Characterization of new air electrodes

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INTRODUCTION

A novel fuel cell was prepared by combining the electrodes for oxidation of sugars and the reduction of oxygen. In order to construct a sugar-air fuel cell with high performance, air electrodes are required to have high catalytic activity for four-electron reduction of O_2 at positive potentials. In the present work, we prepared catalyst modified GC electrodes for oxygen reduction and examined the mechanism of oxygen reduction on these electrodes.

EXPERIMENTAL

Several types of catalyst for the reduction of oxygen were immobilized by casting with a phospholipids solution (MPC). Cyclic voltammetry (CV) and rotating ring-disk electrode (RRDE) voltammetry in alkaline solutions were carried out to evaluate the reduction mechanism.

RESULTS AND DISCUSSION

Fig.1 shows cyclic voltamograms for oxygen reduction at a catalyst modified GC electrode (curve 1). The reduction current of oxygen was almost twice than that at MPC modified (curve 2) or a bare GC (curve 3) electrode. The catalyst on an electrode would make increase in reduction current of O_2 to HO_2^- at ca. -0.4 V

$$O_2 + H_2O + 2e^- \rightarrow HO_2^- + OH^- \quad (1)$$

because, when H_2O_2 was added into the solution, the reduction current at -0.4V increased, suggesting the catalyst assists the disproportionation of HO_2^- like MnOx[1].

$$2\,HO_2^- \rightarrow O_2 + 2OH^- \quad (2)$$

O_2 generated by eq. 2 is reduced as shown by eq. 1. By this disproportionation of HO_2^- an apparent four-electron reduction of O_2 accomplished (eq. 3).

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^- \quad (3) = (1)\times 2 + (2)$$

RRDE results also support an apparent four-electron reduction of O_2 (Fig. 2), where H_2O_2 was detected at a ring electrode.

REFERENCE

1) L. Mao, D. Zhang, T. Sotomura, K. Nakatsu, N. Koshida, T. Ohsaka, Electrochim. Acta, 48 (2003) 1015

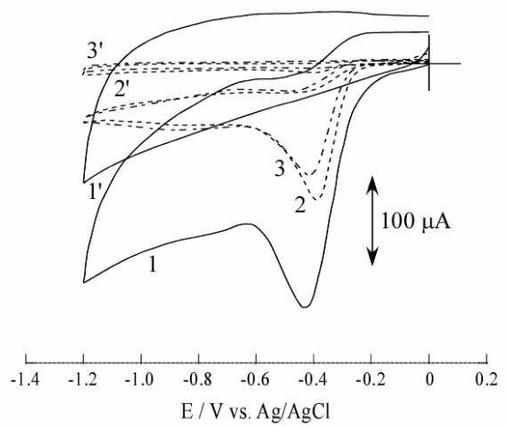

Fig. 1 CVs of oxygen reduction in a 0.1 M NaOH solution at catalyst modified GC (——) , MPC modified GC (−・−) and GC electrodes (-----).Curves 1', 2' and 3' are recorded in N_2 and curves 1,2 and 3 are O_2 saturated solutions. Scan rate, 50 mV/s^{-1}.

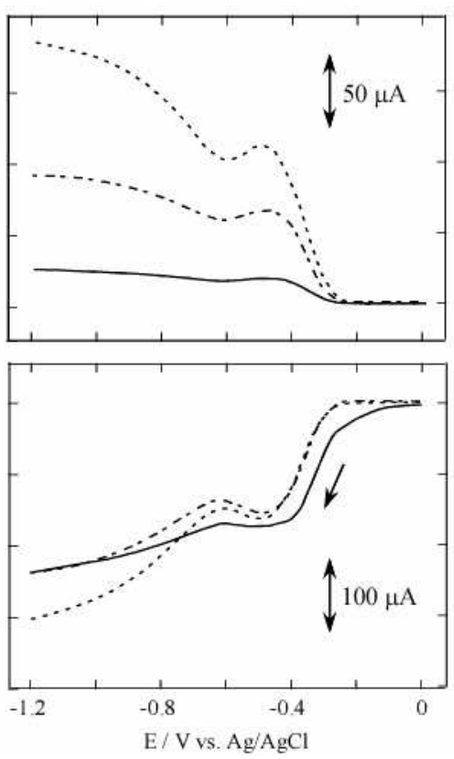

Fig. 2 RRDE voltammograms obtain at catalyst / MPC modifide GC (——) , MPC modified GC (−・−) and GC electrodes (-----) in O_2 - saturated 0.1 M NaOH solution. Electrode rotation rate 1600 rpm. Scan rate , 10 mVs^{-1} . The ring electrode was polarized at +0.50V.