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Implications of Banana Shaped Liquid Crystal in Display Mode

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ABSTRACT

Due to high carrier mobility, the liquid crystals have gained much importance in the field of light and these crystals are used in organic light emitting devices. The shape of classical thermotropic liquids is found to be disk or rod alike. It is considered that the modification in liquid crystals can be done easily because of the fact that the molecules are joined together sterically. There physical properties are complex due to the reason that their molecular structure is not conventional. Since molecules in liquid crystals are polar packed so they tend to show ferro or anti-ferroelectric properties. It is observed that the direction of banana-shaped molecules in liquid crystals is aligned within layers so some characteristics of ferro-electricity are found in these crystals. The current paper describes the implications of banana-shaped liquid crystals in display mode.

Keywords: Banana-Shaped, Liquid, Crystal, Molecule.

I. INTRODUCTION

In banana shape, molecules get less freedom to rotate due to the existences of bend in the core. It is observed that the structure of molecules depressed in layers if the cohesion in the chain is strong. The rotation of molecules is found to be hindered as the molecules are adjoined within the layers.

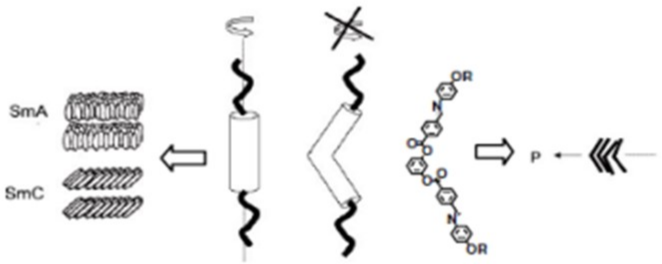

Figure 1: Comparison of calamitic and bent-core molecules and their organization in smectic layers

Spontaneous polarization is found among the layers due to directed structure. This polarization can be in parallel or non-parallel to the direction of bend. As a result, bent core molecules form mesophases so as to get through from a parallel alignment in layers.

It is observed that due to the collapsing of layers, segments of ribbon are formed in semantic layers. These ribbons are arranged in such a way that the molecular direction in adjacent ribbons is observed to be anti-parallel. As a consequence, some space is formed from polar order.

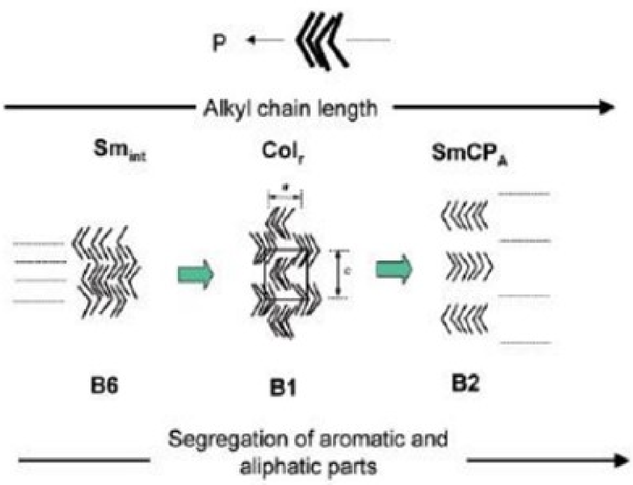

Figure 2 : Columnar phases (B1) and intercalated smectic phases (B6) resulting from the collapse of the polar smectic layers

II. RESEARCH STUDY

Aligned calamitic liquid crystals are uniaxial, due to their shape and polarization anisotropy, and are therefore birefringent, exhibiting different properties for light traveling with the electric field propagating parallel and perpendicular to the director or optic axis. Birefringence is a property usually associated with transparent crystals with a noncentrosymmetrical lattice structure (e.g., calcite). The free rotation in liquids averages out any asymmetry of molecular shape and renders the optically isotropic. The electric vector of incident plane polarized light entering a birefringent medium is split into two mutually perpendicular components called the ordinary (o) and extraordinary (e) rays. The electric field of the o-ray is always perpendicular to the optic axis, so its refractive index no is a constant independent of propagation direction.

The elastic behavior of a liquid crystal phase under a distorting force, such as an electric field or at an interface with a solid surface is determined by the three elastic constants, k11, k22, and k33 that are associated with splay, twist, and bend deformations, respectively). The elastic constants are molecular parameters and describe the restoring forces on a molecule within a liquid crystalline phase in response to an external force that distorts the medium from its lowest energy configuration. The elastic constants co-determine the spatial and temporal response of the director to applied external electrical and magnetic fields. They are also obviously important for surface-stabilized electro-optic displays displaced from their equilibrium states by dielectric interaction with an applied electric field. The equilibrium position is then restored upon removal of the field by elastic forces that originate at the surface between the liquid crystal and the orientation layers that cover the device substrates.

The flow viscosity of the liquid crystalline state is also an anisotropic property, depending on the direction of flow of an individual molecule with respect to the director at any one point within the medium. Three parameters are required to characterize the viscosity of the nematic state, due to the shape anisotropy of its constituent molecules. These are η1, which is perpendicular to the direction of flow, but parallel to the velocity gradient; η2, which is parallel to the direction of flow, but perpendicular to the velocity gradient; and η3, which is perpendicular to the direction of flow and to the velocity gradient. The bulk viscosity of an unaligned nematic liquid crystal is an average of these three viscosity coefficients.

However, individual viscosity coefficients influence the optical response times in an electro-optic display device, due to the constrained anisotropic environment imposed by the boundary conditions and the unidirectionality of any applied electric field. Such an environment is represented by the rotational viscosity γ1, which, in the nematic phase, is associated with the movement of a molecule from a homogeneous planar conformation parallel to the cell surfaces to a homeotropic conformation with the long molecular axis (director) perpendicular to the cell walls and parallel to the applied electric field.

III. DISCUSSION

In the smectic phase, the molecules are tilted at an angle θ from the axis normal to the plane of the layer, forming a mirror plane. This tilt angle is a molecular property and is the same for all molecules of the same compound in the pure state, although it is a temperature-dependent physical parameter. However, the molecules are free to rotate around the layer normal (i.e., around the zenithal axis) on the surface of cone.

Displays that use liquid crystals generally consist of a very thin layer of a nematic or smectic liquid crystal mixture enclosed between two transparent parallel glass substrates hermetically sealed around the edges. The glass plates are held apart by solid spacers (fibers, strips, or beads) to form a uniform cell gap (≈ 2–10 μm), which should be as uniform as possible across the visible area of the display. Thicker cells are generally not used, because they are turbid, due to light scattering, as well as exhibit much longer response times. The inner surfaces of the glass substrates are coated with a whole series of thin, transparent layers with different functions.

The first coating is often a barrier layer (e.g., silica) to prevent leaching of ions from the glass substrates into the liquid crystal, which should be a dielectric with a high resistivity. Color LCDs often incorporate a regular pattern of red, green, and blue color filters that correspond to the pixel pattern. However, the absorption of the other colors at each pixel gives rise to insufficient brightness for LCDs driven in reflection. Therefore, LCDs with color filters are driven in transmission or transflection (transmission and reflection) with a powerful backlight. The next layer is a transparent conducting material, most often indium–tin oxide (ITO), between which the electric field is applied; early displays often used NESA.

Passively addressed LCDs with multiplexed addressing utilize electrodes in a series of rows on one electrode surface and columns on the other electrode surface that are arranged orthogonal to each other. Actively addressed LCDs use a silicon substrate with a series of thin film transistors combined with a (structured or unstructured) back electrode on the other glass substrate. On top of the electrode surface, there may be another thin protective layer to prevent migration of ions into the liquid crystal mixture. The last layer is an alignment layer that is in direct contact with the liquid crystal mixture and is used to induce a homogeneous, uniaxial orientation of the local optic axis, which is usually coincident with the director in the azimuthal plane of the device. The alignment layer should induce the desired direction of the director at both of the substrate surfaces, depending on the type of LCD. In directly addressed or multiplexed addressed LCDs, the two glass substrates are offset to some extent to allow physical contact with the drive electronics. The contacts usually are composed of plastic sheets with alternate strips of conducting and insulating polymers, whose dimensions correspond to the width of the electrodes on the substrate. In high-information-content displays, electrical contact is often achieved by using patterns of conducting adhesives attached directly to the motherboard.

IV. SIGNIFICANCE OF THE STUDY

Once the cell has been constructed, it is evacuated through a small hole to produce a vacuum and then filled with the appropriate liquid crystal mixture under an inert atmosphere. The area around the hole is cleaned to remove excess liquid crystal and then hermetically sealed (e.g., with epoxy resin or even gold). The chosen direction of alignment at the glass substrates is dependent on the optics of the type of LCD. For many types of LCDs, a sheet of polarizer is then attached to the outer surface of one or both substrates—usually by contact bonding. The polarization direction makes angles, α and β to the direction of rubbing at each surface and, therefore, the optic axis (director) of the liquid crystal mixture. Sheets of optical retarders also may be placed between the glass substrates and the polarizers. External plastic sheets, which scatter more transmitted light through a wider viewing angle cone, also may be attached.

The first commercial LCDs were constructed with direct addressing. With this type of addressing, the off voltage can be zero, and the on voltage can be several times the threshold voltage for switching. Therefore, in a twisted nematic (TN) LCD, where the electro-optical characteristic is relatively flat, a good contrast can be attained, as well as low power consumption. However, the need for displays with higher information content (e.g., sophisticated calculators, personal organizers, notebooks, and portable computers) requires more complex addressing schemes, due to the high cost of using many drivers and the absence of sufficient space for the profusion of electrical contacts.

A high-information-content display contains a very large number of pixels, each of which has to be addressed. Individual connections to each element would require M × N connections. There is a limit above which it is impossible to physically connect all the pixels. Multiplex addressing, however, with M electrode columns and N electrode rows allows M × N pixels to be driven by M + N connections, thereby significantly reducing the number of electrode connections.

V. CONCLUSION

In an LCD with multiplex addressing, parallel lines of electrodes are etched onto both glass substrates and then positioned so that they are perpendicular to one another, resulting in a matrix of rows and columns. Each row is sequentially scanned by a scan or select pulse (Vs), whereas the columns are addressed by data pulses (Vd), which contain the information to be displayed. As voltage is applied sequentially to each row, voltage pulses are applied to the corresponding columns. When the combination of row and column voltages in phase with each other is greater than the threshold voltage, the liquid crystal responds to the applied voltage and the pixel is turned on.

An appropriate reduction in the voltage applied to one electrode turns the pixel off. For most nematic LCDs, the root mean square (rms) voltage is the relevant switching parameter, because the response of the liquid crystal is caused solely by an induced polarization of the nematic medium that varies with the square of the applied electric field. Unfortunately, the number of addressable lines in a multiplexed LCD with good legibility is limited, albeit to a much lesser extent than direct addressing.

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