

Fabrication and Application of Magnetite Coated N-doped Carbon Microtubes Hybrid Nanomaterials with Sandwich Structures

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Synthesis of MnO₂@N-doped carbon@MnO₂ microtubes

20 mg N-doped carbon microtubes were dispersed into 30 mL of 0.01M KMnO₄ solution under high power ultrasonication for 1h. Then, the mixture was transferred to a Teflon-lined stainless steel autoclave (50 mL capacity) and heated at 180 °C for 3 h. The product was obtained by centrifugation and dried at 60 °C for 12 h.

Synthesis of MoS₂@N-doped carbon@MoS₂ microtubes

30 mg of N-doped carbon microtubes were dispersed in 30 mL dimethylformamide(DMF), and then 64 mg of (NH₄)₂MoS₄ was added. The mixture was sonicated at room temperature for approximately 60 mins until homogeneous. After that, 1mL NH₃·H₂O was added, and the obtained suspension was sonicated for another 60 min. The mixture was then transferred and sealed in an autoclave with a Teflon liner and was heated at 200 °C for 15 h to yield a dark brown precursor. The precursor was collected by centrifugation and washed with deionized (DI) water for at least 5 times to ensure a complete removal of DMF. The dried precursor was calcined under nitrogen atmosphere at 700 °C for 1 h, with a heating rate of 1 °C min⁻¹.

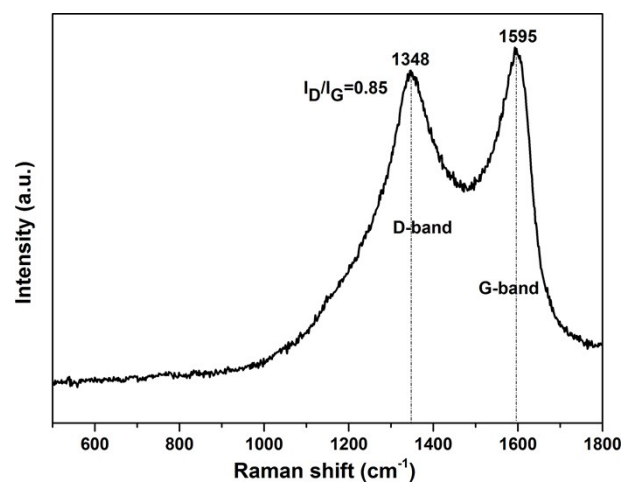


Fig. S1 Raman spectra for N-doped carbon microtubes.

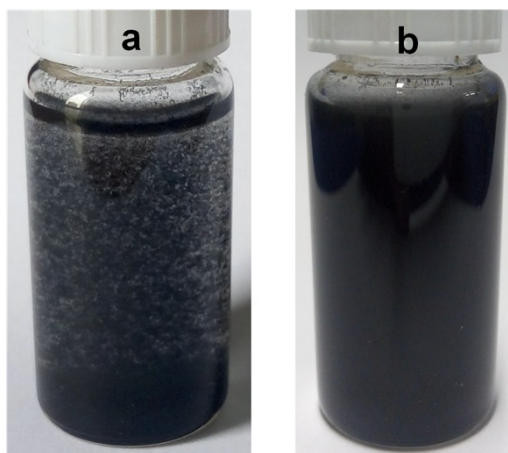


Fig. S2 The optical images of N-doped carbon microtubes(a) and Fe₃O₄@N-doped carbon@Fe₃O₄ microtubes(b) dispersed in water for 30 seconds.

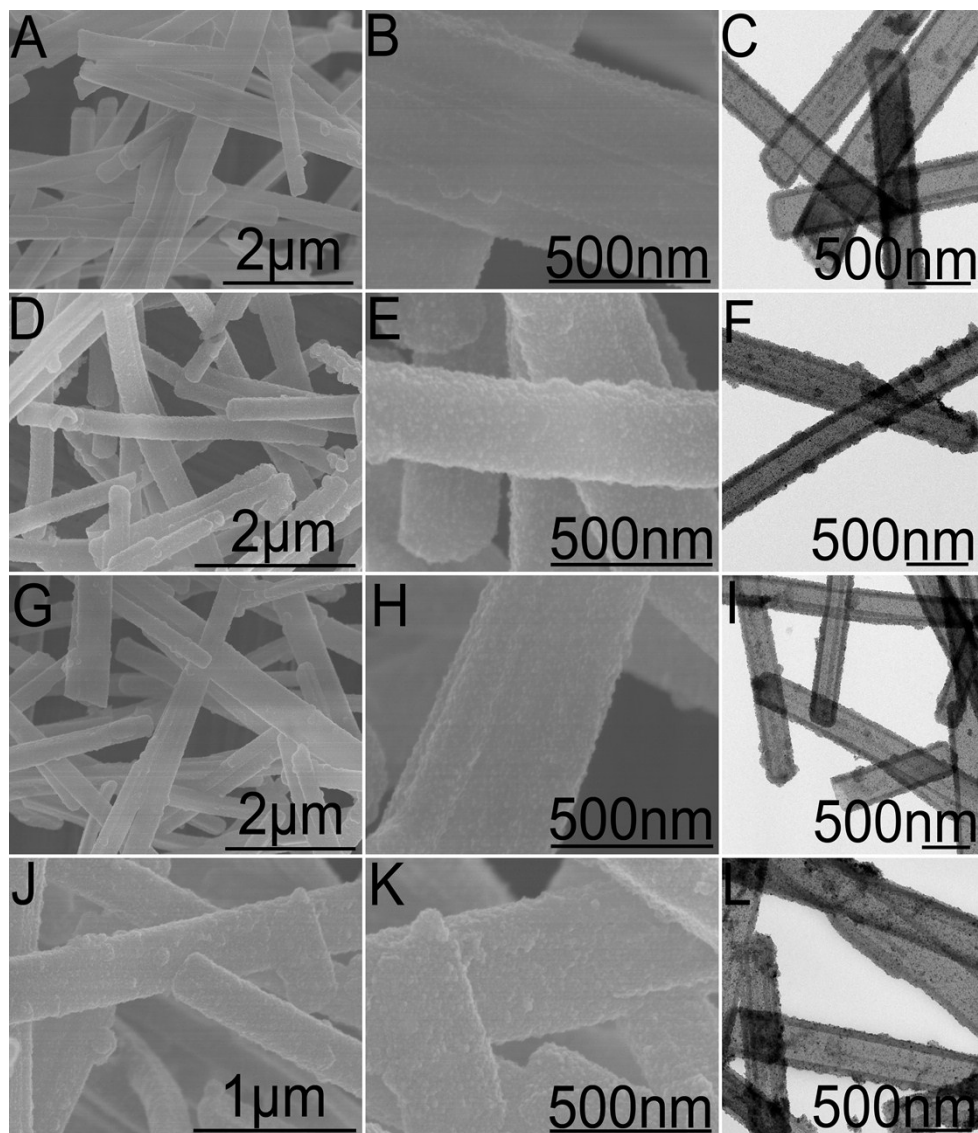


Fig. S3 The SEM and TEM images of Fe_3O_4 @N-doped carbon@ Fe_3O_4 microtubes with the different mass ratio of $\text{Fe}(\text{acac})_3$ to N-doped carbon microtubes, (A,B,C), 0.5:1; (D,E,F), 2:1; (G,H,I), 4:1; (J,K,L), 10:1.

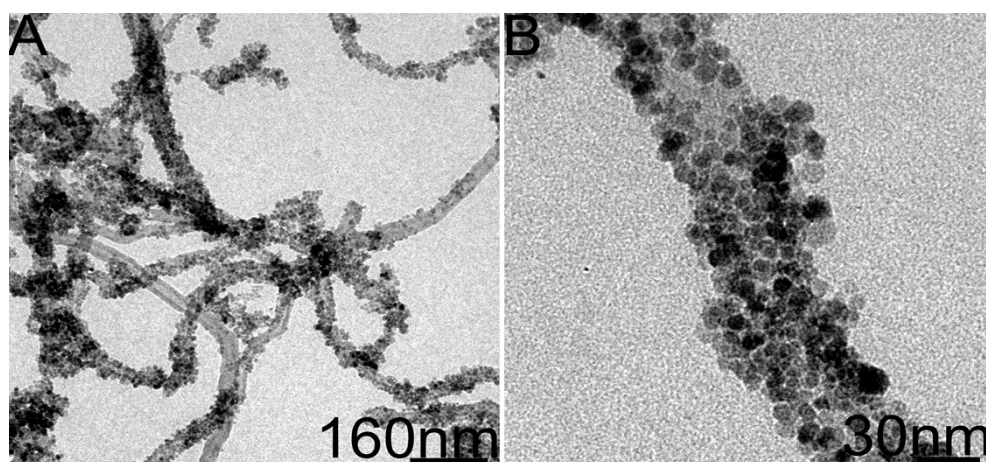


Fig. S4 The TEM images of Fe_3O_4 @CNTs with the 60~100 diameter CNTs as the templates.

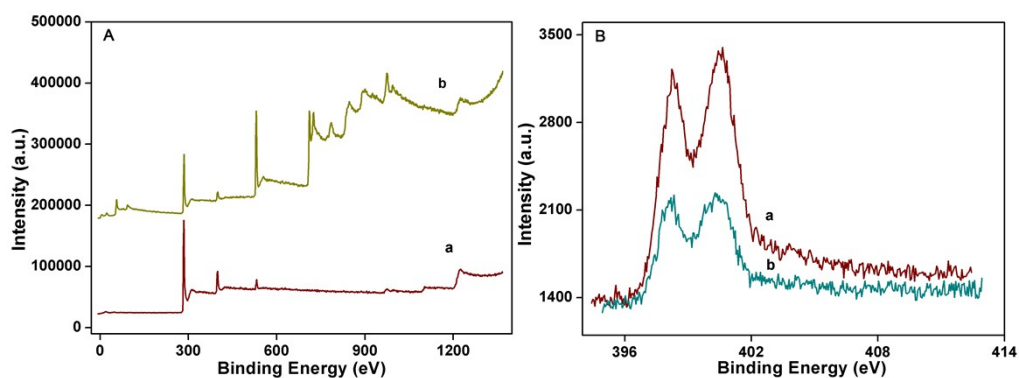


Fig. S5(A)The XPS spectra for the N-doped carbon microtubes(a) and Fe₃O₄@N-doped carbon@Fe₃O₄ microtubes (B)The N1s Spectra for the N-doped carbon microtubes(a) and Fe₃O₄@N-doped carbon@Fe₃O₄ microtubes(b).

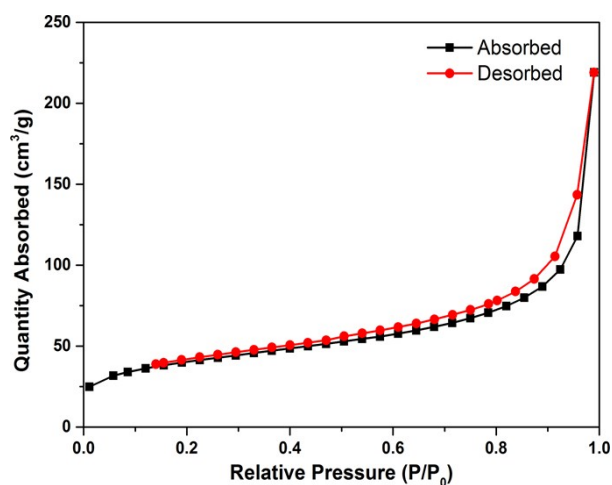


Fig. S6 N₂ adsorption/desorption isotherm of N-doped carbon microtubes.

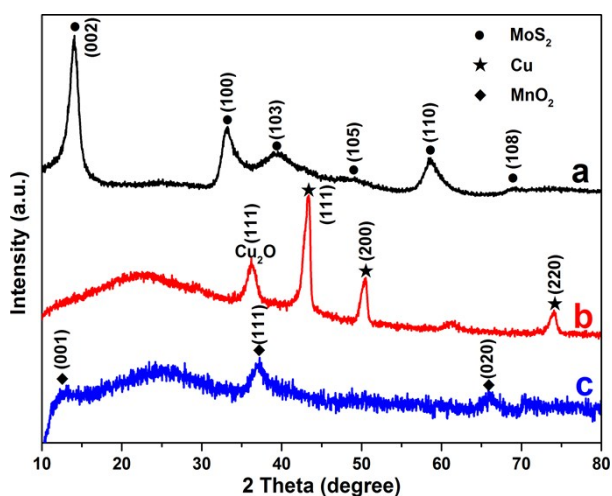


Fig. S7 X-Ray diffraction patterns of MoS₂@N-doped carbon@MoS₂ microtubes(a),

Cu(Cu₂O)@N-doped carbon@Cu(Cu₂O) microtubes (b) and MnO₂@N-doped carbon@MnO₂ microtubes(c).