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Ag nanoparticles on reduced graphene oxide for oxygen reduction reaction in alkaline media

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Attention to the alkaline fuel cells (AFCs) has been increased from the development of anion exchange membrane [1]. Much effort in the past has been focused on Pt and Pd based catalysts for cathodic side catalyst. However, high price and limited supply of the noble metal electrode catalysts restrict the fuel cells commercialization. More recently, several attempts to replace Pt with less expensive materials have been approached. In particular, among the non-Pt electrocatalysts including Pd, Au, Ni, Ag, and Mn-oxides, Ag can be a suitable candidate for non-Pt for ORR in alkaline solutions because Ag is not only about 50 times cheaper than Pt, but also thermodynamically or electrochemically stable at high pH. Moreover, many studies have reported uses of the Ag catalysts in showing higher stability during long-term operation than Pt [2, 3] and NaOH concentration increase from neutral level to very high levels (pH > 15) results in higher ORR activity on Ag though activity on Pt is decreased [4]. In this aspect, development of Ag based catalysts is desirable and significant for highly efficient catalytic materials for practical alkaline fuel cells use. However, small and finely dispersed Ag nanoparticles are difficult to obtain without uses of stabilizer of surfactant over carbon based support because small Ag particles tend to agglomerate to reduce the surface energy. Base on the literature, polyvinylpyrrolidone, citrate, and sodium dodecyl sulphate were used as stabilizer for small Ag nanoparticle formation, which can cause the catalyst deactivation with residual surfactant.

In this study, we produced very small and highly dispersed 60 wt% Ag nanoparticles on reduced graphene oxide (RGO) support via surfactant free method. RDE (rotating disc electrode) test and cyclic voltammetry analysis are applied to investigate the electrocatalytic properties. The prepared catalyst was analyzed by transmission electron microscope (TEM), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS) in order to investigate structural and electronic properties. The prepared catalyst displayed a high ORR activity by shifting the half-wave potential toward more positive values and increasing the mass activity by 50 % than Ag/C via 4-electron charge transfer in the ORR process under alkaline conditions These results suggest that RGO may be a good electrocatalyst support, providing small particle sizes with a good dispersion of the Ag catalysts for use in an ORR electrode in alkaline fuel cells.

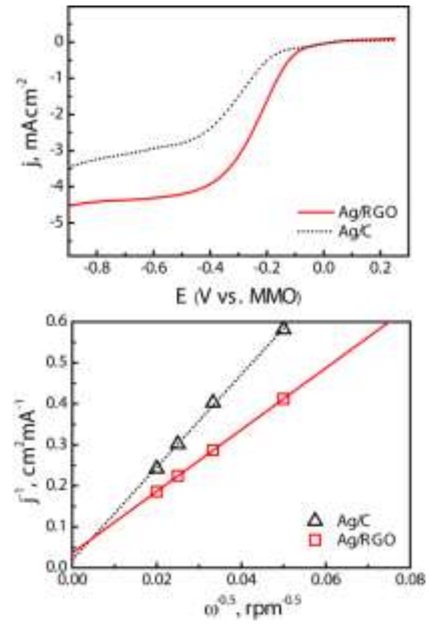

Figure 1. Comparison of the polarization curves for the ORR in an O_2-saturated 0.1 M NaOH solution at a sweep rate of 5 mV/s, room temperature, and a rotation speed of 1600 rpm (top). Levich–Koutecky plots of the ORR collected from the Ag/RGO and Ag/C (bottom).

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