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INVESTIGATION OF FORMATION OF METAL NANOPARTICLES IN CONDUCTING POLYMERS BY ION IMPLANTATION

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ABSTRACT

Ion implantation was used to produce Gold and Nickel nanoparticles embedded in highly conducting polyaniline matrix. It has been observed that gold nanoparticles were formed without any post implantation treatment but Ni-ion implantation under identical conditions did not lead to nanoparticle formation. Formation of nanoparticles was confirmed by XRD measurements. Both gold and nickel ion implanted samples show dose dependent reflectance spectra in the UV-Vis spectral region. The optical behaviour of the samples is remarkably different. Besides the thermodynamic consideration ion beam enhanced diffusion might have led to formation of gold nanoparticles which has been investigated in this study.

INTRODUCTION

Metallic nanoparticles possess unique optical, electronic, chemical, and magnetic properties those are strikingly different from those of the individual atoms as well as their bulk counterparts [1, 2]. For spherical nanoparticles embedded in a dielectric medium the effective dielectric function is based on Maxwell-Garnet Effective Medium theory is given by [3]

$$\varepsilon_{eff}(\omega) = \varepsilon_h \frac{(\varepsilon_i(\omega)+2\varepsilon_h)+2f(\varepsilon_i(\omega)-\varepsilon_h)}{(\varepsilon_i(\omega)+2\varepsilon_h)-f(\varepsilon_i(\omega)-\varepsilon_h)} \quad (1)$$

Where, $\varepsilon_i(\omega)$ and ε_h are the dielectric constants of the metal particles and host matrix respectively and *f* is the filling factor defined as volume of metal inclusions per unit volume of the composite material. Nanoparticles can be embedded into dielectric materials by various physical and chemical methods like vapour deposition, ion implantation and sol-gel synthesis [4] etc.

In the present work we have chosen ion implantation method to prepare gold and nickel nanoparticles embedded in conducting polymer polyaniline. Poly-Aniline (PANI) is a widely studied conducting polymer whose conducting property can be tailored from insulator to metallic conductivity by varying the doping concentration. In this work we have used camphor sulphonic acid doped polyaniline as our model system. The advantage of ion implantation method is that we can control concentration and depth of distribution by choosing the dose and energy of the ion beam. In this method the purity of the implanted species can also be maintained to a very high degree. The main disadvantage of ion implantation method is the damage caused due to the structure of the host material during the process. In some cases the structural damage can be annealed but in case of polymers the damage is permanent. It has been observed that the defects created during the ion implantation play an important role in the formation of metal nanoparticles [5]. Conducting polymers have oxidation state dependent optical properties. Moreover, organic-inorganic nano-composites have numerous possible applications in developing efficient light energy conversion systems, optical devices, and sensors.