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ALKALI METAL BATTERIES

Preventing failure

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Rechargeable batteries comprising electrochemical cells with alkali metal anodes are promising alternatives to conventional lithium-ion batteries. However, the stabilities and lifetimes of these cells are reduced by failure mechanisms, including the electrodeposition of dendritic growths on the anode, the formation of internal short circuits and electrolyte loss as a result of reactions between the electrolyte and the highly reactive anode.

To protect the anodes, solid-electrolyte interphases (SEIs) can be incorporated into the electrochemical cells; however, these must not interfere with ion transport in the cells. Writing in *Nature Energy*, Lynden Archer and colleagues report the use of an artificial SEI that not only protects the anode from these failure mechanisms but also allows charge to be stored. The artificial SEI is made by coating Sn onto either a Li or Na anode. "If these electrochemically active Sn coatings are designed to facilitate fast charge transport between the electrolyte and the underlying alkali metal anode, it would be possible to remove the root cause of failure without compromising overall electrode capacity," says Archer.

To make the Sn coatings on the anodes, a Sn-containing salt is added to a carbonate electrolyte. "As a consequence of straightforward ion-exchange chemistry between the Sn-containing salt and the Li or Na anode, it is possible to create electrochemically active Sn coatings, and the thickness of the coatings is controlled by the concentration of the carrier salt in solution," explains Archer. The Sn-coated anodes have very large exchange current densities, that is, the alkali metal ions are shuttled easily between the electrolyte and underlying alkali metal electrode. "By direct visualization studies of the Sn electrodeposition at Li anodes, and also at notoriously unstable Na electrodes, our study shows that the Sn coatings can indeed arrest rough, dendritic electrodeposition of the alkali metals and, at the same time, limit their parasitic reactions with electrolyte components," says Archer.

"A key innovation in our system is the creation of hybrid anodes in which the Sn coatings passivate the alkali metal and are also able to store substantial amounts of charge as a consequence of alloying reactions," states Archer. An advantage of this approach is that provided the coating materials have a high intrinsic capacity to store Li, such as Sn, Si and In, the interphases formed on the anode can be designed in thicknesses that optimize their protective function while not adding significantly to the overall electrode weight.

Alison Stoddart

ORIGINAL ARTICLE Tu, Z. et al. Fast ion transport at solid–solid interfaces in hybrid battery anodes. *Nat. Energy* https://doi.org/10.1038/s41560-018-0096-1 (2018)