

## **Synthesis and Study Electrical Properties of (PS-CaO) Composites**

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### **Abstract**

In this work, study of electrical properties of polystyrene-calcium oxide composites has been studied. The samples has been prepared by adding calcium oxide to the polystyrene by different weight percentages are (0, 1, 2 and 3). The experimental results showed that the D.C electrical conductivity changed with increase the weight percentages of additional calcium oxide and temperature. Also the activation energy change with increasing of additional calcium oxide.

### **Introduction**

Plastics have been used in great demand nowadays. One of them, for example, is polystyrene which has been widely used for plastic packaging, electronic parts, furniture and expanded polystyrene foam (EPSF). Because of its unique properties such as insulation, low weight and sound absorber, it is then useful for interior decoration and exhibition as well as entertainment venues. In order to obtain good properties of the polymer composites, a number of considerations should be taken into account such as proper quantities, quality of dispersiveness [1]. 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 [2]. The present work deals with the effect of calcium oxide additive on the electrical properties of polystyrene composite.

## Experimental Work

The materials which are used in this paper, are polystyrene as matrix and calcium oxide as a filler. The weight percentages of calcium oxide are (0, 1,2 and 3)wt.%. films of pure polystyrene and polystyrene doped with calcium oxide were prepared using casting technique thickness ranged between (225-615) $\mu\text{m}$ . The resistivity was measured over range of temperature from (30 to 80) $^{\circ}\text{C}$  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  $D = 0.5 \text{ cm}^2$ .

The activation energy was calculated using equation:

$$\sigma = \sigma_0 \exp(-E_a/k_B T) \quad (2)$$

$\sigma$  = electrical conductivity at T temperature

$\sigma_0$  = electrical conductivity at absolute zero of temperature

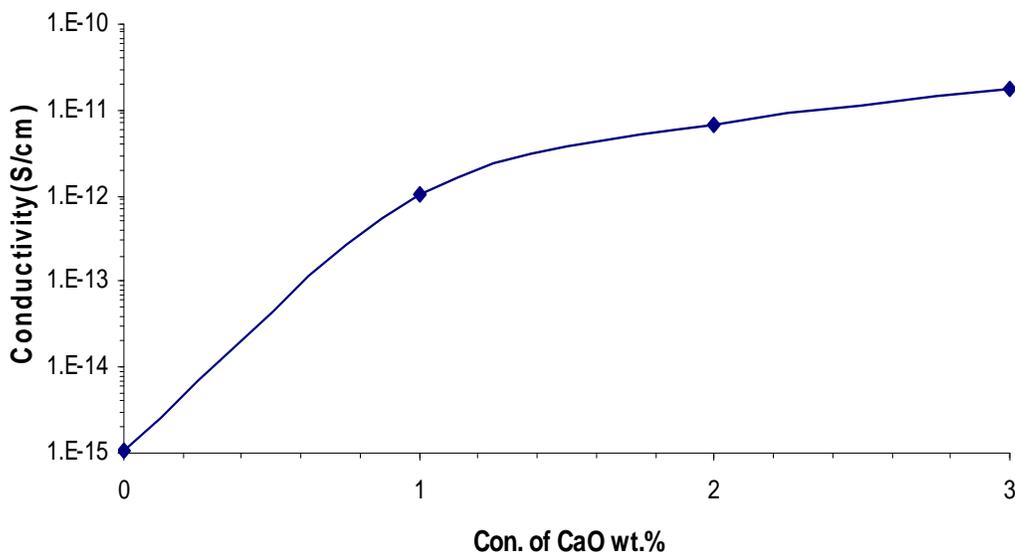
$K_B$  = Boltzmann constant

$E_{act}$  = Activation Energy

## Results and Discussion

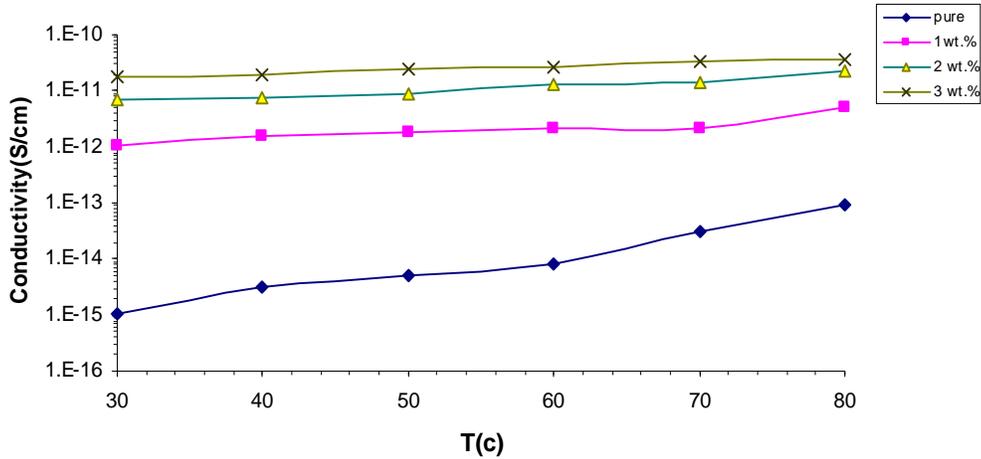
The variation of electrical conductivity as function of weight percentages of calcium oxide at a temperature of 30 $^{\circ}\text{C}$ , the conductivity increases with increase calcium oxide concentration. The increase of conductivity with increasing of concentration of calcium oxide due to increases the charge carriers where calcium oxide particles at a low concentrations are represented by small darker regions and become large when the calcium oxide content increases and 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 [3].

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



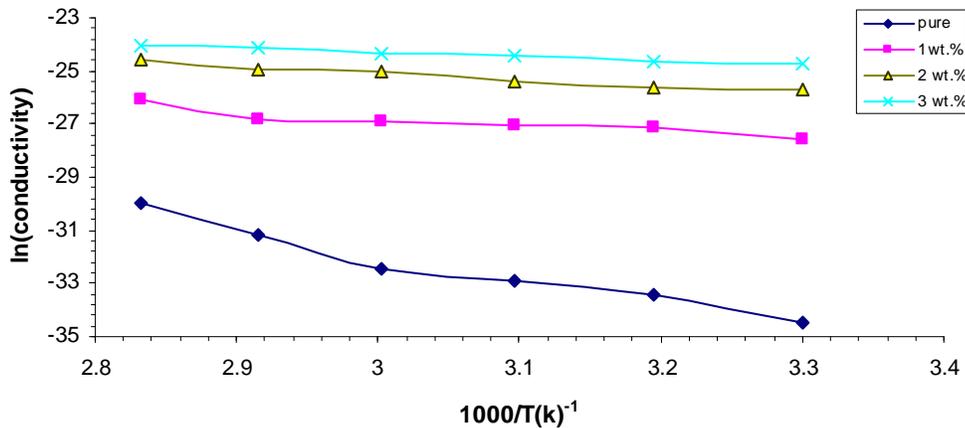
The behavior of D.C electrical conductivity of the samples with the temperature is shown in figure(2). The figure shows that the electrical conductivity increase with increasing temperature that any of this material has a negative thermal coefficient of resistance. the interpretation of this is that the polymeric chains and calcium oxide particles 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 [4].

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

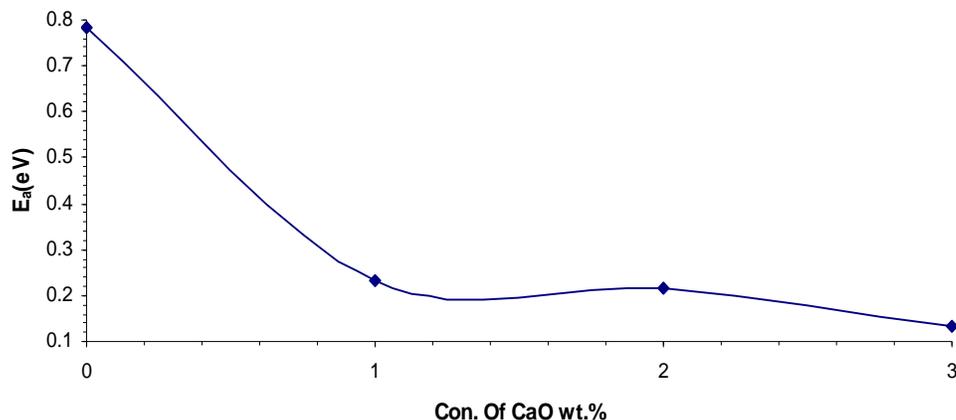


The variation of ln(conductivity) with inverted absolute temperature of composites is shown in figure(3), using equation(2) was calculate activation energy, the high activation energy values for neat sample and low calcium oxide concentration sample can be attributed to the thermal movement of the ions and molecules, whereas the low activation energy values for the samples of higher calcium oxide content can be attributed to the electronic conduction mechanism which is related to the decreasing of the distance between the calcium oxide particles. [5].

**Figure 3:** Variation of D.C electrical conductivity with resprocal absoute temperature for (PS-CaO) composite.



The concentration increasing of calcium oxide less the result of the activation energy as shown in the figure (4) of composites which is a reasonable support for the above discussion [6].

**Figure 4:** Variation activation energy for D.C electrical conductivity with CaO concentration of composite

## Conclusions

1. The D.C electrical conductivity of polystyrene increases with increasing of calcium oxide concentrations and temperature.
2. The activation energy decreases with increasing calcium oxide concentrations.

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