Docket #: S17-133

All-solid-state lithium metal battery based on three-dimensional structural design

Stanford researchers at the Cui Lab have adopted for the first time, a 3D porous lithium (Li) metal anode and flowable interphase to construct an all-solid-state Li metal battery. The flowable interfacial layer can accommodate the interfacial fluctuation and guarantee excellent adhesion at all time, while the 3D Li significantly reduces the interfacial fluctuation from the whole electrode level (tens of micron) to local scale (submicron) and also decrease effective current density for high capacity and high power operation. As a consequence, greatly improved electrochemical performance compared to the conventional Li foil counterpart can be achieved in both symmetric and full cell configuration, which is among the best reported values in the literature. This approach addresses the current challenges in creating commercially viable all-solid-state Li metal batteries for next-generation energy storage.

Figure

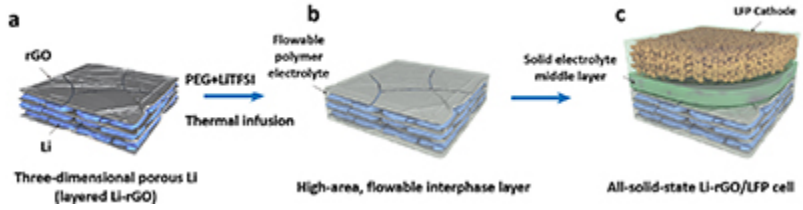

Figure description - Schematic illustrating the fabrication process of the 3D Li anode with flowable interphase for all-solid-state Li battery.

Stage of Research

- Reduced to practice
- Full cells showed greatly improved electrochemical performance compared to the conventional Li foil counterpart can be achieved in both symmetric and full cell

configuration, which is among the best reported values in the literature.
- Noticeably, all-solid-state full cells paired with $LiFePO_4$ exhibited at 80C a high specific capacity even at 5 C rate (110 mAh g^{-1}) and 93.6% capacity retention after 300 cycles at a current density of 3 mA cm^{-2}.
- The structural design is compatible with various solid electrolyte middle layers, including both polymer solid electrolyte and ceramic solid electrolyte.

Applications

- **All-solid-state lithium metal batteries** with improved electrochemical performance, safety, and energy density

Advantages

- Addresses three main challenges of high interfacial resistance at Li/electrolyte interface, low areal capacity and poor power output limiting the viability of all-solid-state lithium (Li) metal batteries
- Benefits of all-solid-state lithium (Li) metal batteries include:
  - Higher energy and power density
  - Higher safety – non-flammable and low risk for dendrite formation
- Superior performance compared to 2D Li anode fuel cell

Publications

- Lin, Dingchang, Yayuan Liu, and Yi Cui. "Reviving the lithium metal anode for high-energy batteries." Nature Nanotechnology 12.3 (2017): 194-206.

Patents

- Published Application: WO2018222379

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