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Characterizing Materials and Interfaces in Solid-State Batteries

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The advent of lithium-ion batteries has brought about a revolution in portable energy storage, spurring the rapid growth of the electric vehicle market. However, further advances in energy storage technologies are needed for electric trucks and planes, as well as for grid storage. Here, I will discuss my group's research on solid-state batteries, which is a rapidly developing technology that could feature higher energy density and improved safety compared to lithium-ion batteries. The presence of solid-solid electrochemical interfaces within solid-state batteries, rather than conventional liquid-solid interfaces, causes different fundamental phenomena to govern behavior of these batteries. Using operando X-ray tomography, cryo-FIB, and other characterization techniques, we visualize the formation of voids during lithium stripping and dendrite growth during plating. Next, alloy anodes are shown to exhibit improved interfacial stability and enhanced cyclability in solid-state batteries compared to Li-ion batteries. The influence of stack pressure on alloy anode evolution is investigated, and we show that anode morphology changes during charge/discharge are highly pressure dependent. Finally, I will briefly discuss other energy storage innovations, including battery materials with improved sustainability and new battery concepts for ultrahigh energy density. Taken together, knowledge of transformation mechanisms in materials is key for engineering them for improved performance, with new materials holding great promise for future battery technologies.

Topical Area

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