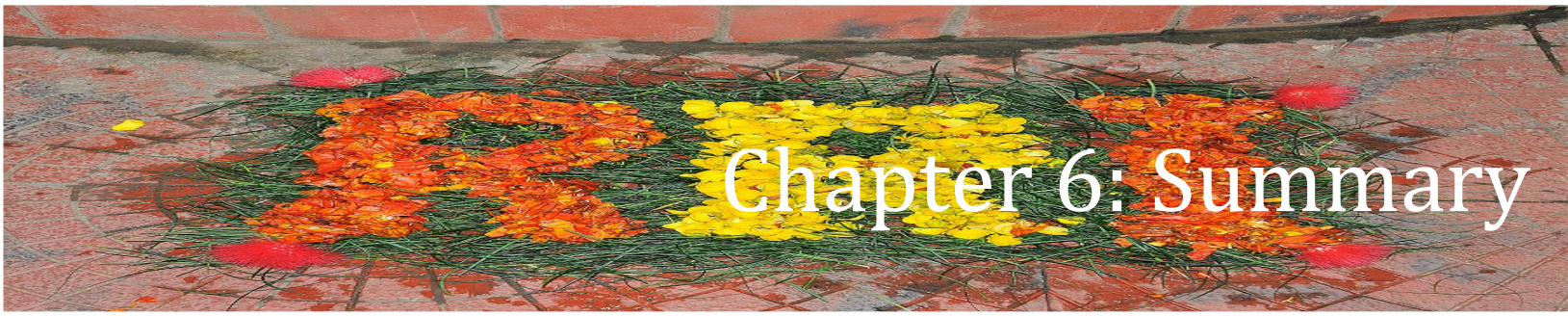

Chapter 6: Summary

In this chapter, I summarize some of the important results and conclusions derived from this thesis work, which deals with **"Synthesis and Characterization of Some Non-conventional Discotic Liquid Crystals"**. I briefly discuss the possibilities and scope for future work based on the results obtained from our experimental work. Broadly, the research work that has been reported in this thesis can be classified as follows:

Chapter 1 (**"Introduction"**) is an introductory chapter and mainly deals with the physical properties of discotic liquid crystals, making them ideal candidates for various optical and electronic devices such as photocopiers, laser printers, photovoltaic cells, light-emitting diodes, field effect transistors, and holographic data storage. Beginning with an overview of liquid crystals, this chapter mainly focuses the major classes of nematic and columnar mesophases formed by discotic mesogens, their efficient and elegant synthetic procedures, relevant mesomorphic and physical properties, photo and electrical conductivity, macroscopic alignment of columnar phases and finally, some applications and perspectives in materials science and molecular electronics.

Though the introduction to liquid crystals is little bit roomy, nevertheless, while reflecting the author's familiarity and awareness about many aspects of the research field it is hoped to provoke the readers to appreciate that pursuing a degree in this young, fascinating and fast developing research field is worthwhile given the potential of the materials as organic semiconductors in contemporary research.

Chapter 2 (**"Novel Benzene-Bridged Triphenylene-Based Discotic Dyads"**) describes non-conventional approach to the synthesis of liquid crystalline materials. Here, we have adopted two main themes of dimer preparation; one is the effect of *flexible-rigid*-mixed spacer and the other is relative orientation of mesogenic groups on the mesomorphic properties. The length of methylene spacer and the type of linkage group has also been varied in order to examine the structure–property relationships. Flexibility of methylene spacer gets

disturbed due to the insertion of benzene ring in the spacer and finally stacking of triphenylene cores become difficult. As a consequence of the above phenomenon these *dimers* were non-mesomorphic but on doping with TNF, an electron acceptor, they gave a hexagonal columnar phase with distinct optical texture, which was further confirmed by X-ray diffraction.

Chapter 3 (**"Synthesis and Characterization of Discotic Liquid Crystalline Gemini Amphiphiles"**) addresses the chemistry and physical properties of novel triphenylene-imidazole based ionic discotic liquid crystalline gemini dimers. This chapter has been divided into two sections. The first portion deals with the first examples of discotic liquid crystalline gemini amphiphiles. This discusses microwave-assisted synthesis of imidazolium-based ionic liquid crystalline dimers based on triphenylene-imidazole-imidazole-triphenylene moieties. The second portion describes novel triphenylene-ammonium-based ionic discotic liquid crystalline gemini amphiphiles which consists of triphenylene-ammonium-ammonium-triphenylene moieties. Ionic discotic gemini, having order and electronic properties of discotic liquid crystals and ion conduction property of ionic liquids, might be very useful for unidirectional transport of ion and energy at nanoscale.

Chapter 4 (**"Discotic Liquid Crystalline Donor-Acceptor-Donor Systems: Synthesis of Novel Triphenylene-Anthraquinone-Triphenylene Triads"**) talks about the first example of donor-acceptor-donor triads in which all the three components represent discotic mesogenic moiety. This presents microwave-assisted facile synthesis of novel triphenylene-anthraquinone-triphenylene-based symmetrical discotic trimers. Here we report the synthesis and characterization of two series of trimeric molecules in which two electron rich triphenylene moieties are attached to a central electron deficient anthraquinone discotic core *via* flexible alkyl spacers. The length of methylene spacer is varied for these two series. Within each series the length of peripheral alkyl chain around anthraquinone core has been varied. It may be noted that the etherification of H-bonded, sterically hindered hydroxyl groups of tetraalkoxy-rufigallol with bulky ω-bromo-substituted triphenylenes failed to produce the desired tri-mesogens under classical thermal reaction conditions. X-ray diffraction experiment, polarizing optical microscopy and differential scanning calorimetry

proved the occurrence of hexagonal columnar phase over a wide range of temperature. Longer spacer length, smaller peripheral alkyl chain length and branching in peripheral alkyl chain of anthraquinone are in favor of liquid crystalline property in these symmetrical trimers. Absence of peripheral alkyl chain around the anthraquinone periphery resulted in failure of mesomorphism. Any one or more than one concurrent following changes might result in formation of super-lattice or molecular double cable.

a. Type of peripheral alkyl chain around anthraquinone
b. Replacement of less electron deficient anthraquinone core with more electron poor core.
c. Type of peripheral alkyl chain around triphenylene
d. Change in the number of attached triphenylene ring per anthraquinone core.

Chapter 5 (**"Novel Imidazole-fused Triphenylene Discotics"**) discusses expansion of triphenylene ring by fusion with imidazole nucleus. Effort has been made to notice the effect of expansion of triphenylene ring, number of peripheral alkyl chains on mesophase behavior of unsymmetrically expanded triphenylene disk. The chemical structures of imidazole-fused triphenylene compounds were confirmed by ^{1}H NMR, MS, UV spectroscopy and elemental analysis. The thermal and mesophase behavior of these mesogens was investigated by polarizing optical microscopy, differential scanning calorimetry and X-ray diffractometry. Both discotic mesogens exhibit columnar phase over a very broad range of temperature. We see that introduction of asymmetry and expansion of conjugated aromatic core of the triphenylene ring by fusion with imidazole nucleus results in widening of liquid crystalline range as well as increment in conductivity values. It has been observed that with increase in the number of peripheral alkyl chains, the phase transition temperature and mesophase structure of unsymmetrical triphenylene-imidazole ring is not affected too much but there was an increase in the intercolumnar distance on increasing the number of peripheral alkyl chains.

As final conclusions, it may be affirmed that the thesis deals with the synthesis and characterization of mesogenic materials varying from archetypal triphenylenes and their dimers to triphenylene-anthraquinone-triphenylene based trimers and materials for organic electronics, using traditional as well as modern synthetic methods. The thesis work spans

across monomeric to trimeric discotic liquid crystals via asymmetrically expanded discotics, pure liquid crystalline compounds and composites, liquid crystals with conventional and unconventional mesophase structures and room-temperature discotic liquid crystals with broad mesophase range and single mesophase structure with different electronic (electron rich or p-type and electron deficient or n-type) properties.

Some of the findings of this thesis have been published/communicated in the following international journals.

1. Novel Benzene-Bridged Triphenylene-Based Discotic Dyads,

   J. Phys. Chem. B, 113, 12887, **2009**.

   Satyam Kumar Gupta, V. A. Raghunathan, V. Lakshminarayanan, and Sandeep Kumar.

2. Microwave-assisted facile synthesis of discotic liquid crystalline symmetrical donor–acceptor–donor triads,

   New J. Chem., 33, 112, **2009**.

   Satyam Kumar Gupta, V. A. Raghunathan and Sandeep Kumar.

3. **Popular article**

   Hot Article: **Microwaves only for novel discotic LC trimers [NJC News]**

   Satyam Kumar Gupta, V. A. Raghunathan, Sandeep Kumar,

   New J. Chem., **2008**.

http://www.njc.cnrs.fr/spip.php?article157

DOI : 10.1039/b808750d

4. The first examples of discotic liquid crystalline gemini surfactants,

   Tetrahedron Letters 51, 5459, **2010**.

   Sandeep Kumar , **Satyam Kumar Gupta**.

5. Stress-strain relation in the collapse of Langmuir monolayer of a dimer of disk shaped moiety,

   The Journal of Chemical Physics 133, 044701, **2010**.

   Bharat Kumar, K. A. Suresh, **Satyam K. Gupta** and Sandeep Kumar.

6. Synthesis and chemistry of triphenylene-ammonium-ammonium-triphenylene diads,

   Satyam Kumar Gupta and Sandeep Kumar.

   Manuscript under preparation.

7. Novel imidazole-fused triphenylene discotics,

   Satyam Kumar Gupta and Sandeep Kumar.

   Manuscript under preparation.