E-MRS Fall Meeting 2021 VIRTUAL

Towards an Artificial Solid Electrolyte Interphase for Magnesium-Sulfur Batteries

The magnesium-sulfur battery is a promising candidate as post-lithium battery system due to its high energy density, improved safety and abundance of the applied raw materials. Its underlying mechanism is comparable to the lithium-sulfur system also facing the challenge of sulfur retention in the cathode to mitigate the polysulfide shuttle. In contrast to Li-S cells, reactions at the metal anode in Mg-S batteries – i.e. reduction of sulfur or electrolyte species at the Mg surface – might lead to anode passivation and localized stripping/plating behavior inducing high overpotentials and dendrite formation, respectively. An artificial solid electrolyte interphase (SEI) represents a popular approach to solve many of these problems at once. It aims to inhibit inadvertent reactions and detrimental in situ SEI formation at the Mg surface, and might enable uniform Mg deposition as well as stable cycling with less active material loss and mitigated self-discharge. Therefore, a thin, homogenous and mechanically stable surface coating is desired, which features high ionic and negligible electrical conductivity while being electrochemically stable in a wide potential range.

In this study, different ionomers and preparation methods were applied in an attempt to meet all requirements. The gained coatings were analyzed by polarization experiments in symmetrical Mg-Mg as well as galvanostatic cycling in Mg-S cells. Electrochemical impedance spectroscopy was applied to gain deeper insights and revealed the limitations of such coatings. Nevertheless, an ionomeric artificial SEI is capable to enhance the Coulombic efficiency as well as the discharge capacity gain, which confirms the artificial SEI to be an important component in the attainment of high-energy magnesium-sulfur batteries.

Joachim Häcker (1), Tobias Rommel (1), Maryam Nojabaee (1), Zhirong Zhao-Karger (2), Norbert Wagner (1), K. Andreas Friedrich (1,3)

(1) Institute of Engineering Thermodynamics, German Aerospace Center (DLR), Pfaffenwaldring 38-40, 70569 Stuttgart, Germany;

(2) Helmholtz Institute Ulm (HIU) Electrochemical Energy Storage, Helmholtzstrasse 11, 89081 Ulm, Germany;

(3) Institute of Building Energetics, Thermal Engineering and Energy Storage (IGTE), University of Stuttgart, Pfaffenwaldring 6, 70569 Stuttgart, Germany