Abstract

Metallic nanoparticles are best known for their unique optical, electronic, chemical and magnetic properties which are surprisingly different from the individual atoms and their bulk counterparts. It has been observed that nanoparticles with different sizes give rise to different colours which are quite different from their bulk intrinsic colours. There are a few metals which can survive as nanoparticles under atmospheric conditions whereas most metal nanoparticles are very reactive due to their large surface to volume ratio. However, certain metal nanoparticles can sustain in specific dielectric media and such studies have been carried out by embedding them into different matrices. Different methods like vapour deposition, thermal diffusion, sol-gel synthesis and dispersion in liquid media have been reported in the literature, but so far no studies have been carried out on nanoparticles embedded in conducting polymers. Therefore, we have chosen conducting polymers as our preferred matrix and metal nanoparticles were embedded in the matrix by ion implantation method.

The choice of conducting polymers is due to their emerging applications as transparent electrodes in electronic devices. These polymers are semiconducting in nature and their conductivity and optical behaviour can be tuned by appropriate doping. On the other hand, nanoparticles have many novel attributes which are well known and they can be manipulated in terms of shape and size to achieve the desired functionality. Therefore, nanoparticles embedded inside the conducting polymers are expected to exhibit interesting properties. It has been observed that metal nanoparticles are capable of forming organized structures and polymer ligands play an important role to influence this organized structure. Temperatures also have significance in controlling aggregate size and morphology. The dielectric constant of the surrounding medium has great influences on optical properties of the nanoparticles. Therefore, larger clusters and smaller distance between clusters provide higher optical response. Ion implantation method has been chosen as our preferred method because the depth of layer of nanoparticles can be controlled by choosing appropriate energy of the ion beam and the concentration of the metal ions can be controlled by the fluence. The process of nanoparticle formation inside a matrix is known as *Ostwald Ripening* where incorporation of metal ions in a matrix above the solubility limit causes agglomeration of particles. Our aim was to investigate the process of formation of optically active metal nanoparticles inside conducting polymer by ion implantation method and also study their optical and electrical behaviour.

In this thesis work, it was planned to use conducting polymer polyaniline (PANI)as our model system in which we planned to implant some transition metal and rare earth atoms. The choice of transition metals and rare earth metals is due to their well known optical properties. PANI is a well studied conducting polymer which has a well known as well as unique aromatic structure facilitating its doping by various kinds of dopants and it has a wide range of applications due to its good electrical conductivity and optical transmission characeristics. PANI wassynthesized by chemical and in-situ method and doped to obtain desired conductivity of PANI films. The filmswere synthesized on ordinary glass and ITO coated glass by drop casting and spin coating techniques. Ion implantaion was carried out at different ion doses to investigate the formation of metal nanoparticles. The ion implanted samples were characterized

to investigate the formation of metal naoparticles by XRD and electron microscopy techniques. The optical behaviour of the ion implanted samples was characterized using UV-Vis absorption, optical reflectance and spectroscopic ellipsometric techniques. The electrical behaviour of the samples was investigated by temperature dependence of electrical conductivity both in presence and absence of magnetic field to understand the dynamics of charge carriers. The obective of this study of the process of formation of metal nanoparticles in conducting polymers and the resulting optical and electrical properties was to find applications of these materials.

Lastly, we have tried lesser harvested technique of incorporating metal nanoparticles into conducting polymer PANI i.e., by the method of Ball milling which works on the principle of grinding and crushing fine metal powders into metallic nanoparticles and mixing uniformly with polymer in a planetary Ball –Mill system to obtain metal nanoparticle incorporated conducting polymer.