LITHIUM METAL BATTERIES

Flow with ultrasound waves

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During battery charging, lithium deposits from electrolytes onto anode surfaces. In Li metal batteries (LMBs) that use metallic Li anodes, the deposition is often non-uniform and causes the formation and growth of Li dendrites. These dendrites pose a serious safety hazard. In particular, at high charging currents, the mass transport limitation in the electrolyte leads to large Li-ion concentration gradients, accelerating dendrite growth and degrading battery capacity and lifetime. Most research on suppressing dendrite growth so far has focused on anode surface treatments, electrolyte and solid–electrolyte interface designs, and separator coating. Now, James Friend and colleagues in the USA and Israel integrate model LMBs with a surface acoustic wave (SAW) device to tackle the issues of the Li-ion concentration gradient and dendrite growth.

The working principle is that ultrasound waves emitted from the SAW device can generate an electrolyte flow, which in turn reduces the Li concentration gradient and leads to more uniform Li deposition during charging. By carefully adjusting the power of the SAW device to an optimum of 100 MHz, the researchers are able to obtain a stable dendrite-free Li–Cu cell with a commercial carbonate-based electrolyte, even at a high current of 6 mA cm^{-2} . The Coulombic efficiency (a reversibility indicator that is defined as the amount of stripped Li divided by the amount of plated Li) is found to be above 80% in the range of $\sim 1\text{--}6 \text{ mA cm}^{-2}$. A full Li/LiFePO₄ cell with a SAW device is also shown to operate for 200 stable cycles with 82% retention of its initial capacity at a moderate current of 2 mA cm^{-2} . By contrast, the same cell without the SAW device shows only 51% capacity retention after 200 cycles.

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