Cathode Materials with Zero Strain for Lithium-Ion Batteries

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The market for Li-ion batteries is undergoing rapid expansion, as portable electronic devices demand a higher energy density and a better cycle life. Even though $LiCoO_2$ cathode has been widely used in commercial Li-ion batteries, electrochemical charge and discharge produces a phase transition as a result of non-uniform strain, which is closely related to capacity fading. This non-uniform dimensional change induces a shearing stress within each particle, and consequently a fracture occurs in most oxides. Hence, a zero-strain cathode material, whose lattice constants do not change during cycling, is known to be ideal for a long operational lifetimes Here we report a zero-strain $LiCoO_2$ cathode material produced by thin-film coating of high-fracture-toughness oxides on the particle surface, which suppresses the phase transition during cycling. The order of capacity retention is well correlated with the fracture toughness of the coated thin-film oxide. ZrO_2-coated $LiCoO_2$ shows no detectable capacity loss up to 70 cycles, while bare $LiCoO_2$ exhibits ~60% of its original capacity after only 30 cycles.