Study the Opto-Electrical Properties of (PVA-PEG)Blend Films

دراسة الخصائص الكهروبصرية لأغشية خلائط البولي فينيل الكحول – بولي اثيلين كلايكول

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Abstract:

Polyvinyl alcohol (PVA) – Polyethylene glycol (PEG) based solid polymer blend electrolytes have been prepared by the solution cast technique. The absorption spectra has been recorded in the wavelength range (280-800) nm. The absorption coefficient, refractive index and extinction coefficient have been determined. The results show that the optical constants increase with the increasing of weight percentages. Also, the electrical properties have been calculated such as electrical conductivity(σ)by using LCR meter which is used to measure the inductance (L), capacitance (C), and resistance (R) of a component, the results show that the electrical conductivity decrease with increasing of the percentages weight of polymers (PVA-PEG).
Keywords: Optical properties, Electrical properties, Thin films, PVA, PEG.

الخلاصة:

تم تحضير مزيج من البوليمرات (بولي فينيل الكحول وبولي اثيلين كلايكول) بتقنية الصب.طيف الامتصاص سجل في مدى من الطول الموجي من(280-800) نانومتر. ايضا تم قياس كلا من معامل الامتصاص, معامل الانكسار ومعامل الخمود.اوضحت النتائج ان الخصائص البصرية تزداد بزيادة النسب الوزنية, كذلك تم حساب الخصائص الكهربائية مثل التوصيلية الكهربائية باستعمال جهاز LCR الذي يستعمل لقياس الحث والسعة والمقاومة وأظهرت النتائج ان التوصيلية الكهربائية تقل بزيادة النسب الوزنية للبوليمرات (بولي فينيل الكحول وبولي اثيلين كلايكول).
الكلمات المفتاحية: الخصائص البصرية, الخصائص الكهربائية, الأغشية الرقيقة, بولي فينيل الكحول, بولي اثيلين كلايكول.

1.Introduction:

Studies on the optical and electrical properties of the latter have recently attracted a lot of attention in view of their application in electronic and optical devices. Polymer blends (PB) is a mixture of at least two polymers or copolymers (polymeric material synthesized from more than single monomer) [1]. Polyvinyl alcohol offers a combination of excellent film forming and binder characteristics, along with insolubility in cold water and organic solvents. This combination of characteristics is useful in a variety of applications. Moreover, it contains a carbon backbone with hydroxyl groups attached to methane carbons.

These hydroxyl groups can be a source of hydrogen bonding, hence the assistance in the formation of polymer blends[2].The study of the optical absorption spectra in solids provides essential information about the band structure and the energy gap in the crystalline and non-crystalline materials. Analysis of the absorption spectra in the lower energy part gives information about atomic vibrations while the higher energy part of the spectrum gives knowledge about the electronic states in the atom[3]. The development of polymer systems with high ionic conductivity is one of the main objectives in polymer research. This is because of their potential applications as electrolytes in solid-state batteries, fuel cells, electrochemical display devices/smart windows, photo electrochemical cells etc., due to their high conductivity, high energy density, wide electrochemical stability and easy process ability.

The main advantages of polymer electrolytes are their mechanical properties, ease of fabrication of thin films of desirable sizes and their ability to form proper electrode/electrolyte contact in electrochemical devices [4]. The stability of polymer thin films on solid substrates is of great technological importance in applications ranging from protective coatings to paintings, micro and optoelectronic devices [5].

2. Experimental part:

The materials were used in this research are (PVA-PEG) blends. The polymers were dissolved in water by using magnetic stirrer with ratio (5:5) (PVA-PEG),for thickness(1.1-1.3)(mm).The weight percentages of (PVA-PEG) are (10, 20, 30, 40, and 50) wt. % were added to mixture and mixed for 10 minutes to get more homogenous solution. The casting technique was used to preparation the blends. The spectra photo metrically by using UV/1800/Shimadzu spectrophotometer.(D.C) measurements have been done using LCR meter which is used to measure the inductance(L),capacitance(C),and resistance(R)of a component , also d.c. power supply(2 Volt).

3. Results and discussion:

Include discussion of the following properties:

3.1 Optical properties:

This paper include practical results of the optical properties in the following:

3.1.1 The absorbance of (PVA-PEG) blends:

Figure (1) shows the relationship between absorbance with wavelength of (PVA-PEG) blend films, from the figure shows that the absorption increases as a result of filler addition, the blends have high absorbance in the UV-region[6].

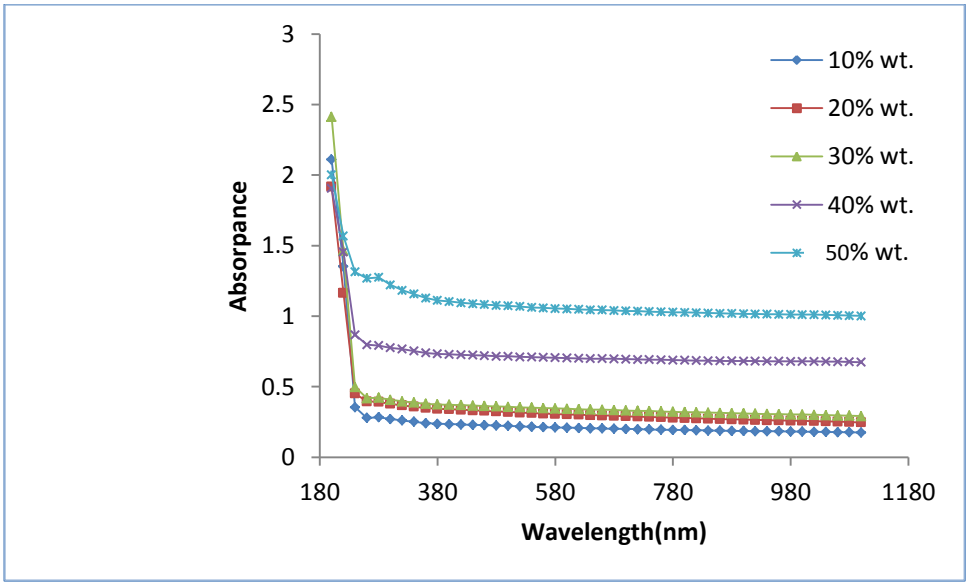

Fig. (1): The variation of optical absorbance for blends with wavelength.

3.1.2 The Absorption coefficient of blends:

Figure (2) shows the optical absorption spectrum of composite for different additive at the wavelength(191)nm, it was found that the composite have a low absorption coefficient at a small photon energy then increase at different rates dependence on the composite structure, this means that the possibility of ions transition is little because the energy of the incident photon is not enough to move the ions from the valence band to the conduction band [63]. At high energy, the change of absorption coefficient is large this is indicates the large probability of electronic transitions are the absorption edge of the region. Analysis of optical absorption spectra could reveal the energy gap (Eg) due to direct and indirect transitions of both crystalline and amorphous materials.The

absorption coefficient (α) was calculated in the fundamental absorption region from the following equation[7]:

$$\alpha = 2.303\frac{A}{t} \qquad (1)$$

Where: A is absorbance and (t) is the thickness of sample.

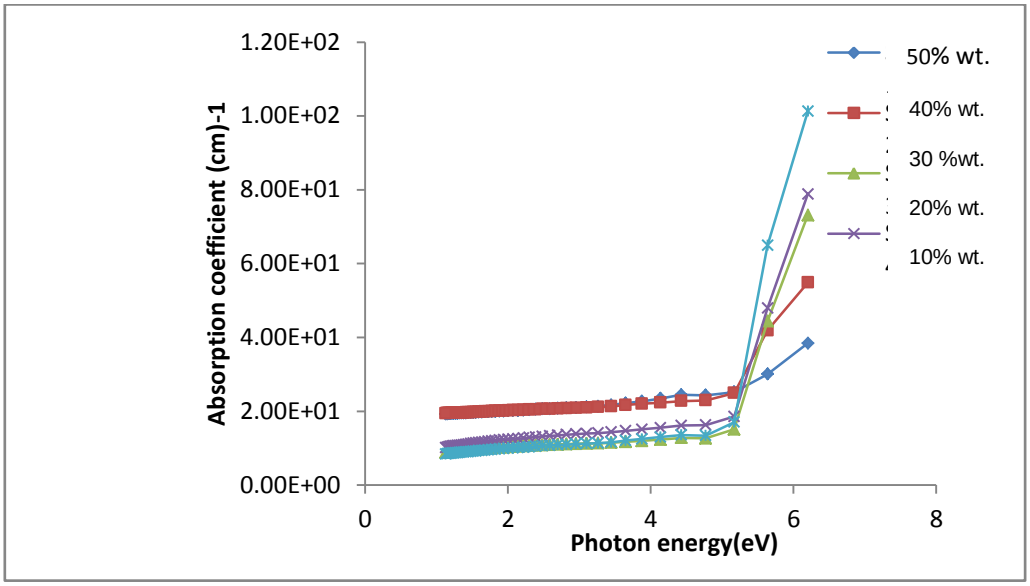

Fig. (2): The absorption coefficient for blends with various photon energy for the direct transition electronic.

3.1.3 Extinction coefficient and refractive index:

These coefficients were calculated as follows:

The extinction coefficient calculated by the relation [8]:

$k = \alpha\lambda / 4\pi$ (2)

Where λ: is the wavelength, α is the absorption coefficient. Figure (3) shows the relationship between extinction coefficients for blends with various photon energy[9].

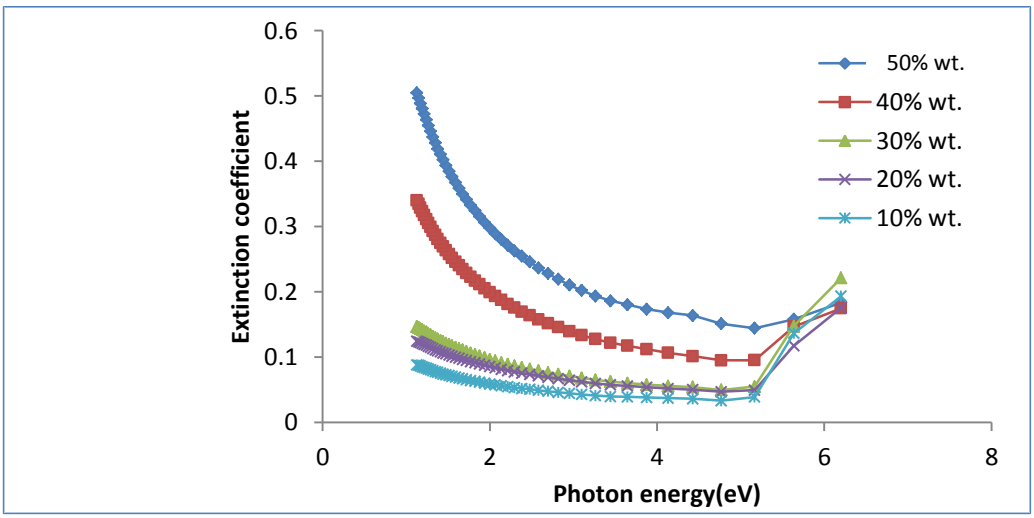

Fig.(3):The extinction coefficient for blends with various photon energy.

The refractive index of the films was calculated by the following equation [7]:

$n= [4R /(R-1)^2 – K^2] – (R+1) / (R-1)$ (3)

where R the reflectance and k the extinction coefficient. Figure (3) shows the variation of extinction coefficient (k) with the photon energy of the blend films, the values decrease with increasing

photon energy due to increased absorption coefficient because that the extinction coefficient depends mainly on absorption coefficient according to the relation between them but after (5.2eV) begin extinction coefficient (k) increases with increasing photon energy, because then become the photon energy is higher than the optical energy gap forbidden[10].

Figure (4) represent the variation of the refractive index (n) with the incident photon energy, the variation is simple in the low energy region while it increased in the high photon energy region, and this behavior may be as a result to the variation of the absorption coefficient which leads to spectral deviation in the location of the charge polarization.

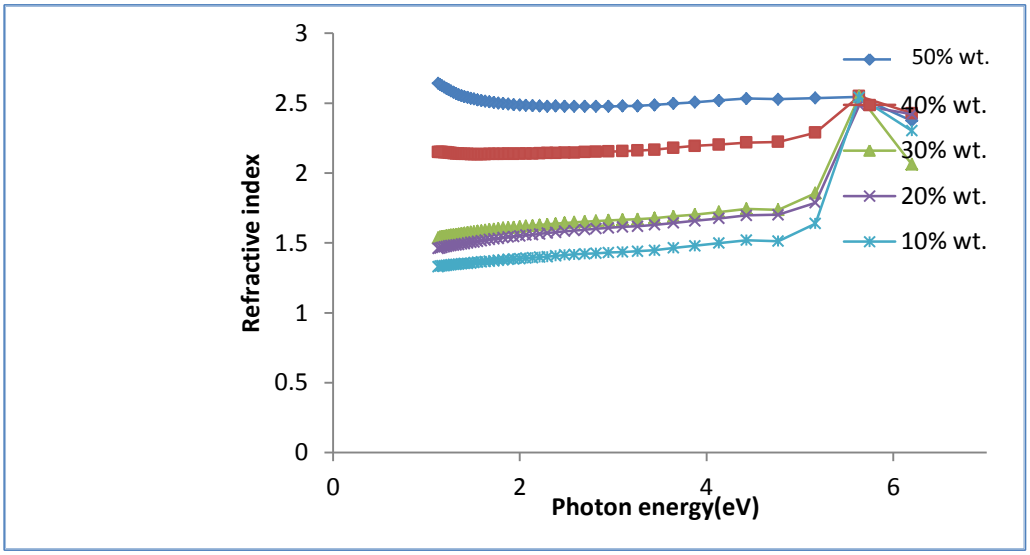

Fig.(4): The relationship between refractive index for blends with photon energy.

3.1.4 Dielectric Constants

The real and imaginary dielectric constants (ε_1 and ε_2) can be calculated by using equations [11]:

$$\varepsilon = \varepsilon_1 - i\,\varepsilon_2 \quad (5)$$

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

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

Where ε_1: is the real part of the dielectric constant, ε_2: is the imaginary part of dielectric constant.

The figures(5,6) show that the real and imaginary parts of dielectric constants are increased with increase of the percentages weight of the (PVA-PEG)blend films, which attributed to increase the absorption and scattering of incident light with increase of the percentages weight. It can be seen that(real dielectric constant) considerably depends on (square refractive index) due to low value of (square extinction coefficient) so, the real dielectric constant increased with the increase of the percentages weight and it is smallest at high wavelength. Figure (6) show the change of (imaginary dielectric constant) as a function of the photon energy.

It can be seen that (imaginary dielectric constant) is dependent on(extinction coefficient) values that change with the change of the absorption coefficient due to the relation between them it [12].

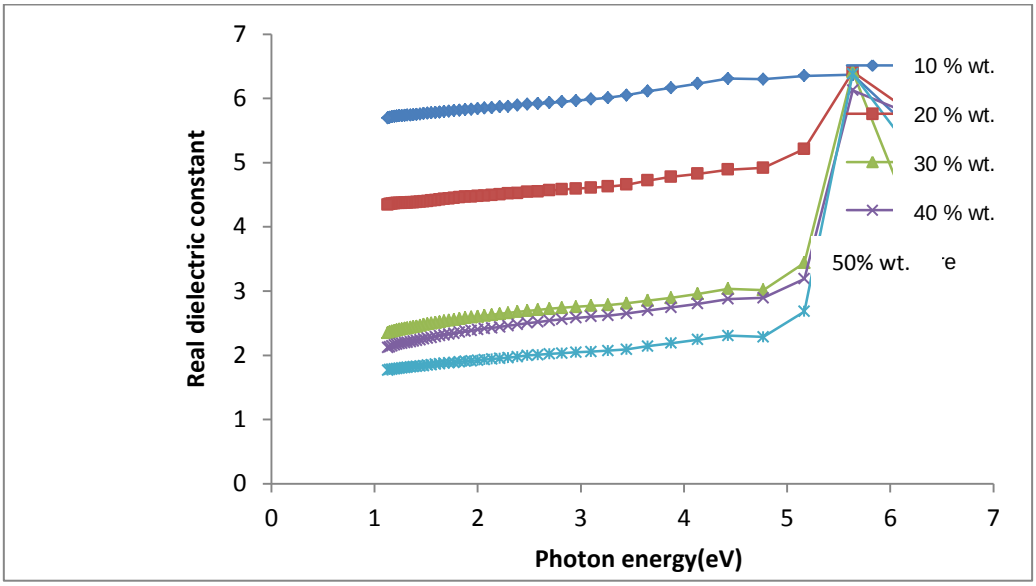

Fig.(5):The relationship between the real part of the dielectric constant for blends with photon energy.

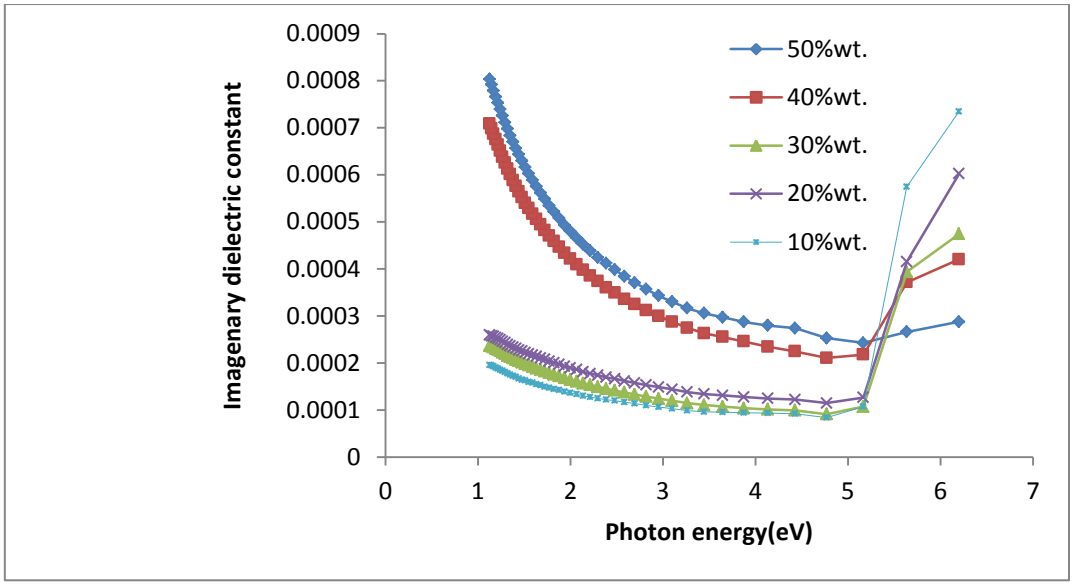

Fig. (6): The relationship between the imaginary part of dielectric constant for blends with photon.

3.2 Electrical Properties:

These properties include electrical measurements at room temperature:

3.2.1D.C. measurements:

Fig (7) shows the D.C electrical conductivity σ_{dc} $(\Omega.cm)^{-1}$ as a function of the percentages weight of (PEG-PVA) blend films samples at room temperature. From Figure(7), we note that the electrical conductivity is increasing with the increase of the percentages weight of (PEG-PVA) blend films. The conductivity value for (PEG-PVA) blend films is(0.08×10^{-11}) $(\Omega.cm)^{-1}$ at (10)(wt%) concentrations while at (50)(wt%) of the concentrations (PEG-PVA) blend films leads to the increase of the conductivity to reach (4.5×10^{-10}) $(\Omega\ .cm)^{-1}$. This behavior can be related to the fact that the electrical properties of composite material may be dominated by the electrical properties of the percentages weight at percentage weight concentration. The electrical conductivity could be increased as a result of increasing of electronic charge carriers which can be increased due to increasing percentages weight content. As it was calculated D.C electrical conductivity σ_{dc} $(\Omega.cm)^{-1}$ of the equation below. These results are in agreement with results reached by the researchers.

$$\sigma = \frac{1}{\rho_v} = \frac{L}{R_v A} \quad (8)$$

Where (ρ_v) is the volume resistively that is different according to the substance , it equals the inverse of the bulk conductivity, (L) is distance between the electrons, and (A) is area between the electrons.

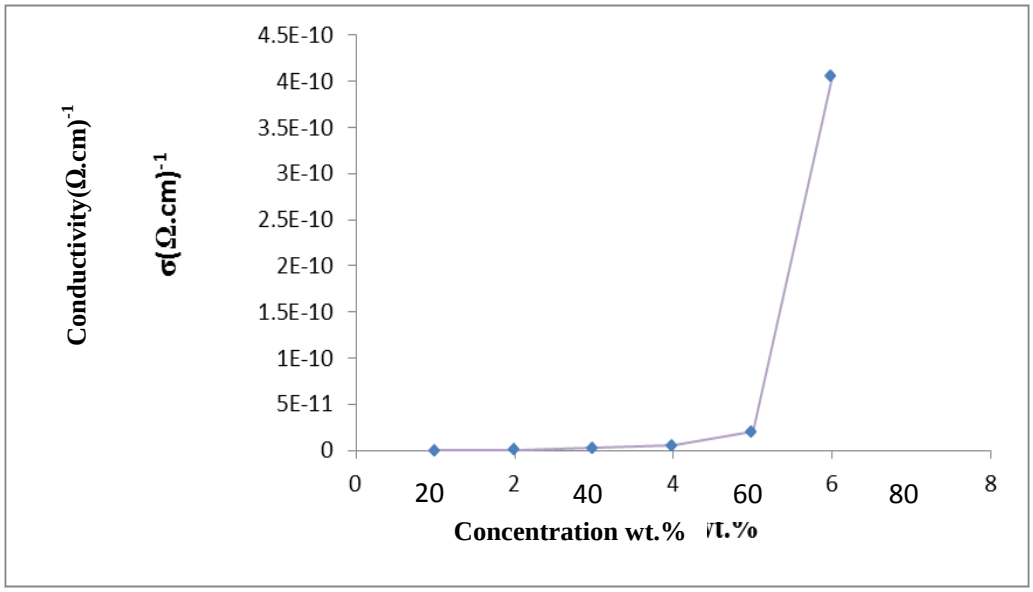

Fig.(7):The relationship between the conductivity for blends with concentration.

3.2.2 A.C. measurements:

Conductance, obtained from (LRC) bridge results, is used to calculate conductivity of (PVA- PEG) samples. Figure (7), shows the frequency dependence of ac conductivity of (PVA-PEG) blend films with different percentages weight of (PEG-PVA) films. (A.C.) it can be observed that the conductivity increases with increasing frequency. This is a common response for polymeric and semiconductor samples due to the tremendous increase of the mobility of charge carriers in the composite materials, The AC conductivity $(\sigma_{a.c})$ can be calculated by the following equation :

$$\sigma_{a.c} = \omega \varepsilon'' \varepsilon_{\circ} \quad (9)$$

where (ω) is the angular frequency,$(\boldsymbol{\varepsilon''})$ is The dielectric loss factor, $(\varepsilon_{\circ})$ is permittivity of free space, here $(\sigma_{a.c})$ represents the ac-conductivity of the polymer sample which arises from the motion of charge carriers through the polymer.

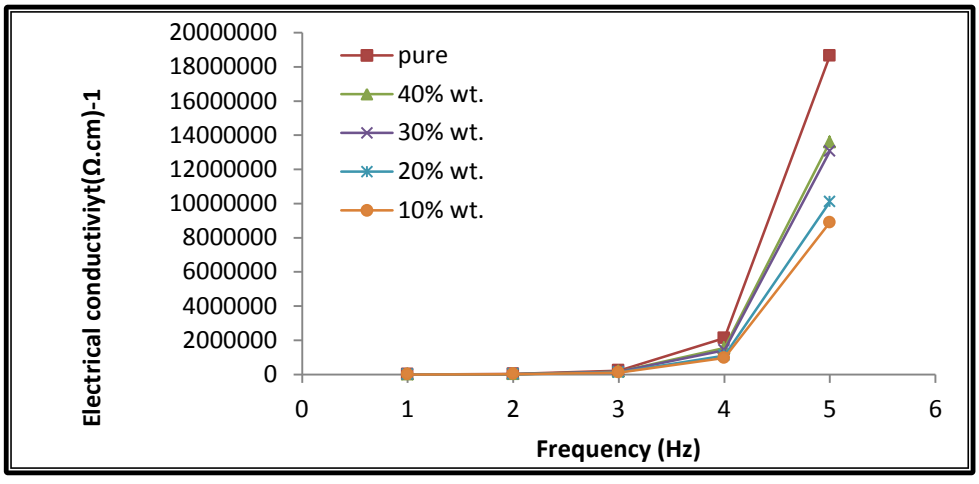

Fig.(4.22): The relationship between the conductivity for blend films versus frequency.

4. Conclusions:

- The PVA–PEG based polymer blend was prepared by casting technique.
- The absorption coefficient is increase with increasing of the percentages weight of these membranes.
- The extinction coefficient is increase with increasing of the percentages weight of these membranes.
- The refractive index is increase with increasing of the percentages weight of these membranes.
- The Real and Imaginary parts of dielectric constant increase with increasing of the percentages weight while the real dielectric constant decrease with increasing the percentages weight of these films.
- The maximum ionic conductivity of $(4.05\times10^{-10})(\Omega.cm)^{-1}$ is observed when the polymer blend at room temperature.

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