Challenges in Measuring Transport Parameters of Carbonate-Based Electrolytes

Lukas Lehnert[1,2]*, Maryam Nojabaee[2], Birger Horstmann[1,2,3], Arnulf Latz[1,2,3], Norbert Wagner[2]

[1]Helmholtz Institute Ulm, Helmholtzstraße 11, 89081 Ulm, Germany
[2]German Aerospace Center, Pfaffenwaldring 38, 70569 Stuttgart, Germany
[3]University of Ulm, Albert-Einstein-Allee 47, 89081 Ulm, Germany
**lukas.lehnert@dlr.de*

Numerical simulations are a powerful tool for the development and improvement of Li-ion batteries. Modelling the mass transport of the involved electrolytic solutions requires precise determination of the corresponding electrolyte parameter. However, the determination methods are still controversially discussed.

In this work, we attempt to measure the complete set of electrolyte parameter for a system of 0.5 M $LiPF_6$ dissolved in a blend of ethylene carbonate and ethyl methyl carbonate (EC:EMC, 3:7 weight) at 20°C and 50°C. To determine the conductivity, the diffusion coefficient, the transference number and the thermodynamic factor we conduct a combination of concentration cell measurements, galvanostatic polarization experiments and electrochemical impedance spectroscopy.

While the conductivity and concentration cell measurements show comparable results to the literature we find the potential response in the polarization experiments deviating from theoretical expectations. Applying galvanostatic polarization experiments to symmetrical metal Li | electrolyte + separator | Li metal cells result in slower, impeded diffusion processes. This indicates the presence of additional, undesired porous structures on the Li electrodes, preventing a reliable evaluation of the electrolyte parameters. To spectrally resolve the diffusive processes, we conduct very low frequency impedance spectroscopy in an attempt to identify the impedance for the sole diffusion through the separator.

1. Sdf
2. Johannes Landesfeind and Hubert A. Gasteiger 2019 J. Electrochem. Soc. 166 A3079
3. Talian et al. The Journal of Physical Chemistry C 2019 123 (46), 27997-28007

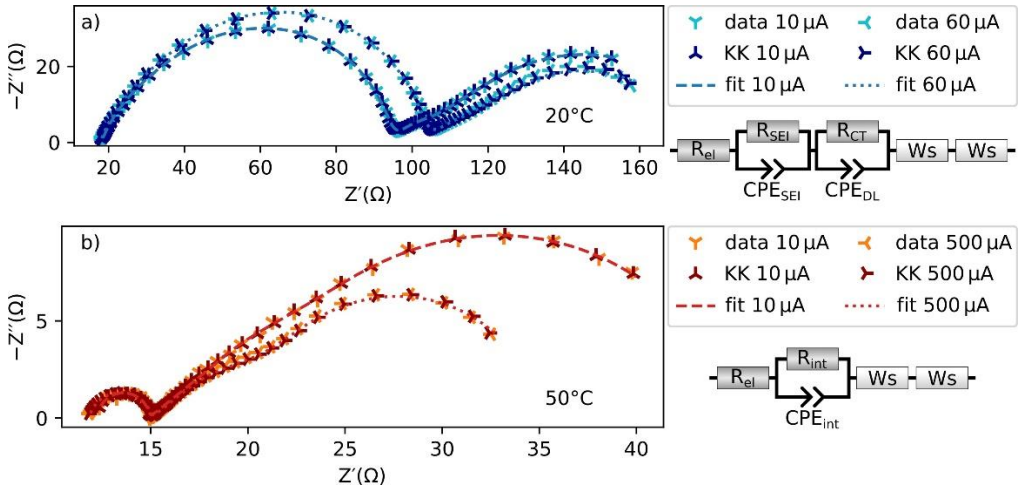

Figure 1: VLF-IS measurements with amplitudes of 60µA, 500µA and 10µA together wit the corresponding equivalent circuits, fits and Kramers-Kronig transformations at 20° C and 50°C respectively.