Liquid Chromatographic Determination of Optical Purity of Liquid Crystals

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Abstract

Liquid chromatographic direct resolution of racemic naphthyl propionate liquid crystals were successful on a commercial chiral column, (S,S)-Whelk-O1. The very simple procedure can be applied to the intermediate and final products without any structural modification.

1. Introduction

Most ferro- and antiferroelectric liquid crystals are chiral and their mesomorphic phase structures and electro-optical properties are largely dependent on the optical purity.[1,2] Thus, for the chiral liquid crystals the occurrence of chemical or thermal racemization has to be checked throughout the synthetic sequence and the investigation of the mesomorphic and electro-optical properties.

However, most research papers on the chiral liquid crystals, did not mention the enantiomeric excess of the materials. They were just assumed to be the same as those of the starting materials or of various inter- mediates without any investigation. It is very important to establish convenient and accurate means of determining the enantiomeric composition in liquid crystal chemistry. Among various techniques, liquid chromatographic separation of enantiomers on the chiral stationary phases (CSPs) might be the choice because this technique is known to be the most simple and convenient means of determining the enantiomeric composition.[3] In this study, we show that a commercial HPLC chiral column, (*S,S*)-Whelk-O1, can resolve various types of naphthyl propionate liquid crystals.

2. Experimental

HPLC analyses were performed with an instrument consisting of Waters model 510 pump, a Rheodyne model 7125 injector with a 20 $\mu\ell$ sample loop, a Youngin model 710 absorbance detector with a 254 nm UV filter and a Youngin D520B computing integrator. A mixed solvent of isopropyl alcohol and hexanes (80:20, v/v) was used as a mobile phase with a flow rate of 2.0 mL/min at room temperature.

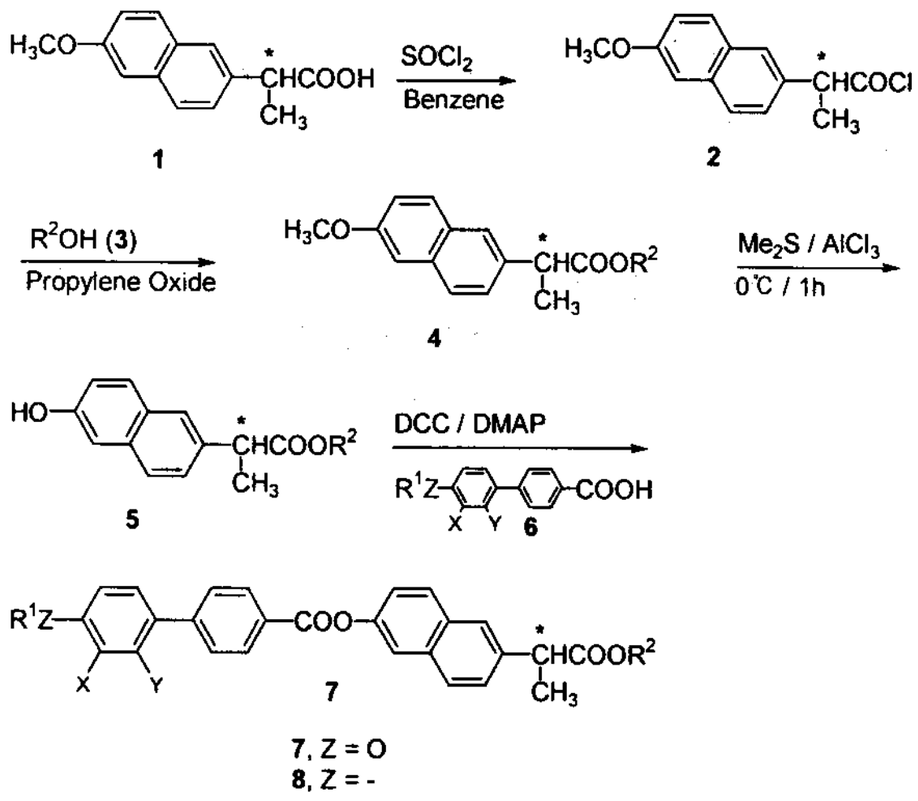
Optical rotations were determined in a solution of chloroform using a JASCO DIP-1000 digital polarimeter with a path length of 1 dm. Concentrations are quoted in g/100 ml. (*S*)-Naproxen (**1**, >98% ee) was purchased from Aldrich Chemical Co., and used without further purification.

3. Results and Discussion

Naphthyl propionate ferroelectric liquid crystals with an ester linkage between naphthalene and biphenyl rings were prepared from (*S*)-naproxen **1** as depicted in Scheme 1.[4]

Since the hydrogen atom on the chiral carbon in the naproxen derivatives **2**, **4**, **5**, **7** and **8** is acidic enough due to the presence of α-naphthalene ring and carboxyl or carbo-alkoxy group, racemization via enolization can take place routinely in the compounds under both acidic and basic reaction conditions. Thus one has to confirm the integrity of chiral center in the intermediate and final products by the HPLC analysis using chiral column.

Scheme 1



The integrity of chiral center in the reaction products **4** was confirmed by the HPLC. Racemic naproxen was obtained from (*S*)-naproxen (**1**) by deprotonating the acidic hydrogen with *n*-butyllithium followed acidification. Thus obtained racemic naproxen was converted to the racemic *n*-butyl ester **4a** (R_2=C_4H_9) according to Scheme 1. HPLC resolution racemic ester **4a** on a chiral column showed a reasonable separation factor [Figure 1 (a)]. Figure 1 (b) shows that chiral **4a** was optically pure (enantiomeric excess: 99% ee); racemization did not occur at all **4a** formation from (*S*)-naproxen.

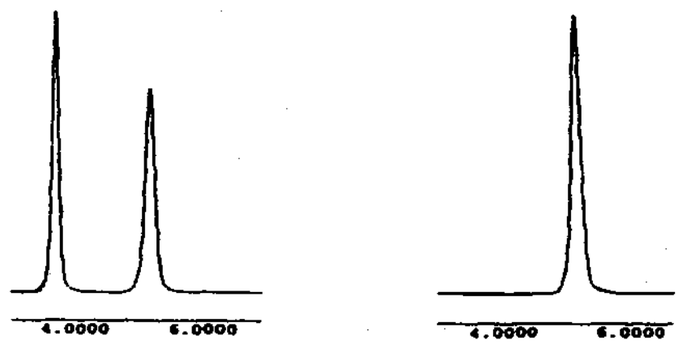
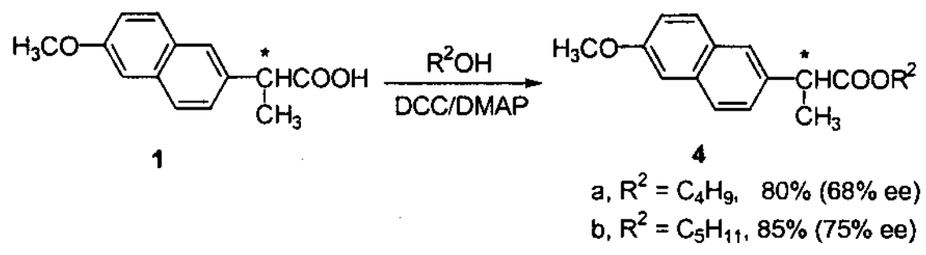


FIGURE 1. Chromatograms for resolving ester **4a** of (a) racemic **4a** and (b) chiral **4a** prepared from (*S*)-naproxen through Scheme 1.

Compounds **5**, **7**, and **8** were resolved with the reasonable separation factors on (*S*,*S*) Whelk-O1 chiral column. The results of chromatographic resolution are summarized in Table 1.

When the esterifications of (*S*)-naproxen **(1)** with alcohols were achieved by using DCC and DMAP as described in the literatures[5-8] some racemizations were occurred (Scheme 2).

Scheme 2

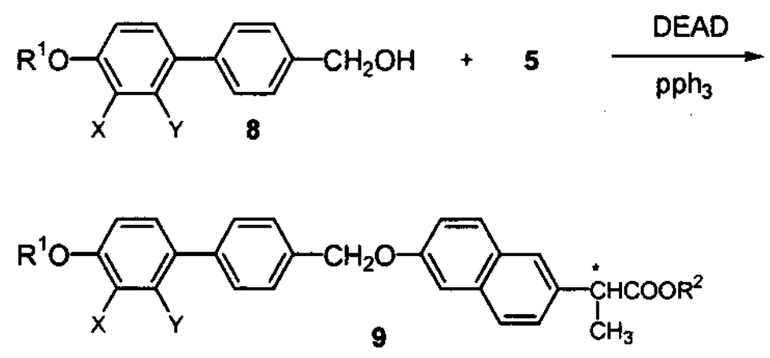


However, in the esterification of **5** and **6** under the same condition no racemization did observe at all.

The specific rotation of compound **7e** (R_1=$C_{10}H_{21}$, R_2=C_4H_9, X=Y=H) prepared by us showed $[\alpha]_D^{27.5}$ = +17.06 which is much higher than the reported value of $[\alpha]_D^{23}$ = +4.93.[9] This proves that the compounds prepared in this study are of better optical purity for investigating physical properties.

Naphthyl propionates having an ethereal linkage **9** were also prepared (Scheme 2). Their optical purities were also estimated in the same manner using the same HPLC chiral column, (*S*,*S*)-Whelk-O1 (Table 1).

Scheme 3



4. Conclusion

Various types of optically pure naphthyl propionate liquid crystals were prepared from (*S*)-naproxen in a four step reaction sequence. We found that a commercial HPLC chiral column, (*S*,*S*)-Whelk-O1, can resolve the (*S*)-naproxen-based liquid crystals. This technique is not only very simple and effective of monitoring the enantiomeric excess of the intermediate and final products but also requires no structural modification at all.

Table 1. Liquid chromatographic resolution of naphthyl propionate liquid crystals **7**, **8**, and **9** on (*S*,*S*)-Whelk-Ol chiral column[a]

Liquid Crystal	R^1	R^2	X	Y	ee (%)	k_1[b]	k_2[b]	α[c]
7a	C_8H_{17}	C_4H_9	H	H	92	3.17	4.91	1.55
7b	C_8H_{17}	C_5H_{11}	H	H	99	3.12	4.79	1.54
7c	C_8H_{17}	C_6H_{13}	H	H	99	3.03	4.19	1.38
7d	C_9H_{19}	C_4H_9	H	H	93	4.27	5.33	1.06
7e	$C_{10}H_{21}$	C_4H_9	H	H	98	3.45	4.84	1.40
7f	C_8H_{17}	C_4H_9	F	H	99	4.14	5.79	1.40
7g	C_8H_{17}	C_5H_{11}	F	H	99	3.21	5.20	1.62
7h	C_8H_{17}	C_4H_9	F	F	99	3.46	4.71	1.36
7i	C_8H_{17}	C_5H_{11}	F	F	99	3.02	3.97	1.31
8a	C_8H_{17}	C_4H_9	H	H	99	2.29	3.37	1.47
8b	C_8H_{17}	C_5H_{11}	H	H	99	2.26	3.15	1.39
8c	C_8H_{17}	C_6H_{13}	H	H	99	2.00	2.95	1.48
9a	C_8H_{17}	C_4H_9	H	H	99	1.76	2.81	1.60
9b	C_8H_{17}	C_5H_{11}	H	H	99	1.60	2.61	1.63
9c	C_8H_{17}	C_5H_{11}	F	H	99	1.77	2.86	1.62
9d	$C_{10}H_{21}$	C_6H_{13}	F	H	99	1.49	2.50	1.68

[a] **See** the Experimental part for the chromatographic condition.
[b] Capacity factor of the first and second eluted enantiomers.
[c] Separation factor.

5. Acknowledgements

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6. References

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