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Program Title (English) : In-situ XAFS study of Ru based bimetallic solid solution alloy nanoparticles with controlled fcc and hcp structures under CO oxidation conditions

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1. Introduction

Platinum-group metal (PGM) catalysts are invaluable to many important applications. How to further improve the catalytic activity has been a key issue due to its high cost and rare reserves. As a design for the cost-effective and high-performance catalysts of PGM catalysts, a method of doping with nonprecious elements is widely used. Ruthenium, nickel and cobalt are significant catalysts for many catalytic reactions. In particular, studies on the CO oxidation performance of Ru, Co and Ni nanoparticles and the surface reaction mechanism of single crystal have been widely investigated. The purpose of this beam time is to observe the electronic structure change of metal alloy nanoparticles during the gas atmosphere.

2. Experimental

First, we observed the ex situ XAFS of the samples in the pellet form. For the in situ measurement, focusing on the In, Co, Cu, Fe, Ni, Pd K-edges, the samples were pressurized and fitted into the in situ holder provided by Dr. Matsumura. The XAFS spectra were obtained under different atmospheres including vacuum, H_2 (1 bar), CO_2 (1 bar) with varying temperatures (RT to 773 K).

3. Results and Discussion

During this beamtime, we have confirmed that all the liquid metal-based nanoparticles are covered by metal oxide layers on their surfaces. The thickness of the surface oxide layers is highly dependent on the particle size. Small NPs have thicker layers. We have also observed Ni metal and In_2O_3 nanoparticle samples under in situ condition of CO_2 and H_2 atmospheres at various temperatures. We have found some structural change of these nanoparticles and Fe and Co nanoparticles under some gaseous conditions. Detailed analysis will be operated in order to understand correlations between structure of nanoparticles and catalysis.