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Photocatalytic activity of TiO_2 on nano-diamond powder prepared by Atomic Layer Deposition

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The photocatalytic decomposition of toluene gas was investigated with TiO_2 on nano-diamond powder (NDP) under UV irradiation. Atomic layer deposition (ALD) was used for the growth of TiO_2 on the NDP. The structure and surface properties of catalysts were characterized by X-ray Diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS) and Transmission Electron Microscopy (TEM). The photocatalytic activity for the toluene decomposition was evaluated by measuring the concentration change of toluene and CO_2 gas with gas chromatography (GC)-flame ionization detector (FID) system.

The photocatalytic activities of TiO_2/NDP catalysts were compared with that of P-25. The rate of initial photocatalytic decomposition of toluene for the TiO_2/NDP catalysts was relatively lower when compared to P-25. The photocatalytic activity of P-25 was rapidly decreased with time, whereas, the deactivation of TiO_2/NDP catalysts was less pronounced. Therefore, as the reaction time increased, the photocatalytic activity of TiO_2/NDP catalysts became higher than that of P-25. The intermediates such as benzaldehyde or benzoic acid, etc were more easily adhered to the active site on the P-25 surface during reaction, resulting in easier deactivation of P-25. These results could be confirmed using FT-IR spectroscopy. We suggest that the NDP used as substrate can reduce the deactivation of TiO_2 on the surface.

Keywords: photocatalytic decomposition, TiO2, nano-diamond, Atomic layer deposition, deactivation