

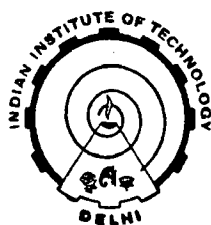
# **STUDIES ON PERSISTENT INTERNAL POLARIZATION AND DIELECTRIC RELAXATION IN POLYPROPYLENE POLYCARBONATE BLENDS**

by

**G. K. NARULA**

DEPARTMENT OF PHYSICS

*Thesis submitted in fulfilment of the  
requirements of the degree of*  
**DOCTOR OF PHILOSOPHY**  
in Physics



to the

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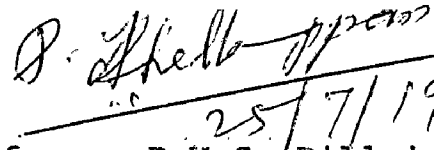
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CERTIFICATE

We are satisfied that the thesis entitled, 'Studies on Persistent Internal Polarization and Dielectric Relaxation in Polypropylene; Polycarbonate Blends' by G.K. Narula 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 our guidance and supervision and that the results contained in it have not been submitted in part or full to any other University or Institute for award of any degree/diploma.

  
19.7.1984

Professor R.G. Mendiratta  
Department of Physics,  
Indian Institute of  
Technology, Haus Khas,  
New Delhi-110016

  
25/7/1984

Professor P.K.C. Pillai  
Head, Department of Physics,  
Indian Institute of Technology,  
Haus Khas, New Delhi-110016

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NEW DELHI-110016

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( G.K. NARULA )

Physics Department  
Indian Institute of Technology  
Delhi

ABSTRACT

Polymers have found applications in almost all spheres of life. In addition to their conventional use as electrical insulators, they now feature as sensitive elements - sensitive to temperature, radiation and electric stress. The further developments in these newer techniques demand an understanding of the underlying dielectric and electronic processes in polymers.

Although persistent polarization and relaxation phenomenon have been studied in polymers by several researchers, but a detailed study of its nature, especially in polymer-blends has seldom been undertaken. The research work presented in this thesis deals with an investigation of these phenomena in poly-blend systems of polypropylene (PP) and polycarbonate (PC). Different dielectric techniques have been employed and the results have been correlated to get an overall view of various aspects of polarization and relaxation phenomena in these poly-blend systems.

Persistent polarization in these materials has been investigated by thermally stimulated discharge (TSD) current method. The molecular origin of polarization has been probed. The relaxation modes have been identified and the relaxation kinetic parameters have been evaluated. It has been found that the  $\alpha$ -relaxation observed in the polyblends is due to

trapping of charge carriers injected from the electrodes as well as the bulk generated carriers in the deep trapping levels which form induced dipoles. These induced dipoles later get oriented due to the action of heat and field. The reorientation of these induced dipoles and the release of the charge carriers from the deep traps gives rise to  $\alpha$ -relaxation. The  $\beta$ -peak observed at higher temperatures is found to be due to trapping of charge carriers at the crystalline amorphous interfaces. Effects of polyblending on the polarization processes have been discussed. It has been found that the total polarization increases with the increase of percentage of PC in the polyblends and is maximum for a 60:40 weight ratio of PC; PP polyblend. This has been explained on the basis of maximum heterogeneity in this polyblend. The activation energy values for the  $\alpha$ -relaxation process in different polyblends have been evaluated and are in the range 0.5 - 0.9 eV and show an increasing trend with the increase in the percentage of PC in the polyblend. This suggests that with the increase of PC ratio more and more deeper traps are created in the polyblends.

The absorption currents which arise in dielectrics on the application/removal of step function field have also been analyzed. It has been found that these currents originate from same polarization mechanisms as determined by TSD studies. The charge carrier injection, trapping, and

transport phenomena have also been studied. Relaxation bands have been obtained from isothermal discharge transients, and low frequency dielectric loss (obtained by Fourier transformation of absorption currents). Activation energy of the relaxation processes have been calculated from the shift of the relaxation bands with time/frequency. Polarization and relaxation phenomena have been investigated by the conventional AC-dielectric bridge experiments also. Useful information has been made on the polarizations in the polyblends and the results support the results obtained by TSD and dc-step response studies.

The conduction mechanism of the charge carriers in the polyblends has been investigated by steady state current measurements. It has been found that the predominant mechanism of conduction in these systems is by Richardson-Schottky (RS) effect i.e. the carriers are injected over the field dependent polymer-electrode barrier. The activation energy values have been calculated.

Surface charge decay studies on corona charged Michlers Ketone (MK); PC binder layers have been carried out for their use in electrophotographic applications. It is found that a 30:70 weight ratio of MK; PC layer is good for electrophotographic applications. The values of initial

acceptance potential and the contrast potential for this layer are 1040 V and 700 V respectively and the residual potential after 30 s of exposure is less than 8%.

## CONTENTS

	Page
Abstract	i-iv
Abbreviations	v
Chapter	
1. General Introduction	1
2. Experimental Details	89
3. Thermally Stimulated Polarization and Discharge Current Studies in PP, PC and PP:PC Polyblends	124
4. Isothermal Step Response and AC Response Studies in PP:PC Polyblends	174
5. Electrical Conduction Studies in PP:PC Polyblends	220
6. Electrophotographic Studies in MK <sub>2</sub> PC Binder Layers	254
7. Summary and Conclusions	280
List of Figures	293
List of Tables	298
Bio-Data	299

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