Visualization of water droplets in the cathode flow field of PEFC

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Intensive R&D efforts of PEFC, stationary or automobile application , are now in progress. Field tests for both applications are under operation in Japan. From this movement, much more research attentions are shifted to and focused on the study of performance loss in the long period of operation.

Water management is very important issue to obtain good performance and stable operation in a long period of operation. Visualization of water droplets in the cathode flow field in a PEFC is a powerful tool to understand the water transport in a cell.

Several papers have been reported so far, Scott et al. and Hashimasa et al. measured two phase flow of methanol and carbon dioxide for DMFC. Tueber et al. and Okazaki et al. measured water condensation and temperature distribution with 2or 3 straight flow field. Scherer et al. using neutron radiography measured two-phase flow of PEFC and DMFC.

A single cell in which transparent flow field plate and wire-cut current collecting plates for a cathode with single serpentine flow field was designed and is shown in Fig.1. The cell has a cupper bock in which hot water is circulated on the anode carbon end plate to obtain homogeneous temperature distribution in the cell. The cell was put in an electric oven to prevent the cell from fogging. Photos are taken during operation with a digital video camera and digital camera.

Fig.2 shows photos taken under 50% cathode gas utilization. Water droplets are observed in the flow channel and the area which water droplets are seen is extended to half way of the entire flow field. With increase of utilization up to 70%, the area water droplets are observed extend more toward cathode inlet. These observations are in good agreement with the prediction from water vapor pressure distribution derived from our cell model. In a PEFC, cross sectional area of a flow channel and flow rate are quite different compared to those of conventional two phase flow study. So it is quite important to investigate closely the formation of gas/liquid two phase flow in a cathode of PEFC.

Fig 3a to Fig3c show the close-ups of water droplets in the flow channels. In Fig3a, liquid (water) films are observed on the walls of current collectors. Fig 3b shows very small droplets on the liquid films. Fig 3c shows a grown water droplets and when it continues to grow, they block the channels completely , then pressure drop jumps up , followed by water pushing out occurs, soon .

Comparison of flow pattern (co-flow and counter –flow) are also studied and the results will be presented at the meeting.

Experimental conditions presented here are as follows:
Tcell=70C, Icd=0.3A/cm2, Thma=Thmc=65C, Uf=70% $H_2$/Air

This work was supported by NEDO.

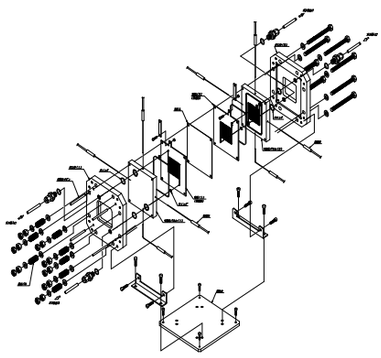

**Fig.1** Cell assembly used in the visualization experiment

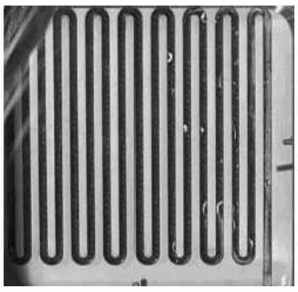

**Fig.2** Water droplets at cathode flow field (Uo=50%)

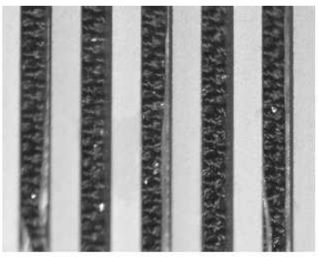

**Fig.3a** Liquid films on the walls of the flow channels

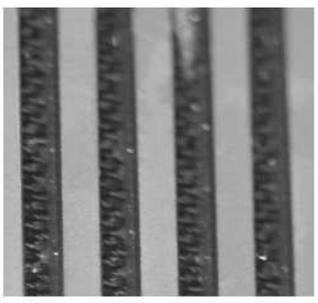

**Fig.3b** Small water droplets on the liquid films

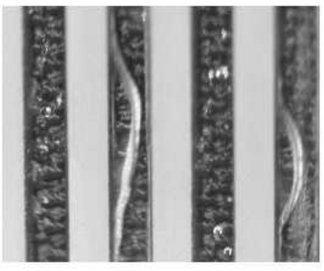

**Fig.3c** Grown water droplets in the cathode flow channels (water pushing out occurs soon)