CREATIONS de UiTM

INTERNATIONAL MEGA INNOVATION CARNIVAL 2024

Navigating Innovation and Seizing Global Fortune

CHANGE THE WORLD THROUGH INNOVATION

e-PROCEEDING

27th APRIL 2024

UNIVERSITI TEKNOLOGI MARA
CAWANGAN SELANGOR, KAMPUS DENGKIL
MALAYSIA

ORGANISED BY:

Universiti Teknologi MARA
Pusat Asasi

Efficient Visible-Light-Active of Ag_2CO_3/Nb_2O_5 photocatalyst for EDCs removal in wastewater

Nur Ramadhan Mohamad Azaludin[1], Zul Adlan Mohd Hir[1], Zuraida Khusaimi[2], Nurul Infaza Talalah Ramli[1] and Hartini Ahmad Rafaie*[3]

[1]Faculty of Applied Sciences, Universiti Teknologi MARA Pahang, 26400 Bandar Tun Abdul Razak Jengka, Pahang, Malaysia

[2]Centre for Functional Materials and Nanotechnology, Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

[3]Centre of Foundation Studies, Universiti Teknologi MARA, Selangor Branch, Dengkil Campus, 43800 Dengkil, Selangor, Malaysia

*Corresponding author: hartinirafaie@uitm.edu.my

ABSTRACT

Photocatalysis has become more attractive and important since it has a great potential in solving environmental problems. One of the most important aspects of environmental photocatalysis is the selection of photo-active materials. Ag-based semiconductor materials are currently catching the interest and research efforts of numerous material researchers due to their wide range of applications especially photocatalyst for wastewater treatment. Silver carbonates (Ag_2CO_3) is a common p-type semiconductor with a moderate band gap of 2.30 eV has also caught interest for its high-performance photocatalytic performance and anti-bacterial properties. To further improve the separation of photo-induced charge carriers, Ag_2CO_3 was employed to couple with niobium pentoxide (Nb_2O_5) can greatly accelerate the charge separation. In this work, hybrid Ag_2CO_3/Nb_2O_5 composite as a photo-active material was successfully prepared by a facile chemical precipitation method. The photocatalytic activities of the hybrid samples were evaluated by monitoring the photodegradation of bisphenol A (BPA) under visible light irradiation. The hybrid Ag_2CO_3/Nb_2O_5 composite sample exhibited promising results in the photocatalysis process with BPA removal of 79.09 % and showed good stability and reusability that can be used up to 4th cycle. The enhanced performance of hybrid Ag_2CO_3/Nb_2O_5 photocatalyst shows that it has potential for designing the dye waste-water treatment.

Keywords: Ag_2CO_3; Nb_2O_5; photocatalysis; visible; wastewater.

1. INTRODUCTION

A lot of emerging pollutants such as endocrine disrupting compounds (EDCs) are discharged into the aquatic system and posing a serious threat. One of the commonly known EDCs is Bisphenol A, an extremely harmful substance substantially produced in various plastic products (Godiya & Park, 2022). Hence, eliminating such hazardous pollutants from the environment or converting it into harmless compounds is crucial. Photocatalysis has been popular for degrading these pollutants into organic compounds (Zamri et al., 2021). Ag_2CO_3 has been identified as an excellent photosensitizer and a highly active visible light-driven photocatalyst due to its small

band gap (~2.17 eV), which is beneficial for sunlight absorption (Rafaie et al., 2023). However, this photocatalyst displays photocorrosion behaviour that had hindered its functionality. Thus, many efforts were taken to improve such drawback. As previously reported, heterojunctions formation between Ag-based photocatalyst and Nb_2O_5, had shown promising properties, like enhanced separation of charge carriers (Osman et al., 2021). Thus, in this work we report the facile preparation of hybrid Ag_2CO_3/Nb_2O_5 composite with different weight ratios using facile chemical precipitation method, as well as its significant photodegradation performance on BPA.

2. METHODOLOGY

2.1. Synthesis of Ag_2CO_3/Nb_2O_5 composite

All chemicals and reagents were used as received and no purification step was done. The facile chemical precipitation method was employed to prepare the hybrid Ag_2CO_3/Nb_2O_5 composite photocatalyst at different molar ratios. Nb_2O_5 (0.01 mol) was added into $AgNO_3$ (0.02 mol) solution prior to sonication for 30 minutes. Na_2CO_3 (0.01 mol) was added into the solution with constant stirring for 1 hour at room temperature. Subsequently, the precipitates of Ag_2CO_3/Nb_2O_5 composite were collected, washed several times with deionized water and dried at 60°C for 24 hours, yielding a pale-yellow powder named as Ag:Nb 1:1. The other molar ratios of Ag_2CO_3 to Nb_2O_5 (1:3,1:5, 3: 1 and 5:1) were synthesised likewise, meanwhile pure Ag_2CO_3 were also be synthesized similarly but without Nb_2O_5.

2.2. Photocatalytic performance

The photocatalytic performance of Ag_2CO_3/Nb_2O_5 composite was evaluated by measuring the degradation of BPA. In all measurements, 0.1 g of photocatalyst were dispersed into BPA solution (200 mL, 10 mg/L) and magnetically stirred for 30 minutes in the dark to achieve the adsorption-desorption equilibrium prior to visible light irradiation for 150 minutes. At each time intervals, 5 mL of sample were extracted out and the change of concentration of BPA was monitored and analysed through UV-vis spectrophotometer at λ_{max} = 276 nm.

3. RESULTS AND DISCUSSION

The photocatalytic activity of Ag_2CO_3/Nb_2O_5 composite photocatalyst was investigated through the photodegradation of BPA and the findings are as depicted in Figure 1 (a). It was found that within 150 minutes, Ag_2CO_3/Nb_2O_5 composite photocatalyst was degraded up to 79.09%. The stability and reusability of Ag_2CO_3/Nb_2O_5 composite photocatalyst was ascertained by the repetitive use of the photocatalyst under the same experimental conditions. After each cycle, the photocatalyst was recovered. Fresh BPA solution was used for each cycle without treating the photocatalyst to any kind of chemical or physical pretreatment before each cycle. As depicted in Figure 1 (b), Ag_2CO_3/Nb_2O_5 composite photocatalyst showed good stability trend even after four cycles. This result suggested that the Ag_2CO_3/Nb_2O_5 composite photocatalyst remained significantly photoactive with good stability towards visible light irradiation. The reduction in percentage degradation might be due to the photocorrosion of the photocatalyst as well as weight loss during the filtration process.

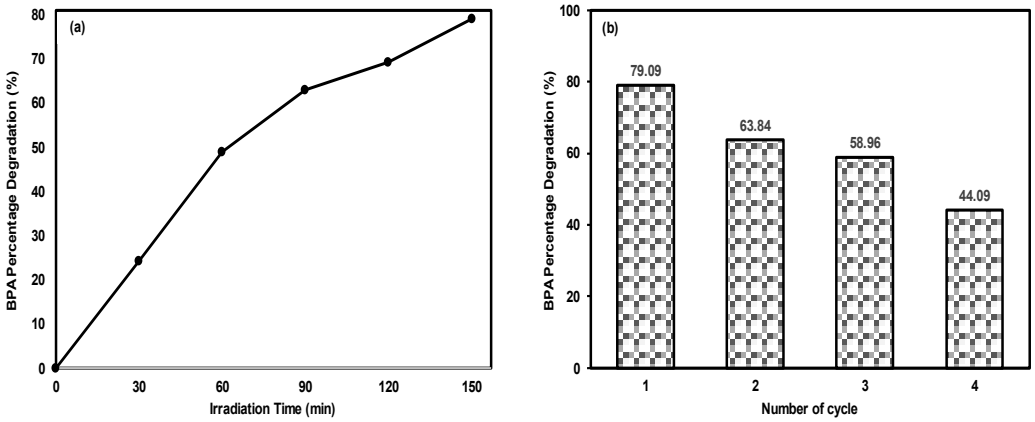

Figure 1. (a) The percentage degradation and (b) The reusability of Ag_2CO_3/Nb_2O_5 composite photocatalyst in degradation of BPA solution. Conditions: [BPA] = 10 mg/L; pH = 6.1; 150 minutes irradiation time.

4. CONCLUSION

In conclusion, it was revealed that Ag_2CO_3/Nb_2O_5 composite photocatalyst exhibit a significant performance of BPA degradation under visible light irradiation in 150 minutes and can be used up to 4th cycle, where the reduction in photocatalytic performance was observed from 79.09% to 44.09%. To improve the photocatalytic performance of Ag_2CO_3 based photocatalysts, another alternative such as adding transition metals e.g., Fe, Co, Ni and decorating the composite with noble metal nanoparticles e.g., Au, Ag also can enhance light absorption through surface plasmon resonance (SPR) effects. This study is hugely beneficial for its potential application in industrial wastewater treatment, especially towards the removal of EDCs, as well as dyes. Furthermore, this research is also a significant strategy for finding semiconductor photocatalyst that is useful towards cost-efficient wastewater treatment process due to the utilization of more affordable visible light irradiation compared to UV light irradiation that is costly.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the financial support provided by the Ministry of Higher Education (MOHE) and Universiti Teknologi MARA (UiTM) for the YTR grant (600-RMC/YTR/5/3 (005/2020)), including the services and facilities provided to carry out the laboratory work in UiTM Pahang Branch, Jengka Campus and Centre for Functional Materials and Nanotechnology, Institute of Science, UiTM Shah Alam, Selangor.

REFERENCES

Godiya, C. B., & Park, B. J. (2022). Removal of bisphenol A from wastewater by physical, chemical and biological remediation techniques. A review. *Environmental Chemistry Letters*.

Osman, N. S., Sulaiman, S. N., Muhamad, E. N., Mukhair, H., Tan, S. T., & Abdullah, A. H. (2021). Synthesis of an Ag_3PO_4/Nb_2O_5 Photocatalyst for the Degradation of Dye. *Catalysts*, *11*(4), 458.

Rafaie, H. A., Ramli, N. I. T., Khusaimi, Z., Mohd Sarjidan, M. A., Dulyaseree, P., & Hir, Z. A. M. (2023). Ag_2CO_3-Based Photocatalyst with Enhanced Photocatalytic Activity for Endocrine-Disrupting Chemicals Degradation: A Review. In *Catalysts* (Vol. 13, Issue 3, p. 540).

Zamri, M. F. M. A., Bahru, R., Suja', F., Shamsuddin, A. H., Pramanik, S. K., & Fattah, I. M. R. (2021). Treatment strategies for enhancing the removal of endocrine-disrupting chemicals in water and wastewater systems. *Journal of Water Process Engineering*, *41*(November 2020), 102017.