European Journal of Scientific Research
ISSN 1450-216X Vol.57 No.4 (2011), pp.583-591

http://www.eurojournals.com/ejsr.htm

Study of Optical and Mechanical Properties for ($PVA-AgCO_3$) Composites

Bahaa H. Rabee
Department of physics, College of Education
Babylon University, Iraq
E-mail: dr_bahaa 19@yahoo.com

Abstract

In this research, samples of pure poly vinyl alcohol and poly vinyl alcohol doped with silver carbonate were prepared using casting technique. The PVA samples with $AgCO_3$ additive prepared with different percentages(0,1,2,4 and 5) wt.% and different thickness. The experimental results showed that the absorption coefficient increases and energy gap of the indirect allowed and forbidden decreases with increase the weight percentage of silver carbonate, the extinction coefficient increases with increase the silver carbonate content. The mechanical properties(Velocity of Ultrasonic wave**,** Specific Acoustic Impedance, Bulk Modulus and Compressibility change with increase the concentration of silver carbonate

Keywords: poly vinyl alcohol, optical properties, composite.

1. Introduction

Composites containing two materials with die rent physical properties exhibit often new properties .The composites can provide improved characteristics not obtain able by any of the original components alone an dare used in a wide variety of industrial products[Kalisza G. *et al*, 2005]. Polymer matrix composites are very popular due to their low cost, high strength to weight ratio, non-corrosive and simple fabrication methods. Polymer matrix composites reinforcement by strong fibrous network is characterized by the high tensile strength, high stiffness, high fracture toughness, good abrasion resistance, good puncture resistance, good corrosion resistance and low cost. A variety of additives are used in the composites to improve the material properties, aesthetics, manufacturing process, and performance. The additives can be divided into three groups -- catalysts, promoters, and inhibitors; coloring dyes; and, releasing agents[KUMAR A.,2008]. In general the interaction of electromagnetic radiation (light) with matter is controlled by three properties, the specific conductivity, the electric conductive capacity and the magnetic inductive capacity. These properties are related to the refractive index and the absorption index of the medium. Ahmed and Asrar, in(2010) studied the effect of lithium fluoride content on some optical properties of polystyrene by different volume percentages from these salts with polymer and by different thickness .The absorption and transmission spectra has been recorded in the wavelength range (190-1100)nm . The absorption coefficient increases and energy gap decreases with volume percentage of salts. This paper deals with results of the effect of silver carbonate on the optical and mechanical properties of poly vinyl alcohol.

2. Experiment

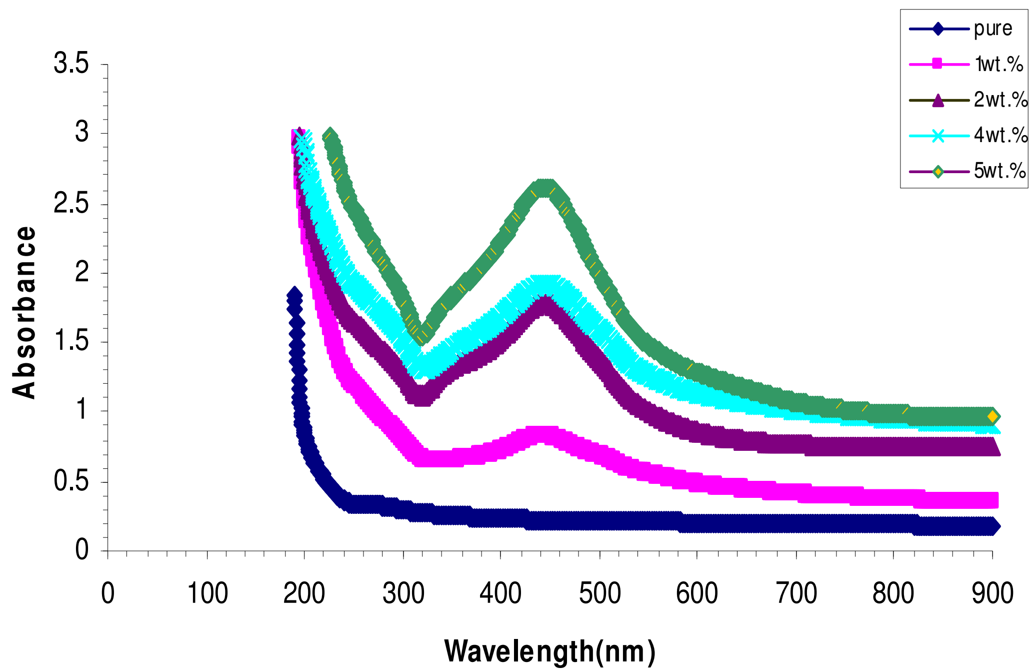
The materials used in the paper is poly vinyl alcohol as matrix and silver carbonate as a filler. The weight percentages of silver carbonate are (0,1,2,4 and 5)wt.%. films of pure PVA and PVA doped with silver carbonate were prepared using casting technique thickness ranged between (70-80)μm. The transmission & absorption spectra of composites have been recording in the length range (190-900)nm using double-beam spectrophotometer (UV-210^{o}A shimedza).

The mechanical properties is measured by Ultrasonic Velocity System Measurement.

3. Results and Discussion

Optical absorbance measurements were taken for silver carbonate- poly vinyl alcohol samples to compare the effect of the filler particles on the optical properties of the composites as shown in figure(1). If the goal is to obtain a transparent composite, the filler needs to be transparent and the scattering at the interface between the filler and the matrix needs to be as small as possible to decrease the absorbance [Laurissa A., 2008]

Figure 1: The relationship between the absorbance and wavelength of the PVA-$AgCO_3$ composites



The absorption coefficient (α) is calculated by using the absorption relation[Majdi K. *et.al.*,1997] :

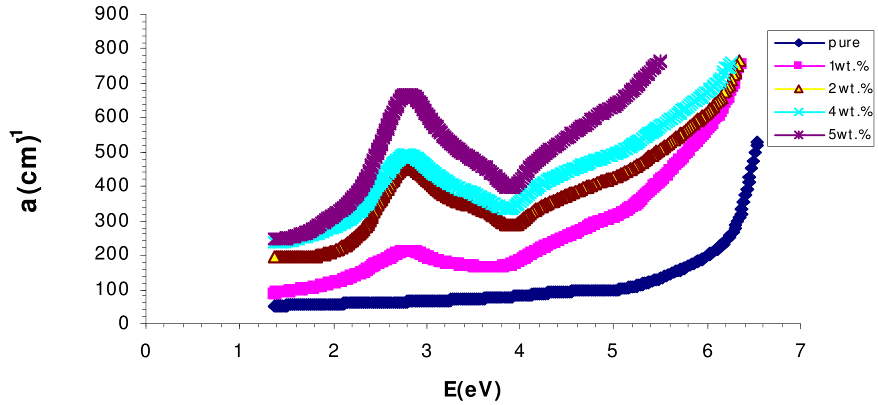
$$I = I_0 \exp(-ad) \quad (1)$$

Hence

$$\alpha = (2.303 \ / d) \log(I_0 / I) = (2.303 \ / d)[A + \log(1 - R^2)] = 2.303 \frac{A}{d}..... \quad (2)$$

Where : d is the thickness of sample and A is absorbance(A=-log(T) and R is the reflectivity, while the parameter T is the transmittance.

Figure 2:



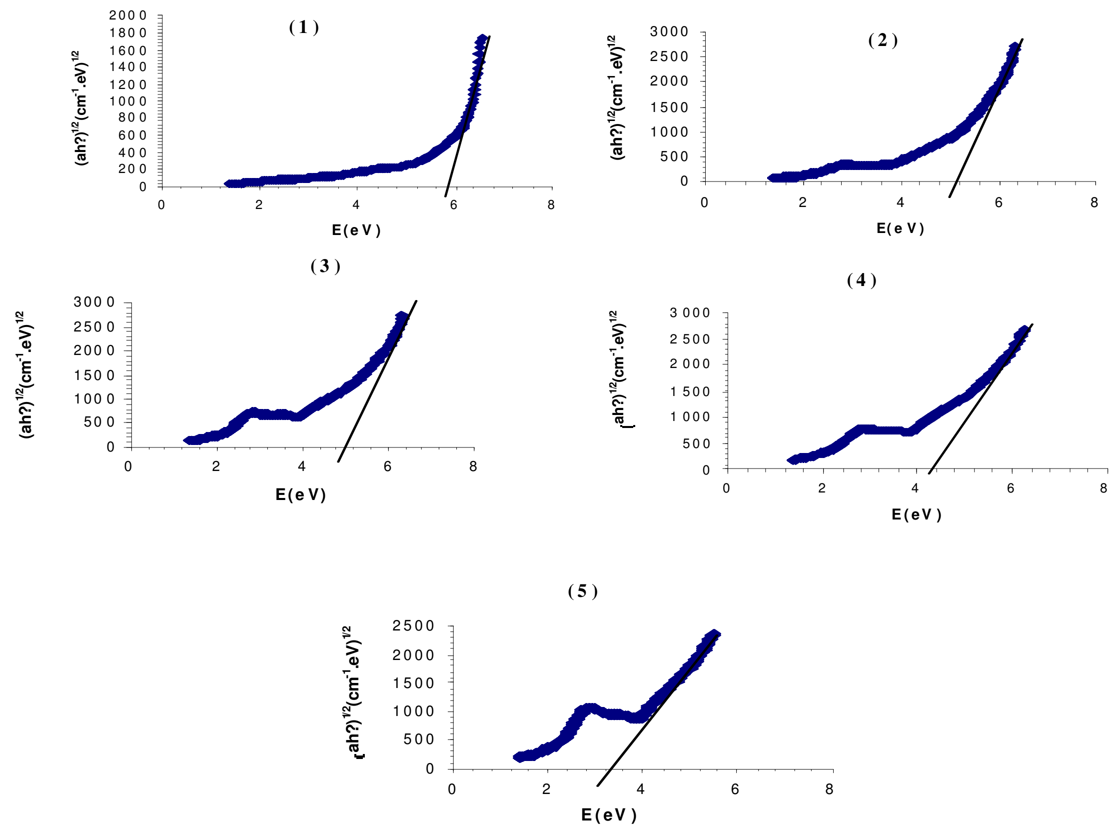
The results showed that the values of absorption coefficient of the PVA-$AgCO_3$ composites less than $10^4 cm^{-1}$ which indicates to the indirect electronic transition. The forbidden energy gap of indirect transition both allowed, forbidden calculated according to the relationship[Kathalingam et.al. , 2007] :

$$ahv = A(hv - E_g)^m \quad (2)$$

Where : hv is the energy of photon , A is proportionality constant and Eg is forbidden energy gap of the indirect transition.

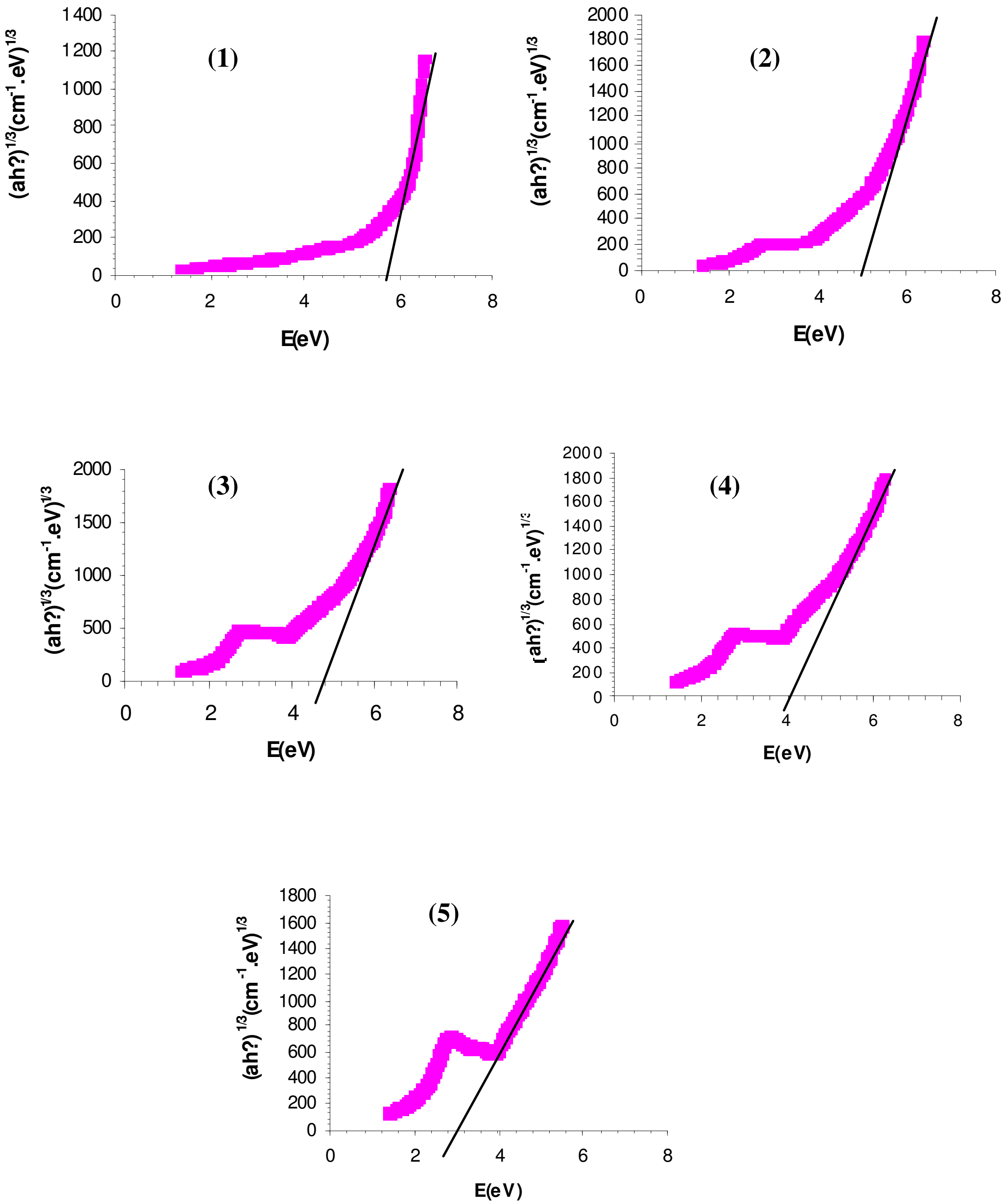
If the value of (m=2) indicates to allowed indirect transition . when the value (m=3) indicates to forbidden indirect transition.

Figure 3: The relationship between $(\alpha h\upsilon)^{1/m}(cm^{-1}.eV)^{1/m}$ and photon energy of PVA-$AgCO_3$ composites



A) the relationship between $(\alpha h\upsilon)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PVA-$AgCO_3$ composites: (1) pure (2) 1wt.% $AgCO_3$ (3) 2wt.% $AgCO_3$ (4) 4wt.% $AgCO_3$ (5) 5wt.% $AgCO_3$

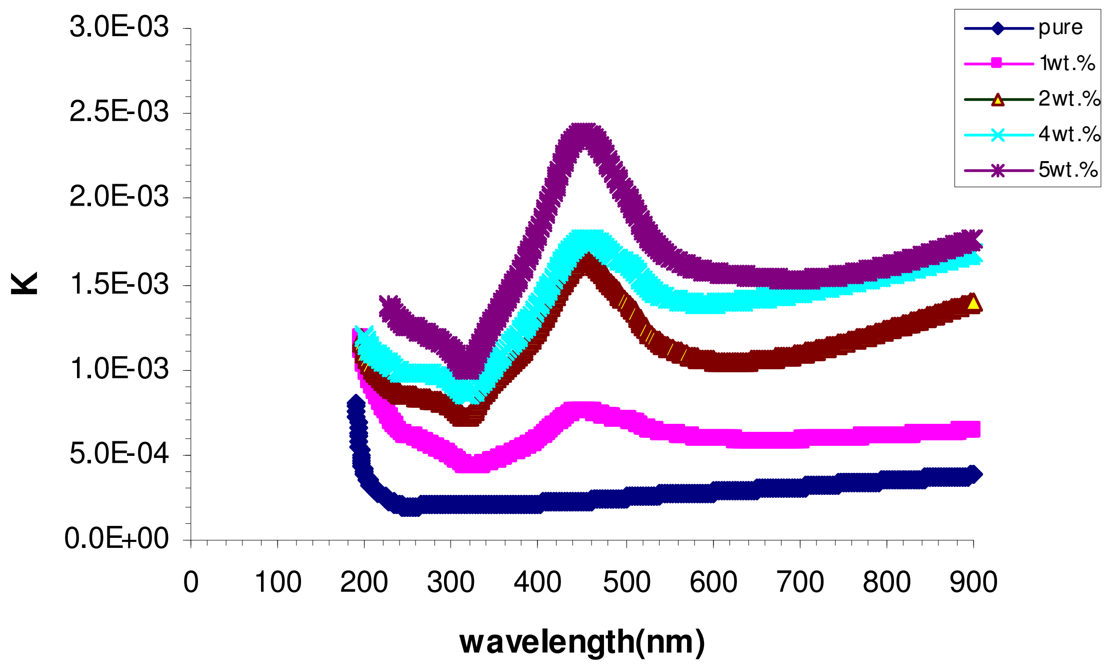
Figure 3: The relationship between $(\alpha h\upsilon)^{1/m}(cm^{-1}.eV)^{1/m}$ and photon energy of PVA-$AgCO_3$ composites - continued



B) the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of PVA-$AgCO_3$ composites:
(1) pure (2) 1wt.% $AgCO_3$ (3) 2wt.% $AgCO_3$ (4) 4wt.% $AgCO_3$ (5) 5wt.% $AgCO_3$

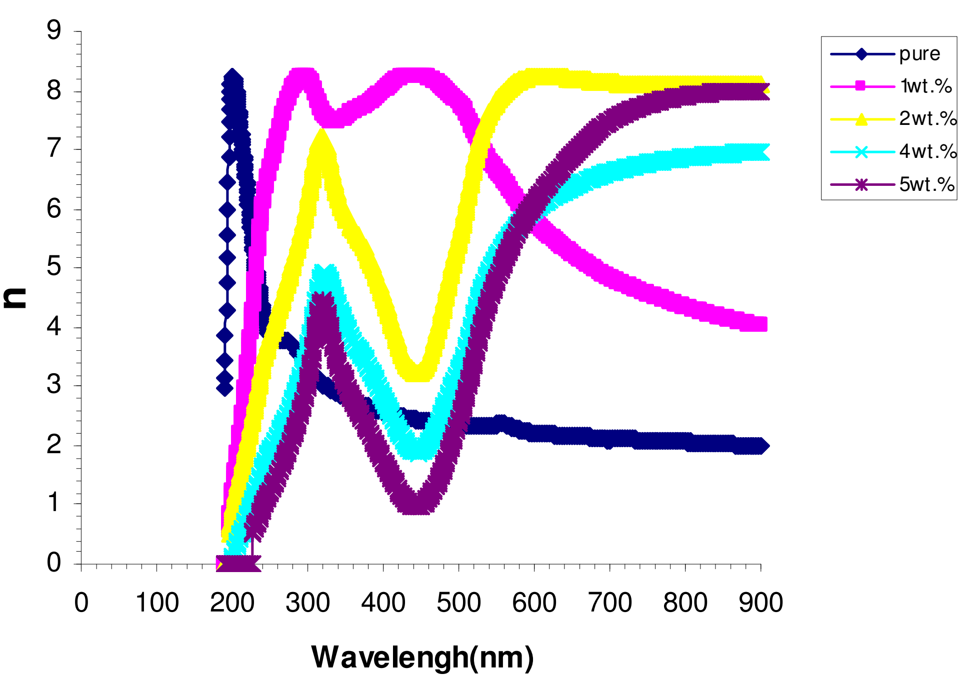
These figures represent the energy gaps for the two indirect transitions. This behavior may explain the fact that the silver carbonate increased the disorder of these materials. The increasing degree of disorder causes the band tail to increase, which according to the electronic structure of amorphous materials, will lead to a decrease of the estimated optical gap[Soliman and Sayed, 2002]. Figure(4) shows the variations of extinction coefficient ($k=\alpha\lambda/4\pi$) with wave length for pure and doped PVA with silver carbonate . This figure shows that, k value increases with increasing of doping concentration. The behavior of extinction coefficient (k) can be ascribed according to high absorption coefficient. This result indicates that the doping atoms of silver carbonate will modify the structure of the host polymer. An interesting result is silver carbonate doping increases the absorbance in the visible region[Ahmed R.,2008].

Figure 4: The relationship between the extinction coefficient (k) and wave length(λ) of the PVA-$AgCO_3$ composites



The variation of the refractive index(for PVA-$AgCO_3$ composites for various different concentration a a function of wavelength at 30°C is shown in figure (5). The figure shows that the refractive index increase as a result of filler addition, this behaviour can be attributed to the increasing of the packing density as a result of filler content.

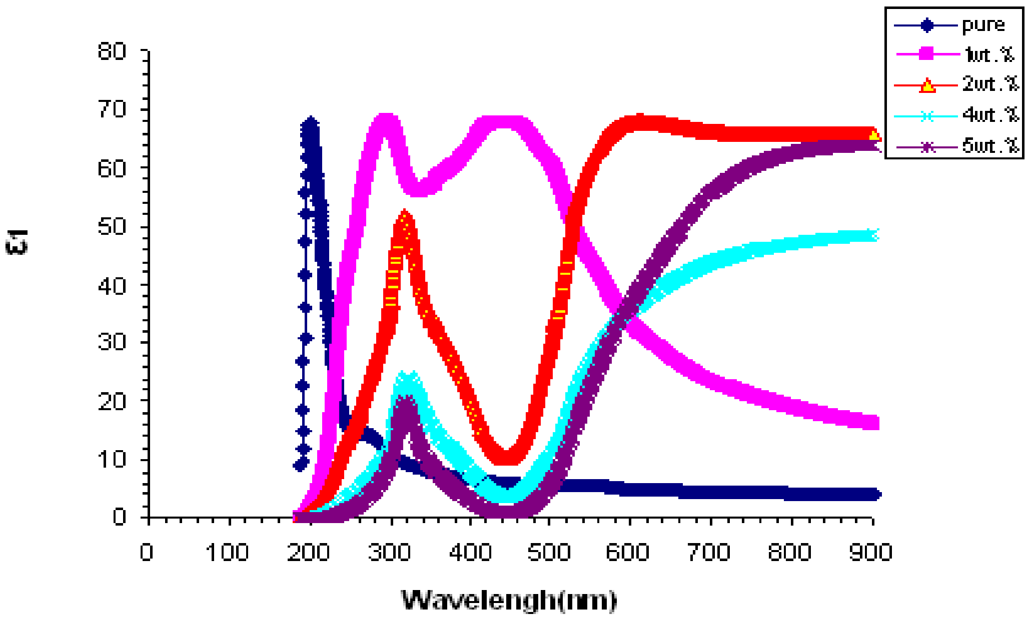
Figure 5: The relationship between the refractive index (n) and wave length(λ) of the PVA-$AgCO_3$ composites



The refractive index also shows a decreasing region in the λ range(350-450)nm which is analogous to valley results from high absorbance of $AgCO_3$ atoms which take place in this wavelength range.

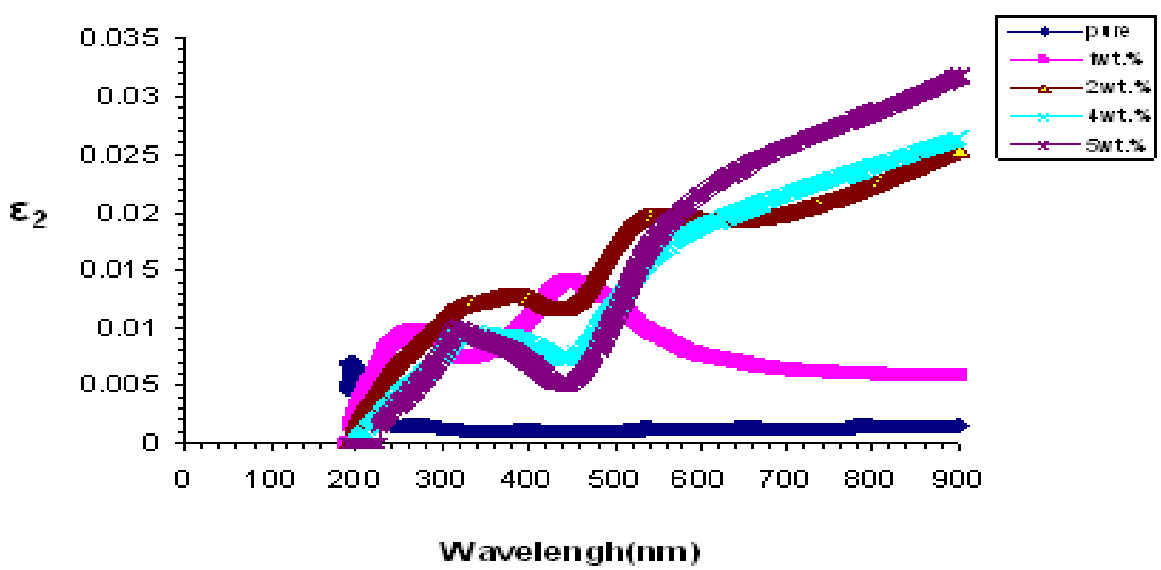
The real and imaginary parts of dielectric constants($\varepsilon_1 = n^2 - k^2$ and $\varepsilon_2 = 2nk$) of pure and doped PVA with $AgCO_3$ with different concentrations are depending on λ are shown in Figs(6 ,7) [Ahmed R.,2008].

Figure 6: The relationship between the real part of dielectric constant and wave length(λ) of the PVA-$AgCO_3$ composites



It is concluded that the variation of ε_1 mainly depends on (n^2) because of small values of (k^2), while ε_2 mainly depends on the (k) values which are related to the variation of absorption coefficients.

Figure 7: The relationship between the imaginary part of dielectric constant and wave length(λ) of the PVA-$AgCO_3$ composites



Figures(8,9,10,11) show the variation the velocity of Ultrasonic wave(V), Specific Acoustic Impedance (Z= ρV where ρ is density), Compressibility($B = (\rho V^2)^{-1}$ and Bulk Modulus($k = B^{-1} = \rho V^2$) with concentration of silver carbonate respectively, using the thickness of sample and delay time was calculate velocity of Ultrasonic wave.

Figure 8: The relationship between the velocity of Ultrasonic wave and the concentration of silver carbonate of PVA-$AgCO_3$ composites

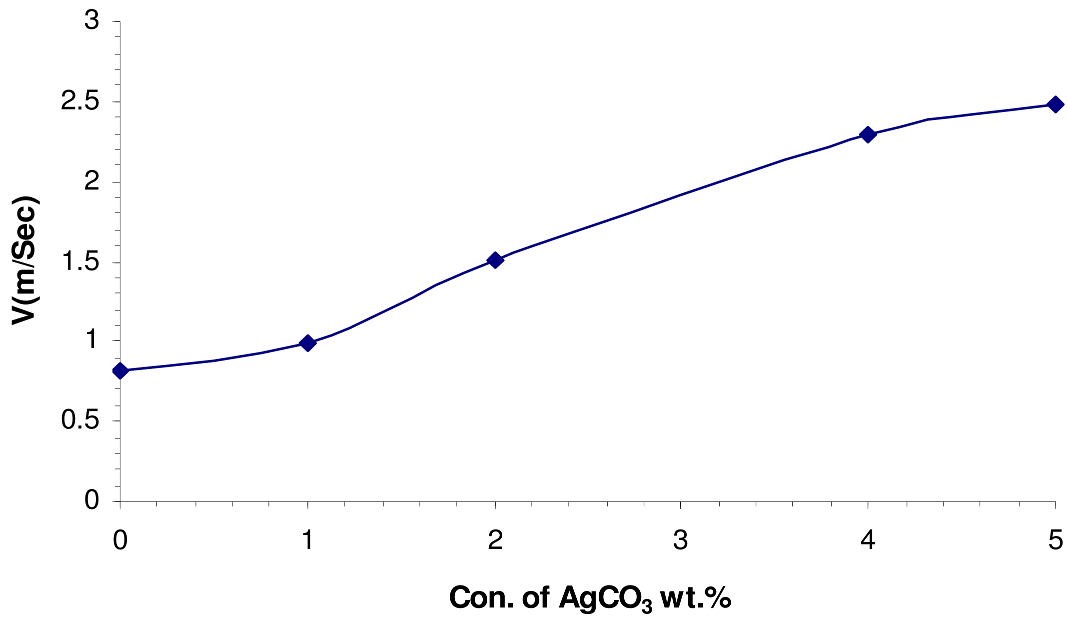


Figure 9: The relationship between the Specific Acoustic Impedance and the concentration of silver carbonate of PVA-$AgCO_3$ composites

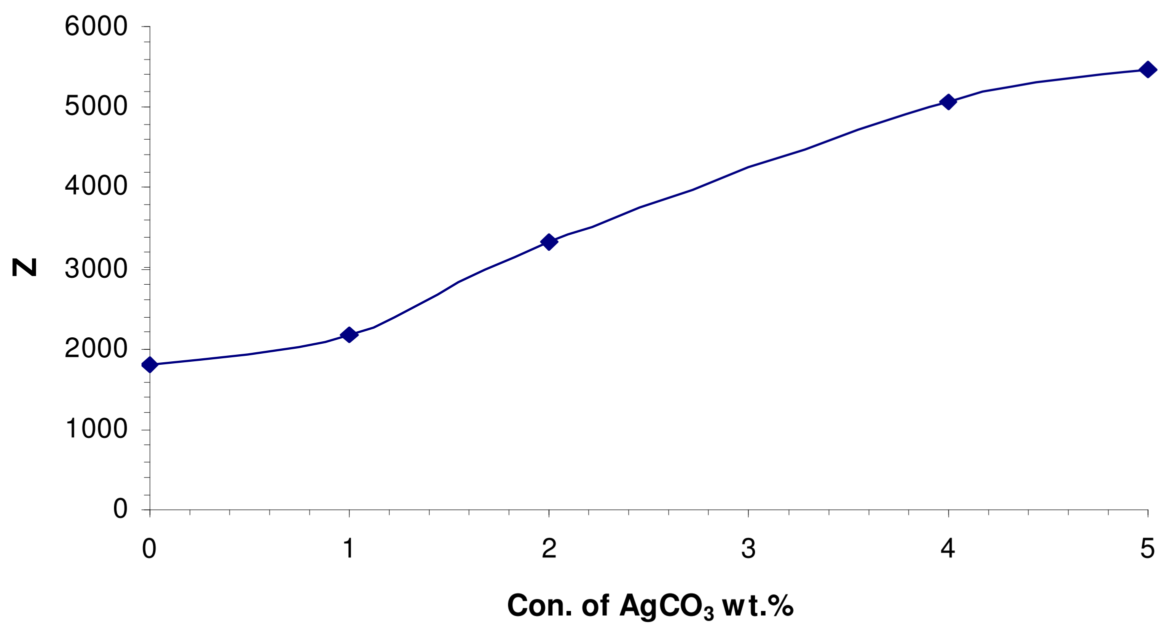


Figure 10: The relationship between the Compressibility and the concentration of silver carbonate of PVA-$AgCO_3$ composites

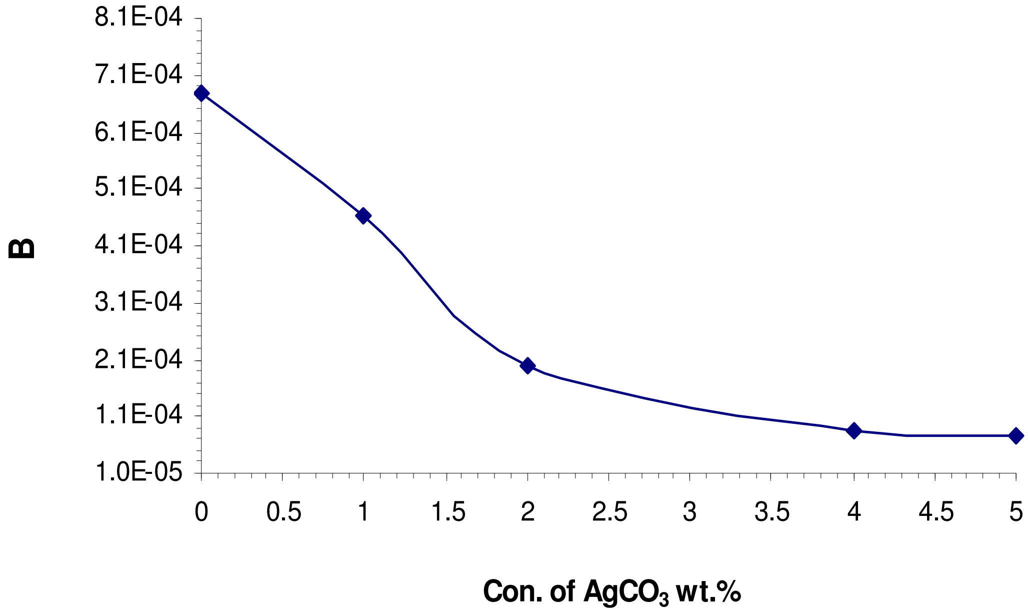
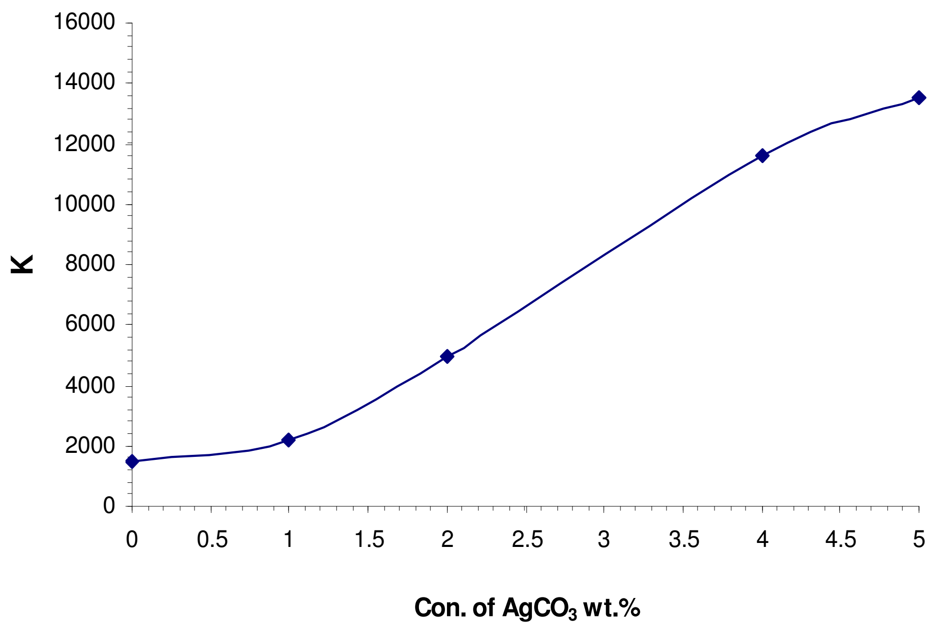


Figure 11: The relationship between the Bulk Modulus and the concentration of silver carbonate of PVA-$AgCO_3$ composites



These figures show that, the velocity of Ultrasonic wave increases with increasing the concentration of silver carbonate, this attributed to silver carbonate particles could act as medium to travel the waves. Consequently, Specific Acoustic Impedance and Bulk Modulus are increasing and Compressibility decreases with increase the concentration of silver carbonate[Al-Bermany *et al*, 2002].

Conclusions

a. The absorption coefficient is increasing with increasing of the filler wt.% content.

b. The experimental results showed that the absorption coefficient less than $10^4 cm^{-1}$ this is indicates to forbidden and allowed indirect electronic transitions.
c. The forbidden energy gap is decreasing with increasing of the filler wt.% content
d. The velocity of Ultrasonic wave**,** Specific Acoustic Impedance and Bulk Modulus are increasing and Compressibility decreases with increase the concentration of silver carbonate

References

[1] Ahmed and Asrar, 2010, "Electronic Transitions For Polystyrene Filled With Lithium Fluoride Additive", Al-Mustansiriya J. Sci, Vol. 21, No. 5.

[2] Ahmed R.m. , 2008, "Optical study on poly(methyl methacrylate)/poly(vinyl acetate)", Zagazig Uni., Zagazig, Egypt, E-mail-rania 8_7@hotmail. com.

[3] Al-Bermany, A.K.J.; Al-Bassam, F.A. and Al-Mamory M.H., 2002, "Babylon Univ. J.", V. 7, No. 3.

[4] KUMAR A.,2008," EFFECT OF EUPHORBIA COAGULUM ON THERMO-MECHANICAL PROPERTIES OF POLYESTER –NATURAL FIBER COMPOSITES", A Thesis OF ENGINEER POLYMER TECHNOLOGY, Department of Applied Chemistry & Polymer Technology Delhi College of Engineering, Delhi-110042.

[5] Kathalingam. A *.et al* , 2007, "Materials Chemistry and physics, Vol.106,No.215.

[6] Kalisza G.; ,E.Grzankaa ,D.Wasikb, A. Swiderska -Srodaa ,S.Gierlotkaa, J.Borysiuka, M.Kaminskab, A.Twardowskib and B.PaÃlosza, 2005," Fabrication and Physical Properties of SiC GaAs Nano-Composites", Proceeding sof the XXXIV International School of Semi conducting Compounds, Jaszowiec.

[7] Laurissa A., 2008," EFFECT OF CARBON FILLER CHARACTERISTICS ON THE ELECTRICAL PROPERTIES OF CONDUCTIVE POLYMER COMPOSITES POSSESSING SEGREGATED NETWORK MICROSTRUCTURES", A Thesis of M.SC., Georgia Institute of Technology.

[8] Majdi K, Zeedan K. and Attar H., 1997,"Optical properties of poly thiophene/ PVC conducting polymer alloy films", Iraqi J. of polym., Vol. 1, No. 1,155-162.

[9] Soliman and Sayed, 2002," Some Physical Properties of Vinylpyridine Carbon-Black Composites", Egypt. J. Sol., Vol. 25, No. 1