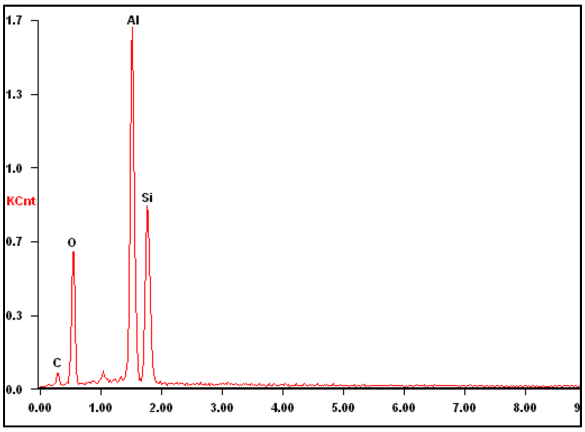
Supporting information



Element	*Wt %*	*At %*
C K	00.06	00.11
O K	30.63	43.06
AlK	40.60	33.84
SiK	28.71	22.99

Figure S1. EDS spectrum of the CNT/SiNT/CNT/AAO composite. Atomic ratio of aluminum to oxygen is larger than 2:3, which indicates that there has little or none of silicon oxide in the membrane.

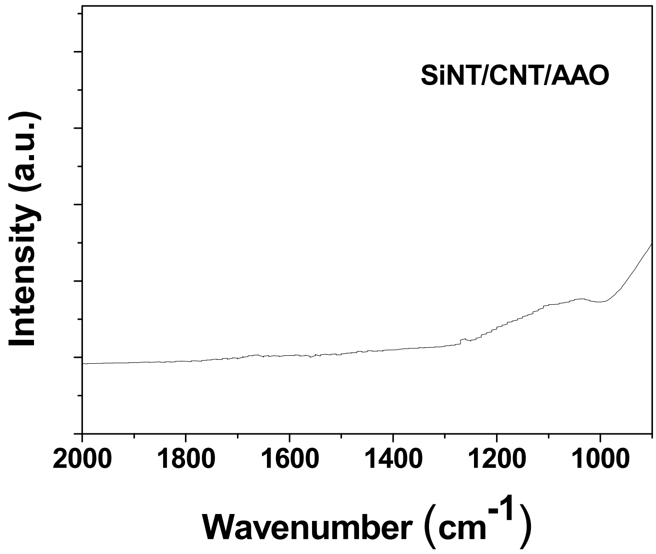


Figure S2. ATR-FTIR spectrum of SiNT/CNT/AAO surface. The absence of the sharp band at 1100 cm^{-1} reveals that there has little or none of SiO_2 on the surface of silicon. The small band should be attributed to the oxidation process when the sample was exposed in air for days before test.

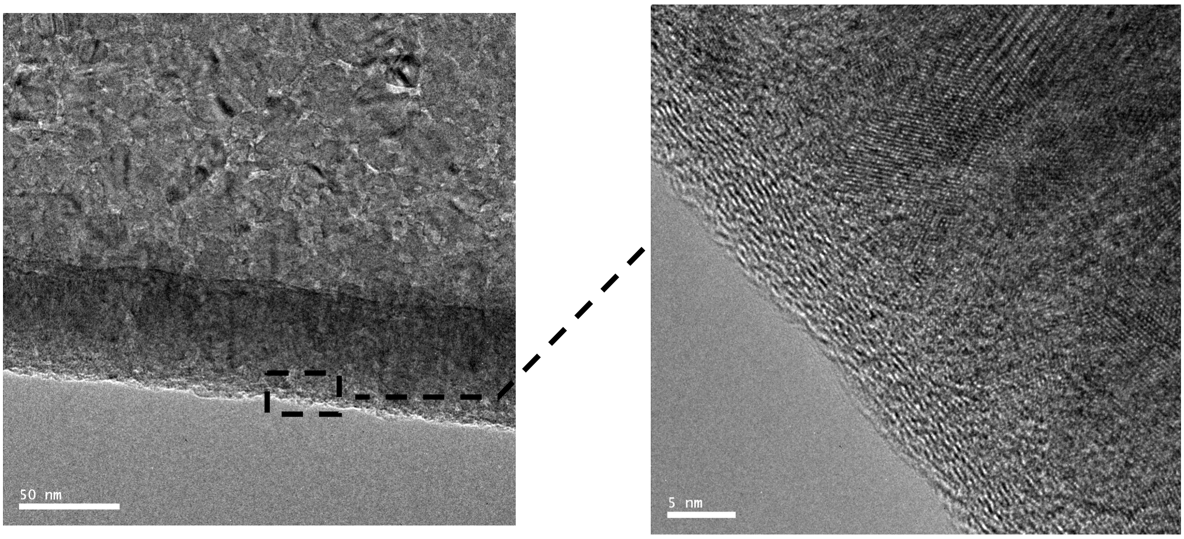


Figure S3. HRTEM images of the wall in CNT/SiNT/CNT. The layer without any fringes should be the carbon layer.

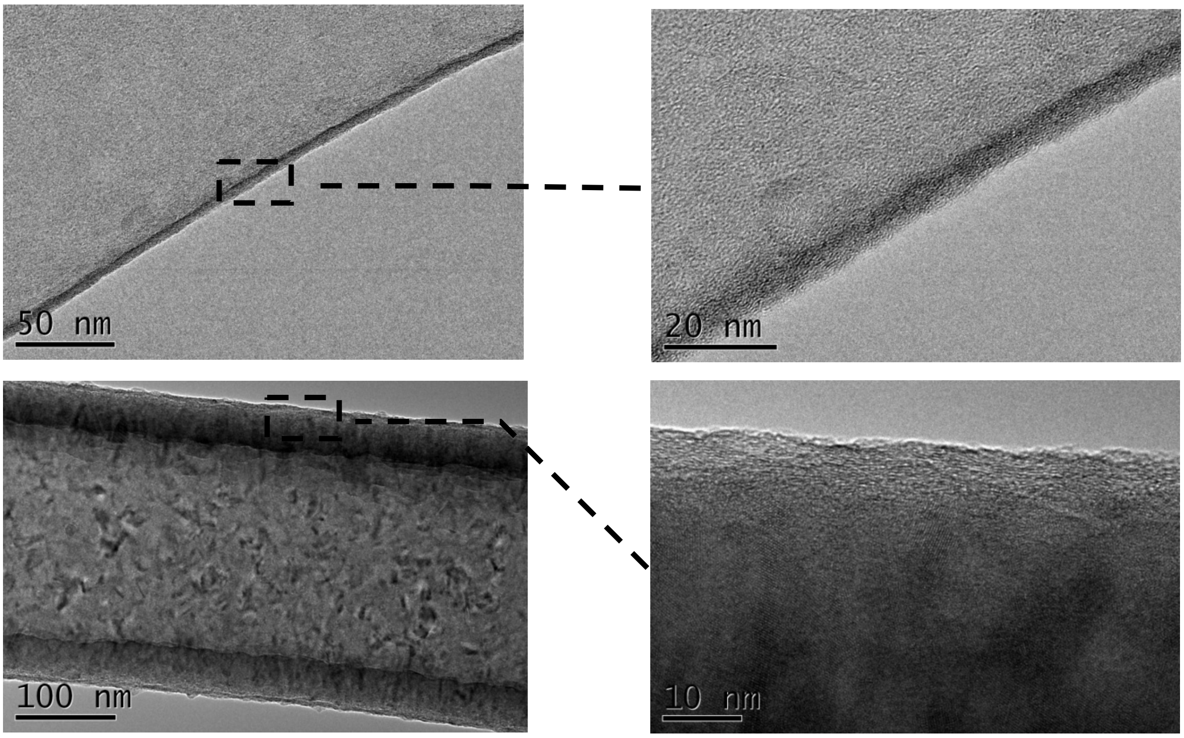


Figure S4. HRTEM images of the wall in CNT and SiNT/CNT.

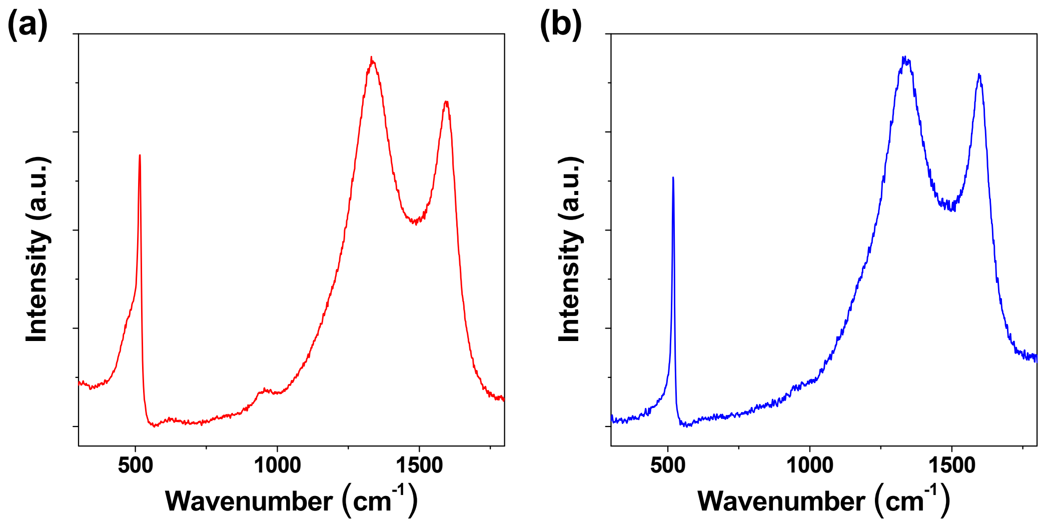


Figure S5. Raman spectra of SiNT/CNT/AAO (a) and CNT/SiNT/CNT/AAO (b).

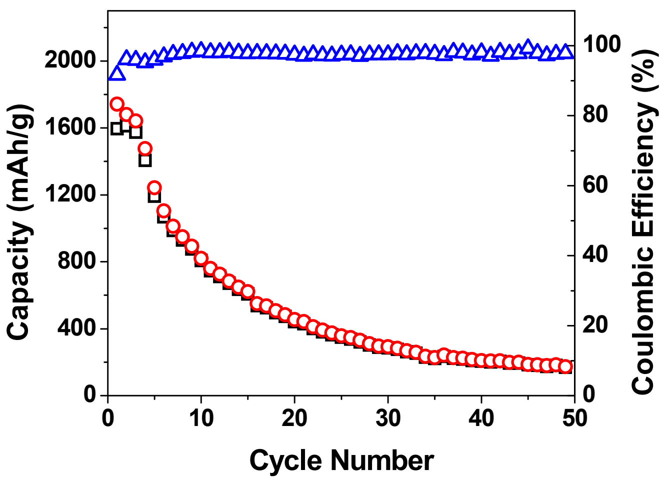


Figure S6. Capacity of discharge (circles), charge (squares) and coulombic efficiency (triangles) vs. cycle number between 2.0 and 0.0 V at a rate of 0.1 C. Capacity fade fast during cycling when the capacity of CNT/SiNT/CNT/AAO membrane over 1092 mAh/g.

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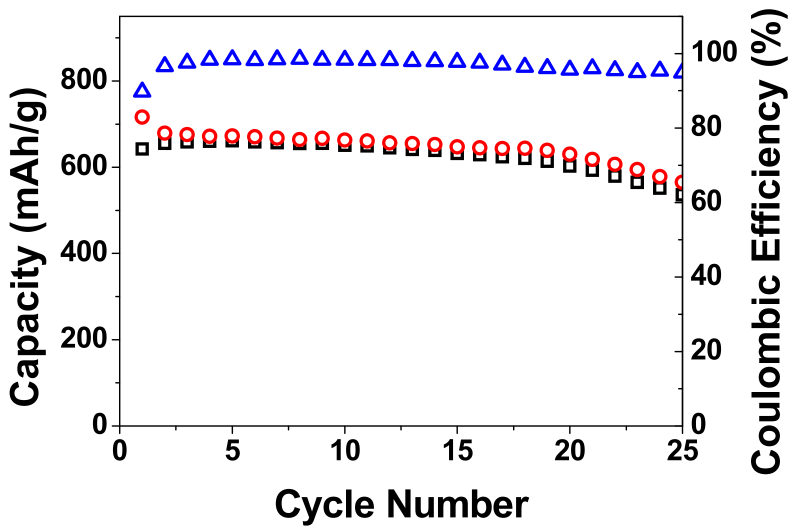

Figure S7. The whole anode capacity of discharge (circles), charge (squares) and coulombic efficiency (triangles) vs. cycle number between 2.0 and 0.0 V at a rate of 0.1 C.

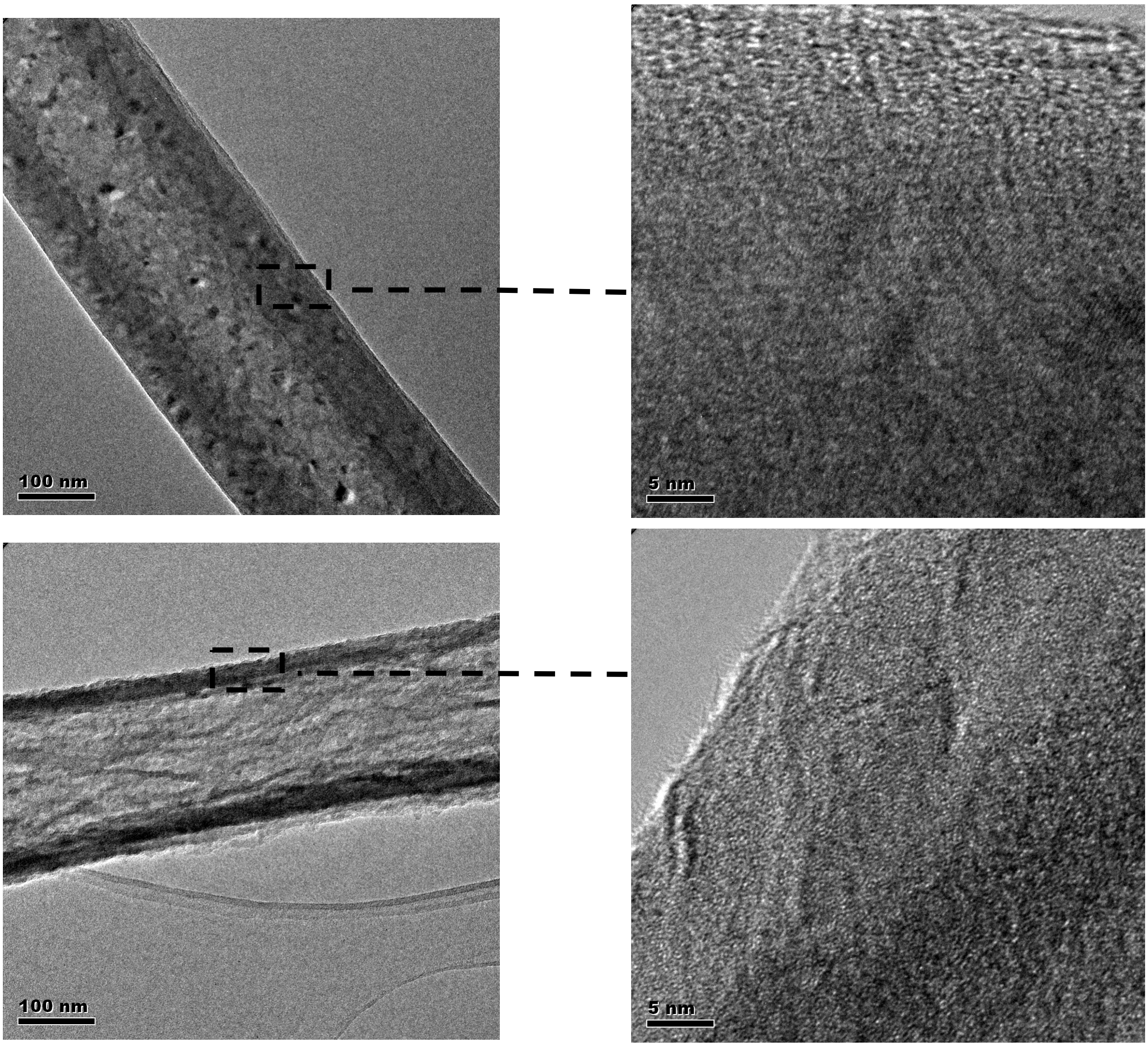

Figure S8. HRTEM images of the wall in CNT/SiNT/CNT after lithium lion inserted into and extracted from silicon material.

Calculation of the maximal capacity

The maximal silicon content should be

$(\text{Volume}_{\text{all}} - \text{Volume}_{\text{AAO}} - \text{Volume}_{\text{cabon}}) \div (1 + \delta_{\text{expansion coefficient}}) \times \text{Density}_{\text{Si}} \div \text{Mass}_{\text{all}} = 26\%$

The maximal capacity should be 4200 × 26% = 1092 mAh/g.

$\text{Volume}_{\text{all}} = \pi r^2 h = 3.14 \times 6.5\, mm^2 \times 60\, \mu m = 7.960\, mm^3$

$\text{Volume}_{\text{AAO}} = 9\, mg \div 3.97\, g/cm^3 = 2.267\, mm^3$

$\text{Volume}_{\text{cabon}} = 0.6\, mg \div 2.2\, g/cm^3 = 0.273\, mm^3$

$\delta_{\text{expansion coefficient}} = 300\%$

The maximal silicon weight be

$(\text{Volume}_{\text{all}} - \text{Volume}_{\text{AAO}} - \text{Volume}_{\text{cabon}}) \div (1 + \delta_{\text{expansion coefficient}}) \times \text{Density}_{\text{Si}} = 3.157$ mg

$\text{Mass}_{\text{all}} = 3.157\, mg + 9\, mg = 12.157\, mg$