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RESEARCH PAPER

Study of the Electrical Characteristics and Development of Nanomembrane, as a Shield Against Gamma Radiation

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ABSTRACT

The casting system was used to make the PMMA/ZnONPs membrane. In the technique (a petri dish with a diameter equal to 5cm). The models are prepared with a thickness in the range (0.28 to 0.35 mm), Optical microscope measurement, the electrical characteristics and shield against gamma radiation are studied. In the Optical microscope measurement at a high concentration of ZnONPs, the results showed that the arrangement of nanoparticles appears as a network. In the electrical characteristics, values of dielectric constant, values of electrical conductivity A.C., and dielectric loss values of (PMMA/ZnONPs) are increased with the growth in the amount of ZnONPs. The transmission radiation after adding ZnONPs decreases with an increase in the concentration of ZnONPs. Quantities of dielectric constant and Quantities of dielectric loss are reduced by growth frequency, so increasing frequency increases A.C. electrical conductivity values. In shielding against gamma radiation, the transmission radiation after adding ZnONPs decreases with an increase in concentrations of ZnONPs; attenuation constant values increase with increasing concentrations of ZnONPs.

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INTRODUCTION

Polymeric nano materials are used in many scientific applications, such as electronics, sensors, and filtration, and the properties of polymeric nano materials can be modified [1-3]. Polymeric nano materials are considered important because they can control their physical properties, including mechanical, thermal, and electrical characteristics. The range of applications for polymeric nano materials is diverse. Polymeric nano materials are used in many products such as sports equipment, food packaging, and electronic devices [4-6]. The increased use of polymer materials that can conduct electricity makes polymers excellent for an extensive range of industrial uses because of their flexibility, cost-effectiveness, and ease of preparation [7-10]. Polymer sheets are characterized via small ionic conductivity. Also, the ionic conductivity present within the polymer arises from the ion transport process, which is influenced by the movement of ions within the polymer. The metal oxides affect ionic conductivity; therefore, the movement within the polymer chains undergoes relaxation, enhancing the electrical properties of the polymers when inorganic additives are present within

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the polymer [11]. When creating a composite PMMA/ZnONPs, it was observed that the peaks of ultraviolet absorption and thermal stability change with varying amounts of added ZnONPs, and it is used in various optical applications [7]. Radiation emanates from most devices that operate in all fields due to technological advancement, and we can reduce the level of radiation emitted from devices by implementing protection measures. By protection, we mean reducing the intensity of radiation to the lowest level via using a material capable of absorbing radiation and placing it between the living organism and the radioactive source. For example, to protect against gamma rays, we use many materials such as granite and concrete [12-13].

MATERIALS AND METHODS

Materials

Poly(methyl methacrylate), Acetone solvent with a purity of 99.5%, Zinc oxide nanoparticles with a purity of 99.8%, with a diameter of 20-30 nm.

Formation of PMMA/ZnONPs membrane

A PMMA/acetone solution was formed by mixing 100 ml of solvent with 1 g of PMMA polymer at room temperature for 30 minutes using a magnetic stirrer, as shown in Eqs. 1 and 2 [14].

$$c_x = \frac{n_x}{v} \quad (1)$$

$$n_x = \frac{m}{Mw} \quad (2)$$

C_x describes concentration, n_x: Describes the number of moles (v): describes the volume of solvent, m: describes the mass of PMMA, M_w: describes the molecular weight.

The PMMA/ZnONPs film was formed using the casting method. In the model (a petri dish with a diameter equal to 5cm). The model was prepared with a thickness in the range of 0.28 to 0.35 mm.

RESULTS AND DISCUSSION

Optical microscope

Optical microscope measurements of PMMA/ ZnONPs are shown in Fig. 1. At PMMA/ 0.5 Wt ZnONPs, the arrangement of nanoparticles appears as clusters, while at PMMA/1Wt ZnONPs and PMMA/1.5Wt ZnONPs, the arrangement of nanoparticles appears as a network [15].

The electrical characteristics

Dielectric constant

Fig. 2 explains the influence of increasing frequency on the dielectric constant of (PMMA/

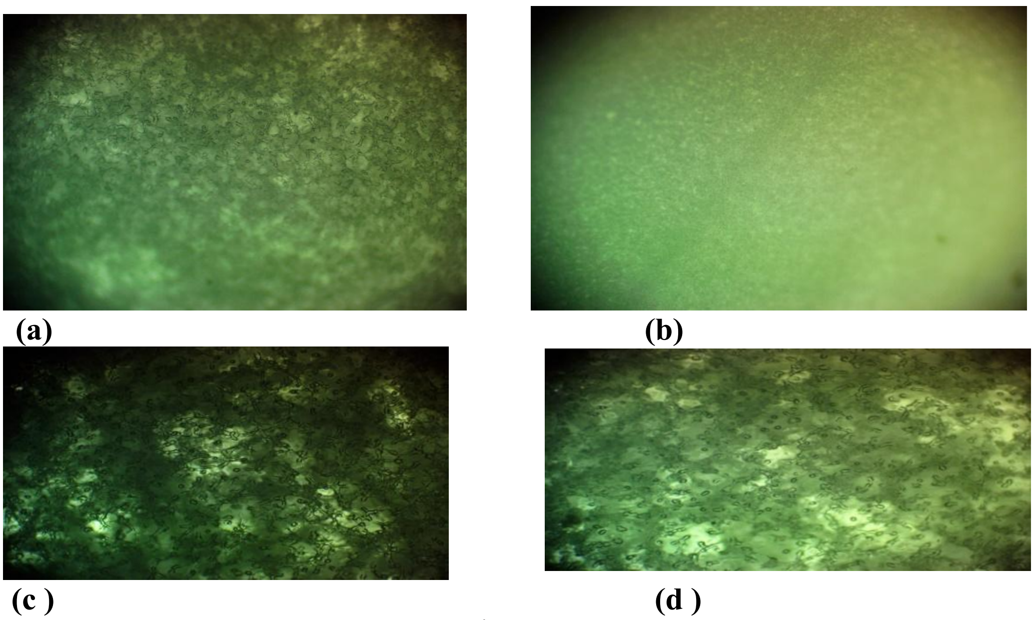

Fig. 1. Optical microscope measurement for (PMMA/ZnONPs), (a) for 0.0 Wt ZnONPs, (b) 0.5 Wt.% ZnO NPs (C) 1Wt.%ZnONPs (d) 1.5Wt.%ZnO NPs.

ZnONPs), values of dielectric constant reduction when increasing the frequency because of the reduction in the polarization generated by the space charge compared to full polarization [16]. The influence of increasing concentration on the dielectric constant of (PMMA/ZnONPs) in Fig. 3, values of dielectric constant rise when increasing the concentration because the charge carrier values are increased [16].

Dielectric loss

The impact of growing frequency on the values of the dielectric loss of (PMMA/ZnONPs) is shown in Fig. 4, where dielectric loss reduction occurs when the growth in values of frequency due to charge carrier values is increased. Fig. 5 shows the impact of growing ZnONPs on the values of the dielectric loss of (PMMA/ZnONPs), The dielectric loss increase with increasing concentration for the

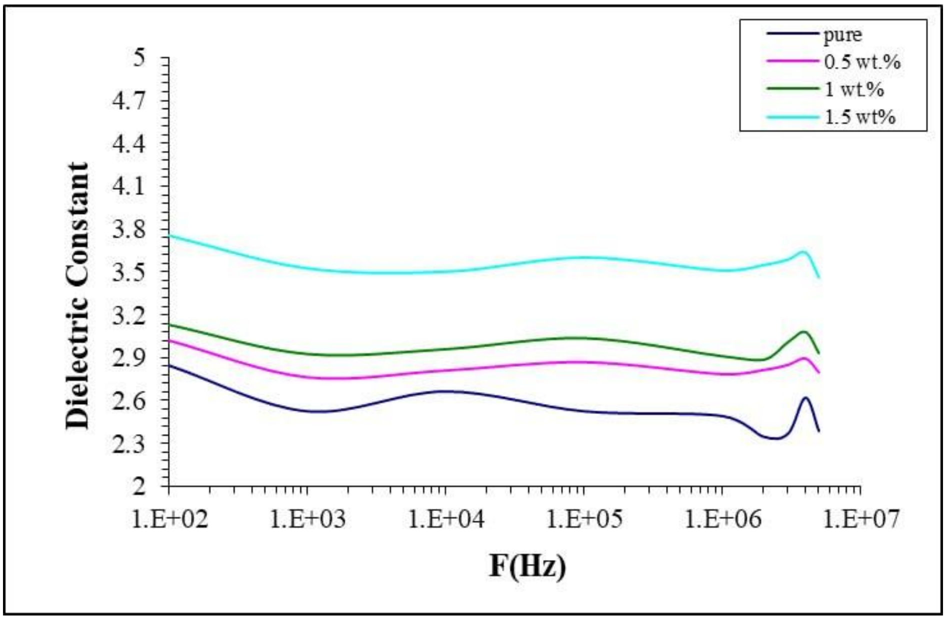

Fig. 2. Impact of growing frequency on dielectric constant of (PMMA/ZnONPs).

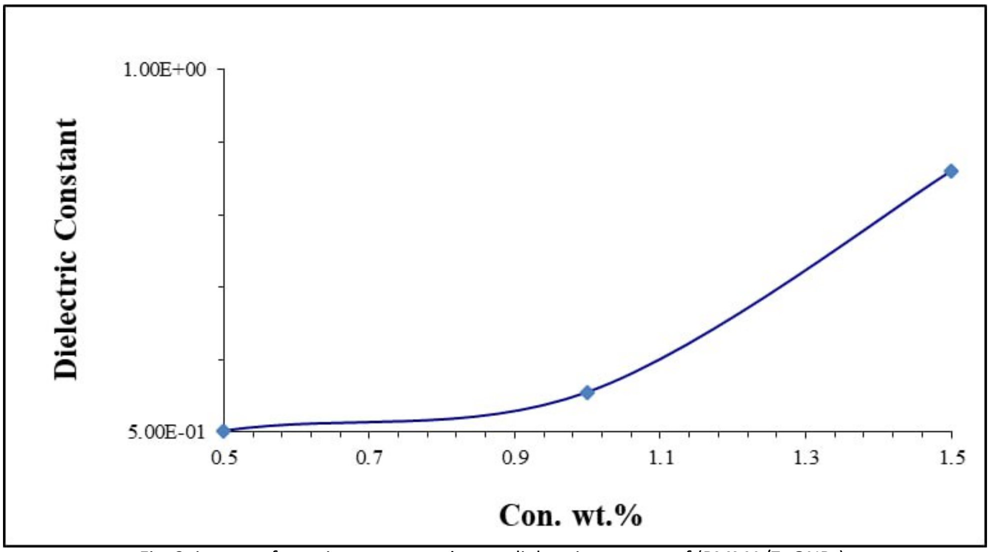

Fig. 3. impact of growing concentration on dielectric constant of (PMMA/ZnONPs).

reason that growing values of the charge carriers and the arrangement of nanoparticles appears as cluster at low concentrations, also at high concentration the arrangement of nanoparticles appears as a continuous network in the nano-film [17-18].

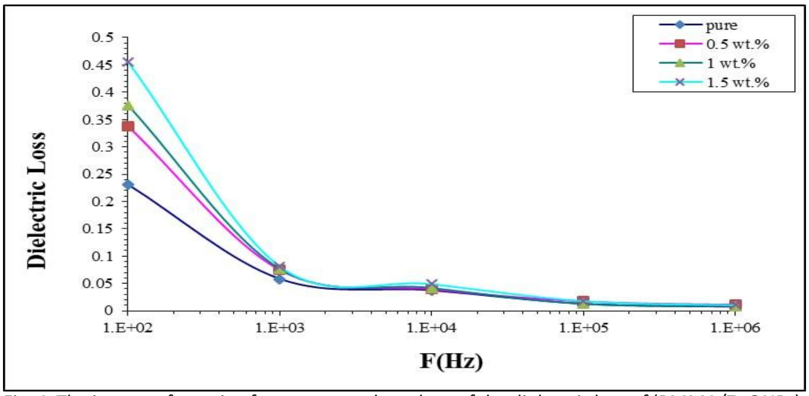

Fig. 4. The impact of growing frequency on the values of the dielectric loss of (PMMA/ZnONPs).

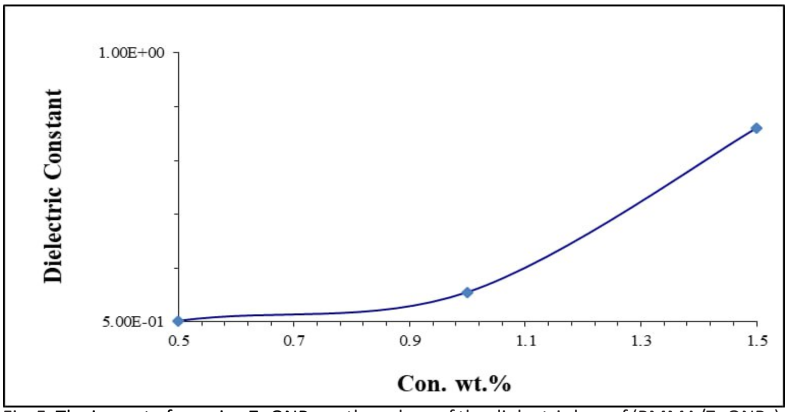

Fig. 5. The impact of growing ZnONPs on the values of the dielectric loss of (PMMA/ZnONPs).

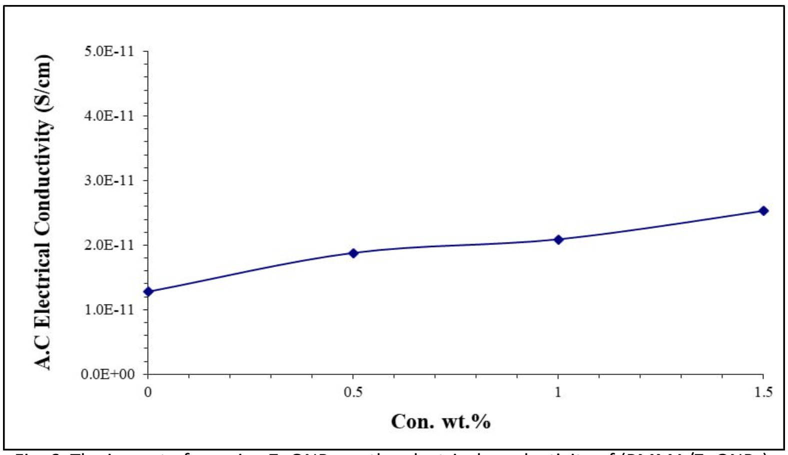

Fig. 6. The impact of growing ZnONPs on the electrical conductivity of (PMMA/ZnONPs).

Electrical conductivity

Fig. 6 explains the impact of growing ZnONPs on the electrical conductivity of (PMMA/ZnONPs) membrane, with electrical conductivity values increasing with increasing concentration due to increased values of charges carried. Fig. 7 explains the effect of increasing frequency on electrical conductivity.Increasing frequency increases A.C. electrical conductivity values. Because of the movement of charge carriers [18].

Shield Against Gamma Radiation

Fig. 8 explains the difference of (N/N_0) of (PMMA/ZnONPs), the transmission radiation

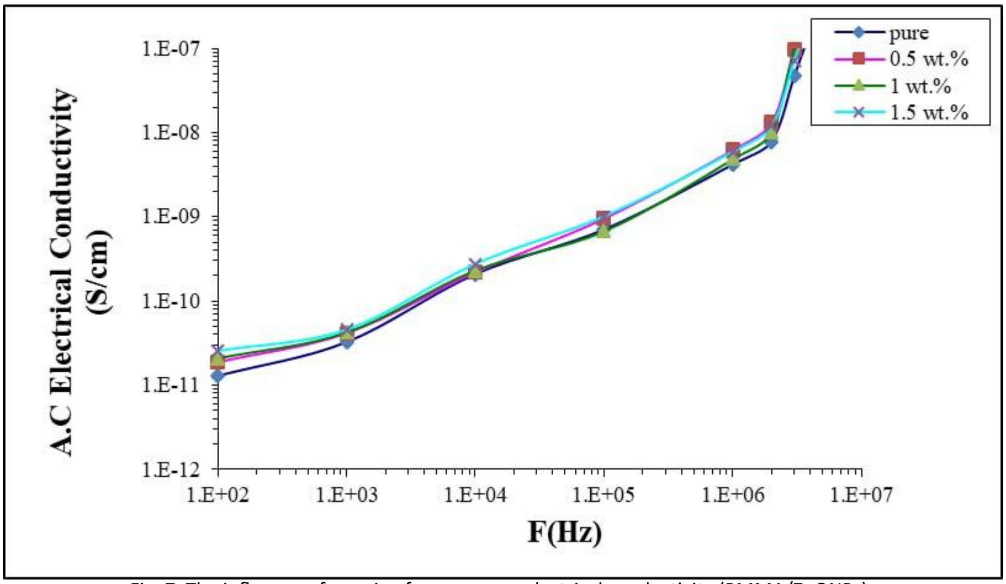

Fig. 7. The influence of growing frequency on electrical conductivity (PMMA/ZnONPs).

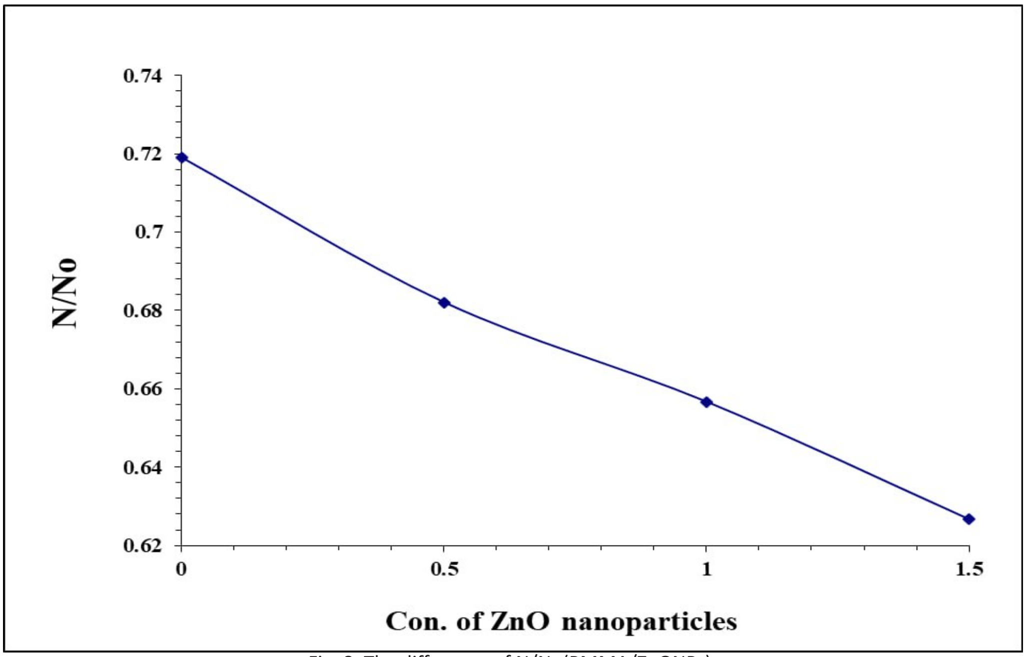

Fig. 8. The difference of N/N_0 (PMMA/ZnONPs).

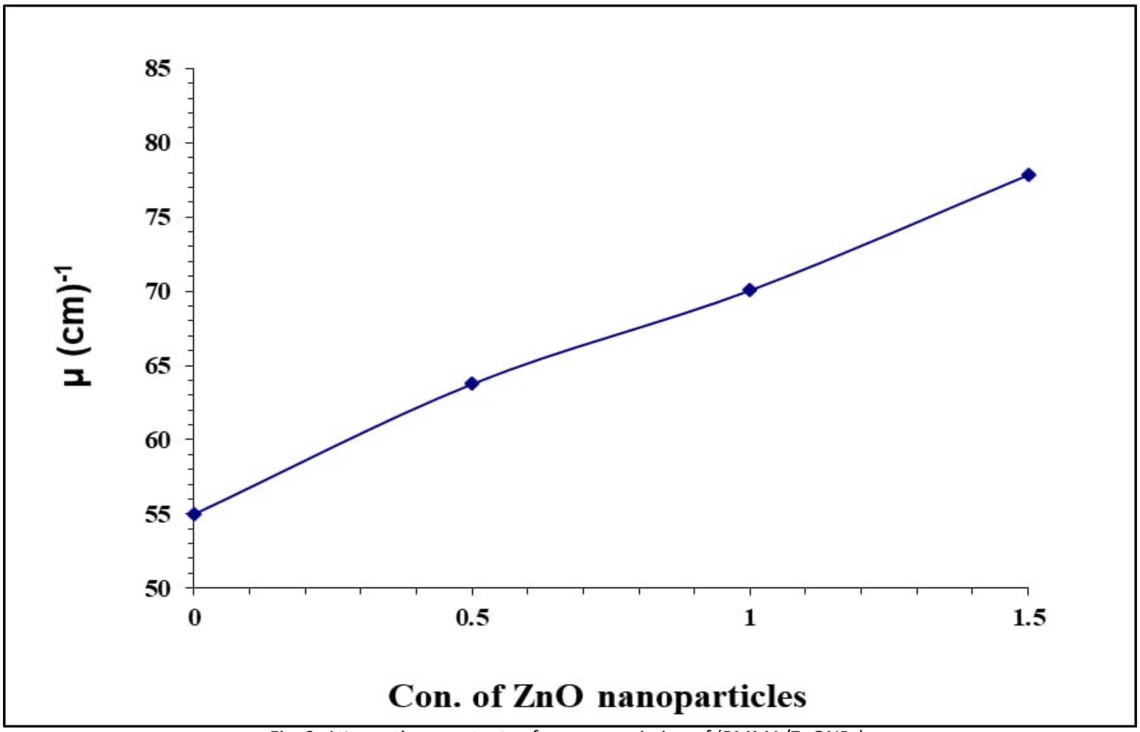

Fig. 9. Attenuation constants of gamma emission of (PMMA/ZnONPs).

after adding ZnONPs reductions with growth in concentrations because of high values of the attenuation radiation. Fig. 9 explains attenuation constants of gamma emission of (PMMA/ZnONPs); attenuation coefficient values increase with increasing concentrations of ZnONPs. Because gamma radiation is absorbed or reflected by the membrane used as a gamma radiation shield [19-20].

CONCLUSION

Optical microscope measurement of PMMA/ZnONPs. At high concentrations of ZnONPs, the arrangement of nanoparticles appears as a network, quantities of dielectric constant, quantities of electrical conductivity A.C., and quantities of dielectric loss of (PMMA/ZnONPs) are increased with a growth in the amount of ZnONPs. Quantities of dielectric constant and Quantities of dielectric loss are reduced by growth frequency, so increasing frequency increases A.C. electrical conductivity values. The transmission radiation after adding ZnONPs decreases with an increase in concentrations of ZnONPs, attenuation constant values increase with increasing concentrations of ZnONPs.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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