Summary

Most commercial lithium-ion batteries have proven to be reliable products with attractive capacities and power densities, but there remains a general requirement for new battery chemistries with even higher energy density to satisfy the needs of next generation electric devices. On one hand, there is a constant need to improve the performance of current applications (e.g., cell phones and personal electronics) and, on the other, to allow the penetration of new market opportunities such as power tools, electric vehicles, and hybrid electric vehicles.

Lithium sulphur batteries represent a relatively new area of exploration within the field of battery research. The discharge/charge process of a typical lithium sulphur battery proceeds through formation of polysulphide intermediates which are soluble in conventional electrolyte systems. Due to concentration gradient soluble polysulphides easily diffuse out of cathode composite forming non-uniform distribution of the sulphur within the cathode. In this work we investigate the sorption properties of manganese modified zeolite silicalite-1 (MnS-1) in a cathode composite. Careful analysis using XPS and FIB microscopy (with EDX) show improved retention of polysulphide species within cathode composite in the case of MnS-1 zeolite as additive. By using *in operando* mode UV-Vis spectroscopy and X-ray absorption spectroscopy we confirmed the role of sorption additive and reinvestigated the mechanism of conversion of sulphur into Li_2S. By using non-sulphur containing electrolyte a high precision analysis of sulphur K-edge XANES and EXAFS spectra was possible. Good cycling behaviour can be observed if MnS-1 zeolite is used as an interlayer between the composite cathode and separator.

Finaly, DEME TFSI - a variant of ionic liquid - is used as electrolyte or additive in the electrolyte of Li–S battery. The effect of electrolyte viscosity is tested. The results show that DEME TFSI and PYR1(2O1) TFSI not only inhibit the dissolution of lithium polysulfides (Li_2S_x), but also decrease the migration rate of polysulfides ions in the electrolyte. Therefore, the shuttle phenomenon in the lithium–sulfur battery is suppressed effectively with the addition of DEME TFSI. Consequently, a coulombic efficiency nearing 100 % and a long cycling stability are achieved.