Chapter 8

SUMMARY AND SCOPE OF FUTURE STUDIES

Properly designed fourteen chalcone derivatives were synthesized using green chemistry and characterized to know their structure and electronic characteristics. Most of them have nonlinear optical activity, disclosed by open aperture z-scan studies. Among these chalcones a series of *(E)-1-(4-substitutedphenyl)-3-(4-hydroxy-3-nitrophenyl)prop-2-en-1-one* exhibited uncommon excitation-dependent emission. This phenomenon of EDF was attributed to the presence of closely spaced energy levels and energetically different associated forms of the molecules and slow rate of the excited state relaxation process in the solvent system. EDF of small size chalcones is quite useful in the field of chemical biology for visualizing biologically active small compounds and studying their mechanism by introducing fluorophores. Studies on cytotoxicity and fluorescence bioimaging are necessary to confirm their promised activity so research work could be carried out in this direction to explore its applicability. Moreover, in this series of four chalcones, the nonlinear absorption coefficient exponentially increases with phonon characteristic energies and the role of a phonon in the origin of nonlinear absorption was also established. So, they can be considered for designing suitable optical devices for optoelectronic applications. Few chalcones were chosen, with different functional groups in a different position of ring A and ring B, to synthesize their corresponding hydrazones. All of them were characterized and exhibited fluorescence as well as NLO property. A structure-property relation was drawn and the position of functional group was considered to be very crucial to get higher NLA. For e.g. the compound *(E)-1-((E)-3-(4-chlorophenyl)-1-phenylallylidene)-2-(2,4-dinitrophenyl)hydrazine* showed very high two-photon absorption coefficient of 6.65 cm/GW.

A series consisting of eight chalcones with the heterocyclic core in the skeleton have been synthesized. The compounds exhibited luminescence when excited with UV radiation at their absorption maximum, along with NLO property, *(E)-3-(naphthalen-2-yl)-1-(pyridin-4-yl)prop-2-en-1-one* **(NPY)** have aggregation signature in its luminescence spectra which in turn lowered its NLO activity. But because of saturable absorption, **NPY** could be used in many laser applications. The presence of the heterocyclic ring at the beta-carbon of the carbonyl moiety

enhances the ß value, which gets further enhanced with the suitable group at the carbonyl side.

A total of twenty six chalcones with the fused-ring core in the chalcone skeleton (11 naphthalene based and 15 anthracene-based compounds) have been synthesized. In most of the NLO chromophore, the planar π-systems have been used as core bridge and end capped with donor or acceptor groups. But in this work, enone moiety of chalcone was used as bridge and π-systems of naphthalene and anthracene as end groups. The linear optical properties of naphthalene fused chalcones proved that substituting ring B of chalcone brings a bathochromic shift in the absorption spectra.

Among the numerous application of NLO, few are high capacity data storage, three-dimensional microfabrication, biological imaging, photodynamic therapy, and frequency upconverted lasing. To find the rational significance of the synthesized chalcones, UCPL studies were also investigated. Interestingly six *(E)-1-(4-substitutedphenyl)-3-(4/2-methoxynaphthalen-1-yl)prop-2-en-1-one* chalcone derivatives exhibited blue upconverted photoluminescence but the **(***E)-1-(4-substitutedphenyl)-3-(naphthalen-1-yl)prop-2-en-1-one* derivatives did not have any UCPL properties**.** Preliminary studies revealed that three-photon absorption is the origin of its blue emission. 2PE microscopy increases the cell viability by using an optimal excitation wavelength. These chalcones could be used in fluorescence microscopy for the analysis of biological systems. It is advantageous over one-photon excitation techniques as with infrared light excitation, much stronger single-photon absorption of the fluorophore can be avoided and light scattering by the cell content gets reduced.

The structure-property relationship between anthracenyl chalcone derivatives and observed two-photon absorption coefficient was outlined. The *cis* isomer was more efficient NLO chromophore than the *trans* isomer at 532 nm laser wavelength. The centroid to centroid distance was less than $6A^0$ and that's why stacking interaction was present which added up to the NLA and expressed in

open aperture z-scan studies for the *cis* isomer chalcone (**ANMeCl** and **ANMeBr**) single crystals.

In the series of five *(2E,2'E,2''E)-3,3',3''-(nitrilotris(benzene-4,1-diyl))tris(1-(4-substitutedphenyl)prop-2-en-1-one)* derivatives, four of them have upconversion photoluminescence properties at near IR region of 990 nm, up-converted to 500 nm region. The wavelength dependent emission, laser power dependence intensity, cytotoxicity and two-photon excitation fluorescence microscopy is under investigation. The primary motive would be biological imaging and their potential use in solar cells. Trigonally branched chalcones with triphenylamine core have not been explored as 2PA chromophores or its fluorescence bioimaging behavior. Research work is being carried out in that direction. Further research work is being carried in that direction.