PHOTOCATALYTIC DEGRADATION OF BENZENE GAS BY THE HYBRID PHOTOCATALYST OF NANOCRYSTALLINE TIO_2/$CAAL_2O_4$:(EU,ND) PHOSPHOR UNDER VISIBLE-LIGHT IRRADIATION

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Abstract

The coupling of TiO_2 with other inorganic oxides such as SiO_2, SnO_2, WO_3, (Sr,La)TiO_{3+}, and $ZnFe_2O_4$ can change the photocatalytic efficiency and the energy range of photo-excitation. This study investigated the photocatalytic behavior of nanocrystalline TiO_2 deposited on long-lasting phosphor of $CaAl_2O_4$:Eu_{2+},Nd_{3+}. The $CaAl_2O_4$:Eu_{2+},Nd_{3+} phosphor powders were prepared via conventional sintering using $CaCO_3$, Al_2O_3, Eu_2O_3, and Nd_2O_3 as raw materials according to the appropriate molar ratios. Nanocrystalline TiO_2 was deposited on $CaAl_2O_4$:Eu_{2+},Nd_{3+} powders via low-pressure chemical vapor deposition (LPCVD). The TiO_2 deposited on the long-lasting phosphor presented different decomposition behaviors with respect to the photo-degradation of benzene gas when compared to that of pure TiO_2. The TiO_2 coated on the phosphor was actively photo-reactive under irradiation with visible light and showed much faster benzene degradation than pure TiO_2, which is almost non-reactive. The coupling of TiO_2 with phosphor may result in an energy band bending in the junction region, which then induces the TiO_2 crystal at the interface to be photo-reactive under irradiation with visible light. In addition, the intermetallic compound of $CaTiO_3$ that formed at the interface between TiO_2 and the $CaAl_2O_4$:(Eu_{2+},Nd_{3+}) phosphor may affect the photocatalytic reaction. In addition, the effect of Ag nanoparticle loading was investigated on the photocatalytic reactivity of the TiO_2/$CaAl_2O_4$:Eu_{2+},Nd_{3+} phosphor. Silver nanoparticles were loaded on the phosphor by mixing with an aqueous Ag-dispersion solution. TiO_2 on the Ag-doped phosphor presented a higher benzene gas decomposition rate than the TiO_2 did on the phosphor without Ag-doping. The photocatalytic characteristics of TiO_2/Ag-$CaAl_2O_4$:(Eu,Nd) hybrid photocatalyst will be discussed with crystalline structure, heterojunction of energy band structure and phosphorescence.

Keywords: Photocatalyst, TiO2, Long lasting phosphor, CaAl2O4:Eu2+,Nd3+

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