



## PREFACE

In recent years, we have witnessed a remarkable growth in the use of synthetic organic polymers in technology for both high-tech and consumer-product applications. Polymers are ideal materials for many industrial applications because they have desirable properties such as durability, processability, transparency, electrical and thermal resistance. As scientific progress continues, polymers are introduced into every aspect of life, from medicine to food packaging to computers.

New or expanded applications are the main reason for the consistent growth of plastics in the last two decades. The use of PVC for pipe, conduit, and siding in construction become common. The water and soft drink bottles made of PET which now dominate grocery shelves have almost completely displaced glass bottles. Similarly, polypropylene used in the casing for almost all automobile batteries has the same basic formula as the polymer used for indoor-outdoor carpeting, transparent overwrap films, lawn furniture, and polyolefin intimate apparel. PMMA can be used to prepare lenses, light covers, glazing (particularly in aircraft), light pipes, meter covers, bathroom fittings, outdoor signs, baths, toys etc. In the present work, we have used the thermoplastic polymer/ poly methylmethacrelate (PMMA) as a matrix.

However, the use of polymers is still limited because of their unexpected dielectric properties and inherent softness. The main goal of material science is to create new materials with physical properties tailored to a particular application and to understand the mechanisms controlling these properties. Composite materials developed by mixing two or more basic constituents, with improved physical properties are the new materials with dramatically increasing interest. In recent years, composite materials formed of insulating materials with embedded metal particles are

under focus because of their special structural properties and the extraordinary optical and electrical properties.

In last few decades, considerable work has been done for the investigation of structural and electrical properties of metal-polymer composites. The electrical properties of insulating polymers can be improved greatly by doping metal particles like carbon, iron or other conducting polymers. Organometals are also excellent alternative as filler. Organometallics provide large number of functional group after ion beam irradiation and consequently provide better adhesion between metal and polymer. This adhesion improves the electrical properties of the composites upon irradiation.

Composites are used in a wide variety of products, from advanced spacecraft to sporting goods to joint implants. Metal doped polymer provides suitable properties for EMI shielding. They are currently being used in various medical procedures and many unconventional applications have been proposed. Polymer composites have also been developed as candidates for different types of sensing applications. The conductive and absorptive properties of insulating polymers doped with conducting materials and the absorptive properties of insulating polymers with non-conducting fillers are sensitive to the exposure of gas vapours. Therefore, they can be used to monitor the existence and concentration of gases in the environment.

Energetic ion beams play a vital role in the field of materials science. Ion beam effect on the materials depends on the ion energy, fluence and ion species. The interaction of the ion with material is the deciding factor in the ion beam-induced material modification. Ion irradiation of polymer can induce irreversible changes in their macroscopic properties such as electrical and structural properties and surface related

mechanical property. These changes are responsible to fundamental events like electronic excitation, ionization, chain scission and cross links as well as mass loss, which take place due to ion beam irradiation. Therefore, the understanding of certain structural rearrangements influences the properties of the polymeric materials/composites opens a way to design devices with required parameters.

For present work, PMMA was synthesized by solution polymerization method. Polymer composites were prepared by doping different concentration of organometallic compound (ferric oxalate, Palladium acetylacetonate and Ni-Dimethylglyoxime) and metal (Ni) particles in PMMA. Self supporting films of composites were prepared by casting method. The irradiation effect on these composites was studied with respect to ion specie, energy and fluence. For this purpose 3 MeV Proton beam, 120 MeV Ni<sup>10+</sup> and 140 MeV Ag<sup>11+</sup> beams were used at different fluences. AC electrical, mechanical, structural, chemical, thermal properties and surface morphology of pristine and irradiated composites were investigated. Thin films of Fe doped PI were prepared on glass and Si substrate by RF sputtering. The films were irradiated with 120 MeV Ni<sup>10+</sup> beam at a fluence of  $5 \times 10^{12}$  ions/cm<sup>2</sup>. Pristine and irradiated thin films were characterized by AFM/MFM, SQUID and UV-Vis spectroscopy.

**Present work is organized into the following chapters:**

**Chapter 1** This chapter deals with the fundamentals of polymers and polymer composites. The importance of ion beam irradiation in the field of material science and in present day technologies is explained. A brief description about energy loss mechanism of ion beam and its effects on the properties of polymer and polymer

composites have been explained in this chapter along with literature survey and motivation for the present work.

**Chapter 2** This chapter deals with the discussion about synthesis of polymer and organometallic compound by chemical method. The working principles and operation of Cyclotron and Pelletron accelerators are discussed. Different characterization techniques have been discussed to do off-line analysis of the pristine and irradiated samples to study the ion beam induced modifications in the composite materials.

**Chapter 3** Effect of 3 MeV Proton beam on Ferric oxalate, Pd(acac), Ni-DMG and Ni powder dispersed PMMA films was studied at different ion fluences. The results obtained from various characterization techniques show the enslavement of different properties of composites upon ion beam irradiation and filler concentration. Dielectric properties are studied by means of Impedance gain phase analyser and microhardness by Vicker's microhardness indenter. Structural properties are studied by means of X-ray diffraction and FTIR analysis. Surface morphology of the pristine and irradiated films is studied by means of AFM and SEM. The results of all characterization techniques have been co-related to give a better and clear view of dielectric, structural, mechanical, chemical, thermal properties and surface morphology.

**Chapter 4** In this chapter swift heavy ion (120MeV, Ni<sup>10+</sup> ions) induced modifications of Ferric oxalate/Pd(acac)/Ni powder dispersed PMMA films at the fluences of  $1 \times 10^{11}$  and  $5 \times 10^{12}$  ions/cm<sup>2</sup> are studied. SHI induces more pronounced effect on the physico-chemical properties of the composites. Significant improvement has been observed in dielectric and mechanical properties after Ni<sup>10+</sup> ion irradiation. XRD, FTIR analysis was carried out for pristine and irradiated samples. Surface morphology was studied by means of AFM and SEM.

**Chapter 5** In this chapter swift heavy ion (140MeV, Ag<sup>11+</sup> ions) induced modifications of Ferric oxalate and Pd(acac) dispersed PMMA films are studied at the fluences of  $1 \times 10^{11}$  and  $5 \times 10^{12}$  ions/cm<sup>2</sup>. Dielectric, structural and surface properties of pristine and irradiated samples are carried out by means of LCR meter, XRD/FTIR and AFM respectively.

**Chapter 6** This chapter summarizes the results obtained by proton, Ni<sup>10+</sup> and Ag<sup>11+</sup> beam irradiations. It also gives conclusions derived from the present investigation along with the future plan of the work.

The **references** are numbered in square bracket in text and are listed at the end of the respective Chapters.