American Journal of Scientific Research
ISSN 2301-2005 Issue 73 (2012), pp. 5-8

http://www.eurojournals.com/ajsr.htm

# Study of Electrical Properties of ( PVA-CaO) Composites

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**Abstract**

The purpose of this present work, study the electrical properties of PVA-CaO composites were studied. The effect of calcium oxide concentration and temperature on the D.C electrical conductivity have been investigated. Results showed that the D.C electrical conductivity is increased with increasing the calcium oxide concentrations and temperature. Also the activation energy change with increasing of calcium oxide concentration.

**Keywords:** Electrical Properties, poly-vinyl alcohol, Composites.

## 1. 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]. Polymer-based composites are system with numerous high technological applications. These applications need a high level of composite production and manufacturing, including the chemical process, material, and structural design to suit specific purposes[2]. The advantages of PVA such of high mechanical strength and water-soluble have played as main role for this selection as compared to other polymer matrices [3] The present work deals with the effect of calcium oxide additive on the D.C electrical properties of poly-vinyl alcohol composite.

## 2. Experiment

The materials which are used in this paper, are poly vinyl alcohol as matrix and calcium oxide as a filler. The weight percentages of calcium oxide are (0, 1,2 and 3)wt.%. films of pure PVA and PVA doped with calcium oxide were prepared using casting technique thickness ranged between (256-645)μm. The resistivity was measured over range of temperature from (30 to 80)$^{o}$C using Keithly electrometer type (616C) .The volume electrical conductivity $\sigma_v$ defined by :

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

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 :

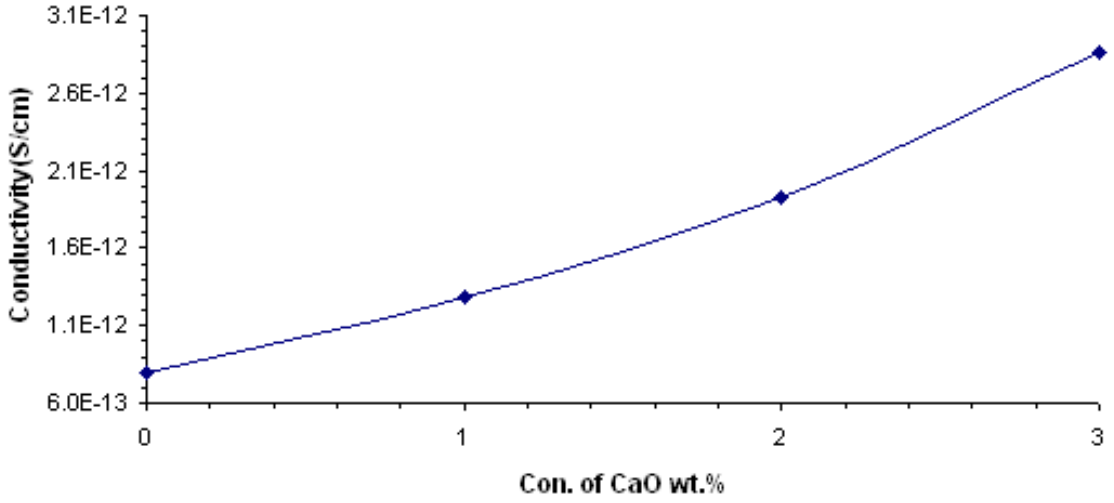
$$\sigma = \sigma_o \exp(-E_a/k_B T) \quad (2)$$

$\sigma$ = electrical conductivity at T temperature
$\sigma_0$ = electrical conductivity at absolute zero of temperature
$K_B$ = Boltzmann constant
$E_{act}$ = Activation Energy

## 3. Results and Discussion

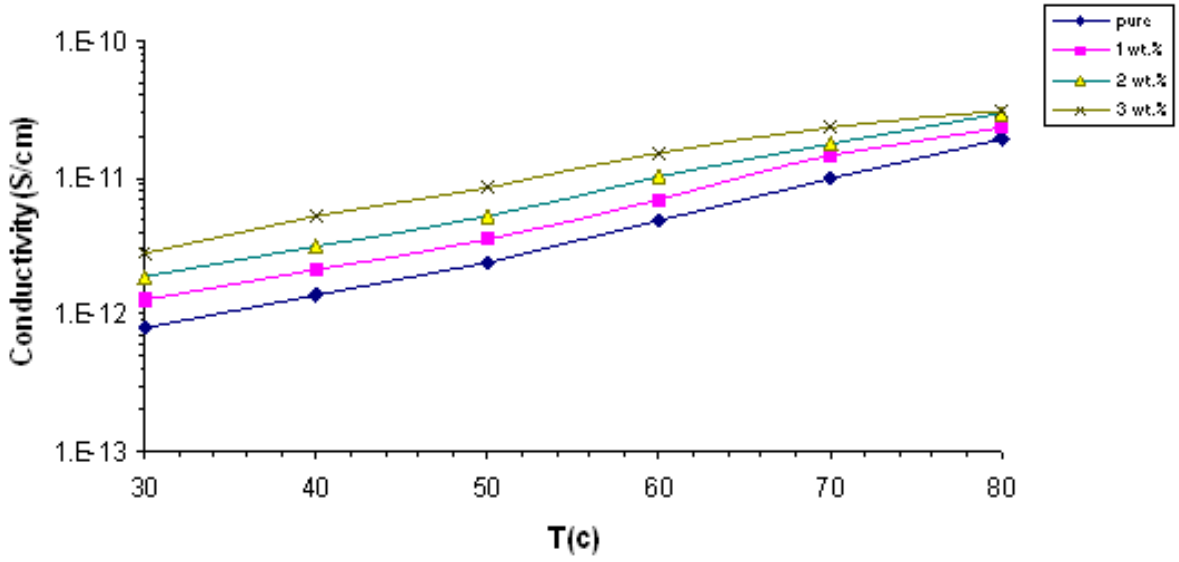
The variation of D.C electrical conductivity as a function of the calcium oxide concentration at a temperature of 30$^{o}$C is shown in figure(1), the conductivity increases with increasing calcium oxide additive concentration. The increase of conductivity with increasing of concentration of calcium oxide due to increases the charge carriers which increased with increasing filler content[4,5].

**Figure 1:** Variation of D.C. electrical conductivity with CaO wt. % concentration of composite



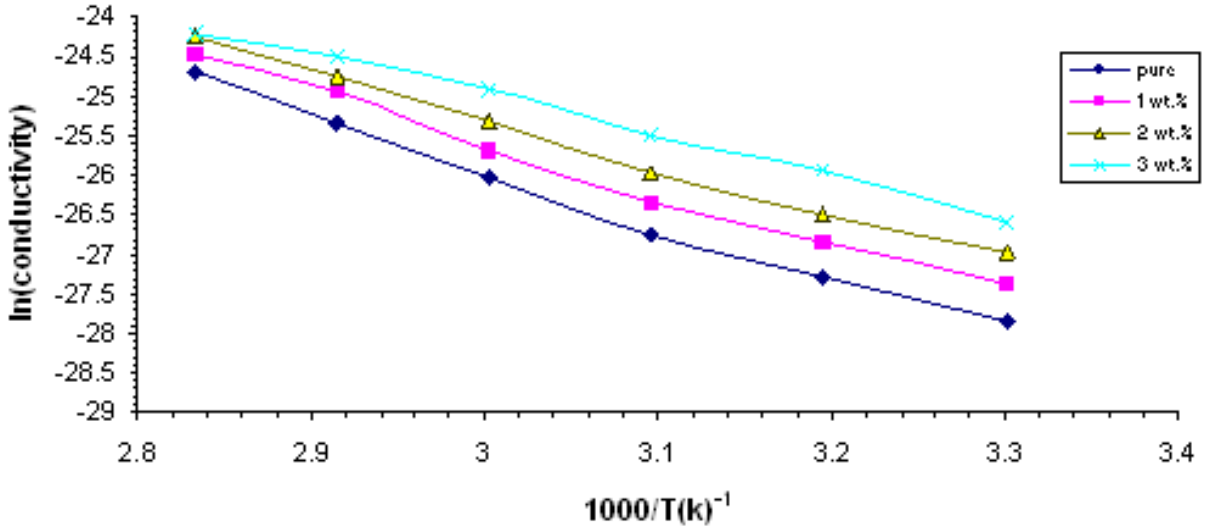

The variation of D.C electrical conductivity for (PVA- CaO) composites of different calcium oxide concentration as function of temperature is shown in figure(2). The figure shows that for all samples of different calcium oxide concentration, the conductivity is increasing with increasing temperature. This behavior can be related to the increasing of the ionic charge carriers as well as increasing of polymer segmental motion as a result of temperature increasing.

**Figure 2:** Variation of D.C. electrical conductivity with temperature for (PVA-CaO) composite



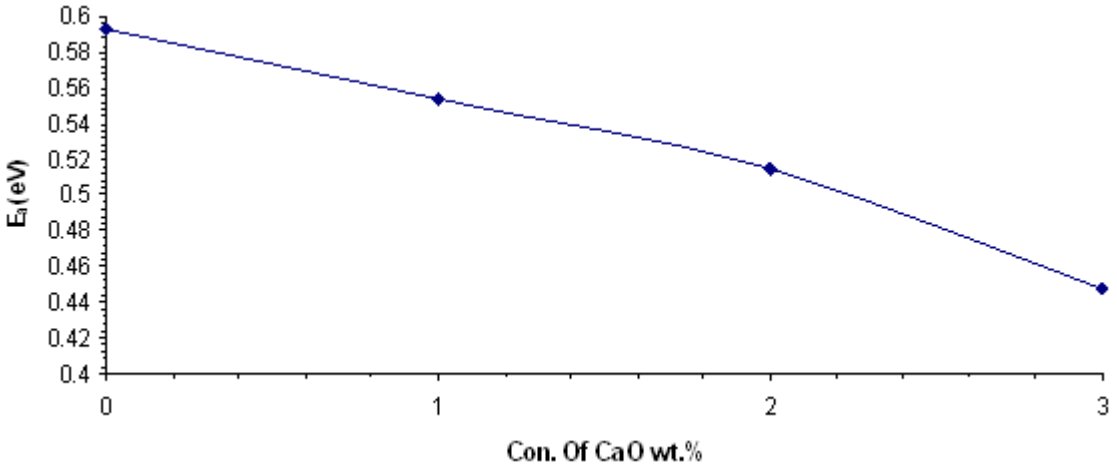

Figure(3) shows the relationship between the ln(conductivity) and inverted absolute temperature of the PVA- CaO composites, using equation(2) was calculate activation energy it can be seen that there are high values of activation energy these high values are attributed to the existence of free ions in the polymer. By adding low concentrations of calcium oxide, the values of the activation energy are decreasing for PVA- CaO composites as a result of the impact of space charge [2].

**Figure 3:** Variation of D.C. electrical conductivity with resprocal absolute temperature for (PVA-CaO) 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 calcium oxide concentrations, the activation energy decreases as a result of the increase of local centres [6], as shown in figure(4) .

**Figure 4:** Variation activation for D.C. electrical conductivity with CaO wt. % concentration (PVA-CaO) composite




## 4. Conclusions

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

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