Solvothermal-Processed Spinel-type Manganese Oxide Microspheres and Their Improved Supercapacitive Properties

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Abstract. Oxide supercapacitors, with advantages of high power density, rapid charge-discharge rates, and long cycle life, have been considered as the promising energy storage devices.[1] Among several materials, manganese dioxide with 3D spinel phase has attracted extensive interest as an appealing electrode material for supercapacitors due to its capability to offer more electrolyte transport paths for the electrons transfer and protons/cations diffusion, which allows enhanced charge transport efficiency through the electrodes during charge/discharge process and leads to good supercapacitive performances.[2] However, the most common strategy to fabricate spinel MnO_2 is complicated and difficult to obtain products with high purity and great quality. In our work, MnO_2 microspheres (MS-MnO_2) with spinel phase have been successfully synthesized by a fast and cost-effective one-step solvethermal route in the presence of tetraethyl ammonium bromide surfactant as the template. The electrochemical performances of the MS-MnO_2 for supercapacitor device applications were investigated by cyclic voltammetry and galvanostatic charge-discharge measurements through a three electrode system in neutral 1M Na_2SO_4 electrolyte. These obtained results showed that the MS-MnO_2 exhibits good specific capacitance (SC) of ~ 190 F/g which was approximately five times higher than that of the commercial β-MnO_2 based device (~36 F/g) and also competitive with that of other reported spinel MnO_2 materials including slightly truncated nanoparticles (21 F/g at 20 mV/s),[3] interconnect nanofibers (241 F/g at 5 mV/s),[2] and particles with polyhedral shape (53 F/g at 10 mA/cm^2).[4] Besides, with excellent SC retention of ~100% and Coulombic efficiency of ~95 % after 1000 cycles at 1 A/g, the as-synthesized spinel MS-MnO_2 materials can be suggested its excellent long-term stability and the potential application in supercapacitors. In addition, the MS-MnO_2 with highly giant cavity through post-annealing treatment can be obtained, which is beneficial for the electrolyte access to the active material, useful for the application in energy storage devices, recharge lithium batteries, photovoltaic devices, solar cells and electrochemical sensors.

References

[1] P. Simon, Y. Gogotsi, Nat. Mater., **7** (2008) 845.
[2] O. Ghodbane, J.-L. Pascal, F. Favier, ACS Appl. Mater. Interfaces, **1** (2009) 1130.
[3] S. Devaraj, N. Munichandraiah, J. Phys. Chem. C, **112** (2008) 4406.
[4] Y. Xue, Y. Chen, M.-L. Zhang, Y.-D. Yan, Mater. Lett., **62** (2008) 3884.

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