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Design and electrochemical performance of nano-micro structured porous materials

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Abstract

Graphene and carbon nanotube present unique structure and excellent properties, such as high specific surface area, high conductivity, high thermal conductivity, etc., and play an increasingly important role in the electrochemical energy storage and conversion. The doping of nano-carbon with nitrogen and boron can modulate the electron and energy band structure, and further improve its physical and chemical properties. The pore structure, pore size distribution and wall thickness of the electroactive material display important effect on the electrolyte infiltration, the ion transport and adsorption, and the overall performance of the battery. The use of doped nano-carbon and porous composite structure can improve the conductivity and the electrochemical surface area and reaction sites of the electroactive materials, and significantly increase the efficiency of energy storage and conversion.

This presentation focuses on some progresses of the doped nano-carbon and porous composite structures, including the following three aspects: (1) The controllable synthesis and electrochemical lithium insertion characteristics of the porous electrode materials. Porous materials have been widely used in a variety of fields, but their large-scale controllable synthesis is still a considerable challenge. We have designed a novel templated freeze-drying method to conveniently control the porous properties of materials, which has been successfully applied to the synthesis of various porous phosphates, oxides and composites, and the electrochemical lithium storage properties have been explored. (2) The porous lithium iron phosphate and nitrogen-doped graphene composite. Three-dimensional porous microspheres composed of $LiFePO_4$ and nitrogen-doped graphene have been synthesized by a solvothermal method. The effect of graphene doping on the nucleation and growth of $LiFePO_4$ and the influence of the unique self-assembled porous microsphere structure on the electrochemical lithium insertion performance have been studied. (3) Supercapacitance properties of doped graphene. A series of dopant graphene materials have been facilely synthesized by a thermal solid state reaction. The regulation of doping configuration on the electronic structure of graphene and the influence on the supercapacitance have been systematically studied. The relevant mechanisms have been proposed and some phenomena in the literature have been reasonably explained.

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