Electronic Supplementary Information (ESI)

Triethoxysilane-derived SiO_x-assisted structural reinforcement of Si/carbon nanotube composite for lithium-ion battery

*Byung Hoon Park[a], Geon-Woo Lee[a], Soo Bean Choi[a], Young-Hwan Kim[a], and Kwang Bum Kim[a]**

[a]Department of Materials Science and Engineering, Yonsei University, 50 Yonsei-ro, Seodaemoon-gu, Seoul 03722, Republic of Korea

**Corresponding author. E-mail: kbkim@yonsei.ac.kr.*

Preparation of acid-treated carbon nanotubes

Acid-treated carbon nanotubes (ACNTs) were prepared by a modified Hummers method. Pristine carbon nanotube (CNT) powder (Carbon Nano-material Technology Co., Ltd., South Korea) was added to concentrated H_2SO_4 under stirring in a cooling bath. Then, under vigorous agitation, $KMnO_4$ was added at a sufficiently low rate to ensure that the temperature of the suspension was maintained at 0 °C. Next, the reaction system was heated to 35 °C and vigorously stirred for 4 h. Subsequently, deionized water was added, and the solution was stirred for 1 h at 0 °C. H_2O_2 (30%) was then slowly added, and the solution was again stirred for 1 h at 0 °C. Finally, the solution was centrifuged and washed with aqueous HCl (0.1 M) repeatedly to remove metal ions. The resulting ACNTs were dried using a vacuum freeze dryer.

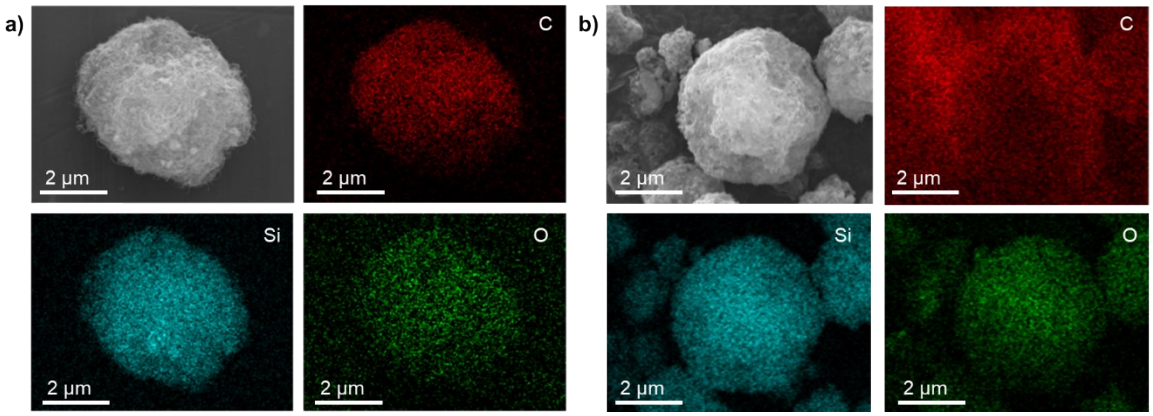

Figure S1. EDS maps of (a) the Si/CNT and (b) Si/CNT/SiO_x microsphere composites. (red: C; blue: Si; and green: O)

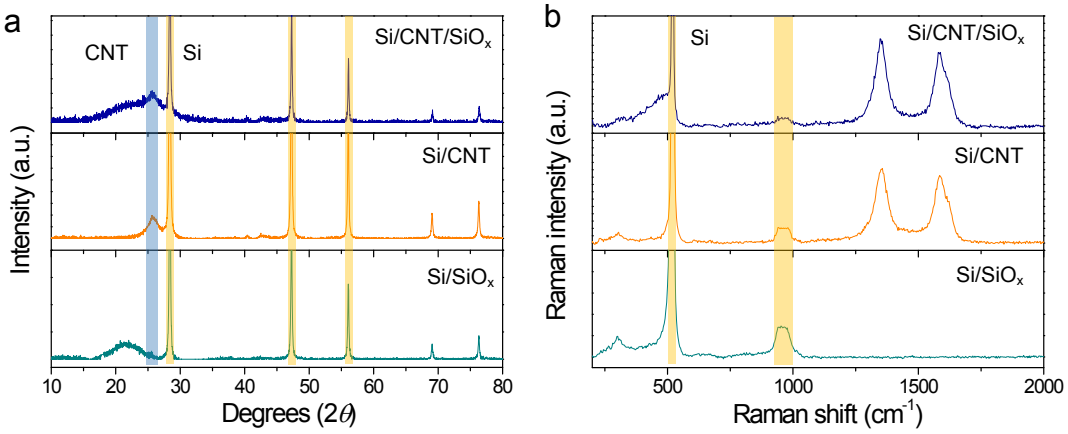

Figure S2. (a) X-ray diffraction (XRD) patterns and (b) Raman spectra of Si/CNT/SiO_x, Si/CNT, and Si/SiO_x composites.

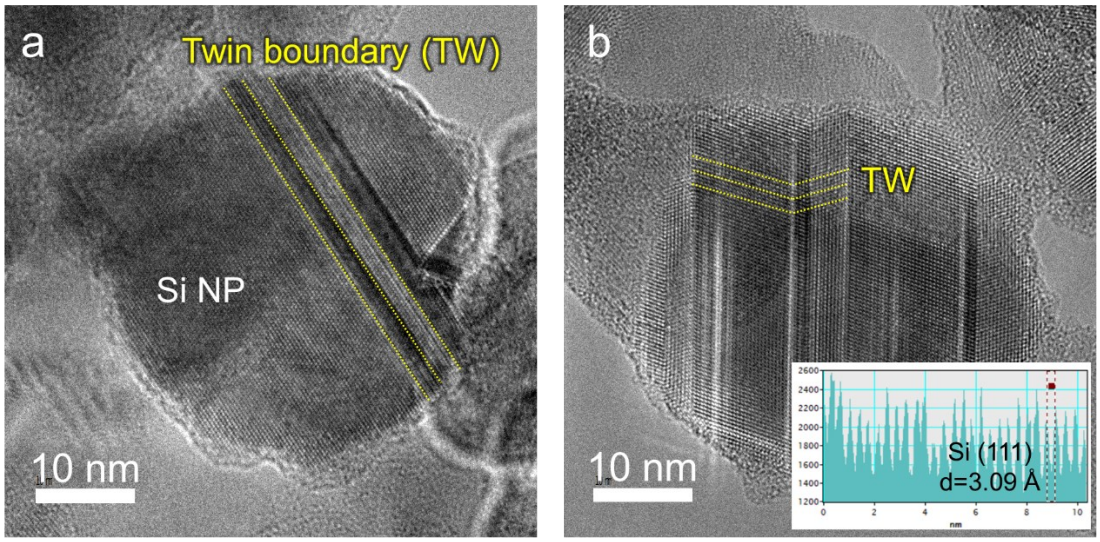

Figure S3. a, b) High-magnification transmission electron microscopy (TEM) images of bare Si nanoparticles (NPs). Lattice fringe pattern of Si NP in (b) shows a d-spacing value of 3.09 Å corresponding to the (111) plane of silicon.

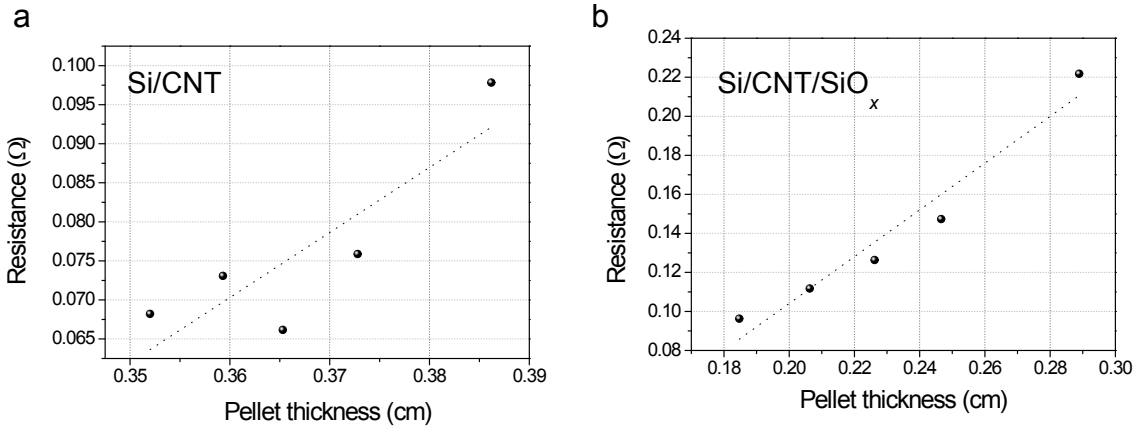

Figure S4. Resistance vs. pellet thickness for (a) Si/CNT and (b) Si/CNT/SiO_x composites.

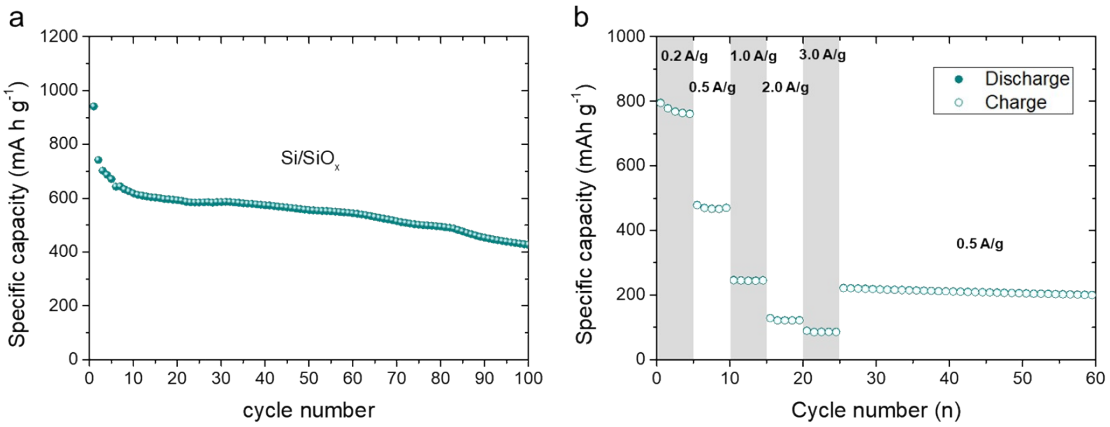

Figure S5. (a) Cycling performances of the Si /SiO_x at a current density of 0.5 A g^{-1}. (b) Rate performance of Si /SiO_x with increasing current density. All the cycling and rate performance tests were conducted at the same charge–discharge rate.

Table S1. Brunauer–Emmett–Teller (BET) surface areas and pore volumes of the Si/CNT and Si/CNT/SiO_x microsphere composites.

Samples	Surface area ($m^2\ g^{-1}$)	Pore volume ($cm^3\ g^{-1}$)
Si/CNT	162.6	1.44
Si/SiO_x/CNT	96.8	0.62

Table S2. Electrochemical impedance spectroscopy (EIS) fit parameters for the Si/CNT and Si/CNT/SiO_x composite electrodes after the 1st and 100th cycles.

		R_s	R_{SEI}	R_{ct}
Point 1 (Si/CNT)	1st lithiated	1.52	1.11	3.35
	100th lithiated	6.43	89.19	20.99
Point 2 (Si/CNT/SiO_x)	1st lithiated	1.70	1.36	3.79
	100th lithiated	1.83	19.37	8.48