

SEI Formation in Li-Ion Batteries Studied by EIS/EQCM-D

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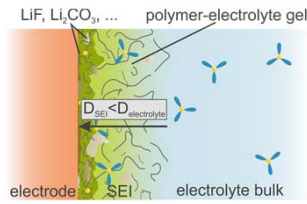
Motivation

Background

The electrochemical decomposition of electrolytes in Li-ion batteries results in layer formation at the electrode-electrolyte interfaces (SEI/SPI).

Challenge

Understanding the electrode-electrolyte interphase buildup and its correlation with the cell electrochemical impedance change.

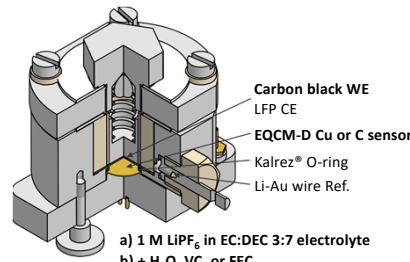


Goal

Analysis of SEI properties on both, copper current collectors and carbons and their influence on electrode impedance by combined electrochemical quartz crystal microbalance with dissipation monitoring (EQCM-D) and electrochemical impedance spectroscopy (EIS).

Experimental Approach

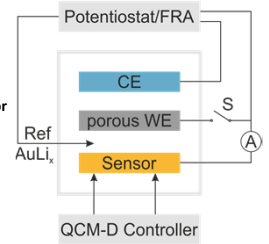
4-Electrode EIS/EQCM-D cell



a) 1 M LiPF₆ in EC:DEC 3:7 electrolyte
b) + H₂O, VC, or FEC

0.1 mV/s CV-rate

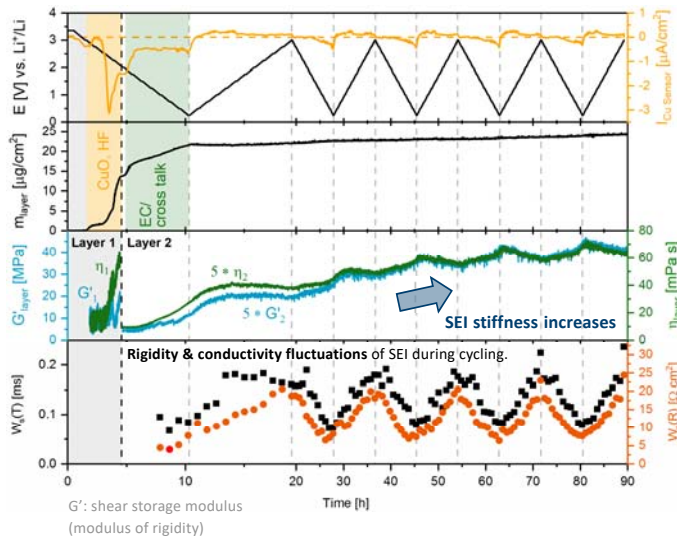
Cell configuration



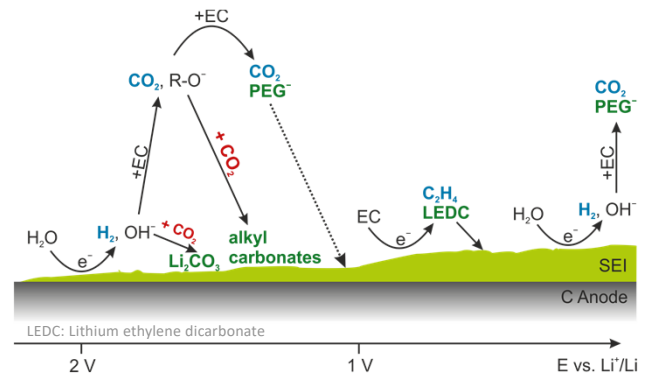
- Super C65 working electrode and Cu or C coated sensor either short-circuited or at open circuit. Cycling against LFP counter electrode. EIS (50 kHz – 50 mHz) every 250 mV.
- EQCM-D fit by multi layered multi harmonic Voigt model (software QTools).

Results

SEI Properties on Cu During Cycling



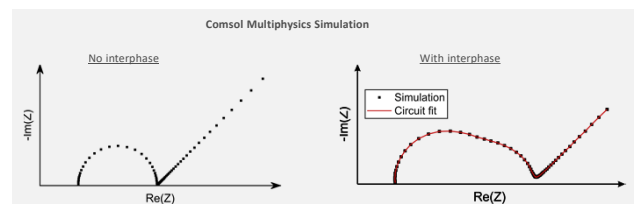
SEI Formation on Carbon in Standard LiPF₆/EC+DEC Electrolyte



SEI Formation on Carbon in Standard LiPF₆/EC+DEC Electrolyte with Additives

	LP47 + H ₂ O	LP47 + VC	LP47 + FEC
d _{SEI}	↑	↓	↔
G' _{SEI}	↑	↔	↑
η _{SEI}	↔	↔	↔
η _{electrolyte}	↑	↔	↔
σ _{SEI}	-	↑	↔

Modelling the SEI for EIS

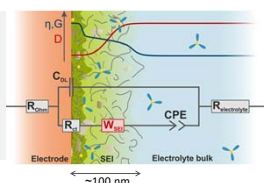


Conclusion

SEI is soft!

$$G'_{SEI} \ll E_{PEG3000} \approx 2.5 \text{ GPa}$$

$$\eta_{SEI} \ll \eta_{Honey} = 1000 \text{ mPa s}$$



Acknowledgment

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