11th International Conference
on Advanced Materials

ICAM2009

Rio de Janeiro Brazil
September 20 - 25

Anodic oxidation of hydrogen in PEFCs with varying platinum loading

G. Selvarani [(1)], P. Sridhar [(1)], S. Pitchumani [(1)] and A. K. Shukla [(1, 2)*\]

(1) CECRI – Madras Unit, CSIR Madras Complex, Chennai - 600113, INDIA.
(2) Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore - 560012, INDIA.
* Corresponding author

Abstract – An optimum Pt loading of 0.05 mg/cm^2 on the anode of PEFC is established through cell polarization and hydrogen-pump experiments.

Hydrogen oxidation reaction (HOR) is an important reaction in PEFCs. In relation to oxygen reduction reaction (ORR) occurring on the cathode of the PEFCs, the HOR that takes place on the anode is relatively less investigated. This is because the anode contributes very little to the activation polarization under typical fuel cell operating conditions as HOR has a relatively much larger value of the exchange-current density than the ORR [1]. In most of the experimental and theoretical studies on PEFCs, the polarization of the anode has been considered negligible unless the operating current density is high enough to reflect mass-transport polarization effect on the anode.

Platinum loading as low as 0.05 mg/cm^2 at the anode of the PEFC stacks is desired for automotive applications [2]. Hence, it is necessary to quantify the performance losses that may arise on reducing anode Pt loading from the present level of about 0.5 mg/cm^2 to 0.05 mg/cm^2. Furthermore, knowledge of HOR in PEFCs is desired to understand quantitative electrode degradation arising due to local H_2 starvation, start-up / shutdown, and cell reversal.

The present study mainly focuses on hydrogen oxidation reaction for fuel cell anode with low Pt loading. In order to establish the optimum loading, the polarization curve (Figure 1) is obtained for H_2/O_2 PEFCs at varying Pt loading at the anode, namely 0.5, 0.25, 0.05 and 0.025mg/cm^2 keeping the cathode Pt loading constant at 0.5 mg/cm^2. It is observed that PEFCs with Pt catalyst loading of 0.5, 0.25 and 0.05 mg/cm^2 at the anode exhibit almost similar performance. However, the PEFC with anode Pt loading of 0.025 mg/cm^2 shows lower performance, especially in higher current density region due to reduced availability of Pt active sites for HOR.

Hydrogen-pump experiments are conducted to determine the performance losses during reduced Pt loading arising due to HOR and hydrogen evolution reaction (HER). From HOR and HER over-potential measurements for varying platinum loading of 0.5, 0.25 0.05 and 0.025 mg/cm^2, it is clear that 0.05 mg/cm^2 Pt loading is the optimum anode loading. It is established that the performance loss is hardly 30mV at the anode for an operating current density of 1.5 A / cm^2 on reduction of Pt loading from 0.5 to 0.05 mg/cm^2. These experiments corroborate the polarization data.

Though the low-loading of Pt (0.05 mg/cm^2) on the anode shows almost identical performance with respect to highly-loaded anode containing 0.5 mg/cm^2, the long-term operation (durability test) is an important issue for commercialization of PEFCs. Therefore, durability study on the PEFC is conducted with optimum platinum loading of 0.05mg/cm^2 on the anode.

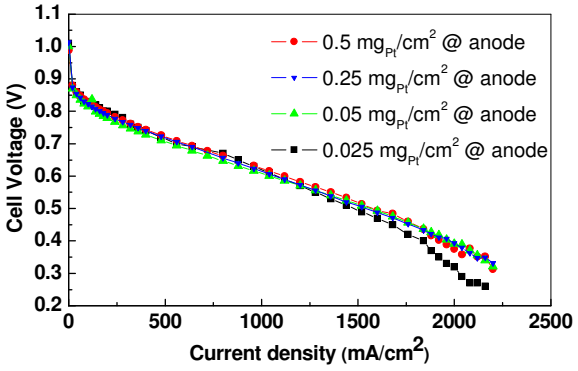

Figure 1: Polarization curves (voltage vs. current density) for PEFCs employing anode with varying platinum loading of 0.5, 0.25, 0.05, and 0.025 mg/cm^2.

1. J. O' M. Bockris and S. Srinivasan, *Fuel cells: Their Electrochemistry*, McGraw-Hill (1969).
2. K. C. Neyerlin, Wenbin Gu, Jacob Jorne and Hubert A. Gasteiger, *J. Electrochem. Soc.,* **154 (2007)** B631-B635.

Acknowledgments

Financial support from CSIR, New Delhi through a supra-institutional project during the XI Five Year Plan is gratefully acknowledged. G. Selvarani is grateful to CSIR, New Delhi for a Senior Research Fellowship.