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How Neutrons and X-rays Help Us Understand Electrochemistry

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Electrochemistry –especially within the context of energy storage, has become a key element of society. Understanding its processes is essential, e.g., for the making of cheaper, lighter and safer batteries or the synthesis of novel functional materials. A number of the concerned processes takes place at so-called "buried-interphases", which can only be investigated using advanced characterization techniques with high penetration depth and sensitivity. This is the case for neutrons and high energy x-rays, which can hence be used to unravel reactions and mechanisms whilst ongoing. Small-angle scattering allows for the detection of structural changes from a couple to a few hundreds of nanometers with high statistical relevance due to high probe flux and relatively large sample area. Small-Angle Neutron Scattering was applied to follow the morphology of a single-ion polymer electrolyte inside a lithium metal cell during cycling at high temperature, which revealed the structural stability of the material under harsh conditions. When used in reflection geometry, Grazing Incidence Small-Angle X-ray Scattering can be used to determine the average structure of thin films, which was done for the case of electrochemically deposited mesoporous silica films. This revealed the vertically oriented hexagonal structure of the porous network and led to the finding of an aggregate-free deposition protocol. This shows the versatility of neutron and X-ray techniques towards new technologies.

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