The Characteristics of Alkaline Fuel Cell Electrode Prepared by Electrophoretic Deposition

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A gas diffusion electrode can be mainly used in energy related field, such as fuel cells. Several preparation methods of the gas diffusion electrode were reported, for example, filtration method or tape casting one for phosphoric acid fuel cell, and rolling method or spraying one for the alkaline fuel cell.

Meanwhile in a colloidal ceramic processing, the electrophoretic deposition[1] (EPD) is well known and is widely used. This technique can produce deposited thin layer from a colloid suspension according the following processes; electrophoresis and deposition. In the electrophoresis process, the charged particles in a colloid suspension move toward the oppositely charged electrode under the electric field, and in the deposition process, particles coagulate to a dense mass.

The aim of this study is to apply an electrophoretic deposition technology to the way of preparing gas diffusion electrodes, and to compare the electrochemical performance of thus prepared electrode to that of conventional-method-prepared ones.

In this work, acetylene black AB-6 and AB-12 powders (Denki Kagaku Kogyo) were utilized as hydrophobic carbon black and hydrophilic one, respectively. They were further grained and mixed in the pure water with the help of the surfactant, then dispersed by using a ultra sonic homogenizer or a jet-mill. Polytetrafluoroethylene (PTFE) dispersion were then added, and mixed with a mixer. The dispersion was poured into a cell, in which several kinds of metal mesh can be placed. In the ordinary preparation, silver mesh was used for anode. Counter electrode, which is platinum or silver mesh, was placed over the anode mesh. Fig. 1 shows the electrophoresis cell. The voltage of 30V was charged between metal meshes. The precipitation was dried up at ambient temperature, and then the precipitation was hot-pressed. Hydrogen hexachloroplatinate (IV) hydrate solution with small amount of isopropyl alcohol was loaded on the precipitation thus prepared, followed by an oxidation in airflow and a reduction in a hydrogen flow. By this procedure, gas diffusion electrodes containing platinum as a catalyst were obtained. Electrolyte used for the measurement was 32%-KOH, which was deaerated by bubbling purified nitrogen gas. The Hg/HgO electrode and platinum foil were used as reference and counter electrodes, respectively. Fig. 2 shows polarization curves for the gas diffusion electrode prepared by using EPD method in 32%-KOH at 80 degrees C. The polarization curves for the gas diffusion electrode prepared by using one of the conventional method [2] is also included for comparison.

The gas diffusion electrode prepared by EPD method has higher activity for both oxygen reduction and hydrogen oxidation than that by conventional method. The Tafel slopes for oxygen reduction and hydrogen oxidation reaction of both electrodes are almost identical, and the catalyst used for both of them is the same. This suggested that the reaction mechanism of both electrodes seems to be the same.

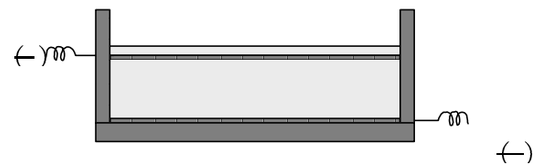

Fig. 1: The electrophoresis cell

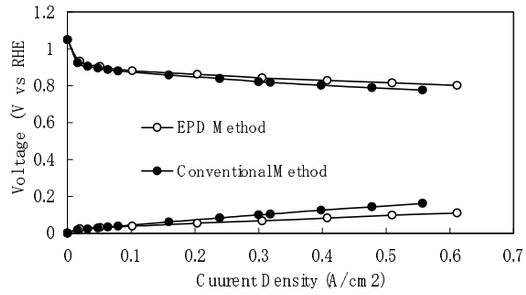

Fig.2: Polarization curves of gas diffusion electrode prepared by EPD and conventional method

References

1) P. Sarkar and P. S. Nicholson, J. Am. Ceram. Soc., 79, 1987 (1996)
2) N. Furuya and H. Aikawa, Electrochemical Society Proceedings Volume 99-21, 180 (1999)