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Electrochemical strain microscopy: principle, analysis, and applications

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ABSTRACT

In this discussion, electrochemical strain microscopy (ESM) as a power tool to probe electrochemistry at the nanoscale is introduced. The imaging mechanism is based on ionic Vegard strain perturbed by charged SPM probe, and the methods to distinguish electromechanical coupling arising from piezoelectric strain, dipolar electrostriction, and electrochemical Vegard strain are discussed first. A phase field based model is then developed to interpret strain response in electrochemical system probed by ESM, and a combination of scanning and spectroscopic experiments are proposed to measure local ionic diffusivity and concentration at the nanoscale. The method has been applied to a variety of lithium ion battery electrodes to correlate the local electrochemistry at the nanoscale to the macroscopic battery performance, and future developments as well as some practical limitations are also discussed.