Supporting information for

Synthesis of N-doped carbon coated metal oxide nanoparticles for enhanced Li-ion storage ability

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Material and Chatacterization

Preparation of $Fe_3O_4@CN_y$ and $CoO_x@CN_y$

All chemicals were used as received without further purification. Chitosan (purchased from Alfa Aesar Co. Ltd.), placed parallel with a dosage of 1.25 g, were dissolved into acetic acid (HAc, 25 mL) and H_2O (75 mL) mixed solution, named solution A. Later, 8.08 g $Fe(NO_3)_3 \cdot 9H_2O$ added into solution A under vigorous stirring, and then a claybank colloid solution appeared in the reactor. The colloid solution was air dried at 353 K for 24 h. After that, the products were calcined at 773 K for 0.5 h with a heating rate of 2 K min^{-1} under the nitrogen flow. Finally, black N-doed encapsulated Fe_3O_4 nanoparticles (i.e., $Fe_3O_4@CN_y$-500-N_2) were abtained. Varying the final calciantion atmopshere to air or temperature to 673 and 873 K, the samples of $Fe_3O_4@CN_y$-500-air, $Fe_3O_4@CN$y-400-N_2 and $Fe_3O_4@CN_y$-600-N_2 were obtained. To prepare the material of $CoO_x@CN_y$-500-N_2, 5.82 g $Co(NO_3)_2 \cdot 6H_2O$ was used under the same synthesis process.

Electrode fabrication

The electrochemical rate-capability and cycling performance of samples were carried out with coin-shaped cells using a metallic lithium film as both the counter and reference electrodes. The mass of the Li metal was typically 15 mg, whereas the mass of samples ranged from 3 mg to 6 mg. The anode was prepared by a coating method, a slurry of 80% (weight percent) active material (the blue powder was ground and sieved before used), 10% conducting carbon black (Super P), and 10% polyvinyli-dene fluoride (PVDF) binder homogeneously mixed in N-methyl pyrrolidinone (NMP) were prepared into viscous slurries for efficient deposition. After the slurries was stirring on a magnetic stirring apparatus until the powder mixed uniformity. The slurries was coated on the copper foil by an automatic film editor, then dried in a vacuum oven at 393 K for 12 h, and cut into circular sheet. Then the

sheet was dried in a vacuum oven at 393 K for 12 h again. The cells were assembled into CR2016 coin cells in a glove box filled with pure argon, in which the moisture and oxygen was strictly controlled to less than 1 ppm. Microporous polypropylene film (Celgard2400) was used as the separator. The electrolyte was 1.0 mol L^{-1} $LiPF_6$ in a mixture of diethyl carbonate (DEC) and ethylene carbonate (EC) in the ratio of 1:1(w : w). The cells had a configuration of Li metal (−) | electrolyte | Sample (+), with a liquid electrolyte.

Characterization

The obtained products were characterized by X-ray powder diffraction (XRD) using a X‘Pert-ProMPD (Holand) D/max-γA X-ray diffractometer with Cu Kα radiation (λ ＝0.154178 nm). The XRD measurement conditions: the scanning current is 40 mA, the scanning voltage is 40 KV, the scanning step is 0.026 ^{o} and the scanning rate is 0.2626 ^{o} s^{-1}. Scanning electron microscopy (SEM) images and EDX were taken on a FEI-quanta 200F scanning electron microscope with acceleration voltage of 30 kV. Transmission electron micrographs (TEMs) were taken on a FEI-Tecnai F20 (200 kV) transmission electron microscope (FEI). X-ray Photoelectron Spectroscopy (XPS) was obtained by using a KRATOS Axis ultra-DLD X-ray photoelectron spectrometer with a monochromatised Mg Kα X-ray (hν = 1283.3 eV). XPS samples were prepared by drying a dispersion of micro-crystals on a piece of silicon wafer. Nitrogen adsorption-desorption isotherms were obtained using a ASAP2050 (Micromeritics Industrument Corp.) surface area & porosity Analyzer at 77 K. The specific surface area was calculated by the Brunauer-Emmett-Teller (BET) method. Thermogravimetric analysis (TGA) was carried out under a flow of air with a temperature ramp of 5 ℃ min^{-1}. The electrochemical properties of products were tested in CR2016 coin cells. All the measurements were controlled and recorded automatically by the LAND CT2001C charge-discharge detector (China, Wu han). Cyclic voltammetry (CV) tests were performed over the potential range of 0.01 - 3.00 V using a CHI660B electrochemical workstation.

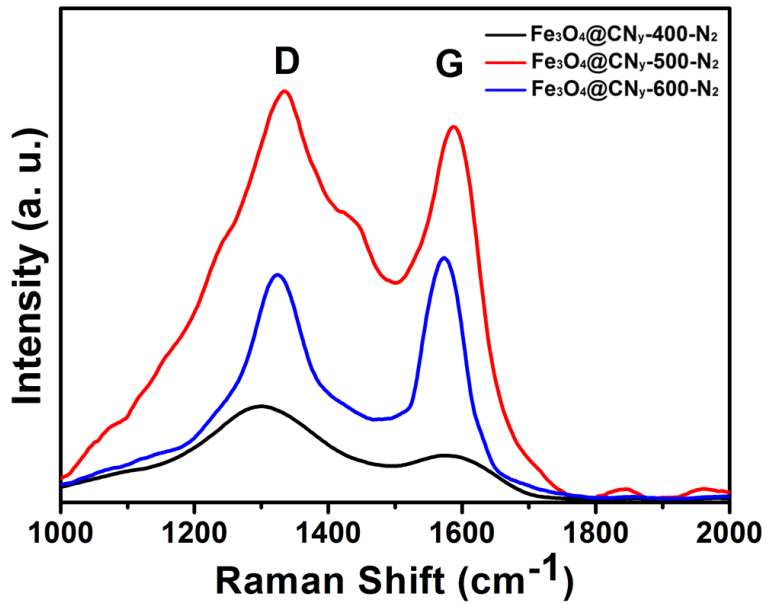

Fig. S1 Raman spectra of Fe_3O_4@CN_y-N_2 (400, 500, 600) after treated with HCl.

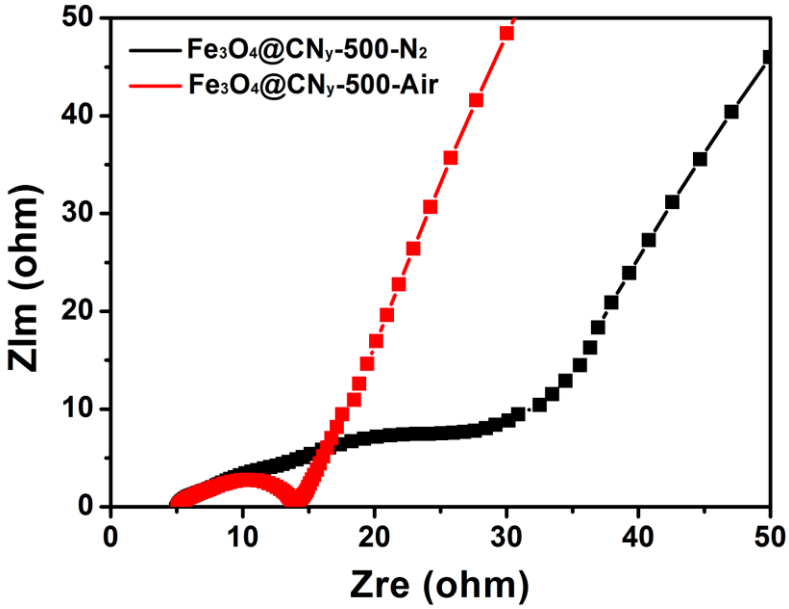

Fig. S2 Nyquist plots of Fe_3O_4@CN_y-500-N_2 and Fe_3O_4@CN_y-500-air electrodes after cycling at the current density of 50 mA g^{-1}.

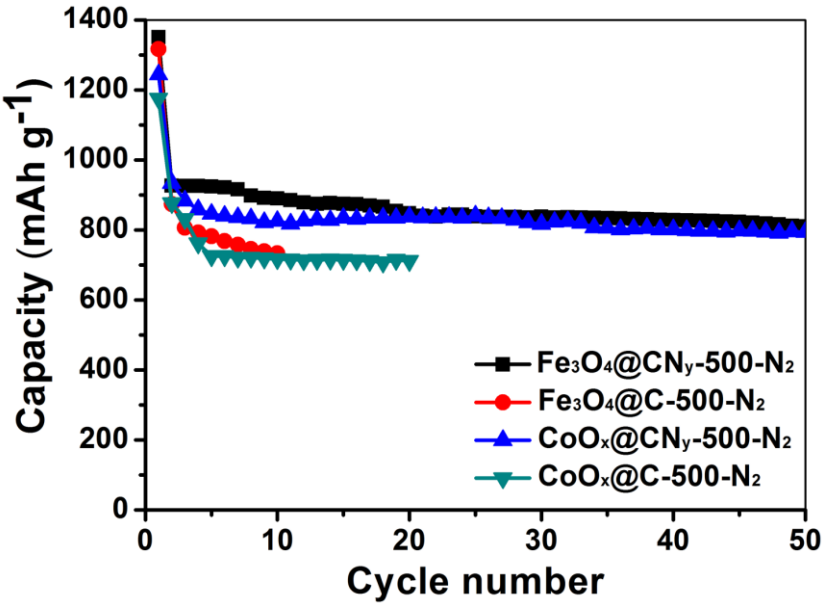

Fig. S3 Cycling performances at the current density of 50 mA g^{-1} of Fe_3O_4@CN_y-500-N_2, Fe_3O_4@C-500-N_2, CoO_x@CN_y-500-N_2 and CoO_x@C-500-N_2 electrodes.