ISSN: 0974-5823 Vol. 7 No. 2 February, 2022

International Journal of Mechanical Engineering

Fabrication and Characterization of ($PVA/BaTiO_3/TiO_2$) Nanocomposites for Electronics Devices

Zanab Ibrahim Zike[1], Majeed Ail Habeeb[2]

[1,2]University of Babylon, College of Education for Pure Sciences, Department of Physics, Iraq

ABSTRACT.

For the [$PVA-BaTiO_3-TiO_2$] nanocomposites were made utilizing the solution casting process, with varied weight percentages of $BaTiO_3$ and TiO_2 nanoparticales (0,1,1.5,2, and 2.5)wt percent. The dielectric characteristics of films were investigated, and the results revealed that as the concentrations of $BaTiO_3$ and TiO_2 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: Polyvinyl Alcohol ,Barium titanate, TiO_2 ,dielectric properties.

INTRODUCTION

Nanotechnology has gotten a lot of press in recent years because nanomaterials and miniaturization are thought to key for strong future. Nanotechnology has opened up a new field of study for processing and producing nanomaterials, which are materials with average crystallite sizes of less than 100 nanometers. Nanocrystalline materials, nanocomposites, carbon nanotubes, and quantum dots are among the materials classified as "nanomaterials." [1,2]. Liquid-Solid composite materials made up of solid or nanofibers or nanoparticles suspended in liquid are known as nanofluids,nanoparticles with a advanced thermal conductivity than their neighboring fluid have been found to rises the effective thermal conductivity for suspension. [3]. Nanocomposites can be amorphous for example a compound material in which by most one phase (usually filler) has sizes in the Nano scale series. For example the filler level ranges Nanometer level, from interactions on the interfaces converted substantially more relevant. As a result of the large inclusion size, the final features reveal significant modifications. [4] Polyvinyl alcohol [PVA]is one for main and utmost frequently used polymer, And it's today charity in a variety for semiconductor solicitation. [5,6].Barium titanate ($BaTiO_3$) is a ferroelectric ceramic powder piezoelectric manufacturing polymer nanocomposite films with ceramic fillers as transducers because of their high dielectric qualities, they've gotten a lot of attention, strong thermal stability and flexibility [7]. Because of its low cost, nontoxicity, and high photocatalytic activity, titanium dioxide [TiO2] is well-known as a substance with strong redox capacity and is employed for water or air purification and photo electrochemical cells [8,9].

EXPERIMENTAL

The films of [PVA-BaTiO3-TiO2] nanocomposites were made by casting process with varied concentrations of (0,1,1.5,2, and 2.5)wt%. 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 [10]:

$$\acute{\varepsilon} = C_p/C_o.$$

The C_p is equivalent capacitance , $C_o$is space capacitor , loss of dielectric (ε'') is from by formula [11]

$$\varepsilon'' = D\,\acute{\varepsilon}$$

Someplace D is the nanocomposites dispersion element following equation[12] determines the A.C electrical conductivity.

$$\sigma_{a.c} = \omega\,\varepsilon''\varepsilon_o$$

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

RESULTS AND DISCUSSION

Fig (1)show linking between dielectric constant with frequency for [$PVA-BaTiO_3-TiO_2$] Nanocomposites, note that the dielectric constant drops as frequency for applied field rises, that could be due to dipole tendencies in the nanoparticles models to orient themselves in the directions of this applied electrical fields, resulting in a drops in space charge polarization to total polarization. [13,14].

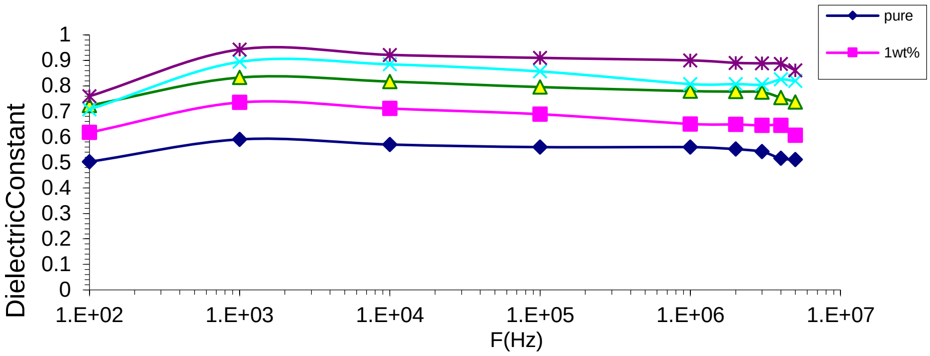
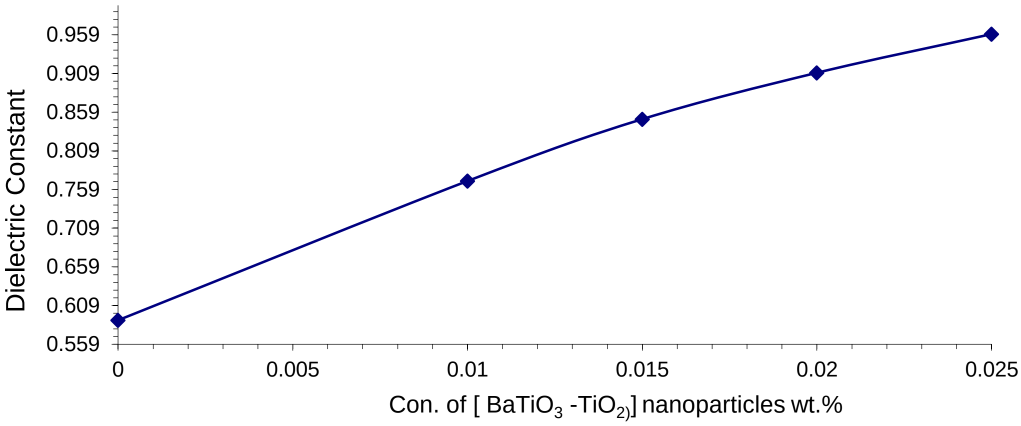


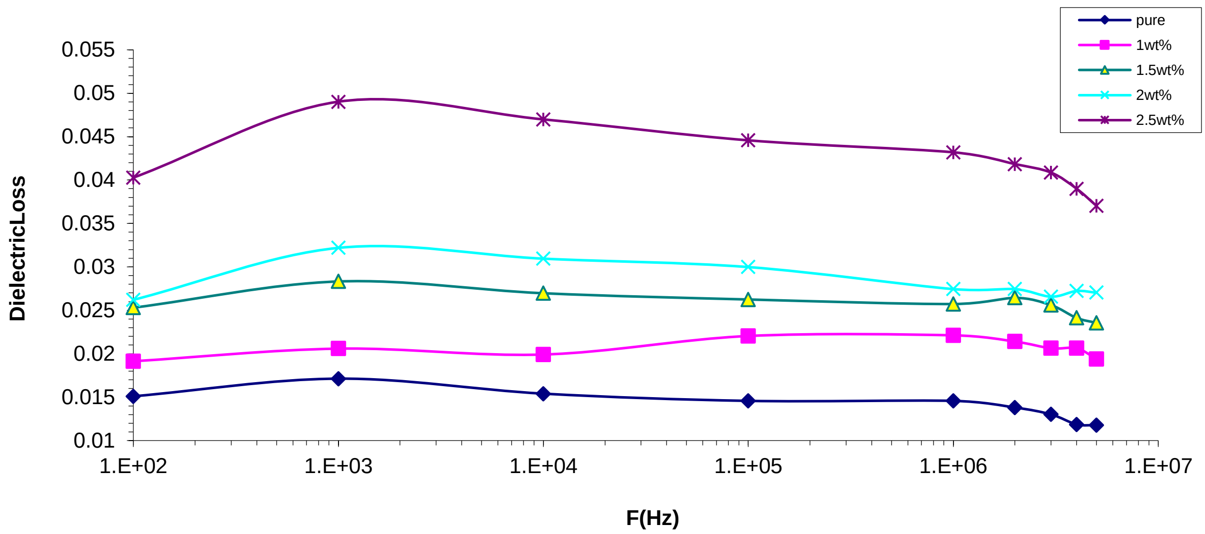
Fig (1) Linking between dielectric constant with frequency for [PVA-$BaTiO_3$-TiO_2] Nanocomposites**.**

Fig (2) show the linking between dielectric constant with concentration for[PVA-$BaTiO_3$-TiO_2] Nanocomposites, note that the dielectric constant rises as the concentration of $BaTiO_3$ and TiO_2 nanoparticles rises, this behavior can be explained by interfacial polarization inside the nanocomposites in an alternating electric field and the rises in charge carriers. [15,16].



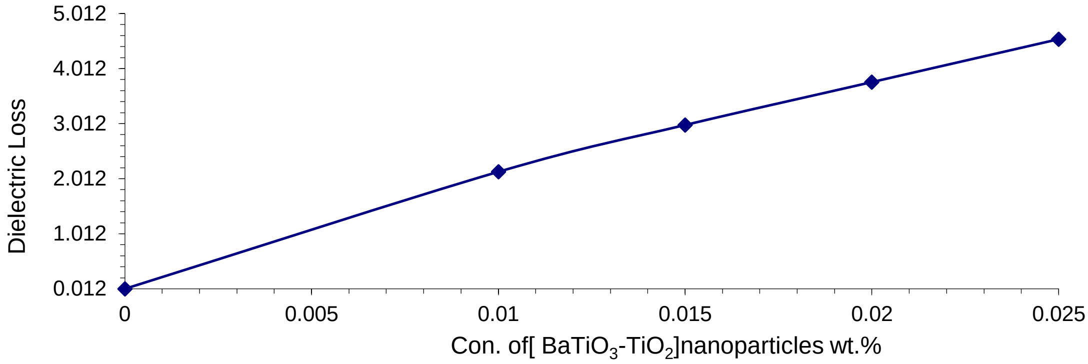
Fig(2) Llinking between dielectric constant with concentration of [PVA-$BaTiO_3$-TiO_2] Nanocomposites.

Figure (3) shows the linking between dielectric loss with frequency of [PVA-$BaTiO_3$-TiO_2] Nanocomposites, we can see that dielectric loss lowers as the frequency of $BaTiO_3$ and TiO_2 nanoparticles increases, this is owing to a reduction in cosmos charge polarization contribution[17]



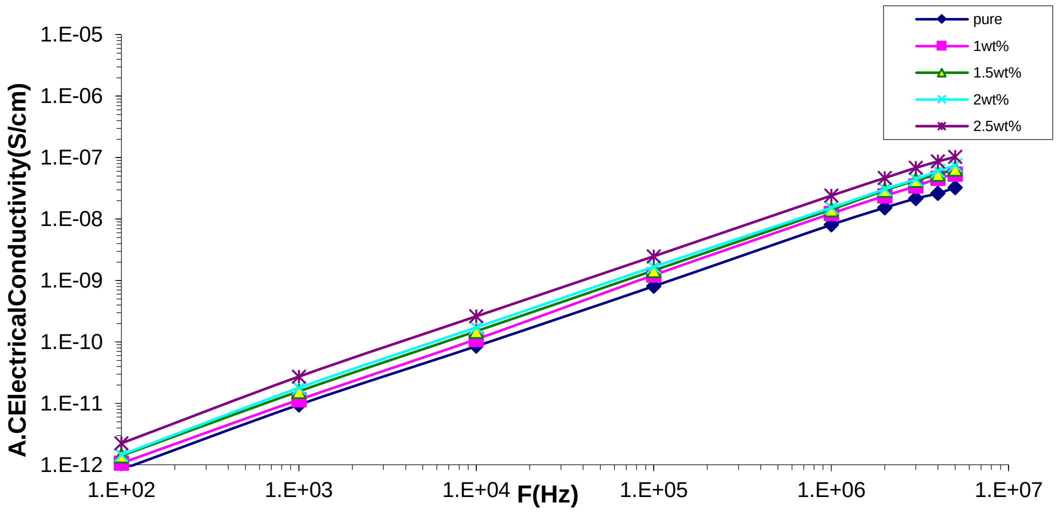
Fig(3) Linking between dielectric loss with frequency for [PVA-$BaTiO_3$-TiO_2]Nanocomposites.

Fig (4) Show the linking between dielectric loss with concentration for [PVA-$BaTiO_3$-TiO_2]Nanocomposites, note that dielectric loss increases as the concentration for $BaTiO_3$ and TiO_2 nanoparticles rises, which is correlated to an rises in The number of charge carriers. At small concentrations of nanoparticles, it forms clusters, but while the concentration for nanoparticles reaches 8wt. percent, forms a continuous network in the nanocomposites [18].



Fig(4) Linking between dielectric loss with concentration of [PVA-$BaTiO_3$-TiO_2] Nanocomposites.

Fig (5) Show the linking between a.c electrical conductivity with frequency of [PVA-$BaTiO_3$-TiO_2] Nanocomposites. Note that a.c electrical conductivity rises as frequency of $BaTiO_3$ and TiO_2 nanoparticles rises, which can be attributed to interfacial polarization [19,20].



Fig(5) Linking between a.c electrical conductivity with frequency of [PVA-$BaTiO_3$-TiO_2] Nanocomposites.

Fig (6) Show the linking between a.c electrical conductivity with the concentration of [PVA-$BaTiO_3$-TiO_2] Nanocomposites,note that a.c electrical conductivity rises as concentration for $BaTiO_3$ and TiO_2 nanoparticles rises, owing to an rises in the charge carriers density in the polymer medium[21].

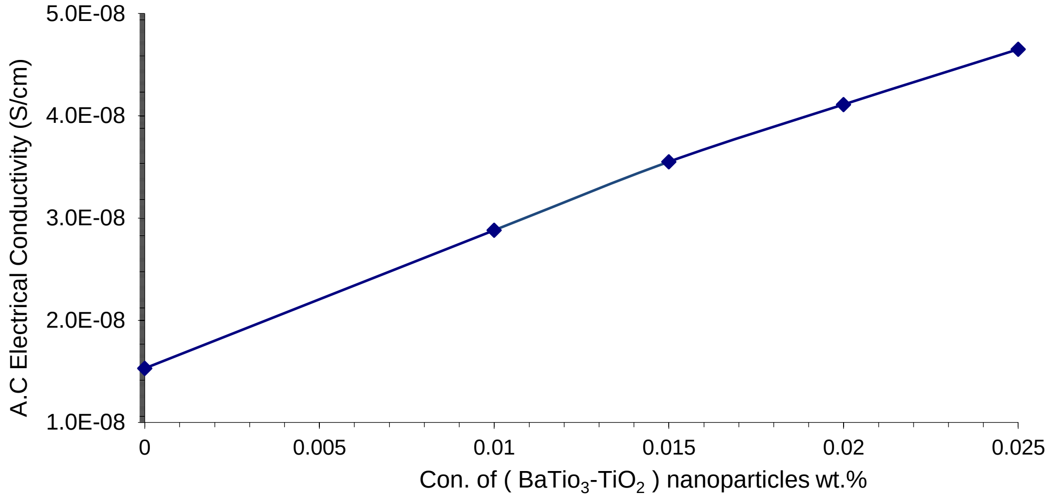


Fig (6) Linking between a,c electrical conductivity with concentration for[PVA-$BaTiO_3$-TiO_2]Nanocomposites.

CONCLUSION

When the concentrations of $BaTiO_3$ and TiO_2 nanoparticles were increased, the dielectric loss, dielectric constant, and a.c electrical conductivity all increase. The dielectric loss and dielectric constant decrease with the frequency for applied electric field increase, while A.C electrical conductivity rises.

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