CHAPTER 7

SUMMARY AND SUGGESTIONS FOR FUTURE WORK

7.1 SUMMARY

The improved methodology has been identified for the growth of organic molecular crystals. The growth conditions are surveyed for the growth of organic molecular crystals and single crystals of anthracene and stilbene were successfully grown. Two modified techniques have been adopted for the growth of anthracene and stilbene single crystals.

Analysis of the grown crystals using various characterization tools reveals that the crystals grown by improved methodology, Selective Self-Seeding Vertical Bridgman Technique (SSVBT) and Double Run Selective Self-Seeding Vertical Bridgman Technique (DRSSVBT) for stilbene and anthracene have yielded good quality crystals. Scintillation timing resolution studies also show better improvement in the detection characteristics of the grown crystal with improved growth methodology.

Raman spectroscopic studies reveal that improved methodology grown crystals are of good quality. X-ray rocking studies and optical microscopic observations on the crystals show that they are devoid of defects. The results of Raman spectroscopic studies on the grown trans-stilbene give the idea that it can be used in dosimeter applications.

To understand the scintillation phenomena the timing resolution and energy resolution studies have been carried out. The results obtained indicate that the crystals grown by SSVBT and DRSSVBT are of better quality. Gamma energy response and timing response for radioactive sources has been carried out. Energy and time
response of stilbene to high-energy proton of energy 5 MeV to 25 MeV has been done for the first time in literature. With well-calibrated detector electronics the energy response of stilbene to proton energy ranging from 5 MeV to 25 Mev is linear, which is contrary to the theoretical prediction of Papadopoluos. The rise time response of stilbene to high-energy proton is also contradictory to the theoretical prediction of Papodopoulos. Rise time spectroscopy in stilbene offers a new means of investigating nuclear phenomena. With improved timing capabilities of available photomultipliers, the zero crossing method has been extended not only to identify a whole range of radiations including heavy ions, but also in the spectroscopy of these radiations. When radiations such as gammas, neutrons, alphas and fission fragments have different rise times, they can be resolved in the rise time spectrum. For a given type of radiation, the rise time is sensitive to the variation of dE/dx with the energy of the radiation. The time resolution and rise time shift on the energy of the radiation helps in energy and time spectroscopy of the particles for high energies. The pulse height and rise time spectroscopy of stilbene offers an idea that this scintillation set-up will be helpful in the particle physics experiments for particle identification and spectroscopy.

Phase transition studies using 2D-ACP AR technique have been done for the grown stilbene crystals for the first time in literature. Distinct changes in EMD of the grown crystal at 210K and 110K were observed and this indicates the phase transition of the grown crystal.

7.2 SUGESTIONS FOR FUTURE WORK

Thermoluminescence studies and Ionoluminescence studies will be useful in understanding the defects and scintillation phenomena of these molecular crystals. Electron donor additive mixed crystals and doped crystals with these pure molecular materials can be grown and the improvement in the fluorescence can be studied. Low temperature phase transition studies can be carried out using DSC and Raman spectroscopy. Detection response of the crystal at low temperature can be carried out.
Apart from scintillation properties, electrical properties of these crystals and changes in the conductivity can be studied with impurity addition. X-ray topographic studies will give finer details about the defect distribution of the grown crystals. Directional anisotropic scintillation response to high-energy protons can be done. DRSSVBT technique can also be used to grow crystals, which have phase transition between freezing temperature to room temperature. Still larger size crystals can be tried with the two modified techniques SSVBT and DRSSVBT, which can be used in coupling with large size PMTS to cover more solid angle in the nuclear experiments. Position sensitive scintillation response studies and calibration of these crystals will be more helpful in angular correlation studies which is used in atomic and particle physics studies. Cone angles variation, capillary tube inclination with vertical axis and its effect on the growth of other crystals which can be grown by melt technique like naphthalene, benzophenone, p-nitroaniline, biphenyl, p-terphenyl, phenanthrene, benzil, m-nitroaniline, adamantane, crysene, urea etc., can be studied.

The scintillation materials listed by Sangster (1956) apart from the materials studied in this dissertation can be grown as single crystals and the scintillation properties can be studied. Scintillation rise time and energy response experiments beyond 25 MeV of protons and alpha up to 200MeV can be done. The theoretical explanation accounting the scintillation response and timing response can be attempted for the experiments narrated in chapter 5. In the theoretical explanation fluorescence lifetime and fluorescence intensity variation for different particles can be included. Energy and time response of these crystals to electron can also be done using microtron.

Similar pulse shape studies can be done for CsI (TI) crystals which is good pulse shape discriminator for high energy protons. The lattice destruction and degradation pulse with respect to fluence will be more useful for using this crystal in particle detection.
Positron 2d-ACAR studies can be done for the aromatic family crystals, which have more attached benzene rings and electron momentum distribution at different planes can be extracted. Theoretical explanation can be attempted for the extracted electron momentum for stilbene shown in Chapter 6.