Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information

Effective Strategies for Improving Electrochemical Properties of Highly Porous Si Foam Anodes in Lithium-Ion Batteries

Taesoo Bok,[a] Sinho Choi,[a] Jeongchan Lee,[b] and Soojin Park*[a]

[a] Interdisciplinary School of Green Energy, Ulsan National Institute of Science and Technology (UNIST), Ulsan 689-798, Korea

[b] Duksan Hi-metal company, Yeonam-Dong, Buk-gu,Ulsan 683-804, Korea

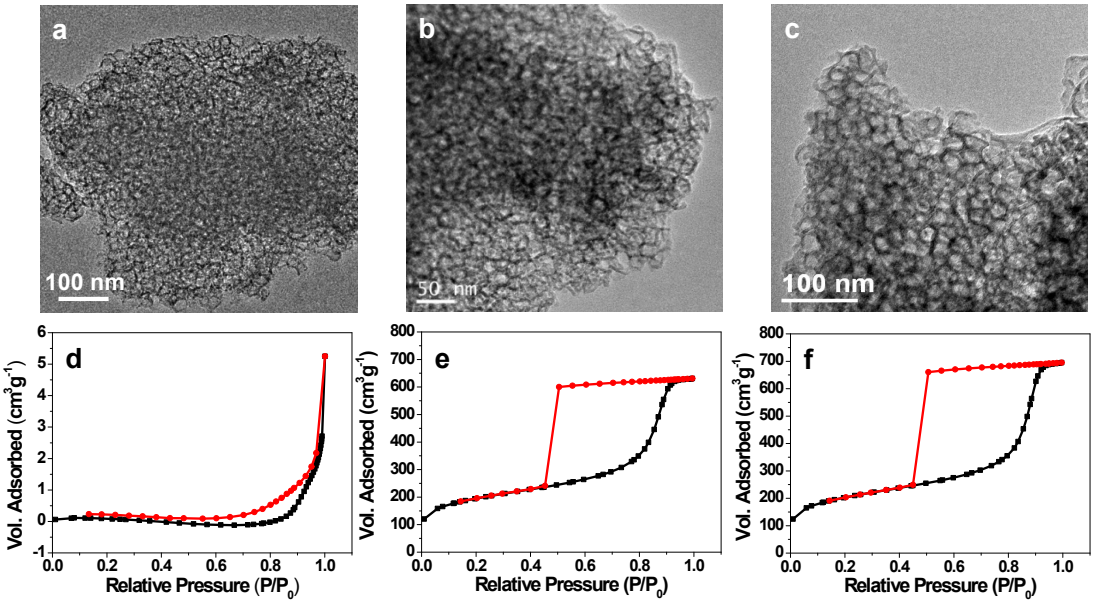

Fig. S1 TEM images of (a) no-calcined SiO_2 foam, (b) air-calcined SiO_2 foam, and (c) oxygen-calcined SiO_2 foam. BET plots of (d) no-calcined SiO_2 foam, (e) air-calcined SiO_2 foam, and (f) oxygen-calcined SiO_2 foam. SEM images of three samples show a similar sponge-like morphology. However, the surface areas of no-calcined SiO_2, air-calcined SiO_2 and oxygen-calcined SiO_2 foam are 0.13 m^2/g, 657.9 m^2/g, and 686.2 m^2/g, respectively.

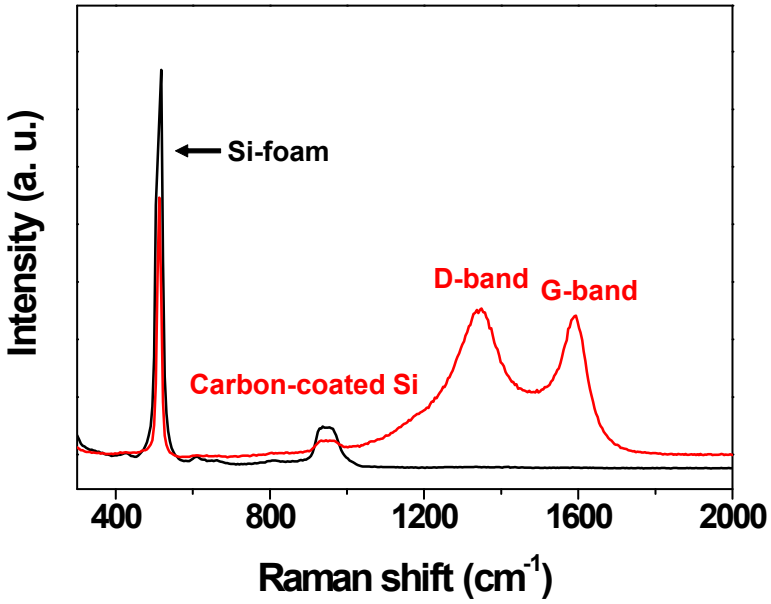

Fig. S2 Raman spectra of as-synthesized Si foam (black line) and carbon-coated Si foam (red line). D/G ratio of 2.21 indicates that amorphous carbon was coated on the Si surface.

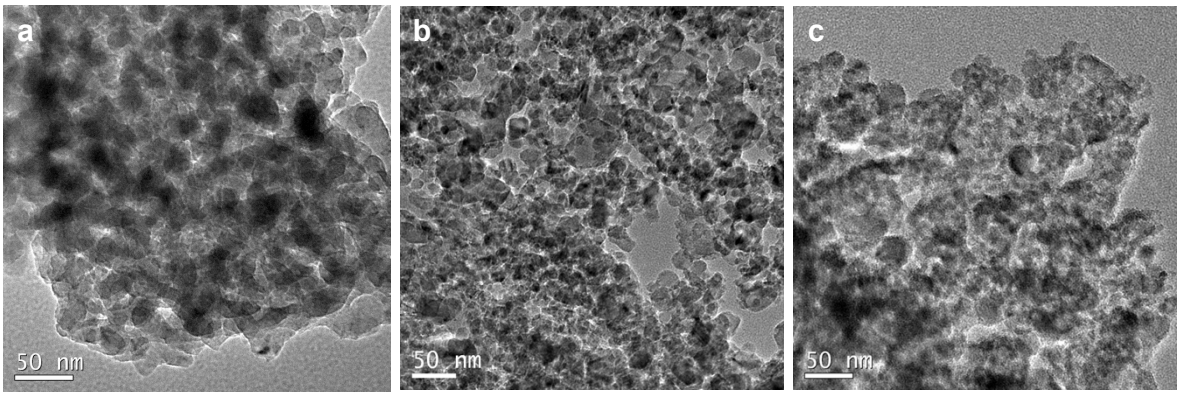

Fig. S3 TEM images of (a) carbon-coated ncSi foam, (b) carbon-coated acSi foam, and (c) carbon-coated ocSi foam.

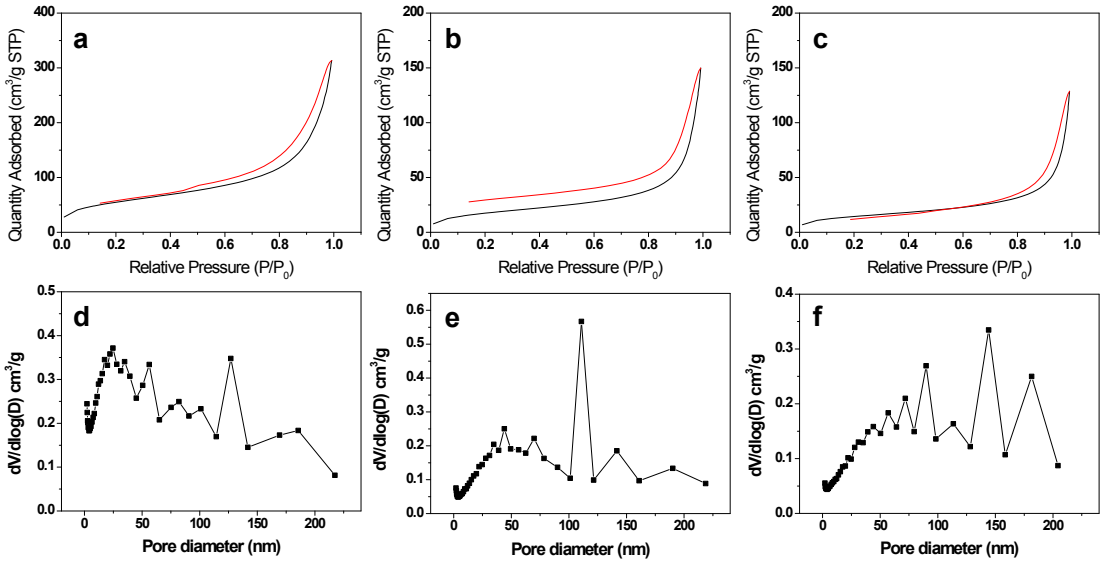

Fig. S4 Surface area and pore size distribution of (a) carbon-coated ncSi foam, (b) carbon-coated acSi foam, and (c) carbon-coated ocSi foam. The surface areas of carbon-coated ncSi, acSi, and ocSi particles are 194.5 m^2/g, 63.2 m^2/g, and 51.8 m^2/g, respectively.

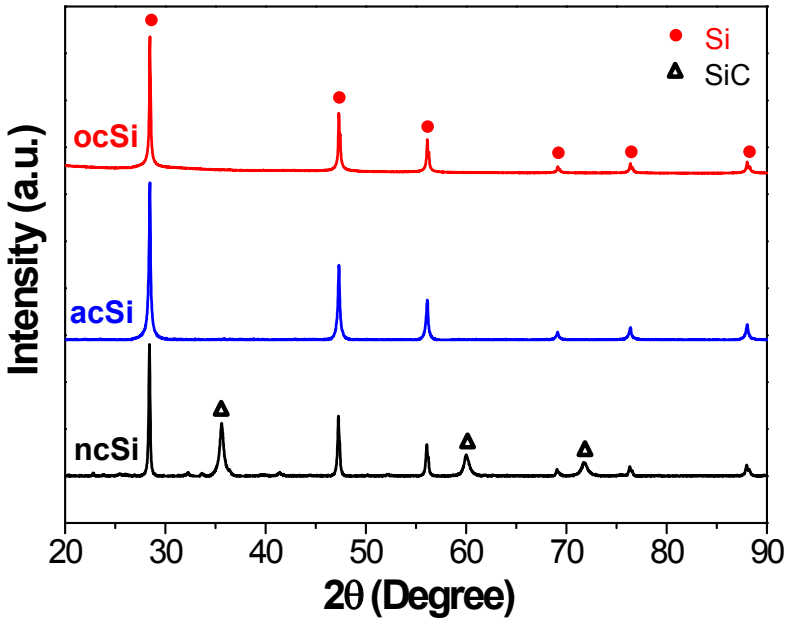

Fig. S5 XRD patterns of ocSi (top), acSi (middle), and ncSi (bottom) particles. In particular, ncSi particles show an existence of SiC layer that was formed during magnesiothermic reaction.

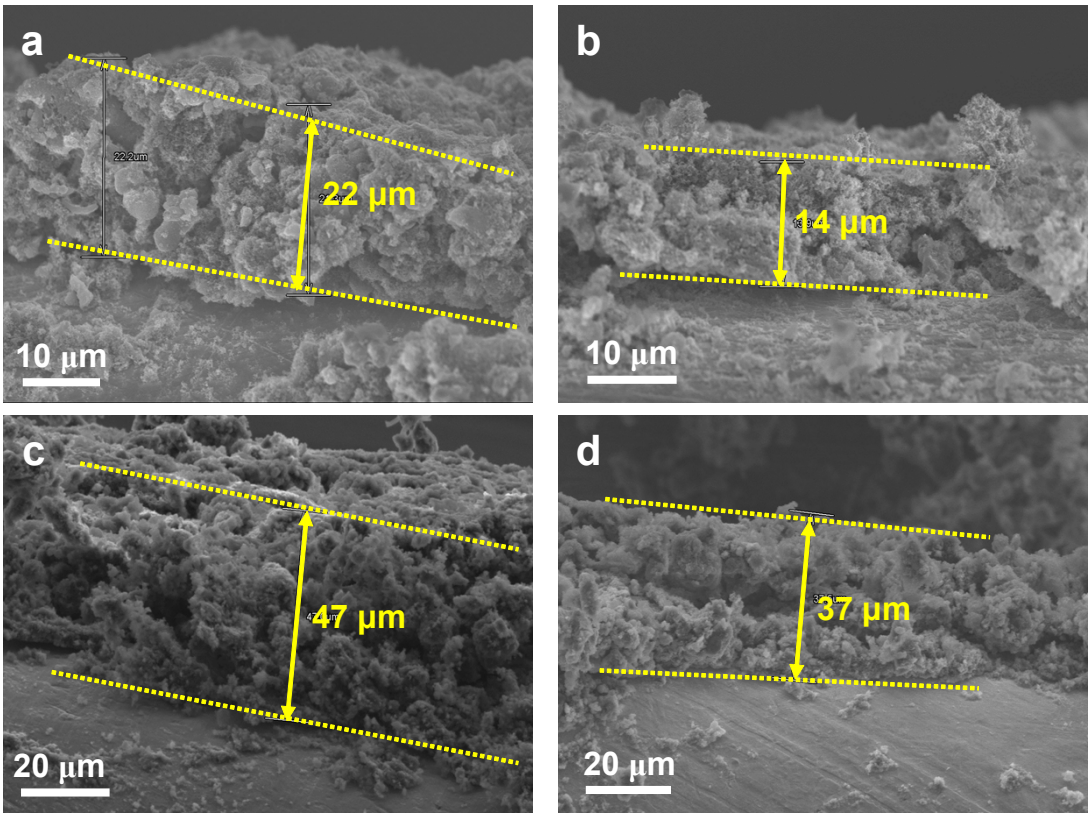

Fig. S6 Cross-sectional SEM images showing volume expansion of two Si electrodes (with and without NaCl) before and after 100 cycles. Electrode thicknesses of Si with NaCl (a: before, c: after cycle) and Si without NaCl (b: before, d: after cycle). The Si electrodes synthesized in the presence of NaCl showed volume expansion of 120% after 100 cycles, while Si electrode without NaCl exhibited 160%.

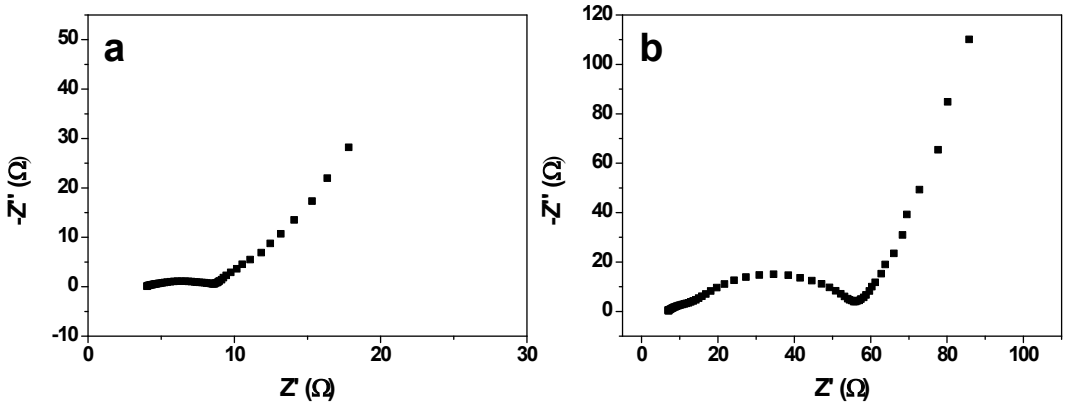

Fig. S7 Nyquist plots of the electrochemical impedance spectra of (a) Ag-loaded ocSi and (b) ocSi electrodes after 50 cycles at a rate of 0.2 C.

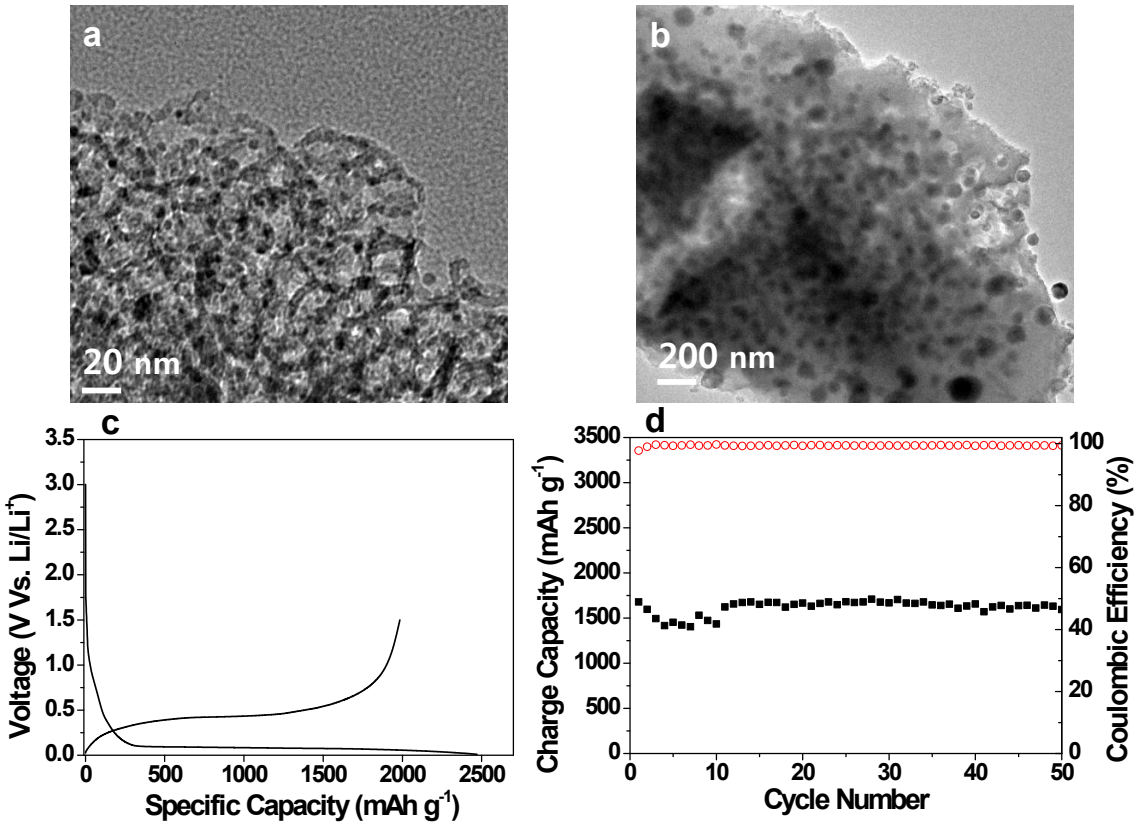

Fig. S8 TEM images of (a) Cu-loaded SiO_2 foam and (b) Cu-doped Si particles. (c) First cycle voltage profile of the Cu-doped Si anode was obtained at 0.05 C rate between 0.005 and 1.2 V. (d) Cycling retention of the Cu-doped Si was obtained at 0.2 C rate (discharge-charge) until 50 cycles. After 50 cycles, a high reversible capacity of 1410 mAh g^{-1} was seen with good capacity retention of 84.2%, compared to initial capacity.