

# 1. Supporting Information for Publication

## 1.1. Formation CVs

Figure S1 shows the full cycles of the experiment which is presented only in parts in Figure 2 of the main manuscript.

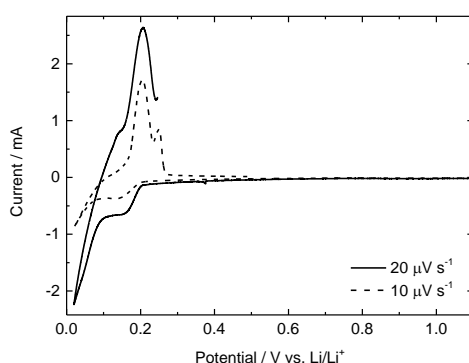


Figure S1: Slow SEI formation CVs using indicated scan rates.

## 1.2. Cycle Aging Test Details

For comparative reasons the cycle aging results of the electrodes used in this study after the benchmarking standard formation protocol are shown in Figure S2. Both the discharge capacity and the coulombic efficiency remain highly stable until around the 70<sup>th</sup> cycle.

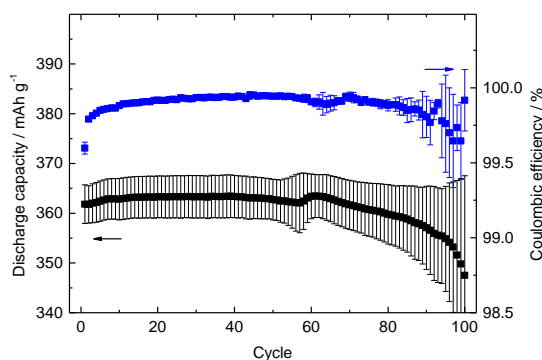


Figure S2: Discharge capacity and coulombic efficiency (cycle aging test) of graphite electrodes pretreated with the standard formation protocol as a benchmark.

The cycle aging data of the cell pretreated with the high-rate, half-cycle and EIS formation protocols (already presented in the main manuscript) are shown in Figures S3, S4 and S5, respectively. The red solid line resembles the main capacity of the cells pretreated with the benchmark formation protocol, which is also shown in Figure S2. Capacities are similar within the error bars.

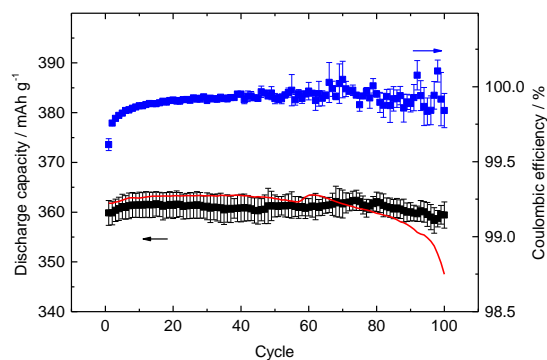


Figure S3: Discharge capacity and coulombic efficiency (cycle aging test) of graphite electrodes pretreated with the high-rate formation protocol. The solid red line resembles the mean capacity of Figure S2.

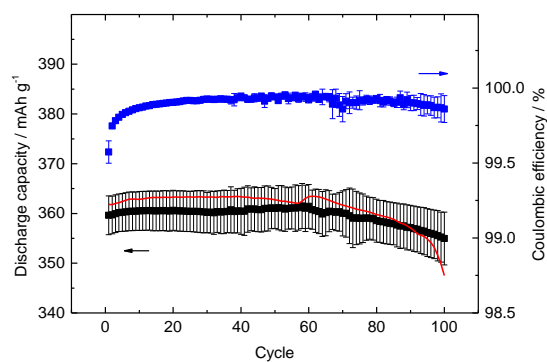


Figure S4: Discharge capacity and coulombic efficiency (cycle aging test) of graphite electrodes pretreated with the half-cycle formation protocol. The solid red line resembles the mean capacity of Figure S2.

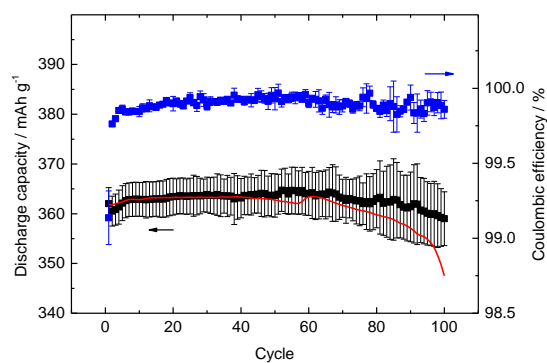


Figure S5: Discharge capacity and coulombic efficiency (cycle aging test) of graphite electrodes pretreated with the EIS formation protocol. The solid red line resembles the mean capacity of Figure S2.

### 1.3. Data of EIS Perturbation Experiments

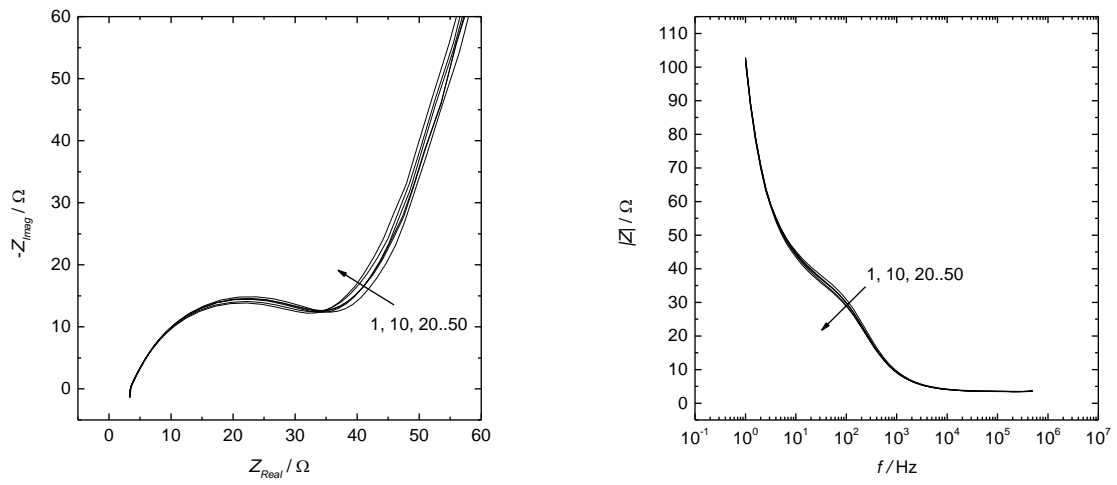


Figure S6: Exemplary Nyquist and Bode plots of data collected during the perturbation of electrodes using the EIS function of the potentiostat in the EIS formation protocol. 50 loops were obtained, only every tenth is shown (indicated by the arrows).