g-C_3N_4/$NaTaO_3$ 복합체의 제조 및 태양광 조사 하에서의 광촉매 특성 평가

Preparation and characterization of g-C_3N_4/$NaTaO_3$ composite and their photocatalytic activity under simulated solar light

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초 록: This Paper reports the photocatalytic activity of g-C_3N_4/$NaTaO_3$ hybrid composite photocatalysts synthesized by ball-mill method. The g-C_3N_4 and $NaTaO_3$ were individually prepared by Solid state reaction and microwave hydrothermal process, respectively. The g-C_3N_4/$NaTaO_3$ composite showed the enhanced photocatalytic activity for degradation of rhodamine B dye (Rh. B) under simulated solar light irradiation. The results revealed that the band-gap energy absorption edge of hybrid composite samples was shifted to a longer wavelength as compared to $NaTaO_3$ and the 50 wt% g-C_3N_4/$NaTaO_3$ hybrid composite exhibited the highest percentage (99.6 %) of degradation of Rh. B and the highest reaction rate constant (0.013 min^{-1}) in 4 h which could be attributed to the enhanced absorption of the hybrid composite photocatalyst in the UV-Vis region. Hence, these results suggest that the g-C_3N_4/$NaTaO_3$ hybrid composite exhibits enhanced photocatalytic activity for the degradation of rhodamine B under simulated solar light irradiation in comparison to the commercial $NaTaO_3$.

1. 서론

In recent year, semiconductor photocatalysts have been attracted much attention because of their high photocatalytic activity, high stability, non-toxicity and environmentally-harmonious characteristics.[1-3] TiO_2 photocatalysts are presently the most actively and widely investigated for applications that can effectively address environmental pollution.[4-6] Recently, $NaTaO_3$ has been used as a photocatalyst for water splitting and environmental remediation under UV light irradiation due to its physical, chemical and structural properties.[7-9] Moreover, $NaTaO_3$ has favorable band edge potentials and delocalized nature of photoexcited electrons which are primary reasons for higher efficiency.[10-12] Recent studies have shown that the photocatalytic activities of doping rare-earth and hybrid composite into the perovskite type alkali tantalates have been significantly improved. These coupling of different semiconductor photocatalysts may increase the photocatalytic efficiency by enhancing the charge separation and extending the photo-formed electron.hole pairs under irradiation.

2. 본론

In this study, the microwave hydrothermal synthesis was used to prepare $NaTaO_3$ and then g-C_3N_4 was prepared by solid state reaction. Finally, g-C_3N_4/$NaTaO_3$ hybrid composite were prepared by ball-mill method. The photocatalytic activity of the g-C_3N_4/$NaTaO_3$ composite was performed by degradation of Rh B dye in aqueous solution under simulated solar light irradiation. Figure 1 shows the XRD patterns of the g-C_3N_4/$NaTaO_3$ composite with various g-C_3N_4 amounts with a range of g-C_3N_4 content from 0 wt% to 50 wt%. The monoclinic phase $NaTaO_3$ has been obtained by microwave hydrothermal method at 180 ℃ for 8 h. These characteristic reflections can be readily indexed as the cubic phase (100), (110), (111), (020), (102), (211) and (220) planes, according to (JCPDS#742477). In the XRD patterns of g-C_3N_4/$NaTaO_3$ composites, no change was observed in the crystal structure of $NaTaO_3$ but a new peak was appeared at 27.4 ° . The inset of Figure 1 shows a magnified image of the diffraction peaks for the (002) plane of g-C_3N_4. The peak at 27.4 ° , could be indexed to graphitic materials as the (002) peak, which is attributed to the interplanar striking of the aromatic compound. Moreover, intensity of this diffraction peaks was increased with increasing content of g-C_3N_4. The schematic of the charge separation and transport of photoinduced charge carrier at the interface of the g-C_3N_4/$NaTaO_3$ composite under simulated solar light is shown in Figure 2. The photoinduced holes migrate from $NaTaO_3$ to the valence band (VB) of g-C_3N_4 which supresses the recombination of photoinduced electron.hole pairs. In addition, g-C_3N_4 and surface in g-C_3N_4/$NaTaO_3$ hybrid composite can act as electron traps and prevents the recombination of the electron-hole pairs. These facts together could be attributed for the enhanced photocatalytic activity of the g-C_3N_4/$NaTaO_3$ composite.

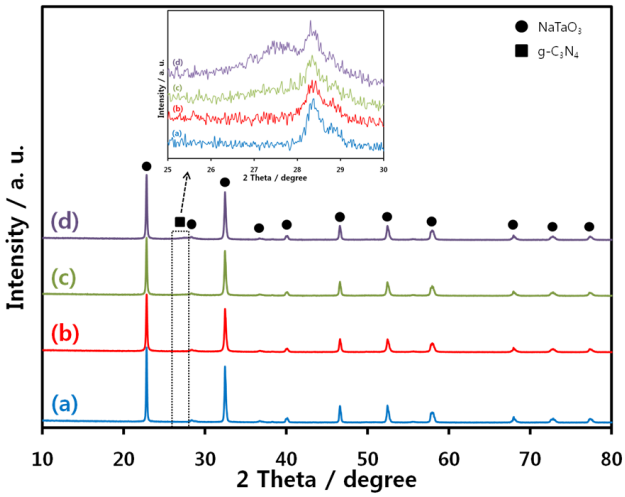

Figure 1. XRD patterns of photocatalysts: (a) $NaTaO_3$, (b) 10 wt% g-C_3N_4/$NaTaO_3$, (c) 30 wt% g-C_3N_4/$NaTaO_3$ and (d) 50 wt% g-C_3N_4/$NaTaO_3$. The inset shows the magnification of the diffraction peaks around 27 ° .

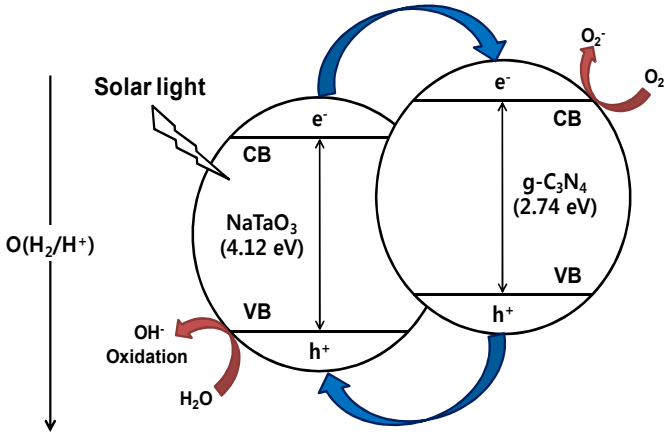

Figure 2. Schematic illustrating the mechanism of degradation of dye by g-C_3N_4/$NaTaO_3$ under solar light irradiation.

3. 결론

Solar-light-responsive g-C_3N_4/$NaTaO_3$ hybrid composite was successfully prepared by the ball-mill method. Diffuse reflectance UV-vis spectra of 50 wt% g-C_3N_4/$NaTaO_3$ composite revealed the lowest band gap energy of about 2.81 eV. The highest efficiency was observed for 50 wt% g-C_3N_4/$NaTaO_3$ hybrid composite. The enhanced photocatalytic performance could be attributed to synergistic effects of band gap lowering, photoinduced electron-hole pair at the interface and the larger surface area of the g-C_3N_4/$NaTaO_3$ hybrid composite photocatalysts which promote the migration effciency of electron.hole pairs leading to enhanced photocatalytic degradation of Rh. B dye under simulated solar light irradiation.

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