Study the Effect of Magnetic Field on Polymer Doping TiO2 Nanoparticles

Zaid A. Hasan

Abstract
The metal nanoparticles (NPs) so as ferromagnetic (FM)/ Polymers is given to nanostructures importance in many electro- optics devices, a base work for these devices is depend on Faraday rotation. In this study the magnetic field effect is appear.

Key Words: Magnetic Field, Optical Properties, PMMA, TiO2.

Introduction
The Faraday effect (magneto- optic effect (MO2)) is more important specially in potential application research such as optical sensors, optical isolators and MO2 memory system (1–4). Faraday effect is study the interaction between the intensity of the light with the matter at presence the magnetic field, (5–8) therefore the ferromagnetic (FM) nanoparticles is interest. (9–13)

Materials and Methods
Poly Methyl Meta Acrylate (PMMA) doped with TiO2 nanoparticles (size: 20- 30 nm, purity: 99.99%) manufacturer (Hongwu nanometer) is to make solution molding mechanism. Mixture the (PMMA/TiO2) by ratios (0.2, 0.4, 0.6 wt %) were melted (30 ml) of chloroform using magnetic stirrer, after that the samples dried.

A diode laser at wavelength of (540 nm) and spot of a diameter of approximately (2mm). The radiation is polarized along the propagation direction, the beam pass through the cell (PMMA/TiO2). The film is positional inside a coil has (B= 400 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 an intensity (I0) 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 figure (1).
Results

Transmittance ($T$) is given by ($T = \frac{I_t}{I_0}$)\(^{(14)}\). Figure (2) is appear the optical transmission spectra as an indicator for concentrations of (TiO\(_2\)) 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 absorbance is decreased by magnetic field affect, therefore the transmittance property is increasing as shown in fig.(2).

![Graph showing transmittance vs. concentration with and without magnetic field]

Absorbance ($A$) can be defined by equation ($A = \log_{10} \frac{1}{T}$)\(^{(14)}\), by applying these equation we find the values of transmittance is indirect proportionality with absorbance, also find from figure (3) the relation between the absorbance and the concentration ($c$) is direct proportionality.

Because of the molecules of (PMMA / TiO\(_2\)) composite is have the permanent dipole moment, therefore when the magnetic field is effect 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 figure (3).

![Graph showing absorbance vs. concentration with and without magnetic field]

The relation between the concentration and the absorption coefficient is direct proportionality as shown in figure (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 ($\alpha$) is direct proportionality as shown in equation ($\alpha = \frac{2.303A}{d}$)\(^{(15)}\) since ($d$) is the thickness.
The extinction coefficient value is calculated from equation \( k = \frac{\alpha \lambda}{4\pi} \) (16), the behavior shows direct proportionality as it is illustrated in figure (5), the magnetic field which is affected on the molecules, therefore the absorption coefficient \( (\alpha) \) decrease and caused to extinction coefficient value to be decrease.

Form figure (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.

The complex dielectric function is \( \varepsilon = \varepsilon_1 + i \varepsilon_2 \) (16), where \( \varepsilon_1, \varepsilon_2 \) is the real and imaginary of dielectric constant, the real part is refer to the dispersal, as must be taken 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 clear in figures (7,8).

**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 magnetic field is make on the better of optical properties.

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