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ABSTRACT:

Atomic transport, the functional principle of battery storage

Diffusion and atomic transport represent core functional principles of rechargeable batteries. However, in comparison to diffusion in metals, we need to take some delicate issues into consideration. Species are charged, but charge neutrality has to be maintained. Battery operation at room temperature needs extremely fast diffusion, which hinders clear measurements. Often, short circuit transport in nanostructured materials is utilized.

After a survey reviewing aspects such as ion diffusion and drift, transfer numbers, Darken or Nernst-Planck interdiffusion, the role of interfaces and traditionally applied electrochemical methods, the talk presents recent experimental studies on thin film geometries. Sputter-deposited layers avoid artifacts of binders and additives. Also, they can work extremely fast. A controlled variation of film thickness and charging rate, the latter even by 5 orders of magnitude, can help identify and measure grain boundary transport [1]. Optical methods allow the in-situ characterization of ion transport and enable measurements of the temperature dependence of diffusion coefficients and transport barriers at phase boundaries [2]. The so-called solid-electrolyte interphase is most important for the stability and cycle life of a battery, similar as growing oxide films in high temperature corrosion of alloys. Its growth is measured with outstanding sensitivity by quartz crystal nanogravimetry [3]. Interestingly, even reversible diffusional growth of intermediate Lithium-Oxide films can be identified which take part in the charge storage of Si and Ge anodes [4].

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