



Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/gmcl19>

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Version of record first published: 24 Sep 2006

To cite this article: Yoshio Aoki, Satoru Nomoto, Takuji Hirose & Hiroyuki Nohira (2000): Helical Twisting Power of New Chiral Dopants Derived from 2-Phenylpropanoic Acid for Nematic Liquid Crystals, *Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals*, 346:1, 35-40

To link to this article: <http://dx.doi.org/10.1080/10587250008023863>

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Helical Twisting Power of New Chiral Dopants Derived from 2-Phenylpropanoic Acid for Nematic Liquid Crystals

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New chiral dopants for nematic liquid crystals were synthesized using optically active 2-phenylpropanoic acid. The magnitude of helical twisting power (HTP) was largely influenced by the linkages between the asymmetric frame and the core moieties. The results of our experiments clearly showed that a steric effect was important to induce a helical macrostructure.

Keywords: nematic liquid crystal; chiral dopant; helical twisting power

Chirality is one of the most interesting subject in liquid crystals^{1,2}). Chiral nematic liquid crystals applicable to super twisted nematic (STN) devices are attractive materials. Recently liquid crystals are widely applied to flat panel display devices of portable computers and TV sets, because a liquid crystal display (LCD) is of greater advantage than a CRT for size, thickness, weight and power

consumption³⁾. Generally the chiral nematic materials consist of achiral host liquid crystal mixtures, which have low viscosities and the wide range of nematic phase, and a chiral dopant having a large helical twisting power (HTP). Therefore, chiral dopants having a large HTP value are required in order to obtain chiral nematic materials showing a fast response. To satisfy this requirement, many optically active compounds for application in nematic mixture have been synthesized⁴⁾. We have also synthesized a variety of chiral compounds for the same purpose⁵⁾. However, the relationship between the structure of chiral dopants and the HTP is not clear, yet. For the purpose of clarifying the relationship, novel chiral dopants derived from optically active 2-phenylpropanoic acid were synthesized and determined their HTP values.

EXPERIMENTS

Commercially available 2-phenylpropanoic acid was used for the synthesis without further purification. New chiral dopants were synthesized in a usual way (See FIGURE 1). They did not show any liquid crystalline phase, so that only their HTP values were determined. The chiral nematic liquid crystalline mixtures were prepared by adding one weight percent of a chiral dopant to the host liquid crystal (ZLI-1132, Merck). Helical pitches in chiral nematic phases were measured using a Cano wedge cell ($\tan\theta = 0.0083, 0.0140, 0.0194, 0.0288$, E.H.C.).

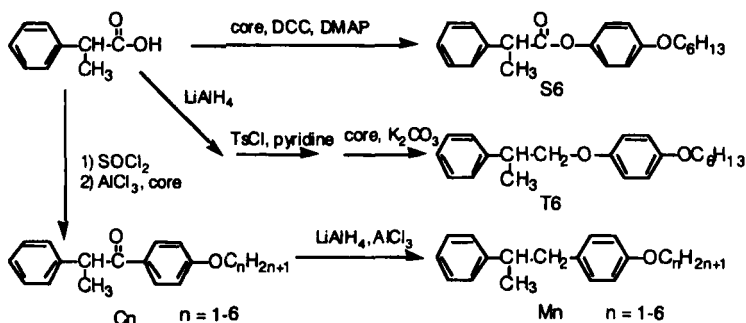


FIGURE 1 Synthetic route of new chiral dopants.

RESULTS AND DISCUSSION

The HTP values and the MHTP values of new chiral dopants are summarized in TABLE 1. In order to discuss a HTP by a molecule, we suggest molar helical twisting power (MHTP), which is defined as the following equation.

$$\text{MHTP} = \frac{1}{p \times m} = \text{HTP} \times \text{Mw} + 1000 (\mu\text{m}^{-1}\text{mol}^{-1}\text{Kg})$$

Here, p is the helical pitch of the mixture, and m is the moles of the dopant per 1Kg of the mixture. Mw is the molecular weight of the chiral dopant. The HTP values and the MHTP values of the chiral dopants are largely influenced by the linkages between the asymmetric frame and the core moieties. Yoshizawa and co-workers reported a relationship between many chiral compounds and their HTP values^{6,7}. According to their discussion, the present chiral dopants

are probably classified into 'a twin molecule' which may exhibit special steric effects on the chirality dependent properties.

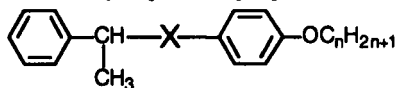


TABLE 1 HTP and MHTP of new chiral dopants.

compounds	X	alkyl chain / n	HTP / μm^{-1}	MHTP [§] $\mu\text{m}^{-1}\text{mol}^{-1}\text{Kg}$
S6	COO	6	7.8	2.54
T6	CH ₂ O	6	7.2	2.25
C1	CO	1	2.2	0.53
C2	CO	2	8.2	2.08
C3	CO	3	8.7	2.33
C4	CO	4	10.4	2.93
C5	CO	5	10.3	3.05
C6	CO	6	10.3	3.19
M1	CH ₂	1	17.5	3.96
M2	CH ₂	2	19.1	4.58
M3	CH ₂	3	17.9	4.55
M4	CH ₂	4	17.1	4.58
M5	CH ₂	5	17.0	4.79
M6	CH ₂	6	16.5	4.88

$$^{\S}\text{MHTP} = \text{HTP} \times \text{Mw} + 1000$$

The MHTP value of the ester type chiral dopant (S6) was nearly equal to that of the ether type chiral dopant (T6). These results show

an ether carbonyl moiety of S6 does not contribute to induce the MHTP. However, the chiral dopant having a ketone carbonyl moiety (C6) showed a relatively large MHTP value ($3.19\mu\text{m}^{-1}\text{mol}^{-1}\text{Kg}$). The absence of an ether bond in C6 should be the cause of the larger MHTP value than that of S6. The closer the chiral center to the core, the less the freedom of its movement due to steric hindrance with the rigid core. M6 having a methylene linkage showed the largest MHTP value ($4.88\mu\text{m}^{-1}\text{mol}^{-1}\text{Kg}$). The fact M6 does not have any strongly polar groups in the molecule suggests that a steric effect is important to induce a helical macrostructure.

C6 and M6 showed relatively large MHTP values, so a relationship between the alkyl chain length and the MHTP values was further investigated (See FIGURE 2).

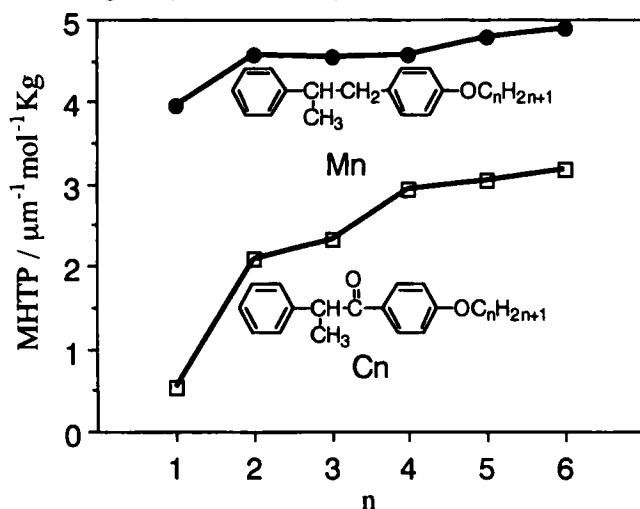


FIGURE 2 A relationship between MHTP and alkyl chain length.

The MHTP values increased with an increase in the length of an alkyl chain. The alkyl chain length of Mn did not appreciably influence the MHTP value, while that of Cn was clearly significant. The reason why the MHTP values of C1 and M1 are relatively small is that the length of methyloxy group is probably not enough to induce a helical macrostructure.

References

- [1] J. W. Goodby, *J. Mater. Chem.*, **1**(3), 307(1991).
- [2] J. W. Goodby, *Mol. Cryst. Liq. Cryst.*, **292**, 245(1997).
- [3] D. Pauluth and A. E. F. wächter, Chirality in Industry II, A. N. Collins, G. N. Sheldrake and J. Crosby Ed., John Wiley & Sons Ltd (1997) pp263–286.
- [4] A. N. Collins, G. N. Sheldrake and J. Crosby, CHIRALITY IN INDUSTRY II, John Wiley & Sons (1998).
- [5] H. Shitara, Y. Aoki, T. Hirose and H. Nohira, *Chem. Lett.*, 261, 1998.
- [6] A. Yoshizawa and I. Nishiyama, *J. Mater. Chem.*, **4**(3), 307(1994).
- [7] I. Nishiyama, H. Ishizuka and A. Yoshizawa, *Ferroelectrics*, **147**, 193(1993).