Fluoroethylene Carbonate-Based Electrolyte Solutions for Very Stable Lithium Metal Stripping−Plating at High Rates and High Areal Capacity.

Elena Markevich [a], Gregory Salitra [a], Doron Aurbach [a], Joern Kulisch [b]
[a] *Department of Chemistry, Bar-Ilan University, Ramat Gan 5290002 Israel*
[b] *BASF SE, Ludwigshafen 67056, Germany*

E-mail: markeve@biu.ac.il

High theoretical specific capacity (3860 mAh g^{-1}) and low negative redox potential make lithium metal an ideal anode for high-energy-density Li batteries. However, dendrite growth and side reactions of the electrolyte solutions limit the cycle life of batteries with Li metal anodes and cause severe safety problems, hindering practical use of these anodes in rechargeable batteries.

Many efforts have been made to stabilize Li metal anodes, including modification of the Li surface by various mechanical, physical, and chemical techniques, increase of the effective Li-electrode surface by the use of anode matrices with very large surface area, the use of solid electrolytes, the addition of selected cations (such as cesium or rubidium) which protect the Li surface from dendrite formation according to self-healing electrostatic shield mechanisms and the use of functional additives in the electrolyte solutions for the *in-situ* formation of a protective SEI.

We demonstrate excellent cycling performance of Li metal anodes in EC-free FEC based alkyl carbonate electrolyte solutions, which were shown to be the most promising electrolyte solutions for high energy-density and high-voltage rechargeable Li batteries. Symmetric Li|Li cells demonstrated an extremely long cycle life and a stable voltage profile for more than 1100 cycles at current densities of 2 mA cm^{-2} and an areal capacity of 3.3 mAh cm^{-2} with a minimal amount of electrolyte solution, sufficient for wetting the separator in coin cells (50 µl/cell or 22 µl cm^{-2}). An increase in areal capacity up to 6 mA h cm^{-2} does not affect the shape of the voltage profiles of the symmetric Li|Li cells.

The use of the FEC-based electrolyte made it possible to obtain stable cycling of Li|NMC cells for hundreds of cycles with high loading of active cathode material with areal capacity of 3.3 mAh cm^{-2}. We attribute the high performance of the Li anodes to the formation of a stable and efficient SEI on the surface of the Li metal electrodes cycled in FEC-based electrolyte solutions. The composition of the SEI was analyzed by Fourier transform infrared spectroscopy and X-ray photoelectron spectroscopy.

References:

[1] Markevich, E.; Salitra, G.; Chesneau, F.; Schmidt, M.; Aurbach, D. ACS Energy Lett. 2017, 2, 1321−1326.