Study some Electrical Properties of (PS-Tio2-Al2O3) Nanocomposite Films Injected with Air Nanobubbles for Antibacterial Applications

Fatimah T. Al-Hussein[1], Bahaa H. Rabee[2]
[1, 2]Department of Physics, College of Education for Pure Sciences, University of Babylon, Iraq
fatimaalhu33@gmail.com, Dr.bahaa19@gmail.com

Abstract

From the studied properties, the prepared films were suitable for optical devices and antibacterial application. The electrical properties of (PS-TiO2-Al2O3) nanocomposites films prepared by casting method have studied. To use in Optical applications and electronic devices. The TiO2 and Al2O3 nanoparticles added with different weight percentages are (1, 2, 3 and 4) wt% were injected air bubbles to generate Nano bubbles in the (PS-TiO2-Al2O3) nanocomposites. The dielectric characteristics of films were investigated, and the results revealed that as the concentrations of Al2O3 and TiO2 nanoparticles rises, the dielectric loss, dielectric constant, and a.c electrical conductivity rises. The dielectric loss and dielectric constant decrease with frequency for the applied electric field rises, while electrical conductivity rises.

Keywords: Nano bubbles, Electrical Properties, Ultrasonic, and Antibacterial.

1. Introduction

Nanobubbles are defined as gas-containing cavities with diameter less than 1µm in a liquid solution [1]. Since the invention of nano bubbles in 1981, researchers have worked very hard to demonstrate their reality and explain the origin of their extraordinarily lengthy stability. Some experts in the area are still dubious regarding the existence of Nano bubbles despite the abundance of circumstantial evidence [2].

Nanobubbles are receiving increasing attention over the past few years, due to their promising applications ranging from flotation, water treatment and surface cleaning to cancer treatment and drug delivery [3]. Because these bubbles have a long residence time in solutions and electrically charged surfaces, this boosts their efficiency, physical absorption, and chemical reactions at the surface of gas and liquids. Given the foregoing, nanobubbles have a wide range of industrial applications, including soil and sediment contamination removal, medication delivery, and food product sterilization [4].

Nanocomposites are a novel form of material that is made by mixing one or more different components at the nanoscale to control and improve structure and properties. Nanocomposites are materials that contain at least one nanoparticle [5]. Coatings, adhesives, fire retardants, consumer goods, medical devices, optical integrated circuits, microelectronic packaging, sensors, automobiles, drug delivery, injection molded products, membranes, packaging materials, aircraft, optical integrated circuits, cars, microelectronic packaging, drug delivery, sensors, injection molded products, membranes, packaging materials, and so on all have potential applications for nanocomposites [6].

In this experiment, we will make a composite of nanomaterials and one of the polymers. The aim of this study: To study the electrical properties of (PS– TiO2-Al2O3) nanocomposites films Where Nano bubbles are generated.

2. Material and Method

The materials used in this paper are polystyrene (PS), titanium oxide (TiO2) and alumina (Al2O3). The nanocomposite was prepared by dissolving PS in 30 ml chloroform in a 75 ml beaker, using a magnetic stirrer to mix .To facilitate the mixing process and increase the homogeneity of the nanocomposite, and different samples are prepared according to the proportions given in table 1

Table 1 shows the concentrations of nanomaterials used in the experiment Polystyrene PS dissolved in chloroform, titanium oxide (TiO2), Alumina (Al2O3).

Concentration(gm)		
PS (gm)	TiO2 (gm)	Al2O3 (gm)
1	0	0
0.98	0.01	0.01
0.96	0.02	0.02
0.94	0.03	0.03
0.92	0.04	0.04

The nanocomposite is injected with air bubbles to generate Nano bubbles in the nanocomposite. After ensuring the homogeneity of the mixture, it is placed in an ultrasonic processor (ULTRASONIC HOMOGENIZER FS-1200 N) with a frequency of 20 KHz and at room temperature can suppose that Nano bubbles can be generated using ultrasound of appropriate quantity and size by controlling energy and time [7]. Using a tube that connects to an air compressor that is placed inside the beaker, thus, tiny air bubbles will be generated, which will disappear later leaving only the Nano-bubbled air. This process lasted for two minutes. To make composite films, a casting process was used. Pour each weight percentage into a Petri dish and allow drying at room temperature for

doi.org/10.31838/hiv22.02.310 Received: 08.04.22, Revised: 09.05.22, Accepted: 11.08.22

5-7 days. Then are taken measurements Optical Properties.
Using an LCR meter type, the dielectric characteristics of nanocomposites films were tested throughout a frequency range of (100Hz to 5106Hz) (HIOKI 3532-50 LCRHITESTER). Defines the dielectric constant (έ) for nanoparticales the equation [8].
Following equation

$$έ = Cp/Co.$$

The Cp is equivalent capacitance, Cois space capacitor, loss of dielectric (ε˝) is from by formula [9].

$$ε˝ = D\, έ$$

Someplace D is the nanocomposites dispersion element following equation [8] determines the A.C electrical conductivity.

$$σ_{a.c} = ω\, ε˝ ε_o$$

This angular frequency is w, and (εo) is free space permissiveness.

3. Results and Discussion

Figure (1) show (PS- TiO2-Al2O3) nanocomposites' dielectric constant vary with angular frequency. As can be observed in this graph, the dielectric constant falls as the frequency increases. This is brought on by a decrease in charge space polarization relative to all polarization. At low frequencies, charge space polarization is the most prevalent type of polarization, and as frequency rises, its significance decreases. The dielectric constant values for all samples of (PS- TiO2-Al2O3) nanocomposites will decrease as the electric field frequency is raised. Ionic polarization responds to changes in field frequencies less strongly than electronic polarization because an ion's mass is higher than an electron's. Electrons respond to field vibrations even at very high frequencies. The electron has a very tiny mass, Electronic polarization is the only type of polarization that exists at higher frequencies [10].
Figure (2) show demonstrates how the dielectric constant is affected by the addition of TiO2-Al2O3 nanoparticles. It is obvious that when TiO2-Al2O3 nanoparticle concentration rises, so does the dielectric constant. This was ascribed to the nanocomposite's internal TiO2-Al2O3 nanoparticles forming a continuous network. TiO2-Al2O3 nanoparticles form clusters or isolated groups at low concentrations (1 weight percent), resulting in a dielectric constant that is about low. At high concentrations (4wt percent), TiO2-Al2O3 nanoparticles create a continuous network within the nanocomposite, which causes the dielectric constant to increase with the volumetric rate of the nanoparticles [11].
Figure (3) show the (PS- TiO2-Al2O3) nanocomposites' dielectric loss. As a result, the dielectric loss lowers as the frequency increases. This is caused by the mobile charges in the polymer backbone. This is caused by the fact that space charge polarization's contribution decreases with frequency. For (PS- TiO2-Al2O3) nanocomposites, the dielectric loss rises once again until it reaches the greatest value at (f=1000Hz). This figure represents the highest absorption of the applied field, or dielectric loss, at a specific frequency. This absorption is brought on by the Maxwell-Wagner effect, which is brought on by alternating current as a result of changes in conductivity and dielectric constant between the phases in the nanocomposite. This electric curren [12].
Figure (4) show the relationship between dielectric loss and concentration (PS-TiO2 Al2O3). As the concentration of Al2O3 and TiO2 nanoparticles rises in nanocomposites, dielectric loss also rises, which is connected to an increase in the number of charge carriers. Clusters develop when nanoparticle concentrations are low, but when they reach 4 weight percent, a continuous network is formed in the nanocomposites.
Figure (5) show illustrates how the A.C conductivity of (PS-TiO2 Al2O3)) nanocomposites varies with frequency (5). The graph demonstrates that A.C conductivity considerably increases when frequency increases from 100 Hz to 5*106 Hz. This results from both charge carrier stimulation of higher states in the conduction band and low-frequency space charge polarization. Conductivity somewhat rises at high frequencies as a result of electronic polarization and hopping charge carriers. The main chain motion and ions movements are the two variables that affect a.c. conductivity. As a result, the conductivity for all rates of TiO2 Al2O3 nanoparticles for ((PS-TiO2 Al2O3)) nanocomposites increases when the frequency is increased [12].
Figure (6) show the relationship between the concentration of (PS-TiO2-Al2O3) nanocomposites and the a.c. electrical conductivity. Note increasing that the a.c. electrical conductivity with the concentration of Al2O3 and TiO2 nanoparticles due to an increase in the charge carriers density in the polymer medium [13].

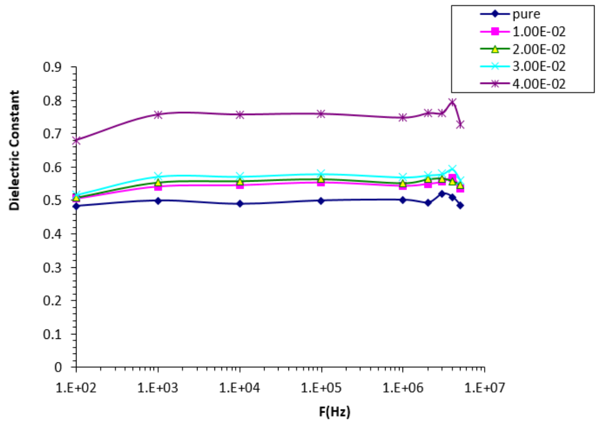

Fig (1) Linking between frequencies with dielectric constant for (PS– TiO2-Al2O3) Nanocomposites.

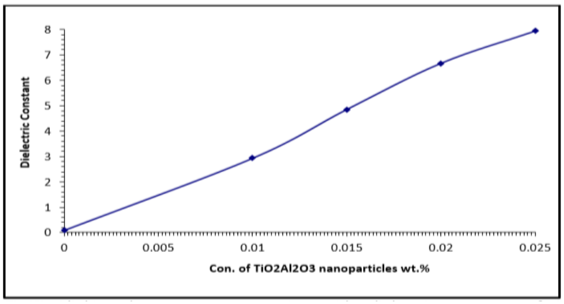

Fig (2) Llinking between concentrations with dielectric constant of (PS– TiO2-Al2O3) Nanocomposites.

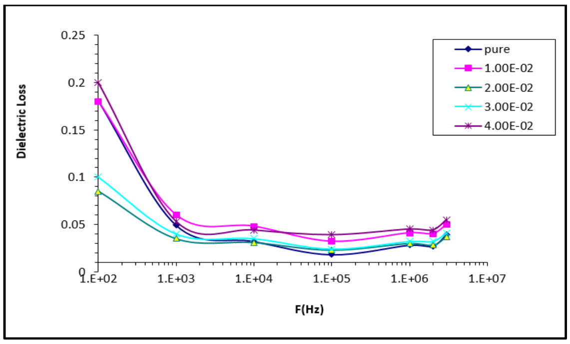

Fig (3) Linking between frequencies with dielectric loss for (PS-TiO2 Al2O3).Nanocomposites

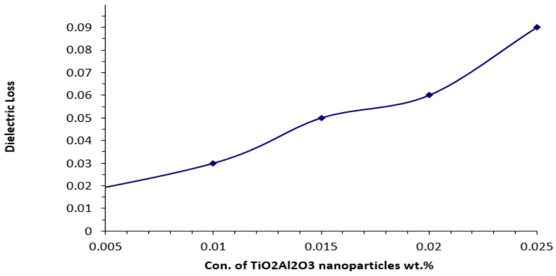

Fig (4) Linking between concentrations with dielectric loss of (PS-TiO2 Al2O3).Nanocomposites.

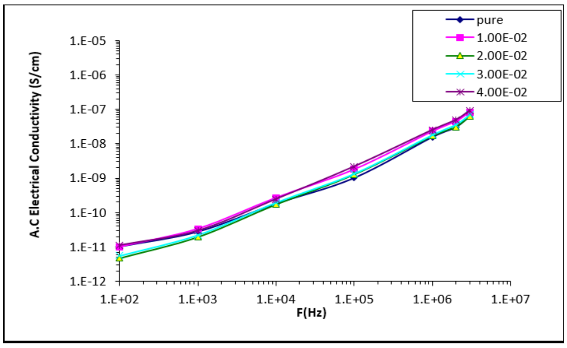

Fig (5) Linking between frequencies with a.c electrical conductivity of (PS-TiO2 Al2O3) Nanocomposites

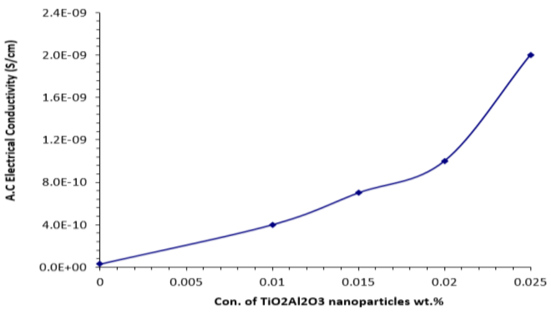

Fig (6) Linking between concentration with a,c electrical conductivity for(PS-TiO2-Al2O3) Nanocomposites.

4. Conclusions

From the studied properties, the prepared films were suitable for antibacterial application. With increasing concentrations of nanoparticles (PS-TiO2Al2O3), When the dielectric constant, a.c electrical conductivity, and dielectric loss all increase. With the frequency for applied electric field increase the dielectric constant and dielectric loss decrease, while A.C electrical conductivity rises.

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