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The Research Progress of α-Fe_2O_3 Photocatalytic Material Research

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Abstract

Semiconductor materials are widely researched by scholars of various countries as photocatalytic materials, while Chi-iron ore α-Fe_2O_3 is the most stable state of all iron oxide because its hexaineal structure is not toxic, good chemical physical stability, easy to recycle and the advantages of narrow belt gaps (2-2.2 eV) show huge potential in various photocatalytic applications. This article briefly describes the research progress of α-Fe_2O_3 in the field of photocatalytic.

Keywords

Semiconductor; α-Fe_2O_3; Photocatalytic.

1. Introduction

Since 1972, the n-type semiconductor material TiO_2 was used by Fujishima as a hydrogenation of hydrogenation of electrode materials [1], and scholars from various countries have studied and tested more than 130 semiconductor materials. These include metal oxides (ZnO, CaO, $ZnWO_4$, WO_3, ZrO_2, $BiTiO_3$, $SrTiO_3$, Fe_2O_3, Ag_2CO_3, BiOBr, BiOC1, $CaFe_2O_4$, BiOC1, $ZnFe_2O_4$,etc.), metal vulcotes (ZnS, CdS, $AgIn_5S$, $CuInS_2$,etc.) and Non -metal inorganic materials and other semiconductor materials, and verified their feasibility as a photocatalytic material through experiments [2,3]. It can be seen that the above catalysts are generally metal oxides or metal sulfides, and the metal oxides in it are stable due to stable chemical properties, simple preparation, non -toxic and abundant reserves due to photocatalytic reactions. In recent years, oxides that have achieved more major progress have been more than transitional metal cations such as TiO_2, α-Fe_2O_3 , CuO, WO_3, ZnO,etc[4].

2. Introduction to α-Fe_2O_3

Iron oxide is a transition metal oxide, including red iron ore (α-Fe_2O_3), magnetic red iron ore (γ-Fe_2O_3), ε-Fe_2O_3, etc. Among these iron oxide, there are few scholars study because of the shortcomings such as ε-Fe_2O_3 difficulty, high cost, and poor catalytic effects. Favorite catalytic materials [5]. Among them, the red iron ore α-Fe_2O_3 is the most stable state of all iron oxide because its hexaineal structure is also non-toxic, good chemical physical stability, easy recycling, and narrow belt gap (2-2.2 eV). The advantages, showing huge potential in various photocatalytic applications [6] . Although the many advantages of α-Fe_2O_3 make it a superior material, as the single α-Fe_2O_3 material introduced above is used in the actual photocatalytic use, there are defects such as photocopy electron-floor-to-ground compound, low quantum efficiency and other defects. Therefore, related scientific researchers' research on the research on α-Fe_2O_3 photocatalysts is in its research on its modification. At present, the modification technology of α-Fe_2O_3 mainly includes appearance structure regulation, ion doping, composite of semiconductor photocatalyst, etc.

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2.1. Preparation Method of α-Fe_2O_3

The synthesis of nanorods, nanowire, nanotube, cube and spindle with different morphologies and appropriate particle sizes is an effective way to prevent the problem of diffusion length and improve carrier separation. So far, a variety of new methods and techniques have been developed to synthesize α-Fe_2O_3 with different nanostructures to achieve effective photocatalytic performance. At present, the main synthesis methods of α-Fe_2O_3 include: hydrothermal method[7], sol-gel method[8], thermal decomposition method[9], microemulsion method[10], microwave assisted method[11], template method[12] and so on.

3. The Modification of α-Fe_2O_3

3.1. Structure Regulation

The appearance and structure of photocatalysts are different, and the performance of the catalysts is different. The composition and structure of the material often play a decisive role in the performance of the material. As far as α-Fe_2O_3 photocatalysts are concerned, the surface structure, crystallinity, particle size and decentralization of the catalyst have a great impact on the composite of its photocopy electron-gap pairs. Therefore, by changing the process and conditions of the synthetic process, a large number of research work is committed to preparing α-Fe_2O_3 photocatalysts with different appearances, such as one-dimensional, two-dimensional, spherical, and interior structure.

Jianhong Chen et al. A facile urea-hydrolysis calcination process for the preparation of α-Fe_2O_3 nanoparticles and α-Fe_2O_3 nanorods was introduced. The effects of hydrolysis temperature, Fe^{3+} concentration, and the molar ratio of urea and Fe^{3+} on nanorod-like precursors and α-Fe_2O_3 nanomaterials were investigated. The results show that the stick-shaped structure of the front-drive body provides a might and template for preparing the α-Fe_2O_3 nanomal stick, and the content of the Fe^{3+}in the rod-shaped front drive body plays a decisive effect on the appearance of the α-Fe_2O_3 nanomal stick[13]. The organic gel that is synthesized by the next step of the room temperature is an organic gel as the front-wheel drive. At different temperatures, the sheets (300-Fe_2O_3 and 400-Fe_2O_3) and spherical (500-Fe_2O_3 and 600-Fe_2O_3) are obtained. The derivative of the appearance of the triple oxide (Fe_2O_3). Through a series of testing methods, the crystal structure and photoelectric performance of the derivative Fe_2O_3 are characterized. Among them, 400-Fe_2O_3 with a carbon set structure shows excellent photocatalytic activity due to its excellent electronic transmission performance and high optical charge separation efficiency. Under a neutral condition, 60 min has an internal light degradation of 97.5% of Roddin B (Rh B), and its degradation efficiency can still reach 85.3% after five consecutive cycle experiments[14].

3.2. Ion Doped

Kerthana S P et al. Mixed cobalt ions to α-Fe_2O_3 and study different doping concentrations. Studies use a simple water heating legal system to prepare nano-ions doped by α-Fe_2O_3 and cobalt ions. Use XRD, UV visible spectrum, Fourier infrared spectrum, etc. The prepared Co-α-Fe_2O_3 is used for qualitative analysis. The results showed that the Co-α-Fe_2O_3 was the diamond surface nanoparticles and had the effect of enhancing the optical catalytic effect. In the photocatalytic experiment, the anecinesia dye was degraded under the ultraviolet light of 365nm. The results showed that the degradation rate of 4% Co doped α-Fe_2O_3 photocatalytic dye reached 92%[15]. Qing-yun xiang et al. Under mild conditions, the α-Fe_2O_3 was incorporated through electrochemical hydrogen. The band gap of the α-Fe_2O_3 after the hydrogen is displayed through the UV visible spectrum is significantly enhanced from the 200-800nm absorption area. Further experiments of photocatalytic degradation dyes show that the photocatalytic efficiency of α-Fe_2O_3 can be greatly improved by atomic hydrogen. The hydrogenation α-Fe_2O_3 can be

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easily recycled through the magnet and has good photocatalytic stability. These discoveries provide possibilities for using this cheap and Earth -rich oxide material in the field of pollution control [16].

3.3. Semiconductor Composite

A single half of the conductor material has many disadvantages such as low light capture efficiency, high compound rate of electronics-cavity pairs, and difficult to separate and recycle. The composite structure consisting of two or more different materials not only has the nature of each single component, but also obtains excellent multifunctional qualities under the synergies of the physical and chemical characteristics of multiple components. In addition, the semiconductor compound of different energy gaps can also expand the range of absorption spectrum[17].

Guiying Rao et al. Through the water heat method, colloidal mix and vacuum filtration, etc., the photocatalyst film composed of $Fe_2O_3/TiO_2/GO$. It studied its elimination effect in solar radiation and darkness, and determined the best weight ratio of $Fe_2O_3/TiO_2/GO$ composite light catalytic film. The results show that when the weight ratio is 50:100:10, the humic acid removal rate is more than 98% in the 2h test under solar radiation. In contrast, the humic acid removal rate was only 51% in the 12h test in the dark[18]. Fang Liu et al. used hydrothermal synthesis method to synthesize magnetic nano-composite Fe_2O_3/MCM-41 with Fe_2O_3 and ethyl orthosilicate as precursors under alkaline conditions through ultrasonic action. The particle size of the composite is relatively uniform spherical morphology, the particle size is about 60nm, the saturation magnetization of 43.1emu/g, its strong magnetic properties are conducive to the cyclic adsorption experiment. When the initial concentration of methylene blue is 90mg/L, the amount of Fe_2O_3/MCM-41 is 30mg, pH is 11, the adsorption temperature is 25°C, and the adsorption time is 10min, the adsorption effect is the best. The fading rate of methylene blue was 82% after 15 cycles of adsorption[19].

4. Conclusion

Since 1972, n-type semiconductors have gradually come into view. In the field of photocatalysis, TiO_2 has been the most studied n-type semiconductor by many scholars. However, TiO_2 has a large band gap width (about 3eV) and can only utilize UV light, so the large band gap width of TiO_2 limits its practical and economic applications. Therefore, α-Fe_2O_3 has been widely used in various photocatalytic applications due to its non-toxicity, good chemical and physical stability, easy recovery, and narrow band gap (2-2.2eV). As for α-Fe_2O_3, many scholars have prepared many excellent α-Fe_2O_3 photocatalytic materials from different preparation methods, and through many modifications, it shows a potential application prospect in the field of sewage treatment.

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