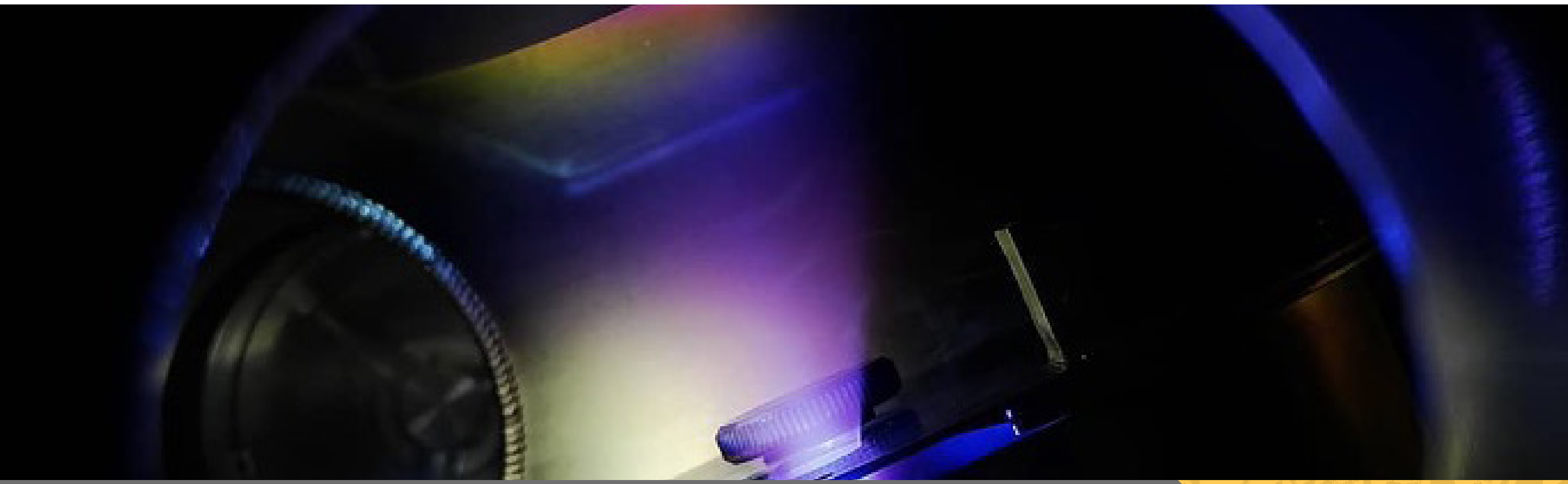
UNIVERSITY OF CAMBRIDGE

ADVANCED MATERIALS RESEARCH & INNOVATION

Facilitating the fabrication of all-solid-state thin film batteries

Royce's Battery module – part of the Ambient Processing Cluster tool based at the University of Cambridge – has been used to fabricate solid state battery thin films to study cutting edge cathode materials, the role that protective coatings can play, and build cathodes with novel 3D architectures.



Advances in the microelectronic industry have caused a surge in demand for miniaturised, on-board energy storage systems that can be implemented in devices with micro or nano-size dimensions, with thin film batteries being an attractive form factor for such applications. Key to the high performance of thin film batteries is how they are handled, with many prominent materials being very air and moisture sensitive. This is even more critical for thin film battery materials, as any surface degradation due to atmosphere exposure can comprise of a significant percentage of the film, impacting overall performance including gravimetric capacity and charge-discharge lifespan.

University of Cambridge is a Partner of the Henry Royce Institute for advanced materials

ROYCE

The Royce Battery Module is part of the Ambient Processing Cluster tool, which comprises ten interconnected glovebox modules for the deposition and processing of a broad range of functional materials. The battery module consists of three different deposition chambers connected directly to an argon glovebox, enables us to grow and study thin film battery materials free from atmospheric exposure.

The battery module contains three types of deposition chamber. The PLD chamber allows us to grow epitaxial cathodes and solid-state electrolytes, which can be grown in preferential crystallographic orientations to study and optimise their performance. Equipped with a carousel, we are able to deposit from up-to 6 target materials sequentially. The PLD chamber has a dual beam setup, allowing us to deposit from two targets simultaneously. The sputtering chamber can be used to deposit metal or oxide films, notably nitrogen containing electrolytes such as LiPON, or cathode coatings to help control metal dissolution from the cathode into the electrolyte. A thermal evaporator is directly attached, enabling sequential depositions of metals such as Li anodes without breaking vacuum.

With the deposition chambers directly connected to an argon glovebox, the Royce Battery module has the capability to manufacture full solid-state thin-film batteries without exposure to atmosphere. This makes it one of the only facilities of its type in the world capable. Two further gloveboxes; a furnace glovebox for the synthesis and processing of target materials for use in the deposition chambers, and the Faraday box can be used to build and electrochemically test battery cells.

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Visit **www.royce.ac.uk/impact** to read more impact case studies from the Henry Royce Institute

"Having this unique thin tool along with a wide range of operando characterisation tools, as well as a highly interdisciplinary approach is allowing us to gain unprecedented new insight into new materials and interface phenomena in solid state batteries."

Prof. Judith Driscoll | Professor of Materials Science, University of Cambridge