Direct pyrolysis and ultrasound assisted preparation of N, S co-doped graphene/Fe_3C nanocomposite as an efficient electrocatalyst for oxygen reduction and oxygen evolution reactions

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ABSTRACT

Bifunctional electrocatalysts to enable efficient oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) are essential for fabricating high performance metal–air batteries and fuel cells. Here, a defect rich nitrogen and sulfur co-doped graphene/iron carbide (NS-GR/Fe_3C) nanocomposite as an electrocatalyst for ORR and OER is demonstrated. An ink of NS-GR/Fe_3C is developed by homogeneously dispersing the catalyst in a Nafion containing solvent mixture using an ultrasonication bath (Model-DC150H; power − 150 W; frequency − 40 kHz). The ultrasonically prepared ink is used for preparing the electrode for electrochemical studies. In the case of ORR, the positive half-wave potential displayed by NS-GR/Fe_3C is 0.859 V (vs. RHE) and for the OER, onset potential is 1.489 V (vs. RHE) with enhanced current density. The optimized NS–GR/Fe_3C electrode exhibited excellent ORR/OER bifunctional activities, high methanol tolerance and excellent long-term cycling stability in an alkaline medium. The observed onset potential for NS–GR/Fe_3C electrocatalyst is comparable with the commercial noble metal catalyst, thereby revealing one of the best low-cost alternative air–cathode catalysts for the energy conversion and storage application.

KEYWORDS

Electrocatalysis; Oxygen reduction and evolution; Energy conversion materials; Hetero atom-doped graphene; Iron carbide nanoparticles

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