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Structural and Compositional Behaviors of Shaped Pt Alloy Nanoparticle Electrocatalysts

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The slow rate of the oxygen reduction reaction (ORR) in the polymer electrolyte membrane fuel cell (PEMFC) is the main concern for the commercialization of this efficient energy conversion technology. One of the strategies is alloying transition metals such as Co, Ni with Pt to modify the surface chemical and physical properties. Extended Pt alloy electrocatalysts with unique surface morphology and electronic surface properties provided ideal models for understanding of the highly improved reaction kinetics for the ORR.(1) In practical Pt alloy nanoparticle electrocatalysts, however, it is quite challenging to design materials to understand the ORR activity owing to the surface complexity and the leaching of transition metal during electrocatalysis.(2,3)

In this study, we describe the design and synthesis of shaped Pt-Ni nanoparticles with controlled composition segregation and particle size and study the structural and compositional behaviors during electrocatalysis. The composition, size and shape of the nanoparticles were controlled by simply changing the synthetic conditions.

The surface composition of the Pt-Ni was measured by X-ray photoelectron spectroscopy (XPS), the bulk composition was tested by energy dispersive X-ray spectroscopy (EDX) and inductively coupled plasma mass spectrometry (ICP-MS), and the element distribution was verified by aberration-corrected scanning transmission electron microscopy and electron energy loss spectroscopy (STEM-EELS), respectively. The results demonstrated that for larger particle size ~9 nm the ORR activity mainly depended on the surface composition and Pt thickness, but for ~4 nm sized catalysts the improved activity mainly resulted from the bulk composition relative to pure Pt.

Reference

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