行政院國家科學委員會專題研究計畫　成果報告

液晶材料研究

計畫類別：個別型計畫
計畫編號：NSC92-2113-M-032-006-
執行期間：92 年 08 月 01 日至 93 年 07 月 31 日
執行單位：淡江大學化學系

計畫主持人：余良杰

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中　華　民　國 93 年 11 月 1 日

行政院國家科學委員會補助專題研究計畫成果報告

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中 華 民 國 93 年 10 月 28 日

Abstract

A rigid core consisting of four phenyl rings connected by three ester functional groups at the para-positions has been used for making mesogenic derivatives. Typical calamitic mesogen with wide mesophase range is obtained when the flexible alkyloxy chains are attached at the *para*-positions of the ending rings. A hockey stick, or bent, shaped molecule is obtained when one of the alkyloxy chains is connected at the *meta*-position, Cn-*m*-Cm, and results in formation of anticlinic Smectic C (SmC_A) in addition to SmC, SmA and N phases.

Keywords: hockey stick, bent shaped molecule, calamitic mesogen, anticlinic Smectic C (SmC_A),SmC, SmA, N phases

摘要

以三酯基連接四苯環為主幹 在尾端之對位各接碳氫長鏈 可得具有大溫度範圍的條形液晶分子 將其中一條碳氫長鏈移到間位 則可得到略為彎曲的曲棍球球棍形分子 觀察到的液晶相為 向列相 層相 A 層相 C 及反斜層相 C 本研究探討分子結構與液晶相之關連性 包含改變碳氫鏈長度 酯基反向 苯環數 及旋光基 對液晶相所造成的變化

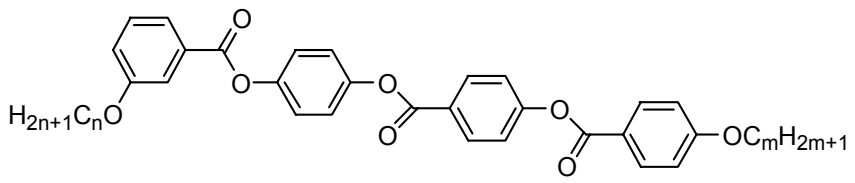
關鍵詞 ：曲棍球球棍形分子 彎曲形分子 向列相 層相 A 層相 C 及反斜層相 C

The mesophase-molecular structure relationship has been studied by varying the length of both the *meta*- and *para*-hydrocarbon chains, Cn and Cm, respectively. Occurrence of SmC_A is more favorable for derivatives having shorter *meta*-chains: for n=4, SmC_A phases are observed for derivatives with m=7 to 14, and for n=12 no SmC_A phase is observed with the same m values.

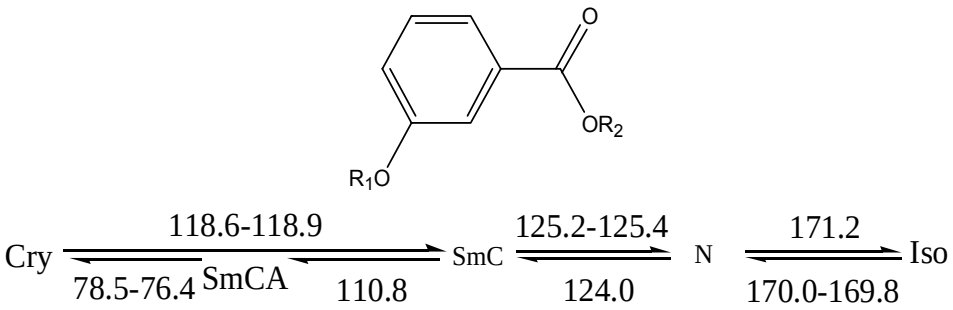
Variation of the aromatic core is also conducted: (1) attach a methoxy group at the *meta*-position of the ending ring, Cn-m_s-Cm; (2) reverse the direction of one of the ester linking groups, Cn-m_A-Cm; (3) remove one of the ending ring, Cn-*m*-Cm_{BA}. Derivatives obtained with these modifications exhibit no SmC_A phase.

Chiral mesogens are obtained by replacing the aliphatic chain of the *meta*- position of Cn-*m*-Cm with ethyl lactate. Mesophase sequences observed are I2-I1-N*-TGBA-SmA for derivatives having m=8 and 10, and I2-I1-N*-UTGBC for m=12 and 14. Peculiar phase transition of iso to iso is observed for all these derivatives, along with the occurrence of TGB indicate that the twisting power is stronger for the hockey stick molecules as compared to the rod-like analogues.

The present study is carried out by optical polarizing microscopy, differential scanning calorimetry, powder X-ray diffraction and electric-field effect.



In this study, the powder x-ray diffraction(XRD) is carried out for a ”hockey stick” shaped mesogen. This compound exhibits three mesophases: Nematic(N), Smectic C(SmC) and anticlinic Smectic C (SmCA) with transition temperatures as shown in scheme 1.



Scheme(1). Phase transition temperatures obtained from polar optical microscopy(P.O.M.) ,unit: ℃ ,heating rate:5℃/min. Cry: crystal, SmC: Smectic C liquid crystalline phase , SmCA:Smectic Canticlinic liquid crystalline phase, N: Nematic liquid crystalline phase, I :isotropic

When the compound is cooled from the isotropic state, the schlieren textures appear indicating the formation of Nematic phase (Fig. 2a). The XRD pattern displays a broaden peak in the small angle region (Fig. 1A), corresponding to a d-spacing of about the molecular length (36.7A°), and a broad band in the wide angle region indicating the liquid-like behaviors.

Figure 2b shows the texture of N-SmC transition at 124.0℃. Textures of N and SmC are observed on the left- and right-hand side, respectively, and in the middle is the texture showing the N-SmC transition bar. When the temperature is below 124.0℃, only the textures of SmC is observed(Fig. 2c). The corresponding XRD pattern (Fig. 2B) displays a sharp peak in the small angle region evidencing the layered structure with layer spacing of 35.1 A°, and along with the broad band at the wide angle region confirm the existence of the phase.

When the temperature is below 110.8 ℃, typical textures of SmCA phase are observed (Fig. 2d). The XRD pattern is rather similar to that of the SmC but with a slightly smaller d-spacing value.

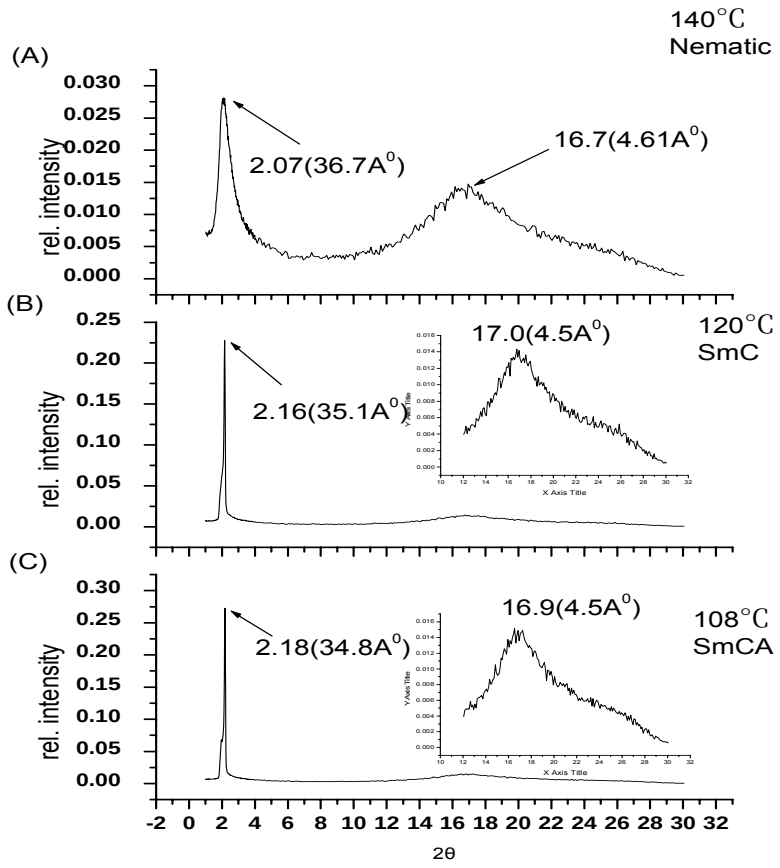


Figure 1. The XRD patterns obtained for the compound in (a)Nematic at 140°C, (b)SmC at 120°C, and (c)SmCA at 108°C

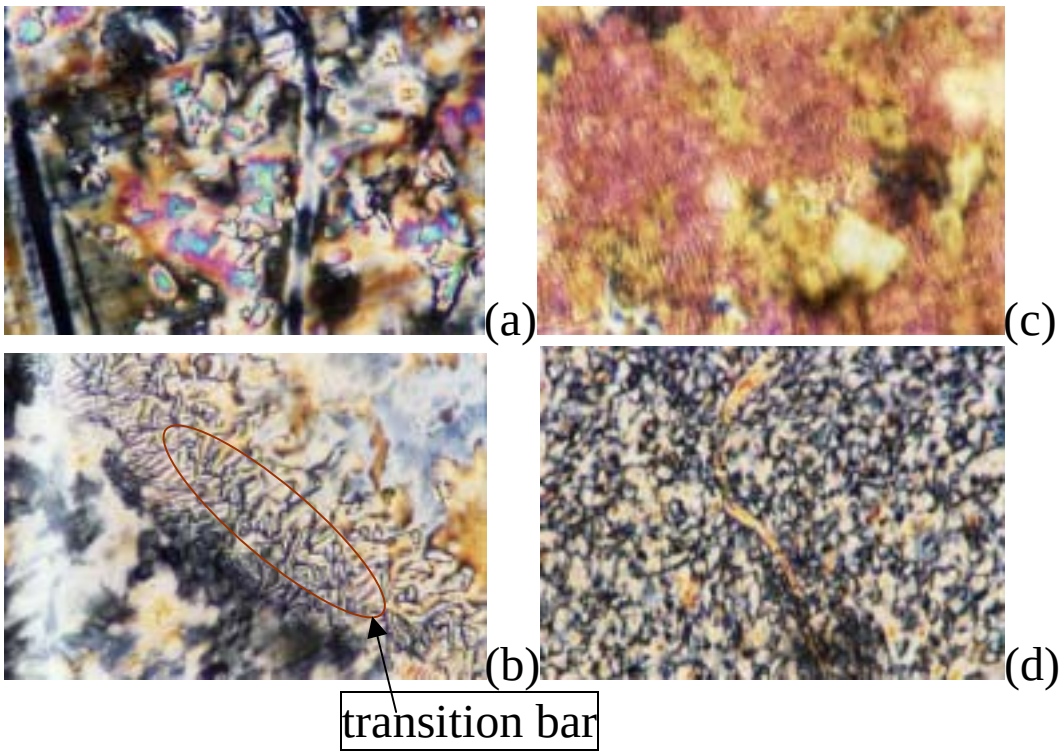


Figure 2. Optical textures at (a) 150.3°C, (b)124.0°C,(c)122.1°C, and (d)109.3°C.