ABSTRACT

Lasers find wide number of applications such as: fiber optic communication, micro-marking and micro-surgery, industrial drilling and welding, remote sensing and range-finding etc. Ultraviolet (UV) radiation is reviewed as clean source for material synthesis and processing. Nonlinear optical frequency convertors are the best source of UV laser radiation, which can generate desirable wavelength that cannot be produced directly by conventional laser sources.

The present thesis deals with the detailed investigation on the growth and characterisation of hippuric acid doped KDP, ADP, ZTS and europium doped LTB, LKBO single crystals for NLO and laser applications. The thesis starts with a brief overview on the theory behind non linear optics, the various types of nonlinear optical crystals and various crystal growth techniques.

Single crystals of hippuric acid (HA) doped ammonium dihydrogen phosphate (ADP), potassium dihydrogen phosphate (KDP) and Zinc tris thiourea sulphate (ZTS) were grown by slow evaporation technique for the first time. The structural information of the grown crystals were studied by powder X-ray diffraction analysis which reveals that the HA:ADP single crystal possess tetragonal crystal structure and the lattice parameters were calculated. From the XRD spectra of HA doped KDP and ZTS, it is confirmed that the grown crystals belong to the orthorhombic crystal system. UV-Vis-NIR optical analysis was carried out to find optical quality of grown crystals. The results show a superior optical transmittance for all our grown crystals in the entire visible region. It is found that the UV cutoff wavelength is around 300 nm for all the HA doped ADP, KDP and ZTS single crystals. The FTIR study identifies the functional groups present in the grown crystals which absorb at definite frequencies. Kurtz and Perry powder second harmonic generation (SHG) measurement confirms the NLO property of the grown HA doped ADP, KDP and ZTS single crystals.

Our study reveals that all the crystals have the SHG property and the crystals are capable of frequency conversion, and second harmonic generation efficiency of ADP, KDP and ZTS have considerably increased by adding the HA as a dopant.

Europium (Eu^{3+}) doped lithium tetraborate ($Eu:Li_2B_4O_7$) and lithium potassium borate ($Eu:LiKB_4O_7$) single crystals were grown from their stoichiometric melt by microtube Czochralski pulling technique (μT-Cz) for the first time. The grown crystals were subjected to powder X-ray diffraction (PXRD) analysis which reveals that the Eu:LTB belongs to tetragonal crystal structure and the crystal structure of Eu:LKBO is orthorhombic. UV-Vis-NIR spectral analysis was carried out to study the optical characteristics of the grown crystals. The crystal is transparent over the entire visible region, and the lower cutoff was observed at 304 nm for Eu:LTB and it was 302 nm for Eu:LKBO single crystals. The presence of functional groups, the existence of BO_3 and BO_4 bonding structure and the molecular associations were analyzed by FTIR spectroscopy. Both the Eu doped crystals were characterized by photoluminescence analysis. Europium ion with trivalent state in the host LTB and LKBO was confirmed by its characteristic emission at 613 nm due to the $^5D_0 \rightarrow {}^7F_2$ transition. The x, y color chromaticity coordinates of the Eu:LTB and Eu:LKBO are found to occur in the red region in the CIE 1931 diagram and it confirms their potentiality for red laser applications and display devices. NLO test on the grown crystals reveal that the SHG conversion efficiency of both Eu:LTB and Eu:LKBO crystals are comparable to that of KDP crystal.

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