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Enhanced ORR performance of Graphene Nanoribbons through strategic heteroatom doping

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Graphene nanoribbons (GNRs) are promising for catalytic applications due to their unique properties. This study explored the effects of heteroatom doping on the performance of GNR-based catalysts in oxygen reduction reactions (ORR). A series of N, S, and P-doped and co-doped carbon catalysts were developed using a single GNR matrix and evaluated for their impact on ORR activity and selectivity in different conditions [1]. The doping of GNRs with N, S, and/or P was performed through hydrothermal synthesis. The GNRs were mixed with different combinations of dopants (NH_4OH, $N_2H_6SO_4$, $K_2S_2O_8$, and P_2O_5) and water, followed by heating and stirring. The resulting product was then mixed with water and NH_4OH, heated in an autoclave system, and finally washed by centrifugation. The impact of N, S, and P doping and co-doping on the catalytic ORR activity and selectivity of GNRs in acidic, neutral, and alkaline media was analyzed. The characterizations revealed that doping introduced heteroatoms and depleted oxygen, with nitrogen being the most effective. Electrochemical analysis indicated that heteroatom insertion and oxygen depletion affected ORR selectivity. Nitrogen improved catalytic activity in high pH, while sulfur and phosphorus were effective in acidic media [2]. These findings suggest that doping can adjust the ORR pathway according to the desired product. By modifying the GNR surface chemistry through doping, it is possible to enhance ORR activity and selectivity without compromising structural integrity. This study deepens the understanding of how heteroatom doping affects the electrochemical behavior of carbon-based catalysts, providing a foundation for future research in optimizing electrocatalysts for energy conversion.

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