Bottom-up *in-situ* Formation of Fe$_3$O$_4$ Nanocrystals in A Porous Carbon-Foam for Lithium-Ion Battery Anode Application

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**Supplementary Information**

**Energy-dispersive X-ray analysis of carbon foam (CF)**

The removal of silica template (80nm, Nanostructured & Amorphous Materials Inc. USA) in the silica/carbon composite was examined by energy-dispersive X-ray analysis (EDX) measurement. The EDX spectra (Figure S1) examined on a large and a spot area on the CF revealed that the silica template was removed completely by HF etching followed by repeated DI washing.

![Energy-dispersive X-ray analysis of carbon foam. EDX scan on a large (left column) and a spot area on the carbon foam (right column), showing the complete removal of silica template by HF etching followed by repeated DI washing.](Figure S1)

**Figure S1.** Energy-dispersive X-ray analysis of carbon foam. EDX scan on a large (left column) and a spot area on the carbon foam (right column), showing the complete removal of silica template by HF etching followed by repeated DI washing.
**FE-SEM images of carbon foam (CF)**

![FE-SEM images of carbon foam (CF)](image)

**Figure S2.** FE-SEM images of CF obtained at low (left) and high magnification (right). In the high magnification image, pores generated by silica nanoparticles of 80 nm can be observed together with large pores generated by aggregates of silica nanoparticles.

**Magnetic property of Fe₃O₄/CF**

![Magnetic property of Fe₃O₄/CF](image)

**Figure S3.** Photograph of Fe₃O₄/CF powder attached on a glass vial wall by a permanent magnet.

**TEM image of Fe₃O₄/CF**

In the Fe₃O₄/CF sample, some of large Fe₃O₄ nanocrystals formed on the surface of CF are observed as shown in Figure S4. From the TEM observation, about 10% of Fe₃O₄ nanocrystals are present on the external surface of CF. Better controlled impregnation of Fe(NO₃)₃ solution (impregnation of smaller portion of Fe(NO₃)₃ solution at a time) can prevent Fe₃O₄ nanocrystals formation on the external surface of CF thus can give more stable cycling performance of Fe₃O₄/CF.
Figure S4. FE-SEM images of Fe₃O₄/CF showing large Fe₃O₄ nanocrystals formed on the external surface of CF.

XPS analysis of Fe(NO₃)₃/CF
To obtain surface chemical information of Fe(NO₃)₃/CF sample, XPS analysis was conducted and the spectrum is shown in Figure S5. The O1s peak at 530.71 eV is predominant in the sample and the N1s peak is observed at 405.55 eV. Fe shows two peaks at 710.3 and 724.5 eV, corresponding to trivalent Fe₂p₃/2 and Fe₂p₁/2, respectively (inset of Figure S5). From the peak area of O1s and from the area ratio of N1s to Fe₂p₃, Fe is present presumably in the form of Fe(NO₃)ₓ(OH)ᵧ·zH₂O in the Fe(NO₃)₃/CF.

Figure S5. XPS spectrum obtained on the Fe(NO₃)₃/CF sample. Inset shows trivalent Fe₂p₃/2 and Fe₂p₁/2 peaks at 710.3 and 724.5 eV, respectively.
Figure S6. Cyclic voltammograms of (a) Fe₃O₄ nanocrystals and (b) Fe₃O₄/CF. Black line denotes for the 1ˢᵗ cycle and red line for the 2ⁿᵈ cycle.