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Photocatalytic Properties of Pt/Er-KTaO3

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Abstract : Photoactive materials have attracted attention due to their potential application in the degradation of environmental pollutants to non-hazardous compounds in an eco-friendly route. Among semiconductor photocatalysts, tantalates such as potassium tantalate (KTaO3) is one of the excellent functional photomaterial. However, tantalates-based materials are less active under visible-light irradiation, the enhancement in photoactivity could be improved with the modification of opto-eletronic properties of KTaO3 by doping rare earth metal (Er) and further photodeposition of noble metal nanoparticles (Pt). Inclusion of rare earth element in orthorhombic structure of tantalate can generate one high-energy photon by absorbing two or more incident low-energy photons, which convert visible-light and infrared-light into the ultraviolet-light to satisfy the requirement of KTaO3 photocatalysts. On the other hand, depositions of noble metal nanoparticles on the surface of semiconductor strongly absorb visible-light due to their surface plasmon resonance, in which their conducting electrons undergo a collective oscillation induced by electric field of visible-light. Furthermore, the high dispersion of Pt nanoparticles, which will be obtained by photodeposition process is additional important factor to improve the photocatalytic activity. The present work is aimed to study the effect of photocatalytic process of the prepared Er-doped KTaO3 and further incorporation of Pt nanoparticles by photodeposition. Moreover, the research is also studied correlations between photocatalytic activity and physico-chemical properties of obtained Pt/Er-KTaO3 samples. The Er-doped KTaO3 microcomposites were synthesized by a hydrothermal method. Then photodeposition method was used for Pt loading over Er-KTaO3. The structural and optical properties of Pt/Er-KTaO3 photocatalytic were characterized using scanning electron microscope (SEM), X-ray diffraction (XRD), volumetric adsorption method (BET), UV-Vis absorption measurement, Raman spectroscopy and luminescence spectroscopy. The photocatalytic properties of Pt/Er-KTaO3 microcomposites were investigated by degradation of phenol in aqueous phase as model pollutant under visible and ultraviolet-light irradiation. Results of this work show that all the prepared photocatalysis exhibit low BET surface area, although doping of the bare KTaO3 with rare earth element (Er) presents a slight increase in this value. The crystalline structure of Pt/Er-KTaO3 powders exhibited nearly identical positions for the main peak at about 22,8o and the XRD pattern could be assigned to an orthorhombic distorted perovskite structure. The Raman spectra of obtained semiconductors confirmed demonstrating perovskite-like structure. The optical absorption spectra of Pt nanoparticles exhibited plasmon absorption band for main peaks at about 216 and 264 nm. The addition of Pt nanoparticles increased photoactivity compared to Er-KTaO3 and pure KTaO3. Summary optical properties of KTaO3 change with its doping Er-element and further photodeposition of Pt nanoparticles.

Keywords : heterogeneous photocatalytic, KTaO3 photocatalysts, Er3+ ion doping, Pt photodeposition
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