SnO_2 Particles Synthesized by Sol-gel and Aerosol Spray Pyrolysis for Next-generation Li-ion Anode Materials

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The development of lithium ion battery (LIB) with high performance has established it as the leading energy storage devices for portable electronics, and attractive candidates for up-scaled applications such as electric vehicles. The latter applications call for advancements in energy and power densities of current technologies. The specific capacities of conventional electrode materials, such as graphite on the anode side can be increased with the exploitation of alternative electrode materials such as tin and tin oxides (Mohri, 2015). Current work discusses the synthesis of SnO_2 particles by aerosol spray pyrolysis (ASP) (Karadimitra, 2001) and sol-gel routes in order to study their nanostructure by exploiting their characteristics towards crystal structure, particle size, morphology, surface area and pore size distribution, while three different coating routes, namely dry mixing, liquid and aerosol route, have also been exploited for the synthesis of carbon coated SnO_2 particles. The above synthesis and coating technologies have been assessed by the evaluation of the electrochemical performance of the respective materials.

The synthesis parameters which have been exploited, such as precursor solution chemistry and calcination temperature profiles, target to the synthesis of SnO_2 particles at different size distributions and morphologies and especially in acquiring a hollow/porous particle morphology which provides increased cyclability potential during the charge/discharge through its nanostructure in order to compensate the significant volume change. Figure 1 depicts SnO_2 polycrystalline particles which have been synthesized by ASP.

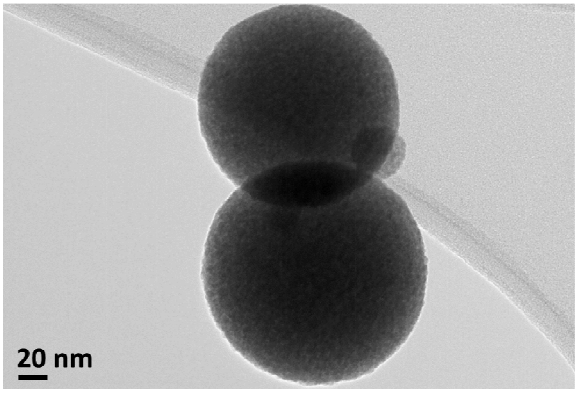

Figure 1. TEM image of SnO_2 nanoparticles synthesized by Aerosol Spray Pyrolysis

The various morphology SnO_2 nanoparticles have been carbon coated by three different routes: dry mixing, liquid (sol-gel) and aerosol synthesis. In the dry mixing case the synthesized nanoparticles were mixed with different carbon sources and calcined at 700ºC for 5 h in Ar atmosphere. Figure 2 depicts the XRD diagrams of SnO_2 nanoparticles (~100 nm) with carbon black (~5 nm) nanoparticles under different weight ratios, showing in each case the reduced Sn metal phase, due to insufficient coverage of the SnO_2 with carbon black particles. In liquid coating route the SnO_2 nanoparticles are either synthesized separately by sol-gel synthesis and then carbon coated by hydrothermal treatment or synthesized and carbon coated in one hydrothermal synthesis step. The carbon coating of SnO_2 particles by aerosol route is performed in one step by a single tin and organic precursor solution.

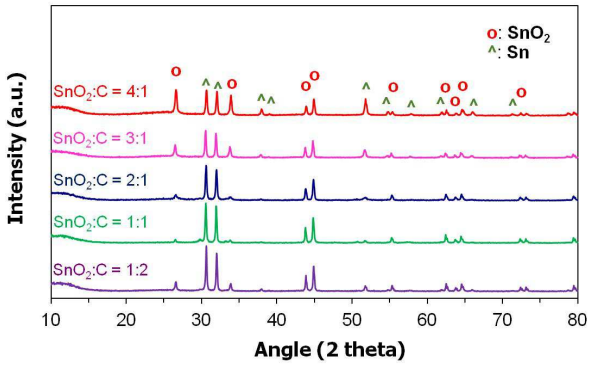

Figure 2. XRD diagram comparison of the carbon coated SnO_2 nanoparticles, under different SnO_2:carbon black ratios.

The electrochemical performance of the developed active anode materials varied with the synthesis and coating technique employed.

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