

**Development and Study of Liquid Crystal Composites
with Organic and Inorganic Functional Dopants for
Electro-optic and Sensing Applications**

DEEPAK VERMA



DEPARTMENT OF PHYSICS

INDIAN INSTITUTE OF TECHNOLOGY DELHI

MAY 2026

© Indian Institute of Technology Delhi (IITD), New Delhi, 2026

**Development and Study of Liquid Crystal Composites
with Organic and Inorganic Functional Dopants for
Electro-optic and Sensing Applications**

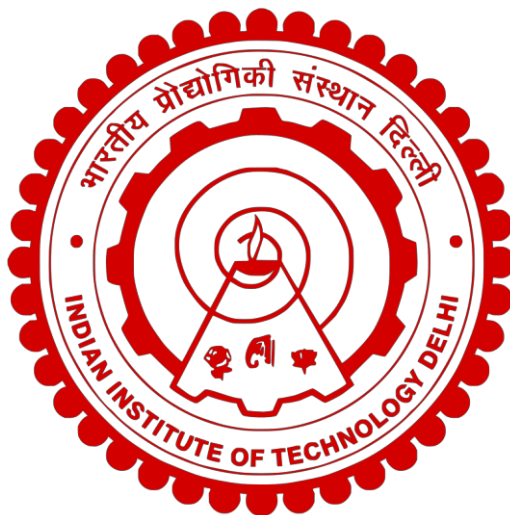
by

DEEPAK VERMA

Department of Physics

submitted

*in fulfillment of the requirements of the degree of Doctor of Philosophy
to the*



INDIAN INSTITUTE OF TECHNOLOGY DELHI

MAY 2026

Dedicated to my Parents and Science

CERTIFICATE

This is to certify that the thesis entitled, “**Development and Study of Liquid Crystal Composites with Organic and Inorganic Functional Dopants for Electro-optic and Sensing Applications,**” being submitted by **Mr. Deepak Verma** to the Indian Institute of Technology Delhi for the award of the degree of Doctor of Philosophy is a record of bonafide research work carried out by him. He has worked under my supervision and guidance and has fulfilled the requirements for the submission of this thesis, which, to the best of my knowledge, has reached the requisite standard.

The contents contained in this thesis have not been submitted in part or in full to any other university or institute for the award of any degree or diploma.

Prof. Aloka Sinha

Department of Physics

Indian Institute of Technology Delhi

Hauz-Khas, New Delhi-110016

ACKNOWLEDGEMENTS

I express my sincere and heartfelt gratitude to my supervisor, Prof. Aloka Sinha, for giving me the opportunity to join her laboratory and for introducing me to scientific research. From initiating my first experiment to guiding me through complex research problems, she has been a constant source of support and inspiration. I am deeply thankful to her for teaching me every aspect of research, including experimental design, procurement of chemicals, setting up new experimental setups, manuscript writing, paper submission, addressing reviewers' comments, and preparing a detailed research plan for securing DST fellowship approval. Her timely guidance, insightful suggestions, and encouragement helped me overcome many challenges and complete this work successfully. I am especially grateful for her support during difficult times, for facilitating collaborations, standing by me when I needed help, and motivating me to maintain both scientific rigor and personal well-being. Her mentorship has not only shaped this thesis but has also played a vital role in my growth as an independent researcher.

Apart from my thesis supervisor, I would like to express my sincere gratitude to the members of my research committee, Prof. Neeraj Khare (Department of Physics, IIT Delhi), Prof. Deepak Kumar (Department of Physics, IIT Delhi), and Prof. Josemon Jacob (Department of Materials Science and Engineering, IIT Delhi) for their valuable time, insightful suggestions, and continued encouragement throughout the progress of my research.

I sincerely acknowledge our scientific collaborators, Dr. Vidhika Punjani and Dr. Golam Mohiuddin, for providing the bent-core sample for this work. I am also grateful to Prof. V. Haridas and his Ph.D. students, Govind Prasad Maurya, Mr. Sagar Jawla, and Mr. Surya Kant Bhardwaj, for providing the AIE chiral dopant, sensing chiral dopant, and gelator compound for this work. I thank Mr. Sagar Jawla and Mr. Surya Kant Bhardwaj for their active involvement in experimental planning, device design, and insightful discussions that significantly contributed to the progress of this research.

I gratefully acknowledge the Nanoscale Research Facility (NRF), Central Research Facility (CRF), IIT Delhi, Departments of Physics and Chemistry, IIT Delhi, for providing the instrumental and characterization facilities essential for this work. I sincerely thank AIRF (JNU Campus) for access to the circular dichroism (CD) measurement facility. I sincerely thank Prof. Divesh Bhatia and his student, Mr. Prateek (Department of Chemical Engineering, IIT Delhi), for their help with the wet milling of nanoparticles. I am thankful to Prof. Jatish Kumar (IISER

Tirupati) and his student Ms. Sreelaxmi T.N. for providing access and helping in the CPL measurements. I also acknowledge Mr. Akshay Bedwal (Ph.D. student at the Department of Chemistry, IIT Delhi) for the help in the synthesis of polymer nanoparticles (PNPs) used in this work.

I gratefully acknowledge the Department of Science and Technology (DST), Government of India, for financial support through the INSPIRE Fellowship (IF190082), and IIT Delhi for providing institutional support and facilities that enabled the successful completion of this research.

I would like to express my thanks to all my lab mates: Dr. Susanta Chakraborty, Dr. Amina Nafees, Dr. Sourav Patranabish, Dr. Asha Kumari, Dr. Aysha Rani, Dr. Rahul Panchal, Dr. Shilpi Bose, Dr. Vaibhav Sharma, Mr. Dhananjay Mandal, Mr. Kaustav Jit Bora, Mr. Debasish Bag, Mr. Rohit Shimpi, Mr. Aman Mishra, Ms. Akriti, and Mr. Deepak Kararwal. Their constant support, cooperation, and assistance in both experimental and non-experimental work have been invaluable throughout my research journey and greatly contributed to the successful completion of this thesis.

I would like to express my sincere gratitude to my friends at IIT Delhi, Mr. Sagar Jawla, Mr. Suryakant Bhardwaj, Dr. Amit Mondal, and my friends at IISER Mohali, Dr. Madhusudan Maity and Ms. Anshika Baghla, who became an important part of my life during the later phase of my Ph.D. Their presence brought a real turning point in my doctoral journey. Through thoughtful scientific discussions, constant encouragement, and emotional support, they helped me overcome both research challenges and personal difficulties. Despite their own demanding work, they always made time for me with genuine care and selflessness, which I will always deeply appreciate.

I also sincerely thank my friends outside the IIT Delhi, Mr. Abhishek Vats, Mr. Harpreet Dhull, Mr. Naval Gurjar, Mr. Akshay Kumar, Mr. Umesh Attal, Mr. Ajay Khandelwal, Mr. Sunny Sharma, Mr. Rupesh Goyal, Mr. Bhim Saharan and Ms. Garima, who, despite being physically distant, always stood by me with their constant encouragement, care, and unseen support.

I would also like to express my special thanks to my friends in nature: dogs, cats, sparrows, crows, and squirrels, whose quiet presence and gentle companionship brought comfort and calm during this journey. This connection with nature helped me maintain a positive mindset, emotional balance, and overall well-being, especially during challenging times.

My thesis would be incomplete without expressing my deepest gratitude to my family. I am profoundly thankful to my late grandmother, Smt. Basanti Devi and my late grandfather, Shri Phool Singh, whose blessings and values have always guided me. I am especially grateful to my parents, Smt. Usha Rani and Shri Rajender Verma, for their unconditional love, constant encouragement, and unwavering faith in me. I also thank my brother Praveen, my Bhabhi Ankita, and my sisters Monika and Payal. My heartfelt thanks also go to my nephew and niece, Harshit and Bhavi, and my bhaanjis, Saumya, Kunjal, and Prisha, whose affection and warmth brought joy and motivation into my life. I am deeply grateful to my entire family for their prayers, care, and moral support, without which this achievement would not have been possible.

May 2026

New Delhi

Deepak Verma

ABSTRACT

Liquid crystals (LCs) exhibit a unique combination of fluidity and long-range molecular order. This gives rise to anisotropic optical, dielectric, and electro-optic properties that are widely exploited in displays, photonic devices, and sensing technologies. However, the inherent physical properties of conventional LCs often limit their performance in applications requiring faster electro-optic response, higher photoluminescence, enhanced optical modulation, higher environmental stability, and sensitive chemical detection. A powerful strategy to overcome these limitations is their integration with the functional organic and inorganic dopants, which can enable precise modulation of dielectric, electro-optic, ionic, photophysical, chiro-optic, and sensing properties. This thesis focuses on the systematic design and development of functional LC composites through the incorporation of ferroelectric nanoparticles (NPs), conjugated polymer NPs, aggregation-induced emission (AIE) active chiral dopants, pseudopeptide gelators, and protonatable chiral molecules, aiming to realize tunable electro-optic, photoluminescent, smart window, and gas-sensing devices.

Chapter one introduces LC materials and their classification based on molecular shape and the physical mechanisms governing phase transitions in LC systems. The LC phases employed in this thesis and their molecular organization are described. The important physical properties of LCs are briefly discussed. The concept and significance of LC composites are then presented, highlighting how the incorporation of functional dopants enables modulation of LC properties. The roles of NPs, AIE-active and sensing chiral dopants, and supramolecular gelators in tailoring the performance of LC and development of electro-optic and sensing devices are also outlined, providing the scientific framework for the studies undertaken in this thesis.

Chapter two describes the procedures for sample preparation, LC composite preparation, and device setups used in this thesis. It includes the synthesis of polymer NPs, preparation of LC-composites, fabrication of unaligned, homogeneous, and homeotropic LC cells, and the preparation of substrates for HCl sensing. The chapter also outlines the experimental techniques and measurement setups employed to study phase transitions, optical, electrical, dielectric, electro-optic, ionic, selective reflection, chiro-optic, rheological, and structural properties of the LC composites. Finally, the methods used for error analysis are briefly discussed to ensure the reliability and accuracy of the reported results.

Chapter three of this work investigates the influence of ferroelectric BaTiO₃ NPs of two different

size ranges (5-15 nm and 50-70 nm) on the dielectric, electro-optic, and ionic properties of an antiferroelectric bent-core LC. The incorporation of BaTiO₃ NPs lowers the phase transition temperatures and modifies the dielectric relaxation behavior of the antiferroelectric SmA phase. The spontaneous polarization decreases from 71 nC/cm² for the pure LC to 48 nC/cm² and 61 nC/cm² for the smaller NPs (5-15 nm) doped LC and larger NPs (50-70 nm) doped LC, respectively, indicating antiparallel dipole-dipole correlations between the ferroelectric NPs and LC molecules. A reduction in response time of approximately 7.1% for the smaller-sized NPs (5-15 nm) doped LC and 30.7% for the larger-sized NPs (50-70 nm) doped LC demonstrates enhanced electro-optic switching performance. Furthermore, direct current conductivity increases by nearly 3.2-fold and 1.6-fold for the smaller (5-15 nm) and larger size (50-70 nm) NPs doped LC, respectively. The smaller-sized NPs additionally reduce ionic contamination by about 16%, suggesting their ion-capturing capability. These findings reveal that both NPs' size and ferroelectricity strongly influence the electro-optic and ion-transport properties of bent-core LC, making them promising candidates for fast-switching electro-optic applications.

Chapter four explores the role of conjugated polymer NPs (PNPs) based on poly(3-hexylthiophene) (P3HT) derivatives in tuning the ionic properties of nematic LC and stabilizing blue-phase LC (BPLC). PNPs with an average size of 15.5 nm, incorporated at concentrations of 0.01 and 0.1 wt.% in 5CB LC, significantly enhance ions' transport properties. Nearly two orders of magnitude increase in direct current conductivity and ion diffusion coefficient, while the mobile ion concentration increases by only ~1.5-fold. These results indicate enhanced ion transport in the nematic host due to the intrinsically conducting nature of the PNPs. Furthermore, incorporation of smaller-sized PNPs (~5 nm) into BPLC at optimized concentrations of 0.005 and 0.01 wt.% gives a phase stabilization effect, with a maximum BP range enhancement of approximately 3 °C observed for the 0.005 wt.% concentration. The electro-optic performance is markedly improved, with hysteresis reduced from 70% to 0.1% and residual birefringence decreased from 2.9% to 0.1%. In addition, at 0.01 wt.% concentration of PNPs, nearly 70% of enhancement in photoluminescence intensity is observed. These findings demonstrate that conjugated PNPs effectively improve ionic transport, thermal stability, electro-optic response, and luminescence characteristics of LC systems, highlighting their potential for advanced photonic and display applications.

Chapter five focuses on the development of tunable luminescent LC systems through the incorporation of a pseudopeptide-based AIE-active chiral dopant into nematic and smectic-A LC hosts. Polarized optical microscopy and circular dichroism spectroscopy confirm efficient

chirality transfer and the formation of a helical cholesteric (N*) phase, whereas the induced smectic-A* phase does not exhibit helical organization. Temperature-dependent photoluminescence studies reveal a strong influence of LC ordering on the AIE characteristics. Circularly polarized luminescence (CPL) is observed in the N* phase, where supramolecular helical ordering and AIE coexist, yielding a maximum luminescence dissymmetry factor (g_{lum}) of 0.071 in the doped 5CB LC. In comparison, the self-assembled chiral aggregate of the dopant in 90% H₂O/DMSO mixture exhibits comparatively lower g_{lum} value of -0.0025, highlighting the role of the LC helical environment in amplifying CPL. The electrically switchable N* LC displays distinct states with haze values of ~45%, ~4%, and ~2% for planar, focal-conic, and homeotropic states, respectively, demonstrating efficient voltage-controlled light modulation for smart-window applications. Furthermore, nearly threefold enhancement in photoluminescence intensity is observed in the focal-conic state, while the induced SmA* phase exhibits approximately 80% higher photoluminescence intensity compared to the N* phase in the doped LC. These multifunctional LC composites therefore provide a platform for CPL, electrically tunable smart windows, and luminescent photonic devices.

Chapter six demonstrates the development of nematic and N* LC physical gels using a pseudopeptide-based gelator capable of forming fibrous supramolecular assemblies for smart-window applications. The gel morphology, viscoelastic response, and electro-optic properties are found to be strongly dependent on gelator concentration and LC phase. Four different gelator concentrations (1, 2, 3, and 4 wt.%) are investigated in nematic 5CB, while a 2 wt.% gelator concentration is optimized for the N* LC system. Among the nematic gels, the 3 wt.% composition exhibits optimized electro-optic performance in a window device with a contrast ratio of 49.01, threshold electric field of 0.64 V/ μ m, operating electric field of 4.21 V/ μ m, rise time of 51.8 ms, and fall time of 55.4 ms. In comparison, the N* LC gel containing 2 wt.% gelator shows a higher contrast ratio of 167, along with a threshold electric field of 1.50 V/ μ m, operating electric field of 4.64 V/ μ m, rise time of 67 ms, and fall time of 91 ms. The superior contrast ratio observed in the N* gel highlights the advantage of light-scattering focal conic state entangled in gel networks for smart-window applications, whereas the nematic gel demonstrates comparatively faster electro-optic switching. These results establish pseudopeptide-based LC gels as promising candidates for electrically switchable smart windows.

Chapter seven reports the design and development of an N* LC-based optical sensor using a strategically designed chiral dopant bearing a protonatable moiety for selective detection of HCl fumes. Protonation of the chiral dopant upon exposure to HCl vapors leads to a change in helical

twisting power, resulting in a measurable shift in the selective reflection wavelength of the N* LC. The sensor exhibits a detection of HCl vapors in the parts-per-million (ppm) range, with a sensitivity of approximately 3.26 nm ppm⁻¹.

The thesis concludes with an outlook on the future scope of the developed NP-LC composites, AIE-active and sensing chiral LC systems, and supramolecular LC gels, highlighting their potential for advanced electro-optic and photonic applications, including electrically tunable smart windows, luminescent displays, adaptive light-scattering and diffusion devices, and smart sensors.

तरल क्रिस्टल (LC) तरलता और दीर्घ-श्रेणी आणविक क्रम का एक अनूठा संयोजन प्रदर्शित करते हैं। इससे विषमदैशिक प्रकाशीय, परावैद्युत और विद्युत-प्रकाशिक गुण उत्पन्न होते हैं जिनका व्यापक रूप से डिस्प्ले, फोटोनिक उपकरणों और संवेदन प्रौद्योगिकियों में उपयोग किया जाता है। हालांकि, पारंपरिक LC के अंतर्निहित भौतिक गुण अक्सर तीव्र विद्युत-प्रकाशिक प्रतिक्रिया, उच्चतर फोटोल्यूमिनेसेंस, उन्नत प्रकाशीय मॉड्यूलेशन, उच्च पर्यावरणीय स्थिरता और संवेदनशील रासायनिक पहचान की आवश्यकता वाले अनुप्रयोगों में उनके प्रदर्शन को सीमित करते हैं। इन सीमाओं को दूर करने की एक शक्तिशाली रणनीति है कार्यात्मक कार्बनिक और अकार्बनिक डोपेंट के साथ उनका एकीकरण, जो परावैद्युत, विद्युत-प्रकाशिक, आयनिक, फोटोफिजिकल, काइरो-प्रकाशिक और संवेदन गुणों के सटीक मॉड्यूलेशन को सक्षम कर सकता है। यह शोध प्रबंध फेरोइलेक्ट्रिक नैनोकणों (NPs), संयुग्मित बहुलक NPs, एकत्रीकरण-प्रेरित उत्सर्जन (AIE) सक्रिय काइरल डोपेंट, स्यूडोपेप्टाइड जेलर और प्रोटोन योग्य काइरल अणुओं को शामिल करके कार्यात्मक LC कंपोजिट के व्यवस्थित डिजाइन और विकास पर केंद्रित है, जिसका उद्देश्य ट्यूनेबल इलेक्ट्रो-ऑप्टिक, फोटोल्यूमिनेसेंट, स्मार्ट विंडो और गैस-सेंसिंग उपकरणों को साकार करना है।

अध्याय एक में LC सामग्रियों और उनके आणविक आकार के आधार पर वर्गीकरण तथा LC प्रणालियों में चरण संक्रमण को नियंत्रित करने वाले भौतिक तंत्रों का परिचय दिया गया है। इस शोध प्रबंध में प्रयुक्त LC चरणों और उनकी आणविक संरचना का वर्णन किया गया है। LC के महत्वपूर्ण भौतिक गुणों पर संक्षेप में चर्चा की गई है। इसके बाद LC कंपोजिट की अवधारणा और महत्व को प्रस्तुत किया गया है, जिसमें यह दर्शाया गया है कि कार्यात्मक डोपेंट का समावेश LC गुणों के मॉड्यूलेशन को कैसे सक्षम बनाता है। LC के प्रदर्शन को अनुकूलित करने और इलेक्ट्रो-ऑप्टिक तथा संवेदन उपकरणों के विकास में NPs, AIE-सक्रिय और संवेदनशील काइरल डोपेंट तथा सुपरमॉलिक्यूलर जेलर की भूमिकाओं की भी रूपरेखा प्रस्तुत की गई है, जो इस शोध प्रबंध में किए गए अध्ययनों के लिए वैज्ञानिक ढांचा प्रदान करती है।

अध्याय दो में इस शोध प्रबंध में प्रयुक्त नमूना तैयार करने, LC कंपोजिट तैयार करने और उपकरण सेटअप की प्रक्रियाओं का वर्णन किया गया है। इसमें पॉलीमर NPs का संश्लेषण, LC-कंपोजिट तैयार करना, असंखित, समरूप और समरूप LC सेल का निर्माण और हाइड्रोक्लोरिक अम्ल (HCl) संवेदन के लिए सबस्ट्रेट तैयार करना शामिल है। अध्याय में LC कंपोजिट के चरण संक्रमण, प्रकाशीय, विद्युत, परावैद्युत, विद्युत-प्रकाशिकी, आयनिक, चयनात्मक परावर्तन, काइरो-प्रकाशिकी, रियोलॉजिकल और संरचनात्मक गुणों के अध्ययन के लिए उपयोग की जाने वाली प्रायोगिक तकनीकों और मापन सेटअपों की रूपरेखा

भी दी गई है। अंत में, रिपोर्ट किए गए परिणामों की विश्वसनीयता और सटीकता सुनिश्चित करने के लिए त्रुटि विश्लेषण के लिए उपयोग की जाने वाली विधियों पर संक्षेप में चर्चा की गई है।

इस शोध के तीसरे अध्याय में दो अलग-अलग आकार श्रेणियों (5-15 nm और 50-70 nm) के फेरोइलेक्ट्रिक BaTiO₃ NPs के प्रभाव का अध्ययन किया गया है, जो एक एंटीफेरोइलेक्ट्रिक बेंट-कोर LC के परावैद्युत, विद्युत-प्रकाशिक और आयनिक गुणों पर पड़ता है। BaTiO₃ NPs के समावेश से चरण संक्रमण तापमान कम हो जाता है और एंटीफेरोइलेक्ट्रिक SmA चरण के परावैद्युत विश्राम व्यवहार में परिवर्तन होता है। स्वतः ध्रुवीकरण शुद्ध LC के लिए 71 nC/cm² से घटकर छोटे NPs (5-15 nm) से युक्त LC के लिए 48 nC/cm² और बड़े NPs (50-70 nm) से युक्त LC के लिए 61 nC/cm² हो जाता है, जो फेरोइलेक्ट्रिक नैनोकणों और LC अणुओं के बीच विपरीत समानांतर द्विध्रुव-द्विध्रुव सहसंबंधों को दर्शाता है। छोटे आकार के NPs (5-15 nm) से युक्त LC में प्रतिक्रिया समय में लगभग 7.1% की कमी और बड़े आकार के NPs (50-70 nm) से युक्त LC में 30.7% की कमी, बेहतर इलेक्ट्रो-ऑप्टिक स्विचिंग प्रदर्शन को दर्शाती है। इसके अलावा, छोटे आकार (5-15 nm) और बड़े आकार (50-70 nm) के NPs से युक्त LC में प्रत्यक्ष धारा चालकता लगभग 3.2 गुना और 1.6 गुना बढ़ जाती है। छोटे आकार के NPs आयनिक संदूषण को लगभग 16% तक कम करते हैं, जो उनकी आयन-ग्रहण क्षमता को दर्शाता है। ये निष्कर्ष बताते हैं कि NPs का आकार और फेरोइलेक्ट्रिसिटी दोनों ही बेंट-कोर LC के इलेक्ट्रो-ऑप्टिक और आयन-परिवहन गुणों को दृढ़ता से प्रभावित करते हैं, जिससे वे तीव्र-स्विचिंग इलेक्ट्रो-ऑप्टिक अनुप्रयोगों के लिए उपयुक्त उम्मीदवार बन जाते हैं।

अध्याय चार में नेमेटिक LC के आयनिक गुणों को समायोजित करने और ब्लू-फेज LC (BPLC) को स्थिर करने में पॉली(3-हेक्सिलथियोफीन) (P3HT) व्युत्पन्न पर आधारित संयुग्मित पॉलीमर NPs (PNPs) की भूमिका का विश्लेषण किया गया है। 15.5 nm के औसत आकार वाले PNPs को 5CB LC में 0.01 और 0.1 भार% की सांद्रता पर मिलाने से आयनों के परिवहन गुणों में उल्लेखनीय वृद्धि होती है। प्रत्यक्ष धारा चालकता और आयन प्रसार गुणांक में लगभग दो गुना वृद्धि होती है, जबकि गतिशील आयन सांद्रता में केवल लगभग 1.5 गुना वृद्धि होती है। ये परिणाम PNPs की आंतरिक चालकता के कारण नेमेटिक होस्ट में बेहतर आयन परिवहन को दर्शाते हैं। इसके अतिरिक्त, 0.005 और 0.01 wt.% की अनुकूलित सांद्रता पर BPLC में छोटे आकार के PNPs (~5 nm) को शामिल करने से चरण स्थिरीकरण प्रभाव प्राप्त होता है, जिसमें 0.005 wt.% सांद्रता के लिए अधिकतम BP रेंज में लगभग 3 °C की वृद्धि देखी गई है। इलेक्ट्रो-ऑप्टिक प्रदर्शन में उल्लेखनीय सुधार होता है, जिसमें हिस्टैरेसिस 70% से घटकर 0.1% और अवशिष्ट द्विअपवर्तन 2.9% से घटकर 0.1% हो जाता है। इसके अतिरिक्त, PNPs की 0.01 wt.% सांद्रता पर,

फोटोल्यूमिनेसेंस तीव्रता में लगभग 70% की वृद्धि देखी गई है। ये निष्कर्ष दर्शाते हैं कि संयुग्मित PNP_s LC प्रणालियों के आयनिक परिवहन, तापीय स्थिरता, इलेक्ट्रो-ऑप्टिक प्रतिक्रिया और ल्यूमिनेसेंस विशेषताओं में प्रभावी रूप से सुधार करते हैं, जो उन्नत फोटोनिक और डिस्प्ले अनुप्रयोगों के लिए उनकी क्षमता को उजागर करते हैं।

अध्याय पाँच में नेमेटिक और स्मेक्टिक-ए LC होस्ट में स्यूडोपेप्टाइड-आधारित AIE-सक्रिय काइरल डोपेंट को शामिल करके ट्यूनेबल ल्यूमिनेसेंट LC सिस्टम के विकास पर ध्यान केंद्रित किया गया है। ध्रुवीकृत ऑप्टिकल माइक्रोस्कोपी और सर्कुलर डाइक्रोइज्म स्पेक्ट्रोस्कोपी कुशल काइरालिटी स्थानांतरण और हेलिकल कोलेस्टेरिक (N*) चरण के निर्माण की पुष्टि करते हैं, जबकि प्रेरित स्मेक्टिक-ए* (SmA*) चरण हेलिकल संरचना प्रदर्शित नहीं करता है। तापमान-निर्भर फोटोल्यूमिनेसेंस अध्ययन AIE विशेषताओं पर LC क्रम के मजबूत प्रभाव को प्रकट करते हैं। N* चरण में सर्कुलरली पोलराइज्ड ल्यूमिनेसेंस (CPL) देखा जाता है, जहां सुपरमॉलिक्यूलर हेलिकल क्रम और एआईई सह-अस्तित्व में होते हैं, जिससे डोपड 5CB LC में अधिकतम ल्यूमिनेसेंस विषमता कारक (g_{lum}) 0.071 प्राप्त होता है। तुलनात्मक रूप से, 90% H₂O/DMSO मिश्रण में डोपेंट के स्व-संयोजित काइरल एग्रीगेट का g_{lum} मान -0.0025 अपेक्षाकृत कम होता है, जो CPL को बढ़ाने में LC के हेलिकल वातावरण की भूमिका को दर्शाता है। विद्युत रूप से स्विच करने योग्य N* LC समतल, फोकल-कोनिक और होमियोट्रोपिक अवस्थाओं के लिए क्रमशः ~45%, ~4% और ~2% के हेज़ मानों के साथ अलग-अलग अवस्थाएँ प्रदर्शित करता है, जो स्मार्ट-विंडो अनुप्रयोगों के लिए कुशल वोल्टेज-नियंत्रित प्रकाश मॉड्यूलेशन को दर्शाता है। इसके अलावा, फोकल-कोनिक अवस्था में फोटोल्यूमिनेसेंस तीव्रता में लगभग तीन गुना वृद्धि देखी गई है, जबकि प्रेरित SmA* चरण डोपड LC में N* चरण की तुलना में लगभग 80% अधिक फोटोल्यूमिनेसेंस तीव्रता प्रदर्शित करता है। इसलिए, ये बहुक्रियाशील LC कंपोजिट CPL, विद्युत रूप से ट्यून करने योग्य स्मार्ट विंडो और ल्यूमिनेसेंट फोटोनिक उपकरणों के लिए एक मंच प्रदान करते हैं।

अध्याय छह में स्मार्ट-विंडो अनुप्रयोगों के लिए रेशेदार सुपरमॉलिक्यूलर असेंबली बनाने में सक्षम स्यूडोपेप्टाइड-आधारित जेलर का उपयोग करके नेमेटिक और N* LC भौतिक जेल के विकास को दर्शाया गया है। जेल की आकृति विज्ञान, विस्कोइलास्टिक प्रतिक्रिया और इलेक्ट्रो-ऑप्टिक गुण जेलर सांद्रता और LC चरण पर अत्यधिक निर्भर पाए गए हैं। नेमेटिक 5CB में चार अलग-अलग जेलर सांद्रता (1, 2, 3 और 4 wt.%) का अध्ययन किया गया है, जबकि N* LC प्रणाली के लिए 2 wt.% जेलर सांद्रता को अनुकूलित किया गया है। नेमेटिक जेल में, 3 wt.% संरचना ने विंडो डिवाइस में 49.01 के कंट्रास्ट अनुपात, 0.64 V/ μ m के थ्रेशोल्ड विद्युत क्षेत्र, 4.21 V/ μ m के ऑपरेटिंग विद्युत क्षेत्र, 51.8 ms के उदय समय और

55.4 ms के पतन समय के साथ अनुकूलित इलेक्ट्रो-ऑप्टिक प्रदर्शन प्रदर्शित किया है। तुलनात्मक रूप से, 2 wt.% जेलर युक्त N* LC जेल 167 का उच्चतर कंट्रास्ट अनुपात दर्शाता है, साथ ही इसका थ्रेशोल्ड विद्युत क्षेत्र $1.50 \text{ V}/\mu\text{m}$, ऑपरेटिंग विद्युत क्षेत्र $4.64 \text{ V}/\mu\text{m}$, राइज़ टाइम 67 ms और फॉल टाइम 91 ms है। N* जेल में देखा गया बेहतर कंट्रास्ट अनुपात स्मार्ट-विंडो अनुप्रयोगों के लिए जेल नेटवर्क में उलझे प्रकाश-प्रकीर्णन फोकल शंकाकार अवस्था के लाभ को उजागर करता है, जबकि नेमेटिक जेल तुलनात्मक रूप से तेज़ इलेक्ट्रो-ऑप्टिक स्विचिंग प्रदर्शित करता है। ये परिणाम स्क्वोडोपेस्टाइड-आधारित LC जेलों को विद्युत रूप से स्विच करने योग्य स्मार्ट विंडो के लिए आशाजनक विकल्प के रूप में स्थापित करते हैं।

अध्याय सात में HCl के वाष्प का चयनात्मक पता लगाने के लिए एक रणनीतिक रूप से डिज़ाइन किए गए काइरल डोपेंट का उपयोग करके N* LC-आधारित ऑप्टिकल सेंसर के डिज़ाइन और विकास की रिपोर्ट दी गई है, जिसमें एक प्रोटोनिट होने योग्य घटक होता है। HCl वाष्प के संपर्क में आने पर काइरल डोपेंट के प्रोटोनन से हेलिकल ट्विस्टिंग पावर में परिवर्तन होता है, जिसके परिणामस्वरूप N* LC की चयनात्मक परावर्तन तरंगदैर्घ्य में मापने योग्य बदलाव होता है। यह सेंसर HCl वाष्प का पता पार्ट्स-पर-मिलियन (ppm) रेंज में लगा सकता है, जिसकी संवेदनशीलता लगभग 3.26 nm ppm^{-1} है।

यह शोध प्रबंध विकसित NP-LC कंपोजिट, AIE-सक्रिय और संवेदनशील काइरल LC सिस्टम और सुपरमॉलिक्यूलर LC जैल के भविष्य के दायरे पर एक दृष्टिकोण के साथ समाप्त होता है, जिसमें विद्युत रूप से ट्यून करने योग्य स्मार्ट विंडो, ल्यूमिनेसेंट डिस्प्ले, अनुकूली प्रकाश प्रकीर्णन और प्रसार उपकरण और स्मार्ट सेंसर सहित उन्नत इलेक्ट्रो-ऑप्टिक और फोटोनिक अनुप्रयोगों के लिए उनकी क्षमता पर प्रकाश डाला गया है।

TABLE OF CONTENTS

CERTIFICATE	i
ACKNOWLEDGMENTS	ii
ABSTRACT	v
सार	ix
TABLE OF CONTENTS	xiii
LIST OF FIGURES	xvi
LIST OF TABLES	xxvii
LIST OF ABBREVIATIONS	xxviii
LIST OF SYMBOLS	xxxi
LIST OF SYNTHESIS SCHEMES	xxxiv
Chapter One: Introduction	1
1.1 Liquid Crystalline State: An Overview and Historical Development.....	1
1.2 Types and classification of LC phases.....	2
1.3 Important properties of LCs.....	7
1.3.1 Order parameter	7
1.3.2 Dielectric anisotropy and threshold voltage	9
1.3.3 Optical anisotropy (Birefringence).....	10
1.3.4 Elastic properties.....	11
1.4 LC composites and various dopants.....	12
1.4.1 Organic and inorganic nanoparticles.....	12
1.4.2 Chiral dopant with aggregation-induced emission and sensing abilities	13
1.4.3 Gelators	14
1.5 Motivation	14
1.6 Objectives of the thesis	15
1.7 Organization of the thesis	16
1.8 Conclusion	20
1.9 References	20
Chapter Two: Experimental methods and techniques	22
2.1 Sample preparation, experimental setups and characterization techniques	22
2.1.1 Miniemulsion technique for synthesizing polymer nanoparticles.....	22
2.1.2 Method of preparation of composites of LC with various dopants	23
2.1.3 Fabrication of LC cells.....	24
2.1.4 Temperature-dependent textural analysis and phase transition measurement.....	25
2.1.5 Dielectric spectroscopy and ion transport behavior	26

2.1.6 Electro-optic measurements	28
2.1.7 Transmittance versus voltage characteristics	30
2.1.8 Electro-optic Kerr effect measurement	31
2.1.9 Selective reflection measurements	32
2.1.10 UV/Vis spectroscopy, Diffuse reflectance, and Haze measurements.....	33
2.1.11 Photoluminescence spectroscopy, quantum yield measurement and time resolved photoluminescence spectroscopy	35
2.1.12 Fluorescence imaging and confocal laser scanning microscopy	37
2.1.13 Circularly dichroism and circularly polarized luminescence spectroscopy.....	38
2.1.14 Fourier transform infrared spectroscopy (FTIR) and Raman spectroscopy	39
2.1.15 Transmission electron microscopy and High-resolution transmission electron microscopy.....	40
2.1.16 Scanning electron microscopy and Field Emission Scanning Electron Microscopy	42
2.1.17 Rheology study	43
2.2 Error analysis and instrument precision	44
2.3 Conclusion	47
2.4 References.....	47
Chapter Three: To investigate the effect of doping ferroelectric Barium Titanate (BaTiO₃) nanoparticles on dielectric, electro-optic and ionic properties of antiferroelectric bent-core liquid crystal.....	50
3.1 Introduction	50
3.2 Experimental details	52
3.3 Results and Discussion	56
3.4 Conclusion.....	71
3.5 References	73
Chapter Four: To study the effect of conjugated polymer nanoparticles on the ion transport in nematic liquid crystal and of polymer dots on the thermal, electro-Optic, and photophysical properties of blue-phase liquid crystal.....	76
4.1 Introduction	76
4.2 Experimental details	79
4.3 Results and Discussion	82
4.4 Conclusion.....	107
4.5 References	108
Chapter Five: To develop AIE-active chiral dopant enabled tunable luminescent liquid crystals and investigation of chiro-optic and photophysical characteristics	111

5.1 Introduction	111
5.2 Experimental details	113
5.3 Results and Discussion	115
5.4 Conclusion.....	131
5.5 References	131
Chapter Six: To develop nematic and cholesteric liquid crystal physical gels using pseudopeptide fibrous assembly for smart window applications	133
6.1 Introduction	133
6.2 Experiments and Methods	135
6.3 Results and Discussion	138
6.4 Conclusion.....	154
6.5 References	154
Chapter Seven: To design and fabrication of a cholesteric liquid crystal based HCl sensor using a protonatable chiral dopant.....	157
7.1 Introduction	157
7.2 Experiments and methods.....	158
7.3 Results and Discussion	162
7.4 Conclusion.....	168
7.5 References	168
Chapter Eight: Conclusion and future scope.....	171
8.1 Conclusion of the work.....	171
8.2 Future scope	174
Publications.....	176
Published work in journals	176
Manuscript under preparation.....	176
Conferences	176
Workshop.....	176
AUTHORS'S BIOGRAPHY	177

LIST OF FIGURES

Figure 1.1 Schematic showing the LC state appearing between the crystalline solid and isotropic liquid during heating and cooling.....	1
Figure 1.2 Classification of LCs based on the mechanism of transition and shape of the LC molecules.....	2
Figure 1.3 Schematic representation of the nematic phase formed by (a) calamitic (rod-like) molecules and (b) bent-shaped molecules.....	3
Figure 1.4 Layer arrangement in (a) SmA and (b) SmC phase formed by calamitic (rod-like) molecules.....	3
Figure 1.5 Schematic showing the helical director twist in the chiral SmC* phase originating from chirality in the SmC phase.....	4
Figure 1.6 (a) SmAP _R , (b) SmAP _F , and (c) SmAP _A phase formed by bent-core LC molecules. Here, $\vec{P}$, $\hat{n}$, and $\hat{k}$ represent the polarization vector, director axis, and layer normal, respectively.....	5
Figure 1.7 Molecular structures of (a) the achiral 5CB liquid crystal molecule and (b) the S811 chiral dopant, along with (c) the helical architecture of the N* phase. Here, * indicates the chiral centre in the S811 molecule.....	6
Figure 1.8 Schematic illustration of the molecular arrangement and helical superstructure of the TGBA* phase.....	6
Figure 1.9 Schematic illustration of the double-twist cylinder and the cubic lattice structures of BPI and BPII.....	7
Figure 1.10 Schematic representing the orientation of nematic LC molecules with respect to the director axis ($\hat{n}$).....	8
Figure 1.11 Schematic representing the electric field-induced reorientation in a positive dielectric anisotropic nematic LC.....	10
Figure 1.12 Schematic representing the splay, twist, and bend elastic distortion in LCs.....	12
Figure 1.13 Schematic illustration of various anisotropic NPs dispersed in a LC matrix.....	13
Figure 1.14 Schematic illustrating the difference between conventional emitters and aggregation-induced emitters.....	14
Figure 1.15 Schematic representing the LC molecules embedded in the porous gel networks.....	14
Figure 2.1 Schematic depicting the steps involved in the miniemulsion technique which is used for synthesis of polymer NPs.....	22

Figure 2.2 Schematic representing the method of preparation of LC composite.....	23
Figure 2.3 Schematic representing the homogeneous and homeotropic alignment of LC molecules in cell.....	24
Figure 2.4 Schematic illustrating the steps involved in the preparation of the substrate for HCl sensing.....	25
Figure 2.5 Image of the experimental setup used at the Liquid Crystal Research Laboratory, IIT Delhi, for temperature-dependent textural analysis of LCs and their composites.....	25
Figure 2.6 Image of the experimental setup used at the Liquid Crystal Research Laboratory, IIT Delhi, for temperature-dependent dielectric spectroscopy of LCs and their composites....	27
Figure 2.7 Circuit diagram of the experimental setup used for spontaneous polarization measurements of LCs and their composites.....	29
Figure 2.8 Schematic representation of the current responses associated with capacitive, polarization, ionic/conductive, and total current contributions under applied voltage waveforms: (a) square-wave voltage and (b) triangular-wave voltage. Here, I_C denotes the capacitive current, I_p the polarization current, I_i the ionic/conductive current, and I the total current response.....	30
Figure 2.9 Schematic of electro-optic setup for observing the transmittance versus voltage characteristics.....	31
Figure 2.10 Schematic of the experimental setup used for analysing the Kerr effect in BPLC and its composites.....	32
Figure 2.11 Schematic of setup used to study selective reflection properties in BPLC and its composites.....	33
Figure 2.12 UV-vis-NIR spectrophotometer (PerkinElmer Lambda 1050) at Central Research facility, IIT Delhi used for absorbance, and haze measurements of LCs and their composites..	34
Figure 2.13 Shimadzu UV-2600i spectrophotometer at SMITA research laboratory, IIT Delhi used for DRS measurement of LC and its composites.....	34
Figure 2.14 Experimental setup at Liquid Crystal Research Laboratory, IIT Delhi, used for temperature-dependent PL spectroscopy of LCs and their composites.....	35
Figure 2.15 Horiba QuantaMaster 8450-22 spectrofluorometer at Sophisticated Analytical and Technical Help Institute (SATHI) facility, IIT-Delhi, used for quantum yield measurement of LCs and their composites.....	36
Figure 2.16 HORIBA DeltaFlex TCSPC system at Sophisticated Analytical and Technical Help Institute (SATHI) facility, IIT-Delhi, used for performing the TRPL spectroscopy of LCs and their composites.....	36

Figure 2.17 Leica TCS SP8 Confocal Laser Scanning Microscope at central research facility (CRF), IIT Delhi used for imaging of LCs and their composites.....	37
Figure 2.18 Chirascan CD spectropolarimeter at Advanced Instrumentation Research Facility (AIRF), Jawaharlal Nehru University, Delhi, used for CD measurements of LC composites..	38
Figure 2.19 JASCO CPL-300 spectrofluoropolarimeter at Professor Jatish Kumar's laboratory, Indian Institute of Science Education and Research Tirupati, Andhra Pradesh, used for CPL measurement of LC composites.....	39
Figure 2.20 (a) Perkin Elmer Frontier spectrometer facility at Chemistry Department, IIT Delhi and (b) Thermo Nicolet IS-50 spectrometer facility at central research facility, IIT Delhi, used for FTIR measurement of LCs and their composites.....	39
Figure 2.21 Renishaw Raman spectrometer facility at Physics Department, IIT Delhi used for Raman spectroscopy of NPs.....	40
Figure 2.22 JEOL JEM-1400 microscope at central research facility, IIT Delhi, used for TEM imaging of NPs.....	41
Figure 2.23 FEI Tecnai TF20 microscope at central research facility, IIT Delhi, used for HR-TEM imaging of NPs.....	41
Figure 2.24 (a) ZEISS SEM EVO 18 and (b) TESCAN MAGNA FESEM microscope at central research facility, IIT Delhi, used for imaging of LC composites.....	42
Figure 2.25 TA Instruments ARES-G2 rotational rheometer at Central research facility, IIT Delhi, used for rheology measurements of LC gels.....	43
Figure 3.1 Molecular structure of host 1-18 bent-core LC compound.....	52
Figure 3.2 HR-TEM images of BaTiO ₃ nanoparticles: (a) before milling and (b) after milling.....	57
Figure 3.3 HR-TEM size distribution of NPs: (a) before milling and (b) after milling.....	57
Figure 3.4 (a) FTIR spectra of pure OA and the OA functionalized BaTiO ₃ NPs (50-70 nm) and (b) Raman spectra of higher size BaTiO ₃ NPs (< 100 nm) before and after milling.....	58
Figure 3.5 POM micrographs obtained during the cooling cycle for nano-doped samples prepared at 0.3 wt.% of BaTiO ₃ in pure LC: (a) TGBA phase in BaTiO ₃ (5-15 nm) doped sample at 125 °C, (b) TGBA in BaTiO ₃ (50-70 nm) doped sample at 132 °C, (c) SmAP _A in BaTiO ₃ (5-15 nm) doped sample at 95 °C, (d) SmAP _A phase in BaTiO ₃ (50-70) nm doped sample at 100 °C, (e) SmX phase in BaTiO ₃ (50-70 nm) doped sample at 85 °C and (f) SmX-Cr transition in BaTiO ₃ (50-70 nm) doped sample at 71.2 °C. In all the recorded micrographs, the polarizer (P) and analyzer (A) are kept crossed. R represents the rubbing direction.....	59

Figure 3.6 Temperature variation of static ϵ in the cooling cycle for pure and doped (0.3 wt.% of BaTiO ₃ in pure LC) samples: (a) pure 1-18 LC, (b) BaTiO ₃ (5-15 nm) doped 1-18 LC, and (c) BaTiO ₃ (50-70 nm) doped 1-18 LC obtained during the cooling cycle. The vertical arrow represents the T_{tr}	60
Figure 3.7 (a) HN-fitting and dielectric modes in the pure sample at 105 °C, (b) temperature-dependent $\delta\epsilon$ and f_r for soft mode and molecular mode: in the pure sample, (c) in BaTiO ₃ (5-15 nm) doped (0.3 wt.%) sample, and (d) in BaTiO ₃ (50-70 nm) doped (0.3 wt.%) sample. The symbols p and m are used to distinguish between the polar soft mode and the molecular mode, respectively	63
Figure 3.8 Variation of P_S as a function of reduced temperature for the pure and the nano-doped (0.3 wt%) LC samples. T_c denotes the TGBA to SmAP _A T_{tr}	65
Figure 3.9 Schematic illustration of (a) antiparallel dipolar coupling between ferroelectric BaTiO ₃ NPs and bent-core liquid crystal (BCLC) molecular dipoles, leading to a reduction in net macroscopic P_S and (b) the size-dependent effect, where smaller NPs (5-15 nm) yield a higher number density with more antiparallel interactions and a stronger reduction in P_S , while larger NPs (50-70 nm) show a lower number density with fewer such couplings and comparatively higher P_S	66
Figure 3.10 Variation of (a) τ_r and (b) η with reduced temperature in pure and doped (0.3 wt%) samples. T_c denotes the TGBA to SmAP _A T_{tr}	67
Figure 3.11 (a) Plot representing the variation of the real part of conductivity with frequency and Jonscher fitting, and (b) σ_{dc} in pure and doped (0.3 wt.%) LC samples as a function of reduced temperature. T_c denotes the TGBA to SmAP _A T_{tr}	68
Figure 3.12 (a) $\tan(\delta)$ plot at different temperature values in NPs (50-70 nm) doped (0.3 wt.%) sample and (b) $\tan(\delta)$ plot for pure and doped (0.3 wt.%) samples obtained at the common temperature lies at a difference of 20 °C from their respective isotropic temperature	69
Figure 3.13 Comparison of (a) D and (b) n as a function of reduced temperature in pure and doped (0.3 wt.%) LC samples. Here, T_{iso} denotes the isotropic to N _{cyb} * T_{tr}	70
Figure 3.14 Variation of (a) P_S , (b) τ_r and (c) η as a function of reduced temperature for the pure LC, OA functionalized BaTiO ₃ (50-70 nm) doped LC and unfunctionalized BaTiO ₃ (<100 nm) doped LC. T_c denotes the TGBA to SmAP _A phase T_{tr}	72
Figure 4.1 Molecular structure of (a) P3HT polymer and (b) PEG-300 surfactant	79

Figure 4.2 Molecular structures of (a) chiral dopant S811 and (b) components of E7 LC, namely 5CB, 7CB, 8OCB, and 5CT. The asterisk (*) denotes the chiral center in the molecular structure of chiral dopant S811.....	81
Figure 4.3 Schematic of electro-optic setup used to perform electro-optic study in the pure and doped BPLCs.....	83
Figure 4.4 Schematic of electro-optic setup used to study selective reflection properties in pure and doped BPLC samples.....	83
Figure 4.5 TEM images and corresponding size distribution of (a,b) Pdots and (c,d) PNPs...	84
Figure 4.6 Comparison of (a) Emission and (b) excitation spectra of P3HT polymer in chloroform, aqueous Pdots and aqueous PNPs.....	84
Figure 4.7 POM texture (a,d) pure 5CB, (b,e) PNPs (0.1 wt%) doped 5CB and (c,f) PNPs (0.01 wt%) doped 5CB. The textures in a-c and d-f are obtained in unaligned and planar aligned cells, respectively.....	85
Figure 4.8 (a) TEM image in PNPs (0.01 wt.%) doped 5CB, (b) TEM image in PNPs (0.1 wt.%) doped 5CB and (c) FE-SEM image obtained after washing the LC from PNPs (0.1 wt.%) doped 5CB.....	85
Figure 4.9 (a) Jonscher fitting of experimental data in pure 5CB and (b) σ_{dc} varying as a function of temperature in pure and doped 5CB samples. Here $T-T_{iso}$ represents the reduced temperature.....	87
Figure 4.10 (a) Uemura fitting, and variation of (b) n , (c) D , and (d) μ as a function of temperature. Here $T-T_{iso}$ represents the reduced temperature.....	88
Figure 4.11 FTIR spectra of E7, pure, and doped BPLCs showing the characteristic nitrile ($C\equiv N$) stretching vibration peak present in all samples.....	89
Figure 4.12 Schlieren nematic texture obtained for E7 LC under a polarizing optical microscope in unaligned cell.....	89
Figure 4.13 Stacked bars representing the transition temperature of different mesophases in pure and doped BPLCs obtained in (a) heating and (b) cooling cycle.....	90
Figure 4.14 POM texture obtained in (a) BPII (38.56 °C), (b) BPI (36.28 °C), (c) BP-N* transition (33.05 °C) and (d) SmA* (27.43 °C) of pure BPLC in cooling cycle (ramp rate 0.5 °C/minute).....	90
Figure 4.15 (a) BPI/BPII, (b) BPI/II to N* transition, (c) N*, (d) SmA* phases in pure BPLC.....	91

Figure 4.16 POM textures obtained in (a) N* in cross-state in doped (0.5 wt.%) BPLC, (b) N* in un-crossed state in doped (0.5 wt.%) BPLC, (c) BP in crossed-state in doped (0.1 wt.%) BPLC and (d) BP in un-crossed state in doped (0.1 wt.%) BPLC.....	92
Figure 4.17 (a) BPI/II, (b) BPI/II to N* transition, (c) N*, and (d) SmA* phases in Pdots (0.005 wt.%) doped BPLC. These textures are obtained in a homemade unaligned cell of thickness 6 microns.....	93
Figure 4.18 (a) BPI/II, (b) BPI/II to N* transition in Pdots (0.01 wt.%) doped BPLC, (c) N* and (d) Iso phase in Pdots (0.5 wt.%) doped BPLC. These textures are obtained in a homemade unaligned cell of thickness 6 microns.....	93
Figure 4.19 POM texture obtained in N* and BP phase of (a,b) Pdots (0.05 wt.%) doped BPLC, (c,d) Pdots (0.01 wt.%) doped BPLC, and (e, f) Pdots (0.005 wt.%) doped BPLC. The above textures are obtained in a homemade planar-aligned cell of thickness ~ 12 microns.....	94
Figure 4.20 FESEM images representing the aggregates of Pdots in (a) Pdots (0.5 wt.%) doped BPLC and (b) Pdots (0.1 wt.%) doped BPLC.....	95
Figure 4.21 TEM image of Pdots (0.005 wt.%) doped BPLC obtained at different magnification scale.....	95
Figure 4.22 Selective reflection spectra obtained at different temperatures in the cooling cycle in (a) BPI/II of pure BPLC, (b) N* phase of pure BPLC, (c) BPI/II of Pdots (0.005 wt.%) doped BPLC, (d) N* of Pdots (0.005 wt.%) doped BPLC, (e) BPI/II of Pdots (0.01 wt.%) doped BPLC, and (f) N* of Pdots (0.01 wt.%) doped BPLC.....	97
Figure 4.23 (a) Selective reflection spectra, (b) reflection peak-1 wavelengths and (c) reflection peak-2 wavelengths obtained in BPI/II varying as a function of reduced temperature in pure and doped BPLCs.....	98
Figure 4.24 Transmittance spectra of empty cell obtained using a halogen light source. The value of the cell gap is calculated using the formula $t = (m \cdot \lambda_m \cdot \lambda_{m+1}) / [2 \cdot n_{air} \cdot (\lambda_{m+1} - \lambda_m)]$	98
Figure 4.25 POM texture obtained in BPII of pure BPLCs (a) before and (b) after applying the electric field ($15 \text{ V } \mu\text{m}^{-1}$).....	100
Figure 4.26 (a) Kerr constant fitting and (b) Kerr constant as a function of reduced temperature in pure and doped BPLCs. The dotted vertical lines represent the phase transition values observed through textural analysis.....	100
Figure 4.27 (a) Threshold voltage and (b) operating voltage as a function of reduced temperature in pure and doped BPLCs. The dotted vertical lines represent the phase transition values observed through textural analysis.....	101

Figure 4.28 Comparison of hysteresis curves for pure and doped BPLCs measured at 2.0 °C below the isotropic transition temperature.....	102
Figure 4.29 (a) Hysteresis (%) and (b) Residual birefringence (%) as a function of reduced temperature in pure and doped BPLCs. The dotted vertical lines represent the phase transition values observed through textural analysis.....	102
Figure 4.30 (a) Hysteresis (%) at $V_{max} = 12 \text{ V}/\mu\text{m}$, (b) Hysteresis (%) at $V_{max} = 10 \text{ V}/\mu\text{m}$, (c) Residual birefringence (%) at $V_{max} = 12 \text{ V}/\mu\text{m}$ and (d) Residual birefringence (%) at $V_{max} = 10 \text{ V}/\mu\text{m}$ as a function of reduced temperature in pure and doped BPLC samples. The dotted vertical lines represent the phase transition values observed through textural analysis.....	103
Figure 4.31 (a) Rise time and (b) fall time as a function of reduced temperature in pure and doped BPLCs. The dotted vertical lines represent the phase transition values observed through textural analysis. Each data point has an uncertainty of ~23 microseconds.....	104
Figure 4.32 Absorbance spectra of pure and doped BPLC samples obtained at ambient temperature. During the measurements, all samples remain in their SmA* phase.....	105
Figure 4.33 Comparison of PL spectra obtained in the (a) BP phase and (b) N* phase of pure and doped BPLCs.....	105
Figure 4.34 PL Peak intensity obtained in (a) heating cycle and (b) cooling cycle in pure and doped BPLCs. The dotted vertical lines represent the phase transition values observed through textural analysis.....	106
Figure 4.35 Fitted lifetime curve for (a) pure BPLC, (b) Pdots (0.005 wt.%) doped BPLC and (c) Pdots (0.01 wt.%) doped BPLC ($\lambda_{ex} = 320 \text{ nm}$ and $\lambda_{em} = 390 \text{ nm}$).....	107
Figure 5.1 Molecular structure of (a) 5CB LC, (b) 8CB LC and (c) FDA AIEgen.....	113
Figure 5.2 Schematic depicting the procedure for preparing FDA doped LC samples.....	114
Figure 5.3 Schematic representation of the electro-optic setup used for the measurement of transmission versus voltage characteristics.....	114
Figure 5.4 POM texture of (a) uniformly aligned N phase of 8CB (35 °C), (b) Striped texture of SmA phase of 8CB (27 °C), (c) Oily streaks N* texture of doped-8CB (35 °C), and (d) broken fan SmA* texture of doped-8CB (27 °C).....	115
Figure 5.5 Homeotropically aligned dark texture obtained in (a) SmA phase of pure 8CB LC and (b) SmA* phase of doped 8CB LC. Inset images in (a) and (b) represent the Maltese cross obtained in conoscopic imaging in POM.....	116

Figure 5.6 Aligned SmA phase of pure 8CB sample with rubbing direction (a) $\parallel$ to the polarizer, (b) at 45° with the polarizer, (c) $\parallel$ to the analyzer, and (d) at 45° with the analyzer.....	116
Figure 5.7 Aligned SmA* phase of doped 8CB sample with rubbing direction (a) $\parallel$ to the polarizer, (b) at 45° with the polarizer, (c) $\parallel$ to the analyser, and (d) at 45° with the analyser.....	117
Figure 5.8 Fingerprint texture obtained in N* phase of (a) doped 5CB LC (27°C) and doped 8CB (35°C) LCs.....	117
Figure 5.9 CD spectra recorded in (a) different mesophases of pure and doped 8CB LC and (b) doped 5CB LC as a function of temperature.....	119
Figure 5.10 (a) Normalized UV/Visible absorbance spectra of FDA estimated through the K-M function and (b) comparison of absorbance spectra of pure and FDA doped LC samples.....	120
Figure 5.11 (a) Normalized PL spectra of FDA ($\lambda_{\text{ex.}} = 355\text{ nm}$) and (b) comparison of PL spectra of pure and FDA doped LC samples at 27°C ($\lambda_{\text{ex.}} = 355\text{ nm}$).....	120
Figure 5.12 Images of pure and doped LC cells (a) under daylight, (b) under UV light (365 nm) and (c) 1931 CIE chromaticity diagram and coordinates of emission color for doped LC samples, (d) CLSM images of pure 5CB (N phase), (e) doped 5CB (N* phase), (f) pure 8CB (SmA phase) and (g) doped 8CB (SmA* phase).....	121
Figure 5.13 Optical textures of FDA doped LC samples observed under cross-polarized and fluorescence modes: (a,b) isotropic phase of doped 5CB, (c,d) N* phase of doped 5CB, and (e,f) SmA* phase of doped 8CB. Panels (a), (c), and (e) correspond to cross-polarized images, while panels (b), (d), and (f) show the corresponding fluorescence images.....	122
Figure 5.14 Deconvoluted PL spectra of (a) pure 5CB-N phase ($\lambda_{\text{ex.}} = 325\text{ nm}$), (b) pure 8CB-SmA phase ($\lambda_{\text{ex.}} = 325\text{ nm}$), (c) doped 5CB-N* phase ($\lambda_{\text{ex.}} = 355\text{ nm}$) and (d) doped 8CB-SmA* phase ($\lambda_{\text{ex.}} = 355\text{ nm}$).....	123
Figure 5.15 Temperature-dependent Integrated PL intensity in (a) FDA doped 5CB LC and (b) in FDA doped 8CB LC. Here, the vertical dashed lines represent the mesophase transitions..	123
Figure 5.16 CPL spectra recorded in various mesophases of pure and FDA doped LCs.....	124
Figure 5.17 Plot of g_{lum} as a function of wavelength recorded in N* phase of FDA doped 5CB sample.....	125
Figure 5.18 (a) CPL spectra and (b) Plot of g_{lum} as a function of wavelength recorded in FDA in DMSO and 90 % H_2O in DMSO (Conc. = $1 \times 10^{-4}\text{ M}$).....	126

Figure 5.19 CPL spectra recorded in the N* phase of the FDA-doped 5CB sample at different positions by rotating and flipping the sample cell.....	126
Figure 5.20 (a) V-T characteristics and (b) PL spectra as a function of electric-field in the planar, focal-conic, and homeotropic state of N* phase of FDA doped 5CB LC.....	128
Figure 5.21 Haze (%) measured in the planar, focal-conic, and homeotropic states of the N* phase in FDA doped 5CB LC.....	128
Figure 5.22 Field-induced textures in N* phase of FDA doped 5CB LC showing the (a) planar state at 0 V/ μ m, (b) focal-conic state at 0.39 V/ μ m, and (c) homeotropic (dark) state at 1.12 V/ μ m, along with the corresponding cell-transmission images for the (d) planar, (e) focal-conic, and (f) homeotropic (dark) states, respectively.....	129
Figure 5.23 Schematic diagram representing light transmission behavior in (a) planar state, (b) electric-field induced focal-conic state, and (c) electric-field induced homeotropic state of N* LC phase.....	129
Figure 5.24 Photoluminescence images showing the electric-field-dependent variation in PL intensity within the square electrode region of the LC cell filled with the FDA-doped 5CB sample in the cholesteric (N*) phase under UV illumination (365 nm), corresponding to the electrically switched (a) planar state at 0 V/ μ m, (b) focal-conic state at 0.39 V/ μ m, and (c) homeotropic state at 1.12 V/ μ m.....	130
Figure 5.25 Response time measurements in transition from (a) planar to focal-conic state and (b) focal-conic to planar state obtained in N* phase of FDA doped 5CB LC.....	130
Figure 6.1 Molecular structure of (a) 5CB LC, (b) CB15 chiral dopant, and (c) S811 chiral dopant.....	136
Figure 6.2 Electro-optic setup utilized for observing T-V characteristics in LCPG samples..	138
Figure 6.3 SEM image of FF at 1 mg/ml concentration obtained after drop casting MeOH solution on a glass coverslip.....	139
Figure 6.4 Vial inversion test results: (a) n ₁ in sol state, (b) n ₂ in sol state, (c) n ₂ in gel state with natural cooling, (d) n ₃ in gel state with natural cooling, (e) n ₄ in gel state with natural cooling, (f) n ₁ in gel state with rapid cooling, and (g) n ₂ in gel state with rapid cooling.....	140
Figure 6.5 Schlieren nematic texture obtained in (a) pure 5CB and (b) n ₁ LC gel.....	140
Figure 6.6 POM texture (a-c) in n ₂ LC gel obtained in slow cooling from isotropic phase at the cooling rate 1 °C/minute and (d) texture obtained in isotropic phase with heating.....	141
Figure 6.7 POM textures (a) fingerprint droplet texture and (b-d) nucleation of spherulites from the fingerprint droplets and coalescence over the entire sample surface in n ₃ LC gel. The dotted circles represent spherulites originating from fingerprint droplets.....	141

Figure 6.8 Miscibility test textures obtained at the contact boundary: (a) n_2 and S811 doped 5CB and (b) n_2 and CB15 doped 5CB. (Yellow and Red arrows represent the left and right-handed nature of helix, respectively).....	142
Figure 6.9 POM textures of the n_4 LC gel recorded during cooling from the isotropic phase at a cooling rate of $1\text{ }^\circ\text{C min}^{-1}$ showing the gradual evolution of crystalline spherulitic textures in panels (a-h), while panel (i) represents the texture obtained after reheating above the isotropic phase.....	142
Figure 6.10 Photographs of the cell filled with the n_3 LC gel obtained under different cooling conditions: (a) slow cooling and (b) rapid cooling.....	144
Figure 6.11 POM textures obtained with rapid cooling for (a,b) n_1 LC gel, (c,d) n_2 LC gel, (e,f) n_3 LC gel, and (g,h) n_4 LC gel.....	144
Figure 6.12 FESEM images recorded after rapid cooling for (a) n_1 LC gel, (b) n_2 LC gel, (c) n_3 LC gel, and (d) n_4 LC gel.....	145
Figure 6.13 FTIR spectra of FF in DCM, FF powder, 5CB, and all nematic (n_1 - n_4) LC gel samples.....	146
Figure 6.14 PL spectra of 5CB and nematic (n_1 - n_4) LC gel samples recorded at ambient temperature.....	146
Figure 6.15 Rheology study: Storage (G') and loss (G'') modulus sweep as a function of (a) strain (%) and (b) angular frequency (ω) in the nematic (n_1 - n_4) LC gel samples.....	147
Figure 6.16 (a) Transmittance versus voltage characteristics and (b) Haze (%) obtained in n_1 , n_2 , n_3 , and n_4 LCPGs. The solid and open symbols in (b) represents Haze (%) obtained in opaque and transparent states, respectively.....	148
Figure 6.17 Field-off and saturated field-on textures and corresponding cell images recorded in (a,b) n_1 LC gel, (c,d) n_2 LC gel, (e,f) n_3 LC gel, and (g,h) n_4 LC gel.....	149
Figure 6.18 Comparison of (a) contrast ratio, (b) threshold and operating voltages, and (c) rise and fall time for nematic (n_1 - n_4) LC gel samples.....	150
Figure 6.19 Fingerprint focal conic texture observed in S811 (3 wt.%) doped 5CB LC.....	151
Figure 6.20 (a) Sol form of c_1 , (b) focal conic fingerprint texture of c_1 , and (c) isotropic dark texture of c_1 obtained after rapidly cooling the sample.....	152
Figure 6.21 (a) Gel form of c_2 (b) focal conic gel network texture of c_2 and (c) isotropic dark texture with gel network in c_2 obtained after rapid cooling the sample.....	152
Figure 6.22 (a) Transmittance (%) versus electric field curve and (b) Haze (%) obtained in the c_2 LC gel sample.....	153

Figure 6.23 (a) Focal conic gel state and corresponding cell image, and (b) homeotropic gel state and corresponding cell image in the c_2 LC gel sample.....	154
Figure 7.1 Representative structure of the C.D. receptor used for HCl sensing.....	159
Figure 7.2 Molecular structure of components (5CB, 7CB, 8OCB, and 5CT) of E7 LC.....	159
Figure 7.3 Schematic represents the method of preparation of N*LC mixture.....	160
Figure 7.4 Schematic illustration showing the step-by-step fabrication process of the HCl sensing N* LC substrate.....	161
Figure 7.5 (a) Schematic and (b) actual experiment setup used for HCl sensing developed at Liquid Crystal Research Laboratory, IIT Delhi.....	162
Figure 7.6 (a) Schlieren texture in E7, (b) fingerprint texture with no HCl exposure (c) fingerprint texture with HCl exposure for 10 seconds, (d) fingerprint texture with HCl exposure for 20 seconds, (e) fingerprint texture with HCl exposure for 30 seconds, (f) fingerprint texture with HCl exposure for 40 seconds, (g) nematic texture having precipitation of CAB with HCl exposure for 60 seconds and (h) isotropic texture with clear precipitation of CAB.....	163
Figure 7.7 Schematic illustration of the sensing mechanism based on analyte-induced elongation of the pitch of the N* phase through interaction with the chiral dopant.....	164
Figure 7.8 (a) oily streaks texture and (b) selective reflection spectra in CAB (16 wt.%) doped E7 sample obtained at ambient temperature.....	165
Figure 7.9 (a) Shift in λ_{SR} of N* LC with HCl exposure of 10 ppm and (b) HCl-concentration dependent shift in λ_{SR} peak of N* LC within 30 seconds.....	165
Figure 7.10 (a) FTIR spectra of E7, CAB, CAB (16 wt.%) doped E7, and protonated CAB (16 wt.%) doped E7, and (b) enlarged view highlighting the broadening of the N-H stretching band after HCl exposure, confirming protonation of CAB.....	166
Figure 7.11 UV-Vis absorbance and (b) fluorescence emission spectra of CAB in methanol at a concentration of 50 μ M.....	167
Figure 7.12 (a) UV-Vis absorption spectrum of E7 LC, (b) excitation and fluorescence emission spectra of E7 LC, and (c) comparison of normalized excitation and emission spectra of E7 and CAB (16 wt.%) doped E7 LC.....	167
Figure 7.13 Photoluminescence (PL) spectra of CAB (16 wt %)-doped E7 LC upon exposure to varying concentrations of HCl, demonstrating concentration-dependent emission response.....	168

LIST OF TABLES

Table 3.1 T_{tr} of different mesophases in pure and doped (0.3 wt.%) samples obtained during heating and cooling cycle.....	59
Table 4.1 Phase transition measurement obtained in pure and PNPs doped 5CB samples.....	86
Table 4.2 Fitting parameters obtained through fitting of life-time curve of pure and doped BPLCs.....	107
Table 5.1 Phase transition temperature in pure and FDA doped LC media.....	118
Table 5.2 Table 5.2 Comparison of $ g_{lum} _{max}$ values for CPL-active N* LC systems governed predominantly by optical rotation.....	127
Table 6.1 Phase transition for pure 5CB and nematic gel samples obtained before and after gelation.....	143
Table 6.2 Electro-optic parameters measured for the cholesteric c ₂ gel sample.....	153
Table 7.1 Phase transition temperature of E7, CAB (2 wt.%) doped E7 and CAB (16 wt.%) doped E7.....	164

LIST OF ABBREVIATIONS

LC: Liquid crystal	PL: Photoluminescence
SmA: Smectic-A	CD: Circular dichroism
SmC: Smectic-C	CPL: Circularly polarized luminescence
SmC*: Chiral Smectic-C	HCl: Hydrochloric acid
SmC _A *: Antiferroelectric Chiral Smectic-C	FTIR: Fourier transform infrared spectroscopy
SmAP _R : Smectic-A with random polar order	AF: Antiferroelectric
SmAP _F : Smectic-A with ferroelectric order	P3HT: poly(3-hexylthiophene-2,5-diyl) polymer derivative
SmAP _A : Smectic-A with antiferroelectric order	FESEM: Field emission scanning electron microscopy
N*: cholesteric	wt. %: weight percentage
S811: S-(+)-2-octyl 4-(4-hexyloxybenzoyloxy)benzoate	ITO: Indium tin oxide
5CB: 4-cyano-4'-pentylbiphenyl	UV: Ultraviolet
TGB: Twist grain boundary	CTAB: Cetyltrimethylammonium Bromide
BPs: Blue phases	POM: polarizing optical microscope
TGBA*: Twist grain boundary-A	H-N: Havriliak Negami
TGBC*-Twist grain boundary-C	FWHM: full width at half maximum
BPI: Blue phase-I	T-V: transmittance-voltage
BPII: Blue phase-II	BPLC: Blue-phase liquid crystal
BPIII: Blue phase-III	Haze(%): Haze percentage
o-ray: ordinary ray	DRS: Diffuse reflectance spectroscopy
e-ray: extraordinary ray	K-M: Kubelka-Munk
NPs: Nanoparticles	QY: Quantum yield
BaTiO ₃ : Barium Titanate	TRPL: Time-resolved photoluminescence
PbTiO ₃ : Lead Titanate	CLSM: Confocal laser scanning microscopy
AIE: Aggregation-induced emission	TEM: Transmission electron microscopy
ACQ: Aggregation-caused quenching	HR-TEM: High-Resolution TEM

SEM: Scanning electron microscopy	PEG-300: Polyethylene glycol-300
dc: Direct current	8OCB: 4-cyano-4'-octyloxybiphenyl
BCLC: Bent-core liquid crystal	5CT: 4-cyano-4'-pentylterphenyl
FNPs: ferroelectric NPs	IPS: in-plane switching
N: nematic	CN: cyano
rpm: rate per minute	DCR: Defect core replacement
OA: oleic acid	ADCT: Adaptive defect core targeting
KBr: Potassium Bromide	LLCs: Luminescent liquid crystals
-COOH: Carboxylic group	N: Nematic
COO ⁻ : carboxylate ion	N*: Chiral nematic
SmX: smectic-X	TPE: Tetraphenylethylene
Cr: Crystal	TPE-PPE: Tetraphenylethylene propylphenylethyne
P: Polarizer	7CB: 4-cyano-4'-heptylbiphenyl
A: analyzer	BINOL: 1,1'-binaphthol
R: Rubbing direction	FDA: Naphthalimide phenylalanine diacetylene
Iso: Isotropic	8CB: 4-cyano-4'-octylbiphenyl
N _{cyb} *: Cybotactic nematic	CLSM: Confocal laser scanning microscopy
M ₁ : Soft mode	SmA*: Chiral smectic-A
M ₂ : Short-axis reorientation mode	-CONH-: Amide bond
M ₃ : ITO mode	LCPG: Liquid crystal physical gel
DTCs: Doubly twisted cylinders	PDLCs: Polymer-dispersed liquid crystals
PNPs: Polymer nanoparticles	PNLCs: Polymer network liquid crystals
Pdots: Polymer dots	CB15: S-4'-(2-Methylbutyl)-4-biphenylcarbonitrile
DMOAP: Dimethyloctadecyl-3-(trimethoxysilyl)propyl ammonium chloride	TLC: Thin-layer chromatography
PDA: Polydopamine	amyloid- β : (A β)

DCM: dichloromethane	CF ₃ CO–: trifluoroacetyl
DSO: Digital storage oscilloscope	CF ₃ : trifluoromethyl
FF (1 wt.%) mixed 5CB: n ₁	C=O stretch: amide-I
FF (2 wt.%) mixed 5CB: n ₂	C.D.: Chiral dopant
FF (3 wt.%) mixed 5CB: n ₃	CAB: HCl-sensitive C.D. receptor
FF (4 wt.%) mixed 5CB: n ₄	ppm: Parts per million
FF (1 wt.%) mixed cholesteric host (S811 (3 wt.%) mixed 5CB): c ₁	FF: Pseudopeptide gelator
FF (2 wt.%) mixed cholesteric host (S811 (3 wt.%) mixed 5CB): c ₂	MeOH: Methanol

LIST OF SYMBOLS

$\hat{n}$: Nematic director	n_e : Extra-ordinary refractive index
P_S : Spontaneous polarization	δ : Phase difference/Optical retardation
β : Helical twisting power	v_o : Velocity of o-ray
p : Pitch	v_e : Velocity of e-ray
c : Concentration of chiral dopant	F_e : Oseen-Frank energy
nm: nanometers	I_0 : Incident light intensity
S : Orientational order parameter	ϕ : Angle between the optic axis and polarizer direction
Ψ : Positional order parameter	Δn_{eff} : Effective birefringence
θ : Angle between the long axis of the LC molecule and the average director axis	$n_e(\theta)$: Effective extraordinary index
$\rho(z)$: Density of the centre of mass of molecules favors a tendency to spend more time in the layer than in the inter-layer region	E : Electric field
ε : Permittivity	f : Frequency
$\varepsilon_{\parallel}$: Permittivity along the long axis of LC molecule	$\varepsilon^*(f)$: Complex permittivity
$\varepsilon_{\perp}$: Permittivity along the short axis of LC molecule	ε' : Real part of permittivity (Energy storage ability)
$\Delta\varepsilon$: Dielectric anisotropy	ε'' : Compex part of permittivity (dielectric loss)
V_{th} : Threshold voltage	C_0 : Empty cell capacitance
F : Electrostatic free energy	$C(f)$: Measured capacitance
V_c : Critical helix unwinding voltage	$\Delta\varepsilon_k$: Dielectric strength of k^{th} mode
d : Thickness of liquid crystal cell	τ_k : Relaxation time of k^{th} mode
K_{11} : Splay elastic constant	α_k : Symmetric broadening parameter k^{th} mode
K_{22} : Twist elastic constant	β_k : Asymmetric broadening parameter of k^{th} mode

K_{33} : Bend elastic constant	τ_f : Fall time
ϵ_0 : permittivity of free space	$\Delta n_{\text{induced}}$: Induced birefringence
Δn : Optical birefringence	K : Kerr constant
n_o : Ordinary refractive index	$\Delta V_{0.5}$: Voltage difference between the forward and backward curve at half of the peak transmittance
n : Mobile ion concentration	λ_{SR} : Selective reflection wavelength
D : Ion diffusion coefficient	n_{avg} : Average refractive index
q : Electronic charge	a : Cubic lattice parameter
ϵ'_b : Bulk dielectric constant	h, k, l : Miller indices of the blue phase cubic structure
$\sigma(f)$: Frequency dependent conductivity	Haze(%) : Haze percentage
σ_{dc} : DC conductivity	T_1 : Incident light intensities with standard reflector
f_h : Hopping frequency	T_2 : Transmitted light intensities with standard reflector
m : Power law exponent	T_3 : Incident light intensities without standard reflector
L : Cell thickness	T_4 : Transmitted light intensities without standard reflector
f_{max} : Abscissa corresponding to ionic peak in $\tan \delta$ plot	$F(R)$: Kubelka-Munk function
$(\tan \delta)_{\text{max}}$: Ordinate corresponding to ionic peak in $\tan \delta$ plot	α : Absorption coefficient
k_B : Boltzmann constant	S : Scattering coefficient
T : Absolute temperature	Φ_{abs} : Absolute quantum yield
R_s : Series resistance	E_{em} : Emitted photon flux
$I(t)$: Total current	E_{abs} : Absorbed photon flux
A : Active Electrode area	A_i : Pre-exponential factors
$\Delta V(t)$: Voltage drop across the load resistor during the polarization reversal	τ_i : Characteristic lifetimes associated with different decay channels

η : Rotational viscosity	g_{lum} : Luminescence dissymmetry factor
τ_s : Switching time	I_L : Left handed circularly polarized light emission
τ_{FWHM} : Time extracted from the full width at half maximum (FWHM) of the polarization peak	G' : Storage modulus
τ_r : Rise time	G'' : Loss modulus
I_R : Right handed circularly polarized light emission	δq : Uncertainty in quantity q

LIST OF SYNTHESIS SCHEMES

Scheme 6.1 Steps involving the synthesis of the FF pseudopeptide gelator.....	136
Scheme 7.1 Steps involving the synthesis of the CAB chiral dopant.....	159