Development of photocatalyst hydrogel composite materials for wastewater treatment

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Abstract

Due to the issue of wastewater discharge from industrial plants, chemical methods have been developed to remove non-biodegradable organic substances. One such method involves the use of photocatalysts to degrade and break down the hydrocarbon bonds of dye solutions. This research focuses on developing photocatalyst-hydrogel composite materials, using zinc oxide (ZnO) as the primary photocatalyst. Comparisons were also made by combining ZnO with three other substances: activated carbon, titanium dioxide, and carbon nitride.

The photocatalyst-hydrogel composites were synthesized using photopolymerization, and their effectiveness was tested on the degradation of three dyes: methyl orange, methylene blue, and rhodamine B. Experimental results showed that the developed materials achieved the highest decolorization efficiency with methylene blue at 95%, followed by methyl orange at 79%, and rhodamine B at 24%. The materials are promising for practical applications due to their pellet-like form, which is suitable for use, and their low production cost.

Introduction

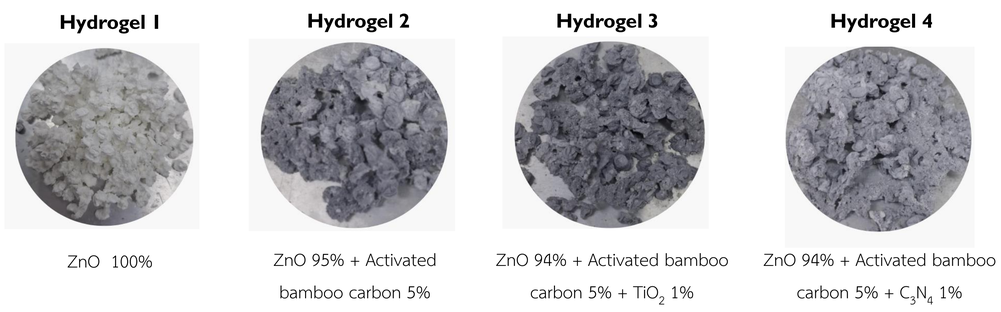
At present, there are many industrial plants that release wastewater into nature without proper treatment before disposal, which is one of the causes of water resource problems and is harmful to humans and animals. Therefore, photocatalysis is used to eliminate wastewater in the form of hydrogel because it has the ability to retain and absorb liquids, is low in toxicity, and is cheap.

Objective

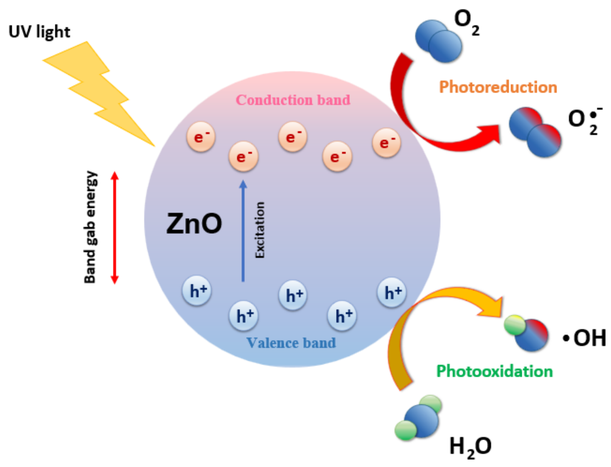
Development of photocatalyst hydrogel composite materials for wastewater treatment

Experiment

Hydrogel production is done by photopolymerization. There are 4 types of hydrogels produced, with ZnO as the main semiconductor and other composites added to test the photocatalytic activity.



• The four manufactured hydrogels were subjected to immersion in dye solution (Methyl orange , Methylene blue and Rhodamine B) during the experiment to increase the adsorption of the solution for 24 hours , and then exposed to UVA for 210 min to photocatalysis to degradation the dye, After that, the absorbance was measured using UV-Vis spectrophotometer and the degradation value was calculated.



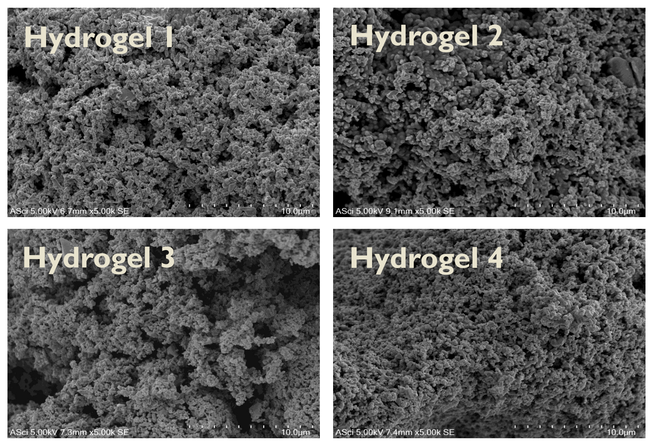
Photocatalytic reaction of ZnO

Conclusion

From the experiment on the fabrication of hydrogels with ZnO as a semiconductor with 4 type of composites, the surface of the hydrogels was examined by SEM. It was found that all 4 hydrogels had ZnO particles covering the entire surface of the hydrogels. Then, the EDS test was performed and It was found that in hydrogel 3, the peak of Ti was found, while in hydrogel 4, the peak of Nitrogen was found. Finally, the degradation of three dyes, methyl orange, methylene blue, and Rhodamine B , It was found that the hydrogels could degrade methylene blue dye at the highest rate of 95%, with hydrogels 1 and 4 degrading methyl orange dye the next best at the highest rate of 79%. The hydrogel with the highest degradation was hydrogel 3, and the dye that degraded the worst in the hydrogel was Rhodamine B, with the highest degradation of 24%, and the hydrogel with the best degradation was hydrogel 2.

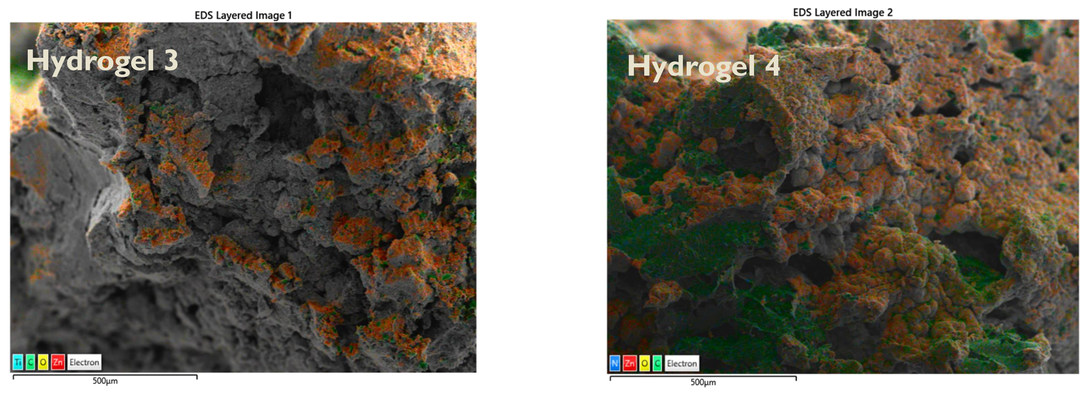
Result

Scanning Electron Microscope (SEM)



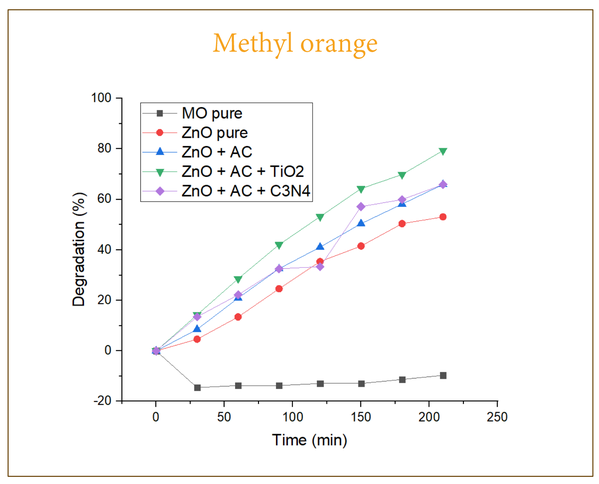
• The morphology of the hydrogel before dye can be seen, with the surface mostly composed of ZnO nanoparticel in Hydrogel 1 and activated bamboo carbon in Hydrogel 2 , 3 and 4. Only small polymer particles are seen, no pores are seen.

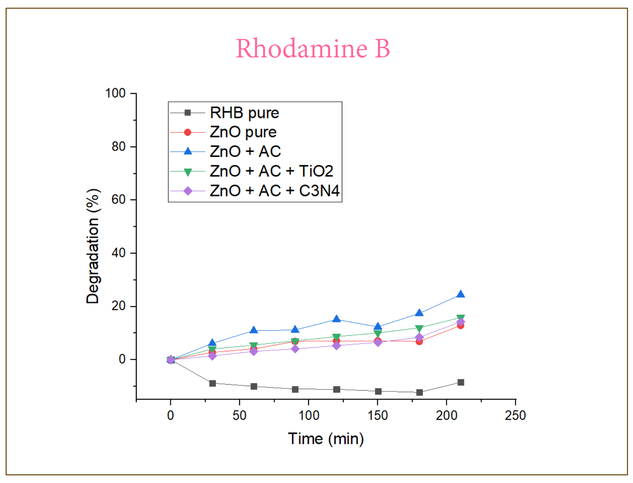
Energy Dispersive X-Ray Spectroscopy (EDS)

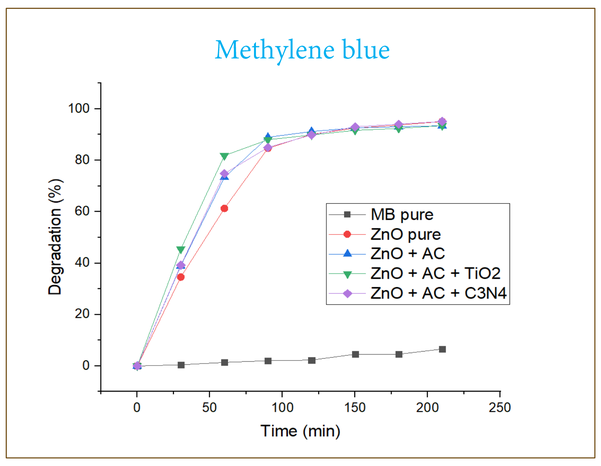


• EDS tests were performed on 3 and 4 hydrogel to examine whether 1% TiO_2 and C_3N_4 composites adhered to the hydrogel. It was found that when tested by EDS, the TiO_2 and C_3N_4 composites adhered to the surface of the hydrogel, as shown by the peaks of Ti and N.

Degradation







• The Hydrogels were able to degradation Methylene blue the best, with a maximum removal of 95% by Hydrogels 1 and 4. The Methyl orange dye degradation efficiency was moderate, with a maximum removal of 79% by hydrogel 3. Finally, the Rhodamine B degradation efficiency was not very good, with a maximum removal of 24% by Hydrogel 2.

Reference

• Pattarawadee Maijan, Pongsaton Amornpitoksuk, Sirinya Chantarak. Synthesis and characterization of poly(vinyl alcohol-g-acrylamide)/SiO_2@ZnO photocatalytic hydrogel composite for removal and degradation of methylene blue. Polymer Volume 203, 26 August 2020, 122771,https://doi.org/10.1016/j.polymer.2020.122771