*Supporting Information*

# An Investigation on Morphology Effect in $Fe_2O_3$ Anodes for Lithium Ion Batteries

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## Experimental Section

### Synthesis of materials

Nano-structured $Fe_2O_3$ materials (nanorods, nanotubes, nanodisks and nanorings) were prepared by a hydrothermal method. Typically, $FeCl_3$ and $NH_4H_2PO_4$ were dissolved in 20 ml deionized water and reacted at 220 °C up to 48h in Teflon-lined stainless steel autoclaves (reaction conditions are shown in Table S1). Solid products were filtered and washed by deionised water and ethanol several times, and then dried at 50 °C. Final crystals were obtained by calcination at 500 °C for 5h.

### Characterisations

X-ray diffraction patterns of nano-structured $Fe_2O_3$ materials were obtained from a Siemens D5000 XRD device within $2\theta$ range from 20° to 70°. $N_2$ adsorption–desorption isotherms of $Fe_2O_3$ materials were measured by using a Micromeritics 3Flex analyzer at the testing temperature of 77 K. The BET surface area was calculated by Brunauer-Emmett-Teller (BET) method, using points at a relative pressure of $P/P^0$=0.05-0.27. The pore size distribution was derived from the adsorption branch using Barret-Joyner-Halenda (BJH) method. The morphology of mesoporous $SnO_2$/C was observed by a field emission scanning electron microscope

(FESEM, Zeiss Supra 55VP). The crystalline microstructures were observed by transmission electron microscopy (TEM) and high resolution TEM analysis (JEOL 2010, accelerating voltage 200kV).

**Cell assembly and electrochemical testing**

The nano-structured electrodes were fabricated by mixing the active materials with acetylene black (AB) and a binder, poly(vinylidene fluoride) (PVDF), at weight ratio of 40:40:20. The mixture was dispersed in *n*-methyl pyrrolidone (NMP) solvent to form a slurry. The slurry was uniformly pasted on Cu foil with a blade. The electrodes were dried at 120 °C in a vacuum oven for 12 hours and subsequently pressed under a pressure of 200 kg $cm^{-2}$. CR2032-type coin cells were assembled in a glove box for electrochemical characterization. A non-aqueous solution of 1 M $LiPF_6$ in a 1:1:1 of ethylene carbonate (EC), diethyl carbonate (DEC), and dimethyl carbonate (DMC) was used as the electrolyte (LB315, GuoTaiHuaRong Co. Ltd.). Li metal disks were used as the counter electrodes for electrochemical testing. Cyclic voltammetry (CV) curves were collected by an electrochemistry workstation (CHI660C) at scanning rate of 0.1 mV $s^{-1}$ within a range of 0.01-3.0 V. Specific capacities were calculated excluding the contribution of conductive carbon agent. The electrochemical impedance spectroscpoy of mesoporous $SnO_2$ and $SnO_2$/C were measured by a.c. impedance method with an applied frequency from 10m to 100k Hz at room temperature, using a CHI electrochemical station. For the active energy measurement, Nyquist plots were collected within the frequency range of 100m – 100k Hz, at different temperature of 35, 40, 45 and 50°C. The cells were galvanostatically charged and discharged at a current density of 0.1, 1 and 10 A $g^{-1}$ (approximate to 0.1C, 1C

and 10C) within the voltage range of 0.01–3 V. For high current testings, the first 3 cycles were tested at low current (0.1A $g^{-1}$) to activate electrode materials.

Table S1. Reaction conditions for hydrothermal syntheses of $Fe_2O_3$ nanorods, nanotubes, nanodisks and nanorings

| | $FeCl_3$ (mg) | $NH_4H_2PO_4$ (mg) | Tempreature ($^oC$) | Time (h) |
|---|---|---|---|---|
| Nanorods | 130 | 3.3 | 220 | 6 |
| Nanotubes | 130 | 3.3 | 220 | 48 |
| Nanodisks | 130 | 11.5 | 220 | 6 |
| Nanorings | 130 | 11.5 | 220 | 48 |

Table S2. BET surface area and pore size distribution of $Fe_2O_3$ nanorods, nanotubes, nanodisks and nanorings, calculated by the nitrogen sorption results.

| | BET Surface Area ($m^2/g$) | Pore Size Distribution (nm) |
|---|---|---|
| Nanorods | 42.4 | 2.3 |
| Nanotubes | 68.4 | 2.2 |
| Nanodisks | 52.1 | 2.4 |
| Nanorings | 89.6 | 2.5 |

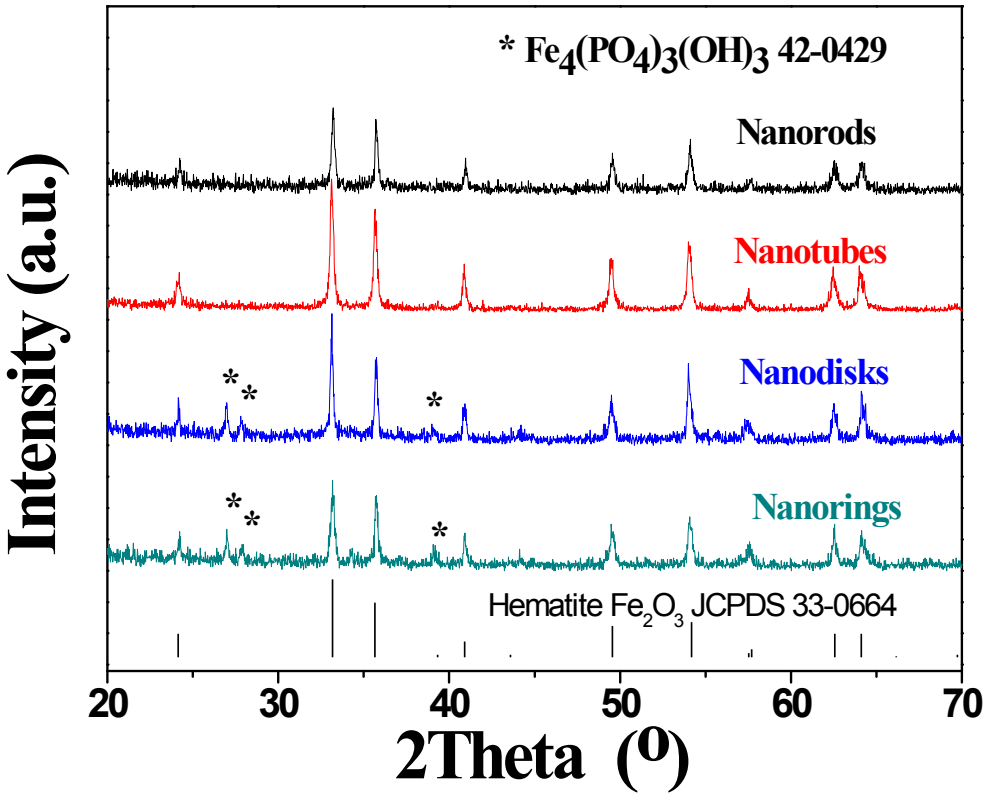


**Figure** S1. X-ray diffraction patterns of nanorods, nanotubes, nanodisks and nanorings $Fe_2O_3$ materials

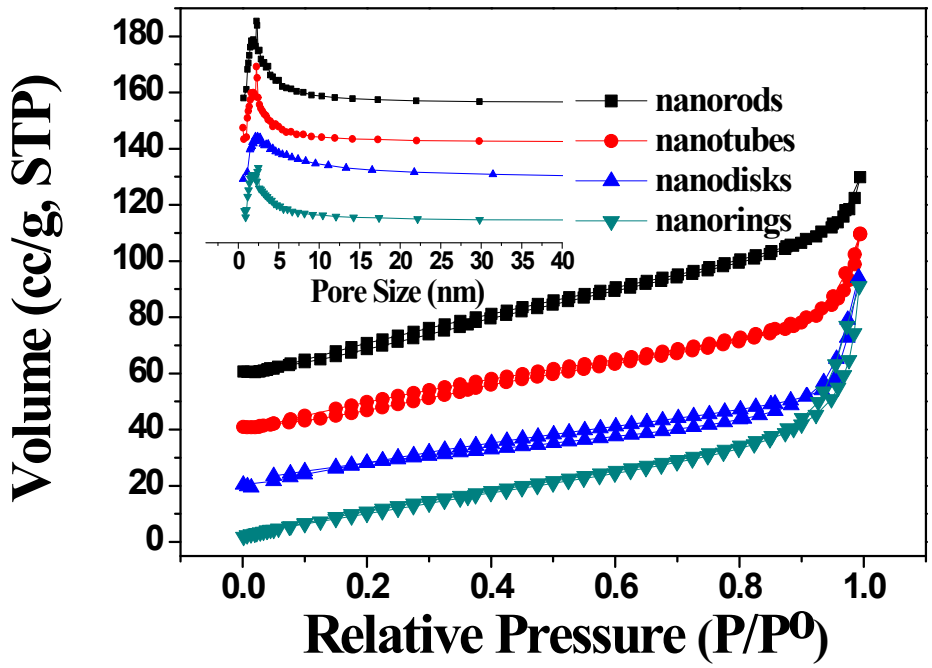


**Figure S2**. Nitrogen sorption isotherms and corresponding pore size distribution (inset) of nanorods, nanotubes, nanodisks and nanorings $Fe_2O_3$ materials. The curves are shifted upwards for clarity.

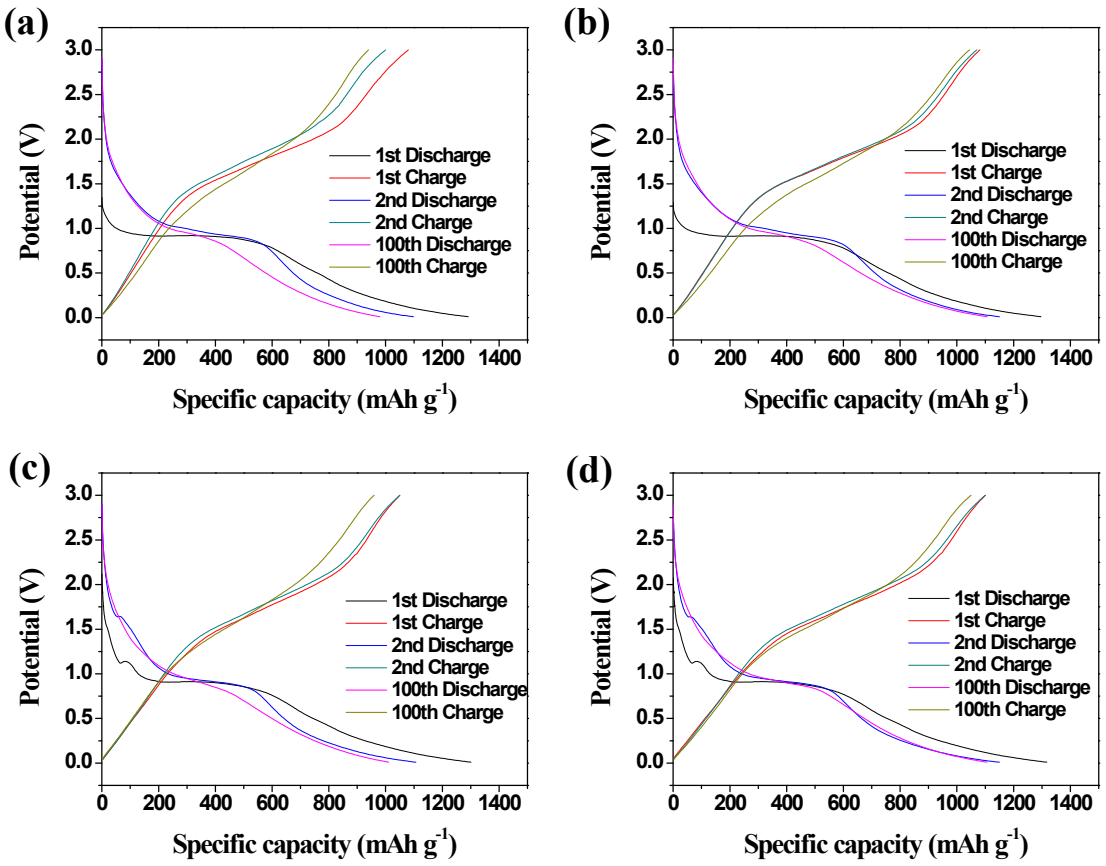


**Figure S3**. Charge/discharge curves of 1st, 2nd and 100th cycles of (a) nanorods, (b) nanotubes, (c) nanodisks and (d) nanorings, at 0.1C.