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Effect of SEI formation on lithium diffusion coefficients in Si thin film anodes

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The solid electrolyte interphase (SEI) is a solid protective barrier that forms at the surface of lithium-ion batteries (LIB) operating outside the stability range of the electrolyte. In particular, that happens at the anode where Li metal reduces the liquid electrolyte forming a solid mixture of inorganic and organic components during the lithiation reaction [1]. A good barrier layer prevents further electrolyte decomposition and prevents the exfoliation of the anode material during cycling. However, if the SEI layer is unstable, it would lead to electrolyte loss, termed 'drying out', and increased electrode impedance. Both processes cause reduced efficiency and capacity fading [2]. Silicon has drawn the attention of researchers as one of the most outstanding alternate materials for the next generation of LIB anodes. It possesses a very high theoretical storage capacity (4200 mAh g^{-1}) compared to all other known materials [3]. However, in addition to the large volume change during Li (de)intercalation process [4], the instability of the SEI layer is a dominant disadvantage of Si anode, which leads to capacity decline and poor kinetics [5]. To understand the effect of SEI on the lithium-ion transport rate in Si thin-film anodes, galvanostatic intermittent titration technique (GITT) measurements were performed on RF sputtered amorphous Si films. The main goal was to determine Li diffusivities with LiClO_4 -based and LiPF_6 -based liquid electrolytes at room temperature. It was found that lithium diffusion coefficients of Si in LiClO_4 -based electrolytes are higher during the Li intercalation process. Furthermore, the morphology, composition, and thickness of the SEI layer are found to be different in various electrolytes, which will lead to differences in lithium-ion diffusion coefficients. To further explore the effect of the SEI layer, in situ neutron reflectometry (NR) will be applied in the near future to continuously study the composition and thickness of the SEI layer in Si anodes during the (de)lithiation process.

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