CHAPTER 6

SUMMARY AND SUGGESTIONS FOR FUTURE WORK

6.1 SUMMARY

The present investigation of this thesis dealt with the development of KDP single crystals grown by Sankaranarayanan-Ramasamy (SR) method along <100>, <001>, <101> orientations and the effect of additive was also studied. Using the same ingredients KDP crystal was also grown by conventional solution growth method. Identical samples prepared with similar orientation using conventional and SR method were subjected for various characterization studies such as UV-Vis spectroscopy, Fourier transform infrared spectral analysis (FTIR), Microhardness, dielectric, High Resolution X-ray diffractometry analysis (HRXRD), thermo gravimetric and differential thermal analysis (TG/DTA) and etching studies. Several samples were analysed.

<100> directional KDP crystals were grown by SR-Method. The 20 mm diameter 30 mm height and 15 mm diameter and 65 mm height crystals were grown with growth rate of 3 mm/day. In the high resolution X-ray diffraction (HRXRD) studies, the curve is very sharp having full width at half maximum (FWHM) of 8 arc sec as expected for a nearly perfect crystal from the plane wave dynamical theory of X-ray diffraction. In conventional method grown KDP and SR method grown <100> KDP the etch pit density (EPD) is 10.5X10^2 cm^-2 and 3X10^2 cm^-2 respectively. The identical elongated rectangular shaped etch pits were observed in SR method and conventional
method grown KDP single crystals. The functional groups of the grown crystal were qualitatively confirmed by FTIR analysis. The dielectric constant was higher and dielectric loss was less in SR method grown crystal as against conventional method grown crystal. The SR method grown KDP has higher transmittance and higher hardness value compared to conventional method grown crystals.

The bulk single crystals of <001> KDP with the dimension of 10 mm diameter and 110 mm length have been grown by SR method. Two different growths were tried, in one the crystal diameter was the ampoule’s inner diameter and in the other the crystal thickness was less than the ampoule diameter. In the first case only the top four pyramidal faces were existing whereas in the second case the top four pyramidal faces and four prismatic faces were existing through our the growth. In SR method length to breadth ratio has been changed to as much as 10:1 using the same stoichiometric solution, and without any change of pH. In the HRXRD studies, full width at half maximum (FWHM) value of the diffraction curve is 20 arc sec. It indicates that the crystalline perfection is good without having any very low angle internal structural grain boundaries. The maximum non-damaging laser intensity at the four sites of the grown crystal were measured. The average value of damage threshold for the KDP crystal is greater than 4.55 ± 0.46 GW/cm², while it is 0.20 GW/cm² for conventional method grown KDP single crystal. The dielectric constant and dielectric loss was measured for SR method grown KDP crystal using two different growths and for conventional method grown KDP crystal. In the two different growths of SR method, the higher dielectric constant and low dielectric loss was observed for the crystal which was not covering the whole ampoule during growth compared to the crystal which was covering the inner diameter of the ampoule. But still lower dielectric constant value and higher dielectric loss was observed for conventional method grown crystal. The dielectric loss was
less in SR method grown crystal as against conventional method grown crystal. In thermal analysis, the starting of decomposition at 185°C is similar in SR method grown KDP crystal and conventional method grown crystal. The SR method grown KDP has higher transmittance and higher hardness value compared to conventional method grown crystals.

The bulk single crystal of <101> KDP with the dimension of 30 mm diameter and 55 mm length has been grown successfully by SR method. The transmittance, hardness, dielectric and etching studies were carried out for SR method grown KDP and conventional method grown KDP single crystals. The results are compared. The higher transmittance, higher microhardness value, higher dielectric constant, less dielectric loss and less EPD shows that the SR method grown crystal has better quality than conventional method grown crystal.

The dimension of the bulk KDP crystals grown by SR method using 5M% KCl is 15 mm diameter, 95 mm height. Addition of 5M% KCl in the bulk growth medium is found to suppress the metal ion impurities to a large extent and increase the growth rate. The additive KCl blocks the metal ions from entering into the crystal lattice and thus avoiding the chain structure, which enhances the crystalline quality. The SR method grown crystal is found to have excellent crystal quality as determined by transmittance, microhardness and dielectric studies.

### 6.2 SUGGESTIONS FOR FUTURE WORK

Mixed crystals of KDP–ADP have attracted considerable attention because of their potential applications in quantum electronics and optoelectronics. The KDP and ADP mixed crystals were grown with different weight percentage using conventional method. This mixed bulk KDP-ADP crystals can be grown with different weight percentage using suitable
orientation by SR method. It has been found that additives have an important role in improving the qualities of KDP crystal and the effect on the adjustment of growth habits. The role of additives such as EDTA, Amino acids on quality and growth rate of KDP crystal grown in conventional method has been studied. The effect of same additives on KDP crystal grown in SR method can be tried. Also the effect of additives on the growth of the KDP-ADP mixed crystals can be tried in SR method. The ways for enhancement of growth rate of KDP in SR method can be found keeping in view the potential application of the material. The unidirectional KDP single crystals of height 110 mm were grown. Efforts can be made to grow larger size KDP single crystal with good optical quality.

Efforts can be made for the growth of negative and zero solubility coefficient materials in SR method. Taking suitable materials, crystal growth from high temperature solution growth (flux growth) can be explored by SR method.