SS-006 **<Invited Talk>**

Nano Electrocatalysis for Fuel Cells

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For both oxygen reduction (ORR) and hydrogen oxidation reactions (HOR) of proton electrolyte membrane fuel cells (PEMFCs), alloying Pt with another transition metal usually results in a higher activity relative to pure Pt, mainly due to electronic modification of Pt and bifunctional behaviour of alloy surface for ORR and HOR, respectively. However, activity and stability are closely related to the preparation of alloy nanoparticles.

Preparation conditions of alloy nanoparticles have strong influence on surface composition, oxidation state, nanoparticle size, shape, and contamination, which result from a large difference in redox priority of metal precursors, intrinsic properties of metals, increasedreactivity of nanocrystallites, and interactions with constituents for the synthesis such as solvent, stabilizer, and reducing agent, etc. Carbon-supported Pt-Ni alloy nanoparticles were prepared by the borohydride reduction method in anhydrous solvent. Pt-Ru alloy nanoparticles supported on carbon black were also prepared by the similar synthetic method to that of Pt-Ni.

Since electrocatalytic reactions are strongly dependent on the surface structure of metal catalysts, the atom-leveled design of the surface structure plays a significant role in a high catalytic activity and the utilization of electrocatalysts. Therefore, surface-modified electrocatalysts have attracted much attention due to their unique structure and new electronic and electrocatalytic properties. The carbon-supported Au and Pd nanoparticles were adapted as the substrate and the successive reduction process was used for depositing Pt and PtM (M=Ru, Pd, and Rh) bimetallic elements on the surface of Au and Pd nanoparticles. Distinct features of the overlayers for electrocatalytic activities including methanol oxidation, formic acid oxidation, and oxygen reduction were investigated.