TOWARDS PRACTICAL CALCIUM-SULFUR BATTERIES – THE NECESSITY OF ANODE PROTECTION

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With the steadily increasing demand on energy storage technologies, battery chemistries apart the conventional lithium-ion battery move into the focus of research due to advantages in terms of energy density, cost or safety. Among the different post-lithium battery systems, the electrochemical pair of calcium and sulfur appears as an interesting but challenging candidate. Despite the recently developed glyme-based $Ca[B(hfip)_4]_2$ electrolyte enabling Ca-S cell cycling [1], the research is still in its infancy with the reported cells exhibiting fast capacity fading partially originated in the polysulfide shuttle. Due the low redox potential of the Ca metal (-2.87 V vs. SHE), calcium is prone to reduce species in its vicinity with the decomposition products of soluble sulfur intermediates limits an efficient and long-term cell cycling.

In Casino Project, DLR has scanned the applicability of a series of various commercially available separators with low thickness for Ca-S batteries. The Ca stripping/plating overpotentials, critical current density and compatibility with sulfur cathode is discussed in details. Apparently, thin polypropylene and cellulose-based separators exhibit low overpotentials (< 0.05 V) in symmetrical Ca-Ca cells, and a significantly reduced voltage hysteresis in Ca-S cells. However, due to the shortened diffusion path, the polysulfide shuttle was found more pronounced, which indicates the need of sulfur retention and/or anode protection approaches. To this end, the development of organic coatings (artificial SEI) synthesized from polymerizable precursors containing monomers and electrolyte salt is pursued. The artificial SEI is being characterized by means of galvanostatic polarization and electrochemical impedance spectroscopy (EIS).

[1] Z. Li, B. P. Vinayan, T. Diemant, R. J. Behm., M. Fichtner, Z. Zhao-Karger (2020). Rechargeable Calcium-Sulfur Batteries Enabled by an Efficient Borate-Based Electrolyte. *Small, 16(39), 2001806.*