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Study of Optical Properties for ($PS-Y_2O_3$) Nanocomposites

Bahaa H. Rabee[1], Tayf Nabeel Khudair[2]

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

Abstract: ***In this paper, samples of nano composites consisting of polystyrene and yttrium oxide nano particles were prepared by using the casting method. The nano composites which the prepared have many industrial and medical applications. The different concentrations of yttrium oxide are (4,8,12and16) wt.%. The results show that the optical properties of polystyrene are changed with the increase of the yttrium oxide concentrations.***

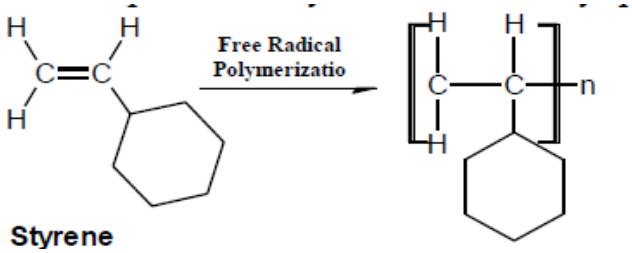
Keywords: Optical Properties, *poly*styrene, yttrium oxide

1. Introduction

Polymers are present in our daily life from the wrappings around the food we eat to the sacks used for the garbage, polymers are practically everywhere [1].polymers are macromolecules built up by small molecules are termed "monomers" and reactions by which they combine are termed polymerization. The number of these repeated units are called degree of polymerization[2]. May be hundred, thousand, tens of thousands or more monomer molecules linked together in a polymer molecule. There are three main structural shapes in which polymer molecules are produced, which can be classified as; linear, branched, or crosslink polymers depending on the structural shape of the polymer molecules[3]. Composite is combined material created by the synthetic assembly of two or more components-a selected filler or reinforcing agent and compatible matrix binder in order to obtain specific properties [4].The components of a composite do not dissolve or otherwise merge completely into each other, but they do act in concert.

There are three fields of producing composite materials namely:-
a) Metal-matrix composites.
b) Ceramic-matrix composites.
c) Polymers-matrix composites

For the interest of this work only the third type of composite will be considered. The polymer used in this work are polystyrene. The polystyrene is an inexpensive and hard plastic and is more common used in ou r everyday life[5]. The body of computers we are using now is probably made of polystyrene, and is also used in toys, and the housing of things like hairdryers and kitchen appliances[6].polystyrene is vinyl polymer. structurally, it is a long hydrocarbon chain, with a phenyl group attached to every other carbon atom is produced by free radical vinyl polymerization:-



Polystyrene is perfect for optical measurements[7]and immunological assays. It is soluble in aromatic hydrocarbon solvants, cyclohexane and chlorinated hydrocarbons.

2. Experimental Part

The materials used in this work are **poly**styrene and yttrium oxide nano. The **poly**styrene was dissolved in chloroform with (30 ml) for different concentrations are (4,8,12and16) wt%. The casting technique is used to preparation the samples. The casting technique is used to preparation the samples. The opticalpropertieswere measured by using UV/1800/Shimadzu spectrophotometer

3. Results and Discussion

The absorbance of($PS-Y_2O_3$)nano composites was measured in the wavelength range (280-780)nm. Fig.1: shows that the absorbance of composites is increased with the increase of theY2O3 nano partical concentration, this behavior attributed to nano particles which absorb the incident light [8].

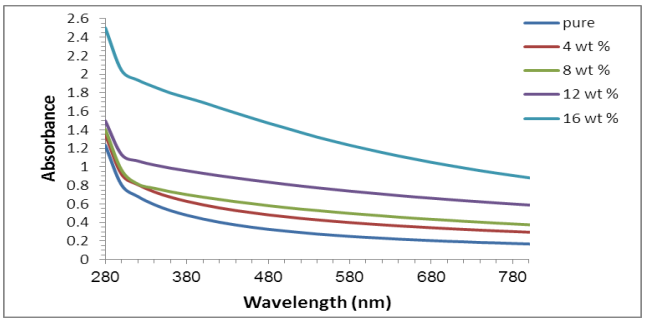


Figure 1: The variation of optical absorbance of($PS-Y_2O_3$) nano composite with wavelength.

The absorption coefficient (α) is defined by [8,9]:

$\alpha = 2.303\ A/d$ …… …. (1)

Where A: is the absorbance of sample and d: is the sample thickness. Figure (2) represents the variation of absorption coefficient of nano composites of different concentration of Y_2O_3 nano partical with the photon energy..

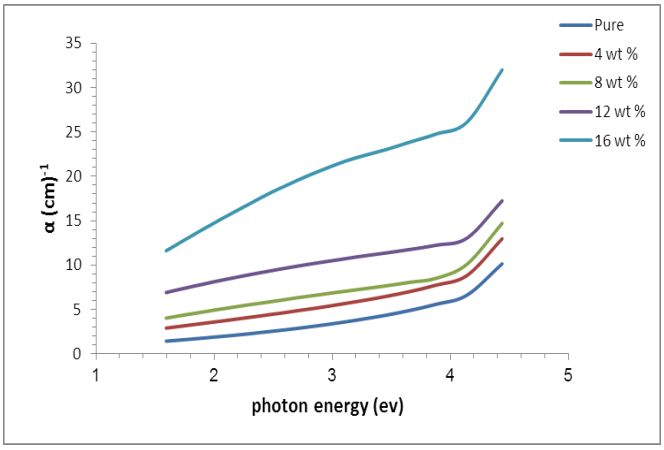


Figure 2: The absorption coefficient of nano composite with various photon energy

From the figure, the absorption coefficient of composites less than 104 cm^{-1} which refer to the nano composites have indirect energy band gap which calculated by[10]:

$\alpha h\upsilon = B(h\upsilon - Eg)^r$ ……(2)

Where: hυ is the photon energy, B is a constant, Eg is the energy band gap, r=2 and 3 for allowed and forbidden indirect transition.

The increase of the concentration of nano partical is produced increase of the localized states in the forbidden gap which decreases the optical energy gap [10] as shown in figures (3 and 4).

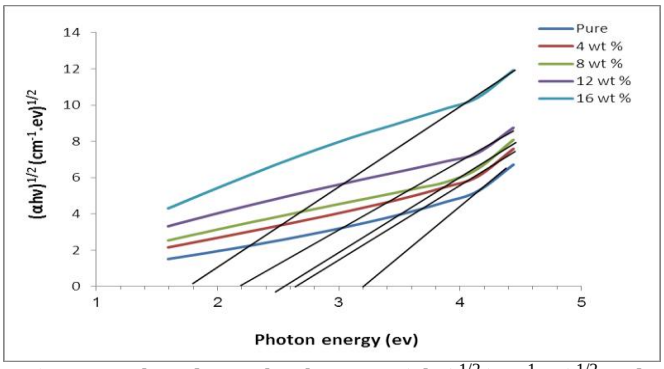


Figure 3: The relationship between $(\alpha hu)^{1/2}(cm^{-1}eV)^{1/2}$ and photon energy of nano composites**.**

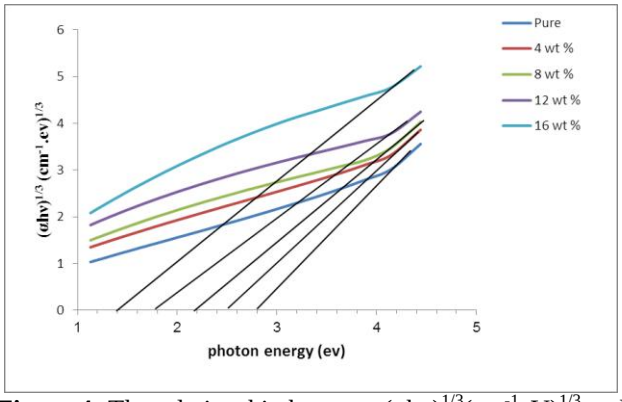


Figure 4: The relationship between $(\alpha hu)^{1/3}(cm^{-1}eV)^{1/3}$ and photon energy of nano composites**.**

The refractive index (n) of the($PS-Y_2O_3$) nano composites is defined :

$n = (1+R^{1/2}) / (1-R^{1/2})$ …… … (3)

Where R is reflectance index

The extinction coefficient (k) of composites is calculated by:

$k = \alpha\lambda/4\pi$ …… …… (4)

The variation of the refractive index for($PS-Y_2O_3$) nano composites for various different concentration a function of wavelength at room temperature is shown in figure (5). The figure shows that the refractive index increase as a result of filler Y_2O_3 nano partical concentration, this behaviour can be attributed to the increasing of the packing density as a result of filler content[11].

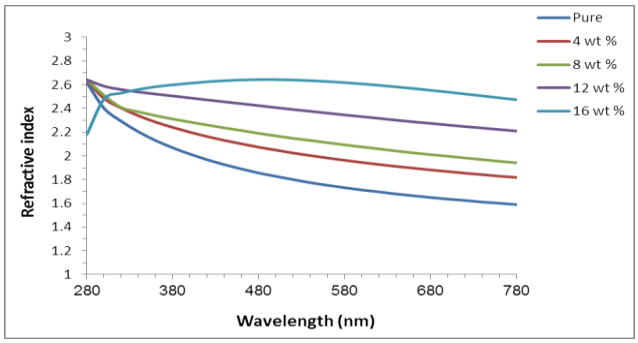


Figure 5: The variation of refractive index of nano composite with wavelength.

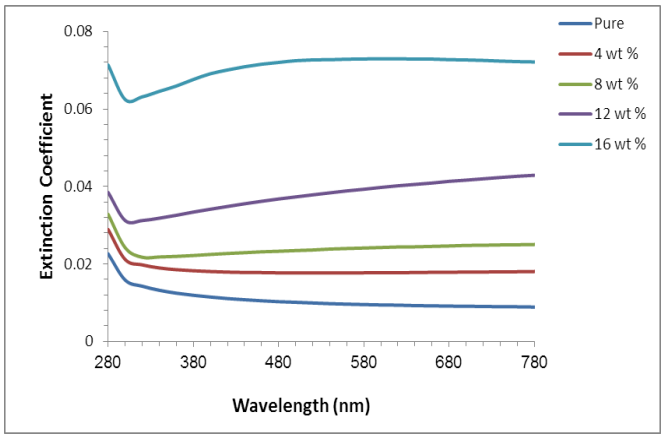


Figure 6: The relationship between the extinction coefficient (k) and wave length of nano composites

The variation of extinction coefficient (k) with wavelength for composites is as shown in figure (6). The extinction coefficient increases with increasing of (PS-Y_2O_3) concentration. This behaviour of extinction coefficient can be ascribed to high absorption coefficient. The extinction coefficient is high at the longest wavelengths and high concentration [11].

The dielectric constants (real (ε1) and imaginary (ε2) parts) are defined by [10]:

$$\varepsilon 1 = n2 - k2 \quad \text{..... ..... (5)}$$

$$\varepsilon 2 = 2nk \quad \text{..... ..... (6)}$$

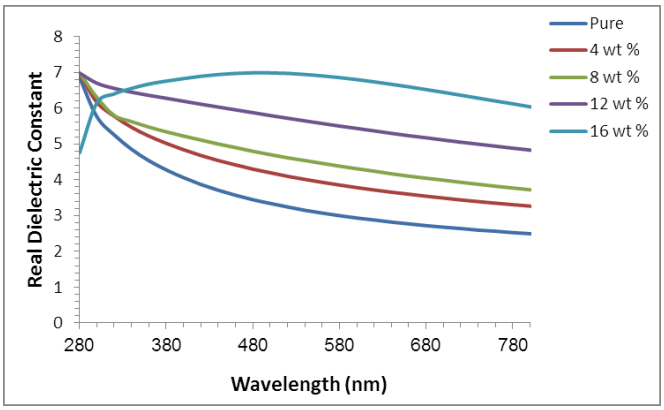


Figure 7: The relationship between the real dielectric constant and wave length of(PS-Y_2O_3) nano composites .

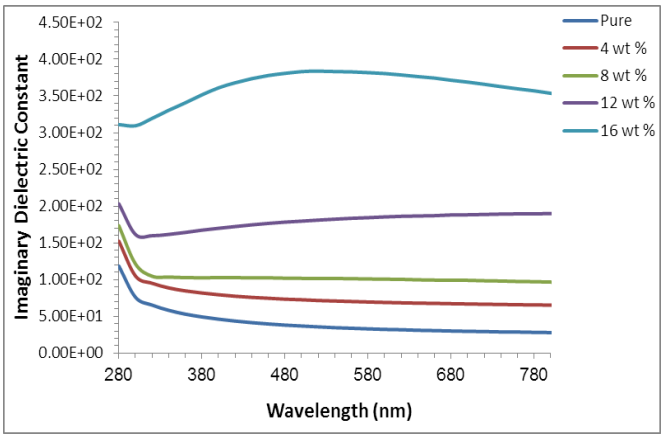


Figure 8: The relationship between the imaginary dielectric constant and wave length of nano composites

Figures (7) and (8) show the relationship between the real and imaginary parts of dielectric constants of(PS-Y_2O_3)nano composites with different concentration of filler. From these figures, the real and imaginary parts of dielectric constants are increased with the increase of the concentration of Y_2O_3 nano partical.

It is concluded that the variation of ε1 mainly depends on (n^2) because of small values of (k^2), while ε2 mainly depends on the (k) values which are related to the variation of absorption coefficients. The values of the real dielectric constant are high with respect to the imaginary dielectric constant [11].

4. Conclusions

1) The absorbance of the polystyrene is increased with the increase of the yttrium oxide nano partical concentration.
2) The absorption coefficient, extinction coefficient, refractive index and real and imaginary dielectric constants
3) The polystyrene are increasing with the increasing of the weight percentages of yttrium oxide nano partical.
4) The indirect energy band gap of the decreased with the increasing of the polystyrene yttrium oxide nano partical concentration.

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