Optimization of Magnesium-Sulfur Batteries by Innovative Material Development (MagSiMal)

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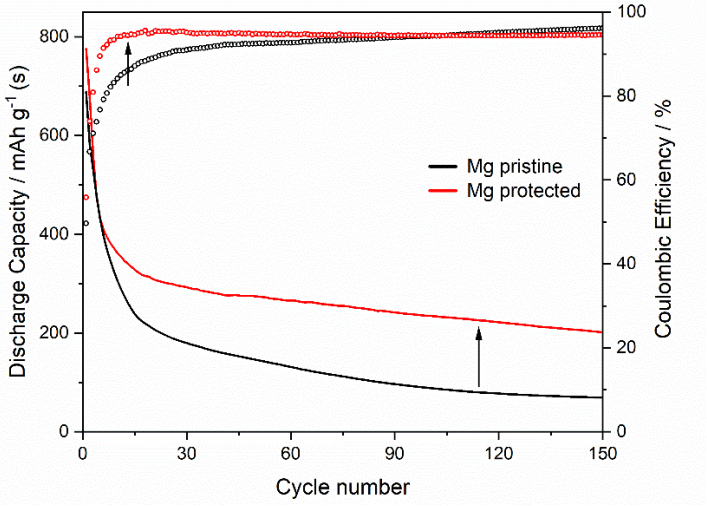
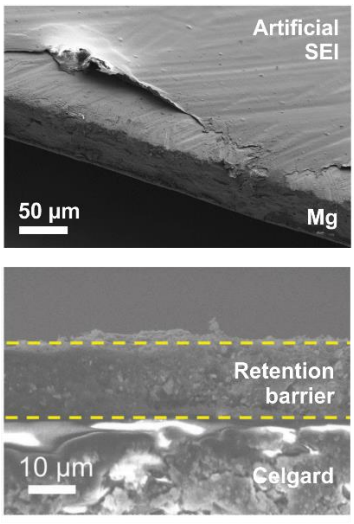
Among the numerous post-lithium battery systems, the magnesium-sulfur battery represents a promising candidate due to its high energy density, improved safety and abundance of the applied raw materials. However, despite intensive research and promising achievements in recent years, the Mg-S battery is still in its infancy facing fundamental challenges like the polysulfide shuttle, sluggish kinetics and parasitic anode reaction resulting in detrimental passivation of the magnesium metal surface and consequential low efficiency.

To tackle the bottlenecks, different material design approaches were pursued in the framework of the MagSiMal project (funded by BMBF). The retention of sulfur species was intended to be achieved by different cathode preparation routes (mechanical intrusion, melt and gas phase infiltration), tailored cathode structures (additives, [1] aerogels, meso- and microporous carbons) and coated separators.[2] Parasitic reactions on the anode side – namely ongoing reduction of electrolyte and sulfur species – were mitigated by an organic and inorganic artificial SEI [3] and in-situ SEI-forming electrolyte additives.[4] In addition, thin anodes were prepared via sputtering to reduce the magnesium excess and enhance the energy density. Finally, Mg-S pouch cells with enhanced capacity were realized showing the general suitability of the pursued approaches. However, the remaining high overpotentials, severe self-discharge and significant capacity fading query the whole Mg-S concept – thus future research directions, realistic targets and potential applications are critically discussed.





[1] J. Häcker et al., *ACS Energy Lett.* 7, 1-9 (2022)
[2] L. Wang et al., *Adv. Sci.* 9, 2104605 (2022)
[3] J. Häcker et al., *J. Mat. Chem. A, to be submitted* (2022)
[4] Z. Li et al., *ACS Appl. Mater. Interfaces,* 13, 33123−33132 (2021)