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Research Article

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Urban landscape water treatment by photocatalytic material prepared by titanium-containing blast furnace slag

Yingna Zhao, Xiongfeng Zeng, Wenli Zhang* and Jianguo Jin

School of Materials Science and Engineering, Hebei United University, Tangshan, Hebei, China

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ABSTRACT

The targeted and prospective specific technique for water resource protection, restoration and governance of the landscape water system were proposed, aiming at the water quality pollution of urban landscape water system. The TiO2 nanometer assembly material was directly prepared, by melt phase-separation method, with Titanium-containing blast furnace slag as the principal raw material and according to the theory of phase separation in glasses as well as the influence and control of phase separation process in the phase separation, for urban landscape quality treatment. The research result shows that, according to the quality evaluation standard for urban landscape water, the five-day biochemical oxygen demand (BOD5), chroma, total phosphorus, total nitrogen and ammonia nitrogen and other indexes reach the standard completely and the chemical oxygen demand (COD) and the content of suspended substance in water are significantly decreased.

Key words: landscape water, water treatment, TiO2 nanometer material and photocatalysis

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INTRODUCTION

The dynamic monitoring and evaluation for water quality of Tangshan Great South Lake and other urban landscape water systems was carried out aiming at the key ecological and environmental issues, for example, water quality pollution of urban landscape water system, quality water resource occupied by landscape water system and impact to secondary wetland environment and so on, and the research was made on the key technologies for governance of mild contamination to large water area by photocatalytic technology with slag and the water system and wetland pollution control by integrative biology and photochemistry, etc [1-5]. The TiO2 nanometer assembly material is directly prepared by melt phase-separation for urban landscape quality treatment; moreover, the TiO2 nanometer assembly material is directly prepared, by melt phase-separation method, with Titanium-containing blast furnace slag as the principal raw material and according to the theory of phase separation in glasses as well as the influence and control of phase separation process in the phase separation [6-9]. The water treatment was carried out for South Lake landscape water system by the assembly material prepared and the photocatalysis effect was performed according to the national quality evaluation standard for urban landscape water.

EXPERIMENTAL SECTION

Select the main raw material of Titanium-containing blast furnace slag from Chengde City and the auxiliary materials of quartz and sodium borate and so on carefully and adopt the process similar to that of ceramic fritted glaze, to prepare the nanometer TiO2 photocatalysis assembly material. On the basis of the systematic research on the phase separation behavior and crystallization behavior of CaO-MgO -Al2O3-SiO2-TiO2 system and relevant systems to which the Titanium-containing blast furnace slag belongs, the optimal conditions for TiO2 crystallization is determined as: 1,230℃ melting temperature, 850℃ heat treatment temperature and 24-hour holding time [10].

for the photocatalysis nanometer assembly material prepared by he Titanium-containing blast furnace slag, the phase

separation structure size of assembly material is about 100nm according to the microscopic structure analysis. The crystals dissolved out are rutile and CaTiSiO5 according to X-ray diffraction analysis.

RESULTS AND DISCUSSION

Energy spectrum analysis and XRD analysis of phase separation system of CaO-MgO-Al2O3-SiO2-TiO2

The blast furnace slag from Chengde City is selected as the research object and is determined as CaO-MgO-Al2O3-SiO2-TiO2 system through the chemical composition, phase analysis and microstructure analysis. The slag is the polymer crystalline phase and glass phase with the perovskite crystal. The melting-phase separation process is adopted in the phase separation system and its phase separation behavior is analyzed by the energy spectrum.

The energy spectrum data, obtained from the heat treatment of specimen at 750□, 800□ and 850□ prior to chemical treatment, is shown in table 1.

Table 1: Energy spectrum test data specimen after chemical leaching (wt%)

Temperature/□	SiO2	Al2O3	Na2O	TiO2	CaO（MgO）
Room temperature	48.61	16.47	8.71	5.48	9.88
750	73.69	2.94	12.50	7.10	0.09
800	75.82	2.15	3.63	8.60	2.65
850	79.45	1.62	0.15	10.42	3.49

(Note: the measurement range of the energy disperse spectroscopy used in the test starts from element Na and there is no element B in the map)

According to the energy spectrum test data in table 1, the content of SiO2 in the specimen is obviously increased after chemical leaching, but the content of CaO2 is obviously decreased, indicating that the specimen has been subject to the phase separation at 750□. In the sample with different heat treatment temperatures as shown in table 1, the content of Na2O in the sample changes greatly, indicating that when the phase separation temperature is low, Na2O will be distributed in the alkali-rich silicon phase and that when the temperature rises Na2O will be distributed from the alkali-rich silicon phase to boron-rich silicon phase.

Fig. 1 indicates that the crystals of rutile and CaTiSiO5 are dissolved out at 750□ and the phase separation and the amount of crystallization increase gradually with temperature rise.

For the photocatalysis nanometer assembly material prepared by he Titanium-containing blast furnace slag, the phase separation structure size of assembly material is about 100nm according to the microscopic structure analysis. The crystals dissolved out are rutile and CaTiSiO5 according to X-ray diffraction analysis.

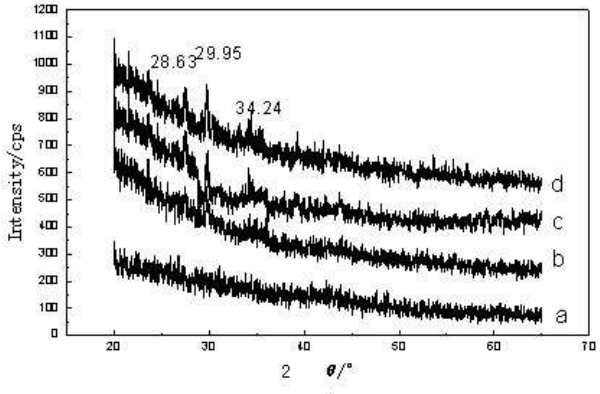

Fig. 1: XRD analysis of specimen (a-700℃, b-750℃, c-800℃and d-850℃)

Photocatalysis treatment of different water areas by photocatalysis assembly material

Three kinds of TiO2 nanometer photocatalysis assembly materials A, B and C are prepared successfully by the Titanium-containing blast furnace slag selected from different regions, for the purpose of experimental research made on nearly 1,000 m2 water area of three scenic spots of Yanglongshui, Qingtianjing and Xixingchi in South Lake water system of Tangshan City.

The experimental research result shows that, according to the quality evaluation standard for urban landscape water, the five-day biochemical oxygen demand (BOD5), chroma, total phosphorus, total nitrogen and ammonia nitrogen

and other indexes reach the standard completely and the chemical oxygen demand (COD) and the content of suspended substance in water are significantly decreased.

The catalytic effect of the photocatalysis treatment time is researched through photocatalytic material B which has a good photocatalysis effect. According to the research result shown in table 2, if the treatment time is 2 weeks, the chemical oxygen demand decreases sharply and all other indexes reach the standard.

Table 2: Influence of photocatalysis time on water treatment effect Unit: ml/L (except for pH)

Item / Specimen	LAS	Ammonia nitrogen	BOD	COD	SS	Total phosphorus	Total nitrogen	pH
Raw water	0.130	7.73	8.22	53.3	18	1.71	9.17	8.01
One-week treatment	0.113	0.703	6.29	43.3	17	0.497	2.19	9.46
Two-week treatment	0.050L	0.169	2.80	37.9	6	0.021	1.03	8.51

CONCLUSION

The TiO2 nanometer assembly material is directly prepared, by melt phase-separation method, with Titanium-containing blast furnace slag as the principal raw material and according to the theory of phase separation in glasses as well as the influence and control of phase separation process in the phase separation. The water treatment was carried out for South Lake landscape water system by the assembly material prepared and the photocatalysis effect was performed according to the national quality evaluation standard for urban landscape water. According to the analysis of various indexes in water quality after treatment: all the indexes of urban landscape water, after treatment by nanometer TiO2 photocatalysis assembly material, meet the requirements of national standard for reclaimed water.

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