

Fe₂O₃-Fe₃C heterostructure encapsulated into carbon matrix for lithium-ion battery anode

Experimental

Synthesis

1 g ferric chloride (Alfa Aesar Co.), 1 g melamine (Sinopharm Chemical Reagent Co.) and 1 g glucose (Sinopharm Chemical Reagent Co.) were added into 30 mL ethanol under stirring and heated to 80 °C until forming a uniform turbid liquid. The turbid liquid was moved into an oven and dried to powder at 80 °C. Then the powder was heated to 800 °C for 4 h in N₂ atmosphere with a heating rate of 4 °C min⁻¹. The prepared powder was Fe-Fe₃C@C. Fe₂O₃-Fe₃C@C, Fe₂O₃@C and Fe₂O₃ were obtained by calcining Fe-Fe₃C@C powder in the air at 400 °C for 3 h and 5 h and 800 °C for 3 h, respectively, with 5 °C min⁻¹ heating rate. The Fe₃C@C was obtained by stirring Fe-Fe₃C@C in 50mL 4wt% HCl for 6h.

Characterization

Powder X-ray diffraction data was obtained by a D/max-2200/PC (Rigaku, Japan) with Cu K α radiation at 3 KW at a scan rate of 2° min⁻¹. A ZESS scanning electron microscope (SEM) was used to investigate the morphology. The micro morphology and lattice fringes were observed by a TEM. An TGA/SDTA851 (METTLER TOLEDO, China). Thermogravimetric analyzer (TGA) was used to observe the pyrolysis process with a heating rate of 10 °C min⁻¹ from 20 °C to 800 °C in the air. The X-ray photoelectron spectroscopy (XPS) data was provided by a Nexsa (Thermo Fisher, America).

Electrochemical Measurement

The electrode sheet is prepared by the following method: The test sample was mixed with conductive agent and the binder in the NMP at a mass ratio of 8:1:1, then the uniform slurry was spreaded on the copper foil with a 150 μ m preparer and dried for 8 h at 80 °C. Finally, the copper foil coated was cut into small discs with a diameter of 12 mm through a microtome. The coin cells were assembled in a glovebox (MBRAUN, Germany) filled with Ar gas, and using Li-metal as counter electrode, 1

M LiPF₆ in EC:EMC:DMC (1:1:1 in volume) as electrolyte, and polypropylene foil as the separator. The cycling, rating and GITT data of the cells were collected by a Land workstation (CT2001A, LAND, China). The CVs and EIS measurements were tested by an electrochemical analyzer (CHI760, China).

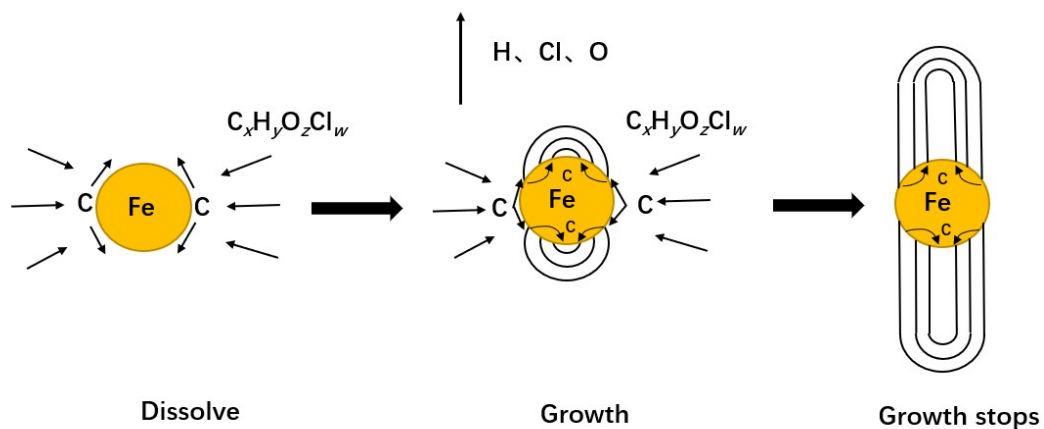


Fig S1. Growth mechanism for CNTs.

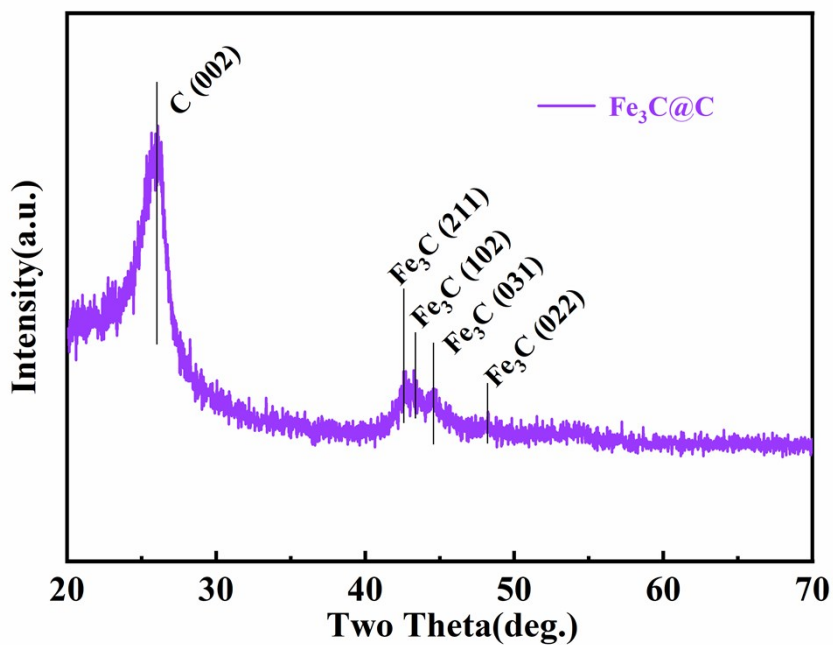


Fig S2. XRD diffraction patterns of $Fe_3C@C$.

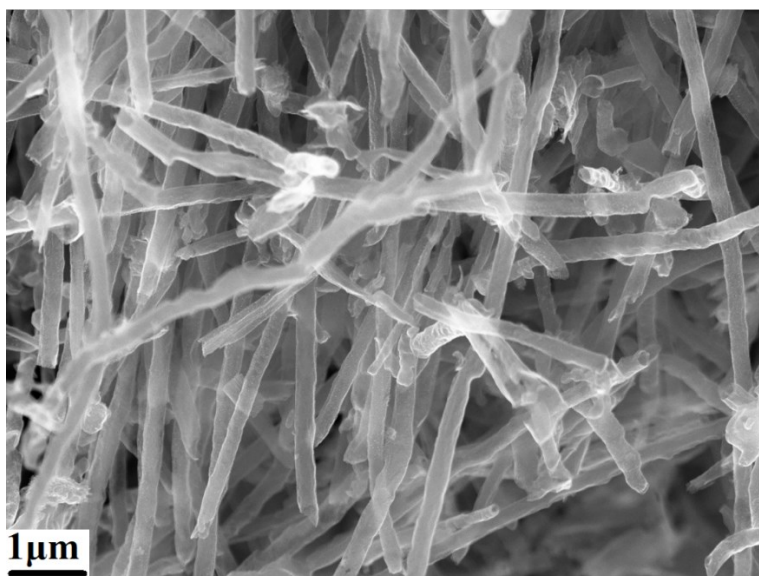


Fig S3. SEM image of $\text{Fe}_3\text{C}@C$

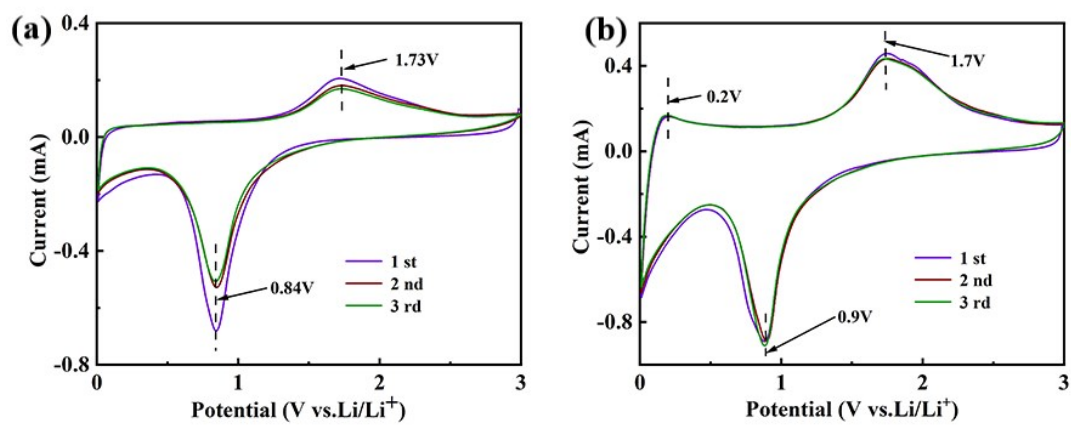


Fig S4. The CV curves of Fe_2O_3 and $\text{Fe}_2\text{O}_3\text{-Fe}_3\text{C}@C$.

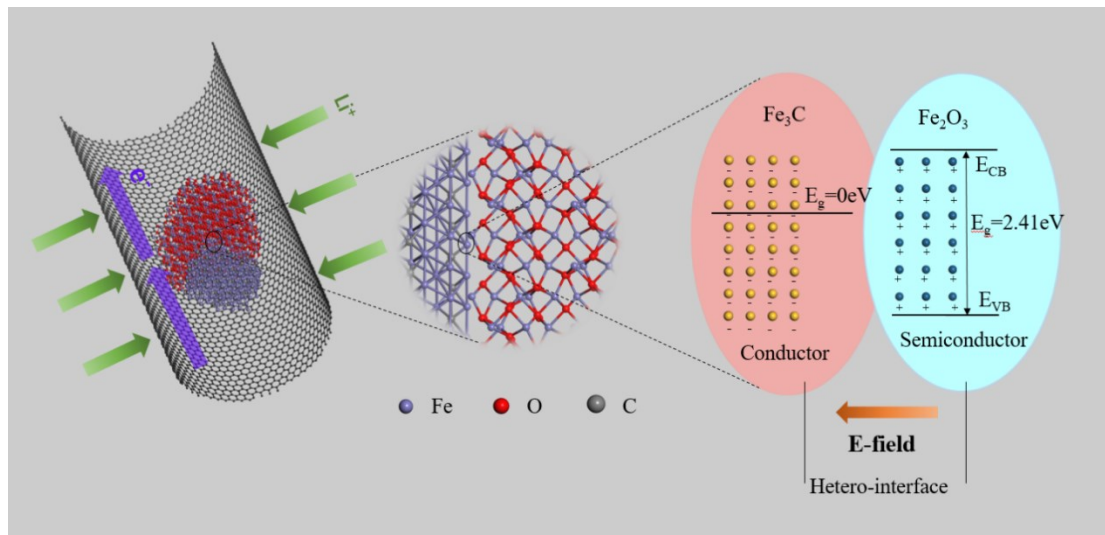


Fig S5. Schematic illustration of the internal E-field for the $\text{Fe}_2\text{O}_3\text{-Fe}_3\text{C@C}$ heterostructure.