Supplementary Information

Binder-Free Metal Fibril–Supported Fe_2O_3 Anode for High-Performance Lithium-Ion Batteries

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Experimental Section

The fabrication of Fe_2O_3/SF was carried out by using RF magnetron sputtering method. The base vacuum pressure of the stainless-steel chamber was 2.0 x 10^{-5} Torr, and the working pressure was 7.0 x 10^{-3} Torr of Ar (99.999%). The target used was Fe_2O_3 (99.99%) and the distance between the target and the substrate was 7 cm. The Fe_2O_3 target was pre-sputtered for 10 min at 200 W to remove the contaminants on the surface before deposition on the SF substrates (Shine co. Ltd., Korea). The deposition was conducted for 20 min at 25 ºC on both side of the SF substrate at 200 W. Copper foil was used for comparative study of different substrate structure and deposition conditions are same as the Fe_2O_3/SF cases. The surface morphology and cross-sectional image of the samples were examined using field emission scanning electron microscope (FE-SEM, S4800, Hitachi). In order to prepare a cross-sectional specimen of Fe_2O_3/SF electrode, it was cut by an argon-ion beam polisher (E3500, Hitachi) at a constant power of 2.1 W (6 kV and 0.35 mA) under vacuum (< 2.0 × 10^{-4} Pa). The surface chemical composition of Fe_2O_3/SF electrodes were investigated by X-ray photoelectron spectroscopy (XPS, Thermo VG scientific).

The 2032 coin type half cells were prepared by assembling the electrodes (Fe_2O_3/SF or Fe_2O_3/Cu foil), Li metal as counter electrodes, polyethylene separator (Asahi-Kasai) that was soaked with the liquid electrolyte (1 M $LiPF_6$ in EC/DEC (50/50 by vol%)) containing 5 wt.% of fluoroethylene carbonate (PANAX ETEC) in an Ar filled glove box. The H_2O content of the electrolyte was less than 10 ppm. The loading density of active material, Fe_2O_3, was 0.4 mg cm^{-2}. The assembled unit cells were cycled at various constant current rates from 40 mA g^{-1} to 16000 mA g^{-1} in the potential range of 0.05 - 3.0 V (vs. Li/Li^+) using a WBCS 3000 battery tester (Wonatech) at 25 ºC. Electrochemical impedance spectroscopy (EIS)

measurements were conducted using the VSP impedance analyzer (Bio-logic SAS) over a frequency range of 0.05 Hz to 1 MHz at an amplitude of 10 mV.

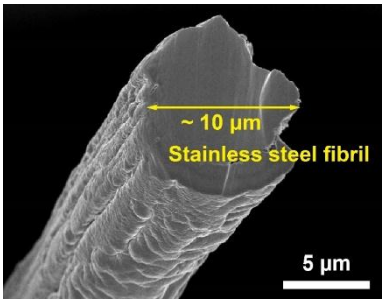

Figure S1. A cross-sectional SEM image of pristine stainless steel fibrils (SF) before Fe_2O_3 sputtering.

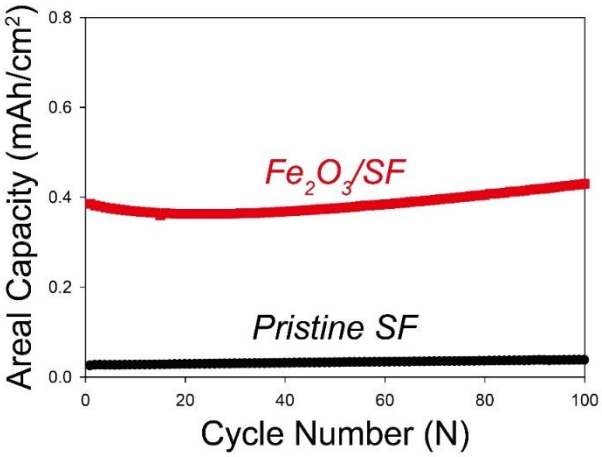

Figure S2. Cycling performance of Fe_2O_3/SF and pristine SF at 0.16 mA/cm^2.

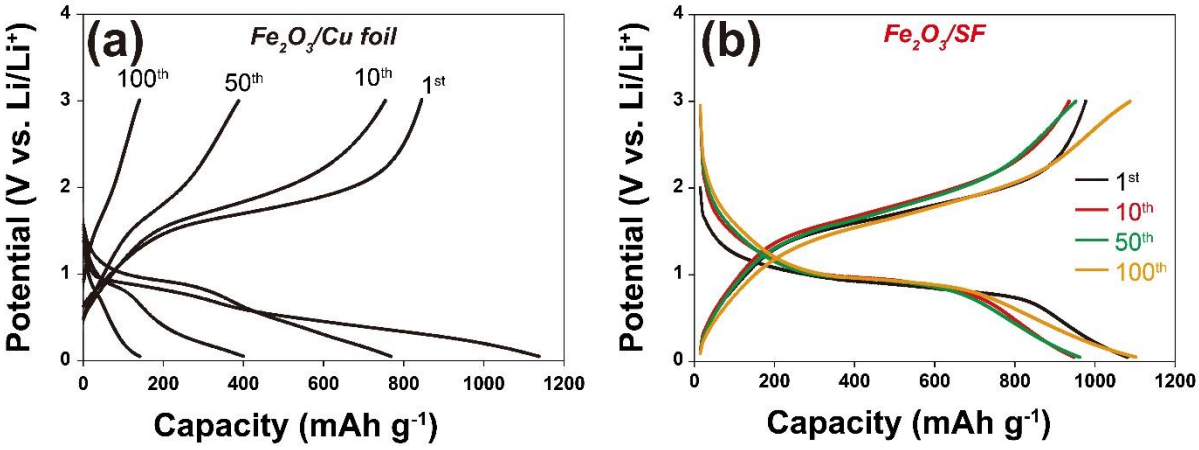

Figure S3. Potential profiles of (a) the Fe_2O_3/Cu foil and (b) the Fe_2O_3/SF electrode (the numbers indicate cycle number) at 400 mA g^{-1}.

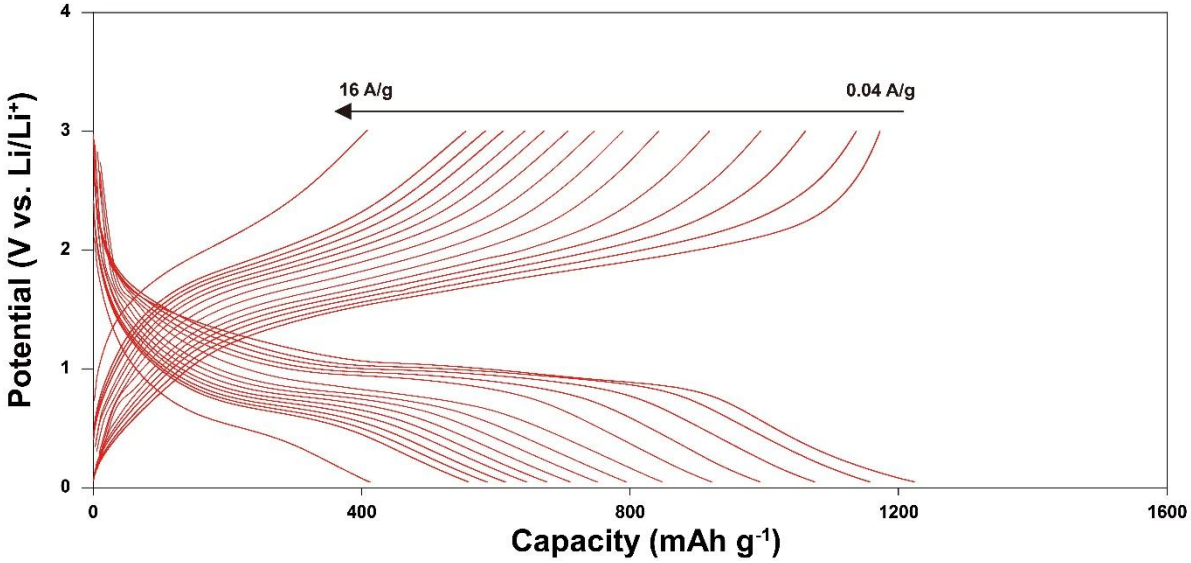

Figure S4. Potential profiles of the Fe_2O_3/SF electrode measured at a series of current rates.

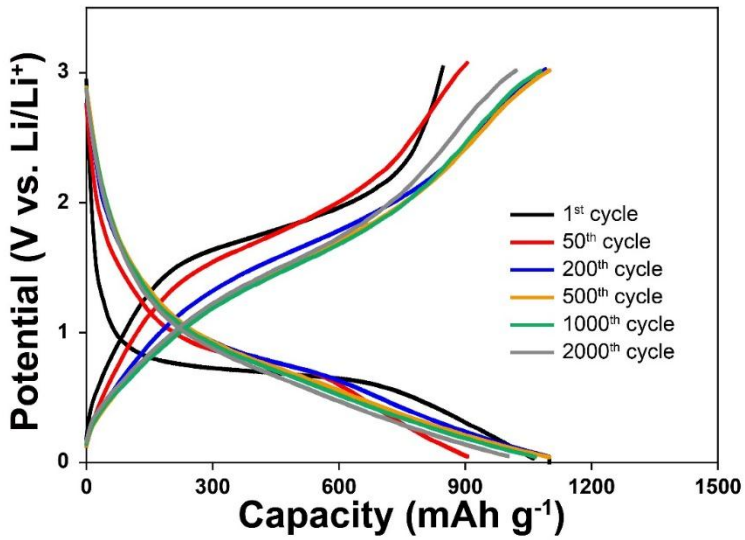

Figure S5. Potential profiles at 8000 mA g^{-1} of the Fe_2O_3/SF electrode (the numbers indicate cycle number).

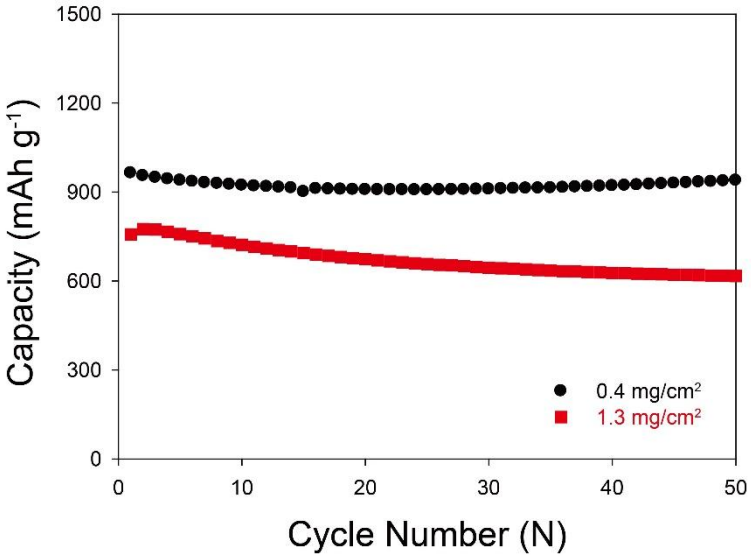

Figure. S6. Cycling performances of the unit cells using Fe_2O_3/SF based on different mass loadings of Fe_2O_3.

Reference	Anode Materials	Rate Capability (mAh/g)	Reversible Capacity (mAh/g)
In this work	**Fe_2O_3/SF**	**~710 @ 4 A/g**	**~ 1000 @ 8 A/g after 2000 cycles**
		~560 @ 8 A/g	
		~420 @ 16 A/g	
#1	α-Fe_2O_3/RGO composite	~332 @ 10 A/g	~ 516 @ 3 A/g after 150 cycles
#2	Mesoporous Fe_2O_3	~424 @ 10 A/g	~ 911 @ 0.2 A/g after 50 cycles
#3	C/α-Fe_2O_3 nanotube arrays	~250 @ 8 A/g	~ 659 @ 0.1 A/g after 150 cycles
#4	Hierarchical Hollow Spheres of Fe_2O_3@PANI	~724 @ 10 A/g	~ 893 @ 0.1 A/g after 100 cycles
#5	a-Fe_2O_3 xerogel	~280 @ 10 A/g	~ 600 @ 5 A/g after 1000 cycles
#6	Fe_2O_3-GNS	~633 @ 5 A/g	~ 633 @ 5 A/g after 100 cycles
#7	Fe_2O_3/graphene	~420 at 5 A/g	~ 800 at 0.2 A/g after 100 cycles
#8	Fe_2O_3 nanorods on CNFs	~245 at 10 A/g	~ 758 at 0.2 A/g after 50 cycles

Table S1. Summary of previous studies on electrochemical performances of various Fe_2O_3 anode materials.

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