Novel $Li_4Ti_5O_{12}$/Si/c-PAN composite anode for Lithium-ion batteries

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Lithium titanium oxide $Li_4Ti_5O_{12}$ (LTO) and silicon (Si) are the most promising anode materials for the next generation of lithium-ion batteries (LIBs). Si attracts the attention for its numerous appealing features: high specific capacity, low operation potential, low cost and abundance. However, extreme increase in volume during cycling leading to its degradation limits its use, while LTO is commercially successful due to its excellent power density, high safety and long cycle life.

This work investigates a combined LTO/Si composite anode in a LIB with excellent electrochemical performance. The LTO/Si system is dispersed in cyclized polyacrylonitrile (c-PAN) polymer matrix, which is widely used as an active conductive material in order to improve electrical conductivity and binding abilities.

The composite anode material is synthesized by a high-energy ball milling, followed by heat treatment in inert atmosphere. In addition, the effect of LTO and Si mass ratio on the electrochemical properties of the battery is studied.

The presence of LTO, Si, and c-PAN in the composite is confirmed by XRD, Raman spectroscopy and SEM-EDS. SEM verifies the good mechanical resilience of an electrode by detecting no cracks and fractures on the electrode surface after being cycled for 100 cycles. Cyclic voltammetry shows a reversible electrochemical response from both LTO lithium intercalation and Si alloying. Therefore, combining c-PAN matrix, LTO and Si results in a LIB with excellent electrochemical performance, because LTO is capable for moderating the volumetric expansion of Si with its stable lattice structure, while Si contributes to capacity of cell.

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