

## Electronic supplementary information

For

### **Heterostructured Ag@In<sub>2</sub>S<sub>3</sub> Composites with Enhanced Lithium Storage Capacity**

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#### **Experimental section:**

**Materials Synthesis:** In this work, Ag nanowires were bought from ZHE JIANG KECHUANG ADVANCED MATERIALS TECHNOLOGY CO., LTD. In a typical procedure for the synthesis of Ag@In<sub>2</sub>S<sub>3</sub> composites, 2 ml suspension of Ag nanowires (ethanol solvent, the density is about 15mg/ml) was dispersed into 23 ml distilled water and stirred for 5 min. Then, about 0.8 mmol indium ( III ) chloride tetrahydrate (InCl<sub>3</sub> 4H<sub>2</sub>O, Alfa Aesar, 97%) was added to the suspension and stirred for 7 min. After that, hexadecyl trimethyl ammonium bromide (CTAB) and thioacetamide (TAA) were in turn dissolved in above mixed solution and stirred for 10 min, respectively. Finally, the obtained solution was transferred to a round flask and refluxed at 95 °C for 80 min. After cooling, the as-synthesized products were harvested after centrifuging four times and dried at 40 °C overnight. The pure In<sub>2</sub>S<sub>3</sub> sheets were obtained in the absence of 2 ml suspension of Ag nanowires (the distilled water is 25 ml).

**Materials Characterization:** The morphology, energy dispersive spectroscopy (EDS) of as-prepared samples were investigated by using a scanning electron microscopy (SEM) Hitachi S4800 operated at 5 kV. Structures of samples were characterized by using a transmission electron microscopy (TEM) Philips FEI 200CX operated at 160 kV, high resolution transmission electron microscopy (HRTEM) JEOL 2100F with an image-side Cs-corrector operated at 200 kV, and X-ray

diffractometer PANalytical X'pert Pro using Cu K $\alpha$  radiation ( $\lambda=1.5416$  Å). Nitrogen adsorption/desorption isotherms were measured on a Beckman coulter omnisorp100cx to evaluate the specific surface area and Barretl-Joyner-Halenda (BJH) pore diameter.

**Electrochemical Measurements:** The electrochemical measurements were carried out using Land CT2001A with lithium metal as the counter and reference electrodes at room temperature. The electrode consists of active material (Ag@In<sub>2</sub>S<sub>3</sub> composites or In<sub>2</sub>S<sub>3</sub> nanosheets), conductivity agent (acetylene black), and polymer binder (polyvinylidene difluoride, PVDF, Aldrich) by a weight ratio of approximately 70:20:10, however, Ag nanowires electrodes only make up of pure Ag nanowires (no conductivity agent and polymer binder). The electrode material loading in each electrode was about 1 mg. The electrolyte was 1 M LiPF<sub>6</sub> in a 1:1 wt/wt mixture of ethylene carbonate and diethyl carbonate. Cell assembly was carried out in an Ar-filled glove box. The cell was charged/discharged at a fixed voltage window between 5 mV and 3 V. Cyclic voltammogram and AC impedance spectra were carried out using an electrochemical work station (CHI660C) to investigate the electrode reaction processes. The scan range of 5 mV-3 V (vs. Li/Li<sup>+</sup>) was swept at the rate of 0.2 mV/s. AC impedance spectra were performed by applying a sine wave with an amplitude of 5.0 mV in the frequency range from 0.01 Hz to 100 kHz.

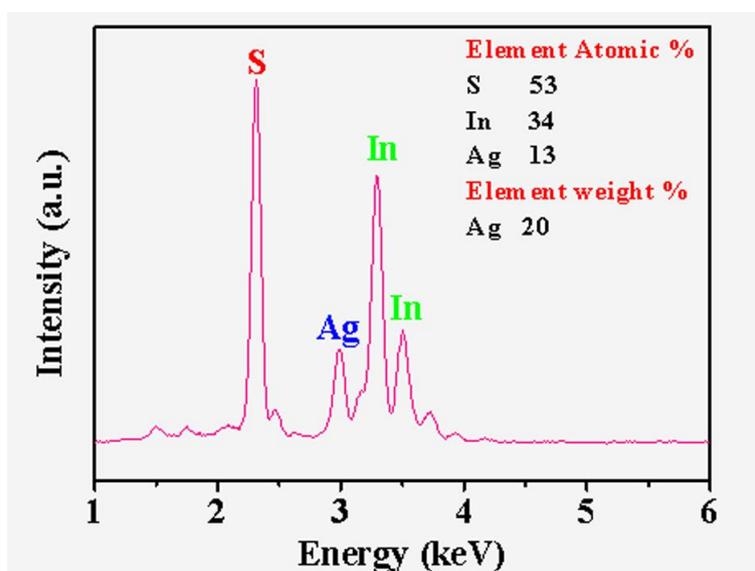
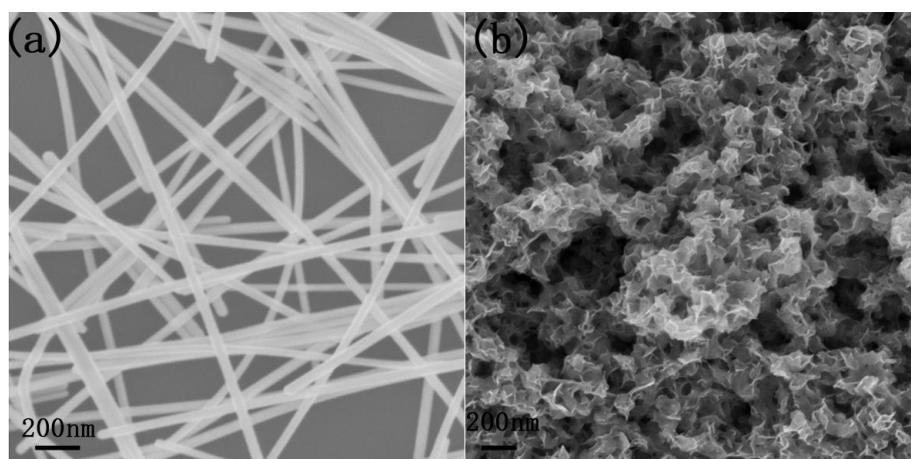
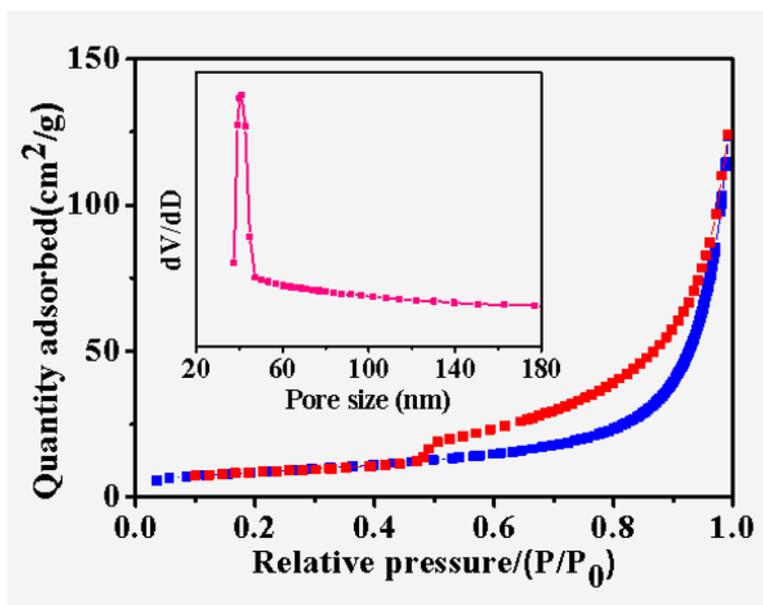


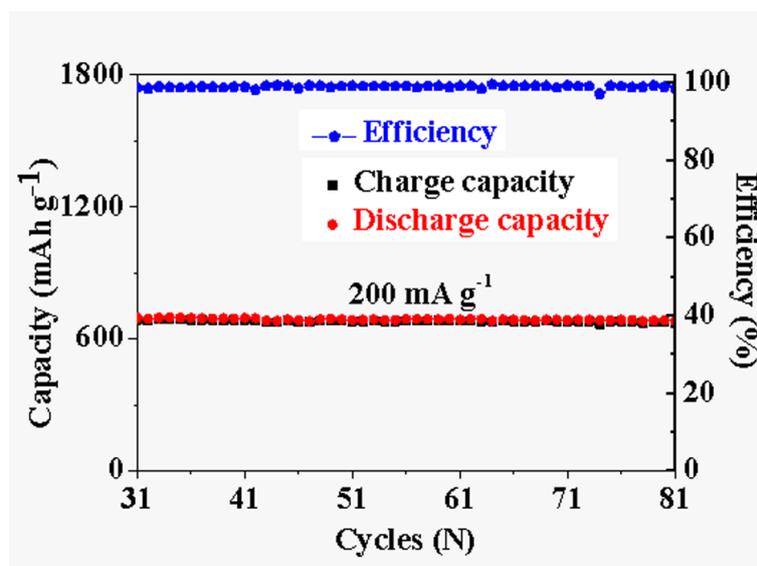
Fig. S1 EDX pattern of as-prepared Ag@In<sub>2</sub>S<sub>3</sub> composites



**Fig. S2** SEM images of Ag nanowires and pure  $\text{In}_2\text{S}_3$  nanosheets.



**Fig. S3** Adsorption-desorption isotherm and pore size distribution of the as-prepared  $\text{Ag}@\text{In}_2\text{S}_3$  composite.



**Fig. S4** Cycling performance and the Coulombic efficiency after rate measurement of the Ag@In<sub>2</sub>S<sub>3</sub> composite electrode.

**Table S1** Kinetic parameters of Ag@In<sub>2</sub>S<sub>3</sub> composite and In<sub>2</sub>S<sub>3</sub> electrodes

Sample	$R_{\Omega}$ ( $\Omega$ )	$R_{ct}$ ( $\Omega$ )	$i_0$ $\mu\text{A cm}^{-2}$
Ag@In <sub>2</sub> S <sub>3</sub>	6.6	55	25
In <sub>2</sub> S <sub>3</sub>	5.6	85	16

Note: In the inset of Figure 5,  $R_{\Omega}$  and  $R_{ct}$  are the ohmic resistance (total resistance of the electrolyte, separator and electrical contact) and charge-transfer resistance, respectively. CPE is the constant phase-angle element, involving double layer capacitance, and  $W$  (Warburg impedance) relates to the diffusion of lithium ions into the bulk electrodes. The exchange current density  $i_0$  is calculated according to the equation of  $i_0 = RT/nFR_{ct}$ ,  $R$  is the gas constant,  $T$  is the absolute temperature,  $n$  is the number of transferred electrons,  $F$  is the Faraday constant. According to the work in ref. [S1],  $n$  is estimated to be 4.33.

[S1]W. H. Ho, C. F. Li, H. C. Liu and S. K. Yen, *J. Power Sources*, 2008, **175**, 897.