SnO$_2$-carbon composite based anodes for Li-ion batteries

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Lithium ion battery (LIB) has been widely regarded as the most promising power source for the coming plug-in hybrid electric vehicle (PHEV) and electric vehicle (EV). New generation electrode materials with high energy, high rate or high safety performance have been extensively studied to meet the challenge requirements for PHEV and EV applications. State-of-the-art anode material for LIB is graphite, which has a theoretical capacity of 372 mAh g$^{-1}$. Tin-based oxides have been considered as a potential substitute for graphite because of their higher theoretical reversible capacity (e.g., 781 mAh g$^{-1}$ for SnO$_2$). The practical application of SnO$_2$, however, is hampered by poor cyclability arising from the large volume change in repeated charging and discharging process, which causes mechanical failure and the loss of electrical contact. (2, 3)

At Argonne National Laboratory, we recently developed a series of approaches to fabricate tin oxide- carbon composites as high capacity, long life anode materials for LIB. We report here a novel ethylene glycol-mediated solvothermal-polyol route for synthesis of SnO$_2$-carbon composites. One example is the SnO$_2$-carbon nanotubes composites. The prepared SnO$_2$-CNTs consist of highly dispersed 3-5 nm SnO$_2$ nanocrystals on the surface of CNTs. As anode materials for Li ion batteries, the composites showed high rate capability and superior cycling stability with specific capacity of 500 mAh g$^{-1}$ up to 300 cycles (figure 1). The second example is SnO$_2$-graphene composites. Similar to SnO$_2$-CNTs system, highly dispersed 3-5 nm SnO$_2$ nanocrystals were formed on the surface and in between the graphene layers. Longer cycle stability was found for the SnO$_2$-graphene system, which implies that two-dimensional support is better than one-dimensional support for stabilizing SnO$_2$.

Detailed synthesis, structural characterization and electrochemical test results of the SnO$_2$-carbon composites will be discussed.

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