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MODIFICATION OF PVC BY ADDITION OF (C + MnO_2) AND STUDY OF THEIR ELECTRICAL PROPERTIES

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ABSTRACT

Polyvinyl chloride (PVC) has been modified by addition of (C + MnO_2).The addition is 5% and 20% by weight. (C + MnO_2) act as a reducing agent and used in dry cells.Short circuit and air gap thermally stimulated conductivity have been studied in the temperature range 303K to 383K. It has been observed that conductivity of (C + MnO_2) added PVC is higher than undoped PVC but it is higher for 5 wt. % than 20 wt. % of (C + MnO_2).Activation energy values were determined from the slope of log σ vs 1000/T plot and represent electronic conduction in modified PVC and ionic in undoped PVC.

Key words: PVC, Short circuit TSC, Air gap TSC, D. C. Electrical conductivity.

INTRODUCTION

A polymer is a large molecule composed of repeating structural units or monomers connected to each other by covalent bonds.Because of their extraordinary range of properties polymer play an indispensible & ubiquitos role in our everyday life. The first major breakdown in field of electrically conducting polymers occurs in 1977 when three scientists A. J. Heeger, A. G. mac Diarmid and H.Shirakawa from different disciplins and different continents, came together and made intellectual connections. For the first time it was demonstrated that polyacetylene (PA), an intrinsically insulating polymer,could become highly conducting on treatment with oxidizing or reducing agents.This process is called doping .The electrical conduction in polymer films has much importance due to discovery of memory phenomenon[1]. Today the study of these materials has become one of the foremost areas of research and the vast applications of these materials have revolutionized the electronic industry, providing promising alternative to Si and Ge. During last two decades through simple modification of ordinary organic conjugated polymers researchers have designed polymers with a wide range of products extending from the most common consumer goods like rechargeable batteries and microelectronics goods to highly specialized application in space, aeronauts and electronics.The electrical conduction in iodine doped polystyrene (PS) & poly (methyl methacrylate) (PMMA) has already been reported[2]. Electrical conduction of succinic acid doped glycine pellet has been discussed[4]. Electrical conduction in polyethyleneterepthalate (PET) film has been studied[5]. Electrical conduction in semiconducting PVC-PMMA thin films has been reported[8].

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Electrical conductivity and permittivity of carbon black-PVC composites were studied over a wide frequency spectrum.

MnO_2 is the principle precursor to ferromagnetic of related alloys.

$MnO_2 + 2C \rightarrow Mn + 2CO$

The key reaction of MnO_2 in batteries is on electron reduction.

The predominant application of MnO_2 is as a component of dry cell batteries[6]. The aim of present study is to investigate air gap TSC and short circuited TSC on dc electrical conductivity of insulating PVC thin films on addition of ($C + MnO_2$) powder.

EXPERIMENTAL

($C + MnO_2$) powder from fresh dry cell is used for study. Thin films of pure PVC and ($C + MnO_2$) doped PVC has been prepared by isothermal evaporation technique. Doping has been done by weight percent material. The percentage of ($C + MnO_2$) powder is 5% and 20% of PVC. The thickness of sample was measured by occulometer in conjuction with travelling microscope having least count 15.38 µm .The thickness of thin films is in the range of 45 µm to 108 µm . Surface of the sample were coated by highly conducting silver paint obtain from Eitecks company, Banglore for perfect electrical contacts.

In air gap and short circuit thermally stimulated conductivity measurement (TSC) regulated power supply was used as the voltage source, while current was recorded by using highly sensitive pico-ammeter with an accuracy of ± 0.2% supplied by scientific equipment Roorkee as a function of temperature[8] in the range of 303 K to 383 K. For air gap TSC a hollow ring was put on that side of sample which was not coated by silver paint. For short circuit TSC both side of sample were coated with silver paint.

RESULTS AND DISCUSSION

D. C. electrical conductivity of thin films of pure PVC and ($C + MnO_2$) doped PVC was measured in the temperature range 303 K to 383K. The temperature dependence of conductivity of pure PVC, 5 wt. % ($C + MnO_2$) doped PVC and, 20 wt. % ($C + MnO_2$) doped PVC thin film is presented in the form of Arrhenius plot as shown in Figs. (1), (2), (3) i.e. log σ vs 1000 /T plots at all values of applied voltage showing straight line.

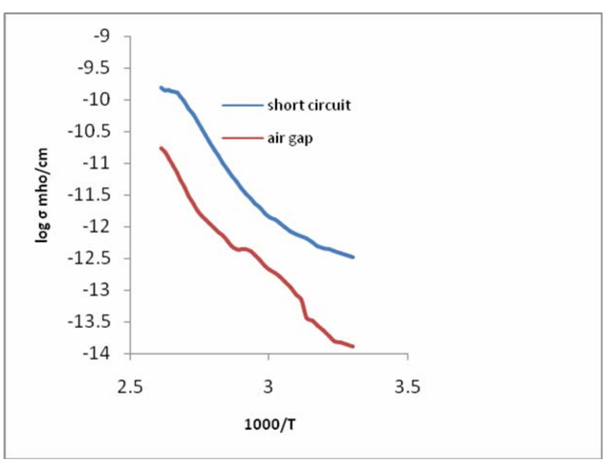

Fig. 1: For Pure PVC

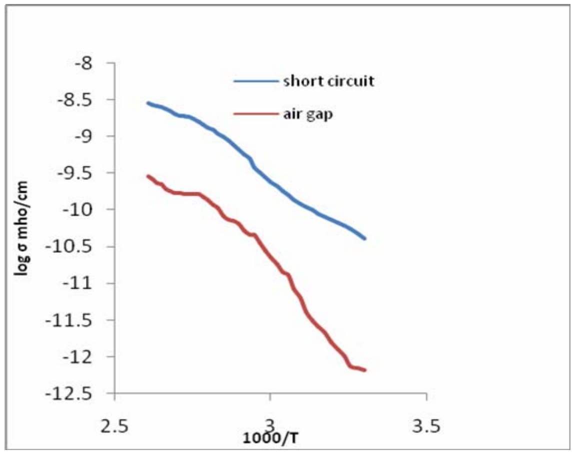

Fig. 2: 5 wt. % (C + MnO_2) doped PVC

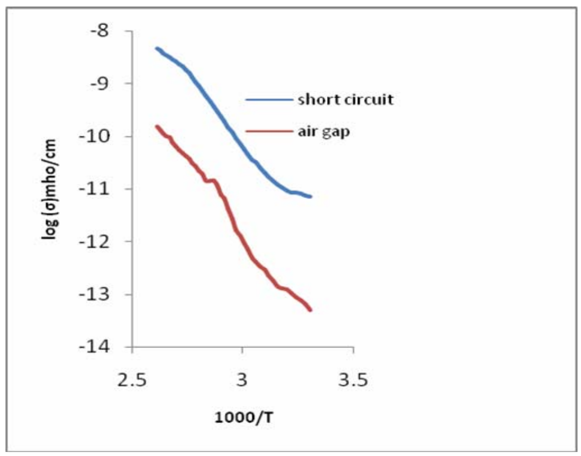

Fig. 3: 20 wt. % (C + MnO_2) doped PVC

From all thermograms, as temperature increases conductivity increases, it shows ohomic nature that is semiconducting nature. The observed variation of logσ vs 1000/T is due to change in conductivity with temperature and nature of trap distribution in sample. The increase in conductivity[3] may be due to softening of sample. It might be due to property of (C + MnO_2) as a reducing agent.

By comparing all thermograms it is observed that conductivity range for 5 wt. % of (C + MnO_2) doped is better than undoped and 20 wt. % of (C + MnO_2) doped PVC. Thus smaller percentage of (C + MnO_2) doping in PVC we get better result for conductivity.

In case of short circuited, the metallic electrodes are brought into contact with the thin film .In this case charge carriers flow from film to metal to estsblished thermal equilibrium resulting into depletion region in the thin film near the electrode.

In case of air gap TSC, the film is metalized on one side only. In presence of finite air gap, the charge on nonmetalized side of the film induces part of its image charge on lower electrode, the result being nonzero internal field, which at high temperature causes net conduction current to flow in the film.

From the comparative study of short circuited and air gap TSC of electrical conductivity it is observed that, in case of air gap TSC conductivity is less as compared to conductivity measured in case of short circuited .It means that when we place hollow ring on thin film and produce air gap on it then its conductivity decreases . It may be due to decrease in charges flowing from lower electrode to upper electrode.Charges may decrease because air is produced between two electrodes; air is insulator and acts as dielectric between two electrodes.

Table 1.

Sample	**Mode**	**Activatin energy (eV)**	
		Low temp. region	**High temp. region**
Undoped PVC	Short Circuit	0.4544	0.9040
	Air Gap	1.1087	1.628
5% (C+ MnO_2) doped PVC	Short Circuit	0.2835	0.3378
	Air Gap	0.9469	0.3621
20% (C + MnO_2) doped PVC	Short Circuit	0.6648	0.5932
	Air Gap	0.6734	0.8896

Activation energy is calculated from the slope of straight line and recorded in Table 1. From table it is observed that in all cases activation energy for air gap TSC is large as compared to activation energy for short circuited. The conductivity of dielectric may be either ionic or electronic or both. Experimentally ionic or electronic conduction are distinguished by measuring activation energy. If activation energy ≤ 1ev then there is electronic conduction and if activation energy ≥ 1ev then there is ionic conduction[7].

For pure PVC, in case of air gap TSC values of activation energy Ea > 1ev, therefore there is current due to ions and all other values of activation energy Ea < 1ev therefore there is current due to electrons.

CONCLUSION

From the present study it is concluded that addition of (C + MnO_2) powder in small amount in insulating polymer like PVC increases the conductivity of PVC in both short circuited and air gap mode.

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