Development of Novel and Grafted Anion Exchange Membrane for Platinum Metal-free Liquid Fuel Car

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A proton exchange membrane fuel cell (PEMFC) is expected greatly as the most effective solution for a new carbon society. However, there is a serious problem that platinum as catalyst is necessary for PEMFC, because proton exchange membranes are strong acid polymer. To overcome this problem, anion exchange membrane fuel cells (AEMFC) are attracting lots of attentions [1]. We have been developing AEMFC using hydrazine hydrate (HH) as a liquid fuel because its theoretical cell voltage is higher than hydrogen. However, because liquid fuels are easy to permeate through the membrane to cathode and HH is converted to the hydroxyl radical (hydroxyl radical attacks main-chain, sub-chain and ion exchange group of anion exchange membrane), durability of membrane is lower than that of proton exchange membrane.

We have developed high durable anion exchange membrane, named PAM-PAM (Protected Ammonium membrane by Pre-Amination Method), by radiation-induced grafting of N-vinyl-imidazole and stylene into poly(ethylene-co-tetrafluoroethylene) (ETFE) film followed by quaternaraization of propyliodide [2]. Molecular structure of PAM-PAM is shown in figure 1.

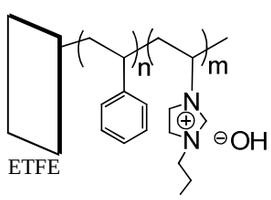

Fig.1. Molecular Structure of PAM-PAM.

In this study, cell performance of MEA using PAM-PAM was evaluated under the various condition.

MEA was prepared by spraying of electrode ink that consists of catalyst, ionomer and solvent. The solvent for ink was prepared in a 1:4 mixture of tetrahydrofuran and 1-propanol. The cathode catalyst was Co-Polypyrrole-C and the anode catalyst was Ni. These catalysts were made into inks using the ionomer/solvent mixture and applied to produce the anode and cathode catalytic layers, respectively. Membrane size was 5x5cm and electrode area was 2x2cm.

However, MEA prepared by the above normal method was not able to generate (Anode: 5wt%-HH+1M-KOH solutions as the fuel at a flow rate of 2mL/min (75 degrees Celsius), Cathode: fully hydrated air at a flow rate of 500mL/min (50 degrees Celsius)).

To confirm elimination of ion exchange group or some kinds of chemical change, molecular bonding was analyzed by FT-IR after immersed in 10wt%-HH at 80 degrees Celsius for 1 hour. Furthermore, ion conductivity and water uptake was measured. As a result, molecular structure of PAM-PAM did not change as shown in figure 2, and ion conductivity and water uptake was maintained.

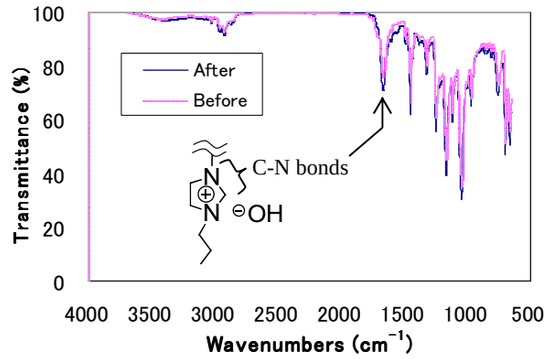

Fig.2. FT-IR spectrum of PAM-PAM.

It was thought that following three reasons because cell resistance was extremely high during cell performance test.

1) There were some kinds of interaction between HH and ion exchange group.
2) The water of cathode side for oxygen reduction was lack, because PAM-PAM hardly penetrate HH (including water) .
3) Connection of ionic conduction pass between ionomer of the electrode and membrane were not formed well.

In order to prevent the interaction between HH and ion exchange group, ethanol (5wt%) was added in fuel as a polarizer and cell performance test was carried out. As a result, cell performance was indicated 70uW/cm^2.

Cell performance under the fully hydrated air condition at 80 degrees Celsius (original condition:50 degrees Celsius) was improved to 9.5mW/cm^2.

Furthermore, to form an ion conduction pass easily, membrane was swelling by N-methyl-pyrrolidone before spray the electrode ink. As shown in figure 3, cell performance improved to 70mW/cm^2 .

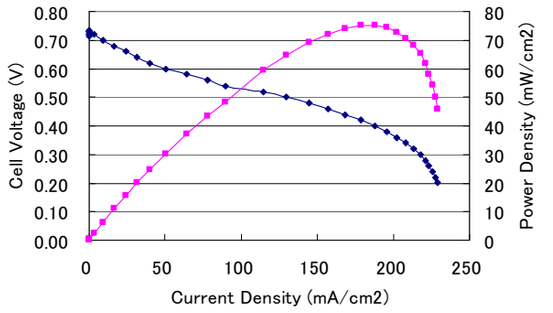

Fig.3. Cell performance of MEA based on PAM-PAM.

Detail results of membrane properties and cell performance will be presented in the conference.

Acknowledgement

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References

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