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RESEARCH ARTICLE

THE EFFECT OF FREQUENCY ON DIELECTRIC PROPERTIES ALUMINUM A-CHLOROACETAMIDE-N-(p-Chloro) PHENYL THIN FILMS

Ajeel, K.I[1]., Hanan A. Radhy Alhazam[2], and Husein ,H. F[1].

[1]Department of Physics, College of Education, University of Basrah, Basrah, Iraq.
[2]Department of Chemistry, College of Science, University of Basrah, Basrah, Iraq.

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In the present study the dielectric parameters were investigated through measuring the equivalent component of the parallel circuit containing capacitance and resistance for thin film of α-chloroacetamide-N-(p-chloro) phenyl compound in the structure Al/compound/Al.At high frequencies, it is found that the dissipation factor is increased with increasing the conduction of films.The relaxation time τ was determined to be 1.59 x 10^{-6} sec.

Key words: Dielectric properties, α-chloroacetamide-N-(p-chloro) phenylpermittivity

INTRODUCTION

The organic materials have attracted widespread research efforts in their use and applications in the semiconductor device such as solar cell and Schottky gate static induction transistor (Kndoetal 1997; Saleh etal 1993). Organic molecular systems have been extensively developed according to the progressing of preparing new molecular materials having compatible desirable characteristics. Dielectric properties in these materials have been studied and investigated in different region of frequencies and temperature (Mott and Davis 1979) and these materials in general, exhibit lower dielectric constants than inorganic oxides and nitrides.

The several major electrical properties which determined the electrical and electronic applications for different organic molecular materials are dielectric strength, dielectric constant, assipat 10.b factor and dielectrics loss (Wrigh et al 1989; Hassan et al 1993 and kuni yoshi et al 2000). Light weight ease of chemical modification and possibility at low temperature (Mott 1982 and Wright 1992). In the present study some of dielectric constant and the dissipation factor is known as the ratio of imaginary part to the real part of dielectric constant have been analyzed of or metal α-chloroacetamide-N-(p-chloro) phenyl films. Measurements of electrical parameters were in the basis of electrical equivalent circuit. The frequency spectral dependence of these parameters was also investigated.

***Corresponding author:** hanan.alhazam@yahoo.com

EXPERIMENTAL PROCEDDURE

The compound Aluminum α-chloroacetamide-N-(p-chloro) phenyl Aluminum was synthesized by the condensation the details of synthesis and analysis including (chemical and thermal analysis were described elsewhere (Radhy 2009). The structure of the expected compound will be shown in Figure (1).

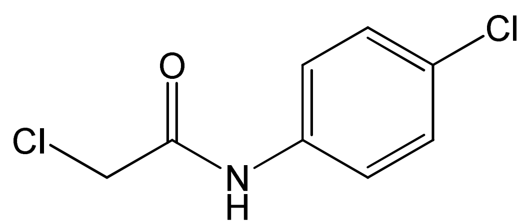

Fig. 1. The structure of the studied molecule

Thin Films have been deposited on Aluminum substrates at normal atmosphere using cast from a solution technique by dissolving the solid grafted compound (0.1 gm) with (10 ml) dimethyl solfoxide (DMSO) as a solvent. Then put it on oven with temperature control and kept it at 60°C for 24 hrs to remove traces of solvent. Aluminum electrodes circular in shaped with 0.1 mm in radius was evaporated on the film surfaces. Under vacuum pressure less than 10^{-4} torr. Evaporation method was used in orders to avoid any air gap existing between the compound and the metallic conduct. Other techniques may be generated series capacitance that affects both measuring capacitance and dissipation factor.

The currents were measured using radiometer amplifier with shielded cables leading to metal lose where the sample was enclosed. The samples were inserted in a cell in a sandwich configuration fixed by platinum electrodes cited above with pressure contact. By RLC bridge model PM 6303 RLC meter at 1 KHZ giving an accuracy of 5% for the capacity value and 4% for the impedance. In order to measure the dielectric properties including series resistance R_s, series capacitance parallel resistance R_p, parallel capacitance C_p, impedance Z and dissipation factor D an RCL bridge model PM 6303 with RLC meter giving an accuracy of 5% for capacity value and 4% for the impedance and an over with temperature controller were used. The measurements were carried out in a tow probes constellation without guard ring. The specimen cell consists of metal box with tow plate electrodes. These electrodes are arranged with a spring so that the hold the specimen under a gentle pressure.

RESULTS AND DISCUSSION

Insulation properties of the compound can be studied by applying alternative electric field. Relationships between dielectric constant and dissipation factor can be estimated though studying the equivalent circuit of compound. The several major electrical properties which determine the electrical application that can be down for the different plastic are electric strength, dielectric constant, dissipation factor and dielectric loss (Ajeel *et al.,* 2003; Hussein etal 2004; Ajeel *et al.,* 2007 and Ibrahim *et al.,* 2007). In general the measurement of dielectric properties of an organic material, just a volume polarization can be deduced to since when material is response to the eclectic field it is consider as a statistical effect and it is not possible to recognize the influence of the single dipole. The impedance is related to capacitance and resistance due to the following relation: (Kroschwitz 1988).

$$1/z = 1/R_P + iwc_p = R_S + 1/jwc_s \qquad ....(1)$$

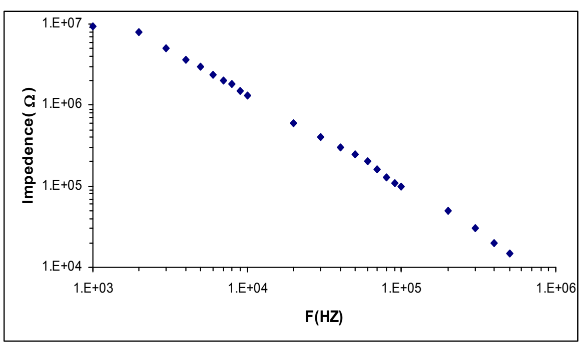

Fig. 2. The variation impedance with frequency

Where the suffix p and s is referred to parallel and series wnn action respectively. The value of resistance is responsible to control the current pass through the capacitor. Figure (2) shows the depending of variation impendence with a frequency.

The impedance decreases about two orders of magnitude with increasing the frequency from $2x10^2$ HZ to $5x10^4$. It can be seen that the decreases the impedance was associated with the increasing the value of dissipation energy in the compound which reveal in the amount of dissipation factor, as shown in Figure (3), which shows the variation of dissipation factors a function of frequency, on the other hand the general behavior of the impedance is according to the combination between the impedance and the resistance. The above results were sustained also by analysis of the equivalent circuit. The parallel capacitance decreased as the frequency is increasing as shown in Figure (4). Figure 5 shows the series resistance has a similar behavior in the frequency range.

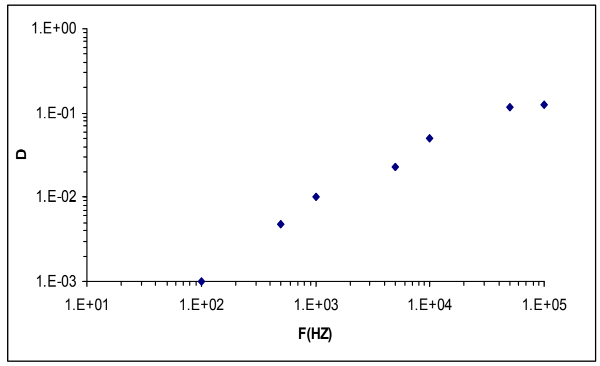

Fig. 3. The dissipation factor with frequency

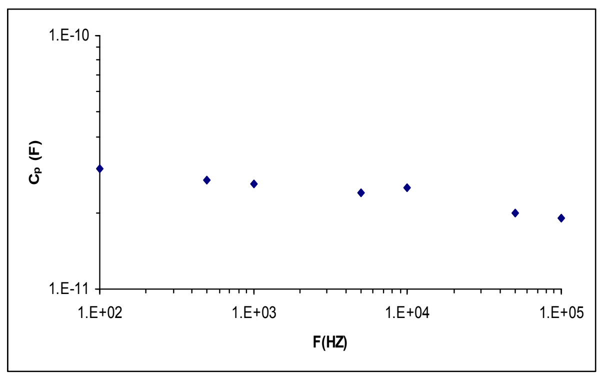

Fig. 4. The variation of parallel capacitance with frequency

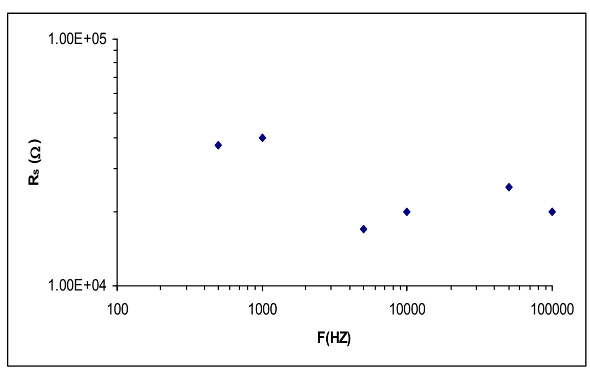

Fig. 5. The series resistance with frequency

The dielectric constant is a complex quantity and it is one of the most important factors that must be known prior any electronic application and it is variation with frequency and temperature. The real and imaginary part of

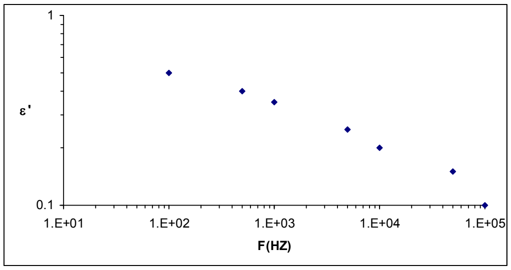

Fig. 6. The real part dielectric constant with frequency

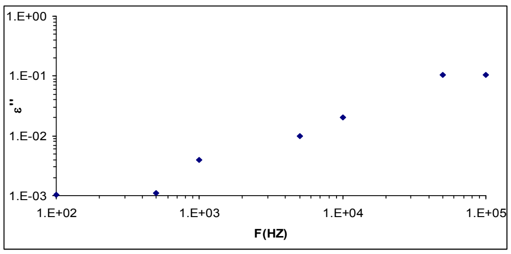

Fig.7. The imaginary part dielectric constant with frequency

dielectric constant $\varepsilon^{'}$ and ε'' respectively can be determined from the following relations (Blythe 1979).

$$\varepsilon^{'}=CP/C_o \quad …….. (2)$$

$$\varepsilon''=1/(R_P C_o W) \quad …… \quad (3)$$

where C_o is the capacitance of two metallic electrode in a free space separated by a distance equal to the compound thickness, W is the angular frequency, and dielectric constant in the above frequency range can be estimated from the following relations

$$\xi^{'}=(C_s/C_o(1+D^2) \quad ……..(4)$$

and the imaginary part of the dielectric constant ε_z and can be calculated from the following equation

$$\xi''=(WR_sC_s^2)/(C_o(1+D^2)) \quad ……………..(5)$$

The real part of the dielectric constant ε which represents the quantity of charges stored in the sample which decrease gradually with increasing frequency has been shown in Figure(6). The dielectric constant has value between 2-10 for most insulating materials and compound blend. The imaginary part of the dielectric is constant relating to the time at which the electric energy transfers to dielectric. The imaginary part of the dielectric constant as a function of measuring frequency can be seen in Figure (7). Where ε''_z was increased due to increasing the dissipation factor, the relation time τ can also be determined by applying Debye relationship (Mott and Davis 1979), where the maximum in the frequency spectrum of the imaginary part of the dielectric constant is corresponding to the ω τ =1 (ω is the angular frequency) and τ is estimated to be ($1.59* 10^{-6}$) sec at room temperature. The strength of relaxation process can be determined from the area under the curve of the imaginary part of the dielectric constant and also can be determined from the difference between static ε_s and the high frequency dielectric constant τ_∞ which estimated to be equal to (2.6). It can be also calculated from the following relation

$$\varepsilon_s-\varepsilon_\infty=(2/\pi)\int_{-\infty}^{\infty}(-CW)d(L_nW) \quad ………………..(6)$$

and get similar result. The dissipation factor is known as the ratio of imaginary part to the real part of dielectric constant and the quality factor can be determined as the inverse volume of dissipation factor (D)

$$D=\varepsilon^{'}/\varepsilon''$$

CONCLUSION

The dielectric properties such as dissipation factor real and imaginary part of the dielectric constant have been determined from analysis the equivalent electrical circuit of compound. The measurement was carried out on thin film of α-chloroacetamide-N-(p-chloro) phenyl in the structure AL/ compound / AL at room temperature.

At high frequencies the dissipation factor was found to increase with increasing the conduction of films. Good agreement was found between two configuration parallel and series circuit. The results were determined in term of the series resistance and capacitance of the equivalent circuit.

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