Fabrication of Cu nanorod arrays as nanostructured current collector for Li-ion batteries

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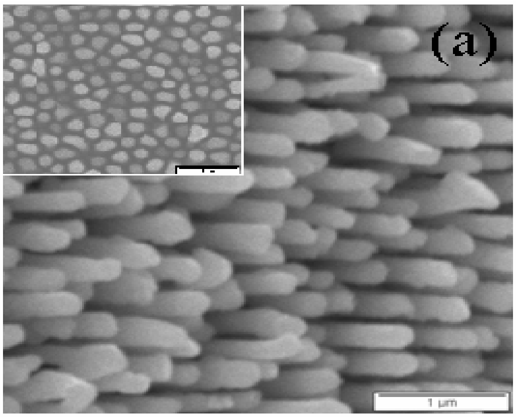
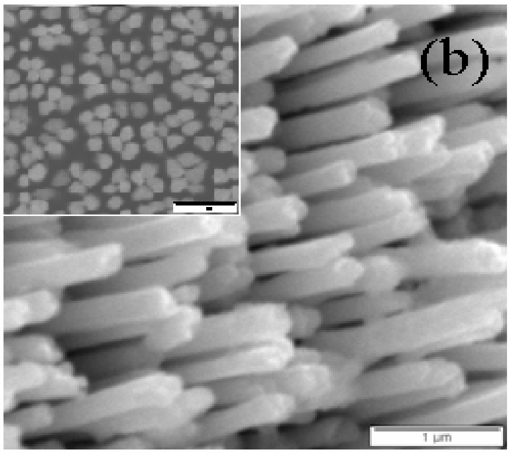
Li-ion batteries are attractive candidates for power sources because of their high energy density and long cycle life. However, due to the slow solid-state diffusion of Li-ion within the electrode materials, the performance of conventional Li-ion batteries charged/discharged at high current rate (> 1C) is severely degraded. Therefore, there is a vigorous research effort in the use of nanomaterials to shorten Li-ion diffusion path length and thus to improve the rate capabilities of Li-ion batteries. Nanorod or nanowire current collectors are expected to bring many advantages: larger surface contact area between current collector and active materials; easier maintenance of short Li-ion diffusion length; and better accommodation of structure strains imposed by electrode reactions.

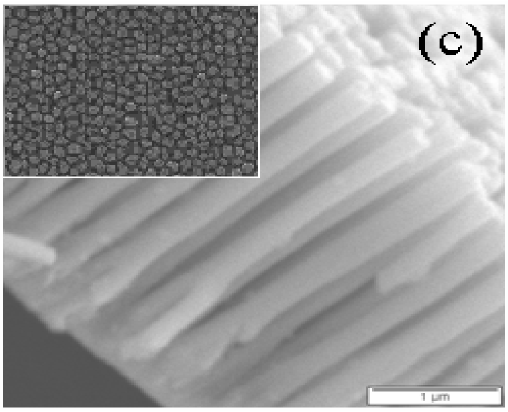
we developed a template-assisted means to fabricate Cu nanorod arrays on Cu foil to be used as current collector. Cu nanorods are potentiostatic deposited in the nanopores of anodized aluminum oxide (AAO) templates with optimized electrodeposition conditions. It is found that nanorods obtained in alkaline electrolye are the most uniform in length. In the future, we will load active materials on the Cu nanorod arrays to create nanostructured rapid rechargeable electrodes with high capacity for Li-ion batteries.



Cross-sectional SEM photos of Cu nanorods deposited in low acid concentration electrolyte



Cross-sectional SEM photos of Cu nanorods deposited in high low acid concentration electrolyte.



Cross-sectional SEM photos of Cu nanorods deposited in alkaline electrolyte.

Fabrication of nano-structured tin-oxide electrode based on Cu nano current collector for Li-ion batteries

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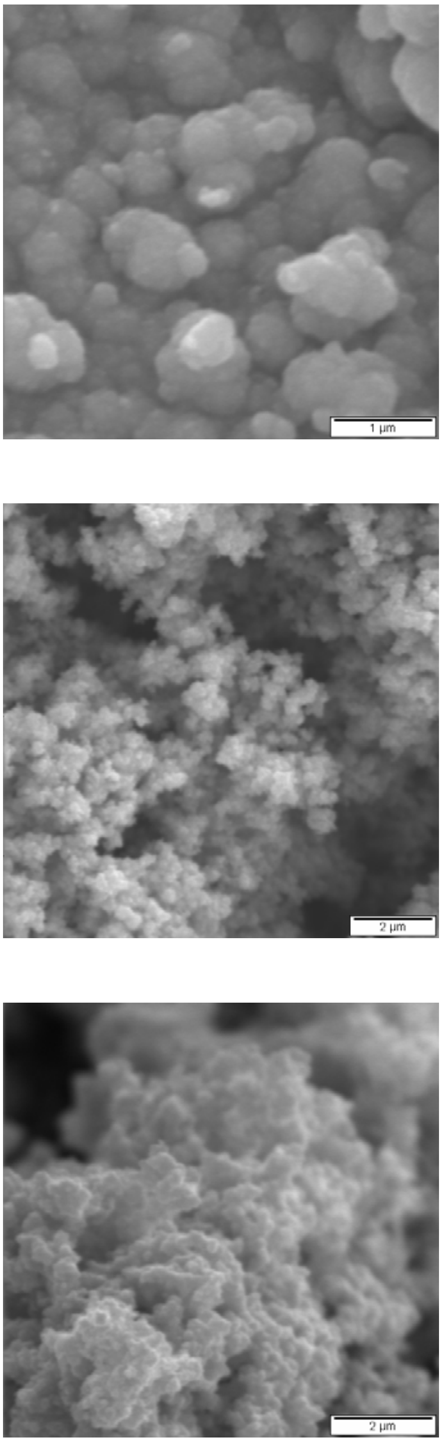
Due to its high transmittance in visible light and good electric characteristics, tin oxide (SnO_2) finds wide ranged applications in catalysis, gas sensors, transparent conductive films for display and solar cells. It is also an attractive candidate as anode materials in Li-ion batteries because of its large capacity, which is more than twice that of graphite. However, during charge/ discharge process, cracks are generated due to the volume change caused by alloying and dealloying reactions between Sn and Li. Thus, SnO_2 gradually detaches from current collector and eventually loss cyclability.

Here, we demonstrate the fabrication of a novel nano-structured SnO_2 electrode for Li-ion batteries. Firstly, a Cu nano-structured current collector with Cu nanorod arrays is fabricated. SnO_2 is then electrodeposited on this nanostructured current collector to serve as the active anode material. In this design, SnO_2 acts like reinforced concrete. This novel electrode is expected to bring many advantages compared to conventional electrode, such as larger surface contact area between current collector and active materials; easier maintenance of short Li-ion diffusion length; and better accommodation of structure strains imposed by electrode reactions. The SnO_2 electrodeposition conditions are optimized. It is found that the electrolyte composition, the electrodeposition current density and the temperature have important effects on the electrodeposition of SnO_2. In addition, a unique advantage of this electrode design is the convenience to switch from SnO_2 to other active materials enabling us to apply new anode materials in Li-ion batteries.



SEM photos of SnO2 particles obtained in different electrodeposition conditions