PREFACE

The advent of polymers represents one of the important industrial revolutions of the 20th century. Polymers are being used practically in every walk of life from domestic to high technology applications. In view of their interesting properties such as strength, elasticity, plasticity, toughness and frictional resistance often comparable with those of metals, that offer a range of very important advantages over the latter such as lighter weight, greater workability, and resistance to corrosion, versatile mechanical, electrical, physical, optical and chemical characteristics.

Ion irradiation of polymeric materials produces irreversible changes in their macromolecular structure and like γ, electron irradiation, can be used to control the physical properties of thin films or to modify the near surface characteristics of a bulk polymers. This technique differs fundamentally from diffusion doping since ion irradiation is not a thermal equilibrium process; rather it is the movement of ions into a solid as a consequence of its accelerating energy and is not the result of a concentration gradient produced by diffusion. Because of the general instability of chemically doped conducting polymers, problems with regards to their practical utilization, many experiments aimed to increase the electrical conductivity of polymers by ion irradiation have been studied and discussed.

The availability of high energy ion beam irradiation facility in the country (i.e. Nuclear Science Centre, New Delhi) which is capable of modifying polymer properties up to fairly good depths (say few mm), it may be worth exploring its application in high technology areas like gas sensor, rechargeable battery, micro-electronics etc. Energy transfer from ionizing radiations to large molecules results in primary ionization and excitation. In polymer samples, it induces breaking of original bonds, production of excited and ionized species of radicals and bonds rearrangement, which are responsible for the most observed chemical modifications. These effects are due to large amount of energy storage in the electronic molecular environment, which comes to the binding energies of simple organic molecules.

The most exciting development in recent years has been the introduction of several new types of polymer blends. They are generally made by blending a thermoplastic with suitable polymers. The significant advantage of polymer blend is that the properties of the finished product can be tailor made to the requirements of the application, which cannot be achieved alone either by thermoset or thermoplastic polymer. Numerous reports are available in literature on modification of polymers by different ions at different energies and fluences. But a detailed study of dielectric properties at different temperatures and frequencies are not much reported.

In the work reported here we have irradiated polyethylene terephthalate (PET), polypropylene (PP), kapton (PI), polyvinyl chloride (PVC) blended with poly ethylene terephthalate (PET), and also with ethyl vinyl acetate (EVA) at different fluences, using 50 MeV Li^{3+} ions at Nuclear Science Centre, New Delhi.

The radiation induced changes in structural, electrical, microhardness, thermal stability and surface morphology are investigated using different characterization techniques.

Dielectric properties of PET, PP and blended PVC with PET were studied in the frequency range 0.05 -100 kHz, and in a temperature range $40^{\circ}C - 150^{\circ}C$ using an LCR meter. It is observed that dielectric properties change with fluence.

The surface morphology of the polymers has been studied using optical microscope. Kapton samples exhibit blister formation on the surface of the film due to irradiation. Mechanical behaviour (microhardness) was studied using Vickers' microhardness indenter on pristine and irradiated samples. It is observed that hardness increases as fluence increases. Mechanical and thermal properties of blended polymeric films were also tested on Instron Tensile tester and thermo gravimetric analysis (TGA) respectively. It is observed that blended polymer consisting of PVC and EVA with equal proportion (ratio) exhibits better mechanical and thermal properties compared to other composition as well as pure samples. Hydrogen gas sensitivity of irradiated polymers was also studied. It is observed that PVC / PET blends give better results for hydrogen gas sensitivity. Thermal stability of irradiated and pristine samples were studied and it is observed that thermal stability of the samples decreases with the increase of fluence. Structural behaviour of pristine and irradiated samples was interpreted from their FTIR spectra.

The entire work is organized in five chapters.

Chapter 1 This chapter deals with the importance of irradiation in the field of material science, historical development of polymers, the structure and morphology of polymers, the effect of irradiation on polymers, the applications of polymers, the fundamental principles of the interaction of swift heavy ion with polymeric materials and aim of present work.

Chapter 2 This chapter describes briefly 15UD Pelletron Accelerator and the techniques used for characterization of samples i.e. FTIR Spectroscopy, LCR Meter, TGA, Optical Microscopy, SEM, Vickers' Microhardness and Instron Tensile Tester.

Chapter 3 This chapter describes the typical properties of polymers used in the present work, preparation of polymeric target, thickness measurement, estimation of range and energy loss using SRIM code, irradiation and measurements of structural, electrical, surface morphology, microhardness, tensile strength and thermal stability.

Chapter 4 The results obtained from different characterization techniques showing the fluence dependent modification of PP, PET, Kapton, Blended PVC and PET; PVC and EVA induced by 50 MeV lithium ion irradiation have been discussed in terms of dielectric properties, thermal stability, structural behavior, mechanical and surface morphology. Tensile strength and sensitivity to hydrogen gas is also discussed.

Chapter 5 This chapter gives summary and conclusions derived from the present investigations and also future plan of work.

The REFERENCES, throughout this thesis are numbered between square bracket in the text and are listed at the end of each chapter.