

NANOSTRUCTURED AMORPHOUS MANGANESE OXIDE CRYOGELS AS CATHODES FOR RECHARGEABLE LITHIUM BATTERIES

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In recent years, amorphous or nanocrystalline manganese oxides have received increasing attention as intercalation cathodes for rechargeable lithium batteries [1-9]. Most of these materials are produced via redox synthesis routes in aqueous or non-aqueous solutions to directly yield powders. Compared with these methods, sol-gel synthesis and processing of manganese oxides via a hydrogel offers an attractive route, one characterized by homogeneous mixing of reactants at the molecular level, precise control over the composition and morphology of the resulting phases, and great convenience for thin film fabrication. In this contribution, we report sol-gel synthesis and processing of nanostructured amorphous manganese oxide cryogels derived from hydrogels, their superior lithium intercalation properties, and dependence of these properties on synthesis conditions.

Manganese oxide hydrogels are synthesized by two different routes, namely, i) reduction of sodium permanganate solution with disodium fumarate solution, and ii) reduction of sodium permanganate solution with solid fumaric acid. Freeze drying is used to extract water from the hydrogels to yield amorphous manganese oxide cryogels. The cryogels derived from hydrogels synthesized by the second route possess nanostructured morphologies and specific surface areas of ca. 350 m²/g. These cryogels yield high specific capacities and superior rate performance. The cryogel with the best performance exhibits 278 mAh/g at C/100 and 174 mAh/g at 2C. The electrochemical performance of these gel samples shows great dependence on both the synthesis route and the precursor concentration. Gels synthesized by the second route exhibit much higher capacities than those synthesized by the first route. Moreover, for both synthesis routes, the higher the precursor concentration, the larger the specific capacity. It is proposed that differences in specific surface area and local structure of the amorphous cryogels derived from different routes and precursor concentrations give rise to the different electrochemical performance. These results suggest the possibility of tailoring the local structure and nano-architecture of amorphous manganese oxide cryogels to result in superior electrochemical performance by controlling the sol-gel synthesis conditions.

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