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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 appliscations, 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 polymer's characterization techniques and synthesis.

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

1. 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 Bloch et al. [4] in 2011. Protective coatings, adhesives, structural foams, and high-strength composites are all possible applications for TLCPs. In aircraft applications where the usage of existing materials is challenging [5], 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 [6].

2. Methodology
In this work two liquid crystalline polymers synthesis has been discussed. Various methods has been described for the preparation of 4-n-alkoxy benzaldehydes, but following procedure is adopted in this investigation as it gives better results, 4-methoxy benzaldehyde as the first member of the series will be bought and purified of (BDH)

grade. 4-n-Alkoxy benzoic acids are prepared by the method of Dave S Vora [7], though other methods are known in the literature as it gave better yield.

2.1.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 [8].

2.1.1. Natural Oil Based LCPs

Cardanol was used to make LCPs to network architectures that are interconnected including mesogens of azobenzene [9]. 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 [9].

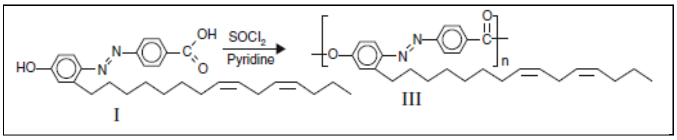

Fig. 1: Poly[4-[(4-cardanyl) azo] benzoic acid] Synthesis

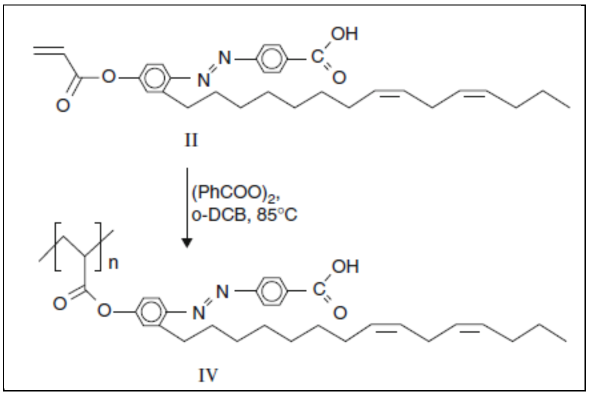

Fig. 2: Poly[4-[(4-acryloyloxycardanyl) azo] benzoic acid] Synthesis

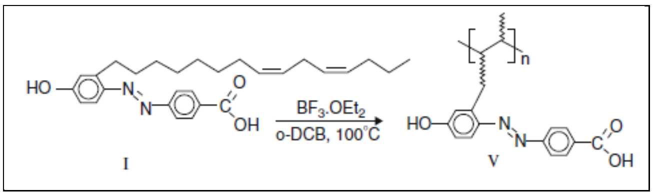

Fig. 3: Poly[4-[(4-cardanyl) azo] benzoic acid] Synthesis

2.1.2. 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:

3. Nanocellulose base LCPs
4. Cellulose derived LCPs
5. Protein based LCPs
6. Chitin and Chitosan based LCPs

3. Characterization of Liquid Crystals

Elemental analysis of liquid crystals and liquid crystalline polymer samples were performed on Perkin-Elmer model 240 microanalyzer. All the liquid crystalline materials were screened during heating by using a polarizing microscope to check their melting behaviour and mesogenic character.Viscometric study of solutions of polymer samples were also carried Graphical method. Some selected liquid crystals were studied by using DSC apparatus to correlate the transition temperatures obtained by thermal polarizing microscopy and to calculate enthalpy changes and entropy changes. Some selected liquid crystals were studied by using DSC apparatus to correlate the transition temperatures obtained by thermal polarizing microscopy and to calculate enthalpy changes and entropy changes.

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

3.1.Differential Scanning Calorimetry

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

3.2.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.

3.3.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^{o}as well as 8^{o}. Moreover, when amethylene unit 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.

4. 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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