ABSTRACT

Nowadays, crystals are produced artificially to satisfy the needs of science, technology and jewelry. The ability to grow high quality new crystals has become an essential criterium for the competitiveness of nations. Advancement in the development of crystal growth is highly demanded in the fields of semiconductors, polarizers, transducers, infrared detectors, ultrasonic amplifiers, ferrites, magnetic garnets, solid state lasers, nonlinear optic, piezoelectric, acousto-optic, photosensitive materials and crystalline thin films for microelectronics and computer industries. The utility of crystals has been extended from the bounds of ornaments to several useful applications in optical, electrical and optoelectronic devices. This thesis presents the possibility of using organic, inorganic and semi organic materials for the fabrication of optoelectronic devices and biomedical applications.

Nonlinear Optics (NLO) deals with the study of the interaction of intense electromagnetic field with materials to produce modified fields that are different from the input field in phase, frequency or amplitude. Second Harmonic Generation (SHG) is a nonlinear optical process that results in the conversion of an input optical wave into an output wave of twice the input frequency.

Nonlinear optical frequency conversion materials have significant impact on laser technology. However, some special nonlinear optical problems called for crystals with improved properties like high transparency in the UV region, high nonlinearity etc. This leads to the synthesis of new NLO materials of high optical quality.

Ferroelectrics are dielectric materials that show spontaneous polarization. The centers of the positive and negative charges within the unit cell of these materials do not coincide (non-centro symmetric). Ferroelectric materials are used in a wide variety of devices, because these materials have the properties of all piezoelectrics, pyroelectrics and ferroelectrics. These materials may be composites, thin-films, bulk single crystals or polycrystalline ceramics. Their excellent dielectric properties make them suitable for electronic components such as capacitors filters etc. Ferroelectric capacitors are used to make ferroelectric RAM for computers. The combined properties of memory devices, piezoelectricity and pyroelectricity make ferroelectric capacitors as one of the most useful technological devices in modern society.

In recent years, many significant achievements have been occurred in the field of nonlinear optics because of the development of New Nonlinear Optical (NLO) crystals of both organic and inorganic types. In the last decades, many researchers have tried to find varieties of new NLO materials for laser applications. The main drawback in organic nonlinear optical materials is low mechanical strength and poor physico-chemical stability. To overcome these drawbacks an attempt has been made to grow semi-organic nonlinear optical crystal (combination of organic acids and inorganic salts and metal-organic coordination compounds) which makes the material to be nonlinear and good mechanical strength.

Optically good quality Single crystal of L-Valine Ferric chloride (LVFC) has been grown successfully by slow evaporation technique. Transparent crystals of good quality have been harvested with in a period of 14 days. Single crystal XRD shows the cubic structure of the crystal. The presence of functional group was confirmed by FTIR analysis. Melting point of the grown crystal has been estimated by the thermal analysis. The green fluorescence emission of the crystal LVFC confirmed its fluorescence

behaviour. The result of the second harmonic generation test conducted on the experimental crystal confirms the non-linear nature of the crystal. Kurtz powder technique shows that the SHG sufficiency of LVFC is nearly 3.65 times of standard KDP. The surface analysis of the crystal was analyzed using SEM.Thus, the optical, NLO and thermal properties of the crystal indicate the suitability of this crystal for photonics device fabrications.

A potentially useful semi organic material Thiosemicarbazide with Manganous Acetate (TSMnAc) has been grown by solution growth slow evaporation technique. Good transparent TSMnAc crystal was obtained in 4 weeks. The grown crystals were characterized by Single crystal XRD studies shows that belongs to Triclinic (P) system. The functional groups present in the crystal were identified using FTIR analysis. In the UV Vis spectrometer the lower cut off wavelength was recorded from the absorption spectrum is 230.74 nm. The band gap energy was found to be 3.5 eV. Mechanical properties such as micro hardness (Hv) and Meyer's index, n, Yield strength, elastic stiffness constant have been carried out by indentation method. The dielectric constant measurements of the crystal at different temperatures and frequencies of the applied field are measured and calculated. The antibacterial and antifungal activities of TSMnAc were performed by Agar well diffusion method against the standard bacteria and fungus. Scanning Electron Microscope (SEM) results were carried out to study the surface morphology of the grown crystal. Nonlinear optical studies of the crystal were carried out and the second harmonic generation efficiency of the powdered sample was measured using Nd: YAG Q-switched laser and found that TSMnAc is 1.5 times greater than that of KDP crystal.

A potentially useful semi organic material Glycine with Manganous Acetate (GMnAc) has been grown by solution growth slow evaporation technique. Good transparentGMnAc crystals were obtained in a time span of 3 weeks. The grown crystals were characterized by Single crystal XRD

studies. The grown crystals have been subjected to powder XRD to identify the intense peaks on various planes. The UV–VIS-NIR Spectrum of the grown GMnAccrystals shows less optical absorption and good transmittance in the entire visible region and the lower cut off wavelength as recorded from the absorption spectrum is 276 nm. The band gap energy was found to be 4.5 eV. The grown crystals were thermally stable up to 71.9◦C. Mechanical properties such as micro hardness (Hv) and Meyer's index (n), Yield strength, elastic stiffness constant have been carried out by indentation method. The dielectric constant and dielectric loss measurements of the GMnAc crystal at different temperatures and frequencies of the applied field are measured and calculated. Electrical properties of the material were investigated over wide frequency and temperature range.The ac/dc conductivity studies are calculated and the activation energy is determined.GMnAc is an electrically non conducting material at room temperature.

A potentially useful semi organic material L–Histidine Cadmium Bromide (LHCdBr) has been grown by solution growth slow evaporation technique. Good transparent LHCdBr crystal was obtained in 2 weeks. The grown crystals were characterized by Single crystal XRD studies shows that belongs to Triclinic (P) system. The grown crystal has been subjected to powder XRD to identify the intense peaks on various planes. The presence of functional groups for the grown crystals was confirmed using FTIR spectroscopy. The optical absorption studies show that the material has wide optical transparency in the entire visible region and the cutoff length is found to be at 315.96 nm. The thermal analysis studies indicate that the material possess optimum thermal stability. The mechanical properties of the grown crystals have been studied using Vickers micro hardness tester.The variation of dielectric constant was studied as a function of frequency. The second harmonic generation was confirmed by Kurtz powder method and it is found to be 0.9 times more than that of KDP crystal.