Catalytic properties of Pd/TiO₂ catalysts containing the combination of Pd⁰/PdOₓ species in benzyl alcohol oxidation

Patcharaporn Weerachawanasak¹*, Joongjai Panpranot²

¹Department of Chemistry, Faculty of Science, King Mongkut’s Institute of Technology Ladkrabang, Bangkok 10520, Thailand
²Center of Excellence on Catalysis and Catalytic Reaction Engineering, Department of Chemical Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok 10330, Thailand
*E-mail: patcharaporn.we@kmitl.ac.th

Abstract: Various Pd/TiO₂ catalysts were prepared by different methods such as electroless deposition (ED), sonochemical (SN), and sol immobilization (IM). According to TEM and XPS results, degree of Pd dispersion, metal particle/cluster size, and oxidation states of palladium were varied on the different Pd/TiO₂ catalysts. Metallic Pd⁰ was mostly observed on the Pd/TiO₂-IM while the Pd/TiO₂-SN contained both Pd⁰ and PdO species. Surprisingly, PdO₂ was the most abundant species on the Pd/TiO₂-ED. The combination of Pd⁰/PdOₓ species were found to be necessary in benzyl alcohol oxidation. The Pd/TiO₂-ED and the Pd/TiO₂-SN showed higher activity than the Pd/TiO₂-IM. Low oxidation activity was obtained when the catalysts contained only metallic Pd⁰. Although metallic Pd⁰ species have been proven to be more active than PdOₓ for benzyl alcohol oxidation, the results in this study, however, emphasized that the reduction of PdOₓ to Pd⁰ by adsorbed benzyl alcohol is an essential step for benzyl alcohol oxidation over supported Pd catalysts. The effect of Pd dispersion was less pronounced for oxidation reaction.

Keywords: Pd/TiO₂ catalyst; Benzyl alcohol oxidation; Electroless deposition; Sonochemical; Sol immobilization