Metal Powder-Pure Water System for Rational Synthesis of Metal Oxide Functional Nanomaterials: a General, Facile and Green Synthetic Approach

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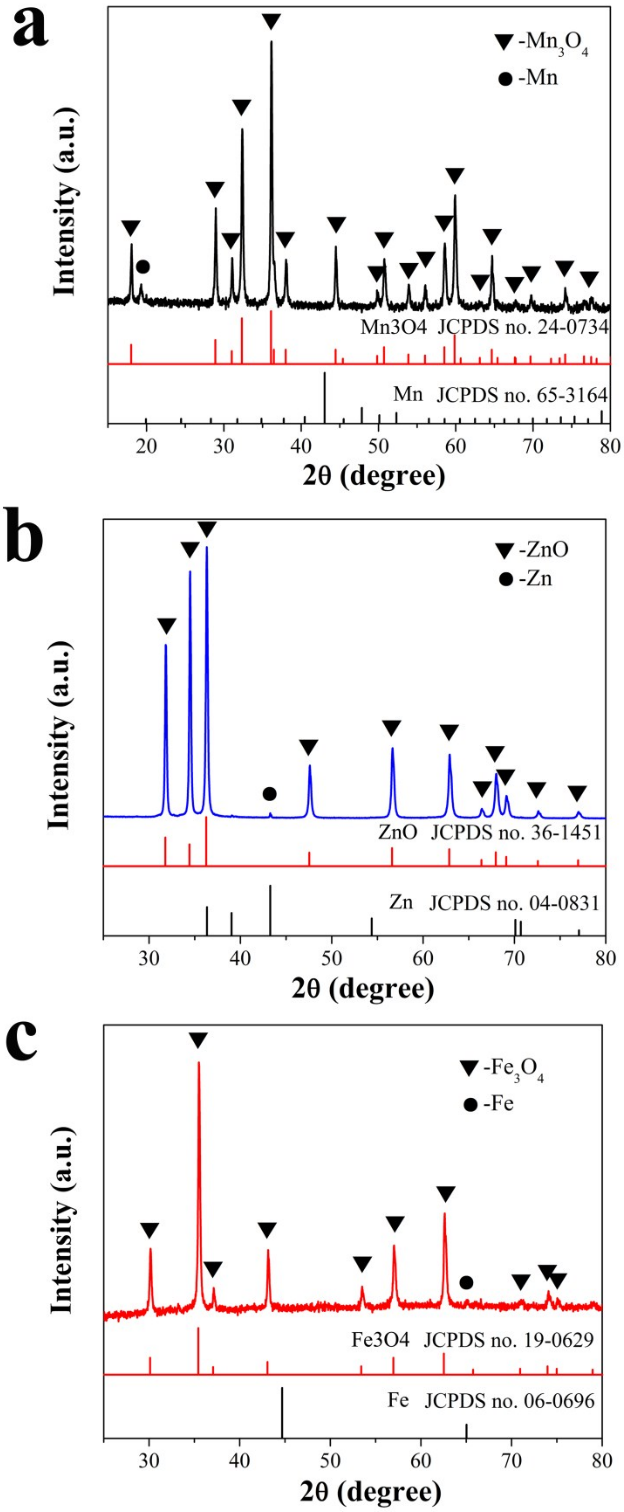

Figure S1. XRD patterns of the samples prepared by *metal powder-pure water* hydrothermal treatments: (a) Mn powder, (b) Zn powder, and (c) Fe powder.

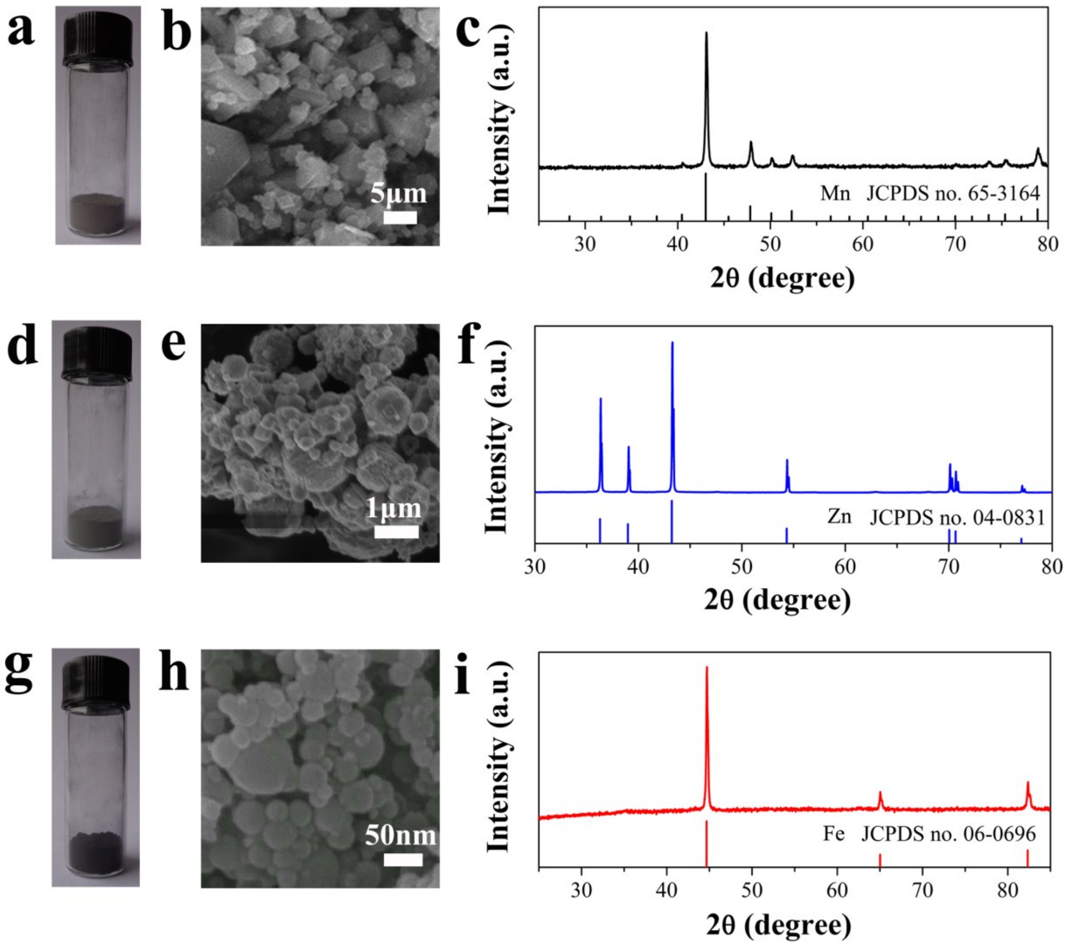

Figure S2. Photographs, SEM images and XRD patterns of the raw metal powders: (a-c) Mn, (d-f) Zn, and (g-i) Fe.

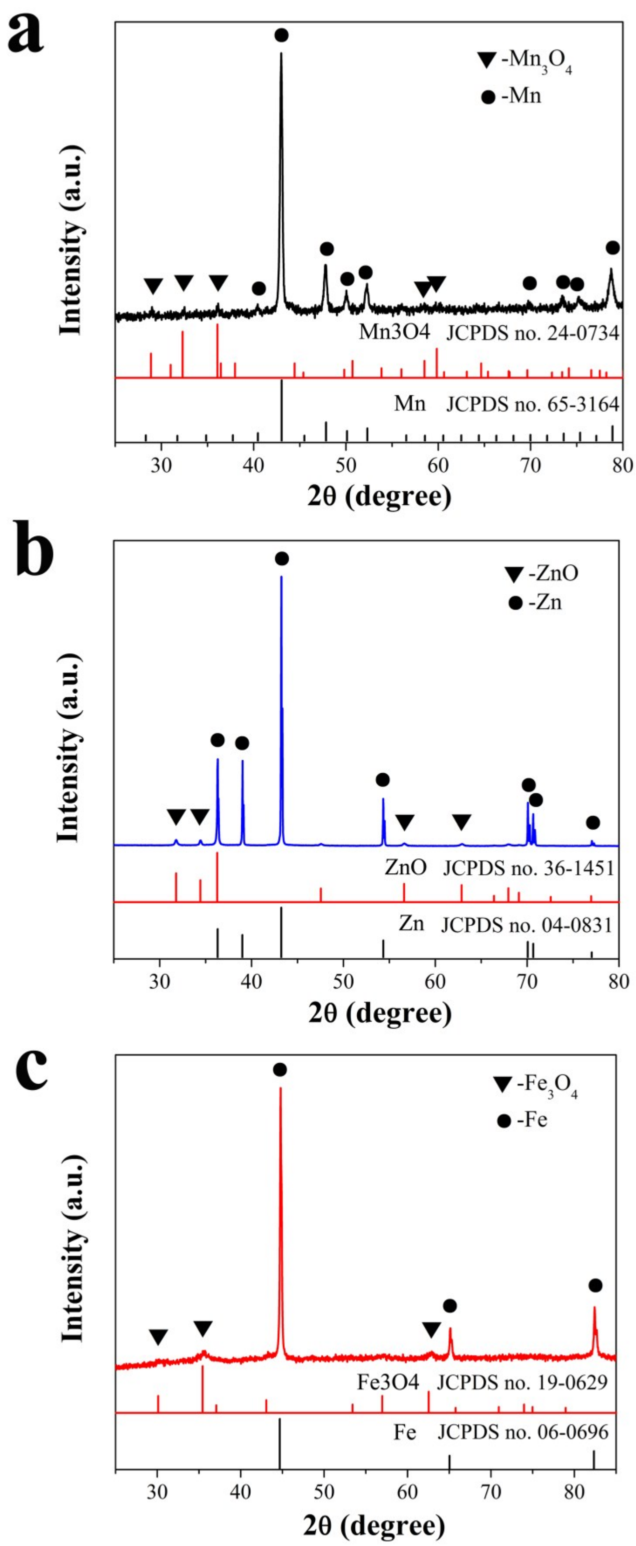

Figure S3. XRD patterns of the samples after the UAPO step: (a) Mn powder, (b) Zn powder, and (c) Fe powder.

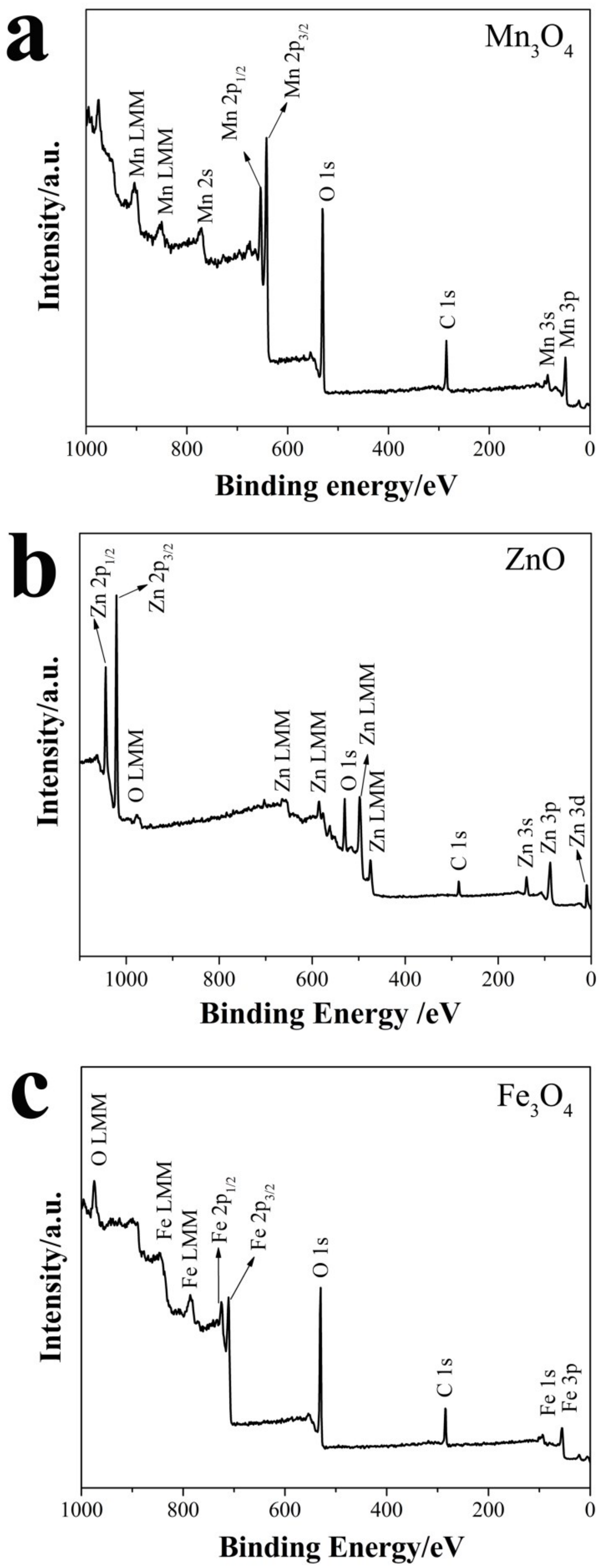

Figure S4. XPS survey spectra of the as-prepared samples: (a) Mn_3O_4, (b) ZnO, and (c) Fe_3O_4.

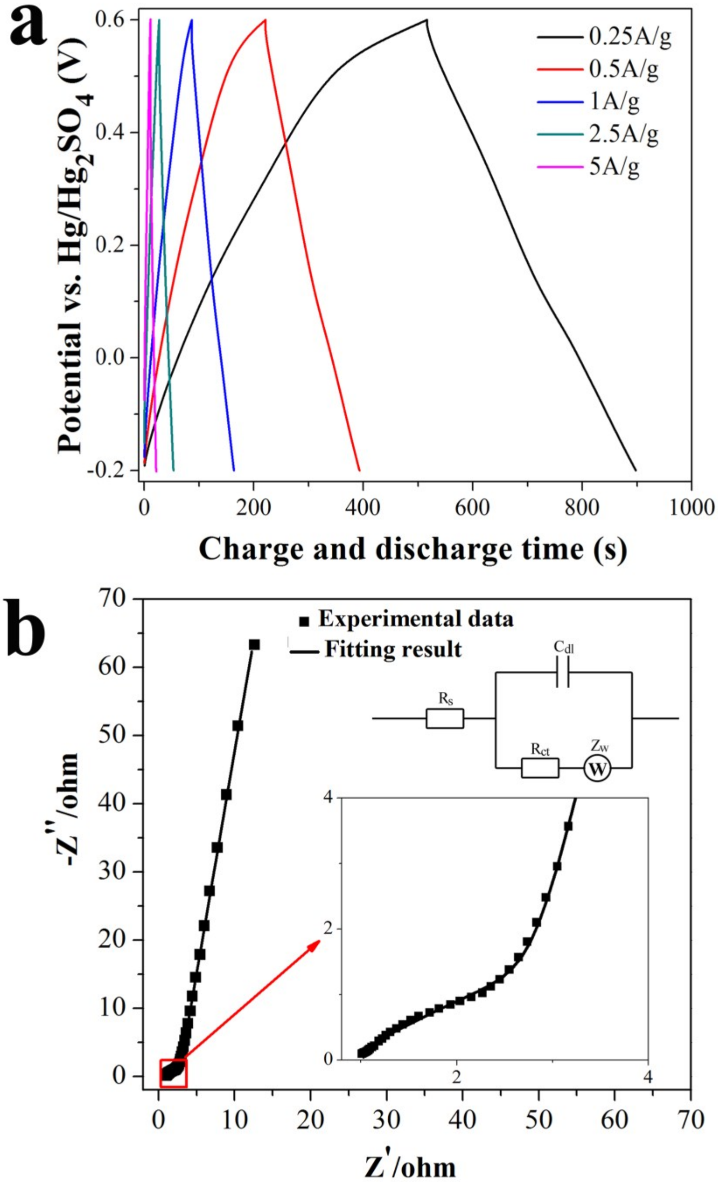

Figure S5. Some electrochemical characterization results of the as-prepared Mn_3O_4 as a supercapacitor electrode material. a: galvanostatic charge-discharge curves, b: EIS spectra at open circuit potential with a bottom inset for an enlargement of the high-frequency region and a top inset for the equivalent electrical circuit used for fitting.

Electrochemical specific capacitance calculation details.

Calculation of specific capacitance (C_s, F g[-1]) in this work is based upon subtraction of the capacitance which belongs to the Ni foam current collector from the total capacitance of the as-prepared Mn_3O_4 electrode according to following equations:

(1) based upon the CV curves:[1,2]

$$C_s = \frac{Q}{\Delta V \times m} = \frac{1}{v \times m \times (V_c - V_a)} \int_{V_a}^{V_c} i(V) dV$$

where m is the mass of the Mn_3O_4 electroactive material in the electrode (g), v is the potential scan rate (V s^{-1}), V_a is the anodic potential (V), V_c is the cathodic potential (V), $i(V)$ is the response current density (A) and V is the potential (V).

(2) based upon the galvanostatic charge-discharge curves:[1-3]

$$C_s = \frac{I \times \Delta t}{m \times \Delta V}$$

where I is the discharge current (A), Δt is the discharge time (s), m is the mass of the Mn_3O_4 electroactive material in the electrode (g) and ΔV is the potential change during discharge (V).

Discussion on Figure S5.

Figure S5a illustrates the galvanostatic charge-discharge curves at different current densities, based upon which the specific capacitances are calculated to be 120, 106, 97, 82, and 68 F g^{-1} at current densities of 0.25, 0.5, 1, 2, and 5 A g^{-1}, respectively (the calculating details of the specific capacitances are described in the above part), in good agreement with those calculated from the CV results. The good supercapacitive performance of the as-prepared Mn_3O_4 material is further confirmed by the EIS result (Figure S5b), which displays a typical impedance characteristics for a capacitor.[4,5] Further deconvoluting the EIS spetra with the equivalent circuit illustrated in the top inset of Figure S5b, the equivalent series resistance R_s and charge transfer resistance R_{ct} respectively with the values of 1.02 Ω and 0.27 Ω can be obtained. The small R_{ct} value indicates the high charge-transfer rate between the electrolyte and the active material due to the nanorod morphology of the as-prepared Mn_3O_4 material, which is highly desirable for power density improvement.[6]

References

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