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Understanding the Degradation of Silicon Electrodes for Lithium-Ion Batteries Using Acoustic Emission and Fracture Mechanics[1]

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Silicon is a promising anode material for lithium-ion battery application due to its high specific capacity, low cost, and abundance. However, when silicon is lithiated at room temperature, it can undergo a volume expansion in excess of 280%, which leads to an extensive fracturing. This is thought to be a primary cause of the rapid decay in cell capacity routinely observed. We have developed a special cell design which allows us to monitor acoustic emissions stemming from mechanical events in the cell and allow for detailed structural analysis using X-ray diffraction with an internal standard. The combined result from acoustic emissions and X-ray diffraction allow for a first of its kind detailed look at how silicon anodes degrade and together with presented theories of fracture mechanics enable a material engineering approach to optimize its long term behavior. In collaboration with Kevin Rhodes and Sergiy Kalnaus.

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