Supplementary material

SiO_x Anode Strengthened by Self-Catalytic Growth of Carbon Nanotubes

Hongjin Xue,[a,b] Yong Cheng,[a*] Qianqian Gu,[a,b] Zhaomin Wang,[a] Yabin Shen,[a,b] Dongming Yin,[a,b] Limin Wang[a,b] and Gang Huang[a*]

[a] *State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry Chinese Academy of Sciences, Changchun, 130022, China*
[b] *University of Science and Technology of China, Hefei, 230026, China*

*Address correspondence to: cyong@ciac.ac.cn; ghuang@ciac.ac.cn.

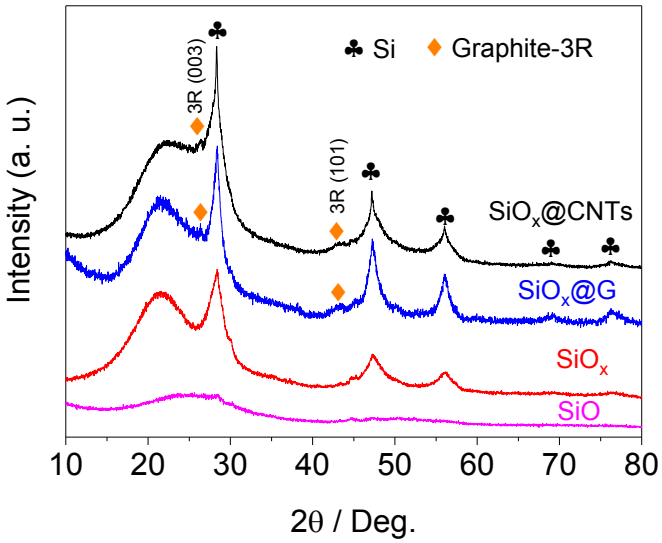

Figure S1. XRD patterns of SiO, SiO_x, SiO_x@G, and SiO_x@CNTs.

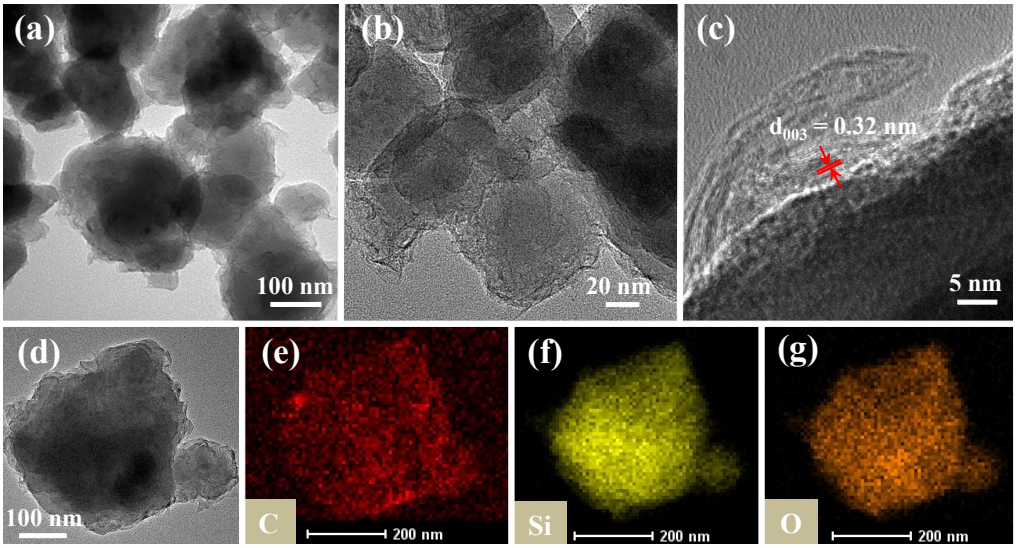

Figure S2. (a,b) TEM images and (c) high-resolution TEM image of SiO_x@G. (d-g) TEM image and EDS elemental mapping images of C, Si, and O of SiO_x@G.

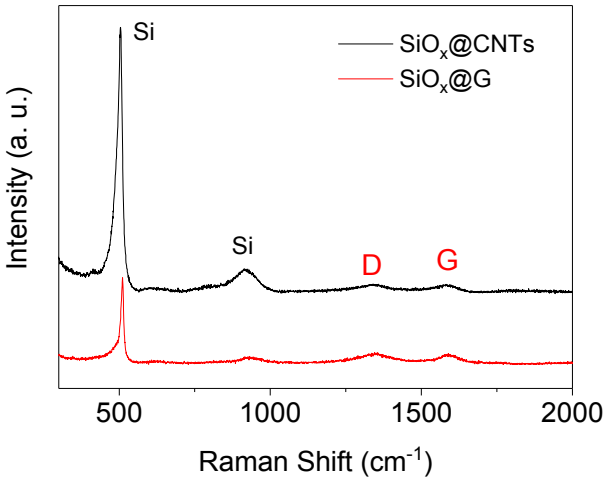

Figure S3. Raman spectra of SiO_x@CNTs and SiO_x@G.

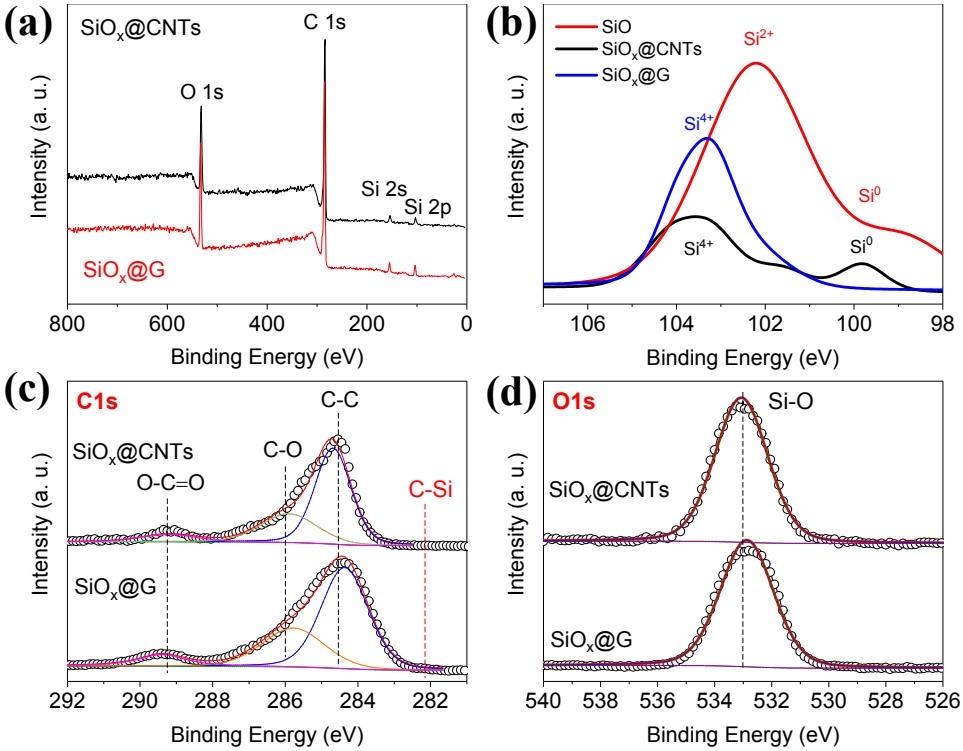

Figure S4. (a) XPS survey spectra of SiO_x@CNTs and SiO_x@G. High resolution XPS spectra of (b) Si2p/Si2s, (c) C1s, and (d) O1s of SiO_x@CNTs and SiO_x@G.

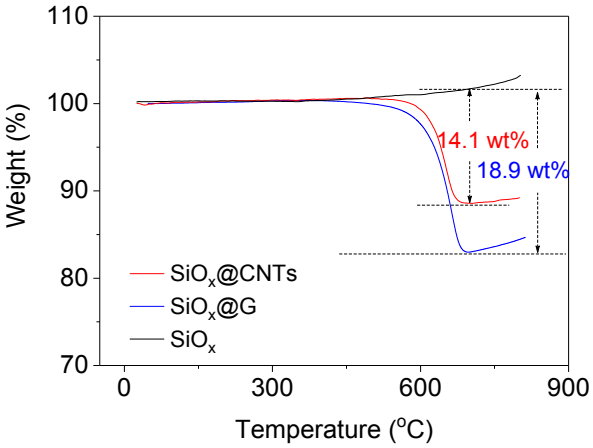

Figure S5. TGA profiles of SiO_x@CNTs, SiO_x@G and SiO_x.

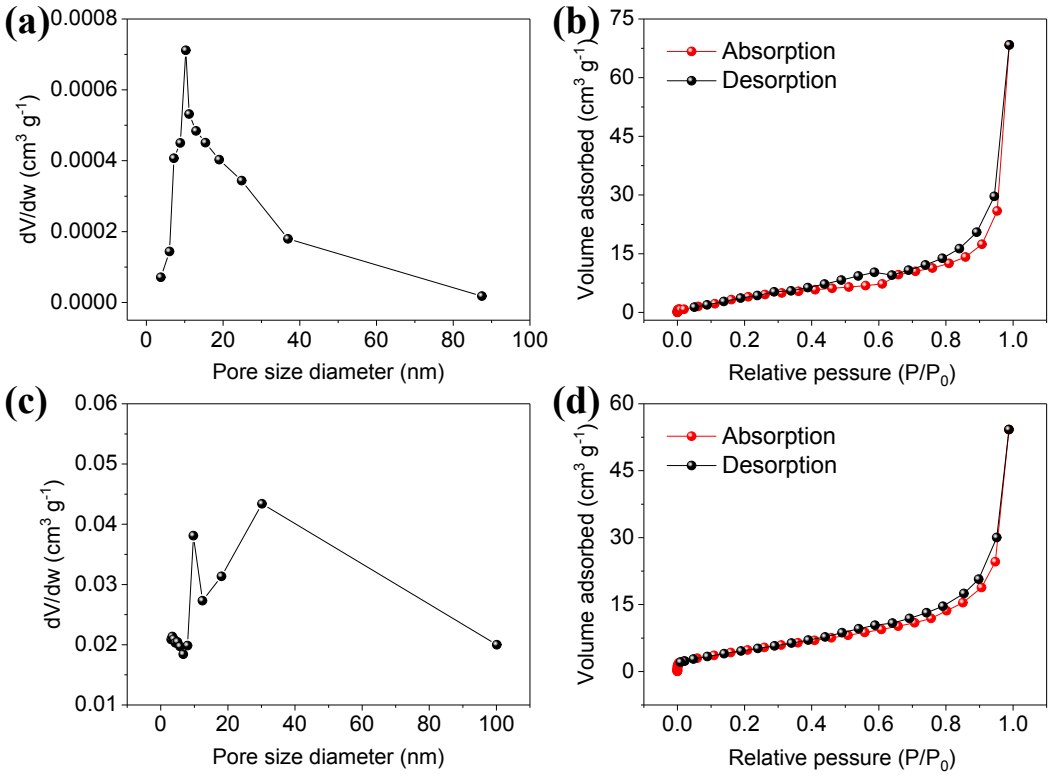

Figure S6. N_2 adsorption/desorption isotherms and pore size distribution curves of (a,b) SiO_x@CNTs and (c,d) SiO_x@G.

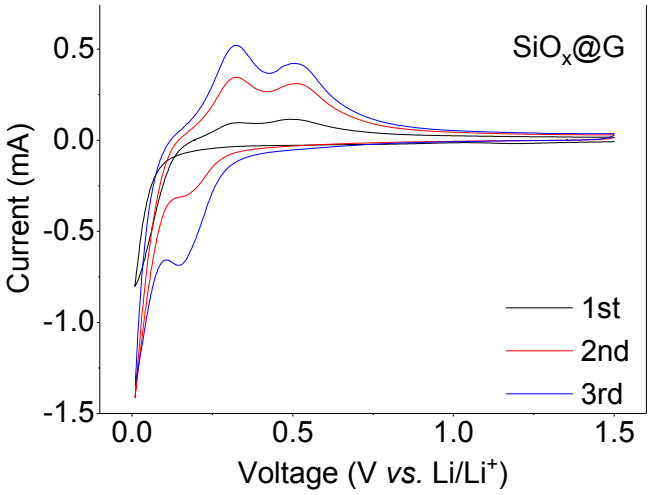

Figure S7. CV curves of SiO_x@G at a scan rate of 0.1 mV s^{-1}.

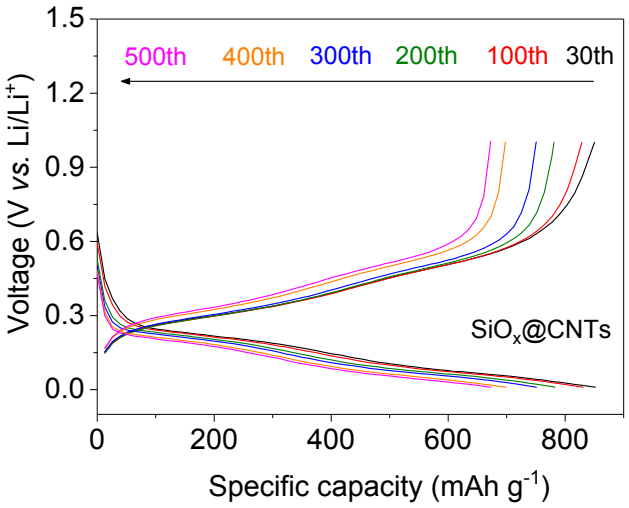

Figure S8. Typical voltage vs. capacity profiles of SiO_x@CNTs in the cycle test.

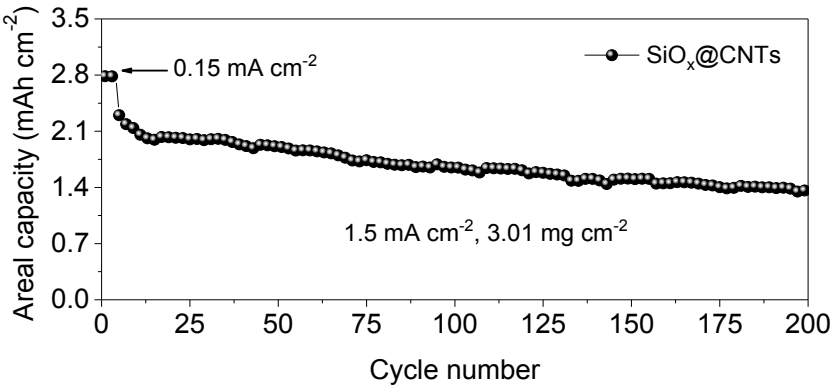

Figure S9. Cycle performance of SiO_x@CNTs at a current density of 1.5 mA cm^{-2}.

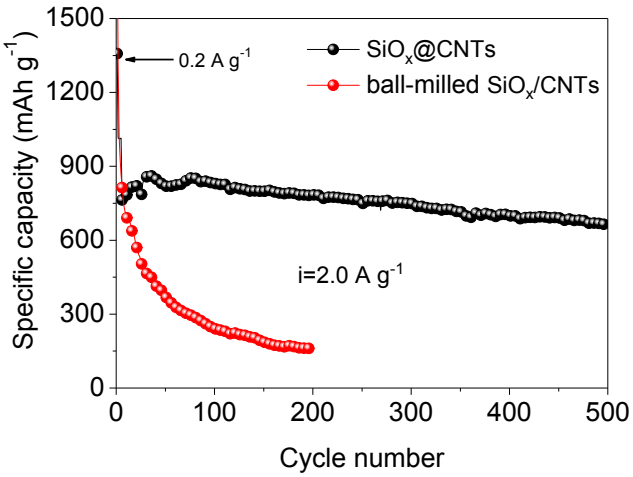

Figure S10. Comparative cycle performance of the SiO_x@CNTs and ball-milled SiO_x/CNTs at a current density of 2 A g^{-1}.

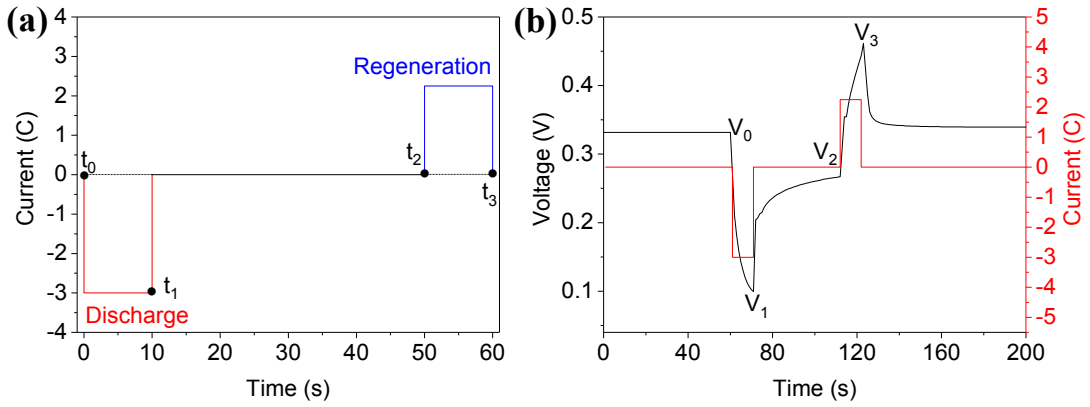

Figure S11. Method of the HPPC test. (a) The battery was pulse discharged for 10 s at a rate of 3 C, which was subsequently relaxed at the open-circuit voltage (OCV) for 40 s, and then charged for 10 s with a regenerative pulse at 75% current (2.25 C rate) of the discharge pulse. The discharge procedure was repeated from 10 to 90% depth of discharge (DOD), which was followed by a 1 h rest period before applying the next sequence. (b) One sequence under 20% DOD.

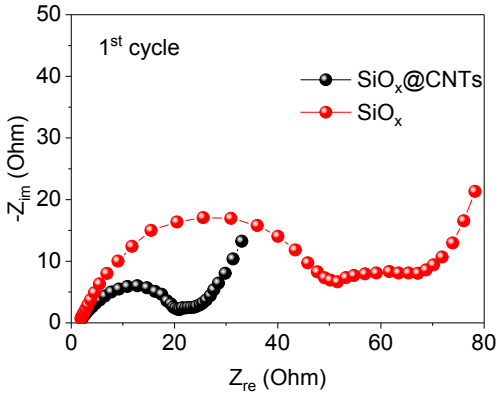

Figure S12. Nyquist plots of SiO_x@CNTs and SiO_x electrodes after the 1st cycle.

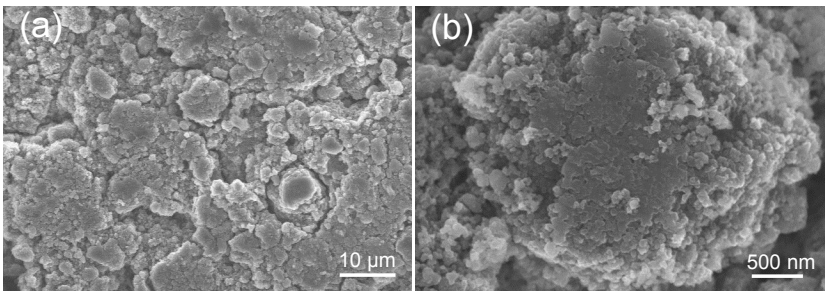

Figure S13. Ex-situ SEM images of SiO_x@G anode after 100 cycles.

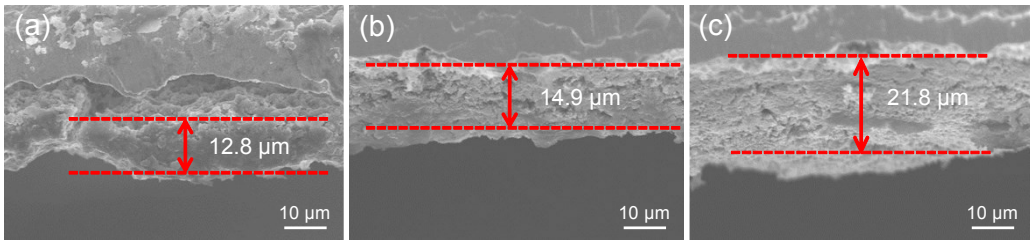

Figure S14. Cross-sectional SEM images of (a) electrode before cycling, and (b) SiO_x and (c) SiO_x@CNTs electrodes after 100 cycles.

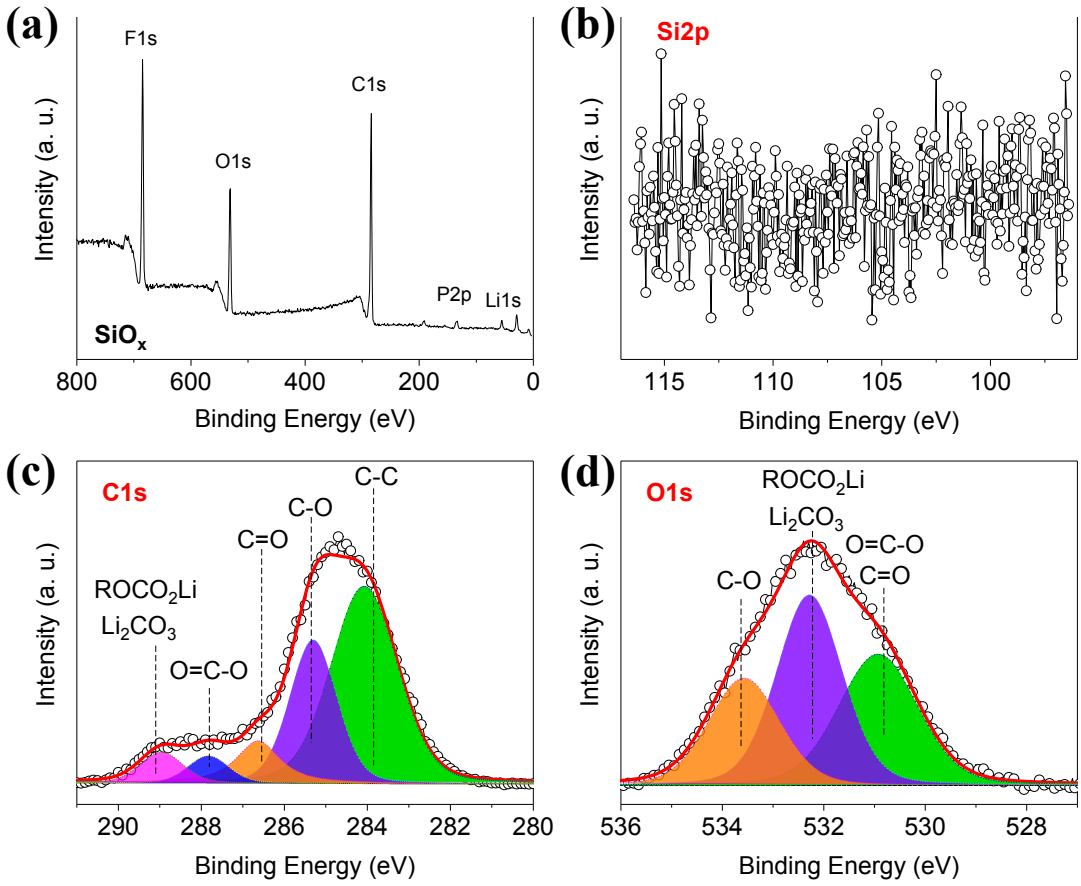

Figure S15. Surface layer characterization of the SiO_x electrode after 100 cycles. (a) Full XPS spectrum and XPS expanded spectra of (b) Si2p, (c) C1s, and (d) O1s.

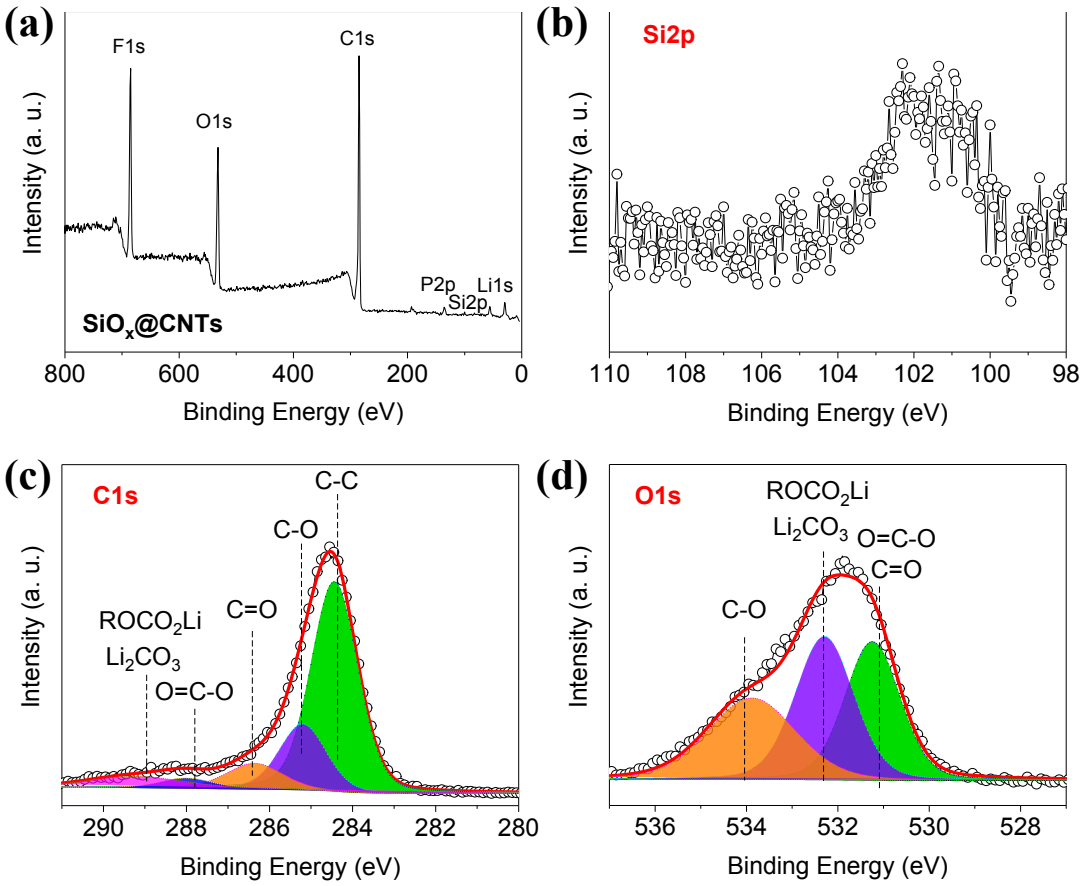

Figure S16. Surface layer characterization of the SiO_x@CNTs electrode after 100 cycles. (a) Full XPS spectrum and XPS expanded spectra of (b) Si2p, (c) C1s, and (d) O1s.

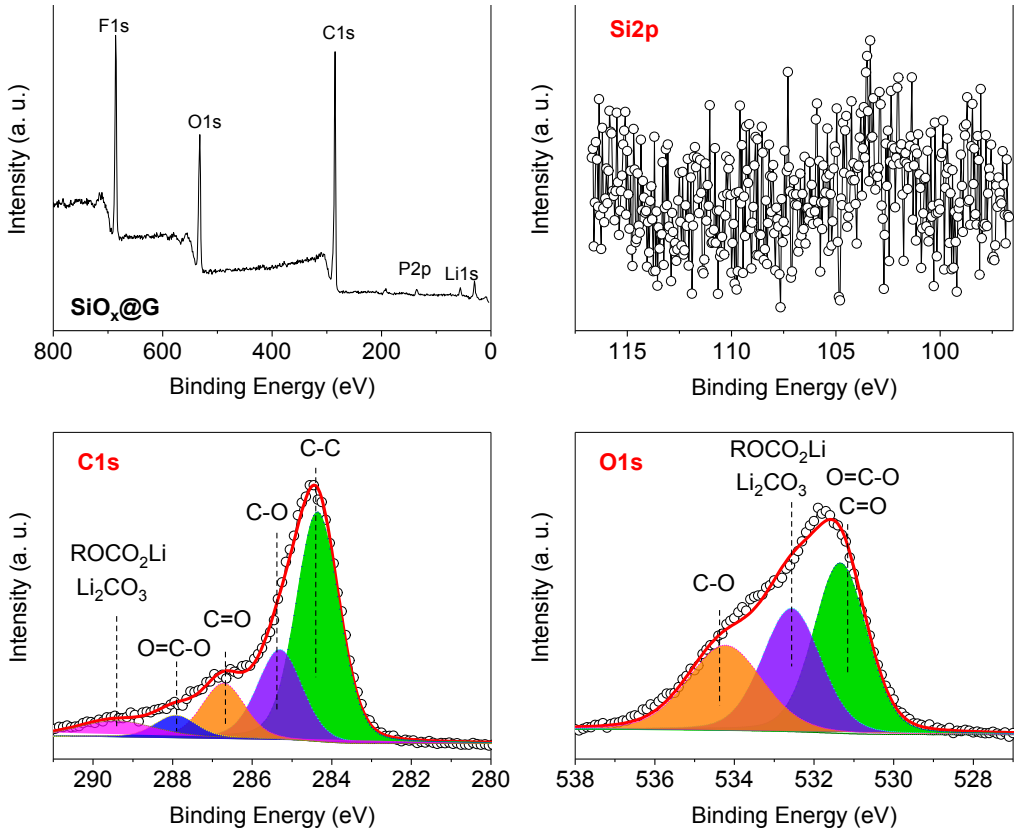

Figure S17. Surface layer characterization of the SiO_x@G electrode after 100 cycles. (a) Full XPS spectrum and XPS expanded spectra of (b) Si2p, (c) C1s, and (d) O1s.

Table S1. Comparative electrochemical performance of the as-prepared SiO_x @CNTs and those of the SiO_x-based composites reported previously.

Materials	Current density (A g^{-1})	Cycle numbers	Capacity (mAh g^{-1})	Retention	Ref.
SiO_x/G/C	0.12	500	487	74.6%	[1]
SiO_x/C spheres	1	400	493	80.9%	[2]
VG@SiO_x/NC	2	500	642	84.2%	[3]
SiO/Sn	0.2	100	850	60.0%	[4]
YS-SiO_x/C@C	0.5	1000	557	76.4%	[5]
SiO_x-C	0.1	100	674	83.5	[6]
p-SiO_x@TiO_2@C	0.7	500	588	61.1%	[7]
SiO_x@CNTs composites	**2**	**500**	**673**	**89.1**	**This work**

The energy density of the full cell is calculated by the following equation:

$$Energy\ \ Density = \frac{C_{cathode} \times C_{anode}}{C_{\text{cathode}} + C_{anode}} \times V_{\text{nominal}}$$

where $C_{cathode}$, C_{anode}, and $V_{nominal}$ are 173 mAh g^{-1}, 1012 mAh g^{-1}, and 3.4 V respectively.

For example, the energy density of the full cell at 0.3 C is:

$$Energy\ \ Density = \frac{173\ \text{mAh}\ \ \text{g}^{-1} \times 1012\ \text{mAh}\ \ \text{g}^{-1}}{173\ \text{mAh}\ \ \text{g}^{-1} + 1012\ \text{mAh}\ \ \text{g}^{-1}} \times 3.4\ \text{V} = 502.3\ \text{Wh kg}^{-1}$$

References

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