Enhanced Photocatalytic Performance of (TiO_2-WO_3) Supported on $Sr_4Al_{14}O_{25}$:Eu, Dy under Visible Light

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Significance and Relevance

- ✓ TiO_2/WO_3 nano-crystalline was coated on the bead-shaped supporter of $Sr_4Al_{14}O_{25}$:Eu^{2+},Dy^{3+} long-lasting phosphor by a hydrothermal reaction method.
- ✓ The photocatalytic decomposition rate varied significantly with the hydrothermal reaction temperature and ratio of TiO_2 and WO_3.
- ✓ Optimum photocatalytic efficiency for the (TiO_2-WO_3)/phosphor composite was occurred with the 5:5 ratio of TiO_2 to WO_3 and heat treatment temperature of 550 °C.

Preferred and 2nd choice for the topic: (1) Photocatalysis and photoelectrocatalytic approaches, solar energy utilization, and (2) Air cleaning and combustion

Preferred presentation: Oral preferred or Short Oral

Introduction and Motivations

Photocatalytic materials have received increasing attention as materials that can decompose harmful environmental pollutants in an eco-friendly manner through redox reactions using light energy. Among the various photocatalytic materials, TiO_2 is the most widely used because it is chemically stable and has a band gap of 3.2 eV, in which photo excitation reactions can occur efficiently. In this study, TiO_2 and WO_3 have been hybridized and supported on the long-lasting phosphor of $Sr_4Al_{14}O_{25}$:Eu,Dy. In the hybrid photocatalyst of (TiO_2-WO_3)-coated long-lasting phosphor, the phosphor may act as an internal light source toward the acceleration or sustenance of photocatalytic reactivity even in the absence of external light irradiation.

Materials and Methods

The long-lasting phosphor powders of $Sr_4Al_{14}O_{25}$:Eu^{2+},Dy^{3+} was prepared to be bead-shaped supporter, following the coating of TiO_2 and WO_3 nano-particles by a hydrothermal synthesis. For the fabrication of phosphor beads, $Sr_4Al_{14}O_{25}$:Eu^{2+},Dy^{3+} phosphor powders were mixed with Na_2SiO_3 aqueous solution to be slurry state. The phosphor droplets were made by extruding the phosphor slurry through 3 mm nozzle syringe and dropping into a 10 wt.% $CaCl_2$ solution, then separated from the solution and annealed at 350 °C for 3h.

For the fabrication of (TiO_2-WO_3)-coated phosphor beads, TiO_2/WO_3-precursor was prepared by mixing titanium isopropoxide (TTIP), tungsten precursor ($Na_2WO_4 \cdot 2H_2O$), ethanol, deionized water, and HNO_3 with appropriate volume ratios, respectively. Then, the TiO_2/WO_3--sol solution was mixed with the prepared $Sr_4Al_{14}O_{25}$:Eu^{2+},Dy^{3+} phosphor beads, transferred into a Teflon-lined autoclave and heat treated in a dry oven at 150 °C for the selected time of hydrothermal reaction.

The photocatalytic performance of the (TiO_2-WO_3)-coated phosphor beads was analyzed with respect to the photobleaching effect of methylene blue and decomposition of toluene gas by UV/Vis spectrometer and gas chromatography (GC), respectively.

Results and Discussion

A photocatalytic performance was investigated by measuring the decomposition of toluene gas under visible light irradiation in 1 L Teflon gas bag with 10g sample of (TiO_2-WO_3)-coated $Sr_4Al_{14}O_{25}$:Eu^{2+},Dy^{3+} beads. The hydrothermal reaction temperature of (TiO_2-WO_3)-coating process was fixed at 550 °C, while the ratio of TiO_2 to WO_3 was 10:0, 7:3, 5:5, 3:7, and 0:10. For comparison, the

photocatalytic performance of $TiO_2/Sr_4Al_{14}O_{25}:Eu^{2+},Dy^{3+}$ composite beads without WO_3 was investigated.

Fig. 1 shows the difference in the photocatalytic efficiency based on the ratio of TiO_2 to WO_3 under visible light irradiation. The highest photocatalytic efficiency occurred when the ratio of TiO_2 to WO_3 was 5:5, where the photocatalytic decomposition of toluene reached over 70% after 90 min. The (TiO_2-WO_3)/$Sr_4Al_{14}O_{25}$: Eu^{2+},Dy^{3+} beads with 7:3 of TiO_2 to WO_3 decomposed 65% of toluene gas after 90 min, whereas that of 3:7 of TiO_2 to WO_3 decomposed 50% of toluene gas. Meanwhile, the $TiO_2/Sr_4Al_{14}O_{25}$: Eu^{2+},Dy^{3+} beads without WO_3 showed 40% decomposition rate of toluene, indicating significantly low photocatalytic efficiency, compared with other samples with WO_3.

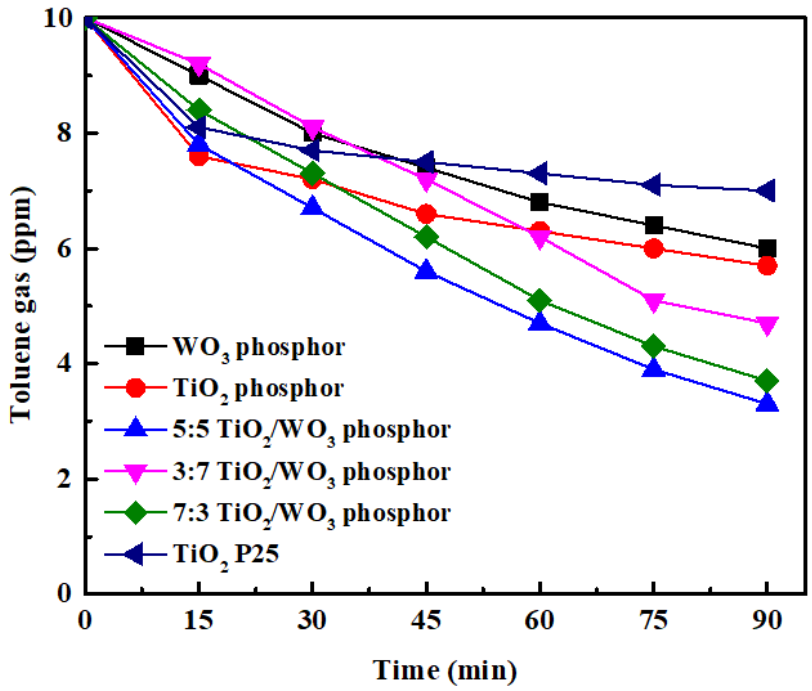

Figure 1. Variations of toluene decomposition under visible light illumination for (TiO_2-WO_3)/phosphor composites.

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