RESEARCH ARTICLE

Synthesis, Characterization, and Photocatalytic Activity of Prepared MWCNT/ZnO Nanocomposite as a Model of Dyes and Pharmaceutical Compounds Removal

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ABSTRACT

The photocatalytic decomposition of brilliant green (BG) dye under several conditions was studied using MWCNT/ZnO nanocomposite. Nanocomposites were prepared *via* utilizing a hydrothermal process. The MWCNT/ZnO nanocomposite properties were studied using techniques (FESEM, and EDX). The most important factors affected the photocatalytic process were studied, like mass of MWCNT/ZnO nanocomposite, concentration of brilliant green (BG) dye, light intensity. The results showed that the photolysis process was low at first and then increased with time. From the results, the photocatalytic decomposition efficiency increased with the surface weight MWCNT/ZnO nanocomposite of (0.1–0.4) g. This also showed that with an increase BG dye concentration, the photolysis efficiency decreased, and showed that the photolysis efficiency was improved by increasing the light intensity.

Keywords: Brilliant green, Dye, Light intensity, Nanocomposite, Photocatalytic.

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INTRODUCTION

The decolonization of textile water is an important issue during the past two decades, not because of its toxicity as dyes but also its effect on the life of marine organisms. Its impact on the beauty of the aquatic environment. As most of the industrial waste pours into the water and wastewater plants, and the most dangerous of them is liquid waste, which constitutes 50% of the dyes in the liquid waste, and this is considered one of the most important problems resulting from industries that threaten the environment.[1-3] Therefore, the photocatalytic process involving semiconductor particles and semiconductor photocatalyst under ultraviolet illumination light may be useful in treating industrial waste discharged into water and wastewater plants.[4,5]

Textile dyes, contain inorganic and organic compounds, and all these dyes are toxic and dangerous and constitute a major concern for the ecosystem, aquatic life, microorganisms, and humans. Therefore, many methods have been used to remove these dyes from wastewater.[3,6-11] The most important of these are methods. Advanced oxidation processes (AOPs) are of great interest in the purification of water from dyes. Dyes are usually destroyed in the presence of semiconductor photocatalysts (ZnO, Co_3O_4, TiO_2, CdS, WO_3) an active light source and an oxidizing agent like air or oxygen.[12-15]

In this research, a surface MWCNT/ZnO nanocomposite was prepared by the hydrothermal method, and several factors were studied, including BG dye concentration, surface mass, and effect of light intensity.

MATERIALS AND METHODS

Preparation of MWCNT/Zinc Oxide Nanocomposite

Nanocomposites were prepared *via* utilizing a hydrothermal process (Scheme 1). 5 g of oxalic acid, 5 g of zinc acetate, and MWCNT was acquired from the refinery of bakery factories, added about 0.05 g were maxed for 15 minutes, then completed to distills water 100 mL then mixed for 20 minutes to get a slurry solution. The resultant mixtures were kept for 24 hours at 160°C in an autoclave. The obtained grayish-white precipitate was filtered, washed several times with DW, and dried at 60°C for 12 hours to yield a fine powder.[16]

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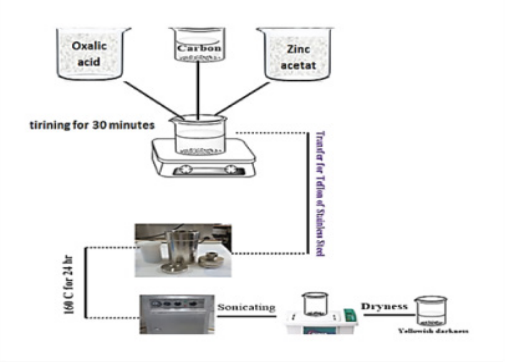

Scheme 1: Preparation of MWCNT/Zinc Oxide Nanocomposite

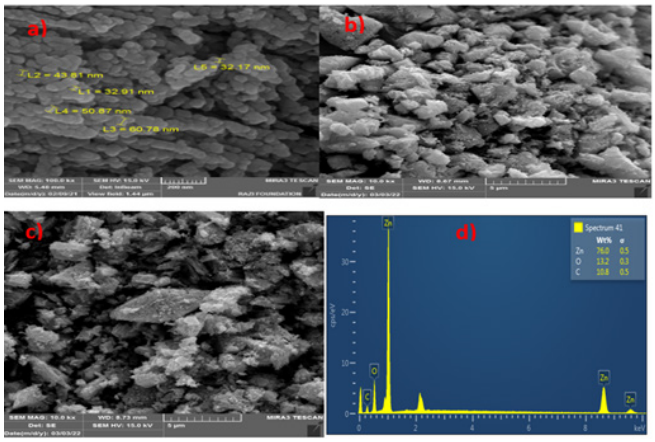

Figure 1: FESEM a) ZnO NPs, b) MWCNT, c) MWCNT/ZnO nanocomposite, d) EDX of MWCNT/ZnO nanocomposite.

Experiments of the Photocatalytic

The photocatalytic activity of the MWCNT/ZnO nanocomposite catalyst was estimate via the degradation of BG dye. All experiments carry out in a 250 mL beaker. The reaction beaker was placed under ultraviolet light, considering the distance between the solution's surface and the light source. Before each test, the lamp is heated for 10 minutes to obtain accurate results. Therefore, a weight of 0.3 g of MWCNT/ZnO nanocomposite was added to BG dye solution with a capacity of 200 mL. The experiment was initially conducted for 10 minutes, known as the so-called adsorption.

The effect of several factors like the quantity of (0.1–0.4 g L^{-1}), BG dye concentration (20–80 mgL^{-1}), The PDF% of BG and apparent rate first order constant were estimated in equation 1:

$$PDE\ (\%)=(A_0-A_t)/A_0 \times 100 \quad (1)$$

Where, A^o : Primary Concentration and At concentration of photolysis (mgL^{-1}) .

RESULTS AND DISCUSSION

Characterization

Image FESEM shows ZnO NPs in a pattern of small balls lined with each other as shown in Figure 1 (a). Micrographs of MWCNT show that the surface is rough and contains irregular clusters as in Figure 1 (b). The MWCNT/ZnO nanocomposite surface. It has large, coarse, irregular particles and also results from spherical clusters resulting from zinc oxide loading as shown in Figure 1 (c). EDX of MWCNT/ZnO nanocomposite as show in Figure 1 (d).[17-19] The nanocomposite having C, O, and Zn indicates the existence of zinc oxide on to MWCNT/ZnO nanocomposite. The highest and lowest values of the elements that existed in the modified MWCNT/ZnO were 76.0 and 10.8 wt.%.[20,21]

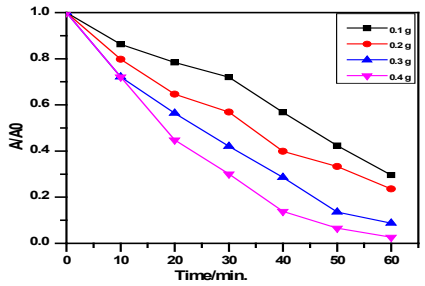

Figure 2: Photocatalytic degradation of BG at several weight MWCNT/ZnO nanocomposite.

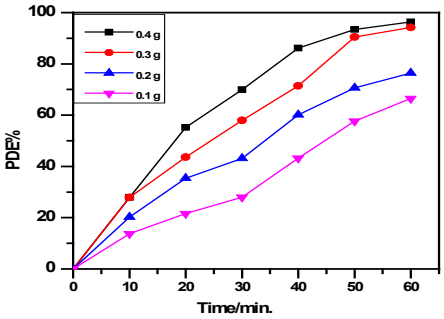

Figure 3: Effect weight MWCNT/ZnO nanocomposite onto photocatalytic degradation BG dye

Effect of Mass Dosage

The effect of the photocatalyst about (0.1–0.4 g) on the photocatalytic degradation of BG dye was studied at primary concentration of BG dye 50 mg/L, light intensity (1.7 mW/cm^2), and pH 6.8 . The experimental result could be analyzed by assume-first order kinetic[22,23] as appear in Figure 2.

Figure 3, data indicates that the rate of photo/catalytic degradation rise via increasing the quantity of MWCNT/ZnO nanocomposite. Furthermore, 0.3 g, the best rate of photocatalytic degradation. In the region less than 0.3 g give low photo catalytic degradation. When the weight of MWCNT/ZnO nanocomposite were increased, the rate of photodegradation was raised because the number of active sites increased.[24,25]

Effect of BG Dye Concentration

The influence of the concentration of BG dye has been studied at pH 6.8, mass of MWCNT/ZnO nanocomposite 0.3 g, light intensity 1.7 mW/cm^2, and concentrations of BG dye (20–80 mg/L).[26] The investigational result could be analyzed to assume-first order kinetic as appear in Figure 4.

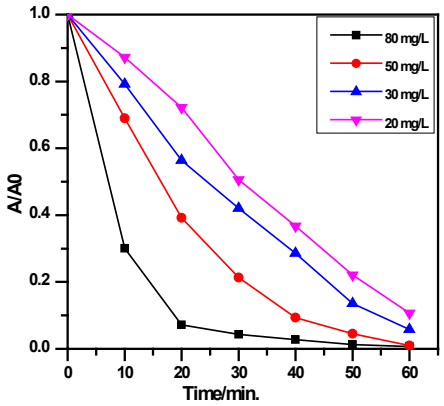

Figure 4: Effect Photo catalytic degradation by MWCNT/ZnO at several concentration of BG dye.

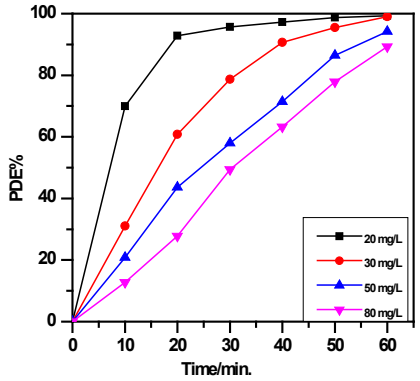

Figure 5: Effect of concentration BG dye on the PDE%.

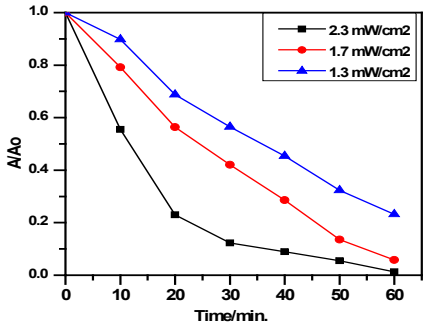

Figure 6: Effect Photo catalytic degradation at different light intensities (L.I.).

Figure 5 shows that when the BG dye concentration was raised, the photodegradation (PDE%) rate decreased. This happens via either reduction of the holes or (OH.) because the active sites will complete coverage *via* dye, or a rising in the concentration of dye caused to rise in the adsorption of dye on the MWCNT/ZnO nanocomposite, which lead to reducing in radical (OH.) generation because so low available of the active site as free on the surface.[23,27]

Light Intensity (L.I.)

The light intensity effect about (2.3–1.3 mW/cm^2) was observed via variable of distance among source light and exposed MWCNT/ZnO nanocomposite surface. Photodegradation of BG dye via the light intensity effect was an investigation in the presence of 0.3 g of MWCNT/ZnO nanocomposite, the concentration of BG dye 50 mg//L, and pH 6.8. It was found that wholly reactions still follow the first-order kinetics as shown in Figure 6. The photo degradation capacity rises when light intensity increases. It probably deduced that the rise of light intensity caused excited particles of MWCNT/ZnO nanocomposite to lead to hole pair electrons. Photocatalysis at low light intensities (1.3 mW.cm^{-2}) decreases because low light intensity reactions involving the formation hole electron are predominant and hole electron re-combination is negligible.[28,29]

CONCLUSION

- MWCNT/ZnO nanocomposite was prepared by the hydrothermal method.
- The best photodegradation of BG dye via the light intensity effect was investigation in the presence of 0.3 g of MWCNT/ZnO nanocomposite, concentration of BG dye 50 mg//L, and pH 6.8.
- The photocatalytic decomposition efficiency increased with the surface MWCNT/ZnO nanocomposite and the best rate of photocatalytic degradation at 0.3 g from MWCNT/ZnO
- The photocatalytic decomposition efficiency decreased with the increase BG dye concentration.

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