Supplementary Information (SI) for Nanoscale.

Electronic Supplementary Information

Surface engineering of nano silicon via in-situ copolymer grafting for lithium ion batteries

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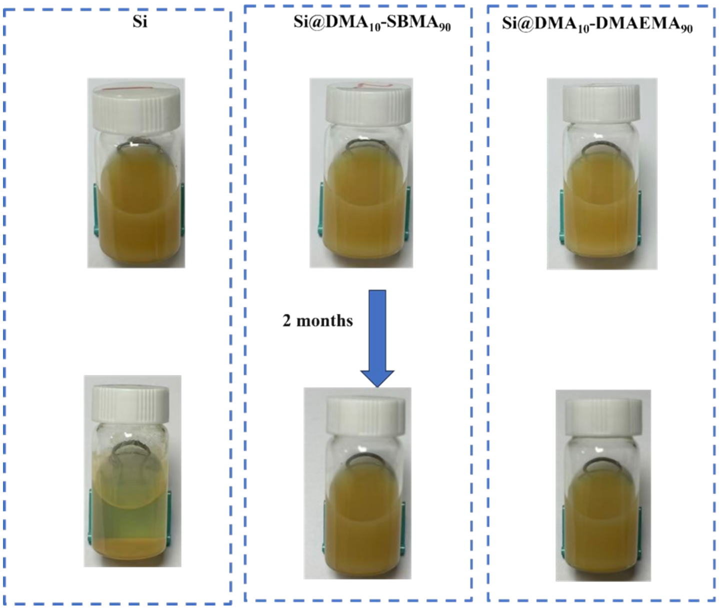

Fig. S1 Digital photographs of Si, Si@DMA$_{10}$-DMAEMA$_{90}$, Si@DMA$_{10}$-SBMA$_{90}$ dispersions before and after standing for 2 months.

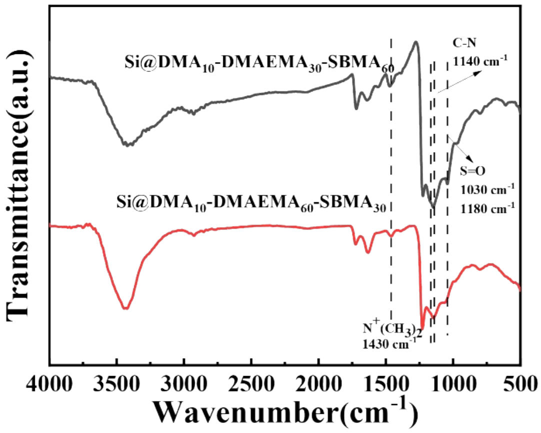

Fig. S2 FT-IR spectra of Si@DMA$_{10}$-DMAEMA$_{30}$-SBMA$_{60}$ and Si@DMA$_{10}$-DMAEMA$_{60}$-SBMA$_{30}$.

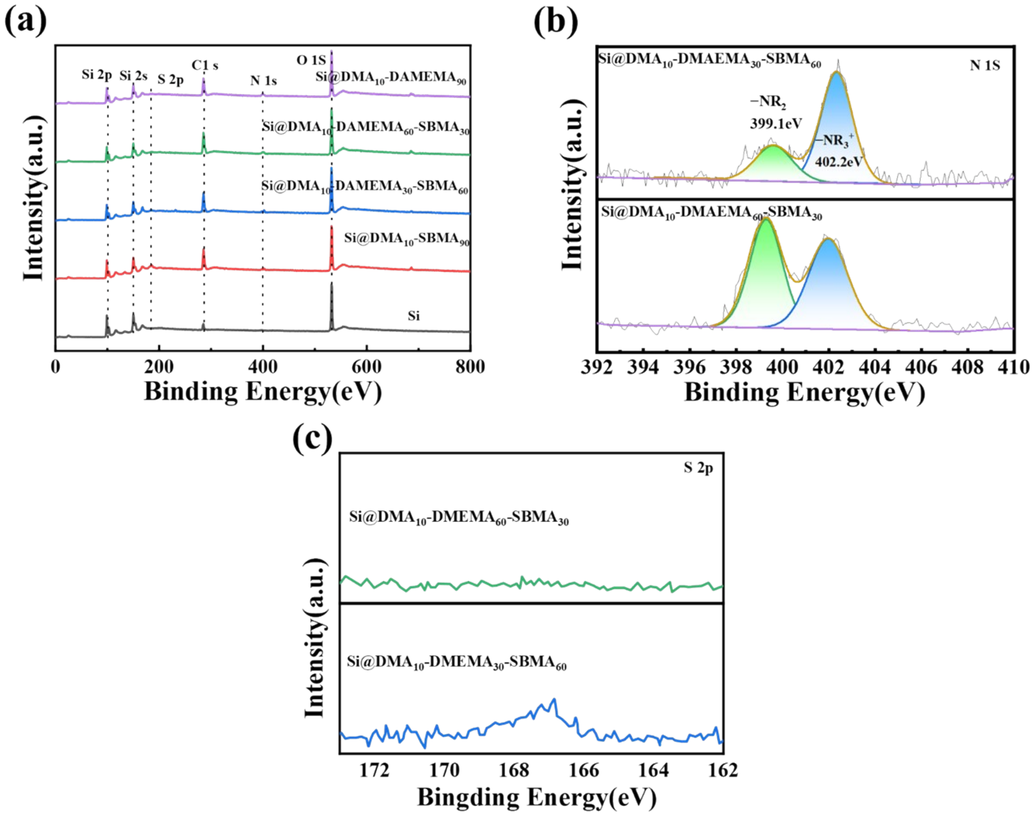

Fig. S3 (a) XPS spectra of bare Si, Si@DMA$_{10}$-SBMA$_{90}$, Si@DMA$_{10}$-DMAEMA$_{30}$-SBMA$_{60}$ and Si@DMA$_{10}$-DMAEMA$_{60}$-SBAMA$_{30}$, Si@DMA$_{10}$-DMAEMA$_{90}$; N 1s (b) and S 2P (c) high-resolution spectra of Si@DMA$_{10}$-DMAEMA$_{30}$-SBMA$_{60}$ and Si@DMA$_{10}$-DMAEMA$_{60}$-SBAMA$_{30}$.

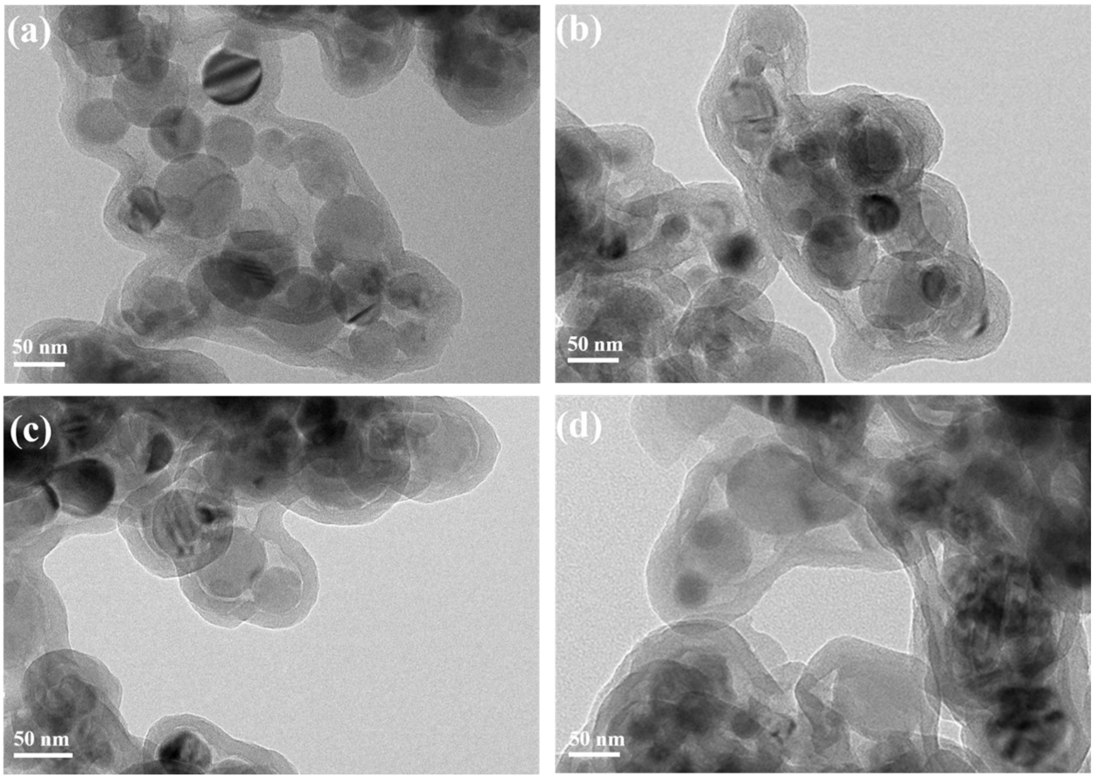

Fig. S4 TEM images of Si@Void@C with different copolymer modification of (a) Si@DMA$_{10}$-SBMA$_{90}$, (b) Si@DMA$_{10}$-DMAEMA$_{30}$-SBMA$_{60}$, (c) Si@DMA$_{10}$-DMAEMA$_{60}$-SBAMA$_{30}$, and (d) Si@DMA$_{10}$-DMAEMA$_{90}$.

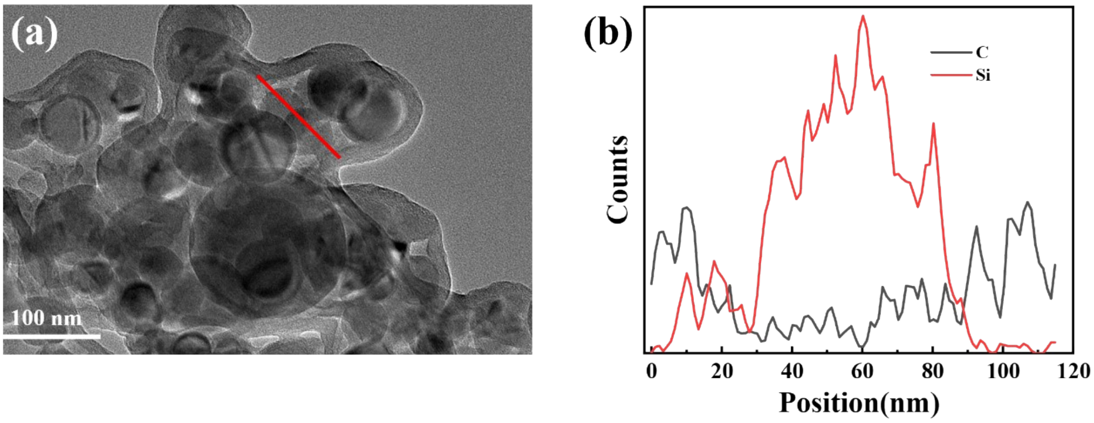

Fig. S5 (a) TEM image of Si@void@C and (b) Elemental line-scanning profiles measured along the orange line.

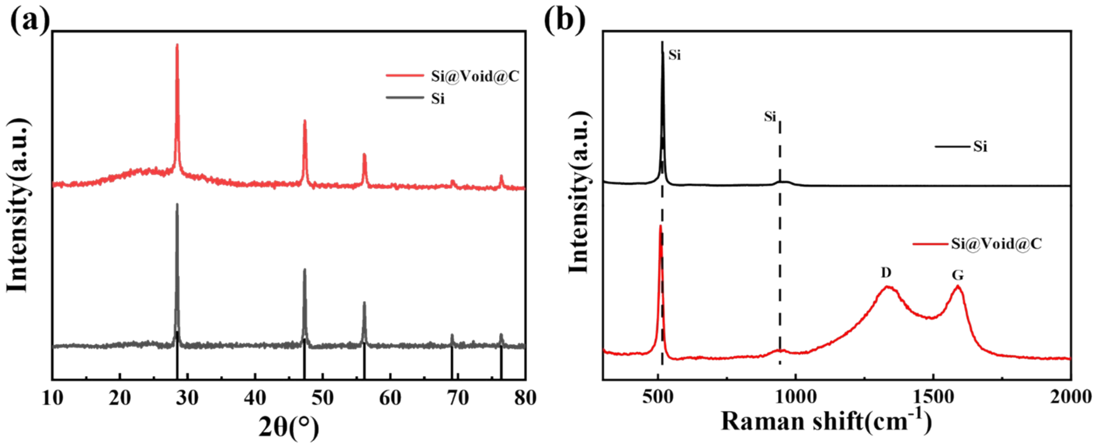

Fig. S6 (a) XRD and (b) Raman patterns of Si, Si@Void@C.

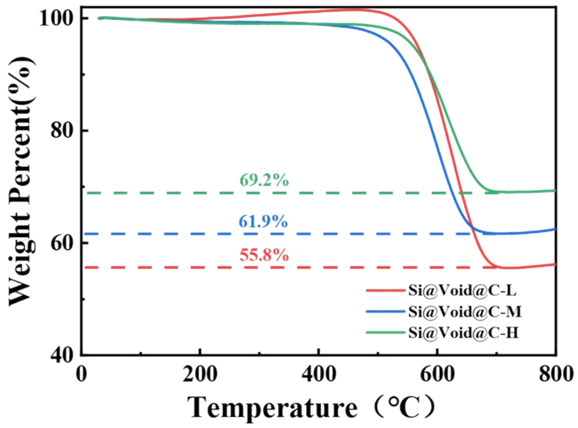

Fig. S7 TGA curves of Si@Void@C-L, Si@Void@C-M and Si@Void@C-H.

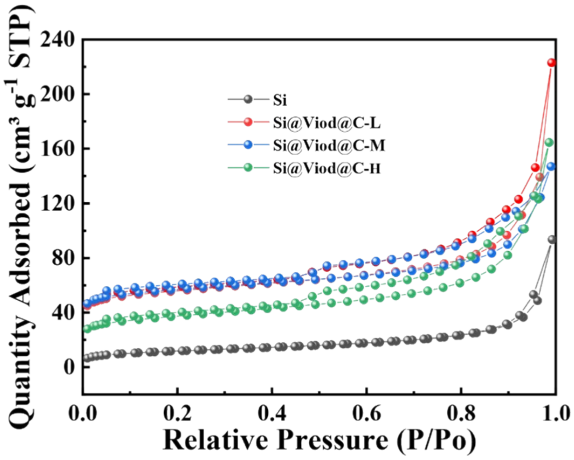

Fig.S8 N_2 adsorption/desorption isotherms of Si, Si@Void@C-L, C@Void@Si-M and C@Void@Si-H.

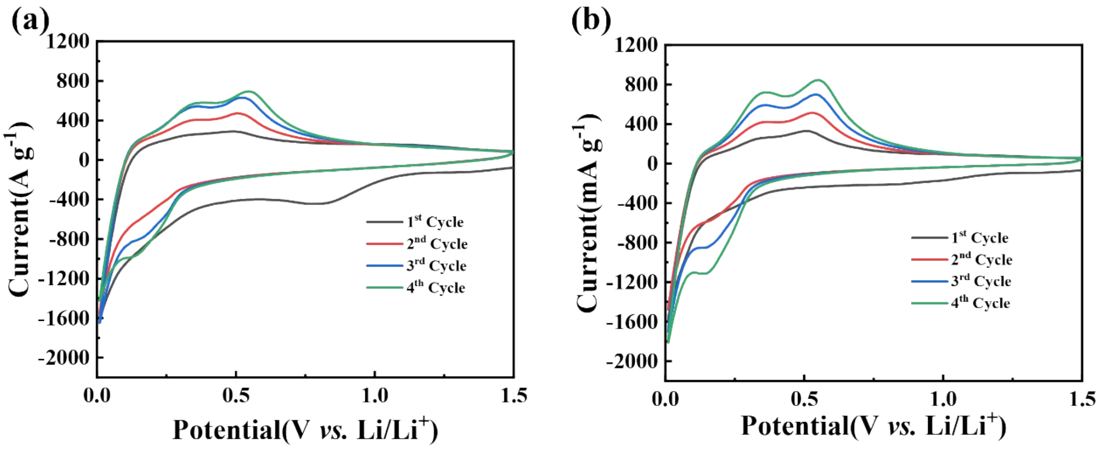

Fig. S9 CV curves of (a) Si@Void@C-L and (b) Si@Void@C-H.

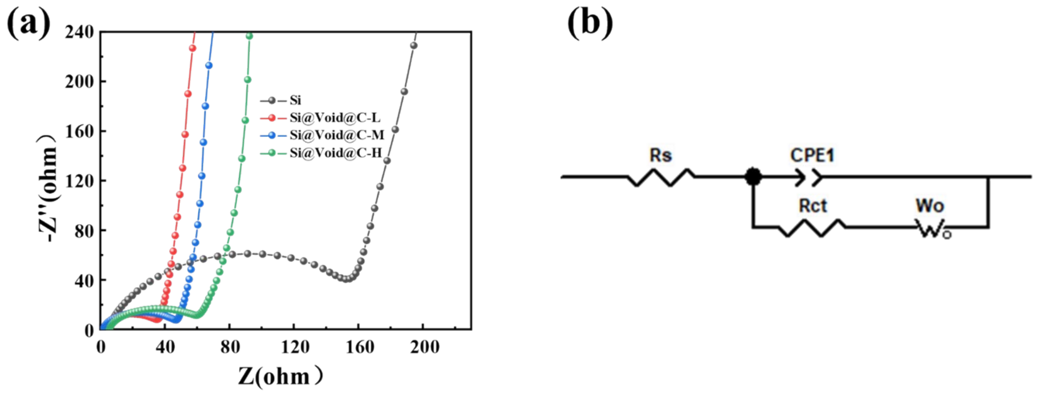

Fig. S10 (a) The corresponding Nyquist plots after fitting different electrodes and (b) equivalent circuit.

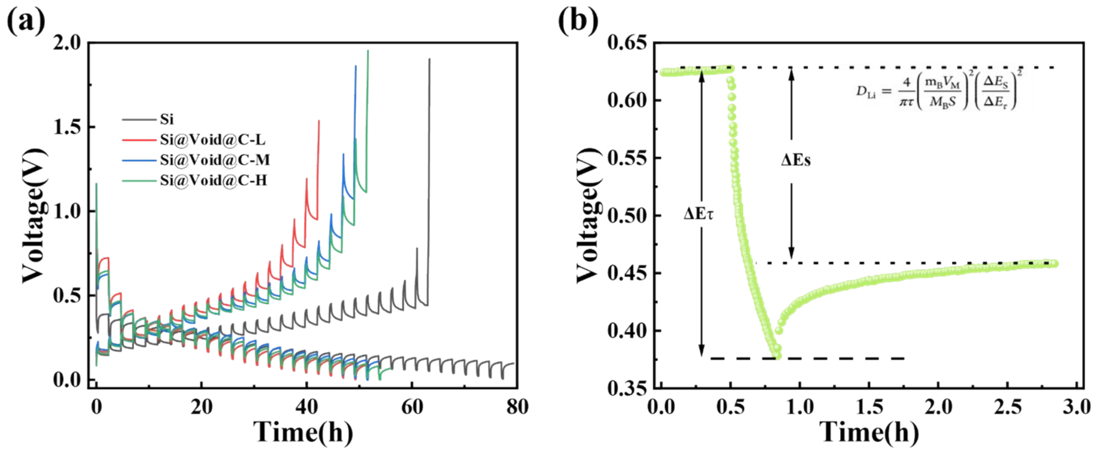

Fig. S11 (a) GITT curves of Si, Si@Void@C-L, C@Void@Si-M, C@Void@Si-H; (b) GITT test schematic diagram.

The Li^+ diffusion coefficients were determined using the indicated calculation formula, where m_B, M_B, and V_M denote the mass, molar mass, and molar volume of active material; τ is the current pulse duration; S is the electrode surface area; ΔE_S and ΔE_τ represent steady-state and transient voltage changes.

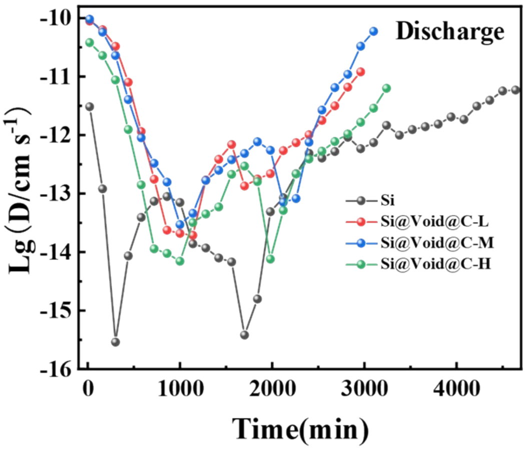

Fig. S12 Discharge ionic conductivity of the electrodes.

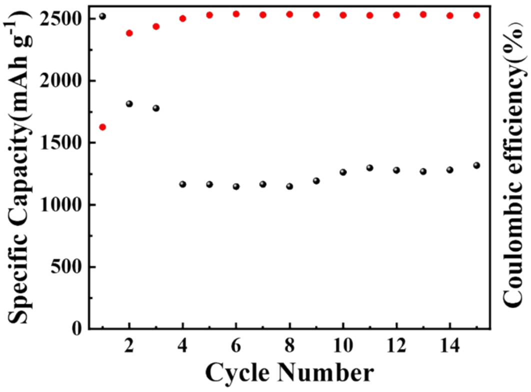

Fig. S13 Si@Void@C-M electrode with a mass loading of 3.5 mg cm^{-2} cycled at 1 A g^{-1}.

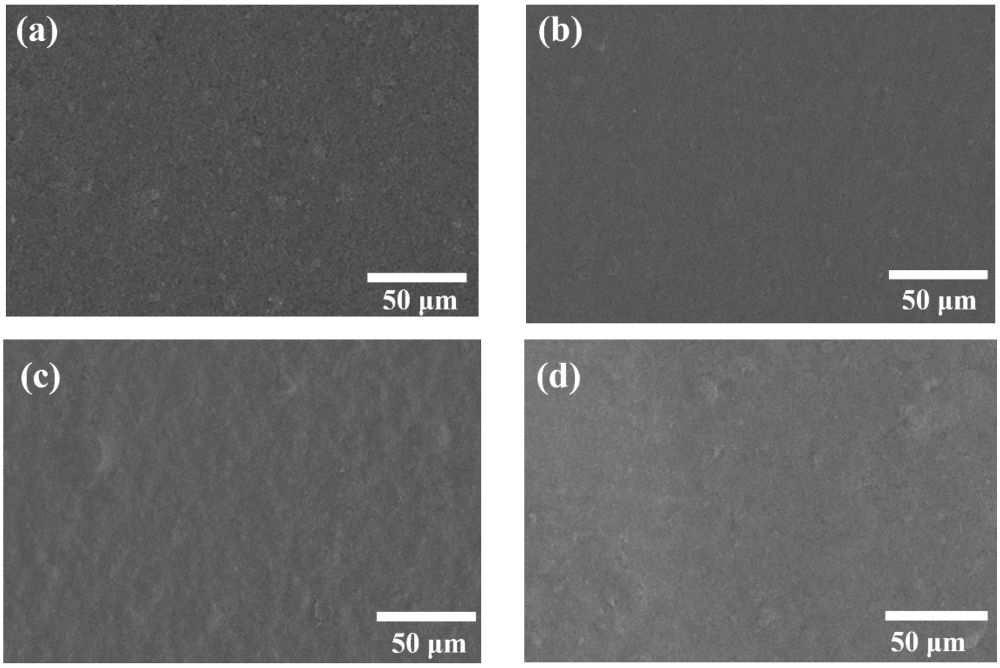

Fig. S14 SEM images of the electrodes before cycle: (a) Si; (b) Si@Void@C-L; (c) Si@Void@C-M;(d) Si@Void@C-H.

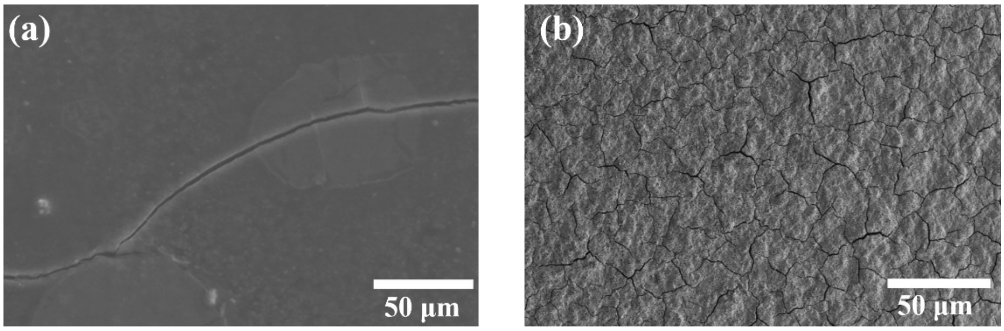

Fig. S15 SEM images of the surface of (a) Si@Void@C-L; (b) Si@Void@C-H electrodes after 500 cycles.

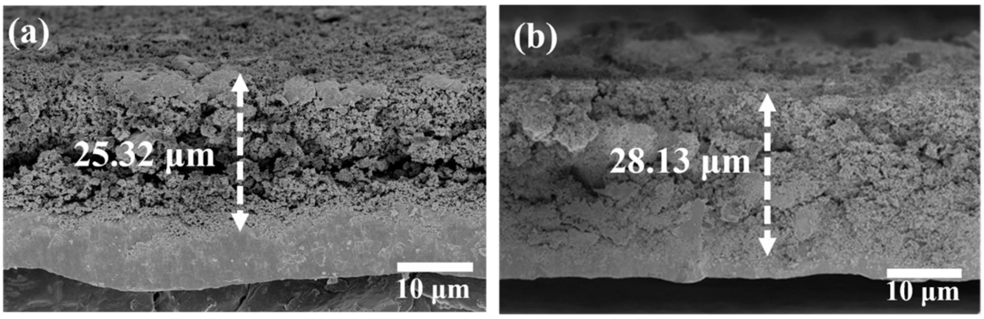

Fig. S16 Cross section of the electrodes before cycle (a) Si@Void@C-L; (b) Si@Void@C-H.

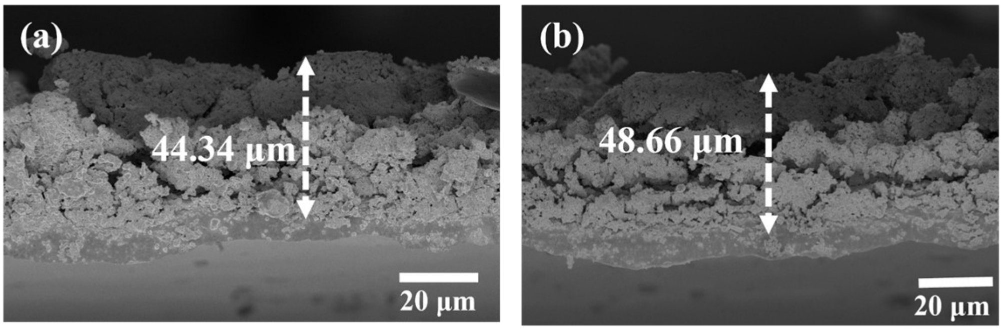

Fig. S17 Cross section of the electrodes after cycle (a) Si@Void@C-L; (b) Si@Void@C-H.

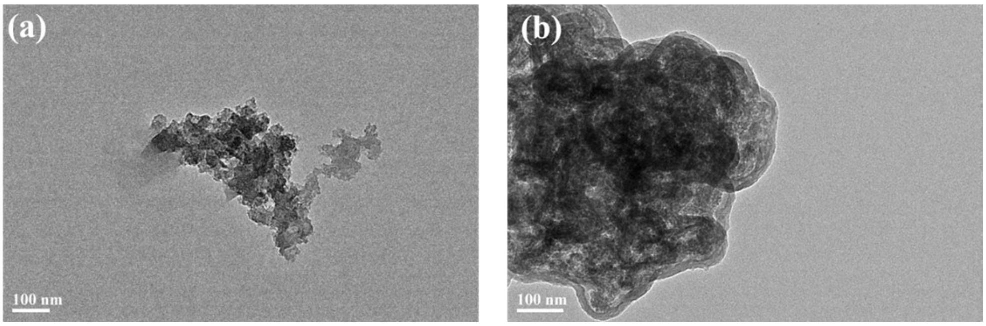

Fig. S18 TEM images of (a) bare Si and (b) Si@Void@C electrodes after cycling.

Table S1 Zeta potentia potential of silicon modified with different copolymers.

Sample	Zeta Potential(mV)
Si	-29.2
Si@DMA$_{10}$-SBMA$_{90}$	16.6
Si@DMA$_{10}$-DMAEMA$_{60}$-SBMA$_{30}$	15.8
Si@DMA$_{10}$-DMAEMA$_{30}$-SBMA$_{60}$	14.3
Si@DMA$_{10}$-DMAEMA$_{90}$	12.6

Table S2 The specific surface area of Si and Si@Void@C.

Sample	Si	Si@Void@C-L	Si@Void@C-M	Si@Void@C-H
BET Surface area	42.85 m^2/g	213.84 m^2/g	211.16 m^2/g	134.28 m^2/g
Pore volume	0.14 cm^3/g	0.35 cm^3/g	0.33 cm^3/g	0.26 cm^3/g

Table S3 The fitted values of resistance components on the basis of the Nyquist plots.

Sample	R_s/Ω	R_{ct}/Ω
Si	5.48	146.62
Si@Void@C-L	2.01	33.07
Si@Void@C-M	2.19	44.36

Si@Void@C-H	5.39	53.91

Table S4 Comparison of electrochemical performance for Si/C composite materials

Sample	Current density (A g^{-1})	Cycles	Specific Capacity (mAh g^{-1})	Rate (mAh g^{-1})	Reference
Si/C-0.70-M	0.5	500	557	988 (2 A g^{-1})	1
Si/C-ZIF-8/CNFs	0.5	500	538.6	437.4 (5 A g^{-1})	2
p-SiNPs@HC-1	1.0	600	600	720 (4 A g^{-1})	3
S-Si-C	1.0	400	734.8	1257.4 (2 A g^{-1})	4
Si@H-CoNPSC	1.0	300	872.8	599.1 (2 A g^{-1})	5
Si@HC	1.0	450	721	753 (2 A g^{-1})	6
Si/C	0.2	200	584.1	575.9 (2 A g^{-1})	7
Si/0.01C	1.0	173	1159	1010 (2 A g^{-1})	8
Si/SWCNT/C/SWCN	1.0	200	1676.5	1554.8(3 A g^{-1})	9
T	0.5	1000	991	756(3 A g^{-1})	10
Si/C HSs This work	1.0	500	992.2	880.1 (5 A g^{-1}) 538.9 (10 A g^{-1})	

Reference

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