PREFACE

Conductive polymer composites, which are lightweight materials and combine the inherent processability of polymers with the electrical conductivity of metals, have been used in a number of applications such as electromagnetic interference (EMI) shields, antistatic devices, thermistors and conducting coatings. Because of the technological importance of these composites, their electrical properties have been widely studied. The properties of composites comprising electrically conductive particles dispersed in an insulating polymer matrix have been studied for over 50 years. Carbon and metal powders, e.g. Ni, Cu, Ag, Al and Fe, have all been used as fillers. Carbons utilized include carbon nanotubes, carbon fibre, graphite, pyrolytic carbons and carbon blacks, the latter having large variations in purity and morphology. The metal powders offer well-defined morphology and a higher intrinsic conductivity than carbon black. In general, at low filler content, the conductive particles are well separated and the composite is insulating, with an electrical conductivity only slightly higher than that of the polymer. Initially the conductivity increases slowly with filler concentration, but then rises rapidly over a narrow concentration range to give a high conductivity with only a weak dependence on further increase in filler concentration.

The percolation theory is commonly used to describe the behavior in the region of rapidly varying conductivity. The conductivity rises at the percolation threshold as the conductive particles begin to aggregate to produce chains of particles in intimate contact, providing conductive paths spanning the sample. The conductivity increases rapidly as more percolation paths form until saturation is approached, when the conductivity rises slowly to its maximum value. This model fails below the

percolation threshold, where it predicts that the composite is an insulator. Effective medium theories have been developed that provide a good description of the evolution of the conductivity across the full range of filler concentrations. The concentration of filler particles at the percolation threshold is sensitive to the shape of the particles.

Polymer based composite films are used in a variety of applications, ranging from reversible fuses and resistive heating tapes for housing electronic equipment to shield against electromagnetic interference. Special interest has been focused on these materials because of their versatile use in semiconductor research.

Ion irradiation of polymeric materials normally induces irreversible changes in their macromolecular structure, which results in the modification of the physico-chemical properties of polymer in a controlled way. Linear energy transfer (LET) from ionizing radiation to target molecules results in primary excitation and ionization. In polymer samples it induces breaking of original bonds, production of excited and ionized species of radicals, and bond rearrangement, which are responsible for most of the observed physico-chemical modifications. On ion irradiation, most of the properties of polymer such as optical, electrical, and mechanical get modified along with its chemical behavior, as shown by solubility and molecular weight distribution measurement.

The present study was undertaken to synthesize the conductive polymer composites system by chemical route method. The purposes of metal polymer composites system have been used for EMI shielding due to their high conductivity.

A details study of its electrical properties as a function of concentration, frequency and fluence of silver ion irradiation was carried out. When the radiation from source interacts with a polymer composites material, the polymer/polymer composites material absorbs its energy and active species such as radicals etc. are produced,

thereby, initiating various chemical reactions. There are three fundamental processes that are the results of these reactions. The different responses to radiation for different polymers are intrinsically related to the chemical structures of the polymers/polymers composites materials. A significant alteration of the electrical, structural, thermal and surface properties of the composites was obtained due to ion beam irradiation.

In the work reported here, three different types of conductive particles were used as filler viz. carbon black (CB), aluminum (Al), copper (Cu). Poly methylmethacrylate (PMMA) and polyvinylchloride (PVC) were used as polymer matrices for making composites. These composites were irradiated with 140 MeV Ag^{+11} ions at different ion-fluences at Inter University Accelerator centre (IUAC) New Delhi.

Also other commercially available composites systems were chosen to study the electrical and optical properties using silver ion beam irradiation. The prepared polymer composites samples were subjected to characterization, manily electrical, structural, thermal and surface morphology before and after ion beam irradiation.

The whole work is divided into following chapters.

Chapter -1

This Chapter starts with an introduction of polymer and polymer composites. The importance of ion beam irradiation in the field of materials science and present day technologies is explained. It also includes brief description about energy loss mechanism of ion beam. A detailed literature survey of polymer/ composites and objective for the present work is emphasized in this chapter.

Chapter-2

The detailed experimental procedures and various characterization techniques employed in these studies are documented in this chapter. Three different types of conductive particles were used as filler viz. carbon black (CB), aluminum (Al),

copper (Cu). Polymethylmethacrylate (PMMA) and polyvinylchloride (PVC) were used as polymer matrix for making composites. The brief descriptions of facility used for exposing the composites materials are described.

Chapter -3

This chapter describes the characterization of three polymer composites prepared by dispersion of conductive fillers carbon black (CB), Aluminum (Al), copper (Cu) in PMMA matrix. These composites were irradiated with 140 MeV Ag+11 ions at different fluences. The various results of experimentations before and after ion beam irradiation are presented. Scientific explanations of various properties e.g. electrical, structural, surface morphology and thermal properties of conductive composites are discussed.

Chapter-4

This chapter describes the characterization of three polymer composites prepared by dispersion of conductive fillers (carbon black (CB), Aluminum (Al), copper (Cu)) in polyvinylchloride (PVC) polymer matrix. These composites were irradiated with 140 MeV Ag^{+11} ions at different fluences. The various results of experimentations before and after ion beam irradiation are presented. Scientific explanations of various properties e.g. electrical, structural, thermal and surface morphology of conductive composites are discussed.

Chapter-5

This chapter deals with the electrical, optical, structural characteristics of 140 Mev Ag^{+11} ions irradiated PP+TiO_2, PP+GF and HDPE+CB composites at different ion fluences by different characterization techniques viz dielectric study, UV-spectroscopy, X-ray diffraction analysis and surface morphology of the composites.

Chapter-6

This chapter summarizes the research work and outlined its significant conclusion and future plan of work.

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