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Cyclic performance of silicon as anode material in lithium ion batteries

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ABSTRACT

Silicon is a promising anode material owing to its high energy density which is an important aspect of the performance metric for lithium ion batteries. In this study, the cyclic behavior of silicon as the anode material in lithium ion batteries is investigated. Chemical–mechanical coupling is considered to analyze the interactions between diffusion and factors influencing the mechanical response of materials. Galvanostatic–potentiostatic charging/discharging cycles are used to investigate the cyclic performance of the material in terms of response time, stress generation, and energy dissipation. The effects of plasticity, c-rate, and maximum state of charge are analyzed. In particular, energy losses due to diffusion dissipation and plasticity are calculated. Contributions of concentration inhomogeneity and stress-induced chemical potential shift on energy loss are quantified. This study yields guidelines for achieving faster charge/discharge by tailoring plasticity, mechanical-to-chemical coupling and limiting SOC.