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# Photosensitisation of Novel $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$ Photocatalyst for EDCs Removal in Wastewater

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## ABSTRACT

Ag-based semiconductor materials are currently catching the interest and research efforts of numerous material researchers due to their wide range of applications. This study aimed to examine the effect of incorporation of niobium pentoxide ( $\text{Nb}_2\text{O}_5$ ) to the structural and morphological properties of silver carbonate ( $\text{Ag}_2\text{CO}_3$ ), as well as the photocatalytic performance of the materials on EDCs, such as Bisphenol A (BPA). The preparation and evaluation on  $\text{Ag}_2\text{CO}_3$ ,  $\text{Nb}_2\text{O}_5$ , and  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  composite were discussed in detailed.  $\text{Ag}_2\text{CO}_3$ ,  $\text{Nb}_2\text{O}_5$ , and  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  composite were synthesized by facile precipitation method at room temperature and were characterised by Fourier Transform Infra-Red (FTIR) spectroscopy, and Field Emission Electron Microscopy (FESEM) for its structural and morphological properties. FTIR analysis revealed the emergence of  $\text{CO}_3^{2-}$ , C–O and Nb=O groups, as well as the development of bridging Nb–O–Nb in the composite structure. Morphological analysis revealed that  $\text{Nb}_2\text{O}_5$  were irregular spherical-shaped and were evenly dispersed on the surface of irregular short rod structure of  $\text{Ag}_2\text{CO}_3$ . Moreover, this study provides a profound understanding towards the coupling system of  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  heterojunction. Lastly, the  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  composites has the potential to be directly and continuously applicable in a real-life event of industrial wastewater treatment on plastic manufacturing and epoxy resin industry.

**Keywords:** Silver carbonate; niobium pentoxide; Bisphenol A; visible light; EDCs

## INTRODUCTION

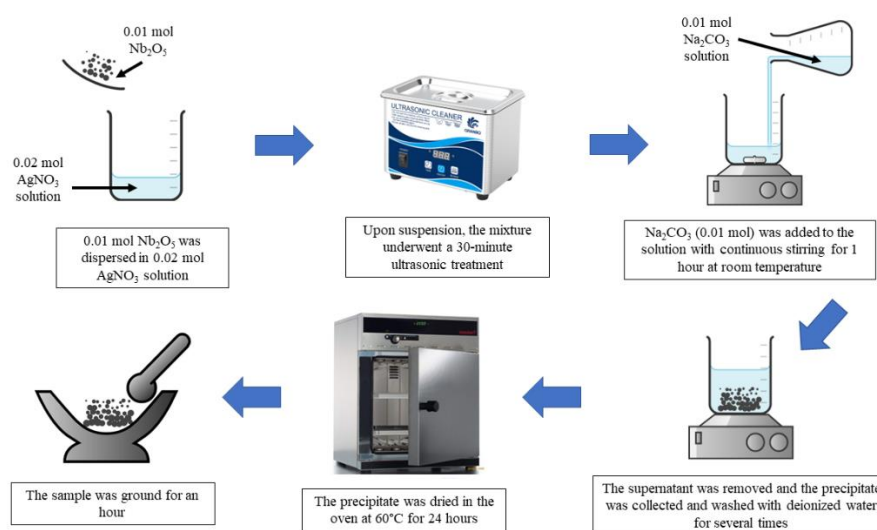
A lot of chemical compounds are discharged into the aquatic system and posing a serious threat. Since conventional wastewater treatment are not intended to eliminate residues of hazardous organic pollutants like EDCs, these toxins end up in aquatic life and eventually enter the human food chain [1]. One of the commonly known EDCs is Bisphenol A, a common industrial chemical produced substantially around the world and commonly found in various plastic products [2]. Photocatalysis has gotten a lot of interest as a promising green technology that can degrade these pollutants into organic compounds [3][4]. Therefore, researchers are working on developing nontoxic, eco-friendly, low-cost, and efficient photocatalysts that can conduct reactions with large amounts of desired products under mild conditions [5]. Numerous studies

reported the used of  $\text{Nb}_2\text{O}_5$  for photodegradation, yet,  $\text{Nb}_2\text{O}_5$  photocatalysts is among the semiconductor photocatalysts that can only be driven by UV light that accounts for just ~5% of the solar spectrum's energy, whereas visible light accounts for 45% and [6][7]. Therefore, efforts should be undertaken to expand the light response of the photocatalyst from UV to visible light for efficient solar energy consumption and there are different kinds of heterojunctions formation on Ag-based photocatalyst with  $\text{Nb}_2\text{O}_5$  have been developed for enhancing its photocatalytic capabilities [5]. Therefore, in this study we report to the best of our knowledge, on photosensitization of  $\text{Ag}_2\text{CO}_3$ -based photocatalyst through heterojunction of  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  composites.

## INNOVATION DEVELOPMENT

### 1. Synthesis of $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$ Photocatalyst

The  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  composite were prepared by facile chemical precipitation method. In this procedure,  $\text{Nb}_2\text{O}_5$  (0.01 mol) was dispersed into the  $\text{AgNO}_3$  (0.02 mol) solution prior to sonication for 30 minutes. Next,  $\text{Na}_2\text{CO}_3$  (0.01 mol) was added with continuous stirring for 1 hour. The obtained precipitate was collected and washed with deionized water for several times before drying in the oven at  $60^\circ\text{C}$ . The pure  $\text{Ag}_2\text{CO}_3$  was prepared likewise but without  $\text{Nb}_2\text{O}_5$  and  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  composite with other molar ratios of  $\text{Ag}_2\text{CO}_3$  to  $\text{Nb}_2\text{O}_5$  (1:3, 1:5, 3: 1 and 5:1) were synthesised similarly. The pure  $\text{Nb}_2\text{O}_5$  was ground before being used.



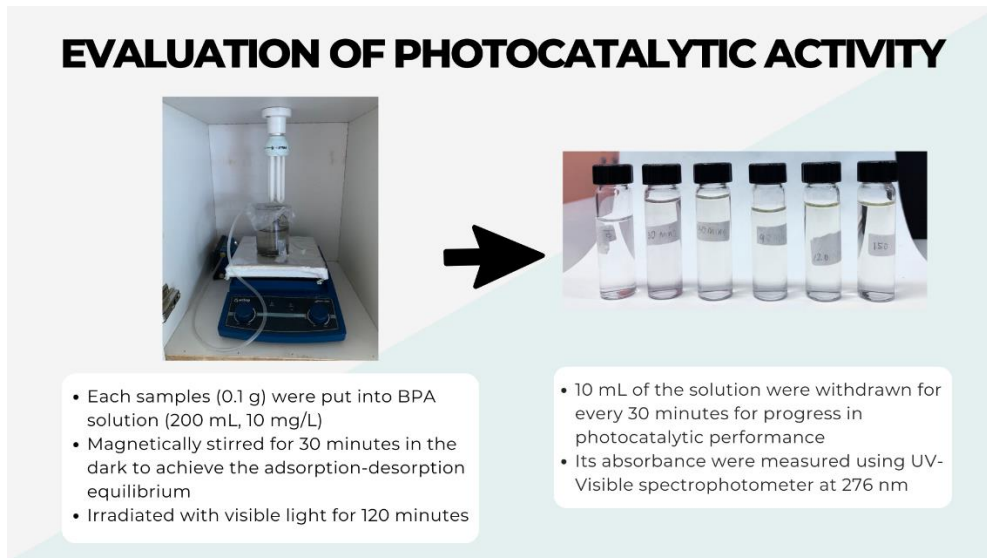
**Figure 1:** Sample preparation pure  $\text{Ag}_2\text{CO}_3$ , pure  $\text{Nb}_2\text{O}_5$  and Ag:Nb composites at different molar ratios

### 2. Photocatalytic Activity Measurement

The photocatalytic performance of the samples was evaluated by measuring the degradation of BPA by UV-vis spectrophotometer in time intervals of 30 minutes. In all measurements, the samples (0.1 g) were put into BPA solution (200 mL, 10 mg/L), and irradiated with visible light, a 23-W fluorescence lamp (Philips). Before the suspensions were irradiated, they were magnetically stirred for 30 minutes in the dark to achieve the adsorption-desorption equilibrium between BPA and the photocatalysts. Before the spectroscopy measurement, these photocatalysts were removed from the photocatalytic reaction systems by filtration. The relative

concentrations of the BPA solutions were determined by the absorbance at 276 nm. The BPA percentage of degradation was calculated using Eq. (1).

$$\text{Percentage degradation (\%D)} = \frac{C_0 - C_t}{C_0} \times 100 \quad (1)$$



**Figure 2:** Photocatalytic activity measurement on EDCs by the prepared samples

## COMMERCIAL POTENTIAL

The photocatalytic performance of  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  is hugely beneficial to investigate as it has the potential to be directly and continuously applicable in a real-life event of industrial wastewater treatment of plastic manufacturing and epoxy resin industry, especially towards the removal of toxic organic pollutants of EDCs, such as Bisphenol A. Furthermore, this research is also a significant strategy for a profound understanding towards the highly stable coupling system of  $\text{Ag}_2\text{CO}_3/\text{Nb}_2\text{O}_5$  heterojunction. In addition, this research would provide a new semiconductor photocatalyst that will aid in towards cost-efficient wastewater treatment process due to the utilization of visible light irradiation that is more affordable compared to using the UV light irradiation that is costly. Figure 3 depicts the achievements of this project.

- Publication

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Main Inventor Name	HARTINI BINTI AHMAD RAFAIE
Faculty	FAKULTI SAINS GUNAAN
IP Type	Copyright

**Figure 3:** Proof of the published work and related Intellectual Property Recognition (IPR)

## CONCLUSION

To conclude, the Ag<sub>2</sub>CO<sub>3</sub>/Nb<sub>2</sub>O<sub>5</sub> composite were successfully prepared with different molar ratios via a simple chemical precipitation method and exhibit irregular spherical-shaped that randomly dispersed on the surface of irregular short rod structure. The FTIR analysis pointed out the existence of several functional groups assigned to their respective stretching vibrations especially for Ag–O (~500cm<sup>-1</sup>), C–O (1071 cm<sup>-1</sup>), CO<sub>3</sub><sup>2-</sup> (~800 cm<sup>-1</sup> and 1350-1500 cm<sup>-1</sup>), Nb–O–Nb (500-650 cm<sup>-1</sup>) and Nb=O (948 cm<sup>-1</sup>). Additionally, this study would be a key approach for gaining a thorough grasp of the morphological and structural characteristics on heterojunction coupling system of Ag<sub>2</sub>CO<sub>3</sub>/Nb<sub>2</sub>O<sub>5</sub> composite. Lastly, the Ag<sub>2</sub>CO<sub>3</sub>/Nb<sub>2</sub>O<sub>5</sub> composites has the potential to be directly and continuously applicable in a real-life event of industrial wastewater treatment on plastic manufacturing and epoxy resin industry.

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