Supporting Information

Highly-Integrated and Interconnected CNT Hybrid Nanofibers Decorated with α-Iron Oxide as Freestanding Anodes for Flexible Lithium Polymer Batteries

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In Fig. S1a, the FT-IR spectrum of PAN before acid-treatment showed a unique peak at 2243 cm^{-1} which is attributed to the nitrile (-C≡N) group of PAN. However, after treatment in Fig. S1b, PAN was hydrolyzed to form a sulfonated polyacrylamide ($-SO_3H$, $O=C-NH_2$) group. The sulfonated polyacrylamide group of sulfonated PAN is determined by the amide group (NH_2-C=O) and sulfonic acid group (SO_3H) characterized by five peaks of N-H, C-N, C=O, O=S=O, and C-S. Therefore, 588 cm^{-1} (N-H), 1214 cm^{-1} (C-N), 1580 cm^{-1} (C=O), 1197 cm^{-1} (O=S=O), and 1040 cm^{-1} (C-S) were definitely confirmed from Fig. S1b. In the case of CNTs, peaks located at 1640 cm^{-1} (C=O) and 3400 cm^{-1} (O-H) corresponding to the carboxylic acid group (-COOH) attached onto surfaces of the acid-treated CNTs were newly observed after acid-treatment, as shown in Fig. S1d. Thererfore, the attachments of both carboxylic group on CNTs and sulfonated polyacrylamide group on PAN after acid-treatment were directly proven by FT-IR results.

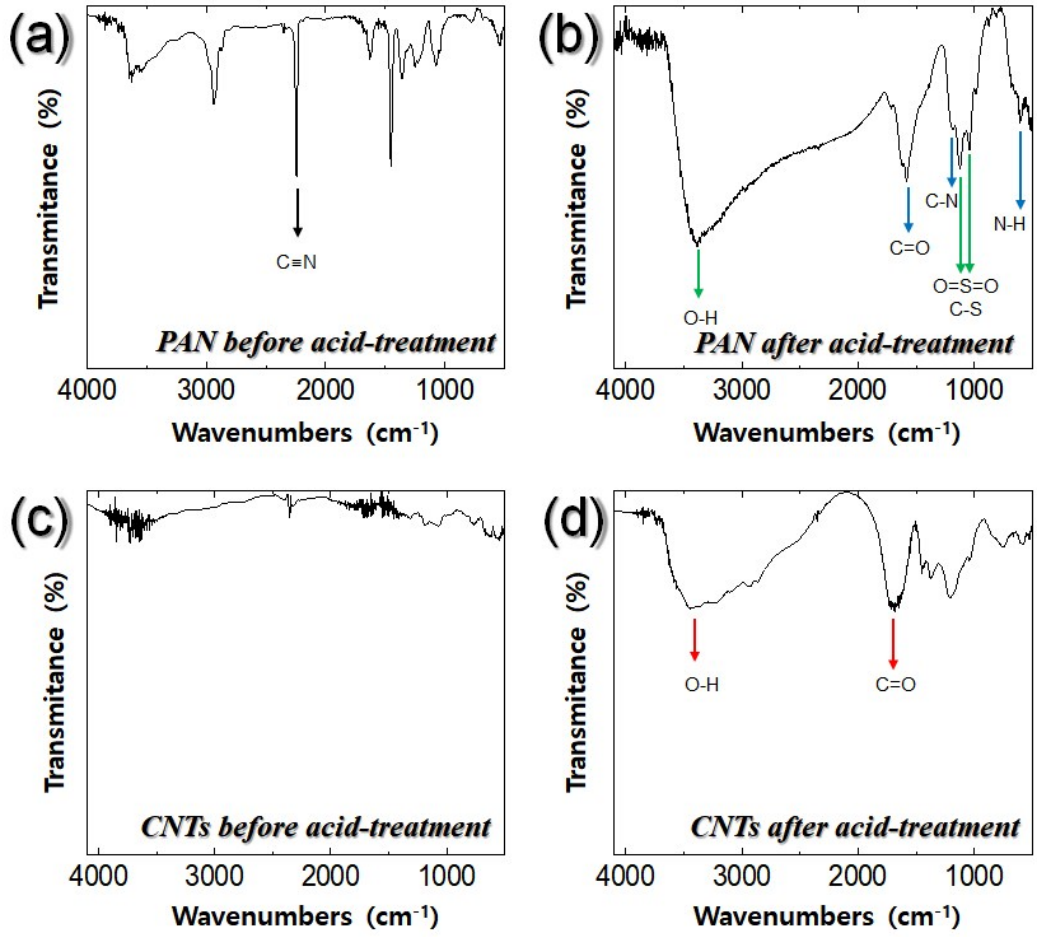

Fig. S1. FT-IR spectra of PAN and CNTs before and after acid-treatment: (a) PNA before acid-treatment, (b) PNA after acid-treatment, (c) CNTs before acid-treatment, and (d) CNTs after acid-treatment.

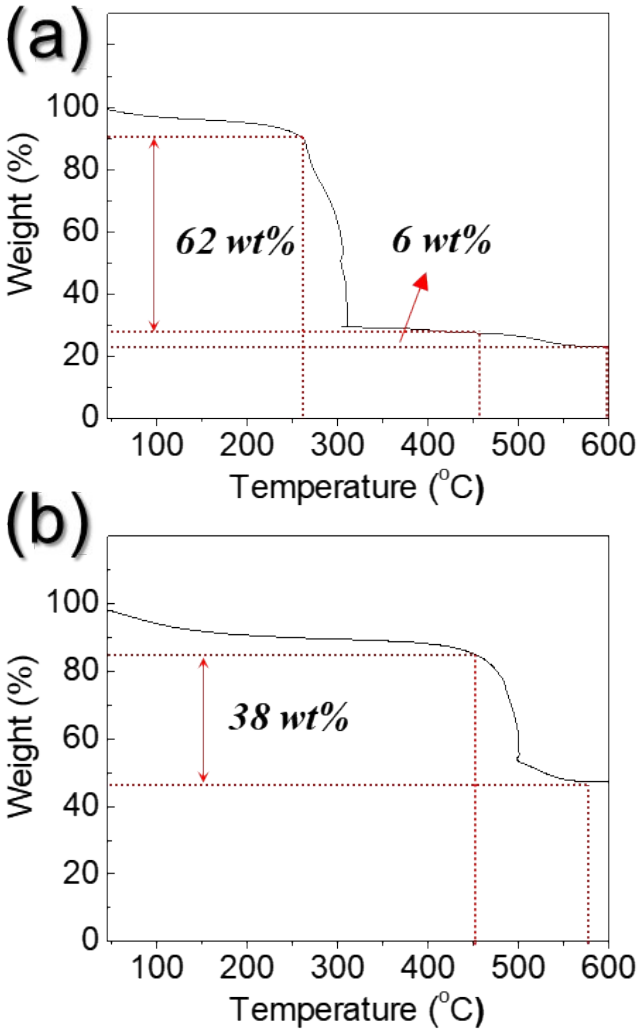

Fig. S2. TGA curve of (a) the as-spun $Fe(acac)_3$/PAN/CNTs composite nanofibers obtained after electrospinning process and (b) HI-CNT/Fe_2O_3 fiber .

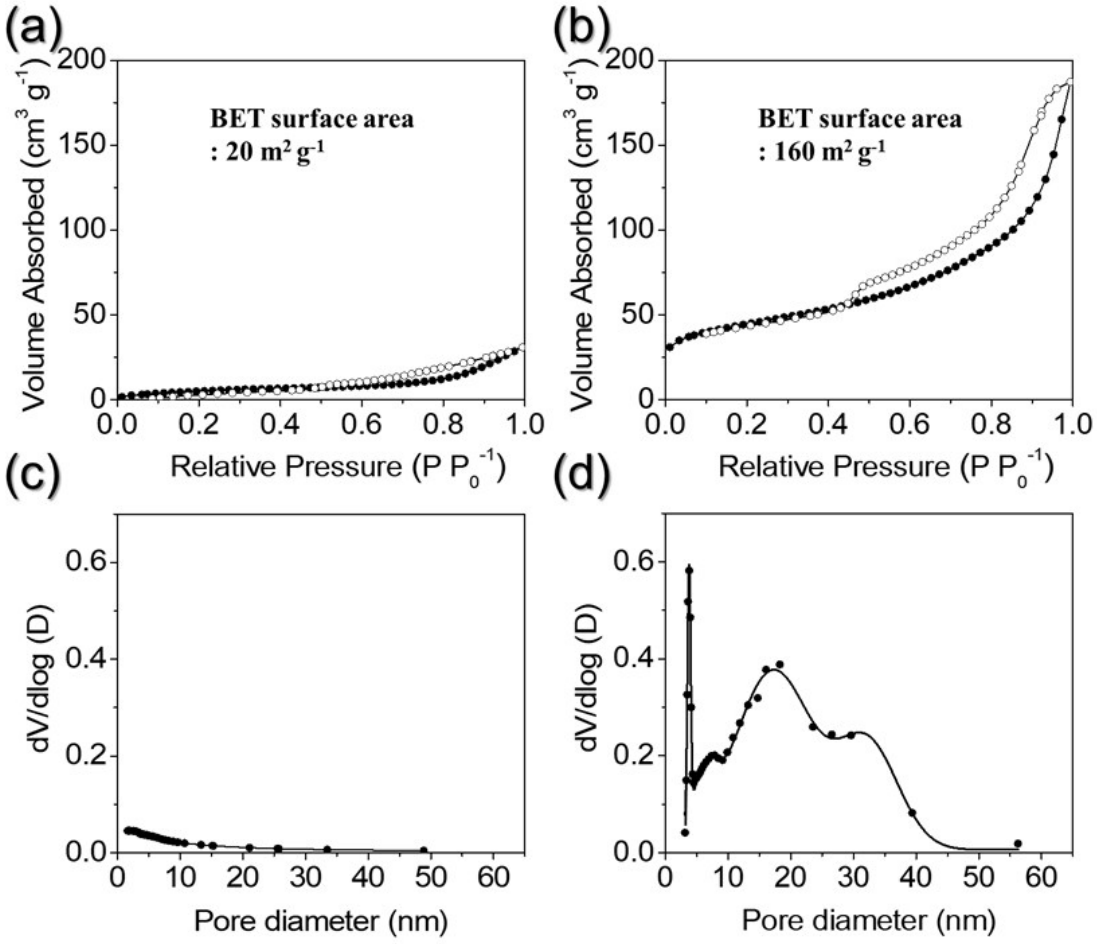

Fig. S3. (a,b) N_2 adsorption-desorption isotherms and (c,d) BJH adsorption pore size distributions: (a,c) as-spun $Fe(acac)_3$/PAN/CNTs composite nanofibers and (b,d) HI-CNT/Fe_2O_3 nanofibers.

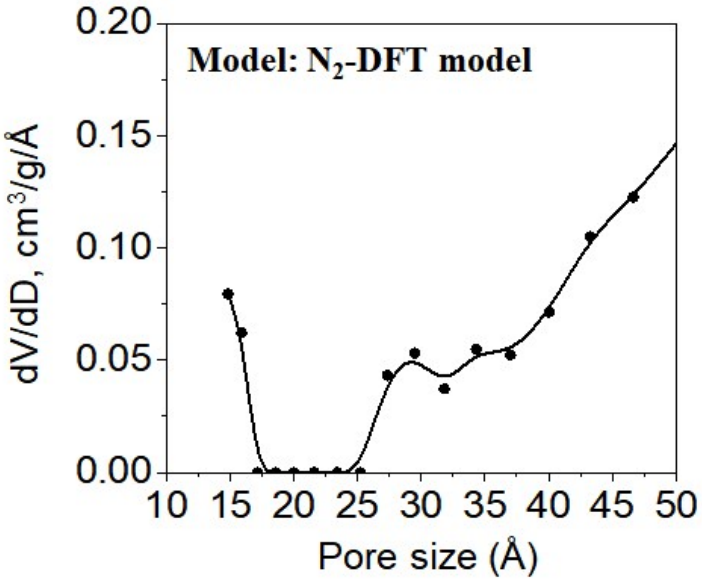

Fig. S4. Pore size distribution of HI-CNT/Fe_2O_3 nanofibers calculated from the N_2-DFT model using desorption isotherms.

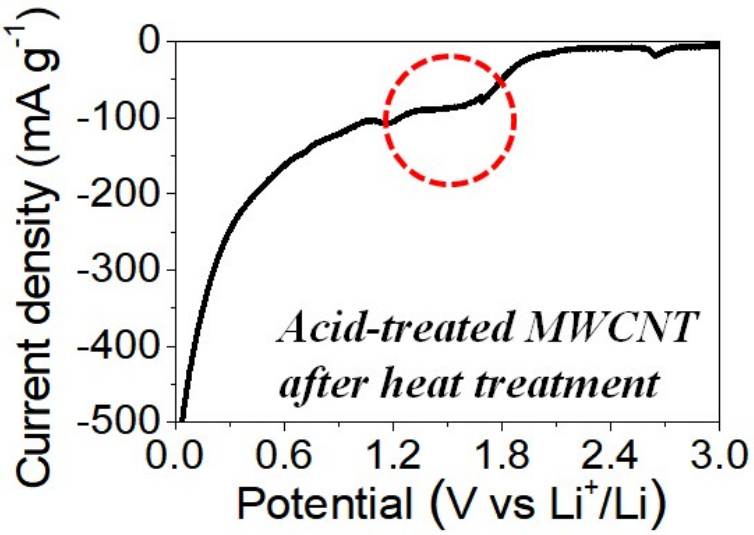

Fig. S5. CV curve of the CNTs prepared by acid- and heat- treatments at a scan rate of 0.1 mV s^{-1} in the 0.001–3.0 V range.

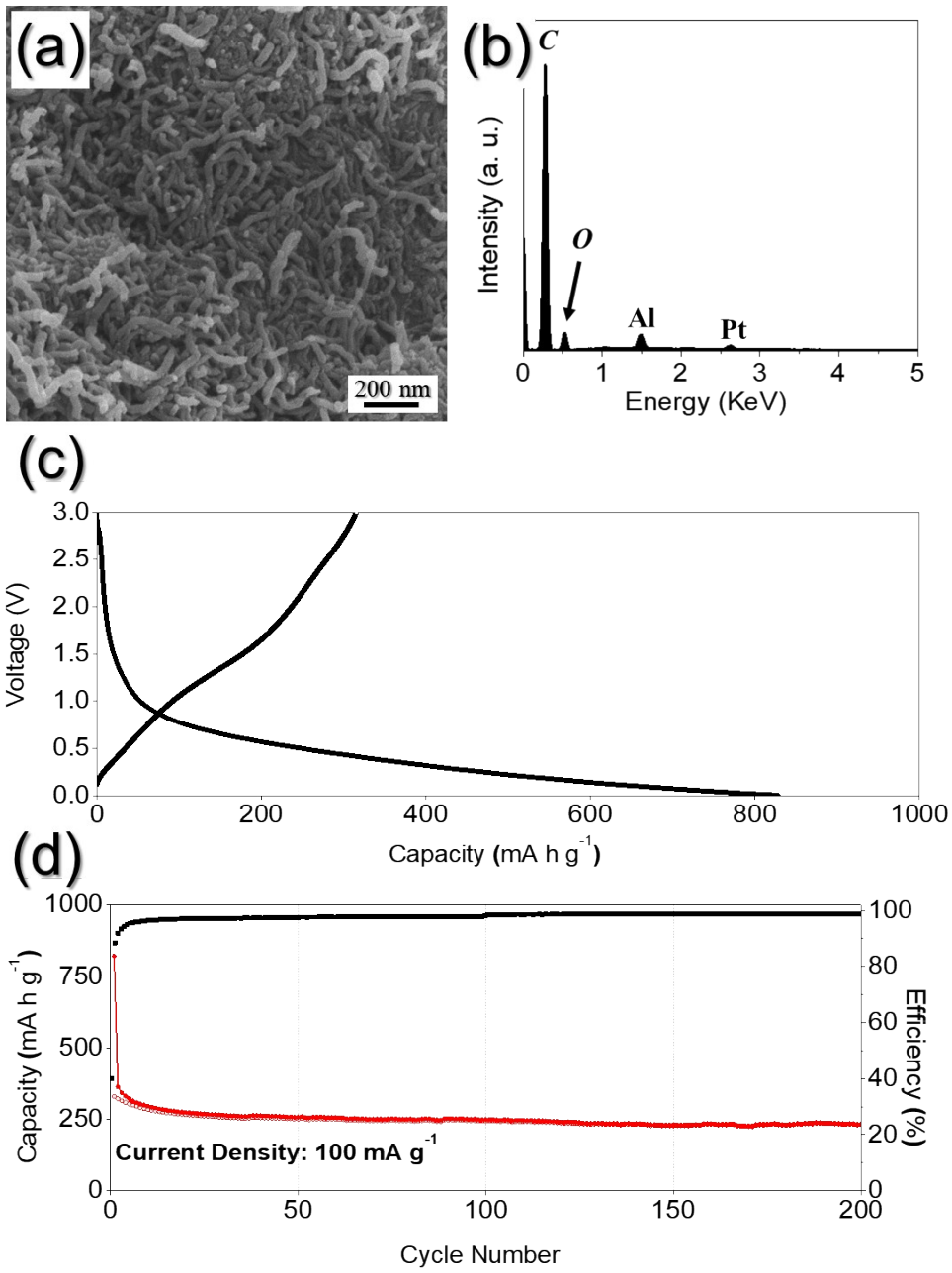

Fig. S6. (a) FE-SEM image, (b) EDS spectrum, (c) charge-discharge profile, and (d) cycle performance of HI-CNT/Fe_2O_3 nanofibers etched by HCl solution.

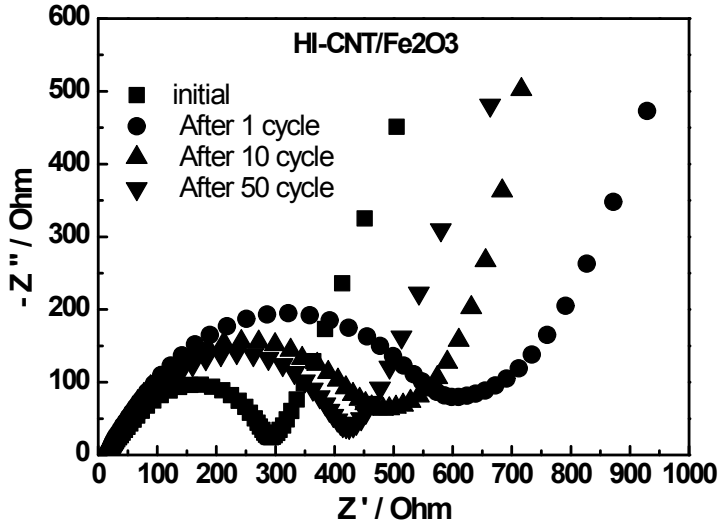

Fig. S7 Electrochemical impedance spectra (EIS) of free-standing HI-CNT/Fe_2O_3 nanofibers electrode cell with cycling.

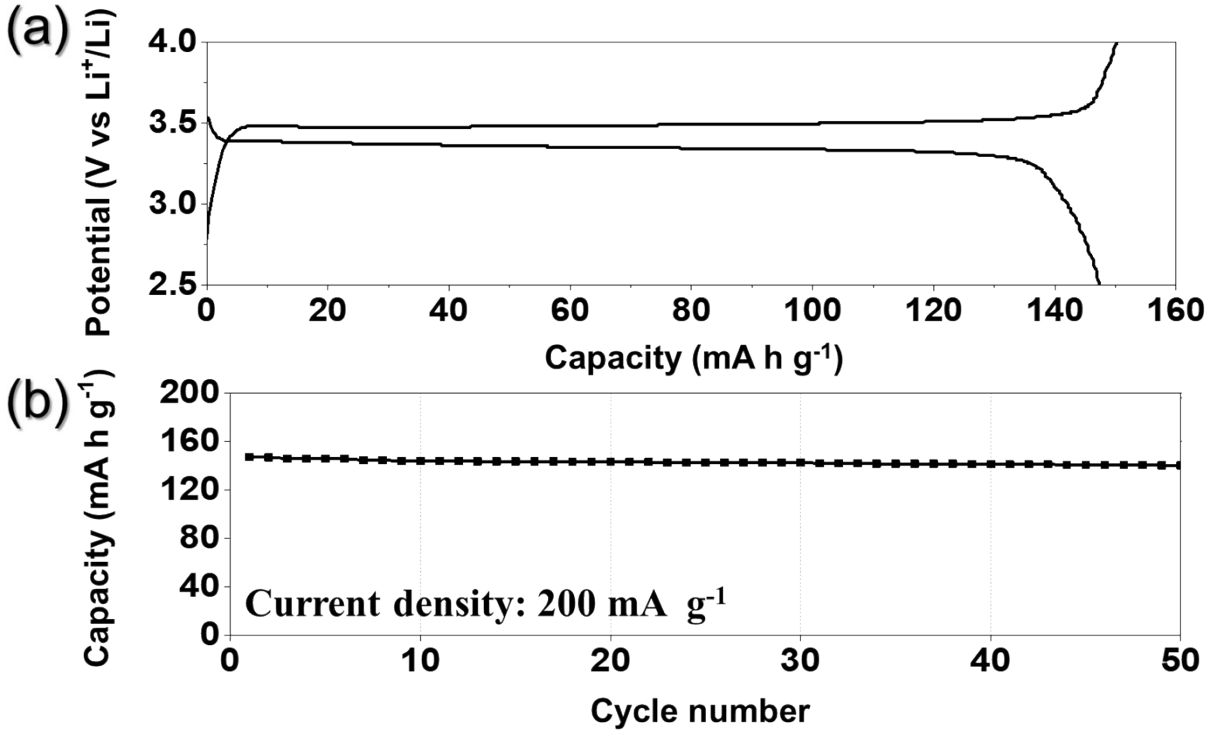

Fig. S8. Electrochemical properties of $LiFePO_4$ fiber cathode in half-cell: (a) charge/discharge profile and (b) cycling performance at a current density of 200 mA g^{-1}.