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LYOTROPIC CHOLESTERIC BLUE PHASE

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Upon carefully cooling a short pitch lyotropic cholesteric phase, made up of disodium cromoglycate, allo-4-hydroxy-ℓ-proline and water, from the isotropic phase, the characteristic platelet texture associated with blue phases is observed.

Many thermotropic cholesteric mesophases show a "blue phase" (BP) a few tenths of a degree below the clearing point. The properties of this phase, or rather phases, have become a topic of extensive theoretical and experimental study. Experimentally, the phases are optically isotropic,[1-4] show selective reflection,[1-5] and a weak transition enthalpy can be measured.[3] They were first identified and continue to be studied and recognized by the characteristic platelet textures observed microscopically.[2,4,6-8] Indeed Gray[2] has stated "...Whenever platelets are observed microscopically then the blue phase also exists and occurs over exactly the same temperature region."

One structural requirement is evident: the pitch of the corresponding conventional cholesteric phase must be short, ∿ 0.4 μm or less.[9-10] Recently, the nematic lyophase of disodium cromoglycate (DSCG) in water has been studied in detail.[11-12] By adding large amounts of optically active amino acids, cholesteric lyophases can be created, and short pitch cholesteric lyotropics showing pitch less than 1 μm have been observed.

It is the purpose of this Letter to report the observation of characteristic platelet textures in 16.3 weight % DSCG/26.07 weight % allo-4-hydroxy-ℓ-proline/H_2O when cooling the sample slowly from the isotropic phase. Observations are made microscopically between crossed polars. Because this system does not have a sharp isotropic-mesophase transition,[11] one observes a two phase region below the clearing point, in which the BP and isotropic phase coexist. On cooling at a rate of 0.2°/min., the sample shows a foggy phase at 36.6°; at 36.4°, it shows white batonnets (Fig. 1). These batonnets slowly grow to large batonnets at 36.0° (Fig. 2,3). At 34.0°, mosaic-like platelet textures are observed (Fig. 4); these textures show several colors -- blue, orange, red and green -- which do not change upon stage rotation.

When the sample is maintained at 34° for 10 min. or more, some further textural transitions of the platelets into modified shapes occur which depend on the thickness of sample. A thick sample (300 μ) has a fan shaped texture (Fig. 5). A thin sample (100 μ) shows a smaller fan shaped region (Fig. 6). Both samples do not show fingerprint textures. On further cooling, the sample becomes cloudy, and then gives fingerprint textures at 30° (Fig. 7).

This change from platelet to fingerprint texture is very distinct optically, but it has not been possible to detect this transition calorimetrically due to the broadness of the transitions from the isotropic to the isotropic + cholesteric mixed phase, and from the isotropic + cholesteric mixed phase to the cholesteric phase. In most samples, it is not even possible to separate these two transition peaks.

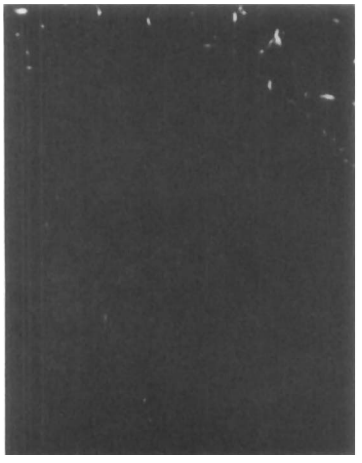

Figure 1

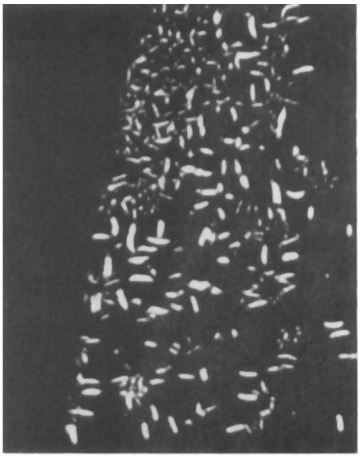

Figure 2

Figure 3

Figure 4

Figs. 1-4. Photomicrographs at 125x (crossed polars) of DSCG/allo-4-hydroxy-ℓ-proline/H_2O.

(1) small batonnets appear at 36.4°.
(2) large batonnets at 36.0°.
(3) same as Fig. 2, 10 minutes later.
(4) platelets at 34.0°.

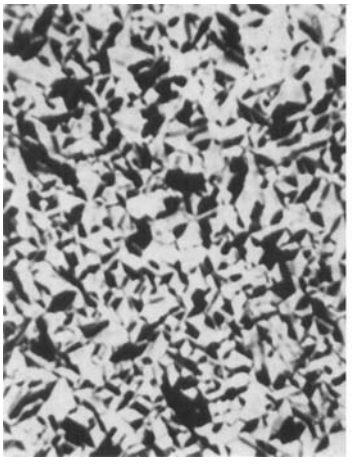

Figure 5

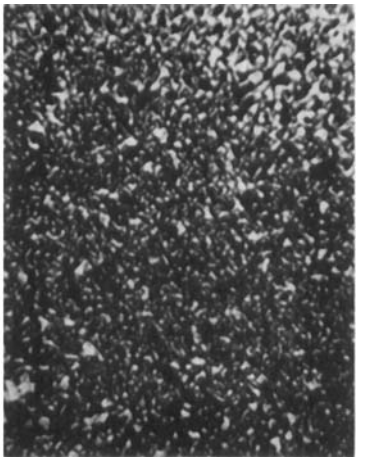

Figure 6

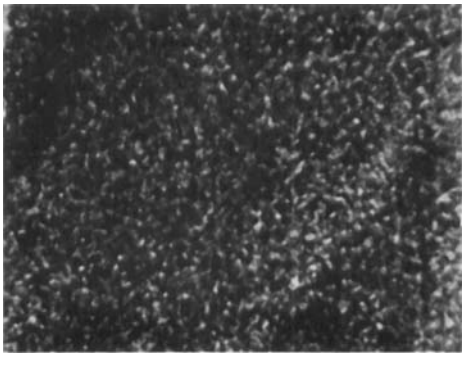

Figure 7

Figs. 5-7. Photomicrographs at 125x (crossed polars) of DSCG/allo-4-hydroxy-ℓ-proline/H_2O.

(5) fan-shaped texture in 300 μ capillary at 34.0°.
(6) fan-shaped texture in 100 μ capillary at 34.0°.
(7) textural changes as temperature is lowered to 30.0°.

The BP of DSCG/allo-4-hydroxy-ℓ-proline/H_2O is not a homogeneous phase, but is a mixed BP-isotropic phase. It is presumably for this reason that we have failed to obtain evidence for the BP by selective reflection[5] or optical activity measurements.[13] Other approaches to characterizing these platelets as a BP, and attempts to modify the samples to attain uniform, unique textures are in progress.

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