Alloy and Nano-structured Oxygen Reduction Catalysts for Proton Exchange Membrane Fuel Cells

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The slow kinetics of oxygen reduction reaction (ORR) at Pt surface has been considered as a major obstacle for the performance enhancement of low temperature proton exchange membrane fuel cell (PEMFC) and its commercialization. Numerous studies have been reported on the development of alloy catalysts (Pt₃M), nano-structured catalysts (single crystal, dendritic structure, core-shell structure, etc), and non-precious metal catalysts [1-5]. Though many of them have successfully demonstrated the initial high performance than Pt catalyst, there are still struggles for finding new catalysts with high performance, low price, excellent stability, and easiness of fabrication.

In this presentation, we will introduce our recent works [6-9] on the development of novel ORR catalysts including binary and ternary alloy catalysts and core-shell catalysts with excellent performance and long-term stability. Besides the conventional Pt₃M (M=Fe, Co, Ni), we have demonstrated Pt₃Y and Pt₃La, which exhibited several times higher activity than Pt and extremely good stability after the accelerated degradation test. We further extended our researches to core-shell catalysts, where alloy core provided modification of electronic structure of Pt shell leading to the enhanced activity and durability at the single cell level. Particularly, the Pd₃Cu@Pt core-shell catalysts were designed by DFT calculations and successfully fabricated as supported ones on carbon by selective reduction of Pt shell on the cores using specific reducing agent. The characterization of the catalysts and evaluation of their performances as well as the durability will be presented.

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