – 225a



225a



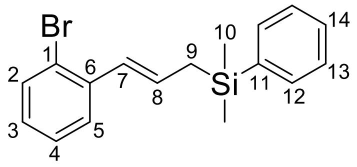
226a

The title compound was prepared according to general procedure **F**, from (*E*)-3-(dimethyl(phenyl)silyl)-1-phenylprop-2-en-1-ol (50 mg, 186 μmol) and dimethylphenylsilane (57.1 μL, 373 μmol) using triflimide (931 μL, 0.05 M in DCM, 5.0 mol%) and 1,3,5-trimethoxybenzene (10 mg, 60.6 μmol). Following conversion to product (93:7 **225a**:**226a**), afforded **225a** in 49% quantitative NMR yield.

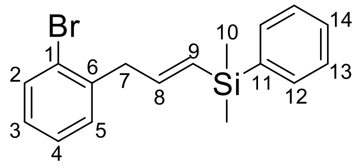
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.49 – 7.40 (m, 5H ((**H**$_{\mathbf{Aromatic}}$)), 7.41 – 7.35 (m, 3H (**H**$_{\mathbf{Aromatic}}$)), 7.32 – 7.24 (m, 2H (**H**$_{\mathbf{Aromatic}}$)), 6.40 – 6.33 (m, 2H (**H5** and **H6**)), 2.03 (d, *J* = 6.8 Hz, 2H (**H7**)), 0.46 (s, 6H (**H8**)).

All spectral data in accordance with literature.[123]

[(*E*)-3-(2-bromophenyl)allyl]-dimethyl-phenyl-silane – 225b



225b

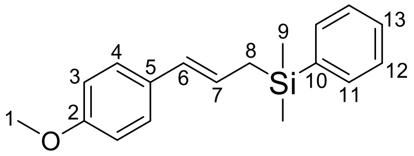


226b

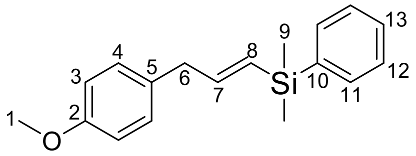
The title compound was prepared according to general procedure **F**, from (*E*)-1-(2-bromophenyl)-3-[dimethyl(phenyl)silyl]prop-2-en-1-ol (50 mg, 144 μmol) and dimethylphenylsilane (66.2 μL, 432 μmol) using triflimide (144 μL, 0.05 M in DCM, 5.0 mol%) and 1,3,5-trimethoxybenzene (9 mg, 54.7 μmol) Following conversion to product (80:20 **225b**:**226b**), afforded **225b** in 55% quantitative NMR yield.

^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.80 – 7.52 (m, 6H (**H**$_{\textbf{Aromatic}}$)), 7.42 – 7.36 (m, 2H (**H**$_{\textbf{Aromatic}}$)), 7.20 – 7.16 (m, 1H (**H**$_{\textbf{Aromatic}}$)), 6.83 (d, *J* = 15.6 Hz, 1H (**H7**)), 6.49 – 6.34 (m, 1H (**H8**)), 2.18 (dd, *J* = 8.3, 1.4 Hz, 2H (**H9**)), 0.55 (s, 6H (**H10**)).
All spectral data in accordance with literature.[117]

[(*E*)-3-(4-Methoxyphenyl)allyl]-dimethyl-phenyl-silane – 225c



225c

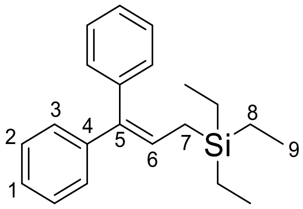


226c

The title compound was prepared according to general procedure **F**, from (*E*)-3-(dimethyl(phenyl)silyl)-1-(4-methoxyphenyl)prop-2-en-1-ol (90 mg, 302 μmol) and dimethylphenylsilane (139 μL, 905 μmol) using triflimide (302 μL, 0.05 M in DCM, 5.0 mol%) and 1,3,5-trimethoxybenzene (6 mg, 35.1 μmol). Following conversion to product (78:22 **225c**:**226c**), afforded **225c** in 22% quantitative NMR yield.

^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.46 – 7.33 (m, 4H (**H**$_{\textbf{Aromatic}}$)), 7.17 – 7.03 (m, 5H (**H**$_{\textbf{Aromatic}}$)), 6.88 (d, J = 15.8 Hz, 1H (**H6**)), 6.48 (dt, *J* = 16.0, 8.0 Hz, 1H (**H7**)), 4.01 (s, 3H (**H1**)), 2.20 (dd, *J* = 8.2, 1.4 Hz, 2H (**H8**)), 0.60 (s, 6H (**H9**)).
All spectral data in accordance with literature.[207]

3,3-Diphenylallyl(triethyl)silane – 227a



The title compound was prepared according to general procedure **F**, from (*E*)-1,1-diphenyl-3-triethylsilyl-prop-2-en-1-ol (100 mg, 308 μmol) and triethylsilane (148 μL, 924 μmol) using triflimide (308 μL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product and column chromatography [SiO$_2$; 100% Petroleum ether] afforded **227a** (60 mg, 63%) as a yellow oil.

$\boldsymbol{R_f}$ = 0.71 [100% Hexane].

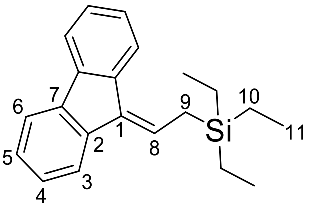
^{1}**H NMR**: (400 MHz, CDCl$_3$) δ 7.44 – 7.40 (m, 2H (**H**$_{\textbf{Aromatic}}$)), 7.36 – 7.33 (m, 2H (**H**$_{\textbf{Aromatic}}$)), 7.30 – 7.26 (m, 3H (**H**$_{\textbf{Aromatic}}$)), 7.25 – 7.23 (m, 4H (**H**$_{\textbf{Aromatic}}$)), 6.22 (t, *J* = 8.8 Hz, 1H (**H6**)), 1.75 (d, *J* = 8.8 Hz, 2H (**H7**)), 0.93 (t, *J* = 7.9 Hz, 9H (**H9**)), 0.59 (q, *J* = 7.6 Hz, 6H (**H8**)).

^{13}**C NMR**: (101 MHz, CDCl$_3$) δ 143.7 (**C5**), 140.6 (**C4**), 139.5 (**C4**), 130.5 (**C**$_{\textbf{Aromatic}}$), 128.4 (**C**$_{\textbf{Aromatic}}$), 128.2 (**C**$_{\textbf{Aromatic}}$), 127.0 (**C**$_{\textbf{Aromatic}}$), 126.8 (**C6**), 126.7 (**C1**), 126.4 (**C1**), 16.1 (**C7**), 7.5 (**C8**), 3.6 (**C9**).

IR: ν_{max} (neat/cm^{-1}) 3078 (C-H), 3024 (C-H), 2950 (C-H), 2873 (C-H), 1664 (C=C).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for C$_{21}$H$_{29}$Si 309.1956; found 309.1994.

Triethyl(2-fluoren-9-ylideneethylsilane – 227b



The title compound was prepared according to general procedure **F**, from 9-[(*E*)-2-triethylsilylvinyl]fluoren-9-ol (300 mg, 930 μmol) and triethylsilane (446 μL, 2.79 mmol) using triflimide (930 μL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product and column chromatography [SiO$_2$; 100% Petroleum ether] afforded **227b** (217 mg, 76%) as a yellow oil.

$\boldsymbol{R_f}$ = 0.63 [100% Hexane].

^{1}**H NMR**: (400 MHz, CDCl$_3$) δ 7.96 – 7.94 (m, 1H (**H**$_{\textbf{Aromatic}}$)), 7.81 – 7.78 (m, 1H (**H**$_{\textbf{Aromatic}}$)), 7.76 – 7.73 (m, 1H (**H**$_{\textbf{Aromatic}}$)), 7.66 – 7.64 (m, 1H (**H**$_{\textbf{Aromatic}}$)), 7.37 –

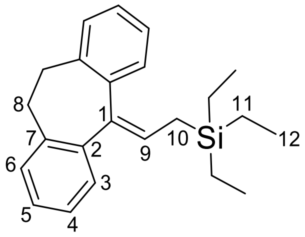
7.28 (m, 4H (**H**$_{\textbf{Aromatic}}$)), 6.94 (t, *J* = 9.8 Hz, 1H (**H8**)), 2.45 (d, *J* = 9.9 Hz, 2H (**H9**)), 0.99 (t, *J* = 7.9 Hz, 9H (**H11**)), 0.66 (q, *J* = 7.9 Hz, 6H (**H10**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 140.4 (**C1**), 139.8 (**C2**), 138.0 (**C2**), 137.7 (**C7**), 132.4 (**C7**), 129.7 (**C**$_{\textbf{Aromatic}}$), 126.9 (**C8**), 126.6 (**C**$_{\textbf{Aromatic}}$), 126.6 (**C**$_{\textbf{Aromatic}}$), 126.5 (**C**$_{\textbf{Aromatic}}$), 124.4 (**C**$_{\textbf{Aromatic}}$), 119.7 (**C**$_{\textbf{Aromatic}}$), 119.4 (**C**$_{\textbf{Aromatic}}$), 119.0 (**C**$_{\textbf{Aromatic}}$), 18.4 (**C9**), 7.5 (**C10**), 3.7 (**C11**).

IR: ν_{max} (neat/cm^{-1}) 3058 (C-H), 2950 (C-H), 2873 (C-H), 1636 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{27}Si$ 307.1837; found 307.1877.

Triethyl-[2-(2-tricyclo[9.4.0.0^^{208}]pentadeca-1(11),3(8),4,6,12,14-hexaenylidene)ethyl]silane – 227c



The title compound was prepared according to general procedure **F**, from 2-[(*E*)-2-triethylsilylvinyl]tricyclo[9.4.0.03,8]pentadeca-1(11),3,5,7,12,14-hexaen-2-ol (100 mg, 285 µmol) and triethylsilane (137 µL, 856 µmol) using triflimide (285 µL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% Petroleum ether] afforded **227c** (85 mg, 89%) as a yellow oil.

R$_f$ = 0.64 [100% Pentane].

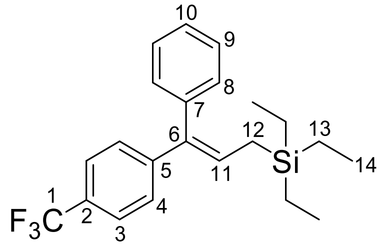
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.28 – 7.27 (m, 1H (**H**$_{\textbf{Aromatic}}$)), 7.21 – 7.17 (m, 4H (**H**$_{\textbf{Aromatic}}$)), 7.14 – 7.11 (m, 2H (**H**$_{\textbf{Aromatic}}$)), 7.05 – 7.02 (m, 1H (**H**$_{\textbf{Aromatic}}$)), 5.93 (t, *J* = 8.7 Hz, 1H (**H9**)), 3.44 – 3.30 (m, 2H (**H8**)), 2.98 – 2.29 (m, 2H (**H8**)), 1.74 – 1.58 (m, 2H (**H10**)), 0.87 (t, *J* = 7.9 Hz, 9H (**H12**)), 0.54 (q, *J* = 7.6 Hz, 6H (**H11**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 142.2 (**C1**), 140.3 (**C2**), 140.1 (**C2**), 139.9 (**C7**), 137.2 (**C7**), 130.1 (**C**$_{\textbf{Aromatic}}$), 128.8 (**C**$_{\textbf{Aromatic}}$), 128.8 (**C**$_{\textbf{Aromatic}}$), 128.6 (**C**$_{\textbf{Aromatic}}$), 128.3 (**C**$_{\textbf{Aromatic}}$), 127.2 (**C**$_{\textbf{Aromatic}}$), 126.7 (**C9**), 126.1 (**C**$_{\textbf{Aromatic}}$), 125.8 (**C**$_{\textbf{Aromatic}}$), 34.0 (**C8**), 32.3 (**C8**), 15.2 (**C10**), 7.5 (**C11**), 3.6 (**C12**).

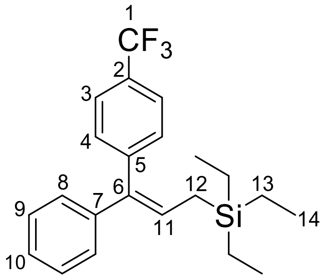
IR: ν_{max} (neat/cm^{-1}) 3058 (C-H), 2950 (C-H), 2873 (C-H), 1597 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{30}Si$ 335.2112; found 335.2150.

Triethyl-[(*E*)-3-phenyl-3-[4-(trifluoromethyl)phenyl]allyl]silane – (*E*)-**227d** and **Triethyl-[(*Z*)-3-phenyl-3-[4-(trifluoromethyl)phenyl]allyl]silane –** (*Z*)-**227d**



(*E*)-227d



(*Z*)-227d

The title compound was prepared according to general procedure **F**, from (*E*)-1-phenyl-3-triethyl-1-[4-(trifluoromethyl)phenyl]prop-2-en-1-ol (70 mg, 178 μmol) and triethylsilane (85.4 μL, 535 μmol) using triflimide (178 μL, 0.05 M in DCM, 5.0 mol%). Following the conversion to products (*E*)-**227d** and (*Z*)-**227d** in an *E*/*Z* ratio 38:62, column chromatography [SiO_2; 100% Petroleum ether] afforded (*E*)-**227d** and (*Z*)-**227d** (58 mg, 86%) as a yellow oil.

R_f = 0.90 [100% Hexane].

Minor (*E*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 8.2 Hz, 2H (**H3**)), 7.39 (ddd, *J* = 7.5, 4.4, 1.3 Hz, 2H (**H9**)), 7.33 – 7.29 (m, 1H (**H10**)), 7.26 (d, *J* = 8.0 Hz, 2H (**H4**)), 7.17 (dd, *J* = 8.2, 1.3 Hz, 2H (**H8**)), 6.25 (t, *J* = 8.8 Hz, 1H (**H11**)), 1.71 (d, *J* = 8.9 Hz, 2H (**H12**)), 0.89 (t, *J* = 7.9 Hz, 9H (**H14**)), 0.53 (q, *J* = 7.7 Hz, 6H (**H13**)).

Minor (*E*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 146.9 (**C5**), 139.6 (**C7**), 138.2 (**C6**), 130.2 (**C8**), 129.2 (**C11**), 128.8 (*J* = 32.2 Hz (**C2**)), 128.5 (**C9**), 127.0 (**C10**), 126.9 (q, *J* = 3.8 Hz (**C3**)), 125.0 (**C4**), 124.4 (q, *J* = 271.8 Hz (**C1**)), 16.4 (**C12**), 7.3 (**C13**), 3.4 (**C14**).

Minor (*E*) ^{19}F NMR: (376 MHz, $CDCl_3$) δ −62.3.

Major (*Z*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 7.9 Hz, 2H (**H3**)), 7.33 (d, *J* = 7.9 Hz, 2H (**H4**)), 7.28 – 7.24 (m, 2H (**H9**)), 7.22 – 7.18 (m, 1H (**H10**)), 7.13 (dd, *J* = 8.3, 1.4 Hz, 2H (**H8**)), 6.22 (t, *J* = 8.9 Hz, 1H (**H11**)), 1.67 (d, *J* = 8.9 Hz, 2H (**H12**)), 0.87 (t, *J* = 7.9 Hz, 9H (**H14**)), 0.53 (q, *J* = 7.7 Hz, 6H (**H13**)).

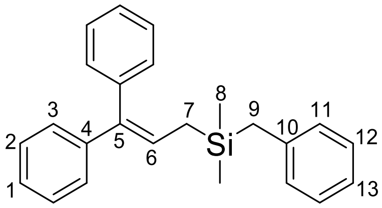
Major (*Z*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 144.4 (q, *J* = 1.5 Hz (**C5**)), 142.7 (**C7**), 138.1 (**C6**), 130.7 (**C4**), 128.8 (q, *J* = 34.1 Hz (**C2**)), 128.2 (**C9**), 128.0 (**C11**), 126.9 (**C8**), 126.7 (**C10**), 125.3 (q, J = 3.7 Hz (**C3**)), 124.4 (q, J = 271.9 Hz (**C1**)), 16.2 (**C12**), 7.3 (**C13**), 3.4 (**C14**).

Major (*Z*) ^{19}F NMR: (376 MHz, $CDCl_3$) δ −62.4.

IR: ν_{max} (neat/cm^{-1}) 2953 (C-H), 2875 (C-H), 1615 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{28}F_3Si$ 377.1830; found 377.1868.

Benzyl-(3,3-diphenylallyl)-dimethyl-silane – 227e



The title compound was prepared according to general procedure **F**, from (*E*)-3-[benzyl(dimethyl)silyl]-1,1-diphenyl-prop-2-en-1-ol (152 mg, 424 μmol) and dimethylbenzylsilane (201 μL, 1.27 mmol) using triflimide (424 μL, 0.05 M in DCM, 5.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% Petroleum ether] afforded **227e** (105 mg, 72%) as a yellow oil.

R$_f$ = 0.74 [100% Hexane].

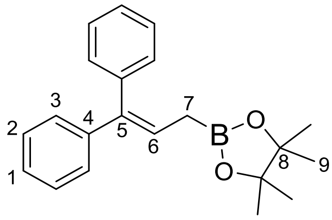
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.40 (tt, J = 8.1, 1.6 Hz, 2H (**H$_{Aromatic}$**)), 7.34 – 7.25 (m, 3H (**H$_{Aromatic}$**)), 7.23 – 7.17 (m, 7H (**H$_{Aromatic}$**)), 7.11 – 7.07 (m, 1H (**H$_{Aromatic}$**)), 6.95 (dd, J = 7.8, 0.9 Hz, 2H (**H$_{Aromatic}$**)), 6.13 (t, J = 8.8 Hz (**H6**)), 2.11 (s, 2H (**H7**)), 1.71 (d, J = 8.8 Hz (**H9**)), 0.01 (s, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.4 (**C5**), 140.5 (**C4**), 140.2 (**C4**), 140.0 (**C10**), 130.4 (**C$_{Aromatic}$**), 128.4 (**C$_{Aromatic}$**), 128.4 (**C$_{Aromatic}$**), 128.2 (**C$_{Aromatic}$**), 128.2 (**C$_{Aromatic}$**), 127.1 (**C$_{Aromatic}$**), 126.8 (**C$_{Aromatic}$**), 126.6 (**C$_{Aromatic}$**), 126.0 (**C$_{Aromatic}$**), 124.2 (**C6**), 25.6 (**C7**), 19.4 (**C9**), −3.3 (**C8**).

IR: ν_{max} (neat/cm^{-1}) 3058 (C-H), 2953 (C-H), 2892 (C-H), 1597 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{24}H_{27}Si$ 343.1837; found 343.1877.

2-(3,3-Diphenylallyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane – 227f



The title compound was prepared according to general procedure **F**, from (*E*)-1,1-diphenyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)prop-2-en-ol (76 mg, 226 μmol) and triethylsilane (108 μL, 678 μmol) using triflimide (226 μL, 0.05 M in DCM, 5.0 mol%) and mesitylene (10 mg, 83.2 μmol), afforded **227f** (40%, NMR yield).

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.41 – 7.18 (m, 10H (**H1**, **H2** and **H3**), 6.33 (t, *J* = 8.3 Hz, 1H (**H6**)), 1.85 (d, *J* = 8.3 Hz, 2H (**H7**)), 1.32 (s, 12H (**H9**)).

All spectral data in accordance with literature.[209]

7.3 Chapter 3 – Experimental

7.3.1 Structural Assignment of Isomers

Assignment of the *E*/*Z* 1,2-substituted alkenes is readily done by extracting the $^3J_{HH}$ across the double bond from the corresponding 1D proton NMR spectrum. While the exact same method cannot be used for tri-substituted alkenes, the $^3J_{CH}$ couplings can be used in a comparable manner i.e. $^3J_{CH,trans} > {}^3J_{CH,cis}$.[158]

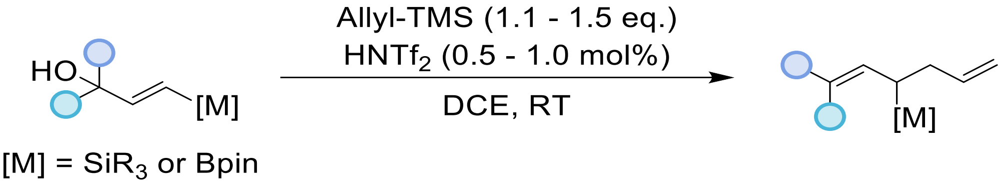
In particular, 2D proton-selective HSQMBC experiments were used using a literature sequence employing a Zero Quantum Filter (ZQF).[159] Generally, a 100-200 Hz Rsnob pulse was sufficient to achieve the required proton selectivity, and acquisition times of 1 s in the direct dimension to ensure the signals were properly defined.

Olefinic protons adjacent to CH's gave simple double doublets with $^3J_{HH} > {}^3J_{CH}$ (**237d**, **237e**, **237f**, **237g**, **237k**, **237l**), so in-phase data was sufficient to extract the individual couplings. For the compounds measured here, $^3J_{CH,trans}$ was in the range 7.9 –9.3 Hz, while $^3J_{CH,cis}$ was 5.7 – 6.3 Hz. Where possible, 1D selective NOESY experiments were used to validate the *E*/*Z* assignments from $^3J_{CH}$ measurements.

Many of the tri-substituted alkenes formed inseparable mixtures of *E*/*Z* isomers with very similar ^{1}H and ^{13}C chemical shifts. For this reason, it was necessary to use acquisition times in the indirect dimension of up to 200 ms, or a nominal resolution of 5 Hz prior to further processing. Various combinations of aliasing, F1 band-selection and increased numbers of increments were used to achieve the required resolution without the need to run excessively long experiments. In addition, $^{1}H,^{19}F$-HMBC and $^{1}H,^{29}Si$-HMBC experiments were used to aid in assignments as required.

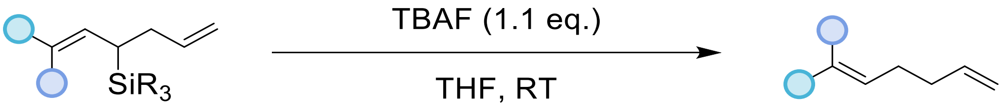
7.3.2 General Procedures

7.3.2.1 General Procedure A – Synthesis of Allylsilanes/boranes



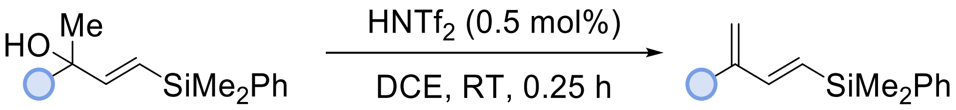
To a solution of vinylsilane/borane in DCE (0.5 M) was added trimethylallylsilane (1.1 – 1.5 eq.) and HNTf$_2$ (0.5 - 1.0 mol%, 0.01 M solution in DCM). This solution was stirred at room temperature. Upon completion, the reaction was quenched with K$_2$CO$_3$ (1 eq.) and reduced under vacuum. The residue was then purified via column chromatography to afford the corresponding (*E*)-allylsilane/borane.

7.3.2.2 General Procedure B – Synthesis of 1,5-Dienes



To a solution of allylsilane in THF (0.25 M) was added TBAF (1.1 eq., 1 M in THF). This solution was stirred at room temperature for 15 minutes. After this time, the reaction was quenched with water, washed with brine, and extracted with diethyl ether. The residue was then purified via column chromatography to afford the corresponding 1,5-diene.

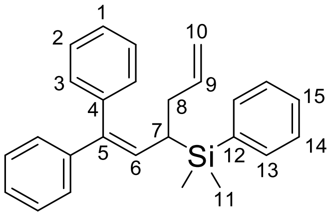
7.3.2.3 General Procedure C – Synthesis of 1,3-Dienes



To a solution of vinylsilane in DCE (0.5 M) was added $HNTf_2$ (0.5 mol%, 0.01 M solution in DCM). This solution was stirred at room temperature for 15 minutes. After this time, the reaction was quenched with K_2CO_3 (1 eq.) and reduced under vacuum. The residue was then purified via column chromatography to afford the corresponding 1,3-diene.

7.3.3 Allylsilanes/boranes

1-(2,2-Diphenylvinyl)but-3-enyl-dimethyl-phenyl-silane – 237a



The title compound was prepared according to general procedure **A**, from (*E*)-3-(dimethyl(phenyl)silyl)-1,1-diphenylprop-2-en-1-ol (50 mg, 145 µmol) and allyltrimethylsilane (30 µL, 160 µmol) using triflimide (730 µL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product and work-up afforded **237a** (50 mg, 93%) as a yellow oil.

$\boldsymbol{R_f}$ = 0.78 [9:1 Hexane:EtOAc].

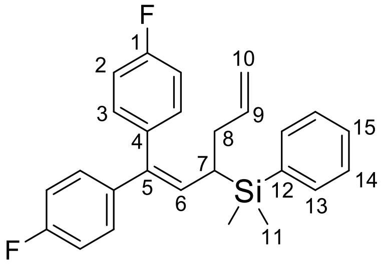
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.42 (dd, *J* = 7.6, 1.7 Hz, 2H ($\mathbf{H_{Aromatic}}$)), 7.37 – 7.31 (m, 3H ($\mathbf{H_{Aromatic}}$)), 7.31 – 7.25 (m, 3H ($\mathbf{H_{Aromatic}}$)), 7.22 (dd, *J* = 7.4 Hz, 2H ($\mathbf{H_{Aromatic}}$)), 7.18 (d, *J* = 7.0 Hz, 1H) ($\mathbf{H_{Aromatic}}$), 7.13 (dd, *J* = 8.2, 1.4 Hz, 1H ($\mathbf{H_{Aromatic}}$)), 6.98 (dd, *J* = 7.9, 1.6 Hz, 2H ($\mathbf{H_{Aromatic}}$)), 5.86 (d, *J* = 11.5 Hz, 1H (**H6**)), 5.82 – 5.74 (m, 1H (**H9**)), 4.96 – 4.91 (m, 2H (**H10**)), 2.30 – 2.25 (m, 1H (**H8**)), 2.19 – 2.08 (m, 2H (**H7** and **H8**)), 0.29 (s, 3H (**H11**)), 0.27 (s, 3H (**H11**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.4 (**C5**), 140.6 (**C4**), 140.5 (**C4**), 139.1 (**C9**), 137.5 (**C12**), 134.2 ($\mathbf{C_{Aromatic}}$), 131.1 (**C6**), 130.3 ($\mathbf{C_{Aromatic}}$), 129.2 ($\mathbf{C_{Aromatic}}$), 128.2 ($\mathbf{C_{Aromatic}}$), 128.1 ($\mathbf{C_{Aromatic}}$), 127.9 ($\mathbf{C_{Aromatic}}$), 127.1 ($\mathbf{C_{Aromatic}}$), 126.7 ($\mathbf{C_{Aromatic}}$), 126.6 ($\mathbf{C_{Aromatic}}$), 115.0 (**C10**), 34.9 (**C8**), 31.1 (**C7**), −4.0 (**C11**), −4.5 (**C11**).

IR: ν_{max} (neat/cm^{-1}) 3054 (C-H), 2953 (C-H), 2853 (C-H), 1597 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M-H]^-$ Calcd for $C_{26}H_{27}Si$ 367.1877; found 367.1888.

1-[2,2-Bis(4-fluorophenyl)vinyl]but-3-enyl-dimethyl-phenyl-silane – 237b



The title compound was prepared according to general procedure **A**, from (*E*)-3-[dimethyl(phenyl)silyl]-1,1-bis(4-flurophenyl)prop-2-en-1-ol (100 mg, 263 μmol) and allyltrimethylsilane (46 μL, 289 μmol) and triflimide (130 μL, 0.01 M in DCM, 0.5 mol %). Following the conversion to product and work-up afforded **237b** (104 mg, 98%) as a colourless oil.

R_f = 0.69 [19:1 Hexane/EtOAc].

^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.42 – 7.39 (m, 2H (**H13**)), 7.38 – 7.34 (m, 2H (**H14**)), 7.33 – 7. 31 (m, 1H (**H15**)), 7.08 – 7.02 (m, 2H (**H3**)), 6.98 – 6.89 (m, 4H (**H2**)), 6.88 – 6.83 (m, 2H (**H3**)), 5.82 – 5.72 (m, 1H (**H9**)), 5.77 (d, *J* = 11.8 Hz, 1H (**H6**)), 4.97 – 4.96 (m, 1H (**H10**)), 4.93 (m, 1H (**H10**)), 2.32 – 2.26 (m, 1H (**H8**)), 2.19 – 2.11 (m, 1H (**H8**)), 2.05 (td, *J* = 11.4, 3.2 Hz, 1H (**H7**)), 0.29 (s, 3H (**H11**)), 0.28 (s, 3H (**H11**)).

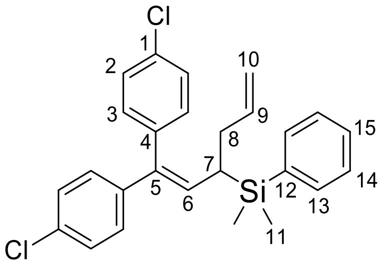
^{13}C NMR: (101 MHz, CDCl$_3$) δ 162.0 (d, *J* = 245.9 Hz (**C1**)), 161.8 (d, *J* = 245.6 Hz (**C1**)), 139.3 (d, *J* = 2.8 Hz (**C4**)), 138.9 (**C9**), 138.6 (**C5**), 137.3 (**C12**), 136.2 (d, *J* = 3.3 Hz (**C4**)), 134.2 (**C13**), 131.7 (d, *J* = 7.9 Hz (**C3**)), 131.4 (**C6**), 129.3 (**C15**), 128.5 (d, *J* = 7.8 Hz (**C3**)), 127.9 (**C14**), 115.2 (d, *J* = 21.3 Hz (**C2**)), 115.2 (**C10**), 115.0 (d, *J* = 21.4 Hz (**C2**)), 34.8 (**C8**), 31.3 (**C7**), −4.3 (**C11**), −4.4 (**C11**).

^{19}F NMR: (376 MHz, CDCl$_3$) δ −115.8, −116.4.

IR: ν_{max} (cm^{-1}) 3069 (C-H), 2920 (C-H), 2946 (C-H), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: [M-H]$^-$ Calcd for C$_{26}$H$_{25}$F$_2$Si 403.1688; found 403.1699.

1-[2,2-Bis(4-chlorophenyl)vinyl]but-3-enyl-dimethyl-phenyl-silane – 237c



The title compound was prepared according to general procedure **A**, from (*E*)-1,1-bis(4-chlorophenyl)-3-[dimethyl(phenyl)silyl]prop-2-en-1-ol (100 mg, 242 μmol) and allyltrimethylsilane (40 μL, 266 μmol) and triflimide (120 μL, 0.01 M in DCM, 0.5 mol %). Following the conversion to product and work-up afforded **237c** (103 mg, 97%) as a colourless oil.

R_f = 0.69 [19:1 Hexane/EtOAc].

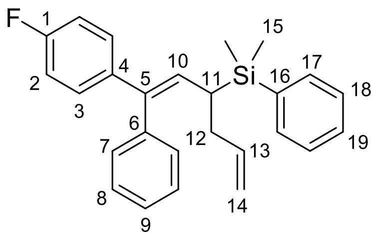
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.43 – 7.31 (m, 5H (**H13**, **H14** and **H15**)), 7.24 (d, *J* = 8.5 Hz, 2H (**H2**)), 7.19 (d, *J* = 8.7 Hz, 2H (**H2**)), 7.00 (d, *J* = 8.7 Hz, 2H (**H3**)), 6.80 (d, *J* = 8.5 Hz, 2H (**H3**)), 5.83 (d, *J* = 11.9 Hz, 1H (**H6**)), 5.80 – 5.70 (m, 1H (**H9**)), 4.97 – 4.96 (m, 1H (**H10**)), 4.94 – 4.92 (m, 1H (**H10**)), 2.33 – 2.27 (m, 1H (**H8**)), 2.20 – 2.12 (m, 1H (**H8**)), 2.07 – 2.01 (m, 1H (**H7**)), 0.29 (s, 3H (**H11**)), 0.29 (s, 3H (**H11**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 141.3 (**C5**), 138.8 (**C9**), 138.5 (**C4**), 138.3 (**C4**), 137.1 (**C12**), 134.2 (**C13**), 132.7 (**C1**), 132.6 (**C1**), 132.3 (**C6**), 131.6 (**C3**), 129.4 (**C14**), 128.6 (**C3**), 128.4 (**C2**), 128.2 (**C2**), 127.9 (**C14**), 115.3 (**C10**), 34.8 (**C8**), 31.6 (**C7**), −4.3 (**C11**), −4.4 (**C11**).

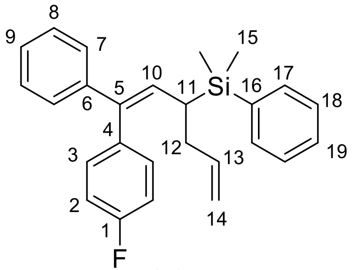
IR: ν_{max} (cm^{-1}) 3067 (C-H), 2918 (C-H), 1618 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{26}H_{27}Cl_2Si$ 437.1068; found 437.1254.

1-[2-(4-Fluorophenyl)2-phenyl-vinyl]but-3-enyl-dimethyl-phenyl-silane – 237d



(*E*)-237d



(*Z*)-237d

The title compound was prepared according to general procedure **A**, from (*E*)-3-[dimethyl(phenyl)silyl]-1-(4-fluorophenyl)-1-phenyl-prop-2-en-1-ol (100 mg, 276 μmol) and allyltrimethylsilane (48.2 μL, 303 μmol) using triflimide (55 μL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product (*E*/*Z* 62:38), and work-up afforded (*E*)-**237d** and (*Z*)-**237d** (99 mg, 93%) as a yellow oil.

R_f = 0.65 [100% Hexane].

Major (*E*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.46 – 7.43 (m, 2H (**H17**)), 7.40 – 7.27 (m, 6H (**H9**, **H8**, **H18** and **H19**)), 7.16 – 7.09 (m, 2H (**H3**)), 7.01 – 6.90 (m, 4H (**H2** and **H7**)), 5.87 – 5.76 (m, 1H (**H13**)), 5.80 (d, *J* = 11.3 Hz, 1H (**H10**)), 5.00 – 4.98 (m, 1H (**H14**)), 4.96 – 4.95 (m, 1H (**H14**)), 2.35 – 2.29 (m, 1H (**H12**)), 2.24 – 2.07 (m, 2H (**H11** and **H12**)), 0.32 (s, 3H (**H15**)), 0.30 (s, 3H (**H15**)).

Major (*E*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 161.8 (d, *J* = 245.6 Hz (**C1**), 140.3 (**C6**), 139.4 (**C13**), 139.4 (d, *J* = 3.1 Hz (**C4**)), 138.9 (**C5**), 137.3 (**C16**), 134.1 (**C17**), 130.1 (**C7**), 130.8 (**C10**), 129.2 (**C19**), 128.4 (d, *J* = 8.1 Hz (**C3**)), 128.2 (**C8**), 127.8 (**C18**), 126.7 (**C9**), 115.0 (**C14**), 114.7 (d, *J* = 20.3 Hz (**C2**)), 34.8 (**C12**), 31.0 (**C11**), −4.1 (**C15**), −4.6 (**C15**).

Major (*E*) ^{19}F NMR: (376 MHz, $CDCl_3$) δ −116.6.

Minor (*Z*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.46 – 7.43 (m, 2H (**H17**)), 7.40 – 7.27 (m, 5H (**H8**, **H18** and **H19**)), 7.26 – 7.21 (m, 1H (**H9**)), 7.16 – 7.09 (m, 2H (**H7**)), 7.01 – 6.90 (m, 4H (**H2** and **H3**)), 5.90 (d, *J* = 11.7 Hz, 1H (**H10**)), 5.87 – 5.76 (m, 1H (**H13**)), 5.00 – 4.98 (m, 1H (**H14**)), 4.96 – 4.95 (m, 1H (**H14**)), 2.35 – 2.29 (m, 1H (**H12**)), 2.24 – 2.07 (m, 2H (**H11** and **H12**)), 0.33 (s, 3H (**H15**)), 0.31 (s, 3H (**H15**)).

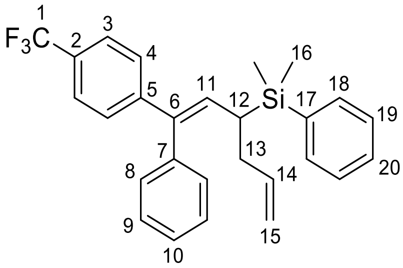
Minor (*Z*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 161.7 (d, *J* = 245.6 Hz (**C1**)), 143.1 (**C6**), 139.4 (**C5**), 138.9 (**C13**), 137.2 (**C16**), 136.3 (d, *J* = 3.3 Hz (**C4**)), 134.1 (**C17**), 131.7 (d, *J* = 7.8 Hz (**C3**)), 131.4 (**C10**), 129.2 (**C19**), 128.1 (**C8**), 127.8 (**C18**), 126.9 (**C7**), 126.6 (**C9**), 115.0 (d, *J* = 20.9 Hz (**C2**), 114.9 (**C14**), 34.8 (**C12**), 31.3 (**C11**), −4.3 (**C15**), −4.6 (**C15**).

Minor (*Z*) ^{19}F NMR: (376 MHz, $CDCl_3$) δ −116.0.

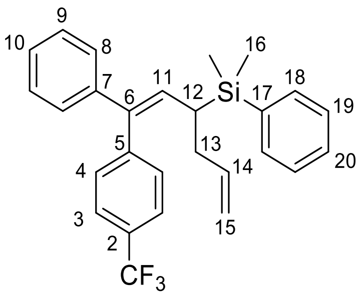
IR: ν_{max} (neat/cm^{-1}) 3069 (C-H), 2955 (C-H), 2905 (C-H), 1600 (C=C).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{26}H_{28}FSi$ 387.1862; found 387.1900.

Dimethyl-phenyl-[1-[2-phenyl-2-[4-(trifluoromethyl)phenyl]vinyl]but-3-enyl]silane – 237e



(*E*)-237e



(*Z*)-237e

The title compound was prepared according to general procedure **A**, from (*E*)-3-[dimethyl(phenyl)silyl-1-phenyl-1-[4-(trifluoromethyl)phenyl]prop-2-en-1-ol (39 mg, 94.3 μmol) and allyltrimethylsilane (16.5 μL, 104 μmol) using triflimide (47.1 μL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product (*E*/*Z* 12:88), and work-up afforded (*E*)-**237e** and (*Z*)-**237e** (35 mg, 85%) as a yellow oil.

R_f = 0.38 [19:1 Hexane:EtOAc].

Major (*Z*) ^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.54 (d, *J* = 7.9 Hz, 2H (**H3**)), 7.42 (dd, *J* = 7.8, 1.6 Hz, 2H (**H18**)), 7.39 – 7.37 (m, 1H (**H20**)), 7.35 (d, *J* = 7.2 Hz, 2H (**H19**)), 7.33 – 7.28 (m, 2H (**H9**)), 7.26 (d, *J* = 7.2 Hz, 1H (**H10**)), 7.12 – 7.10 (m, 2H (**H8**)), 7.03 (d, *J* = 7.8 Hz, 2H (**H4**)), 5.94 (d, *J* = 12.1 Hz, 1H (**H11**)), 5.86 – 5.76 (m, 1H (**H14**)), 5.01 – 4.99 (m, 1H (**H15**)), 4.98 – 4.96 (m, 1H (**H15**)), 2.37 – 2.30 (m, 1H (**H13**)), 2.25 – 2.16 (m, 1H (**H13**)), 2.06 (ddd, *J* = 12.1, 11.1, 3.3 Hz, 1H (**H12**)), 0.33 (s, 3H (**H16**)), 0.32 (s, 3H (**H16**)).

Major (*Z*) ^{13}C NMR: (101 MHz, CDCl$_3$) δ 144.3 (q, *J* = 1.5 Hz (**C5**)), 142.5 (**C7**), 139.2 (**C6**), 138.7 (**C14**), 137.0 (**C17**), 134.1 (**C18**), 132.1 (**C7**), 130.5 (**C4**), 129.3 (**C20**), 128.7 (q, *J* = 32.2 Hz (**C2**)), 128.2 (**C9**), 127.8 (**C19**), 126.9 (**C8**), 126.9 (**C10**), 125.1 (q, *J* = 3.9 Hz (**C3**)), 124.4 (q, *J* = 271.9 Hz (**C1**)), 115.2 (**C15**), 34.7 (**C13**), 31.4 (**C12**), −4.5 (**C16**), −4.5 (**C16**).

Major (*Z*) ^{19}F NMR: (376 MHz, CDCl$_3$) δ −62.3.

Minor (*E*) ^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.49 (d, *J* = 8.1 Hz, 2H (**H3**)), 7.42 (dd, *J* = 7.8, 1.6 Hz, 2H (**H18**)), 7.39 – 7.37 (m, 1H (**H20**)), 7.35 (d, *J* = 7.2 Hz, 2H (**H19**)), 7.33 – 7.28 (m, 3H (**H9** and **H10**)), 7.26 (d, *J* = 7.2 Hz, 2H (**H4**)), 6.96 (d, *J* = 7.7 Hz, 2H (**H8**)), 5.96 (d, *J* = 11.6 Hz, 1H (**H11**)), 5.86 – 5.76 (m, 1H (**H14**)), 5.01 – 4.99 (m, 1H (**H15**)), 4.98 – 4.96 (m, 1H (**H15**)), 2.37 – 2.30 (m, 1H (**H13**)), 2.25 – 2.16 (m, 1H (**H13**)), 2.06 (ddd, *J* = 12.1, 11.1, 3.3 Hz, 1H (**H12**)), 0.32 (s, 3H (**H16**)), 0.31 (s, 3H (**H16**)).

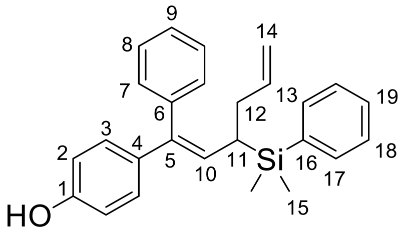
Minor (*E*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 146.6 (q, *J* = 2.1 Hz (**C5**)), 139.6 (**C7**), 139.3 (**C6**), 138.7 (**C14**), 137.0 (**C17**), 133.5 (**C11**), 130.1 (**C8**), 127.0 (**C10**), 127.0 (**C4**), 125.0 (q, *J* = 3.9 Hz, (**C3**)), 128.3 (**C9**), 115.1 (**C15**), 34.7 (**C13**), 31.4 (**C12**), −4.2 (**C16**), −4.2 (**C16**); **C1**, **C2**, **C18**, **C19** and **C20** carbon signals were not observed.

Minor (*E*) ^{19}F NMR: (376 MHz, $CDCl_3$) δ −62.3.

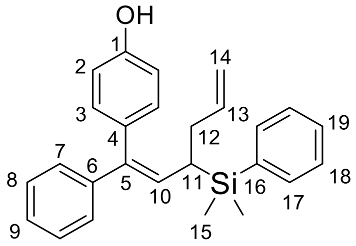
IR: ν_{max} (neat/cm^{-1}) 3065 (C-H), 2953 (C-H), 1604 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{27}H_{28}F_3Si$ 437.1830; found 437.1868.

4-[3-Dimethyl(phenyl)silyl]-1-phenyl-hexa-1,5-dienyl]phenol – 237f



(*E*)-237f



(*Z*)-237f

The title compound was prepared according to general procedure **A**, from 4-[(*E*)-3-dimethyl(phenyl)silyl-1-hydroxy-1-phenyl-allyl]phenol (200 mg, 555 µmol) and allyltrimethylsilane (97 µL, 610 µmol) using triflimide (277 µL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product (*E*/*Z* 75:25), and work-up afforded (*E*)-**237f** and (*Z*)-**237f** (175 mg, 82%) as a yellow oil.

R_f = 0.31 [19:1 Hexane:EtOAc].

Major (*E*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.42 (dd, *J* = 7.7, 1.8 Hz, 2H (**H18**)), 7.38 – 7.30 (m, 5H (**H8**, **H17** and **H19**), 7.28 (d, *J* = 7.2 Hz, 1H (**H9**)), 7.02 (d, *J* = 8.7 Hz, 2H (**H3**)), 6.98 (dd, *J* = 7.9, 1.6 Hz, 2H (**H7**), 6.70 (d, *J* = 8.7 Hz, 2H (**H2**)), 5.85 – 5.76 (m, 1H (**H13**)), 5.75 (d, *J* = 11.6 Hz, 1H (**H10**), 4.96 – 4.95 (m, 1H (**H14**)), 4.93 – 4.91 (m, 1H (**H14**)), 4.70 (s, 1H (**O-H**)), 2.30 – 2.25 (m, 1H (**H12**)), 2.18 – 2.05 (m, 2H (**H12** and **H11**)), 0.32 (s, 3H (**H15**)), 0.34 (s, 3H (**H15**)).

Major (*E*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 154.4 (**C1**), 140.7 (**C6**), 139.9 (**C5**), 139.1 (**C13**), 137.5 (**C16**), 136.1 (**C4**), 134.1 (**C18**), 130.2 (**C7**), 129.1 (**C19**), 129.1 (**C10**), 128.2 (**C3**), 128.1 (**C8**), 127.7 (**C17**), 126.5 (**C9**), 115.0 (**C2**), 114.8 (**C14**), 34.9 (**C12**), 31.0 (**C11**), −4.1 (**C15**), −4.6 (**C15**).

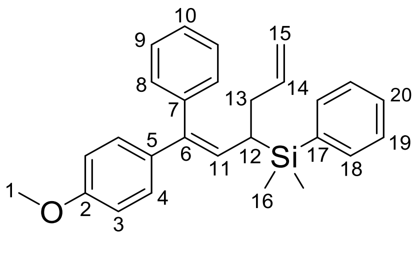
Minor (*Z*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.42 (dd, *J* = 7.7, 1.8 Hz, 2H (**H18**)), 7.41 – 7.21 (m, 8H (**H7**, **H8**, **H9**, **H17** and **H19**), 6.91 (d, *J* = 8.8 Hz, 2H (**H3**)), 6.81 (d, *J* = 8.6 Hz, 2H (**H2**)), 5.85 – 5.76 (m, 1H (**H13**)), 5.75 (d, *J* = 11.6 Hz, 1H (**H10**)), 4.96 – 4.95 (m, 1H (**H14**)), 4.93 – 4.91 (m, 1H (**H14**)), 4.71 (s, 1H (**O-H**)), 2.30 – 2.25 (m, 1H (**H12**)), 2.18 – 2.05 (m, 2H (**H12** and **H13**)), 0.33 (s, 3H (**H15**)), 0.35 (s, 3H (**H15**)).

Minor (*Z*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 154.6 (**C1**), 143.6 (**C6**), 140.0 (**C5**), 139.1 (**C13**), 137.4 (**C16**), 134.1 (**C18**), 132.8 (**C4**), 131.5 (**C3**), 130.1 (**C10**), 129.1 (**C19**), 128.1 (**C8**), 127.7 (**C17**), 127.0 (**C7**), 126.5 (**C9**), 115.1 (**C2**), 114.8 (**C14**), 34.8 (**C12**), 30.8 (**C11**), −4.1 (**C15**), −4.6 (**C15**).

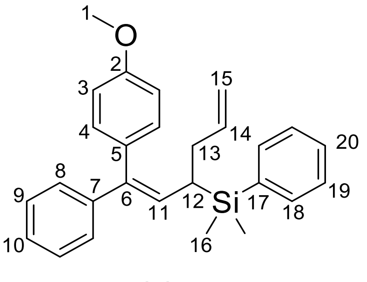
IR: ν_{max} (neat/cm^{-1}) 3529 (O-H), 2957 (C-H), 2901 (C-H), 1606 (C=C), 1246 (C-O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{26}H_{29}OSi$ 385.1982; found 385.1986.

1-[2-(4-Methoxyphenyl)-2-phenyl-vinyl]but-3-enyl-dimethyl-phenyl-silane – 237g



(*E*)-237g



(*Z*)-237g

The title compound was prepared according to general procedure **A**, from (*E*)-3-[dimethyl(phenyl)silyl]-1-(4-methoxyphenyl)-1-phenyl-prop-2-en-1-ol (250 mg, 667 μmol) and allyltrimethylsilane (117 μL, 734 μmol) using triflimide (334 μL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product (*E*/*Z* 80:20), and work-up afforded (*E*)-**237g** and (*Z*)-**237g** (186 mg, 80%) as a yellow oil.

R_f = 0.44 [19:1 Hexane:EtOAc].

Major (*E*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.6, 1.8 Hz, 2H (**H19**)), 7.42 – 7.33 (m, 3H (**H18** and **H20**)), 7.31 (d, *J* = 7.2 Hz, 2H (**H9**)), 7.26 – 7.21 (m, 1H (**H10**)), 7.10 (d, *J* = 8.9 Hz, 2H (**H4**)), 7.01 (dd, *J* = 8.0, 1.7 Hz, 2H (**H8**)), 6.81 (d, *J* = 8.8 Hz, 2H (**H3**)), 5.81 – 5.80 (m, 1H (**H14**)), 5.78 (d, *J* = 11.5 Hz, 1H (**H11**)), 4.99 – 4.97 (m, 1H (**H15**)), 4.95 – 4.94 (m, 1H (**H15**)), 3.81 (s, 3H (**H1**)), 2.33 –

2.27 (m, 1H (**H13**)), 2.21 – 2.08 (m, 2H (**H12** and **H13**)), 0.30 (s, 3H (**H16**)), 0.31 (s, 3H (**H16**)).

Major (*E*) ^{13}C NMR: (101 MHz, CDCl$_3$) δ 158.5 (**C2**), 140.7 (**C7**), 139.9 (**C6**), 139.0 (**C14**), 137.5 (**C17**), 136.1 (**C5**), 134.1 (**C19**), 130.2 (**C8**), 129.2 (**C11**), 129.0 (**C20**), 128.1 (**C9**), 128.0 (**C4**), 127.7 (**C18**), 126.5 (**C10**), 114.8 (**C15**), 113.5 (**C3**), 55.3 (**C1**), 34.9 (**C13**), 30.8 (**C12**), −4.1 (**C16**), −4.6 (**C16**).

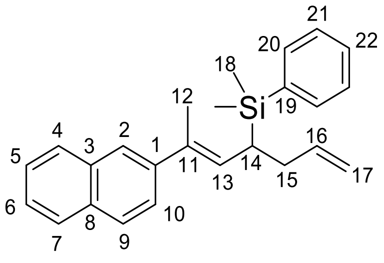
Minor (*Z*) ^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.45 (d, *J* = 7.6, 1.8 Hz, 2H (**H19**)), 7.42 – 7.33 (m, 3H (**H18** and **H20**)), 7.31 (d, *J* = 7.2 Hz, 2H (**H9**)), 7.26 – 7.21 (m, 1H (**H10**)), 7.17 (dd, *J* = 8.2, 1.5 Hz, 2H (**H8**)), 6.93 (d, *J* = 8.8 Hz, 2H (**H4**)), 6.86 (d, *J* = 8.7 Hz, 2H (**H3**)), 5.81 – 5.80 (m, 1H (**H14**)), 5.79 (d, *J* = 11.5 Hz, 1H (**H11**)), 4.99 – 4.97 (m, 1H (**H15**)), 4.95 – 4.94 (m, 1H (**H15**)), 3.81 (s, 3H (**H1**)), 2.33 – 2.27 (m, 1H (**H13**)), 2.21 – 2.08 (m, 2H (**H12** and **H13**)), 0.31 (s, 3H (**H16**)), 0.33 (s, 3H (**H16**)).

Minor (*Z*) ^{13}C NMR: (101 MHz, CDCl$_3$) δ 158.2 (**C2**), 143.6 (**C7**), 140.0 (**C6**), 139.0 (**C14**), 137.4 (**C17**), 134.1 (**C19**), 132.8 (**C5**), 131.3 (**C4**), 130.8 (**C11**), 129.0 (**C20**), 128.0 (**C9**), 127.7 (**C18**), 127.0 (**C8**), 126.4 (**C10**), 114.8 (**C15**), 113.4 (**C3**), 55.2 (**C1**), 34.8 (**C13**), 31.0 (**C12**), −4.1 (**C16**), −4.6 (**C16**).

IR: ν_{max} (neat/cm^{-1}) 3050 (C-H), 2921 (C-H), 1607 (C=C), 1245 (C-O).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{27}H_{31}OSi$ 399.2144; found 399.2148.

[(*E*)-1-Allyl-3-(2-naphthyl)but-2-enyl]-dimethyl-phenyl-silane – 237h



The title compound was prepared according to general procedure **A**, from (*E*)-4-[dimethyl(phenyl)silyl]-2-(2-naphthyl)but-3-en-2-ol (90 mg, 271 µmol) and allyltrimethylsilane (47.3 µL, 298 µmol) and triflimide (135 µL, 1.35 µmol, 0.01 M in DCM, 1.0 mol%). Following the conversion to product and column chromatography [SiO$_2$; 100% pentane] afforded **237h** (79 mg, 82%) as a colourless oil.

R$_f$ = 0.68 [19:1 Pentane:EtOAc].

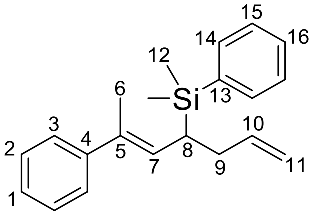
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.84 – 7.81 (m, 2H (**H$_{Aromatic}$**)), 7.78 (d, *J* = 8.7 Hz, 1H (**H$_{Aromatic}$**)), 7.72 (d, *J* = 1.5 Hz, 1H (**H2**)), 7.58 – 7.54 (m, 3H (**H$_{Aromatic}$**)), 7.48 – 7.43 (m, 2H (**H$_{Aromatic}$**)), 7.42 – 7.39 (m, 2H (**H$_{Aromatic}$**)), 7.38 – 7.36 (m, 1H (**H$_{Aromatic}$**)), 5.86 – 5.77 (m, 1H (**H16**)), 5.75 (dd, *J* = 11.0, 1.3 Hz, 1H (**H13**)), 5.00 (ddd, *J* = 17.0, 3.4, 1.5 Hz, 1H (**H17**)), 4.93 (ddt, *J* = 10.1, 2.1, 1.0 Hz, 1H (**H17**)), 2.44 – 2.37 (m, 1H (**H15**)), 2.32 (td, *J* = 11.0, 2.9 Hz, 1H (**H14**)), 2.24 – 2.15 (m, 1H (**H15**)), 1.96 (d, *J* = 1.3 Hz, 3H), 0.41 (s, 3H (**H18**)), 0.38 (s, 3H (**H18**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 141.6 (**C11**), 139.2 (**C16**), 137.7 (**C19**), 134.2 (**C21**), 133.7 (**C$_{Aromatic}$**), 132.9 (**C$_{Aromatic}$**), 132.4 (**C$_{Aromatic}$**), 131.0 (**C13**), 129.3 (**C$_{Aromatic}$**), 128.1 (**C$_{Aromatic}$**), 127.9 (**C20**), 127.6 (**C22**), 126.1 (**C$_{Aromatic}$**), 125.4 (**C$_{Aromatic}$**), 124.6 (**C$_{Aromatic}$**), 123.7 (**C2**), 114.6 (**C17**), 34.8 (**C15**), 30.6 (**C14**), 16.5 (**C12**), −4.1 (**C18**), −4.7 (**C18**).

IR: ν_{max} (neat/cm^{-1}) 3054 (C-H), 2912 (C-H), 2955 (C-H), 1627 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{25}H_{29}Si$ 357.1956; found 357.1994.

[(*E*)-1-Allyl-3-phenyl-but-2-enyl]-dimethyl-phenyl-silane – 237i



The title compound was prepared according to general procedure **A**, from (*E*)-4-(dimethyl(phenyl)silyl)-2-phenylbut-3-en-2-ol (150 mg, 535 µmol) and allyltrimethylsilane (127 µL, 797 µmol) using triflimide (531 µL, 0.01 M in DCM, 1.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% Hexane] afforded **237i** (109 mg, 67%) as a yellow oil.

R$_f$ = 0.75 [9:1 Hexane:EtOAc].

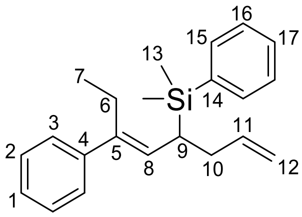
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.54 – 7.51 (m, 2H (**H$_{Aromatic}$**)), 7.40 – 7.27 (m, 7H (**H$_{Aromatic}$**)), 7.22 – 7.18 (m, 1H (**H$_{Aromatic}$**)), 5.79 – 5.70 (m, 1H (**H10**)), 5.56 (dd, *J* = 10.9, 1.3 Hz, 1H (**H7**)), 4.94 (ddd, *J* = 17.0, 3.4, 1.5 Hz, 1H (**H11**)), 4.88 (ddt, *J* = 10.1, 2.1, 1.1 Hz, 1H (**H11**)), 2.36 – 2.30 (m, 1H (**H9**)), 2.22 (td, *J* = 11.0, 2.8 Hz, 1H (**H8**)), 2.14 – 2.07 (m, 1H (**H9**)), 1.82 (d, *J* = 1.3 Hz, 3H (**H6**)), 0.35 (s, 3H (**H12**)), 0.32 (m, 3H (**H12**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 144.6 (**C5**), 139.2 (**C10**), 137.8 (**C13**), 134.2 ($\mathbf{C_{Aromatic}}$), 133.1 (**C4**), 130.2 (**C7**), 129.2 (**C1**), 128.2 ($\mathbf{C_{Aromatic}}$), 127.8 ($\mathbf{C_{Aromatic}}$), 126.3 (**C16**), 125.7 ($\mathbf{C_{Aromatic}}$), 114.5 (**C11**), 34.7 (**C9**), 30.4 (**C8**), 16.5 (**C6**), −4.1 (**C12**), −4.8 (**C12**).

IR ν_{max} (neat/cm^{-1}) 3069 (C-H), 3021 (C-H), 2953 (C-H), 1638 (C=C), 1597 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{26}Si$ 307.1799; found 307.1837.

[(*E*)-1-Allyl-3-phenyl-pent-2-enyl]dimethyl-phenyl-silane – 237j



The title compound was prepared according to general procedure **A**, from (*E*)-1-[dimethyl(phenyl)silyl]-3-phenyl-pent-1-en-3-ol (50 mg, 169 μmol) and allyltrimethylsilane (29.5 μL, 186 μmol) and triflimide (84.3 μL, 0.843 μmol, 0.01 M in DCM, 1.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% pentane] afforded **237j** (31 mg, 57%) as a colourless oil.

$\boldsymbol{R_f}$ = 0.50 [19:1 Pentane:EtOAc].

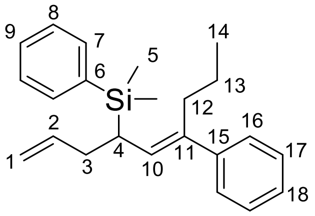
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.54 – 7.52 (m, 2H ($\mathbf{H_{Aromatic}}$)), 7.38 – 7.34 (m, 3H ($\mathbf{H_{Aromatic}}$)), 7.30 – 7.28 (m, 4H ($\mathbf{H_{Aromatic}}$)), 7.23 – 7.18 (m, 1H ($\mathbf{H_{Aromatic}}$)), 5.81 – 5.71 (m, 1H (**H11**)), 5.39 (d, *J* = 11.2 Hz, 1H (**H8**)), 4.95 (ddd, *J* = 17.0, 3.4, 1.4 Hz, 1H (**H12**)), 4.89 (ddt, *J* = 10.1, 2.1, 1.0 Hz, 1H (**H12**)), 2.40 – 2.30 (m, 2H (**H6**), 2.28 – 2.21 (m, 1H (**H10**)), 2.19 (td, *J* = 11.2, 2.6 Hz, 1H (**H9**)), 2.12 – 2.05 (m, 1H (**H10**)), 0.83 (t, *J* = 7.5 Hz, 3H (**H7**)), 0.35 (s, 3H (**H13**)), 0.32 (s, 3H (**H13**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.6 (**C5**), 140.4 (**C4**), 139.2 (**C11**), 137.8 (**C14**), 134.2 ($\mathbf{C_{Aromatic}}$), 129.4 (**C8**), 129.2 ($\mathbf{C_{Aromatic}}$), 128.2 ($\mathbf{C_{Aromatic}}$), 127.8 ($\mathbf{C_{Aromatic}}$), 126.5 ($\mathbf{C_{Aromatic}}$), 126.3 ($\mathbf{C_{Aromatic}}$), 114.5 (**C12**), 34.8 (**C10**), 30.0 (**C9**), 23.1 (**C7**), 13.2 (**C6**), −4.1 (**C13**), −4.8 (**C13**).

IR: ν_{max} (neat/cm^{-1}) 3069 (C-H), 2957 (C-H), 2853 (C-H), 1599 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{22}H_{29}Si$ 321.1956; found 321.1994.

[(*E*)-1-Allyl-3-phenyl-hex-2-enyl]-dimethyl-phenyl-silane – 237k



The title compound was prepared according to general procedure **A**, from (*E*)-1-[dimethyl(phenyl)silyl]-3-phenyl-hex-1-en-3-ol (100 mg, 322 µmol) and allyltrimethylsilane (56.3 µL, 354 µmol) and triflimide (161 µL, 1.61 µmol, 0.01 M in DCM, 1.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% pentane] afforded **237k** (68 mg, 63%) as a colourless oil.

$\boldsymbol{R_f}$ = 0.73 [100% Pentane].

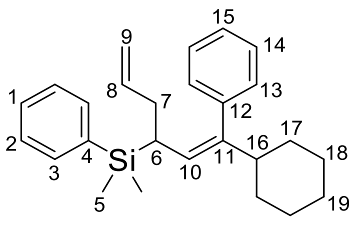
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.54 – 7.51 (m, 2H ($\mathbf{H_{Aromatic}}$)), 7.38 – 7.34 (m, 3H ($\mathbf{H_{Aromatic}}$)), 7.30 – 7.29 (m, 1H ($\mathbf{H_{Aromatic}}$)), 7.27 – 7.25 (m, 3H ($\mathbf{H_{Aromatic}}$)), 7.22 – 7.18 (m, 1H ($\mathbf{H_{Aromatic}}$)), 5.76 (ddt, *J* = 16.9, 10.0, 6.8 Hz, 1H (**H2**)), 5.41 (d, *J* = 11.1 Hz, 1H (**H10**)), 4.95 (ddd, *J* = 17.0, 3.4, 1.4 Hz, 1H (**H1**)), 4.89 (ddt, *J* = 10.1, 2.0, 0.9 Hz, 1H (**H1**)), 2.35 – 2.05 (m, 5H (**H3**, **H4** and **H12**)), 1.24 – 1.15 (m, 2H (**H13**)), 0.80 (t, *J* = 7.3 Hz, 3H (**H14**)), 0.34 (s, 3H (**H5**)), 0.32 (s, 3H (**H5**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 144.1 (**C11**), 139.3 (**C2**), 139.1 (**C15**), 137.8 (**C6**), 134.2 ($\mathbf{C_{Aromatic}}$), 130.3 (**C10**), 129.2 ($\mathbf{C_{Aromatic}}$), 128.2 ($\mathbf{C_{Aromatic}}$), 127.8 ($\mathbf{C_{Aromatic}}$), 126.6 ($\mathbf{C_{Aromatic}}$), 126.3 ($\mathbf{C_{Aromatic}}$), 114.6 (**C1**), 35.0 (**C10**), 32.1 (**C3**), 29.9 (**C4**), 21.6 (**C13**), 14.3 (**C14**), −4.1 (**C5**), −4.8 (**C5**).

IR: ν_{max} (neat/cm^{-1}) 3069 (C-H), 2924 (C-H), 2870 (C-H), 1597 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{23}H_{31}Si$ 335.2112; found 335.2150.

1-[(*Z*)-2-Cyclohexyl-2-phenyl-vinyl]but-3-enyl-dimethyl-phenyl-silane – 237l



The title compound was prepared according to general procedure **A**, from (*Z*)-1-cyclohexyl-3-[dimethyl(phenyl)silyl-1-phenyl-prop-2-en-1-ol (200 mg, 570 µmol) and allyltrimethylsilane (136 µL, 856 µmol) and triflimide (570 µL, 5.70 µmol, 0.01

M in DCM, 1.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% pentane] afforded **237l** (197 mg, 92%) as a colourless oil.

R$_f$ = 0.80 [100 % Pentane].

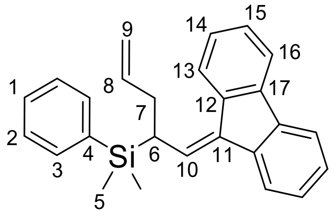
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.40 – 7.30 (m, 6H (**H1**, **H2**, **H3** and **H15**)), 7.20 (d, *J* = 7.2 Hz, 2H (**H14**)), 6.79 (dd, *J* = 7.9, 1.6 Hz, 2H (**H13**)), 5.69 (ddt, *J* = 17.1, 10.2, 7.0 Hz, 1H (**H8**)), 5.14 (dd, *J* = 11.8, 0.8 Hz, 1H (**H10**)), 4.91 – 4.84 (m, 2H (**H9**)), 2.16 – 2.06 (m, 2H (**H16**, and **H7**)), 1.99 – 1.91 (m, 1H (**H7**)), 1.74 – 1.65 (m, 5H (**H6** and **H$_{Cyclohexyl}$**), 1.29 – 1.05 (m, 6H (**H$_{Cyclohexyl}$**)), 0.24 (s, 3H (**H5**)), 0.22 (s, 3H (**H5**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 146.2 (**C11**), 141.9 (**C12**), 139.2 (**C8**), 138.0 (**C4**), 134.3 (**C3**), 129.4 (**C13**), 129.0 (**C1**), 127.7 (**C14**), 127.7 (**C2**), 125.9 (**C15**), 125.5 (**C10**), 114.4 (**C9**), 46.9 (**C16**), 34.9 (**C7**), 33.1 (**C17**), 32.7 (**C17**), 28.8 (**C6**), 26.9 (**C18**), 26.4 (**C18**), 26.3 (**C19**), −4.2 (**C5**), −4.6 (**C5**).

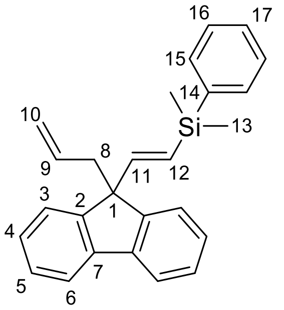
IR: ν_{max} (neat/cm^{-1}) 3069 (C-H), 2922 (C-H), 2851 (C-H), 1638 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{26}H_{35}Si$ 375.2425; found 375.2463.

1-(Fluoren-9-ylidenemethyl)but-3-enyl-dimethyl-phenyl-silane – 242



242



243

The title compound was prepared according to general procedure **A**, from (*E*)-1-cyclohexyl-3-(dimethyl(phenyl)silyl)prop-2-en-1-ol (50 mg, 182 μmol) and allyltrimethylsilane (30 μL, 200 μmol) and triflimide (90 μL, 0.01 M in DCM, 1.0 mol%). The conversion in to product afforded a regioisomeric mixture (**242**:**243** 97:3). The crude mixture was then heated in a pressure vial for 12 hours at 85 ˚C. Following the conversion to product and column chromatography [SiO_2; 100% Pentane] afforded **242** (43 mg, 80%) as a colourless oil.

R$_f$ = 0.90 [9:1 Hexane/EtOAc].

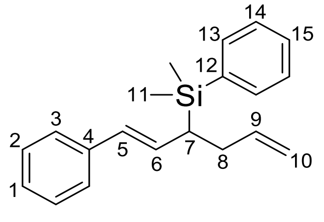
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.5 Hz, 1H (**H**$_{\text{Aromatic}}$)), 7.80 (dd, *J* = 7.4, 0.7 Hz, 1H (**H**$_{\text{Aromatic}}$)), 7.75 (dd, *J* = 8.6, 0.6 Hz, 1H (**H**$_{\text{Aromatic}}$)), 7.63 (dd, *J* = 8.1, 0.5 Hz, 1H (**H**$_{\text{Aromatic}}$)), 7.57 (dd, *J* = 7.4, 2.1 Hz, 2H (**H**$_{\text{Aromatic}}$)), 7.42 – 7.38 (m, 3H (**H**$_{\text{Aromatic}}$)), 7.37 – 7.32 (m, 3H (**H**$_{\text{Aromatic}}$)), 7.31 – 7.29 (m, 1H (**H**$_{\text{Aromatic}}$)), 6.58 (d, *J* = 12.1 Hz, 1H (**H10**)), 5.77 (ddt, *J* = 16.7, 10.1, 6.4 Hz, 1H (**H8**)), 4.98 (ddd, *J* = 17.0, 4.9, 1.6 Hz, 1H (**H9**)), 4.83 (ddd, *J* = 10.1, 3.0, 1.2 Hz, 1H (**H9**)), 3.26 (td, *J* = 11.6, 3.0 Hz, 1H (**H6**)), 2.55 – 2.48 (m, 1H (**H7**)), 2.33 – 2.24 (m, 1H (**H7**)), 0.38 (s, 3H (**H5**)), 0.36 (s, 3H (**H5**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 140.8 (**C11**), 139.8 (**C12**), 138.7 (**C8**), 138.0 (**C12**), 138.0 (**C4**), 136.7 (**C17**), 134.6 (**C10**), 134.2 (**C**$_{\text{Aromatic}}$), 133.5 (**C17**), 129.6 (**C**$_{\text{Aromatic}}$), 128.0 (**C**$_{\text{Aromatic}}$), 127.3 (**C**$_{\text{Aromatic}}$), 126.9 (**C**$_{\text{Aromatic}}$), 126.8 (**C**$_{\text{Aromatic}}$), 126.8 (**C**$_{\text{Aromatic}}$), 124.6 (**C**$_{\text{Aromatic}}$), 119.9 (**C**$_{\text{Aromatic}}$), 119.5 (**C**$_{\text{Aromatic}}$), 119.4 (**C**$_{\text{Aromatic}}$), 115.0 (**C9**), 35.3 (**C7**), 32.1 (**C6**), −3.6 (**C5**), −4.7 (**C5**).

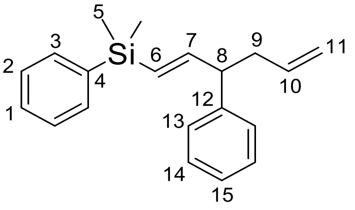
IR: ν_{max} (neat/cm^{-1}) 3020 (C-H), 2952 (C-H), 1604 (C=C).

HRMS: (ESI-TOF) *m/z*: [M-H]$^-$ Calcd for $C_{26}H_{25}Si$ 365.1720; found 365.1731.

Dimethyl-phenyl-[1-(*E*)-styryl]but-3-enyl]silane – 244a and **Dimethyl-phenyl-[(1*E*)-3-phenylhexa-1,5-dienyl]silane – 245a**



245a



244a

The title compounds were prepared according to general procedure **A**, from (*E*)-3-(dimethyl(phenyl)silyl)-1-phenylprop-2-en-1-ol (300 mg, 1.12 mmol) and allyltrimethylsilane (200 µL, 1.23 mmol) using triflimide (560 µL, 0.01 M in DCM, 0.5 mol%). The conversion in to product afforded a regioisomeric mixture (**244a**:**245a** 70:30). Following purification by column chromatography [SiO_2; 100% hexane] afforded the mixture of **244a** and **245a** (252 mg, 77%) as a yellow oil.

R$_f$ = 0.74 [9:1 Hexane:EtOAc].

244a (Major) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 – 7.49 (m, 2H (**H**$_{\text{Aromatic}}$)), (7.38 – 7.26 (m, 6H (**H**$_{\text{Aromatic}}$)), 7.23 – 7.18 (m, 2H (**H**$_{\text{Aromatic}}$)), 6.26 (dd, *J* = 18.6, 6.8

Hz, 1H (**H7**)), 5.80 (dd, *J* = 18.6, 1.3 Hz, 1H (**H6**)), 5.81 – 5.68 (m, 1H (**H10**)), 5.03 – 4.95 (m, 2H (**H11**)), 3.42 (q, *J* = 6.7 Hz, 1H (**H8**)), 2.56 – 2.45 (m, 2H (**H9**)), 0.32 (s, 6H (**H5**)).

244a (Major) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 151.2 (**C7**), 143.7 (**C12**), 138.9 (**C4**), 136.8 (**C10**), 134.0 (**C$_{Aromatic}$**), 129.0 (**C6**), 128.6 (**C$_{Aromatic}$**), 128.0 (**C$_{Aromatic}$**), 127.9 (**C$_{Aromatic}$**), 127.5 (**C$_{Aromatic}$**), 126.5 (**C$_{Aromatic}$**), 116.3 (**C11**), 52.3 (**C8**), 39.9 (**C9**), −2.3 (**C5**), −2.3 (**C5**).

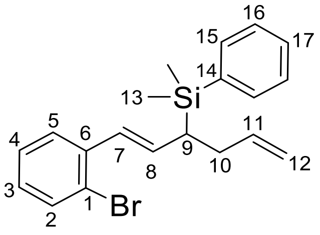
245a (Minor) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 – 7.49 (m, 2H (**H$_{Aromatic}$**)), (7.38 – 7.26 (m, 6H (**H$_{Aromatic}$**)), 7.23 – 7.18 (m, 2H (**H$_{Aromatic}$**)), 6.20 (dd, *J* = 15.9, 0.7 Hz, 1H (**H5**)), 6.05 (dd, *J* = 15.9, 9.2 Hz, 1H (**H6**)), 5.81 – 5.68 (m, 1H (**H9**)), 5.03 – 4.95 (m, 1H (**H10**)), 4.92 – 4.89 (m, 1H (**H10**)), 2.30 – 2.28 (m, 1H (**H8**)), 2.25 – 2.17 (m, 1H (**H8**)), 2.05 – 1.99 (m, 1H (**H7**)), 0.34 (m, 6H (**H11**)).

245a (Minor) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 139.2 (**C9**), 138.9 (**C12**), 137.5 (**C4**), 136.8 (**C5**), 134.2 (**C$_{Aromatic}$**), 132.1 (**C$_{Aromatic}$**), 129.3 (**C6**), 127.9 (**C$_{Aromatic}$**), 127.5 (**C$_{Aromatic}$**), 126.5 (**C$_{Aromatic}$**), 125.8 (**C$_{Aromatic}$**), 114.9 (**C10**), 33.9 (**C7**), 33.6 (**C8**), −4.1 (**C11**), −4.7 (**C11**).

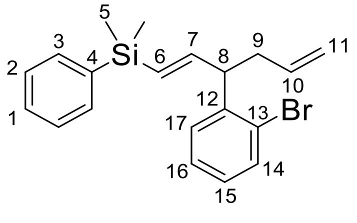
IR: ν_{max} (neat/cm^{-1}) 3067 (C-H), 3024 (C-H), 2853 (C-H), 1638 (C=C), 1600 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{20}H_{25}Si$ 293.1643; found 293.1681.

1-[(*E*)-2-(2-Bromophenyl)vinyl]but-3-enyl-dimethyl-phenyl-silane – 244b and [(1*E*)-3-(2-Bromophenyl)hexa-1,5-dienyl]-dimethyl-phenyl-silane – 245b



245b



244b

The title compound was prepared according to general procedure **A**, from (*E)*-1-(2-bromophenyl)-3-[dimethyl(phenyl)silyl]prop-2-en-1-ol (200 mg, 576 μmol) and allyltrimethylsilane (101 μL, 633 μmol) using triflimide (288 μL, 0.01 M in DCM, 0.5 mol%). The conversion in to product afforded a regioisomeric mixture (**244b**:**245b** 75:25). Following purification by column chromatography [SiO_2;

100% Hexane] afforded a mixture of **244b** and **245b** (161 mg, 75%) as a yellow oil.

R$_f$ = 0.72 [9:1 Hexane:EtOAc].

244b (Major) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.56 (dd, *J* = 8.0, 1.2 Hz, 1H (**H14**)), 7.53 – 7.49 (m, 2H (**H2**)), 7.35 – 7.33 (m, 3H (**H1** and **H3**)), 7.27 (td, *J* = 7.6, 1.2, 1H (**H16**)), 7.19 (dd, *J* = 7.8, 1.7 Hz, 1H (**H17**)), 7.06 (ddd, *J* = 7.9, 7.3, 1.8 Hz, 1H (**H15**)), 6.21 (dd, *J* = 18.7, 6.3 Hz, 1H (**H7**)), 5.84 (dd, *J* = 18.7, 1.3 Hz, 1H (**H6**)), 5.84 – 5.69 (m, 1H (**H10**)), 5.03 – 4.92 (m, 2H (**H11**)), 4.03 (td, *J* = 7.4, 1.4 Hz, 1H (**H8**)), 2.56 – 2.47 (m, 2H (**H9**)), 0.32 (s, 6H (**H5**)).

244b (Major) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 149.3 (**C7**). 142.7 (**C12**), 139.1 (**C4**), 136.2 (**C10**), 134.0 (**C2**), 133.1 (**C14**), 129.0 (**C6**), 129.0 (**C17**), 128.5 (**C15**), 127.9 (**C16**), 127.8 (**C3**), 127.6 (**C1**), 125.2 (**C13**), 116.6 (**C11**), 49.7 (**C8**), 39.0 (**C9**), −2.3 (**C5**), −2.3 (**C5**).

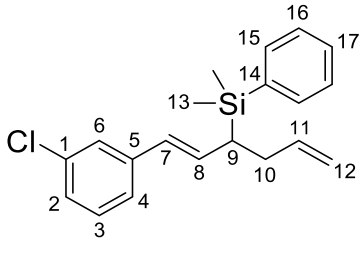
245b (Minor) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.53 – 7.49 (m, 3H (**H$_{\text{Aromatic}}$**)), 7.38 – 7.34 (m, 4H (**H$_{\text{Aromatic}}$**)), 7.22 (d, *J* = 7.2 Hz, 1H (**H$_{\text{Aromatic}}$**)), 7.05 – 6.01 (m, 1H (**H$_{\text{Aromatic}}$**)), 6.54 (d, *J* = 15.8 Hz, 1H (**H7**)), 5.98 (dd, J = 15.8, 9.2 Hz, 1H (**H8**)), 5.84 – 5.69 (m, 1H (**H11**)), 5.03 – 4.92 (m, 2H (**H12**)), 2.35 – 2.30 (m, 1H (**H10**)), 2.28 – 2.20 (m, 1H (**H10**)), 2.14 – 2.08 (m, 1H (**H9**)), 0.36 (s, 6H (**H13**)).

245b (Minor) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 139.1 (**C11**), 138.7 (**C14**), 137.3 (**C6**), 135.4 (**C7**), 134.2 (**C$_{\text{Aromatic}}$**), 132.9 (**C$_{\text{Aromatic}}$**), 129.3 (**C8**), 128.0 (**C$_{\text{Aromatic}}$**), 127.5 (**C$_{\text{Aromatic}}$**), 127.3 (**C$_{\text{Aromatic}}$**), 126.8 (**C$_{\text{Aromatic}}$**), 123.1 (**C1**), 115.1 (**C12**), 34.1 (**C10**), 33.5 (**C9**), −4.1 (**C13**), −4.7 (**C13**).

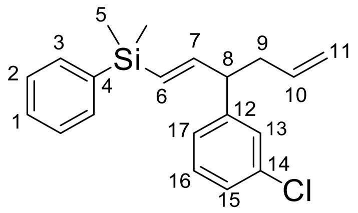
IR ν_{max} (neat/cm^{-1}) 3067 (C-H), 2998 (C-H), 2953 (C-H), 1610 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{20}H_{23}BrSi$ 372.0732; found 372.0782.

1-[(*E*)-2-(3-Chlorophenyl)vinyl]but-3-enyl-dimethyl-phenyl-silane – 244c and **[(1*E*)-3-(3-Chlorophenyl)hexa-1,5-dienyl]-dimethyl-phenyl-silane – 245c**



245c



244c

The title compound was prepared according to general procedure **A**, from (*E*)-1-(3-chlorophenyl)-3-[dimethyl(phenyl)silyl]prop-2-en-1-ol (90 mg, 297 µmol) and allyltrimethylsilane (70 µL, 446 µmol) and triflimide (300 µL, 2.97 µmol, 0.01 M in DCM, 1.0 mol %). The conversion in to product afforded a regioisomeric mixture (**244c**:**245c**, 72:28). Following purification by column chromatography [SiO_2; 100% pentane] afforded a mixture of **244a** and **245a** (53 mg, 55%) as a colourless oil.

R_f = 0.63 [19:1 Pentane:EtOAc].

244c (Major) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 – 7.49 (m, 2H (**H$_{Aromatic}$**)), 7.41 – 7.34 (m, 3H (**H$_{Aromatic}$**)), 7.25 – 7.23 (m, 1H (**H$_{Aromatic}$**)), 7.22 – 7.18 (m, 2H (**H$_{Aromatic}$**)), 7.15 – 7.11 (m, 1H (**H$_{Aromatic}$**)), 7.06 (dt, *J* = 7.4, 1.4 Hz, 1H (**H$_{Aromatic}$**)), 6.20 (dd, *J* = 18.6, 6.7 Hz, 1H (**H7**)), 5.81 (dd, *J* = 18.6, 1.3 Hz, 1H (**H6**)), 5.72 – 5.63 (m, 1H (**H10**)), 5.04 – 4.96 (m, 2H (**H11**)), 3.40 (q, *J* = 6.6 Hz, 1H (**H8**)), 2.56 – 2.42 (m, 2H (**H9**)), 0.34 (s, 3H (**H5**)), 0.33 (s, 3H (**H5**)).

244c (Major) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 150.2 (**C7**), 145.7 (**C12**), 139.0 (**C4**), 138.7 (**C$_{Aromatic}$**), 136.2 (**C10**), 134.0 (**C2**), 129.8 (**C$_{Aromatic}$**), 129.1 (**C6**), 128.4 (**C$_{Aromatic}$**), 128.2 (**C$_{Aromatic}$**), 127.9 (**C$_{Aromatic}$**), 127.9 (**C3**), 127.0 (**C$_{Aromatic}$**), 126.6 (**C$_{Aromatic}$**), 126.2 (**C$_{Aromatic}$**), 116.7 (**C11**), 51.9 (**C8**), 39.7 (**C9**), −2.3 (**C5**), −2.4 (**C5**).

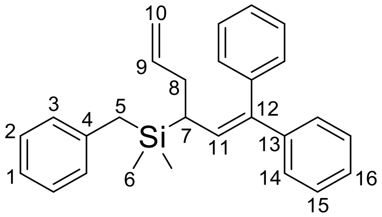
245c (Minor) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.52 – 7.49 (m, 2H (**H$_{Aromatic}$**)), 7.41 – 7.34 (m, 3H (**H$_{Aromatic}$**)), 7.25 – 7.23 (m, 1H (**H$_{Aromatic}$**)), 7.22 – 7.18 (m, 2H (**H$_{Aromatic}$**)), 7.15 – 7.11 (m, 1H (**H$_{Aromatic}$**)), 7.06 (dt, *J* = 7.4, 1.4 Hz, 1H (**H$_{Aromatic}$**)), 6.15 (d, *J* = 15.9 Hz, 1H (**H7**), 6.09 (dd, *J* = 15.9, 8.2 Hz, 1H (**H8**)), 5.81 – 5.73 (m, 1H (**H11**)), 4.96 – 4.90 (m, 2H (**H12**)), 2.36 – 2.29 (m, 1H (**H10**)), 2.25 – 2.16 (m, 1H (**H10**)), 2.06 – 2.00 (m, 1H (**H9**)), 0.35 (s, 3H (**H13**)), 0.34 (s, 3H (**H13**)).

245c (Minor) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 140.3 (**C5**), 139.0 (**C11**), 138.7 (**C14**), 137.2 (**C$_{Aromatic}$**), 136.2 (**C7**), 134.5 (**C$_{Aromatic}$**), 133.9 (**C$_{Aromatic}$**), 129.8 (**C$_{Aromatic}$**), 129.4 (**C$_{Aromatic}$**), 128.2 (**C8**), 127.9 (**C$_{Aromatic}$**), 127.0 (**C$_{Aromatic}$**), 126.4 (**C$_{Aromatic}$**), 125.7 (**C$_{Aromatic}$**), 124.0 (**C$_{Aromatic}$**), 115.1 (**C12**), 34.1 (**C10**), 33.5 (**C9**), −4.2 (**C13**), −4.7 (**C13**).

IR: ν_{max} (neat/cm^{-1}) 3068 (C-H), 2921 (C-H), 1593 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{20}H_{23}ClSi$ 328.1228; found 328.1287.

Benzyl-[1-(2,2-diphenylvinyl)but-3-enyl]-dimethyl-silane – 247a



The title compound was prepared according to general procedure **A**, from (*E*)-3-[benzyl(dimethyl)silyl]-1,1-diphenyl-prop-2-en-1-ol (100 mg, 279 μmol) and allyltrimethylsilane (48.8 μL, 307 μmol) using triflimide (27.9 μL, 0.05 M in DCM, 0.5 mol%). Following the conversion to product and work-up afforded **247a** (105 mg, 98%) as a yellow oil.

R$_f$ = 0.72 [9:1 Hexane:EtOAc].

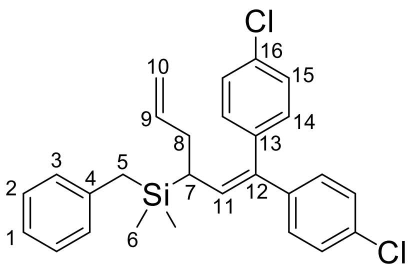
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.37 – 7.29 (m, 3H (**H$_{\text{Aromatic}}$**)), 7.26 – 7.12 (m, 9H (**H$_{\text{Aromatic}}$**)), 7.08 – 7.04 (m, 1H (**H$_{\text{Aromatic}}$**)), 6.90 (d, *J* = 7.0 Hz, 2H (**H$_{\text{Aromatic}}$**)), 5.90 (d, *J* = 12.0 Hz, 1H (**H11**)), 5.88 – 5.81 (m, 1H (**H9**)), 5.03 – 5.02 (m, 1H (**H10**)), 4.99 – 4.98 (m, 1H (**H10**)) 2.35 – 2.03 (m, 2H (**H7** and **H8**)), 2.12 – 2.03 (m, 2H (**H5**), -0.05 (s, 3H (**H6**)), −0.06 (s, 3H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.4 (**C12**), 140.6 (**C13**), 140.4 (**C13**), 139.9 (**C9**), 139.0 (**C4**), 131.3 (**C11**), 130.4 (**C$_{\text{Aromatic}}$**), 128.4 (**C$_{\text{Aromatic}}$**), 128.3 (**C$_{\text{Aromatic}}$**), 128.2 (**C$_{\text{Aromatic}}$**), 127.2 (**C$_{\text{Aromatic}}$**), 126.8 (**C$_{\text{Aromatic}}$**), 126.7 (**C$_{\text{Aromatic}}$**), 124.2 (**C$_{\text{Aromatic}}$**), 115.1 (**C10**), 35.0 (**C8**), 30.7 (**C7**), 24.2 (**C5**), −4.3 (**C6**), −4.6 (**C6**).

IR: $\nu_{\max}$ (neat/cm^{-1}) 3058 (C-H), 2952 (C-H), 1597 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M-H]^-$ Calcd for $C_{27}H_{29}Si$ 381.2033; found 381.2045.

1-[2,2-Bis(4-chlorophenyl)vinyl]but-3-enyl-dimethyl-benzyl-silane – 247b



The title compound was prepared according to general procedure **A**, from (*E*)-3-[benzyl(dimethyl)silyl]-1,1-bis(4-chlorophenyl)prop-2-en-1-ol (500 mg, 1.17 mmol) and allyltrimethylsilane (204 μL, 1.29 mmol) and triflimide (117 μL, 0.05 M in DCM, 0.5 mol%). Following the conversion to product and work-up afforded **247b** (518 mg, 98%) as a colourless oil.

***R*_f_** = 0.74 [19:1 Hexane/EtOAc].

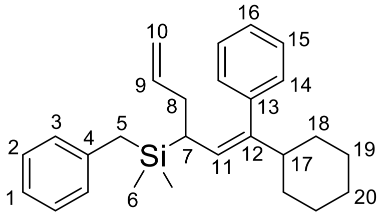
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.31 (d, *J* = 8.4 Hz, 2H (**H15**)), 7.22 – 7.17 (m, 2H (**H15**)), 7.20 (d, *J* = 8.6 Hz, 2H (**H3**)), 7.10 (d, *J* = 7.4 Hz, 1H (**H1**)), 7.05 (d, *J* = 8.4 Hz, 2H (**H14**)), 6.98 (d, *J* = 8.6 Hz, 2H (**H14**)), 6.91 (dd, *J* = 8.4, 1.1 Hz, 2H (**H2**)), 5.85 (d, *J* = 12.2 Hz, 1H (**H11**)), 5.85 – 5.76 (m, 1H (**H9**)), 2.37 – 2.19 (m, 2H (**H8**)), 2.10 (s, 1H (**H5**)), 2.08 (s, 1H (**H5**)), 1.99 (ddd, *J* = 12.2, 10.9, 3.6 Hz, 1H (**H7**)), −0.04 (s, 3H (**H6**)), −0.05 (s, 3H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 141.3 (**C12**), 139.6 (**C4**), 138.7 (**C9**), 138.5 (**C13**), 138.2 (**C13**), 133.0 (**C16**), 132.7 (**C16**), 132.5 (**C11**), 131.7 (**C3**), 128.8 (**C2**), 128.4 (**C15**), 128.4 (**C15**), 128.3 (**C14**), 128.3 (**C14**), 124.3 (**C1**), 115.4 (**C10**), 34.8 (**C8**), 31.0 (**C7**), 24.1 (**C5**), −4.2 (**C6**), −4.5 (**C6**).

IR: ν_{max} (cm^{-1}) 3078 (C-H), 2953 (C-H), 1615 (C=C), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{27}H_{29}Cl_2Si$ 451.1225; found 451.1410.

1-[(*Z*)-2-Cyclohexyl-2-phenyl-vinyl]but-3-enyl-dimethyl-benzyl-silane – 247c



The title compound was prepared according to general procedure **A**, (*Z*)-1-cyclohexyl-3-[dimethyl(benzyl)silyl-1-phenyl-prop-2-en-1-ol (350 mg, 960 µmol) and allyltrimethylsilane (229 µL, 1.44 mmol) and triflimide (192 µL, 9.60 µmol, 0.05 M in DCM, 1.0 mol%). Following the conversion to product and column chromatography [SiO_2; 100% pentane] afforded **247c** (322 mg, 86%) as a colourless oil.

***R*_f_** = 0.79 [19:1 Pentane:EtOAc].

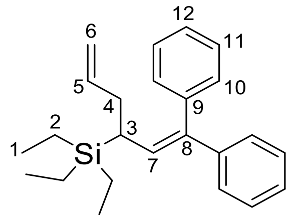
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.29 – 7.16 (m, 5H (**H$_{Aromatic}$**)), 7.05 – 7.02 (m, 3H (**H$_{Aromatic}$**)), 6.88 (d, *J* = 7.3 Hz, 2H (**H$_{Aromatic}$**)), 5.76 (ddt, *J* = 17.2, 10.3, 7.1 Hz, 1H (**H9**)), 5.18 (d, *J* = 11.8 Hz, 1H (**H11**)), 4.97 – 4.96 (m, 1H (**H10**)), 4.93 (dd, *J* = 10.2, 1.5 Hz, 1H (**H10**)), 2.21 –1.96 (m, 3H (**H7** and **H8**)), 2.03 (s, 1H (**H5**)), 2.01 (s, 1H (**H5**)), 1.80 – 1.61 (m, 5H (**H_{Cyclohexyl}**)), 1.33 – 1.03 (m, 6H (**H_{Cyclohexyl}**)), −0.13 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 146.0 (**C12**), 142.0 (**C13**), 140.3 (**C9**), 139.2 (**C4**), 129.5 (**C$_{Aromatic}$**), 128.4 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 128.2 (**C$_{Aromatic}$**), 127.9 (**C$_{Aromatic}$**), 126.1 (**C$_{Aromatic}$**), 125.7 (**C$_{Aromatic}$**), 124.0 (**C11**), 114.6 (**C10**), 46.9 (**C17**), 35.0 (**C8**), 33.3 (**C18**), 32.8 (**C18**), 28.3 (**C7**), 27.0 (**C19**), 26.9 (**C19**), 26.4 (**C20**), 24.1 (**C5**), −4.6 (**C6**), −4.8 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3076 (C-H), 2924 (C-H), 2851 (C-H), 1638 (C=C), 1599 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{27}H_{37}Si$ 389.2582; found 389.2620.

1-(2,2-Diphenylvinyl)but-3-enyl-triethyl-silane – 247d



The title compound was prepared according to general procedure **A**, from (*E*)-1,1-diphenyl-3-triethylsilyl-prop-2-en-1-ol (115 mg, 354 μmol) and allyltrimethylsilane (62 μL, 390 μmol) using triflimide (177 μL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product and work-up afforded **247d** (113 mg, 91%) as a colourless oil.

R$_f$ = 0.79 [19:1 Hexane:EtOAc].

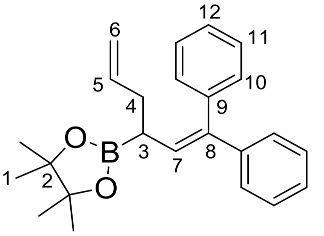
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.36 – 7.32 (m, 2H (**H$_{Aromatic}$**)), 7.28 – 7.26 (m, 1H (**H$_{Aromatic}$**)), 7.25 – 7.23 (m, 2H (**H$_{Aromatic}$**)), 7.21 – 7.17 (m, 5H (**H$_{Aromatic}$**)), 5.96 (d, *J* = 12.0 Hz, 1H (**H7**)), 5.94 – 5.83 (m, 1H (**H5**)), 5.02 – 4.96 (m, 2H (**H6**)), 2.34 – 2.20 (m, 2H (**H3** and **H4**)), 2.15 – 2.09 (m, 1H (**H4**)), 0.86 (t, *J* = 7.9 Hz, 9H (**H1**)), 0.55 (q, *J* = 7.6 Hz, 6H (**H2**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.7 (**C8**), 140.6 (**C9**), 139.5 (**C5**), 132.3 (**C7**), 130.4 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 128.2 (**C$_{Aromatic}$**), 127.1 (**C$_{Aromatic}$**), 126.7 (**C$_{Aromatic}$**), 126.5 (**C$_{Aromatic}$**), 114.8 (**C6**), 35.2 (**C4**), 29.0 (**C3**), 7.79 (**C2**), 2.58 (**C1**).

IR: ν_{max} (neat/cm^{-1}) 3076 (C-H), 2950 (C-H), 2875 (C-H), 1597 (C=C).

HRMS: (APCI-TOF) *m/z*: $[M-H]^-$ Calcd for $C_{24}H_{31}Si$ 347.2190; found 347.2201.

2-[1-(2,2-Diphenylvinyl)but-3-enyl]-4,4,5,5-tetramethyl-1,3,2-dioxaborane – 247f



The title compound was prepared according to general procedure **A**, from (*E*)-1,1-diphenyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)prop-2-en-ol (50 mg, 149 μmol) and allyltrimethylsilane (26 μL, 164 μmol) using triflimide (74.4 μL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product and work-up afforded **247f** (53 mg, 98%) as a yellow oil.

R_f = 0.52 [9:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.37 – 7.33 (m, 2H (**$H_{Aromatic}$**)), 7.30 – 7.27 (m, 1H (**$H_{Aromatic}$**)), 7.24 – 7.22 (m, 1H (**$H_{Aromatic}$**)), 7.22 – 7.16 (m, 6H (**$H_{Aromatic}$**)), 6.05 (d, *J* = 10.7 Hz, 1H (**H7**)), 5.74 (ddt, *J* = 17.0, 10.1, 6.8 Hz, 1H (**H5**)), 5.00 (ddd, *J* = 17.0, 3.4, 1.5 Hz, 1H (**H6**)), 4.95 – 4.92 (m, 1H (**H6**)), 2.36 – 2.21 (m, 2H (**H3** and **H4**)), 2.17 – 2.11 (m, 1H (**H4**)), 1.23 (s, 6H (**H1**)), 1.23 (s, 6H (**H1**)).

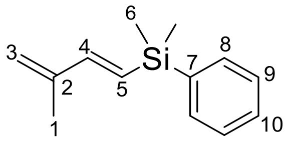
^{13}C NMR: (101 MHz, $CDCl_3$) δ 143.2 (**C8**), 140.9 (**C9**), 140.5 (**C9**), 138.1 (**C5**), 130.3 (**C7**), 128.3 (**$C_{Aromatic}$**), 128.1 (**$C_{Aromatic}$**), 127.4 (**$C_{Aromatic}$**), 126.9 (**$C_{Aromatic}$**), 126.7 (**$C_{Aromatic}$**), 115.3 (**C6**), 83.4 (**C2**), 36.1 (**C4**), 24.9 (**C3**), 24.8 (**C1**).

IR: ν_{max} (neat/cm^{-1}) 3062 (C-H), 2978 (C-H), 2931 (C-H), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{24}H_{30}BO_2Si$ 361.2339; found 361.2333.

7.3.4 1,3-Dienes

Dimethyl-[(1*E*)-3-methylbuta-1,3-dienyl]-phenyl-silane – 235



The title compound was prepared according to general procedure **C**, from (*E*)-4-(dimethyl(phenyl)silyl)-2-methylbut-3-en-2-ol (100 mg, 454 μmol) using triflimide

(2.27 mL, 0.01 M in DCM, 0.5 mol%). Following the conversion to product and work-up afforded **235** (89.1 mg, 97%) as a yellow oil.

Rf = 0.34 [100% Hexane].

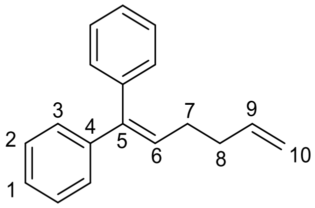
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.56 – 7.53 (m, 2H (**H9**)), 7.38 – 7.36 (m, 3H (**H10** and **H8**)), 6.70 (d, *J* = 18.9 Hz, 1H (**H4**)), 5.95 (d, *J* = 18.9 Hz, 1H (**H5**)), 5.10 (s, 1H (**H3**)), 5.04 (s, 1H (**H3**)), 1.88 (dd, *J* = 1.20, 0.7 Hz, 3H (**H1**)), 0.39 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 148.3 (**C4**), 143.6 (**C2**), 138.9 (**C7**), 134.0 (**C9**), 129.1 (**C10**), 127.9 (**C8**), 127.1 (**C5**), 117.8 (**C3**), 18.1 (**C1**), −2.4 (**C6**).

All spectral data in accordance with literature.[210]

7.3.5 1,5-Dienes

1-Phenylhexa-1,5-dienylbenzene – 264a



The title compound was prepared according to general procedure **D**, from 1-(2,2-diphenylvinyl)but-3-enyl-dimethyl-phenyl-silane (75 mg, 203 μmol) and TBAF (224 μL, 224 μmol, in 1 M THF). Following purification by column chromatography [SiO_2; 100% pentane] afforded **264a** (33 mg, 70%) as a colourless oil.

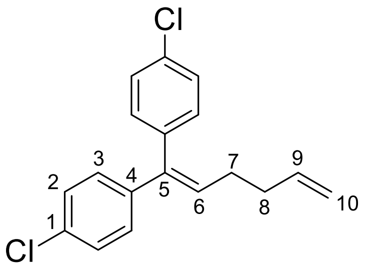
Rf = 0.78 [19:1 Pentane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.39 – 7.27 (m, 4H (**H$_{Aromatic}$**)), 7.26 – 7.17 (m, 6H (**H$_{Aromatic}$**)), 6.08 (t, *J* = 7.2 Hz (**H6**)), 5.81 (ddt, *J* = 16.7, 10.2, 6.4 Hz, 1H (**H9**)), 5.02 (ddd, *J* = 17.1, 3.4, 1.5 Hz, 1H (**H10**)), 4.98 – 4.95 (m, 1H (**H10**)), 2.26 – 2.19 (m, 4H (**H7** and **H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 142.9 (**C5**), 142.1 (**C4**), 140.3 (**C4**), 138.3 (**C9**), 130.1 (**C$_{Aromatic}$**), 129.3 (**C6**), 128.2 (**C$_{Aromatic}$**), 127.4 (**C$_{Aromatic}$**), 127.0 (**C$_{Aromatic}$**), 127.0 (**C1**), 115.1 (**C10**), 34.2 (**C7**), 29.3 (**C8**).

Spectral data in accordance with literature.[211]

1-Chloro-4-[1-(4-chlorophenyl)hex-1,5-dienyl]benzene – 264b



The title compound was prepared according to general procedure **D**, from 1-[2,2-bis(4-chlorophenyl)vinyl]but-3-enyl-dimethyl-benzyl-silane (100 mg, 221 μmol) and TBAF (244 μL, 244 μmol, in 1 M THF). Following purification by column chromatography [SiO_2; 100% pentane] afforded **264b** (58 mg, 87%) as a colourless oil.

$\boldsymbol{R_f}$ = 0.56 [100 % Pentane].

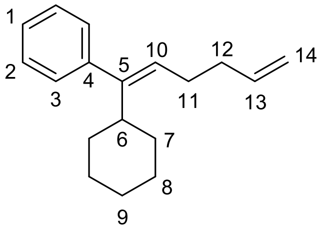
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.5 Hz, 2H ($\mathbf{H_{Aromatic}}$)), 7.23 (d, *J* = 8.7 Hz, 1H ($\mathbf{H_{Aromatic}}$)), 7.13 – 7.01 (m, 4H ($\mathbf{H_{Aromatic}}$)), 6.06 (t, 7.3 Hz, 1H (**H6**)), 5.84 – 5.74 (m,1H (**H9**)), 5.04 – 4.97 (m, 2H (**H10**)), 2.21 – 2.17 (m, 4H (**H7** and **H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 141.0 (**C5**), 140.0 (**C4**), 138.2 (**C9**), 137.9 (**C4**), 131.4 ($\mathbf{C_{Aromatic}}$), 130.4 (**C1**), 130.0 (**C1**), 128.8 (**C6**), 128.7 ($\mathbf{C_{Aromatic}}$), 128.6 ($\mathbf{C_{Aromatic}}$), 128.5 ($\mathbf{C_{Aromatic}}$), 115.4 (**C10**), 34.0 (**C7**), 29.3 (**C8**).

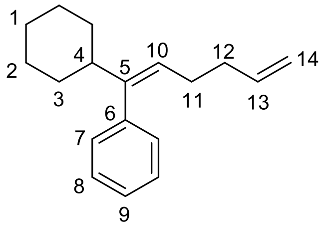
IR: ν_{max} (neat/cm^{-1}) 3076 (C-H), 2976 (C-H), 2909 (C-H), 2844 (C-H), 1591 (C=C).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{18}H_{16}Cl_2Si$ 304.600; found 304.0696

[(1*Z*)-1-Cyclohexylhexa-1,5-dienyl]benzene – (*Z*)-264c and [(1*E*)-1-Cyclohexylhexa-1,5-dienyl]benzene – (*Z*)-264c



(*E*)-264c



(*Z*)-264c

The title compound was prepared according to general procedure **D**, from 1-[(*Z*)-2-cyclohexyl-2-phenyl-vinyl]but-3-enyl-dimethyl-benzyl-silane (75 mg, 200 μmol) and TBAF (220 μL, 220 μmol, in 1 M THF). Following the conversion to product (44:56, *E/Z*). Purification by column chromatography [SiO_2; 100% pentane] afforded **(*Z*)-264c** and **(*E*)-264c** (35 mg, 73%) as colourless oils.

R_f = 0.69 [100% Pentane].

Minor (*E*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.28 – 7.21 (m, 3H (**H1** and **H2**)), 7.13 (dd, *J* = 8.0, 1.6 Hz, 2H (**H3**)), 5.87 (ddt, *J* = 16.8, 10.1, 6.5 Hz, 1H (**H13**)), 5.22 (t, *J* = 7.0 Hz, 1H (**H10**)), 5.06 (dq, *J* = 17.1, 1.7 Hz, 1H (**H14**)), 4.99 (ddt, *J* = 10.3, 2.3, 1.3 Hz, 1H (**H14**)), 2.63 – 2.58 (m, 1H (**H6**)), 2.32 – 2.27 (m, 2H (**H11**)), 2.21 – 2.15 (m, 2H (**H12**)), 1.71 – 1.60 (m, 4H ($\mathbf{H}_{\mathbf{Cyclohexyl}}$)), 1.36 – 1.20 (m, 5H ($\mathbf{H}_{\mathbf{Cyclohexyl}}$)), 1.07 – 1.03 (m, 1H ($\mathbf{H}_{\mathbf{Cyclohexyl}}$)).

Minor (*E*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 146.8 (**C5**), 144.0 (**C4**), 138.5 (**C13**), 128.7 (**C3**), 128.2 (**C10**), 127.4 (**C2**), 126.1 (**C1**), 114.7 (**C14**), 40.5 (**C6**), 34.2 (**C12**), 32.0 (**C7**), 27.1 (**C11**), 26.8 (**C8**), 26.0 (**C9**).

Major (*Z*) ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.30 (t, *J* = 7.3 Hz, 2H (**H8**)), 7.25 – 7.20 (m, 1H (**H9**)), 7.05 (dd, *J* = 8.2, 1.4 Hz, 2H (**H7**)), 5.73 (ddt, *J* = 16.9, 10.2, 6.6 Hz, 1H (**H13**)), 5.38 (td, *J* = 7.1, 1.2 Hz, 1H (**H10**)), 4.97 – 4.86 (m, 2H (**H14**)), 2.13 – 2.10 (m, 1H (**H4**)), 2.07 – 1.98 (m, 2H (**H12**)), 1.94 – 1.88 (m, 2H (**H11**)), 1.78 – 1.69 (m, 4H ($\mathbf{H}_{\mathbf{Cyclohexyl}}$)), 1.65 – 1.61 (m, 1H ($\mathbf{H}_{\mathbf{Cyclohexyl}}$)), 1.32 – 1.18 (m, 4H ($\mathbf{H}_{\mathbf{Cyclohexyl}}$)), 1.14 – 1.03 (m, 1H ($\mathbf{H}_{\mathbf{Cyclohexyl}}$)).

Major (*Z*) ^{13}C NMR: (101 MHz, $CDCl_3$) δ 147.3 (**C5**), 141.7 (**C6**), 138.5 (**C13**), 128.8 (**C7**), 127.7 (**C8**), 126.1 (**C9**), 124.1 (**C10**), 114.5 (**C14**), 46.1 (**C4**), 34.3 (**C12**), 32.4 (**C3**), 28.2 (**C11**), 26.8 (**C2**), 26.3 (**C1**).

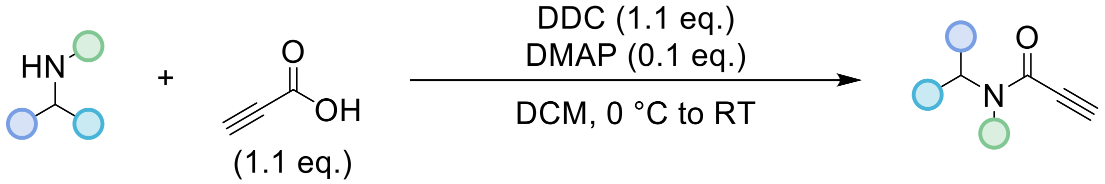
IR: ν_{max} (neat/cm^{-1}) 3076 (C-H), 2976 (C-H), 2851 (C-H), 1640 (C=C).

HRMS: (APCI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{18}H_{25}$ 241.1912; found 241.1951.

7.4 Chapter 4 – Experimental

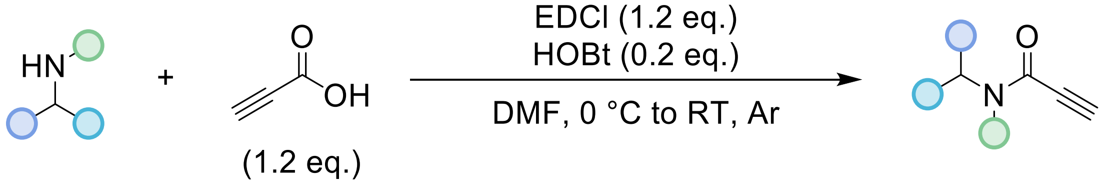
7.4.1 General Procedures

7.4.1.1 General Procedure A – Synthesis of Propynamides



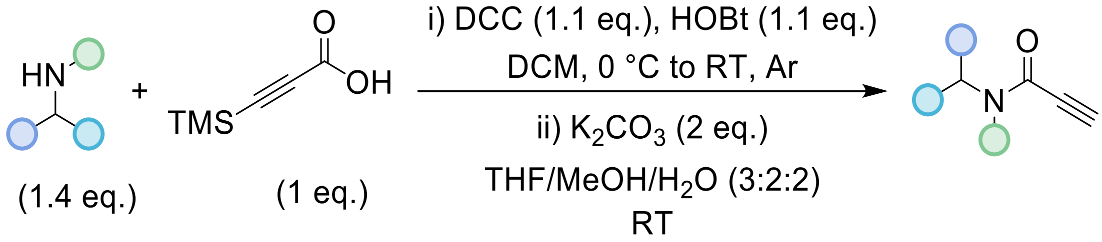
To a solution of the corresponding amine (1 eq.) in DCM (0.5 M), under air atmosphere at 0 °C was added DDC (1.1 eq.) and 4-DMAP (0.1 eq.). The reaction mixture was stirred for 10 minutes at 0 °C. Propiolic acid (1.1 eq.) was then added, and the reaction mixture was allowed to warm to room temperature over 1 hour and stirred for 3 hours. Upon completion the reaction mixture was quenched with sat. Na_2CO_3 solution (15 ml), extracted with DCM (3 × 15 ml), washed with brine, and dried over Na_2SO_4. The reaction mixture was filtered and concentrated under *vacuo*. The reaction mixture was then purified via column chromatography to get the corresponding propynamide.

7.4.1.2 General Procedure B – Synthesis of Propynamides



To a solution of the corresponding amine (1 eq.) in dry DMF (0.5 M) were added EDCI (1.2 eq.) and HOBt (0.2 eq.) at 0°C. The reaction mixture was stirred for 10 minutes. Propiolic acid (1.2 eq.) was then added dropwise, and the reaction mixture was allowed to warm to room temperature and stirred for 2-12 hours. Upon completion the reaction mixture was quenched with water (15 ml), extracted with ethyl acetate (3 × 15 ml), washed with brine, and dried over Na_2SO_4. The reaction mixture was filtered and concentrated under *vacuo*. The reaction mixture was then purified via column chromatography to get the corresponding propynamide.

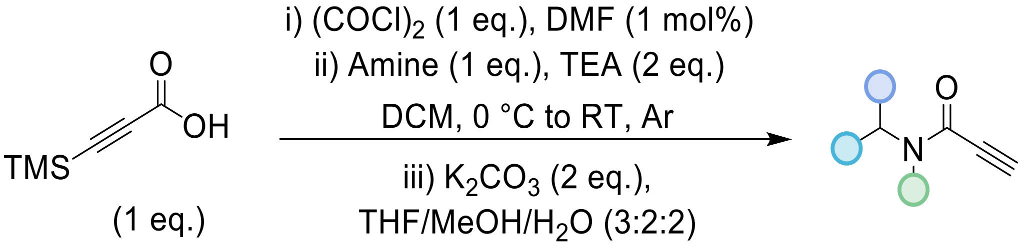
7.4.1.3 General Procedure C – Synthesis of Propynamides



To a solution of 3-(trimethylsilyl)propiolic acid (1 eq.) in dry DCM (0.5 M) under argon, were added HOBt (1.1 eq.) and DCC (1.1 eq.) at 0°C, in that order. The resulting slurry was stirred for 1 hour at room temperature. The corresponding amine (1.4 eq.) was then added dropwise mixture was stirred for 10 minutes. Propiolic acid (1.2 eq.) was then added dropwise and stirred overnight. The heterogenous solution was filtered over celite and concentrated under *vacuo*. The corresponding TMS-protected alkyne was dissolved in 3:2:2 ratio of

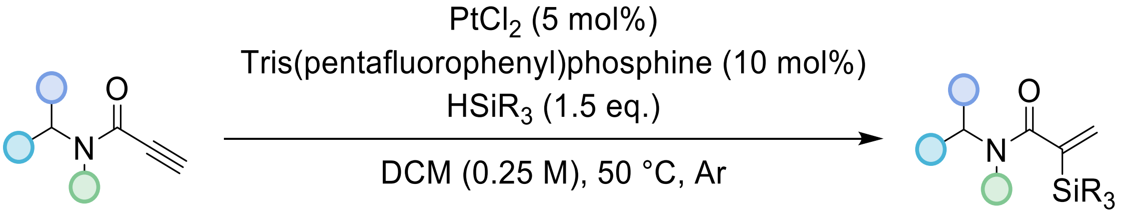
$THF/MeOH/H_2O$ solution, treated with potassium carbonate (2 eq.) and stirred for 1 hour. The reaction mixture was concentrated under *vacuo* and then diluted with water and extracted with EtOAc. The organic layer was washed with brine, dried over Na_2SO_4 and concentrated under *vacuo.* The crude reaction mixture was then purified via column chromatography to get the corresponding terminal alkyne.

7.4.1.4 General Procedure D – Synthesis of Propynamides



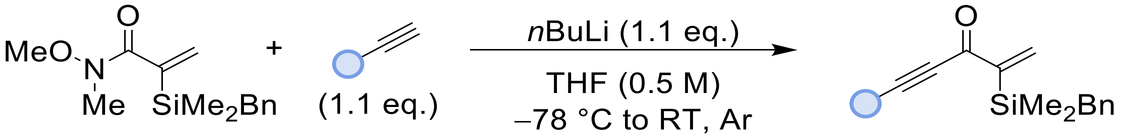
To a solution of 3-(trimethylsilyl)propiolic acid (1 eq.) in dry DCM (0.5 M) under argon was added dry DMF (1 mol%). Oxalyl chloride (1 eq.) was then added dropwise at 0 °C to the reaction mixture. The reaction was stirred at room temperature for 1 hour. Upon completion the reaction mixture was concentrated under vacuo. The acyl chloride was taken on without further purification. The amine (1 eq.) was added to a separate reaction flask in dry DCM (0.5 M), triethylamine (2 eq.) was then added dropwise at 0 °C. The acyl chloride was resuspended in dry DCM (0.5 M) under argon into a separate flask and then added to the reaction mixture dropwise. The reaction mixture was left to stir at room temperature overnight. The corresponding TMS-protected alkyne was dissolved in 3:2:2 ratio of $THF/MeOH/H_2O$ solution, treated with potassium carbonate (2 eq.) and stirred for 1 hour. The reaction mixture was concentrated under *vacuo* and then diluted with water and extracted with EtOAc. The organic layer was washed with brine, dried over Na_2SO_4 and concentrated under *vacuo.* The crude reaction mixture was then purified via column chromatography to get the corresponding terminal alkyne.

7.4.1.5 *General Procedure E – Synthesis of α-Silyl-α,β-unsaturated Amides*



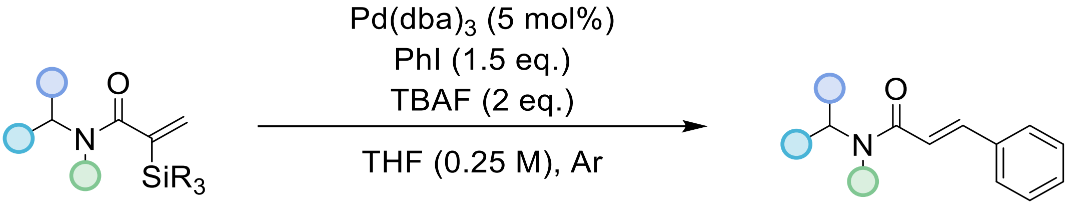
To oven dried vial, purged with argon were added platinum (II) chloride (5 mol%), and tris(pentafluorophenyl)phosphine (10 mol%) in dry DCM (0.25 M). The resultant mixture was stirred at 50 °C for 30 minutes. After this time the corresponding propargylic amide (1 eq.) was added to the reaction vessel, followed by silane (1.5 eq.). Upon completetion the reaction was reduced under *vacuo* and subjected to purification via column chromatography to obtain the correspoding α-silyl-α,β-unsaturated amide.

7.4.1.6 *General Procedure F – Synthesis of α-Silyl-α,β-unsaturated Compounds*



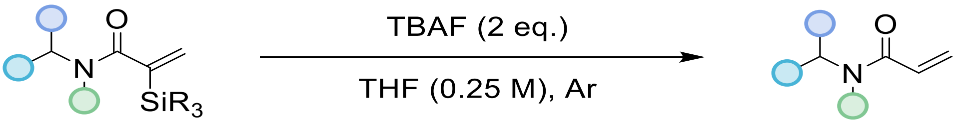
To a solution of the terminal alkyne (1.1 eq.) in THF (0.5 M) under argon, *n*BuLi (1.1 eq., 1 M in hexane) was added dropwise at −78 °C. The mixture was stirred for 30 minutes before the α-silyl-α,β-unsaturated Weinreb amide (1 eq.) was added. The mixture was allowed to slowly warm to room temperature upon completion of the addition. Upon completion the reaction was quenched with sat. NH_4Cl and extracted with DCM (3 × 10 ml), subsequently dried with anhydrous $MgSO_4$, and concentrated under *vacuo*. The crude product was then subjected to column chromatography to afford the corresponding α-silyl-α,β-unsaturated compound.

7.4.1.7 *General Procedure G – Synthesis of α,β-Unsaturated Amides*



To oven dried round bottom flask, purged with argon were added α-silyl-α,β-unsaturated amide and TBAF (2 eq., 0.5 M in THF) in dry THF (0.5 M). The resultant mixture was stirred at room temperature for 15 minutes before adding phenyl iodide (1.5 eq.) and then Pd(dba)$_3$ (5 mol%). Upon completetion the reaction was quenched with water and extracted with DCM (3 × 10 ml). The combined organic fractions was then washed with brine, dried using Na_2SO_4 and reduced under *vacuo* and subjected to purification via column chromatography to obtain the correspoding α,β-unsaturated amide.

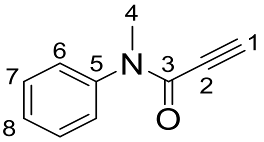
7.4.1.8 General Procedure G – Synthesis of α,β-Unsaturated Amides



To oven dried round bottom flask, purged with argon were added α-silyl-α,β-unsaturated amide and TBAF (2 eq., 0.5 M in THF) in dry THF (0.5 M). The resultant mixture was stirred at room temperature for 1 hour. Upon completetion the reaction was quenched with water and extracted with DCM (3 × 10 ml). The combined organic fractions was then washed with brine, dried using Na_2SO_4 and reduced under *vacuo* and subjected to purification via column chromatography to obtain the correspoding α,β-unsaturated amide.

7.4.2 Propynamides

***N*-Methyl-*N*-phenyl-2-propynamide – 283a**



The title compound was prepared according to general procedure **A**, from *N*-methyl aniline (1 g mg, 9.34 mmol) and propiolic acid (320 µL, 5.14 mmol) using DDC (2.12 g, 10.3 mmol) and DMAP (114 mg, 0.934 mmol). Following the conversion to product, work-up and column chromatography [SiO_2; 5:1 Hexane:EtOAc] afforded **283a** (1.20 g, 81%) as a white solid.

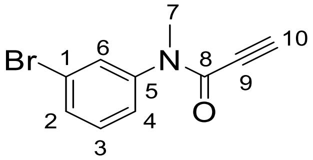
R$_f$ = 0.13 [5:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.42 (dd, *J* = 5.9, 1.6 Hz, 2H (**H6**)), 7.39 – 7.35 (m, 1H (**H8**)), 7.29 (d, *J* = 8.2 Hz, 2H (**H7**)), 3.34 (s, 3H (**H4**)), 2.81 (s, 1H (**H1**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 153.2 (**C3**), 142.8 (**C5**), 129.5 (**C6**), 128.3 (**C8**), 127.4 (**C7**), 79.6 (**C1**), 76.4 (**C2**), 36.7 (**C4**).

All spectral data in accordance with literature.[212]

***N*-(3-Bromophenyl)-*N*-methyl-2-propynamide – 283b**



The title compound was prepared according to general procedure **A**, from 3-bromo-*N*-methylaniline (500 mg, 2.69 mmol) and propiolic acid (180 µL, 2.96 mmol) using DDC (611 mg, 2.96 mmol) and DMAP (33 mg, 269 µmol). Following the conversion to product, work-up and column chromatography [SiO_2; 9:1 Hexane:EtOAc] afforded **283b** (499 mg, 78%) as orange oil.

R_f = 0.40 [3:1 Hexane:EtOAc].

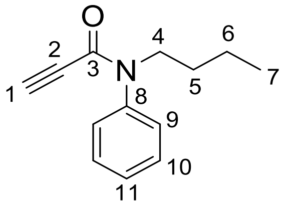
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 7.9 Hz, 1H (**H4**)), 7.47 (m, 1H (**H6**)), 7.32 – 7.24 (m, 2H (**H2** and **H3**)), 3.32 (s, 3H (**H7**)), 2.87 (s, 1H (**H10**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 152.9 (**C8**), 143.9 (**C5**), 131.5 (**C4**), 130.7 (**C2** or **C3**), 130.6 (**C2** or **C3**), 126.2 (**C6**), 122.6 (**C1**), 80.2 (**C10**), 76.1 (**C9**), 36.6 (**C7**).

IR: ν_{max} (neat/cm^{-1}) 3285 (C≡C-H), 3063 (C=C-H), 2916 (C-H), 2092 (C≡C), 1623 (C=O), 1571 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{10}H_9BrNO$ 237.9868; found 237.9868.

***N*-Butyl-*N*-phenyl-2-propynamide – 283c**



The title compound was prepared according to general procedure **A**, from *N*-(but-1-yl)aniline (1 g, 6.70 mmol) and propiolic acid (455 µL, 7.40 mmol) using DDC (1.52 g, 7.40 mmol) and DMAP (82 mg, 67 µmol). Following the conversion to product, work-up and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **283c** (1.05 g, 77%) as yellow oil.

R_f = 0.24 [5:1 Hexane:EtOAc].

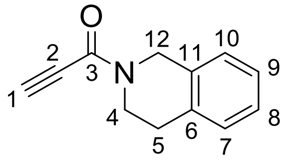
^{1}**H NMR**: (400 MHz, CDCl$_3$, mixture of rotamers observed, minor indicated by *) δ 7.44 – 7.36 (m, 3H (**H11** and **H9**)), 7.26 – 7.20 (m, 2H (**H10**)), 3.98 – 3.94 (m, 2H (**H4***)), 3.77 – 3.73 (m, 2H (**H4**)), 3.20 (s, 1H (**H1***)), 2.77 (s, 1H (**H1**)), 1.55 – 1.46 (m, 2H (**H5**)), 1.36 – 1.28 (m, 2H (**H6**)), 0.93 – 0.86 (m, 3H (**H7**)).

^{13}**C NMR**: (101 MHz, CDCl$_3$, mixture of rotamers observed, minor indicated by *) δ 153.3 (**C3***), 153.3 (**C3**), 141.4 (**C8**), 139.6 (**C8***), 129.5 (**C9***), 129.4 (**C9**), 128.5 (**C10**), 128.4 (**C11**), 127.7 (**C11***), 127.1 (**C10***), 79.5 (**C2**), 79.3 (**C2***), 76.7 (**C1**), 76.5 (**C1***), 52.2 (**C4***), 48.6 (**C4**), 31.0 (**C5***), 29.6 (**C5**), 20.1 (**C6**), 19.8 (**C6***), 13.9 (**C7**), 13.8 (**C7***).

IR: ν_{max} (neat/cm^{-1}) 3280 (C≡C-H), 2957 (C=C-H), 2931 (C-H), 2870 (C-H), 2100 (C≡C), 1630 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{13}H_{15}NONa$ 224.1056; found 224.1051.

1-(3,4-Dihydro-2(1*H*)-isoquinolinyl)-2-propyn-1-one – 283d



The title compound was prepared according to general procedure **A**, from 1,2,3,4-tetrahydro-isoquinoline (500 mg, 3.75 mmol) and propiolic acid (254 µL, 4.13 mmol) using DDC (852 mg, 4.13 mmol) and DMAP (46 mg, 375 µmol). Following the conversion to product, work-up and column chromatography [SiO$_2$; 5:1 Hexane:EtOAc] afforded **283d** (625 mg, 90%) as colourless oil.

R$_f$ = 0.32 [2:1 Hexane:EtOAc].

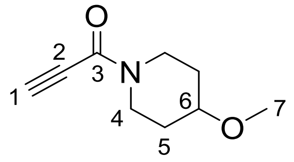
^{1}**H NMR**: (400 MHz, CDCl$_3$, mixture of rotamers observed, minor indicated by *) δ 7.23 – 7.13 (m, 4H (**H$_{Aromatic}$**)), 4.91 (s, 2H (**H12***)), 4.77 (s, 2H (**H12**)), 4.01 (t, *J* = 5.9 Hz, 2H (**H4**)), 3.86 (t, *J* = 6.1 Hz, 2H (**H4***)), 3.19 (s, 1H (**H1***)), 3.15 (s, 1H (**H1**)), 2.95 (t, *J* = 5.8 Hz, 2H (**H5**)), 2.89 (t, *J* = 6.1 Hz, 2H (**H5***)).

^{13}**C NMR**: (101 MHz, CDCl$_3$, mixture of rotamers observed, minor indicated by *) δ 152.6 (**C3**), 152.3 (**C3***), 134.6 (**C11***), 133.9 (**C11**), 132.3 (**C6***), 132.1 (**C6**), 129.1 (**C$_{Aromatic}$***), 128.8 (**C$_{Aromatic}$**), 127.2 (**C$_{Aromatic}$**), 126.9 (**C$_{Aromatic}$**), 126.7 (**C$_{Aromatic}$**), 126.7 (**C$_{Aromatic}$***), 126.2 (**C$_{Aromatic}$**), 79.8 (**C2***), 79.0 (**C2**), 75.9 (**C1***), 75.8 (**C1**), 48.6 (**C12***), 44.7 (**C12**), 44.1 (**C4**), 39.8 (**C4***), 29.6 (**C5**), 28.3 (**C5***).

IR: ν_{max} (neat/cm^{-1}) 3190 (C≡C-H), 3058 (C=C-H), 2968 (C-H), 2102 (C≡C), 1738 (C=O), 1610 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{12}H_{12}NO$ 186.0912; found 186.0919.

1-(4-Methoxy-1-piperidinyl)-2-propyn-1-one – 283e



The title compound was prepared according to general procedure **A**, from 4-methoxypiperidine (500 g, 4.34 mmol) and propiolic acid (294 µL, 4.78 mmol) using DDC (986 mg, 4.78 mmol) and DMAP (53 mg, 434 µmol). Following the conversion to product, work-up and column chromatography [SiO$_2$; 5:1 Hexane:EtOAc] afforded **283e** (599 mg, 83%) as an orange oil.

R

$\boldsymbol{R_f}$ = 0.25 [1:1 Hexane:EtOAc].

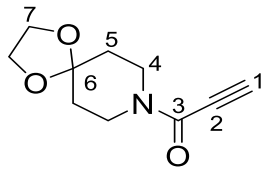
^{1}H NMR: (400 MHz, CDCl$_3$) δ 3.95 – 3.90 (m, 1H (**H4**)), 3.81 – 3.76 (m, 1H (**H4**)), 3.64 – 3.60 (m,1H (**H4**)), 2.51 – 3.46 (m, 2H (**H4** and **H6**)), 3.36 (s, 3H (**H7**)), 3.10 (s, 1H (**H1**)), 1.88 – 1.79 (m, 2H (**H5**)), 1.70 – 1.60 (m, 2H (**H5**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 151.8 (**C3**), 79.1 (**C2**), 75.7 (**C1**), 75.0 (**C6**), 56.0 (**C7**), 44.1 (**C4**), 38.3 (**C4**), 31.1 (**C5**), 29.9 (**C5**).

IR: ν_{max} (neat/cm^{-1}) 3207 (C≡C-H), 2929 (C=C-H), 2825 (C-H), 2100 (C≡C), 1617 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_9H_{14}NO_2$ 168.1019; found 168.1019.

1-(1,4-Dioxa-8-azaspiro[4.5]dec-8-yl)-2-propyn-1-one – 283f



The title compound was prepared according to general procedure **A**, from 1,4-dioxa-8-azaspiro[4.5]decane (1 g, 6.98 mmol) and propiolic acid (470 µL, 7.68 mmol) using DDC (1.58 g, 7.68 mmol) and DMAP (85 mg, 698 µmol). Following the conversion to product, work-up and column chromatography [SiO$_2$; 1:1 Hexane:EtOAc] afforded **283f** (1.28 g, 94%) as white solid.

$\boldsymbol{R_f}$ = 0.33 [1:1 Hexane:EtOAc].

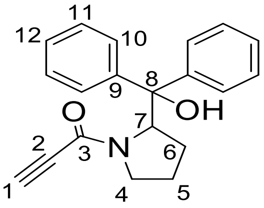
^{1}**H NMR**: (400 MHz, $CDCl_3$) δ 3.99 (s, 4H, (**H6**)), 3.86 - 3.85 (m, 2H (**H4**)), 3.86 - 3.85 (m, 2H (**H4**)), 3.11 (s, 1H (**H1**)), 1.76 – 1.74 (m, 2H (**H5**)), 1.71 – 1.69 (m, 2H (**H5**)).

^{13}**C NMR**: (101 MHz, $CDCl_3$) δ 151.8 (**C3**), 106.9 (**C6**), 79.2 (**C1**), 75.6 (**C2**), 64.7 (**C6**), 45.2 (**C4**), 39.5 (**C4**), 35.6 (**C5**), 34.6 (**C5**).

IR: ν_{max} (neat/cm^{-1}) 3322 (C≡C-H), 3009 (C=C-H), 2849 (C-H), 2883 (C-H), 2096 (C≡C), 1615 (C=O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{10}H_{14}NO_3$ 196.0995; found 196.0984.

1-(2-(Hydroxydiphenylmethyl)pyrrolidine-1-yl)prop-2-yn-1-one – 283g



The title compound was prepared according to general procedure **A**, from diphenyl-2-pyrrolidinemethanol (300 mg, 1.18 mmol) and propiolic acid (80 µL, 1.30 mmol) using DDC (268 mg, 1.30 mmol) and DMAP (14 mg, 118 µmol). Following the conversion to product, work-up and column chromatography [SiO_2; 5:1 Hexane:EtOAc] afforded **283g** (326 mg, 91%) as a white foam.

***R**$_f$* = 0.55 [3:1 Hexane:EtOAc].

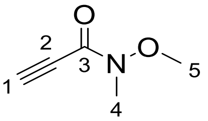
^{1}**H NMR**: (400 MHz, $CDCl_3$) δ 7.42 – 7.39 (m, 4H (**H$_{Aromatic}$**)), 7.34 – 7.27 (m, 6H (**H$_{Aromatic}$**)), 5.97 (s, 1H (**O-H**)), 5.19 (dd, *J* = 8.9, 4.8 Hz (**H7**)), 3.79 (ddd, *J* = 11.0, 8.4, 5.9 Hz, 1H (**H4**)), 3.16 (s, 1H (**H1**)), 3.04 (dt, *J* = 11.0, 7.6 Hz, 1H (**H4**)), 2.21 – 2.14 (m, 1H (**H5**)), 2.06 – 2.00 (m, 1H (**H5**)), 1.63 – 1.56 (m, 1H (**H6**)), 1.06 – 0.99 (m, 1H (**H6**)).

^{13}**C NMR**: (101 MHz, $CDCl_3$) δ 155.2 (**C3**), 145.8 (**C9**), 143.0 (**C9**), 128.2 (**C10**), 128.2 (**C10**), 127.8 (**C11**), 127.8 (**C11**), 127.6 (**C12**), 127.6 (**C12**), 82.0 (**C2**), 80.0 (**C1**), 76.4 (**C8**), 66.8 (**C7**), 50.3 (**C4**), 29.9 (**C5**), 22.9 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3451 (O-H), 3239 (C≡C-H), 2981 (C=C-H), 2924 (C-H), 2111 (C≡C), 1612 (C=O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{20}H_{19}NO_2Na$ 328.1302; found 328.1313.

N-methoxy-*N*-methylpropiolamide – 283h



The title compound was prepared according to general procedure **A**, from propiolic acid (1 g, 14.2 mmol) and *O,N*-dimethylhydroxylamine hydrochloride (1.53 g, 15.7 mmol) using DDC (3.24 g, 15.7 mmol) and diisopropylethylamine (2.74 ml, 15.7 mmol). Following the conversion to product and column chromatography [SiO_2; 5:1 Hexane:EtOAc] afforded **283h** (1.47 g, 91%) as yellow oil.

R

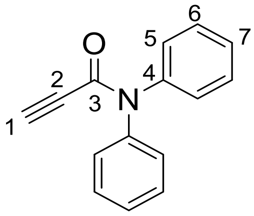
R_f = 0.44 [1:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz,CDCl$_3$) δ 3.78 (s, 3H (**H5**), 3.22 (br s, 3H (**H4**), 3.12 (s, 1H (**H1**).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 153.3 (**C3**), 78.9 (**C2**), 76.8 (**C1**), 62.4 (**C5**), 32.4 (**C4**).

All spectral data in accordance with literature.[213]

N,N-Diphenyl-2-propynamide – 283m



The title compound was prepared according to general procedure **D**, from 3-(trimethylsilyl)propiolic acid (285 mg, 2.00 mmol), and diphenylamine (677 mg, 4.00 mmol), using oxalyl chloride (203 µL, 2.40 mmol) and DMF (6 µL, 80 µmol). The crude product was subjected to TMS-deprotection using potassium carbonate (829 mg, 6 mmol). Following conversion to product, work-up and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **283m** (279 mg, 63%) as yellow solid.

R_f = 0.27 [3:1 Hexane:EtOAc].

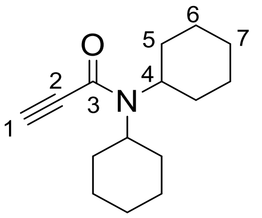
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.43 – 7.28 (m, 7H (**H$_{Aromatic}$**)), 7.29 (d, J = 7.6 Hz, 2H (**H$_{Aromatic}$**)), 7.22 (t, J = 6.9 Hz, 1H (**H$_{Aromatic}$**)), 2.95 (s, 1H (**H1**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 152.6 (**C3**), 141.9 (**C4**), 141.1 (**C4**), 129.5 (**C5** or **C6**), 129.2 (**C5** or **C6**), 129.1 (**C5** or **C6**), 128.5 (**C7**), 126.9 (**C7**), 126.0 (**C5** or **C6**), 81.0 (**C1**), 76.9 (**C2**).

IR: ν_{max} (neat/cm^{-1}) 3181 (C=C-H), 3086 (C-H), 2920 (C-H), 2851 (C-H), 2098 (C≡C), 1628 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{15}H_{12}NO$ 222.0913; found 222.0919.

***N,N*-Dicyclohexyl-2-propynamide – 283n**



The title compound was prepared according to general procedure **D**, from 3-(trimethylsilyl)propiolic acid (284 mg, 2 mmol) and dicyclohexylamine (795 µL, 4.00 mmol) using oxalyl chloride (300 mg, 2.40 mmol) and DMF (6 µL, 80 µmol). The crude product was subjected to TMS-deprotection using potassium carbonate (829 mg, 6 mmol). Following conversion to product, work-up and column chromatography [SiO$_2$; 20:1 Hexane:EtOAc] afforded **283n** (340 mg, 73%) as yellow oil.

R$_f$ = 0.21 [5:1 Hexane:EtOAc].

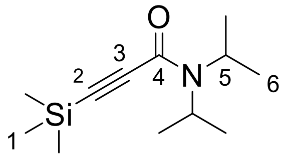
^{1}H NMR: (400 MHz, CDCl$_3$) δ 4.13 (s, 1H (**H4**)), 3.08 (s, 1H (**H4**)), 3.02 (s, 1H **H1**), 2.32 (m, 2H (**H$_{\text{Cyclohexyl}}$**)), 1.86 – 1.74 (m, 7H (**H$_{\text{Cyclohexyl}}$**)), 1.69 – 1.58 (m, 3H (**H$_{\text{Cyclohexyl}}$**)), 1.51 – 1.48 (m, 3H (**H$_{\text{Cyclohexyl}}$**)), 1.39 – 1.09 (m, 7H (**H$_{\text{Cyclohexyl}}$**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 152.7 (**C3**), 59.7 (**C2**), 55.8 (**C1**), 31.4 (**C$_{\text{Cyclohexyl}}$**), 29.6 (**C$_{\text{Cyclohexyl}}$**), 26.5 (**C$_{\text{Cyclohexyl}}$**), 26.0 (**C$_{\text{Cyclohexyl}}$**), 25.3 (**C$_{\text{Cyclohexyl}}$**), 25.3 (**C$_{\text{Cyclohexyl}}$**).

IR: ν_{max} (neat/cm^{-1}) 3298 (C=C-H), 3227 (C=C-H), 2924 (C-H), 2853 (C-H), 2098 (C≡C), 1612 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{15}H_{23}NONa$ 256.1678; found 256.1677.

Diisopropyl-3-(trimethylsilyl)-propiolamide – 283o'



The title compound was prepared according to general procedure **C**, from 3-(trimethylsilyl)propiolic acid (214 mg, 1.50 mmol) and diisopropylamine (294 µL, 2.10 mmol) using DDC (206 mg, 1.65 mmol) and HOBt (223 mg, 1.65 µmol). Following the conversion to product and column chromatography [SiO_2; 20:1 Hexane:EtOAc] afforded **283o’** (214 mg, 63%) as colourless oil.

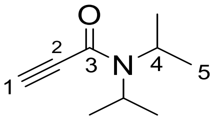
R_f = 0.49 [5:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 4.52 (s, 1H (**H5**)), 3.66 (s, 1H (**H5**)), 1.35 (d, *J* = 6.8 Hz, 6H (**H6**)), 1.26 (d, *J* = 6.8 Hz, 6H (**H6**)), 0.22 (s, 9H (**H1**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 153.2 (**C4**), 98.0 (**C3**), 95.1 (**C2**), 45.8 (**C5**), 21.1 (**C5**), 20.2 (**C6**), −0.5 (**C1**).

All spectral data in accordance with literature.[171]

Diisopropyl-propiolamide – 283o



The title compound was prepared according to general procedure **C**, from diisopropyl-3-(trimethylsilyl)-propiolamide (315 mg, 1.40 mmol) and potassium carbonate (580 mg, 4.20 mmol). Following the conversion to product and column chromatography [SiO_2; 5:1 Hexane:EtOAc] afforded **283o** (214 mg, 99%) as yellow oil.

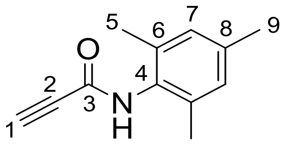
R_f = 0.15 [5:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 4.59 (s, 1H (**H4**)), 3.60 (s, 1H (**H4**)), 3.01 (s, 1H (**H1**)), 1.38 (d, *J* = 6.8 Hz, 6H (**H5**)), 1.25 (d, *J* = 6.8 Hz, 6H (**H5**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 152.5 (**C3**), 77.3 (**C2**), 45.9 (**C1**), 21.0 (**C4**), 20.1 (**C5**).

All spectral data in accordance with literature.[171]

N-(2,4,6-Trimethylphenyl)-2-propynamide – 283p



The title compound was prepared according to general procedure **C**, from 3-(trimethylsilyl)propiolic acid (285 mg, 2.00 mmol) and 2,4,6-trimethylaniline (337 µL, 2.40 mmol) using DDC (454 mg, 2.20 mmol) and HOBt (297 mg, 2.20 mmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **283p** (241 mg, 64%) as yellow oil.

R

$\boldsymbol{R_f}$ = 0.36 [3:1 Hexane:EtOAc].

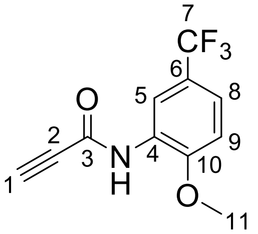
^{1}**H NMR**: (400 MHz, DMSO-d_6) δ 9.95 (s, 1H (**N-H**)), 6.86 (s, 2H (**H7**)), 2.22 (s, 3H (**H9**)), 2.09 (s, 6H (**H5**)).

^{13}**C NMR**: (101 MHz, DMSO-d_6) δ 150.1 (**C3**), 136.2 (**C4**), 134.7 (**C6**), 131.0 (**C8**), 128.4 (**C7**), 78.4 (**C2**), 76.3 (**C1**), 20.50 (**C9**), 17.9 (**C5**).

IR: ν_{max} (neat/cm^{-1}) 3226 (N-H), 3026 (C=C-H), 2916 (C-H), 2853 (C-H), 2105 (C≡C), 1627 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{12}H_{14}NO$ 188.1075; found 188.1082.

***N*-[2-Methoxy-5-(trifluoromethyl)phenyl]-2-propynamide – 283q**



The title compound was prepared according to general procedure **C**, from 3-(trimethylsilyl)propiolic acid (285 mg, 2.00 mmol) and 3-amino-4-methoxybenzotrifluoride (459 mg, 2.40 mmol) using DDC (454 mg, 2.20 mmol) and HOBt (297 mg, 2.2 mmol). The crude product was subjected to TMS-deprotection using potassium carbonate (552 mg, 4 mmol). Following the conversion to product and column chromatography [SiO_2; 5:1 Hexane:EtOAc] afforded **283q** (83 mg, 17%) as yellow oil.

$\boldsymbol{R_f}$ = 0.21 [3:1 Hexane:EtOAc].

^{1}**H NMR**: (400 MHz, DMSO-d_6) δ 10.25 (s, 1H (**N-H**)), 8.04 (s, 1H (**H5**)), 7.54 (d, *J* = 8.6 Hz (**H8**)), 7.26 (d, *J* = 8.7 Hz (**H9**)), 4.43 (s, 1H (**H1**)), 3.90 (s, 3H (**H11**)).

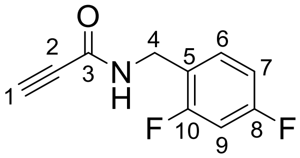
^{13}C NMR: (101 MHz, DMSO-d_6) δ 153.5 (**C3**), 150.4 (**C10**), 126.2 (**C4**), 124.3 (q, *J* = 271.2 Hz, (**C7**), 123.4 (q, *J* = 3.6 Hz, (**C5**), 120.7 (q, *J* = 32.2, (**C6**), 120.4 (q, *J* = 3.4 Hz, (**C8**)), 112.0 (**C2**), 78.1 (**C1**), 56.2 (**C11**).

^{19}F NMR: (376 MHz, DMSO-d_6) δ −60.0

IR: ν_{max} (neat/cm^{-1}) 3272 (N-H), 3226 (C=C-H), 3024 (C-H), 2916 (C-H), 2985 (C-H), 2107 (C≡C), 1617 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{11}H_9NO_2F_3$ 244.0585; found 244.0592.

N-[(2,4-Difluorophenyl)methyl]-2-propynamide – 283r



The title compound was prepared according to general procedure **C**, from 3-(trimethylsilyl)propiolic acid (285 mg, 2.00 mmol) and 2,4-difluorobenzylamine (285 µL, 2.40 mmol) using DDC (454 mg, 2.20 mmol) and HOBt (297 mg, 2.20 µmol). The crude product was subjected to TMS-deprotection using potassium carbonate (552 mg, 4 mmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **283r** (195 mg, 50%) as yellow oil.

R$_f$ = 0.28 [3:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, DMSO-d_6) δ 9.26 (m, 1H (**N-H**)), 7.38 – 7.32 (m, 1H (**H9**)), 7.25 – 7.21 (m, 1H (**H7**)), 7.08 (m, 1H (**H6**)), 4.29 (d, *J* = 5.9 Hz, 2H (**H4**)), 4.19 (s, 1H (**H1**)).

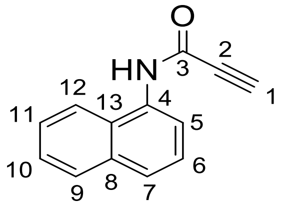
^{13}C NMR: (101 MHz, DMSO-d_6) δ 161.6 (dd, *J* = 245.5, 12.2 Hz (**C8** or **10**)), 160.1 (dd, *J* = 247.9, 12.4 Hz (**C8** or **C10**)), 151.7 (**C3**), 131.1 (dd, *J* = 9.9, 5.9 Hz (**C6**)), 121.4 (dd, *J* = 15.2, 3.6 Hz (**C5**)), 111.4 (dd, *J* = 21.2, 3.7 Hz (**C7**)), 103.8 (dd, *J* = 25.8 Hz (**C9**)), 78.0 (**C2**), 76.3 (**C1**), 35.9 (d, *J* = 3.7 Hz (**C4**)).

^{19}F NMR: (376 MHz, DMSO-d_6) δ −111.6, −114.2.

IR: ν_{max} (neat/cm^{-1}) 3286 (N-H), 3033 (C=C-H), 2924 (C-H), 2103 (C≡C), 1633 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{10}H_8NOF_2$ 196.0586; found 196.0580.

N-(Naphthalen-1-yl)propiolamide – 283s



The title compound was prepared according to general procedure **B**, from 1-naphtylamine (358 g, 2.5 mmol) and propiolic acid (200 μL, 3 mmol) using EDCI (575 mg, 3 mmol) and HOBt (68 mg, 500 μmol). Following the conversion to product, work-up and column chromatography [SiO$_2$; 5:1 Hexane:EtOAc] afforded **283s** (460 mg, 94%) as orange oil.

R_f = 0.25 [3:1 Hexane:EtOAc].

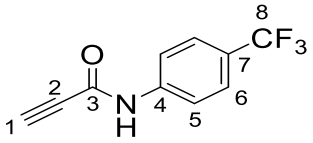
^{1}H NMR: (400 MHz, DMSO-d_6) δ 10.83 (s, 1H (**N-H**)), 7.96 (m, 2H ($\mathbf{H_{Aromatic}}$)), 7.84 (d, *J* = 8.1 Hz, 1H ($\mathbf{H_{Aromatic}}$)), 7.59 – 7.51 (m, 4H ($\mathbf{H_{Aromatic}}$)), 4.45 (s, 1H (**H1**)).

^{13}C NMR: (101 MHz, DMSO-d_6) δ 151.0 (**C3**), 133.7 ($\mathbf{C_{Aromatic}}$), 132.1 ($\mathbf{C_{Aromatic}}$), 128.1 ($\mathbf{C_{Aromatic}}$), 128.0 ($\mathbf{C_{Aromatic}}$), 126.5 ($\mathbf{C_{Aromatic}}$), 126.2 ($\mathbf{C_{Aromatic}}$), 125.5 ($\mathbf{C_{Aromatic}}$), 123.0 ($\mathbf{C_{Aromatic}}$), 122.7 ($\mathbf{C_{Aromatic}}$), 78.4 (**C2**), 77.5 (**C1**).

IR: ν_{max} (neat/cm^{-1}) 3199 (N-H), 2920 (C=C-H), 2953 (C-H), 2851 (C-H), 2104 (C≡C), 1625 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for C$_{13}$H$_{10}$NO 196.0755; found 196.0762.

N-(4-Trifluoromethylphenyl)propiolamide – 283t



The title compound was prepared according to general procedure **B**, from 4-aminobenzotrifluoride (403 mg, 2.5 mmol) and propiolic acid (200 μL, 3.0 mmol) using EDCI (575 mg, 3.0 mmol) and HOBt (68 mg, 500 μmol). Following the conversion to product, work-up and column chromatography [SiO$_2$; 9:1 Hexane:EtOAc] afforded **283t** (463 mg, 87%) as white solid.

R_f = 0.38 [2:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, DMSO-d_6) δ 11.16 (s, 1H (**N-H**)), 7.80 (d, *J* = 8.5 Hz, 2H (**H6**)), 7.70 (d, *J* = 8.5 Hz, 2H (**H5**)), 4.52 (s, 1H (**H1**)).

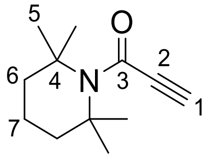
^{13}C NMR: (101 MHz, DMSO-*d$_6$*) δ 150.0 (**C3**), 141.7 (**C4**), 126.2 (q, *J* = 3.6 Hz, (**C6**)), 124.2 (q, *J* = 271.4 Hz, (**C8**)), 124.2 (q, *J* = 32.1 Hz, (**C7**)), 119.7 (**C5**), 78.0 (**C2**), 78.0 (**C1**).

^{19}F NMR: (376 MHz, DMSO) δ −60.5

IR: ν_{max} (neat/cm^{-1}) 3199 (N-H), 3017 (C=C-H), 2920 (C-H), 2851 (C-H), 2104 (C≡C), 1625 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{10}H_7F_3NO$ 214.0472; found 214.0470

2,2,6,6-Tetramethyl-1-piperidinyl-2-propyn-1-one – 283u



The title compound was prepared according to general procedure **D**, from 3-(trimethylsilyl)propiolic acid (285 mg, 2.00 mmol), and 2,2,6,6-tetramethylpiperidine (675 µL, 4.00 mmol), using oxalyl chloride (203 µL, 2.40 mmol) and DMF (6 µL, 80 µmol). The crude product was subjected to TMS-deprotection using potassium carbonate (829 mg, 6 mmol). Following conversion to product, work-up and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **283u** (355 mg, 92%) as yellow oil.

R$_f$ = 0.27 [10:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 3.13 (s, 1H (**H1**), 1.74 – 1.65 (m, 6H (**H6** and **H7**), 1.59 (s, 12H (**H5**).

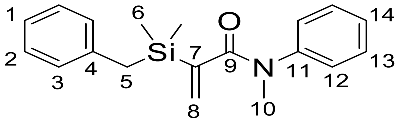
^{13}C NMR: (101 MHz, $CDCl_3$) δ 155.1 (**C3**), 81.3 (**C2**), 78.4 (**C1**), 57.3 (**C4**), 39.2 (**C6**), 29.9 (**C5**), 15.1 (**C7**).

IR: ν_{max} (neat/cm^{-1}) 3199 (C=C-H), 3015 (C-H), 2967 (C-H), 2085 (C≡C), 1600 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{12}H_{19}NONa$ 216.1364; found 216.1366.

7.4.3 α-Silyl-α,β-unsaturated Amides

2-(Benzyldimethylsilyl)-*N*-methyl-*N*-phenylacrylamide – 284a



The title compound was prepared according to general procedure **E**, from *N*-methyl-*N*-phenyl-2-propynamide (250 mg, 1.57 mmol) and benzyldimethylsilane (470 µL, 2.36 mmol) using platinum (II) chloride (20 mg, 78.5 µmol) and tris(pentafluorophenyl)phosphine (83 mg, 157 µmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **284a** (326 mg, 67%) as yellow oil.

Rf = 0.51 [3:1 Hexane:EtOAc].

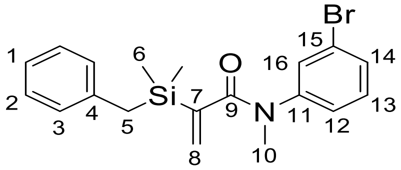
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.31 (t, *J* = 7.6 Hz, 2H (**H12**)), 7.24 – 7.20 (m, 1H (**H14**)), 7.18 (d, *J* = 7.6 Hz, 2H (**H2**)), 7.08 – 7.04 (m, 3H (**H1** and **H13**)), 6.98 (d, *J* = 7.4 Hz, 2H (**H3**)), 5.68 (s, 1H (**H8**)), 5.45 (s, 1H (**H8**)), 3.35 (s, 3H (**H10**)), 2.17 (s, 2H (**H5**)), 0.04 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 173.1 (**C9**), 148.0 (**C7**), 144.5 (**C11**), 139.4 (**C4**), 131.9 (**C8**), 129.2 (**C12**), 128.6 (**C3**), 128.2 (**C3**), 127.7 (**C13**), 127.0 (**C14**), 124.3 (**C1**), 37.9 (**C10**), 25.4 (**C5**), −3.3 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3049 (C=C-H), 2916 (C-H), 2853 (C-H), 1627 (C=O), 1593 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{19}H_{24}NOSi$ 310.1627; found 310.1617.

2-(Benzyldimethylsilyl)-*N*-(3-bromophenyl)-*N*-methylacrylamide – 284b



The title compound was prepared according to general procedure **E**, from *N*-(3-bromophenyl)-*N*-methyl-2-propynamide (100 mg, 421 µmol) and benzyldimethylsilane (100 µL, 632 µmol) using platinum (II) chloride (7 mg, 21.1 µmol) and tris(pentafluorophenyl)phosphine (23 mg, 42.1 µmol). Following the conversion to product and column chromatography [SiO_2; 15:1 Hexane:EtOAc] afforded **284b** (115 mg, 70%) as yellow oil.

Rf = 0.37 [3:1 Hexane:EtOAc].

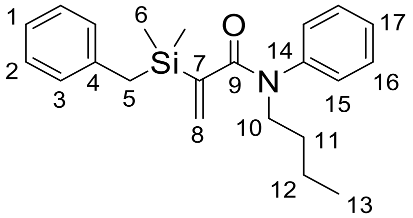
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.35 (ddd, *J* = 8.0, 1.8, 0.9 Hz, 1H (**H14**)), 7.22 – 7.16 (m, 4H (**H2**, **H13** and **H16**)), 7.07 (t, *J* = 7.4 Hz, 1H (**H1**)), 7.01 (d, *J* = 7.1 Hz, 2H (**H3**)), 6.97 (d, *J* = 7.6 Hz, 1H (**H12**)), 5.67 (s, 1H (**H8**)), 5.49 (s, 1H (**H8**)), 3.32 (s, 3H (**H10**)), 2.22 (s, 2H (**H5**)), 0.08 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 173.0 (**C9**), 147.8 (**C7**), 145.8 (**C11**), 139.3 (**C4**), 132.3 (**C8**), 130.7 (**C12**), 130.4 (**$C_{Aromatic}$**), 130.0 (**$C_{Aromatic}$**), 128.7 (**$C_{Aromatic}$**), 128.6 (**C3**), 128.3 (**C2**), 126.1 (**$C_{Aromatic}$**), 124.4 (**C1**), 122.5 (**C15**), 37.9 (**C10**), 25.3 (**C5**), −3.2 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3043 (C=C-H), 2917 (C-H), 2145 (C-H), 1639 (C=O), 1598 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{19}H_{23}NOSiBr$ 388.0.732; found 388.0718.

2-(Benzyldimethylsilyl)-*N*-butyl-*N*-phenylacrylamide – 284c



The title compound was prepared according to general procedure **E**, from *N*-butyl-*N*-phenyl-2-propynamide (200 mg, 994 µmol) and dimethylbenzylsilane (236 µL, 1.49 mmol) using platinum (II) chloride (17 mg, 49.7 µmol) and tris(pentafluorophenyl)phosphine (51 mg, 99.4 µmol). Following the conversion to product and column chromatography [SiO_2; 25:1 Hexane:EtOAc] afforded **284c** (226 mg, 65%) as yellow oil.

R$_f$ = 0.39 [3:1 Hexane:EtOAc].

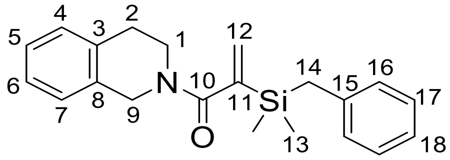
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.39 (m, 2H (**H15**)), 7.33 – 7.31 (m, 1H (**H17**)), 7.26 (t, *J* = 7.5 Hz, 2H (**H2**)), 7.15 – 7.12 (m, 3H (**H1** and **H16**)), 7.06 (d, *J* = 7.4 Hz, 2H (**H3**)), 5.67 (s, 1H (**H8**)), 5.45 (s, 1H (**H8**)), 3.85 (t, *J* = 6.4 Hz, 2H (**H10**)), 2.26 (s, 2H (**H5**)), 1.61 – 1.58 (m, 2H (**H11**)), 1.43 – 1.37 (m, 2H (**H12**)), 0.97 (t, *J* = 7.3 Hz, 3H (**H13**)), 0.12 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 172.6 (**C9**), 147.9 (**C7**), 143.2 (**C14**), 139.4 (**C4**), 131.6 (**C8**), 129.1 (**C15**), 128.7 (**C16**), 128.5 (**C3**), 128.2 (**C2**), 127.1 (**C17**), 124.2 (**C1**), 49.5 (**C10**), 30.0 (**C11**), 25.4 (**C5**), 20.2 (**C12**), 13.9 (**C13**), −3.5 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3058 (C=C-H), 2955 (C-H), 2929 (C-H), 1647 (C=O), 1593 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{22}H_{30}NOSi$ 352.2097; found 352.2107.

2-(Benzyldimethylsilyl)-1-(3,4-dihydroisoquinolin-2(1*H*)-yl)prop-2-en-1-one – 284e



The title compound was prepared according to general procedure **E**, from 1-(3,4-dihydro-2(1*H*)-isoquinolinyl)-2-propyn-1-one (200 mg, 1.07 mmol) and benzyldimethylsilane (255 μL, 1.61 mmol) using platinum (II) chloride (18 mg, 53.5 μmol) and tris(pentafluorophenyl)phosphine (57 mg, 107 μmol). Following the conversion to product and column chromatography [SiO_2; 5:1 Hexane:EtOAc] afforded **284e** (205 mg, 57%) as yellow oil.

R$_f$ = 0.36 [2:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$, mixture of rotamers observed, minor indicated by *) δ 7.31 – 7.01 (m, 10 H (**H$_{Aromatic}$**)), 5.89 (s, 1H (**H12**)), 5.71 (s, 1H (**H12**)), 4.84 (s, 1H (**H9**)), 4.76 (s, 1H (**H9***)), 4.58 (s, 1H (**H9**)), 4.55 (s, 1H (**H9***)), 3.95 (m, 1H (**H1**)), 3.86 (m, 1H (**H1***)), 3.64 (m, 1H (**H1**)), 3.60 (m, 1H (**H1***)), 2.95 (m, 1H (**H2**)), 2.90 (m, 2H (**H2***)), 2.82 (m, 1H (**H2**)), 2.37 (s, 2H (**H14***)), 2.30 (s, 2H (**H14**)), 0.21 (s, 3H (**H13**)), 0.13 (s, 3H (**H13**)), 0.08 (s, 3H (**H13***)), 0.05 (s, 3H (**H13***)).

^{13}C NMR: (101 MHz, $CDCl_3$, mixture of rotamers observed) δ 172.7 (**C10**), 172.3 (**C10**), 148.3 (**C11**), 139.2 (**C15**), 134.0, 133.2, 129.2, 128.8, 128.6, 128.5, 128.4, 128.3, 128.2, 127.0, 126.9, 126.7, 126.6, 126.4, 126.0, 124.4, 124.2, 49.3 (**C9**), 44.5 (**C1**), 44.1 (**C9**), 39.8 (**C1**), 29.9 (**C2**) 28.5 (**C2**), 25.7 (**C14**), 25.1 (**C14**), −3.4 (**C13**), −3.5 (**C13**).

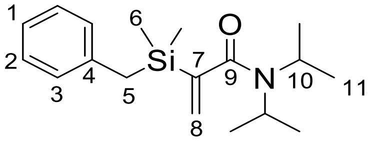
IR: ν_{max} (neat/cm^{-1}) 3021 (C=C-H), 2958 (C-H), 2916 (C-H), 2849 (C-H), 1599 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{21}H_{26}NOSi$ 336.1784; found 336.1786.

Additional NMR data were acquired from nominal temperatures of 25 °C to 145 °C in 10 °C intervals (see spectral appendix for NMR spectra at each temperature). Temperatures reported are externally calibrated using the Bruker ethylene glycol-d_6 reference sample Z10629, and AU program calctemp.

VT NMR at 398 K ^{1}H NMR: (400 MHz, Ethylene glycol d_6) δ 7.20 – 7.11 (m, 6H (**H$_{\mathbf{Aromatic}}$**)), 7.06 – 7.03 (m, 3H (**H$_{\mathbf{Aromatic}}$**)), 5.81 (d, *J* = 2.4 Hz, 1H (**H12**)), 5.69 (d, *J* = 2.4 Hz, 1H (**H12**)), 4.61 (m, 2H (**H9**)), 3.69 (t, *J* = 6.1 Hz, 2H (**H1**)), 2.81 (t, *J* = 6.2 Hz, 2H (**H2**)), 2.27 (s, 2H (**H14**)), 0.09 (s, 6H (**H13**)).

2-(Benzyldimethylsilyl)-*N,N*-diisopropylacrylamide – 284g



The title compound was prepared according to general procedure **E**, from diisopropyl-propiolamide (100 mg, 653 μmol) and benzyldimethylsilane (155 μL, 980 μmol) using platinum (II) chloride (11 mg, 32.7 μmol) and tris(pentafluorophenyl)phosphine (35 mg, 65.3 μmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **284g** (98 mg, 49%) as yellow oil.

R$_f$ = 0.73 [2:1 Hexane:EtOAc].

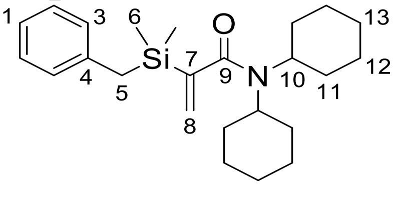
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.22 (t, *J* = 7.5 Hz, 2H, (**H2**)), 7.09 – 7.04 (m, 3H, (**H1** and **H3**)), 5.71 (d, *J* = 2.4 Hz, 1H, (**H8**)), 5.47 (d, *J* = 2.5 Hz,1H, (**H8**)), 4.02 – 3.99 (m, 1H, (**H10**)), 3.39 – 3.36 (m, 1H, (**H10**)), 2.29 (s, 2H, (**H5**)), 1.46 (d, *J* = 6.5 Hz, 6H, (**H11**)), 1.08 (d, *J* = 6.3 Hz, 6H, (**H11**)), 0.12 (s, 6H, (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 172.9 (**C9**), 149.9 (**C7**), 139.4 (**C4**), 128.6 (**C3**), 128.3 (**C2**), 125.6 (**C8**), 124.3 (**C1**), 29.9 (**C10**), 25.4 (**C5**), 20.9 (**C11**), −3.5 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3058 (C=C-H), 2963 (C-H), 2892 (C-H), 1628 (C=O), 1597 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{18}H_{30}NOSi$ 304.2097; found 304.2113.

2-(Benzyldimethylsilyl)-*N,N*-dicyclohexylacrylamide – 284h



The title compound was prepared according to general procedure **E**, from *N,N*-dicyclohexyl-2-propynamide (100 mg, 429 μmol) and dimethylbenzylsilane (102 μL, 644 μmol) using platinum (**II**) chloride (7 mg, 21.5 μmol) and tris(pentafluorophenyl)phosphine (23 mg, 42.9 μmol). Following the conversion to product and column chromatography [SiO_2; 20:1 Hexane:EtOAc] afforded **284h** (101 mg, 64%) as yellow oil.

R$_f$ = 0.39 [5:1 Hexane:EtOAc].

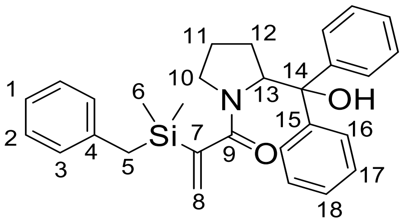
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.22 – 7.18 (m, 2H (**H3**)), 7.09 – 7.00 (m, 3H (**H1** and **H2**)), 5.68 (d, *J* = 2.2 Hz, 1H (**H8**)), 5.42 (d, *J* = 2.3 Hz, 1H (**H8**)), 3.59 – 3.56 (m, 1H (**H**$_{\textbf{Cyclohexyl}}$)), 3.31 (m, 1H ((**H**$_{\textbf{Cyclohexyl}}$)), 2.91 – 2.88 (m, 1H (**H**$_{\textbf{Cyclohexyl}}$)), 2.58 – 2.55 (m, 2H (**H**$_{\textbf{Cyclohexyl}}$)), 2.28 (s, 2H (**C5**)), 1.88 – 1.75 (m, 6H (**H**$_{\textbf{Cyclohexyl}}$)), 1.64 – 1.62 (m, 7H (**H**$_{\textbf{Cyclohexyl}}$)), 1.52 – 1.42 (m, 6H (**H**$_{\textbf{Cyclohexyl}}$)), 1.30 – 1.05 (m, 11H (**H**$_{\textbf{Cyclohexyl}}$)), 0.11 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 173.2 (**C9**), 150.0 (**C7**), 140.2 (**C4**), 139.4 (**C4**), 128.5 (**C2** or **C3**), 128.3 (**C2** or **C3**), 128.2 (**C2** or **C3**), 125.2 (**C8**), 124.3 (**C1**), 124.1 (**C1**), 59.1 (**C10**), 55.9 (**C10**), 31.4 (**C**$_{\textbf{Cyclohexyl}}$), 30.3 (**C**$_{\textbf{Cyclohexyl}}$), 29.7 (**C**$_{\textbf{Cyclohexyl}}$), 26.8 (**C**$_{\textbf{Cyclohexyl}}$), 26.2 (**C**$_{\textbf{Cyclohexyl}}$), 25.9 (**C**$_{\textbf{Cyclohexyl}}$), 25.8 (**C**$_{\textbf{Cyclohexyl}}$), 25.5 (**C**$_{\textbf{Cyclohexyl}}$), 25.4 (**C**$_{\textbf{Cyclohexyl}}$), 25.3 (**C**$_{\textbf{Cyclohexyl}}$), 25.2 (**C5**), −3.5 (**C6**), −3.5 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3024 (C=C-H), 2927 (C-H), 2853 (C-H), 1628 (C=O), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{24}H_{38}NOSi$ 384.2723; found 384.2724.

2-(Benzyldimethylsilyl)-1-(2-(hydroxydiphenylmethyl)pyrrolidine-1-yl)prop-2-en-1-one – 284i



The title compound was prepared according to general procedure **E**, from 1-(2-(hydroxydiphenylmethyl)pyrrolidine-1-yl)prop-2-yn-1-one (100 mg, 327 μmol) and benzyldimethylsilane (105 μL, 491 μmol) using platinum (II) chloride (6 mg, 16.4 μmol) and tris(pentafluorophenyl)phosphine (17 mg, 32.7 μmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **284i** (109 mg, 74%) as yellow oil.

R_f = 0.35 [2:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.55 (dd, *J* = 8.0, 1.4 Hz, 2H (**H_{Aromatic}**)), 7.43 (d, *J* = 7.1 Hz, 2H (**H_{Aromatic}**)), 7.36 – 7.28 (m, 5H (**H18** and **H_{Aromatic}**)), 7.24 – 7.18 (m, 3H (**H_{Aromatic}** and **H2**)), 7.07 (t, *J* = 7.4 Hz, 1H (**H1**)), 7.01 (d, *J* = 7.2 Hz, 2H (**H3**)), 5.52 (d, *J* = 2.3 Hz,1H (**H8**)), 5.43 (d, *J* = 2.3 Hz, 1H (**H8**)), 5.16 – 5.12 (m, 1H (**H13**)), 3.25 (ddd, *J* = 11.2, 8.0, 3.0 Hz, 1H (**H10**)), 2.65 (td, *J* = 10.1, 7.0 Hz, 1H (**H10**)), 2.24 (s, 2H (**H5**)), 2.15 – 2.05 (m, 1H (**H12**)), 2.00 – 1.90 (m, 1H (**H12**)), 1.48 – 1.41 (m, 1H (**H11**)), 1.33 – 1.26 (m, 1H (**H11**)), 0.10 (s, 3H (**H6**)), 0.09 (s, 3H (**H6**)).

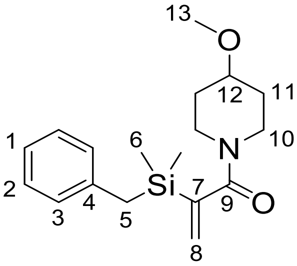
^{13}C NMR: (101 MHz, $CDCl_3$) δ 175.3 (**C9**), 148.7 (**C7**), 145.7 (**C15**), 143.1 (**C15**), 139.1 (**C4**), 129.7 (**C8**), 128.5 (**C3**), 128.3 (**C2**), 128.2 (**C_{Aromatic}**), 128.1 (**C_{Aromatic}**), 128.0 (**C_{Aromatic}**), 127.5 (**C_{Aromatic}**), 127.4 (**C18**), 127.3 (**C18**), 124.4 (**C1**), 82.1 (**C14**), 67.6 (**C13**), 51.0 (**C10**), 30.2 (**C12**), 25.0 (**C5**), 24.1 (**C11**), −3.5 (**C6**), −3.5 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3456 (O-H), 2988 (C-H), 2917 (C-H), 1610 (C=O).

3022 (C=C-H), 2946 (C-H), 2894 (C-H), 2823 (C-H), 1617 (C=O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{29}H_{33}NO_2SiNa$ 478.2178; found 478.2179.

2-(Benzyldimethylsilyl)-1-(4-methoxypiperidin-1-yl)prop-2-en-1-one – 284j



The title compound was prepared according to general procedure **E**, from 1-(4-methoxy-1-piperidinyl)-2-propyn-1-one (200 mg, 1.20 mmol) and benzyldimethylsilane (284 µL, 1.79 mmol) using platinum (II) chloride (20 mg, 59.8 µmol) and tris(pentafluorophenyl)phosphine (64 mg, 120 µmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **284j** (246 mg, 65%) as yellow oil.

R_f = 0.41 [2:1 Hexane:EtOAc].

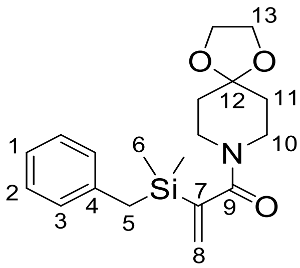
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.20 (t, *J* = 7.5 Hz, 2H (**H2**)), 7.07 (t, *J* = 7.4 Hz, 1H (**H1**)), 7.04 (d, *J* = 7.4 Hz, 2H (**H3**)), 5.77 (d, *J* = 2.4 Hz, 1H (**H8**)), 5.57 (d, *J* = 2.4 Hz, 1H (**H8**)), 4.00 – 3.97 (m, 1H (**H10**)), 6.63 – 3.61 (m, 1H (**H10**)), 3.42 (ddd, *J* = 11.3, 7.5, 3.5 Hz (**H12**)), 3.36 (s, 3H (**H13**)), 3.35 – 3.32 (m, 1H (**H10**)), 3.19 – 3.15 (m, 1H (**H10**)), 2.28 (s, 2H (**H5**)), 1.89 – 1.87 (m, 1H (**H11**)), 1.76 – 1.73 (m, 1H (**H11**)), 1.59 – 1.55 (m, 1H (**H11**)), 1.47 – 1.45 (m, 1H (**H11**)), 0.12 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 172.0 (**C9**), 148.2 (**C7**), 139.2 (**C4**), 128.6 (**C3**), 128.3 (**C2**), 128.0 (**C8**), 124.4 (**C1**), 75.7 (**C12**), 55.9 (**C13**), 44.2 (**C10**), 38.5 (**C10**), 31.5 (**C11**), 30.5 (**C11**), 21.2 (**C5**), −3.5 (**C6**), −3.6 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3022 (C=C-H), 2946 (C-H), 2894 (C-H), 2823 (C-H), 1617 (C=O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{18}H_{28}NO_2Si$ 318.1889; found 318.1903.

2-(Benzyldimethylsilyl)-1-(1,4-dioxa-8-azaspiro[4.5]decan-8-yl)prop-2-en-1-one – 284k



The title compound was prepared according to general procedure **E**, from 1-(1,4-dioxa-8-azaspiro[4.5]dec-8-yl)-2-propyn-1-one (250 mg, 1.28 mmol) and benzyldimethylsilane (304 µL, 1.92 mmol) using platinum (II) chloride (17 mg, 64.0 µmol) and tris(pentafluorophenyl)phosphine (68 mg, 128 µmol). Following the conversion to product and column chromatography [SiO_2; 2:1 Hexane:EtOAc] afforded **284k** (264 mg, 60%) as yellow oil.

R_f = 0.43 [1:1 Hexane:EtOAc].

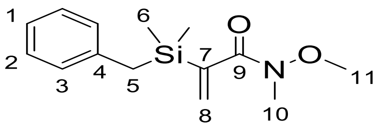
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.22 – 7.19 (t, *J* = 7.5 Hz, 2H, (**H2**)), 7.07 (t, *J* = 7.4 Hz, 1H, (**H1**)), 7.04 (d, *J* = 7.6 Hz, 2H, (**H3**)), 5.78 (d, *J* = 2.1 Hz, 1H, (**H8**)), 5.58 (d, *J* = 2.2 Hz, 1H, (**H8**)), 3.98 (d, *J* = 4.4 Hz, 4H, (**H13**)), 3.75 – 3.73 (m, 2H, (**H10**)), 3.48 – 3.47 (m, 2H, (**H10**)), 2.28 (s, 2H, (**H5**)), 1.72 – 1.70 (m, 2H, (**H11**)), 1.60 – 1.58 (m, 2H, (**H11**)), 0.12 (s, 6H, (**H6**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 172.1 (**C9**), 148.1 (**C7**), 139.2 (**C4**), 128.6 (**C3**), 128.3 (**C2**), 128.2 (**C8**), 124.4 (**C1**), 107.2 (**C12**), 64.6 (**C13**), 45.0 (**C10**), 39.4 (**C10**), 35.7 (**C11**), 35.0 (**C11**), 25.1 (**C5**), −3.6 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 2926 (C=C-H), 2955 (C-H), 2883 (C-H), 1617 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{19}H_{28}NO_3Si$ 346.1838; found 346.1831.

2-(Benzyldimethylsilyl)-*N*-methoxy-*N*-methylacrylamide – 284l



The title compound was prepared according to general procedure **E**, from *N*-methoxy-*N*-methylpropiolamide (250 mg, 2.21 mmol) and dimethylbenzylsilane (525 µL, 3.32 mmol) using platinum (**II**) chloride (37 mg, 111 µmol) and tris(pentafluorophenyl)phosphine (118 mg, 221 µmol). Following the conversion to product and column chromatography [SiO$_2$; 3:1 Hexane:EtOAc] afforded **284l** (379 mg, 65%) as yellow oil.

R$_f$ = 0.19 [3:1 Hexane:EtOAc].

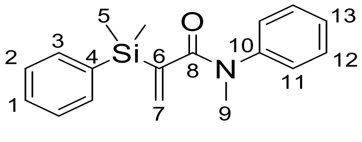
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.21 (t, *J* = 7.5 Hz, 2H (**H2**)), 7.07 (t, *J* = 7.4 Hz, 1H (**H1**)), 7.03 (d, *J* = 7.5 Hz, 2H (**H3**)), 6.04 (d, *J* = 2.1 Hz, 1H (**H8**)), 5.60 (d, *J* = 2.3 Hz, 1H (**H8**)), 3.58 (s, 3H (**H11**)), 3.22 (s, 3H (**H10**)), 2.26 (s, 2H (**H5**)), 0.11 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 173.4 (**C9**), 148.3 (**C7**), 139.3 (**C4**), 129.9 (**C8**), 128.6 (**C3**), 128.3 (**C2**), 124.4 (**C1**), 60.9 (**C11**), 33.1 (**C10**), 25.5 (**C5**), −3.2 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3029 (C=C-H), 2936 (C-H), 2860 (C-H), 1628 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{14}H_{22}NO_2Si$; 264.1420 found 264.1443.

2-(Dimethyl(phenyl)silyl)-*N*-methyl-*N*-phenylacrylamide – 284m



The title compound was prepared according to general procedure **E**, from *N*-methyl-*N*-phenyl-2-propynamide (100 mg, 629 μmol) and dimethylphenylsilane (144 μL, 943 μmol) using platinum (**II**) chloride (8 mg, 31.5 μmol) and tris(pentafluorophenyl)phosphine (34 mg, 62.9 μmol). Following the conversion to product and column chromatography [SiO_2; 20:1 Hexane:EtOAc] afforded **284m** (91 mg, 49%) as yellow oil.

$\boldsymbol{R_f}$ = 0.23 [5:1 Hexane:EtOAc].

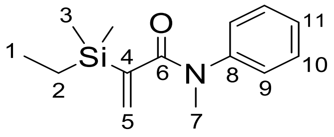
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.49 – 7.47 (m, 2H ($\mathbf{H_{Aromatic}}$)), 7.40 – 7.28 (m, 5H ($\mathbf{H_{Aromatic}}$)), 7.24 – 7.13 (m, 3H ($\mathbf{H_{Aromatic}}$)), 6.88 (m, 2H ($\mathbf{H_{Aromatic}}$)), 5.73 (s, 1H (**H7**)), 5.51 (s, 1H (**H7**)), 3.25 (s, 3H (**H9**)), 0.38 (s, 6H (**H5**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 173.1 (**C8**), 148.4 (**C6**), 144.3 (**C10**), 136.9 (**C4**) 134.3 ($\mathbf{C_{Aromatic}}$), 133.0 (**C7**), 129.5 ($\mathbf{C_{Aromatic}}$), 129.1 ($\mathbf{C_{Aromatic}}$), 127.9 ($\mathbf{C_{Aromatic}}$), 126.8 ($\mathbf{C_{Aromatic}}$), 37.8 (**C9**), −2.6 (**C5**).

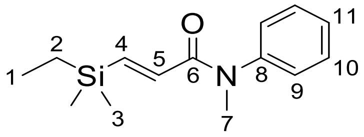
IR: ν_{max} (neat/cm^{-1}) 3059 (C=C-H), 2143 (C-H), 1626 (C=O), 1598 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{18}H_{22}NOSi$ 296.1471; found 296.1464.

2-(Dimethyl(ethyl)silyl)-*N*-methyl-*N*-phenylacrylamide – 284n and **(*E*)-3-(Dimethyl(ethyl)silyl)-*N*-methyl-*N*-phenylacrylamide – 285s**



284n



285s

The title compound was prepared according to general procedure **E**, from *N*-methyl-*N*-phenyl-2-propynamide (50 mg, 315 μmol) and dimethylethyl (125 μL, 945 μmol) using platinum (**II**) chloride (4 mg, 15.8 μmol) and tris(pentafluorophenyl)phosphine (17 mg, 31.5 μmol). Following the conversion to product (86:14, **284n**:**285s**) and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **284n** and **285s** as a regioisomeric mixture (71 mg, 91%) as yellow oil.

$\boldsymbol{R_f}$ = 0.38 [3:1 Hexane:EtOAc].

^{1}H NMR (α-isomer 284n): (400 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.7 Hz, 2H (**H9**)), 7.23 (t, *J* = 7.4 Hz, 1H (**H11**)), 7.13 (d, *J* = 7.3 Hz, 2H (**H10**)), 5.71 (s, 1H (**H5**)), 5.52 (s, 1H (**H5**)), 3.35 (s, 3H (**H7**)), 0.88 (t, *J* = 7.9 Hz, 3H (**H1**)), 0.53 (q, *J* = 7.7 Hz, 2H (**H2**)), 0.04 (s, 6H (**H3**)).

^{13}C NMR (α-isomer 284n): (101 MHz, CDCl$_3$) δ 173.5 (**C6**), 149.0 (**C4**), 144.3 (**C8**), 129.5 (**C5**), 129.2 (**C9**), 127.6 (**C10**), 126.9 (**C11**), 29.8 (**C7**), 7.2 (**C2**), 7.0 (**C1**), −3.6 (**C3**).

^{1}H NMR (β-isomer 285s): (400 MHz, CDCl$_3$) δ 7.40 (t, *J* = 7.3 Hz, 2H (**H9**)), 7.20 – 7.11 (m, 3H (**H10** and **H11**)), 7.14 (d, *J* = 18.3 Hz, 1H (**H5**)), 6.16 (d, *J* = 18.4 Hz, 1H (**H4**)), 3.36 (s, 3H (**H7**)), 0.81 (t, *J* = 8.0 Hz, 3H (**H1**)), 0.46 (q, *J* = 7.9 Hz, 2H (**H2**)), −0.06 (s, 6H (**H3**)).

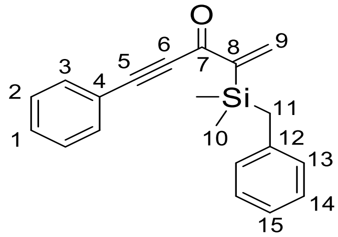
^{13}C NMR (β-isomer 285s): (101 MHz, CDCl$_3$) δ 165.8 (**C6**), 144.5 (**C5**), 143.6 (**C8**), 135.0 (**C4**), 131.1 (**C9**), 129.8 (**C10**), 127.3 (**C11**), 128.7 (**C7**), 7.2 (**C2**), 6.9 (**C1**), −4.0 (**C3**).

IR: ν_{max} (neat/cm^{-1}) 3081 (C=C-H), 2963 (C-H), 2892 (C-H), 1629 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+Na]$^+$ Calcd for $C_{14}H_{21}NONaSi$ 270.1290; found 270.1305.

7.4.4 α-Silyl-α,β-unsaturated Compounds

2-(Benzyldimethylsilyl)-5-phenylpent-1-en-4-yn-3-one – 299a



The title compound was prepared according to general procedure **F**, from 2-(benzyldimethylsilyl)-*N*-methoxy-*N*-methylacrylamide (50 mg, 189 µmol) and phenylacetylene (23 µL, 209 µmol) using *n*BuLi (200 µL, 209 µmol, 1 M in hexane). Following the conversion to product, work-up and column chromatography [SiO$_2$; 100:1 Hexane:EtOAc] afforded **299a** (27 mg, 47%) as yellow oil.

R$_f$ = 0.61 [5:1 Hexane:EtOAc].

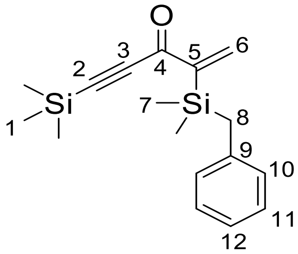
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.61 (d, *J* = 6.9 Hz, 2H (**H3**)), 7.46 (t, *J* = 7.4 Hz, 1H (**H1**)), 7.40 (t, *J* = 7.3 Hz 2H (**H2**)), 7.20 (t, *J* = 7.6 Hz, 1H (**H14**)), 7.13 (d, *J* = 1.9 Hz, 1H (**H9**)), 7.06 (t, *J* = 7.4 Hz, 1H (**H15**)), 6.99 (d, *J* = 7.2 Hz, 2H (**H13**)), 6.41 (d, *J* = 1.9 Hz, 1H (**H9**)), 2.35 (s, 2H (**H11**)), 0.17 (s, 6H (**H10**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 183.6 (**C7**), 151.6 (**C8**), 144.4 (**C9**), 139.6 (**C12**), 133.1 (**C3**), 130.7 (**C1**), 128.8 (**C3**), 128.4 (**C14**), 128.3 (**C13**), 124.3 (**C15**), 120.4 (**C4**), 91.8 (**C5**), 86.1 (**C6**), 25.1 (**C11**), −3.4 (**C10**).

IR: ν_{max} (neat/cm^{-1}) 3024 (C=C-H), 2865 (C-H), 1617 (C=O), 1594 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{20}H_{21}OSi$ 305.1362; found 305.1376.

2-(Benzyldimethylsilyl)-5-(trimethylsilyl)pent-1-en-4-yn-3-one – 299c



The title compound was prepared according to general procedure **F**, from 2-(benzyldimethylsilyl)-*N*-methoxy-*N*-methylacrylamide (25 mg, 89.1 μmol) and TMS-acetylene (14 μL, 98 μmol) using *n*BuLi (99 μL, 98 μmol, 1 M in hexane). Following the conversion to product, work-up and column chromatography [SiO$_2$; 100:1 Hexane:EtOAc] afforded **299c** (22 mg, 81%) as yellow oil.

R$_f$ = 0.70 [5:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.19 (t, *J* = 7.6 Hz, 1H (**H11**)), 7.09 – 7.06 (m, 1H (**H12**)), 7.04 (d, *J* = 2.0 Hz, 1H (**H6**)), 6.96 (d, *J* = 7.0 Hz, 2H (**H10**)), 6.37 (d, *J* = 2.0 Hz, 1H (**H6**)), 2.30 (s, 2H (**H8**)), 0.27 (s, 9H (**H1**)), 0.13 (s, 6H (**H7**)).

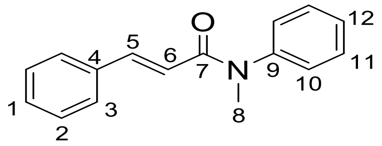
^{13}C NMR: (101 MHz, CDCl$_3$) δ 183.3 (**C4**), 151.1 (**C5**), 145.1 (**C6**), 139.6 (**C9**), 128.4 (**C10**), 128.3 (**C11**), 124.3 (**C12**), 100.1 (**C3**), 98.9 (**C2**), 25.0 (**C8**), −0.5 (**C1**), −3.5 (**C7**).

IR: ν_{max} (neat/cm^{-1}) 3028 (C=C-H), 2846 (C-H), 1617 (C=O), 1598 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{17}H_{25}OSi_2$ 301.1444; found 301.1454.

7.4.5 α,β-Unsaturated Amides

N-Methyl-*N*-phenylcinnamamide – 297



The title compound was prepared according to general procedure **G**, from 2-(benzyldimethylsilyl)-*N*-methyl-*N*-phenylacrylamide (50 mg, 162 μmol) and iodobenzene (27 μL, 243 μmol) using $Pd_2(dba)_3$ (7 mg, 8 μmol) and TBAF (325 μL, 324 μmol, 1 M in THF). Following the conversion to product, work-up and column chromatography [SiO_2; 2:1 Hexane:EtOAc] afforded **297** (25 mg, 67%) as yellow oil.

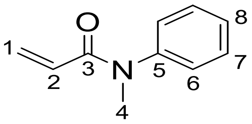
R R_f = 0.57 [5:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 15.6 Hz, 1H (**H5**)), 7.44 (t, *J* = 7.5 Hz, 2H (**H3**)), 7.36 (t, *J* = 7.4 Hz, 1H (**H1**)), 7.33 – 7.27 (m, 5H (**H2**, **H10** and **H12**)), 7.24 (d, *J* = 7.3 Hz, 2H (**H11**)), 6.37 (d, *J* = 15.5 Hz, 1H (**H6**)), 3.42 (s, 3H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 166.3 (**C7**), 143.8 (**C9**), 141.8 (**C5**), 135.3 (**C4**), 129.8 (**C10**), 129.6 (**C1**), 128.8 (**C11**), 128.0 (**C2**), 127.7 (**C12**), 127.5 (**C3**), 118.9 (**C6**), 37.7 (**C8**).

All spectral data in accordance with literature.[214]

N-Methyl-*N*-phenylacrylamide – 291



The title compound was prepared according to general procedure **H**, from 2-(benzyldimethylsilyl)-*N*-methyl-*N*-phenylacrylamide (30 mg, 107 μmol) and TBAF (430 μL, 213 μmol, 1 M in THF). Following the conversion to product, work-up and column chromatography [SiO_2; 2:1 Hexane:EtOAc] afforded **291** (14 mg, 92%) as yellow oil.

R_f = 0.44 [1:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.41 (t, *J* = 7.4 Hz, 2H (**H7**)), 7.33 (t, *J* = 7.3 Hz, 1H (**H8**)), 7.17 (d, *J* = 7.8 Hz, 1H (**H6**)), 6.36 (d, *J* = 16.8 Hz, 1H (**H1**)), 6.07 (dd, *J* = 16.1, 10.4 Hz, 1H (**H2**)), 5.51 (d, *J* = 10.3 Hz (**H1**)), 3.36 (s, 3H (**H4**)).

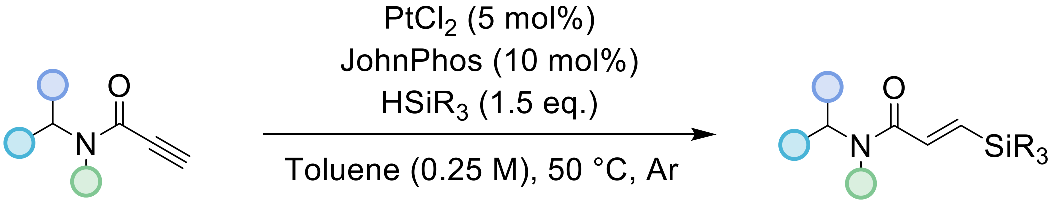
^{13}C NMR: (101 MHz, $CDCl_3$) δ 165.9 (**C3**), 143.6 (**C5**), 129.7 (**C6**), 128.6 (**C8**), 127.7 (**C2**), 127.5 (**C1**), 127.4 (**C7**), 37.6 (**C4**).

All spectral data in accordance with literature.[215]

7.5 Chapter 5 – Experimental

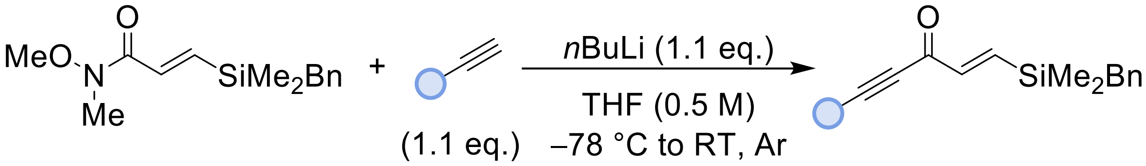
7.5.1 General Procedures

7.5.1.1 General Procedure A – Synthesis of β-(E)-Silyl-α,β-unsaturated Amides



To oven dried vial, purged with argon were added platinum (II) chloride (5 mol%), and JohnPhos (10 mol%) in dry toluene (0.25 M). The resultant mixture was stirred at 50 °C for 30 minutes. After this time the corresponding propargylic amide (1 eq.) was added to the reaction vessel, followed by silane (1.5 eq.). Upon completetion the reaction was reduced under *vacuo* and subjected to purification via column chromatography to obtain the correspoding β-(*E*)-vinylsilane.

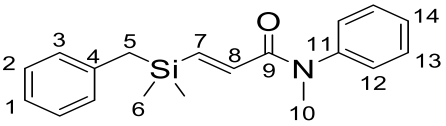
7.5.1.2 General Procedure B – Synthesis of β-(E)-Silyl-α,β-unsaturated Compounds



To a solution of the terminal alkyne (1.1 eq.) in THF (0.5 M) under argon, *n*BuLi (1.1 eq., 1 M in hexane) was added dropwise at −78 °C. The mixture was stirred for 30 minutes before the α-silyl-α,β-unsaturated Weinreb amide (1 eq.) was added. The mixture was allowed to slowly warm to room temperature upon completion of the addition. Upon completion the reaction was quenched with sat. NH_4Cl and extracted with DCM (3 × 10 ml), subsequently dried with anhydrous $MgSO_4$, and concentrated under *vacuo*. The crude product was then subjected to column chromatography to afford the corresponding β-(*E*)-silyl-α,β-unsaturated compound.

7.5.2 β-(*E*)-Silyl-α,β-unsaturated Amides

(*E*)-3-(Benzyldimethylsilyl)-*N*-methyl-*N*-phenylacrylamide – 285a



The title compound was prepared according to general procedure **A**, from *N*-methyl-*N*-phenyl-2-propynamide (250 mg, 1.57 mmol) and dimethylbenzylsilane (704 µL, 2.36 mmol) using platinum (II) chloride (20 mg, 79 µmol) and JohnPhos (47 mg, 157 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **285a** (301 mg, 62%) as yellow oil.

R

$\boldsymbol{R_f}$ = 0.46 [3:1 Hexane:EtOAc].

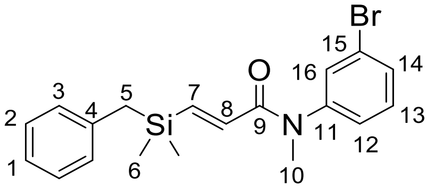
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.37 (t, *J* = 7.4 Hz, 2H, (**H$_{Aromatic}$**)), 7.32 – 7.29 (m, 1H, (**C14**)), 7.19 – 7.10 (m, 5H, (**H$_{Aromatic}$** and **H8**)), 7.06 (t, *J* = 7.4 Hz, 1H, (**C1**)), 6.90 (d, *J* = 7.4 Hz, 2H, (**H$_{Aromatic}$**)), 6.12 (d, *J* = 18.5 Hz, 1H, (**H7**)), 3.36 (s, 3H, (**H10**)), 2.07 (s, 2H, (**H5**)), −0.06 (s, 6H, (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 165.5 (**C9**), 143.5 (**C11**), 143.1 (**C8**), 139.2 (**C4**), 135.6 (**C7**), 129.5 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 127.6 (**C$_{Aromatic}$**), 127.2 (**C$_{Aromatic}$**), 124.3 (**C$_{Aromatic}$**), 37.6 (**C10**), 25.4 (**C5**), −3.7 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3053 (C=C-H), 1638 (C=O), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{19}H_{24}NOSi$ 310.1627; found 310.1617.

(*E*)-3-(Benzyldimethylsilyl)-*N* –(3-bromophenyl)-*N*-methylacrylamide – 285b



The title compound was prepared according to general procedure **A**, from *N*-(3-bromophenyl)-*N*-methyl-2-propynamide (100 mg, 421 µmol) and benzyldimethylsilane (100 µL, 632 µmol) using platinum (II) chloride (7 mg, 21.1 µmol) and JohnPhos (13 mg, 42.1 µmol). Following the conversion to product and column chromatography [SiO_2; 19:1 Hexane:EtOAc] afforded **285b** (115 mg, 70%) as yellow oil.

$\boldsymbol{R_f}$ = 0.37 [3:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.0 Hz, 1H (**H14**)), 7.33 (s, 1H (**H16**)), 7.25 – 7.14 (m, 4H (**H2**, **H8**, and **H13**)), 7.08 (d, *J* = 7.3 Hz, 1H (**H1**)), 7.03 (d, *J*

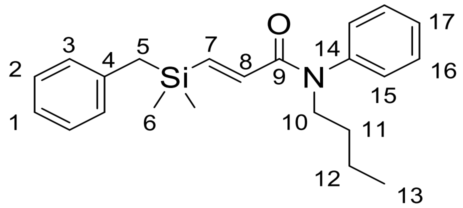
= 8.0 Hz, 1H (**H12**)), 6.92 (d, *J* = 7.5 Hz, 2H (**H3**)), 6.11 (d, *J* = 18.5 Hz, 1H (**H7**)), 3.34 (s, 3H (**H10**)), 2.10 (s, 2H (**H5**)), 0.02 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 165.4 (**C9**), 144.8 (**C11**), 144.3 (**C8**), 139.2 (**C4**), 135.2 (**C7**), 130.7 (**C$_{Aromatic}$**), 130.7 (**C$_{Aromatic}$**), 130.3 (**C$_{Aromatic}$**), 128.4 (**C3**), 128.3 (**C2**), 126.0 (**C$_{Aromatic}$**), 124.4 (**C1**), 122.9 (**C15**), 37.6 (**C10**), 25.4 (**C5**), −3.6 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3043 (C=C-H), 2917 (C-H), 1639 (C=O), 1598 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{19}H_{23}NOSiBr$ 388.0732; found 388.0718.

(*E*)-3-(Benzyldimethylsilyl)-*N* -butyl-*N*-phenylacrylamide – 285c



The title compound was prepared according to general procedure **A**, from *N*-butyl-*N*-phenyl-2-propynamide (200 mg, 994 μmol) and benzyldimethylsilane (236 μL, 1.49 mmol) using platinum (II) chloride (17 mg, 49.7 μmol) and JohnPhos (30 mg, 99.4 μmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **285c** (286 mg, 82%) as yellow oil.

R$_f$ = 0.32 [5:1 Hexane:EtOAc].

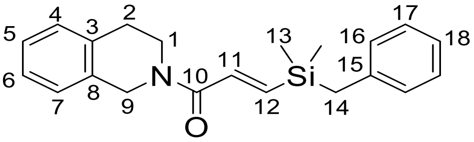
^{1}H NMR: (400 MHz, $CDCl_3$, mixture of rotamers observed, minor indicated by *) δ 7.26 – 6.85 (m, 9H (**H8** and **H$_{Aromatic}$/***)), 6.76 (d, *J* = 7.6 Hz, **H$_{Aromatic}$/***)), 5.90 (d, *J* = 18.4 Hz, 1H (**H7**)), 3.66 – 3.62 (m, 2H (**H10**)), 3.55 – 3.51 (m, 2H (**H10***)), 2.05 (s, 2H (**H5***)), 1.92 (s, 2H (**H5**)), 1.42 – 1.31 (m, 2H (**H11/***)), 1.23 – 1.12 (m, 2H (**H12/***)), 0.77 – 0.73 (m, 3H (**H13/***)), 0.22 (s, 6H (**H6**)), 0.32 (s, 6H (**H6***)).

^{13}C NMR: (101 MHz, $CDCl_3$, mixture of rotamers observed, minor indicated by *) δ 165.1 (**C9**), 143.0 (**C8**), 142.2 (**C14**), 139.3 (**C4**), 136.0 (**C7**), 129.5 (**C$_{Aromatic}$**), 129.2 (**C$_{Aromatic}$***), 128.5 (**C$_{Aromatic}$***), 128.3 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 128.3 (**C$_{Aromatic}$**), 128.2 (**C$_{Aromatic}$***), 128.1 (**C$_{Aromatic}$***), 127.7 (**C$_{Aromatic}$**), 127.1 (**C$_{Aromatic}$***), 124.3 (**C$_{Aromatic}$**), 124.0 (**C$_{Aromatic}$***), 49.5 (**C10**), 49.2 (**C10***), 28.9 (**C11**), 28.2 (**C11***), 25.5 (**C5***), 25.3 (**C5**), 20.2 (**C12**), 20.2 (**C12***), 14.0 (**C13**), −3.4 (**C6***), −3.7 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3053 (C=C-H), 2965 (C-H), 2932 (C-H), 1650 (C=O), 1596 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{22}H_{30}NOSi$ 352.2097; found 352.2107.

(*E*)-3-(Benzyldimethylsilyl)-1-(3,4-dihydroisoquinolin-2(1*H*)-yl)prop-2-en-1-one – 285e



The title compound was prepared according to general procedure **A**, from *N*-(naphthalen-1-yl)propiolamide (100 mg, 540 µmol) and benzyldimethylsilane (128 µL, 810 µmol) using platinum (**II**) chloride (9 mg, 27 µmol) and JohnPhos (16 mg, 54 µmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **285e** (145 mg, 80%) as yellow oil.

R_f = 0.35 [3:1 Hexane:EtOAc].

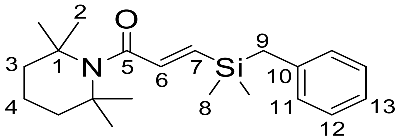
^{1}H NMR: (400 MHz, $CDCl_3$, mixture of rotamers observed, minor indicated by *) δ 7.24 – 7.07 (m, 8H (**H$_{Aromatic}$/***)), 7.02 (d, *J* = 7.1 Hz, 2H, (**H$_{Aromatic}$**)), 6.64 (d, *J* = 18.5 Hz,1H, (**H11***)), 6.62 (d, *J* = 18.6 Hz, 1H, (**H11**)), 4.78 (s, 1H, (**H9**)), 4.63 (s, 1H, (**H9***)),

^{13}C NMR: (101 MHz, $CDCl_3$, mixture of rotamers observed, minor indicated by *) δ 166.0 (**C10**), 165.6 (**C10***), 143.7 (**C11***), 143.4 (**C11**), 140.1 (**C15***), 139.3 (**C15**), 135.2 (**C12***), 135.0 (**C12**), 134.2, 133.5, 132.6, 129.0, 128.4, 128.3, 128.2, 127.0, 126.8, 126.7, 126.7, 126.4, 126.2, 124.4, 124.2*, 47.5 (**C9***), 44.8 (**C9**), 43.5 (**C1**), 40.2 (**C1***), 29.7 (**C2**), 28.6 (**C2***), 25.7 (**C14***), 25.5 (**C14**), −3.4 (**C13**), −3.5 (**C13***).

IR: ν_{max} (neat/cm^{-1}) 3029 (C=C-H), 2963 (C-H), 2852 (C-H), 1599 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{21}H_{26}NOSi$ 336.1784; found 336.1786.

(*E*)-3-(Benzyldimethylsilyl)-1-(2,2,6,6-tetramethylpiperidin-1-yl)prop-2-en-1-one – 285f



The title compound was prepared according to general procedure **A**, from 2,2,6,6-tetramethyl-1-piperidinyl-2-propyn-1-one (100 mg, 518 μmol) and dimethylbenzylsilane (123 μL, 777 μmol) using platinum (**II**) chloride (9 mg, 25.9 μmol) and JohnPhos (15 mg, 51.8 μmol). Following the conversion to product and column chromatography [SiO_2; 25:1 Hexane:EtOAc] afforded **285f** (88 mg, 49%) as yellow oil.

R

$\boldsymbol{R_f}$ = 0.76 [5:1 Hexane:EtOAc].

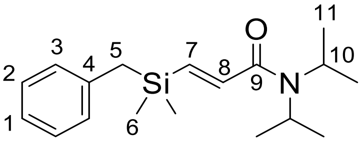
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.18 (t, *J* = 7.5 Hz, 2H (**H12**)), 7.05 (t, *J* = 7.4 Hz, 1H (**H13**)), 6.99 (d, *J* = 7.4 Hz, 2H (**H11**)), 6.83 (d, *J* = 18.5 Hz, 1H (**H6**)), 6.57 (d, *J* = 18.5 Hz, 1H (**H7**)), 2.19 (s, 2H (**H9**)), 1.75 (br s, 6H (**H3** and **H4**)), 1.42 (s, 12H (**H2**)), 0.10 (s, 6H (**H8**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 169.9 (**C5**), 142.7 (**C6**), 139.5 (**C10**), 137.7 (**C7**), 128.4 (**C11** and **C12**), 124.3 (**C13**), 56.0 (**C1**), 36.4 (**C3**), 30.3 (**C2**), 25.6 (**C9**), 14.6 (**C4**), −3.5 (**C8**).

IR: ν_{max} (neat/cm^{-1}) 3033 (C=C-H), 2946 (C-H), 2849 (C-H), 1618 (C=O), 1596 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{21}H_{33}NOSi$ 344.2404; found 344.2412.

(*E*)-3-(Benzyldimethylsilyl)-*N,N*-diisopropylacrylamide – 285g



The title compound was prepared according to general procedure **A**, from diisopropyl-propiolamide (100 mg, 653 μmol) and benzyldimethylsilane (155 μL, 978 μmol) using platinum (**II**) chloride (11 mg, 32.7 μmol) and JohnPhos (20 mg, 65.3 μmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **285g** (110 mg, 56%) as yellow oil.

$\boldsymbol{R_f}$ = 0.72 [2:1 Hexane:EtOAc].

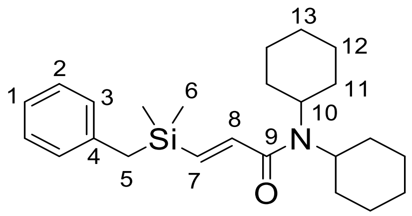
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.20 (t, *J* = 7.6 Hz, 2H (**H2**)), 7.07 (t, *J* = 7.3 Hz, 1H (**H1**)), 7.00 (d, *J* = 7.3 Hz, 2H (**H3**)), 6.92 (d, *J* = 18.5 Hz, 1H (**H8**)), 6.51 (d, *J* = 18.5 Hz, 1H (**H7**)), 3.90 (s, 1H (**H10**)), 3.74 (s, 1H (**H10**)), 2.19 (s, 2H (**H5**)), 1.36 (s, 6H (**H11**)), 1.20 (s, 6H (**H11**)), 0.11 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 166.4 (**C9**), 140.7 (**C8**), 139.5 (**C4**), 138.1 (**C7**), 128.4 (**C2**), 128.3 (**C3**), 124.3 (**C1**), 48.1 (**C10**), 45.9 (**C10**), 25.7 (**C5**), 21.6 (**C11**), 20.7 (**C11**), −3.4 (**C6**).

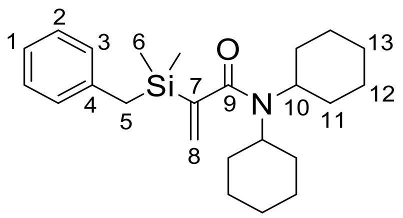
IR: ν_{max} (neat/cm^{-1}) 3057 (C=C-H), 2960 (C-H), 2896 (C-H), 1632 (C=O), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for C$_{18}$H$_{30}$NOSi 304.2097; found 304.2113.

(*E*)-3-(Benzyldimethylsilyl)-*N,N*-dicyclohexylacrylamide – 285h and 2-(Benzyldimethylsilyl)-*N,N*-dicyclohexylacrylamide – 284h



285h



284h

The title compound was prepared according to general procedure **A**, from *N,N*-dicyclohexyl-2-propynamide (100 mg, 429 µmol) and dimethylbenzylsilane (102 µL, 644 µmol) using platinum (**II**) chloride (7 mg, 21.5 µmol) and JohnPhos (13 mg, 42.9 µmol). Following the conversion to product (67:33, **285h**:**284h**) and column chromatography [SiO$_2$; 20:1 Hexane:EtOAc] afforded **285h** and **284h** as a regioisomeric mixture (77 mg, 47%) as colourless oil.

R$_f$ = 0.48 [3:1 Hexane:EtOAc].

^{1}H NMR (α-isomer 284h): (400 MHz, CDCl$_3$) δ 7.22 – 7.18 (m, 2H (**H3**)), 7.09 – 7.00 (m, 3H (**H1** and **H2**)), 5.68 (d, *J* = 2.2 Hz, 1H (**H8**)), 5.42 (d, *J* = 2.3 Hz, 1H (**H8**)), 3.59 – 3.56 (m, 1H (**H$_{Cyclohexyl}$**)), 3.31 (m, 1H ((**H$_{Cyclohexyl}$**)), 2.91 – 2.88 (m, 1H (**H$_{Cyclohexyl}$**)), 2.58 – 2.55 (m, 2H (**H$_{Cyclohexyl}$**)), 2.28 (s, 2H (**C5**)), 1.88 – 1.75 (m, 6H (**H$_{Cyclohexyl}$**)), 1.64 – 1.62 (m, 7H (**H$_{Cyclohexyl}$**)), 1.52 – 1.42 (m, 6H (**H$_{Cyclohexyl}$**)), 1.30 – 1.05 (m, 11H (**H$_{Cyclohexyl}$**)), 0.11 (s, 6H (**H6**)).

^{13}C NMR (α-isomer 284h): (101 MHz, CDCl$_3$) δ 173.2 (**C9**), 150.0 (**C7**), 140.2 (**C4**), 139.4 (**C4**), 128.5 (**C2** or **C3**), 128.3 (**C2** or **C3**), 128.2 (**C2** or **C3**), 125.2 (**C8**), 124.3 (**C1**), 124.1 (**C1**), 59.1 (**C10**), 55.9 (**C10**), 31.4 (**C$_{Cyclohexyl}$**), 30.3 (**C$_{Cyclohexyl}$**), 29.7 (**C$_{Cyclohexyl}$**), 26.8 (**C$_{Cyclohexyl}$**), 26.2 (**C$_{Cyclohexyl}$**), 25.9 (**C$_{Cyclohexyl}$**), 25.8 (**C$_{Cyclohexyl}$**), 25.5 (**C$_{Cyclohexyl}$**), 25.4 (**C$_{Cyclohexyl}$**), 25.3 (**C$_{Cyclohexyl}$**), 25.2 (**C5**), −3.5 (**C6**), −3.5 (**C6**).

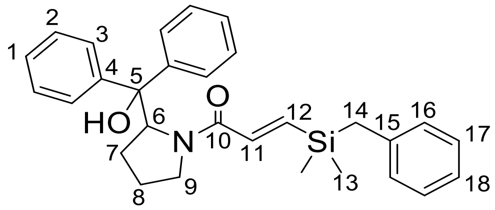
^{1}H NMR (β-isomer 285h): (400 MHz, $CDCl_3$) δ 7.20 (t, *J* = 7.4 Hz, 2H (**H3**), 7.07 (t, *J* = 7.5 Hz, 1H (**H1**)), 7.01 (d, *J* = 7.6 Hz, 2H (**H2**)), 6.91 (d, *J* = 18.5 Hz, 1H (**H8**)), 6.56 (d, *J* = 18.5 Hz, 1H (**H7**)), 2.19 (s, 2H (**H5**)), 1.80 – 1.53 (m, 15H (**H$_{\mathbf{Cyclohexyl}}$**)), 1.28 – 1.09 (m, 7H (**H$_{\mathbf{Cyclohexyl}}$**)), 0.10 (s, 6H (**H6**)).

^{13}C NMR (β-isomer 285h): (101 MHz, $CDCl_3$) δ 166.5 (**C9**), 140.6 (**C8**), 139.4 (**C4**), 138.2 (**C7**), 128.4 (**C3**), 128.3 (**C2**), 124.3 (**C1**), 57.5 (**C10**), 55.8 (**C10**), 32.1 (**C$_{\mathbf{Cyclohexyl}}$**), 30.3 (**C$_{\mathbf{Cyclohexyl}}$**), 26.6 (**C$_{\mathbf{Cyclohexyl}}$**), 26.3 (**C$_{\mathbf{Cyclohexyl}}$**), 25.4 (**C5**), −3.4 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3028 (C=C-H), 2932 (C-H), 2850 (C-H), 1623 (C=O), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{24}H_{38}NOSi$ 384.2723; found 384.2724.

(*E*)-3-(Benzyldimethylsilyl)-1-(2-(hydroxydiphenylmethyl)pyrrolidine-1-yl)prop-2-en-1-one – 285i



The title compound was prepared according to general procedure **A**, from 1-(2-(hydroxydiphenylmethyl)pyrrolidine-1-yl)prop-2-yn-1-one (100 mg, 327 μmol) and benzyldimethylsilane (105 μL, 491 μmol) using platinum (II) chloride (6 mg, 16.4 μmol) and JohnPhos (10 mg, 32.7 μmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **285i** (118 mg, 79%) as yellow oil.

R$_f$ = 0.32 [2:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.43 – 7.28 (m, 10H, (**H1** – **H3**)), 7.21 (t, *J* = 7.6 Hz, 2H, (**H17**)), 7.14 (d, *J* = 18.5 Hz, 1H, (**H11**)), 7.08 (t, *J* = 7.4 Hz, 1H, (**H18**)), 6.98 (d, *J* = 7.4 Hz, 2H, (**H16**)), 6.86 (s, 1H, (**O-H**)), 6.37 (d, *J* = 18.5 Hz, 1H, (**H12**)), 5.30 – 5.26 (m, 1H, (**H6**)), 3.40 – 3.33 (m, 1H, (**H9**)), 2.97 – 2.91 (m, 1H, (**H9**)), 2.19 (s, 2H, (**H15**)), 2.13 – 1.98 (m, 4H, (**H7** and **H8**))), 0.12 (s, 6H, (**H13**)).

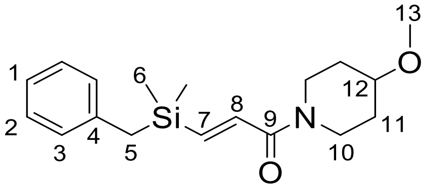
^{13}C NMR: (101 MHz, $CDCl_3$) δ 168.2 (**C10**), 146.4 (**C4**), 145.3 (**C11**), 139.2 (**C15**), 135.3 (**C12**), 128.4 (**C16**), 128.4 (**C17**),128.4 (**C$_{\mathbf{Aromatic}}$**), 128.1 (**C$_{\mathbf{Aromatic}}$**), 127.9 (**C$_{\mathbf{Aromatic}}$**), 127.5 (**C$_{\mathbf{Aromatic}}$**), 127.4 (**C$_{\mathbf{Aromatic}}$**), 127.3 (**C$_{\mathbf{Aromatic}}$**), 124.4 (**C18**), 82.1

(**C5**), 66.8 (**C6**), 48.7 (**C9**), 29.4 (**C7**), 25.5 (**C14**), 23.3 (**C8**), −3.5 (**C13**), −3.5 (**C13**).

IR: ν_{max} (neat/cm^{-1}) 3455 (O-H), 2982 (C-H), 2912 (C-H), 1617 (C=O), 1600 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{29}H_{33}NO_2SiNa$ 478.2178; found 478.2179.

(*E*)-1-(4-Benzyldimethylsilyl)buta-1,3-dien-2-yl)-4-methoxypiperidine – 285j



The title compound was prepared according to general procedure **A**, from 1-(4-methoxy-1-piperidinyl)-2-propyn-1-one (200 mg, 1.20 mmol) and benzyldimethylsilane (284 μL, 1.79 mmol) using platinum (II) chloride (20 mg, 59.8 μmol) and JohnPhos (36 mg, 120 μmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **285j** (237 mg, 63%) as yellow oil.

R_f = 0.33 [1:1 Hexane:EtOAc].

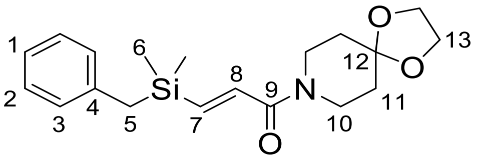
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.20 (t, *J* = 7.6 Hz, 2H (**H2**)), 7.08 – 7.06 (m, 1H (**H1**)), 7.01 (d, *J* = 8.1 Hz, 2H (**H3**)), 6.97 (d, *J* = 18.5 Hz, 1H (**H8**)), 6.54 (d, *J*= 18.6 Hz, 1H (**H7**)), 3.92 – 3.90 (m, 1H (**H10**)), 3.64 (m, 1H (**H10**)), 3.44 – 3.39 (m, 1H (**H12**)), 3.37 (s, 3H (**H13**)), 3.25 – 3.24 (m, 1H (**H10**)), 3.13 – 3.09 (m, 1H (**H10**)), 2.19 (s, 2H (**H5**)), 1.82 – 1.81 (m, 2H (**H11**)), 1.58 – 1.49 (m, 2H (**H11**)), 0.12 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 165.6 (**C9**), 142.9 (**C8**), 139.4 (**C4**), 135.0 (**C7**), 128.4 (**C2**), 128.4 (**C3**), 124.4 (**C1**), 75.5 (**C12**), 55.92 (**C13**), 42.8 (**C10**), 39.1 (**C10**), 31.5 (**C11**), 30.3 (**C11**), 25.6 (**C5**), −3.4 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3018 (C=C-H), 2947 (C-H), 2899 (C-H), 2825 (C-H), 1615 (C=O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{18}H_{28}NO_2Si$ 318.1889; found 318.1903.

(*E*)-3-(Benzyldimethylsilyl)-1-(1,4-dioxa-8-azaspiro[4.5]decan-8-yl)prop-2-en-1-one – 285k



The title compound was prepared according to general procedure **A**, from 1-(1,4-dioxa-8-azaspiro[4.5]dec-8-yl)-2-propyn-1-one (250 mg, 1.28 mmol) and benzyldimethylsilane (304 µL, 1.92 mmol) using platinum (II) chloride (17 mg, 64.0 µmol) and JohnPhos (38 mg, 128 µmol). Following the conversion to product and column chromatography [SiO_2; 10:1 Hexane:EtOAc] afforded **285k** (318 mg, 72%) as yellow oil.

R$_f$ = 0.43 [1:1 Hexane:EtOAc].

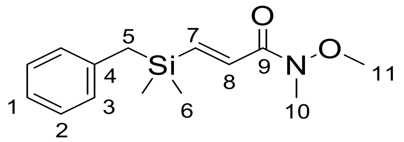
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.20 (t, *J* = 7.6 Hz, 2H (**H2**)), 7.07 (t, *J* = 7.4 Hz, 1H (**H1**)), 6.99 (d, *J* = 8.9 Hz, 2H (**H3**)), 6.98 (d, *J* = 18.5 Hz, 1H (**H8**)), 6.54 (d, *J* = 18.6 Hz, 1H (**H7**)), 3.99 (s, 4H (**H13**)), 3.74 – 3.72 (m, 2H (**H10**)), 3.52 – 3.50 (m, 2H (**H10**)), 2.19 (s, 2H (**H5**)), 1.70 – 1.67 (m, 4H (**H11**)), 0.12 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, $CDCl_3$) δ 165.6 (**C9**), 143.1 (**C8**), 139.4 (**C4**), 134.9 (**C7**), 128.4 (**C2**), 128.4 (**C3**), 124.4 (**C1**), 107.1 (**C12**), 64.6 (**C13**), 43.9 (**C10**), 40.4 (**C10**), 35.9 (**C11**), 34.8 (**C11**), 25.6 (**C5**), −3.4 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 2928 (C-H), 2956 (C-H), 2890 (C-H), 1615 (C=O).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{19}H_{28}NO_3Si$ 346.1838; found 346.1831.

(*E*)-3-(Benzyldimethylsilyl)-*N*-methoxy-*N*-methylacrylamide – 285l



The title compound was prepared according to general procedure **A**, from *N*-methoxy-*N*-methylpropiolamide (200 mg, 1.77 mmol) and dimethylbenzylsilane (420 µL, 2.65 mmol) using platinum (II) chloride (30 mg, 88 µmol) and JohnPhos (53 mg, 177 µmol). Following the conversion to product and column chromatography [SiO_2; 3:1 Hexane:EtOAc] afforded **285l** (238 mg, 51%) as a yellow oil.

R$_f$ = 0.25 [3:1 Hexane:EtOAc].

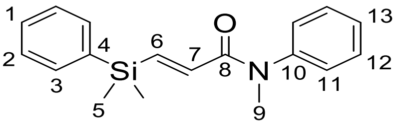
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.24 (d, *J* = 18.6 Hz, 1H (**H8**)), 7.19 (d, *J* = 7.6 Hz, 2H (**H2**)), 7.07 (d, *J* = 7.4 Hz, 1H (**H1**)), 7.00 (d, *J* = 7.3 Hz, 2H (**H3**)), 6.76 (d, *J* = 18.7 Hz, 1H (**H7**)), 3.65 (s, 3H (**H11**)), 3.25 (s, 3H (**H10**)), 2.20 (s, 2H (**H5**)), 0.12 (s, 6H (**H6**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 166.0 (**C9**), 145.5 (**C8**), 139.2 (**C4**), 132.4 (**C7**), 128.4 (**C2**), 128.4 (**C3**), 124.4 (**C1**), 61.9 (**C11**), 32.7 (**C10**), 25.5 (**C5**), −3.5 (**C6**).

IR: ν_{max} (neat/cm^{-1}) 3028 (C=C-H), 2937 (C-H), 2835 (C-H), 1627 (C=O).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{14}H_{22}NO_2Si$; 264.1420 found 264.1443.

(*E*)-3-(Dimethyl(phenyl)silyl)-*N*-methyl-*N*-phenylacrylamide – 285r



The title compound was prepared according to general procedure **A**, from *N*-methyl-*N*-phenyl-2-propynamide (100 mg, 62.9 μmol) and dimethylphenylsilane (144 μL, 943 μmol) using platinum (**II**) chloride (8 mg, 31.5 μmol) and JohnPhos (19 mg, 62.9 μmol). Following the conversion to product and column chromatography [SiO$_2$; 20:1 Hexane:EtOAc] afforded **285r** (94 mg, 51%) as a yellow oil.

R$_f$ = 0.22 [5:1 Hexane:EtOAc].

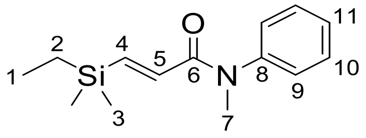
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.39 – 7.35 (m, 4H (**H$_{Aromatic}$**)), 7.32 – 7.28 (m, 4H (**H$_{Aromatic}$**)), 7.26 (d, *J* = 18.4 Hz, 1H (**H7**)), 7.15 – 7.13 (m, 2H (**H$_{Aromatic}$**)), 6.19 (d, *J* = 18.5 Hz, 1H (**H6**)), 3.36 (s, 3H (**H9**)), 0.25 (s, 6H (**H5**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 165.1 (**C8**), 143.5 (**C7**), 142.8 (**C10**), 137.1 (**C4**), 136.3 (**C6**), 133.4 (**C$_{Aromatic}$**), 129.6 (**C$_{Aromatic}$**), 129.3 (**C$_{Aromatic}$**), 127.9 (**C$_{Aromatic}$**), 127.6 (**C$_{Aromatic}$**), 127.3 (**C$_{Aromatic}$**), 37.6 (**C9**), −2.9 (**C5**).

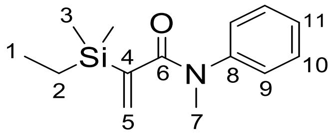
IR: ν_{max} (neat/cm^{-1}) 3057 (C=C-H), 2144 (C-H), 1636 (C=O), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{18}H_{22}NOSi$ 296.141; found 296.1464.

(*E*)-3-(Dimethyl(ethyl)silyl)-*N*-methyl-*N*-phenylacrylamide – 285s and **2-(Dimethyl(ethyl)silyl)-*N*-methyl-*N*-phenylacrylamide – 284n**



285s



284n

The title compound was prepared according to general procedure **A**, from *N*-methyl-*N*-phenyl-2-propynamide (50 mg, 315 µmol) and dimethylethyl (42 µL, 472 µmol) using platinum (**II**) chloride (4 mg, 15.8 µmol) and JohnPhos (10 mg, 31.5 µmol). Following the conversion to product (27:73, **285s**:**284n**) and column chromatography [SiO_2; 5:1 Hexane:EtOAc] afforded **285s** and **284n** as a regioisomeric mixture (46 mg, 59%) as yellow oil.

R_f = 0.35 [3:1 Hexane:EtOAc].

^{1}H NMR (α-isomer 284n): (400 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.7 Hz, 2H (**H9**)), 7.23 (t, *J* = 7.4 Hz, 1H (**H11**)), 7.13 (d, *J* = 7.3 Hz, 2H (**H10**)), 5.71 (s, 1H (**H5**)), 5.52 (s, 1H (**H5**)), 3.35 (s, 3H (**H7**)), 0.88 (t, *J* = 7.9 Hz, 3H (**H1**)), 0.53 (q, *J* = 7.7 Hz, 2H (**H2**)), 0.04 (s, 6H (**H3**)).

^{13}C NMR (α-isomer 284n): (101 MHz, $CDCl_3$) δ 173.5 (**C6**), 149.0 (**C4**), 144.3 (**C8**), 129.5 (**C5**), 129.2 (**C9**), 127.6 (**C10**), 126.9 (**C11**), 29.8 (**C7**), 7.2 (**C2**), 7.0 (**C1**), −3.6 (**C3**).

^{1}H NMR (β-isomer 285s): (400 MHz, $CDCl_3$) δ 7.40 (t, *J* = 7.3 Hz, 2H (**H9**)), 7.20 – 7.11 (m, 3H (**H10** and **H11**)), 7.14 (d, *J* = 18.3 Hz, 1H (**H5**)), 6.16 (d, *J* = 18.4 Hz, 1H (**H4**)), 3.36 (s, 3H (**H7**)), 0.81 (t, *J* = 8.0 Hz, 3H (**H1**)), 0.46 (q, *J* = 7.9 Hz, 2H (**H2**)), −0.06 (s, 6H (**H3**)).

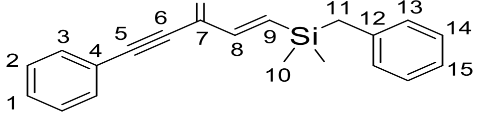
^{13}C NMR (β-isomer 285s): (101 MHz, $CDCl_3$) δ 165.8 (**C6**), 144.5 (**C5**), 143.6 (**C8**), 135.0 (**C4**), 131.1 (**C9**), 129.8 (**C10**), 127.3 (**C11**), 128.7 (**C7**), 7.2 (**C2**), 6.9 (**C1**), −4.0 (**C3**).

IR: ν_{max} (neat/cm^{-1}) 3081 (C=C-H), 2963 (C-H), 2892 (C-H), 1629 (C=O).

HRMS: (ESI-TOF) *m/z*: $[M+Na]^+$ Calcd for $C_{14}H_{21}NONaSi$ 270.1290; found 270.1305.

7.5.3 β-(*E*)-Silyl-α,β-unsaturated Compounds

(*E*)-1-(Benzyldimethylsilyl)-5-phenylpent-1-en-4-yn-3-one – 322a



The title compound was prepared according to general procedure **B**, from 2-(benzyldimethylsilyl)-*N*-methoxy-*N*-methylacrylamide (50 mg, 189 µmol) and phenylacetylene (23 µL, 209 µmol) using *n*BuLi (200 µL, 209 µmol, 1 M in hexane). Following the conversion to product, work-up and column chromatography [SiO$_2$; 100:1 Hexane:EtOAc] afforded **322a** (39 mg, 68%) as yellow oil.

R$_f$ = 0.63 [5:1 Hexane:EtOAc].

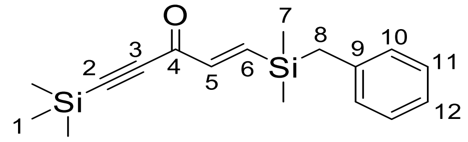
^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.61 (d, *J* = 7.0 Hz, 1H (**H3**)), 7.48 (d, *J* = 19.0 Hz, 1H (**H8**)), 7.48 – 7.46 (m, 1H (**H1**)), 7.41 (t, *J* = 7.3 Hz, 2H (**H2**)), 7.23 (t, *J* = 7.6 Hz, 2H (**H14**)), 7.11 (t, *J* = 7.4 Hz, 1H (**H15**)), 7.03 (d, *J* = 7.2 Hz, 2H (**H13**)), 6.58 (d, *J* = 19.0 Hz, 1H (**H9**)), 2.26 (s, 2H (**H11**)), 0.19 (s, 6H (**H10**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 178.7 (**C7**), 151.6 (**C8**), 144.3 (**C9**), 138.8 (**C12**), 133.2 (**C3**), 130.9 (**C1**), 128.8 (**C2**), 128.5 (**C14**), 128.4 (**C13**), 124.6 (**C15**), 120.2 (**C4**), 92.9 (**C5**), 86.3 (**C6**), 25.3 (**C11**), −3.7 (**C10**).

IR: ν_{max} (neat/cm^{-1}) 3018 (C=C-H), 2869 (C-H), 1612 (C=O), 1599 (C=C).

HRMS: (ESI-TOF) *m/z*: [M+H]$^+$ Calcd for $C_{20}H_{21}OSi$ 305.1362; found 305.1376.

(*E*)-1-(Benzyldimethylsilyl)-5-(trimethylsilyl)pent-1-en-4-yn-3-one – 322c



The title compound was prepared according to general procedure **B**, from (*E*)-3-(benzyldimethylsilyl)-*N*-methoxy-*N*-methylacrylamide (25 mg, 89.1 µmol) and TMS-acetylene (14 µL, 98 µmol) using *n*BuLi (99 µL, 98 µmol, 1 M in hexane). Following the conversion to product, work-up and column chromatography [SiO$_2$; 100:1 Hexane:EtOAc] afforded **322c** (18 mg, 67%) as yellow oil.

R$_f$ = 0.70 [5:1 Hexane:EtOAc].

^{1}H NMR: (400 MHz, CDCl$_3$) δ 7.39 (d, *J* = 19.0 Hz, 1H (**H5**)), 7.23 (t, *J* = 7.6 Hz, 2H (**H11**)), 7.10 (t, *J* = 7.4 Hz, 1H (**H12**)), 7.00 (d, *J* = 7.4 Hz, 2H (**H10**)), 6.48 (d, *J* = 19.0 Hz, 1H (**H5**)), 2.23 (s, 2H (**H8**)), 0.27 (s, 9H (**H1**)), 0.15 (s, 6H (**H7**)).

^{13}C NMR: (101 MHz, CDCl$_3$) δ 152.2 (**C5**), 144.0 (**C6**), 138.8 (**C9**) 128.5 (**C10**), 128.3 (**C11**), 124.7 (**C12**), 100.3 (**C3**), 100.2 (**C2**), 25.3 (**C8**), −0.5 (**C1**), −3.7 (**C7**). **C4** not observed.

IR: ν_{max} (neat/cm^{-1}) 3022 (C=C-H), 2853 (C-H), 1618 (C=O), 1594 (C=C).

HRMS: (ESI-TOF) *m/z*: $[M+H]^+$ Calcd for $C_{17}H_{25}OSi_2$ 301.1444; found 301.1454.

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