Size- and shape-controlled Rh nanoparticles synthesized via microwave assisted-alcohol reduction method and their activity in CO oxidation

Yoshihide Nishida[1],
Katsutoshi Sato[2, 3], Katsutoshi Nagaoka[1,3]
[1] *Graduate School of Engineering, Oita University, Oita, Japan*
[2] *ESICB, Kyoto University, Kyoto, Japan*
[3] *Faculty of Science and Technology, Oita University, Oita, Japan*

*E-mail: nagaoka@oita-u.ac.jp

It is not easy to control size and shape of metal nanoparticle because it is thermodynamically unstable. On the other hand, since catalytic reaction occurs over the surface on metal atoms, size- and shape-controlled synthesis of metal nanoparticles is important for improving their catalytic activity. In addition, Rh has been widely used as industrial catalysts. In this research, we focused on controlling size and shape of Rh nanoparticle and its CO oxidation activity. In previous researches, controlling size and shape of nanoparticle is achieved by changing several factors such as preparation-temperature, time, concentration of metal precursor, pH of solvent and so on. In contrast, we successfully controlled the size and shape of Rh nanoparticles via microwave assisted-alcohol reduction method with changing only type of alcohols as reductant. In addition, we investigated their CO-oxidation activity and found that size and shape of Rh nanoparticle influences on it.

Rh nanoparticles with different size were prepared by microwave assisted-alcohol reduction method. Initially, $RhCl_3 \cdot 3H_2O$ as metal precursor and polyvinylpyrrolidone as the stabilizer were dissolved in different alcohols (ethanol, 2-ethoxyethanol, 2-(2-ethoxyethoxy)ethanol, ethylene glycol, diethylene glycol, and triethylene glycol) as reductant. This solution was heated to 165 °C with microwave irradiation and maintained at this temperature for 15 min. Obtained colloidal solution was precipitated and dried under vacuum at 40 °C. γ-Al_2O_3 supported Rh nanoparticle catalysts were prepared by wet impregnation method. The Rh loading used was 1 wt%.

Fig. 1 shows X-ray diffraction(XRD) patterns for size- and shape-controlled Rh nanoparticles. The diffraction peaks of Rh nanoparticles were attributed to fcc structure and the peaks became sharper when alcohol with longer main chain was employed. Furthermore, HR-TEM images showed that most of Rh nanoparticles form single crystal and particle shape also changed according to particle size. Therefore, it is suggested that reductant influence not only particle size but also particle shape.

Catalytic activity test for CO oxidation was carried out under oxidizing atmosphere ($CO/O_2/N_2$: 0.5/0.5/49 mL/min) without reduction pretreatment. Fig. 2 shows CO oxidation activity for size- and shape-controlled Rh/γ-Al_2O_3. It was found that catalytic activity nearly corresponded with trend in size of Rh nanoparticle.

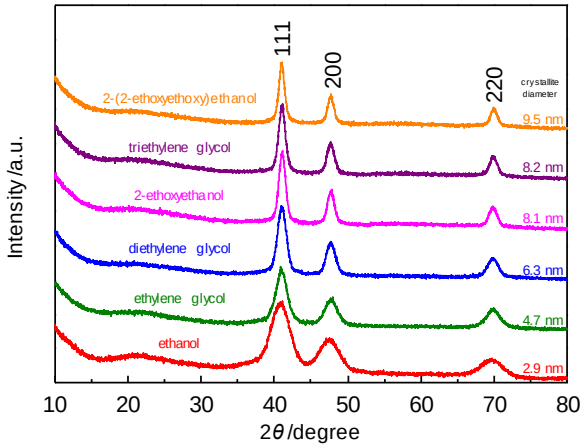

Fig. 1. XRD patterns of size- and shape-controlled Rh nanoparticle.

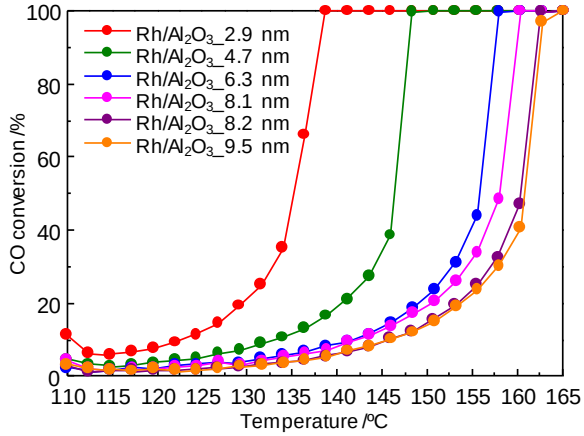

Fig. 2. Size dependence of CO oxidation activity of Rh catalysts.