Electronic Supplementary Information for

Oleic–acid–assisted carbon coating on Sn nanoparticles for Li ion battery electrodes with long-term cycling stability†

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Experimental detail

Materials

Commercial Sn wire (0.3 mm in diameter) and oleic acid (OA, EP grade) were purchased from Nano Technology Inc. (Korea) and Samchun Chemical (Korea), respectively, and used directly as the starting material and liquid medium, respectively, without further treatment.

One-pot synthesis of carbon-coated Sn nanoparticles (Sn@C nanocomposites)

The carbon-coated Sn nanoparticles (NPs) were easily fabricated through electrical explosion of commercial Sn wire using electrical pulse equipment (model NTi-miniP, Nano Technology Inc., Korea); in this process, the automatic system continuously fed the wire and applied the electrical pulse. The electrical explosion process was performed with a 40 mm feeding distance of Sn wire and application of a 320 V charging voltage into the OA liquid media (700 mL). The resulting suspension of well-dispersed Sn NPs was sonicated for 30 min and then filtered through a PVDF membrane (Durapore® PVDF, 0.45 μm pore size, Millipore Co.). After filtration, the product was dried *in vacuo* at 150 °C for 10 h and a black powder was collected.

Characterization

The microstructure and phase identification were characterized using a field-emission scanning electron microscopy (FE-SEM; model S-4800, Hitachi, Japan), transmission electron microscopy (TEM; model Tecnai G2 F30 S-Twin, FEI, USA) operated at an acceleration voltage of 300 keV and equipped with an X-ray energy dispersive spectroscopy (EDS; model EDAX, AMETEK, USA), and X-ray powder diffraction (XRD; model Miniflex II, Rigaku, Japan). To determine the weight of carbon, the thermal behavior of the product

was analyzed through thermogravimetric analysis (TGA; model DTG-60A, Shimadzu, Japan) with heating to 1000 °C in air. The weight ratio of carbon was also determined *via* elemental analysis (EA; model vario EL cube, Elementar Analysensysteme GmbH, Germany) at a combustion temperature of 1100 °C. The microstructure and chemical composition were further investigated using high-resolution transmission electron microscopy (HR-TEM), selected-area diffraction pattern (SAED), and high-angle annular dark-field (HAADF) scanning transmission electron microscopy (STEM) images. In addition, N_2 adsorption-desorption isotherm was measured to determine the Brunauer-Emmett-Teller (BET) specific surface area (model BELSORP-mini II, BEL, Japan).

Electrochemical evaluation

i. Fabrication of working electrode

To fabricate the working electrodes, a slurry comprising 70 wt% active material, 15 wt% conducting additive (Super P™ carbon black, MMM Carbon), and 15 wt% binder (sodium alginate, Sigma-Aldrich) dissolved in distilled water was prepared. The obtained balck mixture was uniformly spread onto Cu foil using a doctor blade. Then, the distilled water was evaporated *via* consecutive heat treatments at 40 °C for 8 h and 100 °C for 4 h in a vacuum oven. After drying, the material was pressed under 10 MPa and then cut into a disk approximately 11 mm in diameter.   A typical working electrode contained 2–3 mg of active material in an electrode disk.

ii. Electrochemical measurement

All electrochemical measurements were carried out at a room temperature using Swagelok™-type two-electrode half-cells consisting of Li metal foil, which was used as both the counter and reference electrode, a seperator film (Celgard 2400 membrane), and the as-

prepared working electrode. The electrolyte was 1 M $LiPF_6$ dissolved in 1:1:1 v/v/v of ethylene carbonate/propylene carbonate/diethyl carbonate (EC/PC/DEC) containing 10 wt% fluoroethylene carbonate (FEC) as a co-solvent. The cells were assembled in an Ar-filled glove box in order to avoid a contamination of oxygen and moisture (O_2 and H_2O < 1 ppm). Using the assembled cells, both the cyclic voltammetry (CV) analysis and galvanostatic charge-discharge tests were evaluated in a fixed potential window of 0.01-3.0 V (*vs.* Li^+/Li); the results were recorded on an automatic battery cycler (model WBCS 3000, WonATech, Korea). Electrochemical impedance spectroscopy (EIS) analysis was also carried out using an electrochemical workstation (model Ivium-n-Stat electrochemical analyzer, Ivium Technologies B. V., Netherlands). After 50 cycles of the galvanostatic charge-discharge test, the impedance response was collected by applying 10 mV AC voltage while maintaining a constant DC voltage in the frequency range 0.01 Hz–100 kHz.
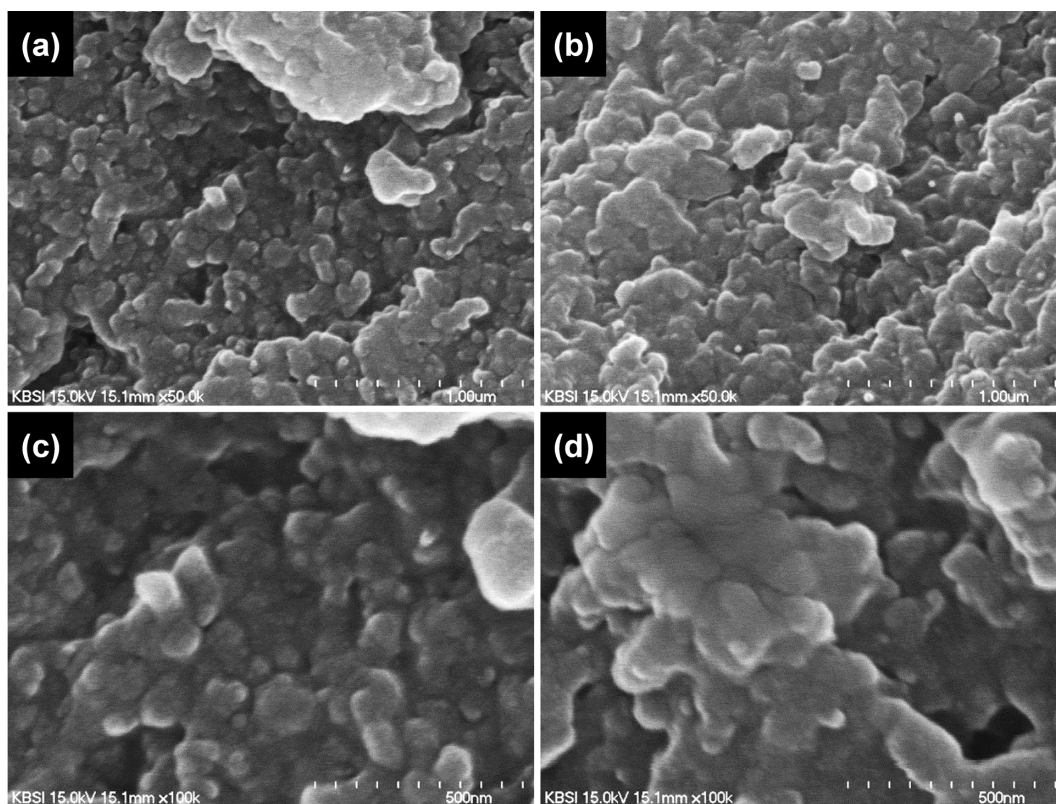
Fig. S1 Typical FE-SEM images of the Sn@C nanocomposites: (a, b) Low- and (c, d) high-magnification images.
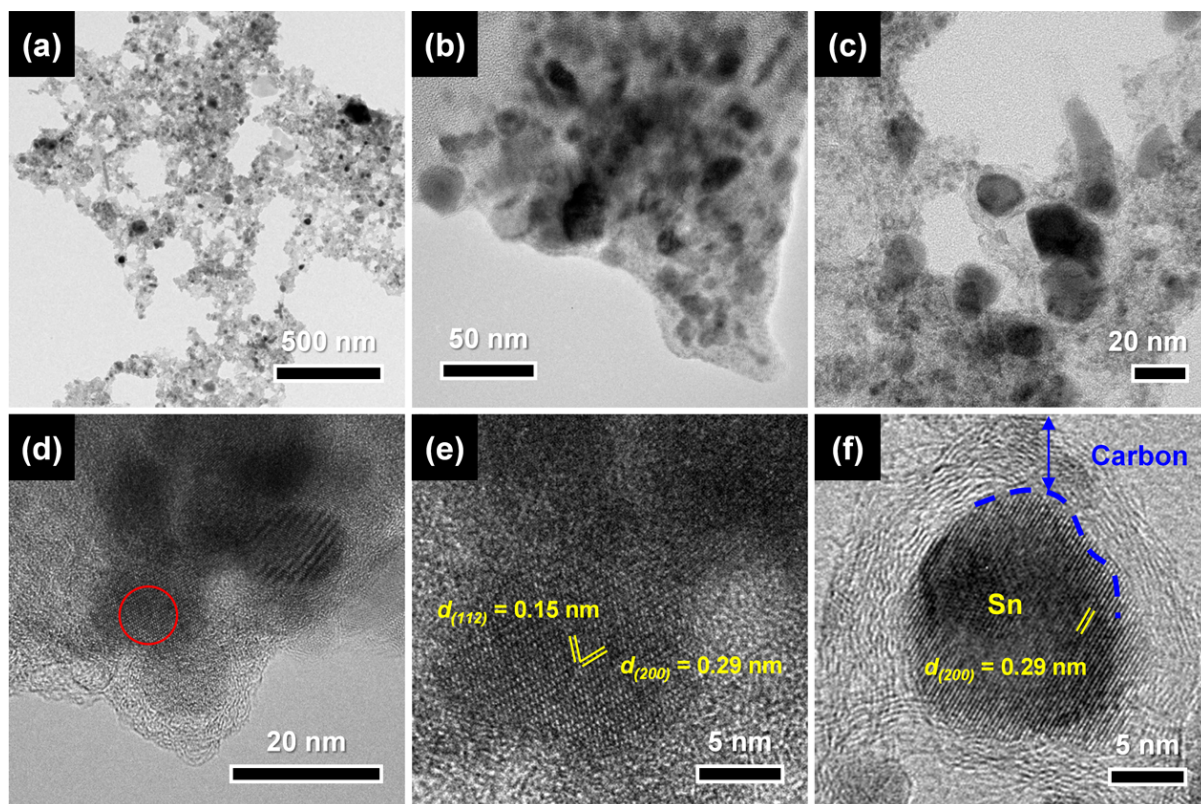
Fig. S2 (a, b) Low- and (c, d) high-magnification TEM micrographs of the Sn@C nanocomposites, (e) HR-TEM image taken from the red circle in (d), (f) TEM image of an individual Sn@C nanocomposite, showing the distinct two zone of Sn and the uniform carbon-coating layer.
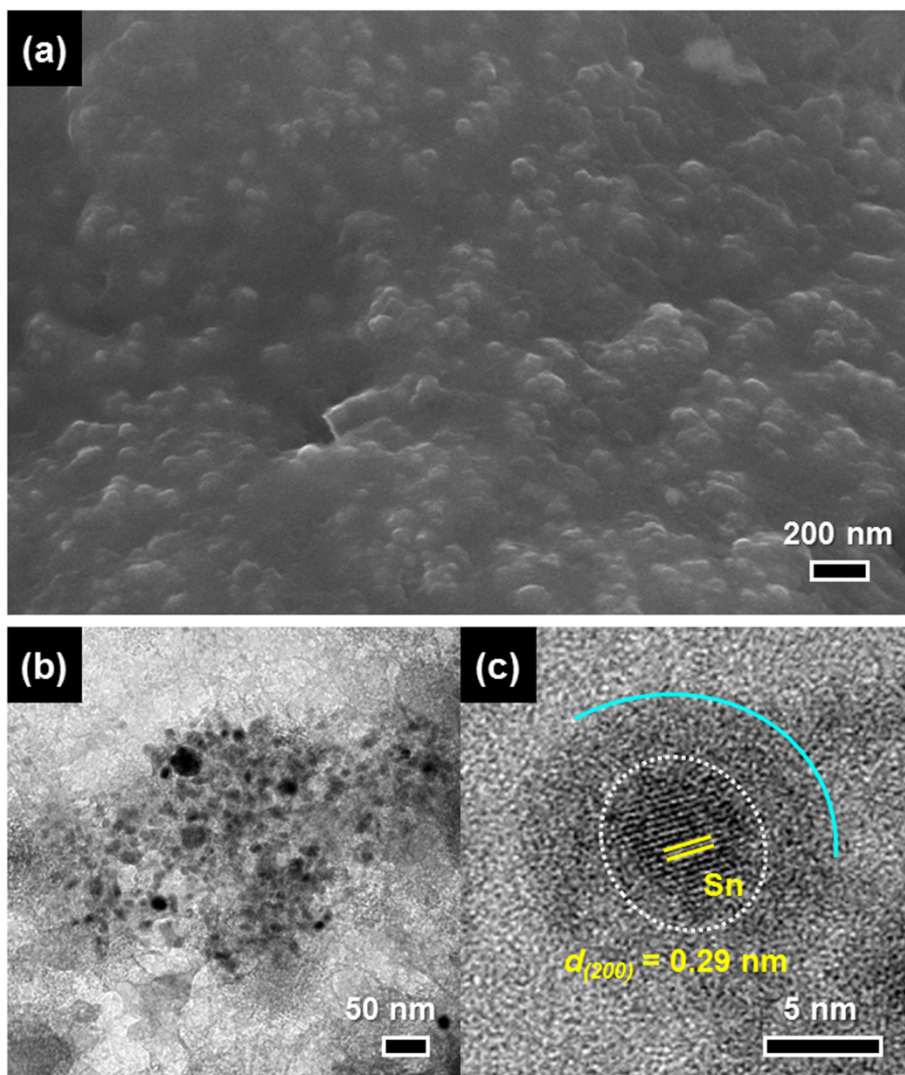
Fig. S3 The microstructural observation of Sn@C nanocomposite after galvanostatic charge/discharge test over 200 cycles. (a) FE-SEM and (b) TEM images, (c) HR-TEM micrograph of an individual Sn@C nanocomposite.

Table S1. Atomic composition in wt% (C, H, and O) of the Sn@C nanocomposites as determined by EA.

	Weight ratio (%)		
	Carbon (c)	**Hydrogen (H)**	**Oxygen (O)**
EA	47.58 (±0.02)	4.35 (±0.01)	13.02 (±0.04)