Materials Science & Engineering Master's Defense

Conductive polymeric binders for Lithium-ion battery anode

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abstract

Tin (Sn) has a high-specific capacity (993 $mAhg^{-1}$) as an anode material for Li-ion batteries. To overcome the poor cycling performance issue caused by its large volume expansion and pulverization during the charging and discharging process, many researchers put effort on it. Most of the strategies is through nanostructured material design and introducing conductive polymer binders serve as matrix of the active material in anode. Here we report the incorporation of a conducting polymer and conductive hydrogel into Sn-based anodes using one-step electrochemical deposition via a 3-electrode cell method: the Sn particles and conductive component can be deposited onto the working electrode in situ and simultaneously. A well-defined three dimensional network structure consisting of Sn nanoparticles coated by the conducting polymer is achieved. Such a conductive polymer- hydrogel network has multiple advantageous features: meshporous polymeric structure can offer the pathway for Lithium ion transfer between the anode and electrolyte; the continuous electrically conductive polypyrrole network, with the electrostatic interaction with poly(2-acrylamido-2-methyl-1-propanesulfonic acid-co-acrylonitrile) as both the crosslinker and doping cation for polypyrrole can decrease the volume expansion by creating porous space and soften system itself. Besides, the pre-UV-cured polyNIPAM thin polymeric film on the surface also benefits the improvement of capacity, resulting a capacity retention over 80% after 20 cycles, compared with only 54.7% of that of control sample. The cycle is performed under current of 0.1 C.

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