Supplementary Material (ESI) for Chemical Communications

Stacked Porous Tin Phosphate Nanodisk Anodes

Sanghan Lee, Jaephil Cho*

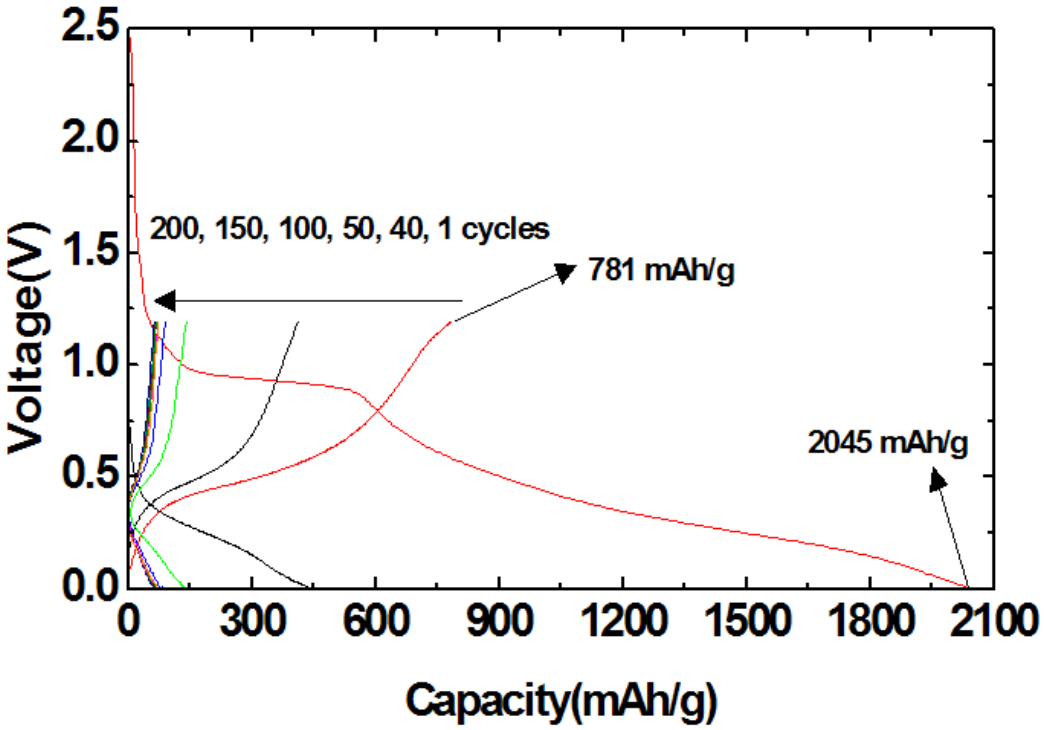
School of Energy Engineering, Ulsan National Institute of Science & Technology, Ulsan, Korea 689-798

Experimental Methods

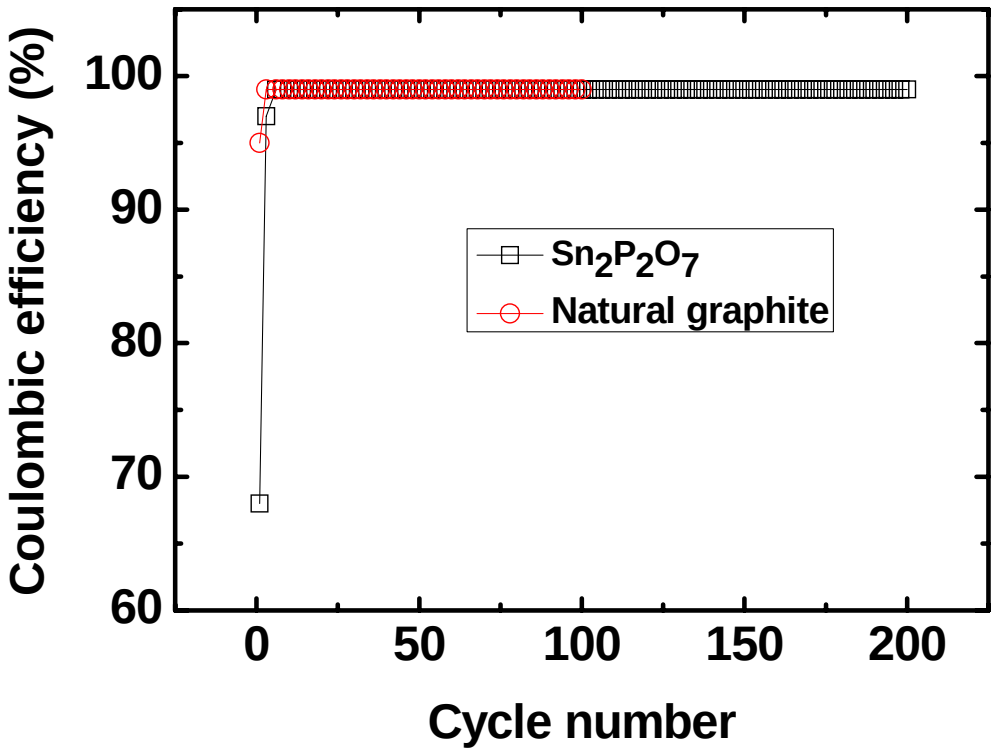
The stacked porous nanodisks was synthesized by mixing 8.8g of $SnCl_4.5H_2O$ and 7.5g of H_3PO_4 (85%), which was then followed by the dissolving of 120 *ml* ethanol. The mixture was stirred at 40°C for 1 h and then loaded in an autoclave at 180°C for 24h. After cooling to room temperature, the precipitate was recovered by centrifugation, followed by repeated washing with distilled water, and dried in a vacuum at 100°C for 10 h. The as-prepared powders were heated at a rate of 300°C/hr to 600°C and were maintained at this temperature for 10 min. before being quenched at a room temperature. The electrolyte for the coin-type half cells (2016 type) was 1 M $LiPF_6$ with ethylene carbonate/diethylene carbonate/ethyl-methyl carbonate (EC/DEC/EMC) (30: 30: 40 vol. %). For preparing SnO_2, all the process was identical to above except for not using H_3PO_4. The coin-type half cells were cycled at a rate of 0.5 C (1 C = 700 mA/g) for 220 cycles between 0 and 1.2 V. The electrode was composed of 80 wt. % active material, 10 wt. % poly(vinyliedene fluoride) binder, and 10 wt. % Super P carbon black.

For reference pitch-coated natural graphite, The binder used was a mixture of SBR with an average particle, size of~100 nm and CMC (carboxymethyl cellulose) with a 98:2 weight ratio, and deionized water was used as a solvent. SBR particles were believed to be finely distributed between the particles even though it was not water-soluble. The electrode composition was coated NG:binder in a weight ratio of 96:4. In the present case, a conducting agent was not used. During drying of the coated electrode at 110°C, SBR fine particles melted between the NG particles. The electrolyte used and electrochemical tyest method were same to above.

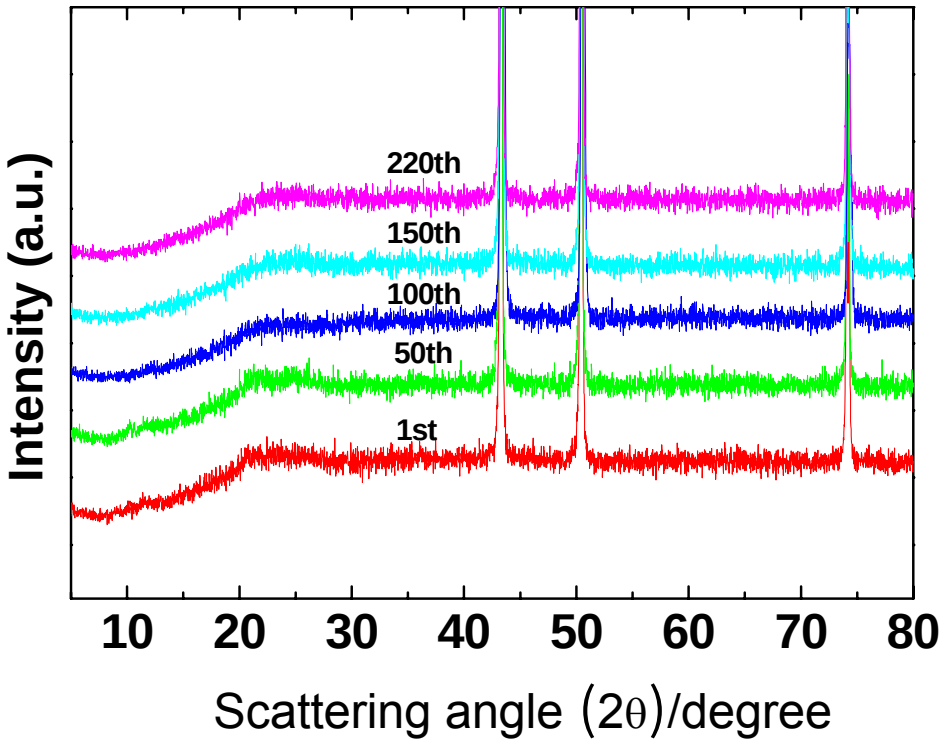
Powder X-ray diffraction (XRD) (D/Max2000, Rigagu) measurements using Cu Kα radiation was used to identify the phase. Samples were observed using scanning electron microscopy (SEM) (JSM 6400, JEOL) and transmission electron microscopy (TEM) (JEOL 2010F).



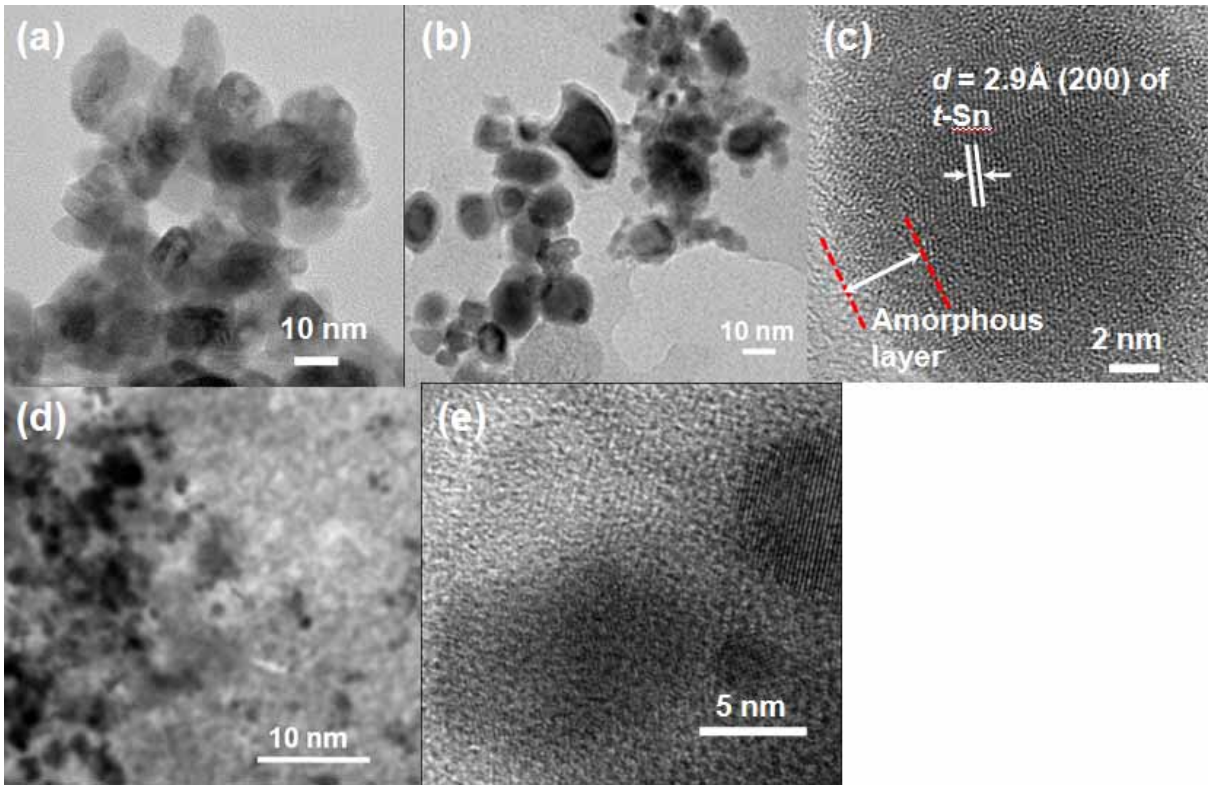
S1. Voltage profiles of SnO_2 nanoparticles after 1st, 40th, 50th, 100th, 150th, 220th cycles between 1.2 and 0V in coin-type half cell at a rate of 0.5C (= 350 mA/g).



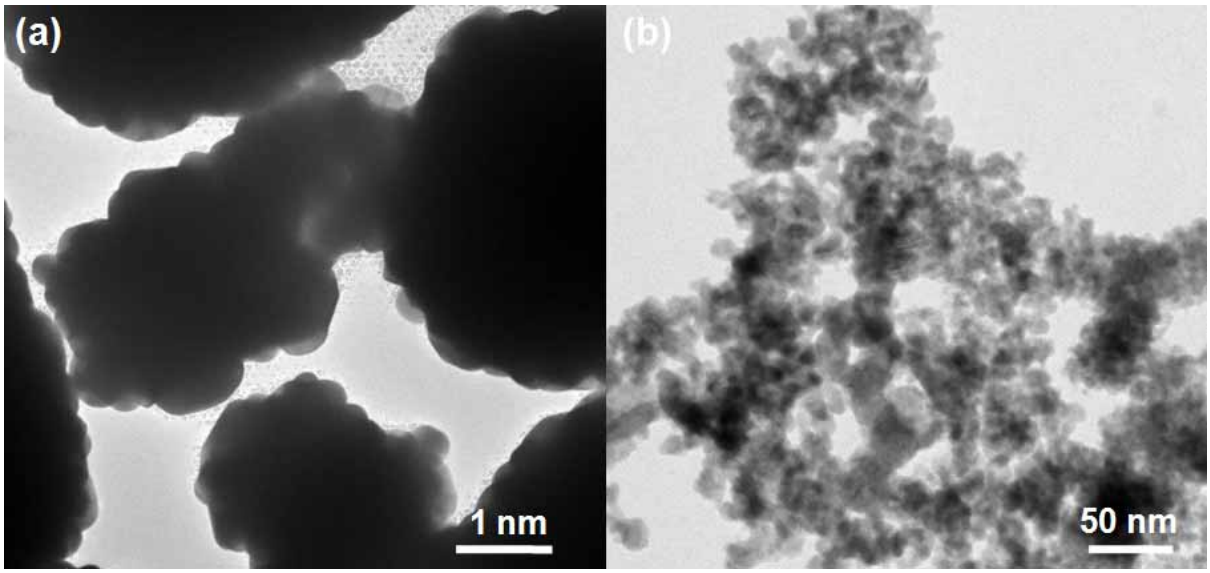
S2. Plot of coulombic efficiency of $Sn_2P_2O_7$ and natural graphite as a function of cycle number.



S3. Ex-situ XRD patterns of the $Sn_2P_2O_7$ nanodisk electrodes after 1, 50, 100, 150, 220 cycles.



S4. TEM images of (a) as-prepared SnO_2 nanoparticles, (b and c) after 20 cycles, and (d and e) after 100 cycles.



S5. TEM images of bulk $Sn_2P_2O_7$ particles; (a) as-prepared and (b) after 50 cycles.