Preparation of Liquid Crystals-Nano Particles Composites

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Abstract

Revolutionary developments in the fabrication of Nano sized particles have created enormous expectations in the last few years for the use of such materials in areas such as medical diagnostics and drug-delivery, and in high-tech devices. By its very nature, nanotechnology is of immense academic and industrial interest as it involves the creation and exploitation of materials with structural features in between those of atoms and bulk materials, with at least one dimension limited to between 1 and 100nm. Most importantly, the properties of materials with Nano metric dimensions are, in most instances, significantly different from those of atoms or bulk materials. Research efforts geared towards new synthetic procedures for shape and size-uniform Nano scale building blocks as well as efficient self-assembly protocols for manipulation of these building blocks into functional materials has created enormous excitement in the field of liquid crystal research. Despite the seeming diversity of these research topics, this review will make an effort to establish logical links between these different research areas.

Keywords: Liquid crystals, Nano metric

1. Introduction

Substances known as liquid crystals display a phase of matter with characteristics half Way Between those of a crystalline solid and a regular liquid. Liquid crystals (LCs), for example, have molecules that are orientated and/or organized in a manner similar to that of a crystal, yet they flow like liquids. The several phases that the LCs has are referred to as mesophases.LC phases come in a wide variety of forms, and they can be identified by their disparate physical characteristics (such dielectric and birefringence). The kind of ordering that exists can be used to categorize the different LC phases. Order can be classified as either short-range (limited to molecules near each other) or long range (extending to larger, occasionally macroscopic dimensions). Positional order can be defined as whether Molecules are arranged in any kind of ordered lattice, while orientation order can be defined as whether molecules are primarily pointing in the same direction. The two types of LCs are Lyotropic and thermo tropic LCs. Whereas Lyotropic LC exhibit phase transitions as a function of temperature and the concentration of the Mesogen in a solvent (usually water), thermo tropic LCs exhibit a phase transition into the LC phase as temperature is changed, and most thermo tropic LCs will have an isotropic phase at high temperatures [372–379]. Nematic LCs is among the most prevalent types of thermo tropic LCs, characterized by long-range orientation order in the molecules but no positional order. Because of their anisotropic physical properties and elastic mediated interaction between medium and foreign objects, Nematic liquid crystals (NLCs) emerge as a smart fluid for dispersing Nano structures (i.e. Nanoparticles, nanotubes, and quantum dots), which is promising for self-assembly of nanostructures. Furthermore, because of the NLCs' surface anchoring, the Nano-structures and the NLCs Matrix may share inherent qualities. Therefore, scattered nanostructures in NLCs may change the characteristics of composites that are beneficial for usage in devices [380]. NLCs Nano-structure composites have garnered significant interest from scientists in the fields of soft matter and Nano science due to their extraordinary capabilities, which have led to the emergence of a multidisciplinary research area [381–383].

2. Experimental techniques

To prepare the LCs NPs composites, a small weight percentage of NPs will be added to the NLCs. In order to achieve homogenous dispersions; the composites will be agitated during the Isotropic phase of LCs using a hot plate and magnetic vibrator. The Differential Scanning Calorimeter (DSC) of the NETZSCH model DSC-200-F3 Maia will be used to conduct the thermodynamically analysis of the pure and dispersed samples. For fully-grown peaks, transition temperatures, transition enthalpy, and entropy will be Calculated to within 0.1 ºC of each other. The composites of NPs and LCs will be placed in a parallel plate capacitor constructed from glass electrodes coated with indium tin oxide (ITO) for electro optic measurements. A polarized light microscope (PLM) will be used to verify the homogeneous dispersion of NPs in the LCs matrix. White light transmission intensity sensor (manufactured by Instec, USA) mounted on a PLM will be used to measure the photovoltaic output, while an Aglientmultimeter (model 34410A) with six and a half numbers will be used to measure the photovoltaic output. Plots of the Transmission-Voltage (T-V) curve will be made for both pure and composite LCs. From the T-V curve, the switching threshold voltage (Vth) will be ascertained. A Newton's Phase Sensitive Multi Meter (model PSM1735) in conjunction with an Impedance Analysis Interface (IAI model-1257) will be used to collect dielectric data in the 1 Hz–35 MHz frequency range. With a temperature resolution of 3 mK and an accuracy of ±0.1 ºC, an Instec hot stage (model HS-1) will be used to regulate the temperature of the samples for the Dielectric studies.

3. Result and Discussion

The primary goal of the proposed work is to examine the key physical characteristics of composites that will be helpful for the development of new potential display and molecular electronic devices, including transmission voltage characteristics, switching time, threshold voltage, viscosity, elastic constant, permittivity, dielectric anisotropy, relaxation frequency, dielectric strength, and C-V characteristics. The task described here has two components. On the one hand, it seeks to delve deeper into the fundamental understanding of the properties of the LC-NPs composite, with particular attention to the interaction between liquid crystal molecules and Nano particles. As one of the "bottom-up" approaches to Nano technology, this will be helpful to control the spatial arrangement of the particles by dispersion in liquid crystal phases. Conversely, the goal of dispersing nanoparticles is to improve the physical and electro-optical characteristics of the liquid crystal host. Ferro electric and metallic Nano particles are among the fascinating materials that Nano technology is producing that continue to pique researchers' curiosity the most. By creating composites, the unique qualities of Nano particles can be used to augment or improve the properties of functional materials. These Nano-composites combine the structural and functional flexibilities of the host with the optical and electrical tenability of Nano particles. LCs is an intriguing class of soft materials with remarkable self-orientation properties that can be manipulated by an external stimulus, such as an electric or magnetic field [383]. Ag-NPs, or metal nanoparticles, have been found to enhance the electrical and electro optical properties of NLCs 4-(Trans-4-n- hexylcyclohexyl) are othiocyanatobenzoate (6CHBT). These properties include lower effective ion content, a faster electro-optic response because of the reduced rotational viscosity, a lower Threshold voltage and a quicker response time of the host materials [384]. The percolation limit on the amount of NPs that can be dispersed in LC medium remains a topic of interest and debate despite initial experimental observations. The achievement of homogenous dispersion of NPs remains a challenge. The development of NPs in liquid crystal medium with high quality dispersion and no aggregation could lead to the development of new devices using LC-NPs composites. These investigations also shed light on the fundamental characteristics of composite materials, particularly with regard to the interactions between liquid crystal molecules and nanoparticles. Therefore, these studies could help with nanoparticle self-assembly using liquid crystal Orientation forces.

4-(trans-4-n-hexylcyclohexyl) Isothiocyanatobenzoate	**Name of NPs with place from where they procured**
H3C N C S **6CHBT Cr** 12.5 oC **N** 43.0 oC **I** **4'-pentyl-4-cyanobiphenyl** **Cr** 20.0 oC **N** 35.0 oC **I** **NLCs mixture (Merck, Code-1049M8016130010)** **Cr** 8.0 oC **N** 51.0 oC **I**	Silver nanoparticles (Sigma-Aldrich), Barium–Titanate nanoparticles (Sigma-Aldrich).

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