Electronic Supplementary Material (ESI) for RSC Advances.

Electronic Supporting Information (ESI) for

Synthesis of Polygonal Co_3Sn_2 Nanostructure with Enhanced Magnetic Properties

Zheng Yi,[abc] Xin Tian, [bc] Qigang Han,[ab]* Jianshe Lian,[c] Yaoming Wu[b] and Limin Wang[b]*

a. Roll Forging Research Institute, Jilin University, Changchun 130025, China. E-mail: hanqg@jlu.edu.cn; Fax: +86 431 85094340; Tel: +86 431 85094340.

b. State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, CAS, Changchun 130022, China. E-mail: lmwang@ciac.ac.cn; Fax: +86 431 85262836; Tel: +86 431 85262447.

c. College of Materials Science and Engineering, Jilin University, Changchun 130025, China.

Experimental section

Synthesis of Co and Co_3Sn_2 intermetallic

All reagents were purchased from Aladdin Reagent Co., Ltd. (China). We obtained the polygonal Co_3Sn_2 intermetallic by a one-pot solvothermal reaction. In a typical synthetic process, $CoCl_2 \cdot 6H_2O$ and $SnCl_2 \cdot 2H_2O$ with variational mole ratio (3:2 and 3:4) were dissolved into 25 mL ethylene glycol, then 1.0 g of polyvinylpyrrolidone (PVP, MW = 58 000) was added into the solution with continuous ultrasonication for formation a homogeneous solution (denoted A). Meanwhile, 2 g of sodium hydroxide and 4 mL of hydrazine hydrate are added into 5 mL of deionized water (denote B). After magnetic stirring for 0.5 h, the B solution was added into the A solution drop by drop under continuous magnetic stirring. Subsequently, the mixing was transferred to a 50 mL Teflon-lined autoclave and tightly sealed, then maintained at 200 °C for 12 h and cooled naturally to room temperature. The as-prepared products were collected by centrifugation, washed thoroughly by deionized water three times and absolute ethyl alcohol two times, and finally dried in a vacuum oven at 60 °C overnight. For comparison, the neat Co alone was prepared by this similar process.

Characterization

Powder X-ray diffraction (XRD) patterns of as-prepared products were collected by using a Bruker D8 Focus power X-ray diffractometer with copper target at a scan rate of 2 ^{o} min^{-1}. The surface morphology was characterized by scanning electron microscope (SEM, HITACHI S-4800, Japan) at an acceleration voltage of 10 kV. Transmission electron microscopy (TEM) and energy-dispersive X-ray spectroscopy (EDS) element mapping were performed on a FEI Tecnai G2 S-Twin instrument with a field emission gun operating at 200 kV. M/H hysteresis loop was recorded with a Quantum Design MPMS XL-7 SQUID magnetometer at 300 K.

Electrochemical measurements

The working electrode was prepared by coating the N-methy1-2-pyrrolidone (NMP) slurry containing active material (Co_3Sn_2 intermetallic), acetylene black (as the conductive agent), and polyvinylidene fluoride (PVDF, as the binder agent) with a weight ratio of 70:15:15 onto a copper foil and drying in a vacuum oven at 60 ^{o}C for 12 h. Then, the cells were assembled by using CR 2025 coin-type cell configuration with pure lithium as the counter electrode, a Celgard 2400 membrane as the separator, and 1 M $LiPF_6$ dissolved in ethylene carbonate and diethylene carbonate (1:1 in volume) as the electrolyte. Note that this process was carried out in a glove box filled with highly pure argon gas. The charge-discharge performance was tested between 0.01 V and 2.0 V using a programmable battery testing system (LAND CT2001A) at room temperature.

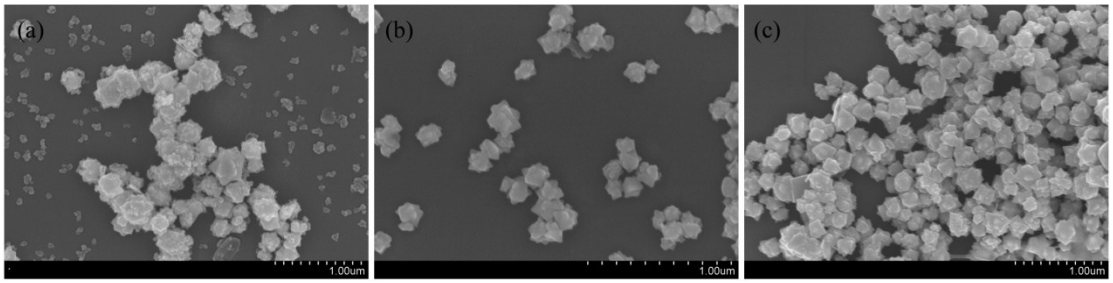

Fig. S1. The SEM images of obtained Co_3Sn_2 with different addition of PVP (a) 0 g, (b) 0.5 g and (c) 1.0 g.

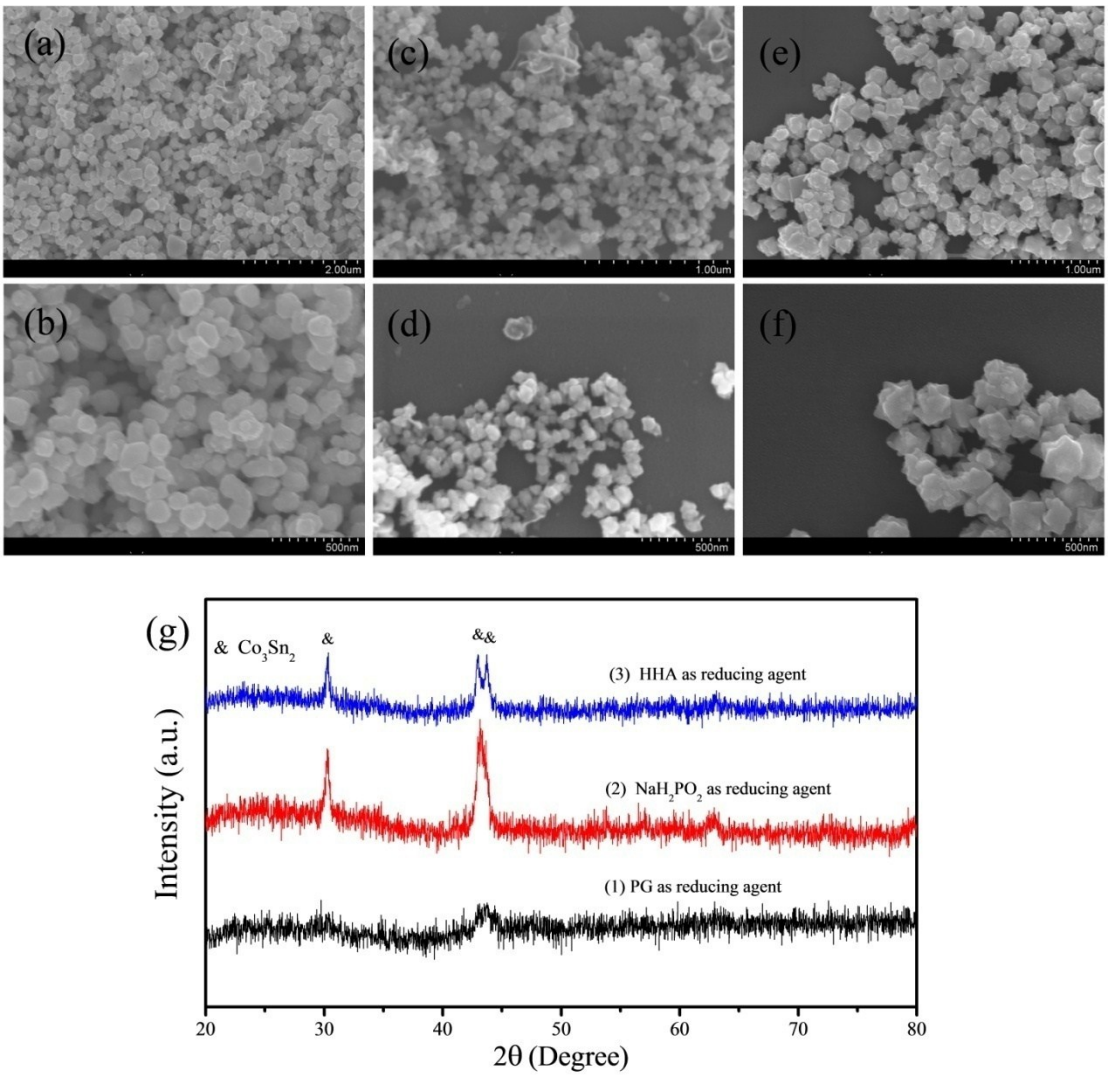

Fig. S2. The SEM images of obtained Co_3Sn_2 by different reducing agents (a, b) propylene glycol (PG), (c, d) NaH_2PO_2 and (e, f) hydrazine hydrate (HHA); (g) the corresponding XRD patterns of the products obtained by different reducing agents.

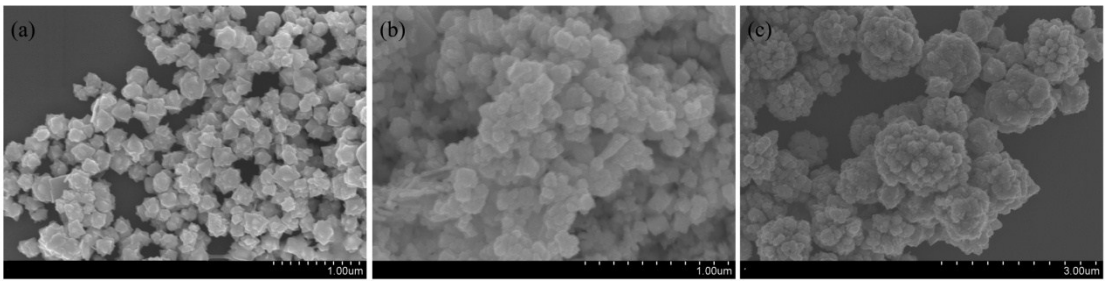

Fig. S3. The SEM images of the Co_3Sn_2 polygon in the different solvents of (a) ethylene glycol, (b) ethyl alcohol and (c) mixed solvent of ethyl alcohol and ethylene glycol in a volume ratio of 1:1.

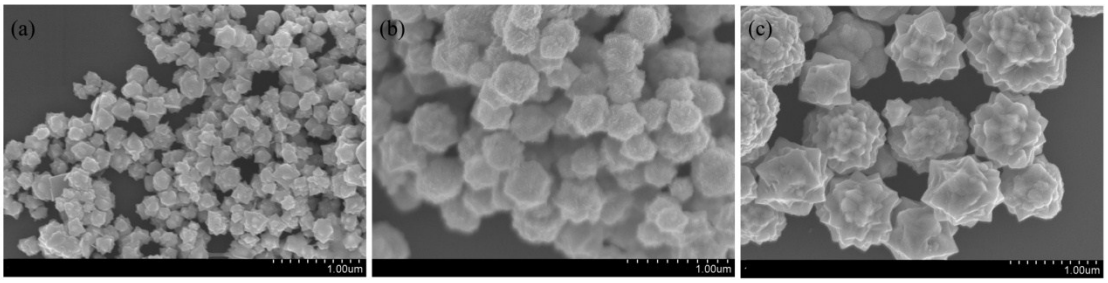

Fig. S4. The SEM images of the Co_3Sn_2 polygon prepared with different concentration of $CoCl_2 \bullet 6H_2O$ at 1, 2 and 4 mmol; the particle sizes of the Co_3Sn_2 polygon are (a)150, (b) 300 and (c) 600 nm, respectively.

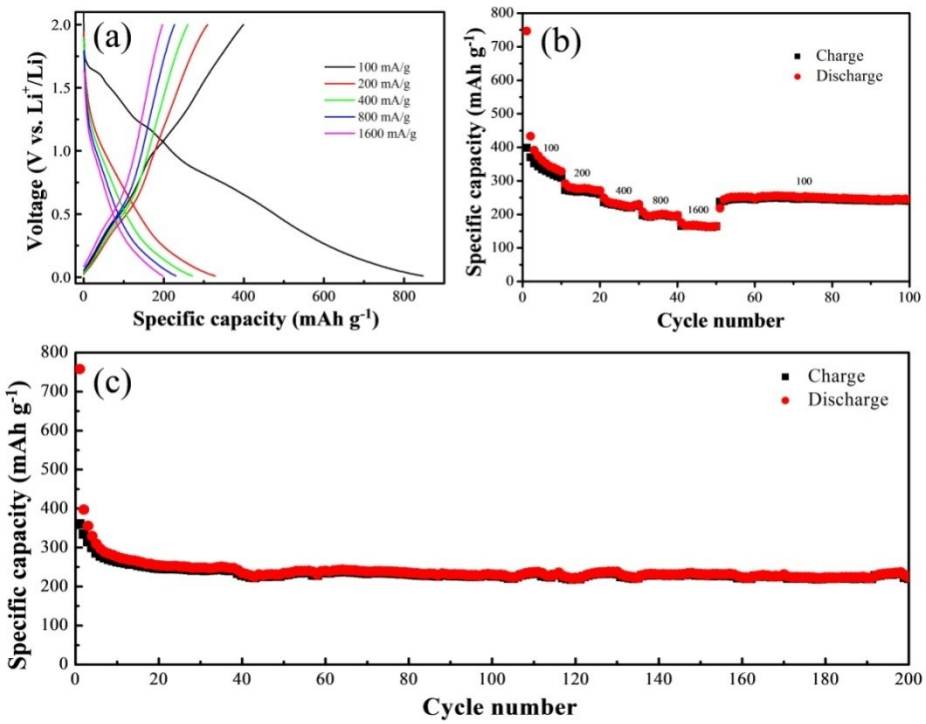

Fig. S5. (a) Voltage *vs.* capacities curves of the Co_3Sn_2 polygon, specific capacities *vs.* cycle numbers curves of the Co_3Sn_2 polygon as anode material for lithium ion battery (b) at different current densities from 100 to 1600 mA g^{-1} and (c) at current density of 100 mA g^{-1}.