ISSN 2616-5872 Vol.4, Issue 7: 22-25, DOI: 10.25236/AJEE.2022.040704

Application of Tin Oxide Nanomaterials in Environmental Photocatalysis

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Abstract: *Photocatalytic technology has become a hot technology for environmental pollution control due to its advantages of good stability, high degradation efficiency and no secondary pollution. The application of tin oxide nano materials in environmental photocatalysis is proposed. Acetaldehyde gas was selected to simulate the pollutant, and tin oxide nano materials were used to degrade acetaldehyde concentration in a photocatalytic reactor. The experimental results show that the degradation rate of 95% pure tin oxide nanomaterials in environmental photocatalysis is 88.82%, which indicates that the photocatalytic degradation performance of tin oxide nanomaterials is better.*

Keywords: *Tin oxide; Nanometer material; Photocatalysis; Applied research*

1. Introduction

With the development of society, the rapid development of chemical, pharmaceutical, coal and other industries has provided many conveniences for our daily life. However, a large number of harmful gases emitted by them have also had a serious impact on the environment. Excessive inhalation of harmful gases has caused harm to human noise, and even some toxic and harmful pollutants pose a serious threat to people's lives and health. Therefore, with the improvement of people's quality of life, people gradually realize the importance of the ecological environment, and propose green production, and enhance the awareness of environmental protection [1-3]. However, when solving the environmental pollution caused by these organic pollutants, the commonly used treatment methods physical method and biological method cannot be widely used, because these environmental pollution treatment methods will cause secondary pollution, and the treatment cost is high, and the treatment methods are more complex. However, the oxidation and reduction of organic pollutants to harmless substances through chemical substance chemical methods can effectively make up for these deficiencies. Moreover, this chemical method has become a new and high technology in the current environmental pollution control, and has gradually been recognized by people. Relevant scholars have also deeply studied this technology. Among them, tin oxide nanomaterials have attracted many researchers' attention because of their excellent stability and photoelectric properties. Tin oxide nanomaterials with safety, non-toxic and low cost show a broad application prospect in the field of environmental pollution control. For example, Shi Qianying [4] and others proposed the research on photocatalytic degradation of rhodamine B by tin oxide/magnetic nano onion carbon composite. In order to improve the photocatalytic performance of tin oxide (SnO2) and expand its application in the field of printing and dyeing wastewater treatment, a new magnetic recoverable tin oxide/magnetic nano onion carbon (SnO2/MCNOS) composite was prepared by simple hydrothermal synthesis The composite was studied by SEM, XRD, XPS, UV Vis DRS and FT-IR, and the paramagnetism of the composite was determined by hysteresis loop Rhodamine B (RhB) of 10 mg/L was selected as a typical organic pollutant to evaluate the photodegradation efficiency of the composite prepared above The results showed that SnO2/MCNOs had better photocatalytic activity than pure SnO2. Finally, according to the physicochemical and photocatalytic properties, the degradation mechanism of RhB by the prepared composite was proposed This method effectively analyzes the photodegradation effect of tin oxide nanomaterials, but this study has some limitations. It does not analyze tin oxide nanomaterials with different purity.

In order to solve the problems described above, effectively improve the effect of environmental governance, reduce environmental pollution, and improve the efficiency of pollutant treatment, this paper uses tin oxide nanomaterials as photocatalysts to effectively degrade a variety of organic pollutants, and deeply analyzes the degradation effect. This study first introduces the experimental materials and equipment, then explains the experimental methods and procedures, and finally, analyzes the experimental results in detail. This research has important environmental protection value.

2. Experimental materials and experimental instruments

Tin oxide nanomaterials [5] are surface resistance controlled materials with photocatalytic properties. In order to deeply study their application in environmental photocatalysis, acetaldehyde gas cylinders are used to simulate the source of pollutant gases, and 200W xenon lamps are used to simulate the solar light source. Ultraviolet light is filtered through filters, so that photocatalytic reactions in the visible light region can be simulated. At the same time, In order to make tin oxide nanomaterials reach the adsorption equilibrium state when absorbing organic pollutants, it is necessary to carry out dark reactions in a dark environment, so as to avoid the interference of adsorption on the degradation of pollutants. Referring to Lambertian law, there is a certain relationship between the concentration change of organic pollutant gas and absorbance, so the principle of this experiment is to obtain the degradation degree of organic pollutant gas through absorbance, and then obtain the photocatalytic performance of tin oxide nanomaterials. SnO2 tin oxide produced by Shanxi Renben Technology Co., Ltd., C2H4O acetaldehyde gas produced by Henan Yuanzheng Special Gas Co., Ltd., C6H12 cyclohexane produced by Liaoning Yufeng Chemical Co., Ltd. and other materials were mainly used in the photocatalytic experiment of tin oxide nanomaterials. The experimental equipment mainly used UV2550 ultraviolet visible spectrophotometer produced by Lianhua Technology. The specific materials and instruments [6] used in the experiment are shown in the table 1:

Table 1: List of experimental materials and experimental instruments

Name	Chemical formula/model	Manufacturer
Tin oxide	SnO2	Shanxi Renben Technology Co., Ltd.
Acetaldehyde gas	C2H4O	Henan Yuanzheng Special Gas Co., Ltd.
Cyclohexane	C6H12	Liaoning Yufeng Chemical Co., Ltd.
Oleic acid	C18H34O2	Jinan Guoshi Weiye Chemical Co., Ltd.
Xenon light source	PL-X300D	Anpuri Technology
UV-visible spectrophotometer	UV2550	Lianhua Technology
Electron microscope	VHX-7000N	Keyence
Electronic Analytical Balance	ZH4636	Nanjing Huaxin Analytical Instrument Manufacturing Co., Ltd.
Photocatalytic reactor	FF-200	Shanshi Technology
Proton transfer reaction mass spectrometer	FTR-TOF-1000	Beijing Inglehead Analytical Technology Co., Ltd.

70%, 80%, 90% and 95% pure tin oxide nanomaterials were prepared using the above experimental materials in the table 1 and equipment. This material is the main research object for experimental analysis. The specific use methods of experimental materials and equipment are described in detail in the third chapter. The photocatalytic reactor used in this experiment is a stainless steel axe reactor, which can reduce the effect of the experimental equipment on the adsorption of acetaldehyde gas. The main parameters of the experiment are set as follows: the experimental temperature simulates the optimal room temperature of 25 °C, and the experimental humidity is controlled at about 40%; the "dip-coating" method is used to apply four kinds of tin oxide nanomaterials with different purities on four glass slides respectively. , and control the net weight of tin oxide nanomaterials on each glass slide to 50 mg; in the photocatalytic reaction experiment, the ultraviolet light irradiation intensity was set to 25 μW*cm-2, and the average flow rate of acetaldehyde gas in the photocatalytic reactor was Controlled at 0.3L*min-1.

3. Experimental methods and experimental procedures

Before this photocatalytic experiment [7], the glass slide coated with tin oxide nanomaterials was first irradiated with ultraviolet light with a radiation intensity of 100 μW*cm-2, and then activated by water vapor with a humidity of 50%, so that It can promote the regeneration of the surface active substances of the tin oxide nanomaterials, and avoid errors in the experimental results caused by the interference of environmental factors.Then the specific steps of the photocatalytic reaction experiment [8] of tin oxide nanomaterials are as follows: first, open the steel cylinder filled with synthetic air and let the air flow to the washing cylinder as the carrier gas of this experiment; Then set the humidity of the whole experimental device. When the humidity of the catalytic reactor reaches 40%, lift the acetaldehyde cylinder and open it, let the acetaldehyde gas flow into the photocatalytic reactor, and enter the dark reaction experimental stage under the condition of no light. At this time, pay attention to observing and recording the reading of the proton transfer reaction mass spectrometer; After the acetaldehyde concentration at the outlet and inlet of the photocatalytic reactor is consistent, turn on the ultraviolet light and enter the experimental stage of the photocatalytic reaction. At this time, the acetaldehyde gas concentration in the photocatalytic reactor will decrease under the influence of the photocatalytic reaction of tin oxide nano materials. After the acetaldehyde concentration in the reactor decreases to a stable data, the experiment is finished. The ultraviolet light can be turned off and the current experimental data can be recorded [9]. If the formula is used to describe the photocatalytic reaction of tin oxide nanomaterials this time, it is:

$$M = \eta \frac{\lambda C_1}{1 + \lambda C_1} = \frac{L\left(C_1 - C_2\right)}{S} \tag{1}$$

In the formula, M represents the Langmuir-Hinshelwood model of tin oxide nanomaterials; η represents the photocatalytic reaction coefficient of tin oxide nanomaterials; λ represents the adsorption equilibrium constant of acetaldehyde gas; L represents the volume flow parameter of carrier gas in the photocatalytic reactor ; S represents the surface area parameter of tin oxide nanomaterials; C_1, C_2 represent the acetaldehyde gas concentration parameters before and after the photocatalytic experiment, respectively. Combined with the experimental steps and the photocatalytic reaction kinetic model of tin oxide nanomaterials, this paper decided to use the change of acetaldehyde gas concentration to evaluate the photocatalytic performance of tin oxide nanomaterials. After completing the above experimental methods and experimental program design, analyze the photocatalytic performance of tin oxide nanomaterials.

4. Experimental results

The purpose of this study is to protect the environment and effectively degrade pollutants. Therefore, in the experimental process, acetaldehyde gas pollutants are taken as the degradation object, and tin oxide nanomaterials with different purity are used as photocatalysts. This experiment mainly monitors the change of acetaldehyde gas concentration before and after dark reaction and photocatalytic reaction of tin oxide nanomaterials, that is, to analyze the degradation of acetaldehyde by different pure tin oxide nanomaterials in different time periods. Tin nanomaterials are 70%, 80%, 90% and 95% pure tin oxide nanomaterials respectively. The duration of the experiment is 100min, and the reaction time set in the dark environment is 30min, that is, 30min dark reaction. The 100min experimental data are counted, and the degradation effect diagram of different purity tin oxide nanomaterials on acetaldehyde gas is obtained, as shown in Figure 1:

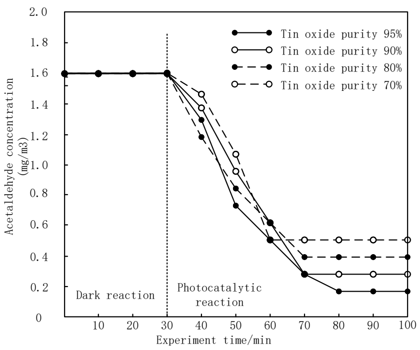

Figure 1: Photocatalytic degradation performance of tin oxide nanomaterials for acetaldehyde

ISSN 2616-5872 Vol.4, Issue 7: 22-25, DOI: 10.25236/AJEE.2022.040704

It can be seen from the figure that in the dark reaction stage 30 minutes before the experiment, the acetaldehyde concentration did not change. When the experiment entered the photoreaction catalysis stage, the acetaldehyde concentration showed a sharp drop. Among them, 70% pure tin oxide nanomaterials can degrade acetaldehyde concentration of 1.12 mg/m3 in 60 minutes, and the degradation rate reaches 69.57%; 80% pure tin oxide nanomaterials can degrade acetaldehyde concentration of 1.17 mg/m3 in 70 minutes , the degradation rate reaches 72.67%; 90% pure tin oxide nanomaterials can degrade acetaldehyde concentration of 1.33 mg/m3 within 70 minutes, and the degradation rate reaches 82.6%; 95% pure tin oxide nanomaterials can degrade ethyl acetate within 80 minutes. The aldehyde concentration was 1.43 mg/m3, and the degradation rate reached 88.82%. It can be seen that the degradation rates of tin oxide nanomaterials with different purities to ethanol gas are not the same, and with the increase of the purity of tin oxide nanomaterials, the degradation rate shows an upward trend. The results of this experiment show that the higher the purity of tin oxide nanomaterials, the better the degradation performance in ambient photocatalysis.

5. Conclusion

The increasingly serious environmental pollution has prompted people to pay more and more attention to environmental protection. At present, Semiconductor Photocatalysts that conform to green chemistry perform well in degrading organic pollutants and are widely used in environmental protection. This study focuses on the semiconductor multifunctional materials represented by tin oxide nano materials, and carries out its application research in environmental photocatalysis. Through acetaldehyde gas simulation of pollutants, this paper completed the whole experimental process of tin oxide nanomaterials under dark reaction and photocatalytic reaction, mainly focusing on the degradation effect of different purity tin oxide nanomaterials on acetaldehyde gas. In this experiment, tin oxide nanomaterials have good degradation rate of organic pollutants and excellent photocatalytic degradation performance, which has certain practical value.

Acknowledgements

Science and technology research project of Jiangxi Provincial Department of Education (GJJ218811)

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