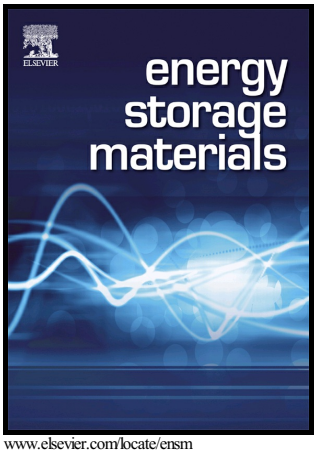

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Abstract

The electrochemical performances of electrode materials in lithium secondary batteries are closely correlated with their mechanical integrity. Direct design of surface layer based on mechanical properties can significantly simplify the optimization process. The Young's modulus (E), hardness (H) and fracture toughness (K_{IC}) of prototypical $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ (NCA) are characterized with indentation method. E and H decrease over by 50%, and K_{IC} decreases by 38% with delithiation. By contrast, the mechanical properties of NCA are effectively stabilized by Ti-doping. NCA exhibits much higher strain with lithiation/delithiation compared to the solid solution, and is tend to fracture during charge-discharge. Therefore, NCA samples with a nanoscale Ti-doped surface layer are prepared, and the mechanical stability is significantly enhanced by the surface layer. After 100 cycles, all the pristine NCA particles have been pulverized by the lithiation/delithiation processes, while almost all the particles with Ti-doped