STUDY OF LIQUID CRYSTALLINE POLYMER SYNTHESIS AND ITS CHARACTERIZATION TECHNIQUES

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Abstract

Liquid crystals (LCs) have intrigued the scientific community's interest throughout the recent decades. Liquid crystal distinctive features, as well as its vast range of applications, have been intensively studied. However, their synthesis and successful characterisation have started the process of evaluating their usefulness in several domains. Certain characterization procedures evaluate a compound's potential to possess liquid crystal quantities, as not all alignment could demonstrate Liquid crystal behaviour, making it an unsuitable candidate for further application. Here, we concentrate on the liquid crystalline polymers characterization techniques and synthesis.

Keywords: *Liquid Crystal, Polymerization, Synthesis process, Characterization*

Introduction

Liquid crystalline polymers (LCPs) are made up of two primary types of units: rigid and flexible. Although the hard component is due to molecular alignment, the flexible part is due to the liquid crystal's fluidity. Mesogen is the stiff element of the LCP texture, and it plays an important role. As a result, achieving the best balance of these two components during the production of liquid crystalline polymer is critical. Because of its great rigidity, benzene is frequently used as the backbone of LCPs. TLCPs (thermotropic liquid crystalline polymers) are created when heated and then cooled. LCPs have potential applications [1] in a variety of industries, the most common of which is liquid crystal display. Padmavathy et al. [2] created an isocyanate-based mesogen for the manufacture of liquid crystal polymers. Mulani et al.[3] synthesised and characterised azoxy-based mesogenic diols in another investigation.The cholesteric thermotropic liquid crystalline polyesters based on isosorbide were synthesised by Chavan et al. [4] in 2011.Protective coatings, adhesives, structural foams, and high-strength composites are all possible applications [5] for TLCPs. In aircraft applications where the usage of existing materials is challenging [6], TLCPs are commonly employed for protective coatings. Due to their viscosity, high-molecular-weight polymers are difficult to process. TLCPs are also utilised to treat high-molecular-weight polymers that are impossible to process using traditional methods [7].

Problem Definition

The research is entitled as, "**Study of Liquid Crystalline Polymer Synthesis and Its Characterization Techniques".**In the present study it is planned to exploit further the current and desirable characteristics of mesomorphic liquid crystalline polymers. Moreover, it is proposed to synthesize mesogens with a terminal group having high dipole moment to give compounds which can exhibit positive dielectric anisotropy

Objective

The main objective of this research is to explain the concept of "**Study of Liquid Crystalline Polymer Synthesis and Its Characterization Techniques**", to identify the issues related to the model, and to suggest ways of resolving them.

- To discuss the various methods of synthesis of new kind of liquid crystalline polymers and its essential properties.
- To explore the techniques of characterization of liquid crystal.

Scope of Study

over three decades were passed since first publications appearance committed to the LC polymers that are thermotropic study and synthesis containing mesogenic organisations (liquid crystals with a poor molecular mass model molecules) both in molecular chain and side strands (polymer backbone polymers that are liquid crystalline) (polymers that are liquid crystalline side chain as well as polymers that are Comb shaped). Liquid crystalline polymers are the latest high growth area based on hydroxy naphthalene or hydroxy benzoic acids or bisphenols - all with a basic aromatic polyester skeleton. LC polymers are new type of product with strength to weight ratio seven times of steel wire. Their impact strength is very high even in thin sectioned parts. The present time is characterized by the rapid development of studies aimed at construction of nanostructured materials with external stimuli controlled physicochemical properties, because of this greater scope of this study.

Polymerization of LC

Polymers including better-disciplined molecule placement in each of the three dimensions draw a lot of attention due to its odd yet highly precisely accurate as well as locate optical, mechanical and electrical capabilities. Monomers for liquid crystals (LC) polymerization via photoinitiation [8-11] is a common method for generating well-ordered polymer networks. Working with reactive mesogens with low molecular weight allows for a large range of self-organizing molecular structures. A photopolymerization approach [12-15] may lock every one of these molecular order types it into polymer network, utilising an alignment phases and techniques variety.

Photopolymerization is highly quick, that was the benefit of suppressing phase transitions and separation while the pyrolysis process.

Rub-on polymer (typically polyetherimide) exteriors, surfactant-treated substrates, outer external electromagnetic sectors, as well as flows are all known strategies for constructing In LCs, there is a single unified molecular sequence. Surprisingly, they seem to be frequently combined to produce coverings includes much more intricate molecular structures [16].

Structures are printable, as well as a photopolymerization method enables local polymerization using the photomask to produce micrometre-scale structures. Self-organization of the LC but also polymerization on a local (lithographic) scale combination is an excellent example of a top-down/bottom-up structuring technology [16, 17].

Synthesis of Liquid Crystalline Polymers

Melting and dissolution are the two processes through which is a term that refers to a crystal lattice including an organized arrangementcan become the somewhat disordered LC, depending on whether a LCs are thermotropic or lyotropic, respectively. Thermotropic LCs create mesophases by varying the temperature, whereas lyotropic LCs require a solvent present, as well as mesogens are formed; not the solubilized molecules themselves, but their own associates and solvates [18].

➢ **Natural Oil Based LCPs**

Cardanol was used to make LCPs to network architectures that are interconnected including mesogens of azobenzene [19]. The group azobenzene has been created through a coupling diazo process among 4-aminobenzoic acid and cardanol. A resultant monomer, benzoic acid 4-[(4-cardanyl) azo], has been polymerized ustilizing pyridine and thionyl chloride by self-polycondensation to provide poly[4-[(4-cardanyl)azo]benzoic acid]. Through acryloylation and free radical polymerization, Poly[4-[(4-acryloyloxycardanyl)azo]benzoic acid] might be formed through the monomer. Poly[4-[(4-cardanyl)azo]benzoic acid] has been obtained throughcationic polymerization of the monomer. The polymers are made from cardanol as shown in Figs. 1, 2, and 3 [19].

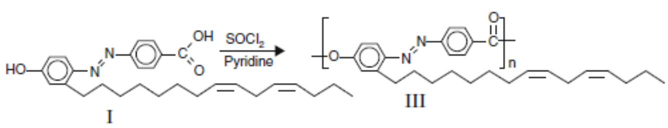

Fig. 1: Poly[4-[(4-cardanyl)azo]benzoic acid] Synthesis

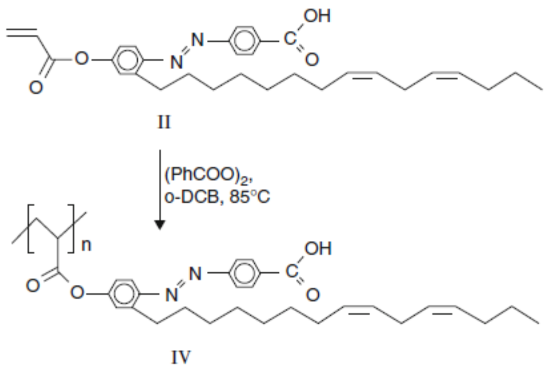

Fig. 2: Poly[4-[(4-acryloyloxycardanyl)azo]benzoic acid] Synthesis

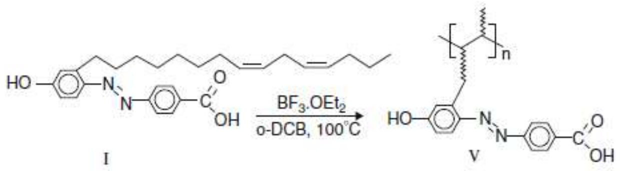

Fig. 3: Poly[4-[(4-cardanyl)azo]benzoic acid] Synthesis

LCPs includes a lipid base

The term "amphiphilic lipids" refers to a molecules classthat are entirely unique which don't change abruptly throughsolid state to liquid form, although instead traverse through states that are 'intermediate' in which features can be noted in liquids and solid crystals. Temperature changes are attributed to so mesomorphic behaviour, which cause 'chain fusion,' or the alkyl chains transformation to a low organized list due to grow thermodynamically occurrence unfavourable ring knots as well as, as a result, grow chain space needs ('transition to a thermotropic phase,') as well as to modification in the state of hydration, which cause groups of polar heads binding to liquid while becoming hydrated.Soy lecithin and Egg lecithin is two amphiphilic fats which can be converted to LCs or used in intravenous fluid medication management.

Except that there are other LCP synthesise exist such as:

- Nanocellulose base LCPs
- Cellulose derived LCPs
- Protein based LCPs
- Chitin and Chitosan based LCPs

Characterization of Liquid Crystals

The characterization of the liquid crystalline phase is done using a variety of techniques, including DSC, PLM, and XRD.

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- **Differential Scanning Calorimetry**

DSC is a useful method for determining transition temperatures and differentiating between phases. This approach was used to confirm a phenylenedimeramidepara or (PPD) liquid crystal structure with lamellar produced with as a forerunner, essential oil.

Microscopy with Polarized Light

Microscopy with Polarized Lightis a frequently utilised method for studying and identifying the phases that LCs show. Various textures can be noticed when a TLLC is located between the two glass cover plates as well as examined by a Microscopy with Polarized Light at appropriate conditions or temperatures, based on the LC phase type. The interference of light waves travelling through the material creates beautiful kaleidoscopic visuals known as textures.

Technique of X-Ray Diffraction

A thermotropic LC phase securing chains strategy in CnPCs, as determined by wide angle XRD structural characterisation, showed a strong diffraction high point inside the area of low 2θ among3^oas well as 8^o. Moreover, when a methylene units grows number, a diffraction peak's d-spacing increases from 1.20 nm in C2PC to 1.37 nm in C5PC to 1.86 nm in C6PC. The presence of positional order on a quasi-long or short range scale is indicated by these diffraction peaks.

Conclusion and Future aspects

Displays made of liquid crystal or LCDs, thermometers made of liquid crystals, hyperspectral imaging, as well as a wide variety of many other industrial uses are among the most promising candidates. LCs will play a more essential part in modern technology as research in these subject progresses and new applications emerge. Because most LC compounds are polymorphic, determining their specific phases is critical for determining its destiny for various use. Numerous characterisation methods, such as XRD, POM, and DSC, possess shown to be less effective for determining the liquid crystalline characteristics of a wide range of substances. Many novel approaches for analysing various characteristics of LCs have also been established, and as new applications for these compounds are contemplated, new characterization techniques will emerge in the future.

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