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Characterization of Electrical Properties of (PVA-LiF) Composites

[1]Ahmed Hashim, [2]Amjed Marza, [3]Bahaa H. Rabee ,[4] Majeed Ali Habeeb, [5]Nahida Abd-alkadhim,
[6]Athraa Saad, [7]Zainab Alramadhan
[1,3,4]Babylon University, College of Education , Department of physics, Iraq.
[2,6]Babylon University, College of Science , Department of chemistry, Iraq.
[5]Babylon University, Enjineering Affairs, Iraq.
E-Mail: ahmed_taay@yahoo.com

Abstract
Composites consisting of poly-vinyl alcohol as matrix and lithium fluoride as a filler has been investigated with different percentages of lithium fluoride are (0,5,10, and 15) wt.%. The electrical conductivity of composite has been studied at different temperature. The results showed that the D.C electrical conductivity increases with increasing the lithium fluoride concentrations and temperature. Also the activation energy change with increasing of lithium fluoride concentration.
Keywords: Composites, Electrical Conductivity, lithium fluoride.

Introduction

In recent years, 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*. [1]. Poly(vinyl alcohol) (PVA), as it is well known for its interesting behavior and its versatile applications. In water, there exist two possible intermolecular interactions among PVA chains or between PVA and water, as follows: (1) H-bonding between modified hydroxyl groups on PVA chains and (2) H-bonding between the —OH groups of PVA and water molecules[2]. The present work deals with study the effect of lithium fluoride on the D.C electrical properties of poly-vinyl alcohol composite.

Experiment

The materials which are used in this paper, is poly vinyl alcohol as matrix and lithium fluoride as a filler. The weight percentages of lithium fluoride are (0,5,10 and 15)wt.%. Films of pure poly vinyl alcohol and poly vinyl alcohol doped with lithium fluoride were prepared using casting technique thickness ranged between (213-614)μm. The resistivity was measured over range of temperature from (30 to 80)^{o}C using Keithly electrometer type (616C) .The volume electrical conductivity σ_v defined by :

$$\sigma_v = \frac{1}{\rho_v} = \frac{L}{RA} \quad \text{.....(1)}$$

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= 0.5 cm^2 .

The activation energy was calculated using equation :

$$\sigma = \sigma_o \exp(-E_a/k_BT) \quad \text{.....(2)}$$

σ = electrical conductivity at T temperature
σ_0 = electrical conductivity at absolute zero of temperature
K_B = Boltzmann constant
E_{act} = Activation Energy

Results and Discussion

The variation of D.C electrical conductivity as function of concentration of lithium fluoride at temperature (30^0C) is shown in figure(1). The figure shows that the D.C electrical conductivity of the poly-vinyl alcohol increases with increase Lithium Fluoride concentration.

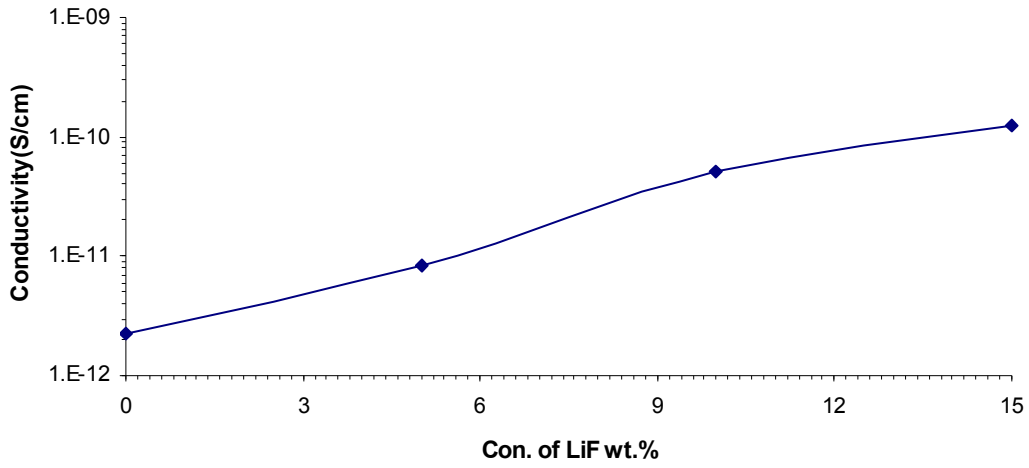

FIG.1
Variation of D.C electrical conductivity with LiF wt.% concentration of composite.

The increment in D.C electrical conductivity of composite is ascribed to the rearrangement of lithium fluoride particles throughout the polymer matrix. At low concentrations, the lithium fluoride particles are represented by small darker region. Note also that the lithium fluoride concentration increases the darker regions become larger and start to form some kind of network, when the lithium fluoride concentration is higher, the network starts to connect to each other to form some kind of conductive path through the polymer matrix [3].

Figure (2) shows the variation of the bulk electrical conductivity of composite with temperature. The electrical conductivity of composites increases with increase of temperature. This means that these materials have resistance of negative thermal coefficient; that is, having the resistance decrease with the increase of temperature. This is because polymer chains and lithium fluoride ions could act as traps for the moving charge carriers by hopping process[4], with the increase of temperature, the motion of polymer chains increase; as a result of the ions of lithium fluoride move. Consequently, the trapped charge carriers are releasing and the conductivity of composite increase as a result for the increase of the charge carriers and mobility of these charges[3].

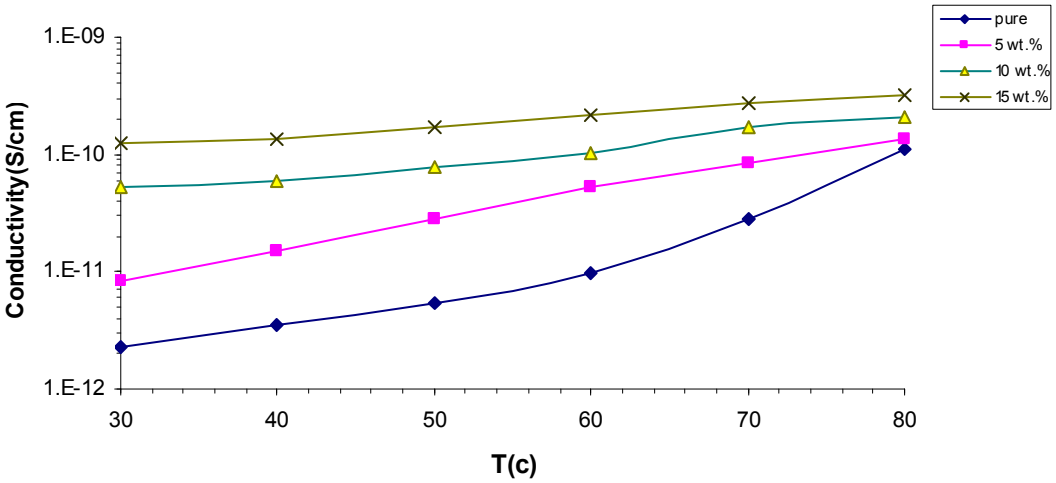

FIG.2
Variation of D.C electrical conductivity with temperature for(PVA-LiF) composite

Figure(3) shows the relationship between the ln(conductivity) and inverted absolute temperature of composites of different concentration of lithium fluoride, the high values of activation energy are attributed to

the existence of free ions in the polymer. By adding low concentrations of lithium fluoride, the values of the activation energy are decreasing of composites as a result of the impact of space charge [5].

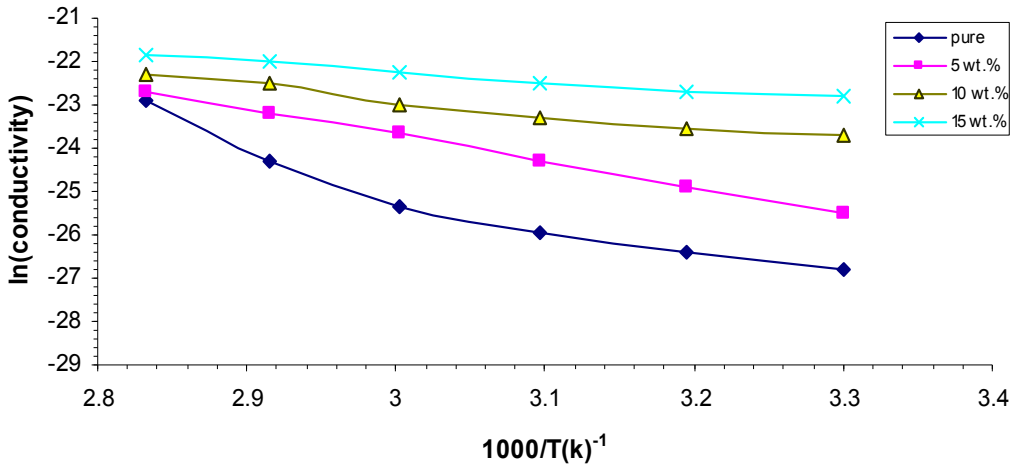

FIG.3
Variation of D.C electrical conductivity with resprocal absoute temperature for (PVA-LiF) composite.

The addition of low concentrations creates local energy levels in the forbidden energy gap which act as traps for charge carriers, which move by hopping among these levels. By increasing the lithium fluoride concentrations, the activation energy decreases as a result of the increase of local centers [6], as shown in figure(4)

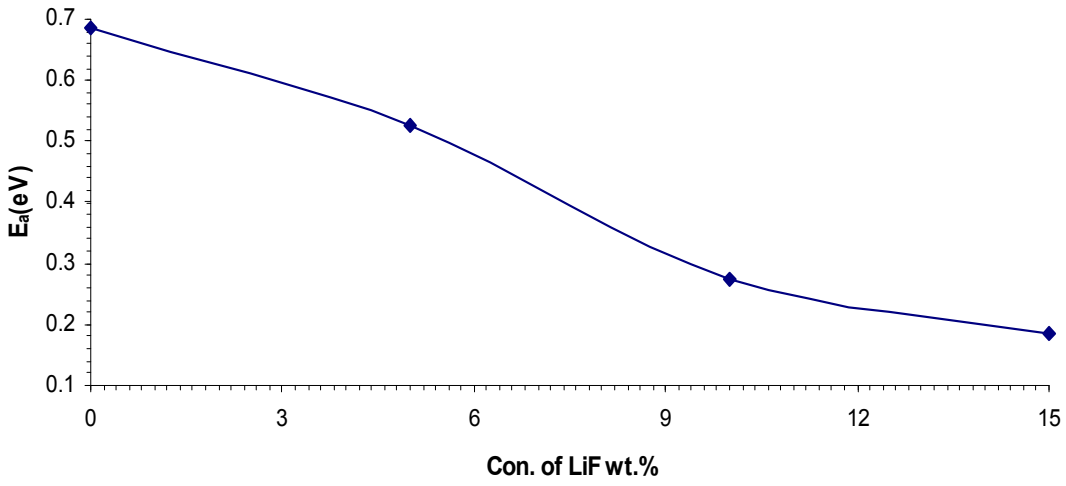

FIG.4
Variation activation energy for D.C electrical conductivity with LiF concentration of composite

Conclusions

1. The D.C electrical conductivity of the poly-vinyl alcohol increases by increasing the Lithium Fluoride concentrations and the temperature.
2. The activation energy of D.C electrical conductivity decreases by increasing Lithium Fluoride concentrations.

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