

Plasma Effect on A.C Electrical Properties of (pva-pvp-MnO₂) Nano Composites for Piezoelectric Application

Farah T. M. Noori¹, Mehdi .E .M²

University of Bagdad, the College Sciences, Department of Physics, Iraq

Abstract: This paper, study Fourier transforms Infrared Spectroscopy Analysis and the effect of plasma effect on A.C electrical and piezoelectric properties of biopolymers blend with addition of Magnesium oxide as (PVA-PVP/MnO₂) Nano composites. The magnesium oxide nanoparticle was added to the polymers mixture (polyvinyl alcohol 86wt.% and Polyvinyl pyrrolidone 16wt.%) with different weight percentages are (0, 2, 4, 6,8) wt.%. The piezoelectric properties started from pressure (80-200) Pa before and after plasma. The result describes it at diagnosis using the polymers mixture spectrum and we found that there are no chemical interaction between two polymers and it's good physical mixture als A.C electrical which is measured in the frequency range we note increase in dielectric Constance at increasing concentrations magnesium oxide in the temperature of room for configuring network of particles magnesium oxide that the increase in dielectric constant back increase shipments polarized at increasing concentrations. And the resistance decrease with the increase pressure and concentration of art added because polarization inside the composites. But the resistance less than its majority shed plasma and when increase of the weight percentages of magnesium oxide nanoparticle.

Keywords: Nano composite, Fourier transforms Infrared Spectroscopy Analysis, A.C electrical, piezoelectric properties polyvinyl alcohol, polyvinyl pyrrolidone, magnesium Oxide, pressure (par).

1. Introduction

A polymer is typically used in electrical and mechanical applications are noted for their use as insulators, both electrical and thermal. They are loss reflectors of light tending to be translucent or transparent .Some of them are subject and flexible to deform motion number of important science include:

Engineer polymers –Polymer designed to replace metals example poly acryl nitrite (PVA), piezo polymers-polymers engine iced for transducer technology as actuators and sensors such as polyvinyl alcohol (PVA) and (PVP) , thermal stability polymers-polymers oxidative stability and have excellent thermal such as (PVP) and Polymer conducts-polymers that exhibit electrical conductivity comparable to those of metals such as (PVA).

Piezoelectric polymer is increasingly considered as favorable materials for a variety of electrical applications [3]. One of the most important of the piezoelectric polymer is poly (vinyl alcohol) [4].

Poly (vinyl alcohol) (PVA) is one of the superior polymeric matrices results from the widespread industrial applications. For instance, when doped with phosphoric acid it can be used as a solid polymer electrolyte in solid state electro chromic displays and solid state photocells [5]. Polyvinyl pyrrolidone (PVP) is a conjugated polymer gains its importance from its moderate electrical conductivity, environmental stability and ease of processing. Moreover, PVP and PVA are miscible a toxic insoluble in water features four- install it. Due to the impermeability be in high visible area and near infrared region so it has been included in the oxides connectivity [7].

When polymeric materials are manufactured ends they will have good a piezoelectricity and mechanical rigidity [8].

2. Materials and Method

The materials which used in this work are polyvinyl alcohol 86 wt. % and polyethylene glycol 14 wt. % as a matrix and the manganese oxide nanoparticle as filler.

The manganese oxide nanoparticle was added to the polymers with concentrations are (0, 2, 4, 6 and 8) wt.%. The casting technique was used to preparation the nanocomposites. The piezoelectric l properties of (PVA - PVP-MnO₂) started from pressure (80-200) Pa and A.C electricof (PVA -PVP-MnO₂) nanocomposites are measured by using ((tangent Angle Los (capacitance) (LCR meter) type (HIOKI 3532-50 LCR HI TESTER). At frequency for(1000Hz – 5MHz).

2.1 Fourier transforms Infrared Spectroscopy Analysis

The aim of use the device is bounds find in materials and make sure that it has been an chemical interaction between two using articles in the polymers mixture or it's physical mixture and type article. From the figure (1) we can observe the spectrum of infrared of (PVA-PVP) .As that all spectra bearing totals ultimate of bounds article which display my within the range wave (3800-700) and found that the curved divided into three parts .The first area is strong bonds within the range 3253.8, 3259.49, 3253.8 cm⁻¹ within (3200-3600)cm⁻¹ which represents the group of hydroxyl is bond O-H, which is characterized by strength according to the number wave and be large in that region about (95-96) .The second area has a wide range of medium and medium length and large of waveform setting is (3200-2800)cm⁻¹ is between(2906-2941)cm⁻¹ which represent the regions of the mix on the order and the peaks located in this region

represent the C-H bonds, is the second pillar in the composites. Either the area appears when the wave number is set to blend (1647.47, 1416.77) cm^{-1} , within range (1700-1400) cm^{-1} the found this peak reference to C=C bonds, this is the region weak rather an area presence bonds C=C. As for the last they (1083.54, 912.65, 835.76) cm^{-1} within (1350-800) cm^{-1} the presence of peak refers to the bond C-O this bond in weak region, thus appears all bonds in compound (PVA-PVP). Either in film (PVA-PVP-MnO₂) with concentrations (0,2,8) % described as Fig (4-10, a, b, c) respectively, we find that in addition to the four bonds in composite display in four bonds of the other in installation chemical Nano composites where bond O-H appear within the wave number (3253.8, 3259.49, 3253.8) cm^{-1} any of the (3400-3200) extent of within the area powerful bonds, as for

the second which are less strong appear bond C-H stretch bond within wave number (2914.87, 2940.51, 2906.33, 2912.03) these bonds of strong somewhat. The region third it the region, which display my where bonds weak an bond area C=C which display my within the wave number (1647.47, 1653.16, 1653.16, 1416.77, 1419.62, 1416.77) any within the range (1800-1400) as the region fourth and final they bond area weak and appear in which C-O, MnO₂ tris, C-H, C-O within wave number (1371.2, 1374.05, 1374.05, 1317.09, 1319.94, 1317.09), (1083.54, 1083.54), (912.65, 912.65, 91.66), (835.76, 832.91, 832.91) hence we find that there are no find bonds of anew when mixing two bio polymer or Nano composites or any interaction chemical no it, s physical blend

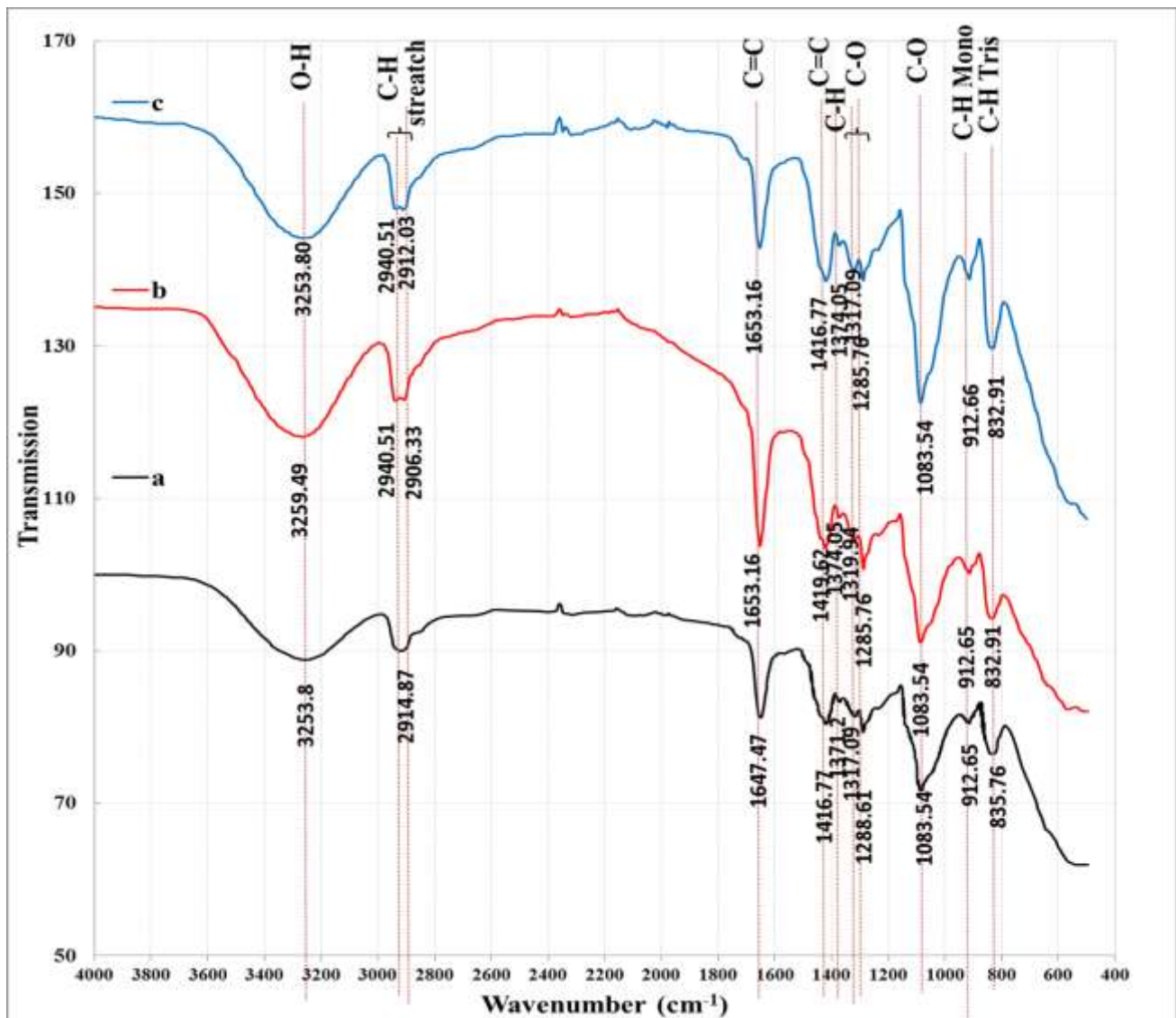


Figure 1: Relations wavenumber(cm^{-1}) and transmission of three composites

2.2 The A.C electrical properties

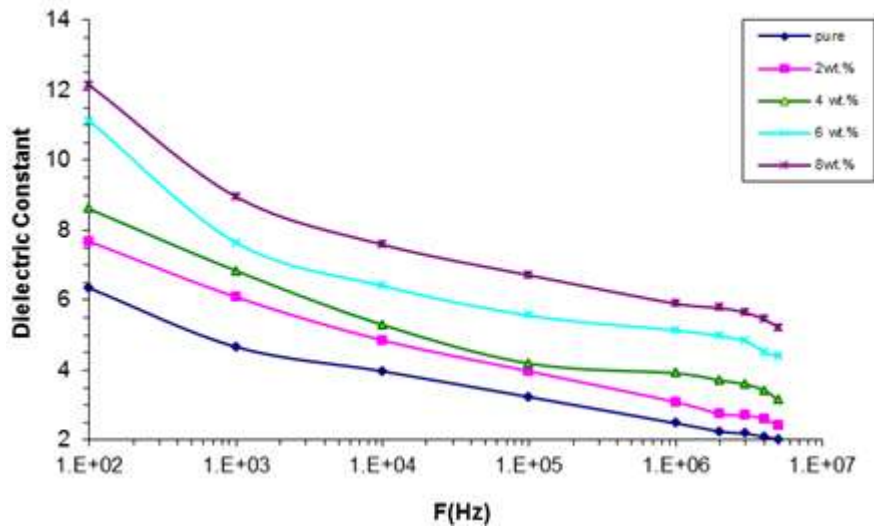
The electrical properties A.C for the (PVA-PVP-MnO₂) Nano composites were studied at room temperature the frequency ranging from (100Hz -5MHz). The electric response of a material can be described by its dielectric parameters, dielectric constant (ϵ_r), dielectric tangent loss ($\tan\delta$) and dielectric loss factor (ϵ_i).

The real dielectric constant for (PVA-PVP-MnO₂) Nano composites before plasma.

The variation of the real dielectric constant of (PVA-PVP-MnO₂) Nano composites and frequency show in figure (2). Notes from this figure the dielectric constant decrease when increasing the frequency. This is attributed to decreasing of

space charge polarization with respect to the total polarization. The space charge polarization becomes more contributing type of polarization at low frequencies, and less contributing with the increase of frequency. The other types of polarizations appear at subsequent frequencies. The ionic polarization reacts slightly to the variation in the field frequencies compared with electronic polarization; this is because the mass of ion is greater than that of the electron. The electrons respond even to the high frequencies of the

field vibrations. The low mass of electron makes the electronic polarization was the only type of polarization at higher frequencies, this makes the dielectric constant approximately constant for all samples at high frequencies literature Survey .The dielectric constant was collect by $\epsilon = \frac{D}{E}$. When ϵ_i imaginary dielectric constant, ϵ_r real dielectric constant .



The figure (2) variation between dielectric constant and frequency.

The imaginary dielectric constant for (PVA-PVP-MnO₂) Nano composites before plasma

Losses are high at low frequency but this decrease with increase of frequency. This is attributed to the decrease of contributed the ionic polarization with increasing of frequency , while at high frequency which reaches to (5*10⁶)Hz, the dielectric loss is approximately fixed for all composites. This is due to another polarization mechanisms which occur in high frequency. Also notice the value of

dielectric loss increases with the increasing of (MnO₂) concentration as shown in figure (3) This is The variation of dielectric loss with frequency for (PVA-PVP-MnO₂) composites is shown in figure (4). It is obvious from this figure that the values of dielectric due to the increase of ionic charge carriers with increasing of concentration 1.The dielectric loss collect from equation $Tan \delta = \frac{I}{2\pi f \epsilon_0 \epsilon_r}$.

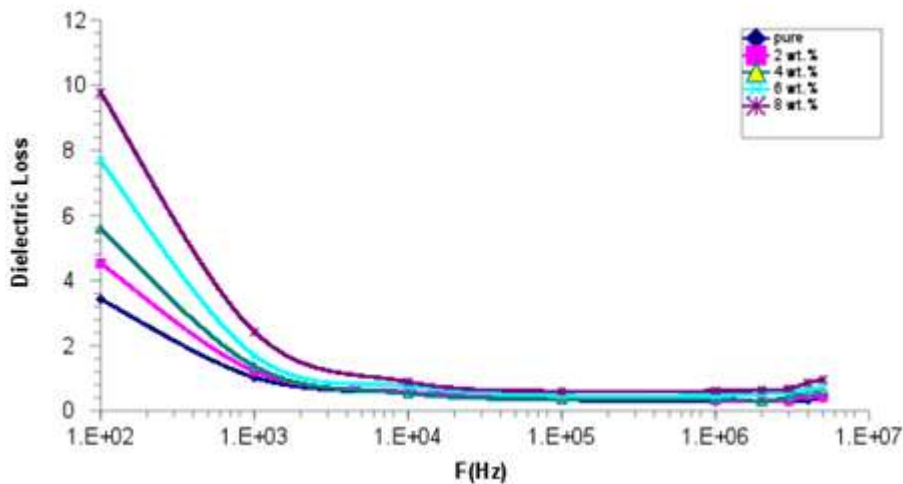
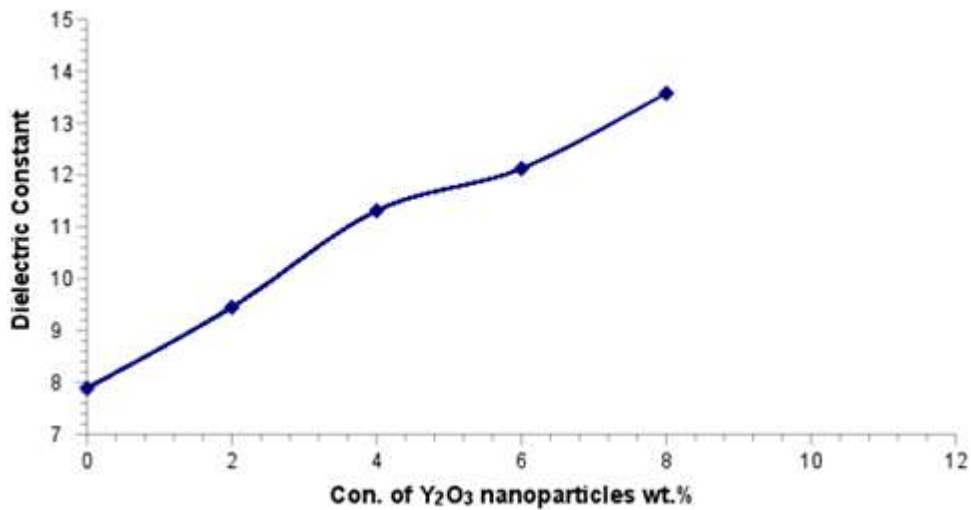


Figure 3: Variation between dielectric loss and frequency.

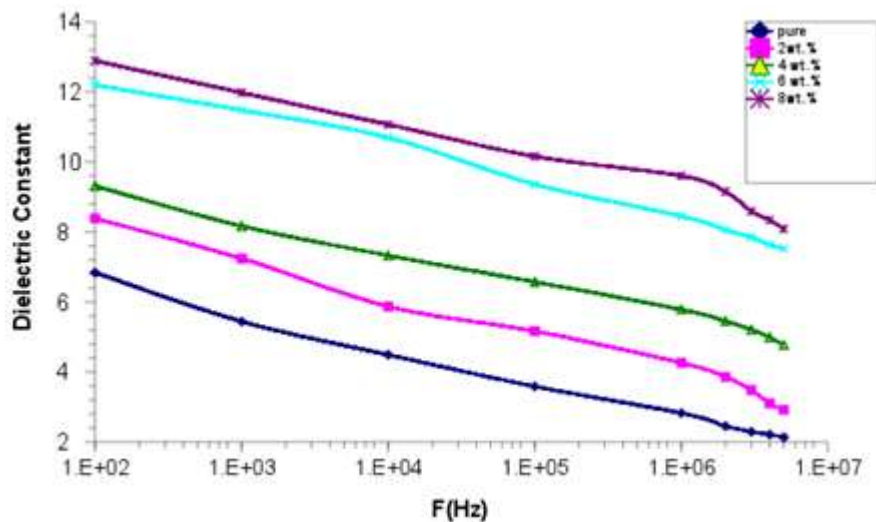


The figure (4) relationship dielectric constant and concentration MnO₂.

The electric properties of material can be described by its dielectric parameters, dielectric constant (ϵ_r), dielectric tangent loss ($\tan\delta$) and dielectric loss factor (ϵ_i). The dielectric properties MnO₂ (0, 0.01, 0.02, 0.03, and 0.04) . Samples, frequency dependent (ϵ_r) and $\tan\delta$ were collect in the frequency range of 100 KHz to 6MHz at room temperature (RT). The sample is use in circle form having a diameter of 6mm. The values of parallel resistance and capacitance were obtained as a function of frequency. The dielectric constant was collect from equation $\epsilon_r = \frac{C}{C_0}$. The tangent of dielectric loss angle can be evaluated using the equation $\tan \delta = \frac{I}{V}$. The dielectric loss factor was

also measured in terms of tangent loss factor given by equation $\epsilon_i = \epsilon_r \tan\delta$.

The real dielectric constant will decrease more when plasma applied with increase line angle wave. Through the figure (5) show ϵ_r as a function of frequency for sample. The dielectric constant ϵ_r decrease on arrange with increase in frequency. The decrease in ϵ_r at high frequencies is based due to the dielectric relaxation. Through the Koop's theory can be explained dielectric dispersion. This theory, the dielectric structure is considered to be consisting of double layers, where one layer is conducting and other one is insulating.



The figure (5) variation between dielectric constant and frequency.

Through the shape (7) we note that the condition increase than higher concentration. We note that the resistance less more than after irradiation as plasma.

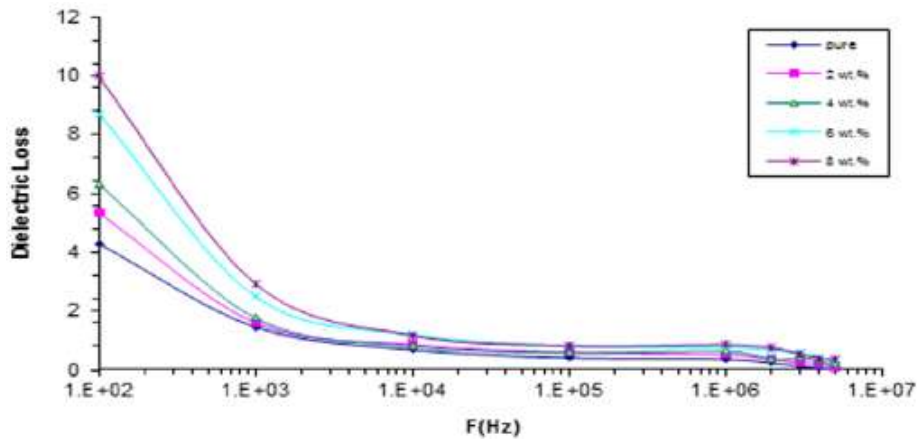


Figure 6: Show variation between dielectric loss and frequency.

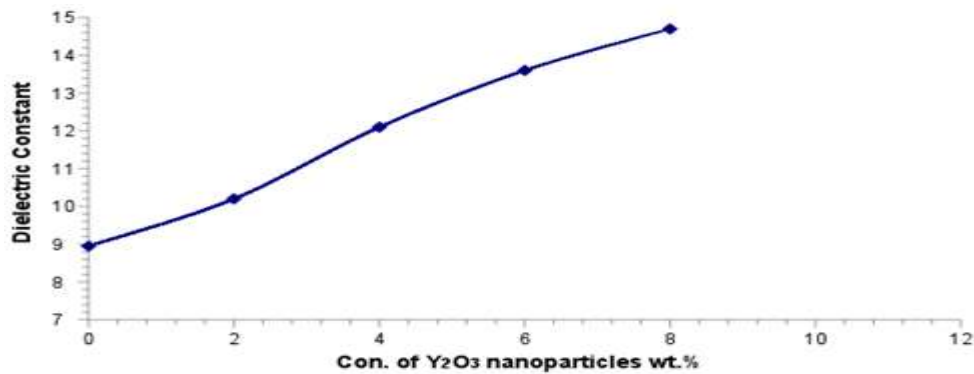


Figure 7: Relationship dielectric constant and concentration MnO_2 .

Piezoelectric effect

When you shed pressure on Nano composites we note that the resistance less than and used samples with thickness (0.13, 0.128, 0.1263, 0.1241, 0.1211) mm. The increase concertino because of that in all material there atoms within the article are random and when shed pressure on this article we note that this atoms involved in the direction of specific any occur process polarization and when increase pressure we note that the order of atoms stop no matter how shield pressure by any event polarization fully. TO add concentrations (MnO_2) is working on increase carriers ,consignment this clearly our through x-ray where we note that the more the proportion of concentrations above the article crystal which has a large number of carriers send to. The figu (1) show piezoelectric before plasma. The goal of piezoelectric is to get the energy lost within the article are the result of the presence of atoms more random within the articleat the shed pressure ensure atoms within the article at the shed pressure will have atoms as direction particular with the pressure of polarization. Table show the decrease of resistance at increasing pressure and focus article added and piezoelectric effect after plasma Piezoelectric effect.

When you shed pressure on Nano composites we note that the resistance less than and used samples with thickness (0.13, 0.128, 0.1263, 0.1241, 0.1211) mm. The increase concertino because of that in all material there atoms within the article are random and when shed pressure on this article we note that this atoms involved in the direction of specific any occur process polarization and when increase pressure we note that the order of atoms stop no matter how shield pressure by any event polarization fully. TO add

concentrations (MnO_2) is working on increase carriers ,consignment this clearly our through x-ray where we note that the more the proportion of concentrations above the article crystal which has a large number of carriers send to. The figu (1) show piezoelectric before plasma. The goal of piezoelectric is to get the energy lost within the article are the result of the presence of atoms more random within the articleat the shed pressure ensure atoms within the article at the shed pressure will have atoms as direction particular with the pressure of polarization. Table show the decrease of resistance at increasing pressure and focus article added as table(2).

Table 1: Show pressure and resistance blend and MnO_2 filler.

Pressure	Resistance blend	Resistance 0.01	Resistance 0.02	Resistance 0.03	Resistance 0.04
80	265	215	191	177	153
100	215	198	161	131	121
120	185	165	138	104	92
140	155	132	102	75	64
160	122	111	87	40	34
180	103	94	63	21	19

Table 2: show pressure and resistance blend and MnO_2 filler

pressure Pa	Resistance blend	Resistance 0.01	Resistance 0.02	Resistance 0.03	Resistance 0.04
80	221	199	161	137	113
100	200	187	131	111	80
120	175	164	101	76	61
140	145	112	79	49	37
160	132	90	40	23	18
180	113	74	23	11	5

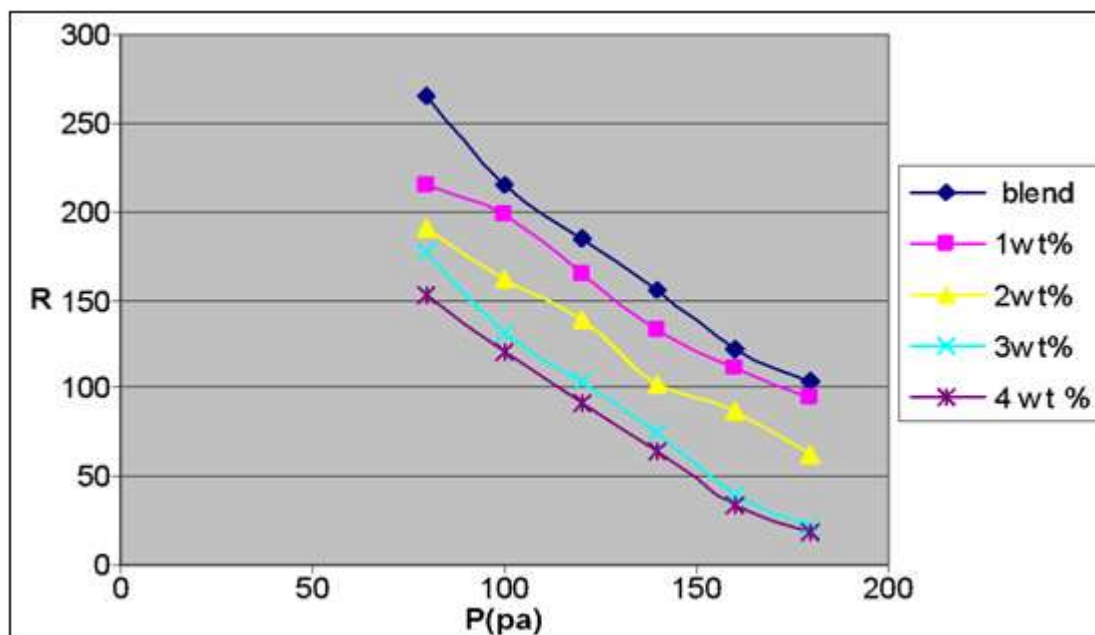


Figure (1) show variation between resistant(R) and pressure (Pa) before plasma

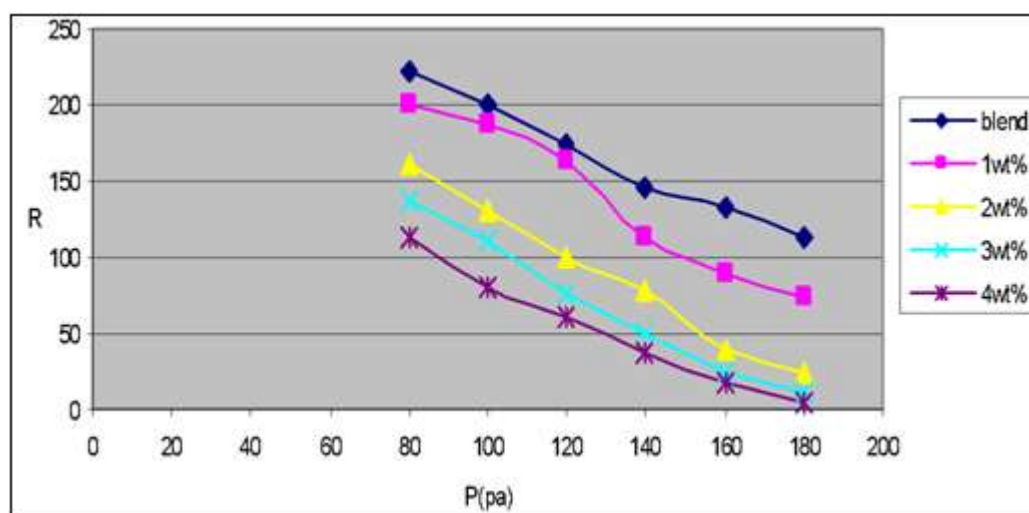


Figure (2) show variation between resistant(R) and pressure (Pa) after plasma

3. Conclusions

The conductivity of (PVA-PVP-MnO₂) nanocomposites increases with increase of shed pressure and the concentrations of fillers. We note connectivity increase after shed plasma due to increased carriers shipment inside.

Was the expense of dielectric Constant when increase article added shed plasma increase dielectric constant due to increased shipments polarizerization.

References

- [1] S.Chand and M.S.Bhatnagar, "A text Book chemistry and Technology of polymers", Volume-1 Basic concept, India, publishing com. LTP First edition
- [2] H. Van Vlack, "Elements of materials science and Engineering" Addison-Wesley publishing company, INC. (1989).
- [3] Y. Erol charvey, "Design, Fabrication and Testing of Piezoelectric Polymer PVDF microstructures" online at sacks 15, 141-146, (2006)
- [4] A. Goddard and Karasawa, "Force Fields, Structure , and properties of poly(vinylidene fluoride) Crystal", *Macromolecules*, 25,
- [5] A.K. Bajpai , S. K. Shukla , S. Bhanu, and S. Kankane , " Responsive polymers in controlled drug delivery", *Progress in Polymer Science*, Vol.33, P.P. 1088–1118, (2008) .
- [6] B.L. Lopez, A.I. Mejia and L. Sierra, "Biodegrade ability of polyvinyl alcohol", *Poly. Eng. and Sci.* vol. 39, No. 8, pp. 1346-1352, (1999).
- [7] B.L. Lopez, A.I. Mejia and L. Sierra, "Biodegrade ability of polyvinyl alcohol", *Poly. Eng. and Sci.* vol. 39, No. 8, pp. 1346-1352, (1999).
- [8] R.L.Mccullough, "Concept of Fiber-Resin Composites", Marcel Dekker, New York, (1971).
- [9] M. P. Steven, "*Polymer Chemistry*", New York Oxford University. press, M. P. Steven, "*Polymer Chemistry*", New York Oxford University

- [10] Jump up ^ Alan D. MacNaught, Andrew R. Wilkinson, ed. (1997). *Compendium of Chemical Terminology: IUPAC Recommendations (the "Gold Book")* (2nd ed.). Blackwell Science. ISBN 0865426848.
- [11] V.C.H. Wiley: "*Ullmanns Encyclopedia Chemistry*", 6th edition, Weinheim (2002).
- [12] B. A. Newman, C. H. Yoon, K. D. Pae, & J. I. Scheinbeim, "*Piezoelectric Activity and Field-Induced Crystal Structure Transition in poled PVDF Films*", *J. Appl. Phys.*, 50(10), 6095-6100, (1979).
- [13] J. Akedo and M. Lebedev, "Piezoelectric Properties and Poling effect of Pb(Zr, Ti)O Thick films prepared for micro actuators by aerosol deposition", *Applied physics letters*, 77(11), 1710-1712, (2000).
- [14] S. K. Saxena, "Polyvinyl Alcohol (PVA)", *Chemical and Technical Assessment*, 61st JECFA, (2004).
- [15] S. P. Seth, and D. V. Gupta, "A course in Electrical Engineering Materials", 2nd Ed. Dhanpat Rai and Sons, (1981).
- [16] H. Frohlich, "Theory of Dielectrics", 2nd Ed. Oxford Uni. Press, (1958).
- [17] Structural and dielectrical study of PZT/PVDF Film Composites IA Al Ajaj, FT Noori, NN Ramoo *Int. J. Appl. or Innovation in Eng. Manage* 2 (4), 79-88