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Improvement Dielectric Properties of Polymer Blend by Addition Co_2O_3 Nanoparticles for Electronics Devices

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ABSTRACT

For the (PVA-PVP-Co_2O_3) nanocomposites, various weight ratios of (Co_2O_3) nanoparticle are (0,1.6,3.2,4.8 and 6.4) wt percent of (Co_2O_3) nanoparticles were used in solvent casting method. It was discovered that as the concentration of (Co_2O_3) nanoparticles in the (PVA-PVP-Co_2O_3) nanocomposites increased, so did their dielectric loss, dielectric constant, and A.C electrical conductivity. Dielectric loss and dielectric constant decrease as frequency increases, while electrical conductivity rises.

KEY WORDS : Polyvinyl alcohol, polyvinyl pyrrolidone, cobalt oxide nanoparticles, dielectric properties.

INTRODUCTION

Two or more distinct phases, each distinct in its physical and chemical properties, are separated by a length interface in a composite material. Since polymer composites can be used in so many different technological applications, they've gotten a lot of attention. They can be used in a variety of everyday applications, including shielding electronic devices from radio interference and thermally optical recording. Polymeric materials are primarily used within electronic applications [1]. The study of a sub-electron egativity stance's was used to determine AC impedance. Polymers' (AC) impedance can be reduced by charge carriers in their structure. Nanocomposites of organic and inorganic materials have gained attention in a variety of fields in the field of science and material technology.When nanoparticles have shorter wavelength of light than visible light, the scattering loss is reduced even further. As a result of the combination of the unique properties of every part, quantum dot and host polymer, the nanocomposite's interest has increased. Other classical substances can't compare to its tuneable and one-of-a-kind qualities. Polyethylene terephthalate (PVA) is a nontoxic polymer that is commonly used in polymeric blends because of its good physical and chemical properties, excellent film properties, noncarcinogenic, biocompatible, biodegradable characteristics and emulsfyingl. Pharmacological, cosmetic and surgical structures industries can benefit from these extraordinary properties. Polymeric blends have the potential to be more beneficial due to the simplicity of their fabrication and the ease with which the polymer electrolytes' characteristics can be modified by varying the blend's polymer composition. These polymeric blends have become increasingly important as a means of improving, without the use of chemicals, new sub-stances by enhancing their properties. From a scientific perspective, polymeric blends can reveal relationships between structural characteristics that help us better understand the polymer interactions that underlie physics [2,3]. It is possible to dissolve polyvinyl pyrrolidone in water and in other polar solvents. Due to its ability to absorb moisture from the air. To achieve surface passivation and good dispersion, pyrrolidone complexes with many inorganic salts [4]. MRI contrast enhancement, magnetic cell separation, hypothermia treatment, and magnetic resonance imaging (MRI) are just a few of the many potential uses for magnetic nanoparticles that scientists are currently investigating[5]. Particles must be , well-dispersed, chemically stably and of a uniform size for the vast majority of these applications to work., PVP can quickly become wet, especially during the winter and rainy seasons.

EXPERIMENTAL PROCEDURE

By using a casting solution, different weight percent concentrations of the (PVA-PVP-Co_2O_3) nanocomposites films were prepared (0, 1.6 ,3.2 ,4.8 and 6.4) wt%.(58) weight percent polyvinyl alcohol and (42) weight percent polyvinyl pyrroidone were dissolved in (40 ml) of distill water before being added to the polyvinyl alcohol solution. LCMeter was used to measure the (PVA-PVP-Co_2O_3) nanocomposites' dielectric characteristics (dielectric loss, dielectric constant and A.C electrical conductivity) at room temperature in the (100Hz -5MHz) frequency.

The following relationship describes the dielectric constant (ε'): [6,7,8]

$\varepsilon' = Cp / Co$ (1)

Capacitance (Cp) and vacuum capacitance (Co) are used in this equation. Equation dielectric loss (ε'') calculated:[9,10,11]

$\varepsilon'' = \varepsilon' D$ (2)

The dispersion factor is represented by the letter (D). The electrical conductivity of alternating current is determined by :[12 ,13 ,14]

$\sigma ac = \omega \varepsilon'' \varepsilon'$ (3)

Where (ω) denotes the angular frequency. We can see from figure (1) that as applied frequency increases, the dielectric constant values of the ($PVA-PVP-Co_2O_3$) nanocomposites decrease. This decrease in space charge polarization to total polarization corresponds to an increasing frequency. At low frequencies, the space charge polarization plays a larger role, and as the frequency rises, this role diminishes.[15,16]

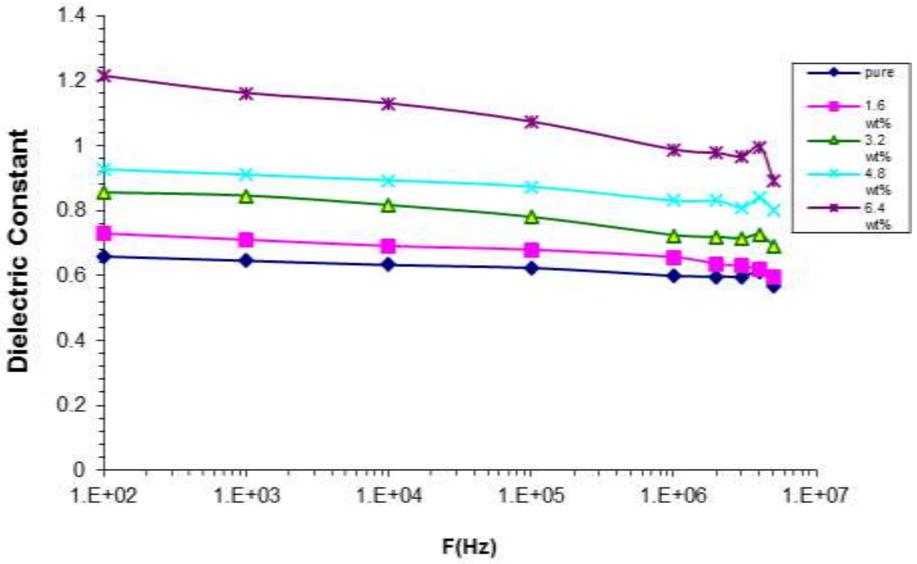

Figure (1): Dielectric constant difference with frequency for PVA-PVP-Co2O3 nanocomposites.

Based on the dielectric constant values shown in figure (2), the rise in charge carriers and the continuant network formation of (Co_2O_3) ions within the composite are responsible for the increase in dielectric constant values.[17,18]

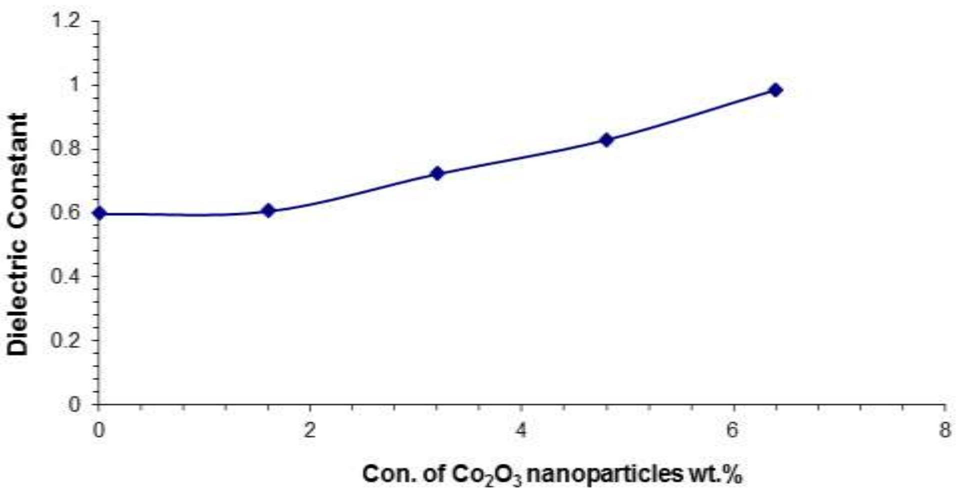

Figure (2): Dielectric constant difference with (Co_2O_3) nanoparticle concentration in ($PVA-PVP-Co_2O_3$) nanocomposites.

Figure (3) shows the dielectric loss of ($PVA-PVP-Co_2O_3$) nanocomposites as a function of frequency (Hz). The dielectric loss is high at low applied frequencies, but decreases with increasing applied frequencies. This can be attributed to the actuality that as the frequency rises, the space charge polarization contribution decreases.[19,20]

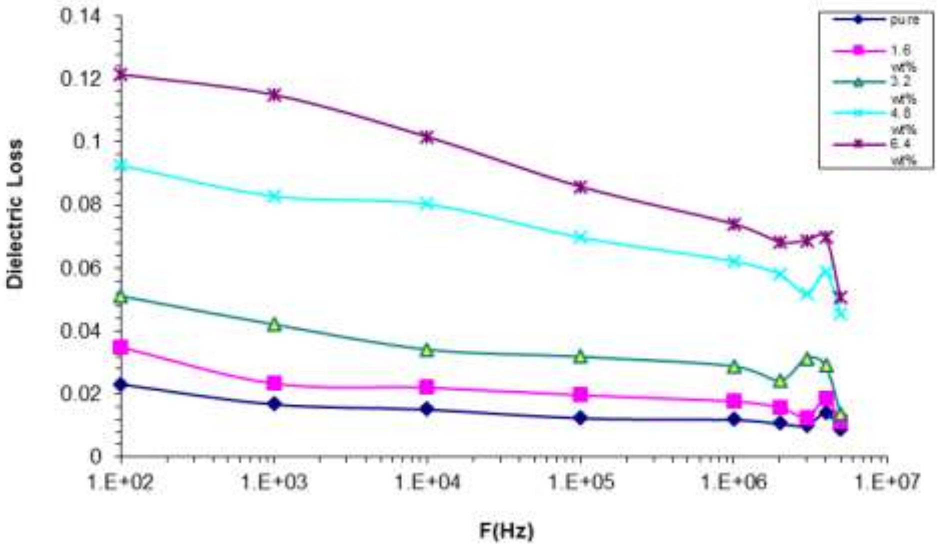

Figure (3): Dielectric loss variation with frequency for (PVA-PVP-Co_2O_3) nanocomposites

When the amount of (Co_2O_3) nanoparticles is increased, the dielectric loss rises due to the higher concentration of charge carriers. This is shown in figure (4).[21,22]

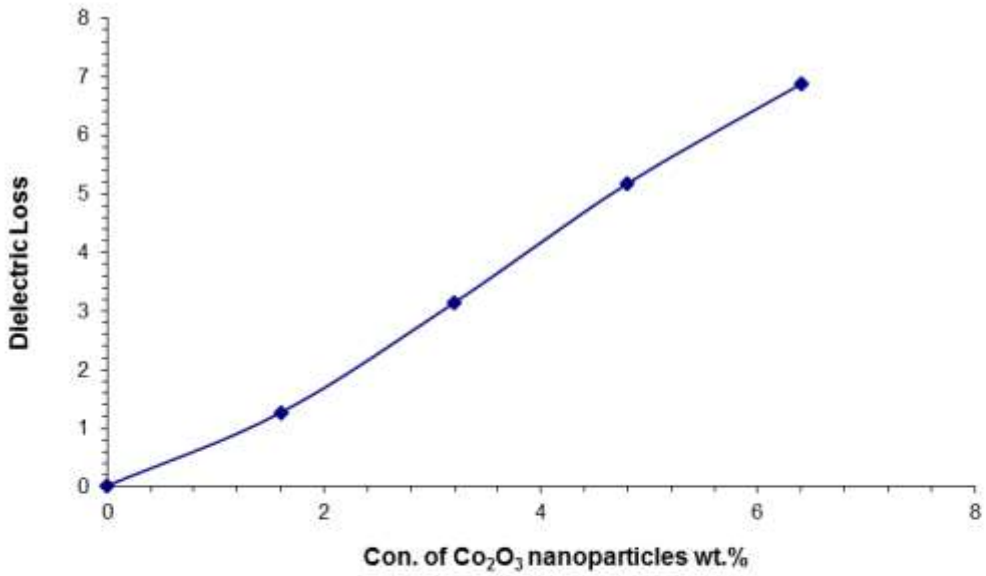

Figure 4: Dielectric loss variation with (Co_2O_3) nanoparticle concentration in (PVA-PVP-Co_2O_3) nanocomposites.

Figure (5) depicts the difference of alternating current electrical conductivity for (PVA-PVP-Co_2O_3) nanocomposites with frequency; the figure demonstrates that alternating current electrical conductivity increases significantly with the raise of frequency, this is related to the space charge polarization that happens at low frequencies, as well as the motion of charge carriers caused by the hopping process.[23,24]

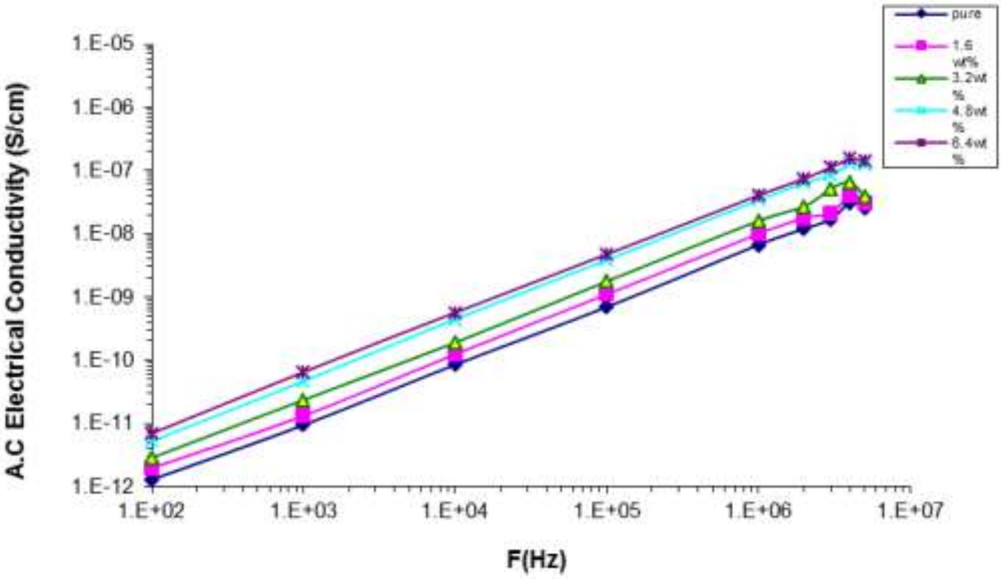

Figure (5): A.C electrical conductivity of (PVA-PVP-Co_2O_3) nanocomposites varies with frequency.

The variation in (A.C) electrical conductivity of (PVA-PVP-Co_2O_3) nanocomposites with increasing concentration of (Co_2O_3) is depicted in figure (6). The electrical conductivity of a polymer matrix increases with an increase in the concentration of (Co_2O_3) nanoparticles, as a result of an increase in the density of charge carriers in the polymer matrix.[25]

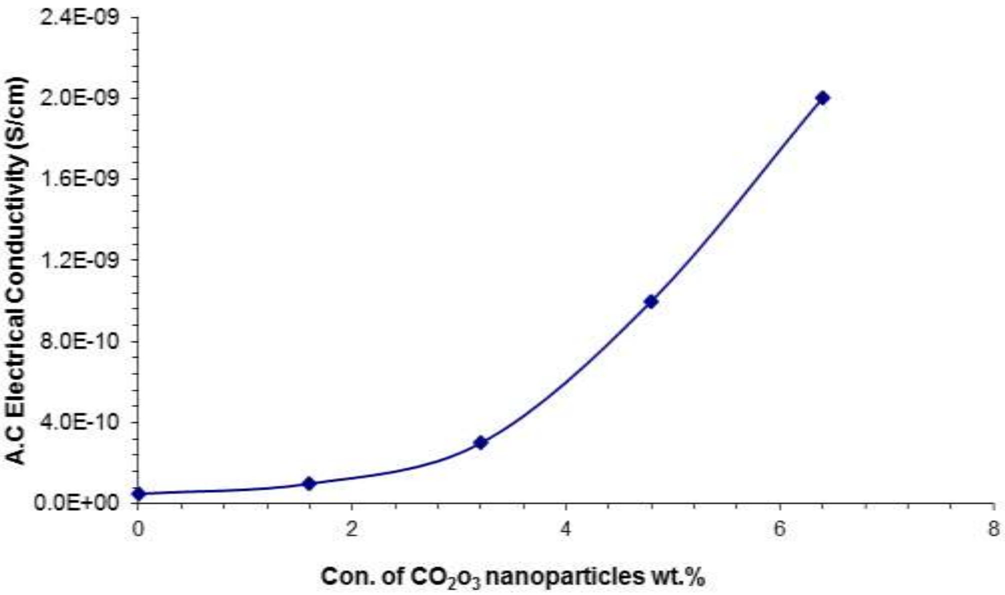

Figure (6) The relationship between (AC) electrical conductivity and different concentrations for (PVA-PVP-Co_2O_3) nanocomposites.

CONCLUSIONS

The results of the experiments on dielectric properties showed that as the frequency increased, the dielectric constant and loss decreased while A.C electrical conductivity increased. An increase in the (Co_2O_3) wt.% content increases the dielectric constant, dielectric loss, and alternating-current (AC) conductivity. According to the findings, the (PVA-PVP-Co_2O_3) nanocomposites could be used in a variety of optoelectronics applications

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