

Fabrication and Evaluation of PMMA-PC/Sb2O3-go Nanocomposites Films for Antibacterial Activity

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Abstract

The casting method was used for the preparation of (PMMA-PC) blend films doped with Sb2O3-GO nanoparticles (1.4, 2.8, 4.2, and 5.6 wt. %). Various techniques, including Scanning Electron Microscopy (SEM) and optical microscopic techniques, were used to characterize the (PMMA-PC/ Sb2O3-GO) nanocomposites. Two different strains of pathogenic bacteria, *Staphylococcus aureus* (G+ve) and *Escherichia coli*. (G-ve), were used to investigate the effectiveness of (Sb2O3-GO) nanoparticles. The outcomes showed that both of these bacterial species illnesses can be treated with (PMMA-PC/ Sb2O3-GO) nanocomposites due to their potent antibacterial activity. The results show increasing the percentage of antimony oxide and graphene oxide NPs leads to the inhibition zone of these bacteria is increased.

Keywords: Nonocompsite, graphene oxide, SEM, antibacterial activity.

1. Introduction

Inorganic and organic material fusion research has advanced significantly in recent years, creating nanohybrid material systems that perform better in a variety of applications. Specifically, this integration could usher in a new era in improving the effectiveness and cost of next-generation optoelectronic devices that can be used in novel and varied applications like as light emitting devices (LEDs) solar cells and antibacterial [1, 2]. It is possible to create composite films with certain qualities, for example, biodegradability and antimicrobial properties, which are advantageous for almost all applications, by carefully selecting the basic components [3]. There has been an increase in interest in creating and developing metal ion-polysaccharide complexes over the past few decades for use in a variety of common commercial applications, including antibacterial, water purification, the creation of novel catalysts, and many more [4, 5]. The polymer is the ideal material to utilize as a network or matrix since it exhibits a number of benefits; the simplicity of film creation and the improvement of nano-fillers' capabilities by utilizing their contact with polymers. PMMA is recognized as a host polymer due to its capacity for attaining high stretching, impact resistance, high absorption coefficients in the visible spectrum, and ions mobility control of the polymers [6, 7]. PMMA is furthermore frequently chosen because of its reasonable qualities, inexpensive cost, and simplicity in handling. polycarbonate (PC) is a thermoplastic polymer with excellent temperature, impact, and transparency properties. In addition to its superior optical qualities, it possesses a high elastic modulus and mechanical strength. Medical applications including optical lenses, CDs and DVDs, and electronic instruments frequently employ PC [8]. An ideal host for NPS producing NCPs is a

PC. These NCPs are crucial for study because of their optical characteristics, which encourage greater application in optoelectronic devices. Additionally, it replaces a variety of standard metals and alloys that frequently have greater costs in a variety of industrial applications. Characteristics work together to lower the cost of optoelectronic devices and improve their quality. The choice of (Sb2O3-GO) nanoparticles for this work was made based on their favorable characteristics and capacity to build membranes. In order to improve the optical characteristics and bacterial activity of (PMMA-PC/Sb2O3-GO) nanocomposites, antimony oxide and graphene oxide (GO) were infused into the natural polymer matrix in this work. Analysis of the effect of dopants on the optical characteristics of the polymers has been done using optical microscopy [9, 10]. Therefore, the major purpose of this work is to develop active films based on a blend of natural polymer and metal oxides nanoparticles.

2. Materials and Method

Polymethylmethacrylate (PMMA), polycarbonate (PC), antimony oxide (Sb2O3), and graphene oxide (GO) were employed in this study. The casting technique was used to prepare nanocomposites films (PMMA-PC/ Sb2O3). The films were prepared by dissolving 1g of the (PMMA-PC) blend with a ratio of 80/20 % in chloroform using a magnetic stirrer. The (Sb2O3) NPs were introduced in the polymeric blend by (1.4%, 2.8%, 4.2%, and 5.6%). A scanning electron microscope (SEM HV: 5.0 KV, Det: InBeam, MIRA3 TESCAN) was used to test the surface morphology of (PMMA-PC/Sb2O3-GO) nanocomposites. For antibacterial activity, using the disc diffusion technique the antibacterial activity of the investigated samples of (PMMA-PC/ Sb2O3-GO) nanocomposites was assessed. Gram-positive (*Staphylococcus aureus*) and gram-

negative (*Escherichia coli*) bacteria were both cultivated on Muller-Hinton agar. The disks of the (PMMA-PC/Sb2O3-GO) nanocomposites were positioned on top of the medium and incubated for 24 hours at 37°C. Measurements were made on the inhibition zone diameter.

3. Results and Discussion

Figure (1) shows SEM images of (PMMA-PC/Sb2O3 GO) nanocomposites with and without various Sb2O3-GO NP content concentrations. It is found that image (A) in figure 1 for polymers is softer, uniform, and coherent. It is clear that the surface morphology of the (PMMA-PC) mix has changed as a result of the addition of Sb2O3-GO nanoparticles (see images B-C-D and E). The (PMMA-PC/Sb2O3-GO) nanocomposites' surface morphology exhibits many aggregates or chunks that are dispersed widely on the top surface [11]. The number of black dots on the surface rises as the concentration of Sb2O3-GO nanoparticles rises, as seen in image (D). This results similar with the results of the previous researcher [12, 13]

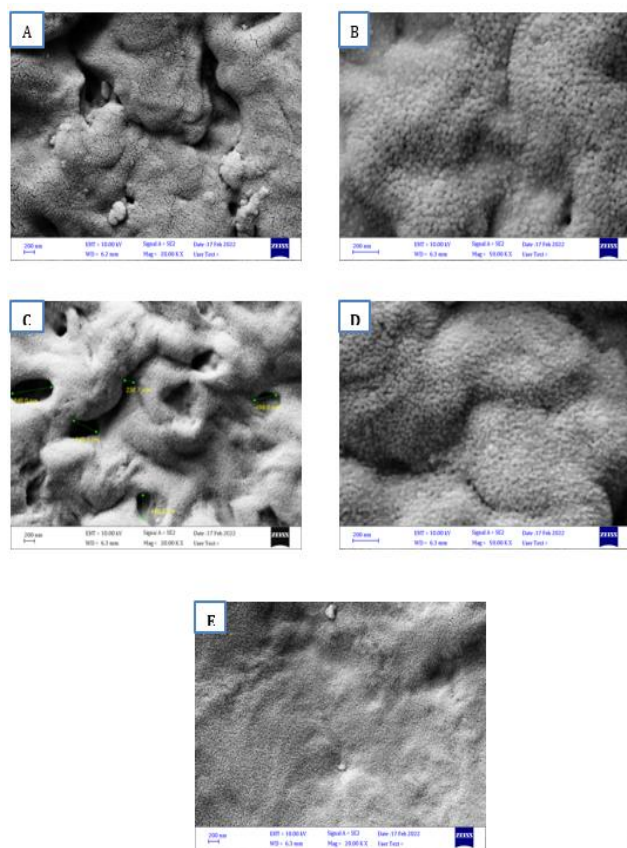


Figure (1): SEM images for (PMMA-PC/Sb2O3-GO) Nanocomposites: (A) for pure (B) for 1.4 wt.% Sb2O3-GO NPs (C) for 2.8 wt.% Sb2O3-GO NPs (D) for 4.2wt.% Sb2O3-GO NPs (E) for 5.6 wt.% Sb2O3-GO NPs

Figure (2) shows the images of (PMMA-PC/Sb2O3-GO) nanocomposites films which were recorded for samples of varying contents at a magnification power of 10x. However, they show a clear difference in the samples, as shown in figures (A, B, C, D, and E), when the concentrations of Sb2O3 and GO increase in (PMMA-PC) blend, the nanoparticles form clusters inside the polymer blend [14]. When the concentrations of nanoparticles

reach 5.6 wt %, the particles form concentration network paths where charge carriers are allowed to pass through causing a change in the material properties [15].

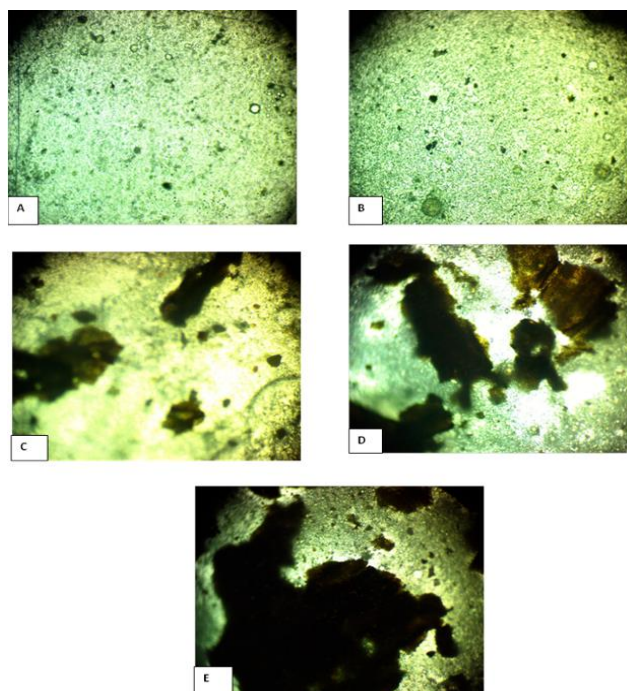


Figure (2). photomicrographs for (PMMA-PC/Sb2O3-GO) nanocomposites (A) for (PMMA-PC) blend (B) for 1.4wt% Sb2O3-GO nanoparticles, (C) for 2.8wt% Sb2O3-GO nanoparticles, (D) for 4.2wt% Sb2O3-GO nanoparticles, (E) for 5.6wt% Sb2O3-GO nanoparticles.

Figures (3, 4 and 5) show the inhibition zone as a function of concentrations (Sb2O3-GO)NPs, the antibacterial activity of the (PMMA-PC/Sb2O3-GO) nanocomposites were evaluated by using commonly found in a hospital settings, *Staphylococcus aureus* (G+ve) and *E. coli* (G-ve) via disc diffusion technique [16]. From the figure it can be seen that (PMMA-PC/Sb2O3-GO) shown potent antibacterial action against *Staphylococcus aureus* (G+ve) and *E. coli* (G-ve) [17]. The inhibitory zone of these bacteria is expanded when the proportion of antimony and graphene oxide NPs increases. The possible mechanism of action (PMMA-PC/Sb2O3-GO) nanocomposites' positive charge and the bacterium's negative charge, produce an electromagnetic attraction between the nanoparticles of the nanocomposites and the bacteria. When the attraction occurs, oxidation of the bacterial cell's outer and inner membranes, which finally led to their destruction and the release of essential components including adenine and protein, ultimately leading to the cell's death [18]. The antibacterial activity of (PMMA-PC/Sb2O3-GO) nanocomposites may also be attributed to reactive oxygen species (ROS) produced with different quantities of Sb2O3 and GO nanoparticles [19, 20]. The conductivity of the (PMMA-PC/Sb2O3-GO) nanocomposites and the significance of electron transport in the antibacterial process both affect the antibacterial effects of Sb2O3-GO NPs [21, 22]. Reactive oxygen species (ROS) bursts are also produced by electron transport between the Sb2O3 and GO in the bacterium cells and the growth medium. By causing intracellular oxidation, membrane potential fluctuation, and the release of cellular contents, ROS cause the death of

bacteria.

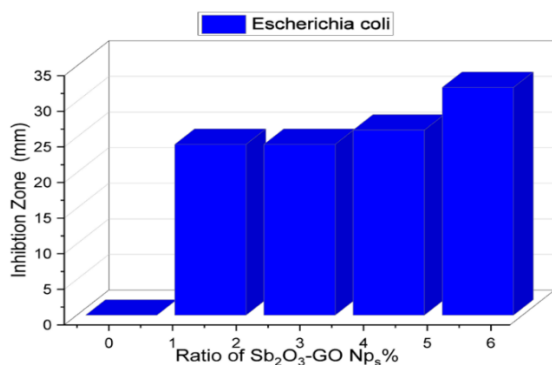


Figure (3). Variation of inhibition zone diameter with (Sb₂O₃-GO) NPs concentrations against *Escherichia coli* for (PMMA-PC/ Sb₂O₃-GO) nanocomposites.

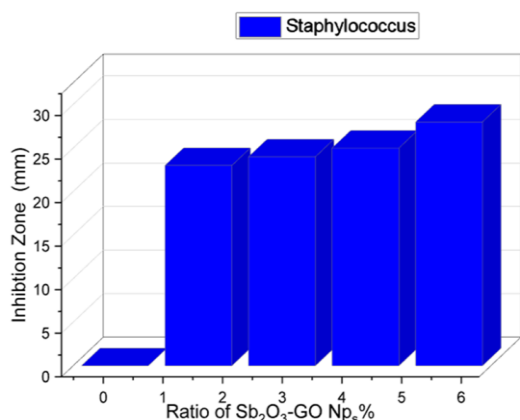


Figure (4). Variation of inhibition zone diameter with (Sb₂O₃-GO) NPs concentrations against *Staphylococcus* for (PMMA-PC/ Sb₂O₃-GO) nanocomposites.

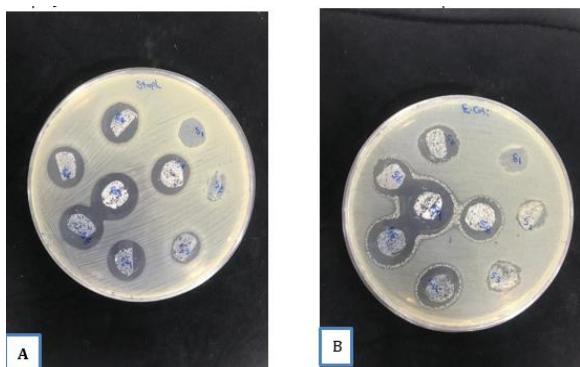


Figure (5) Antibacterial activity of (PMMA -PC/Sb₂O₃-GO) nanocomposite. Zone of inhibition of (PMMA -PC/Sb₂O₃-GO) nanocomposite against A: *Staphylococcus*; B: *Escherichia coli*.

4. Conclusions

This work includes the synthesis of (PMMA -PC/Sb₂O₃-GO) nanocomposites and studying the structure, and activity of (PMMA-PC/Sb₂O₃-GO) nanocomposites as antibacterial. The scanning electronic microscope SEM shows aggregates or chunks on the surface that are homogenous and coherent. (PMMA -PC/Sb₂O₃-GO) nanocomposites that have been synthesized also effective antibacterial properties against two separate pathogenic bacterial strains. Therefore, the food, drug, and beauty industries may all benefit from this. According

to the current study, biosynthesized nanoparticles can exhibit strong antibacterial activity, which opens up a wide range of options for the development of antibiotics and other medications to combat different pathogenic bacterial strains.

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