In-situ study of PdZn and PdCuZn catalysts for CO_2 hydrogenation by Ambient Pressure X-ray Photoelectron Spectroscopy (APXPS)

Ying-Chih Lo[1], Chia-Hsin Wang[1]*, Yaw-Wen Yang[1,2]

[1]National Synchrotron Radiation Research Center, Hsinchu, 30076, Taiwan
[2]Department of Chemistry, National Tsing-Hua University, Hsinchu, 30013, Taiwan

Abstract

The conversion of CO_2 to value-added chemicals efficiently plays an important role in reducing CO_2 emissions. Pd-Zn and Pd-Cu-Zn nanoparticles have been demonstrated as the potential catalysts for CO_2 hydrogenation. In this report, we study the PdZn and PdcuZn catalysts for CO_2 hydrogenation by APXPS. The PdZn and PdCuZn nanoparticles were prepared by the impregnation method and the crystallinity and particles size distribution were confirmed by X-ray diffraction, and transmission electron microscopy. The surface evolution of catalytic solid was investigated in the CO_2 hydrogenation at the pressure of 0.5 mbar with a mixing gas by CO_2 and H_2 by 3:1via APXPS at TLS BL24A. APXPS revealed the change in the composition of the catalysts during the reaction process. Palladium oxide gradually decreased, whereas PdZn alloy increased at 473K in bimetallic catalyst. In addition, O 1s spectra revealed a peak at binding energy of 531.2 eV, which corresponds to CO adsorbed on the surface of Pd metal. On the other hand, for PdCuZn nanoparticles, palladium and palladium oxide dramatically decreased at 423K, and the surface of trimetallic catalyst is composed mainly of Pd-Cu-Zn alloy at 573K. This change of surface composition led to less carbon monoxide formation compared to PdZn catalyst. These results are consisted with the catalyst activity tests via GC-MS. The more detail will be discussed in this report.

Keywords – Ambient pressure X-ray photoemission spectroscopy; CO_2 hydrogenation.