STUDIES ON THE ELECTRONIC AND PYROELECTRIC PROPERTIES IN POLYMERS WITH SPECIAL REFERENCE TO POLY (VINYLIDENE FLUORIDE)

By
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CERTIFICATE

I am satisfied that the thesis entitled "Studies on the Electronic and Pyroelectric Properties in Polymers with Special Reference to Poly(vinylidene Fluoride) by Tara Kaura is worthy of consideration for the award of the Degree of Doctor of Philosophy and is a record of the original bonafide research work carried out by her under my guidance and supervision. The results in it have not been submitted in part or full to any other university or institute for award of any Degree/Diploma

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PREFACE

The last two/three decades have seen a phenomenal growth of the science of materials and it is still continuing with more and more involvement in terms of both the scientific manpower and financial commitments. Basically the attempt has been to invent new materials to find new technological applications of the existing ones. Synthetic polymers belong to such a class of important materials with their remarkable diversity of properties. There are well known electrical applications of polymers in the form of devices but basically the role of the polymers is to resist electrical conduction. They have gained special status because of the need for large area electronic devices and low cost of fabrication.

Among the class of polymers the PVDF has emerged as one of the most promising material for variety of reasons. It is suitable for various technological applications such as IR detectors, ultrasonic transducers,optical and electronic devices etc. However, the details of structural properties in relation to its chemical and pyroelectric behaviour are not well understood. The field therefore remains an area of certain amount of controversy and contention.

The attempt through the investigations contained in this thesis has been to understand the correlation between the electrical and the structural properties of PVDF . It has also been possible to establish how these structural

properties depend on variations of temperature or stresses applied and thereby showing stability of PVDF when used in the form of devices. A short account of the work chapter-wise is presented below.

Chapter I of the thesis is devoted to an overall view of the present status of the understanding of the electronic and pyroelectric properties of polymers together with the actual and possible technological applications. In addition this chapter also contains an outline of the scope of present investigations and motivation for carrying out the same.

Chapter II deals with the details of the sample preparation and the various measurement techniques employed in the present studies. The results of the measurements of the optical and structural properties of PVDF are also described in this chapter.

The third Chapter contains the results of measurements of the effect of field and temperature on absorption currents in PVDF . The low frequency dielectric loss has also been evaluated using Hamon's approximation. The analysis of the observed experimental results enable us to identify the mechanism responsible for electrical conduction in PVDF.

In Chapter IV carrier mobility has been determined using a step field excitation technique. The results have been analysed with an aim to understand the conduction process in PVDF .

Chapter V deals with the results of the study of surface potential decay characteristics of solvent-cast pure and iodine doped and commercial unstretched and stretched PVDF films. An attempt is made to understand the processes involved in the corona poling of PVDF .

In Chapter VI a new model is proposed for pyroelectric effect taking into account the hopping of trapped charge carriers over the potential barrier and the existance of trapped charge gradient. The theory has been tested using some of the experimental results on solvent cast PVDF films.

Chapter VII contains the results and analysis of TSC investigations carried out in a series of experiments involving different poling conditions. These studies have enabled the evaluation of the trap depth , trap density, capture cross-section and attempt to escape frequency associated with prominent trapping centers.

A summary of the results and conclusions of the various studies on the electronic and pyroelectric properties in PVDF is presented in Chapter VIII.

Part of the results presented in the thesis have also resulted in the following research papers.

1. Proposed Model for Pyroelectric Effect in Poly(vinylidene Fluoride), J. Appl. Polym. Sci., 25,703-710(1980).

2. Drift Mobility Determination Using Surface Charge Decay Technique in Polyvinylidene Fluoride (PVDF), Polymer, 80, 232 (1981).

3. Step Voltage Transient Currents in Polyvinylidene Fluoride, J. Appl. Phys., July 1983

4. Pyroelectric Current in Cellulose-Acetate Films, Presented in the Conference on Ferroelectrics, 1980, IIT Delhi, India.

5. Absorption Current Studies in Polyvinylidene Fluoride (to be published).

6. Thermally Stimulated Currents in I_2 and Chloranil Doped PVDF (communicated).

7. Surface Potential Decay in PVDF in Stretched and Unstretched PVDF Films (communicated).

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