

# 3D Si/C Particulate Nanocomposites Internally-Wired with Graphene Networks for High Energy and Stable Batteries

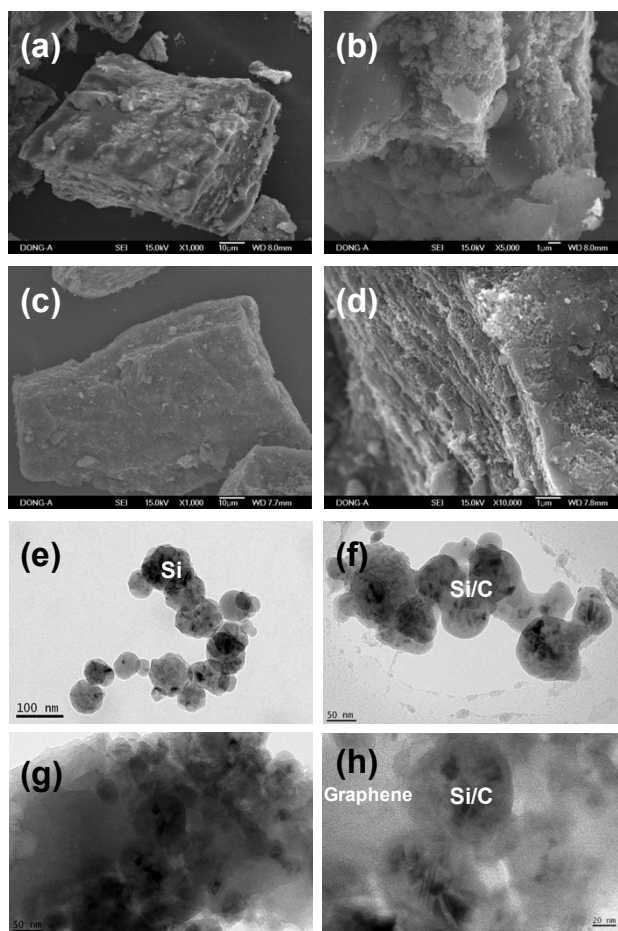
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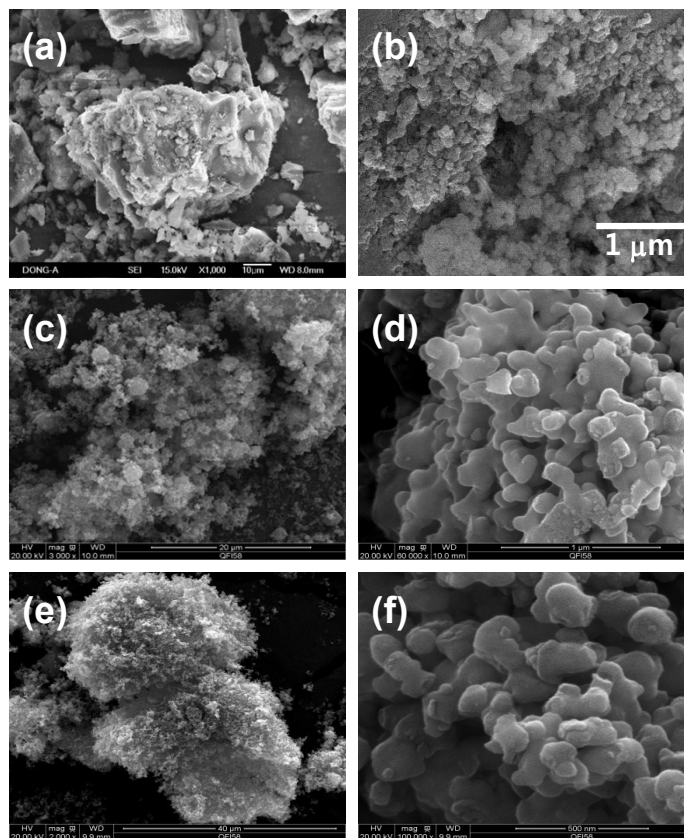
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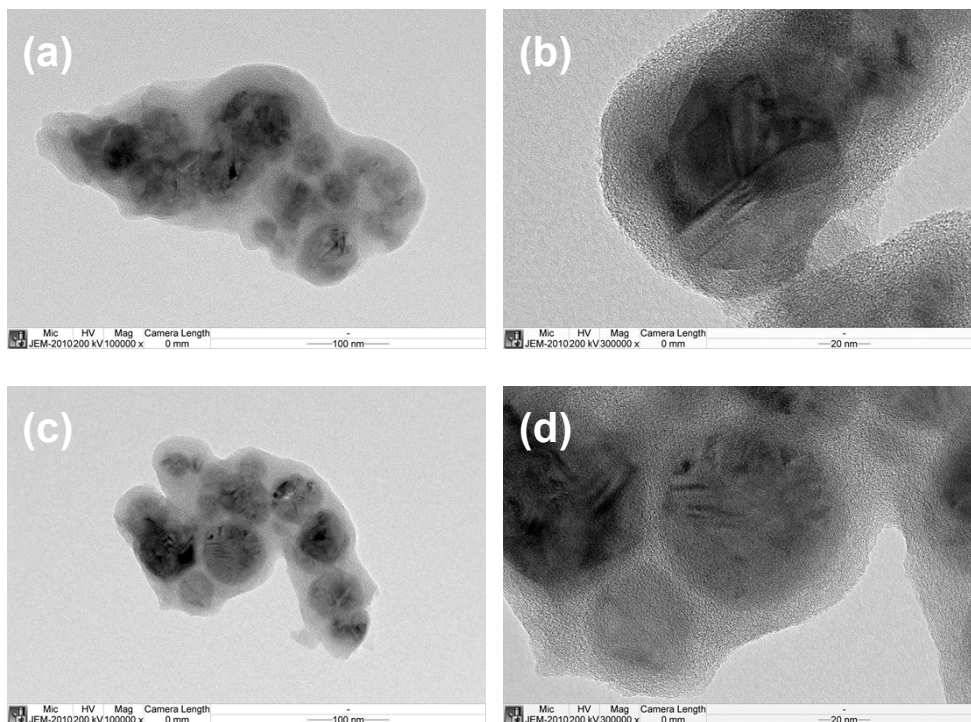
## Supporting Information



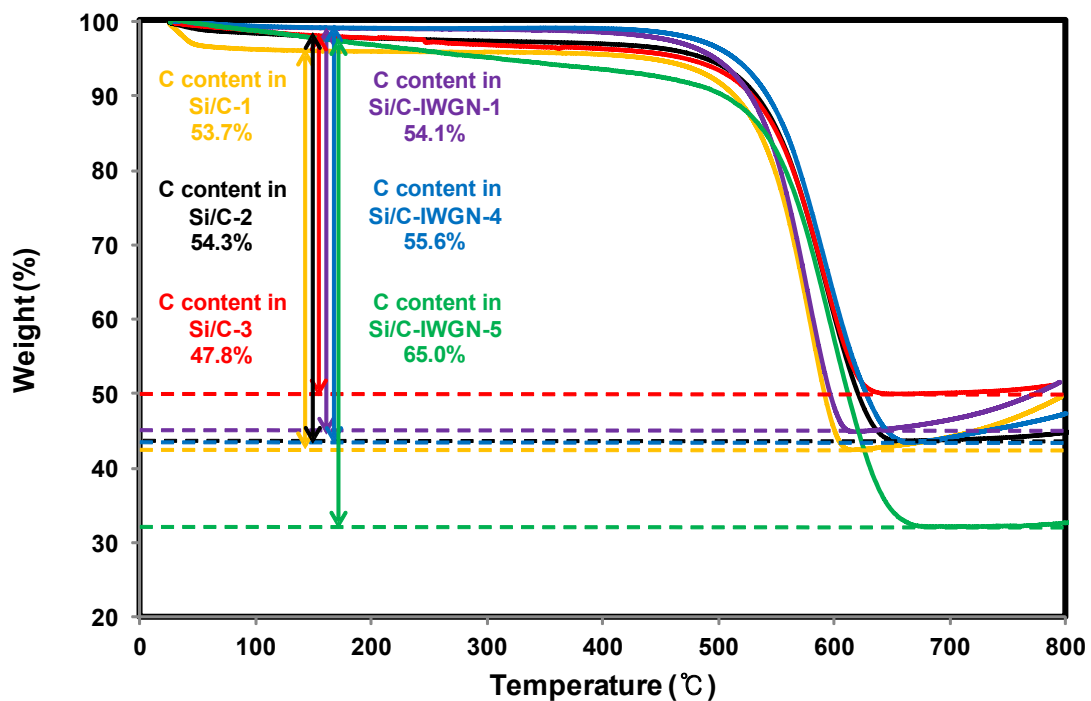
**Figure S1.** SEM images of (a, b) Si/C-IWGN-1, (c, d) Si/C-IWGN-2, and TEM images of (e) SiNPs, (f) Si/C-1 and (g, h) Si/C-IWGN-1.



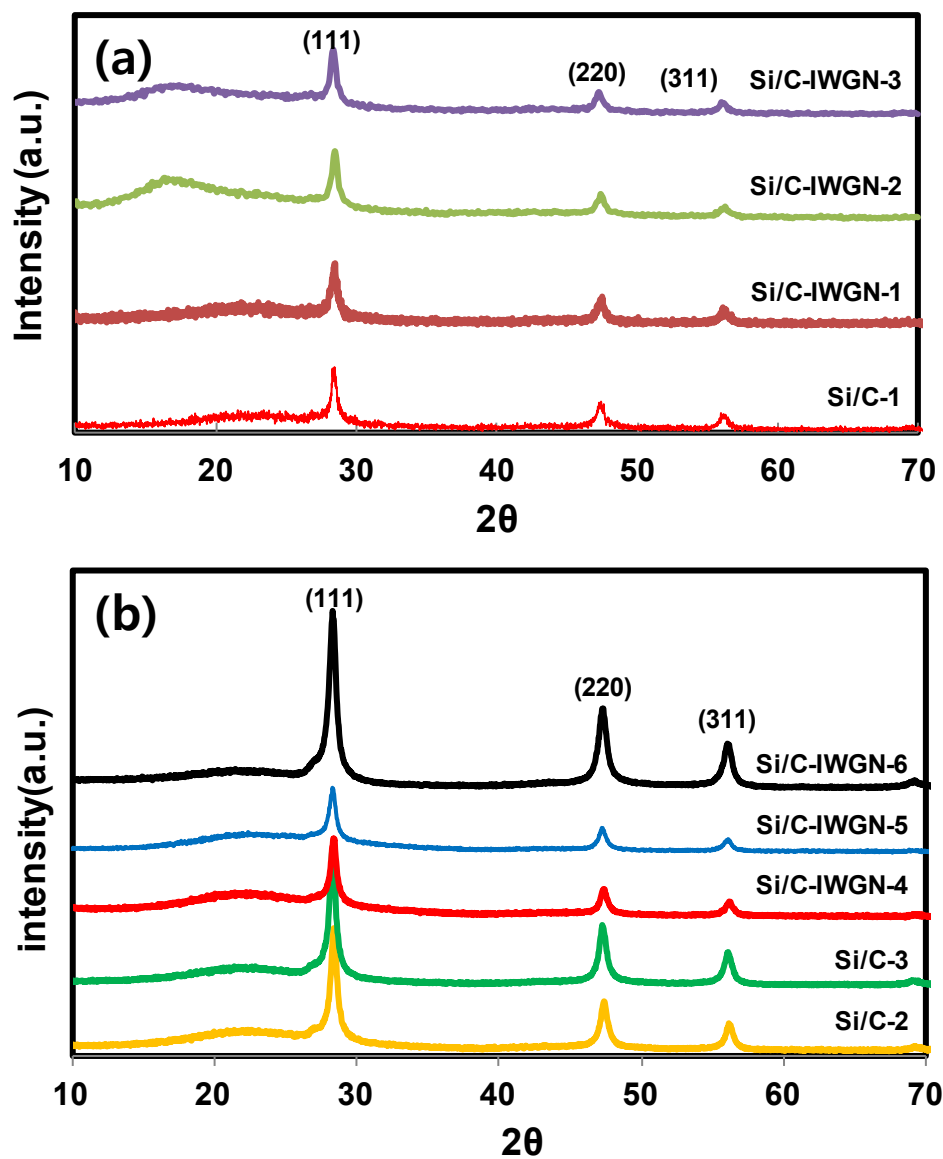
**Figure S2.** SEM images of (a, b) Si/C-1, (c, d) Si/C-2 and (e, f) Si/C-3.



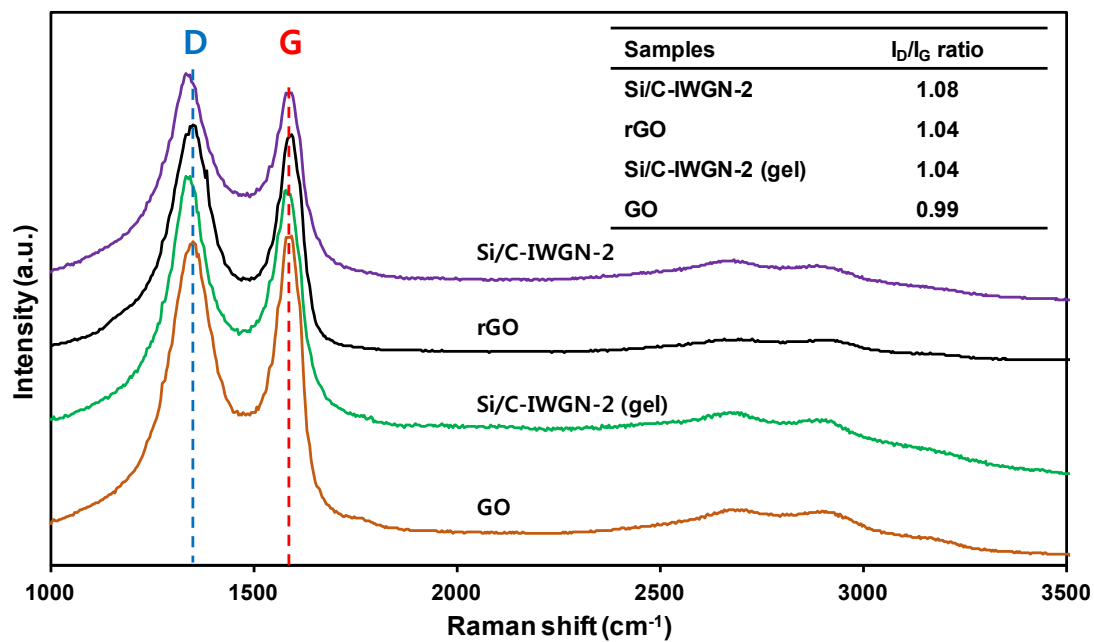
**Figure S3.** TEM images of (a, b) Si/C-2 and (c, d) Si/C-3.



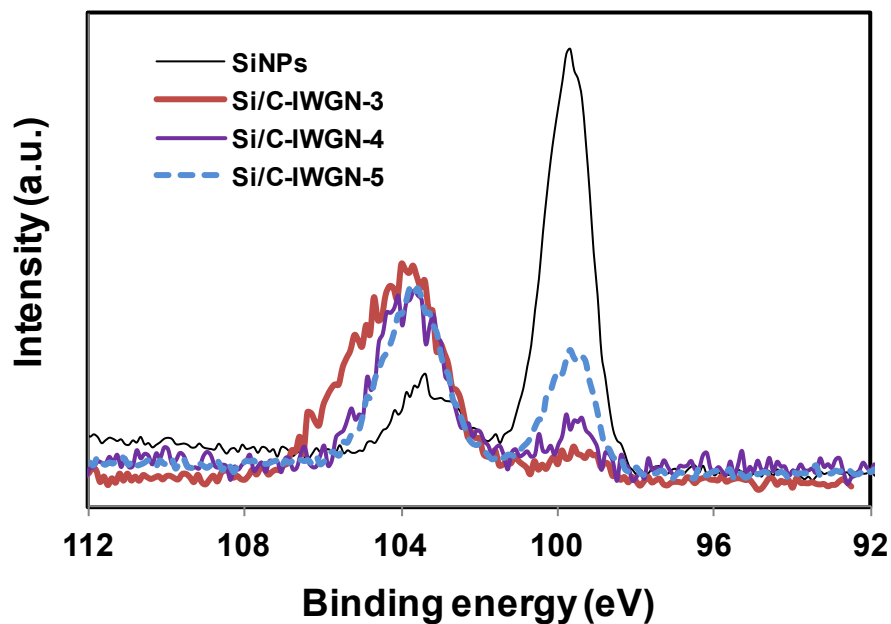
**Figure S4.** TGA profiles of reference Si/C samples, Si/C-IWGN-1, Si/C-IWGN-4 and Si/C-IWGN-5 run in air flow.



**Figure S5.** XRD patterns of (a) Si/C-1 and Si/C-IWGN-1~3 and (b) Si/C-2 and Si/C-IWGN-4~6 series samples.



**Figure S6.** (a) FTIR and (b) Raman spectra of GO, Si/C-IWGN-2(gel), thermally reduced rGO and Si/C-IWGN samples.

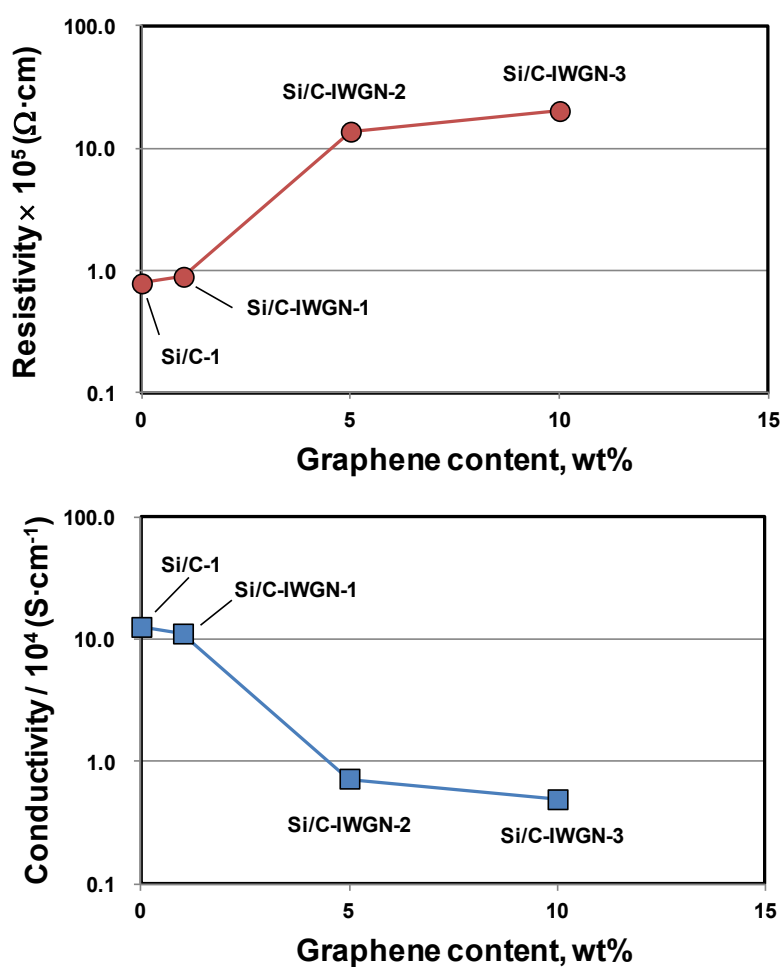


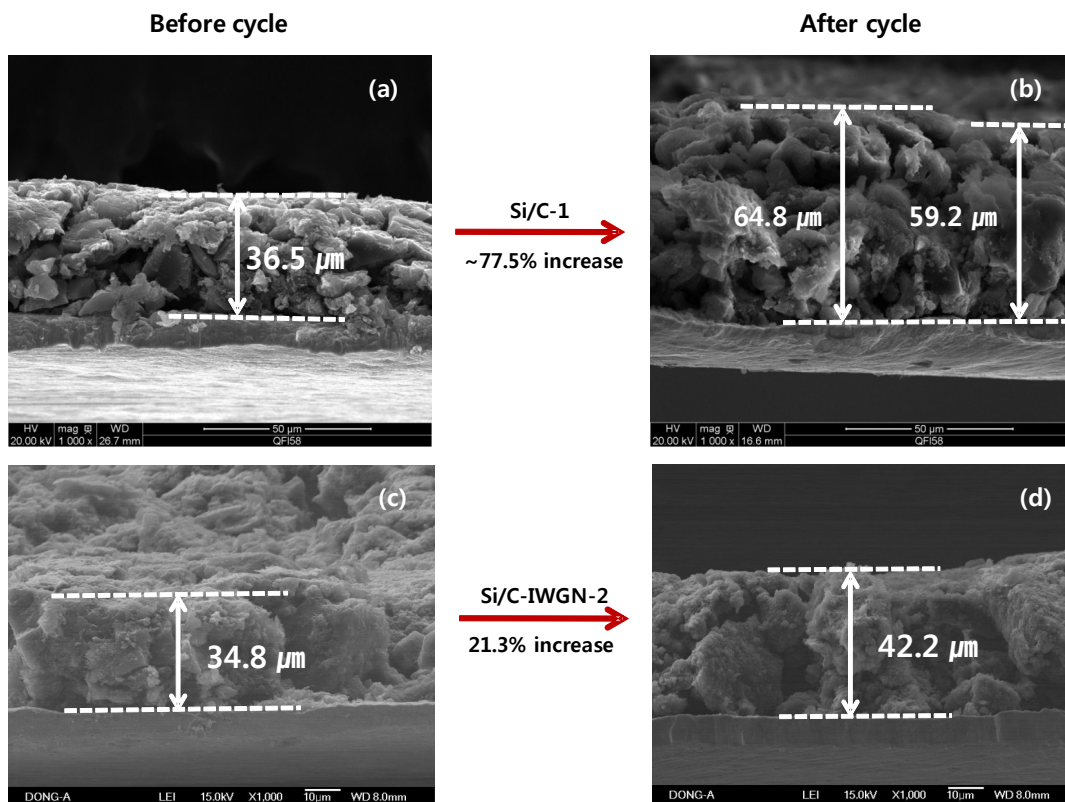
**Figure S7.** X-ray photoelectron spectra of SiNPs, Si/C-IWGN-3, Si/C-IWGN-4 and Si/C-IWGN-5.

**Table S1.** Electrode sheet resistance and conductivity

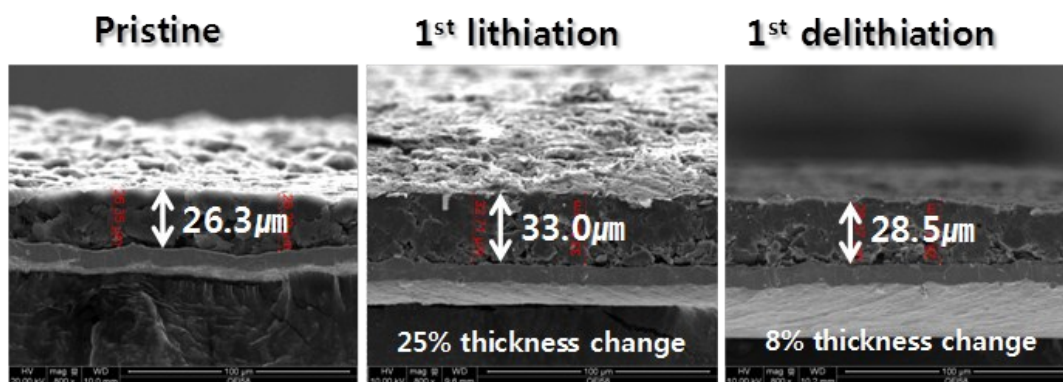
Electrodes	Sheet resistance <sup>a</sup> (mΩ per square)	Coating thickness <sup>b</sup> (μm)	Resistivity <sup>c</sup> (Ω·cm)	Conductivity <sup>d</sup> (S·cm <sup>-1</sup> )
Si/C-1	1.97	40.3	7.9'10 <sup>-6</sup>	1.3'10 <sup>5</sup>
Si/C-IWGN-1	2.28	39.3	9.0'10 <sup>-6</sup>	1.1'10 <sup>5</sup>
Si/C-IWGN-2	38.15	36.2	1.4'10 <sup>-4</sup>	7.1'10 <sup>3</sup>
Si/C-IWGN-3	56.52	36.0	2.0'10 <sup>-4</sup>	5.0'10 <sup>3</sup>

Notes; <sup>a</sup>Sheet resistances are average values on 10~12 different measurements, <sup>b</sup>coating thicknesses are average values on 6 different measurements, <sup>c</sup>Resistivity = (sheet resistance) / (coating thickness) and <sup>d</sup>Conductivity = (Resistivity)<sup>-1</sup>.

**Figure S8.** Sheet resistivity and conductivity measured on electrodes of Si/C-1 and Si/C-IWGN-1~3 series samples.



**Figure S9.** SEM images of (a, b) Si/C-1 and (c, d) Si/C-IWGN-2 before (left column) and after cycling for 50 cycles at  $0.5 \text{ A g}^{-1}$ .

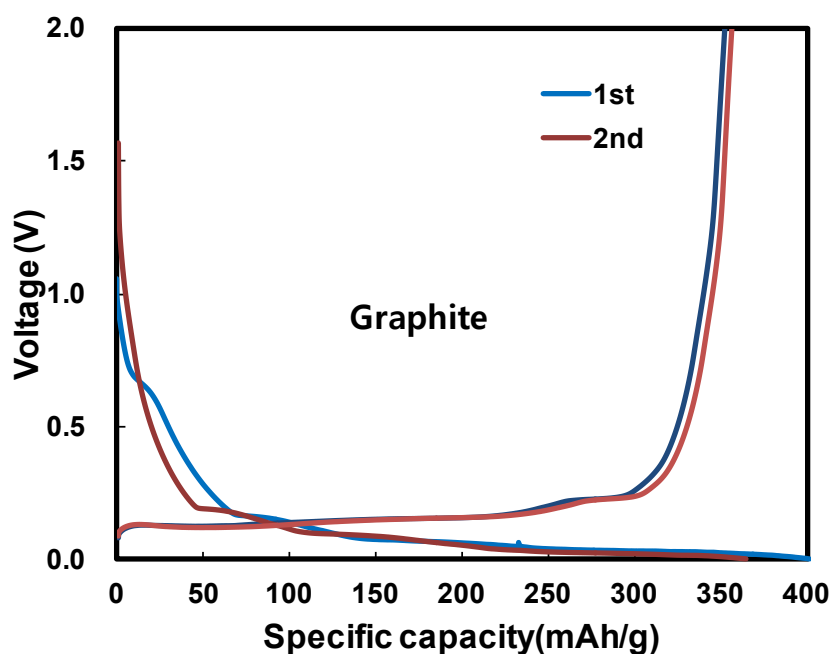


**Figure S10.** SEM images of electrode cross-sections of graphite for its pristine and after the first lithiation and delithiation.

**Table S2.** Coating densities and volumetric capacities electrodes

Samples	Si/C-IWGN-3	Si/C-IWGN-6	Si-Gr	Graphite
$\text{mg}_{\text{A.M.}}/\text{cm}^{2\text{a}}$	1.51	1.63	1.91	3.43
$\text{mg}_{\text{total}}/\text{cm}^{2\text{b}}$	1.89	2.04	2.39	4.29
coating thickness ( $\mu\text{m}$ ) <sup>c</sup>	31.0	37.2	22.1	26.3
coating density ( $\text{g}_{\text{total}}/\text{cm}^3$ ) <sup>b</sup>	0.61	0.55	1.09	1.63
specific capacity-1 ( $\text{mAh}/\text{g}_{\text{A.M.}}$ ) <sup>a</sup>	994	1557	899	370
specific capacity-2 ( $\text{mAh}/\text{g}_{\text{total}}$ )	795	1246	719	296
volumetric capacity <sup>d</sup> ( $\text{mAh}/\text{cm}^3_{\text{total}}$ ) <sup>b</sup>	484	682	777	483

Notes; <sup>a</sup>values based on the mass of active material (A.M.) only, <sup>b</sup>values based on the total mass inclusive of active material, binder and conductive additive coated on electrode, <sup>c</sup>measured by SEM of electrode cross-section, and <sup>d</sup>volumetric capacity ( $\text{mAh}/\text{cm}^3_{\text{total}}$ ) = specific capacity-2 ( $\text{mAh}/\text{g}_{\text{total}}$ )  $\times$  coating density ( $\text{g}_{\text{total}}/\text{cm}^3$ ).

**Figure S11.** Voltage profiles of graphite for the initial two cycles at the current of  $100 \text{ mA g}^{-1}$  between  $0.005 - 2.0 \text{ V}$ .