Development of durable electrocatalysts for PEFC through graphitization of carbon support surface

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Electrocatalytic reactions related to polymer electrolyte fuel cell (PEFC) have been well studied by many researchers, in order to develop it as one of the next generation energy technologies. One of major problems to overcome is low durability of electrocatalysts, which is partially derived by carbon corrosion. Based on our previous studies and also other reports, electrocatalysts made by Pt deposition on graphitized carbon supports leads to improvement of their durability toward carbon corrosion. Therefore, graphitization is a key for developing durable catalysts. On the other hand, graphitization results in lowering the interaction of Pt particles and carbon supports. Then, aggregation of Pt particles followed by loss of the active surface comes to be a problem. Consequently, optimization of graphitization degree becomes important.

In this study, we started with two kinds of commercially available carbon black, Vulcan and Ketjen black. These two types of carbon were heated at different temperatures (1100, 1600, 2000 ˚C) under Ar atmosphere. Then, platinum particles were deposited on them using Pt(II) acetylacetonate as a precursor. Prepared electrocatalysts were electrochemically evaluated by typical three electrode half-cell setup. For analyzing durability, the protocol recommended by Fuel Cell Commercialization Conference of Japan (FCCJ)[1] was used.

Carbon samples with heat treatment at 1600 and 2000 ˚C lost their surface area mainly because their defect sites were lost and rather smooth surface was developed. When Pt particles (20 %) were deposited on carbon, hydrophobic solvent, dicloromethane, was used for better interaction with hydrophobic graphitized carbon support. As a result, well dispersed Pt particles on carbon were obtained even though samples heated at 2000 ˚C showed a certain degree of aggregation. Each Pt deposited carbon sample was evaluated by TEM. Fig. 1 shows aTEM image of Pt deposited on heat-treated Vulcan at 1600 ˚C. Comparing to Pt on non-treated Vulcan, at the edge of carbon particles, the graphite layers are observed. Even after graphitization, Pt particles are still well dispersed on the carbon support.

Eight different samples were evaluated from the points of electrochemical active surface area, oxygen reduction reactivity, and TEM images before and after the durability test. We will discuss about the optimum condition for developing highly durable electrocatalysts through our investigation.

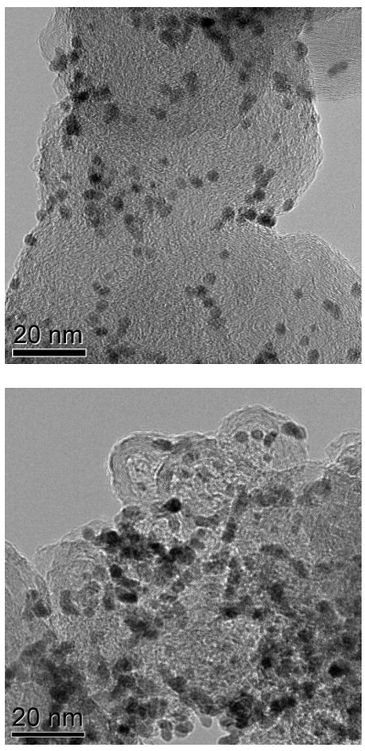

Figure 1. TEM images of Pt/Vulcan. Top: non-treated, Bottom: heat treated at 1600 ˚C.

References

1. A. Ohma, et al., ECS Trans, **2011** 41(1) 755.