# Study on the Preparation of Graphene Oxide Composites by Ultraviolet-Assisted $TiO_2$ Reduction and Its Photodegradation Mechanism of Methyl Orange

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**Abstract:** With the rapid development of the social economy, environmental pollution has become a worldwide problem. In particular, water pollution is related to the further development of people's livelihood and the economy. At present, in the difficulty of water pollution control becoming an environmental problem, the need for an efficient water pollution control method has become the top priority. In view of this, this paper analyzes the preparation of UV-assisted $TiO_2$-reductiong graphene oxide composites by studying $TiO_2$. The mechanism of ultraviolet-assisted $TiO_2$-photodegradation of methyl orange was studied. A new method for controlling water pollution is proposed to provide relevant guidance for related research on environmental pollution control.

## 1. Research Background

### 1.1 Literature review

In 2017, Xu Wentao and others believed that graphene oxide and titanium isopropoxy were used to prepare a catalyst by in situ sol-gel method. This catalyst is $TiO_2$. Relevant studies have been carried out on $TiO_2$. Under the action of ultraviolet photodegradation, the catalyst has a positive effect on the treatment of water pollution, and the degradation rate is as high as 92% (Xu et al, 2017). Li Cuixia and others did related research on graphene oxide in 2018. A new type of conforming material was prepared by reducing and oxidizing $TiO_2$ through heat treatment and ultraviolet irradiation. In the process of explaining $TiO_2$, methyl orange was added to make the crystal structure of $TiO_2$ more stable and effectively improve the degradation efficiency (Li et al, 2018). Tu Chengyu et al. used sol-gel method in 2019 and added Zr to $TiO_2$ to form a new oxidizing material, and studied its structure and properties. The degradation rate of methyl orange was over 97% by adding methyl orange into the degradation process of $TiO_2$ under light irradiation. It can also increase the degradation rate and catalytic activity (Tu et al, 2019). In 2018, Liu Jiantao et al. studied the preparation of composite graphene oxide materials by hydrothermal method. The structure and properties of the samples were tested by X-ray diffraction and ultraviolet irradiation. The results showed that the degradation effect of methyl orange under different illumination conditions was significantly different. The catalytic performance of $Nd_{3+}$ $TiO_2$ complexes for visible light is more remarkable (Liu et al, 2018).

### 1.2 Purpose of research

In recent years, some researchers in water treatment have studied $TiO_2$ photocatalyst. They believe that this new material does not need high temperature and pressure in the preparation process, and its properties are stable, safe and non-toxic, which has a significant effect on water pollution control. It can oxidize most of the organic matter through different illumination with multi-$TiO_2$. In the process of water environment treatment, some harmful substances are transformed into non-toxic and harmless forms, which is of great significance to the treatment of environmental pollution. This chemical is very easy to obtain and can be recycled. The catalytic efficiency can be improved by incorporating different substances into the composite materials. This is of great significance to the industrialization of photocatalytic degradation of polluted water.

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## 2. $TiO_2$ Relevant Overview

### 2.1 Crystal structure of $TiO_2$

$TiO_2$ is the chemical formula of titanium dioxide, commonly known as titanium dioxide. This chemical material is mostly used for the transformation of organisms and plays an important role in sterilization. Now its development and utilization are more and more extensive, which is an effective medium to promote the development of new industries in the future. There are three structures of $TiO_2$ in nature, namely tetragonal rutile, tetragonal anatase and orthorhombic slate. But the common feature of these three structures is that their basic units are octahedral. Because of the different structure of $TiO_2$, its chemical properties are different. The anatase type is relatively high in optical activity, and the rutile type is the most stable. Anatase and plate titanium dioxide can be transformed into rutile at high temperature (Gao et al, 2018).

### 2.2 Properties and applications of $TiO_2$

$TiO_2$ in nature is a kind of substance with amphoteric oxides, which is white powder and live white solid. The molecule weight of $TiO_2$ is 79.9, the melting point is between 1830 and 1850, and the boiling point is between 3200 and 3500. The relative density of $TiO_2$ is also relatively small, and the solubility in water is very small, only soluble in HF and hot concentrated sulfuric acid. $TiO_2$ has super absorbency, and the amount of absorbency is related to its surface area. Because of these properties of $TiO_2$, it is a very important inorganic material in industry at present. It can be used not only as an antimicrobial agent in industrial production, but also in coatings, cosmetics and other products. Moreover, $TiO_2$ plays an important role in water purification and sewage treatment. Because it is non-toxic and harmless, it has become the first choice for water pollution control (Li et al, 2017).

### 2.3 Preparation of $TiO_2$

Under the current technological conditions, there are three main methods to prepare nano-powder $TiO_2$: solid phase method, gas phase method and liquid phase method. Solid-phase method is characterized by a large number of preparation, but this method has a low energy utilization rate for $TiO_2$, and it is difficult to treat its surface and shape. Gas phase method can solve this problem very well. For the current laboratory research, this method is the simplest, with the lowest cost and equipment requirements, but the production of this method is low. These two methods are currently the most important preparation methods for subsection $TiO_2$ (Zhang et al, 2018).

## 3. Preparation of Graphene Oxide Composites by Ultraviolet-assisted $TiO_2$ Reduction

### 3.1 Structure and properties of graphene

Graphene is a monoatomic layer separated from graphite. It was first discovered by British scientists geim and novoselov in 2004 when graphite was physically peeled off. Graphene is the thinnest material found in the world. Its thickness is 0.335 nm, the bond length of C-C bond is 0.142 nm, and the bond angle is 120 degrees. Graphene is the basic unit of other dimensional carbon materials. The most perfect structure of this material is that the carbon atoms are arranged periodically in the graphene plane in a six-membered ring structure. This arrangement is made up of one carbon atom and three adjacent carbon atoms bonded to each other in the form of SP2 hybridization. Graphene fin curvature occurs when there are five-membered ring lattices in graphene lattices. If more than 12 five membered ring lattices exist, a 0 dimensional fullerene sphere will form. When graphite is thin on a straight line, the seamless hollow tube curls and becomes one-dimensional carbon nanotubes; when the thin plane of multilayer graphite interacts with PI electrons, it will accumulate to form 3D graphite, which makes it difficult to peel off the layers (Zhu et al, 2018).

### 3.2 Preparation of Graphene Oxide Composites by Hydrolysis

Hydrolysis method is used to prepare $TiO_2$ in laboratory. The main materials used are Ti $(SO)_4$, HF (40 wt%), $C_2H_6O$ (anhydrous), MethylOrange, flake graphite, $KMnO_4$ (CP), $NaNO_3$ (CP), concentrated sulfuric acid (CP), hydrogen peroxide (CP), all of which are deionized water.

Firstly, deionized water of 200, 160, 120, 80, 40 mol/L of HF (hydrogen sulfuric acid) and 192 mg of Ti $(SO)_4$ and 50 ml of Ti $(SO)_4$ were poured into beaker. Because of the hydrolysis of Ti(SO) $_4$, HF was added to the water and Ti $(SO)_4$ was added. Next, the disposed solution was handwritten for 10 minutes and then stirred by magnetic force for 15 minutes. The reaction solution was then poured into the PTFE reactor and placed at 180 C for 12 hours. Finally, the sediments were removed by $C_2H_6O$ and deionized water, and the samples were placed in a drying chamber at 60 C for 24 hours. In this way, anatase nano-powder $TiO_2$ with different crystal planes was obtained.

## 4. Photodegradation mechanism of methyl orange by Ultraviolet-assisted titanium dioxide

Using $TiO_2$ as catalyst, organic pollutants were thoroughly mineralized and degraded in water pollution control. In this process, because the energy gap of $TiO_2$ is 3.2eV, only photons with wavelength less than 387lun can be absorbed, which affects the utilization of sunlight and catalytic efficiency of $TiO_2$. In order to improve the catalytic efficiency of $TiO_2$, researchers doped metal impurities on its surface to improve the absorption of visible light. Although this method can accelerate the catalytic effect of $TiO_2$, it will still lose the complex effect of electrons and reduce the efficiency of catalytic reaction in work engineering. Therefore, this paper mainly studies the synthesis of different loads of A $g\text{-}0_2$, using the prepared gA-O. Methyl orange was degraded under visible light. The degradation kinetics of methyl orange under visible light irradiation and the mechanism of dye-sensitized photocatalysis were investigated by observing $TiO_2$ as a catalyst assisted by ultraviolet light.

### 4.1 Experiment

Ultraviolet-assisted catalytic degradation of methyl orange: The experiment was carried out in a 70 ml quartz tube. Firstly, 0.0059 $TiO_2$was used as catalyst to put into the test tube, and then 50 ml of water containing 10 mg/u methyl orange was added. Then methyl orange containing catalyst $TiO_2$was placed for 1 hour to ensure the adsorption equilibrium of the reactants on the catalyst surface. Because the longer the wavelength is, the stronger the photon energy is. The absorbance of $TiO_2$is also an important factor affecting its photocatalytic activity. Therefore, the band gap width of anatase $TiO_2$is about 3.2 Ve, and its absorbance is reflected in its width. Observational experiments show that $TiO_2$ has strong absorption at 395 nm, which is determined by the width of anatase $TiO_2$itself.

### 4.2 Result

In the process of catalyzing methyl orange, the degradation efficiency of methyl orange becomes lower and lower after 3 hours with the decrease of light, which indicates that the influence of light on $TiO_2$ as catalyst is decisive. Under ultraviolet irradiation, methyl orange adsorbed on $TiO_2$ is stimulated, and then electrons are injected into the conduction band of $TiO_2$. Under the continuous aggregation of these electrons, various active oxides are formed with oxygen molecules on the surface. These oxides attack methyl orange molecules and degrade them. Ultraviolet radiation plays an important role in the process of conducting electrons and oxidizing reactions, thus accelerating the reaction of electrons and oxygen molecules. Therefore, under the irradiation of ultraviolet light, the degradation rate of $TiO_2$ can be clearly seen through experiments.

In previous studies, the degradation process of metal-supported catalysts was less studied. It can be seen from the above experiments that under the condition of insufficient oxygen, metal loading can effectively promote the reduction reaction of methyl orange $TiO_2$ under visible light excitation. In the catalytic process of $TiO_2$, metals can capture electrons rapidly. If light is used to replace metal impurities, this problem can also be well solved. It can also be seen from experiments that the key to improve the catalytic activity of methyl orange is to effectively promote charge separation and the reaction of $TiO_2$-band electrons with oxidizing species. Because of the effect of ultraviolet radiation, the catalytic activity of sample $TiO_2$ under visible light irradiation increases rapidly with the increase of illumination.

## 5. Conclusion

In summary, environmental pollution is becoming more and more serious, especially water pollution. How to solve this social problem has become the focus of attention. Relevant scholars use chemical raw materials as catalysts to control water pollution, and commercial use of pure photocatalysts. However, the catalyst is highly dependent on ultraviolet radiation, resulting in low utilization rate and can not be recycled. In order to improve the catalytic efficiency and make the catalyst more practical, scholars began to look for physical and chemical means to improve the catalyst. For example, catalysts are doped with composite materials and metal fragments to activate the performance of catalysts and improve the catalytic efficiency. Through these improvements, the water pollution control can be better accomplished and the water pollution control can be thoroughly solved with the same material and financial resources.

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