CHAPTER V
DISCUSSIONS AND CONCLUSIONS

5. INTRODUCTION

Nanotechnology deals with nanometer size objects. Size dependent new physical aspects have been generating a continuous thrust for new practical applications [1]. Lead sulfide (PbS) nanocrystals with dimension in the range of 1–20 nm are of technological interest for advanced optoelectronic applications. They show a strong quantum confinement effect when the crystallite size becomes equal to the dimension of Bohr exciton [2,3]. Earlier investigations into the fundamental limits of the performance of PbS nanoparticle based devices confirm their ability to become a versatile technological platform for the creation of better optoelectronic devices [1–3]. A variety of different methods have been employed to grow the PbS nanoparticles on different substrates [4]. Growth of the nanoparticle films for device applications is still an emerging field of research. In this work, the optical and electrical properties of PbS nanoparticle films were grown by a modified spray pyrolysis method.

The chemical spray pyrolysis technique (SPT) has been, during last three decades, one of the major technique to deposit a wide variety of materials in thin film form. The prime requisite for obtaining good quality thin film is the optimisation of preparative
conditions viz. substrate temperature, spray rate, concentration of solution etc. This is the most critical parameter as it enables control over the size of the droplets and their distribution over the preheated substrates. The enhancement in deposition efficiency and improvement in quality of the thin films can be achieved with these atomization techniques. The detailed processes are discussed in chapter III and chapter IV. The spray deposition method is particularly attractive because of its simplicity. It is fast, inexpensive, vacuumless and is suitable for mass production.

The effect of dopants on the band structure, crystal structure and surface morphology of Lead Sulphide thin films on optically plane glass substrates has been investigated. The dopants include cadmium, Lithium and Zirconium. The band-gap energies of the thin films were determined from the absorbance spectra measured by UV-VIS spectrophotometer. The crystal structure was studied by using x-ray diffraction technique. The surface morphology of the films was studied by using the SEM results.

5.1 LEAD SULPHIDE THIN FILM

Lead Sulphide thin film on glass substrate were prepared from 0.01M lead acetate and 0.01M thiourea precursor solution using R.T.Model spray pyrolysis method. XRD studies show that, films prepared are in nanocrystalline range. Also the diffraction
peaks are found to be in good agreement with standard ASTM data. Optical studies show that the band gap energy is in the range of 1.81eV. SEM studies show that the film surface found to have uniform grains and the grain size obtained are of the order of 15-20 nm and this is in agreement with the calculated values from the XRD result. Electrical resistance is in the range of 150 Giga Ohms. Vicker’s Hardness value was found to be 74. The electrical resistance of the lead sulphide is found to be of the order of 150 Giga Ohms.

5.2 CADMIUM DOPED LEAD SULPHIDE THIN FILM

Lead Sulphide thin film on glass substrate were prepared by R.T.Model spray pyrolysis method. XRD studies show that films prepared are in nanocrystalline range. Also the diffraction peaks are found to be in good agreement with standard ASTM data. Optical study shows that the band gap energy increase from 1.98eV to 2.03eV as doping of cadmium increases. SEM studies show that the film surface found to have uniform grains and the grain size obtained agrees with the calculated values from the XRD result. Electrical resistance is in the range of Giga Ohms. Hardness measurement for different doping concentration of Cadmium was found by Vicker’s hardness method. The hardness value decreases when the concentration of Cadmium increases. The resistance of the film was measured at room temperature; it was observed that the resistance of the film increases in the
order of 200 giga ohms, when the molarity of the cadmium compound molarity increases.

5.3. LITHIUM DOPED LEAD SULPHIDE THIN FILM

Lead Sulphide thin film on glass substrate were prepared by R.T.Model spray pyrolysis method. XRD studies show that films prepared are in nanocrystalline range. Also the diffraction peaks are found to be in good agreement with standard ASTM data. Optical studies show that the band gap energy decreases from 2.00eV to 1.43eV by increasing the dopend Lithium. SEM studies show that the film surface found to have uniform grains and the grain size obtained agrees with the calculated values from the XRD result. Electrical resistance is in the range of Giga Ohms. Hardness measurement for various doping level of Lithium shows that the hardness value increases as the doping concentration of Lithium increases. The resistance of the film was measured at room temperature; it was observed that the resistance of the film decreases in the order of 50 giga ohms, when the molarity of the lithium compound molarity increases.

5.4. ZIRCONIUM DOPED LEAD SULPHIDE THIN FILM

Lead Sulphide thin film on glass substrate were prepared by R.T.Model spray pyrolysis method. XRD studies show that films prepared are in nanocrystalline range. Also the diffraction peaks are found to be in good agreement with standard ASTM data. Optical studies show that the band gap energy decrease from the
range of 1.10eV to 1.43eV as Zirconium concentration increases. SEM studies show that the film surface found to have uniform grains and the grain size obtained agrees with the calculated values from the XRD result. Electrical resistance is in the range of Giga Ohms. Hardness measurement of Zirconium doped Lead sulphide shows that the hardness increases as the concentration of Zirconium increases. The resistance of the film was measured at room temperature; it was observed that the resistance of the film increases in the order of 250-300 Giga ohms, when the molarity of the zirconium increases.

5.5. CONCLUSION

The photoconductivity property of lead sulfide is an intrinsic characteristic of the material and not the result of thermal vibration, impurity or crystal defects. Photoconductivity is, however, greatly enhanced by the introduction of impurity ions or crystal defects into the lattice. It has long been known that polycrystalline lead sulfide films might be used as the basic useful photo detector. The lead sulfide photo detector was brought to the manufacturing stage of development in Germany about 1943. After five decades, lead sulfide detectors are still in great demand as sensors for major military systems, as well as industrial, commercial and medical applications [6-7]. In order to prepare the PbS infrared detector, two primary methods: vacuum sublimation and chemical deposition have been used. In
both methods, PbS is prepared as a polycrystalline thin film deposited on a glass, quartz, and sapphire or strontium titanate substrate.

In the present study the nanocrystalline lead sulphide thin film has been successfully prepared by an improved spray pyrolysis method. This method is proved to be simple, cost effective, accurate and reproducible for the preparation of nanocrystalline thin films. The preparation of lead sulphide and doped lead sulphide thin film is helpful for further study on the infrared detector.

REFERENCE