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Amorphous Hierarchical Porous Manganese Oxides for Supercapacitors with Excellent Cycle Performance and Rate Capability

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Abstract

Manganese oxides are considered as great pseudo-capacitance materials due to their high theoretical capacitance, but they usually suffer from unstable cycle performance and poor rate capability. To explore whether above problems are associated with crystallinity, electrochemical performances of amorphous and crystalline manganese dioxide are thoroughly investigated. Especially, ex-situ XPS and ICP-OES measurements are carried out to examine whether the amount of intercalated Na^+ ions is determined by crystallinity and has influence on cycle performance and rate capability. Meanwhile, relationship between pore size distribution and electrochemical performance of manganese dioxides is discussed. We find that the amorphous manganese dioxide with hierarchical pores presents the best performance in this work, which exhibits a specific capacitance of 405.2 F g^{-1} at a scan rate of 1 mV s^{-1} and 391.9 F g^{-1} at a current density of 0.1 A g^{-1} in a three-electrode system. Moreover, the amorphous-phase nanoparticle electrode possesses an excellent cycle life with 95.1% retention of its initial capacitance after 5200 cycles and a good rate capability of 75.3% retention at 10 mV s^{-1}, which are superior to that of the crystalline one in this work and lots of reported crystalline MnO_2 nano-materials.

Keywords: Amorphous manganese dioxide; hierarchical porous structure; cycle performance; rate capability; supercapacitor electrode.

1. Introduction