SF-P015

Understanding Deactivation of Ru Catalysts by In-situ Investigation of Surface Oxide Stability under CO Oxidation and Oxidative/Reductive Conditions

Kamran Qadir[1], Sang Hoon Joo[2], Bongjin S. Mun[3], Jeong Young Park[1]

[1]EEWS Graduate School, KAIST, Daejeon, 305-701, South Korea
[2]School of Nano-Bioscience and Chemical Engineering, UNIST, Ulsan, 689-798, Republic of Korea
[3]Department of Applied Physics, Hanyang University ERICA, Ansan, 426-791, South Korea

In addition to the catalysts' activity and selectivity, the deactivation of catalysts during use is of practical importance. It is crucial to understand the phenomena of the deactivation to predict the loss of activity during catalyst usage so that the high operational costs associated with catalyst replacement can be reduced. In this study, the activity of Ru catalysts, such as nanoparticles (3～6 nm) and polycrystalline thin film (50 nm), have been investigated under CO oxidation and oxidative/reductive reaction conditions at various temperatures with the ambient pressure X-Ray photoelectron spectroscopy (APXPS). With APXPS, the surface oxides on the catalyst are measured and monitored in-situ. It was found that the Ru film exhibited faster oxidation-and-reduction compared to that of nanoparticles showing mild oxidative-and-reductive characteristics. Additionally, the larger Ru nanoparticles showed a higher degree of oxide formation at all temperatures, suggesting a higher stability of the oxide. These observations are in agreement with the catalytic activity of Ru catalysts. The loss of activity of Ru films is correlated with bulk oxide formation, which is inactive in CO oxidation. The Ru nanoparticle, however, does not exhibit deactivation under similar conditions, suggesting that its surface is covered with a highly active ultrathin surface oxide. Since the active oxide is more stable as nanoparticles than as a film, the nanoparticles showed mild oxidative/reductive behavior, as confirmed by APXPS results. We believe these simultaneous observations of both the surface oxide of Ru catalysts and the reactivity in real time enable us to pinpoint the deactivation phenomena more precisely and help in designing more efficient and stable catalytic systems.

Keywords: Co oxidatation, AP-XPS, Ru catalysts