Electrospun novel nanostructured Sn-based perovskites ($MSnO_3$) as anodes for high-performance lithium ion batteries

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Among the potential anode materials, Sn-based binary or ternary oxides have been extensively studied for application in LIBs because of their high theoretical capacity (~ 782 mAh g^{-1}), controllable size and morphology. However, the practical use of Sn-based oxides has been hindered by their poor cycling performance and fast capacity fading. In order to improve the electrochemical properties of Sn-based oxides, composite structures composed of electrochemically inactive matrix have been demonstrated as a promising solution. By keeping this in mind, nanostructured $MSnO_3$ (M=Ca, Sr, Ba) perovskites with suitable morphologies and microstructures should be desirable as anode for LIBs.
In this work, 1 dimensional (1D) nanostructured $CaSnO_3$ perovskites with unique morphologies have been prepared by a facile electrospinning method and subsequent suitable calcinations in air. In a typical procedure, polyacrylonitrile (PAN) was dissolved in N,N-dimethylformamide (DMF) with vigorous stirring to form a 10 wt% solution. Stoichiometric amounts of $Ca(NO_3)_2 \cdot 4H_2O$ and $SnCl_2 \cdot 2H_2O$ were then added into the solution in order to yield a homogenous viscous solution. Then, the as-prepared solution was electrospun into nanofibers. Finally, the as-spun fibers were sintered at suitable temperature in air.
Figure 1 displays the XRD pattern of $CaSnO_3$, which match well with JCPDS data (Card No. 77-1797, a = 5.532 Å, b = 5.681 Å, c = 7.906 Å). Moreover, the morphology of $CaSnO_3$ is further characterized by SEM and TEM, as shown in Figure 2. The conventional electrospun fiber morphology of $CaSnO_3$ has been maintained after calcinated at 600 ºC for 24 h (Figure 2a). It is clearly seen that this sample contains uniform interior hollow structures with rough surfaces. The average diameter is ~ 560 nm. Furthermore, hollow tube-like morphology with a wall thickness of ~ 109 nm is clearly revealed in Figure 2b, which is in agreement with the SEM observation. Significantly, the unique $CaSnO_3$ nanofibers as anode for LIBs demonstrate exceptional electrochemical performance with high initial discharge capacity (1149 mAh g^{-1}) substantially improved cycling stability (~ 650 mAh g^{-1} after 50 cycles), which can be used as promising electrode for high-performance LIBs (Figure 3).
In the presentation, the effects of the preparation condition including reactant concentrations, different polymer, and calcinations temperature on the fibrous morphologies as well as the electrochemical performance of 1D nanostructured $MSnO_3$ (M=Ca, Sr, Ba) perovskites will be discussed.

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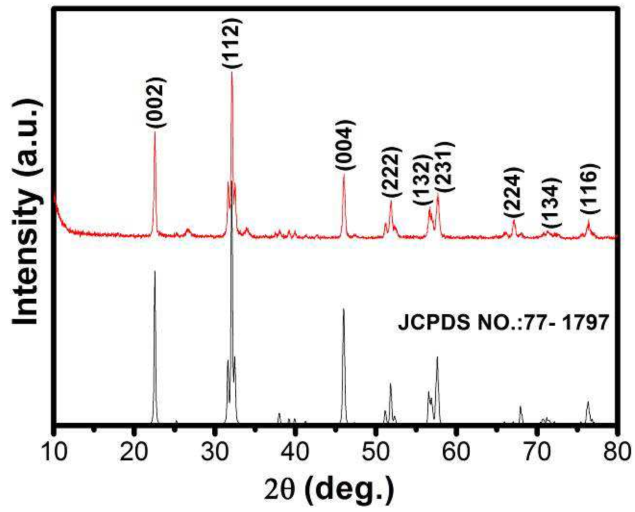

Figure 1. XRD pattern of as-prepared $CaSnO_3$ nanotubes.

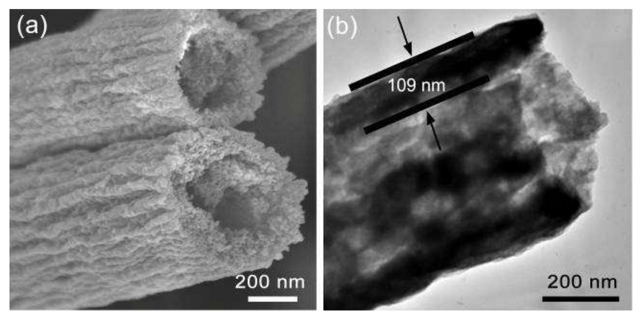

Figure 2. (a) SEM image, (b) TEM image of $CaSnO_3$ nanotubes.

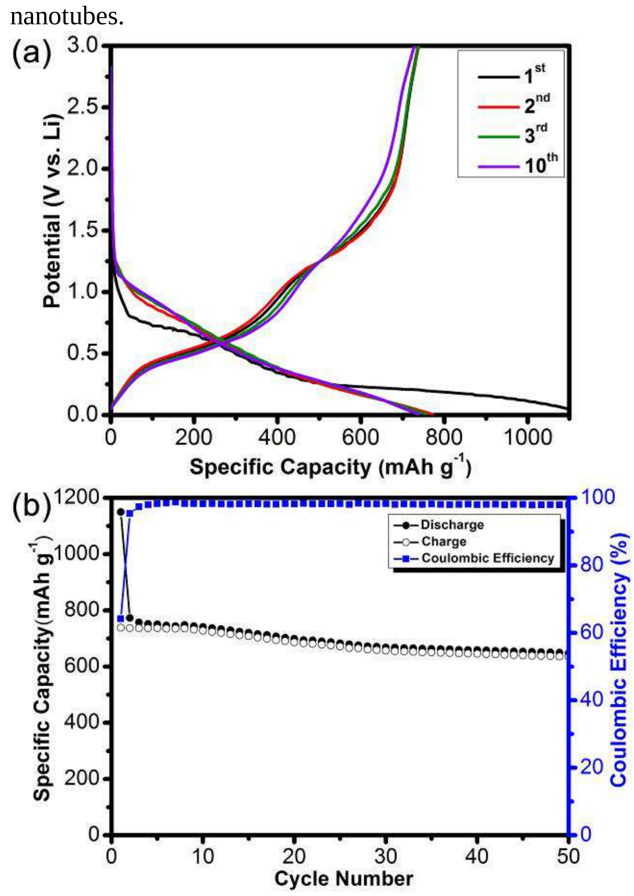

Figure 3. (a) discharge/charge profiles and (b) cyclic performance of $CaSnO_3$ nanotubes at a current density of 60 mA g^{-1}.