A Novel Air Electrode with Charcoal-like Catalysts

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Introduction—A four-electron reduction of O_2 with a low overpotential in air electrodes has been a long-sought goal in electrochemical energy conversion technologies including metal/air batteries or fuel cells [1]. Finely dispersed platinum (Pt) supported on high area carbon bases is known to be an excellent electrocatalyst for four-electron reduction of O_2 and is widely used. However, Pt suffers from the disadvantages of high cost, gradual degradation in catalytic activity, and poor selectivity. This greatly motivates development of novel, low-cost air electrodes with higher selectivity in place of Pt electrodes [2].

Here, we demonstrate new findings on utilization of charcoal-like materials (Cat) as electrocatalysts for the reduction of O_2 in aqueous media.

Experimental— A glassy carbon (GC, 6mm in diameter) coated Cat (Nafion-Cat/GC) electrode with an ethanol dispersion containing Cat particle and 0.05 wt % Nafion suspension was used as working electrode. The Cat surface coverage is 1.3 mg cm^{-2}. The suspension was prepared from a mixture of a 0.05 wt. % Nafion ethanol solution and Cat powders through 5 min ultrasonic agitation.

Results and discussion—The cyclic voltammetry (CV) response for O_2 reduction obtained at Nafion-Cat/GC electrode shows only one reduction peak in alkaline, neutral and acid solutions. The reduction peak potentials shifted to more positive potentials, compared with that at bare GC electrode. Moreover, the Koutecky-Levich plots suggested that the overall reduction of O_2 at Nafion-Cat/GC electrode is actually $4e^-$-process (Fig. 1).

The function of Cat and the mechanism of the O_2 reduction will be discussed in detail.

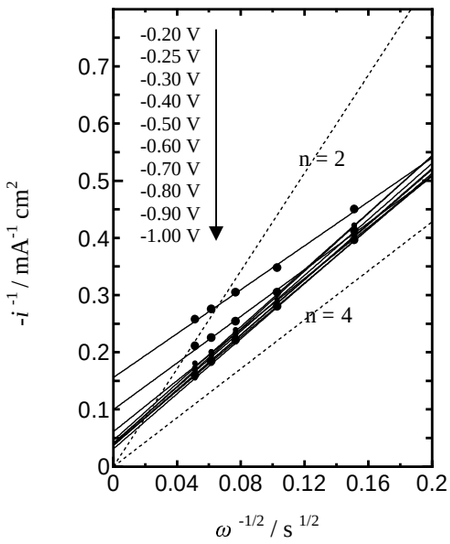

Fig. 1 Koutecky-Levich plots obtained for O_2 reduction at Nafion-Cat/GC disk electrode in O_2-sat. 0.1 M KOH solution at rotation rates 400, 900, 1600, 2500 and 3600 rpm (solid lines). The dotted lines correspond to the theoretical responses for $2e^-$ and $4e^-$ processes of O_2 reduction.

References:

1. 'Electrochemical Oxygen Technology', by Kim Kinoshita, The Electrochemical Society Series, John Wiley & Sons, Inc., NY (1992).

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