Impact of alloying with rare-earth elements in Pd-Ir based ternary catalysts on oxygen reduction reaction activity

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Alloying transition metals with Pd based catalysts changes the electronic structure of Pd because of a geometry and ligand effects. Thus, rare-earth elements are effective in increasing the ORR activity by making Pd more metallic. In this study, rare-earth elements were alloyed with Pd and Ir using a polyol process. As the rare-earth elements have larger atomic sizes and much lower reduction potentials than those of Pd, the amount that can be incorporated in Pd based alloy catalysts with rare-earth elements via the polyol process is limited. Most of the rare-earth elements on the surface were located in the grain boundary as metal oxides. When the composition ratio of Pd, Ir, and rare-earth elements was 4:1:0.1, Pd-Ir-Y, Pd-Ir-La and Pd-Ir-Sc alloy catalysts had higher metallic Pd contents, as determined by X-ray photoelectron spectroscopy, electrochemical surface area, and half-wave potential measurements, respectively. However, the catalysts including more rare-earth elements had higher durability due to the metal oxide on surface. In particular, the metallic Pd portion in the ternary alloy had a strong relationship with the activity towards the ORR.