Low Temperature Batteries for Deep Space Missions

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The low temperature environment in space is quite challenging for common/state of the art lithium-ion batteries. The effects of slower kinetics along with the life limiting mechanisms (e.g., lithium plating) triggered by these extreme conditions limit the applicability of current energy storage approaches under these conditions. Therefore, we want to develop and characterize lithium-ion batteries which still provide high current densities at temperatures of lower than $-20\,℃$ for future deep space missions.

Using a combination of impedance measurements, concentrations cells and galvanostatic pulse experiments introduced by Landesfeind[1] et al. we determine the four transport parameter of electrolytes. We measure conductivity, diffusion coefficient, transference number and thermodynamic factor at temperatures down to $-40\,℃$. The results of the measurements parametrize our modelling of reference battery cells involving 1D+1D simulations and 3D simulations for fundamental analysis.

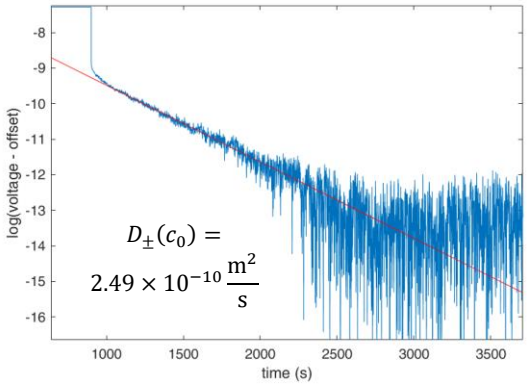

Fig 1: Galvanostatic pulse polarization measurement of 1 M $LiPF_6$ in EC:DEC (1:1, v v) for determining the diffusion coefficient.

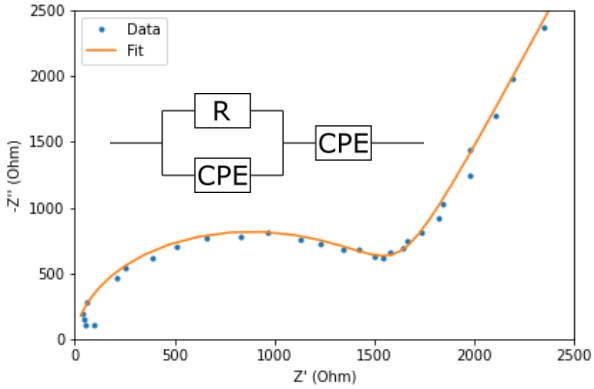

Fig 2: Electrochemical impedance spectroscopy of 1 M $LiPF_6$ in EC:DEC (1:1, v v) for determining the conductivity.

***Keywords**:* lithium ion batteries, low temperatures, transport parameters, electrochemistry

1. Johannes Landesfeind and Hubert A. Gasteiger 2019 J. Electrochem. Soc. **166** A3079