Supplementary material

N-Doped Gel-structure Constructs Long Cycling Si Anodes at High Current Densities for High Performance Lithium-ion Batteries

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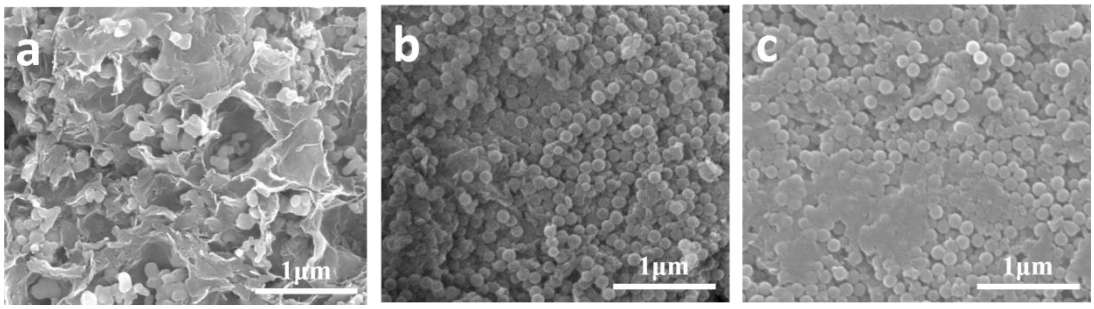

Fig. S1. SEM images of (a) Si@NG-ppy nanocomposites, (b) Si@NG@SiO_2-gel nanocomposites and (c) Si@NG@SiO_2@C-gel nanocomposites.

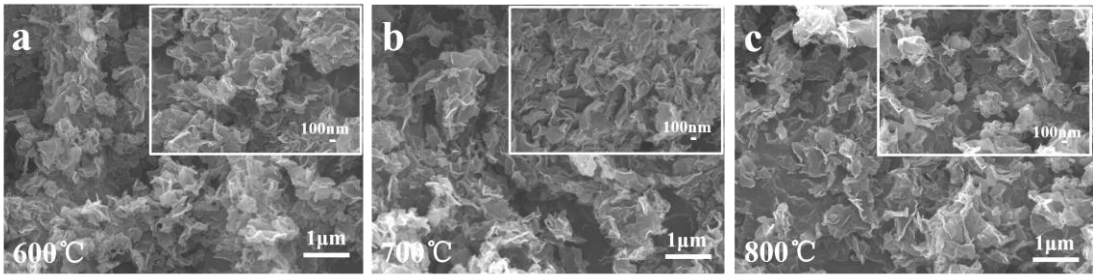

Fig. S2. SEM morphology of SNGC-gel at different temperatures. (a) SNGC-gel-600 °C；(b) SNGC-gel-700 °C；(c) SNGC-gel-800 °C

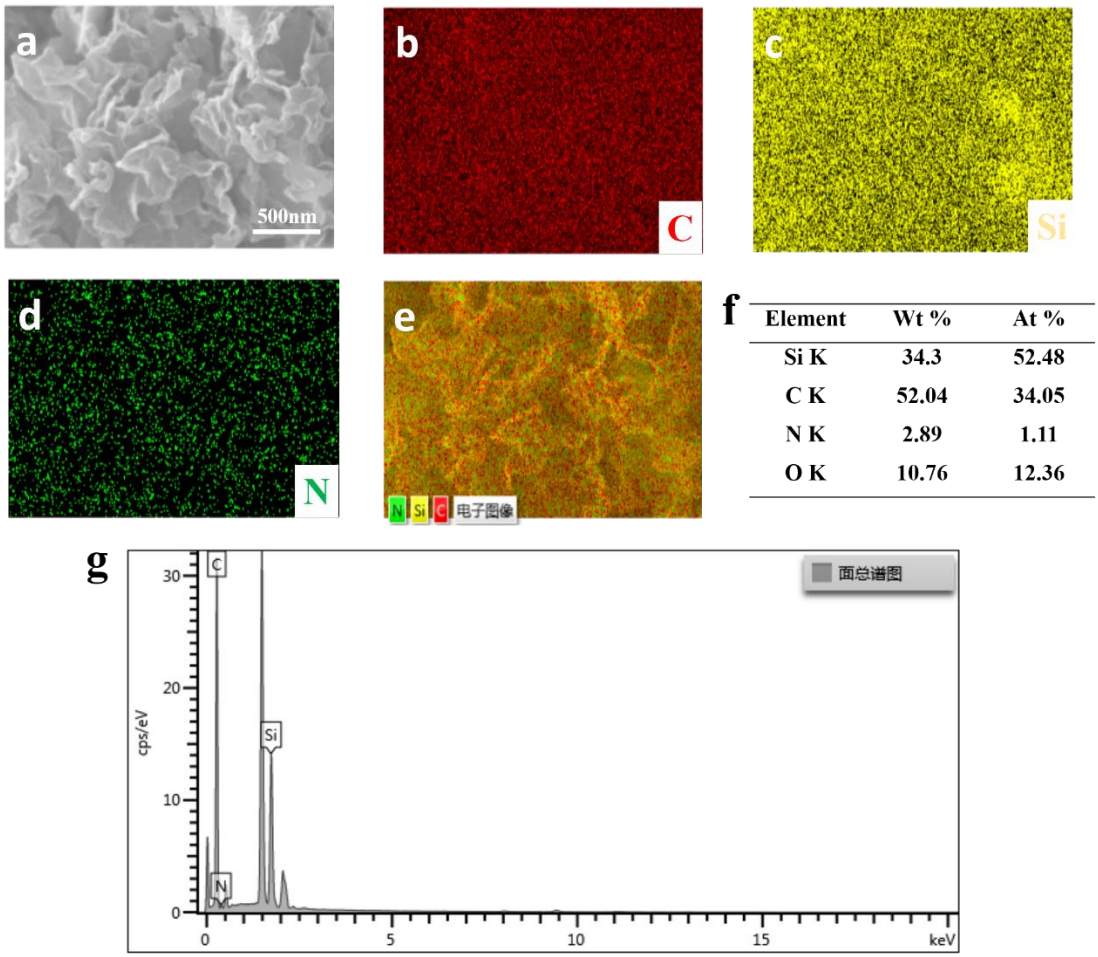

Fig. S3. (a) SEM images of SNGC-gel nanocomposites and the EDS elemental maps corresponding to C, Si, and N (b-e); (f) elemental ratios of SNGC-gel nanocomposites; (g) EDS spectrum of SNGC-gel nanocomposites.

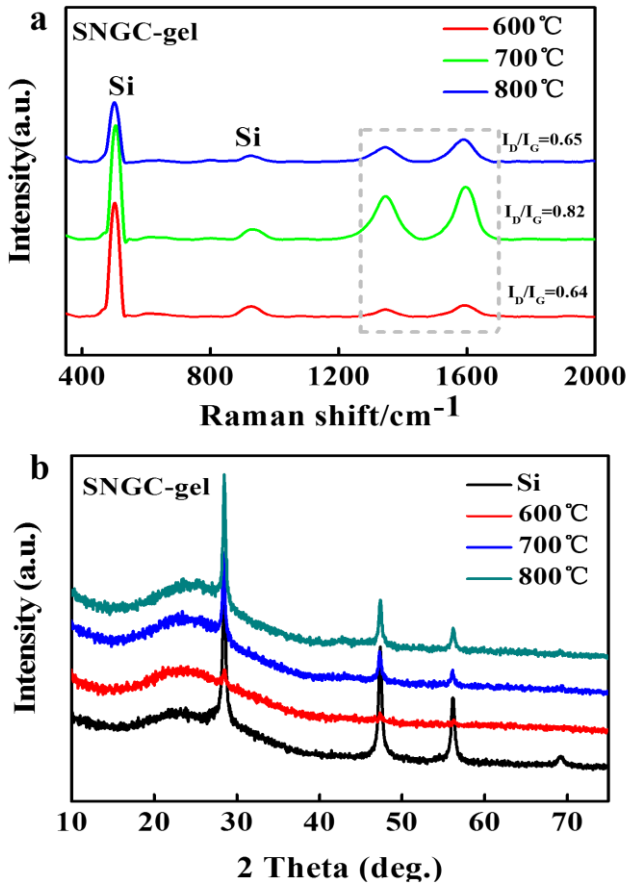

Fig. S4. (a) Raman spectra of SNGC-gel-600 °C，SNGC-gel 700 °C，SNGC-gel-800 °C；(b) XRD patterns of Si, SNGC-gel-600 °C，SNGC-gel-700 °C，SNGC-gel-800 °C.

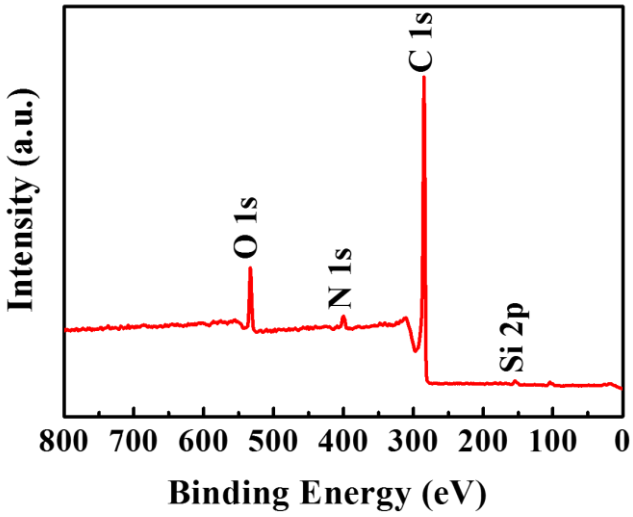

Fig. S5. XPS survey spectrum of the SNGC-gel.

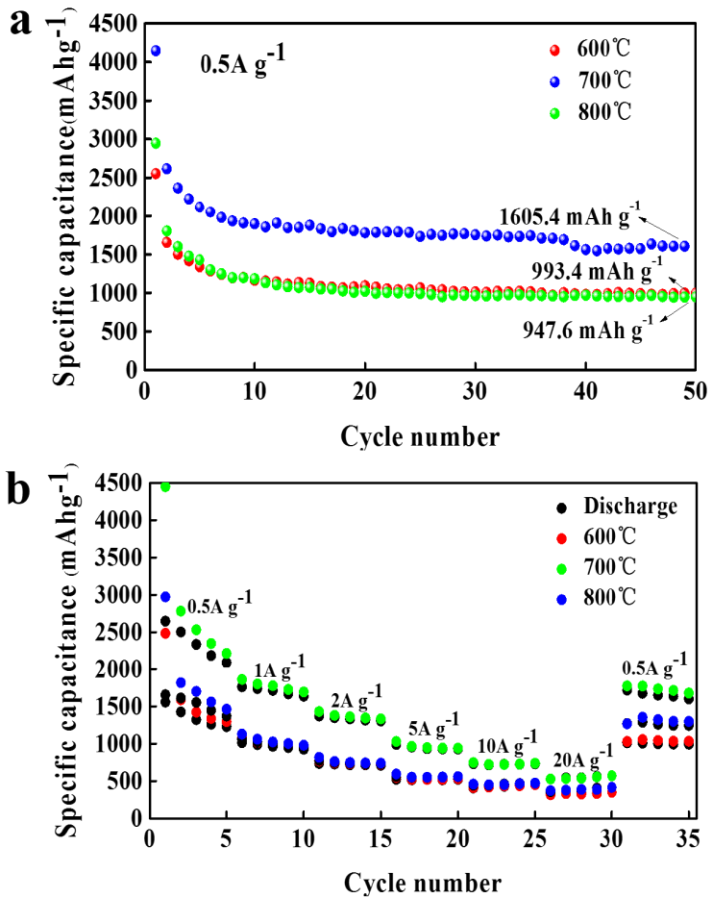

Fig. S6. (a) Cycling performances of SNGC-gel (600 °C, 700 °C, 800 °C) at 0.5 A g^{-1}; (b) Rate capabilities of SNGC-gel (600 °C, 700 °C, 800 °C).

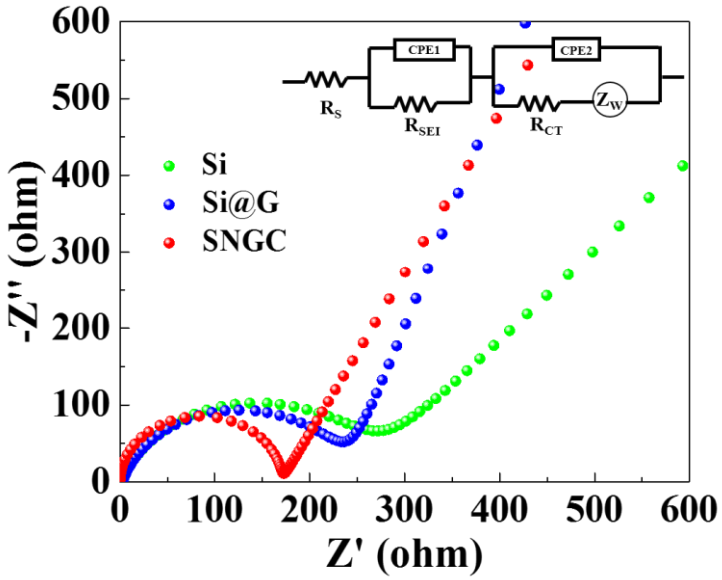

Fig. S7. Nyquist plots of the Si, Si@G and SNGC.

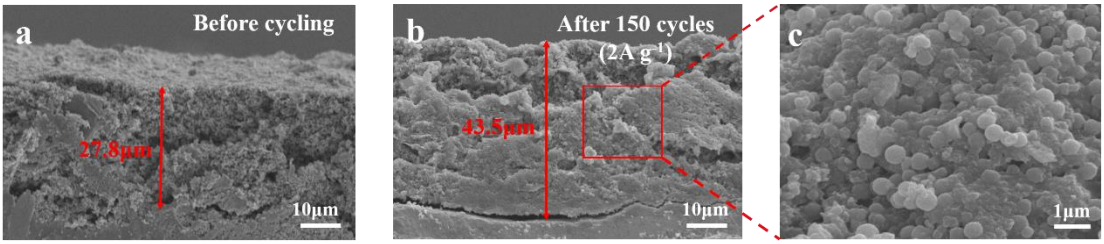

Fig. S8. (a) Cross-sectional SEM images of the SGC electrode before cycling; (b) Cross-sectional SEM images of the SGC lectrode after 150 cycles at the charged state with a current density of 2 A g^{-1}. (c) Fig. c is a partial enlarged view of the internal structure of Fig. b

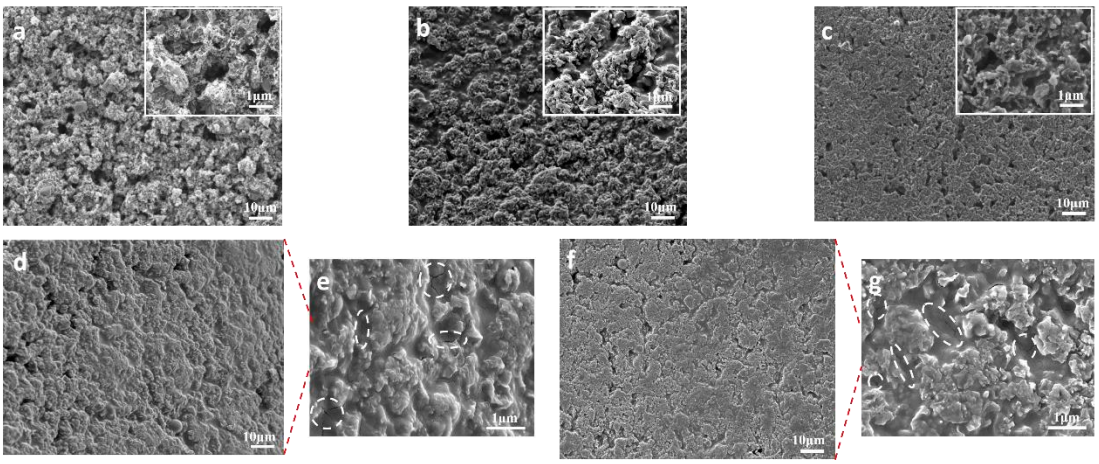

Fig. S9. Electrode cyclic surface morphology and partial enlargement. Top-view SEM images of SNGC-gel electrode surface morphology obtained after (a) 0, (b) 5, (c) 10, (d) 50, (e) partially enlarged view of Fig. d, (f) 100 cycles and (g) partially enlarged view of Fig. f.

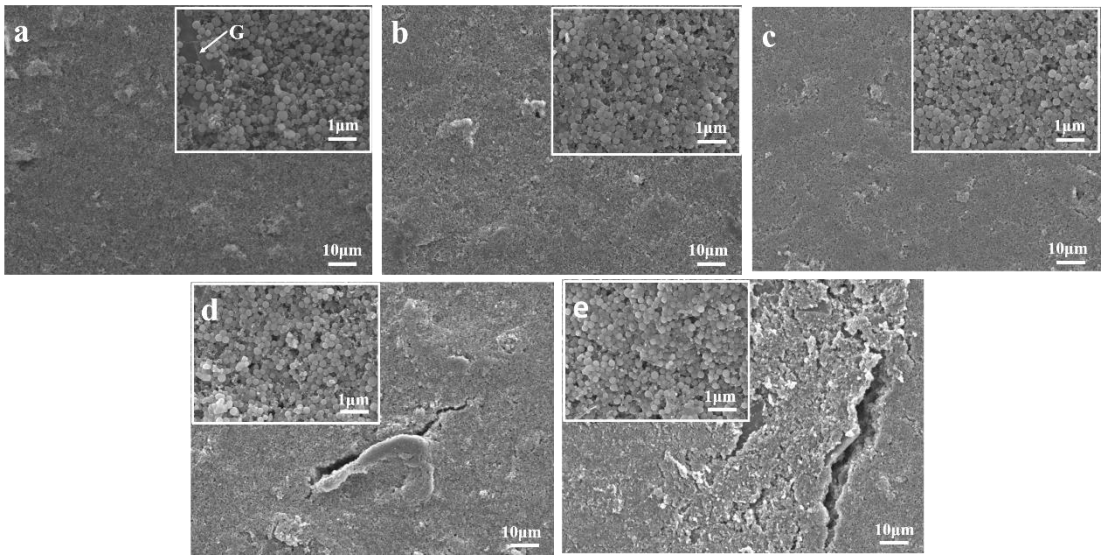

Fig. S10. Electrode cyclic surface morphology and partial enlargement. Top-view SEM images of SGC electrode surface morphology obtained after (a) 0, (b) 5, (c) 10, (d) 50, (f) 100 cycles.

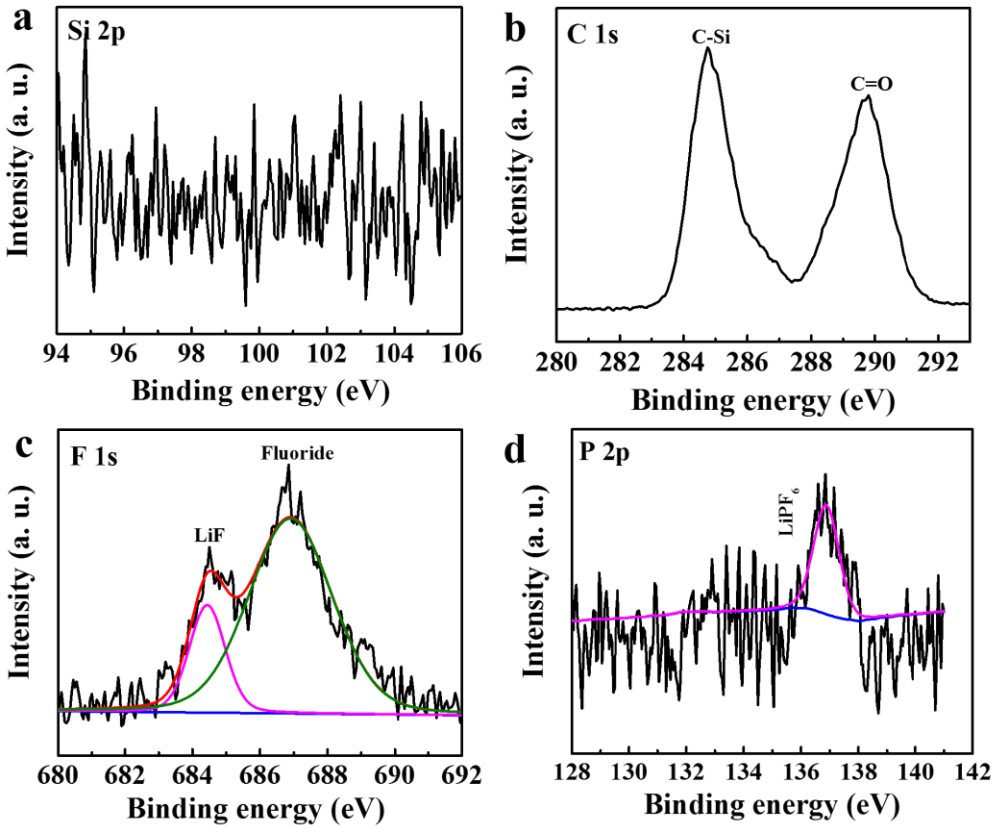

Fig. S11. XPS spectrum (a) Si 2p, (b) C 1s, (c) F 1s and P 2p of SNGC-gel composite electrode after 400 cycles in $LiPF_6$.

Table S1 Impedance parameters for before cycling, SNGC-300 and SNGC-1000 electrodes.

Electrode	R_S/Ω	R_{SEI}/Ω	R_{CT}/Ω
before cycling	0.05	-	175
SNGC-300	0.12	26.6	150
SNGC-1000	0.32	39.8	186.6

Table S2. Electrochemical performance comparison Si/C-based anode materials in LIBs.

Sample	Current density	Cycling stability (mAh g^{-1})	The content of conductive additive	Refs.
Si–graphene	0.5 A g^{-1}	1004 mAh g^{-1} after 100 cycles	20%	*RSC Adv.* **2016,** *6*, 4835
Porous Si/rGO	1 A g^{-1}	1000 mAh g^{-1} after 50 cycles	20%	*ACS Appl. Mater. Interfaces*, **2015**, 7, 7855
Si@rGO	2 A g^{-1}	1287 mAh g^{-1} after 100 cycles	10%	*Nano Lett*. 2015, 15, 7742
Si@C-rGO	0.3 A g^{-1}	931 mAh g^{-1} after 400 cycles	10%	*Adv. Energy Mater,* **2016,** *6*, 1600904.
Si/graphite/carbon	0.5 A g^{-1}	400 mAh g^{-1} after 300 cycles	10%	*RSC Adv,* **2016,** *6*, 69882
Si@SiO_x@C	0.5 A g^{-1}	1030 mAh g^{-1} after 500 cycles	20%	*ACS Appl. Mater. Interfaces* **2016,** *8*, 31611
Porous Si/C	0.2 A g^{-1}	1552 mAh g^{-1} after 200 cycles	20%	*RSC Adv,* **2015,** *5*, 35598
Si@HC/CNFs	0.2 A g^{-1}	1020.7 mAh g^{-1} after 100 cycles	-	*J. Power Sources* **2017,** *342*, 467
Porous Si@C nanotub	0.2 A g^{-1}	1300 mAh g^{-1} after 200 cycles	20%	*Cryst. Eng. Comm.* **2017,** *19*, 1220
Si/p-C(N-spc)	0.4 A g^{-1}	1607 mAh g^{-1} after 100 cycles	20%	*J. Mater. Chem. A* **2013,** *1*, 15068

Si/rGO	0.1 A g^{-1}	1433 mAh g^{-1} after 100 cycles	20%	*ACS Nano,* **2015,** *9,* 1198
Mesoporous Si@C	1 A g^{-1}	990 mAh g^{-1} after 1000 cycles	20%	*J. Mater. Chem. A* **2016,** *4*, 6098
Si/C/graphene	0.2 A g^{-1}	760 mAh g^{-1} after 100 cycles	10%	*Carbon* **2015,** *84,* 434