تأثير الليزر المستمر على الخصائص البصرية للأغشية الرقيقة

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The influence of continuous laser on the optical characteristics of Thin Films

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Abstract: In this study the effects of He: Ne laser that has wavelength 632.8 nm on optical characteristics of perfect PMMA materials have been examined. The spectrum of absorbance and transmittance was achieved in that wavelength from (190-890) nm utilizing ultraviolet spectroscopy. The findings present that energy gap of the sample decreasing with increase time of exposure to radiation .The extinction and absorption coefficients, as well as refraction index of substance PMMA that is pure and irradiated, which increasing with increase the period of exposure except the transmittance. By increase the time of irradiation the parts (real and imaginary) of dielectric constant is increasing.

Keywords: PMMA materials, the extinction and absorption coefficients, the energy gap energy.

الملخص: في هذه الدراسة تم فحص تأثيرات ليزر He: Ne ذو الطول الموجي 632.8 نانومتر على الخصائص البصرية لمواد PMMA المثالية. تم تحقيق طيف الامتصاصية والنفاذية في هذا الطول الموجي من (190-890) نانومتر باستخدام التحليل الطيفي فوق البنفسجي. أظهرت النتائج أن فجوة الطاقة في العينة تتناقص مع زيادة وقت التعرض للإشعاع ومعاملات الاخماد والامتصاص وكذلك معامل انكسار مادة PMMA النقية والمشععة والتي تزداد مع زيادة فترة التعرض ما عدا النفاذية. من خلال زيادة وقت التشعيع ، تزداد الأجزاء (الحقيقية والخيالية) لثابت العزل الكهربائي.

الكلمات الرئيسية: مواد PMMA ، معاملات الاخماد والامتصاص ، فجوة الطاقة

Introduction

Poly (methyl methacrylate), all the more regularly called PMMA, is a normally utilized ease thermoplastic polymer with unfathomable applications to regular daily existence. PMMA is the most economically significant acrylic polymer and is sold under a few business trademarks including Plexiglas® and Acrylite®. High straightforwardness makes PMMA an ideal substitution for glass where effect or weight is a genuine concern. PMMA is viable with human tissue making it a significant material for transfers and prosthetics, particularly in the field of ophthalmology due to its straightforward properties.

PMMA is shaped through square, emulsion, or suspension polymerization of methacrylic corrosive. PMMA was believed to be an atactic polymer through the primary portion of the twentieth century. This implies that the substituents of the sub-atomic chain substitute haphazardly along the chain. Since the improvement of present-day gear and strategies, it has been resolved that the sub-atomic chains are generally syndiotactic, which means the sub-atomic chain's substituents substitute consistently. The last preparation of PMMA is refined through infusion embellishment or expulsion at liquefy temperatures going from 200-230 ºC[1]

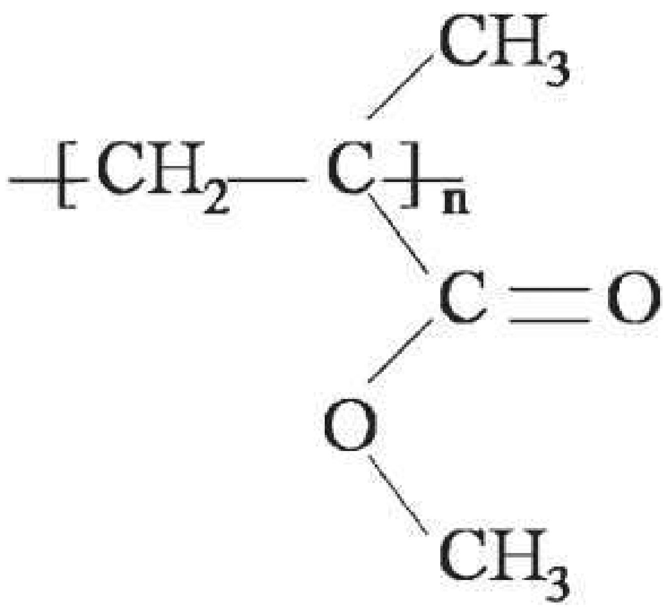

Fig. 1. Chemical structures of PMMA

As of late, the electronics and optical characteristics of those materials that have been widely explored inferable from their applications in current optical gadgets. The materials of polymeric have one-of-a-kind properties like low thickness, lightweight, as well as high adaptability and are broadly utilized in different mechanical sectors [2, 3]. PMMA is a significant and intriguing polymer on account of its appealing physical and optical characteristics. Poly(methyl methacrylate) contains bunches that are hydrophobic (methylene) and hydrophilic (carbonyl) in every unit. In addition, it has shown in polymer waveguide, the PMMA structure has pulled in numerous consideration for utilizing the optical properties and optoelectronic gadgets inferable from their minimal effort as well as volume efficiency. To develop, the discovery that can be created an enormous refractive file contrast contrasted and acryl amide-based photopolymers [4-6]. Most polymeric surfaces just as PMMA don't have explicit properties of surface required in different use, as well as the surfaces of them that should be blessed into receive acquire the material of polymers with required properties of surface in different cases. The laser treatment is one advantageous method of treating polymers [7–11]. Thus, it is needed to investigate the effect of treatment on the polymers characteristics.

Utilized Materials and Method

The underlying materials that pre-owned it in this work is Poly Methyl Methacrylate (PMMA) materials were set up by utilizing projecting procedure, it was broken up in glass container thirty ml through utilizing chloroform attractive stirrer and set in Petri dish 5 cm breadth into setting up the film. In addition, the example was poured in a 25 cm^2 glass bowl after cleaning it with water using an ultrasonic instrument. The example thickness is $5x10^{-2}$ centimeter. Absorption and transmission spectra accomplished for frequencies between 190-890 nm by utilizing twofold bar spectrophotometer ultraviolet CECIL-2700, which equipped by optimize 300 pluses establishment at room temperature prior to effect by He: Ne laser. Then the film is irradiated with a continuous laser, as well as the absorption spectra were recorded. To calculate the extinction coefficient (k), the following equation can be used [9]:

$$k = \frac{\alpha\lambda}{4\pi} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Here α presents the absorption coefficient, and λ presents the wavelength. To calculate the absorption coefficient (α), the following equation can be used:

$$\alpha = \frac{2.303A}{t} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Hence, A and t present absorption and the thickness of films, respectively. It can be used the following equation to calculate the absorbance and transmittance:

$$A+R+1= 1 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where T is transmittance. The refractive index (n) is calculated by using the following equation:

$$n = \sqrt{\frac{4R}{(R-1)^2}} - \frac{R+1}{R-1} \ldots\ldots\ldots (4)$$

By using the following equation to calculate the allowed indirect transition energy gap:

$$\alpha hv = (hv - E_g)^n \ldots\ldots\ldots (5)$$

Here, hv and A is the photon energy and the proportional constant, respectively. And E_g and n present the allowed or forbidden energy gap of direct transition and a constant, respectively.

Equations 6 and 7 are expressed of real and imaginary complex dielectric constant respectively [12]:

$$\varepsilon_1 = n^2 - k^2 \ \ldots\ldots\ldots\ldots\ldots (6)$$

$$\varepsilon_2 = 2nk \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Results and Discussions

Clearly seen from fig. 2, the spectra of absorbance as frequency amplitude for the occurrence of light. This figure presents the power of the pinnacle expanded together with expanding of the illumination time yet no move in the pinnacle position, for example, when used laser on the polymer doesn't variation the designed substance of the structure, however, new actual characteristics are shaped.

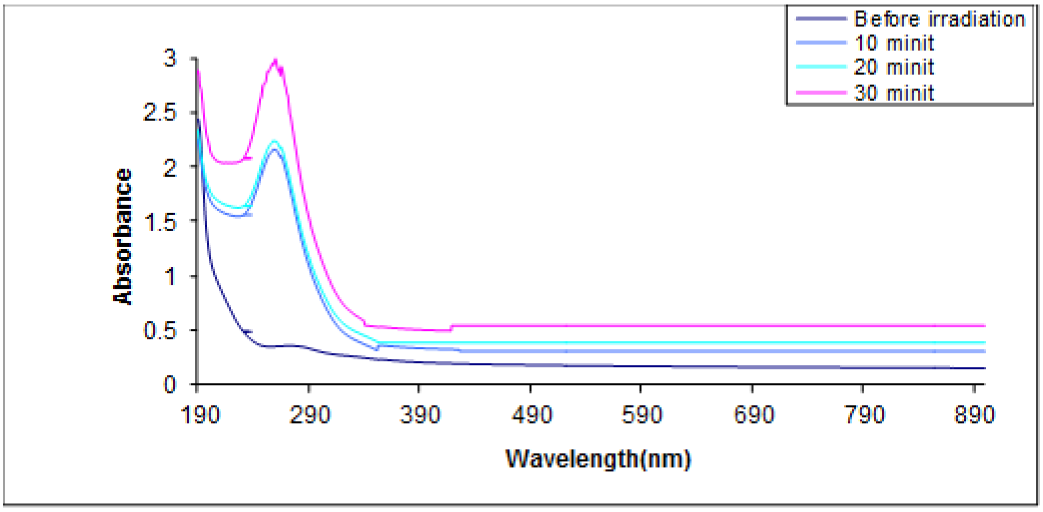

Fig. 2: Absorption spectra as a function of incident wavelength.

Therefore, the optical transmittance of these materials with wavelength is shown in figure (3). This figure shows decreasing transmittance spectra with increasing laser irradiation time.

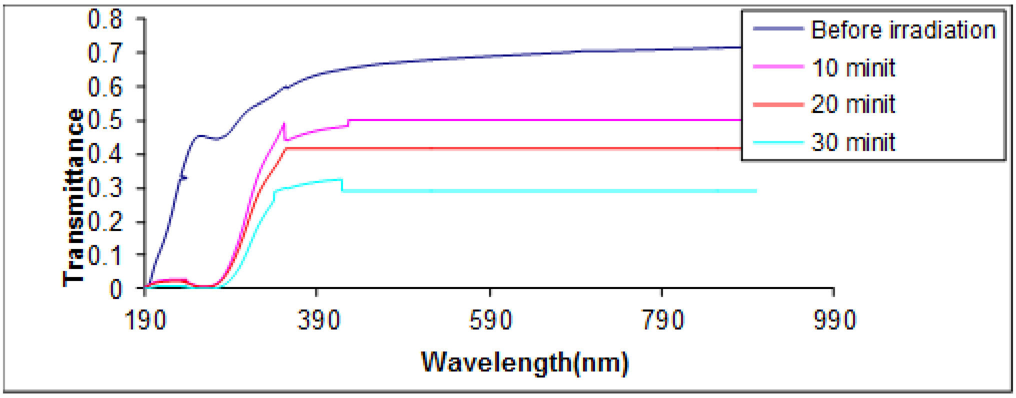

Fig. 3: The transmittance spectrum is a function of the incident wavelength.

By utilizing equation (2) to determine the absorption coefficient (α). From figure (4) shows, the absorption coefficient (α) is also a function of the photon energy, which tends to be observed to be slightly absorbed in low value of energy. In other words, the chance of changing the electrons are minimal on the basis that moving the electrons from the valence band to the conduction band due to the incident photon energy is not adequate. $(h\upsilon < E_g)$.

In addition, it has noticed the absorption is greater at high energies, which shows that the high probability of electron transitions as a result. Thus, the incident photons' energy is sufficient to transfer the charge from the valence band to conduction band. Therefore, the energy of the incident photon is more considerable than the forbidden energy gap [13]. This demonstrates that the absorption coefficient is to know the quality of the electron moves when the absorption coefficient estimates is high ($\alpha > 10^4$)/ cm at high energies. It is normal for the instantaneous change of the electron to occur, as well as the energy and moment is preserved via the electrons and photons. At low energies, the coefficient of swallowing is low ($\alpha<10^4$) /cm. It's often for the electron to circularly change, and the electronic force is preserved with helping of a photon.

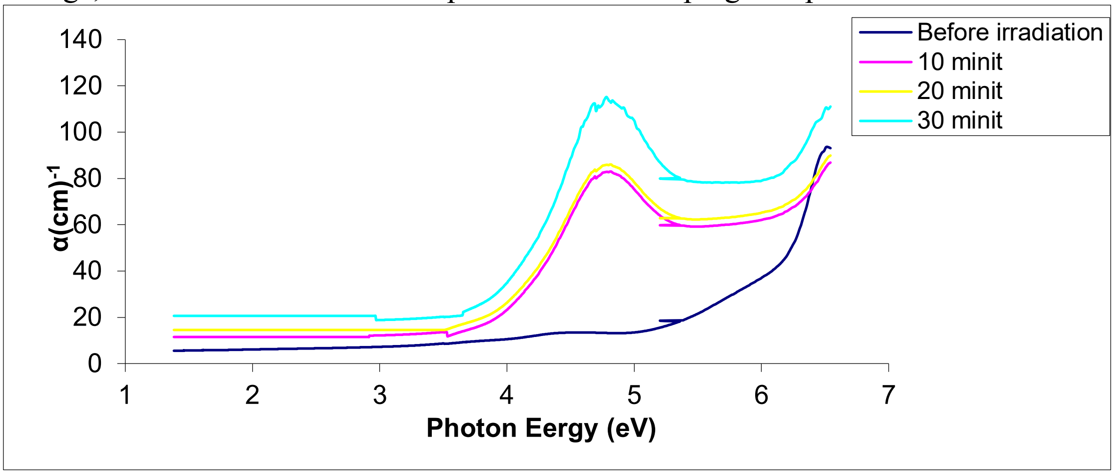

Figure 4: The absorption coefficient with photon energy

The relationship between absorption edges with the energy function of photons is shown in Fig. 5. At the extension of the curve, we got indirect allowed gap transition.

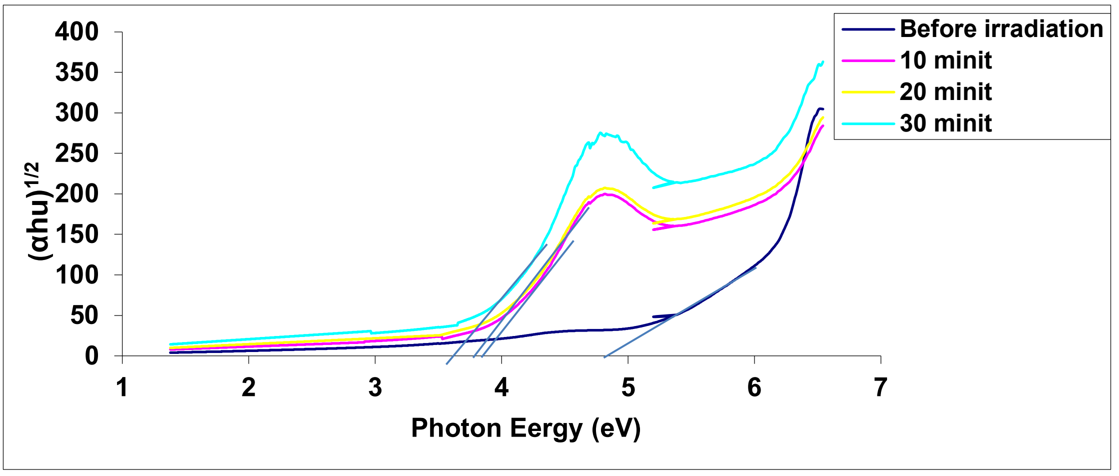

Fig. 5: $(h\nu\alpha)^{1/2}$ is as an energy of function photon.

The coefficient of extinction with wavelength is illustrated in fig. 6. It was seen that increase in the time of laser irradiation *lead to an* increase in *k*. At the longest wavelengths, the extinction coefficient is high.

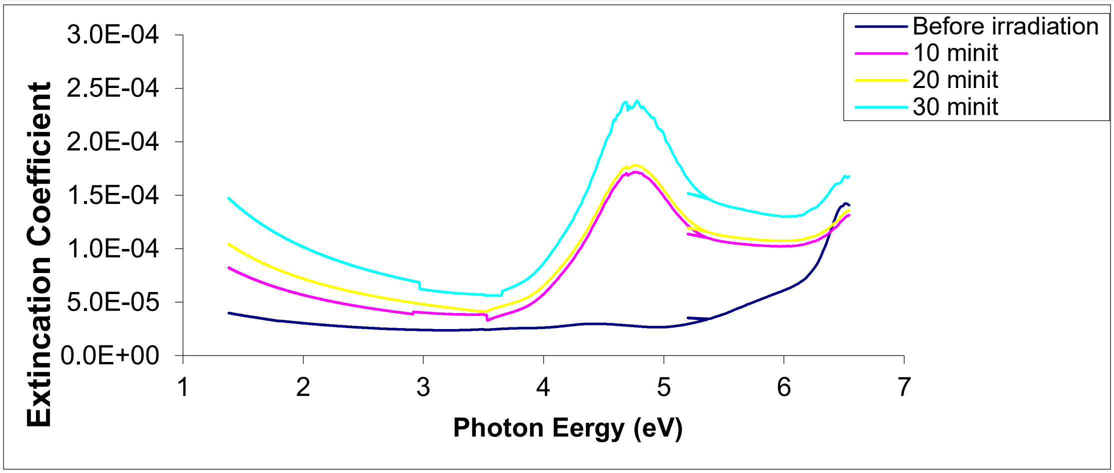

Fig. 6: Extinction coefficient as a function of wavelength

The real dielectric relies upon $n^2$and k^2 but the imaginary dielectric is based on k and n, the real and imaginary dielectric constant $\in_1$ and $\in_2$ have been determined from Equations (6) and (7), Figures (7), and (8) These constants are shown to change with the wavelengths. The values of the true dielectric constant are high with admiration for the dielectric constant, as they depend on the values of n and k.

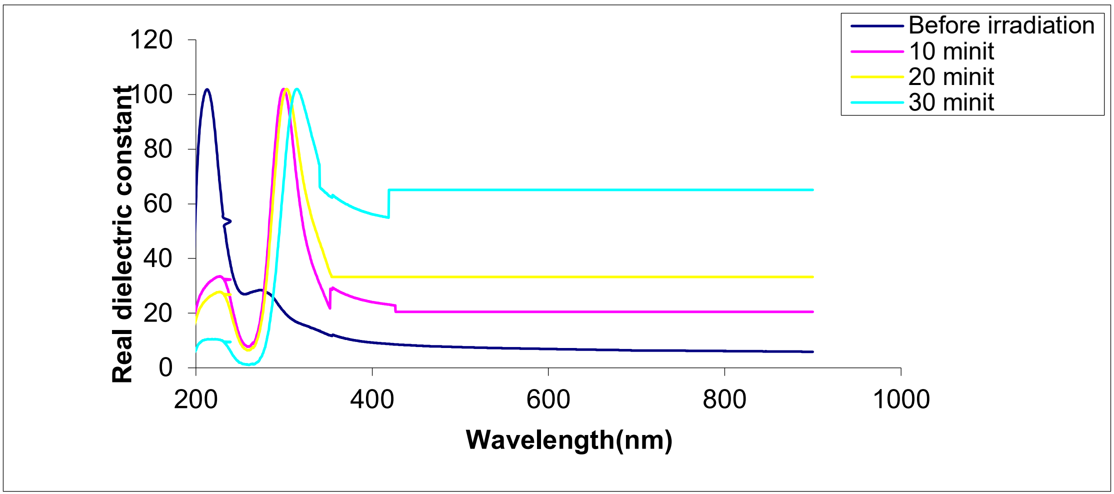

Fig. 7.the real dielectric constant of PMMA films as a function wavelength.

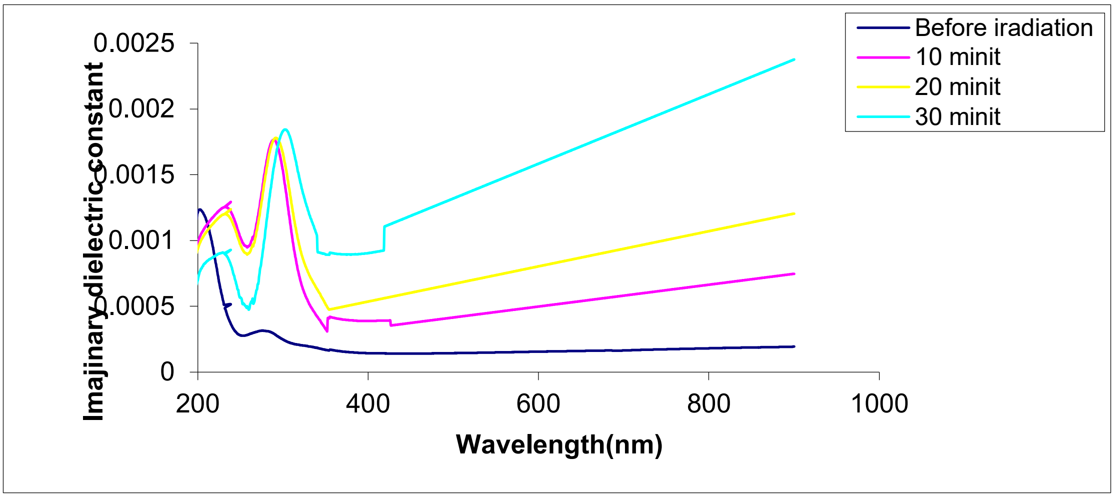

Fig. 8. The imaginary dielectric constant of PMMA films as a function wavelength

Conclusion

In this current work, we have studied Poly (Methyl Methacrylate) (PMMA) structure to calculate optical properties that represent as absorbance, absorption and extinction coefficients, and refraction index, which increase with the time of the laser pulses. However, transmittance was decreased with increasing the period of laser pluses. In addition, the value of the coefficient of absorption is less than 10^4/cm, which shows that the high probability of electron transitions as a result. Therefore, the allowed indirect of the optical energy transition is considerable than the transition of forbidden indirect.

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