

Supporting Information

Facile fabrication of 2D stanene via dealloying strategy for potassium storage

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Experimental

The layered Li_5Sn_2 powder was prepared by heating the mixture of Li film and bulk Sn powder (at a weight ratio of Li: Sn \approx 0.15) in Ar at 600°C for 6 hours. And then, putting as-prepared Li_5Sn_2 in a beaker filled with deionized water. Then biatomic layers were separated by diffusing hydrogen bubbles with the help of magnetic stirring for several hours. And then, as-prepared mixture solution was sonicated for 30 minutes to disperse 2D stanene (Fig. S3, ESI†). After that, filtering out the remaining solid parts and washing them with deionized water and ethanol to remove lithium hydroxide in the system. Finally, as-fabricated 2D stanene was dried by oven at 60 °C.

Morphological and Structural Characterization: The morphology and microstructure of the samples were systematically investigated by SEM (JEOL-7500), TEM (Tecnai G2 F20 UYWIN), XPS (ESCALAB 250), and XRD (Rigaku D/max2500PC) was carried out using Cu K α radiation over the range of 5~90° measurement. X-ray photoelectron spectra (XPS) were recorded by a Thermo Electron Corporation ESCALAB 250 XPS spectrometer using a monochromatized Al K α radiation with 200 eV pass energy with 30 eV step over the sample(500 μm \times 500 μm). Raman spectra of as-prepared samples were recorded on a Horiba JY LaRAM ARAMIS Raman microscopy.

Electrochemical experiments were carried out in 2032 coin-type cells. As for Sn bulk and 2D stanene samples, the working electrodes were prepared by mixing active

materials, carbon black, and Polyvinylidene Fluoride (PVDF) at a weight ratio of 7:2:1 and pasted on pure copper foil. And then dried at 120°C under vacuum for 12 h. Pure Lithium foil was used as the counter electrode. The electrolyte consisted of a solution of 0.8 M KPF₆ in 50 Vol% ethylene carbonate (EC) with 50 Vol% diethyl carbonate (DEC) and a polypropylene film as the separator. The cells were assembled in an argon-filled glove box with the concentration of moisture and oxygen below 0.1 ppm. The charge and discharge measurements were operated on Land CT2001A system at various current densities (74.4, 148.8, 297.6, 595.2, 1190.4, 2380.8 and 4761.6 mA g⁻¹). Electrochemical impedance spectroscopy (EIS) measurements were executed on Autolab electrochemical workstation (PGSTAT302N). The impedance spectra were recorded by applying a sine wave with amplitude of 5.0 mV over the frequency range from 100kHz to 0.01 Hz. Fitting of the impedance spectra to the proposed equivalent circuit was performed by the code Zview. All electrochemical experiments were carried out at around 24 °C.

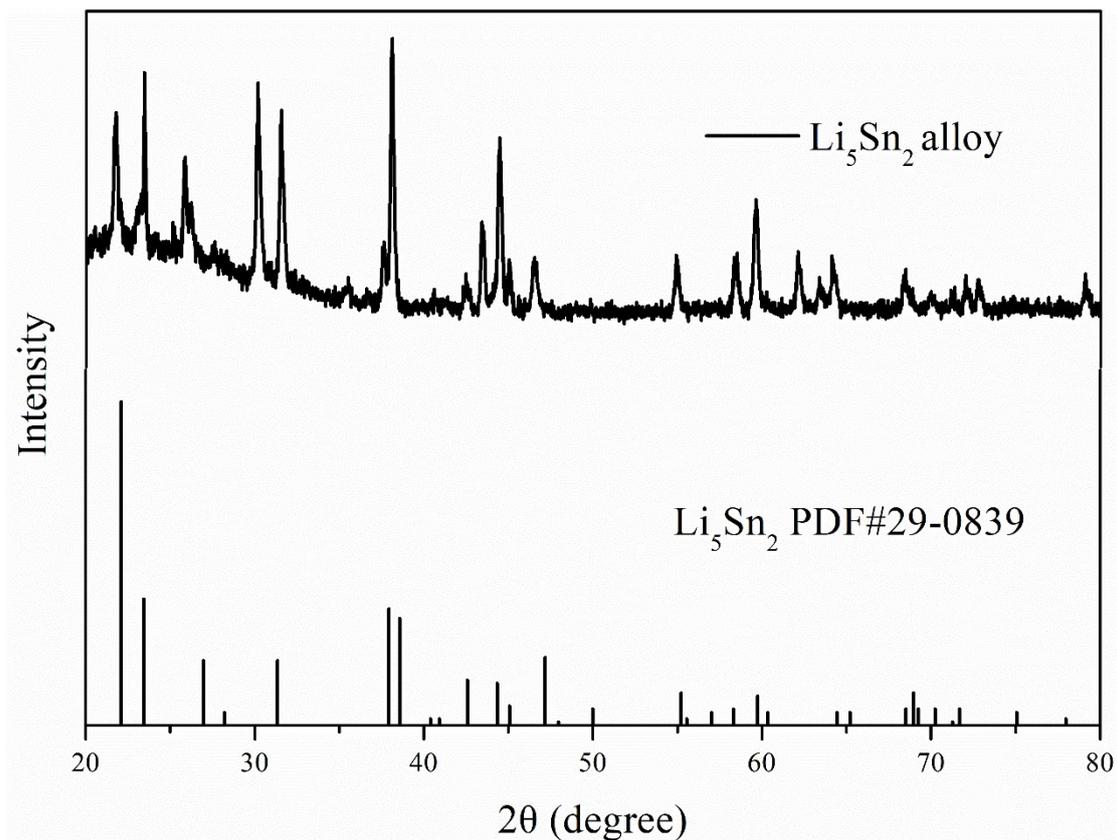


Fig S1. XRD of as-prepared Li_5Sn_2 powder, which is corresponded to Li_5Sn_2 (PDF#29-0839).

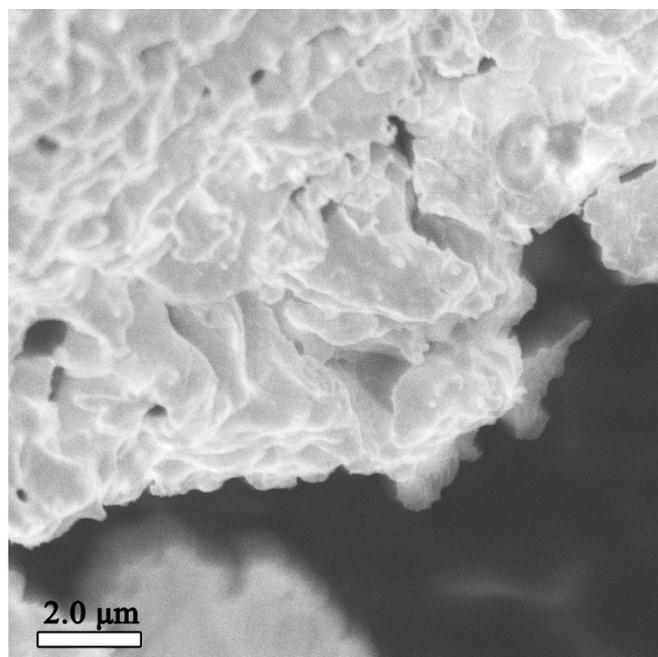


Fig S2. SEM of as-prepared Li_5Sn_2 powder, it is clear that Li_5Sn_2 has a layered structure.

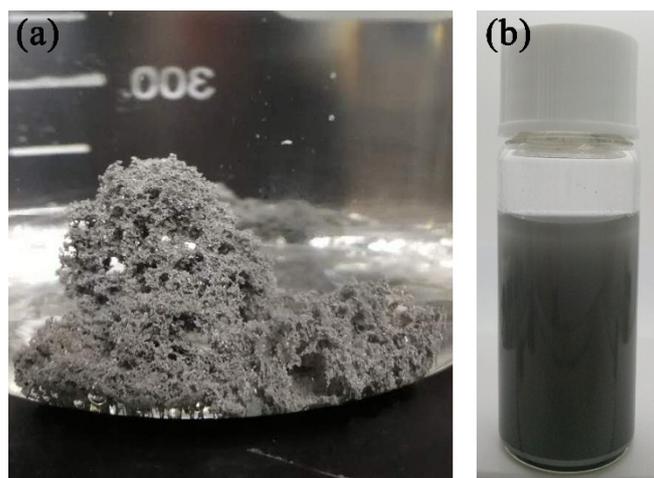


Fig S3. a) Picture of as-prepared Li_5Sn_2 powder etched by deionized water. b) Picture of **2D stanene nanosheets** dispersed in deionized water after sonicating the etched Li_5Sn_2 powder.

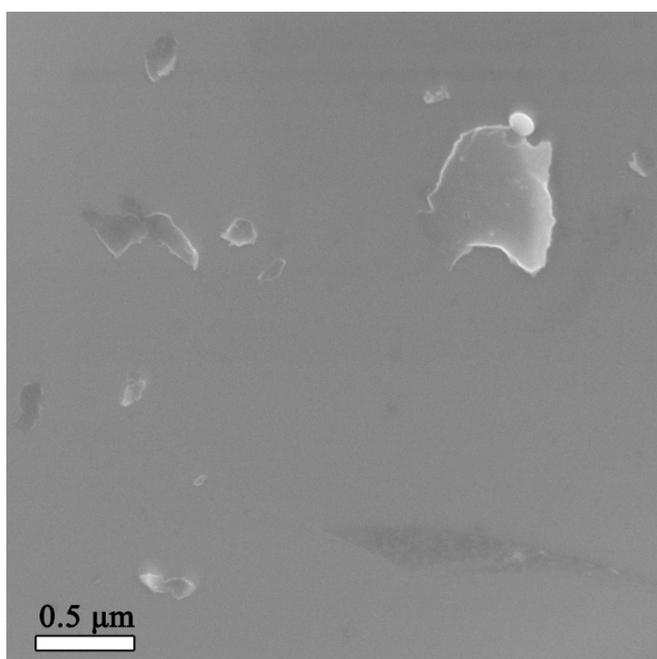


Fig S4. SEM of **2D stanene nanosheets**.

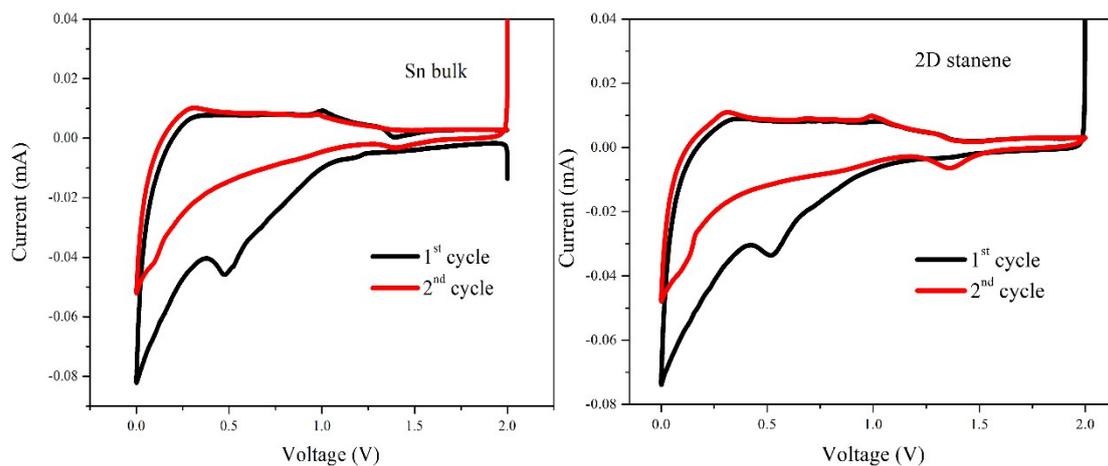


Fig S5. a) and b) The first two cycles CV of Sn bulk and 2D stanene respectively.

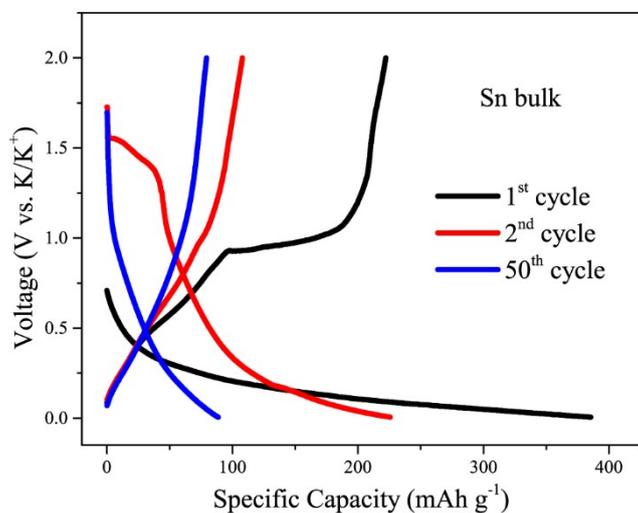


Fig S6. Selected first-two and the 50th charge–discharge curves of Sn bulk at a current density of 74.4 mA g^{-1} .

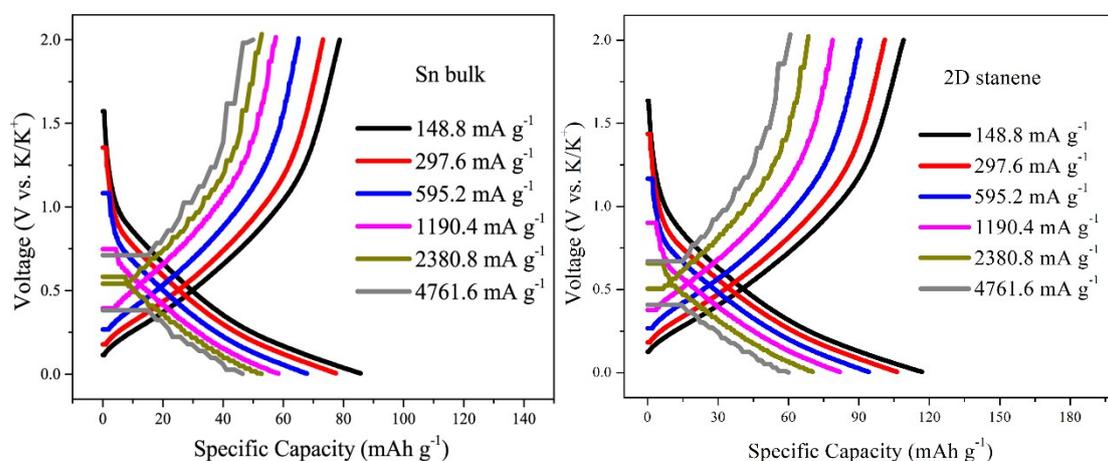


Fig S7. Rate performances of 2D stanene and Sn bulk at various current densities from 148.8 mA g^{-1} to 4761 mA g^{-1} .

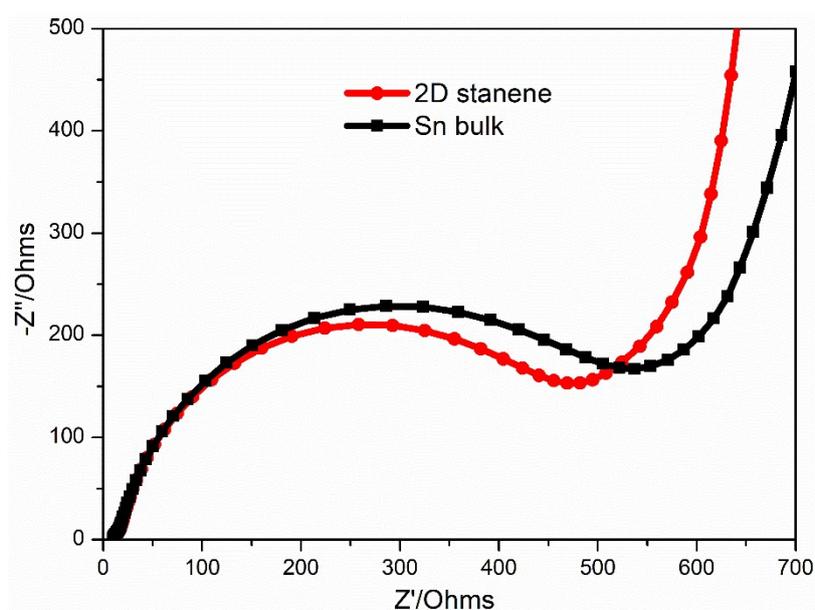


Fig S8. Nyquist plots of 2D stanene and Sn bulk.

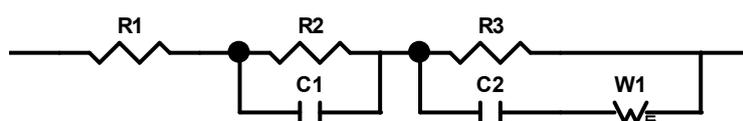


Fig S9. Randles equivalent circuit for 2D stanene and Sn bulk electrode/electrolyte interface. R_1 is the electrolyte resistance, and C_1 and R_2 are the capacitance and resistance of the surface film formed on the electrodes, respectively. C_2 and R_3 are the double-layer capacitance and charge-transfer resistance, respectively, W_1 is the Warburg impedance related to the diffusion of sodium ions into the bulk electrodes.

Samples	$R_1(\Omega)$	$R_2(\Omega)$	$R_3(\Omega)$
2D Stanene	11.95	9.26	409.1
Sn bulk	10.41	11.19	456.7

Table S1. Fitting results of AC impedance spectra of 2D stanene and Sn bulk.

To identify the conductivity of 2D stanene and Sn bulk, the electrochemical impedance spectroscopy (EIS) measurements were carried out. As presented in Fig. S8 (ESI[†]), semicircle radius of 2D stanene is smaller than that of the Sn bulk electrode. The values of film and charge-transfer resistances are 9.26 and 409.1 ohms, respectively, for 2D stanene, which are lower than those of Sn bulk (11.19 ohms and 456.7 ohms; Table S1, ESI[†]). These results indicate that 2D stanene possesses high conductivity of the whole electrode and leads to easier and quicker charge transfer processes compared with Sn bulk.