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# Effect addition $Al_2O_3$ on the (A.C, D.C) Electrical Properties of Ethylene-Alpha Olefin Copolymer

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**Abstract:** ***In the present work, the effect of the addition of $Al_2O_3$ on some electrical properties of Ethylene-alpha olefin copolymer has been studied. For such a purpose, many samples have been prepared by adding $Al_2O_3$ on the Ethylene-Alpha Olefin by different weight percentages (0.2, 0.4, 0.6, 0.8 and 0.10) w.t% by using casting method. The experimental results showed that the electrical properties measured at room temperature. The results showed that the D.C and A.C electrical conductivity of (Ethylene-Alpha Olefin-$Al_2O_3$) Composites copolymer is increased with the increasing of the weight percentages of $Al_2O_3$.***

**Keywords:** Alpha Olefin Copolymer, $Al_2O_3$ , Electrical Properties

## 1. Introduction

Composite Materials are described by the three traditional primary classifications they are: metals, ceramics, and polymers [1]. Many of modern technologies require materials with unusual combinations of properties that cannot be met by the conventional metal, alloys, ceramics, and polymeric materials. This is especially true for materials that are needed for aerospace, underwater, and transportation applications[2]. A composite material is basically a combination of two or more materials, each of which retains its own distinctive properties. Usually the term composite is applied to materials that are created by mechanical bonding two or more different materials together. The resulting materials have characteristics that are not characteristics of the component in isolation[3]. Recently polymer matrix-ceramic filler composites receive increased attention due to their interesting electrical and electronic properties, Integrated decoupling capacitors, angular acceleration accelerometers, acoustic emission sensors and electronic packaging are some potential applications fields [4].

α-Olefins (terminal alkenes) of carbon number 4–20 are important basic products in the chemical industry, and these are used as the comonomer in the ethylene/α-olefin copolymerization, the raw material of long-chain alcohols, and the base material of synthetic lubricant oil as shown in figure(1) [5,6]. Straight chain olefins produced by the oligomerization of ethylene are more useful than branched olefins, because of the high biodegradability of the products. The one-step process using a triethylaluminum catalyst was developed by the Gulf Oil Chemical Co. (Chevron Corp.) to produce ethylene oligomers having the Shultz-Flory distribution [5]. The two-step process using the same catalyst is known as the Ethyl process (Albemarle Corp.) and the products have a Poison distribution with a relatively narrow distribution. These processes required both a high reaction temperature and ethylene pressure due to the low catalytic activity of triethylaluminum [5].

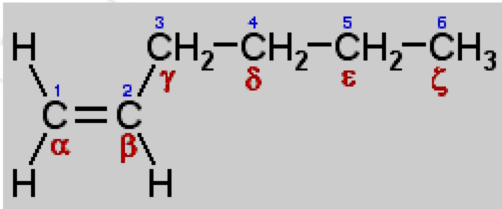

**Figure 1:** Structure of Ethylene-Alpha Olefin Copolymer

polymeric based composite materials are being used in many applications, such as automotive, sporting goods, marine, electrical, industrial, construction, household appliances, etc. Polymeric composites have high strength and stiffness, light weight, and high corrosion resistance. In the past decade, extensive research work has been carried out on the natural fiber reinforced composite materials in many applications. Natural fibers are available in abundance in nature and can be used to reinforce polymers to obtain light and strong materials. Natural fibers from plants are beginning to find their way into commercial applications such as automotive industries, household applications, etc. [7].

Composites, the wonder materials are becoming an essential part of today's materials due to the advantages such as low weight, corrosion resistance, high fatigue strength and faster assembly. They are extensively used as materials in making aircraft structures, electronic packaging to medical equipment and space vehicle to home building. There is much interest in the development of inexpensive composite polymers with an appropriate weight, appropriate electric conductivity and/or appropriate impact value for use with practical articles [8]. The importance of polymers is mainly because polymers are still regarded as a cheap alternative material that is manufactured easily. The intensive use of polymer in broad use has led to the development of materials for specific applications namely composites [9]. Ceramic materials are typically brittle, possess low dielectric strength and in many cases are difficult to be processed requiring high temperature. On the other hand, polymers are flexible, can be easily processed at low temperatures and exhibit high dielectric break down fields [8].

## 2. Experimental Part

Ethylene-Alpha Olefin solution was prepared by dissolving it in benzene by using magnetic stirrer in mixing process to get homogeneous. Composites of (Ethylene-Alpha Olefin - $Al_2O_3$) films are prepared by using casting method. The alumina (as a filler) are added to Ethylene-Alpha Olefin (as matrix) with different concentrations are (0,1,2,3 and 4) wt.% and mixed for 90 minutes to get more homogenous solution.

The resistivity was measured at room temperature using Keithley electrometer type 2400 sours mater. The volume electrical conductivity ($\zeta_v$) defined by [10] :

$$\sigma_v = \frac{1}{\rho} = \frac{L}{R\,A} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

A = guard electrode effective area.
R = volume resistance (ohm).
L = average thickness of sample (cm).
In this model the electrodes have circular area A= $D^2\pi/4$ where D= 0.5 $cm^2$.

In the frequency (f) range (100-5×$10^6$) Hz at room temperature. The measured capacitance, C(w) was used to calculate the dielectric constant, έ (w) using the following expression:

$$\varepsilon'(w) = C(w)\frac{d}{\varepsilon_\circ A} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where (d) is sample thickness and (A) is surface area of the sample. whereas for dielectric loss ε"(w):

$$\varepsilon''(w) = \varepsilon' C(w) \times \tan\delta(w) \qquad \ldots\ldots\ldots\ldots \ (3)$$

Where tanδ(w) is dissipation factor . The AC conductivity $\zeta_{ac}$ can be calculated by the following equation:

$$\sigma_{ac}(w) = \varepsilon_\circ w \varepsilon'' \qquad \ldots\ldots\ldots\ldots \ (4)$$

## 3. Results and Discussion

Figure (2) shows the electrical volume conductivity as a function of the concentration of $Al_2O_3$ at a temperature of 30°C, it appears that the conductivity increases with the increase of the $Al_2O_3$ additive concentration. The increase of conductivity with increasing concentration of $Al_2O_3$ is due to the increase of the charge carriers, which increase with the increase of filler contact [11].

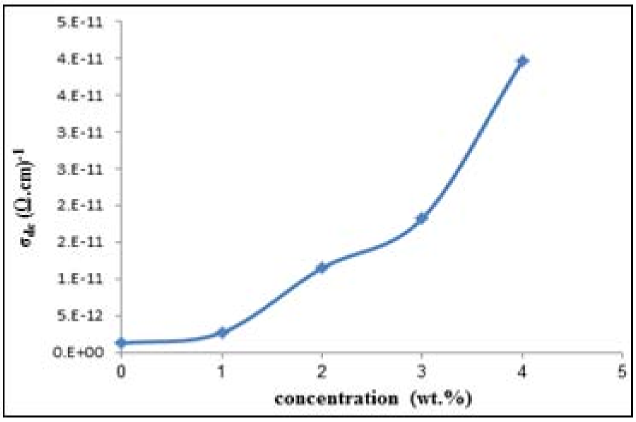


**Figure 2:** Variation of D.C. electrical conductivity with $Al_2O_3$ wt. % concentration for (Ethylene-Alpha Olefin - $Al_2O_3$) composite

Figure (3) shows the variation of dielectric constant for (Ethylene-Alpha Olefin - $Al_2O_3$) composites of different aluminum oxide concentration as function of frequency at room temperature. At low frequency region in addition to polarization due to Ethylene-Alpha Olefin and $Al_2O_3$, the space charge polarization plays a major role in increasing dielectric constant of composite [12]. The space charge polarization arises from the (Ethylene-Alpha Olefin - $Al_2O_3$) interfaces. The dielectric constant increases with weight fraction of $Al_2O_3$. The increase in dielectric constant with weight fraction of $Al_2O_3$ supports the fact of the space charge polarization contribution. The dielectric constant of composite increases with addition of $Al_2O_3$ reflects the formation of capacitance network of Al [13].

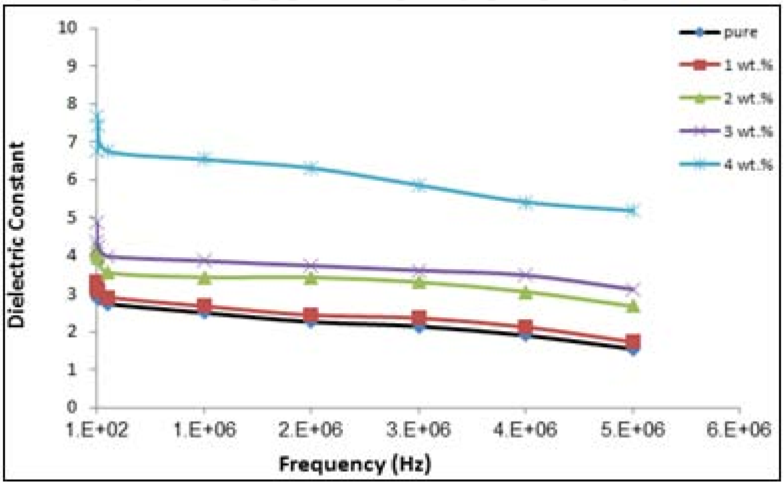


**Figure 3:** Variation dielectric constant with frequency for (Ethylene-Alpha Olefin - $Al_2O_3$) composite.

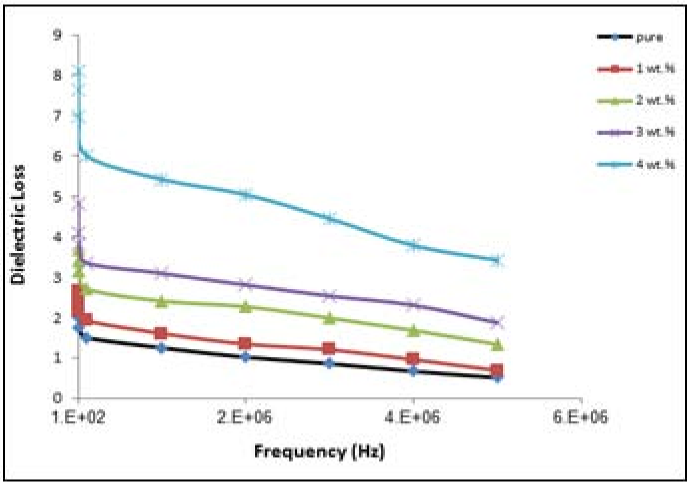


**Figure 4:** Variation of dielectric loss with frequency for (Ethylene-Alpha Olefin - $Al_2O_3$) composite

Figure (4) shows the variation of the dielectric loss of (Ethylene-Alpha Olefin - $Al_2O_3$) composites as a function of frequency at room temperature, the values of ε" are high for frequencies, and decreasing with increasing frequency. The increasing of $Al_2O_3$ concentration increases the height of the peak and increasing its broadness for these specimens. This is due to the overlapping of relaxation process which are attributed to some structural changes that take place in the composite as result of filler addition. The increasing of the peak height of ε" with increasing $Al_2O_3$ concentration indicates the enhancement of conductivity in these specimens, i.e. enhancement of losses [14].

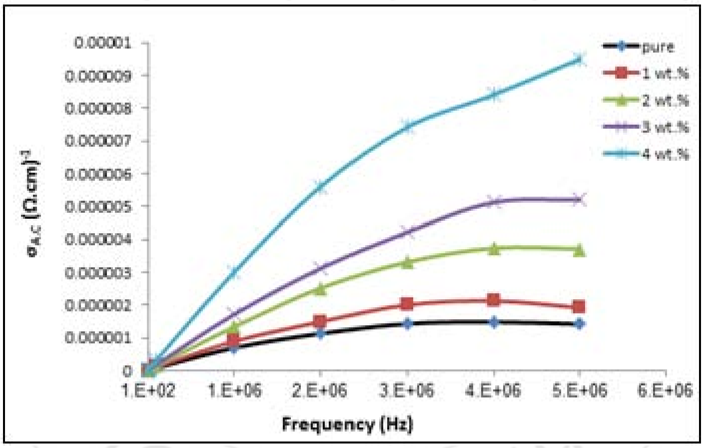


**Figure 5:** Variation of A.C electrical conductivity Frequency for (Ethylene-Alpha Olefin - $Al_2O_3$) composite

The variation of A.C electrical conductivity as a function of frequency for (Ethylene-Alpha Olefin - $Al_2O_3$) composites at room temperature is given in figure (5). The figure shows that in low and intermediate frequency region the electrical conductivity for all (Ethylene-Alpha Olefin - $Al_2O_3$) composites is increasing with frequency. But the higher frequency region is almost constant of A.C electrical conductivity with increasing angular frequency. The increasing of A.C electrical conductivity with angular frequency in the low frequency region can be attributed to the interfacial polarization [12]

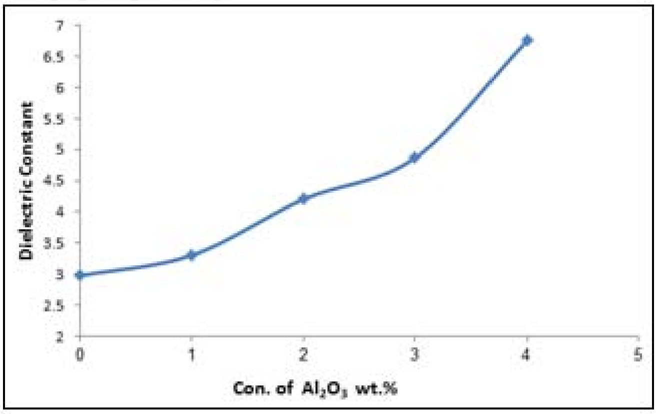


**Figure (6):** variation of the dielectric constant of (Ethylene-Alpha Olefin - $Al_2O_3$) composites with the concentration of aluminum particles at 100 Hz

The dielectric constant of composites increases with the increase of concentrations of the $Al_2O_3$, this is due to the increase the dipoles charge [15], as shown in figure (6).

The dielectric loss is increased with the increase of concentrations of aluminum oxide particles as a result of the dipole charge increase [16] as shown in figure (7).

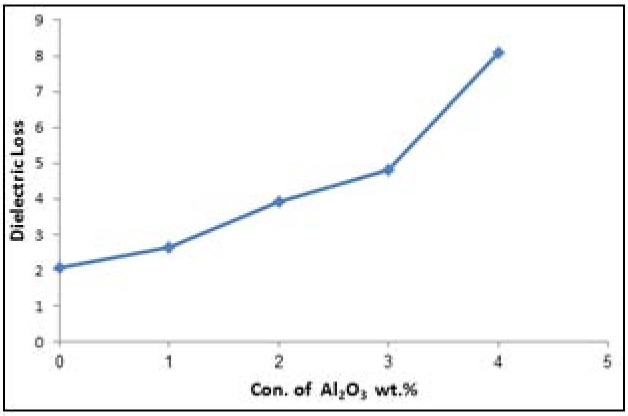


**Figure 7:** variation of dielectric loss of (Ethylene-Alpha Olefin - $Al_2O_3$) composites with the concentration of $Al_2O_3$ particles.

The conductivity increases with the increase of the concentrations of aluminum oxide particles as shown in figure (8), this due to forms a continuous network inside the in a composite [17].

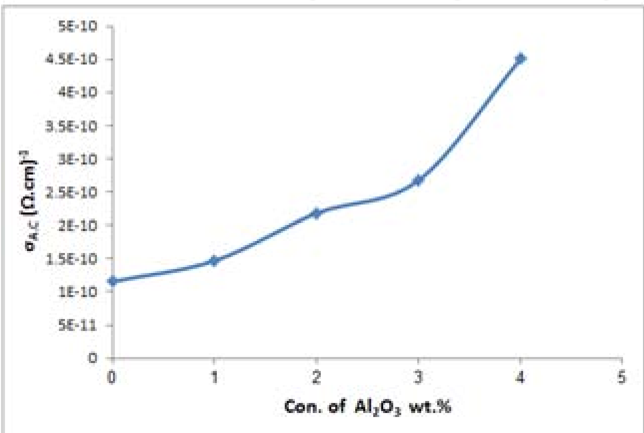


**Figure 8:** Variation of A.C electrical conductivity of (Ethylene-Alpha Olefin - $Al_2O_3$) composites with the concentration of $Al_2O_3$ nanoparticles

## 4. Conclusions

1) The dielectric constant of Ethylene-Alpha Olefin is decreasing with the increasing of the frequency, and increases with the increase of the aluminum oxide particles concentrations.
2) The dielectric loss of composites decreases with the increase of the frequency, and increases with the increase of the aluminum oxide particles concentrations.
3) The A.C electrical conductivity of (Ethylene-Alpha Olefin - $Al_2O_3$) composites increases with the increase of the concentration of aluminum oxide particles concentrations and frequency.
4) The D.C electrical conductivity of the Ethylene-Alpha Olefin increases by increasing the $Al_2O_3$ concentrations.

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