Graphene-like porous carbons as a sulfur host for lithium-sulfur batteries

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Lithium-sulfur batteries (LSBs) are recognized as the next generation energy storage systems due to their high theoretical capacity of 1675 mAh g^{-1} and energy density of 2600 Wh kg^{-1}. However, such disadvantages as low sulfur electrical conductivity, polysulfides shuttle effect and volume expansion are limiting their practical application.

Herein, the advantages of using bio-waste-derived graphene-like porous carbons (GPCs) as a carbon matrix for sulfur immobilization are discussed. GPCs were obtained by carbonization of pre-washed, dried and milled rice husk wastes at 500 °C in inert atmosphere and thermo-chemical activation (750 °C, Ar atmosphere) of the formed carbonaceous product by using KOH as an activator. According to peaks intensities of Raman spectrum, the prepared GPCs are characterized by presence of reduced graphene oxide in the structure, the ratio of intensities of 2D band to G band (I_{2D}/I_G) is equal to 0.74, corresponding to the formation of a few-layered graphene structure. Based on TEM observations, the GPCs are presented by flake-like hierarchical porous structure, the presence of disordered transparent and well-formed graphene layers, which lie on top of each other was observed. The sulfur was immobilized on the formed carbon matrix by melt-diffusion and mechanochemical methods. As a result, the sulfur content in the matrix was 68-70 wt%.

The electrochemical performance was studied by CV, which demonstrated the good reversibility of sulfur reduction and lithium polysulfides oxidation. Further research will be focused on the preparation of composite GPCs with various modifiers (MXene, metal oxides) to create the additional sites for chemical adsorption of polysulfides and reduce the shuttle effect.

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