

Determination of Faraday Effect on Optical Properties for Polymers Blend Doping Metal Nanoparticles: A Descriptive Study

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DOI: 10.9734/bpi/ntpsr/v7/2855B

ABSTRACT

Present study highlights the Faraday effect use a magnetic field, this effect is clearly a appear through of the results. The optical properties test without magnetic field is appear the absorptance is direct proportionality with the concentration, while find the anther optical properties is inversely proportionality. Many electro-optic systems rely on the faraday effect as their foundation, which gives metal nanoparticles (NPs) and ferromagnetic (FM) polymers relevance in nanostructures.

Keywords: Magnetic field; faraday effect; optical properties; (PS- PMMA); Ag.

1. INTRODUCTION

The Faraday effect (magneto- optic effect (MO) is more important specially in potential application research such as optical sensors, optical isolators and MO memory system [1-4]. A Faraday effect current probe offers several advantages, especially for the current measurements in high-voltage circuits. Since measurement information is conveyed by variations in the intensity of an optical signal, the probe can be perfectly insulated electrically from the measurement and recording circuitry either by the free space propagation of a light beam or the transmission of the signal via fiber optics [5]. Magnetic field sensors (i.e., magnetometers) have been an intensive area of research over the last few decades and optical magnetometers have reached sensitivities that make them interesting candidates for applications such as magneto-encephalography and magneto-cardiography [6,7]. Faraday effect is study the interaction between the intensity of the light with the matter at presence the magnetic field [8-11] therefore the ferromagnetic (FM) nanoparticles is interest [12-16].

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2. MATERIALS AND METHODS

Polymers blend (PS- PMMA) doped with Ag nanoparticles (size: 20- 30 nm, purity: 99.99%) manufacturer (Hongwu nanometer) is to make solution molding mechanism. Mix the (PS- PMMA/Ag) by ratios (0.2, 0.4, 0.6 wt %) were melted (30 ml) of chloroform using magnetic stirrer, after that the samples dried.

A (He – Ne) laser at wavelength of (650 nm) and spot of a diameter of approximately (2mm). The radiation is polarized along the propagation direction, the beam pass through the cell (PS- PMMA/Ag). The blend film is positional inside a coil has ($B= 400 \text{ m T}$), when the operation laser device the laser beam is filled on the cell which is vertically to the wave vector. At first take a intensity (I_0) for laser spot before the applied the magnetic field, after that apply the magnetic field on the cell for all concentrations , and measure the intensity for laser radiation which the passes the cell (I). Each measurement has been repeated many times, and every time wait about (10 min) see Fig. (1).

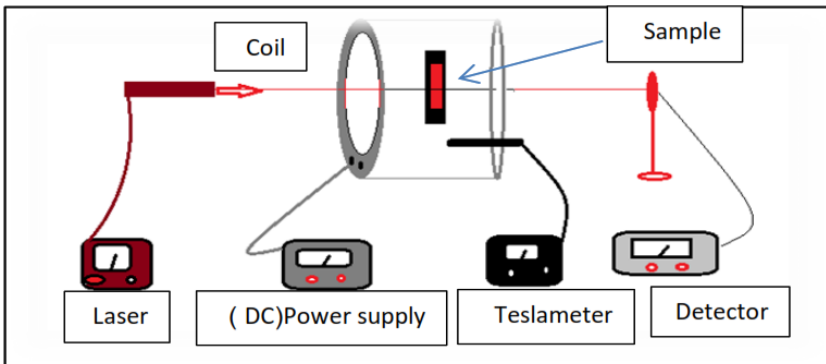


Fig. 1. Schematic representation of the magneto – optic system which is used in the search

3. RESULTS

Transmittance (T) is given by ($T = I_t / I_0$) [17]. Fig. (2) is appear the optical transmission spectra as a indicator for concentrations of (Ag) nanoparticles. This is due to the raise nanoparticles molecules that contain the electrons outer orbits, these electrons absorb the energy of the incident photons, and excited to higher levels. Thus part of the incident light is absorbed by the substance and does not passing through it.

As a result of the absorptance is decreased by magnetic field affect, therefore the transmittance property is increasing as shown in Fig. (2).

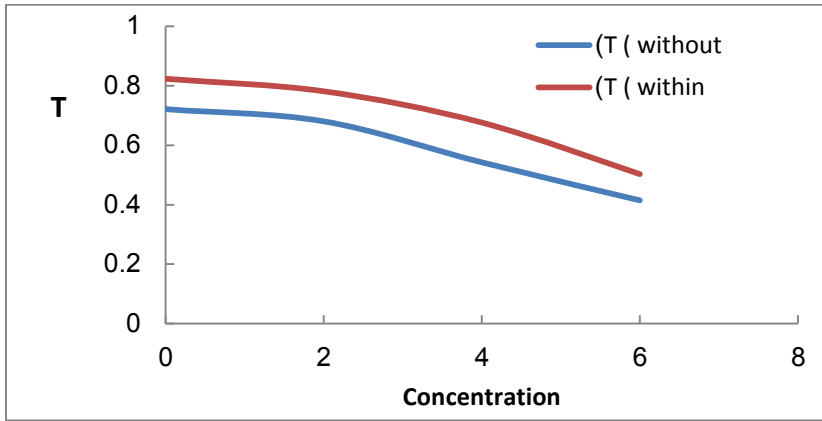


Fig. 2.The relation between transmittance (T) and the concentration for (PS –PMMA/Ag) films

Absorbance (A) can be defined by equation $(= \log \frac{1}{T})$ [17], by applying these equation we find the values of transmittance is indirect proportionality with absorbance ,also find from Fig. (3) the relation between the absorbance and the concentration (c) is direct proportionality.

Because of the molecules of (PS- PMMA / Ag) nanocomposite is have the permanent dipole moment, therefore when the magnetic field is affect on it, this molecules is aligned with the magnetic field direction. This phenomenon is to create the absorbance property is decrease, this effect is clear in Fig. (3).

The relation between the concentration and the absorption coefficient is direct proportionality as shown in Fig. (4, and the magnetic field causes better alignment of the dipoles, therefore the absorption coefficient value is decrease. In addition to the relation between the absorbance (A) with the absorption coefficient (α) is direct proportionality as shown in equation $(\alpha = 2.303 \frac{A}{d})$ [18] since (d) is the thickness.

The extinction coefficient value is calculated from equation $(= \frac{\alpha \lambda}{4 \pi})$ [19], the behavior shows direct proportionality as it in illustrated in Fig. (5), the magnetic field which is affected on the molecules, therefore the absorption coefficient (α) decrease and caused to extinction coefficient value to be decrease.

Form Fig. (6) the relation between the refractive index and the concentration for the samples is direct proportionality. The magnetic field causes better alignment of the dipoles, therefore the impedance of matter is became less than for the photons of the light, and we find the transmittance is increased.

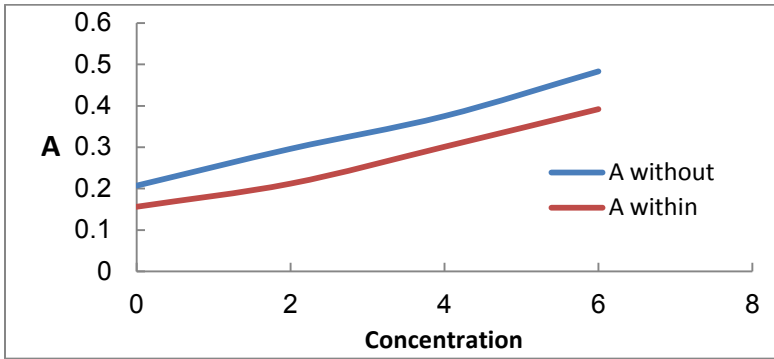


Fig. 3. The relation between Absorbance (A) and the concentration for (PS –PMMA/Ag) films

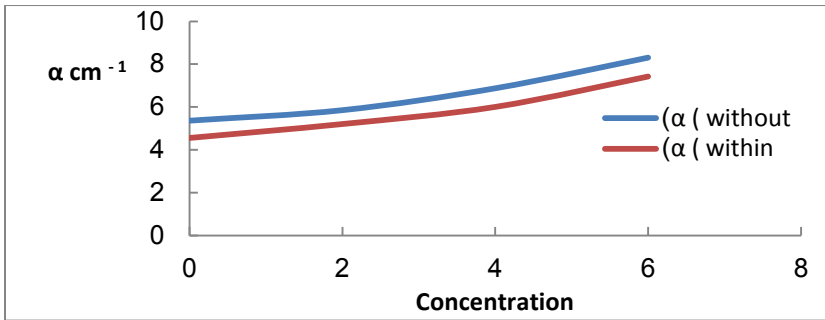


Fig. 4. The relation between Absorption coefficient (α) and the concentration for (PS –PMMA/Ag) films

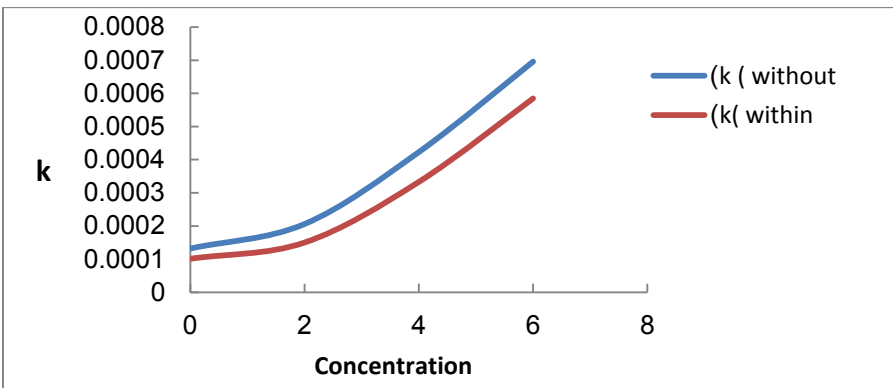


Fig. 5. The relation between extinction coefficient (k) and the concentration for (PS –PMMA/Ag) films

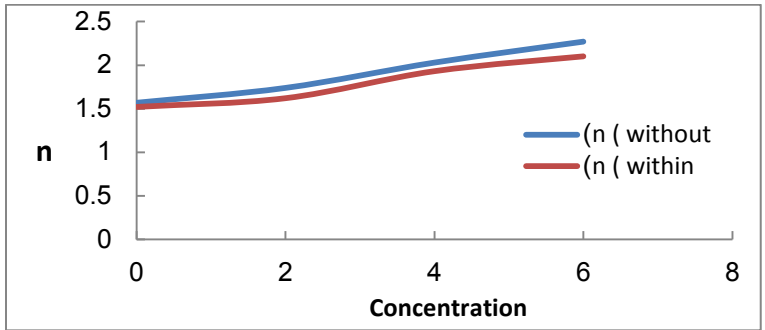


Fig. 6.The relation between refractive index (n) and the concentration for (PS -PMMA/Ag) films

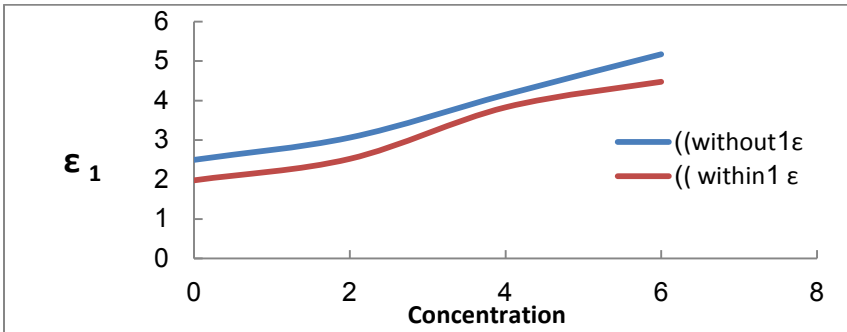


Fig. 7. The relation between real dielectric constant (ϵ_1) and the concentration for (PS -PMMA/Ag) films

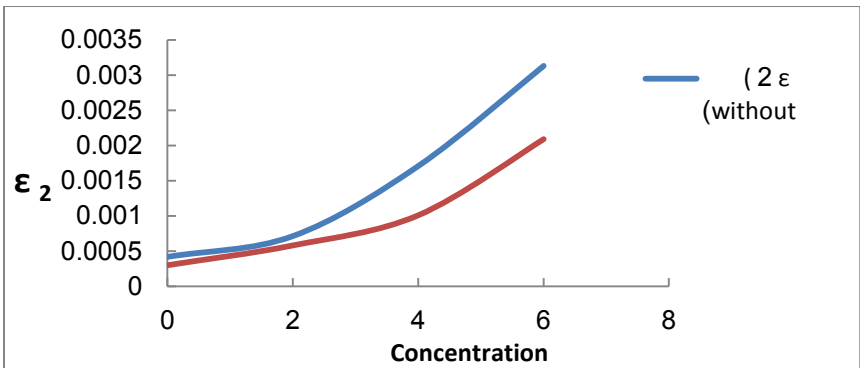


Fig. 8. The relation between imaginary dielectric constant (ϵ_2) and the concentration for (PS -PMMA/Ag) films

The complex dielectric function is ($\epsilon = \epsilon_1 + \epsilon_2$) [19], where (ϵ_1, ϵ_2) is the real and imaginary of dielectric constant, the real part is refer to the dispersal, as must be take in to account the actual motion of the electrons in the optical medium which the light is traveling, and the imaginary parts to indicate the missing ratio electromagnetic wave traveling in the optical medium, the both parts depend on photon energy of samples and also on the refractive index of samples due to the magnetic field make the decrease (n), therefore we find the both dielectric constant are decreased this result is agreed with reference [20] this clear in Figs (7,8).

4. CONCLUSION

The optical properties test without magnetic field is appear the absorptance is direct proportionality with the concentration, while find the anther optical properties is inversely proportionality, but when applying the magnetic field on the all samples the transmittance is have more value for all samples, while the other optical properties value is became less than, therefore the Faraday effect by using the magnetic field is make the betterment of optical properties.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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This chapter is an extended version of the article published by the same author(s) in the following journal. Journal of Physics: Conference Series, 1818, 012002, 2021.