Bimodal Pt Synthesized On Heat Treated Carbon Black Support in Arc Plasma Process

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Hydrogen oxidation reaction and oxygen reduction reaction occur on the supported Pt nano-catalyst in the proton exchange membrane fuel cell. Carbon black supported Pt is a still promising platform for nano-catalyst though other carbonaceous supports and non-carbon supports have been suggested. In general, furnace carbon black is used for support material thank to large specific surface area, good electrical conductivity, and chemical inertness. However, carbon corrosion degrades catalyst performance by electrically isolating detached Pt. Also, surface oxide species makes the catalyst be hydrophilic. In this regard, Vulcan XC-72 carbon black was heat-treated at 1,000 ℃, 1,100 ℃, and 1,200 ℃ for 4 hours in a reducing environment in order to change crystallinity and surface properties. As the heat treatment temperature is increased, specific surface area by BET analysis is not markedly changed. However, changes of crystallinity from x-ray diffractometry, Raman spectroscopy, and high resolution transmission electron microscopy are notable. After that, Pt/C nano-catalysts are synthesized by arc plasma deposition process. As-received Vulcan XC-72 and heat-treated one at 1,200 ℃ are chosen for support materials. During the process, Pt atoms are directly deposited on mechanically agitating carbon black particles. Morphology of as-synthesized Pt/Cs is observed and particle size is measured by image analysis for TEM photographs. Pt on the heat-treated carbon has a bimodal size distribution while Pt on the as-received one shows a narrow singular distribution. Accordingly, electrochemical active surface area is slightly lower for the heat-treated carbon and however, Pt durability is prominently improved. In addition, carbon corrosion resistance is also improved. Conclusively, Pt morphology can be tailored by carbon heat treatment in the arc plasma synthesis and durable Pt/C is synthesized without post-synthesis heat treatment in liquid base synthesis.