

Support Information

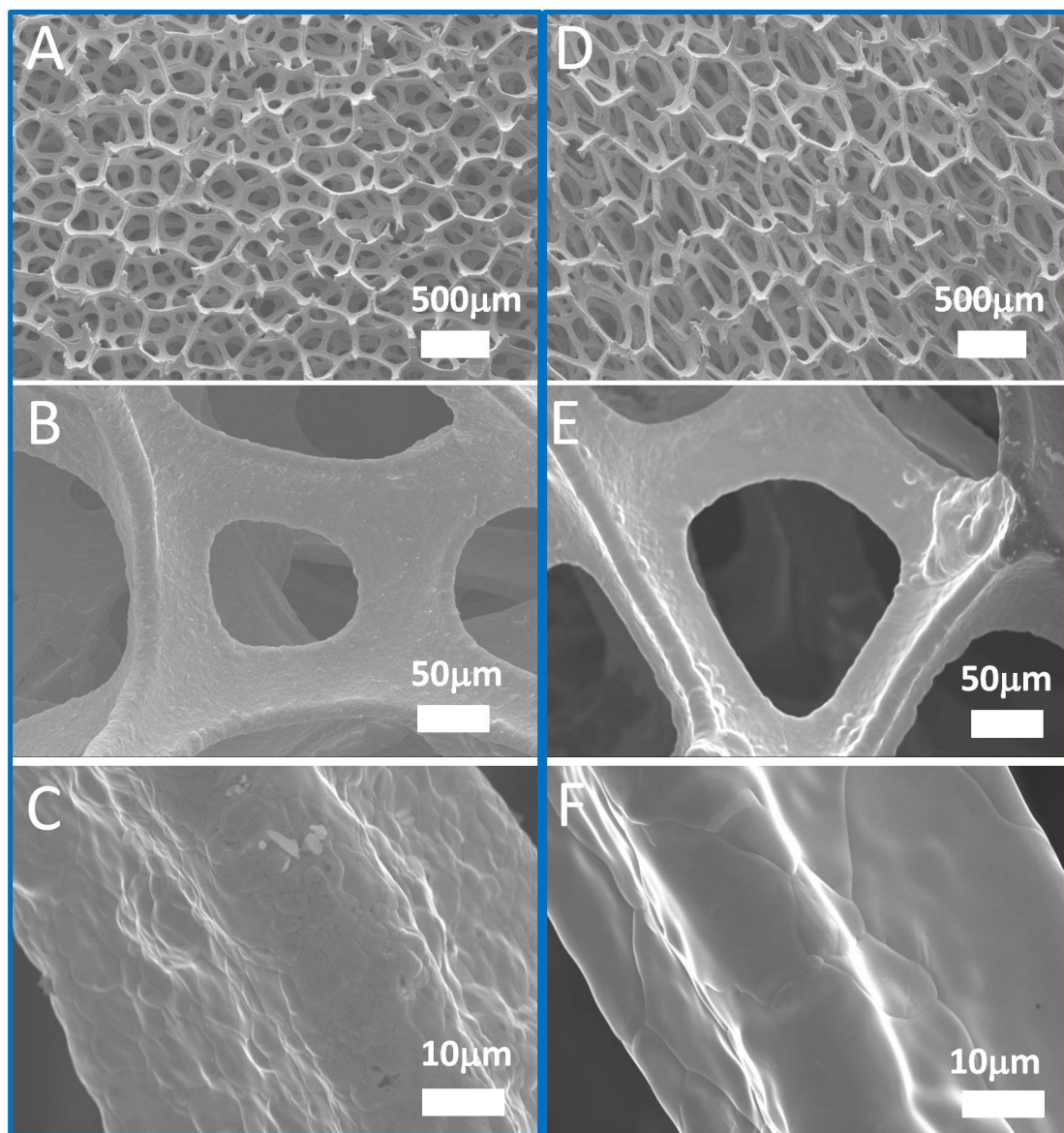


Fig. S1. SEM images of Ni foam before (A-C) and after (D-F) graphitic wall deposition.

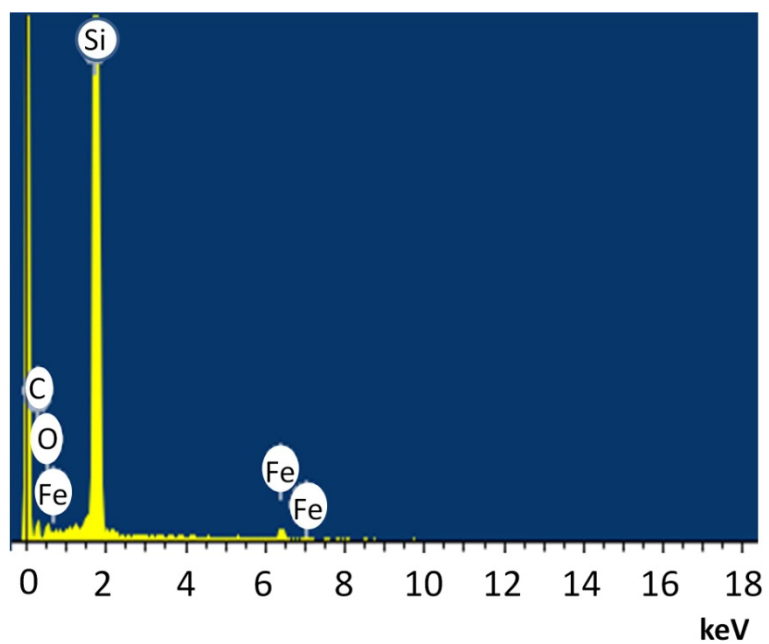


Fig. S2. EDX of the Si CNW/3D GF composite.

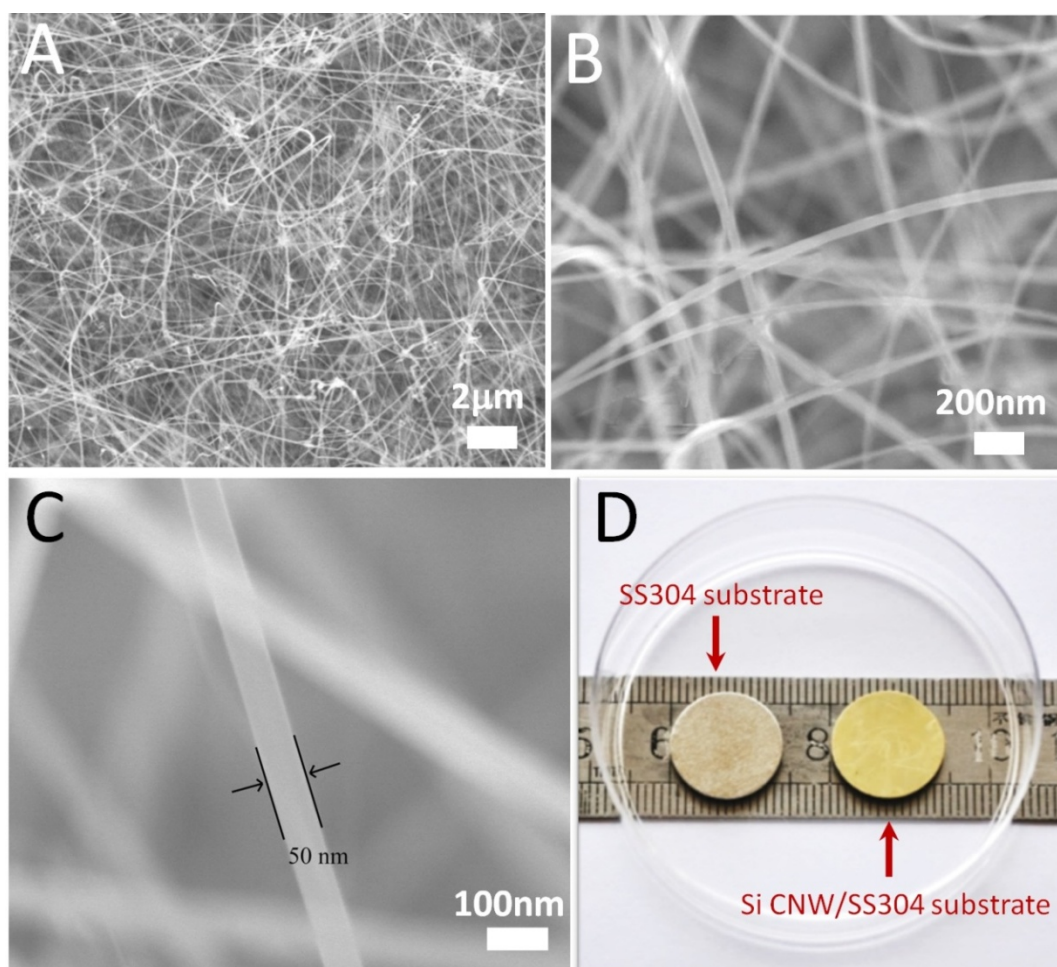


Fig. S3. SEM images of the Si CNW arrays on SS304 substrate (A-C) and photograph of real samples of SS304 substrate and Si CNW-grown SS304 substrate.

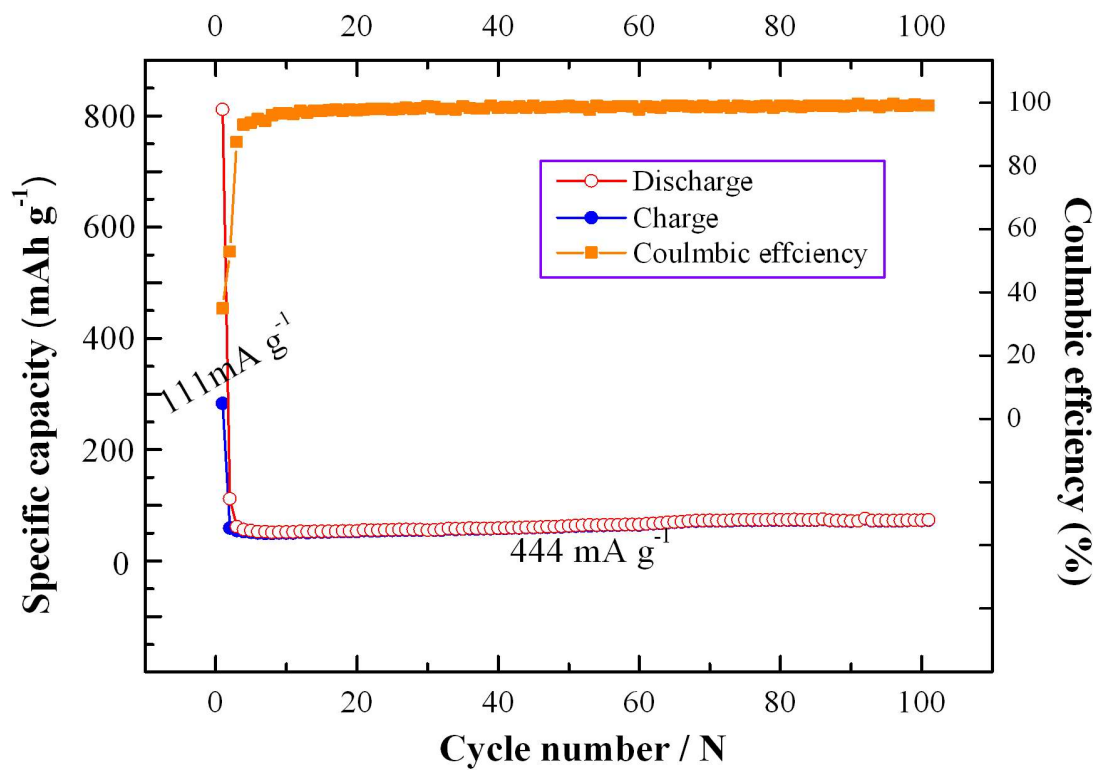


Fig. S4. Cycling performance of the 3D GF electrode based lithium-ion battery.

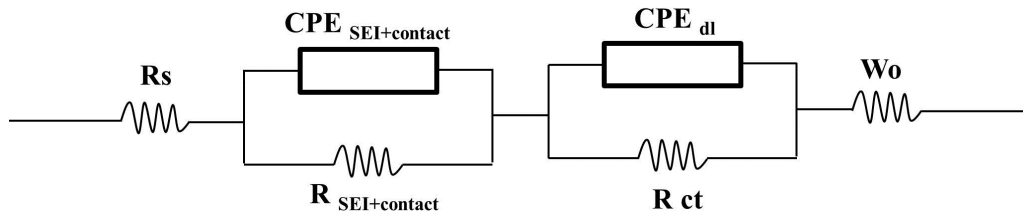
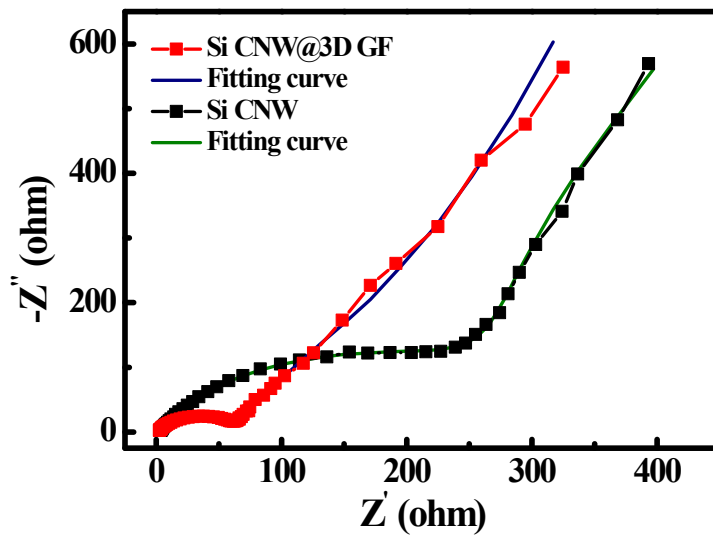


Fig. S5. Impedance spectrum (upside) and equivalent circuit (downside) of the Si CNW/3D GF electrode. R_s : resistance for the electronic conductivity of the electrodes and ionic conductivity of the electrolyte solution, as well as the electronic contact resistances associated with the cell shell, current collectors, and electrode materials; $CPE_{SEI+contact}$: constant phase element for SEI film and contact interface between active materials and current collectors; $R_{SEI+contact}$: resistance for SEI film and contact interface between active materials and current collectors; CPE_{dl} : constant phase element (Space double-layer capacitance); R_{ct} : charge transfer resistance; W_o : Warburg impedance.

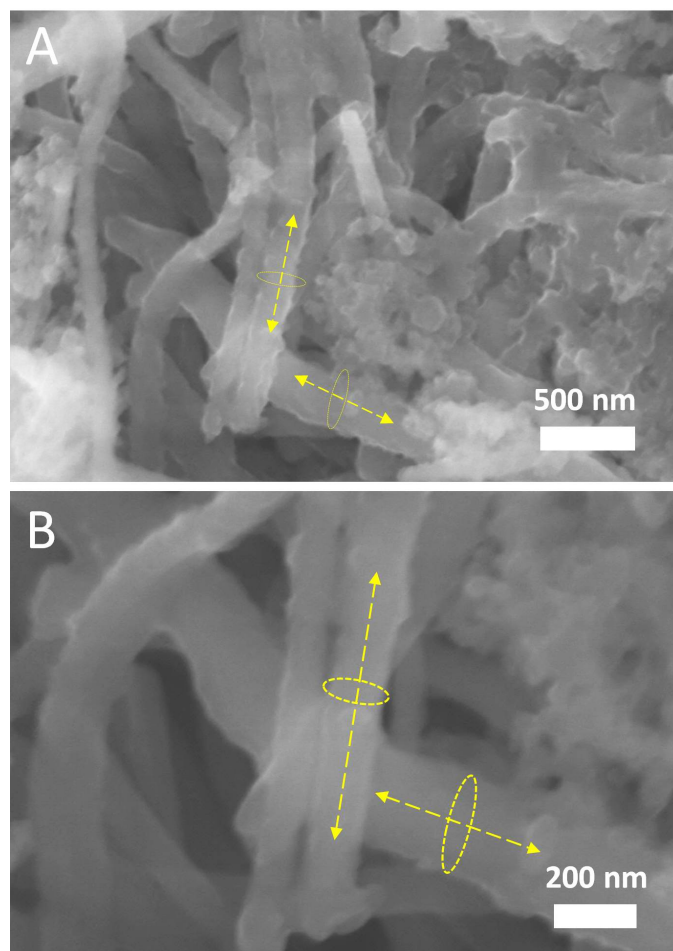


Fig. S6. SEM images of the Si CNWs of the composite electrode after 100 cycles. The yellow circles plus arrowed lines indicate the individual Si CNWs.

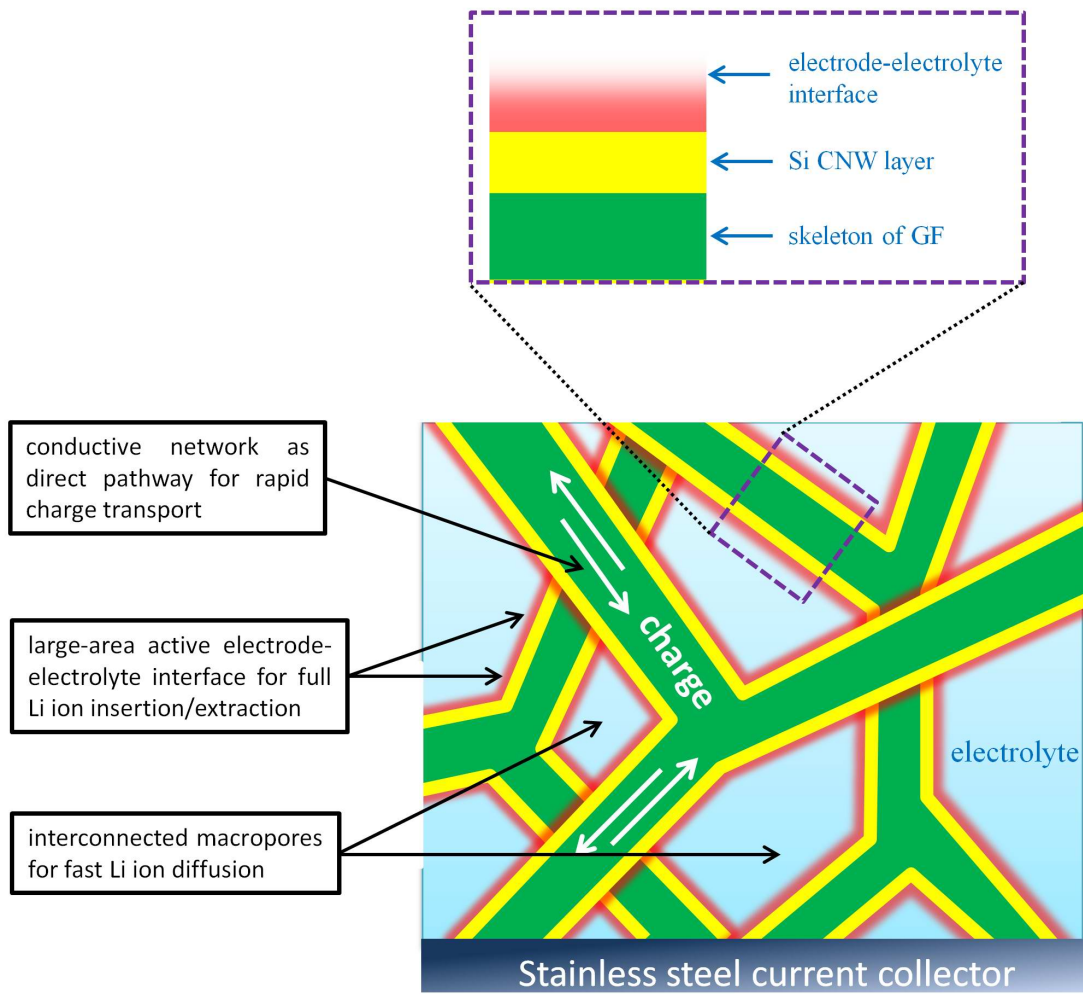


Fig. S7. Schematic illustration of possible mechanism for the Si CNM/3D GF based batteries with high performance.

Tab. S1 Impedance parameters calculated from the equivalent circuit of Figure 5E

	$R_s(\Omega)$	CPE_T	CPE_P	$R_{ct}(\Omega)$	$Z_w(R)$	$Z_w(T)$	$Z_w(P)$	$i_0(\text{mA}/\text{cm}^2)$ $i_0=RT/nFR_{ct}$ t
SiCNW/ 3D GF	1.676	1.4283e-5	0.77906	64.77	3.592	1.3024e-4	0.35777	0.4
Si CNW	2.959	1.043e-5	0.78789	317.3	6020	0.31859	0.87015	0.08

Tab. S2 Impedance parameters calculated from the equivalent circuit model including the resistance of SEI and contact

	$R_s(\Omega)$	$CPE_{SEI+contact}$		$R_{SEI+contact}(\Omega)$	CPE_{dl}	$R_{ct}(\Omega)$	W_o			$i_0(\text{mA}/\text{cm}^2)$ $i_0=RT/nFR_{ct}$
		CPE_T	CPE_P				W_R	W_T	W_P	
SiCNW / 3D GF	1.169	1.1598e-5	0.81963	52.83	-5.8414e-4	127.1	30.39	4.3253e-3	0.42858	0.2
Si CNW	2.908	1.0988e-5	0.78623	292.3	6.669e-5	512.4	1.421	2.0701e-4	0.56545	0.05