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Study of the Optical Properties of Polyvinyl Alcohol/PluronicF-127Blends Doped with Flavonoids Extracted from Hibiscus Sabdariffa L. plant

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ABSTRACT

Thin films of the polymer blends (pluronicF127 and polyvinyl alcohol) doped with different ratios of flavonoids extracted from Hibiscus Sabdariffa L. plant (0.03, 0.05, 0.07, 0.09, 0.12, and 0.15) % wt., were prepared by a spin coating method. The optical properties of the prepared films were examined by Fourier transform infrared (FTIR), UV-Visible.The optical propertiesof synthesized polymer blends using absorbance spectra at wavelengths (200-900 nm). It is obvious that amaximum wavelength of polymer blends are dramatically increase until it reaches (400) nm with the increase of the weight ratios flavonoidsextracted from Hibiscus Sabdariffa L. plant from (0.03to0.15) wt% in the mixture of polymer blends/flavonoids. These shifts in the wavelength gave information on the samples that can absorb light in a quite broad spectral range up to the visible region. The values of the energy gap decrease from (4.87 ev) to (4.5 ev) as the increases flavonoids in the polymer blends.

Keywords: Polyvinyl alcohol, PluronicF-127, Hibiscus Sabdariffa L. plant and Optical properties.

1. INTRODUCTION

Polymers and semiconducting polymers have a wide range of technological applications such as adhesives, coating, lithograph, sensors and as solid-state electrochemical cells; they can be directly deposited on to chips in any shape or size. As well know, a great variety of low dimensional-related studies holds many researchers interest and attention because of their amazing optical properties and their possible applications in many fields [1, 2]. The substances made from biodegradable materials will generate increasing numbers of smart microelectronic, optical micro and photonic pieces and systems and novel generations of photovoltaic. These polymer compounds also can provide a good application in optics, electronics, Ionics, membranes, mechanics, protective and functional coatings [3] and catalysis, sensors and biology. in recent years, polyvinyl alcohol (PVA) polymers have interesting because of their variety of applications [4, 5]. Polyvinyl alcohol is a good compound having high dielectric strength, good charge depot ability and dopant-dependent electrical. VA with carbon chain backbone and hydroxyl groups attached to methane carbons, these OH group can be asource of hydrogen bonding and hence help the coming into being of polymer blends [6]. Consequently, PVA has been used overall to synthesize films for disconnection and pressure have driven actions such as microfiltration, ultrafiltration, inverse osmosis and evaporation [7-13]. Pluronic F-127 triblock copolymers amphiphilic synthetic polymers with surface activity. The molecular structure of Pluronic F-127is an A-B-A block copolymer of poly (ethylene glycol) (PEG) and Poly (propylene glycol) (PPG) [14] as shown in figure (1). Polymer blends polyvinyl alcohol and Pluronic F-127 are a biodegradable polymer, with good film-forming properties and outstanding thermal, mechanical and chemical stability [15]. Roselle (Hibiscus Sabdariffa L. plant) could be used for various applications because it has several important chemical compounds such as flavonoids, anthocyanin, and many other compounds. The Roselle seed oil has high antioxidant activities [16] and many other benefits.

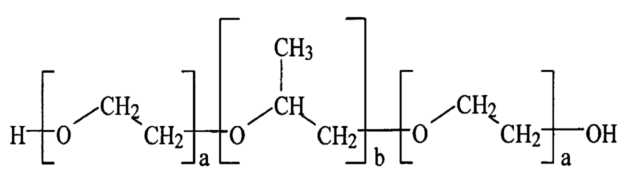

Figure 1.Pluronic F-127 molecular structure

In this work, weprepared biodegradable blends from PVA and Pluronic F-127, which were doped with flavonoidsextract of the Roselle (Hibiscus Sabdariffa L. plant) to prepared anew-biodegradablesensors, which can be degradable with time and less the pollution.

2. Materials and Instruments

PVA, PluronicF-127 were purchased from Merck and used as received flavonoid extract of the Roselle (Hibiscus Sabdariffa L. plant) was extracted from the commercial plant in the market in our laboratory. The polymer blend samples were coated to slides by Spin Coater on Backer Laboratory Equipment, vacuum pump, model:VE135N,Voltage:230v/50-60Hz.The FTIR spectra were recorded IR spectra (KBr discs) on a JASCO FT/IR 4200, with a wave number range of 400-4000cm^{-1}. The absorption spectra were measured in the range of 200-1100 nm for 10^{-3} by using UV-Visible spectrophotometer type Shimadzu UV-160A. that available at Polymer Research Center, Basrah University, Iraq.

3. Experimental

3.1 Extraction of flavonoid from Hibiscus Sabdariffa

Amount of 50 gm of the dried flower of Hibiscus Sabdariffa was defatting by soxhlet apparatus with 500 ml of hexane. The solid residue was extracted with 500 ml of 80% methanol by stirrer at 25C° for 24 hours. The methanolic extract was filtered and evaporated to half volume under reduced pressure in a rotary evaporator, after that precipitation of a flavonoid extractby 1% Lead acetate. The precipitate was collected and dissolved in a mixture of (30 ml of conc. HCl and 25 ml of acetone). The mixture was filtered, and the solvent was evaporated to solid powder, which was dissolved in distilled water and mixed with the same volume of ethyl acetate and extracted by separating flask [17]. Ethyl acetate was collected and evaporated to dryness under reduced pressure in the rotary evaporator.

3.2 Preliminary phytochemicals analysis

Preliminary phytochemical study (color reactions) on flavonoid extract with performed using standard procedures in order to determine the presence of alkaloid (Dragendroff test),carbohydrates (Molish test), glycosides (Benedict test),steroids (Liebermann-Bur chard test), phenolic compound ($FeCl_3$), flavonoids (Shinoda test)and terpenoids (Salkowsky test) [18,19].

Table (1): Qualitative analysis of flavonoid extract.

Chemical constituent	Remarks of flavonoids extract
Alkaloids	-
Carbohydrates	-
Glycosides	-
Phenolic compounds	+
Flavonoid	+
Steroids	-
Terpenoids	-

3.3 Preparation and Doping of the polymer blends

A mixture of polyvinyl alcohol (PVA) and PulronicF-127with random ratio (1:1) was dissolved in distilled water and stirred with high-speed mixer at a constant temperature for 30 minutes. Doping polymer blends with flavonoids extract is carried out by adding the weighed flavonoids extract to the solution of PVA- PulronicF-127 after the prepared directly to give a polymer blend/flavonoid extract system containing (0.03, 0.05, 0.07, 0.09, 0.12 and 0.15) g wt.% of doping [20]. The mixture was stirred well for 15 minutes to guarantee that the homogenous distribution offlavonoids extractin the polymer matrix. Then the solutions were poured in the above proportions on glass slides with dimensions of 2mm×2mm in the manner of spin coater.

4. Results and discussion

4.1 FTIR analysis

The spectra were showed the band at 2934 cm^{-1}assigned to aliphatic (C–H). Broadband resulting from hydroxyl group stretching (O-H)at 3317.9 cm^{-1}as shown in (Fig. 1).From the (Fig.2,Figur3,and Figure 4) the band at 3435.5cm^{-1}showsa week band to a terminalhydroxyl group(O-H)of Pluronic F -127 and sharp band at 2886.9 to aliphatic (C–H).The graphs were indicated, that the nature of the bonding between the polymer blend chains together is a physical interaction, as well as with flavonoids extract.

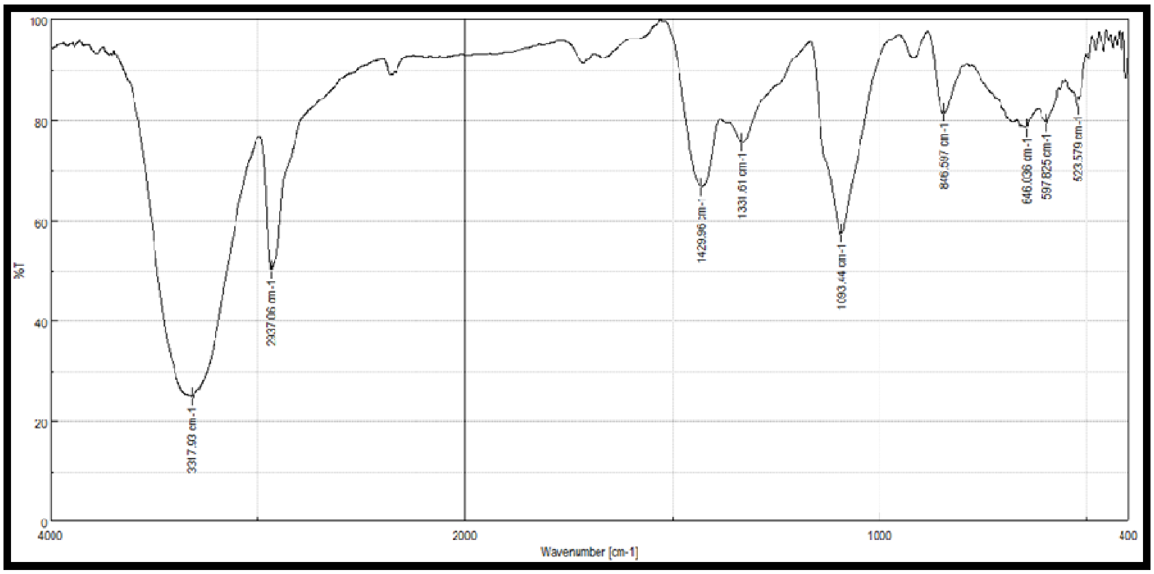

Figure (1): FTIR of PVA.

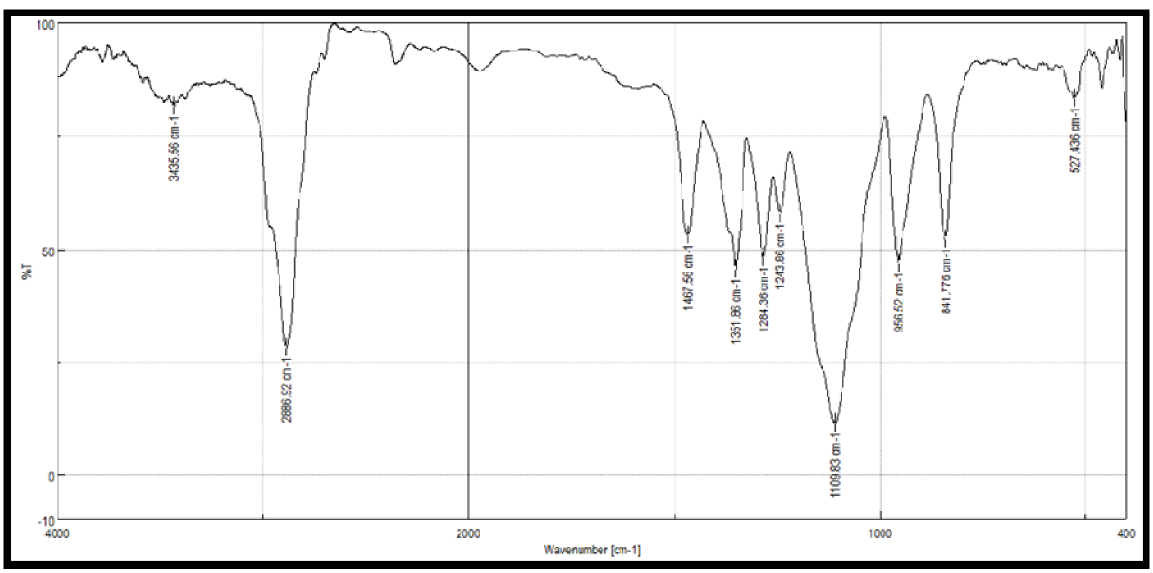

Figure (2) FTIR of Pluronic F-127.

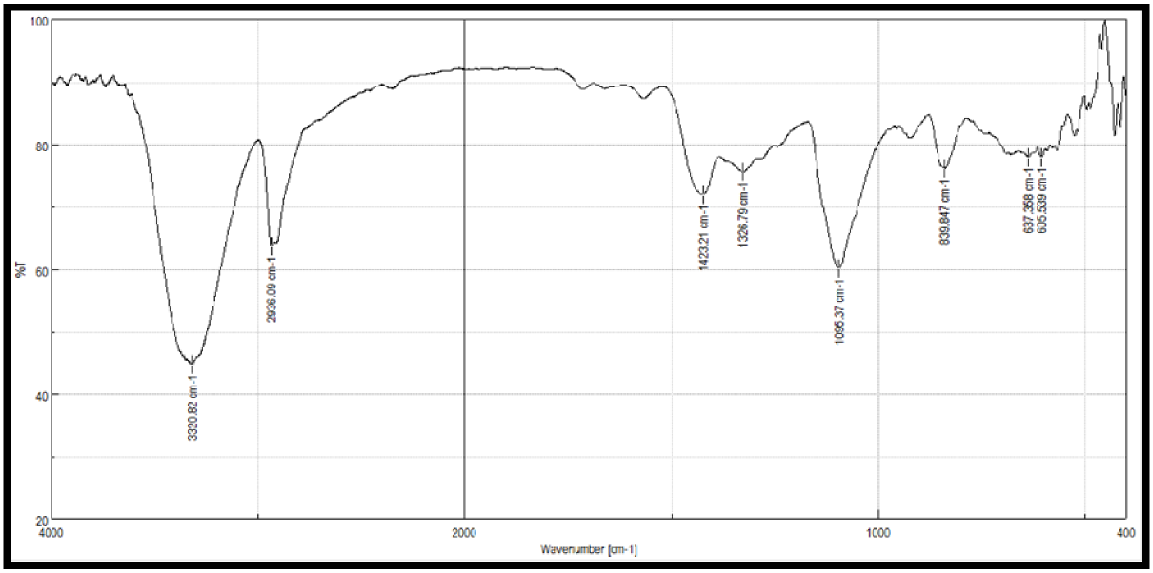

Figure (3): FTIR of a polymer blend of Pluronic F-127 and PVA.

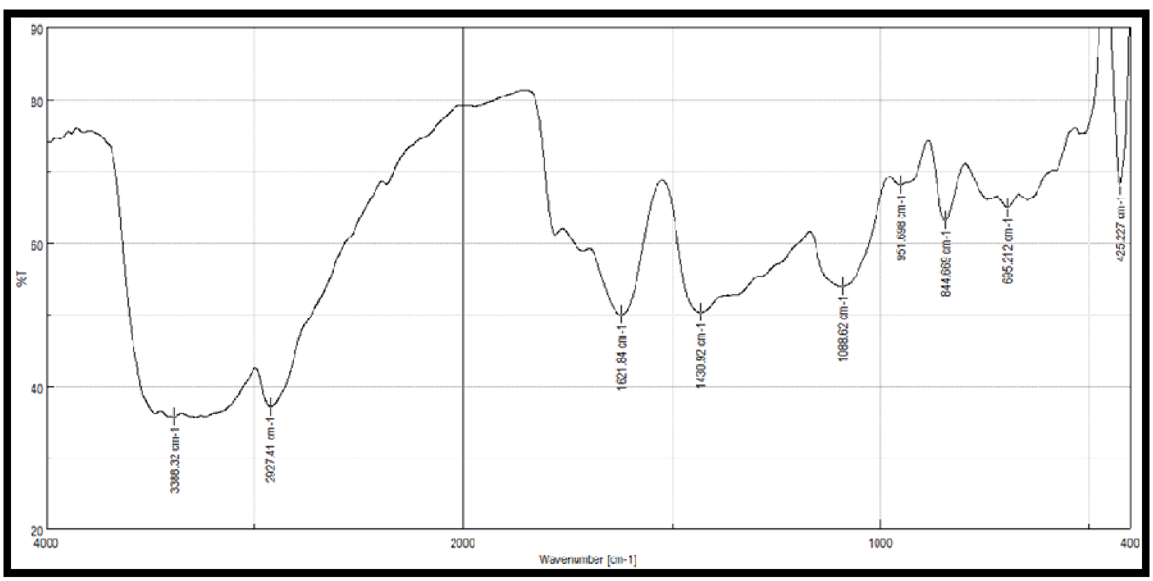

Figure (4): FTIR of a polymer blend with 0.12% ofFlavonoidextracted from Hibiscus Sabdariffa L. plant.

4.2 Optical measurement of the polymer blend

The optical characterization of the polymers blends give information about other physical properties, e.g. band gap energy and band structure, optically active defects etc. and may be of endureinterest for several different applications. The absorption spectra of the blends PVA- PulronicF-127 as well as PVA- PulronicF-127 doped with flavonoids extract are shown in figure (5). It is clear from the figure that the spectrum of PVA- PulronicF-127 (Pure)exhibits a maximum wavelength around (250) nm, butapparently, one peak was sharp and creep up toward higher wavelength. It is obvious that the maximum wavelength raises dramatically until it reaches to (400) nm with increasing the weight ratios of the flavonoids extract to the mixture. These shifts in the wavelength pointing to the formation on the samples can absorb light in a quite broad spectral range up to the visible region [21, 22]. Therefore, VA- PulronicF-127/ flavonoids extract films are excellent UV absorber. The optical band gap of the films has been calculated using Eq. (1):

$$(\alpha h\nu) = A_O\,(h\nu - E_g)^{1/2} \quad (1)$$

where $h\nu$ is the photon energy, A_o is a constant, E_g is the band gap energy[23], and α is the absorption coefficient that is defined by the Beer-Lambert's lawusing Eq.(2):

$$\alpha = \frac{2.303A}{d} \quad (2)$$

Where A is the absorbance and $d$is the film thickness, which was about 1 micrometer [24]. The band gap energy can be calculated by plotting $(\alpha h\nu)^2$ versus $h\nu$. The figures (6) and (7) show the relationship between absorption coefficient and photon energy for pure and the different ratios of flavonoids extracting the blends (PVA- PulronicF-127).The value band energy gap of photon E_g decreases from (4.87 ev) to (4.5ev) when flavonoids extract increase from 0% to o.15 as indicated in the table (2).After that, we have noted the value of the energy gap remained at the same level of 4.5 ev despite the increase of the ratio flavonoids extract to 0.15% in the blend. This can be attributed to the arrival of the polymeric blends to the saturation of the added flavonoids extractso it does not have a clear effect on the value of the energy gap.

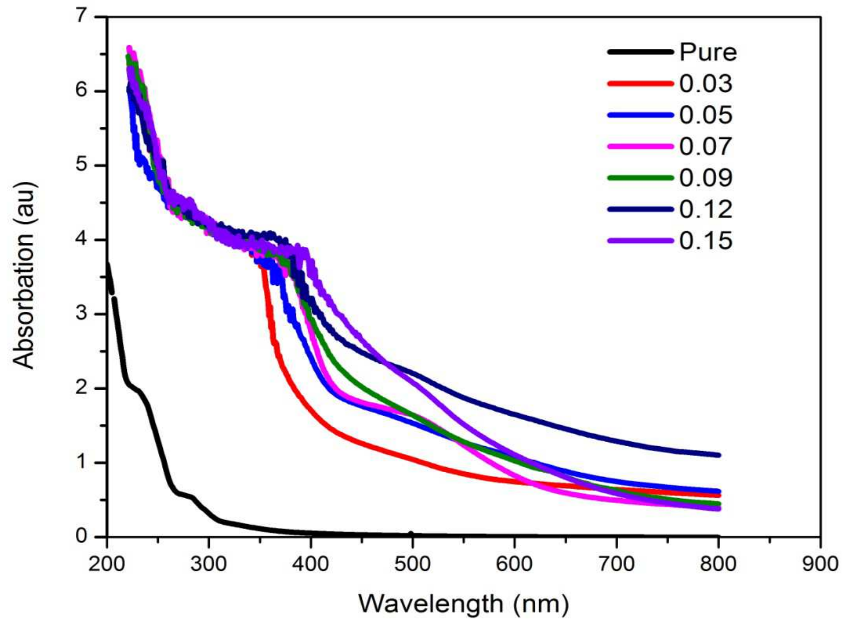

Fig 5. The absorbance spectra as a function of wavelength for PVA- PulronicF-127 flavonoids extractfor all concentration ratios.

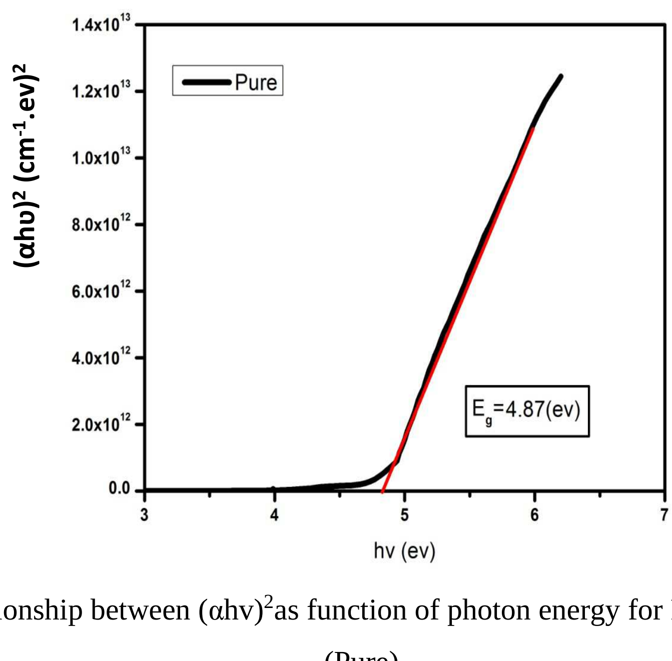

Fig 6. The relationship between $(\alpha hv)^2$as function of photon energy for PVA- PulronicF-127 (Pure).

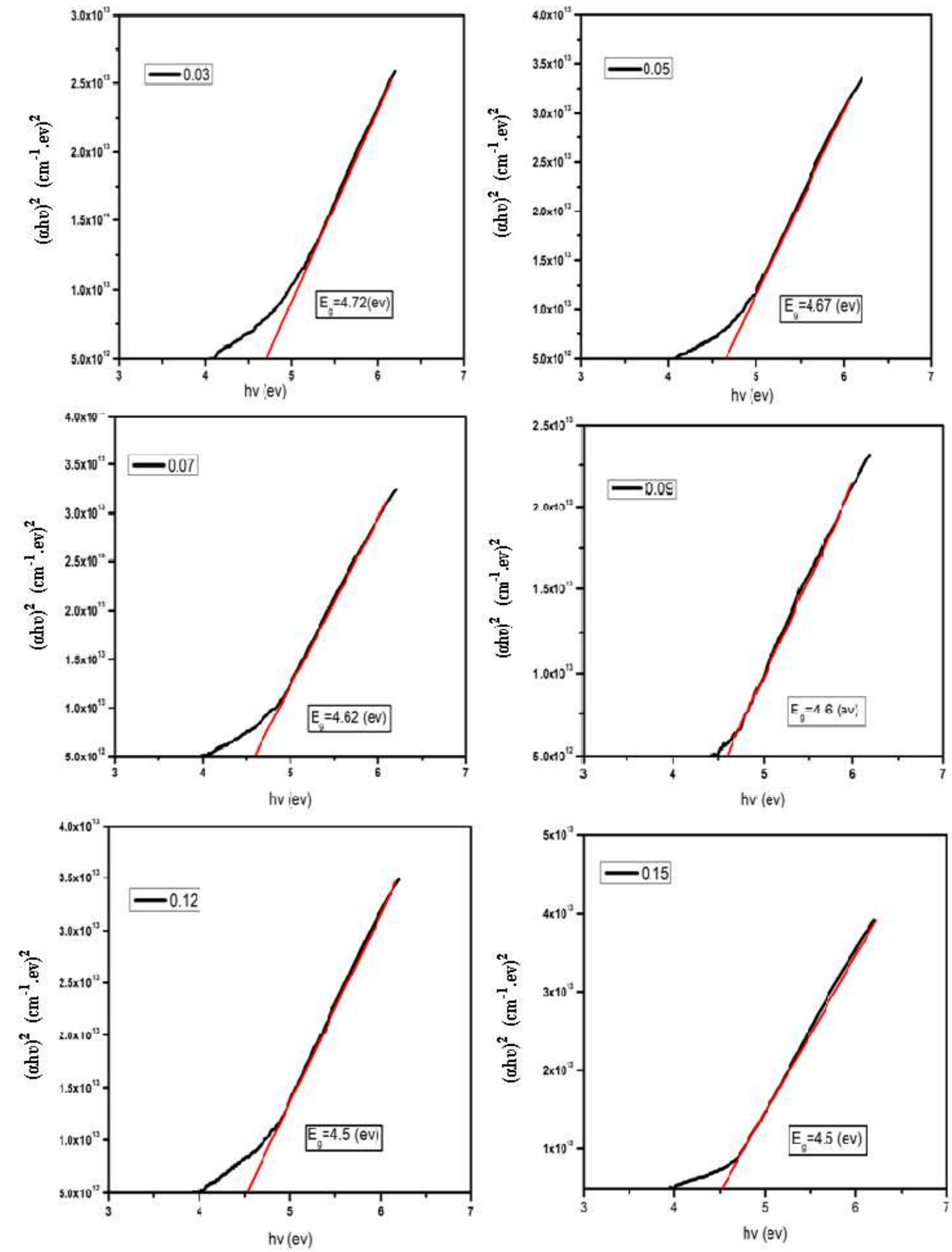

Fig 7. The relationship between $(\alpha h\nu)^2$ as function of photon energy for PVA- PulronicF-127 /flavonoids extract for all concentration ratios.

Table 2. The energy gap for all concentration of blend (PVA- PulronicF-127 /flavonoids extract) ratio.

Wt% flavonoids extract in PVA- PulronicF-127	Energy Gap Eg(eV)
0	4.87
0.03	4.72
0.05	4.67
0.07	4.62
0.09	4.6
0.12	4.5
0.15	4.5

4.Conclusion

In this study, the polymer blends of PVA and Pluronic F-127 doped with different ratios of flavonoids extract thatextracted from Hibiscus Sabdariffa L. plant the study was made the effect of incorporating flavonoids extracton the PVA and Pluronic F-127 blends through the study of optical properties. The prepared biodegradable polymer blends were interconnected with the flavonoids extractby hydrogen bonding as a Physical coherence. From the results of the blends we can conclude that the Spectral investigations revealed that the spectra show some noticeable changes in peak absorption and location relative to the wavelength with an increase flavonoids extractin the mixture and this may be due to the link between the flavonoids extract and the polymer. Also, it has been found that the films have excellent absorption of ultraviolet radiation. The analysis of the optical measurement data showed the energy gap decrease from 4.87eV to 4.5ev, as the flavonoids extract ratio increase from 0% to 0.12% in the mixture. Therefore, these compounds can play multiple roles to prepare anew-doping polymer tools with good protection from the harmful effects of ultraviolet rays. This makes possibility of preparation biodegradable materials, whichcan be decomposed after a period of time and thus it is possible to reduce the occurrence of pollution in the environment.

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