High-performance anode materials for next generation Na-ion batteries

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Because of their high energy density, Li-ion batteries have attracted attention as a large energy storage system over their traditional use for portable and electric vehicle applications. However, there are concerns about the scarcity, uneven global distribution and high cost of lithium resources. Compared with Li, Na has the advantages of natural abundance and low cost. Furthermore, Na and Li are in the same main group, exhibiting similar chemical properties, which translates to a resemblance between operational characteristics in Li-ion batteries and Na-ion batteries. Therefore, Na-ion batteries have been suggested for the alternatives to Li-ion batteries for large-scale systems. For the practical use of Na-ion batteries, studies for finding suitable electrode materials with high energy density, good cyclability and rate performance for Na-ion batteries have been actively conducted. Although several cathode materials have been suggested, the anode choices are severely limited because of the unique characteristic of Na. Na-ions cannot be stored in the commercial layered graphite because of their large radius. Si based materials are expected to be the most promising anode for Li-ion batteries, but it is electrochemically inactive with Na. To explore a high-performance anode materials for Na-ion batteries, we synthesized i) pure Sn electrodes with various structures such as Sn nanofibers, Sn multilayer, and Sn foam ii) MoS_2/MoO_x ($2<x<3$) composites using one-step electrodeposition process. The Sn electrodes exhibited a high reversible capacities and excellent cycle performances. After cycling, the Sn electrodes exhibits no loss of active materials and it was attributed to the pore volumes in the electrodes which accommodated the volume change during sodiation/desodation, and structural stabilities of them. The MoS_2/MoO_x showed highly reversible capacity and superior cycling stability. After cycling, the electrode material showed almost no crack or fracture and well maintained the contact with substrate, which are attributed to the buffering action of MoO_x phase during sodiation/desodiation of Na^+ in MoS_2 phase.

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