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Study of Electrocatalysts for the ORR Based on Nanocomposites of Polypyrrole-$CoSe_2$ Supported on Nitrogen-Doped Graphene

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ABSTRACT

The cathodic oxygen reduction reaction (ORR) is key and an important factor in the performance of low-temperature fuel cell (PEMFC), since a major voltage loss takes place at the cathode. The use of traditional, high cost, platinum-based catalytic materials is one of the barriers for successful large-scale introduction of PEMFC in the energy market. An interest exists in developing alternative catalytic materials.

In this project a novel catalytic material is proposed. First, graphite oxide was prepared by a modified Brodie's method and then treated with thermal reduction and surface nitrogen doping. The treatment consisted of synthesizing polypyrrole nanoparticles, as the nitrogen source, by chemical polymerization on the graphite oxide surface, which then was thermally treated under argon atmosphere over a period of time at high temperatures.

Cobalt-Selenium ($CoSe_2$) is proposed as the metal catalyst to further increase ORR activity. Polypyrrole nanoparticles synthesized by chemical polymerization on the nitrogen doped graphene with a specific proportion (ca. 12 wt%), is expected to aid the ORR activity in the composite.

The nitrogen doping proposed for the catalyst support showed an increase in ORR activity, with no further modifications, during the cyclic voltammetry (CV) experiments, indicating that the doping was successful. X-Ray Diffraction (XRD) showed that the (002) carbon peak for the graphite oxide was displaced to lower 2-theta angles as compared to its graphite precursor, an evidence for the successful addition of oxygen groups on the graphite inter-laminar surface. SEM and EDX analyses also showed the reduction of oxygen content after doping with nitrogen and a morphology indicative of exfoliated graphene sheets. Additionally BET analysis showed an increase in surface area for the catalyst support after the nitrogen doping and thermal reduction.

Keywords: ORR; Graphene; Nitrogen doping.