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Preparation and Photocatalytic Properties of MgO / C3N4 Nanosheets

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Abstract: With the rapid development of social economy and industry, China's environmental pollution problem is becoming more and more serious, and the treatment method of water pollution is particularly concerned.Therefore, the synthesis of an efficient, stable, and pollution-free catalyst is considered as a potential approach to solve these problems.As a new type of photocatalytic material, g-C3N4 is favored by many researchers.In order to further improve its photocatalytic activity, a simple one-step roasting method was adopted to load MgO on g-C3N4 material and synthesized a series of MgO / C3N4 nanosheet samples with different MgO content, which were characterized by UV diffuse reflection spectroscopy (UV-Vis DRS), specific surface area measurement (BET), infrared spectroscopy, X-ray diffraction (XRD) and UV visible spectroscopy.

Keywords: Sewage treatment; MgO / C3N4 nanosheet; Photocatalysis; Heterostructure

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1. Literature review

1.1 Status quo of water pollution

In recent years, with the rapid development of China's industry, the pollution problem brought to the environment is becoming more and more serious, and the treatment method of water pollution gets special attention.At present, China's water pollution has been very common, and there is a more serious trend, therefore, we must actively find the appropriate wastewater treatment technology, effectively control such water pollution, to solve the problem of environmental pollution.[1]

1.2 Content and significance of the study

1.2.1 Main contents of the study

To improve the photocatalytic performance of g-C3N4, we prepared MgO / C3N4 nanosheet samples in the presence of melamine and NH4NO3, using a series of MgO / C3N4 composites / C3N4 composites with different MgO contents to test the photocatalytic properties of MgO / C3N4 nanosheets with different MgO contents, and selected the optimal mass ratio of MgO / C 3 N 4 nanosheets.In addition to the stability tests and mechanism comparison experiments on MgO / C3N4 nanosheets, we expect that the introduction of MgO can effectively improve the photocatalytic properties of MgO / C3N4 composites under visible light.[2]

1.2.2 Study Significance

Due to the complete mineralization of organic compounds, photocatalysis has been successfully used to remove various pollutants released from the environment.[3]The basis of this approach is the production of very active species, such as hydroxyl radicals, which can oxidize the dye molecules, enabling them to degrade the dye and remove it from water and wastewater.

2. Experimental section

2.1 Experimental reagents and experimental instruments

2.1.1 Experimental instrument

The main experimental instruments required for the experiment are shown in Table 2-1.

Table 2-1, Experimental instruments

Instrument name	model	manufacturer
electronic analytical balance	AUY120	Shanghai Youyi Instrument Co., Ltd
Photochemical reactor	DJY-1A	Nanjing DuoHelp Technology Development Co., LTD
Vacuum blast drying box	DZX-60908	Shanghai Fuda Experimental Equipment Co., Ltd
ultraviolet spectrophotometer	Aligent8453	Agilent Technologies Co., Ltd
Low-speed desktop and large-capacity centrifuge	RJ-TDL-50A	Wuxi Ruiyang Analytical Instrument Co., Ltd
close roaster	DRZ-12	Longkou Electric Furnace Factory
Fourier transform infrared spectrometer	NICOLER380	American Electric Company
Automatic specific surface area meter	TriStarII3020	American Mike

And crucible, measuring cylinder, volumetric bottle, glass rod, pipette, rubber head drop tube, beaker, etc.

2.1.2 Experimental reagent

The experimental reagents required for the experimental sample preparation and for the performance test are shown in Table 2-2. Deionized water was used during the experiment.

Table 2-2, experimental reagents

Reagent name	molecular formula	specifications	生产厂家
melamine	$C_3H_6N_6$	chemically pure	Sinopharm Group Chemical Reagent Co., LTD
ammonium nitrate	NH_4NO_3	chemically pure	Tianjin Damao Chemical Reagent Factory
magnesium nitrate	$Mg(NO_3)_26H_2O$	analytical reagent	Tianjin Tianli Chemical Reagent Co., LTD
absolute ethyl alcohol	CH_3CH_2OH	analytical reagent	Tianjin Tianli Chemical Reagent Co., LTD
rhodamine B	$C_{28}H_{31}ClN_2O_3$	analytical reagent	Tianjin Hengchengxing Industry and Trade Co., Ltd. Chemical reagent branch

2.2 Experimental Methods

2.2.1 Preparation of MgO / C3N4 nanosheet composites

Put 3.0 g of melamine and 0.45 g of ammonium nitrate and grind it into a mortar with a specific amount of magnesium nitrate for 20 minutes.The ground medicine was heated in a 30-ml crucible in a maver furnace with a temperature of 100. C, with a 100 increase every 30 min. C, until heated to 550. It was maintained for 2 h after C.After the crucible is cooled to room temperature, the synthetic catalyst is removed and ground into powder for further study.

Table 2-3 Content of MgO

Standard number (MgO percentage content)	1(2%)	2(2.5%)	3(3%)	4(4%)
Mg (NO3) 26H2O content (g)	0.154	0.193	0.231	0.308

2.2.2 MgO / C3N4 nanosheets catalyzed the degradation of the same concentration of rhodamine B assay

Pour 510-5 mol/L of rhodamine B solution into brown bottles and reserve in the dark.

Six tubes were labeled 1,2,3,4,5,6, and 50 mL of rhodamine B solution was poured into six tubes, followed by 5 mg of pure melamine in tube 1,5 mg of melamine and ammonium nitrate, and 5 mg MgO contents of 0.5%, 1%, and 3% MgO / C3N4 nanosheets in tubes 3,4, and 54, respectively.

Rotors were placed in 6 tubes and placed into the photochemical reaction tank, stirred and adsorbed in the dark for 30 min, and the solution in each tube was sampled, and then 8 drops of hydrogen peroxide were added in the tube, which were again put into the photochemical reaction tank every 30 min for 4 times.

After the reaction, the sample was centrifuged in a centrifuge for 5 min, and the supernatant was taken and the absorbance was determined by a UV spectrophotometer.

2.2.3 Mass ratio of the best MgO / C3N4 nanosheets

Put 3.0 g melamine and 0.45 g ammonium nitrate into a mortar and grind 0.154 g, 0.193 g and 0.308 g magnesium nitrate for 20 min.Put the ground medicine into the crucible and heat it in the maver furnace, adjusting the maver furnace temperature to 100. C, with a 100 elevation of every 30 min. C, until heated to 550. It was maintained for 2 h after C.After the crucible has cooled to room temperature, remove the resultant catalyst and ground it into ground powder.

2.2.4 Optimum amount of H2O2 screening

The amount of 50 mL of rhodamine B solution at 510-5 mol/L was poured into six tubes, and then 50 mg MgO MgO / C3N4 nm sheets of 2.5% were added to each tube.Rotors were placed in 6 tubes and put into the photochemical reaction tank, first stirred and adsorbed in the dark for 30 min in the dark, and the solution in each tube was sampled, then 2,4,6,8,10 drops of hydrogen peroxide in tubes 1 to 5, sampled every 30 min for a total of 4 times.

After the reaction, the sample was centrifuged in a centrifuge for 5 min, and the supernatant was taken and the absorbance was determined by a UV spectrophotometer.

2.2.5 MgO / C3N4 nanosheet degradation experiment for optimal pH

The standard NaOH solution was diluted into NaOH solutions of pH 11,9, and 7 with deionized water, and 98% concentrated sulfuric acid was diluted to a solution of 0.00184 mol/L, 0.0000 and 0.0000184 mol/L, and configured with a solution of rhodamine B with a concentration of 510-5 mol/L with different pH values.

Take 6 test tubes, A solution of 50 mL of rhodamine B at 510-5 mol/L was poured into the test tubes, Then 50 mg MgO C3N4 MgO of 2.5% were added to each tube, Add to tubes 1 to 3 with 14 mL of 0.184 mol/L, 0.00,184 mol/L, and 0.0,000184 m o l / L of sulfuric acid solution and 31 mL of distilled water, respectively, Add 45 mL of distilled water to test tube 4, 45 m L sodium hydroxide solution of pH 9 and 11 was added to tubes 5 and 6, respectively.

2.2.6 MgO / C3N4 Nanometer sheet stability test

One tube was taken to add 50 mL of rhodamine B solution of 510-5 mol/L and MgO / C3N4 nanosheet complex of 5.5%, put the rotor in the tube and into the photochemical reaction tank, stirring and adsorption for 30 min, followed by 8 drops of hydrogen peroxide in the tube and then the reaction for 40 min.After the reaction, the samples were centrifuged in a centrifuge for 5 min. After the centrifugation, 3 mL of supernatant was taken and measured for their absorbance by a UV spectrophotometer.Then remove the upper clear liquid, add 50 mL of ethanol and water ratio of 1:1 mixture for washing, deattachment, centrifugation, wash again with distilled water, centrifuge, and perform the second round of stability test in the same way.

2.2.7 Mechanism comparison test

Four tubes were taken, adding 50 mL of 510-5 mol/L rhodamine B solution to 50 and 50 mg best catalytic MgO / C3N4 nanosheets to the tubes, followed by a drop of triethanolamine, a drop of isopropanol to tube 2, and tube 3 to 1min N2.

3. Conclusion

A series of MgO / C3N4 nanocomposites with different MgO content were prepared by a simple one-step roasting method and characterized.Experimental results of the photocatalytic degradation of rhodamine B showed that the catalytic degradation capacity of the MgO / C3N4 nanosheet composite was significantly higher than that of the original g-C3N4 material.When the mass score of MgO is 2.5%, the time catalytic performance is the best, and the degradation rate of rhodamine B is as high as 97%, which is 46% higher than that of pure g-C3N4.Thus, it is observed that MgO / C3N4 nanosheet composite can effectively degrade rhodamine B in aqueous solution, and moreover, MgO / C3N4 nanosheet composite did not show good reaction stability in cycle experiments because MgO attached to the C3N4 surface generated magnesium hydroxide and magnesium carbonate.

For degradation of rhodamine B solution, the amount of H2O2 has great influence on the catalytic efficiency.The lowest concentration of rhodamine B for catalytic degradation when the amount of hydrogen peroxide was 0.336 ml, and the degradation rate reached 97.2%.Meanwhile, using MgO / C3N4 nanosheet composite with the same MgO content to degrade different pH rhodamine B, which found that the degradation effect of MgO / C3N4 nanosheet under acidic conditions was not ideal, but showed obvious degradation effect under neutral or alkaline conditions.In addition, the first-round degradation rate of rhodamine B was 69.8%, and then it was 38.7%, and the poor stability was due to the decomposition of magnesium oxide into magnesium hydroxide and magnesium carbonate.Mechanistic experiments show that holes have little role during degradation, and hydroxyl radicals play the largest role.

Through this study, the problem of water pollution was effectively solved.It has a positive impact on the economic benefits and environmental optimization of the plant.

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