Supporting information

Electrospun eggroll-like $CaSnO_3$ nanotubes with high lithium storage performance

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EXPERIMENTAL SECTION

Synthesis of $CaSnO_3$

All chemical reagents were used as received. Polyacrylonitrile (PAN) was dissolved in N,N-dimethylformamide (DMF) with vigorous stirring to form a 10 wt% solution. Stoichiometric amounts of $SnCl_2 \cdot 2H_2O$ and $Ca(NO_3)_2 \cdot 4H_2O$ were added into PAN/DMF solution. Stirring of this solution for 24 h at room temperature resulted in homogenous solution. To study the effect of reactant concentrations on the nanofibers morphologies, two types of precursor solutions were prepared with different weight ratio of metallic precursor concentration over PAN concentration from 1.30 : 1 (CSO-NT) to 0.65 : 1 (CSO-NR) (The weight of PAN was kept constant). A high voltage of 15 kV was applied between the needle tip and aluminum collector. The needle tip to the collector was 14 cm. Finally, the as-spun fibers were sintered at 600 ºC for 24 h in air.

Characterization

The crystallite structure and morphology of the samples were examined by powder X-ray diffraction (Bruker D8 Advance, Cu-Kα radiation, λ = 1.5418 Å), Field Emission Scanning Electron Microscope (FESEM, JEOL JSM-7600F), and Transmission Electron Microscope (TEM, JEOL 2100F) with energy-dispersive X-ray spectroscopy (EDX) part. The lattice parameter was evaluated by TOPAS Rietveld Refinement software. The surface area analysis was recorded using Brunauer Emmett and Teller (Micromeritics, ASAP 2020). The samples were also characterized by Fourier transform infrared (FT-IR) spectra (a Perkin Elmer Spectrum GX instrument), Thermogravimetric analysis (TGA, Q500, 10 ^{o}C min^{-1} under air atmosphere) and X-ray photoelectron spectroscopy (XPS, PHI, PHI5300 system).

Electrochemical Measurements

The working electrodes consisted of active materials, polyvinylidene fluoride (PVDF) and conductive agent (Super-P-Li) with a weight ratio of 6:2:2. The electrochemical measurements were investigated using CR 2016 coin cell assembled with metallic lithium as a counter electrode, Celgard 2400 as the separator and 1 M $LiPF_6$ in ethylene carbonate/diethylene carbonate (EC:DEC = 1:1) as the electrolyte. The cell was assembled in an Ar-filled glovebox. The Galvanostatic discharge-charge cycling (0.005 V−3 V) and Cyclic Voltammetry (CV) (0.005 V−3.0 V, 0.1 mV^{-1}) were tested using Neware battery tester at different current density and Solartron 1470E, respectively. Electrochemical impedance spectroscopy (EIS) was recorded in the frequency range 100 kHz to 0.1 Hz by applying 10 mV bias voltage. The data was analyzed using Zplot and Zview software (version 2.2).

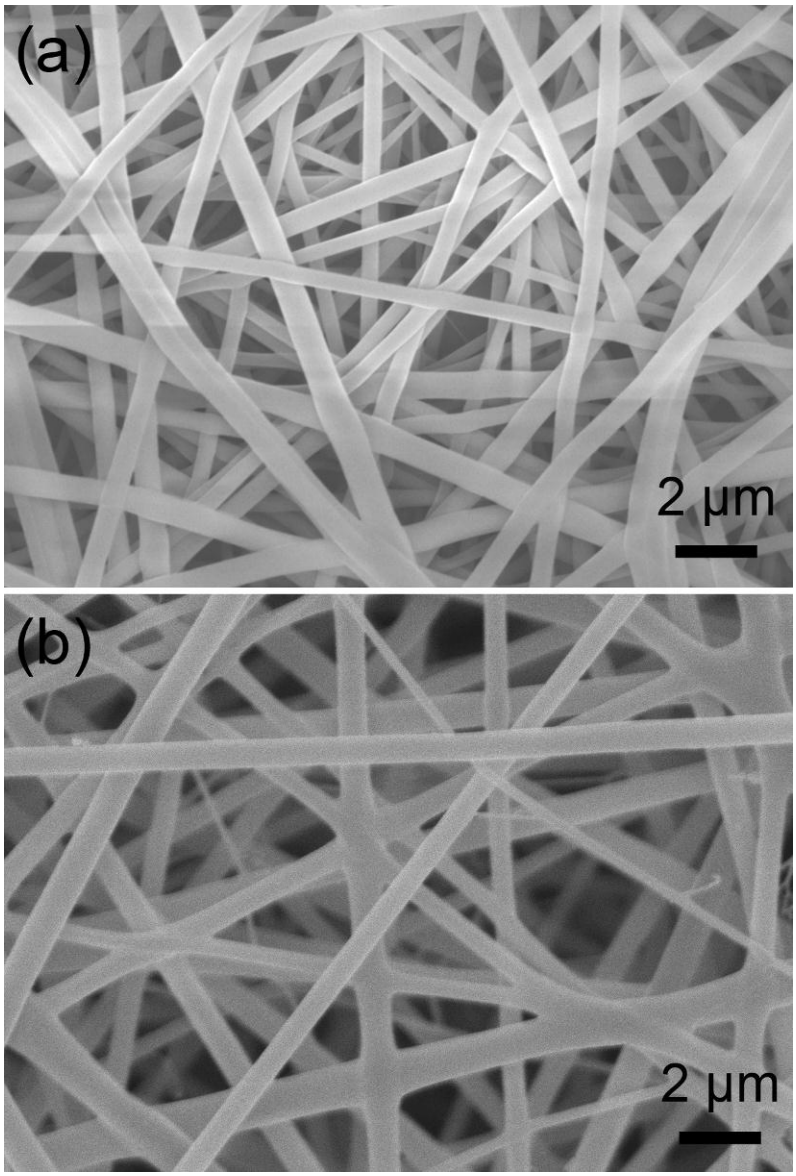


Fig. S1 FESEM images of as-spun nanofibers with different weight ratios of the metallic precursor and polyacrylonitrile (PAN) polymer: (a) 1.30 : 1, (b) 0.65 : 1.

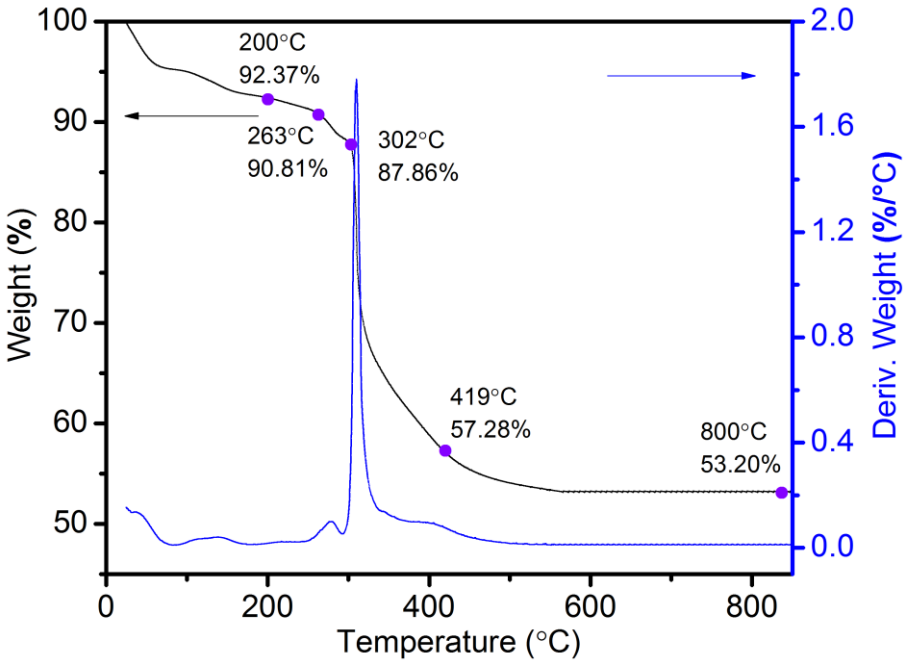


Fig. S2 TGA curve of the as-spun precursor with the weight ratio of 1.30 : 1 between the metallic precursor and PAN, which were measured from room temperature to 850 ºC in air.

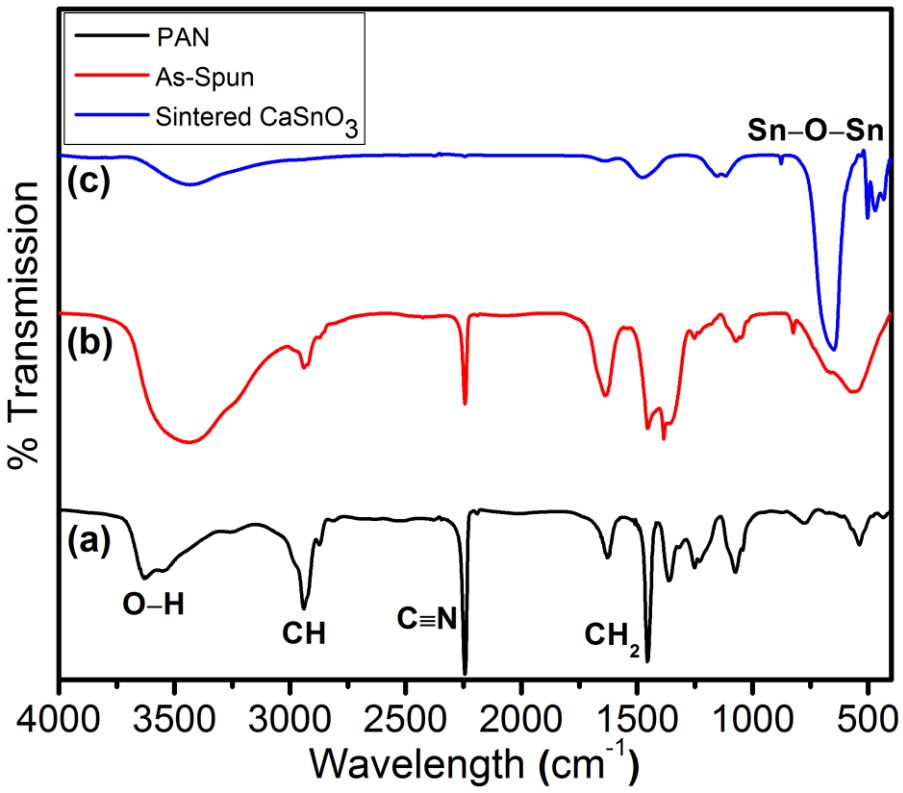


Fig. S3 FTIR spectra of (a) the PAN, (b) as-spun nanofibers, and (c) the sintered $CaSnO_3$ nanotubes at 600 ºC for 24 h.

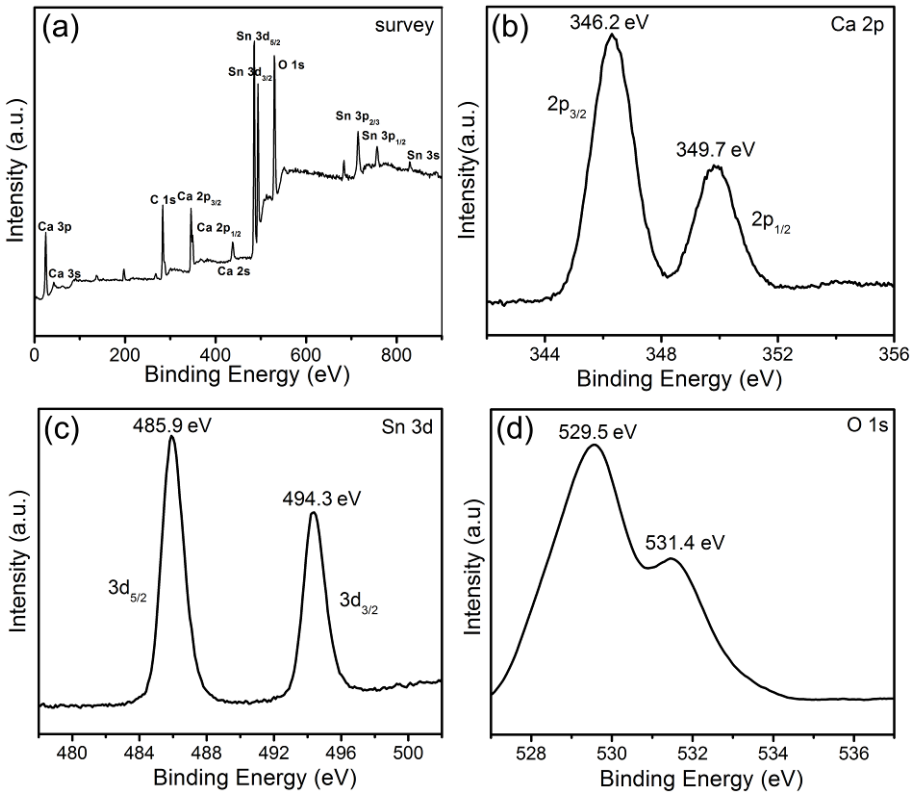
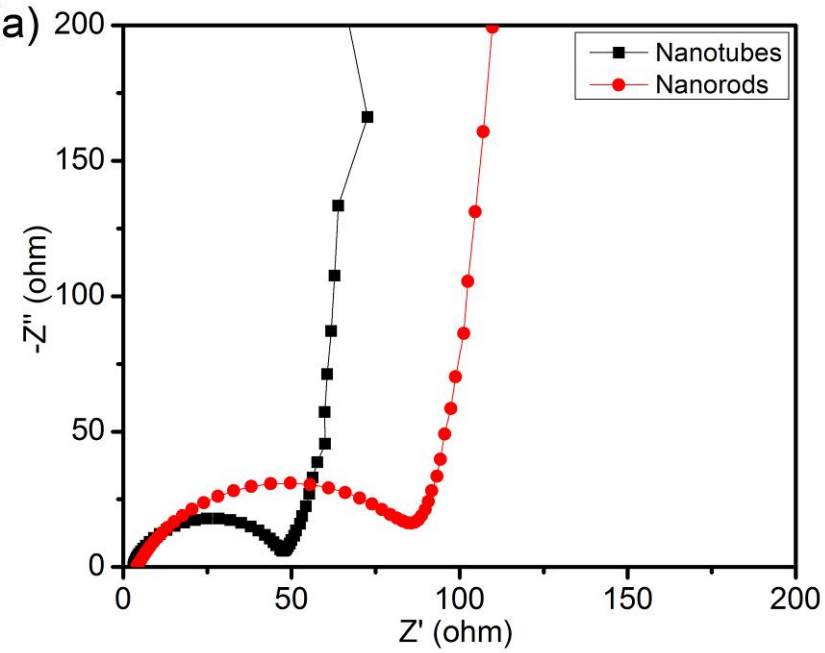
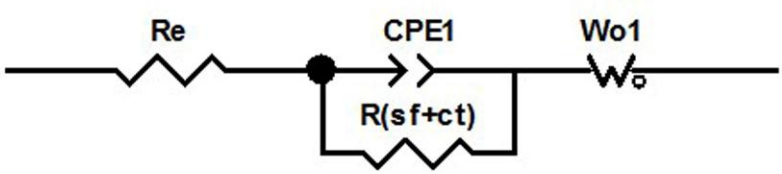


Fig. S4 XPS spectra of CSO-NT (a) survey scan, (b) high resolution Ca 2p scan, (c) high resolution Sn 3d scan, and (d) high resolution O 1s scan.

(a)



(b)



(c)

Impedance Paremeters	Electrode Materials	
	Nanotubes	Nanorods
R_e/Ω	3	4
$R_{(sf+ct)}/\Omega$	40	87
CPE/μF	18	48

Fig. S5 (a) Nyquist plots of CSO-NT and CSO-NR. (b) Equivalent circuit used to fitting the experimental data. (c) Fitted impedance data obtained from Nyquist plots using the circuit in (b).

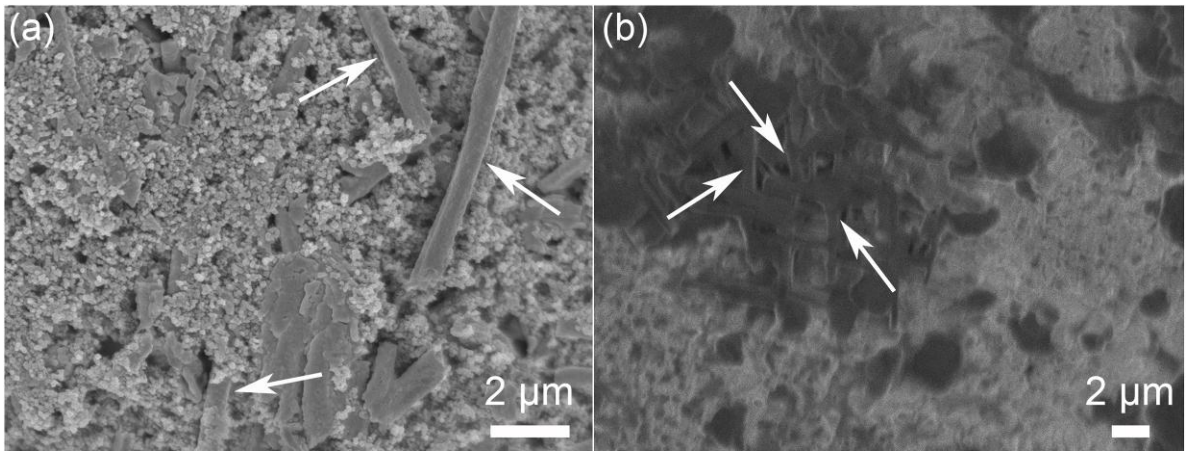


Fig. S6 SEM images of (a) raw CSO-NT electrode (b) CSO-NT electrode after 50 cycles. (It should be noted that the particles around the nanofibers are conductive carbon black and PVDF binder.)