Facile Synthesis of Graphene Supported FeSn$_2$ Nanocrystals with Enhanced Li-Storage Capability

Ya Ye, Ping Wu,* Xin Zhang, Tongge Zhou, Yawen Tang, Yiming Zhou* and Tianhong Lu

Jiangsu Key Laboratory of New Power Batteries, Jiangsu Collaborative Innovation Center of Biomedical Functional Materials, School of Chemistry and Materials Science, Nanjing Normal University, Nanjing 210023, PR China.

E-mail: zjuwuping@njnu.edu.cn; zhouyiming@njnu.edu.cn

Experimental Section

**Synthesis of G-FeSn$_2$ Nanohybrid.** Typically, 20 mg graphene oxide (GO) and 5 g poly (vinyl pyrrolidone) (PVP) were dispersed in 50 mL diethylene glycol (DEG) in a three-necked flask, and then 0.3 mmol SnCl$_2$·2H$_2$O and 0.15 mmol FeCl$_3$·2H$_2$O were added to the solution. After the solution was heated to 170 °C, 10 mL DEG of 1 M NaBH$_4$ was added, and the solution was maintained at 170 °C for 1 h. The entire reaction was protected under N$_2$ flow. Finally, the resulting product was washed with distilled water and ethanol, and then dried at 80 °C under vacuum. For comparison, bare FeSn$_2$ nanocrystals were obtained through the same approach but without GO matrix.

**Characterization.** The morphology, composition, and structure of the samples were characterized by transmission electron microscopy (TEM, Hitachi H-7650, 120
kV), scanning electron microscopy (SEM, JEOL JSM-7600F), high-resolution transmission electron microscopy (HRTEM, JEOL JEM-2010F, 200 kV) coupled with energy-dispersive X-ray spectrometer (EDX, Thermo Fisher Scientific). X-ray powder diffraction (XRD) measurements were performed with Model D/max-rC diffractometer using Cu-Kα radiation (λ=0.15406 nm) and operating at 45 kV and 100 mA.

**Electrochemical Measurements of G-FeSn₂ Nanohybrid.** Electrochemical measurements were performed by 2025 type coin cells which were assembled in an Ar-filled glove box (IL-2GB, Innovative Technology). The anode was made as follows: 80 wt % G-FeSn₂ nanohybrid, 10 wt % Super P carbon black, and 10 wt % polyvinylidene fluoride (PVDF) in N-methyl-2-pyrrolidene (NMP) were mixed, then the slurry was coated on copper foams (12 mm in diameter) and dried under vacuum at 120 °C for 12 h. The counter electrode was lithium foil (15 mm in diameter), and the electrolyte solution was 1 M LiPF₆ in ethylene carbonate (EC) and dimethyl carbonate (DMC) (1:1 by volume). Finally, the cells were aged for 12 h before measurements. A galvanostatic cycling test of the assembled cells was carried out on a Land CT2001A system in the potential range of 0.01-2 V. Cyclic voltammetry (CV) measurements were recorded on a CHI 660C electrochemical workstation in the potential range of 0.0-2.0 V at a scan rate of 0.1 mV s⁻¹. The voltages mentioned herein were referred to Li⁺/Li redox couple.
Fig. S1 Coulombic efficiencies versus cycle number for bare FeSn$_2$ nanocrystals and G-FeSn$_2$ nanohybrid in the potential range of 0.01-2 V at a current density of 100 mA g$^{-1}$. 
Fig. S2 Areal capacity versus cycle number for G-FeSn$_2$ nanohybrid in the potential range of 0.01-2 V at a current density of 100 mA g$^{-1}$. 