Evaluation of effect of operating and shape condition by simplified two-dimensional PEFC analysis model.

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INTRODUCTION

In the development of more efficient and stable Polymer Electrolyte Fuel Cell (PEFC), it is important to propose the optimal operating condition and the optimal shape that can uniform the distribution of current density and relative humidity in a single cell. In this study, we improved the former model that is PEFC reaction and flow analysis model, and we developed the new model that includes the flow and heat transfer of cooling water. It could be used for real cell calculation in detail. Furthermore, we proposed the guideline for optimum operation condition and optimum component shape.

MODEL DEVELOPMENT

In this study, serpentine separator was object. Fig.1 shows the PEFC simulation model. Gas flow velocity, concentration and temperature were calculated in the gas channel on the anode and cathode. The governing equations are equations of continuity, motion, energy and species in gas, membrane, GDL and cooling water. The analytical equations were discretized by using the finite difference method and solved as unsteady problem.

RESULTS AND DISCUSSION

Fig.2 shows current density distributions in case of 30μm membrane and 50μm membrane. In Fig.2, as the membrane thickness increased, the current density decreased because of the increase of resistance overvoltage. In the result of 30mmm membrane, the current density is high in the upstream of the anode and cathode channel, and it is low in the downstream, because the concentration overvoltage is larger than the other overvoltage. In the result of 50mm membrane, the current density is high in the position of the inlet where the anode vapor concentration is high, because the influence of the resistance overvoltage increases.

The evaluation chart of the membrane thickness and the GDL thickness concerning the current density distribution, shown in Fig.3, was made. It is thought that the information for the best design of the PEFC component can be obtained by calculating in various conditions by this PEFC numerical analysis model, and by making such an evaluation chart according to the demand condition of each use and operation condition.

CONCLUSION

A past PEFC numerical analysis model was improved, and the influence of the thickness of membrane and gas diffusion layer on cell characteristics was examined by using this model. As a result, it is found that the current density distribution increases by thinning the membrane and the gas diffusion layer, the information about the design of the best shape to increase average current density and to decrease the current density distribution could be obtained.

REFERENCE

Inoue, G., Y.Matsukuma and M.Minemoto, “Reaction and Flow Analysis for Polymer Electrolyte Fuel Cell,” Proceedings of Fuel Cell Seminar 2003, Miami USA, November 216-219 (2003)

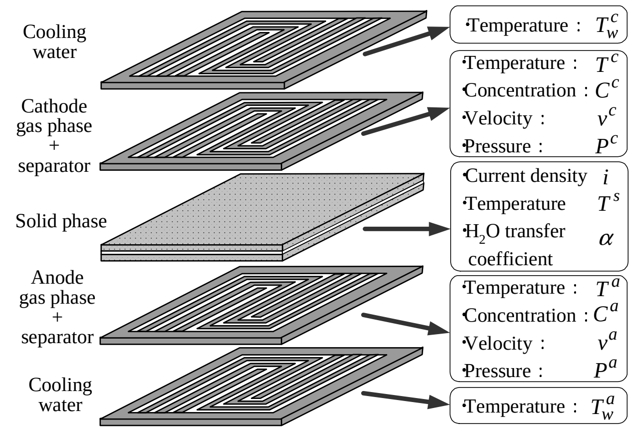

Fig.1. Model for the simulation of PEFC

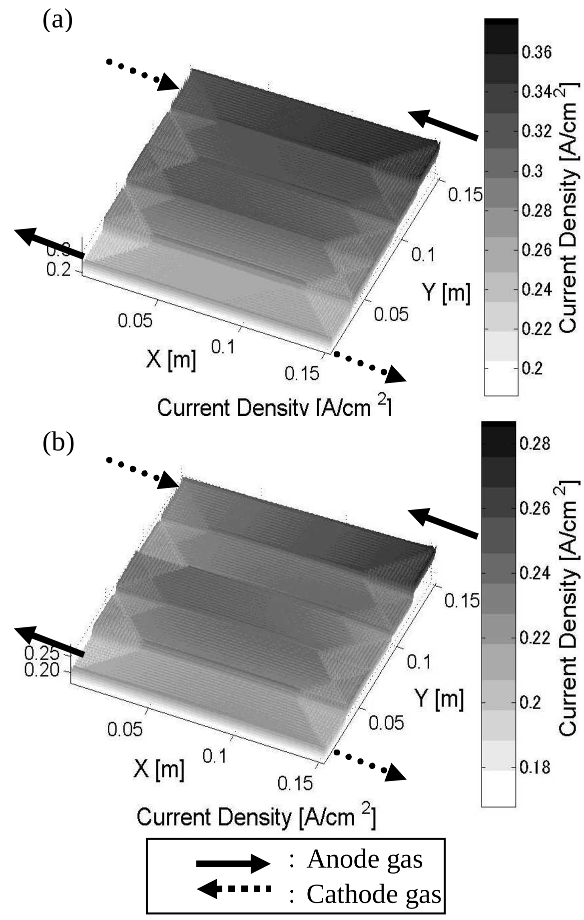

Fig.2. Effect of thickness of membrane on current density distribution in case of 30μm membrane(a) and 50μm membrane(b)

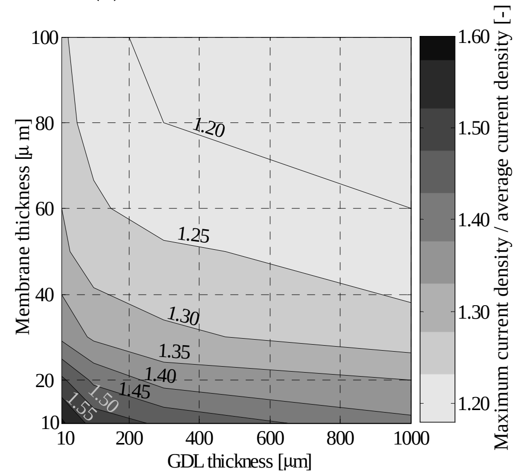

Fig.3. Effects of thickness of membrane and GDL on current density distribution