

Core-shell Structured Carbon Coated LiFePO₄-rGO Hybrids for High Power Lithium Ion Battery Cathodes

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Novel nanostructured electrode materials with better stability and rate capability have been actively investigated to meet the demand for high power performance needed in hybrid and electric cars. LiFePO₄ is one of the most promising cathode candidates with lower toxicity, lower cost and improved safety especially for high power applications. The kinetic limitations associated with this ionically and electrically insulating material have been often resolved with nanostructure architecting of the electrodes.

Herein, we fabricated core-shell structured, carbon-coated LiFePO₄-reduced graphene oxide (rGO) hybrid materials for high power lithium ion battery cathode. In fabricating hybrid active materials/graphene composites, rGO is often added to the aqueous precursor solution of the active materials¹. However, hydrophobic nature of rGO surface makes it unstable in aqueous solutions leading considerable aggregation. This lack of consideration to prevent from aggregation of hydrophobic graphene in aqueous environment could lead inefficient utilization of graphene surface as hybrid templates. To overcome this limitation, we employed hydrophilic graphene oxide (GO) as starting scaffolds. By combining in-situ polymerization reaction² for size constrained nanoparticle synthesis of LiFePO₄ and extreme colloidal stability of hydrophilic GO in aqueous solution, true nanoscale hybrid materials of LiFePO₄-rGO were fabricated.

Highly crystalline LiFePO₄ nanoparticles with a size about ~30 nm were templated on the well-dispersed rGO sheets. (Fig. 1) Intimate interaction between active materials and conducting framework ensured efficient electron supply to the active materials. Further improvement could be accomplished with carbon coating of the hybrids. With the enhanced dispersion of conducting 2-D networks, intimate contact formation between active materials and conducting networks and size-constrained particle growth, the fabricated hybrid cathode showed a superior rate capability and cyclability to bulk LiFePO₄ and carbon-coated LiFePO₄ within a potential window of 2.0 V– 4.3 V vs. Li/Li⁺ at room temperature. (Fig. 2)

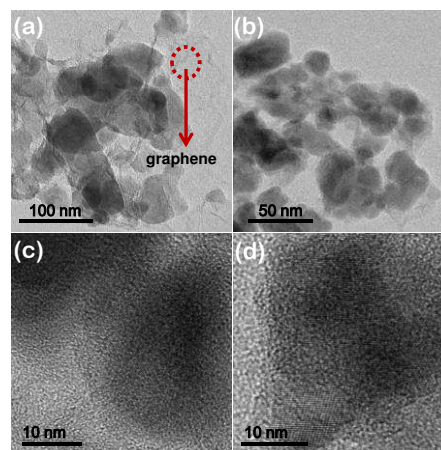


Figure 1. (a,b) TEM images of LFP/C-rGO hybrid, HR-TEM image of (c) LFP/C-rGO hybrid, and (d) LFP.

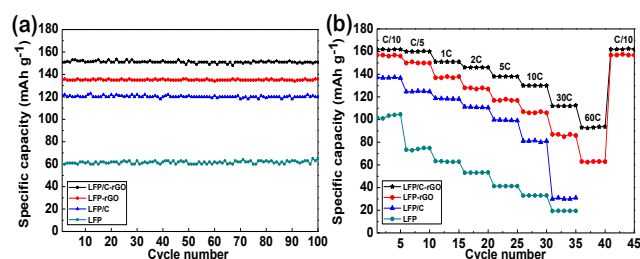


Figure 2. Electrochemical properties of LFP/C-rGO hybrid electrodes. Comparison of (a) capacity retention, and (b) rate capability between LFP, LFP/C, LFP-rGO hybrid and LFP/C-rGO hybrid

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