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Studying the linear and non- linear optical properties of olive oil by using z- Scan technology

دراسة الخصائص البصرية الخطية واللاخطية لزيت الزيتون باستخدام تقنية المسح الضوئي

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ABSTRACT:

This Research presents a new study suggesting photonic laser applications. The material which is used olive oil that can be classified as an organic compound having non- linear properties. Such properties are not found in the other materials only by storing the material; it has become possible to be used in the photonic applications where high resolution sample was used of olive oil has wavelength (632 nm) with apower of (2 mw). After taking sample of pure olive oil, the linear optic,a properties such as penetration absorption, emission energies gapanddielectric constant real and imaginary partially (ε_r)&(ε_i) and study liner refractory coefficient as well also studying property of fluorescence of olive oil and then studying the optic non- linear properties denoted by non- linear refractive coefficient and non- linear absorption coefficient. This is conducted Z-scan technology.

الخلاصة

مادة البحث جديدة ومقترحة لتطبيقات الليزر الفوتونية. المادة المستخدمة هي زيت الزيتون الذي يمكن تصنيفه كمركب عضوي يمتلك مواصفات لا خطية وهذه المواصفات لا توجد في بقية المواد الا عن طريق تشويبالمادة ولذلكهذه الصفات جعلت من الممكن استخدامه في التطبيقات الفوتونية حيث استخدمت عينة ذو نقاوة عالية من زيت الزيتون. وان ليزر هليوم-نيون ذات طول موجي (632 نانومتر) وذو قدرة (2ملي واط). اخذت عينة من زيت الزيتون النقي تم قياس الخصائص البصرية الخطية المتضمنة كل من النفاذية والامتصاصية ولانبعاثيه وفجوة الطاقة وثابت العزل الكهربائي بجزئية الحقيقي والخيالي(ε_r)(ε_i) ومعامل الانكسار الخطي وكذلك دراسة خاصية الفلورة لزيت الزيتون. ومن ثم دراسة الخصائص البصرية اللاخطية المتمثلة بمعامل الانكسار اللاخطي ومعامل الامتصاص اللاخطي وهذه تمت باستخدام تقنية حديثة متمثلة بـ (Z-scan).

Introduction:

Visual ultraviolet applicable analysis is necessary to study the optical absorption that he crystal focus represented by olive oil which is considered as an organic materials consists of two main groups of materials: (saponifables, nonsaponifables). Olive oil is considered as strong compound containing (π) electron and this is good factor in obtaining optic nonlinear properties (1) where non- linear absorption has an important role in the non- linear ignition.

The optic linear absorptive linear and porous emission properties, energies and fluorescence were drawn based on (UV- Visible Spectors) measuring each of the optic linear properties denoted by the linear reflexive index and linear absorptive reflexive index the liquid crystals of optic nonlinear properties had great interest in industrializing them as they have such properties automatically without adding any ashes to them and this is an important characteristic in many industries and optic systems and also necessary in the current and future laser applications. Optics in general cannot be excepted from the non- linear properties as when there are optical inputs of high intensity; that is, there is change in the reflexive index and absorption index which in turn depends on density (2). As for the optic nonlinear properties represented by the non-linear reflexive index and non-linear absorption index were measured by Z-Scan by using the open hole technology for calculation the non-linear absorption index and closed hole for calculation the non-linear reflexive index (3,4).

1. Analyzing the (uv-visible spectroscopy) is made by using this device which is usually used for measuring the linear and non-linear optic properties and studying its relation with the

wavelength. The properties which have been measured using this device after placing the liquid crystal represented by olive oil. Absorption was studied. The absorption and its relation with the wavelength as well as the porosity emission linear absorption reflexive indexes energygap K-index (5) and the following indices shows the calculation of absorption, emission, porosity and idleness factor K and energies: following equation

The absorptance (À) represents the logarithm of the reciprocal of transmittance (ˈT)(6)

$$A = \log\frac{1}{T} \dots\dots\dots\dots\dots 1$$

$$\alpha = \frac{1}{d}\ln\left(\frac{1}{T}\right) \dots\dots\dots\dots 2$$

where d is the thickness of sample T is the transmittance, the extinction coefficient is obtained interns of the absorption coefficient (7,8)

$$E(e\upsilon) = 1240/\lambda(\text{nm}) \dots\dots\dots\dots\dots\dots\dots 3$$

$$Eg = h\upsilon \dots\dots\dots\dots\dots 4$$

$$K = \frac{\lambda\alpha}{4\pi} \dots\dots\dots\dots\dots\dots 5$$

Optical constants included refractive index (n), extinction coefficient (k), and real (ε_r) and imaginary parts (ε_i) of dielectric constant. The refractive index (n) can be calculated from the following equation (9)

$$n = \left[\frac{4R}{(R-1)^2} - k^2\right]^{1/2} - \frac{(R+1)}{(R-1)} \dots\dots\dots\dots\dots\dots\dots 6$$

....

($\varepsilon_r$andε_i) can be calculated by using equations(10)

$\varepsilon_r = \mathbf{n}^2 - k^2$ ……………………..7

$\varepsilon_i = 2\mathbf{n}k$ ……………………8

2. Z-scan technology, this is new technology and it is usually used for studying the non- linear optical properties where the laser ray is parallel with the density of Kaws curve through the lens. The sample and second length are measured along Z-axiies (optic axis) through focal point (11,12) where such method is represented by two techniques: open hole and closed hole. The method of open hole is used to measure non- linear absorption index and this techniques is consistent with laser emitted light after lifting the detector, then, it is not sensitive to any non-linear ray and there are other technologies to measure the non- linear absorption index such as technology of measuring the interception, deterioration and mix of the four waves. However, this technique is considered as more precise and modern than the previous techniques. Figure (1) illustrates to us this technology.

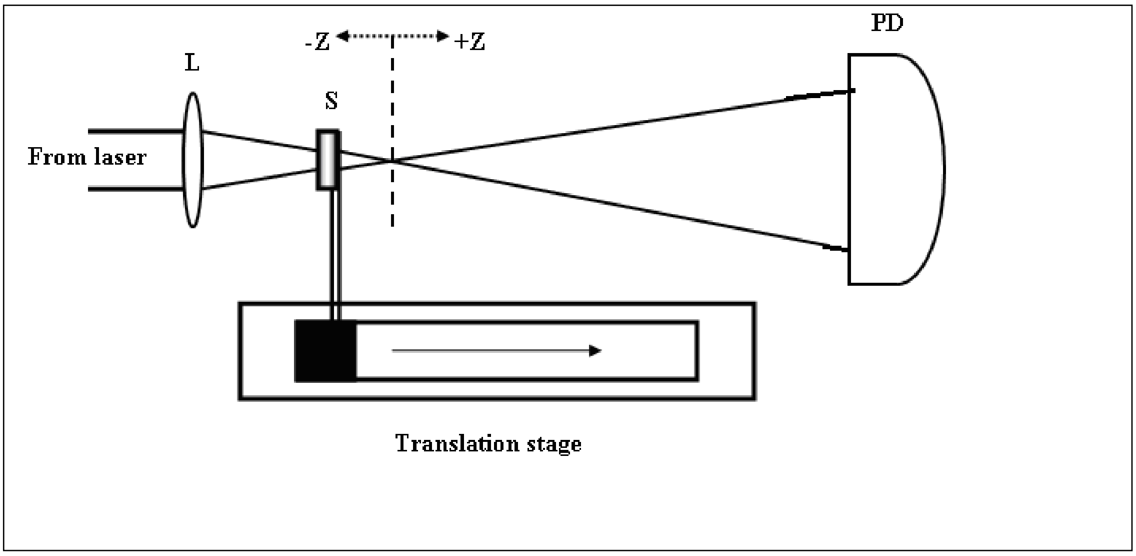


Figure (1) A schematic diagram of open - aperture Z- scan.

The absorption index can be calculated from the following equation (13,14)

$$\beta = \frac{2\sqrt{2}}{ILeef}\ \Delta T \ldots\ldots\ldots\ldots\ldots\ldots 9$$

$$\Delta T = 0.406\Delta\Phi_o \ldots\ldots\ldots\ldots\ldots\ldots\ldots .10$$

where: ΔT *p-v* : change in normalized
transmittance between peak and valley, which its
equal |Tp-Tv|Φo nonlinear phase shift,
k = 2π n /λ, λ: is the wavelength of the beam
Leff = (1- exp-αot) / αo ……………11
Leff: the effective length of the sample, can be
determined from the following formula, t: the sample lengthtion:

n2 =ΔΦo /Io Leff k .. ……………. 121

In case of closed hole, the non- linear reflexive index can be calculated through the above mentioned equaions(5,10,11) and figure (2) illustrates the technique of the closed hole represented by placing aperture or detector (12)

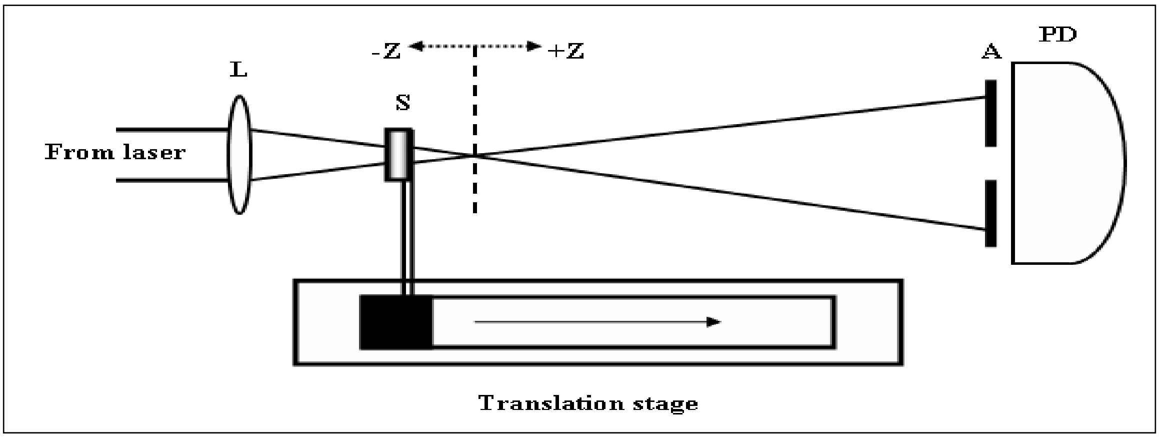


Figure (2) A schematic diagram of closed- aperture Z- scan
L =Lens, S= sample , A=aperture , D=detector

Practical Aspect:

1. Findings & Discussion:

a- Linear Findings

The optic properties of olive oil have been calculated represented by porosity, absorption linear reflection absorption index, energiesgap, idleness index K and the following shapes shows the relation of each variable with the wavelength:

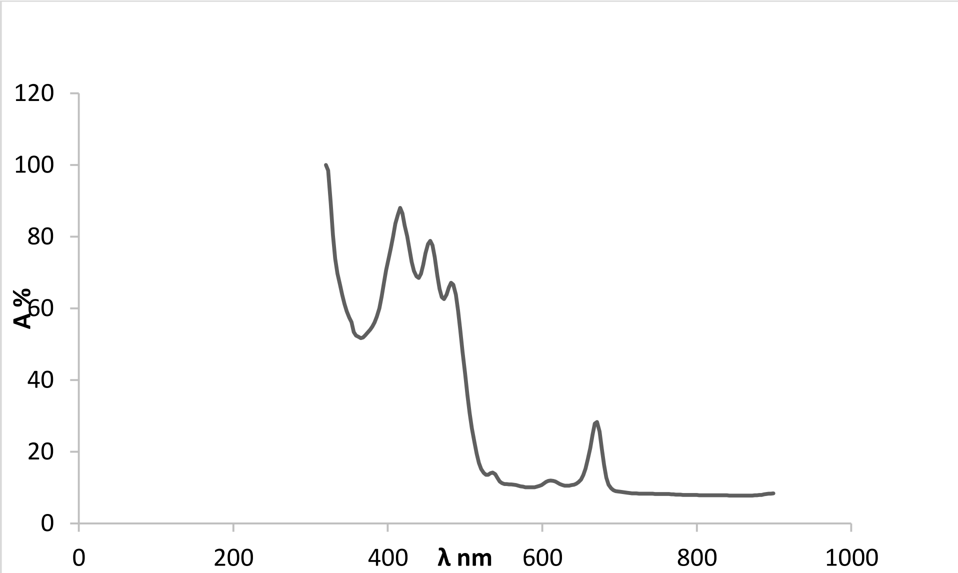
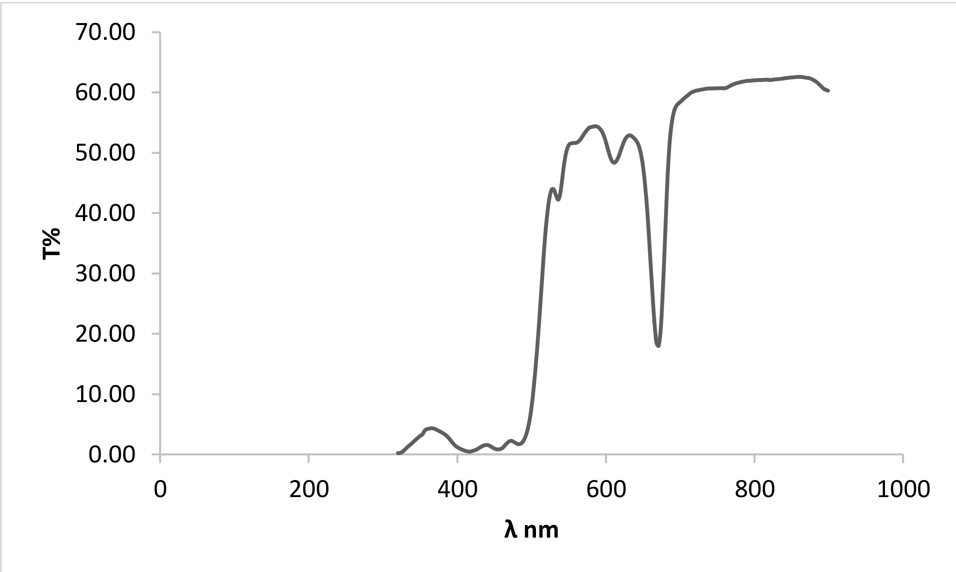
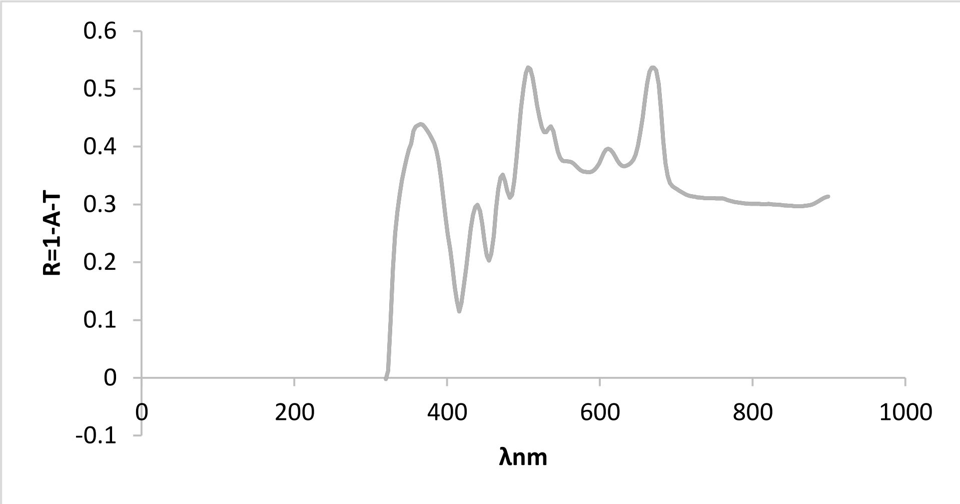


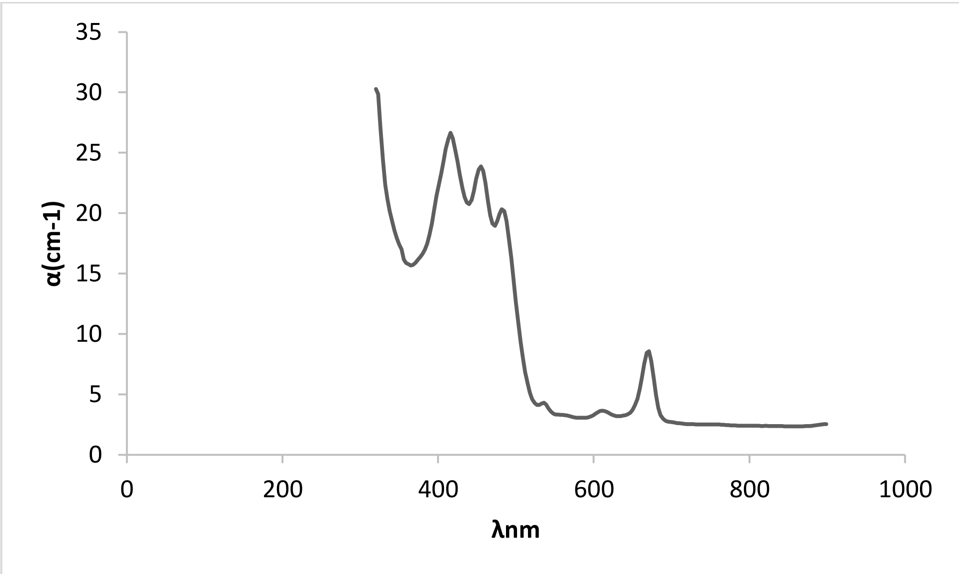
Figure (3) show the relationship between the wavelength and absorption



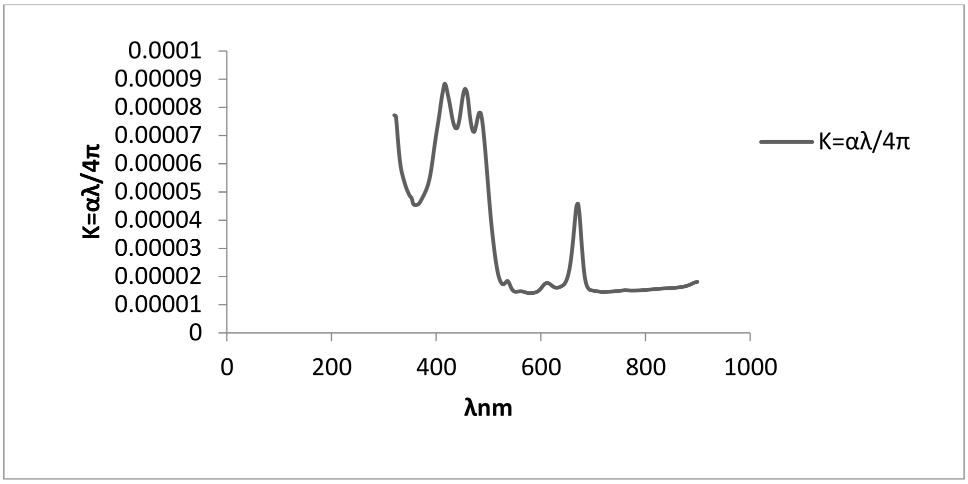
Figure(4)The relationship between the wavelength and penetration



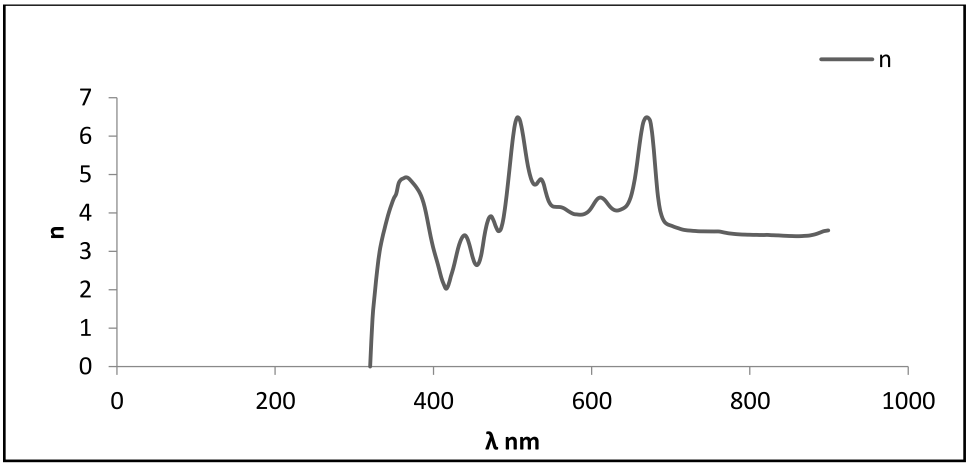
Figure(5)The relationship between the wavelength and reflcation



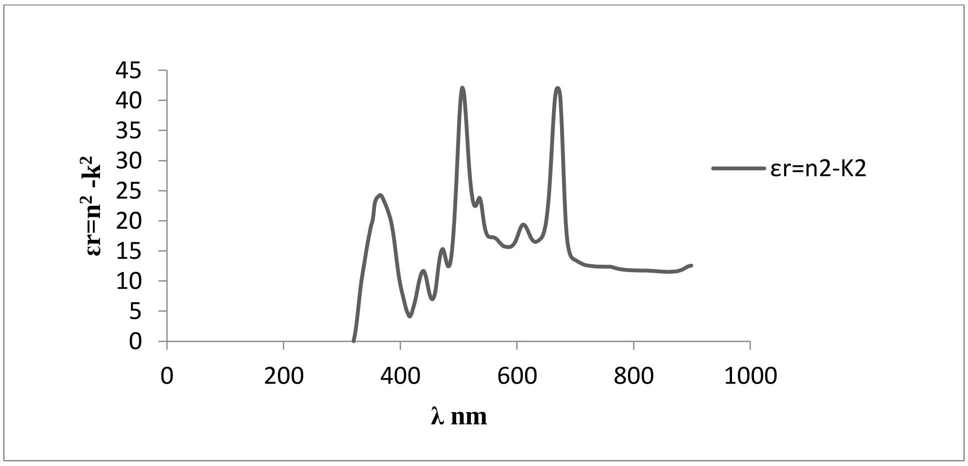
Figure(6)The relationship between the wavelength and absorption coefficient



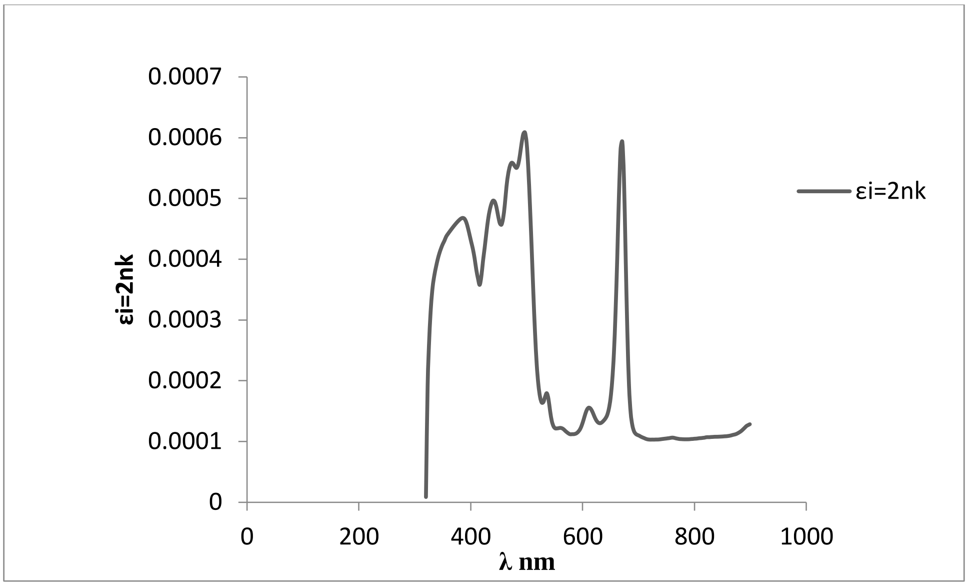
Figure(7)The relationship between the wavelength and idleness index



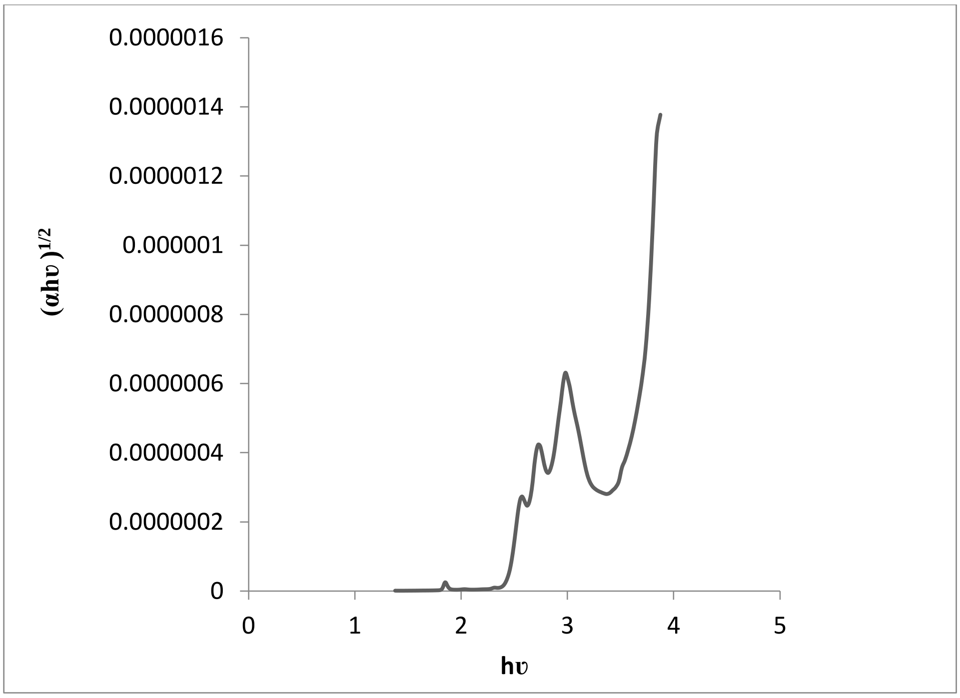
Figure(8)The relationship between the wavelength and The refractivecoefficient



Figure(9)The relationship between the wavelength and dielectric constantreal part



Figure(10)The relationship between the wavelength and The fantasypart



Figure(11)The relationship between theenergyand the energy gab

Fluorescence Measurement

Fluorescence is the molecular absorption of light energy at one wavelength and its nearly instantaneous re-emission at another, usually longer, wavelength. Some molecules fluoresce naturally and others can be modified to make fluorescent compounds

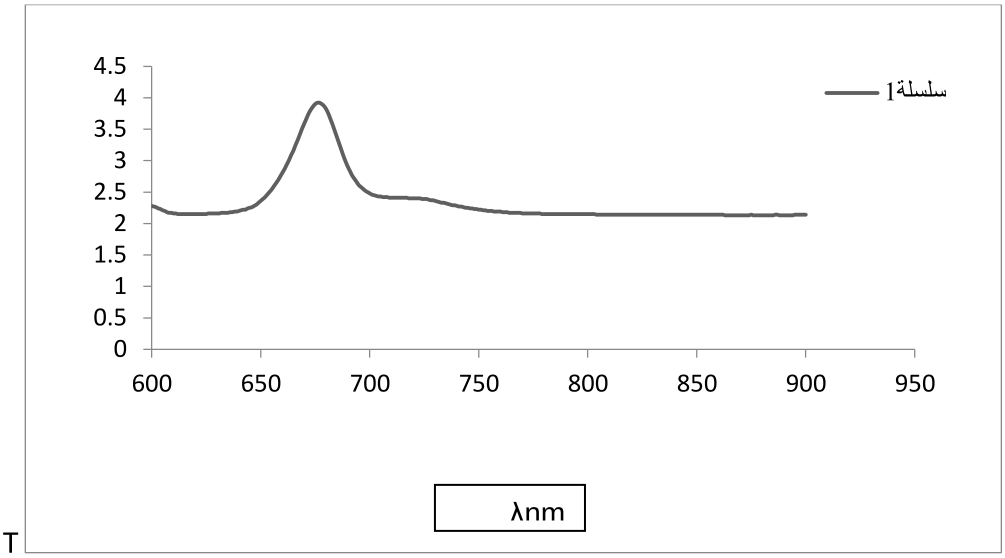
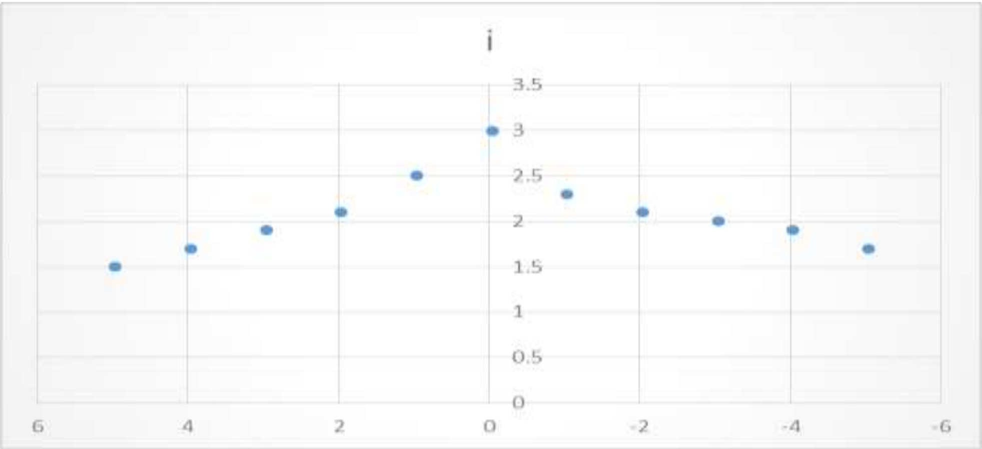


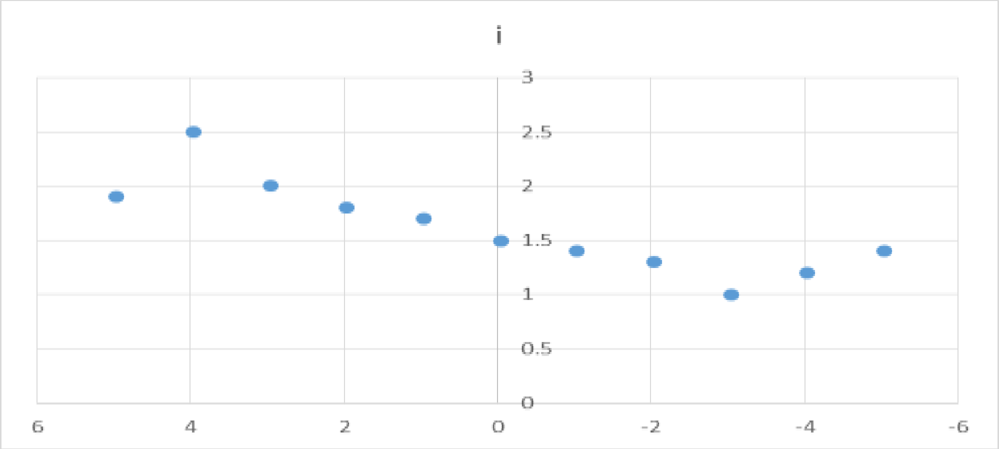
Figure (12) Fluorescence spectrum oftheOlive oil

b- Non- linear Findings:
In case of the open hole, figure(13) show the relation of each of: (Z, I)



Figure(13) normalized transmittance versus position at 632 nm

In case of closed whole. figure(14)show the relation of each of: (Z, I)



Figure(14) normalized transmittance versus position at 632 nm

Table(1)includes the value of the reflexive liner index by use (reflectometer) and the absorption non- linear index and non- linear reflexive which were calculated for the olive oil using laser of wavelength (632nm) as shown in the table:

λnm	n_0	$\Delta\Phi_0$rad	L_{eff}(cm)	B(cm/watt)	$n_2$cm^2/watt
632	1.4675	0.369	0.771×10^{-3}	1.22×10^{-3}	2.1×10^{-6}

Conclusions:

There are a set of techniques and approaches to identify the linear optic response and fluorescence depending on the spectroscopy of ultraviolet- visible rays based on (UV-Visible) device and studyingthe reflexive liner index by use (reflectometer) , reflexive index and absorption index and relation of each with the wavelengths. In order to identify the active materials visibly of non- linear properties,(Z-Scan) technology was used. It is one of the simplest experimental methods used to learn the non- linear optic properties. The results showed that the olive oil has good non-linear visible properties that can be used in the light applications.

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