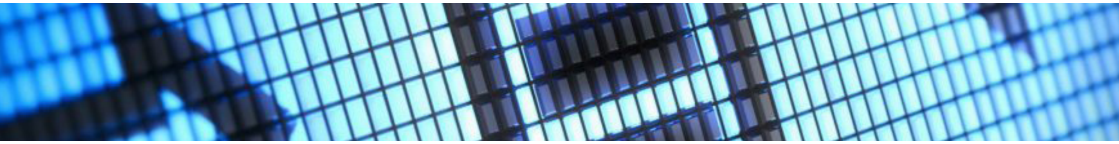
ENERGY STORAGE

UNIVERSITY OF OXFORD

ROYCE FACILITIES UNDERPIN MAJOR STUDY ON SOLID-STATE STORAGE DEVICES

Royce facilities for fabrication and characterisation of air-sensitive battery materials underpinned collaborative research from The Faraday Institution's SOLBAT project on solid-state electrochemical storage devices. Results demonstrate that the critical stripping current is a major factor limiting the power density in lithium and sodium anode solid-state cells; considerable pressure may be required to achieve even modest power densities.



THE CHALLENGE

Solid-state batteries have the potential to deliver higher specific energy and energy density, with enhanced safety. Cells with lithium metal anodes are particularly promising. In support of research on solid-state cells, Royce facilities at the University of Oxford underpinned the fabrication, characterisation and testing of air-sensitive battery materials. Gloveboxes enabledhandling and processing under an argon atmosphere, with very low (<1ppm) concentrations of oxygen and water vapour. Advanced characterisation tools, such as the Zeiss Merlin SEM incorporated workflows and transfer arrangements to enable devices and materials to be transferred seamlessely for investigation.

In the study reported in Nature Materials, three-electrode electrochemical cells were fabricated, to determine the cycling properties as lithium metal was plated and stripped. Even 99% dense ceramic electrolytes are susceptible to the penetration of lithium dendrites, resulting in short circuit failures. It was found that the threshold of current density below which dendrites do not form was increased by the application of increasing pressure to the cell and that insufficient pressure led to contact loss at the anode during battery discharge. This demonstrated that lithium metal creep is the primary mechanism of replenishing lithium metal at the interface to the solid electrolyte.

THE RESULTS

The publication suggested that a single stripping experiment offers a viable method for predicting the threshold current density below which there will be no contact loss, dendrite formation will not occur and therefore at which cells can be cycled indefinitely.

The Li/Li6PS5Cl interface was studied in this work to investigate the effect of dendrite formation and cell failure. The Na/Na-ß"-alumina interface was also investigated and reported in ACS Applied Materials and Interfaces, demonstrating that the results are applicable for other combinations of metal anode and solid electrolytes.

The prospect for solid-state batteries combines delivery of higher specific energy and energy density with enhanced safety. Royce's funding for air-sensitive fabrication and characterisation facilities helped enable this collaborative investigation with The Faraday Institution. Research on solid-state batteries will be accelerated thanks to the findings, which demonstrate that a single stripping experiment offers a viable method for predicting the maximum current density at which cells can be cycled indefinitely.

Prof Peter Bruce | Wolfson Chair
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This work represents an ongoing collaboration with between Royce and The Faraday Institution to support their electrochemical energy storage research with state-of-the-art equipment.

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