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Evidence for An Hexagonal Phase in Twisted Nematics

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EVIDENCE FOR AN HEXAGONAL PHASE IN TWISTED NEMATICS

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Abstract :
Sequences of microscopic photographies show different behaviors during the isotropic-cholesteric transition in a binary diagram untwisted nematic-cholesterol ester. For certain conditions, a mosaïc texture arises between the isotropic liquid and the focal-conic texture, the germination of which gives evidence for an hexagonal symmetry. The large variation of pitch from the nematic phase to the pure cholesterol ester can explain these facts if we consider the Brazovskii's theory of cholesteric transitions.

I - INTRODUCTION

For number of years, several phenomena were pointed out in the vicinity of the isotropic-cholesteric transition. Peculiarly the occurence of a metastable phase was reported by O. Lehman [1], G. Friedel [2] and later by G. W. Gray [3] who called it the "blue homeotropic phase". That "blue phase" being optically isotropic and not visible in transmitted light, the observations were performed in reflected light. Then, observations of white [4] and coloured [5] platelets were made near the isotropic-cholesteric transition. It seems that there

exists no real difference between these platelets and the "blue phase" [6].
Nevertheless, only pure cholesteric compounds were observed for which the pitch at the transition has a well defined value. Now, it is well known [7] that one can obtain a twisted mesophase by mixing even infinitely small amounts of pure cholesteric with a simple nematic compound. It is then possible to examine a very large scale of cholesteric transitions with different pitches.

II - EXPERIMENTAL

We have observed the isotropic-cholesteric transition when moving along the equilibrium line of the binary diagram : (7 one) heptyloxybenzilidene-aminofluorenon / cholesteryl nonanoate (CN). The photographs were taken between crossed polarizer and analyzer in transmitted light.

- First sequence (FIGURE I) presents the cooling of a mixture with high concentration of CN (85 mol %).

FIGURE I a Mixture with 85 mol % CN : platelets texture.

Small platelets appear first, green or blue-green coloured, the shapes of which are varied and not very well defined (FIGURE Ia).

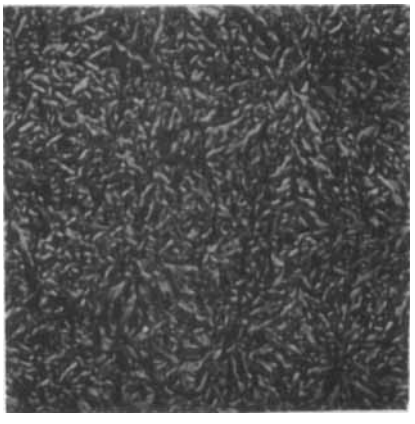


FIGURE Ib Mixture with 85 mol % CN : focal conic texture.

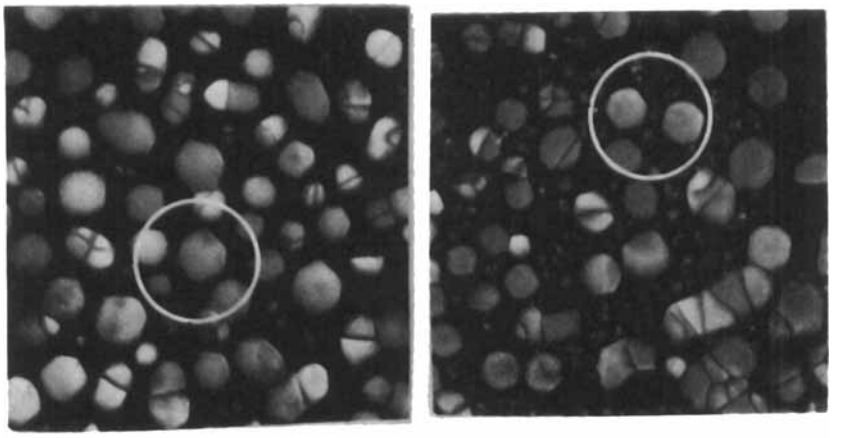
Then, just a few tenth of degree lower, a complex focal-conic texture arises (FIGURE Ib). This transition seems to be monotropic for higher concentrations of CN : the platelet texture does not appear when heating from the focal conics.

- Second sequence (FIGURE II) is similar but for lower concentration of CN (35 mol %).

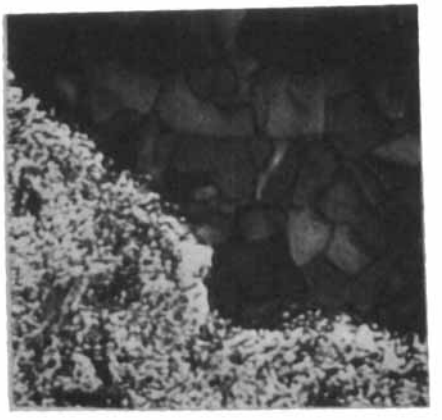
Platelets again appear but they are larger and for a number of them it is easy to define a hexagonal symmetry (FIGURE IIa).

Then, they coalesce in a mosaïc texture which becomes polychromic (FIGURE IIb).

Only several degrees lower it transforms into a complex focal conics (FIGURE IIc).



IIa IIb



IIc

FIGURE II Mixture with 35 mol % CN
a - platelets texture
b - coalescence of platelets, mosaïc texture
c - mosaïc texture transforms in focal conic texture

For such mixtures, the transformation is reversible and appears when heating, about 2° C under the isotropic phase.

At last, for low CN concentrations (< 20 mol %) the isotropic liquid transforms directly in a focal conic texture with large monodomains (FIGURE III).

FIGURE III Mixture with 15 mol % CN : focal conic texture with large monodomains.

These observations allow us to draw the schematic diagram of the FIGURE IV

III - DISCUSSION

In the Brazovskii's theory of cholesteric transitions, it is expected that, with regard to the pitch length, the transition from the isotropic liquid can occur by three different ways :

when the period is large a first order transition leads directly to a spiral phase i. e. : a normal twisted nematic .

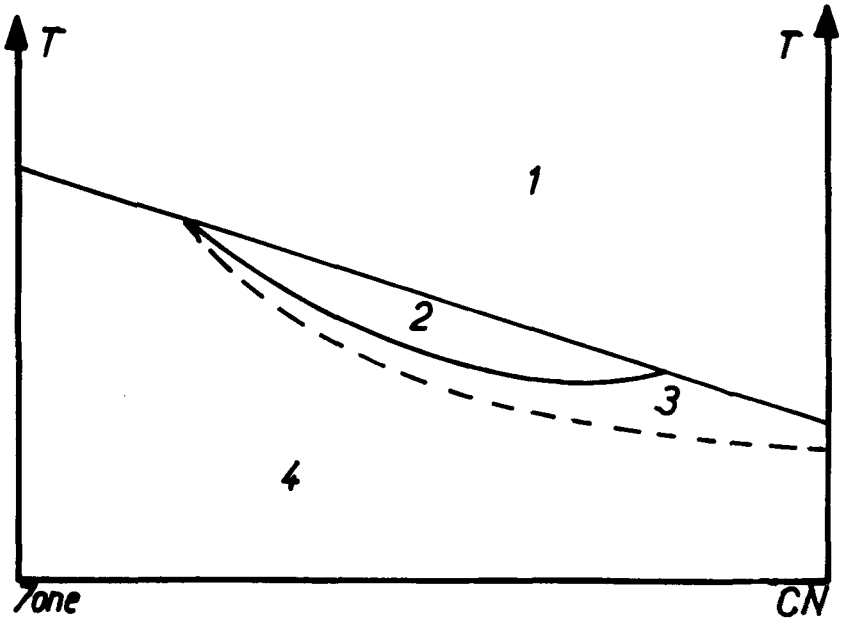


FIGURE IV Schematic binary diagram of 7 one with CN :
1 - isotropic phase
2 - platelets mosaic texture
3 - surfusion of mosaic texture
4 - focal conic cholesteric

for smaller periods there exists first a phase with hexagonal symmetry which transforms at lower temperature in the spiral phase.

if the pitch again decreases, this hexagonal phase disappears.

This theoretical behavior can be compared to our experimental observations : in our diagram, the pitch varies continuously from an infinite value (pure 7 one) to a relatively small period (pure CN). For large pitches, the isotropic-cholesteric transition arises without the hexagonal phase. Then, with decreasing pitches, an intermediary hexagonal phase exists which presents

reversible thermotropic transitions. For very small pitches, it vanishes but remains metastable along a little domain through a monotropic transition. These results seem to be consistent with Brazovskii's predictions and the system seems to be useful to complete the enthalpic measurements already performed at the cholesteric-isotropic transition [9].

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