Effect of Graphitic Carbon Support with Non-Pt composition on the Anode Durability for PEMFC

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Since the fuel cell vehicles from the Hyundai Motors, Toyota and Honda are commercialized, the polymer electrolyte membrane fuel cell (PEMFC) is considered as a promising power train for the ultimate eco-friendly car due to high energy efficiency, zero harmful emissions and low-temperature operation. For the long time, the catalyst degradation under the transient conditions such as cell reversal and start-up/shut-down is a major challenge to address relating increase the durability of membrane electrode assembly (MEA) in the PEMFC system [1]. Cell reversal resulted in detrimental damage to materials in the MEA. There are some approaches to mitigate for the cell reversal under the hydrogen fuel starvation at the anode such as the addition of the oxygen evolution catalyst and the increase of the crystallinity of carbon support in the anode catalyst layer [1-3]. Recently, the authors presented the multifunctional hydrogen oxidation catalyst having Ir and Ru as active metals and reported that the Pt catalyst could be replaced with IrRu supported on carbon catalyst in the anode side [4]. In addition, the anode durability of an MEA under full hydrogen starvation condition is drastically enhanced due to the higher activity of IrRu/C for oxygen evolution reaction (OER).

In this work, the effect of graphitic carbon support on the anode durability using non-Pt composition such as $IrRu_4$ alloy is studied. The carbon supports with different crystallinities were prepared by heat treating Ketjen Black(KB) 300JD at 2250 and 2800 ℃, which named as 22KB and 28KB, respectively. The IrRu alloy was loaded onto different carbon supports with 30wt.% loading by a simple impregnation method using rotary evaporator followed by reduction under hydrogen gas at 300 ℃. The crystalline structure and size of the supported IrRu catalyst estimated from the XRD (not shown) is a hexagonally close packed structure and around 5 nm in the all catalysts.

For the MEA fabrication, the catalyst slurries using home-made anode catalysts were prepared by ball-mixing method. Three MEAs were tested under hydrogen starvation condition to measure the time (t_{CR}) when the MEA reached the -2V at 200 mA/cm^2.

As shown in Fig. 1, the durability of the anode in the MEA increased as the heat treatment temperature of the carbon support increased. The t_{CR} for $IrRu_4$/KB was only around 30 min. In contrast, the t_{CR} for $IrRu_4$/22KB and $IrRu_4$/28KB was elongated dramatically to 2.9 h and 3.5 h, respectively. It indicated that combination of the crystallinity of carbon and OER active compositions such as IrRu alloy could be a solution to increase the cell reversal durability.

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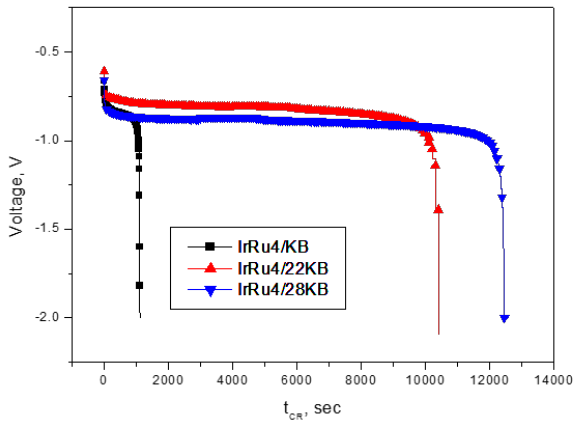

Fig.1 Effect of carbon support on durability of anode under the cell reversal condition.

REFERENCES

[1] C. Qin, J. Wang, D. Yang, B. Li and C. Zhang, Catalysts, 6 (2016) 197.
[2] R.T. Atanasoski, D.A. Cullen, G.D. Vernstrom, G.M. Haugen, and L.L. Atanasoska, ECS Electrochem. Letters, 2 (2013) F25.
[3] J. Jung, B. Park, and J. Kim, Nanoscale Research Letters, 7 (2012) 34.
[4] E. You, M. Min, S.-A. Jin, T.-Y. Kim, and C. Pak, 2016 PRiME, Honolulu, HI, USA, 2- 7 Oct. 2016, Abstract No. 2799.