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Supporting information

Interfacial modification of lightweight carbon foam current collector for high energy density Si/LCO lithium-ion batteries

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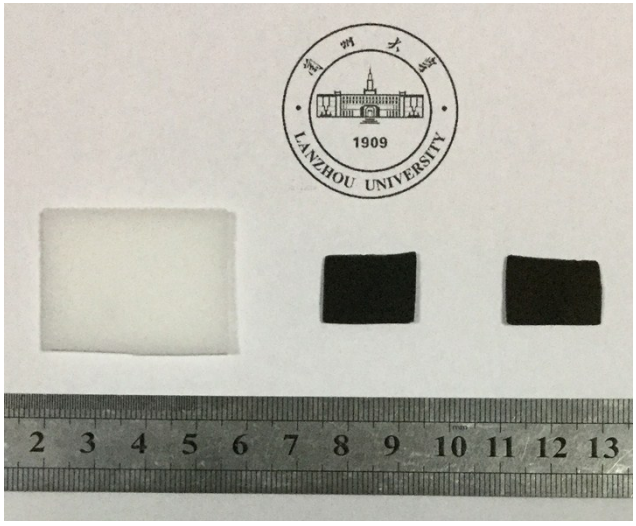

Figure S1. Optical photographs of the used melamine formaldehyde foam (left), carbon foam (middle) and as-deposited Si anode (right).

Figure S2. Optical photograph of one piece of carbon foam ($1\times1\times0.1$ cm^3) on an analytical balance.

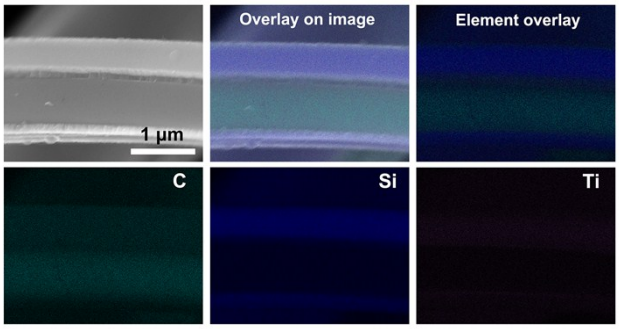

Figure S3. The EDS element mappings of the as-deposited carbon foam/Ti/Si electrode shown in the inset of Figure 2d. We can find the Ti layer and Si layer deposited on the carbon foam.

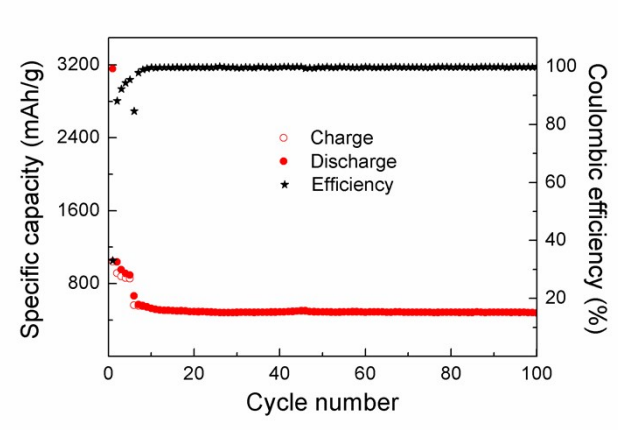

Figure S4. The cycle performance of the Si anode without Ti layer modification at 2.0 A g^{-1} after an initial activation at 0.2 A g^{-1} for 5 cycles.

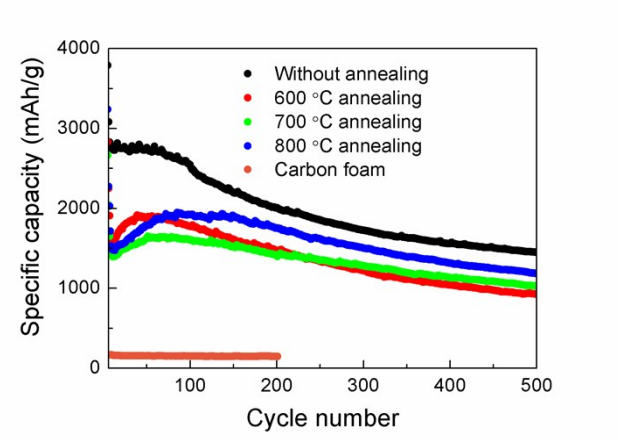

Figure S5. Cycle performances at a current density of 2.0 A g^{-1} for the carbon foam, Si electrode withou annealing, and Si electrodes annealed respectively at 600, 700, and 800 °C.

Table S1. Comparison of the specific capacity for Si electrode withou annealing and Si electrodes annealed at different temperatures.

Annealing process	Specific capacity (mAh g^{-1})		Capacity retention (%)
	Initial	After 500 cycles	
Without annealing	2868	1463	51
600 °C annealing	2040	923	45
700 °C annealing	1821	1026	56
800 °C annealing	2036	1185	58

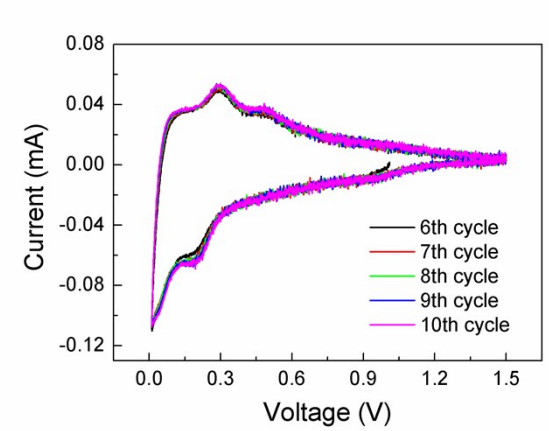

Figure S6. CV curves from the 6th to 10th cycle for the Si electrode tested at a scan rate of 0.02 mV s^{-1} over a potential window of 0.01-1.5 V versus Li/Li^+. The almost coincident CV profiles demonstrate that the electrode tends to stabilize after an activation in the initial several cycles.

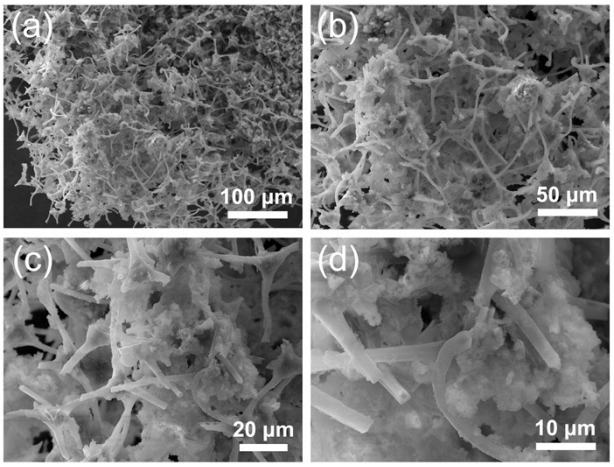

Figure S7. SEM images of the Si electrode after 1000 cycles and another 300 cycles for rate test. It can be found that the cycled electrode maintains its original three-dimensional network structure, and the active Si material is still adhered onto the carbon foam framework.

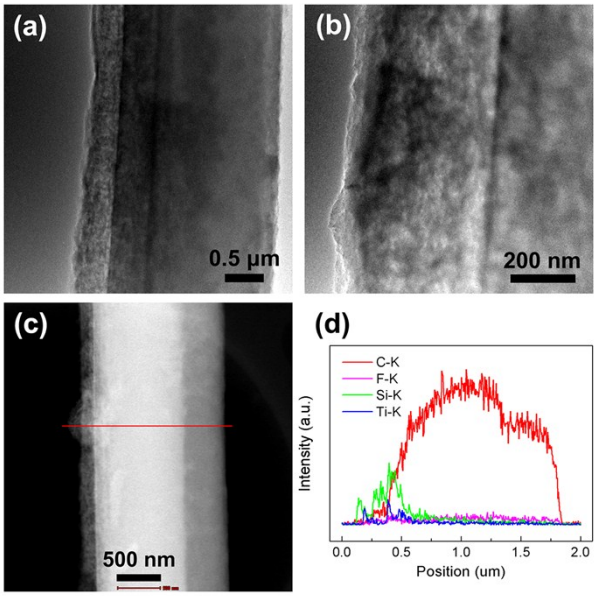

Figure S8. (a, b) TEM images, (c) STEM image and (d) corresponding EDX line scan curves of the Si electrode after 1000 cycles and another 300 cycles for rate test. It can be seen that the active Si material and Ti modification layer are still adhered onto the carbon foam framework after long-term cycle.

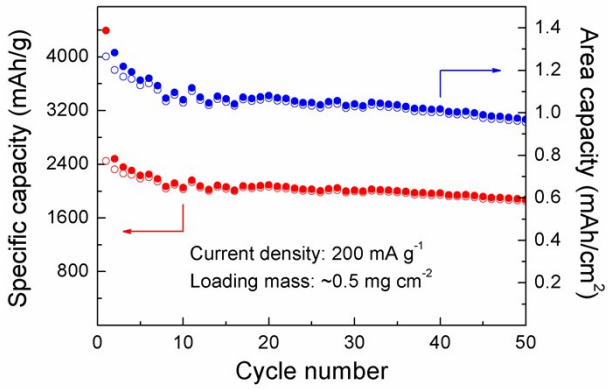

Figure S9. Cycle performance of the Si electrode with higher loading mass. We prepared the electrode with loading mass of ~0.5 mg cm^{-2} by repeatedly depositing Ti modification layer and Si active layer. The electrode shows initial discharge and charge capacities of 4394 and 2449 mAh g^{-1} at 200 mA g^{-1}, corresponding to area capacities of 2.27 and 1.27 mAh cm^{-2}, respectively. After 50 cycles, the reversible capacity still maintains at 1875 mAh g^{-1}, demonstrating that the electrode with higher loading mass owns good cyclability as well.

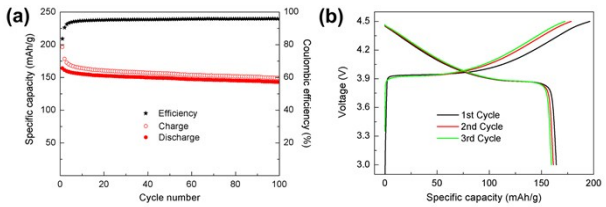

Figure S10. (a) Cycle performance of the casted $LiCoO_2$ electrode at a current density of 50 mA g^{-1} over a potential window of 3.0-4.5 V. (b) Corresponding galvanostatic charge/discharge

curves.

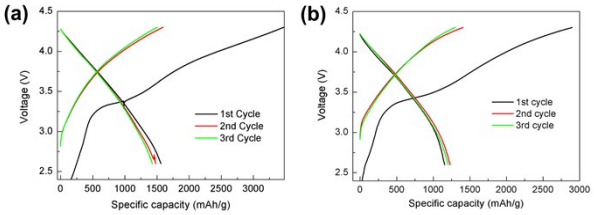

Figure S11. The initial three galvanostatic charge/discharge cycles of the Si/LCO full cell at (a) 1.0 A g^{-1} and (b) 2.0 A g^{-1}.

Table S2: Comparison of cycling performance and energy density of the recently reported Si-based anodes.

Structure	Capacity / mAh g^{-1}	Capacity retention	Cathode materials	Full-cell Capacity retention	Energy density (Wh kg^{-1})	Ref
Si/C-IWGS	700	82% after 100 cycles at 0.5 A g^{-1}	$Li[Ni_{0.75}Co_{0.1}Mn_{0.15}]O_2$	88% after 750 cycles	>240	S1[1]
CNT-Si	2364	90% after 100 cycles at 0.4 A g^{-1}	$Li[Ni_{0.85}Co_{0.05}Mn_{0.10}]O_2$	81% after 500 cycles	348	S2[2]
C-SiO_x	905	74% after 100 cycles at 1.5 A g^{-1}	$Li[Ni_{0.8}Co_{0.15}Al_{0.05}]O_2$	61% after 100 cycles	508.5	S3[3]
MSi/C/rGO	626	74% after 1000 cycles at 2.0 A g^{-1}	$LiCoO_2$	81% after 50 cycles	N/A	S4[4]
Al-Si alloy	810	81% after 500 cycles at 2.0 A g^{-1}	$LiCoO_2$	75% after 200 cycles	N/A	S5[5]
Mesoporous Si@SiO_2	1772	49% after 1400 cycles at 1.8 A g^{-1}	$LiCoO_2$	60% after 100 cycles	292	S6[6]
Si-NW GNR	1500	After 300 cycles at 1.0 A g^{-1}	$LiCoO_2$	75% after 174 cycles	386	S7[7]
PF-Si/graphene	~1000	>60% after 1000 cycles at 2.1 A g^{-1}	$LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$	85% after 100 cycles	420	S8[8]
SiNPs/graphene	1103	1000 cycles at 14 A g^{-1}	$LiCoO_2$	83% after 100 cycles	468	S9[9]
Si/Ti/Carbon foam	1422	91% after 1000 cycles at 2.0 A g^{-1}	$LiCoO_2$	67% after 200 cycles	479.5	This work

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