A mesoporous carbon with graphitic structure prepared and used in Li-S Batteries

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Rechargeable lithium/sulfur (Li/S) batteries have high potential for energy storage devices with high theoretical specific capacity of 1675 mAh g⁻¹ and high specific energy density of 2600 Wh Kg⁻¹ [1]. Despite the great promises, nature sulfur is highly insulating and the “shuttle mechanism” [2] lead to low utilization of active materials in the cathode. Efforts of addressing these challenges have focused on loading sulfur into conductive porous carbon matrix, especially on mesoporous carbon [3-4]. And increasing the graphitization of mesoporous carbon, is expected to enhance their electrical conductivity, which is significantly to reduce resistance of electron transfer [5].

In this work, mesoporous carbon with graphitic structure (G-MC) have been synthesized by a two-step route, which is an in situ MgO template method (simultaneous template and carbonization) without the need for metal catalyst and activation processes. The magnesium citrate is used as the precursor of carbon and provide nanometer sized MgO particles template. Then, MC is graphitized at a high temperature of 2000 ℃.

The surface area, pore volume, and pore size distribution analyses obtained from nitrogen sorption isotherms give more direct evidence of the encapsulation of sulfur inside G-MC materials. As shown in Fig. 1, pore diameter, BET specific surface area and pore volume of G-MC is ~3.82 nm, ~920 m²/g and ~1.73 cm³/g, respectively. After sulfur loading, the BET surface area and pore volume decrease dramatically which give more direct evidence of the encapsulation of sulfur inside G-MC material.

The HTEM was carried out in order to further confirm the mesoporous structure of G-MC. In Fig. 2 (a), it clearly shows that the resultant G-MC possesses a 2D hexagonal mesostructure and the walls are graphitized.

The curves in Fig. 4 (a) have two potential plateaus. The upper plateau at 2.3 V corresponds to the reduction of elemental sulfur (S₈) to highly oxidized polysulfides, the plateau at 1.75 V indicates the reduction of highly sulfides to lower sulfides and Li₂S or Li₂S₂. Compared to MC/S, the 2000 ℃ G-MC/S composites has achieved high discharge capacity of 1169mAh/g at current density 200mA/g, which can be concluded that mesoporous carbon with graphitic structure can accelerate the kinetic process of the electric conductivity in the electrodes and improve electrochemical performance.

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