

Study on the Properties of Nitrogen-doped Nano-TiO₂ Photocatalytic Composites

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Abstract: Titanium dioxide materials are widely used in contemporary chemical industrial products, because of its good photocatalytic effect, it has a good comprehensive function of anti-fouling, sterilization and deodorization. Nitrogen-doped nano-TiO₂ catalytic composite can effectively solve the traditional problem of difficult separation and recovery, and has a broader application prospect. In this study, the properties and advantages of nanometer titanium dioxide were analyzed.

1. Introduction

Since the 1970s, the photocatalytic decomposition has been found on the semiconductor titanium dioxide electrode, thus the research on the photocatalytic technology began. through decades of development, semiconductor-based photocatalytic technology has developed rapidly in many fields, such as medical health, environmental protection and hygiene. at present, nano-photocatalytic technology has become one of the most active research fields in the world.[1]In industrial products, most of the white and light-colored materials contain titanium dioxide, and some non-colored products also contain titanium dioxide, currently the most important applications are paint, paper, plastics, intersecting, fiber, cosmetics and so on. existing studies can see that under the action of uv or daylight, titanium dioxide can be activated to produce free radicals with high catalytic activity, so that it can produce very strong photoredox ability and adhere to the surface of the object. after covering some formaldehyde organic or inorganic substances, it plays a good air purification role.

2. Properties of Nanometer Titanium Dioxide Photocatalyst

2.1. Nano-Size Effect of Photocatalyst

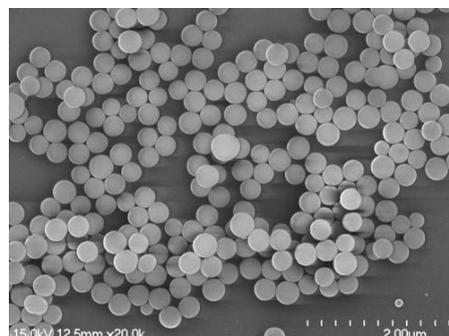


Figure 1 Microstructure of titanium dioxide

The nano-size effect of the photocatalyst is mainly reflected in the quantum effect, the surface area effect and the carrier diffusion effect. The energy gap between the conduction band and the valence band will widen and the energy of the photogenerated electrons and holes will increase, and then the redox ability will be enhanced. when the particle size of the photocatalyst decreases to the nanometer level, the specific surface area of the material will increase and enhance the adsorption capacity to the substrate.[2]the smaller the particle size, the faster the photogenerated electrons

diffuse from the inside of the crystal to the surface, the shorter the time required, and the continuous decrease of the electron and hole recombination rate will significantly improve the photocatalytic efficiency.

2.2. Properties of Titanium Dioxide Photocatalytic Materials

There are two kinds of crystalline morphology of nanometer titanium dioxide, namely rutile type and anatase type, the former is more stable and dense than the latter, with high hardness, density, dielectric constant, refractive index, coloring force, covering force and so on. the anatase titanium dioxide has higher reflectivity in the short-wave portion of visible light than rutile titanium dioxide, with a blue hue and higher photocatalytic activity. Under specific conditions, anatase carbon dioxide can be converted to rutile carbon dioxide.[3]If the photocatalyst is loaded on the substrate in the form of particles or made into a thin film, it can effectively solve the problem of difficult separation recovery. Because the suspended phase catalyst has the disadvantage of poor stability, it has a strong toxic defect in the specific environment. In addition, because of the low dispersion of the photocatalyst and the limited common contact area between the reactants, there will be poor light absorption effect.



Figure 2 Nanosized titanium dioxide powder

3. Application of Nitrogen-Doped Nanometer Titanium Dioxide as Photocatalyst

3.1. Environmental Applications

With the development of modern industrial society, although people's living standards are constantly improving, the corresponding water pollution and prevention have become a serious problem in the world. At present, more than half of the seven rivers in China have significant organic or heavy metal pollution, and the lakes such as Taihu Lake are eutrophication. Water pollution is harmful to human body and environment, and many organic pollutants are difficult to be degraded by microorganisms under natural conditions. Therefore, some organic pollutants can be treated by using the photocatalytic action of semiconductors. When using this treatment method, it has the characteristics of low cost, simple operation and strong oxidation ability, even under normal temperature rent, it can also have enough time to realize the treatment of pollutants. In addition to breaking down and destroying organic matter, photocatalysis can synthesize some organic matter under suitable conditions, such as non-aqueous solvent. After photocatalysis, styrene can be polymerized into polystyrene. Nanosized titanium dioxide can treat organic pollutants and inorganic pollutants, and can effectively deal with the pollution caused by heavy metal ions such as mercury and lead. In addition, the photocatalytic action can also decompose and transform toxic pollutants, such as H₂S, SO₂ Wait.



Figure 3 Nano titanium dioxide production products

3.2. Health Care Applications

Titanium dioxide is applied to ceramics and glass, because carbon dioxide has a good refractive index, so glass and ceramics have very good opacity and whiteness. Glass based on titanium dioxide reduces UV penetration and is therefore widely used in colored floor tiles, porcelain panels, glass fibres, including refractories, sanitary ware and other glass crafts. Apply nanometer titanium dioxide material to sterilization and disinfection in domestic water to ensure the health and safety of domestic water. For the glass, ceramics and so on in the sanitary facilities such as hospitals, homes and hotels, the photocatalyst loaded with titanium dioxide can be used for antibacterial deodorization, which is an ideal antibacterial deodorization material. If the use of anatase nanometer titanium dioxide, then in the long-term action of ultraviolet light, can kill malignant hela cells, for Bacillus subtilis black variant spore, Escherichia coli, salmonella and other killing rate of more than 98%. [4] At the same time, it can also add nanometer titanium dioxide to the paint, so as to achieve the function of sterilization, deodorization, house and so on. It can be used in breeding places other than home and hospital, and play a good role in air purification and antibacterial and antifouling. For some cancer-controlling cells, nano-titanium dioxide materials can lose their activity when they are photocatalytic.

3.3. Anti-Fog and Self-Cleaning Coating

Coatings are paint using organic solvents or water-based paint, including paint, pigments, resins, solvents and a variety of materials such as driers, resulting in a combination of viscous suspensions. By applying the coating on the surface of the object, a very tough coating film can be formed, which can play a protective and decorative role. At present, the paint is the largest user of titanium dioxide, and the proportion of consumption in our country is about 65%. titanium dioxide as a common pigment accounts for more than 50% of the cost of colorant costs. Among the white paint, titanium dioxide has the best performance in the paint, not only has the more conspicuous color, but also has the very strong coloring and covering power, can prolong the service life of the paint. Under ultraviolet light, the water on the titanium oxide film can be completely infiltrated, so it can be applied to the surface of the car glass mirror, the mirror installed in the bathroom and the mirror of the car can be coated with the titanium oxide film. When the sun shines, titanium oxide will produce a very strong oxidation capacity, with super hydrophilicity.

4. The Deficiency of Nanometer Titanium Dioxide Catalytic Technology and Its Application Prospect

4.1. Inadequate Photocatalytic Technology for Nanometer Titanium Dioxide

In order to use nanometer titanium dioxide for photocatalytic action, it is necessary to rely on ultraviolet light activation and low utilization of solar light. the photocatalytic quantum efficiency is low because of the slow transfer rate and high recombination rate of photo-induced electrons as well as hole pairs. During the use of powder-like titanium dioxide, separation operation and recovery will be difficult.

4.2. Prospect of Nanometer Titanium Dioxide Photocatalysis

Nanosized titanium dioxide can be applied to the enhancement of natural light source or photocatalytic fixation technology, and a new photocatalytic reactor with high efficiency can be designed. In a broader future application prospect, it can further promote the photocatalytic application of nano-titanium dioxide. Titanium dioxide as one of the main raw materials in the electrode, in the total production of electrode, based on titanium dioxide material production of more than 70% of the electrode, so the use of very large. Titanium dioxide is mainly used in the surface coating of welding rods, and can play a very good role in dilution, deoxidation, slag making and stabilization. The welding rod based on titanium dioxide material has very good mechanical properties, and it has the characteristics of stable arc and fast point arc when operating, and the weld of welding out is beautiful. Because titanium can form relatively stable titanium nitride with nitrogen, it can enter the slag quickly.

Electronic ceramics are also an important application of nanometer titanium dioxide. Because titanium dioxide has the characteristics of high resistivity and high dielectric constant, it can produce ceramic components with many functions such as electromagnetic properties, semiconductor properties and optical properties of titanium dioxide in the manufacture of capacitor ceramics, thermosensitive ceramics, piezoelectric ceramics and so on. These ceramic elements can be applied to electrical components such as filters, capacitors, signal sensors, humidity automatic controllers, etc. Titanium dioxide has good ultraviolet absorption ability and photochemical catalysis, so it can be used in fungicides, deodorants, adsorbents and other chemical products. In addition, titanium dioxide can be used in soap, artificial leather, rubber cloth, asphalt brick, waterproof pulp and so on.

5. Conclusion

Nitrogen-doped nanometer titanium dioxide can have remarkable photocatalytic effect under sunlight or UV irradiation, and can be widely used in cosmetics, lithium batteries, electronic ceramics, paint and so on. It can have good pollution prevention, deodorization, health care and so on. It can be predicted that nanometer titanium dioxide composites will have a more extensive application.

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