ISSN 2229-5518

The optical properties of thin films of polymer PS/MR-Eosin prepared by cast methods

Alaa J. Mohammed
Al-Muthanna Univ., college of science, Al-Muthanna, Iraq.

Abstract: Thin films of polymer Polystyrene (PS) grafted with Methyl red and Eosin dyes were prepared by the cast method. The Absorption spectra of thin films was studies at the range wave number (300-800) nm. This is represented by The Absorption (A) and Transmittance (T) spectra. The Absorption coefficient (α), Reflection coefficient (R) and the energy gap (Eg) were computed.

We found that the polymer graft with dyes having bigger increase in the Absorption spectra from (0.7) to (2.15) with increase the energy; Also we see when we added the dyes the energy gap for PS/Eosin-MR is confined between the energy gap for PS/Eosin and PS/MR these was qualities of polymeric composites. The real and imaginary parts of the dielectric constant show that the polymer PS graft dyes having peaks at the photon energy (2.3±0.05) eV but for PS/Eosin the real part was lower than PS/MR and PS/Eosin-MR.

Introduction

Polystyrene is very low cost and is extensively used where price alone dictates. Its major characteristics include rigidity, transparency, high refractive index, good electrical insulation characteristics, low water absorption, and ease of coloring and processing [1]. A more serious limitation of polystyrene in many applications is its brittleness. This limitation led to investigation a mixture of polystyrenes with material having rubber properties [2].

In recent years, polymers with different optical properties have been attracted much attentions due to their applications in the sensors, light-emitting diodes, and others. The optical properties of these materials can be easily tuned by controlling the filler concentrations. Though a great deal of work has been reported on such materials [3–4], it is still meaningful to extend the research of these polymers. Polystyrene has attracted the attention of scientists for its interesting features and its superior physical and chemical properties. Polystyrene (PS) is amorphous polymer with bulky side groups. Major characteristics of PS include rigidity, transparency, high refractive index, good electrical insulation characteristics, low water absorption, and ease of processing which makes important for many applications in industry [5- 6]. Moreover, PS is traditionally considered as an excellent host material for composites. In view of this increasing importance, the structure and conformation of polystyrene have received considerable attention in the recent literature. Dye – doped polymers (DDP) are new materials which existing optical properties. DDP find application in fields of modern photonic technology apart from its use as an alternative to solid state laser media [7] .

The study of optical absorption and particularly the absorption edge is a useful method for the investigation of optically-induced transitions and for the provision of information about the band structure and energy gap in both crystalline and amorphous materials. The measurements of the optical absorption coefficient, particularly near the fundamental absorption edge, provide a standard method for investigation. Detailed studies of doped polymer with different dopant concentrations and thickness allow the possibility of choice of the desired properties [8].

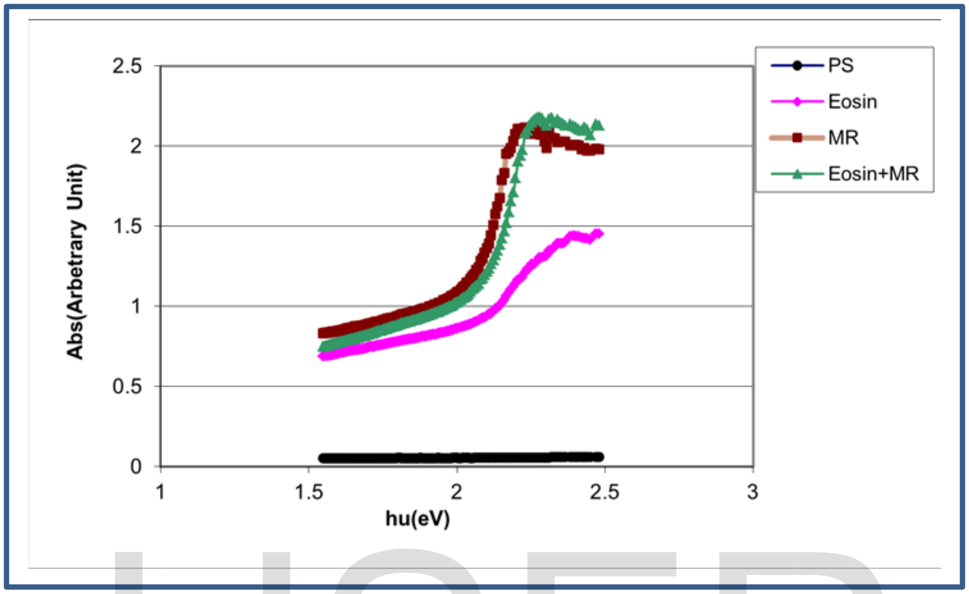
Aim of this work was prepared thin films polystyrene graft by Methyl red and Eosin dyes using cast methods and studies their optical properties for it represented by the Absorption and Transmittance spectra, Reflection coefficient (R) and energy gap (E_g) to know the effect of dyes on polystyrene.

Experiment

Thin films of polymer PS graft with dyes such as (Methyl red and Eosin) was prepared by cast methods, it’s solved by Tetra hairdo furan (THF) at room temperature. The solution of PS was prepared by taking 1gm with 20mel of THF and put it on hotplate stirrer for (120) minutes. Appropriate mixtures of PS and (methyl red, Eosin) solutions were mixture with 5% weight ratio of dyes and stirred continuously for to obtain a homogeneous solutions. The solution was poured into flat glass plate dishes for 24 hr, these homogeneous solutions were spread on a glass plate and allowed to evaporate the solvent slowly in air at room temperature. The thickness of the prepared films was measured using the optical interferometer method employing He-Ne laser 0.632µm. The absorbance and transmittance spectra were recorded using UV mate SP -8001 double-beam spectrophotometer in the wavelength optical a range 190-1100nm, the measurements were carried out at room temperature.

Result and Discussions

The Absorption spectra (A) for polymer Polystyrene graft with dyes of Eosin and Methyl red as thin films were recorded using UV-Vis Spectrophotometer in the wavelength range of (500-800) nm as Figs.(1).



Figure(1): Show the Absorption spectra as a function of wavelength.

From Fig (1) we see that the Absorption spectra of PS are lower than PS graft with dyes. We see that thin films of polystyrene pure having nearly straight line and when we added the dyes to the polymer the Absorption spectra was jumped to a value higher than 0.5 of Absorption. So at the polymer graft with dyes we see bigger increase in the Absorption spectra from (0.7) at the energy (1.55) eV to (2.15) at the energy (2.25)eV with increase the energy depending on the type of dyes.

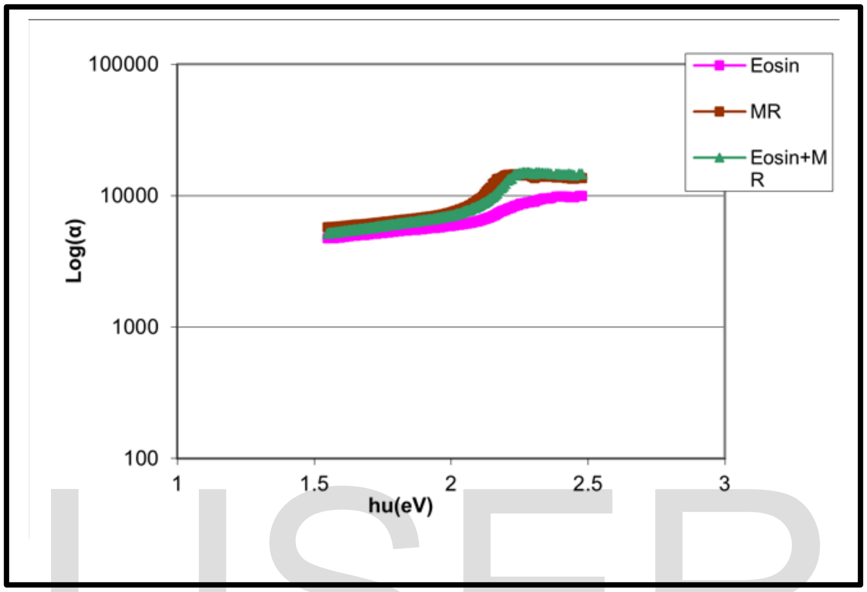
The Absorption coefficient (α) of thin films can be estimated after the correction of the reflectivity by [9]:

$$\alpha = \frac{2.303}{d} A \qquad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where ,d, is the thickness of the film and ,A, is the Absorbance.

ISSN 2229-5518

from, α , we can determined the energy gap (Eg) and phonon energy (Ep)depending on α values; if $\alpha > 10^3$ that is lead to the direct transition and when $\alpha < 10^3$ these values lead to indirect transition [10].



Figure(2): Show the Absorption coefficient as a function of the energy.

The plot of $(\alpha h\upsilon)^{1/2}$ versus photon energy are shown in Fig (3) with two straight lines are obtained for each case from indirect transition, one at lower energy corresponds to phonon absorption transition and the photon energy intercepts at Eg-Ep . The other lines correspond to phonon energy emission processes and photon energy intercept at Eg+Ep. From intercepts it's found Eg and Ep which are shown at the table (1).

ISSN 2229-5518

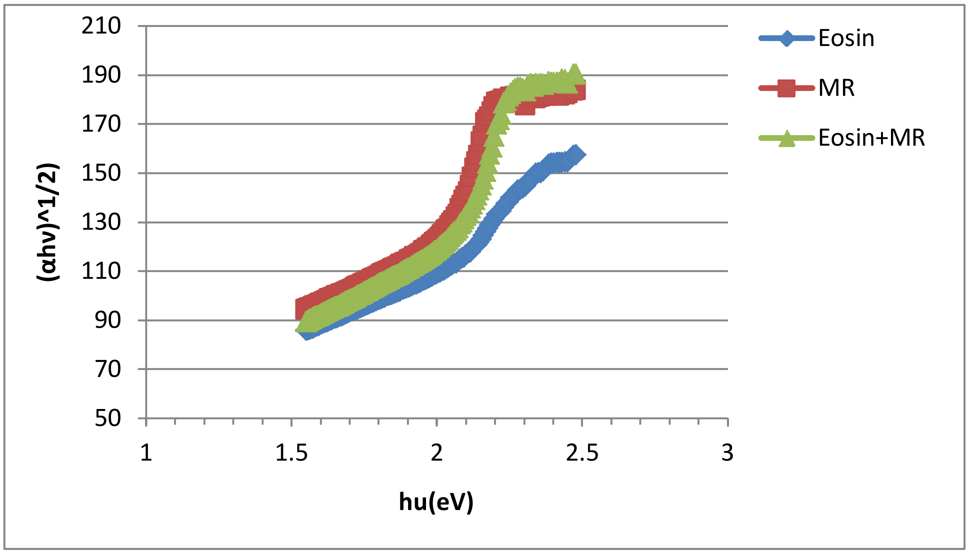


Fig (3): show $(\alpha h\upsilon)^{1/2}$ as a versus of photon energy.

Table (1): Show energy gap and phonon energy values for thin films.

Sample	Eg(eV)	Ep(eV)	Reference
PS	2.45	0.45	[11]
PS/Eosin	1.4	0.3	current study
PS/MR	1.56	0.26	current study
PS/Eosin-MR	1.5	0.4	current study

From table (1) we see that the energy gap for polymer PS (Pure) is equal to (2.45eV)[11] with phonon energy equal to (0.45eV), The addition of dyes to PS leads to decrease of energy gap to become equal to (1.5±0.1)eV with phonon energy unstable depending on the type of dyes . This result is very important to improve polymer (PS) to use it in different applications such as Windows colored absorbing the sun's rays, electronic devices and solar cell applications. Also we see when we added the dyes the energy gap for PS/Eosin-MR is confined between the energy gap for PS/Eosin and PS/MR these qualities of polymeric composites [12].

Fig (4) shows the relationship between Reflectivity (R) as a function of photon energy. From this figure we see that the reflectivity values of polymeric films confined between 1.5eV to 2.4 eV that is depending on the type of polymers, and also its decreases with increase the photon energy; The reflectivity of PS/MR films was lower than of PS/Eosin and when we mixed Eosin with MR dyes at the ratio (50:50) and graft polymer PS with it to get PS/Eosin-MR thin films this case make the reflectivity values limited between values of PS/Eosin and PS/MR.

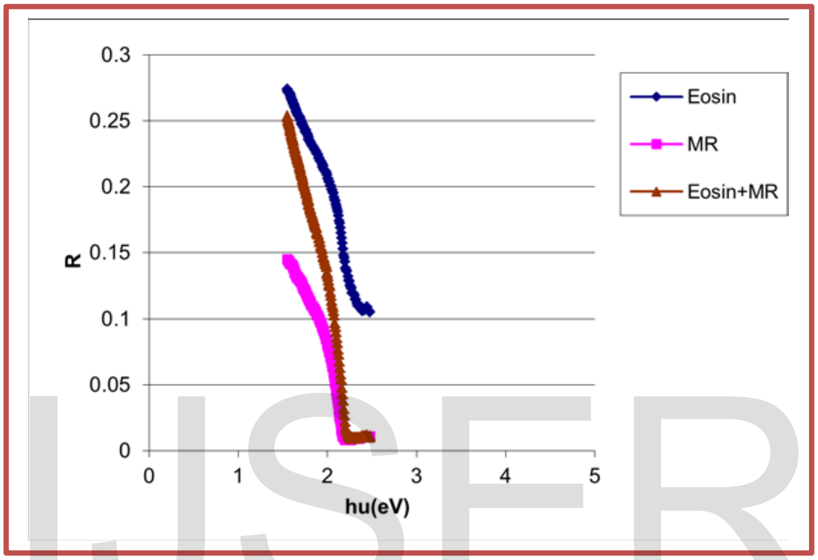
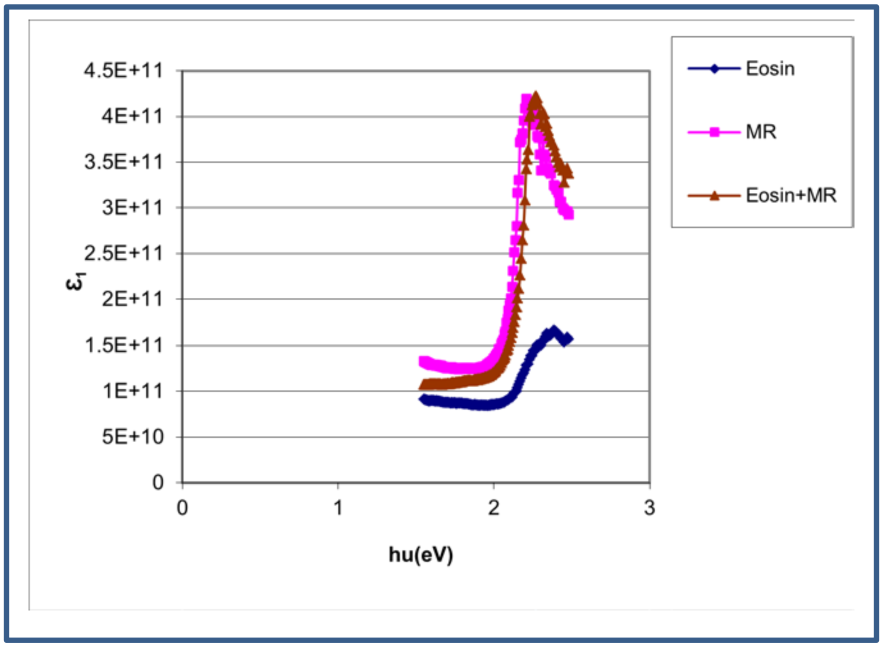
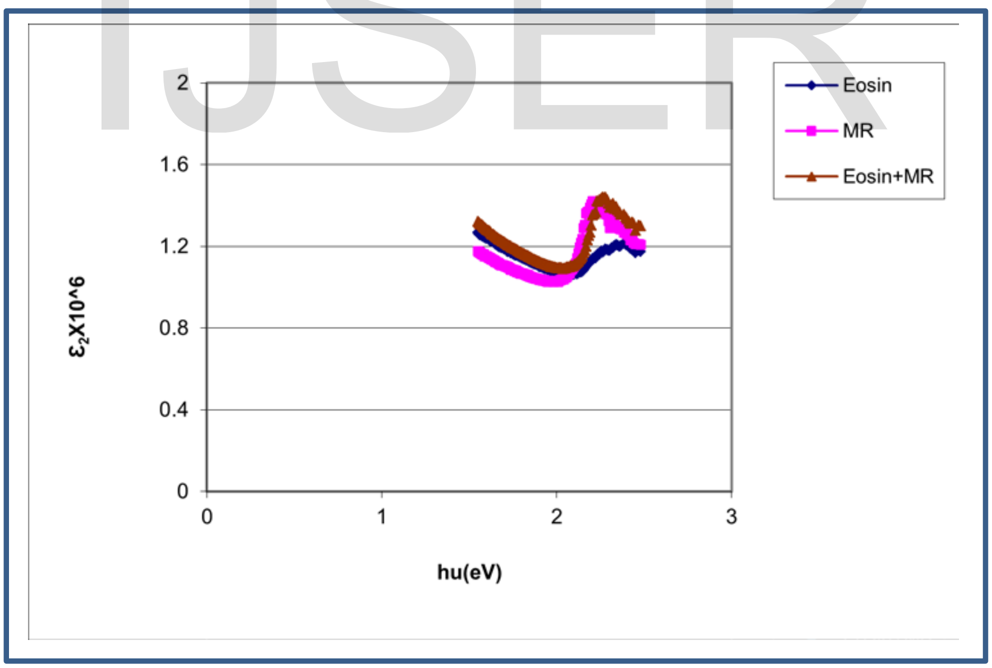


Fig (4): shows the relationship between Reflectivity (R) vs photon energy.

The real part (ε_1) and Imaginary part (ε_2) of the dielectric constant calculated by using optical techniques was shown at the figure (5) and (6), from figure(5) the polymer PS graft dyes having peaks at the photon energy (2.3±0.05) eV but for PS/Eosin the real part was lower than PS/MR and PS/Eosin-MR.



Fig(5): show the real part of the dielectric constant of Polymer PS graft Eosin and MR dyes.



Fig(6): show the Imaginary part of the dielectric constant of Polymer PS graft Eosin and MR dyes

References

1- Chanda M., and Roy S.K., (2009): Industrial Polymer Specialty Polymers, and Their Applications, Taylor & Francis Group, LLC.

2- Kim Ki H., and Wow H. J., (2008): Improvement of tensile properties of poly(methyl methacrylate) by dispersing multi-walled carbon nanotubes functionalizedwithpoly(3-hexylthiophene)-graft-poly(methyl methacrylate), Composites Science and Technology, vol.68, pp.2120-2124.

3- J Luo, Li X, Q Hou, *Adv Mater*., 19(8), 2007, p.1113-1117.

4- H Y Zhen, W Xu, W King, *Macromol. Rapid. Commun*, 27(24), 2006, p.2095—2100.

5- M. Shaffer and K Koziol, *Chem. Commun.*18, 2002, p. 2074.

6- J. P. Walker and S A Asher , *Analyical Chemical* 77 (6), 2005, p. 1596.

7- Achamma Kurian Nibu A George, Binoy Paul, V.P. N. Nampoori And C. P.G. Vallabhan," Studies on Fluorescence Efficiency and Photodegradation of Rhoda mine 6G Doped PMMA Using a Dual Beam Thermal Lens Technique", Laser Chemistry, 20(2-4),2002.

8- Osiris W. Guirguis, Manal T. H. Moselhey, J Mater Sci., 46 (2011) 5775–5789.

9- K.M.Ziadan, A.Shawi and H.A.Al-Attar, Iraqi J. of Polymers, Vol.2, No.1, 95-102,(1998).

10- G.A.Khan, C.A.hoGarth, J.Mat. Science, 25(1990),3002-3007.

11- Ali S. Ali, **Basrah Journal of science, Vol . 30 (2), 2012.**

12- Ali S. Ali, MSc. Thesis, Basrah University, college of Science, Basrah, Iraq, 2007.