Effect of addition Lithium Fluoride on some Electrical Properties of Polystyrene

Dr. Asrar Abdul Muniam , Ahmed Hashim

Al-Mustansiriyah University, college of Science

Abstract

In the present work , effect of addition Lithium Fluoride on some electrical properties of polystyrene has been studied . for that purpose , many samples has been prepared by adding Lithium Fluoride on the polystyrene 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 ستايرين. ولهذا الغرض تم تحضير نماذج بإضافة فلوريد الليثيوم إلى البولي ستايرين 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

Electrical conduction in polymers have been extensively studied in recent years to understand the nature of charge transport in these material. Various conduction mechanisms such as Schottky effect , the pool-frenkel effect , space charge limited conduction and hopping conduction have been suggested for the charge transport[T. G. Abdel-Malik *et.al*,2008]. Polystyrene is a preferred material in electronic technology due to its dielectric and mechanical properties and its low cost . PS can be subjected to high temperature and pressure variations, during the manufacture of electronic components [A.EL- Tawansi *et.al*,1989].

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].

Experiment

The materials used in the papar is polystyrene as matrix and Lithium florid 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 , 14.6 , 17.66 , 21 , 24.6 , 28.5 , 32.75 , 37.4 , 39.4) vol% The Hot Press method is used to press the powder mixture. The mixture of different LiF percentages have been compacted at temperature 145^{o}C under a pressure 100 par for 10 minutes . Its cooled to room temperature , the samples were dis shap of a diameter about 30mm and thickness ranged between (1.75-2.2) 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)^{o} 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 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= 1.1 cm^2.

Results and Discussion

Figure (1) show electrical volume conductivity as function of the concentration of LiF at a temperature of 50º C from the figures we note the concentration increasing of LiF the conductivity increases slightly to reach a concentration of LiF (21 vol%) where the value of the conductivity of this concentration (1.22×10^{-14} (ohm.cm)$^{-1}$) when increasing the focus more than that, the electrical conductivity to a large increase to the value (1.64×10^{-14} (ohm.cm)$^{-1}$) at the concentration of LiF (24.6 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 (21 vol% - 24.6 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 content increases but when the concentration of LiF reaches to (22.8vol%), 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].

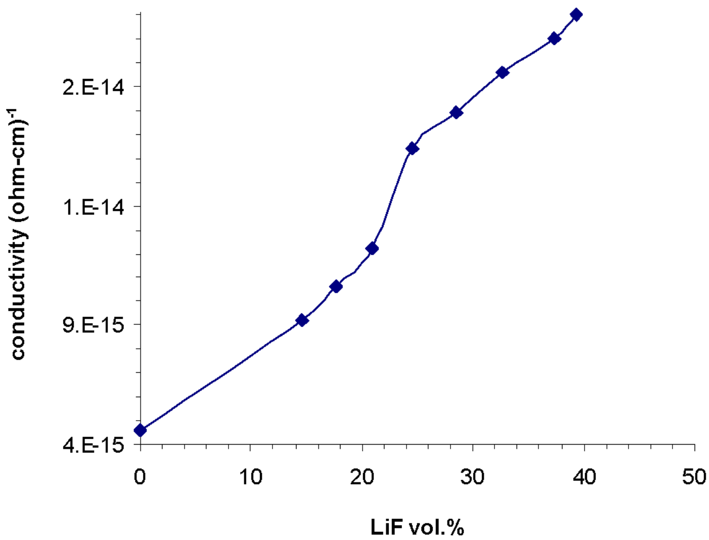

Figure (1) variation of D.C electrical conductivity with LiF vol% concentration for(PS-LiF) composite

Figure (2) shows the behavior of electrical volume conductivity of the samples with the temperature. Note that the electrical conductivity increase with 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].

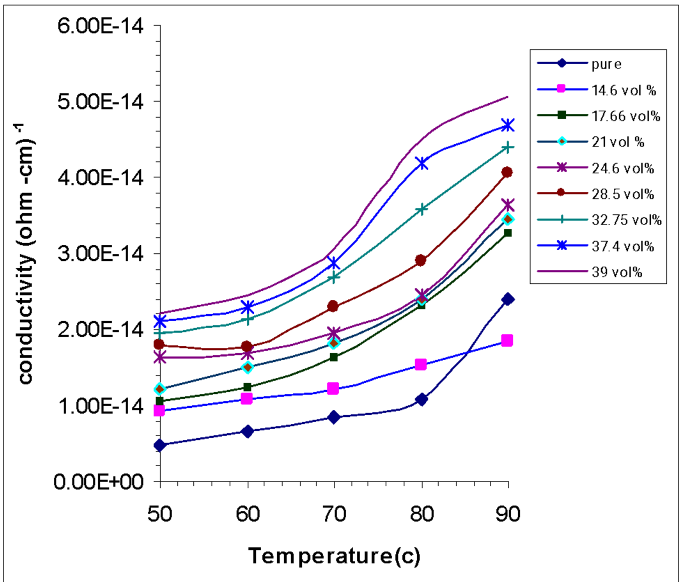

Figure (2) variation of DC electrical conductivity with temperture for(PS-LiF) composite

Figure (3) shows the relationship between the conductivity and inverted absolute temperature of the PS-LiF composites, using 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 (0.5094 ev to 0.3263 ev) for PS-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 activation energy values of all samples of PS-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* ,2008] .

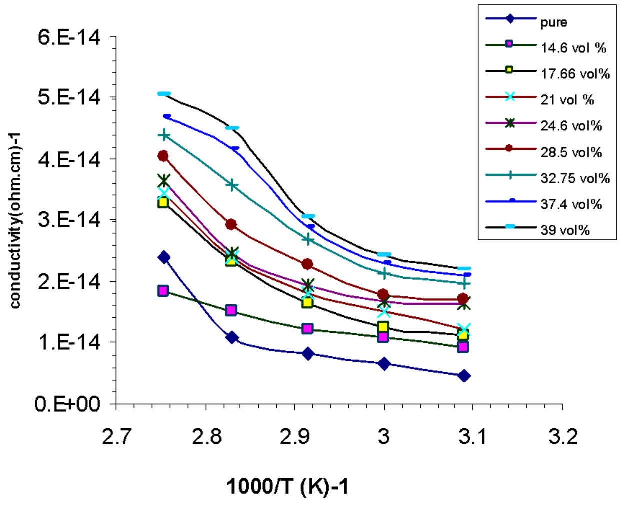

Figure (3) variation of DC electrical conductivity with resprocal absoute temperture for(ps-LiF) composite

The concentration increasing of lithium fluoride less the result of the activation energy as shown in the figure (4) of PS-LiF composites , it is clear that the mechanism of conductivity in the samples at low filler concentration is Hopping.

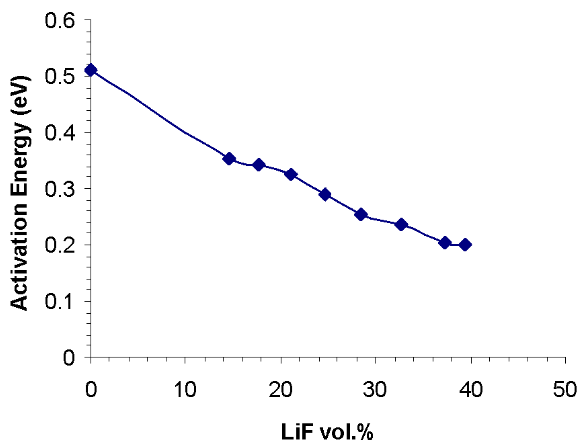

Figure (4)Variation activation energy for D.C electrical conductivity with LiF vol% concentration for (ps-LiF) composite

tends from (0.2901eV 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 PS increases by increasing of LiF concentrations and temperature .
2. The activation energy of D.C electrical conductivity is decreases by increasing LiF concentrations .

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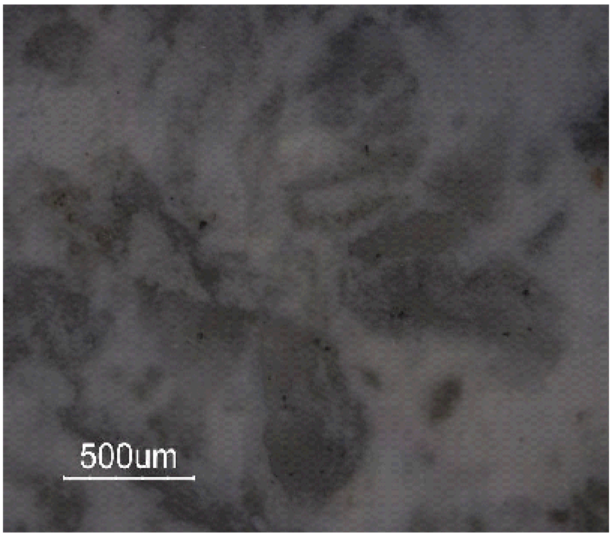
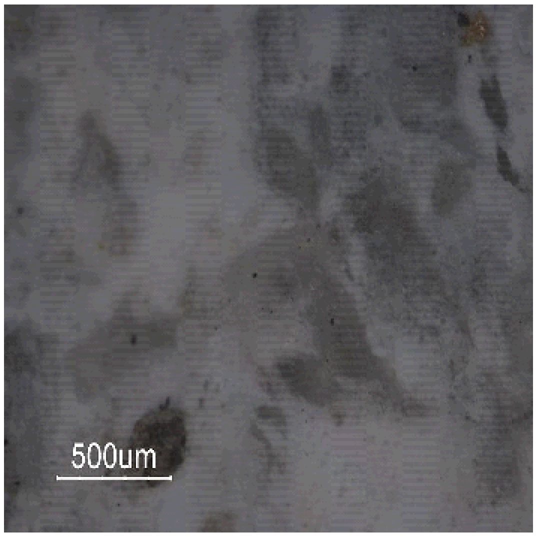
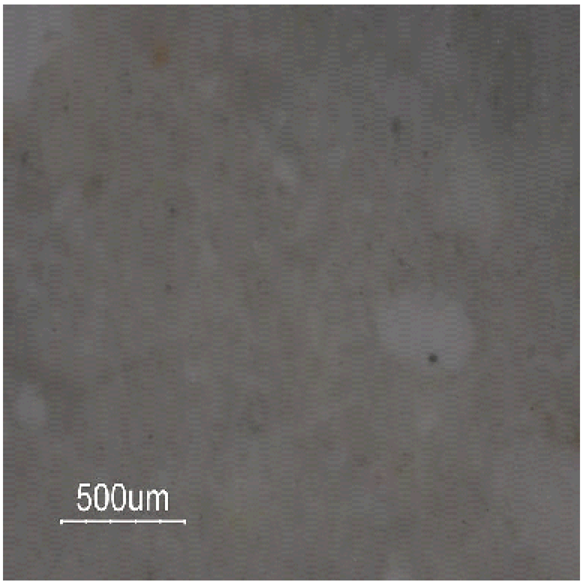


(B)



(A)



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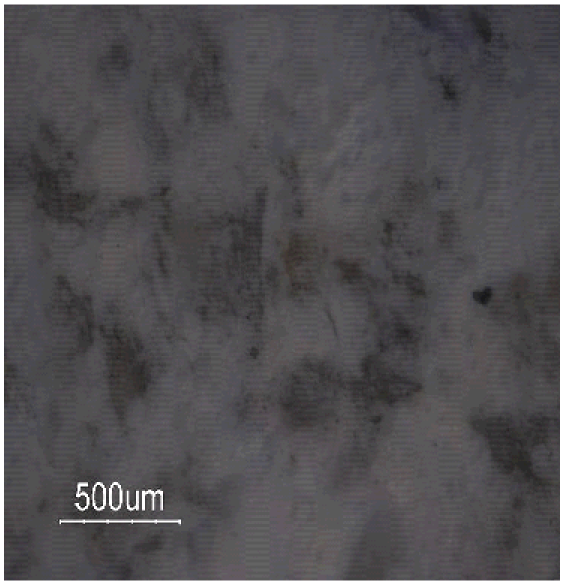

(C)

Figure (2) photomicrographs of PS-LiF composites(x50)

(A) 14.6 vol.% LiF (B) 21 vol.% LiF
(C) 32.75 vol.% LiF (D) 39.4 vol% LiF