Effect of addition Lithium Fluoride on some Electrical properties of High Density Polyethylene

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Abstract

In the present work , effect of addition Lithium Fluoride on some electrical properties of high density polyethylene has been studied . for that purpose , many samples has been prepared by adding Lithium Fluoride on the high density polyethylene by different volume percentages from these salts with polymer and by different thickness . The experimental results showed that the DC electrical conductivity changed with increasing the concentration of additional salts and increasing of temperature . Also the activation energy change with increasing of additional salt .

الخلاصة

في هذا البحث تم دراسة تأثير إضافة فلوريد الليثيوم على الخواص الكهربائية للبولي اثيلين عالي الكثافة. ولهذا الغرض تم تحضير نماذج بإضافة فلوريد الليثيوم إلى البولي اثيلين عالي الكثافة وبنسب حجمية مختلفة من هذه الأملاح مع البوليمر وبسمك مختلف. أظهرت النتائج إلى أن التوصيلية الكهربائية المستمرة تتغير مع زيادة تركيز المضاف الملحي وزيادة درجة الحرارة . كما أن قيم طاقة التنشيط تتغير مع زيادة تركيز الملح المضاف.

Introduction

Many polymers have excellent electrical properties , as well as a variety of physical , chemical , and mechanical properties , that make them very suitable for insulating materials. Since knowledge of the nature of electrical conduction in insulating materials is incomplete [T. Miyamoto and K. Shibayama,1973].The composite materials has increased considerably and several formulae have appeared purporting to relate the effective physical constants. Of such a material to the constants of the constituents and their volume fractions[W. E . A. Davies,1970].

In the recent years conjugated conducting polymers have been the mian focus of research throughout the world . Since the discovery led by 2000 chemistry Nobel winners, Shirakawa, MacDiarmid and Heeger , the perception that plastic could not conduct electricity has changed Nowadays, conducting polymers also known as conductive plastics are being developed for many uses such as corrosion inhibitors, compact capacitors, antistatic coating, electromagnetic shielding and smart windows;

which capable to vary the amount of light to pass[M. Harun *et al*,2009 ,Z.Al-Ramadhan,2008] .Electrical conductivity measurement is one of the most convenient tools in studying Such structural changes of powder compacts , and has the advantage that the conductivity can de measured continuously throughout the whole densification process [R . Matsushita *et al*,1977]. The present work deals with the effect of Lithium Fluoride additive on the electrical properties of HDPE composite.

Experimental work

The materials used in this work have high density polyethylene as matrix and Lithium fluoride as a filler.

The electronic balanced of accuracy 10^{-4} have been used to obtain a weight amount of LiF powder and polymer powder . these mixed by Hand Lay up and the Microscopic Examination used to obtain homogenized mixture .The volume percentages of LiF which equivalent weight percentages are (0, 15.5 , 16.26 , 19.37 , 22.77 , 26.5 , 30.6 , 35.1 and 37.09) vol% . The Hot Press method used to press the powder mixture. The mixture of different LiF percentages have been compacted at temperature 120°C under a pressure 100 par for 10 minutes . It is cooled to room temperature , the samples were dis shap of a diameter about 30 mm and thickness ranged between (1.83-2.15) mm . The coating unit (Edward coating System E3C6A) has been used for deposition of thin film Aluminum electrode on both sides of each sample . The resistivity was measured over range of temperature from (50 to 90)° C using Keithly electrometer type (616C) . The volume electrical conductivity σ_v defined by :

$$\sigma_v = \frac{1}{\rho_v} = \frac{L}{RA}$$

Where :

A = guard electrod effective area.

R = volume resistance (Ohm) .

L = average thickess of sample (cm) .

In this model the electrodes have circular area $A = D^2\pi/4$ where $D = 1.1\ cm^2$.

Results and Discussion

Figure (1) show electrical volume conductivity as function of the concentration of LiF at a temperature of 50°C from the figures we show that the concentration increasing of LiF the conductivity increases slightly to reach a concentration of LiF (22.77 vol%) where the value of the conductivity of this concentration (1.2×10^{-14} (ohm.cm) $^{-1}$) when increasing the focus more than that, the electrical conductivity to a large increase to the value (1.65×10^{-14} (ohm.cm) $^{-1}$) at the concentration of LiF (26.5 vol%)) and an increase in the concentration of lithium fluoride, the more the increase will be little that any of the electrical conductivity of composites increase significantly when the lithium fluoride concentration ranges between the (22.77 vol% - 26.5 vol% (The increase of conductivity with increasing of concentration of LiF due to increases the charge carriers ions which increased with increasing filler contact where the LiF ions at a low concentrations are represented by small darker regions and become large when the lithium fluoride concentration increases but when the concentration of LiF reachs

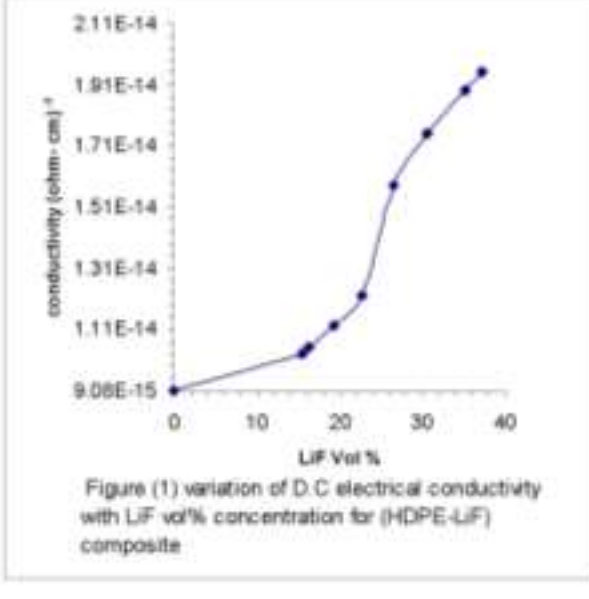
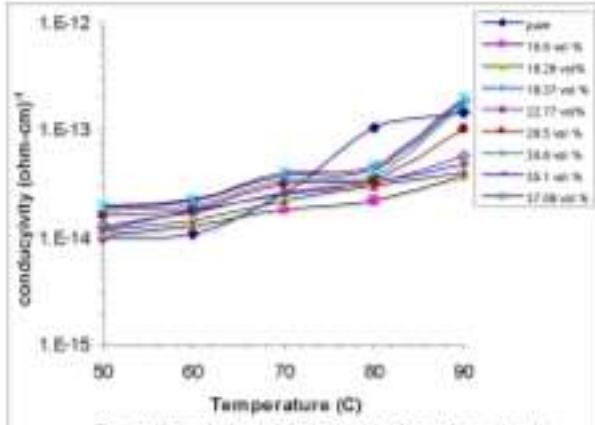


Figure (1) variation of D.C electrical conductivity with LiF vol% concentration for (HDPE-LiF) composite

to (24.63vol%), the network will be connected to each other containing the overlapping paths to allow the charge carriers to pass through, where the charge

carriers with routes through which the electrical resistance be less [S. Bhattacharya *et al*,2008, X. J. He *et al*,2005, N. K. Srivastava and R. M. Mehra,2003].

Figure (2) shows the behavior of electrical conductivity of the samples of HDPE-LiF composites with the temperature. Note that the electrical conductivity increase with



Figure(2) variation of D.C electrical conductivity with temperature for (HDPF-LiF) composite

increasing temperature that any of this material has a negative thermal coefficient of resistance .the interpretation of this is that the polymeric chains and lithium fluoride ions act as traps the charge carriers which transited by hopping process. On increasing the temperature , segments of the polymer being to move , releasing the trapped charges . The released of trapped charges is intimately associated with molecular motion . The increase of current with temperature is attributed to two main parameters , charge carriers and mobility of these charges. The increase of temperature will increase the number of charge carriers exponentially. The mobility depends on the structure and the temperature [Z.Al-Ramadhan,2008, K.S. Majdi and H .J. Fadhal,1997].

Figure (3) show the illustrate the variation conductivity with inverted absolute temperature of the HDPE-LiF composites, we use the equation[$\sigma = \sigma o \exp(-Ea/kBT)$] was calculate activation energy and shows us to calculate the activation energy , high values to the activation energy ranges between (0.835ev to 0.387ev) for HDPE-LiF

composites these values are due to the presence of free ions in the commercial polymers and the addition of low concentration of lithium fluoride reduced the

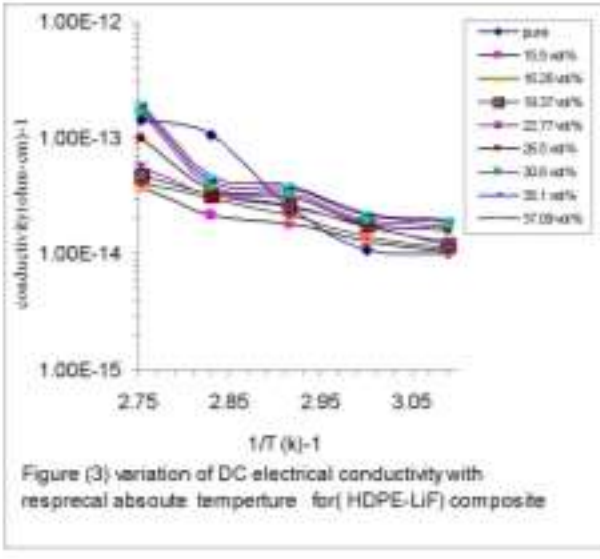


Figure (3) variation of DC electrical conductivity with resprecal absolute temperture for(HDPE-LiF) composite

activation energy values of all samples of HDPE-LiF composites the result of the space charge effect in the contact regions where the shipment In addition to the concentration of low-power levels localized in the forbidden energy gap act as traps to charge carriers and charge carriers were moving by Hopping[M. Hamzah *et al*]. The concentration increasing of lithium fluoride less the result of the activation energy as shown in the figure (4) of HDPE-LiF composites , it is clear that the mechanism of

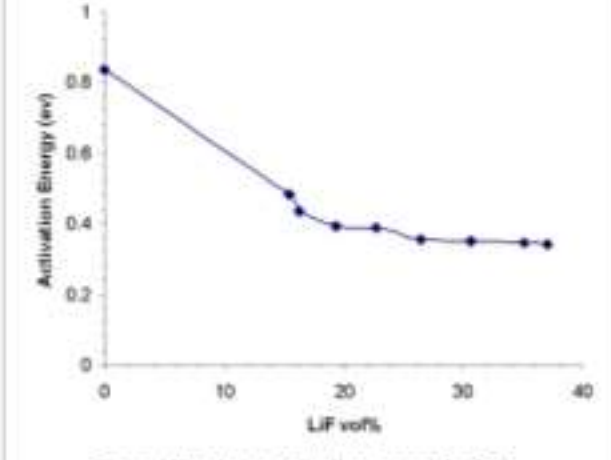


Figure (4)Variation activation energy for D.C electrical conductivity with LiF vol% concentration for (HDPE-LiF) composite

conductivity in the samples at low filler concentration is Hopping. The low values of activation energy extends from 0.34ev to 0.1992ev at higher LiF concentration , the amount of interconnecting network is increased , this enhance the conduction between LiF particles and lead to decrease of the activation energy [M. S. Ahmed and A. M. Zihilif,1992].

Conclusions

1. The D.C electrical conductivity of the HDPE increase by increasing of LiF concentrations and temperature .

2. The activation energy decreasing by increasing LiF concentrations .

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