Supporting Information

Winding aligned carbon nanotube composite yarns into coaxial fiber full batteries with high performances

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Preparation of the composite yarn

The as-synthesized LMO nanoparticles were dispersed in N-methyl pyrrolidinone to form a suspension (concentration of 5 mg mL^{-1}) through an ultrasonic treatment for 1 h. The suspension was then dropped onto the aligned CNT sheet. A CNT-LMO composite yarn was scrolled from the above LMO-deposited CNT sheet. The scrolling process is shown in Figure S13. The CNT-Si/CNT composite yarn was prepared by a similar process with the formation of an Archimedean scroll.

Fabrication of the full-cell

A cotton fiber was used as the substrate that had been further covered with a shrinkable tube as a protecting layer. A CNT-LMO composite yarn was then wound onto the cotton fiber. Afterwards, the gel electrolyte with the solvent of tetrahydrofuran was coated onto the sample, followed by evaporation of the solvent. The coating process was repeated for three times to produce a thick gel electrolyte, followed by winding a CNT-Si/CNT composite yarn. After drying in vacuum at 60 ℃ for 5 h, the sample was transferred to a glove box. The gel electrolyte was then dipped into 1 M $LiClO_4$ solution in ethylene carbonate/diethyl carbonate (50/50, v/v). Finally, the sample was inserted into another shrinkable tube as a packaging layer while both open ends were sealed by polydimethylsiloxane, which could be hardened at room temperature for 2 h. After that, a fiber full-cell was fabricated and its electrochemical performance was investigated under ambient condition.

Mechanical test

Mechanical measurements were tested on a HY0350 table-top universal testing instrument. The cotton fibers with an average diameter of 40 μm were first stabilized onto sample holders with a gauge length of 5 mm and loaded in a uniaxial tension at a rate of 1 mm min^{-1}.

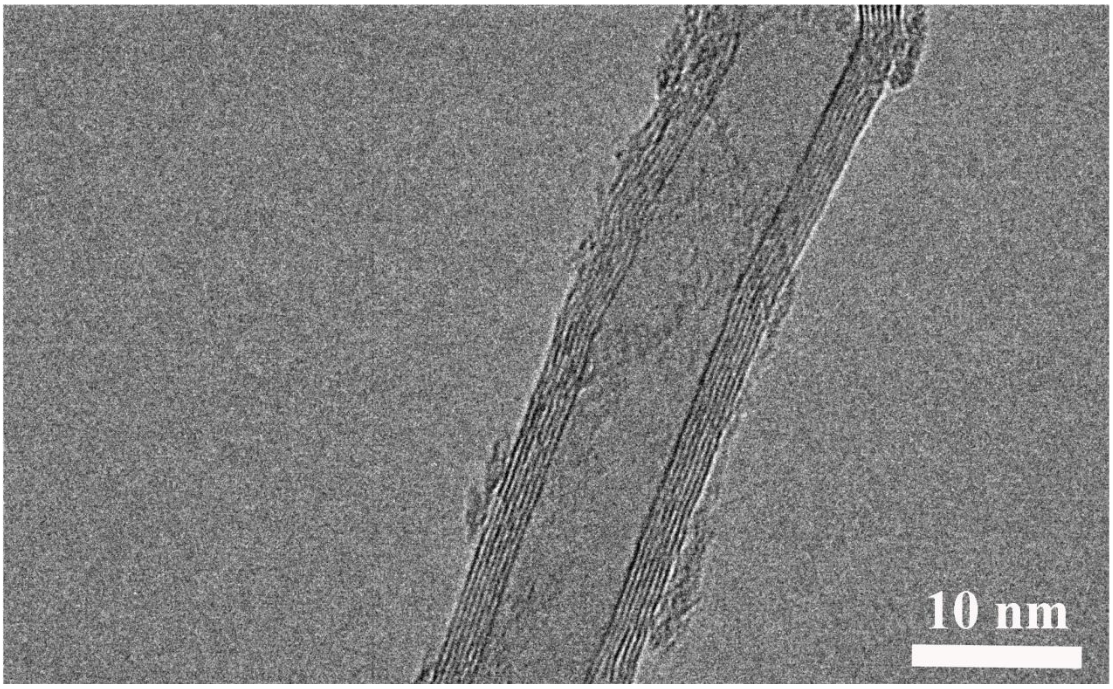

Figure S1. High-resolution TEM image of a CNT.

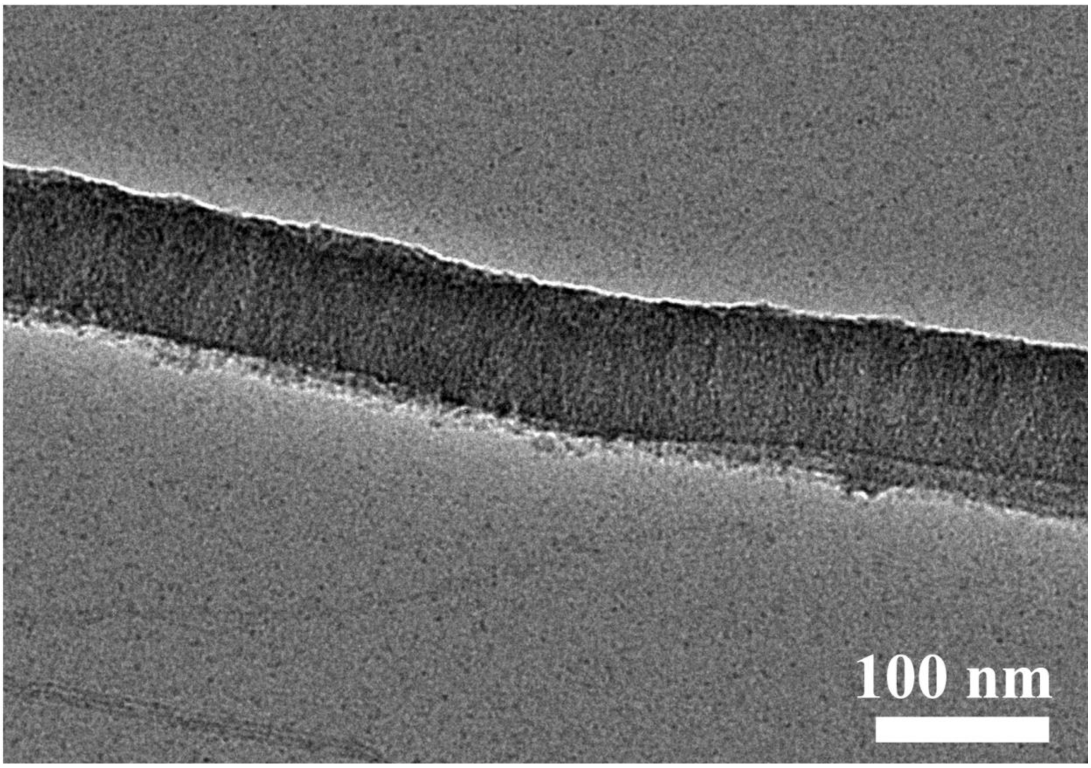

Figure S2. High-resolution TEM image of a coaxial CNT/Si nanotube.

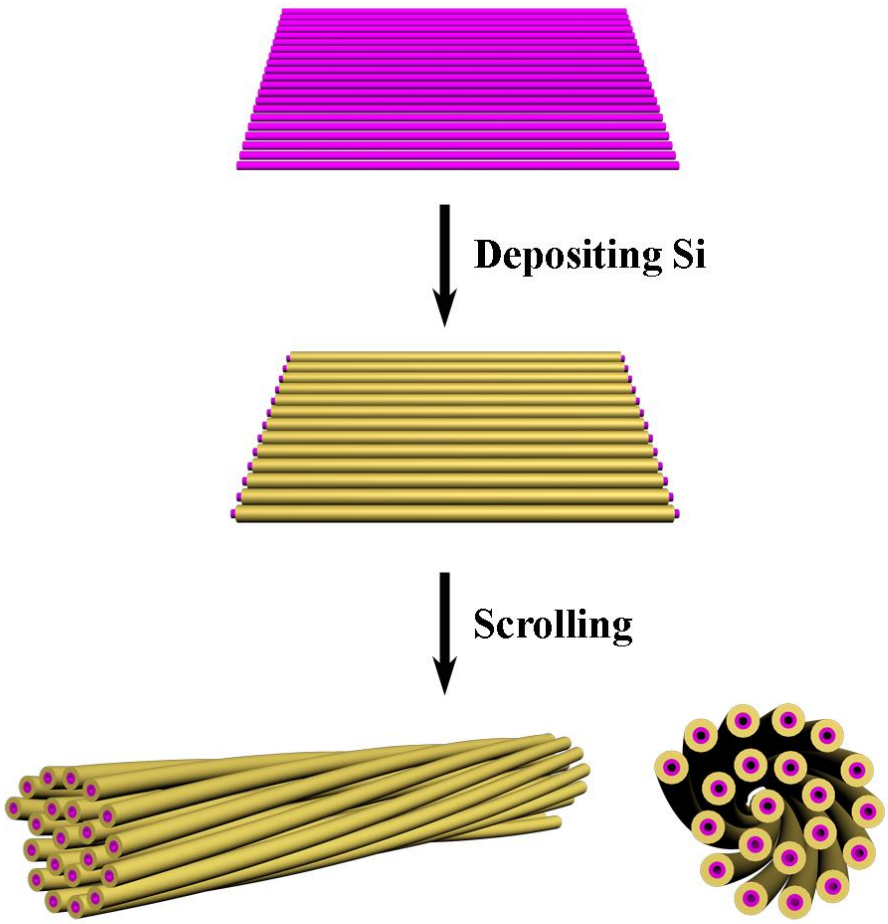

Figure S3. Schematic illustration to the preparation of the CNT-Si composite yarn without a hybrid layered structure. Pink and yellow colors correspond to CNT and Si, respectively.

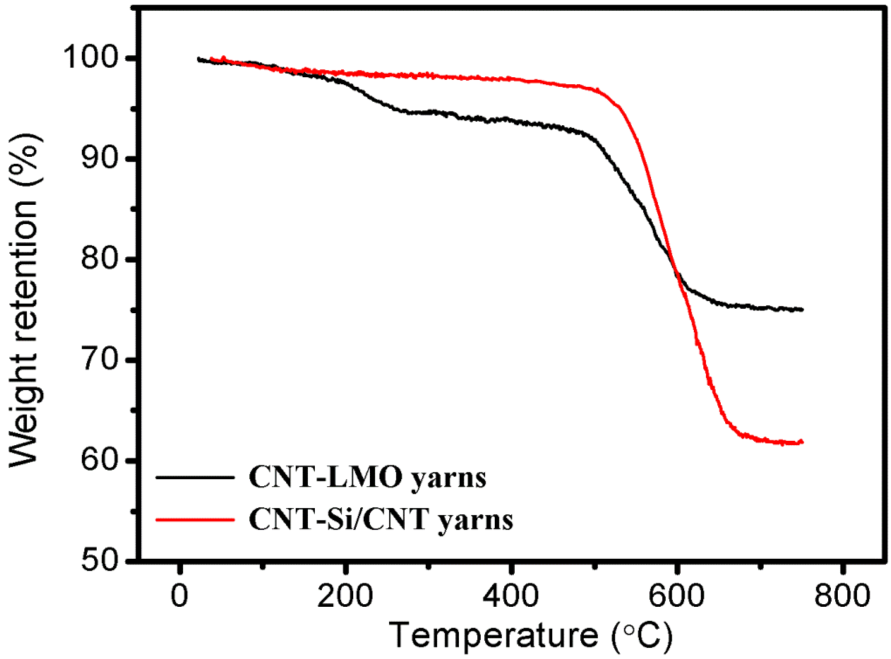

Figure S4. Thermogravimetric analysis of CNT-Si/CNT and CNT-LMO composite yarns in air.

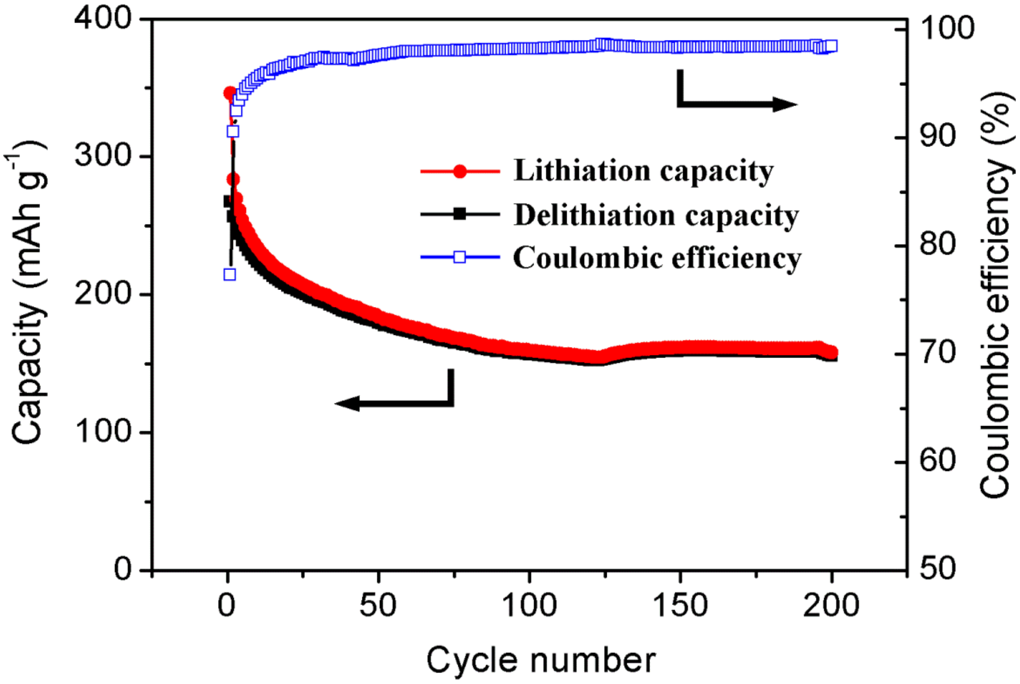

Figure S5. Cyclic performance of bare CNT at a voltage window of (0.005–3.0) V versus Li/Li^+ at a current density of 1 A g^{-1}.

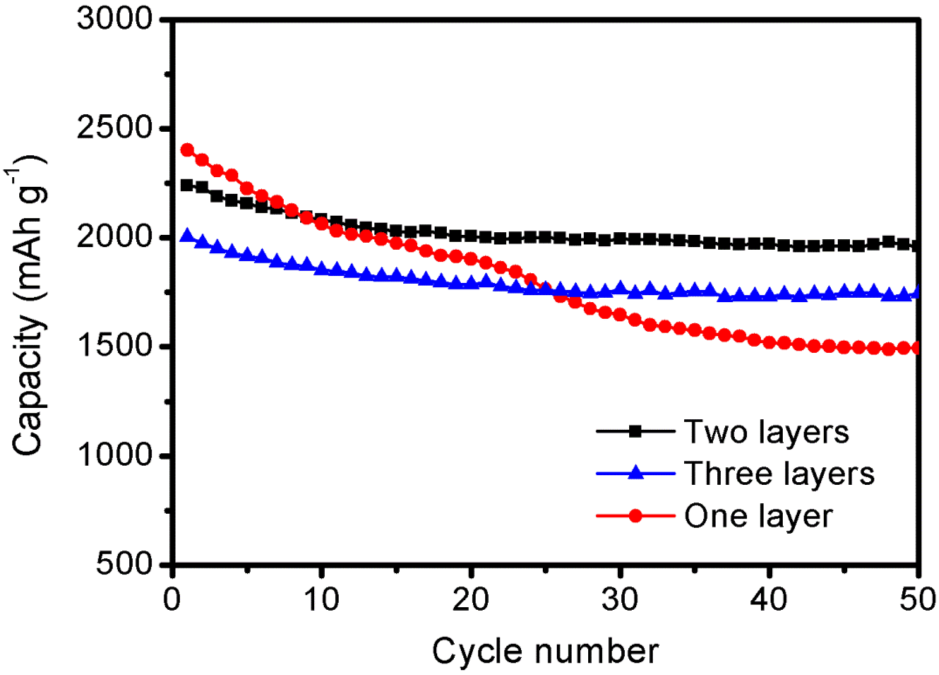

Figure S6. Effect of the thickness of bare CNT sheet on the electrochemical performance of CNT-Si/CNT composite yarn.

Figure S7. Photograph of a CNT-LMO composite yarn being wound onto a cotton fiber.

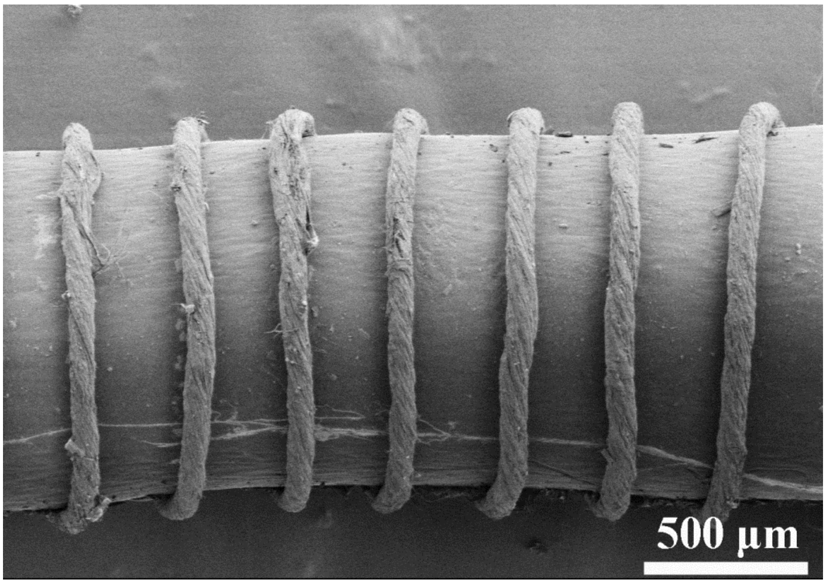

Figure S8. SEM image of a CNT-LMO yarn wrapped on a cotton fiber.

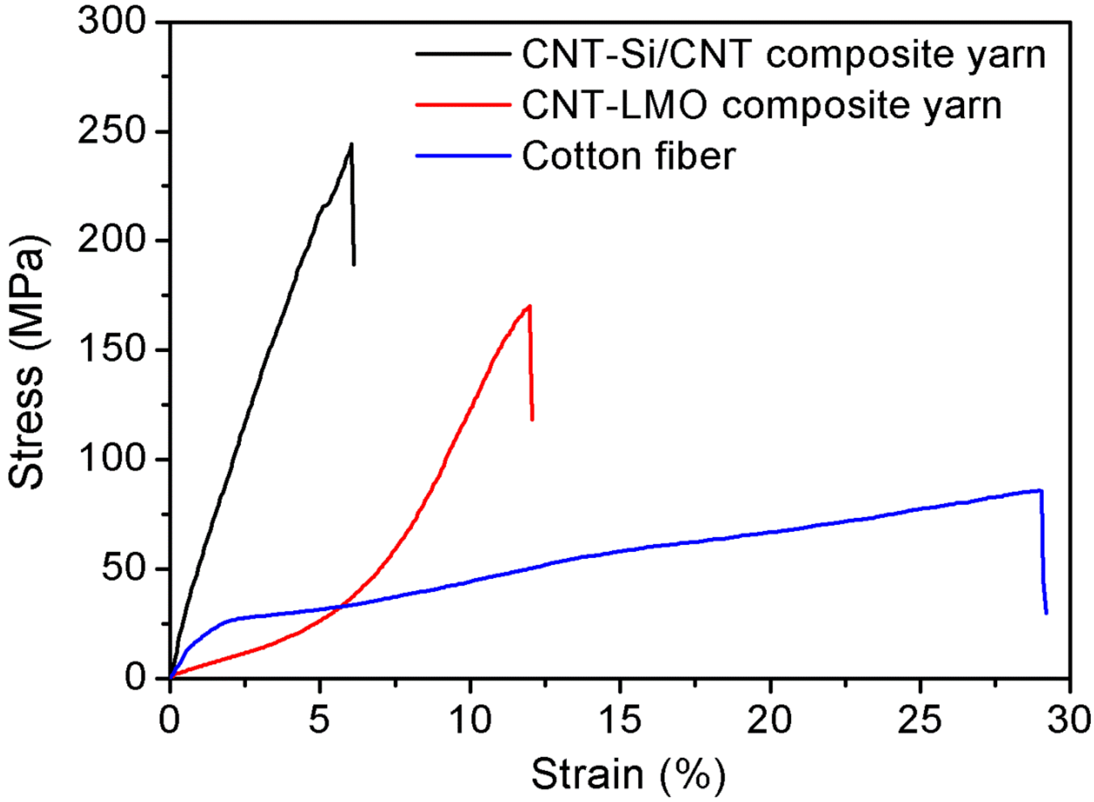

Figure S9. Stress-strain curves of the cotton fiber and CNT-LMO and CNT-Si/CNT composite yarns.

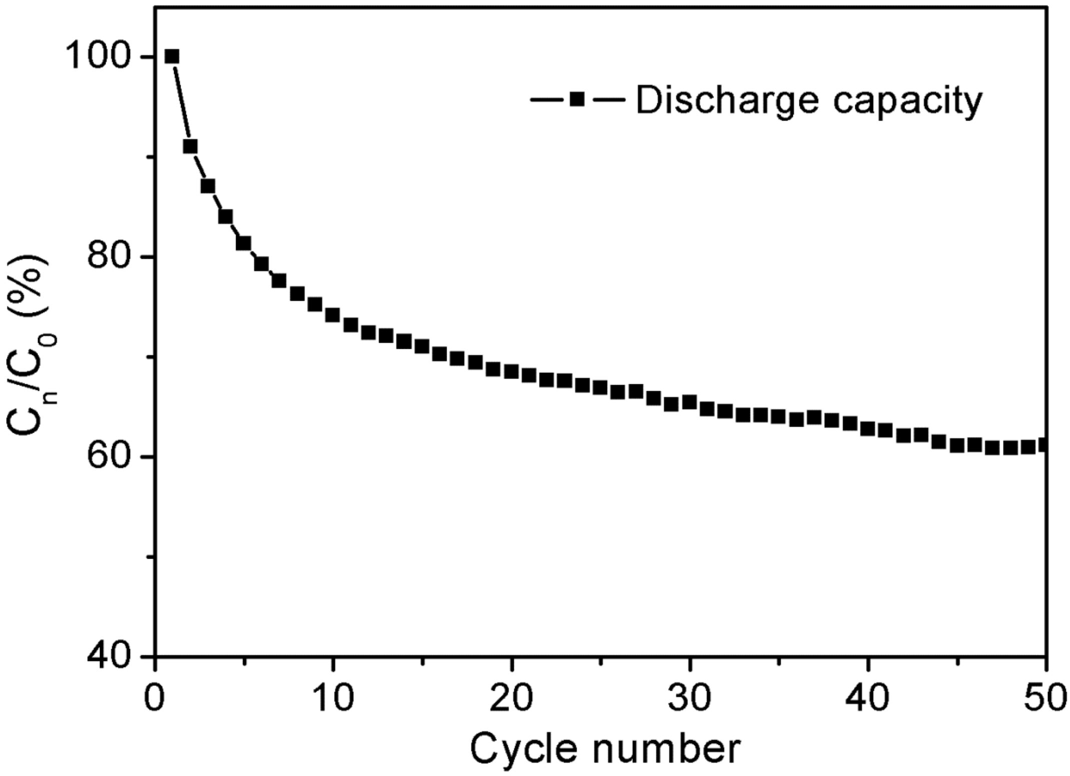

Figure S10. Cyclic stability of a full-cell with an excessive cathode capacity of CNT-LMO composite yarns (n/p = 0.5) in a voltage range of (2.0−4.3) V at a current density of 1 C (2661 mA g^{-1}) relative to the CNT-Si/CNT anode. C_0 and C_n represent the discharge capacity at the first and following cycles, respectively. Here, the specific capacity was calculated based on the weight of CNT-Si/CNT anode.

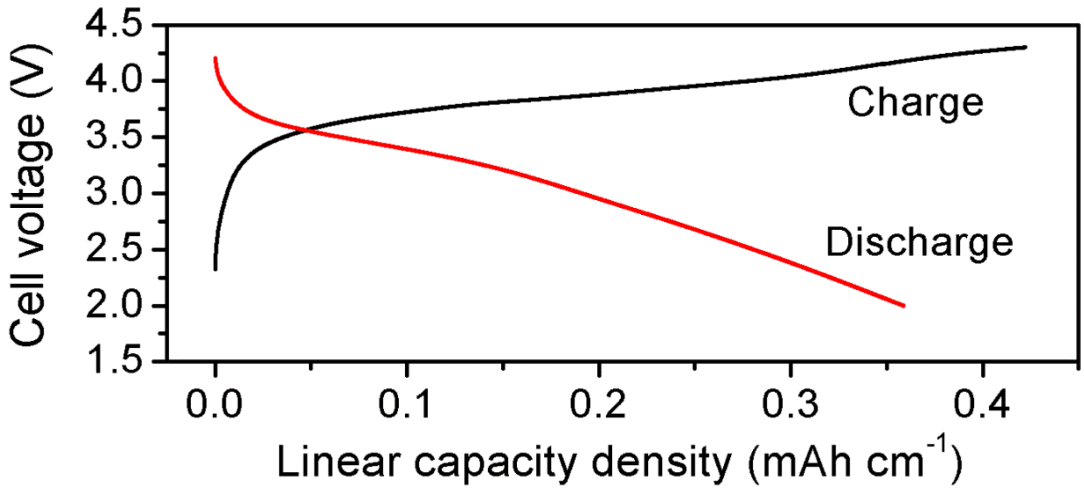

Figure S11. Voltage profile of a full-cell (a pitch distance of 200 μm) with CNT-LMO and CNT-Si/CNT composite yarns as cathode and anode, respectively.

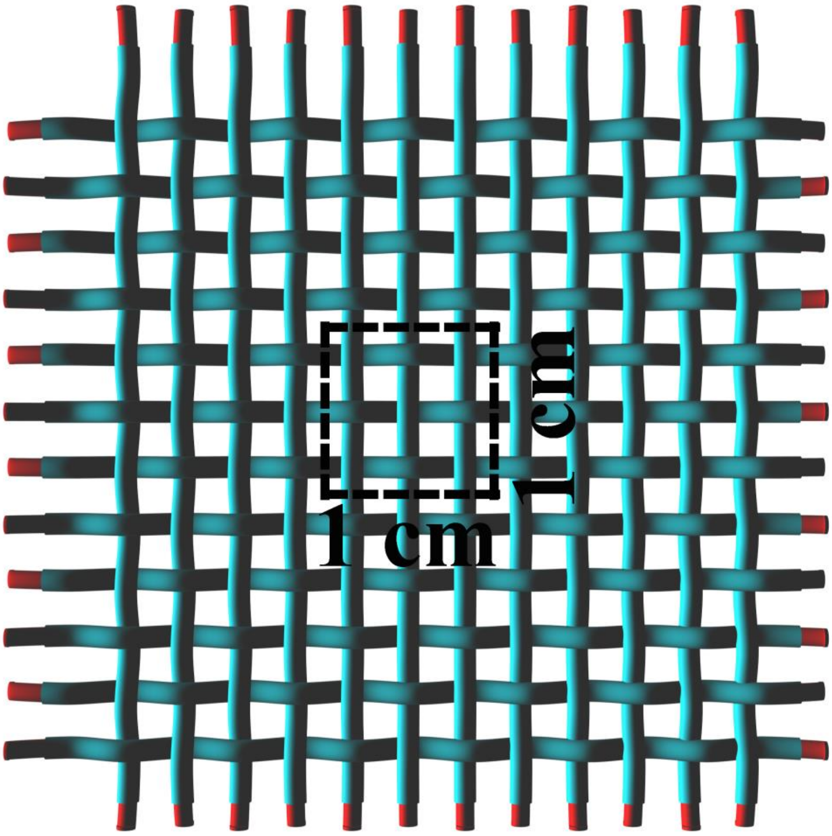

Figure S12. Schematic illustration of an energy storage textile consisting of coaxial fiber-shaped LIBs in an interlaced form.

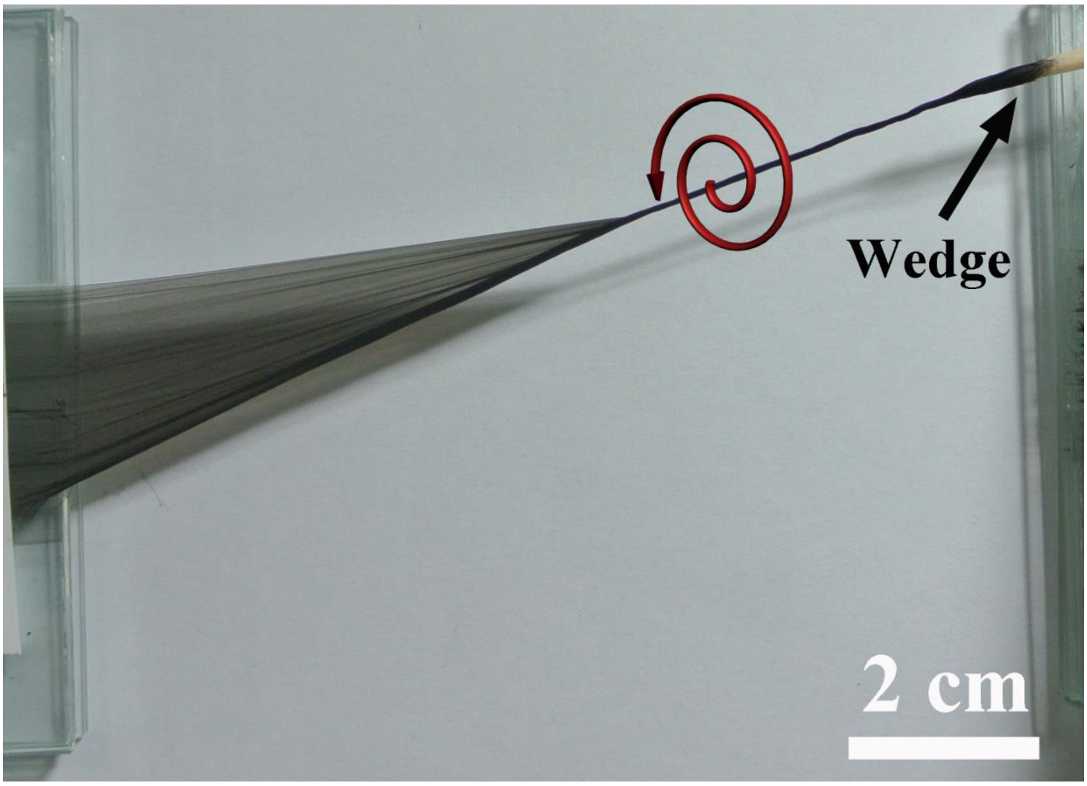

Figure S13. Photograph of preparation of a bare CNT yarn showing an Archimedean scroll.