

Study on the Preparation and Photocatalytic Performance of Eu/N-doped Titanium Dioxide

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Abstract: Eu/N-doped TiO_2 samples were prepared by the sol-gel method and impregnation method. The photocatalytic degradation of methyl orange was used as model reaction to evaluate the activity of Eu/N-doped TiO_2 samples. The structure of Eu/N-doped TiO_2 samples were characterized by XRD. It is found that: (1) The doping of Eu and N had little influence on the structure of TiO_2 . (2) The Eu/N-doped TiO_2 samples calcined at 450°C showed higher photocatalytic activity under visible light irradiation.

Key words: TiO_2 ; Eu/N-doped; Photocatalyst; sol-gel method; impregnation method

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Nanometer titanium dioxide has been shown to be potentially advantageous for environmental remediation as it may lead to complete mineralization of organic pollutants with the use of ultraviolet light. However, the large scale application of titanium dioxide is hampered due to its wide band-gap of 3.2 eV when solar light is used^[1-2]. In the attempt to create a red shift of the band gap energy, a number of groups have approached this problem by doping titanium dioxide with some elements^[3-5]. Asahi et al. reported nitrogen doped titania that possessed visible light photocatalytic activity in the photo-degradation of methylene blue and acetaldehyde. Zhao et al. reported on doped TiO_2 with both nonmetal element boron and metal oxide Ni_2O_3 which enhanced degradation efficiency of toxic organic pollutants under visible light irradiation.

In this paper, Eu/N-doped TiO_2 samples were prepared and their photocatalytic activities were evaluated under visible light irradiation.

1 Experiment

1.1 Preparation of titanium dioxide samples

At room temperature, a certain amount of europium nitrate was dissolved into the mixture including 30 mL ethanol, 3 mL deionized water, 5 mL acetic acid to obtain solution A. Solution B was prepared by mixing 15 mL $\text{Ti}(\text{O}i\text{Bu})_4$, 5 mL acetic acid, 60 mL ethanol with continuous stirring for 30 min. Solution A was added drop-wise into solution B with quick stirring until the mixture became clear completely. The gelation of

the sol was carried out in a vacuum oven at 30°C , then dried at 60°C for 2 h, further drying at 110°C for 1 h. Impregnated the gel in aqua ammonia, furthermore, drying it at 110°C for 2 h. Subsequently treated in Mullite furnace at $400 \sim 500^\circ\text{C}$ for 3 h.

1.2 Photocatalytic performance test

Photocatalytic activity of the samples were evaluated by measuring the degradation rate of methyl orange which was carried out in a photochemical reaction instrument. A 100 W incandescent lamp was used as visible light source. Firstly, added 15 mg titanium dioxide powder into 200 mL water and dispersed by ultrasonic vibrator for 30 min, then transferred into photochemical reaction instrument, added certain amount of methyl orange in it with continuously stirring for 10 min, turn on the lamp, take out certain amount of the slurry from the reaction instrument every 30 min, after centrifugation, the solution was obtained. Then measuring its absorption intensity by UV-VIS spectroscopy at 467 nm, calculate the degradation rate of methyl orange η .

2 Results and Discussion

2.1 Main Phase of doped TiO_2 powder

Crystallinity of TiO_2 samples were identified by X-ray diffractometer (DDX-3200). Fig 1 showed the XRD patterns of doped samples calcined at 450°C . It can be seen that all the samples are in the form of anatase. It is found that the doping of Europium and nitrogen had little influence on the structure of TiO_2 .

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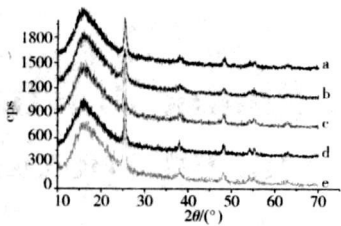


Fig 1 XRD Patterns of doped TiO_2 samples
a TiO_2 b TiO_2/Eu (0.3%); c TiO_2/N d TiO_2/Eu (0.3%), N e TiO_2/Eu (0.5%), N

2.2 Influence of calcined temperature

The degradation rate of methyl orange by TiO_2 calcined at different temperature has been shown in table 1. It can be seen that the sample calcined at 450°C possessed the highest photocatalytic activity

Tab 1 Degradation rate of methyl orange by doped TiO_2 calcined at different temperature

$T/^\circ\text{C}$	350	400	450	500	550
degradation rate in 3 hr/%	9.68	29.23	39.79	23.55	6.31

2.3 Influence of the doping with different elements on the photocatalytic performance of TiO_2

Fig 2 shows that all samples could partly degrade methyl orange under visible light irradiation. we could estimate from the experimental result that doping of impurities would caused some blemishes in the lattice of

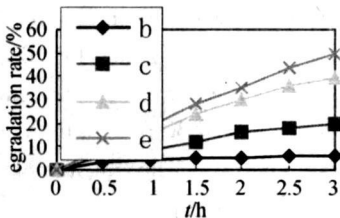


Fig 2 The degradation rate of doped TiO_2

anatase TiO_2 . These changes would have a positive effect on the combining of electrons-hole pairs emerged under visible light irradiation on the surface of TiO_2 as well as the excited wave length of the semiconductor

3 Conclusions

- (1) Eu/N doped TiO_2 samples were prepared by the sol-gel method and impregnation method
- (2) The doping of Eu and N had little influence on the structure of TiO_2 .
- (3) The Eu/N co-doped nanometer titanium dioxide powders possessed higher photocatalytic activity than the samples doped Eu or N lonely

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铈、氮掺杂二氧化钛光催化剂的制备及性能研究

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摘要: 采用溶胶-凝胶法结合浸渍法制备了同时掺杂 Eu/N 的纳米二氧化钛粉体。以甲基橙为目标污染物, 对样品的光催化性进行了研究, 并采用 XRD 对粒子晶型进行了表征。结果表明: ① 试验条件下, 铈、氮的掺杂对于 TiO_2 晶型基本没有影响; ② 在焙烧温度为 450°C 条件下制备出的掺铈、氮纳米二氧化钛样品具有较好的可见光光催化活性。

关键词: TiO_2 ; Eu/N 掺杂; 光催化剂; 溶胶-凝胶法; 浸渍法

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