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ACCEPTED MANUSCRIPT

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Highlights

- Graphene nanoflakes were grown & functionalized with varying levels of nitrogen
- Atomic iron was added to graphene nanoflakes to produce an active ORR catalyst
- Iron incorporation steps were optimized to avoid damaging the catalytic structure
- The elemental composition and crystallography of the catalyst was studied
- A simplified iron incorporation technique leads to improved catalytic activity

Abstract: In the present work, graphene nanoflakes (GNFs) were grown at both low and high levels of nitrogen functionalization and subsequently put through a wet-chemical method to add iron functionalities to the surface and create active catalyst centers. No mechanical treatments are used in order to minimize the formation of defects on the GNFs and evaluate if iron-nitrogen-GNF edges or surface sites can generate catalytic activity rather than the macropore structures holding these functionalities on porous carbon black. The catalysts produced under various synthesis routes were characterized and screened for their performance as an oxygen reduction reaction (ORR) catalyst. Characterization included an electrochemical study, an examination of the carbon and nitrogen content and bonding structure, in addition to Raman analysis and the calculation of the BET surface areas. It was found that samples that were both treated with iron acetate and put through pyrolysis produced the most active samples. These samples were composed of graphitic carbon and contained a large amount of pyridinic nitrogen. Additionally,

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