# **Supplementary information**

# Sn(salen)-derived SnS nanoparticles embedded in N-doped carbon for high performance lithium-ion battery anodes

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## **Experimental Section**

#### Chemicals

Salicylaldehyde (98%), ethylenediamine ( $\geq$  99.5%), methanol (99.8%), tin(II) chloride (98%), trimethylamine ( $\geq$  99%), ethyl alcohol ( $\geq$  99.5%), and sulfur were purchased from Sigma-Aldrich. All the chemicals were directly used without further purification.

#### Synthesis of tin salen ligand (Sn(salen))

The salen ligand (H<sub>2</sub> salen) was synthesized by adding salicyladehyde (1.06 mL, 10 mmol) and ethylenediamine (0.67 mL, 5.3 mmol) in methanol (30 mL). The reaction mixture was stirred at 70 °C for 2 hours. After cooling to room temperature, the precipitate was filtered, washed with methanol and dried under vacuum. To synthesize Sn(salen) complex, H<sub>2</sub>salen (1.34 g, 5 mmol) and tin(II) chloride (0.948 g, 5 mmol) were added in ethanol (50 mL). Then triethylamine (1.4 mL) was added dropwise to the stirred solution. The reaction mixture was stirred at 85 °C for 24 hours. The yellow precipitate was washed with ethanol and dried under vacuum.

#### Synthesis of SnS/N-C nanocomposites

The prepared Sn(salen) complex and sulfur powder were mixed by 1:1 weight ratio, and grounded in mortar. The obtained yellow mixture was heated to 155 °C for 2 hours under Ar atmosphere. After then, the temperature was raised to 700 °C immediately and maintained for 2 hours to pyrolysis the Sn(salen).

### Materials characterization

Scanning electron microscopy (SEM) was performed by Hitachi (Regulus 8230) with secondary electron (SE) mode and backscattered electron (BSE) mode. Transmission electron microscopy (TEM) and scanning transmission electron microscopy (STEM) were used by a JEOL-2100F coupled with an energy dispersive X-ray spectroscopy detector (EDS, Oxford

instrument). JEM-ARM200F was used to obtain Cs-corrected STEM images. X-ray diffraction (XRD, JP/D/MAX-2500H) was conducted by using Cu Kα radiation. Thermo-gravimetric analysis (TGA, Discovery TGA) was used to test the contents of SnS. X-ray photoelectron spectroscopy (XPS) was performed by Sigma Probe instrument (ThermoFisher Scientific) with Al Kα. Elemental analysis was obtained by a Thermo Scientific Flash 2000 organic elemental analyzer.

#### **Electrochemical characterization**

The electrode slurry was prepared by mixing active materials (70wt%), super P (15wt%), and polyvinylidene fluoride (15wt%) with n-methyl-2-pyrrolidinone. After the slurries were coated onto the Cu foil, they were dried at 60 °C in a vacuum. The prepared electrodes were cut into circle with a diameter of 11 mm, and the loading mass of active material on electrode is over 1.0 mg cm<sup>-2</sup>. The 2032-type coin cells were assembled in Ar-filled glove box. The electrolyte is 1.0 M LiPF<sub>6</sub> in ethylene carbonate/diethylene carbonate with a volume ratio of 1:1. The lithium foil is used as counter and reference electrodes. All coin cells were galvanostatically cycled in a range of 0.01-3.0 V (vs. Li<sup>+</sup>/Li) with WBCS 3000S cycler (WonAtech, Korea). The capacity of SnS/N-C nanocomposites is calculated based on the weight entire composite including N-doped carbon.



**Fig. S1** XRD patterns obtained with different ratio (1:1 and 1:2) between Sn(salen) and elemental sulfur (S<sub>8</sub>).



Fig. S2 TEM images of the samples (a, b) at 400 °C, (c, d) at 500 °C, (e, f) at 600 °C.



Fig. S3 EDS mapping of SnS/N-C nanocomposites.

Tab	le.	S1.	E	lemental	anal	lysis	of	SnS	/N-C	c n	nanoc	omp	osites.
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% Composition/Mass										
С	Ν	Н	S	0						
36.02	3.06	0.17	19.32	3.76						



Fig. S4 Cyclic voltammograms of SnS/N-C nanocomposites at different scan rates.



Fig. S5 TEM images of SnS/N-C nanocomposites after 20 cycles at a constant current density of 100 mA  $g^{-1}$ .