Preparation, Characterization and Photocatalytic Activity of a New Noble Metal Modified TiO2@SrTiO3 and SrTiO3 Photocatalysts

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Abstract : Among the various semiconductors, nanosized TiO2 has been widely studied due to its high photosensitivity, low cost, low toxicity, and good chemical and thermal stability. However, there are two main drawbacks to the practical application of pure TiO2 films. One is that TiO2 can be induced only by ultraviolet (UV) light due to its intrinsic wide bandgap (3.2 eV for anatase and 3.0 eV for rutile), which limits its practical efficiency for solar energy utilization since UV light makes up only 4-5% of the solar spectrum. The other is that a high electron-hole recombination rate will reduce the photoelectric conversion efficiency of TiO2. In order to overcome the above drawbacks and modify the electronic structure of TiO2, some semiconductors (eg. CdS, ZnO, PbS, Cu2O, Bi2S3, and CdSe) have been used to prepare coupled TiO2 composites, for improving their charge separation efficiency and extending the photoresponse into the visible region. It has been proved that the fabrication of p-n heterostructures by combining n-type TiO2 with p-type semiconductors is an effective way to improve the photoelectric conversion efficiency of TiO2. SrTiO3 is a good candidate for coupling TiO2 and improving the photocatalytic performance of the photocatalyst because its conduction band edge is more negative than TiO2. Due to the potential differences between the band edges of these two semiconductors, the photogenerated electrons transfer from the conduction band of SrTiO3 to that of TiO2. Conversely, the photogenerated electrons transfer from the conduction band of SrTiO3 to that of TiO2. Then the photogenerated charge carriers can be efficiently separated by these processes, resulting in the enhancement of the photocatalytic property in the photocatalyst. Additionally, one of the methods for improving photocatalyst performance is addition of nanoparticles containing one or two noble metals (Pt, Au, Ag and Pd) deposited on semiconductor surface. The mechanisms were proposed as (1) the surface plasmon resonance of noble metal particles is excited by visible light, facilitating the excitation of the surface electron and interfacial electron transfer (2) some energy levels can be produced in the band gap of TiO2 by the dispersion of noble metal nanoparticles in the TiO2 matrix; (3) noble metal nanoparticles deposited on TiO2 act as electron traps, enhancing the electron–hole separation. In view of this, we recently obtained series of TiO2@SrTiO3 and SrTiO3 photocatalysts loaded with noble metal NPs. using photodeposition method. The M- TiO2@SrTiO3 and M-SrTiO3 photocatalysts (M= Rh, Rt, Pt) were studied for photodegradation of phenol in aqueous phase under UV-Vis and visible irradiation. Moreover, in the second part of our research hydroxyl radical formations were investigated. Fluorescence of irradiated coumarin solution was used as a method of ˙OH radical detection. Coumarin readily reacts with generated hydroxyl radicals forming hydroxycoumarins. Although the major hydroxylation product is 5-hydroxycoumarin, only 7-hydroxyproduct of coumarin hydroxylation emits fluorescent light. Thus, this method was used only for hydroxyl radical detection, but not for determining concentration of hydroxyl radicals.

Keywords : composites TiO2, SrTiO3, photocatalysis, phenol degradation
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