JÜLICH Forschungszentrum | HELMHOLTZ-INSTITUTE MÜNSTER

ISEA Stromrichtertechnik und Elektrische Antriebe | RWTH AACHEN UNIVERSITY

PhD presentations at ISEA

All presentations online (ZOOM) and at seminar rooms at CARL, Campus-Boulevard 89, 52074 Aachen.
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Monday, 9 January 2023
9 a. m. [Time zone Berlin]
Ruijie Ye, M. Sc.
“Sustainable Fabrication of Ceramic Solid Electrolytes for Solid-state Lithium Batteries”
(presentation language: English)

Tuesday, 10 January 2023
9 a. m. [Time zone Berlin]
Felix Weber, M. Sc.
“Stability of Lithium Electrolyte Interphase Enabling Rechargeable Lithium-Metal Batteries”
(presentation language: English)

Abstract

Ruijie Ye

“Sustainable Fabrication of Ceramic Solid Electrolytes for Solid-state Lithium Batteries”

Solid-state lithium batteries (SSLBs) are considered to be one of the most promising next-generation Li batteries due to their high capacity and intrinsic safety. Garnet-type $Li_7La_3Zr_2O_{12}$ (LLZO) is one representative of oxide-based solid electrolytes (SEs) for SSLBs. A thin freestanding LLZO sheet can be fabricated by tape-casting and used as separator in SSLBs. However, organic solvents and additives employed in the conventional tape-casting often give rise to safety concerns and high manufacturing costs. Hence, development of a water-based processing route for SEs and SSLBs reduces both manufacturing costs and environmental footprint.
In this work, the first sustainably produced LLZO thin sheet was reported, where water and eco-friendly polymers were applied within the tape-casting process. The key Li^+/H^+ exchange involved in the fabrication process was investigated. On the basis of this LLZO thin sheet, two types of SSLBs were successfully developed with $LiFePO_4$-polyethylene oxide and $LiCoO_2$-LLZO composite cathodes, respectively, which were fabricated for the first time by sustainable water-based processes. This work demonstrated the feasibility of an environmental friendly processing route for SSLBs. Their sustainable processing offers additional advantages of SSLBs over conventional batteries in terms of ecological and economic benefits.

PhD presentations at ISEA

Felix Weber

"Stability of Lithium Electrolyte Interphase Enabling Rechargeable Lithium-Metal Batteries"

Energy storage systems are crucial for handheld mobile applications and electric mobility, but state-of-the-art solutions suffer from limited storage capacity. Replacing graphite, the mostly used anode material in lithium-ion batteries, by metallic lithium increases the storage capacity by a factor of ten. However, it leads to electrolyte decomposition and lithium loss over time when combined with a liquid electrolyte. This is a key challenge in enabling rechargeable lithium-metal batteries.

This thesis develops scanning electrochemical microscopy (SECM) for use on lithium metal surfaces to observe and understand the decomposition reactions at the lithium/electrolyte interface. It is revealed that lithium reacts with a baseline electrolyte even without an external potential applied, leading to thick surface layers. The addition of film forming additives is found to stabilize the interface and reduce electrolyte decomposition reactions. Further stabilization is achieved by coating lithium with graphite to form a selective passivation layer that fully inhibits the creation of an electrically insulating layer of agglomerated decomposition products.

The overall goal is to provide a fundamental understanding of the reactions at the lithium/electrolyte interface as well as identify and evaluate concepts that lead to the successful development of rechargeable lithium-metal batteries.