

Influence of Gamma Radiation on Some Optical Properties and Urbach Energy of (PMMA- Doped Red Methyl) Films

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Abstract

We have studied the effect of gamma irradiation on the optical transmission, absorbance, absorption coefficient, and Urbach energy for (PMMA- doped red methyl) film deposited by using solvent casting method .The optical transmission (T %) in the wavelength range (190-1100) nm of films was measured , it was seen that all the parameters were affected by gamma irradiation.

Key words : PMMA films , Optical properties , gamma radiation.

Introduction

Poly (methyl methacrylate) PMMA has considerable attention in recent year owing to its low cost, good tensile strength, and hardness, high rigidity, transparency, low optical loss in the visible spectrum, low glass temperature, good insulation properties and thermal stability dependent on tactility, it can be considered as a good host for inorganic nanoparticle due to their high surface to bulk ratio which can significantly affect the properties of PMMA matrix [1-4], as a result of the above properties, PMMA has been extensively used in various industrial sectors, it is used as a substrate material for precision optics components, in memory, gas sensing, PMMA can be tailored chemically to fit awide range of photonics and optoelectronics applications, liquid crystal display [5-7].

Irradiation with X-rays, alpha, beta and gamma radiation also have a significant effect on polymer properties and some physical properties are usually modified [8]. Radiations by γ -rays change the physical properties of the materials the internal structure of the absorbed substances. Studies on the changes in optical properties of thin film irradiated with ionizing radiations yield valuable information regarding the electronic processes in these materials [9].

The aim of the present work is to study the effect of γ -irradiated on some optical properties and Urbach energy of of (PMMA- doped red methyl) films

Experimental details

Poly (methyl methacrylate) from (sigma Aldrich comblt Germany) , chloroform has purity of 99.8% (HPLC_ was used as a common solvent for both pure PMMA and (red methyl) were dissolved separately in chloroform for 4 hours at room temperature. Appropriate mixtures of PMMA and 8% weight (red methyl) solutions were mixed . The solution was poured into flat glass plate dishes. Homogenous films were obtained after drying the solution in an oven for 24 hours. The thickness of the prepared films was in the range of $25 \pm 1 \mu\text{m}$. the prepared samples were irradiated by gamma ray dose from (^{137}Cs) with activity (0.5 μCi), for seven days. The irradiation facility is at the College of Science , University of Diyala .

The absorbance and transmittance spectra were recorded by using double bean schimadzu UV/VIS-160A in the wavelength optical a range (190-1100) nm, the measurements were carried out at room temperature.

Results and Discussion

Figure (1) shows the variation of transmittance with wavelength for unirradiated (PMMA-doped red methyl) & Irradiated one. Transmittance for unirradiated film is higher than that for irradiated one, this might be attributed to the increased scattering of photons by crystal defects, and the free carrier absorption of photons contributed to the reduction in optical transmittance [10].

Figure (2) shows the absorptance of unirradiated & irradiated (PMMA- doped red methyl) films versus wave length from this figure the absorptance [irradiated (PMMA- doped red methyl)] > absorptance [unirradiated (PMMA- doped red methyl)]. The irradiated thin film shows a much softer absorption edge, possibly indicating the presence of sub-band gap levels associated with defects.

The following relation could be used for calculating the absorption coefficient (α) [11]:

$$\alpha = \frac{2.303A}{t} \quad \text{----- (1)}$$

Where (A) is the absorptance and (t) is the film thickness.

Fig. (3) shows the dependence of the absorption coefficient (α) on the wave length for the samples. At short wavelength (α) takes higher value ($\alpha \geq 10^4$) cm^{-1} and then increases with the decrease of λ (increasing photon energy).

The Urbach relation as follows [12]:

$$\alpha = \alpha_0 e^{hv/E_e} \quad \text{----- (2)}$$

Where (E_e) is the Urbach energy, ($h\nu$) is photon energy. Fig. (4) shows the relationship between $\ln(\alpha)$ and photon energy. The value of (E_e) for (PMMA- doped red methyl) films of irradiated is (0.173 eV) and as deposited is (0.182 eV).

The relatively high band gap values obtained in this work can be explained by the disorder present in the film.

Conclusions

The actions of irradiation by gamma ray on (PMMA- doped red methyl) films are: increasing the absorbance and absorption coefficient, and decreasing the transmittance and Urbach energy. The Urbach energy decreases from (0.182 eV) to (0.173 eV).

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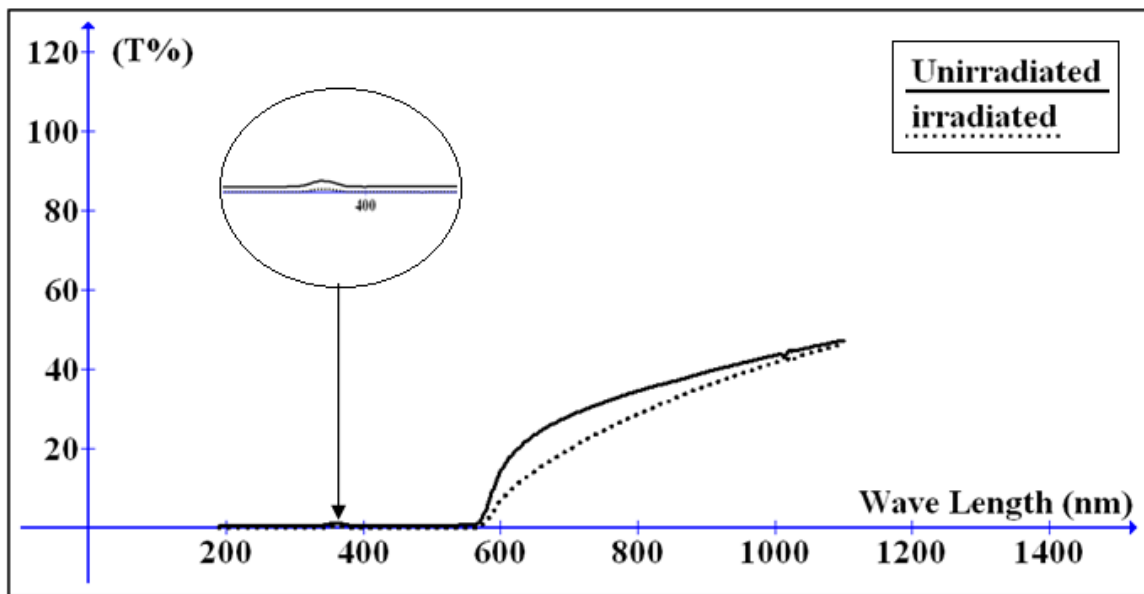


Figure No. (1) Optical transmittance of (PMMA- doped red methyl) before and after irradiation

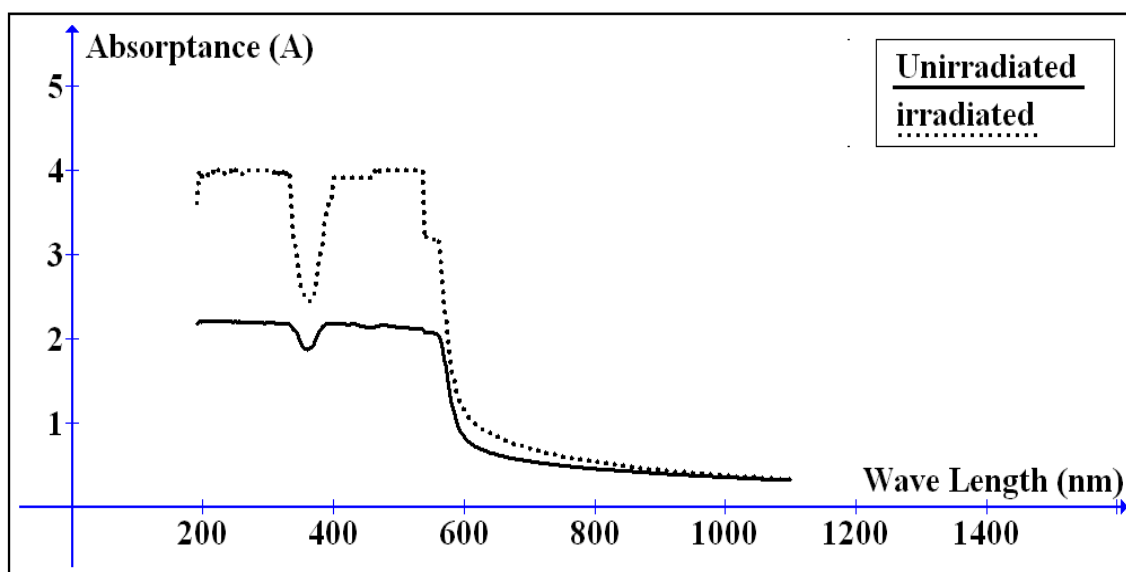


Figure No. (2) Absorbance of (PMMA- doped red methyl) before and after irradiation

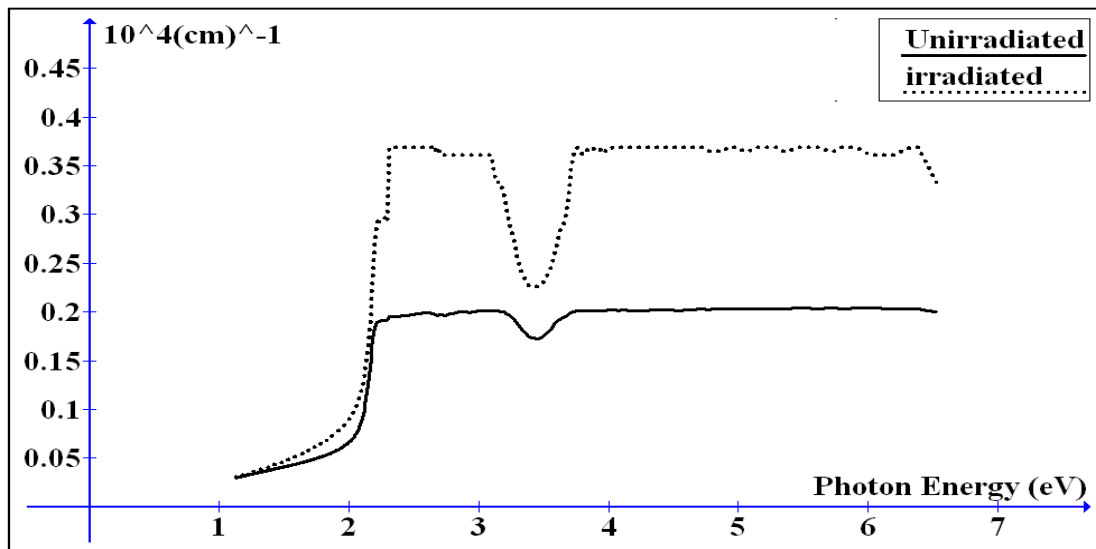


Figure No. (3) The absorption coefficient of (PMMA- doped red methyl) before and after irradiation

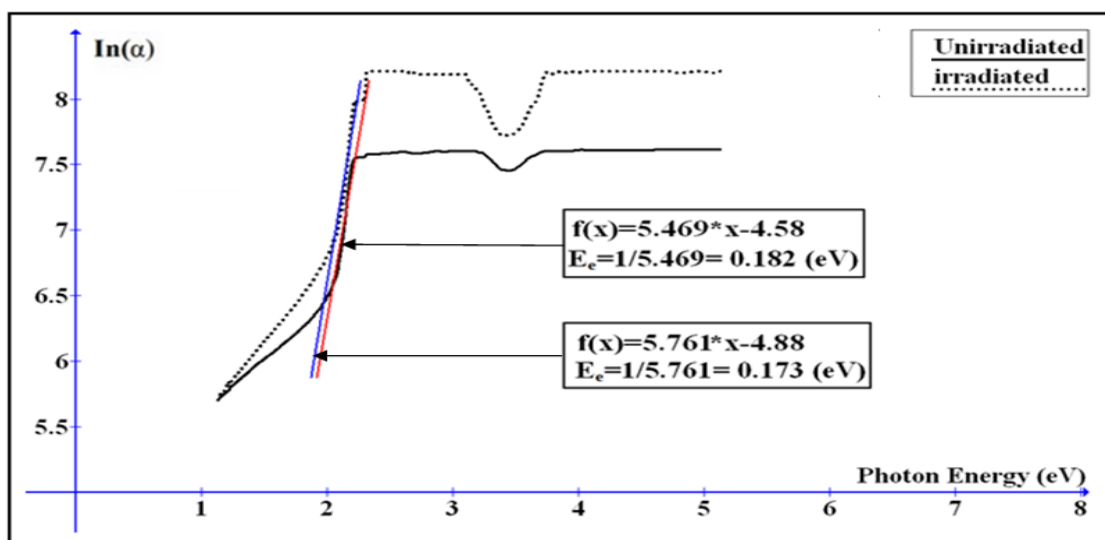


Figure No. (4) Relation between $\ln\alpha$ and photon energy of (PMMA- doped red methyl) before and after irradiation

تأثير أشعة كاما في بعض الخصائص البصرية وطاقة أورباخ لأغشية (PMMA- doped red methyl)

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الخلاصة

تم في هذا البحث دراسة تأثير أشعة كاما في النفاذية البصرية، والامتصاصية، ومعامل الامتصاص، وطاقة أورباخ لأغشية (PMMA- doped red methyl) المحضرة بطريقة الصب. قيست النفاذية البصرية ضمن المدى الأطوال الموجية (190-1100nm)، ومن تحليل هذه الأطياف وجد أن جميع المعلمات التي تمت دراستها تأثرت بأشعة كاما.

الكلمات المفتاحية : أغشية بولي مثيل ميثاكريلات، الخواص البصرية، أشعة كاما.