Li_2S/Mo Interlayer to Defend against Dendrite Formation

An interlayer with sluggish kinetics can initiatively suppress lithium dendrites efficiently.

Lithium metal is believed to be the ultimate anode because of its extremely high capacity, small density and lowest electrode potential, but a metallic lithium anode has not been commercialized in consideration of potential risks due to the formation and propagation of lithium dendrites in conventional liquid electrolytes. Adopting nonflammable inorganic solid electrolytes to use with Li anodes is a promising way to develop a next-generation technology for energy storage. The chemical stability and large shear modulus of inorganic solid electrolytes were considered key to preventing the penetration of lithium dendrites, but recent research revealed that batteries using solid electrolytes are prone to short circuits at large current, because a hard-solid electrolyte (thermodynamically stable) actually promotes rapid dendrite penetration. More strategies to defend against dendrite formation in solid electrolytes are hence desirable.

Xiaosong Liu (Chinese Academy of Sciences) and his co-workers recently developed the feasibility of building a soft interlayer (kinetically stable) using MoS_2 to improve bifunctionally the performance of the Li/garnet interface. Employing X-ray absorption spectra (XAS) at **TLS 16A1**,[1] the team found that, a nanoscale-thin MoS_2 layer in contact with the Li anode can be converted into an interlayer composed of Mo and Li_2S through a conversion reaction. The S K-edge XAS of samples cycled at varied current densities are shown in **Fig. 1**. These results demonstrate that this interlayer formed *in situ* grows dynamically as the current density increases. The formation and thickening of the thin Li_2S/Mo interlayer at large current density should be responsible for the reversible polarization. Furthermore, this interlayer could both decrease an interfacial resistance and defend initiatively against dendrites on tuning the distribution of current and the deposition of lithium.

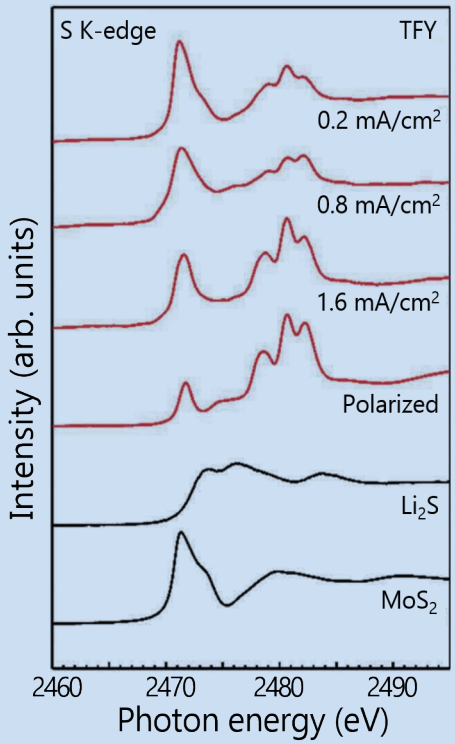

Fig. 1: S K-edge XAS detected in mode total fluorescence yield (TFY) of the cycled samples. The spectra of Li_2S and MoS_2 powder are shown as fingerprints to assign the possible reaction products. [Reproduced from Ref. 1]

In summary, this work proposes to decrease the interfacial resistance and to prevent the growth of lithium dendrite simultaneously through the formation of interlayers *in situ* enabled by a conversion reaction of MoS_2 layers coated on a bare $Li_{6.5}La_3Zr_{1.5}Ta_{0.5}O_{12}$ (LLZO) pellet. The sluggish kinetics of the conversion reaction resulting from the poor electronic conductivity makes the interlayer formed *in situ* kinetically stable, which can effectively hinder further reaction of MoS_2 with Li. This work provides a new strategy to optimize the interface of anodes by screening for more candidates that undergo a conversion reaction. (Reported by Yan-Gu Lin)

This report features the work of Xiaosong Liu and his collaborators published in Energ. Environ. Sci. ***12****, 1404 (2019).*

TLS 16A1 BM – Tender X-ray Absorption, Diffraction

- XANES, EXAFS
- Materials Science, Chemistry, Condensed-matter Physics, Environmental and Earth Science

Reference

1. J. Fu, P. Yu, N. Zhang, G. Ren, S. Zheng, W. Huang, X. Long, H. Li, X. Liu, Energ. Environ. Sci. **12**, 1404 (2019).