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Electrical Evaluations of Manufactured Polyethylene Terephthalate with Dl-Alanine Bulk Films Mixture

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ABSTRACT
Manufactured polyethylene terephthalate (PET) was mixed with different percentages by weight of DL-Alanine. PET and DL-Alanine diagnosis has been done by FTIR spectrophotometer. The electrical measurement has been done at applied dc voltage 5 volt and has been calculated. The dielectric properties have been measured and calculated. The measured dielectric properties are the quality factor (Q), dissipation factor (D), parallel resistance (Rp), series resistance (Rs), Impedance (Z), parallel capacitance (Cp), series capacitance (Cs) and phase angle (Φ). The calculated minimum and maximum electrical conductivity is $3.7*10^{\wedge}-7$ S m^{-1} for sample (1) wt1% dl-alanine to polyethylene terephthalate weight and 787.5 S m^{-1} for sample (4) wt7.5% dl-alanine to polyethylene terephthalate weight. The dielectric constant (έ) was calculated; the minimum and maximum values are $1.6*10^{\wedge}3$ for sample (2) wt2.5% dl-alanine to polyethylene terephthalate weight and $2.9*10^{\wedge}4$ for sample (1) wt1% dl-alanine to polyethylene terephthalate weight. The calculated minimum and maximum dielectric loss(ε'') is 136 for sample (2) and $3*10^{\wedge}4$ for sample (1). The frequency dependant ac conductivity (σac), the frequency independent dc conductivity and the reactance at different percentages by weight of dl-alanine to the weight of PET has been calculated.
Keywords: PET; DL-Alanine; mixtures; FT-IR spectroscopy; electrical evaluation.

I. INTRODUCTION

Polyethylene terephthalate (PET), is a chemical name of polyester. PET is used for fiber or fabric applications, it is usually referred to as "polyester". If it is used for container and packaging applications, it is typically called "PET" or "PET" resin[PETRA (2013)]. The problem of PET utilization is presently being solved mainly by physical (bottle to bottle process) and chemical (receiving raw materials or polyol) recycling[I. Vitkauskiene, et al., (2011)]. Recycled post-consumer plastics offer a particularly attractive option for blending with other polymers to enhance their physical and mechanical properties. Polyethylene terephthalate (PET), for example,
is an engineering plastic that is ubiquitous in soft-drink bottles, packaging, electronics, and many other applications. Accordingly, reusing PET is an industrial priority owing to environmental pressure and the substantial amount of energy required to produce it.[S. Lashgari, et al., (2011)]. DL-Alanine Linear Formula is CH3CH(NH2)COOH (Sigma-Aldrich Co, Ltd (2014)). Supplied from GCC Laboratory Product Gainland Chemical Company Sandy Croft DEESIDE U.K. has appearance (color) white, appearance (form) powder or crystalline powder. DL-Alanine sweetens salty or acid taste and enhance natural flavor. The intensive use of polymer in broad use has led to the development of materials for specific applications namely composites. Recently polymer matrix-ceramic filler composites receive increasing attention due to their interesting electrical and electronic properties. Integrating decoupling capacitors, angular acceleration accelerometers, acoustic emission sensors and electronic packaging are some potential applications. However flexible polymers can be easily processed at low temperatures and exhibit high dielectric break down field[B. Hussien, (2011)]. The electrical properties of these polymeric materials can be enhanced by incorporation of filler into polymer matrix, because dispersed filler will enhance various physical properties of the host polymer[A. O. Musa, et al., (2008)]. Studies of the dielectric properties of polymers have increased importance because it provides an understanding to movement of molecular chains and its applications in electrical and electronic engineering. The dielectric study is performed on room temperature. It is well known that the most of the dielectric properties such as (dielectric constant, dissipation factor and elastic dispersion) compliance in polymeric materials are dispersive as the frequency is reduced frequencies[National Physics Laboratory, (2014)]. This is well for polymer composites in the solid or visco-elastic state; the physical structure is of great importance in determining the dielectric behavior. The dielectric properties of polymer composites materials have been studied with a view modifying the properties of polymer systems for practical applications. The conventional inorganic insulators and dielectrics have to large extent been replaced by polymers on account of their ability to be tailor

made for specific needs. Epoxies and polyesters have been used in electronics as insulators, dielectrics, substrates, potting compounds, embedding materials and conformal coatings[M. Akram, et al., (2005)]. Several methods have been proposed to prepare polymer composites, such as sol-gel reaction, interactive polymerization and polymerization via melt processing, depend upon the nature of nano-particles and types of polymeric matrix. The final properties of these composites depend upon various parameters like size of particles, method of preparation of composites and dispersion of particles into the polymeric matrix[R. Jotania, et al., (2013)]. The design of polymer composites requires materials that can improve their electrical performance. Polymer filled with non-sized conductive filler can make functional polymer composites. In addition, the attached functional groups may enhance the interfacial interaction between the polymer matrix and the filler[I. Tantis, et al., (2012)].

In this work a discussion of PET DL-Alanine with in continuation of this work it has considered worthwhile and of great significant chemical interest the PET with DL-Alanine as bulk samples. Electrical and dielectric evaluations such as conductivity, dielectric constant, dielectric loss, impedance, ac conductivity and dc conductivity of PET and DL-Alanine samples mixtures. These are studied and investigated.

II. EXPERIMENTAL WORK:

PET preparation:

Weight 25g of PET flacks from local water drink bottles, which have been put in round 500 ml in capacity, which is fixed by stand on a heater and drop 25% NaOH, Klaus Englert (EMC, Laboratory Germany) solution PH14 on the amount of the flacks. A stirrer Gallenkump Cat. No. 56 425 made in England, was inserted into the vertical neck B24, a thermometer in the side neck B19 and the condenser at the other side neck B19, which was connected to a path of cold water with pump gw 220 v 50 HZ and 0.6A to ensure condesation, while the system was run at 100-130^{o}C of the heater (The Numeral controls Electric Heated) as shown in Figure (1). After six hours, until PET was reacted and precipitate at the bottom of the round, and filtered at 100oC by using Whitman filter paper chart 10.0 cm. made in England by W&R BALSTON LIMITED. While the solution was collected into flask, left the precipitate over night to be dried and etching into Petri dish, put into the round and add 25 mil. of ethylene glycol (Gainland Chemical Company, U.K.), 0.3 parts of zinc chloride (Merck, Darmstadt, Germany)[Schofer, et al., (1962)] and reflux for 6 hours. The precipitate was filtered at 100^{o}C by using Whitman filter paper chart 10.0 cm. The precipitate have been left over night to be dried, this is a white paste like substance of PET with PH10 by the detection with indicator paper Mecherey-Nagel, Germany. The solution was collected into flask, and the prepared PET was collected into plastic container.

Fig.(1) Set up of PET preparation

FT-IR tests:

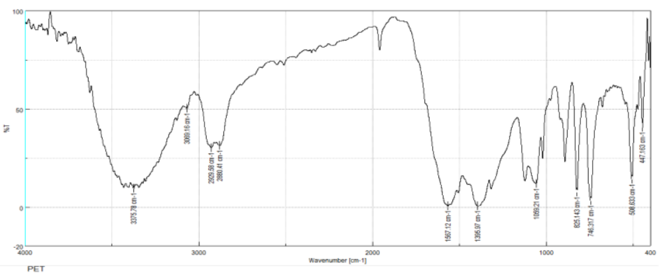

Fig.(2). FT IR spectroscopy of PET.

FTIR test of manufactured polyethylene terephthalate (PET), have been done with Kbr disc by using JASCO FTIR 4200 spectrophotometer serial No. C081761018, Japan, the spectra were taken in region of wave number 400-4000 cm-1 as shown in Figure (2). The FTIR spectra of (PET) confirms the presence of the carbonyl group in conjugation with aromatic ring appear at 1900 cm-1. The peaks 746.317 cm^{-1} is the aromatic C-H wagging. The peak at 885.143 cm-1 corresponds to aromatic C-H out of plane bending. The O-C-C asymmetric stretching is split at 1128 and 1059 cm-1. Aromatic C-C stretching appears at 1500 cm-1. Peak at 1395.97 is the deformation C-H alkane. The stretching vibration at 2929.58 cm^{-1} is the C-H asymmetric. The OH band is at 3375.78 cm-1[S. Vijayakumar, et al., (2012)]. Table (1) shows the comparison between the obtained results with previous study.

Table 1 Comparable of obtained results of PET with previous study.

Functional group obtained results	Wave number cm^{-1}	Functional group Ref.	Wave number cm^{-1}
Carbonyl group	1900	Carbonyl group	1713
Aromatic C-H wagging	746.317	Aromatic C-H wagging	721.8
Aromatic C-H out of plane	885.143	Aromatic C-H out of plane	871.5
O-C-C symmetric stretching	1128 and 1059	O-C-C symmetric stretching	1128 and 1091
C-H deformation alkane	1395.97	C-H deformation alkane	1399
Aromatic C-C stretching	1500	Aromatic C-C stretching	1505
C-H asymmetric stretching	2929.58	C-H asymmetric stretching	2960
OH band	3375.78	OH band	3297.3 and 3400

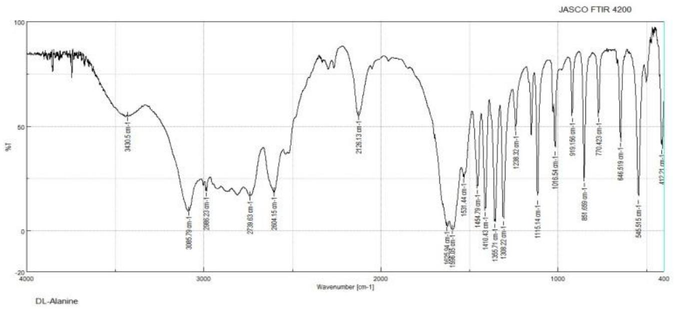

Fig.(3). FT-IR spectroscopy of DL-Alanine

FTIR test of DL-Alanine powder supplied from GCC (Gainland Chemical company, U.K), was done with KBr disc by using JASCO FTIR 4200 spectrophotometer serial No. C081761018, Japan. The spectra were taken in the region of wave number 400-4000 cm-1 as shown in Figure (3). The band 412.21 cm^{-1} is referring to amino acid molecules and hydrogen bond. Conformations of the amino acid molecules themselves and hydrogen bond lengths occur with temperature variation that compared to the change in vibrationally of other amino acid upon cooling, would indicate structural phase transition occurs. Methyl group -CH3. Making it one of the simplest α-amino acid with respect to molecular weight[Wikipedia, (2014)]. 770.423 cm^{-1} is COO wagging. 645.519 cm^{-1} and 651.659 cm^{-1} is COO- in plane deformation 1238.32 cm^{-1} is NH3 rocking. C-H and N-H bending is at 1308.22 cm-1[E. Gallegos-Loya, et al., (2011)]. 919.156 cm^{-1} these band are anomaly in DL-Alanine[V. S. Minkov, et al., (2010)]. The band at 1115.514 cm^{-1} is the CH2 stretching coupled with adjacent CH2 group[A. Parth (2000)]. The band at 1410.43 cm-1 is symmetric C-COO- bending and the wave number at 1454.76 cm-1 is C-H deformation of >CH3[R. Davis etal (2010)]. 1594 cm-1 attribute to the stretching vibration of (NH) C=O group[M Rashid, et al., (2014)]. N-H…O appear around 2739.63 cm^{-1}. The OH band is at 3375.78 cm^{-1}[S. Vijayakumar, et al., (2012)]Table (2) shows the comparison of the obtained results with previous study.

Table 2. Comparable of obtained results of FTIR of DL-Alanine with previous studies.

Functional group obtained results	Wave number cm^{-1}	Functional group Ref.	Wave number cm^{-1}
Carboxylate COO^- in plane deformation	645.519 and 651.659	Carboxylate COO^- in plane deformation	651, 646 and 647
COO wagging	770.423	COO wagging	771
CH2 stretching coupled with adjacent CH2 group	1115.514	CH2 stretching coupled with adjacent CH2 group	1063 and 1300

$NH3^+$ rocking	1238.32	$NH3^+$ rocking	1236
C-H and N-H bending	1308.22	C-H and N-H bending	1306
symmetric C-COO^- stretching	1410.43	Symmetric C-COO^- stretching	1400
C-H deformation of CH_3 >	1454.76	C-H deformation of > CH_3	14
Asymmetric (NH) C=O	1595.05 and 1625.94	Asymmetric (NH) C=O	1594
C-H asymmetric stretching of -CH3	2985.23	C-H asymmetric stretching of -CH3	2995
N-H stretching	3085.79	N-H Stretching	3200

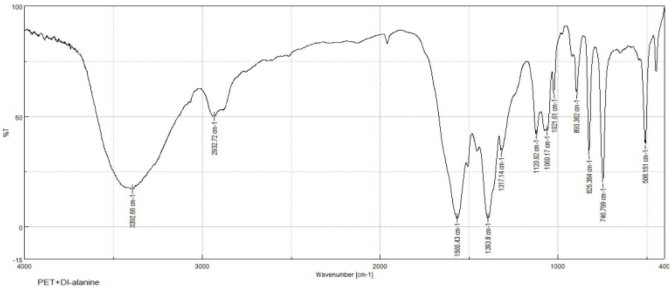

Fig. (4). FTIR Spectroscopy of Polyethylene terephthalate and Dl-Alanine mixture

FTIR test of manufactured polyethylene terephthalate (PET) and DL-Alanine powder supplied from GCC (Gainland Chemical Company, U.K), mixture was done with KBr disc by using JASCO FTIR 4200 spectrophotometer serial No. C081761018, Japan. The spectra were taken in the region of wave number 400-4000 cm^{-1} as shown in Figure (4). The FTIR spectra of (PET) confirms the presence of the carbonyl group in conjugation with aromatic ring appear at 1624.73 cm^{-1}[S. Vijayakumar, et al., (2012)]. The peaks 746.799 cm^{-1} is the aromatic C-H wagging[E. Gallegos-Loya, et al., (2011)]. Amino acid molecules themselves and hydrogen bond lengths occur with temperature variation that compared to the change in vibrationally of other amino acid upon cooling, would indicate structural phase transition occurs. This is referred to at the peak 412.12 cm^{-1} Methyl group -CH3. Making it one of the simplest α-amino acid with respect to molecular weight[Wikipedia, (2014)]. The O-C-C asymmetric stretching is split at 1120.92 and 1060.17 cm^{-1}. Aromatic C-C stretching appears at 1565.43 cm^{-1}. Peak at 1395.97 is the deformation C-H alkane The spectral region at 2932.72 cm^{-1} is characterized by many bands associated with stretching CH and CH3. OH band is at 3392.66 cm^{-1}[S. Vijayakumar, et al., (2012)]. Table 3 shows the compression of the obtained results with previous study.

Table 3 comparable of obtained results with previous study of PET and DL-Alanine

Functional group obtained results	Wave number cm-1	Functional group ref.	Wave number cm-1
Carbonyl group with aromatic ring	1624.73	Carbonyl group with aromatic ring	1713
Aromatic C-H wagging	746.799	Aromatic C-H wagging	721.8
Amino acid molecules	412.12	Amino acid molecules	412.12
O-C-C symmetric stretching	1120.97 and 1060.17	O-C-C symmetric stretching	1128 and 1091
Asymmetric NH C=O	1565.43	Asymmetric (NH) C=O	1594
Stretching CH and CH3 band	2932.72	C-H asymmetric stretching of -CH3	2995
OH band	3392.66	OH band	3297.3 and 3400

III. SAMPLE PREPARATION:

Glass substrates have been cleaned by rinse for several times with distilled water and were socked in acetone and shaking for one hour until they were dried. The glass substrates have been rinsed again for several times with distilled water have been put in furnace under vacuum at 80 oC for one hour to be dried from the residue of the distilled water. The clean glass substrate have been put into sensitive balance sort Sartorius, Germany and the prepared white paste of PET has been put on the clean glass substrates by using spatula and was weighed, DL-Alanine (Gainland Chemical company U.K) wt% has been put by using spatula on PET paste and were weighed. The composite has performed to a suitable shape by using a spatula. Two copper wires were connected at both side of the sample and left to dry. The dimensions of the samples have been measured by Vernier certificate, India, as shown in Table (4). The sample undergoing dielectric measurements by using RCL meter FLUKE PM 6303A.

Electrical and Dielectric measurement:

The current and the voltage across the bulk samples were measured using electric circuit as shown in Figure (5). The sample has been put inside enclosure of wood box with slide glass front. The resistivity and the conductivity were calculated as a function of time[T. S. Bachari, (2014)].

$\rho = RA/d$ (1)

$\sigma = d/RA$ (2)

Where ρ is the resistivity of the sample, R is the resistance calculated from I/V. A is the effective cross sectional area of the electrode A =πD^2/4. And d is the thickness of the sample.

RCL Meter, FLUKE PM Automatic 6303A . No. Lo 781003, Germany, were used to measure the dielectric properties of the samples. The dielectric measurements and calculations were done at room temperature and at constant frequency I KHz. The dielectric constant is[B. Hussien, (2011)]:

$Cs(w) = \frac{d}{\varepsilon o A} \acute{\varepsilon}(w)$ (3)

Where εo is permittivity of free space 8.85*10^-12 F m^{-1}.

d is the thickness of the sample, A is the effective area of the electrode. Cs is the series capacitance.

Whereas the dielectric loss is

$\varepsilon'' = \acute{\varepsilon}/Rp\ Cp\ w$ (4)

$\sigma ac = \varepsilon''\ \varepsilon o\ w.$ (5)

$Rp = 1/D\ w\ Cp.$ (6)

where w= 2πf. D is the dissipation factor, Cp is the parallel capacitance

The conductance can be calculated using the following expression:

$Gs = \acute{\varepsilon}\ Co\ w.$ (6).

Where Co is the free space capacitance

$Co = \varepsilon\ o * A/d$

Wher A is the area of the copper wire = π D2/4 = 3.846 *10^-3 mm^2.

D = 0.07 mm.

Co = 4.86 * 10^-16 Farad.

The conductivity can be calculated using the following expression[A. O. Musa, et al., (2008)].

$\sigma' = \sigma ac + \sigma dc$ (7)

Where $\sigma' = d/A\ Gs$ (8).

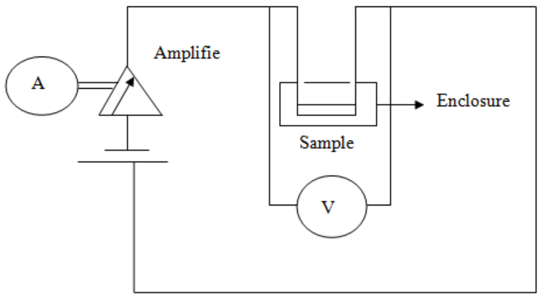

Fig. (5). Schematic diagram of the electrical measurement circuit.

Table 4 Sample preparation.

Samples	Weight of PET gm.	Wt%DL-Alanine	Length mm.	Width mm.	Thickness mm.	area of effective electrodes mm^2
1	0.04	1	12.7	6	0.8	7.85*10^-3
2	0.04	2.5	12.5	5.4	1.7	3.85*10^-1
3	0.04	5	12.6	6	0.8	7.85*10^-3
4	0.04	7.5	12.4	6	1.6	3.14*10^-2
5	0.04	10	12.3	5.5	0.7	9.5*10^-3

Table 5 electrical properties of the samples.

Sample1					Sample 2				
I nA	V mv	RMΩ	ρ Ω m	σ S m^{-1}	InA	Vmv	RMΩ	ρ Ω m	σ S m^{-1}
3.75	4.6	1.226	1.203	0.83	0.8	4.04	5.05	114.2	8.7*10^-3
0.45	145	322.2	3.1*10^2	3.1*10^-3	0.9	1.06	1.177	266.7	3.7*10^-3
0.075	176	2346.6	2.3*10^6	4.3*10^-7	0.95	17.9	18.88	4.2*10Λ3	2.3*10^-4
0.04	108	2707.5	2.6*106^	3.7*10^-7	2.8	11.9	4.25	9.6*10Λ2	1*10^-3

45	128	2.862	2.8*10 ^ 3	3.5*10^-4	29	18.3	0.632	1.4*10^2	6.9*10^-3
26.66	130	4.9	4.8*10^3	2*10^-4	85	7.87	0.21	47.612	0.021
134	91	0.679	6.6*10^2	1.5*10^-3	190	7.08	0.037	8.449	0.118
92.8	56	0.6	5.9*102^	1.6*10^-3	230	7.89	0.034	7.77	0.128
75	0.3	0.004	3.925	0.255	280	7.81	0.027	6.318	0.158
55	0.39	0.007	6.975	0.143	800	7.82	0.009	0.488	2.046
40	0.09	0.002	2.207	0.452	670	7.92	0.011	2.679	0.373
28	38	1.36	1.3*10^3	7.5*10^-4	2800	6.78	0.002	0.548	1.823
20	9	0.45	4.4*10^ 3	2.2*10^-4	6000	7.1	0.001	0.267	3.731
12.5	9.2	0.736	7.2*10^ 2	1.3*10^-3	5000	7.52	0.002	0.34	2.935
72	-1.2				9000	7.4	8x10^-4	0.186	5.37
3.4	0.3	0.087	86.07	0.011	19000	7.42	3*10^ -4	0.088	11.3
2.65	1.26	0.475	4.6*10^2	2.1*10^-3	95000	8.49	8*10^-5	0.022	49.408
76	146	1.921	1.8*10^3	5.2*10^-4	Sample4				
47.3	3.1	0.065	64.31	0.015	I nA	V mv	RMΩ	ρ Ω m	σ S m^{-1}
17	-0.2				0.9	19.4	21.55	423.8	0.0024
15.5	-0.32				8	32.1	4	786.9	0.0013
13.5	-0.06				9	23.8	2.64	518.4	0.0019
Sample3					23	18.8	0.82	161.2	0.0062
I nA	V mv	R MΩ	ρ Ω m	σ S m^{-1}	25	20.1	0.8	158.2	0.0063
0.003	1.047	335.04	328.75	0.0304	95	12.8	0.13	26.43	0.0378
0.0029	0.974	335.8	329.5	0.00303	180	75.8	0.421	82.64	0.0121
0.0021	1.492	710.5	697.2	0.00143	900	40.2	0.044	0.0876	11.407
0.0065	1.089	1697.5	164.39	0.00608	9000	18.2	0.002	0.0039	252.25
3	36.4	12.133	11.9	0.084	18000	37.4	0.002	0.0041	242.6
9	105	11.666	11.44	0.087	22000	41.2	0.001	0.0036	272.1
24	111	4.625	4.538	0.22	85000	55	6*10^-4	0.00126	787.5
90	119.8	1.331	1.306	0.765	Sample5				
270	104	0.385	0.377	2.645	I nA	V mv	RMΩ	ρ Ω m	σ S m^{-1}
900	106	0.117	0.115	8.652	2.9	61.7	21.3	28.888	0.0346
600	105	0.175	0.171	5.823	8	67.3	8.412	11.416	0.0875
2800	105	0.0375	0.0367	27.176	98	56.7	0.578	1.249	0.8
1200	102	0.085	0.0834	11.985	260	55.9	0.215	0.291	3.427
9000	106.3	0.0118	0.0115	86.283	700	55	0.078	0.106	9.377
45000	103	0.0023	0.0022	445.24	950	52	0.055	0.074	13.461
					9800	59	0.006	0.00817	122.39
					28000	53.7	0.002	0.0026	384.2
					70000	118	0.001	0.0023	437.109

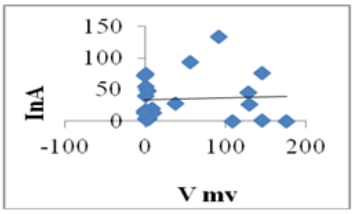

Fig. (6). I-V characteristics wt1% DL-Alanine

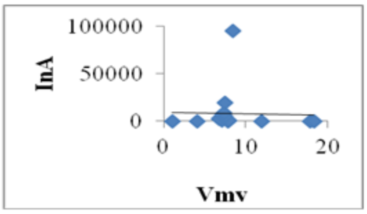

Fig. (7). I-V characteristics wt2.5% DL-Alanine

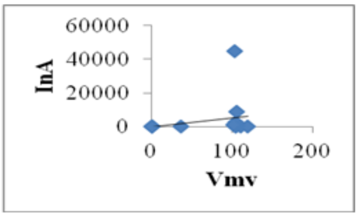

Fig. (8). I-V characteristics of wt5% DL-Alanine.

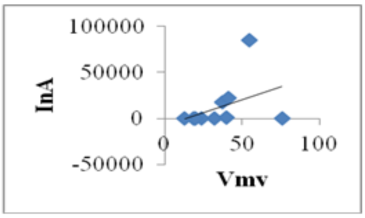

Fig. (9). I-V characteristics of wt7.5% DL-Alanine

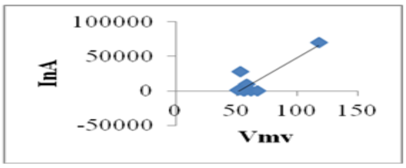

Fig. (10). I-V characteristics of wt10% DL-Alanine.

Table 6 Dielectric properties measurement and calculations.

Sample	Q As	Cp PF	Cs PF	Rs MΩ	Rp* MΩ	Z Ω	Dissipation factor	Φ deg.
1	9.04	2.8	2.6	4.8	54.68	55.66	1.04	-86.5
2	11.5	3	3.1	5	624.4	53.23	0.085	-82.5
3	4.45	3	3.2	4.21	235.5	51.64	0.225	-77.3
4	3.41	2.7	2.9	15.78	204.4	56.74	0.289	-72.9
5	28	2.9	2.9	1.978	183	54.87	0.03	-88.7
sample	έ	ε″	Gs S	σ ac S m^{-1}	σ′ S m^{-1}	σ dc S m^{-1}	σ S m^{-1}**	
1	2.9x10^4	3*10Λ4	5*10^-3	1.7*10^-3	509.55	509.53	0.108	
2	1.6x10^3	136	3*10^-5	8*10^-6	0.132	0.1319	4.066	
3	3.2x10^4	7*10^3	5*10^-4	3.9*10^-4	50.955	50.995	39.268	
4	1.6*10^4	5*10^3	3*10^-4	2.7*10^-4	13.757	13.7552	130.5	
5	2.4*10^4	7*10^2	4*10^-4	3.8*10^-5	29.473	29.4729	107.87	

* Calculated from Rp= 1/DwCp.
** Average values of the electrical conductivity calculated from Table (3).

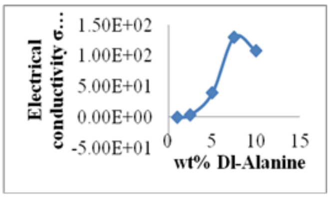

Fig. (11). the effect of wt% Dl-alanine on the electrical conductivity.

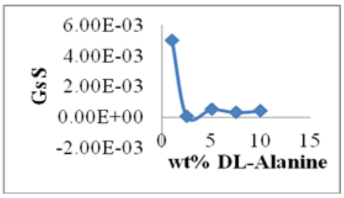

Fig. (12). the dependence of conductance on wt% DL-Alanine

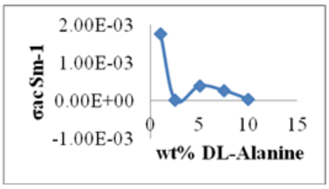

Fig. (13). the effect of wt% Dl-alanine on ac conductivity.

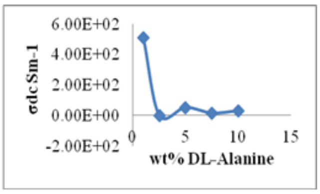

Fig. (14). the effect of Dl-Alanine on dc conductivity σ_{dc}

IV. RESULTS AND DISCUSSION:

The FTIR spectroscopy of PET as shown in Figure (2), Table (1), is a powerful tool technique for studying the qualitative and quantitative analysis of natural and synthetic molecules. Determination stating that carboxyl and hydroxyl are the end group units available in PET. For example, the C=O stretch of carbonyl group appears around 1700 cm^{-1} in variety of molecules. Hence, the correlation of this band wave number position with the carbonyl functional group in the chemical structure is used to identify the carbonyl functional group in the sample[ChemAnalysis LLC: FTIR (2014)]. The investigation include the FTIR spectroscopy analysis of DL-Alanine, as shown in figure (3), Table (2), the advantage of FTIR spectroscopy is that the indication the frequencies for each functional groups, such as methyl group (-CH3), CH2, NH3 COO, COO-[R. Davis (2010)]. FTIR spectroscopy of PET and Dl-alanine indicate the functional group frequencies of the obtained results with previous studies. For examples, the wave numbers, the peaks 746.799 cm^{-1} is the aromatic C-H wagging. The O-C-C asymmetric stretching is split at 1120.92 and 1060.17 cm^{-1}. Aromatic C-C stretching appears at 1565.43 cm^{-1}. Peak at 1395.97 cm^{-1} is the deformation C-H alkane. The spectral region at 2932.72 cm^{-1} is characterized by many bands associated with stretching CH and CH3. OH band is at 3392.66 cm^{-1}[S. Vijayakumar, et al., (2012)]. The measurements of electrical properties such the current as a function of time and the voltage across the bulk samples, rather than the calculation of the resistivity and the electrical conductivity (σ), by using the circuit in Figure (5). Impedance, the quality factor (Q), dissipation factors (D), rather than the calculations of dielectric constant (έ), the dielectric loss (ε″), the ac conductivity (σac), conductance (Gs) and ac conductivity (σac). The measurements were carried out at different percentages by weight of DL-ALanine (1wt%, 2.5wt%, 5wt%, 7.5wt% and 10wt%) of PET as films composites as shown in Table (3).

Table (5), Figure (6) shows the I-V characteristics of PET with sample (1) wt1% DL-Alanine to the PET weight, the random distribution due to the unstable of current in variation with voltage across the sample. In Figure (7), for sample (2) wt2.5% DL-Alanine to the weight of PET, shows increase in current with decrease in voltage across the sample, until there is no decrease in voltage. Figure (8), for sample (3) wt5% DL-Alanine to of PET weight shows that Ohm Law is applicable. Although there is no variation in voltage after 1800 sec. Figure (9), shows the I-V characteristics of sample (4) wt7.5% DL-Alanine to PET weight, the voltage also have the same values after 2760 sec. For sample (5) wt10% DL-Alanine to the weight of PET, in Figure (10) the I-V characteristics is the same as in Figure (8) and the voltage is nearly the same for the whole period of measurement that is 2400 sec as shown in Figure (10). The calculation of electrical conductivity (σ) by applying formula (3), shows wide variety of the conductivity as the current is a function of time[M. Serin, et al., (2003)]. For example the minimum and maximum electrical conductivity is $3.7*10^{\Lambda}$-7 S m^{-1} for sample (1) and 787.5 S m^{-1} for sample (4). These are indicating as the percentages by weight of DL-Alanine are increased the conductivity was increased. In general, electrical conductivity of these material (polyester resin/carbon fibre composites) depends on filler content and these materials are typically disordered structures consisting of randomly arranged conducting fillers dispersed in a polymer medium[J. Vilcakova, et al., (2000)]. Depending on the concentration of the filler and the electrical conductivity can change by several orders of magnitude. This can be achieved for any polymer by traditional doping with charge carrier[J. N. Coleman, et al., (1998)]. Figure (11) shows the effect of wt% DL-Alanine on the average electrical conductivity in Table (5), the electrical conductivity is increased with increasing wt% DL-Alanine.

Table (6), shows that the dielectric constant (έ) is $2.9*10^{\Lambda}4$ for sample (1) is decreased to 1.6x103 for sample (2) is raised again to maintain the same level of magnitude to $3.2*10^{\Lambda}4$ and $2.4*10^{\Lambda}4$ for samples (3) and (5), and the same behavior for the dielectric loss (έ) is $3*10^{\Lambda}4$ for sample (1) wt1% of Dl-Alanine to the weight of PET and the reduction is 136 for sample (2) and is raised at percentages by weight of (wt5%) DL-Alanine to the weight of PET to $7*10^{\Lambda}3$ at sample (3). The behavior of the real part dielectric constant (έ) and the imaginary part dielectric loss (ε″), this is result from the inability of polarization process to follow rate of change of the oscillating applied field [Z. Ahmed, (2014)]. The calculations of conductance is $5*10^{\Lambda}$-3 S for sample (1) and decreased to $3*10^{\Lambda}$-5 and $4*10^{\Lambda}$-4 S at samples (2) and sample (5). The frequency dependant ac conductivity (σac) has minimum value $8*10^{\Lambda}$-6 S m^{-1} for sample (2) and maximum value $1.7*10^{\Lambda}$-3 S m^{-1} for sample (1), these results are coincident with result obtained by[B. Hussien, (2011)]. Figure (12) shows the dependence of the conductance Gs on the wt% DL-Alanine, there is decreased in the conductance with increasing wt% DL-Alanine. Figure (13) shows the effect of wt% DL-Alanine on the frequency dependent ac conductivity (σac) of the composite. The conductivity is decreased with increase percentages by weight (wt%) of DL-Alanine, for example at wt2.5% DL-Alanine $8*10^{\Lambda}$-6 S m^{-1} and wt10% 3.8*10Λ-5 S m^{-1}. In Figure (14) shows that the frequency independent dc conductivity (σdc) is decreased at samples (2) and (4) to the value 0.1319 S m^{-1} and 13.7552 S m^{-1} and is increased at samples (3) and (5), to values 50.995 S m^{-1} and 29.2729 S m^{-1} less than in sample (1) 509.53 S m^{-1}. The wt% DL-Alanine was chosen to allow the composite to conductive. Obviously from Figure (6) at wt5% DL-Alanine, Ohmic conduction have taken place[J. F. Filler et al., (2002)].

V. CONCLUSIONS:

1- The dependencies of the conductivity (σ) as a function of time on (1wt%, 2.5wt%, 5wt%, 7.5wt% and 10wt%) Dl-Alanine shows a wide range of variations, these are depend on the measurement of I-V characteristics.
2- DL-Alanine wt% of PET were studied and investigated, these are shown the dependencies of the electrical and dielectric properties of the composite films of wt% DL-Alanine.
3- The measurements of the impedance, charge (Q), Rp, Rs, Cp, Cs, D and έ, show different behavior for each property, accept for Q is increased with increasing wt% DL-Alanine.
4- The calculated values of Rp had been done, because it was detected by the FLUCK LRC meter instrument.
5- The dependence of the calculated values of the dielectric constant (έ), dielectric loss (ε″) on the measured properties has a regular behavior, there is alternative decreased and increased.
6- The calculations of the conductance (Gs), give a brief results of the dependence of the wt% DL-

Alanine on the dielectric properties of the composites films. 7- The dependence of the calculated ac conductivity (σac) on the dielectric loss (ε′′), is directly proportional.

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الدراسة الكهربائية لمخلوط الأغشية الحجمية للأثلين
متعدد الترفثاليت مع الدل-ألانين

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ثامر سلمان بجاري

الملخص :

تم تصنيع و مزج وزن ثابت من ترفثاليت متعدد الأثلين مع نسب وزن مختلفة للدل-ألانين لأجراءات القياسات الكهربائية. تشخيص ترفثاليت متعدد الاثلين و الدل-ألانين تم بواسطة جهاز مطياف تحويلات فورير للأشعة تحت الحمراء. تم قياس وحساب الخصائص الكهربائية عند تسليط جهد 10 فولت وقياس وحساب خصائص العزل. خصائص العزل الكعربائي المقاسة عامل النوع, عامل التشتت, مقاومة التوازي, مقاومة التوالي, الممانعة, متسعة التوازي, متسعة التوالي, وأنحراف الطور. تم حساب أوطأ وأعلى توصيل كهربائي $3.8*10^{-7}$ سيمنز م$^{-1}$ لنموذج رقم (1) نسبة وزن 1% من وزن الدل ألانين لوزن ترفثاليت متعدد الأثلين و 787.5 سيمنز م $^{-1}$ النموذج رقم (4) نسبة وزن 7,5% من وزن الدل-ألانين لوزن ترفثاليت متعدد الأثلين. تم حساب أوطأ و اعلى قيم لسماحية العزل $1.6*10^{3}$ النموذج (2) نسبة وزن 2,5% من الدل-ألانين لوزن ترفثاليت متعدد الأثلين و $2.9*10^{4}$ النموذج (1) نسبة وزن 1% من الدل-الانين لوزن ترفثاليت متعدد الأثلين. أوطأ واعلى قيم لفقد العزل 136 للنموذج نسبة وزن 2,5% للدل-ألانين لوزن ترفثالايت متعدد الأثلين و $3*10^{4}$ النموذج (1) . تم حساب التوصيل المتناوب المعتمد على التردد, التوصيل المستمر و الممانعة للنسب المختلفة للدل-ألانين لوزن الترفثاليت متعدد الأثلين.

كلمات مفتاحية: ترفثاليت متعدد أثلين, دل-ألانين, طيف تحويلات فورير للآشعة تحت الحمراء, الكهربائية.