Enhancing the Performance of Lithium Ion Batteries via Disorder/Order Engineering

A plenary talk

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Publication date:
2017

Abstract for NENS 2017

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To enhance the electrochemical performances of energy storage materials, many efforts have been put into fabrication of new nanostructures, in particular nanocrystalline particles containing quantum dots and superlattices via the nanoscale design strategy [1]. However, we have recently proposed a different strategy, namely disorder engineering, to enhance the electrochemical performances of the battery materials [2]. By disorder/order engineering, we mean that we first create the disordered structure in the cathode materials and then tune the degree of disorder by varying chemical composition of the materials and heat-treatment conditions. The two types of cathode material series, i.e., lithium-sodium-vanadium phosphates phosphate series with varying Fe/V ratio [2] and vanadium-tellurite series with different V/Te ratios [3,4], are synthesized by biotemplate and melt-quenching approach, respectively. Subsequently they are heat-treated at different temperatures for various durations under reducing conditions to tune the degree of disorder in structural network. The synthesized materials are mixed with additives, assembling into the coin batteries. The electrochemical characterizations of these materials shows that proper tuning of the degree of disorder in the material including carbon network can lead to a considerable enhancement of discharge capacity, energy storage density, and capacity retention after charge-discharge cycles. Through the disorder/order engineering and structural characterization, we provide insights into both the performance enhancement and the ion intercalation, as well as into ionic and electronic diffusion mechanisms. Furthermore, we reveal the relation between the capacity retention of batteries and the decay of the disorder in structural network of cathode materials.

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