Mechanism Panel Abstract & Speaker Biography

Investigation of polysulfide transport in lithium sulphur batteries via optical transmission spectroscopy

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Lithium sulphur batteries have the potential to improve the capacity performance and safety of lithium based energy storage devices. Current limitations for this technology include short lifetime, shuttling phenomena in the electrolyte and active material loss due to solubility issues. In order to overcome these issues, deeper understanding of the mechanisms involved during the cycling of these cells is needed.[1] In particular, being able to accurately model the reaction-diffusion of the several polysulfide species expected within the gap between the anode and cathode of the battery would enable to refine the interpretation of experimental data and help addressing new device design rules. Unfortunately common characterisation techniques do not allow in operando analysis of electrolyte composition within standard cells and bespoke cell design is needed to access this type of information. For example, by measuring cells which included a transparent window, Patel et al. correlated the concentration of the different species in the electrolyte of lithium sulphur cells to the optical reflection of the device measured via UV-vis spectroscopy.[2] This approach demonstrated the possibility to spectroscopically access the electrolyte composition and the potential of quantifying the concentration of the different polysulfide species in operando mode.

In this study we present measurements of in operando spatially resolved optical transmission spectroscopy performed on horizontal lithium sulphur batteries. We fabricated battery structures by depositing lithium and sulphur electrodes on conductive patterned glass which was subsequently sealed. Injection of the electrolyte in the structure resulted in cells showing a semi-transparent gap between the cathode and the anode. Optical transmission measurements as a function of distance from the electrodes were performed with resolution in the order of 50 µm. The obtained spectra were deconvoluted on the basis of literature values of the absorption onset for polysulfides of different length. Measurements were performed to monitor the dynamics of polysulfide transport during charging and discharging of the battery. The discussion of our data include the potential and limitations of this approach at estimating concentration profiles in the electrolyte of lithium sulphur batteries and the extension of the analysis to extract the diffusion coefficient of the species based on the electrical and spectroscopic data. Finally we anticipate how UV-vis measurements could be used to monitor degradation pathways in lithium sulphur batteries.

References

1. Wild, M., et al. Energy Environ. Sci., 2015, 8, 3477—3494
2. Patel, M. U. M., et al. ChemSusChem 2013, 6, 1177 – 1181

Speaker Biography:

Davide Moia is a Research Associate in the Physics department of Imperial College. Davide has worked on the kinetics of electron transfer in electrochemical and solid state solar cells for his PhD.

He is currently developing spectroscopic techniques to measure charge (ionic and/or electronic) transport properties of liquid electrolytes, conjugated polymers, as well as perovskite solar cells.