Dually modified $Li_4Ti_5O_{12}$ anode revealing high lithium storage capacity

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Though Li-ion batteries (LIBs) technology is relative mature through decades of development, electric vehicles urgently require for electrode materials with extremely long lifespan and elevated capacities. $Li_4Ti_5O_{12}$ (LTO) exhibits remarkable cyclability owing to the negligible volume variation during charging/discharging, high safety due to the stable charge/discharge plateaus around 1.55 V (*vs* Li^+/Li) and environmental benignity.[1] However the poor electronic conductivity restricts the electrochemical performance especially at high current densities.[2,3]

In this work, the LTO coated with carbon layer together with Cu inclusions (LTO@C-Cu) was fabricated simply by annealing the mixture of precipitation method prepared LTO and a certain amount of $Cu(NO_3)_2 \cdot 3H_2O$ and pyrrole in a stainless steel autoclave at 550 °C. With the dual modification of LTO, the obtained product exhibits high reversible capacity (285.3 mAh g^{-1} at 100 mA g^{-1} for 100 cycles) and outstanding rate capabilities (achieving capacities of 318.8, 260.5, 234.2, 205.6 and 157.9 mAh g^{-1} at 100, 200, 400, 800 and 1600 mA g^{-1}, respectively), which are superior to those of pure LTO (P-LTO) and carbon-coated LTO (LTO@C) (see Figure 1). The thin carbon layer forms a conductive framework to enhance the electron transfer in individual LTO particles, the uniform-distributed Cu nanoinclusions behave as bridges among the LTO particles to provide extra electronic conductivity for the whole electrode, and the increased interface contributes to accelerating the interfacial diffusion of Li-ions. The simple fabrication method proposed is suitable for mass production of LTO with excellent reversible capacity even at high current densities (174.7 mAh g^{-1} after 600 cycles at 1000 mA g^{-1}).

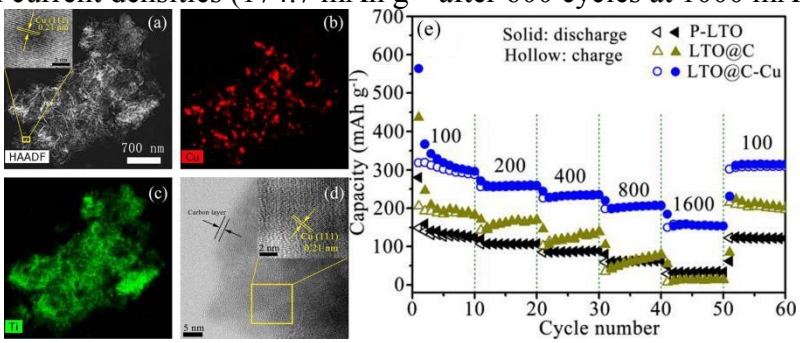

Figure 1. (a) HAADF-STEM image of LTO@C-Cu and the corresponding EDS mapping of Cu (b) and Ti (c), and HRTEM image of Cu nanoparticles (d). (e) Rate performance at different current densities from 100 to 1600 mA g^{-1} of P-LTO, LTO@C and LTO@C-Cu.

References:

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