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Effects of texture in carbon fiber electrodes for direct methanol fuel cells

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Direct methanol fuel cells (DMFCs) have recently become the focus of much interest. Methanol is an attractive fuel because its energy density is much higher than that of hydrogen. DMFCs is promising power source for a range of applications including transportation and portable power sources. In fact, dissipation by polarization at the cathode were dominated a fair percentage. Generally, dissipation that occurred inside of fuel cell includes activation polarization, resistance polarization, and diffusion polarization. Reduction of polarization at the cathode is an important issue in development of the DMFCs. In this work, effects of texture in carbon fiber electrodes were studied. By means of structure optimization of membrane electrode assembly (MEA), activation polarization and diffusion polarization were reduced.

MEA inks were prepared using carbon-supported catalysts, 54% Pt-Ru / C (TEC61E54, Tanaka Kikinzoku Kogyo K.K.), for the anode and 50% Pt / C (TEC10E50E, Tanaka Kikinzoku Kogyo K.K.) for the cathode. The MEA inks contained catalyst, isopropyl alcohol, ion-exchanged water, and 5 wt% Nafion® solution. The mixture was sprayed on Teflonized carbon paper and carbon cloth. Hybrid MEA was prepared using Teflonised carbon paper (24mm×24mm, TGP-H-060, Toray)) for the anode electrode, carbon cloth (24mm × 24mm, Shinano Kenshi Co., Ltd.) obtained by carbonization of silk fabrics at 1400°C for the cathode electrode, and Nafion® 117 membrane (Aldrich). Reference MEA was prepared using Teflonised carbon paper for anode and cathode electrode. DMFC performances were measured using a Fuel cell test system (Scribner 890B-100/10) at 60 °C in the loadings of Pt-Ru catalyst for the anode and Pt catalyst for the cathode of each 1 mg/cm^2. Air and 6 vol % methanol aqueous solution were supplied using a Gas/fuel supply unit (Toyo Corp., 890-G3 MH/OD). Flow rate of air is at 100, 250, and 500 mL/min, and Methanol solution is at 2.8 mL/min.

Fig. 2 shows the DMFC performances of the hybrid MEA and the reference MEA at air flow rate of 500 mL/min. The maximum power densities were 48.1 and 43.3 mW/cm^2 in the hybrid MEA and the reference MEA, respectively. The open-circuit voltages (OCV) were 740 mV for the hybrid MEA and 670 mV for the reference MEA. The OCV increase suggested that reduction of affect of methanol crossover (MCO) by improvement of O_2 feeding. Additionally, voltage drop by the diffusion polarization appeared at higher current density (> 180 $mAcm^{-2}$) was reduced in the hybrid MEA using carbon cloth electrode. The O_2 feeding in the hybrid MEA at air flow rate of 250 mL/min (plot ○ in **Fig. 3**) was comparable to that in the reference MEA at air flow rate of 500 mL/min (plot □ in **Fig. 2**). The effects of carbon cloth texture showed in **Fig. 4** enables to drive DMFCs at low air flow rate.

The effects of texture in carbon cloth electrodes are on the O_2 diffusion and/or on the remove of the generated water. It was suggested that the carbon cloth electrodes was useful to improve DMFC performances.

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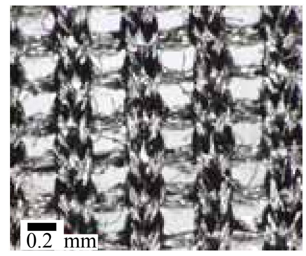

Figure 1. An optical microscope image of the carbon cloth.

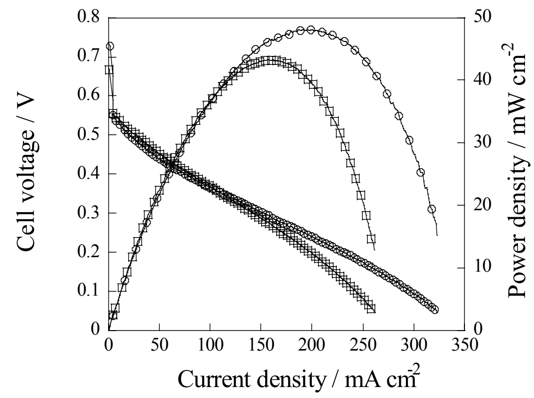

Figure 2. Effects of texture in carbon fiber electrodes of hybrid MEA (○) and reference MEA (□) on the DMFC performance. Air flow rate is 500 mL/min.

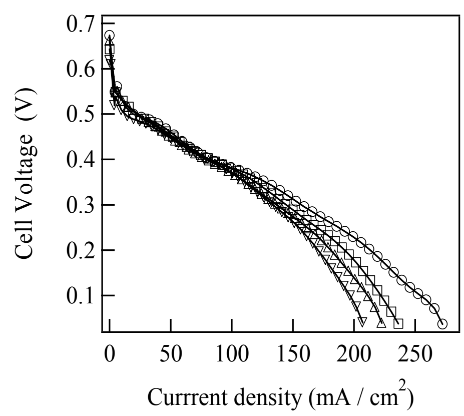

Figure 3. Effects of the texture in carbon fiber electrodes on DMFC performance at several air flow rate in the hybrid MEA ((○) 250 mL/min, (△) 100 mL/min) and reference MEA ((□) 250 mL /min, (▽) 100 mL /min).

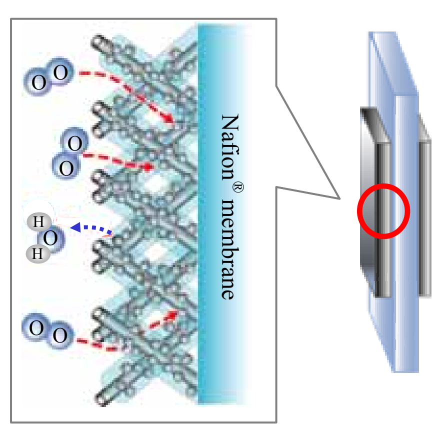

Figure 4. Schematic representation of the effects of the texture in the carbon cloth electrode.