Effect of anodic potentials for fabricating co-doped TiO_2 on the photocatalytic activity

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Abstract : The TiO_2 films were prepared in the H_2SO_4 solution containing NH_4F at different anodic voltages, to compare the photocatalytic performances of titania for purification of waste water. The microstructure was characterized by a Field-emission scanning electron microscopy (FE-SEM) and X-ray diffractometry (XRD). Chemical bonding states and co-doped elements of F and N were analyzed using surface X-ray photoelectron spectroscopy (XPS). The photocatalytic activity of the co-doped TiO_2 films was analyzed by the degradation of aniline blue solution. From the result of diffuse reflectance absorption spectroscopy(DRS), it is indicated that the absorption edge of the F-N-codoped TiO_2 films shifted toward visible light area, and the photocatalytic reaction of TiO_2 was improved by doping an appropriate contents of F and N.

1. Introduction

TiO_2 is the most widely used photocatalyst for the decomposition of various organic pollutants for its high activity and chemical stability. However, the band gap energy only allows TiO_2 to absorb ultraviolet light, which accounts for a small part of solar energy. The purpose of this study is to prepare F-N-codoped TiO_2 with higher photocatalytic activity under visible irradiation, and to explain the relationship to fabrication parameters and a high specific surface area, and to compare the photocatalytic performance of visible light active F-N-codoped TiO_2 films fabricated in same electrolyte at different voltages, which was evaluated by analyzing the degradation of aniline blue.

2. Experimental and Results

The F-N-codoped TiO_2 on Ti substrate was prepared by using an electrochemical anodic oxidation process. Titanium sheets(99.5%) were cut into 30 mm × 40 mm rectangular samples and degreased by ultrasonic in acetone, rinsed in distilled water and dried in air at room temperature. And then Ti sheets were chemical etched in HF, HNO_3,H_2SO_4 aqueous solution for 1 min at room temperature. The electrolyte was composed of 1.0M H_2SO_4 / 4wt% NH_4F and anodization voltage was applied at 30 V and 180 V. Annealing in air at 550℃ for 1h was done to fabricate Anatase and Rutile TiO_2 layers for the sample anodized at 30 V. The observation and the analysis of the F-N-codoped TiO_2 were carried out using FE-SEM, XPS and XRD, and the diffused reflectance of the film was executed using UV-Vis spectrophotometer. The photocatalytic reaction was measured by the degradation rate of aniline blue.

3. Conclusions

In this work, morphology of TiO_2 films was different according to the anodic potentials. Nanotube was seen for the film anodized at 30 V. The TiO_2 films for 180 V exhibited a porous microstructure with submicron and nano sized spherical pores. From the investigation of chemical bonding states by XPS, F and N were observed in the TiO_2 films. Compared with films prepared at 30 V, the titania fabricated at 180 V shows more effective photocatalytic activity. And the co-doping of the F and N leads to much narrowing of the band gap compared to pure TiO_2 film, and it remarkably enhanced the photocatalytic reaction under visible irradiation.

References

1. Chung-Chin Yen, J. Solid State Chem., 184 (2011) 2053
2. Hsin-Hung Ou, J. Mol. Catal. A: Chem., 275 (2007) 200
3. Lan Sun, J. Hazard. Mater., 171 (2009) 1045
4. Ya-Fang Tu, Mater. Res. Bull., 45 (2010) 224