PEFC Electrode Catalysts Supported on Carbon Nanofibers: Nanostructure and catalytic properties

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1. INTRODUCTION

For Polymer Electrolyte Fuel Cells (PEFCs), carbon materials are important as electrode catalyst supports, determining cell performance. As carbon-based catalyst supports act also as current collecting passes, a use of highly conductive carbon fibers is of technological interest. Therefore in this study, nanostructure and catalytic properties of Pt electrode catalysts supported on carbon fibers are systematically studied, especially on carbon fibers with various crystalline structures.

2. EXPERIMENTAL

Three kinds of carbon nanofibers were used in this study. Pt catalysts (as 20wt%Pt/C) were impregnated via an in-situ colloidal procedure using H_2PtCl_6, $NaHSO_3$ and H_2O_2. Electrode catalysts were obtained after calcination in H_2 atmosphere at 200^oC for 2h. Nanostructure of the electrode catalysts was observed by FESEM and STEM. Crystallite size was determined by XRD. Effective surface area was determined by CV, and activities for oxygen reduction were evaluated using rotating electrodes. Pt loading was measured by TG in air.

3. RESULTS AND DISCUSSION

Table 1 shows Pt crystallite size determined by XRD, ranging from 3.3 to 5.6 nm.

(1) Pt catalysts supported on carbon nanotubes

FESEM micrograph of Pt electrode catalysts supported on tubular carbon fibers (nanotubes) is shown in Fig.1. Pt particles were a few nm in diameter, but their distribution was rather inhomogeneous. It can be considered that high dispersion of Pt catalysts on carbon nanotubes is still difficult even using this in-situ colloidal process.

(2) Pt electrode catalysts supported on Herringbone-type carbon nanofibers

Fig.2 shows FESEM micrograph of Pt electrode catalysts supported on herringbone-type carbon nanofibers, in which their graphene plain is tilted ca. 45^o from the fiber direction. It has been found that homogeneity of Pt distribution was improved, whereas no Pt particles existed on some parts of fiber surfaces.

(3) Pt electrode catalysts support on Platelet-type carbon nanofibers

Fig.3 shows FESEM micrograph of Pt electrode catalysts supported on platelet-type carbon fibers. We can clearly find that Pt particles are distributed homogeneously on the surface of this carbon fiber. Effective surface area of Pt electrode catalysts, determined by CV, was also comparable to that of Pt on carbon black (Vulcan), the state-of-the-art material for catalyst supports.

4. SUMMARY

Using the in-situ colloidal impregnation process, we have succeeded to deposit Pt nanoparticles on carbon black and carbon nanofibers (Platelet, Herringbone, Tubular), with a crystallite diameter of ca. 3-6nmϕ. In addition, it became clear that homogeneity of Pt particles dispersion on carbon fibers depends on the type of fibers: Platelet>Herringbone>Tubular. Detailed evaluations of catalytic and electrochemical activities of these electrode catalysts are in progress.

ACKNOWLEDGMENT

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Table 1: Pt crystallite size measured by XRD

Carbon support	Crystallite size (nm)
Carbon black (Vulcan)	3.4
CNF-Platelet	3.3
CNF-Herringbone	3.9
CNF-Tubular	3.6
VGCF	5.6

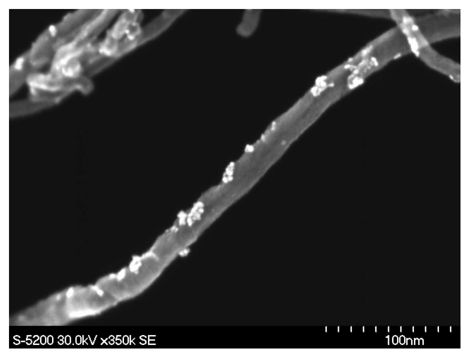

Fig. 1: FESEM micrograph of Pt electrode catalysts support on tubular carbon nanofibers (nanotubes).

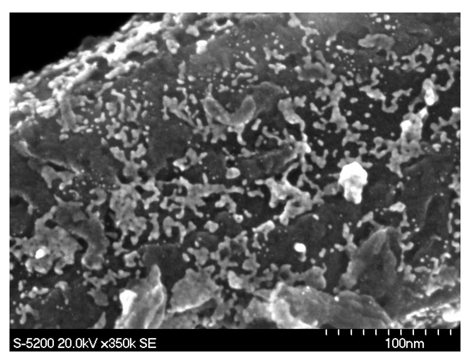

Fig. 2: FESEM micrograph of Pt electrode catalysts support on herringbone-type carbon nanofibers.

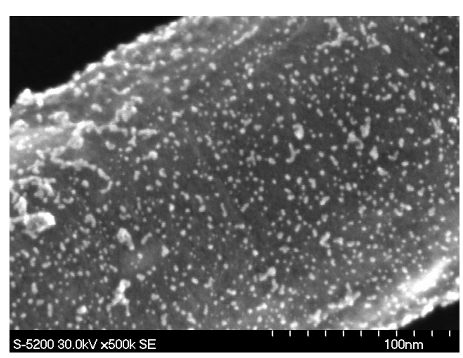

Fig. 3: FESEM micrograph of Pt electrode catalysts support on platelet-type carbon nanofibers.