TSDC of Thermoelectret of PVC-PMMA Blend Films

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Abstract: In this paper the results of thermally stimulated discharge current (TSDC) study of thermoelectret of polyvinyl chloride (PVC) - polymethyl methacrylate (PMMA) blend film are presented. The sample is in the form of a thin film poled at different poling fields, thereby forming a thermoelectret. TSDC has been carried out in a temperature range 301K to 373K and at five different polarising fields. Results are discussed on the basis of space charge polarisation. The activation energy of the sample has been found to be 0.11 eV. which is in good agreement with the reported orders of magnitude.

Keywords : blend film , TSDC ,Thermoelectret.

1. INTRODUCTION

TSDC of polymer has become a widely used experimental technique for the investigation of various material parameters such as charge storage properties, determination of mean depth of the internal charge, activation energies of traps, trap structure of the material etc. Suzuki et al[1] studied characterisation of polymers can be done with a considerable accuracy by using TSDC technique. Kellar et al[2] studied polyblends of PS and PMMA employing TSDC. The polyblends of PMMA and polyvinyl pyrrolidone (PVP) have been studied by Khare et al[3]. Negau and Negau[4] obtained new results in thermally stimulated discharge current (TSDC) peak above room temperature. Sangawar[5] measured D.C. electrical conductivity of doped electrets of PS and PMMA. Belsare et al[6] studied the iodine doped polyblends of PS and PMMA using TSDC. Burghate et al[7] measured thermally stimulated discharge current (TSDC) and dielectric constant of semiconducting glasses.

In the recent years a great deal of interest has been centered on the study of highly conducting polymer materials. Khare et al[5] measured the thermally stimulated discharge current (TSDC) and electrical conductivity in metal (1) and ethyl cellulose-metal (1)/(2) systems. It is only in recent years

that the possibility of technological application of electrification of polymers due to its contact with metal has been discovered[6]. The availability of new measuring techniques such as thermally stimulated discharge current[7] has freshened interest in achieving better understanding and application of the phenomena.

However, no attempts seems to have been made to study the thermoelectrets properties of blend film. It was therefore, brought to be in fitness of things to undertake study of polyblend of PVC and PMMA, using thermally stimulated discharge current (TSDC) technique. The basic principle of this technique is to study the charge decay by heating the electret at a constant rate. This technique is a basic tool to identify and evaluate the dipole reorientation process, trapping and recombination levels in electrets.

2. Experimental Details

The polyvinyl chloride (PVC) of commercial grade supplied by Polychem Industries, Mumbai and polymethyl methacrylate (PMMA) supplied by Dental Products of India Ltd., Mumbai, were used for the study.

2.1 Preparation of samples

For the preparation of films, 0.6 gm of PVC and 0.4 gm PMMA were dissolved in 10 ml of tetrahydrofuran (THF) (AR grade) and uniform solution was obtained by subjecting it to 2 hours heating at a constant temperature 313 K. The solution so prepared was gradually and carefully poured over a perfectly plane and clean glass plate, which was kept floating on a pool of mercury, for leveling, thereby ensuring uniform thickness of the film. The whole system was placed inside the constant temperature and dust free chamber, to allow the solvent to evaporate completely. In this way the films were prepared by isothermal evaporation technique.[18-19] The films were subjected to 12 hours heating at constant temperature, to remove the traces of solvent. Both the sides of the sample film were coated were coated with quick drying silver paint (supplied by Elteck Pvt. Ltd., Bangalore) to ensure good electrical contacts. The coated sample pellet was subjected to uniform heating at a temperature of 353K in furnace.

Electret Preparation

The sample pellet was mounted into the sample holder with pressure contacts. The sample holder was placed in constant temperature oven at 373K. The sample so heated upto polling temperature 373K was allowed at that temperature for about 1 hour. The polarizing field, Ep was maintained for 30 min. between two opposite faces of sample so that the sample film is polarized for a definite time. With the applied electric field the sample was allowed to cool down to room temperature

301K. The electrets were prepared at different polarizing fields : Ep=131kv/m, 262kv/m,393 kv/m, 524kv/m, and 655 kv/m respectively.

Measurements of Thermally Stimulated Discharge (TSD) Current

After electret formation, the sample holder assembly was placed in high temperature furnace. The sample was short circuited through a sensitive picoammeter (Model DPA III Scientific Equipments, Roorkee, having accuracy ±1 pA) for the measurement of discharge current. Then the sample was heated at a uniform rate of 3.50 c/min from 301K to 373K. The temperature was recorded by digital thermometer having an accuracy ± 1°c. The purpose of preparation of electrets was to observe the effect of polarizing field Ep, on the properties of electrets.

RESULTS AND DISCUSSION

The result of the present study are presented in the form of thermograms which are curves between TSDC current and temperature of the sample film at different polarizing fields as represented in Fig.1.

The thermograms of Fig. 1 show (i) almost single prominent peak for the sample film at each polarizing field. (ii) The current peaks are of different magnitudes and occur at different temperatures for the film polarised with different polarizing fields. The results can be discussed at below.

The constituents of the sample film namely PVC and PMMA are well known polar[6-11] molecules. Naturally the sample will inherit these or their modification, if any in displaying its behavior.

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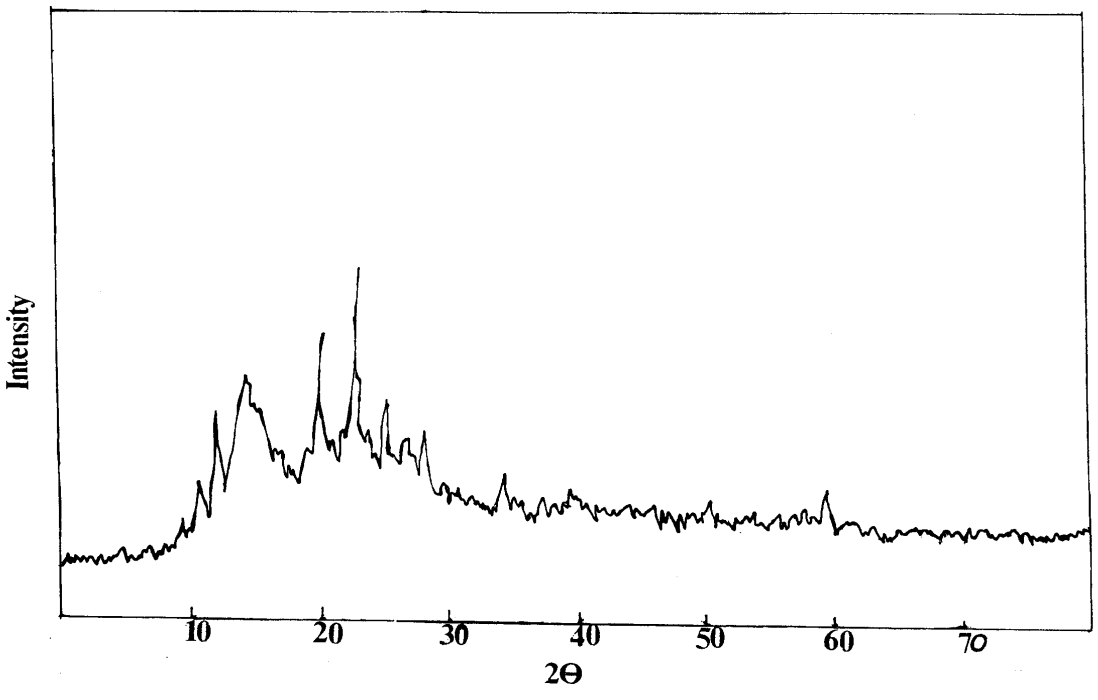

Fig 1 X- ray diffractogram of sample

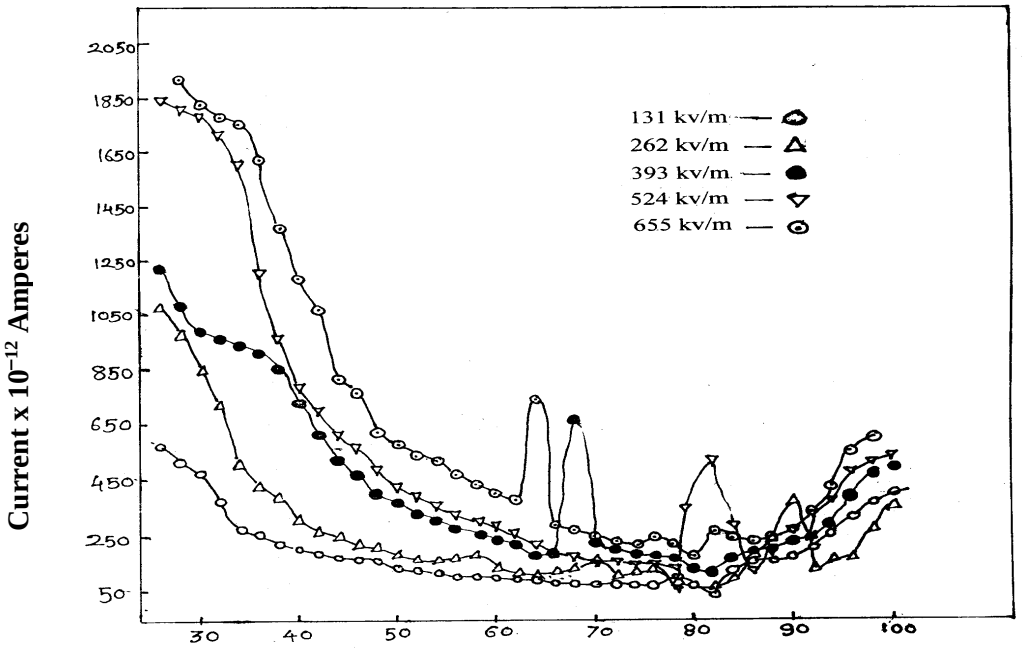

Fig. 2 TSDC for sample [current Vs temperature plot]

Fig 3 : Arrhenius Plots