

NANO-STRUCTURED BINARY INTERMETALLICS AS NEGATIVE ELECTRODE FOR LITHIUM ION BATTERIES

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ABSTRACT

Electric vehicles are being focused as the promising solution for environmental pollution and exhaustion of natural energy. Especially, lithium secondary batteries are expected to be an alternative power source for electric vehicles owing to their superior properties to the other competitors. For the practical application, however, the present lithium battery technology should be improved in aspects of power density and safety. Power density is related to current, therefore to the Li uptake/extraction kinetics. The kinetics can be improved by both decreasing diffusion length and increasing diffusivity because the rate-determining step is solid-stated diffusion of lithium ions in active materials. Most previous researches focused on the method to decrease diffusion length by preparing thin film or nano-sized electrode materials, which possesses a common drawback; high irreversible capacity, low energy density and difficulty in handling ultra fine powder materials. Here we show a new approach for the improvement of rate capability. We studied on the Ga and In-based binary intermetallics that are lithiated by the conversion reaction with an extraction of inactive atoms (Cu). After lithiation, the binary intermetallics CuGa_2 and Cu_7In_3 are converted to the nanocomposites of Li-A (A: Ga or In) alloys and extracted metallic Cu. In these nano-structured composites, a partial bonding between A and Cu prevails due to a strong affinity between two components. This partial bonding leads to a weakening in the bond strength between Li and A atoms, which is evidenced by the peak shift in Raman spectroscopy and X-ray diffraction patterns. As a result, the rate capability of de-lithiation is dramatically improved and the discharge rate becomes comparable to that of supercapacitors.