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# DETERMINATION OF THE CHOLESTERIC SCREW SENSE BY THE DROPLET METHOD

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*Abstract*

A new and simple way to determine the handedness of a room temperature cholesteric liquid crystal by comparison with a cholesteric phase of known screw sense and from the characteristic optical patterns displayed by cholesteric and nematic droplets floating in an isotropic solvent is described.

To fully characterize the helix structure of a cholesteric liquid crystal, the pitch magnitude as well as the screw sense must be known.

The screw sense is generally determined by examining either the transmission and reflection characteristics of the cholesteric mesophase in the infrared or visible spectrum (1-6), or from the Grandjean-Cano method based on the observation of the disclination lines occuring in a wedge shaped cholesteric sample with homogeneous planar boundary conditions (7-10).

It is also possible to use the contact method based on a comparison with a cholesteric phase of known screw sense (11-13).

In this paper we would like to describe a new and simple method to determine the handedness of a room temperature cholesteric liquid crystal by the droplet method.

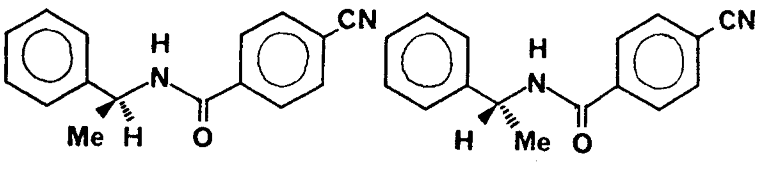
It is well known that by mixing two cholesterics having opposite handedness, it is possible to get a compensated nematic mixture. So by adding increasing quantities of an unknown cholesterogen to two reference cholesteric phases, having known but opposite screw sensewe can expect that :

- the two samples having the same helical twist will lead to cholesteric phases in the whole concentration domain with a small pitch variation.
- the two samples having opposite screw sense will lead to cholesteric phases showing a regular pitch variation and having opposite handedness from both sides of a particular concentration corresponding to a compensated nematic phase.

The pitch variation of the mixtures will be easily determined from the optical pattern displayed by cholesteric droplets floating in an isotropic solvent (a spiral shaped structure whereas in the same conditions nematic droplets have a star configuration) (14,17).

This technic was developped during our study of twisting powers of optically active molecules dissolved in nematic liquid crystals. For this reason we applied this method to twisted nematics.

The reference samples were twisted MBBA and MBAB (15) by enantiomeric N-(α-phenylethyl) p-cyanobenzamide (-) 1 R and (+) 1 S having good twisting powers (16) and easily prepared from (-) or (+) α-phenylethylamine.




(+) 1 S (-) 1 R

The reference liquid crystals $D_1$ (2.09% of (-) 1 R in MBBA), $D_2$ (1.15% of (-) 1 R in MBAB), $G_1$ (2.44% of (+) 1 S in MBBA) and $G_2$ (1.32% of (+) 1 S in MBAB) were shown to be by the Grandjean-Cano wedge method (9,16) respectively right-handed ($D_1$ and $D_2$) and left-handed cholesterics ($G_1$ and $G_2$).

In order to determine the handedness of the cholesteric phase I (2.4% of cholesterylchloride in MBBA), we prepared a set of mixtures I + $G_1$ and I + $D_1$ and plotted the resulting pitch against the relative concentration cholesterylchloride/ reference compound.

As we see from diagramm 1, the pitch has about the same value for the mixtures I + $G_1$ whereas for mixtures I + $D_1$ pitch sign changes and a compensated phase was obtained for a particular concentration showing that the cholesterics I and $D_1$ have opposite handedness, cholesteryl chloride in MBBA leading to a left-handed phase.

The diagramm 2 reports the same kind of experiment conducted in MBAB in order to determine the screw sense of the solution II (6.7% of cholesterylchloride in MBAB) by comparison with the references $D_2$ and $G_2$. The solution II is also a left-handed mesophase.

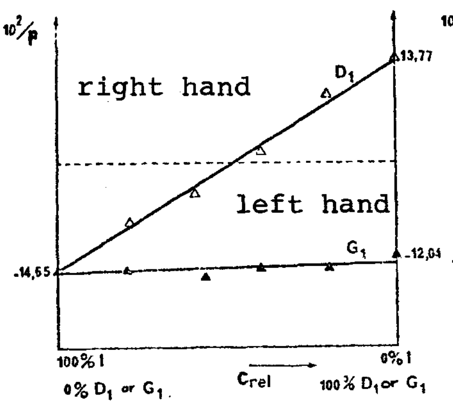



*Diagramm 1*

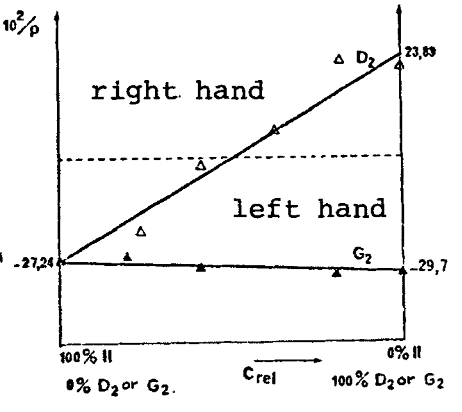



*Diagramm 2*

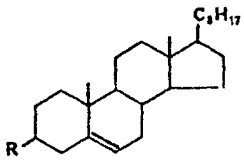
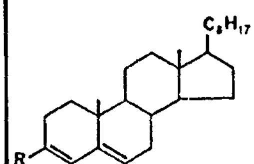
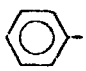
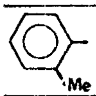
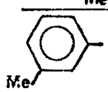
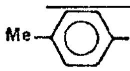
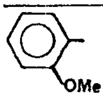
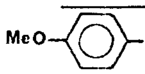
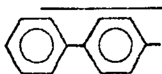
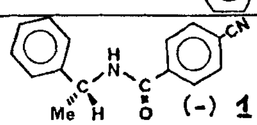
We shall remark that cholesteryl chloride in MBBA leads to a left-handed phase as shown yet by Saeva and Wysocki (18) whereas pure cholesteryl chloride is a right-handed cholesteric (1).

Finally we would like to point out that this method can be used for a rapid qualitative screw sense determination by using cholesterics having the same pitch value and making only 50/50 mixtures with the reference phases.

Some other exemples of screw sense determination by this method are reported in Table I as well as the molecular twisting powers $\beta_M$ of several optically active molecules determined by the droplet method (17). All these screw sense values were checked by the Grandjean-Cano wedge method (16).

TABLE I

SCREW SENSE OF TWISTED NEMATICS AND TWISTING POWERS

| Doping molecule | **R** | $\beta_M$ in MBBA | $\beta_M$ in MBAB |
|---|---|---|---|
|  | Cl | -17.4 | - 8.2 |
| | OH | - 1.1 | - 5.7 |
| | $O-\overset{O}{\overset{\|}{C}}-C_{13}H_{27}$ | -25.2 | -16.7 |
| | OTHP | -27.6 | -20.5 |
|  |  | + 3.9 | + 4.7 |
| |  | - 1.7 | - 2.7 |
| |  | + 5.4 | + 3.5 |
| |  | +12 | + 5.1 |
| |  | + 9.1 | + 6.0 |
| |  | +15.6 | + 2.7 |
| |  | + 0.7 | + 3.1 |
|  (-) 1 R | | + 9.7 | +19.9 |

$\beta_M = \beta\ M_D/M_N$ and $\beta = 1/p.c$ ; $\beta$ were determined from the slopes of the experimental curves $1/p = f\ (c)$, pitches p being expressed in microns and C in g/g, $M_D$ and $M_N$ being the molecular weights of the doping molecule and the nematic. A positive $\beta_M$ value refers to a right handed cholesteric. Reference compound (-) 1 R was studied by the Grandjean-Cano method.

## BIBLIOGRAPHIE

(1) G. Friedel, Ann. Phys. (Paris) 18, 273 (1922).

(2) H. de Vries, Acta Cryst. 4, 219 (1951).

(3) H. Stegemeyer, Ber. Bunsenges. Phys. Chem. 78, 860 (1974).

(4) L.B. Leder, J. Chem. Phys., 55, 2649 (1971).

(5) G. Gottarelli, B. Samori and C. Stremmenos, Chem. Phys. Letters, 40, 308 (1976).

(6) F.D. Saeva, Mol. Cryst. 18, 375 (1972).

(7) F. Grandjean, C.R. Acad. Sci. Paris 172, 71 (1921).

(8) R. Cano, Bull. Soc. Min. Crist., 91, 20 (1968).

(9) J.P. Berthault, J. Billard and J. Jacques, C.R. Acad. Sci. Paris 284 C, 155 (1977).

(10) G. Heppke and F. Oestreicher, Mol. Cryst. Liq. Cryst., 41 (Letters), 245 (1978).

(11) J. Billard, C.R. Acad. Sci., 274 B, 333 (1972).

(12) N. Isaert, B. Soulestin and J. Malthete, Mol. Cryst. Liq. Cryst., 37, 321 (1976).

(13) G.W. Gray, D.G. Mc. Donnell, Mol. Cryst. Liq. Cryst. , 34 (Letters) 211 (1977).

(14) S. Candau, P. Le Roy and F. Debeauvais, Mol. Cryst. Liq. Cryst. 23 , 283 (1973).

(15) MBBA = p-methoxybenzylidène p-n-butylaniline
MBAB = p-methoxy p-n-butylazoxybenzene (Licristal Merck IV).

(16) P. Seuron, Thèse de Docteur-Ingénieur, Université Louis Pasteur, Strasbourg (1979).

(17) J.M Ruxer, G. Solladié, S. Candau, Mol. Cryst. Liq. Cryst., 41 (Letters), 109 (1978).

(18) F.D. Saeva and J.J. Wysocki, J. Amer. Chem. Soc., 93, 5928 (1971).