

Supporting Information

Conversion of Silica Nanoparticles into Si Nanocrystals through Electrochemical Reduction

Hiroto Nishihara,^{a,} Takashi Suzuki,^a Hiroyuki Itoi,^{a,b} Bai-Gang,^{a,c} Shinichiro Iwamura,^{a,d} Raúl Berenguer^{a,e} and Takashi Kyotani^a*

^a Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Sendai 980-8577, Japan

^b Department of Applied Chemistry, Faculty of Engineering, Aichi Institute of Technology, 1247 Yachigusa, Yakusa, Toyota 470-0392, Japan

^c School of Chemical Engineering, University of Science and Technology Liaoning, Qianshanzhong Road 185, Anshan 114051, China

^d Division of Chemical Process Engineering, Graduate School of Engineering, Hokkaido University, N13W8 Kita-ku, Sapporo 060-8628, Japan

^e Universidad de Málaga, Andalucía Tech, Departamento de Ingeniería Química, 29071 Málaga, Spain.
Corresponding author: nishihara@tagen.tohoku.ac.jp

S1. I-t curves during potentiostatic reduction of SNP/C(6) and SNP/C(18)

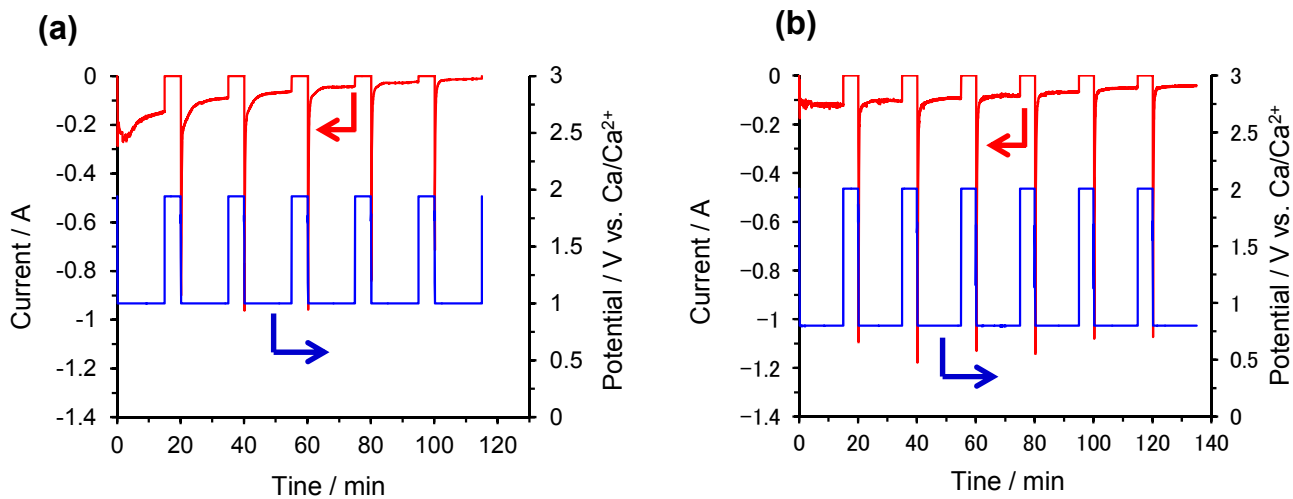


Figure S1. *I-t* curve during potentiostatic reduction of SNP/C(6) at 1.0 V (vs. Ca/Ca²⁺) and SNP/C(18) at 0.8 V, together with a potential profile.

S2. CV pattern of SNP/C(12)R-HF

Figure S2 shows the CV pattern of SNP/C(12)R-HF. It displays the characteristic Li insertion processes into crystalline (1st cathodic cycle) or amorphous (2nd and successive cycles) silicon at around 0.01-0.15 V (single-step process) or 0.01-0.3 V (two-step process), respectively.^[1-2] The cathodic peak at 0.75 V observed only in the 1st negative scan has been widely assigned to the formation of a solid electrolyte interface (SEI).^[1] When the potential scan is reversed, a broad anodic process appears between 0.1-0.7 V, involving the stepwise Li extraction at around 0.3 and 0.5 V to form electrochemically active amorphous Si. The well definition of Li extraction peaks at 0.3 and 0.5 V, even at the 10th anodic scan, suggests that the buffer nanospace produced by SiO₂ electro-reduction may alleviate the destruction of carbon framework during the reversible expansion/contraction of Si nanoparticles upon cycling.

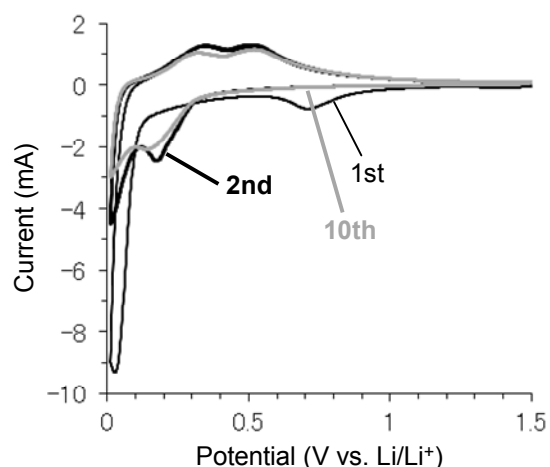


Figure S2. Successive cyclic voltammograms (1st, 2nd and 10th) of SNP/C(12)R-HF. Scan rate is 0.1 mV s⁻¹.

S3. Charge/discharge results of SNP/C(18)R

Figure S3 shows an illustration of the structure of SNP(18)R and its charge/discharge performance as a negative-electrode for LIBs. Because of the presence of SiO₂, SNP(18)R shows much lower capacity than SNP/C(6)R-HF and SNP/C(12)R-HF.

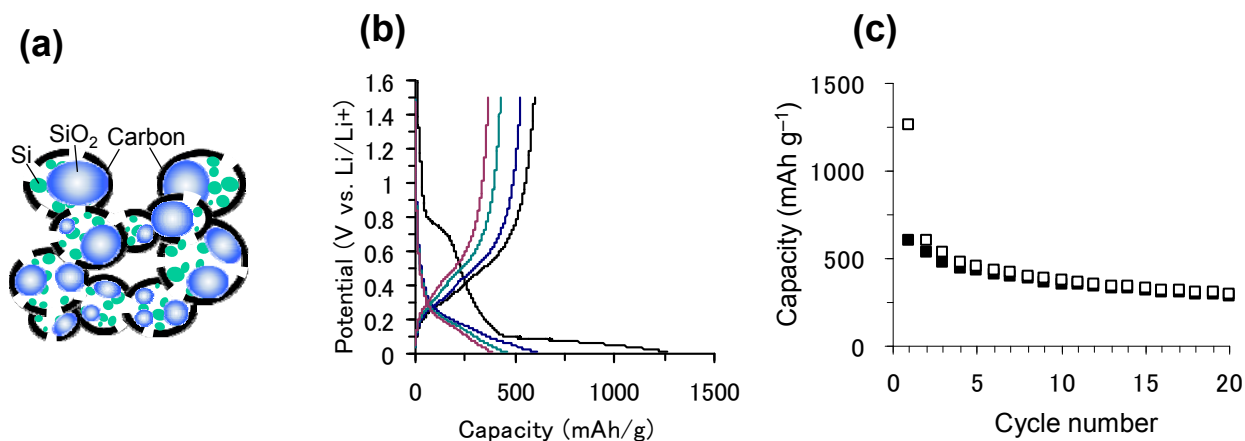


Figure S3. (a) An illustration for the structure of SNP/C(18)R; (b) Charge/discharge curves (1st, 2nd, 5th, and 10th) of SNP/C(18)R. Current density is 200 mA g⁻¹; (c) Charge/discharge capacities of SNP/C(18)R versus cycle number.

References

- [1] S. Iwamura, H. Nishihara, T. Kyotani, *J. Phys. Chem. C* **2012**, *116*, 6004.
- [2] S. Iwamura, H. Nishihara, T. Kyotani, *J. Power Sources* **2013**, *222*, 400.