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Supplementary Information

Synthesis of ZnSb@C Microflowers Composite and Its Enhanced Electrochemical Performance for Lithium-Ion and Sodium-Ion Batteries

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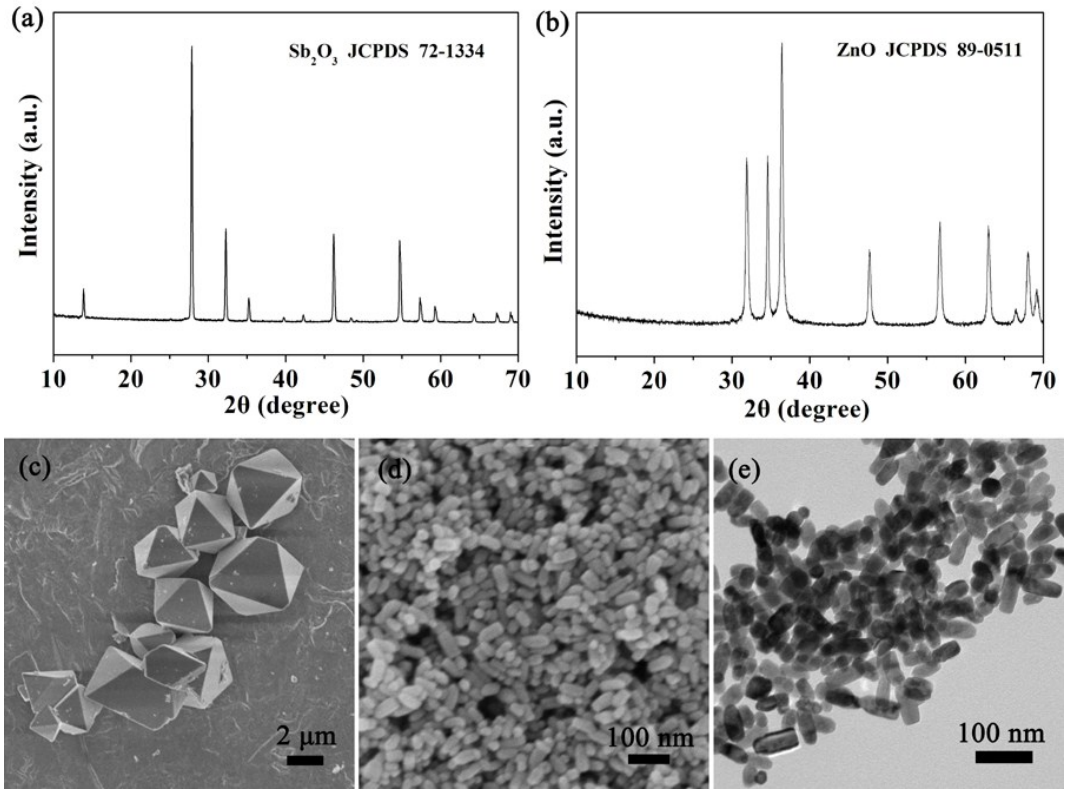

Figure S1. XRD patterns of (a) Sb_2O_3 octahedron and (b) ZnO nanoparticles. (c) SEM image of Sb_2O_3 microoctahedron, (d-e) SEM and TEM images of ZnO nanoparticles.

Figure S1a-1b show the XRD pattern of the Sb_2O_3 and ZnO precursor. The identified diffraction peaks can be assigned to the antimonous oxide Sb_2O_3 (JCPDS card no. 72-1334) and hexagonal zinc oxide ZnO (JCPDS card no. 89-0511), respectively. SEM image in Figure S1c shows the Sb_2O_3 precursor is composed of octahedrons with average size about 4 μm. SEM and TEM images in Figure S1d-1e show the ZnO precursor is composed of nanorods with average length of 80 nm and diameter of 20 nm.

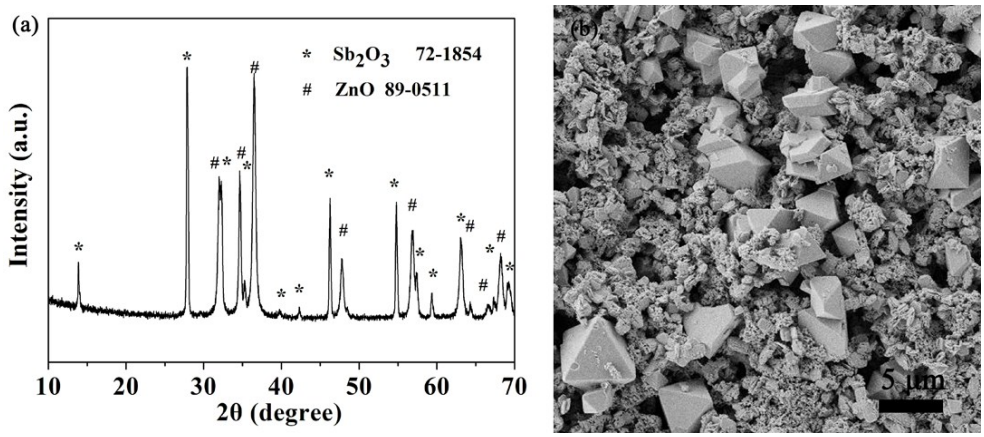

Figure S2. (a) XRD patterns (b) SEM image of mixed Sb_2O_3 octahedron and ZnO nanoparticles composite.

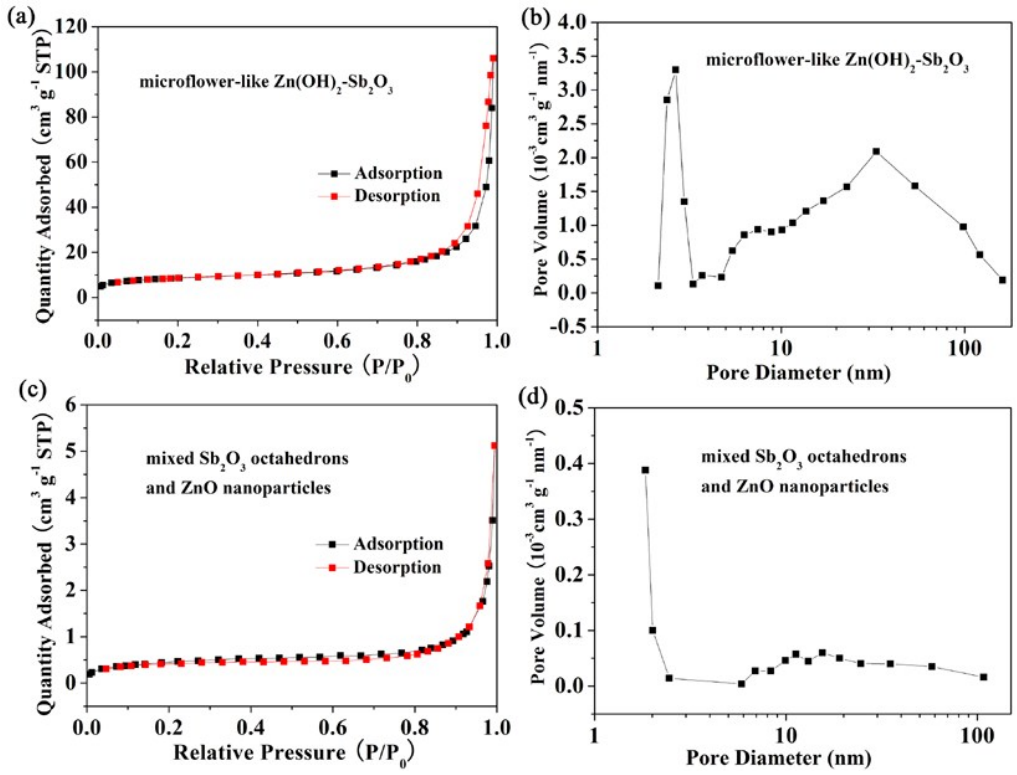

Figure S3. (a) N_2 adsorption-desorption isotherms and (b) pore size distributions of the microflower-like $Zn(OH)_2$-Sb_2O_3 precursors. (c) N_2 adsorption-desorption isotherms and (d) pore size distributions of the mixed Sb_2O_3 octahedrons and ZnO nanoparticles composite.

Figure S3 shows the N_2 adsorption-desorption isotherms and pore size distributions of the microflower-like $Zn(OH)_2$-Sb_2O_3 precursors and mechanically mixed Sb_2O_3 octahedrons and ZnO nanorods composite. The specific BET surface area and the pore volume of the $Zn(OH)_2$-Sb_2O_3 microflowers precursor are 18.89 m^2 g^{-1} and 0.071 cm^3 g^{-1}, respectively, which are much bigger than these of the mixed Sb_2O_3 octahedrons and ZnO nanorods composite (1.65 m^2 g^{-1} and 0.0033 cm^3 g^{-1},

respectively).

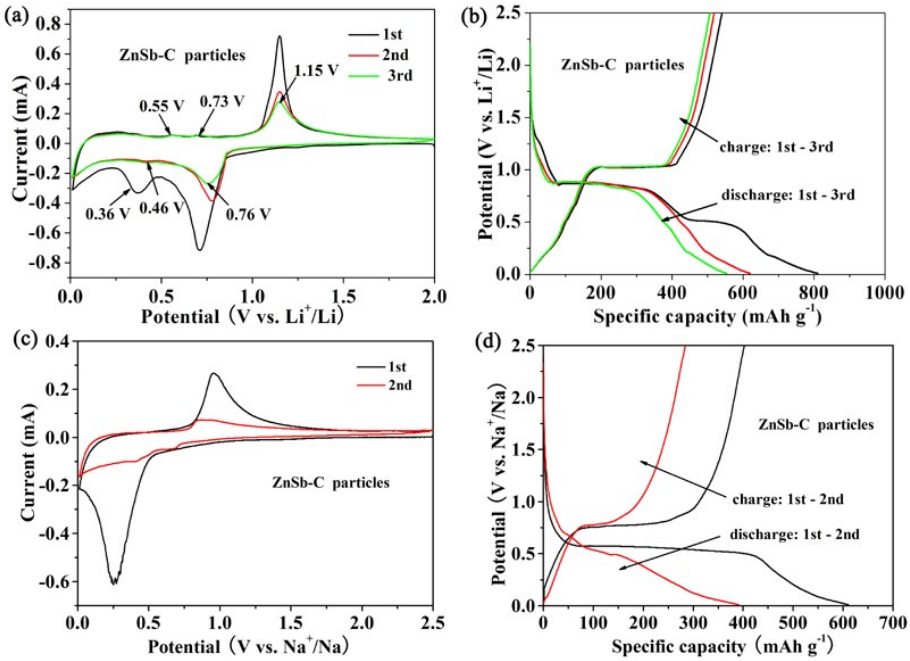

Figure S4. (a) Cyclic voltammograms at a scan rate of 0.1 mV s^{-1} and (b) initial charge/discharge potential profiles of the ZnSb-C composite at 100 mA g^{-1} between 0.01 to 2.5 V in Li-ion batteries. (c) Cyclic voltammograms at a scan rate of 0.1 mV s^{-1} and (d) initial charge/discharge potential profiles of the ZnSb-C composite at 100 mA g^{-1} between 0.01 to 2.5 V in Na-ion batteries.

Table S1 Comparison of ZnSb@C microflowers and ZnSb-C particles composites (this work) and various reported ZnSb-C or Sb-C as anodes for Li-ion or Na-ion batteries.

Material	Reversible capacity/mAh g^{-1}	Rate (mA g^{-1})	Batteries	Ref.
ZnSb@C microflowers	480.5 /240th cycles	100	Li-ion	This work
ZnSb-C particles	305.4 /240th cycles	100	Li-ion	This work
ZnSb nanotubes	400/100th cycles	100	Li-ion	[16]
ZnSb nanoparticles	215/100th cycles	100	Li-ion	[16]
ZnSb nanoparticles	100 /70th cycles	100	Li-ion	[15]
ZnSb nanowires	190/70th cycles	100	Li-ion	[15]
ZnSb nanoflakes	500/70th cycles	100	Li-ion	[15]
ZnSb/MgO/C composite	443/300th cycles	50	Li-ion	[25]
ZnSb/C nanocomposite	520/200th cycles	100	Li-ion	[14]
Zn_4Sb_3 nanotubes	450/100th cycles	100	Li-ion	[17]
Zn_4Sb_3 nanowires	300/100th cycles	100	Li-ion	[17]
Zn_4Sb_3 nanorods	200/100th cycles	100	Li-ion	[17]
ZnSb@C microflowers	393.4 /240th cycles	50	Na-ion	This work
ZnSb-C particles	145.3 /240th cycles	50	Na-ion	This work
ZnSb/C composite	298 /30th cycles	50	Na-ion	[22]
Zn – Sb – C mixture	170 /30th cycles	50	Na-ion	[22]
	377 /100th cycles	20	Na-ion	[23]
Rod-like Sb-C composite	430.9/100th cycles	50	Na-ion	[21]
Sb/C Fibers	350/300th cycles	100	Na-ion	[20]
10-Sb@C	385/500th cycles	100	Na-ion	[28]

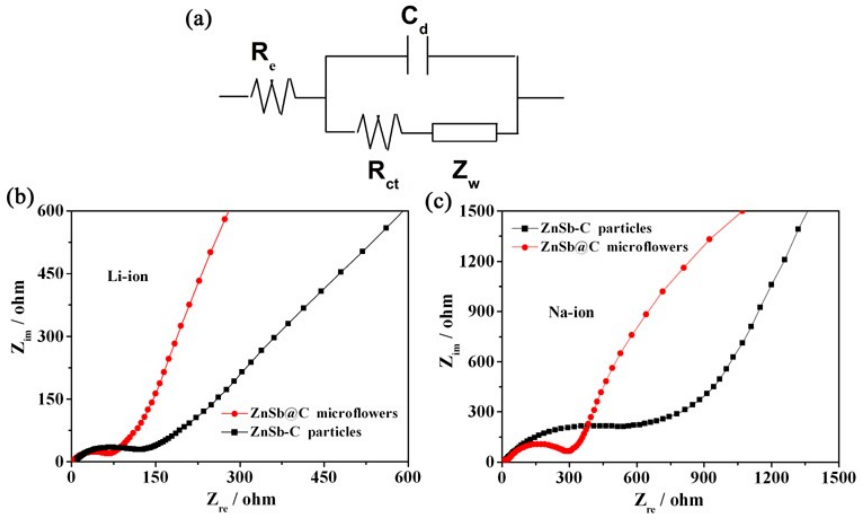

Figure S5 (a) Equivalent circuit used to model the impedance spectra ; (b) Nyquist plots obtained for the ZnSb@C microflowers and ZnSb-C particles composites in Li-ion batteries; (c) Nyquist plots obtained for the ZnSb@C microflowers and ZnSb-C particles composites in Na-ion batteries.

Electrochemical impedance spectroscopy (EIS) of the ZnSb@C microflowers and ZnSb-C particles composites are carried out, as show in Figure S5. The EIS spectra of the electrodes could be well fitted by the Nyquist plots, which consist of a semicircle in the high-to-medium frequency region and a slope line in the low frequency region. The semicircle in the high-to-medium frequency region is related to the interfacial charge-transfer resistance (Rct) and the oblique line followed with the semicircle represents the Warburg impedance (Zw). As shown in Figure S5, the diameter of the semicircle for the ZnSb@C microflowers composite (both of in Li-ion and Na-ion batteries) are smaller than those of the ZnSb-C particles composite, indicating that the ZnSb@C microflowers composite demonstrates superior electronic conductivity.