Study the Optical Characteristics of the extraction Pigments from Vinca flowers

دراسة الخصائص البصرية للصبغات المستخلصة من ازهار الفينكا

Dr. Adnan F. Hassan Alaa Meahdy Mohamed
University of Kufa /College of Science / Physics Department

Abstract:

In this study , we had been three organic pigments extraction from Vinca flowers ,which are they have five color (yellow , red, white ,pink and purple) in the laboratory at room temperature. So we measurement the concentration of solvent for each the three pigments extraction from vinca pink , yellow and purple, considering the concentration for each pigment is constant .

The optical characteristics had been studied like (absorption, transmittance, reflectance ,Fluorescence and energy gap). Also the optical constant were calculated including (absorption coefficient and extinction coefficient) for three pigments and shown that the value of absorption coefficient increases when the Photon Energy increases, with constant the concentration ,but the value of extinction coefficient is decreases with increases wavelength.

Absorption and fluorescence for the three extraction pigments is a good, they have ability to absorbed a high quantity from the sun light.

The results also shown that the values of energy gap for the three pigments are(2.5 - 2.1) eV, which is within the limits work of the solar cell energy gap (photon energy was largest then or equal energy gap).

الخلاصة:

تم استخلاص ثلاثة صبغات عضوية من ازهار الفينكا التي تمتاز بالوانها الخمسة (الاصفر ،الاحمر ،الابيض ، الوردي والبنفسجي) في المختبر وبدرجة حرارة الغرفة . كذلك تم قياس تركيز المحلول لكل من الصبغات الثلاثة التي استخلصت من ازهار الفينكا الوردية والصفراء والبنفسجية،حيث اعتبر ان التركيز لكل صبغة ثابت.

درست الخصائص البصرية مثل (الإمتصاصية ، الفلورة ، النفاذية ، الإنعكاسية وفجوة الطاقة) ايضا تم حساب الثوابت البصرية التي تشمل (معامل الإمتصاص ،و معامل الخمود) للصبغات الثلاثة وتبين ان معامل الامتصاص ترتفع قيمتها عندما تزداد طاقة الفوتون مع ثبوت التركيز، لكن معامل الخمود تقل قيمه مع زيادة الاطوال الموجية .

وجد ان الامتصاصية والفلورة لهذه الصبغات االمستخلصة الثلاثة جيدة ،اي انها تمتلك القابلية على امتصاص كمية ضوء الشمس بنسبة عالية.

اظهرت النتائج إن قيمة فجوة الطاقة لكل من الصبغات الثلاثة تتراوح بين (2.1eV - 2.5) وهذا يضمن العمل وفق حدود فجوة الطاقة للخلية الشمسية(حيث تكون طاقة الفوتون اكبر اوتساوي من فجوة الطاقة).

Introduction:

Solar panel is used for fluorescence generation , through the conversion of light energy rather than thermal energy into electrical or thermal energy , and the resulting energy is renewable natural energy , the environment-friendly clean.

What distinguishes the new technology for the manufacture of solar cells , is used for organic pigments and thus there was no need to silicon material and is known to be currently conducted many attempts for the production of solar cell plants.

Scientists Qdtmcn of finding a way to make a synthesis of light synthetic , which make it possible to harness sunlight to produce unlimited amounts of electricity or hydrogen or other fuels to energy from the water -rich cleanly and inexpensively[(1)] . The miracle of photosynthesis , which formed an important event in the continued emergence of life on Earth , a process very Al-Assaobho what the human mind is still struggling with all his force and the accumulation of knowledge-based simulation of these divine miracle in the laboratory , trying to find a new source

of inexhaustible energy to replace the chronic problems of the world . And Kthirmen scientists work Pfkrhhzh miracle and Bashaddam chloroplasts in the leaves of plants as well as the extraction of organic pigments of flowers that perform photosynthesis , as a group of scientists in order to get the green Al- Blassdat grinding spinach leaves and separate the components by using a centrifuge , and was purifying chloroplasts and saved in the case of water-soluble.

But the complex proteins on a thin piece of glass coated wafer of gold and covered with semiconductor and then another layer of metal[(2)].

In this research ,we choosing the **Vinca flowers** for extraction to get of organic pigments ,and to study the optical Characteristics to know the specialty range to use these as luminescent solar concentrators of panels or films .Vinca flowers are plants of family Apocynaceae and the scientific name Catharanthusrosea, the flowers with pink color, white , yellow , purple and red ,violet and a wooden leg , Leather securities oval shape[(3)].

Molecular formula **(Cu6 H60 Nu O13)** and Molar mass (**737.89 gm.mol^{-1}**) , these plants are contains of two component vinblastine and vincristine[(4)] . The figure (1) is show Form of vinca flowers and formulas structure.

Experimental Detailsand Optical Characterization:

1- Sample extraction:

After we take group of vinca flowers with color (yellow , pink and purple) to balance as soft states. Organic pigments extraction or the plant cells from vinca , by using two solvents, namely methanol (9%) and water(1%) were used for extraction procedure. The extraction protocol involved the addition of 25 ml of 1 g of sample and for 2 h at low speed (75 rpm) in an orbitory shaker (Neolab) . Samples were then stored at 20°C for overnight in the dark to allow for maximum diffusion of phenolics from the cellular matrix. Samples were taking for analysis to the centrifuged at (7,000) rpm for (10 min) . [(5)] , Separated the solvent of extraction from the leaky . Finally, from the extraction vinca ,we have get three pigments with color (yellow , pink and purple).

2- Measurement the quantity of pigments extractby measurement the Absorbance:

We find the concentration of the three pigments **(yellow, pink and purple)** by using the equation (1) as following:

C = 20.2(absor. at 645) + 8.02 (absor. at 663)*(V/ 1000 * W)----------(1) [(6)]

Where:

C : concentration of the pigment

V : volume of extract last to the pigment

W : weight soft to the plant

The concentrations of the three pigments yellow, pink and purple are difference (0.02 , 0.01 , 0.04) mg.g^{-1} to follow.

3- Measurement the absorption spectra for three pigments:

The absorption spectra for the three pigments extraction from vinca are shown in fig(2).The three pigments have absorption intensity increases with a little shifting towards higher wavelengths with concentration constant.

4- Measurement the absorption spectrum for mixture of solvents:

UV-Spectrophotometer was used to measurements the absorption and transmission spectrum[(7)] , for three pigments and mixture of solvents (methanol CH3OH and water H2O) in the wavelength range (200-800) nm. Noticed the absorption curve of absorption spectrum to the mixture of solvents(methanol -water) have wavelength range from (100 - 350 nm) , it meaning the mixture of solvent have absorption within the spectral range of absorption pigments. The figure (3) is show Optical absorbance spectra mixture of solvents (Methanol- water).

5- Transmission Spectra:

Observed, there are simple difference between values of the transmission for three pigments, it is increases with increases wavelength in visible region .The fig.(4) is show the optical transmission spectra of three pigments.

6- Absorption Coefficient:

Absorption coefficient represents the attenuation that occurs in incident photon energy on the material for unit thickness, and main reason for this attenuation is attributed to the absorption processes[8]. The absorption coefficient (α) was calculated in the fundamental absorption region using Lambert law:

$$Ln(I_0/I) = 2.303A = \alpha d \quad -----(2)$$

$$\alpha = 2.303A/d \quad -----(3)$$ [9]

Where: I_o and I are the intensity of incident and transmitted light respectively .
A : The optical absorbance , d : The thickness.

Fig.(5) shows the curves of absorption coefficient with photon energy for the three pigments where their values increase rapidly beyond absorption edge regions.

7- Reflectance:

The reflectance has been found by using the relationship:

$$R + T + A = 1 \quad -----(4)$$ [10]

For three pigments a higher reflectance in UV region at wavelength (200-380)nm, and the reflectance values is drop at the wavelength (420)nm. Fig.(6) shows the optical reflectance spectra for the three pigments.

8- Extinction Coefficient:

Extinction coefficient (k) for the three pigments was calculated by using the relation [11]:

$$K = \frac{\alpha\lambda}{4\pi}. \quad -----(7)$$

Variations of extinction coefficient as a function of wavelength are shown in fig.(7) . The peak of the extinction coefficient is start from (150) to the visible wavelength region for three pigments.

9- Fluorescence spectra:

Fluorescence is the emission of light by a substance that has absorbed light or other electromagnetic radiation [12] . Fluorescence max values show that Fluorescence curves deviate to the red-Stokes shift with the concentration constant it agree with Beer – Lambert Law.
We can be seen from fig.(8) the three pigments have a higher Fluorescence about (1.07- 0.99 - 0.099) at visible wavelength region(380 - 510)nm.

10-Energy Gap:

Study of material by means of optical absorption provides a simple method for explaining some features concerning the band structure of material . For determination of optical band gap energy, the method based on the following relation[13]:

$$\alpha h\nu = A(h\nu - E_g)^r \quad -----(8)$$

Where :
hυ is the photon energy.
E_g : The band gap energy.
A and r are constant.

The value of (**r**) depends on the nature of the transition. In this case it's value was found to 1/2 (which corresponds to direct band to band transition)[14]. The figures(9,10,11) shows the plot of $(\alpha h\upsilon)^2$ and hυ for the three pigments . The linear nature of the plot indicates the existence of direct transitions.

In the figures (9 ,10,11) , from the straight line obtained at high photon energy the direct allowed energy gap could be determined**.** The values of the energy photon for the three pigments was largest then energy gap .The values of the above optical parameters at energy gap for three pigments are expressed in table (1).

Table (1)The values of energy gap (E_g) ,wavelength(λ_c), Transmission(T) , Absorption Coefficient(α), Reflectance(R) ,Extinction Coefficient(K) and Fluorescence(F) for three pigments

Pigment	Concentration $mg.g^{-1}$	E_g(eV)	λ_c (nm)	$\alpha(cm)^{-1}$	K	F	A	T	R
pink	0.01	2.2	540	0.49	2.11	0.99	0.21	61.2	0.1
yellow	0.02	2.5	496	0.16	6.66	1.07	7.33	84.4	0.08
purple	0.04	2.1	564	0.19	8.79	0.099	8.65	82.2	0.09

Conclusions:

1-Methanol and water is a good solvent to vinca flowers.

2-The three pigments which are extraction is a good pigments ,because they have a high fluorescence and absorption in the visible region, this is how the material should be to suitable to prepared panels or films as concentrators of solar cell .

3-The values of transmission and reflectance of the three pigments, to agree with the work to be effective region for absorption of both solar cell and the three pigments used.

6- Optical band gap $\mathbf{E_g}$ was determined by the photon energy values, the values of optical band gap was less than photon energy for three pigments ,which within the limits work of solar cell energy gap.

7-The three pigments have a good values for extinction coefficient at visible wavelength region(496– 564)nm **.**

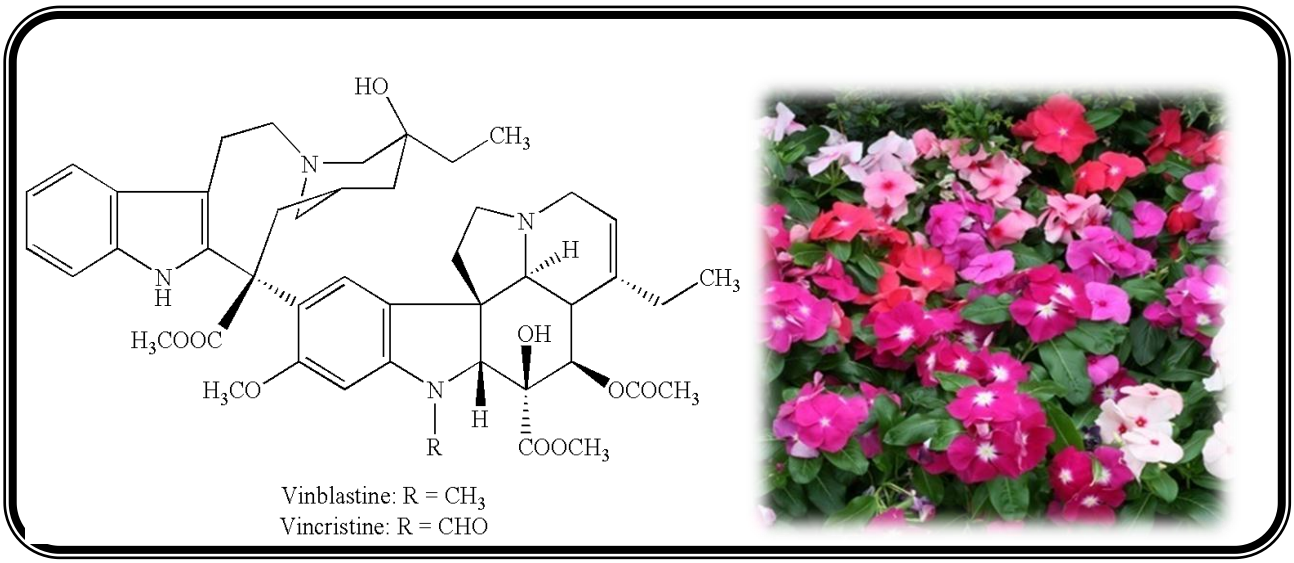

Figure (1) Form of vinca flowers and formulas structure

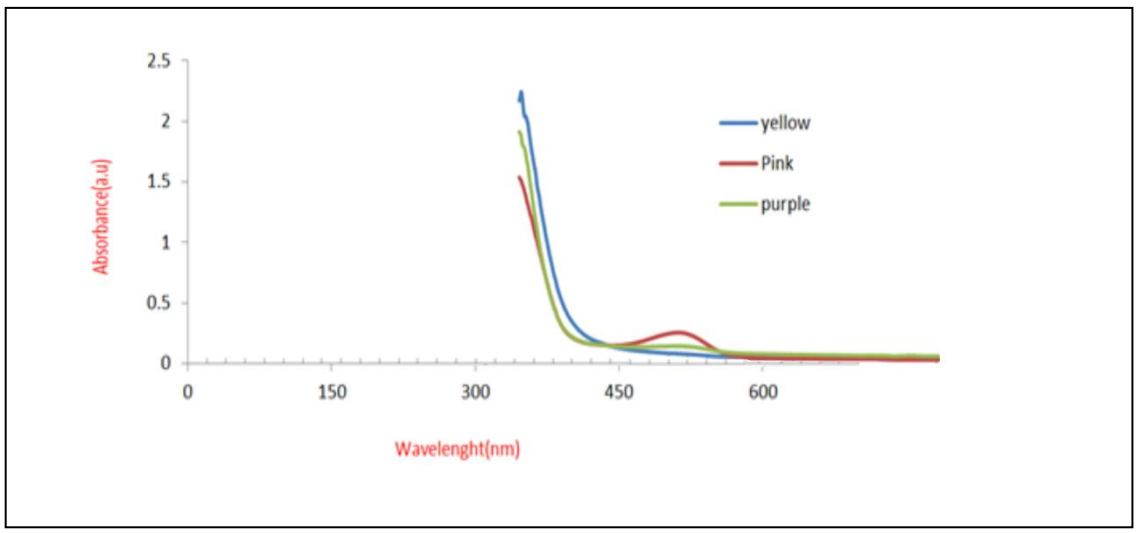

Fig.(2) Optical absorbance spectra of three pigments.

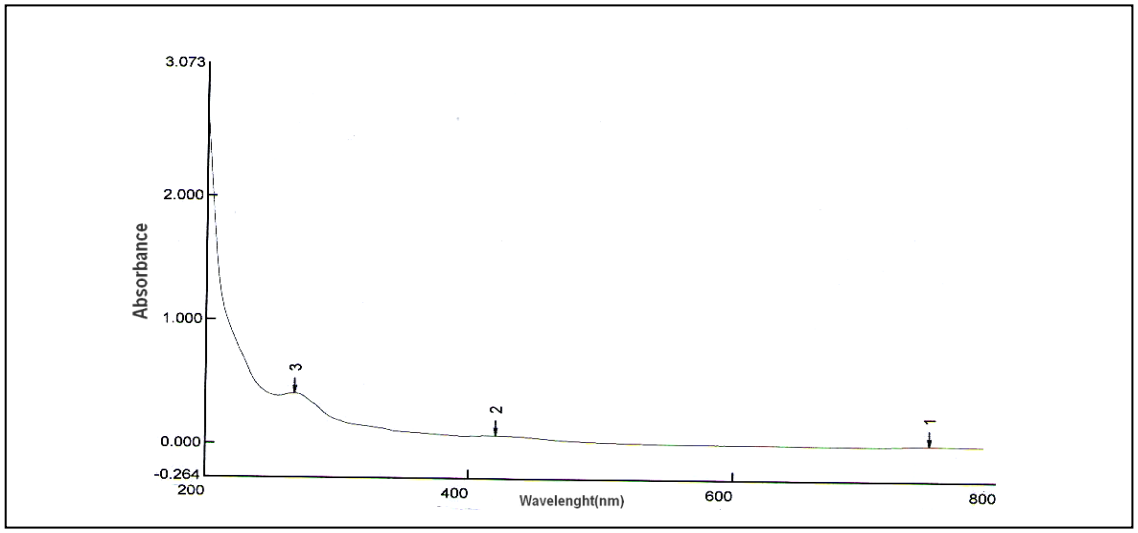

Fig.(3) Optical absorbance spectra mixture of solvents (Methanol- water).

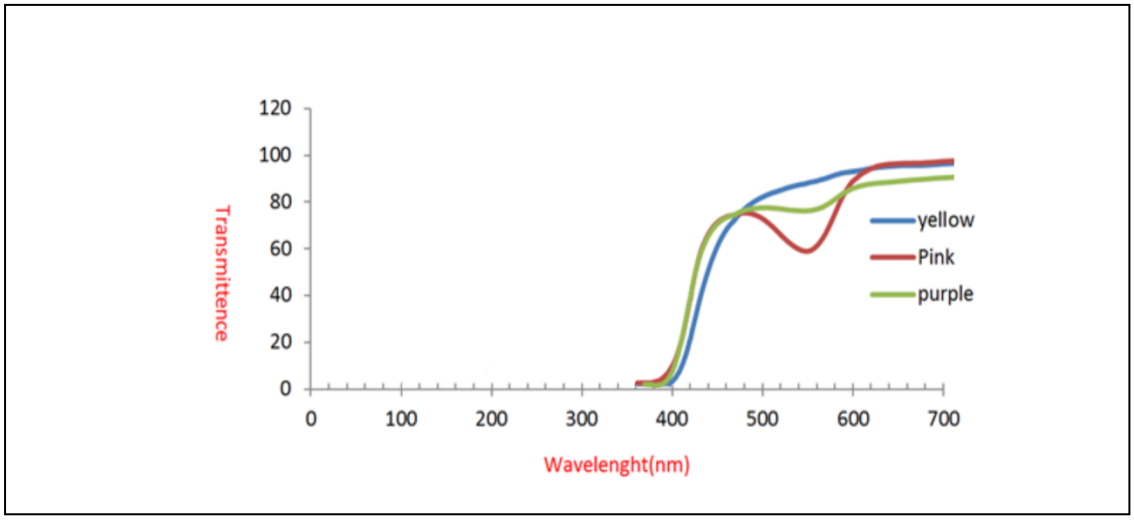

Fig.(4) Optical transmission spectra of three pigments.

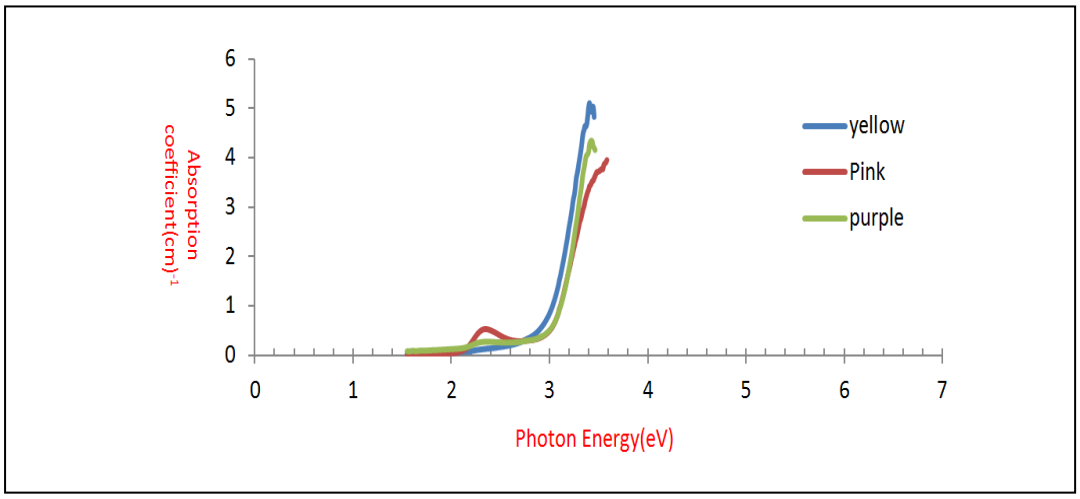

Fig.(5)Optical absorption coefficient with photon energy of the three pigments.

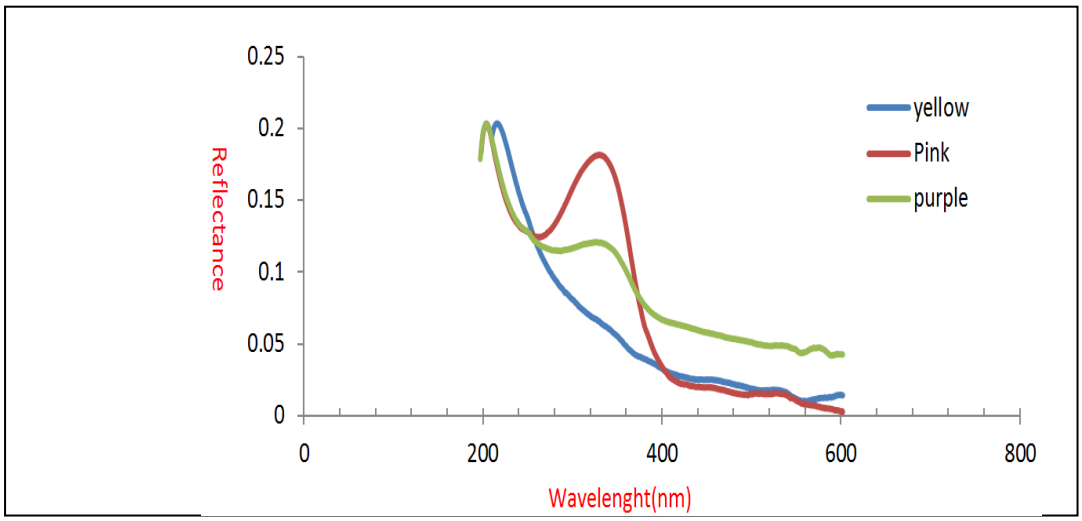

Fig.(6)Reflectance spectra with wavelength of the three pigments

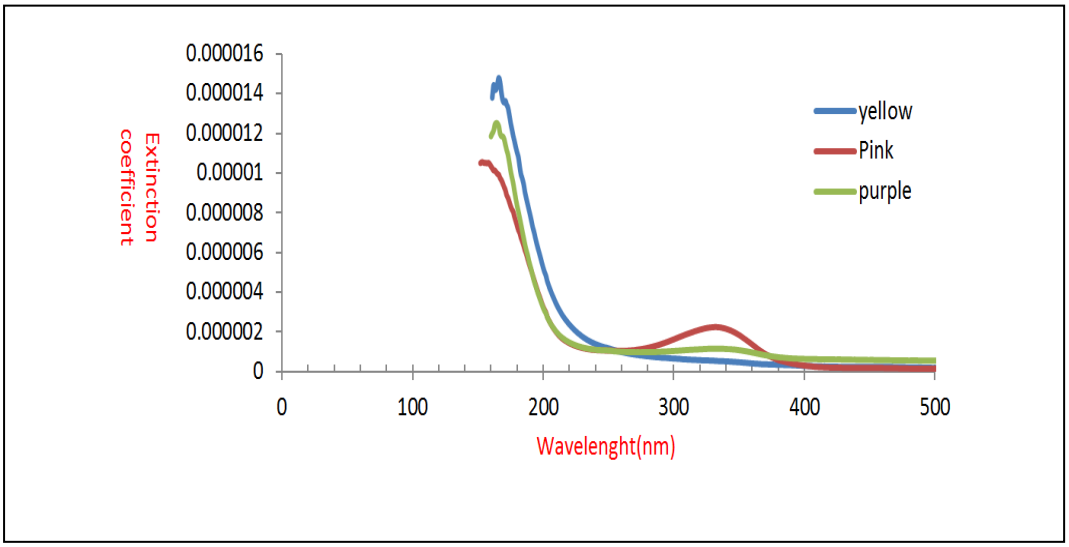

Fig.(7) Extinction coefficient spectra with wavelength ofthree pigments

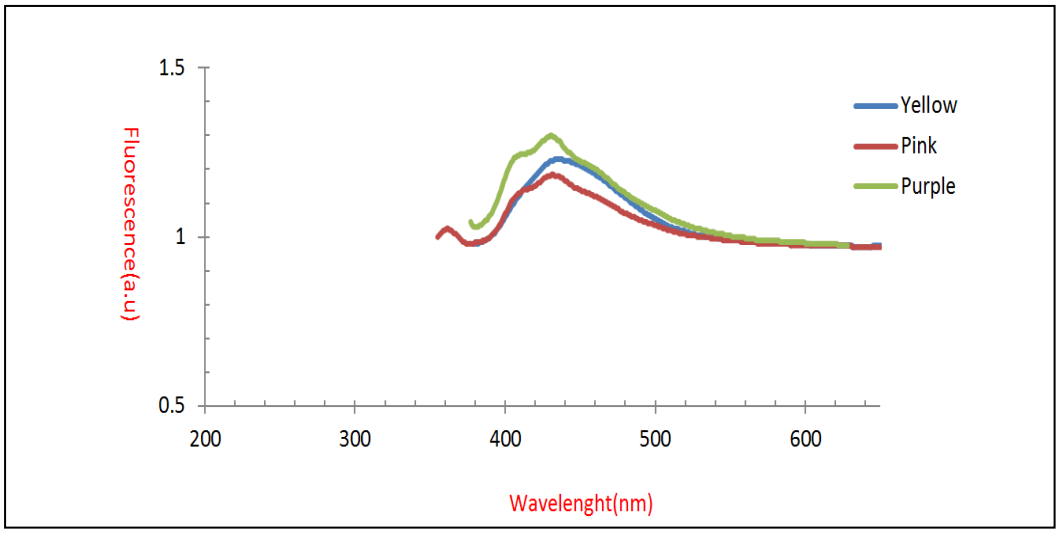

Fig.(8) Fluorescence spectra with wavelength of three pigments

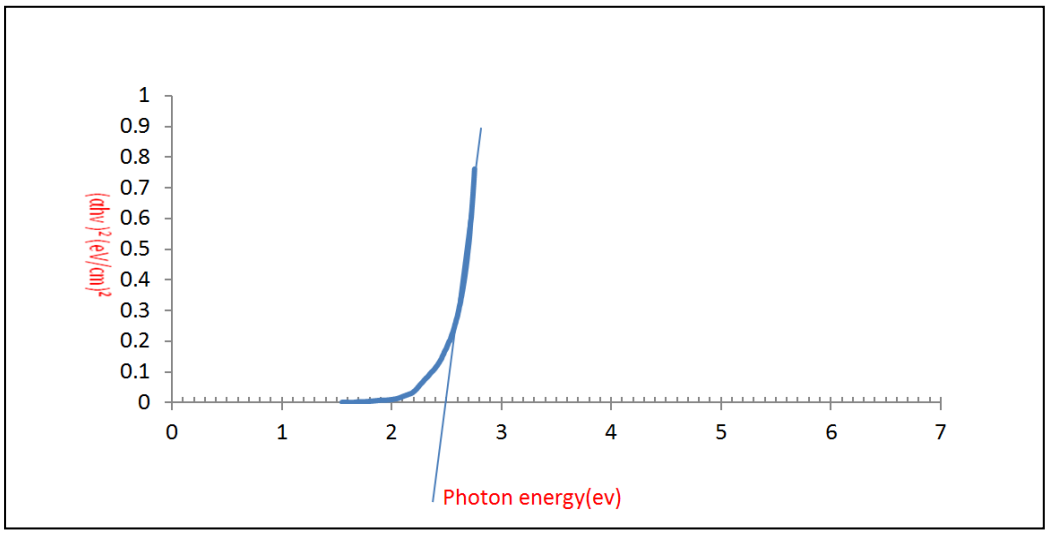

Fig.(9) Variation of $(\alpha h\upsilon)^2$ with photon energy of pigment yellow

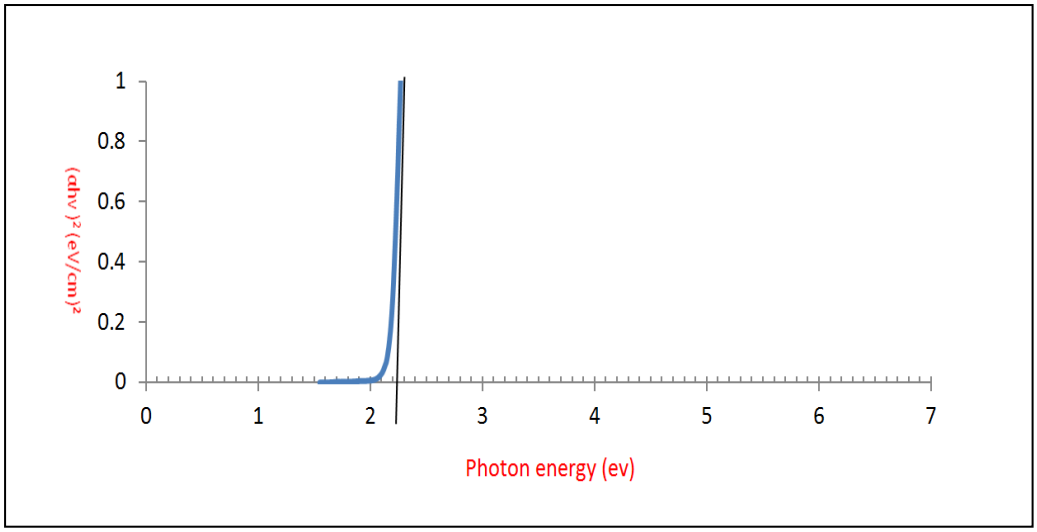

Fig.(10) Variation of $(\alpha h\upsilon)^2$with photon energy of pigment Pink

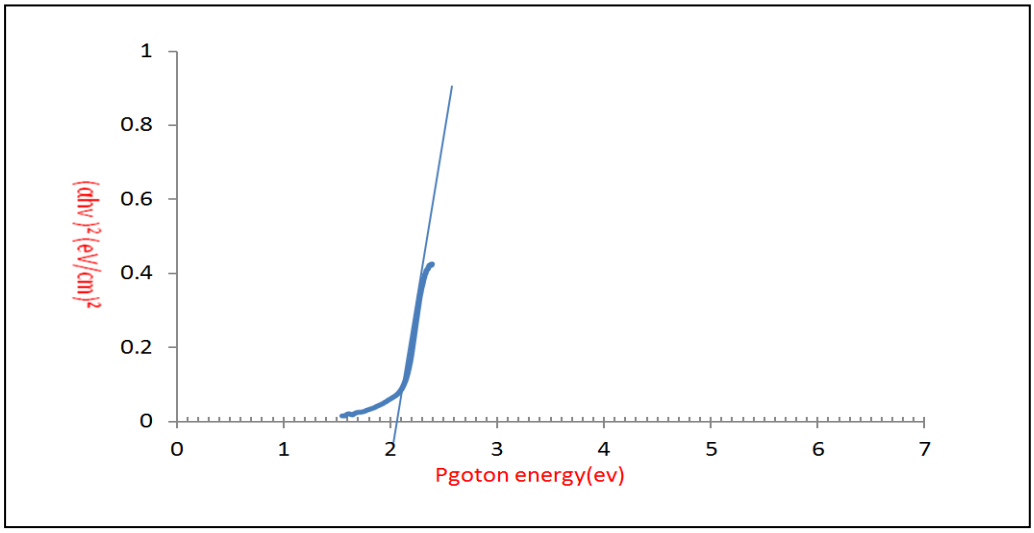

Fig.(11) Variation of $(\alpha h\upsilon)^2$ with photon energy of pigment purple

References:

1) Falah Hausen Araby "Study the effect of three factors on the out put parameters of silicon solar cell", MSc. Thesis, Babylon University, 2006.
2) Karl Martin Karlsson ,"Design, Synthesis and Properties of Organic Sensitizers for Dye Sensitized Solar Cells". Doctoral Thesis ,Stockholm 2011.
3) Nau J. , "Vinca ,In :G.A Ball, jr.(ed) The ball redbook ", 15th Ed. Reston Pulishing Co., Reston, VA. pp.782-783 ,1991 .
4) kirori and hindu ,"Atext book of optics" , subrahmayam department mal college university of dethi , reader in physics, 2000 .
5) Joseph MA, Lloyd WR, Ralph DW (2004). "Anthocaynins from black sorghum and their antioxidant properties". Food Chem., 90: 293-301. Kahkonen MP, Hopia AI, Vuorela HJ, Rauha JP, Pihlaja K, Kujala TS (1999). Antioxidant activity of plant extracts containing phenolic compounds. J. Agric. Food Chem., 47: 3954-3962.
6) Makinney G. , "Absorption of light by chlorophyll " . Solution. Biol. Chem. 140:315-322 , 1941 .
7) FaizSalih A., Thesis of M.SC. " Luminescent solar concentrators to improve solar cell conversion efficiency". University of Kufa –Collage of Sciences,2013.
8) Faiz Salih A. and Nibras F. Ali . "Study the Optical Characteristics of Epoxy Panel doped with Fluorescein -Sodium Dye" . University of Kufa-College of Science,2013.
9) IlicaS.,CaglarY.,CaglarM., and Demirci B. ,"Polycrystalline Indium-Doped ZnO Thin Films: Preparation and Characterization",Journal of optoeelectronicsb and advanced materials Vol.10,No.10,PP. 2592-2598,(2008).
10) Bertmun I.B. ,"Handbook of Fluorescence Spectra of Aromatic Molecules", Academic Press , New York , (1965).
11) Clemson (Cooperative extension) . Home and Garden, information center. Prepared by Karen Russ, "HGIC Information Specialist, and Bob Polomski, Extension Consumer Horticulturist", Clemson University (New 03/99) **,** HGIC 1158 ,1-888-656-9988 .
12) Alaa Mahdi M. ,Thesis of M.SC.. "Improve solar cell energy conversion efficiency by using illuminescent dye concentrators" . University of Kufa –Collage of Sciences,2014.
13) Nibras F.AL-Shammary ,"Optical characteristics of NiO thin film on glass formed by Chemical spray pyrolysis". Journal of Kufa physics ,Vol. 2, No.1 (2010).
14) Kidowaki H. , Oku T., Akiyama T., Suzuki A. , Jeyadevan B. and Cuya J. ,"Fabrication and Characterization of CuO-based Solar Cells" ,Journal of Materials Science ResearchVol.1, No.1 (2012).