CHAPTER- 5

UV- VISIBLE AND SECOND HARMONIC GENERATION STUDIES

5.1 Introduction

Single crystals plays very important role in the optical communication as well as device applications in connection with light pulses. It is very much essential to know the optical transmittance range and non linear optical behavior. These factors determine the suitability of the grown crystals for optical applications. This chapter deals with the UV-Visible spectroscopic studies of the pure and K⁺, Na⁺ and Zn²⁺ ions doped LACC crystals and also the second harmonic generation efficiency of all the grown crystals.

5.2 UV- Visible Spectroscopic Studies.

To determine the optical transmittance range and hence to know the suitability of pure and K⁺, Na⁺ and Zn²⁺ ions doped LACC crystals for optical applications, the UV-VIS–NIR transmittance/absorbance spectrum were recorded with a Varian Cary 100 Bio UV- VIS spectrophotometer in the range 200-800 nm and 200 -1200 nm. The recorded spectra (transmittance/absorbance) of pure and K⁺, Na⁺ and Zn²⁺ ions doped LACC crystals are displayed in figures 5.1 to 5.4.
Fig. 5.1: UV-Visible transmittance spectra of pure LACC single crystals.
Fig. 5.2: UV-Visible absorption spectra of potassium chloride (2 & 4 mole %) doped LACC single crystals.
Fig. 5.3: UV-Visible absorption spectra of sodium chloride (2\% & 4 mole \%) doped LACC single crystals.
Fig. 5.4: UV-Visible absorption spectra of zinc chloride (1 & 3 mole %) doped LACC single crystals.

From the above figures it was noticed that all the grown crystals show there was no significant absorption in the entire UV-Visible range. This is the advantage of using the amino acids, where the absence of strongly conjugated bonds leads to wider transparency.
in the visible and UV spectral regions [172]. The lower cut at 200 nm along with good optical transparency enhances the usefulness of LACC for optoelectronic applications and it is an essential parameter for NLO applications. The lower cut-off wavelength of the pure and K⁺, Na⁺ and Zn²⁺ ions doped LACC crystals are almost same. The forbidden energy gap of the grown crystals are calculated using the relation \( E_g = \frac{hc}{\lambda} \).

Where, \( h \) - is the plank's constant

\( c \) - is the velocity of light

and \( \lambda \) - is the cut-off wavelength

In the present study the obtained value of \( E_g = 5.87 \) eV. This indicates that all the grown crystals are insulators. Again it was noticed that the optical transmittance of all the grown crystals (pure and K⁺, Na⁺ and Zn²⁺ ions doped LACC crystals) almost same. Which indicates that the type of dopants the concentration of dopants in the present study didn’t affect or change the optical transmittance of the crystals in the entire UV-Visible region.

5.3. Second Harmonic Generation Measurement Studies

The powder SHG measurements for the pure and K⁺, Na⁺ and Zn²⁺ ions doped LACC crystals were performed using the Kurtz and Perry powder technique [202]. The finely powdered sample was densely packed between two transparent glass slides. A fundamental laser beam of 1064 nm wavelength (8 ns pulse width with 10 Hz pulse rate) from an Nd-YAG LASER was made to fall normally on the sample cell. The power of the incident beam was measured using a power meter. The input LASER energy incident on
the capillary tube was 4.3 mJ /5.3 mJ per pulse, an energy level optimized not to cause any chemical decomposition in the sample. The KDP crystal was used as the reference material in the SHG measurement.

The NLO property of the crystal was confirmed by the Kurtz and Perry powder technique. The transmitted fundamental wave was passed over a monochromator which separates 532 nm (second harmonic signal) from 1064 nm and absorbed by a CuSO₄ solution which removes the 1064 nm light. The green light was detected by a photomultiplier tube and displayed on a storage oscilloscope. The powder SHG efficiency of the crystal is compared with KDP and the results are given in Table 5.1.

Table 5.1: Relative SHG efficiency of the pure and K⁺, Na⁺ and Zn²⁺ ions doped LACC crystals

<table>
<thead>
<tr>
<th>sample</th>
<th>SHG efficiency (x times of KDP)</th>
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<tbody>
<tr>
<td>Pure LACC</td>
<td>0.57</td>
</tr>
<tr>
<td>LACC + 2 mole % KCl</td>
<td>0.514</td>
</tr>
<tr>
<td>LACC + 4 mole % KCl</td>
<td>0.50</td>
</tr>
<tr>
<td>LACC + 2 mole % NaCl</td>
<td>0.47</td>
</tr>
<tr>
<td>LACC + 4 mole % NaCl</td>
<td>0.352</td>
</tr>
<tr>
<td>LACC + 1 mole % ZnCl₂</td>
<td>0.94</td>
</tr>
<tr>
<td>LACC + 3 mole % ZnCl₂</td>
<td>1.706</td>
</tr>
</tbody>
</table>
Form the table 5.1 it was noticed that the SHG efficiency of the pure LACC is very much changed by the dopants as well as the doping concentration. When we dope the higher ionic radii $K^+$ ions and the almost equal ionic radii $Na^+$ ions the SHG efficiency of the material is less than that of pure LACC, but when the smaller ionic radii $Zn^{2+}$ ions are doped with pure LACC the SHG efficiency of the material is increased significantly with respect to the doping concentration. This is due to the change in the the polarizability of the metal ions present in the material. The polarizability of the smaller ionic radii $Zn^{2+}$ ions are very much greater than that of the $K^+$ and $Na^+$ ions. Thus the SHG efficiency of the $Zn^{2+}$ ions doped LACC crystals possess high second harmonic generation efficiency and hence it can be used as an efficient frequency conversion material.