PHOTODEGRADATION OF RHODAMINE B BY WO_3/GLASS FOAM VISIBLE-LIGHT THIRD GENERATION PHOTOCATALYST

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Abstract

This work focused on the evaluation of the photocatalytic activity of the glass foam, a chemically and physical stable support, coated with WO_3–visible-light photoactive compound for degradation of rhodamine B. In this way, the removal of the rhodamine B in aqueous solution by WO_3/glass foam was compared with the removal of rhodamine B by uncoated glass foam during the experimental stages of the photocatalytic tests: adsorption and visible-light irradiation. The uncoated sample presented no photocatalytic activity, whereas WO_3/glass foam removed approximately 33% of rhodamine B from aqueous solution. Physical and chemical characterization of the photocatalyst was carried out by 3D scanning microscopy and energy dispersive X-ray spectroscopy (EDAX) coupled with scanning electrone microscopy (SEM).

Introduction

Tungsten trioxide is one of the representative visible-light active photocatalyst and also materials based on the WO_3 were developed and investigated for their photocatalytic properties in the visible spectral range as a need to overcome the dependence on the UV electromagnetic radiation [1]. In order to enhance the efficiency and the potential application, research studies were conducted to develop photocatalyst that involve their immobilization on different supports or preparation of films. The advantage of this type of photocalysts (known as the third generation of photocatalysts) compared to nanoparticles, is given by the fact that it is not required an additional procedure for separating the photocatalyst from aqueous solution eliminating the cost and the disadvantages associated with the separation techniques such as incomplete separation and loss of photocatalytic activity. Different supports were involved in designing immobilized photocatalyst including steel, SiO_2, glass, FTO glass, glass foam.

Glass foam is a material which has gained a lot of interest mostly as an insulating material in the construction industry, but the combination of various properties such as chemical and biological stability, porous and rigid structure makes it attractive as an absorber, sound insulator and as support for photocatalysts, suitable for environment application such as water and air purification [2-6].

The aim of the present work was to investigate the ability of WO_3 immobilized on the glass foam to remove rhodamine B (RhB) by a photodegradation process. Considering the chemical stability and the toxicity of the RhB, it has been selected as a substance to degrade and to evaluate the photocatalytic activity of the WO_3 supported on the glass foam.

Experimental section

Different samples were obtained as described in a previous study [7] and involved for a comparative evaluation of photocatalytic properties: glass foam (0.750 g) coated with 0.046 g WO_3 and uncoated glass foam of approximately 0.700 g. The photocatalytic experiments were carried out using UV-VIS spectroscopy by monitoring the absorbance of RhB aqueous solution (20 mL of 1.5 mg L^{-1} initial concentration) at certain time intervals. The photocatalytic

experiments consisted of two subsequent steps: adsorption of the RhB on the samples and the removal of RhB by photodegradation under simulated visible light.

In addition to the photocatalytic evaluation, the samples were characterized for investigation of the porous structure and semi-quantitative chemical composition using 3D scanning microscopy and EDAX spectroscopy coupled with SEM (not presented in the paper).

Results and discussion

The degradation of RhB by the supported WO_3 sample and uncoated glass foam under two hours of visible light irradiation is presented below, in figure 1.

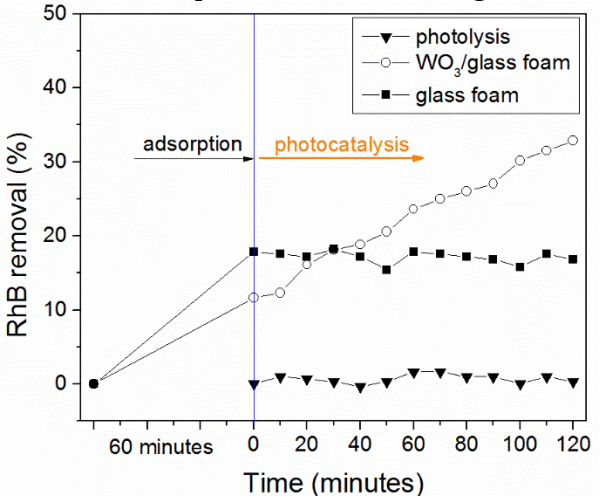

Figure 1. Removal of RhB from aqueous solution by: WO_3 supported on glass foam (marked with ○), glass foam (marked with ■) and with no catalyst (only RhB aqueous solution; marked with ▼) during adsorption and visible-light exposure

It could be noticed that during the photocatalytic experiments, RhB was firstly removed in the adsorption stage (12% for immobilzed photocatalyst –WO_3/glass foam and 17% for the uncoated glass foam) followed by removal of RhB by photodegradation (achieved only by WO_3/glass foam).

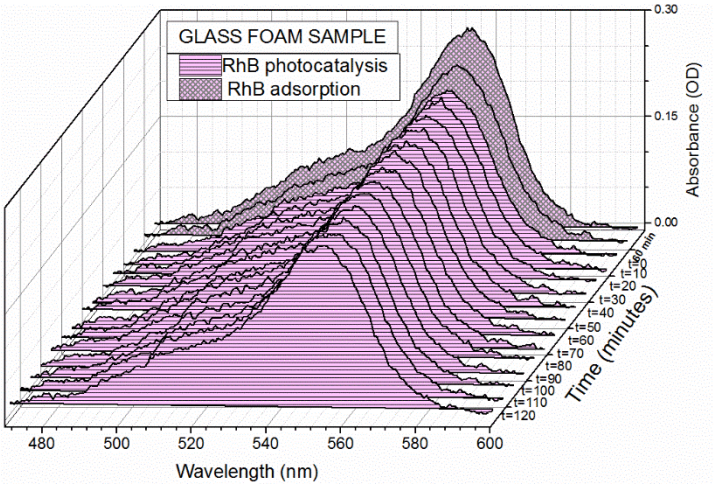

Figure 2. Absorbance decrease of the RhB aqueous solution corresponding to the uncoated glass foam during photocatalytic experiment

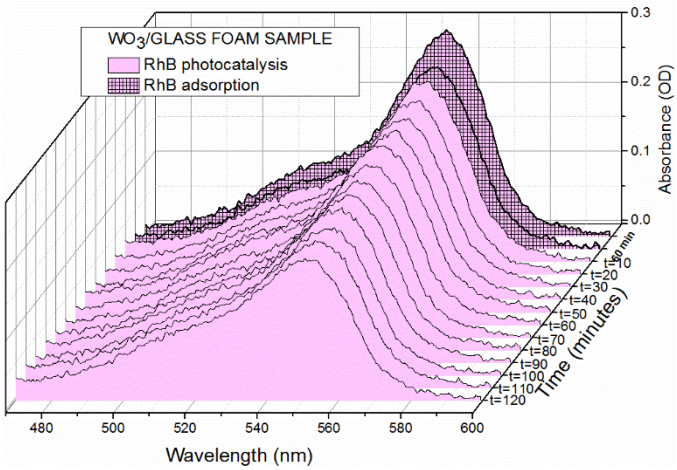

Figure 3. Absorbance decrease of the RhB aqueous solution corresponding to WO_3/glass foam during photocatalytic experiment

As well, the decrease of peak absorbance intensity of the RhB solution for the two samples involved in the study are represented in figure 2 and figure 3. The percent of the RhB removal obtained after adsorption step is higher for the uncoated glass foam even if the mass of the glass foam is lower than the mass of the glass foam used as support, which illustrates that the adsorption may be affected also by other factors including the morphology and the porosity of the glass foam.

The uncoated glass foam presented no photocatalytic activity which emphasize that the photodegradation of RhB for the supported WO_3 sample is given by the WO_3 activity. Moreover, the experiments carried out with uncoated glass foam and with RhB aqueous solution indicated the stability of the RhB under visible light irradiation.

Conclusion

Based on the photocatalytic experiments carried out for the glass foam activated with WO_3 and for the uncoated glass foam, it could be concluded that a higher removal of RhB was achieved by WO_3/glass foam, obtained as a result of both adsorption and photocatalysis process. The removal of RhB given by the photocatalytic properties of the WO_3 was 21% (of total removal of 33%). The uncoated glass foam acted only as an adsorbent, which proved the chemical stability regarding the photocatalytic reaction for RhB degradation.

The photocatalytic activity of the WO_3/glass foam validates the potential for glass foam utilization as a catalyst support dedicated for but not limited to environmental application.

Acknowledgements

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