

ANALYSIS OF BANANA SHAPED CRYSTAL AND THEIR CHARACTERIZATION

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ABSTRACT

The helical super structures can be formed if the direction of molecular bent alignment is disfavored. In banana mesogens, axis is found at ninety degree angle of the layer planes. Liquid crystal phase can be formed easily with bent core molecules having number of rings ranging from five to seven.

It is observed that the existence of banana shape depends on various factors like conjugation, doplar moment and position of charges etc. The current paper characterize the banana shaped crystal and their assemblies.

KEYWORDS: *Banana-shape , crystal, molecule*

INTRODUCTION

Change in the mesomorphic behavior is noticed if some change is found in the molecular structure. It is also noticed that the linking groups ; which are used to connect different rings in banana-shaped mesogens ; can influence the chemical nature.

The mesospheric behavior of banana-shaped crystals can be changed with the help of lateral substituent. In this case, the mesospheric nature depends on the factors such as electronic properties, volume and position of the substituent.

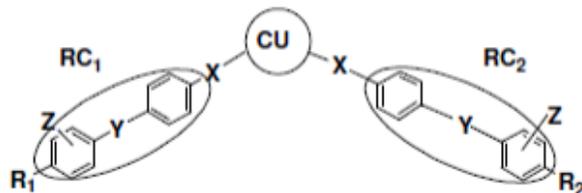


Figure 1: General template for the molecular structures of banana shaped mesogens

The main role of various substituents in bent-core molecular segment is to minimize the melting point and isotropization temperature. In some cases, it is found that

these substituents may destabilize mesomorphism or increase the thermal range of mesophase.

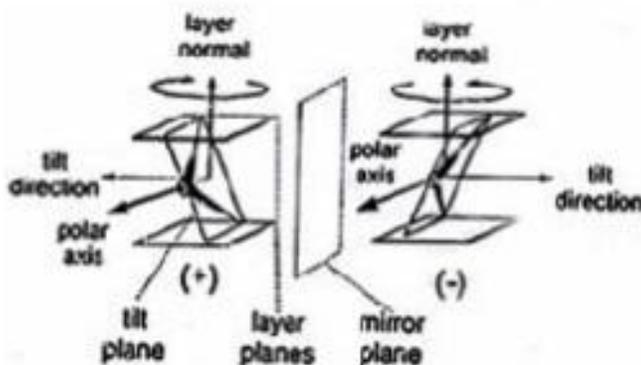


Figure 2: Geometric chirality of polar smectic layers formed by tilted bent-core molecules

In most cases alkyl or alkoxy chains are used as terminal groups to build banana-shaped mesogens. The trend in clearing temperatures with the increasing number of carbon atoms in the chain can either enhance, decrease or can be independent of the chain length.

The terminal chains can also be linked by sulphur, carbonyl or carboxylic groups to the rigid outer rings. Usually the introduction of perfluoro alkyl chain is

accompanied with a strong increase in the transition temperatures.

Recent reports indicate that the appropriate terminal substituents can be used as an important structural parameter for obtaining ferroelectric switching in banana mesophases. The racemic or chiral terminal tail comprising of 2-octyloxycarbonyl group was employed to promote the formation of anticlinic interlayer interfaces based on the fact that ferroelectric structures require an

anticlinic interlayer correlation in bent core systems.

RESEARCH STUDY

Several remarkable advances in bent-core molecular architecture have resulted from the directed synthesis of new molecules. This to an extent circumvents the existing problems in the field and led to the discovery of new phases. For example, bent-core mesogens having a polar cyano group instead of the usual alkyl or alkoxy group on one arm of the bent core represents the first examples of thermotropic mesogens exhibiting a direct transition from N to the polar partial bilayer biaxial smectic phase in pure compounds.

Shape biaxiality of the cyanobiphenyl unit (a rod like molecule known to exhibit Nu phase) was enhanced by attaching bent-core molecules to realize Nb phase; one of the most sought after phases in thermotropic LCs. More recently hydrogen bonded supramolecular self-assembly process has been employed as a useful strategy to obtain different multifunctional banana-shaped liquid crystals

These approaches offer new way to control microscopic and macroscopic structure and its response to the external fields. Thus banana-shaped mesogens represent a new sub-field in thermotropic LCs which not only have attracted attention from the stand point of fundamental research but also in terms of their possible usage in technological applications especially to devise new ferroelectric switches.

Despite the fact that these mesogens lack molecular chirality, they form macroscopic chiral structures such as ferro- and /or antiferroelectric smectic phases and also helical superstructures that are not comparable with chiral fluid phases exhibited by conventional LCs also arose significant interest. A large number of studies involving molecular design and synthesis have evidenced that the mesomorphic behavior of bent-core molecules depends critically on the nature of molecular subunits such as rigid aromatic cores, linking groups, lateral substituents, and terminal chains.

In majority of the cases five ring resorcinol-based banana-shaped molecules have been investigated with variations in terminal chains, connecting groups and lateral substitutions. It has been revealed that, the lateral substituents at the central and terminal aromatic cores, profoundly influence the thermal behavior which in turn depends on the nature (electronegativity and size) and the position at which they are attached.

Particularly, the influence of the substituents at the central core is found to be dominant. To substantiate such observations there is a need for the further investigations on molecular systems that comprise of new rigid cores.

All nine Schiffs-base typed compounds that have been synthesized exhibit liquid crystalline phases. As in most banana-shaped liquid crystals, a phenyl or biphenyl central part promotes the formation of B-

phases. All the compounds are meta stable in nature.

DISCUSSION

A liquid crystal phase of matter can be described as one where the constituent molecules are sufficiently disordered to confer the flow properties of a liquid, yet still retain some degree of ordering such that the phase is anisotropic. Not surprisingly, given this broad definition, many different types of liquid crystal phase are known, and these are very basically classified as nematic (N) and smectic (Sm), with a further subdivision of the smectic phases into smectic A, smectic C, smectic B, smectic I and smectic F.

Additionally, reduced-symmetry (handed) analogues of these mesophases exist where the constituent molecules are chiral and non-racemic, in some phases (e.g., nematic and smectic C) the handed nature of the molecules confer a temperature dependent helical structure on the liquid crystal phase, whereas in other phases (e.g., smectic A) the handed nature of the molecules does not actually confer any such reduced symmetry to the liquid crystal phase under normal conditions. Such molecular chirality can also generate additional liquid crystal phases such as ferroelectric, ferrielectric, antiferroelectric, twist-grain boundary and blue phases that do not have comparable non-chiral analogues.

Constituent molecules of the compounds that generate the above mentioned calamitic liquid crystalline phases and disordered crystalline smectic phases are usually very

much rod-like in nature. However, these calamitic phases can also be exhibited by materials that consist of bent-core molecules, provided that the bend is not too acute and provided that the molecular length is sufficient to overcome the destructive nature of the bent-shape.

Indeed some of the above mentioned calamitic liquid crystal phases can also be exhibited by materials with molecules of unusual shapes, such as X-shapes and Y-shapes, and by side-chain and main-chain polymers that incorporate appropriate mesogenic units.

Materials with rod-like molecular architectures, and the calamitic phases that they exhibit, constitute the vast majority, and the most investigated type of liquid crystals, largely because so many such systems generate liquid crystalline phases, and because it is this type of liquid crystal that is used in display applications. However, materials with disc-shaped molecules can generate liquid crystalline phases in the form of the discotic nematic (ND) and a wide variety of columnar phases where different levels of molecular ordering are possible.

Much research regarding banana-shaped liquid crystals has involved materials with various substituents in the remaining positions of the central benzene ring core unit. Such substituents can confer steric and polar influences, which obviously affect the molecular interactions and hence the melting points, mesophase morphologies and transition temperatures.

SIGNIFICANCE OF THE STUDY

The bend at the heterocyclic central oxadiazole core is estimated to be 140° , which is somewhat intermediate between the linear 180° situation that would of course generate conventional mesomorphism, and the 120° of 1,3-disubstituted phenylenes that tends towards the generation of banana phases. Such an intermediate angle of bend could facilitate the generation of conventional mesomorphism, but of a biaxial nature.

The range of molecular architectures that support the generation of liquid crystalline and other mesophases has grown rapidly over the last 30 years as research interest in the usual and technologically interesting nature of such materials has intensified. Currently, much research interest and excitement surrounds liquid crystalline materials that consist of banana-shaped molecules, and bent-core molecules

In the case of materials of truly banana-shaped molecules, the liquid crystalline phases are of a completely different miscibility class to those generated by compounds composed of calamitic molecules, and they are generated to relatively high temperatures, despite a bent core. Furthermore, and of particular interest, some of these so-called banana liquid crystal phases exhibit reduced symmetry properties (helical structures and ferro- and antiferro-electric switching), despite the molecules being achiral.

Along a similar theme of banana liquid crystals, a wide range of materials with bent-

core molecular architectures have been synthesized and evaluated. Banana-shaped molecules are near-symmetrical with a rather acute (120°) bending angle that is always near the centre of the molecule, hence the term banana-shaped, with linking groups symmetrically opposed from the centre.

CONCLUSION

Non-banana-shaped bent-core systems will often have the bend at, or near, the end of the molecule, and/or the linking groups will all run in the same direction; also the bend may not be as acute as that seen in banana-shaped systems.

Although extremely exciting properties are seen in materials of bent-core and of banana-shaped molecules, all the interest is academic at the present time. However, since the direction of polarization of banana phases, such as the B2 and B4 phases, is in the plane of the layers rather than orthogonal as is the case in the conventional chiral smectic C phase, then applications in the area of non-linear optics (second harmonic generation) have been suggested.

It seems certain that high technology applications will eventually arise from further collaborative research in the areas of bent-core and banana-shaped systems, and in connected areas of chiral induction from achiral molecules and materials that generate the biaxial nematic phase.

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