

Description

This invention relates to a novel organic compound and a liquid crystal composition containing the same. More particularly it relates to an organic compound having an optically active group and a liquid crystal composition containing the same.

Use applications of liquid crystal display elements have been rapidly expanded due to improvements in circuit, driving mode and cell preparation technique and further, particularly due to improvement in the characteristics of liquid crystal compositions filled in the elements. However, as to liquid crystal display elements, a number of problems to be solved have still been left.

For example, narrow angle of view, inferior contrast, low response rate, still small display capacity, reduction in the display quality due to ambient temperature change, etc. are mentioned. Among these, the reduction in the display quality due to ambient temperature change is caused by temperature change in the threshold voltage V_{th} .

In recent years, as a means usually employed, there is a method of retaining the display quality by adding a slight quantity of an optically active substance to a liquid crystal composition to inhibit the reverse twist of liquid crystal molecules and thereby impart a right turn or left turn helical structure to the liquid crystal molecules. For example, this method can have an advantageous effect upon the cases of TN (twisted nematic) mode display elements, SBE (supertwisted birefringence effect) mode display elements, etc.

However, if the twistability of an optically active substance added as a dopant is too low, it is required to add the dopant in a relatively high concentration in order to obtain a necessary pitch; hence this is evident to have a disadvantageous effect upon other substance parameters.

Thus, there has been long awaited an optically active substance having a high twistability i.e. a capability of exhibiting, when added to liquid crystals, a shorter pitch than those of other substances.

For example, when a commercially available CB-15 made by BDH Co., Ltd. or compounds disclosed in Japanese patent application laid-open Nos. Sho 62-81354/1987 and Sho 62-81355/1987 are added in only one % by weight to nematic liquid crystal compositions, they have a capability of exhibiting a pitch around 10 μm ; hence they can be said in a certain sense to be practically usable, optically active substances.

However, when generally known optically active substances, including the above-mentioned compounds, are added, they increase the pitch of liquid crystal substances with temperature rise; hence they often have an undesirable influence upon the liquid crystal substances. For example, in the case of SBE mode, the intrinsic pitch P of liquid crystal compositions varies depending on temperature change, whereby the ratio (P/d) of the intrinsic pitch P of liquid crystal compositions to the cell thickness d of display elements also varies. Usually the P/d is 2 or less, but if it exceeds 2 due to temperature change, 270° twist changes to 90° twist.

Further, in the aspect of improvement for increasing the display capacity, it is necessary to improve the steepness of change in the transmittance when voltage is impressed to display elements. G. Bauer and W. Fehlenbach reported a calculation result that when the twist is changed to 270°, the steepness is improved to a large extent (15th Freiburg Liquid Crystal Meeting (1985)), but in this case, too, it is necessary therefor to be free from change in the intrinsic viscosity depending on temperature (i.e. temperature-dependency of intrinsic pitch).

As to a method for solving this problem, an optically active compound having a negative temperature characteristic i.e. a substance the intrinsic pitch of which decreases with temperature rise has been found in recent years, and when this substance is mixed in a suitable quantity with a conventional optically active substance having a positive temperature characteristic, a composition having no temperature-dependency of the intrinsic pitch has been obtained (Emoto et al, Japanese patent application No. Sho 61-179194/1986).

However, such a method that a compound having a positive temperature characteristic is mixed with a compound having a negative one in a suitable proportion to be free from the temperature-dependency of the intrinsic pitch is very troublesome and further it is difficult to have a pitch of a necessary length precisely exhibited.

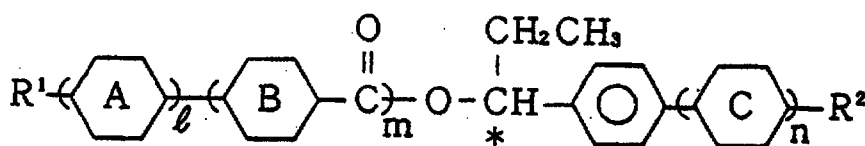
In order to solve these problems, a compound having a short pitch and also having no temperature-dependency of the intrinsic pitch has been desired.

SUMMARY OF THE INVENTION

The present inventors have made extensive research in order to obtain an optically active compound having characteristics required for realizing a liquid crystal composition having preferable characteristics as described above, i.e. an optically active compound having a high twistability and also having no temperature-dependency of the intrinsic pitch, and as a result have achieved the present invention.

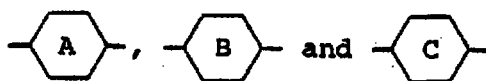
The present invention resides in

an optically active compound expressed by the formula

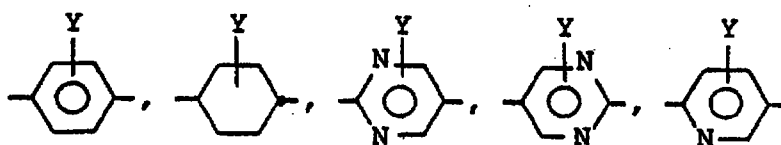


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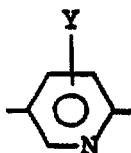
wherein R¹ and R² each represent an alkyl group,
an alkoxy group each of 1 to 20 carbon atoms, a halogen atom or hydrogen atom; *l*, *m* and *n* each represent
0 or 1; and



each independently represent



or



wherein Y represents hydrogen atom, a halogen atom or cyano group,
a liquid crystal composition containing at least one member of the above optically active compound,
and
an electrooptical element constituted by using the above liquid crystal composition.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The compound of the present invention exhibits no liquid crystallinity by itself.

A first specific feature of the compound of the present invention consists in that when it is used as a dopant for liquid crystal compositions, a small quantity of the compound added induces a high twist structure. As shown in Example 2 mentioned later, when the compound is added in 1% by weight to a liquid crystal composition having no twist structure, the resulting pitch is as short as 3.7 μm at 25°C so that it is possible to prepare a liquid crystal composition having an optimized twist structure i.e. a chiral liquid crystal composition in a smaller quantity of the compound added.

This is seen to be a surprising specific structure, taking into account the fact that an optically active compound currently known as a dopant, e.g. C-15 (a trade name of product made by BDH Co., Ltd.) affords a pitch of 63 μm and even CB-15 (a trade name of product made by the Company) affords nothing but 10 μm .

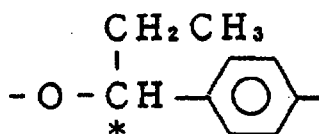
Further, a second specific feature of the compound of the present invention consists in that change in the pitch depending on temperature is very flat. As shown in Example 2, the temperature characteristic δp is as very flat as 0 at $t_1=20^\circ\text{C}$ and $t_2=60^\circ\text{C}$; thus it is possible to easily provide a liquid crystal composition having

a good temperature characteristic (i.e. a small temperature dependency) of pitch.

Further, since the compound of the present invention has a high twistability, the quantity thereof added necessary for obtaining a chiral liquid crystal composition having an optimized twist structure may be small so that it is possible to blend the compound with various kinds of liquid crystal substances. Examples of such liquid crystal substances are Schiff's bases, biphenyls, phenylcyclohexanes, phenylpyridines, phenylpyrimidines, phenyldioxanes, cyclohexylbiphenyls, cinnamic esters, phenyl esters, etc. and liquid crystal compositions obtained by combining compounds optionally chosen from among the foregoing compounds.

Further, chiral liquid crystal compositions obtained by adding the compound of the present invention i.e. liquid crystal compositions having a twist structure are not limited only to chiral nematic compositions, but also refer to compositions having chiral smectic C phase, having a twist structure had in smectic phase, particularly smectic C phase. In recent years, a research on a novel drive mode utilizing chiral smectic C phase has been extensively made (Clark et al: Applied Phys. Lett., 36, 899 (1980)) and when the compound of the present invention is added to a compound or a composition having smectic C phase, it is possible to induce chiral smectic C phase.

The superior specific features of the compound of the present invention as described above are considered to originate from the central core of the chemical structure of the compound i.e.



and with regard to the structures on both the sides of the above core, the specific features are not restricted thereby so much, as expressed by the above formula (I).

Names of concrete compounds preferred among those of the present invention will be enumerated below:

optically active 4-methylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-ethylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-propylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-butylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-hexylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-heptylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-nonylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-decylbenzoic acid 1-phenyl-1-propyl ester
 optically active 4-ethoxybenzoic acid 1-phenyl-1-propyl ester
 optically active 4-pentyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 4-octyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 4-chlorobenzoic acid 1-phenyl-1-propyl ester
 optically active 4-bromobenzoic acid 1-phenyl-1-propyl ester
 optically active 4-fluorobenzoic acid 1-phenyl-1-propyl ester
 optically active 4-cyanobenzoic acid 1-phenyl-1-propyl ester
 optically active 2-fluorobenzoic acid 1-phenyl-1-propyl ester
 optically active 2-cyanobenzoic acid 1-phenyl-1-propyl ester
 optically active 3-fluorobenzoic acid 1-phenyl-1-propyl ester
 optically active 3-cyanobenzoic acid 1-phenyl-1-propyl ester
 optically active 4-ethylbenzoic acid 1-(4-methylphenyl)-1-propyl ester
 optically active 4-pentylbenzoic acid 1-(4-pentylphenyl)-1-propyl ester
 optically active 4-heptylbenzoic acid 1-(4-ethylphenyl)-1-propyl ester
 optically active 4-decylbenzoic acid 1-(4-propyloxyphenyl)-1-propyl ester
 optically active 4-undecylbenzoic acid 1-(4-butyloxyphenyl)-1-propyl ester
 optically active 4-dodecylbenzoic acid 1-(4-hexyloxyphenyl)-1-propyl ester
 optically active 4-methoxybenzoic acid 1-(4-butylphenyl)-1-propyl ester
 optically active 4-propyloxybenzoic acid 1-(4-pentylphenyl)-1-propyl ester
 optically active 4-pentyloxybenzoic acid 1-(4-hexyloxyphenyl)-1-propyl ester
 optically active 4-pentyloxybenzoic acid 1-(4-fluorophenyl)-1-propyl ester
 optically active 4-pentyloxybenzoic acid 1-(4-cyanophenyl)-1-propyl ester
 optically active 4-fluorobenzoic acid 1-(4-methylphenyl)-1-propyl ester
 optically active 4-cyanobenzoic acid 1-(4-ethylphenyl)-1-propyl ester

5 optically active 4-fluorobenzoic acid 1-(4-butyloxyphenyl)-1-propyl ester
 optically active 4-cyanobenzoic acid 1-(4-pentyloxyphenyl)-1-propyl ester
 optically active 4 cyanobenzoic acid 1-(4-cyanophenyl)-1-propyl ester
 optically active 2-fluoro-4-butylbenzoic acid 1-phenyl-1-propyl ester
 optically active 2-fluoro-4-hexylbenzoic acid 1-phenyl-1-propyl ester
 optically active 2-cyano-4-pentylbenzoic acid 1-phenyl-1-propyl ester
 optically active 2-cyano-4-octylbenzoic acid 1-phenyl-1-propyl ester
 optically active 2-fluoro-4-propyloxybenzoic acid 1-phenyl-1-propyl ester
 10 optically active 2-fluoro-4-heptyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 2-cyano-4-butyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 2-cyano-4-nonyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 3-fluoro-4-ethylbenzoic acid 1-phenyl-1-propyl ester
 optically active 3-fluoro-4-pentylbenzoic acid 1-phenyl-1-propyl ester
 optically active 3-fluoro-4-heptylbenzoic acid 1-phenyl-1-propyl ester
 15 optically active 3-cyano-4-propylbenzoic acid 1-phenyl-1-propyl ester
 optically active 3-cyano-4-hexylbenzoic acid 1-phenyl-1-propyl ester
 optically active 3-cyano-4-nonylbenzoic acid 1-phenyl-1-propyl ester
 optically active 3-fluoro-4-propyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 3-fluoro-4-pentyloxybenzoic acid 1-phenyl-1-propyl ester
 20 optically active 3-fluoro-4-octyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 3-cyano-4-methyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 3-cyano-4-pentyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 3-cyano-4-decyloxybenzoic acid 1-phenyl-1-propyl ester
 optically active 2-fluoro-4-methylbenzoic acid 1-(4-pentylphenyl)-1-propyl ester
 25 optically active 2-fluoro-4-butylbenzoic acid 1-(4-heptylphenyl)-1-propyl ester
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 30 optically active 2-cyano-4-pentylbenzoic acid 1-(4-ethylphenyl)-1-propyl ester
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 optically active 4-methylcyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 optically active 4-ethylcyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 optically active 4-butylcyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 40 optically active 4-pentylcyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 optically active 4-octylcyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 optically active 4-decylcyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 optically active 4-propyloxycyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 optically active 4-hexyloxycyclohexylcarboxylic acid 1-phenyl-1-propyl ester
 45 optically active 4-heptyloxycyclohexylcarboxylic acid 1-phenyl-1-propyl ester
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 optically active 4-ethylcyclohexylcarboxylic acid 1-(4-pentylphenyl)-1-propyl ester
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 50 optically active 4-pentylcyclohexylcarboxylic acid 1-(4-hexylphenyl)-1-propyl ester
 optically active 4-pentylcyclohexylcarboxylic acid 1-(4-hexyloxyphenyl)-1-propyl ester
 optically active 4-hexylcyclohexylcarboxylic acid 1-(4-butylphenyl)-1-propyl ester
 optically active 4-hexylcyclohexylcarboxylic acid 1-(4-butyloxyphenyl)-1-propyl ester
 optically active 4-octylcyclohexylcarboxylic acid 1-(4-nonylphenyl)-1-propyl ester
 55 optically active 4-ethyloxycyclohexylcarboxylic acid 1-(4-methylphenyl)-1-propyl ester
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 optically active 2-ethylpyrimidine-5-carboxylic acid 1-phenyl-1-propyl ester
 optically active 2-butylpyrimidine-5-carboxylic acid 1-phenyl-1-propyl ester
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 optically active 5-nonyloxy pyridine-2-carboxylic acid 1-phenyl-1-propyl ester
 optically active 5-ethylpyridine-2-carboxylic acid 1-(4-hexylphenyl)-1-propyl ester
 40 optically active 5-propylpyridine-2-carboxylic acid 1-(4-hexylphenyl)-1-propyl ester
 optically active 5-propyloxy pyridine-2-carboxylic acid 1-(4-decylphenyl)-1-propyl ester
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 optically active 5-hexyloxy pyridine-2-carboxylic acid 1-(4-nonyloxyphenyl)-1-propyl ester
 optically active 5-heptylpyridine-2-carboxylic acid 1-(4-nonylphenyl)-1-propyl ester
 optically active 5-heptyloxy pyridine-2-carboxylic acid 1-(4-decylphenyl)-1-propyl ester
 optically active 5-octylpyridine-2-carboxylic acid 1-(4-butylphenyl)-1-propyl ester
 55 optically active 4-butylbenzoic acid 1-(4-pentyl-4'-biphenyl)-1-propyl ester
 optically active 4-pentylbenzoic acid 1-(4-pentyl-4'-biphenyl)-1-propyl ester
 optically active 4-pentylbenzoic acid 1-(4-pentyloxy-4'-biphenyl)-1-propyl ester
 optically active 4-hexylbenzoic acid 1-(4-butyl-4'-biphenyl)-1-propyl ester

optically active 4-hexylbenzoic acid 1-(4-nonyl-4'-biphenyl)-1-propyl ester
 optically active 4-hexyloxybenzoic acid 1-(4-pentyloxy-4'-biphenyl)-1-propyl ester
 optically active 4-heptylbenzoic acid 1-(4-propyl-4'-biphenyl)-1-propyl ester
 optically active 4-heptylbenzoic acid 1-(4-butyloxy-4'-biphenyl)-1-propyl ester
 5 optically active 4-heptyloxybenzoic acid 1-(4-hexyl-4'-biphenyl)-1-propyl ester
 optically active 4-octylbenzoic acid 1-(4-nonyl-4'-biphenyl)-1-propyl ester
 optically active 4-octylbenzoic acid 1-(4-decyl-4'-biphenyl)-1-propyl ester
 optically active 3-fluoro-4-pentylbenzoic acid 1-(4-hexyl-4'-biphenyl)-1-propyl ester
 optically active 3-fluoro-4-hexyloxybenzoic acid 1-(4-propyl-4'-biphenyl)-1-propyl ester
 10 optically active 3-fluoro-4-octylbenzoic acid 1-(4-pentyl-4'-biphenyl)-1-propyl ester
 optically active 3-cyano-4-butylbenzoic acid 1-(4-propyl-4'-biphenyl)-1-propyl ester
 optically active 3-cyano-4-butyloxybenzoic acid 1-(4-pentyl-4'-biphenyl)-1-propyl ester
 optically active 3-cyano-4-nonylbenzoic acid 1-(4-hexyloxy-4'-biphenyl)-1-propyl ester
 optically active 3-cyano-4-decyloxybenzoic acid 1-(4-octyl-4'-biphenyl)-1-propyl ester
 15 optically active 2-butylpyrimidine-5-carboxylic acid 1-(4-butyl-4'-biphenyl)-1-propyl ester
 optically active 2-pentylpyrimidine-5-carboxylic acid 1-(4-nonyl-4'-biphenyl)-1-propyl ester
 optically active 2-pentyloxy-pyrimidine-5-carboxylic acid 1-(4-pentyl-4'-biphenyl)-1-propyl ester
 optically active 2-hexylpyrimidine-5-carboxylic acid 1-(4-propyl-4'-biphenyl)-1-propyl ester
 optically active 2-hexylpyrimidine-5-carboxylic acid 1-(4-pentyloxy-4'-biphenyl)-1-propyl ester
 20 optically active 2-octylpyrimidine-5-carboxylic acid 1-(4-nonyl-4'-biphenyl)-1-propyl ester
 optically active 2-octyloxy-pyrimidine-5-carboxylic acid 1-(4-decyl-4'-biphenyl)-1-propyl ester
 optically active 2-nonylpyridine-5-carboxylic acid 1-(4-methyl-4'-biphenyl)-1-propyl ester
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 optically active 5-heptylpyrimidine-2-carboxylic acid 1-(4-hexyl-4'-biphenyl)-1-propyl ester
 30 optically active 5-heptyloxy-pyrimidine-2-carboxylic acid 1-(4-nonyl-4'-biphenyl)-1-propyl ester
 optically active 5-octylpyrimidine-2-carboxylic acid 1-(4-nonyloxy-4'-biphenyl)-1-propyl ester
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 35 optically active 2-hexylpyridine-5-carboxylic acid 1-(4-propyl-4'-biphenyl)-1-propyl ester
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 55 optically active 5-pentylpyridine-2-carboxylic acid 1-phenyl-1-propyl ester
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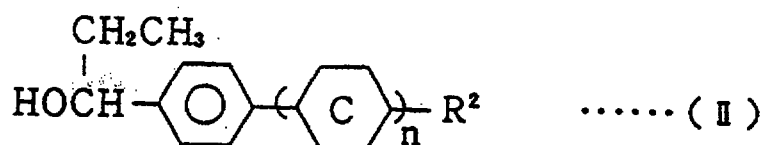
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 15 optically active 1-(4-octylphenyl)-1-propanol
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 optically active 1-(4-undecylphenyl)-1-propanol
 optically active 1-(4-dodecylphenyl)-1-propanol
 20 optically active 1-(4-chlorophenyl)-1-propanol
 optically active 1-(4-bromophenyl)-1-propanol
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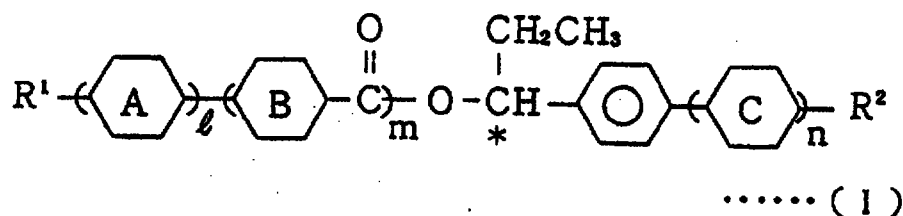
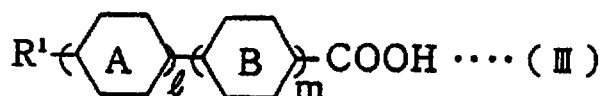
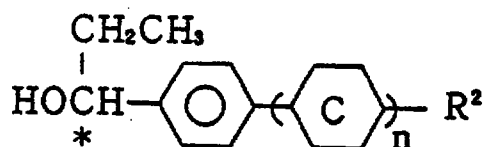
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 optically active 1-{4-(4-nonyloxycyclohexyl)phenyl}-1-propanol
 optically active 1-{4-(4-decyloxycyclohexyl)phenyl}-1-propanol

(Preparation of the Compound)

The compound of the formula (I) of the present invention may be suitably prepared for example by way of the following route:



↓
Optical
resolution



wherein R^1 , R^2 , ℓ , m , n ,



each are as defined above.

Namely, a 1-substituted propanol as a racemate expressed by the formula (II) is optically resolved to selectively obtain S-form and R-form, followed by reacting therewith a carboxylic acid expressed by the formula (III) to obtain the compound of the formula (I).

The compound of the present invention will be described in more detail by way of Examples.

Example 1

Preparation of R-(-)-4-octyloxybiphenyl-4'-carboxylic acid 1-phenyl-1-propyl ester (a compound of the formula (I) wherein



R^2 =hydrogen atom, $\ell=m=1$ and $n=0$)

(First step)

Preparation of optically active 1-phenyl-1-propanol:

A mixture of ($\pm$)-1-phenyl-1-propanol (40.9 g), tributyrin (99.8 g) and lipase P (15 g) was agitated at 35°C for 502 hours, followed by filtering off lipase P and subjecting the residue to vacuum distillation to obtain S-(-)-1-phenyl-1-propanol (19.9 g). bp: 71.8°C/2.5 mmHg, $[\alpha]_D^{24.8} = -14.4^\circ$ (neat).

Further, a fraction of bp 101.3°C/2.6 mmHg was subjected to hydrolysis reaction in a conventional manner

to obtain R-(+)-1-phenyl-1-propanol (10.2 g). $[\alpha]_D^{24.7} = +25.8^\circ$ (neat).

(Second step)

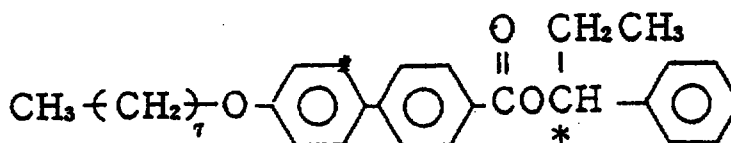
5 Preparation of the captioned compound:

A mixture of R-(+)-1-phenyl-1-propanol (5.5 g) prepared in the first step, 4-octyloxy-4'-carboxylic acid (15 g), 4,4'-dicyclohexylcarbodiimide (9.5 g), 4-dimethylaminopyridine (0.6 g) and dichloromethane (90 ml) was agitated at room temperature for 2 hours, followed by filtering off the resulting insolubles, distilling off dichloromethane, purifying the residue according to column chromatography using toluene as a solvent and twice re-crystallizing the resulting substance from ethanol to obtain R-(-)-4-octyloxybiphenyl-4'-carboxylic acid 1-phenyl-1-propyl ester. Mp 53.5-54.3°C, $[\alpha]_D^{25.0} = -87.3^\circ$ (C=1.15, CHCl₃).

Further, this product was confirmed to well accord with the captioned compound according to elemental analysis, NMR spectra and IR spectra.

Example 2 (Use example 1)

The compound of Example 1 of the present invention i.e.



was added in 1% by weight to a nematic liquid crystal composition (a commercially available ZLI-1132 made by Merck Company) to prepare a chiral nematic liquid crystal composition. This composition was filled in a wedge-form cell subjected to a parallel aligning treatment and the resulting cell was observed under a polarizing microscope. As a result, the following helical pitches were observed:

Temperature T (°C)	20	25	30	40	50	60
Pitch length (μm)	3.7	3.7	3.7	3.7	3.8	3.8
δ_{p20-T}	—	—	0	0	0.089	0

" δ_{p20-T} " in the above Table refers to a parameter expressing the temperature characteristic and is defined by the following equation:

$$\delta_{p20-T} = \frac{2(p(20) - p(T))}{p(20) + (T)} \times \frac{100}{20 - T}$$

In this equation,

p(20): pitch length at 20°C

p(T): pitch length at T°C

As described above, the exhibited pitch length is very short and further, there is almost no change in the pitch with temperature rise.

Thus, it was confirmed that the compound of the present invention is a superior pitch-adjusting agent for liquid crystal compositions.

55 Claims

1. Optically active compounds of the formula:

to obtain R-(+)-1-phenyl-1-propanol (10.2 g). $[\alpha]_D^{24.7} = +25.8^\circ$ (neat).

(Second step)

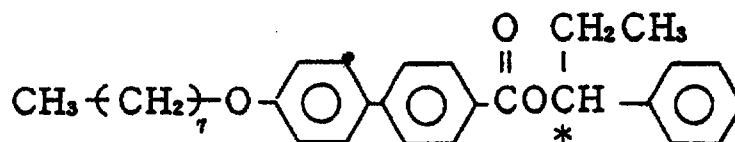
5 Preparation of the captioned compound:

A mixture of R-(+)-1-phenyl-1-propanol (5.5 g) prepared in the first step, 4-octyloxy-4'-carboxylic acid (15 g), 4,4'-dicyclohexylcarbodiimide (9.5 g), 4-dimethylaminopyridine (0.6 g) and dichloromethane (90 ml) was agitated at room temperature for 2 hours, followed by filtering off the resulting insolubles, distilling off dichloromethane, purifying the residue according to column chromatography using toluene as a solvent and twice recrystallizing the resulting substance from ethanol to obtain R-(-)-4-octyloxybiphenyl-4'-carboxylic acid 1-phenyl-1-propyl ester. Mp 53.5-54.3°C, $[\alpha]_D^{25.0} = -87.3^\circ$ (C=1.15, CHCl₃).

Further, this product was confirmed to well accord with the captioned compound according to elemental analysis, NMR spectra and IR spectra.

Example 2 (Use example 1)

The compound of Example 1 of the present invention i.e.



was added in 1% by weight to a nematic liquid crystal composition (a commercially available ZLI-1132 made by Merck Company) to prepare a chiral nematic liquid crystal composition. This composition was filled in a wedge-form cell subjected to a parallel aligning treatment and the resulting cell was observed under a polarizing microscope. As a result, the following helical pitches were observed:

Temperature T (°C)	20	25	30	40	50	60
Pitch length (μm)	3.7	3.7	3.7	3.7	3.8	3.8
δ_{p20-T}	—	—	0	0	0.089	0

" δ_{p20-T} " in the above Table refers to a parameter expressing the temperature characteristic and is defined by the following equation:

$$\delta_{p20-T} = \frac{2(p(20) - p(T))}{p(20) + (T)} \times \frac{100}{20 - T}$$

In this equation,

p(20): pitch length at 20°C

p(T): pitch length at T°C

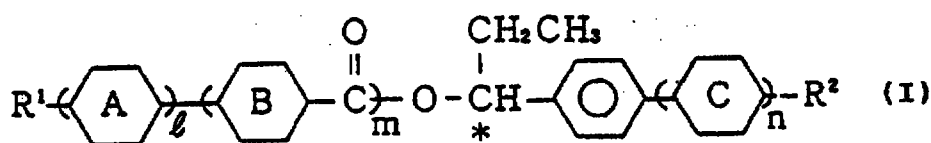
As described above, the exhibited pitch length is very short and further, there is almost no change in the pitch with temperature rise.

Thus, it was confirmed that the compound of the present invention is a superior pitch-adjusting agent for liquid crystal compositions.

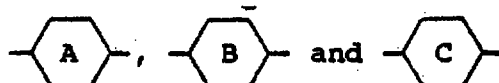
55 Claims

1. Optically active compounds of the formula:

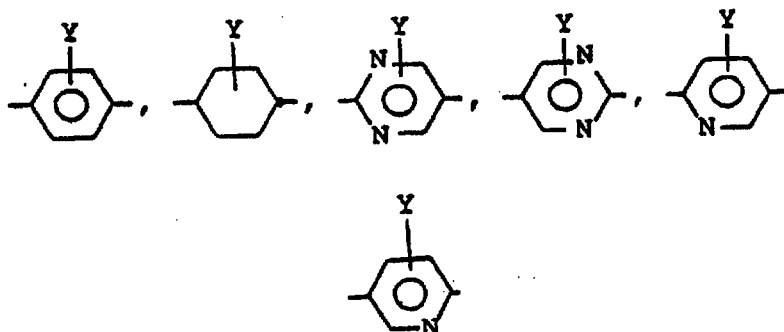




in which R^1 and R^2 are each a hydrogen or halogen atom or an alkyl or alkoxy group containing up to 20 carbon atoms; ℓ , m and n are each 0 or 1; and



are independently a group

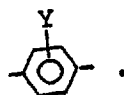


(In which Y is hydrogen or halogen atom or a cyano group).

2. An optically active compound according to claim 1 in which m is 1.
3. An optically active compound according to claim 2 in which ℓ is 1.
4. An optically active compound according to claim 3 in which n is 0.
5. An optically active compound according to claim 4 in which



each represent a group

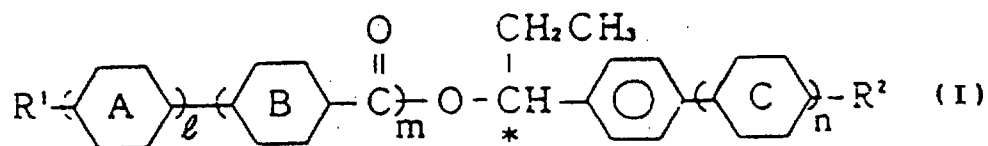


6. A liquid crystal composition comprising at least two components, at least one of which is an optically active compound as defined in any one of the preceding claims.
7. An electrooptical element containing a liquid crystal composition as defined in claim 6.

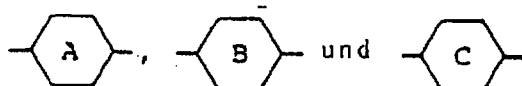


Patentansprüche

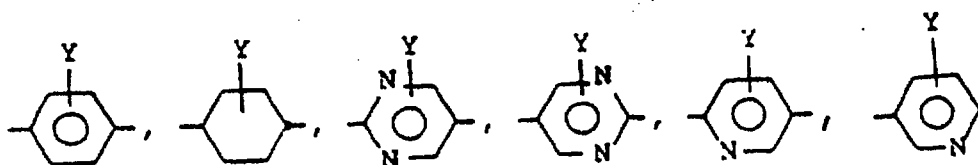
1. Optisch aktive Verbindung der Formel:



worin R^1 und R^2 jeweils ein Wasserstoff- oder Halogenatom sind oder eine Alkyl- oder eine Alkoxygruppe mit bis zu 20 Kohlenstoffatomen repräsentieren; ℓ , m und n jeweils 0 oder 1 sind; und



unabhängig voneinander eine



-Gruppe repräsentieren (bei welcher Y Wasserstoff oder ein Halogenatom oder eine Cyanogruppe bedeutet).

2. Optisch aktive Verbindung nach Anspruch 1, bei welcher m gleich 1 ist.
3. Optisch aktive Verbindung nach Anspruch 2, bei welcher ℓ gleich 1 ist.
4. Optisch aktive Verbindung nach Anspruch 3, bei welcher n gleich 0 ist.
5. Optisch aktive Verbindung nach Anspruch 4, bei welcher



jeweils eine



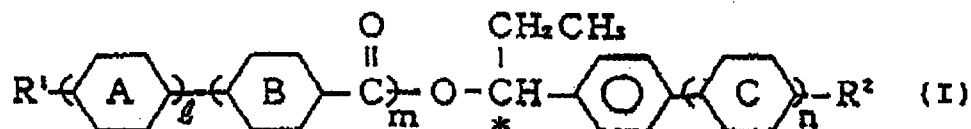
-Gruppe repräsentieren.

6. Flüssigkristallzusammensetzung mit mindestens zwei Komponenten, wovon mindestens eine eine optisch aktive Verbindung gemäß einem der voranstehenden Ansprüche ist.
7. Elektrooptisches Element mit einer Flüssigkristallzusammensetzung nach Anspruch 6.

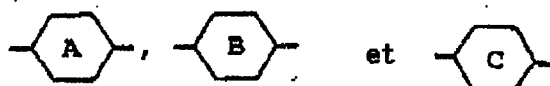


Revendications

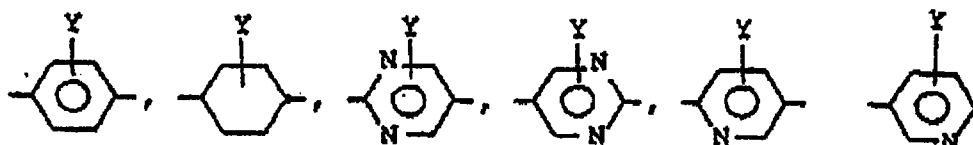
1. Composés optiquement actifs de la formule



dans laquelle R^1 et R^2 sont chacun un atome d'hydrogène ou d'halogène ou un groupement alkyle ou alcoxy contenant jusqu'à 20 atomes de carbone; ℓ , m et n sont chacun 0 ou 1; et

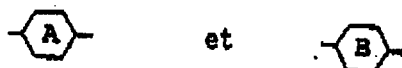


sont indépendamment l'un de l'autre un groupement

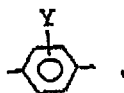


(dans lequel Y est un atome d'hydrogène ou d'halogène ou un groupement nitrile).

2. Composé optiquement actif suivant la revendication 1, dans lequel m est 1.
 3. Composé optiquement actif suivant la revendication 2, dans lequel ℓ est 1.
 4. Composé optiquement actif suivant la revendication 3, dans lequel n est 0.
 5. Composé optiquement actif suivant la revendication 4, dans lequel



représentent chacun un groupement



6. Composition liquide cristalline comprenant au moins deux composants dont au moins un est un composé optiquement actif tel que défini dans l'une quelconque des revendications précédentes.
 7. Élément électro-optique contenant une composition liquide cristalline telle que définie dans la revendication 6.

