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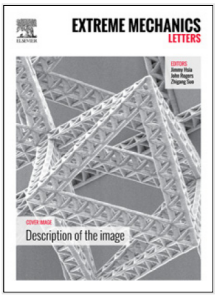

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Modeling large patterned deflection during lithiation of microstructured silicon

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Abstract

The application of silicon potentially provides more than nine-fold increase in the gravimetric storage capacity of anodes in the lithium-ion batteries. However, lithium intercalation into silicon matrix (lithiation) leads to nearly three-fold volume increase of silicon anodes after their full charging by lithium ions. Such enormous volumetric change in combination with inhomogeneity in lithium concentration and displacement constraints causes large mechanical stresses in the silicon resulting in non-elastic deformation, internal cracks and anodes failure or essential decrease in their life time. This problem can be significantly diminished by the use of anodes with small feature sizes particularly in the form of a honeycomb-shaped microstructure. In the present paper, finite element modeling was applied to explain the observed mechanical behavior of honeycomb-structured silicon anodes during