

Supplementary Information

Iron sulfide-embedded carbon microsphere anode material with high-rate performance for lithium-ion batteries

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Figure S1 Scanning electron microscopic images (a and b) and transmission electron microscopic images (c and d) of PFe-S-CM.

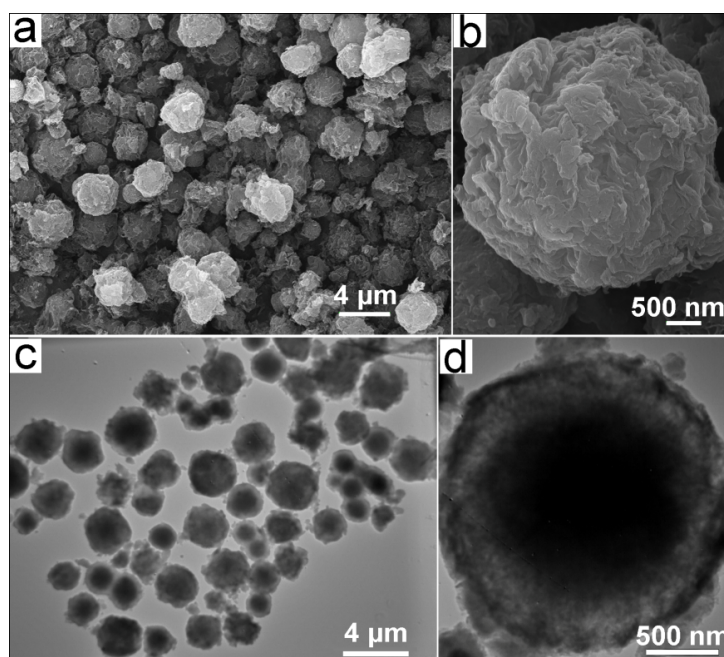


Figure S2 Thermogravimetric analysis of Fe-S-CM in air/argon atmosphere from room temperature to 1000 °C at 5 °C/min.

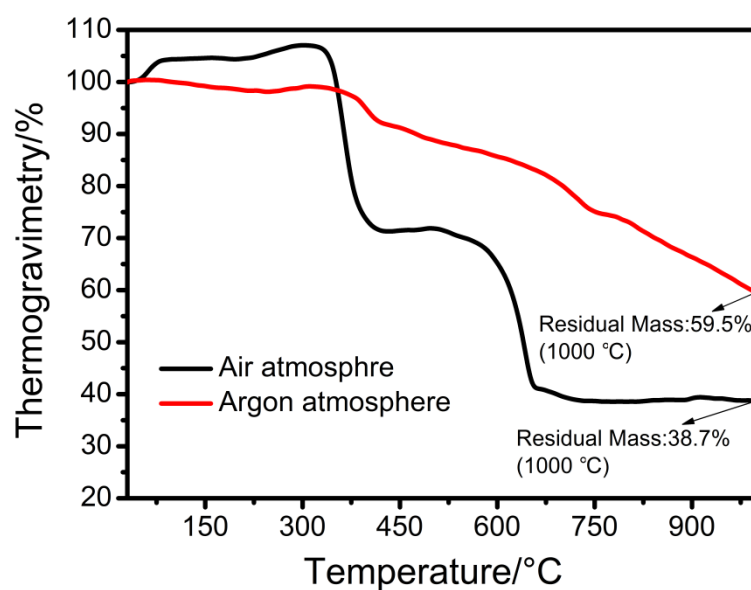
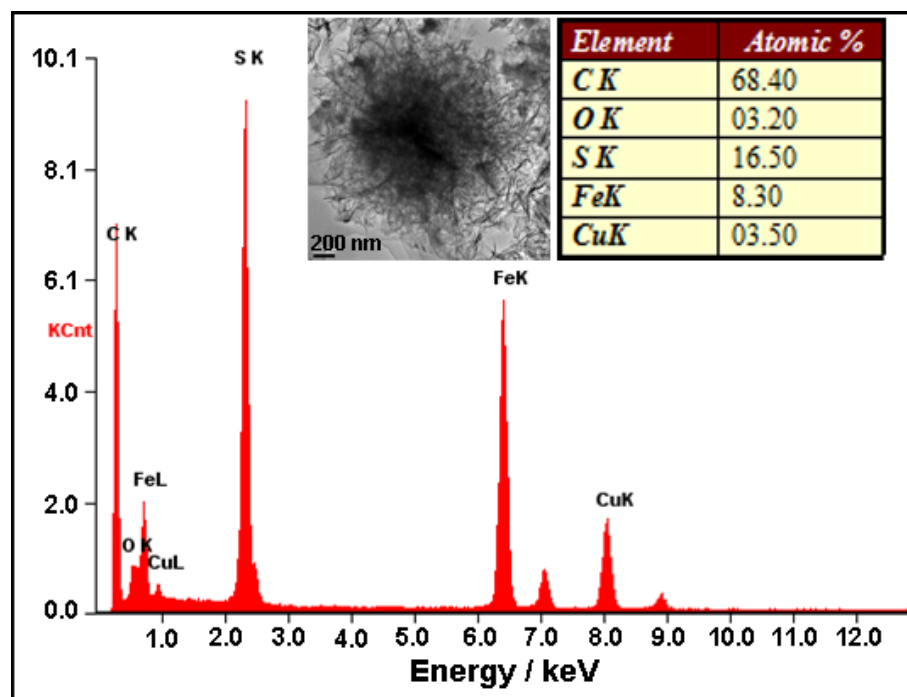


Figure S3 Energy dispersive X-ray analysis of Fe-S-CM. All the signals of elemental copper and oxygen and partial signal of elemental carbon come from the substrate (copper microgratings and polymer membrane) of HRTEM sample. The ratio of Fe/S from this spectrum coincides with that from TGA analysis. (The inserted HRTEM image in spectrum is the selected area for energy dispersive X-ray analysis)



Experimental Information

Characterizations:

X-ray diffraction (XRD) measurements were performed with a Rigaku D/max-2500B2+/PCX system using CuK α radiation ($\lambda=1.5406$ Å) over the range of 5-90° (2 θ) at room temperature. The weight ratio of iron sulfide and Fe/S ratio in Fe-S-CM were calculated by residual/losing mass of thermogravimetric analysis (TGA; Netzsch STA-449C) from room temperature to 1000 °C by the programming rate of 5°C/min. The morphologies and structures of Fe-S-CM were observed by Zeiss Supra 55 scanning electron microscope (SEM), Hitachi H-800 transmission electron microscope (TEM) and JEOL JEM-2100 high resolution transmission electron microscope (HRTEM). The energy dispersive x-ray analysis (EDAX) of Fe-S-CM was carried out via JEOL JEM-3010 HRTEM. Samples for TEM and HRTEM observation were prepared by dispersing products in ethanol with an ultrasonic bath for 15 min and then a few drops of the resulting suspension were placed on a copper grid.

Electrochemistry:

The electrochemical performance of composite electrode was measured with a two-electrode system. Lithium sheet was used as counter electrode, and composite electrode comprising PFe-S-CM or Fe-S-CM (80.0 wt. %), acetylene black (10.0 wt. %) and polyvinylidene fluoride (10.0 wt. %) binder was used as working electrode. 1 M LiPF₆ solution in a 1/1 (volume ratio) mixture of ethylene-carbonate and dimethyl-carbonate was used as electrolyte. Celgard® monolayer polypropylene was used as the separator of our test system. All the above mentioned elements were finally encapsulated into a CR2032 button battery as a system. The construction of all the test batteries was carried out in an argon-filled glove box where H₂O and O₂ content were controlled below 1 ppm. The test battery was galvanostatically charged and discharged between 0.01 and 2.50 V vs. Li/Li⁺ at 50, 500, 1000 and 5000 mA/g by LAND CT2001A System (Wuhan, China) at room temperature. Cyclic voltammetry (CV) test and electrochemical impedance spectra (EIS) were carried out with an electrochemical workstation (CH Instruments CHI660B, Shanghai, China).