

Anisotropic cyclohexyl ether

The invention relates to new anisotropic compounds, and in particular the new class of cyclohexyl cyclohexylmethyl ethers, and liquid crystal (LC) mixtures which contain cyclohexyl cyclohexylmethyl ethers and are used as a dielectric for liquid crystal displays. The invention furthermore relates to processes for the preparation of the new anisotropic compounds.

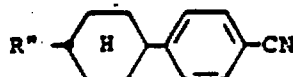
Anisotropic biphenyl compounds of the formula (10)



(10)

in which R' is, for example, an alkyl radical are known, for example, from German Offenlegungsschrift 2,356,085 and belong to the substances used in most cases for LC mixtures.

It is furthermore known from German Offenlegungsschrift 2,636,684 that the comparatively high viscosity and Δn values of the compounds (10) can be reduced if one of the phenylene rings is replaced by a trans-1,4-cyclohexylene ring, which leads to phenylcyclohexanes of the formula (20)



(20)

in which R'' has the same meaning as R' in formula (10).

As is known, the Δn values of anisotropic components of LC mixtures are a measure of the optical anisotropy and are expressed as $\Delta n = n_{II} - n_I$, as the difference in the refractive indices parallel and perpendicular to the molecular axis of the substance in question.

For some types of LC displays, in particular the so-called "guest-host" effect cells, nematic LC phases with the smallest possible Δn values, for example not exceeding 0.1, are required. By replacing one of the phenylene rings in the compounds (10) by the trans-cyclohexylene ring, the Δn value is virtually reduced by half ($\Delta n \approx 0.22$ in compounds of the formula (10), $\Delta n \approx 0.12$ in compounds of the formula (20)).

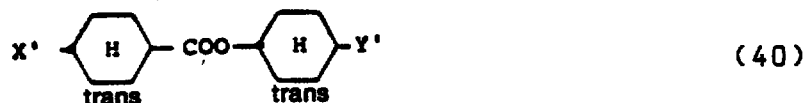
If the second phenylene ring of the anisotropic compounds (10), or the remaining phenylene ring of the compounds (20), is now also replaced by the cyclohexylene ring, the cyclohexylcyclohexanes known from German Offenlegungsschrift 2,702,598, of the formula (30)



in which R'' has the meaning given for R' in formula (10), are obtained; the Δn value here is again reduced, and in particular to values below 0.1, typically to about $\Delta n = 0.06$.

The disadvantage of the compounds (20), however, is the fact (see R, Pohl et al., Phys. Letter 65A (2), 169/1978) that hydrogenation of the second phenylene ring causes a marked tendency to form smectic phases.

Finally, the prior art also includes the cyclohexyl cyclohexanoates described in Mol. Cryst. Liq. Cryst. 56 (1979) 105, of the formula (40)



in which X' and Y' are alkyl, alkylcyclohexyl or nitrile groups.

The compounds (40) have advantageously low Δn values, a relatively low viscosity and, in contrast to the known compounds (30), no marked tendency to form smectic phases, so that the carboxyl group was to be regarded as a comparatively critical constituent for the advantageous properties of the compounds (40).

However, the carboxyl group, as a bridge between the cyclohexyl rings (A) and (B) of the formula (40), is relatively reactive and sensitive towards hydrolysis.

The object of the present invention are new anisotropic compounds which offer the advantages of the cyclohexyl cyclohexanoates of the formula (40), but, in comparison with these, have a higher chemical stability.

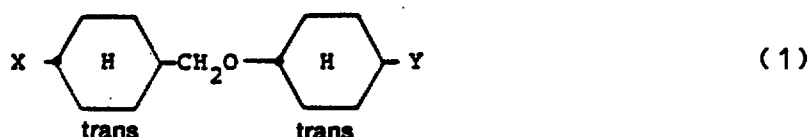
The object of the invention furthermore includes LC mixtures which contain new anisotropic compounds, and

(27)

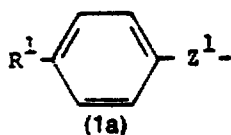
processes for the preparation of new anisotropic compounds.

It has been found that the objects of the invention are achieved by replacing the carboxyl group which joins the cyclohexyl rings (A) and (B) of the compounds (40) to one another by an ether bridge of the formula $-\text{CH}_2\text{O}-$. Surprisingly, that is to say in contrast to the expectation of experts, the ethers have generally lower melting points than the corresponding carboxyl compounds (40).

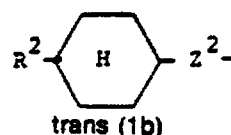
The new anisotropic compounds according to the present invention have the formula (1)



in which X and Y are each hydrogen atoms, alkyl groups with 1 to 12 C atoms, alkoxy groups with 1 to 12 C atoms, mono-alkylamino groups with 1 to 12 C atoms, nitrile groups, nitro groups or halogen atoms, or cyclic radicals of the formula (1a) or (1b)



or



in which R^1 and R^2 are hydrogen atoms, alkyl groups with 1 to 12 C atoms, alkoxy groups with 1 to 12 C atoms, mono-alkylamino groups with 1 to 12 C atoms, nitrile groups, nitro groups or halogen atoms and Z^1 and Z^2 are single covalent bonds or groups of the formulae $-\text{COO}-$, $-\text{OOC}-$, $-\text{CH}_2\text{O}-$ or $^-\text{OCH}_2-$, with the proviso that only one of the groups X and Y is a cyclic radical of the formulae (1a) or (1b).

The alkyl part in the alkyl, alkoxy or N-monoalkyl-amino radicals of X, Y, R^1 and R^2 is preferably straight-chain; alkyl parts with 3 to 10 C atoms, in particular 3 to 8 C atoms, are frequently preferred here. Cl and Br are usually preferred as halogen for X, Y, R^1 and R^2 .

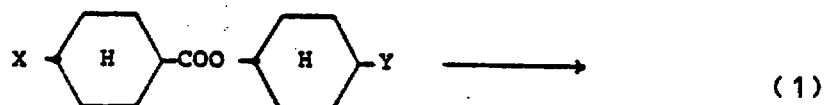
Those compounds (1) in which X is not identical to Y are furthermore frequently preferred.

LC mixtures which consist chiefly or virtually

completely (for example up to 90% by weight) of compounds (1) mixed with one another or contain at least one compound (1) as a component, for example in amounts of 2 to 40% by weight, based on the LC mixture, for example with known anisotropic compounds and/or other components suitable for LC mixtures, can be prepared with the new anisotropic compounds.

The new anisotropic compounds (1) and the LC mixtures prepared with them are generally suitable for nematic phases of low optical anisotropy and low viscosity; if the LC mixture according to the invention or the compounds (1) according to the invention have a positive DC anisotropy, the nematic phases are particularly suitable for the known LC displays in the form of twisted cells in multiplex operation and for the known LC displays which operate on the basis of the so-called guest-host effect. If the LC mixture according to the invention or the compounds (1) according to the invention have a negative DC anisotropy, the nematic phases formed with them are particularly suitable for known LC displays which operate by the inverse guest-host effect, as dynamic scattering cells (DS) or as so-called DDM cells.

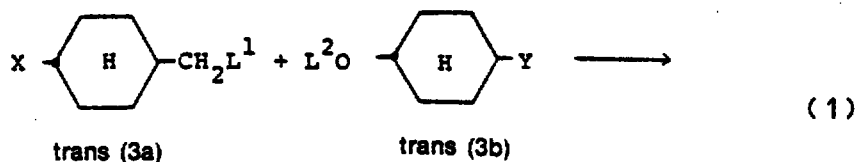
The new compounds (1) can be obtained by a process in which the corresponding cyclohexyl cyclohexanoates, for example those obtainable in accordance with the abovementioned literature reference, are reduced, that is to say



wherein X and Y have the abovementioned meaning, for example with the aid of $\text{BF}_3/\text{NaBH}_4$, by the method which is known per se (see, for example, G.R. Pettit and D.M. Piatate, J. Org. Chem. 27 (1962) 2127) for reductive conversion of esters into ethers.

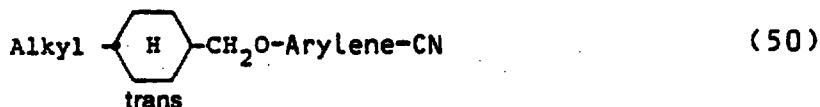
The new compounds (1) can furthermore also be obtained by condensation or etherification of a corresponding p-X-trans-cyclohexylmethyl compound of the formula (3a) with a corresponding p-Y-trans-cyclohexyloxy compounds (sic)

of the formula (3b), that is to say

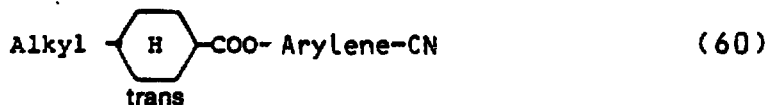


wherein X and Y have the abovementioned meaning and L^1 and L^2 are leaving groups or leaving atoms which form L^1L^2 with one another during the condensation. If L^1 is, for example, halogen, such as Br, the condensation can be carried out with $\text{L}^2 = \text{H}$ to form hydrogen halide L^1L^2 as the by-product, which can be bonded in the customary manner with an organic substance, for example pyridine, or inorganic substance, for example sodium carbonate, to promote the reaction.

A method which is suitable for the preparation of the new compounds (1) by condensation or etherification is ... (sic) by G. W. Gray and D. G. McDonnell in Mol. Cryst. Liq. Cryst. 53 (1979) 147-166 for cyclohexylmethyl ethers with an aromatic (phenylene, biphenylene or naphthylene) ring on the ether group, that is to say for compounds of the formula (50)



which, however, have generally higher melting points than the corresponding carboxyl compounds of the formula (60)



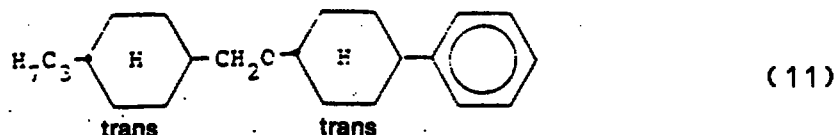
Surprisingly, the ethers of the formula (1) according to the invention have, however, generally lower melting points than the corresponding cyclohexyl cyclohexanoates of the formula (40).

The starting compound (3a) or (3b) for the synthesis of the compounds (1) according to the invention by condensation or etherification is known or can be prepared analogously to the known compounds.

The preparation of compounds (1) according to the invention is illustrated in the following examples.

Example 1

Preparation of trans-4-phenylcyclohexyl trans-4'-n-propyl-
5 cyclohexylmethyl ether of the formula (11)

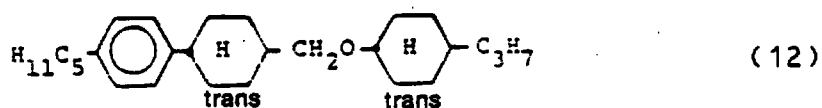


0.8 g (0.021 mol) of NaBH₄ were taken in 70 ml of diethylene glycol dimethyl ether, while cooling with ice, and 4.5 g (0.0137 mol) of trans-4-phenylcyclohexyl
10 trans-4'-n-propylcyclohexanoate in 75 ml of tetrahydrofuran and 37 ml (0.29 mol) of boron trifluoroetherate in 75 ml of tetrahydrofuran were added simultaneously, during which the temperature did not rise above 5°C. When the addition had ended, the reaction mixture was brought to room tempera-
15 ture and warmed at the reflux temperature for 1 hour. For working up, 100 ml of 2 N HCl were added and the organic solvents were distilled off. The aqueous phase was extracted three times with methylene chloride and the organic phases were washed with sodium chloride solution, dried
20 over Na₂SO₄ and concentrated. The crystalline crude product was chromatographed over silica gel and recrystallized from ethanol. T_k 50.5°C, T_c (22°C).

The T_k value of the corresponding cyclohexyl cyclohexanoate compound (40), in contrast, is 84.4°C and
25 the T_c value (69.5°C). As is usual, T_k here is the temperature of transition from the crystalline to the liquid phase and T_c is the clear point. A T_c value quoted in parentheses means measurement in the supercooled state.

Example 2

30 Preparation of trans-(4"-n-pentyl)-4'-phenylcyclohexyl-methyl trans-4-n-propylcyclohexyl ether of the formula (12)



0.8 g (0.021 mol) of NaBH_4 were taken in 70 ml of diethylene glycol dimethyl ether, while cooling with ice, and 5.5 g (0.0137 mol) of trans-4-n-propylcyclohexyl trans-(4"-n-pentyl)-4'-phenylcyclohexanoate in 75 ml of tetrahydrofuran and 37 ml (0.29 mol) of boron trifluoroetherate (sic) in 75 ml of tetrahydrofuran (sic) were added simultaneously, during which the temperature did not rise above 5°C . When the addition had ended, the reaction mixture was brought to room temperature and warmed under the reflux temperature for 1 hour. For working up, 100 ml of 2 N HCl were added and the organic solvents were distilled off. The aqueous phase was extracted three times with methylene chloride and the organic phases were washed with sodium chloride solution, dried over Na_2SO_4 and concentrated. For purification, the product, that is to say the compound (12), was chromatographed over silica gel and recrystallized from ethanol. T_c 87.7°C .

The compound (12) showed a marked tendency to form supercooled melts and is not frozen down to 0°C . In contrast, the corresponding cyclohexyl cyclohexanoate has a T_k value of 84.2°C and a T_c value of 177.3°C .

Example 3

The compound of the formula (11) according to the invention prepared according to Example 1 by reduction of the corresponding cyclohexyl cyclohexanoate was also prepared by condensation or etherification of corresponding compounds of the formulae (3a) and (3b). For this, the procedure was as follows:

(A) Preparation of trans-4-n-propylcyclohexylmethanol of the formula (31)



23.8 g (0.14 mol) of trans-4-n-propylcyclohexanecarboxylic acid were dissolved in 150 ml of dry ether and the solution was added dropwise to a suspension of 11.4 g (0.3 mol) of LiAlH_4 in 300 ml of ether, while stirring. After the addition, the mixture was warmed at the reflux

temperature for 2 hours and the excess LiAlH_4 was then decomposed with water, while cooling. The reaction mixture was then poured onto 20% hydrochloric acid and stirred until the inorganic salts dissolved. The product of the formula (31) was extracted with diethyl ether and the organic phases were washed with water, dried over MgSO_4 and concentrated.

(B) Preparation of trans-4-n-propylcyclohexylmethyl bromide of the formula (32)



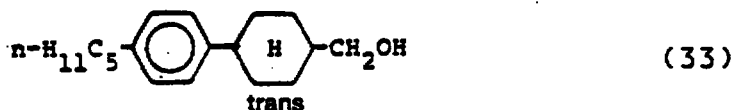
15.6 g (0.1 mol) of the compound (31) obtained according to section (A) were taken in 150 ml of a pyridine/ benzene mixture (1:1) at 0°C , and 9.0 g (0.033 mol) of PBr_3 were added dropwise, with stirring. The reaction mixture was stirred at 0°C for 2 hours and then at room temperature for 2 hours, poured onto ice/2 N HCl and extracted with diethyl ether. The ether extracts were washed once each with 2 N HCl, 2 N NaOH and sodium chloride solution, dried over Na_2SO_4 and concentrated. For purification, the bromide of the formula (32) was chromatographed over silica gel.

(C) Preparation of the compound (11) by etherification
1.56 g (0.065 mol) of NaH were taken in 30 ml of dry tetrahydrofuran (THF), 11.4 g (0.065 mol) of trans-4-phenylcyclohexanol in 20 ml of THF were slowly added, while controlling the evolution of hydrogen, and the mixture was stirred overnight at room temperature. 14.2 g (0.065 mol) of the bromide of formula (32) obtained according to section (B) in 20 ml of THF were slowly added dropwise and the entire mixture was warmed at the reflux temperature for 2 hours. For working up, the THF was distilled off, the residue was poured onto ice-water, the mixture was extracted with diethyl ether and the ether phases were washed with sodium chloride solution, dried over Na_2SO_4 and concentrated. The crude product of the formula (11) was purified over silica gel and recrystallized from ethanol.
 T_k 50.5°C , T_c (22°C).

Example 4

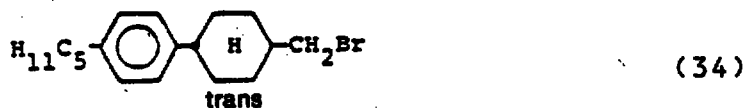
The compound of the formula (12) prepared according to Example 2 by reduction of the corresponding cyclohexyl cyclohexanoate was also prepared by condensation or etherification of the corresponding compounds of the formulae (3a) and (3b). The procedure here was as follows:

(A) Preparation of trans-(4'-n-pentyl)-4-phenylcyclohexylmethanol of the formula (33)



38.3 g (0.14 mol) of trans-(4'-n-pentyl)-4-phenylcyclohexanecarboxylic acid were dissolved in 150 ml of dry diethyl ether and the solution was added dropwise to a suspension of 11.4 g (0.3 mol) of LiAlH_4 in 300 ml of ether, while stirring. When the addition had ended, the mixture was warmed at the reflux temperature for 2 hours and the excess LiAlH_4 was then destroyed with water, while cooling. Thereafter, the reaction mixture was poured onto 20% hydrochloric acid and stirred until the inorganic salts dissolved. The product was extracted with diethyl ether and the ether phases were washed with water, dried over MgSO_4 and concentrated.

(B) Preparation of trans-(4'-n-pentyl)-4-phenylcyclohexylmethyl bromide of the formula (34)



26.0 g (0.1 mol) of the compound (33) obtained according to section (A) were taken in 150 ml of a pyridine/benzene mixture (1:1) at 0°C , and 9.0 g (0.033 mol) of PBr_3 were added dropwise, while stirring. The reaction mixture was stirred at 0°C for 2 hours and then at the reflux temperature for 2 hours, poured onto ice/2 N HCl and extracted with diethyl ether. The ether extracts were washed once each with 2 N HCl, 2 N NaOH and sodium chloride solution, dried over Na_2SO_4 and concentrated. For purification, the bromide (34) was chromatographed over silica gel and recrystallized from ethanol.

- (C) Preparation of the compound (12) by etherification.
- 1.56 g (0.065 mol) of NaH were taken in 30 ml of dry THF, 9.23 g (0.065 mol) of trans-4-n-propylcyclohexanol in 20 ml of THF were slowly added, while controlling the evolution of hydrogen, and the mixture was stirred at room temperature overnight. 21 g (0.065 mol) of the compound (34) obtained according to section (B) in 20 ml of THF were slowly added dropwise and the entire mixture was heated at the reflux temperature for 2 hours. For working up, the THF was distilled off, the residue was poured onto ice-water, the mixture was extracted with diethyl ether and the ether phases were washed with sodium chloride solution, dried over Na_2SO_4 and concentrated. The crude product was purified over silica gel and recrystallized from ethanol.
- The physical data of the resulting compound (12) are given in Example 2.

Examples 5-73

- The following anisotropic compounds of the formula (1) according to the invention can also be obtained in an analogous manner to Examples 1-4:

Examples

- | | |
|----|--|
| 5 | trans-4-phenylcyclohexyl trans-4'-n-propylcyclohexylmethyl ether |
| 6 | trans-4-phenylcyclohexyl trans-4'-n-pentylcyclohexylmethyl ether |
| 25 | trans-4-phenylcyclohexyl trans-4'-n-heptylcyclohexylmethyl ether |
| 7 | trans-4-phenylcyclohexyl trans-4'-n-nonylcyclohexylmethyl ether |
| 8 | trans-(4"-n-propyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |
| 30 | trans-(4"-n-pentyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |
| 10 | trans-(4"-n-heptyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |
| 11 | trans-(4"-n-nonyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |
| 35 | trans-(4"-n-propyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |
| 12 | trans-(4"-n-pentyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |
| | trans-(4"-n-heptyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |
| | trans-(4"-n-nonyl)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether |

- 13 trans-(4"-n-propyl)-4'-phenylcyclohexylmethyl
trans-4-n-pentylcyclohexyl ether
- 14 trans-(4"-n-propyl)-4'-phenylcyclohexylmethyl
trans-4-n-heptylcyclohexyl ether
- 5 15 trans-(4"-n-propyl)-4'-phenylcyclohexylmethyl
trans-4-n-nonylcyclohexyl ether
- 16 trans-(4"-n-pentyl)-4'-phenylcyclohexylmethyl
trans-4-n-pentylcyclohexyl ether
- 17 trans-(4"-n-pentyl)-4'-phenylcyclohexylmethyl
10 trans-4-n-heptylcyclohexyl ether
- 18 trans-(4"-n-pentyl)-4'-phenylcyclohexylmethyl
trans-4-n-nonylcyclohexyl ether
- 19 trans-(4"-n-heptyl)-4'-phenylcyclohexylmethyl
trans-4-n-pentylcyclohexyl ether
- 15 20 trans-(4"-n-heptyl)-4'-phenylcyclohexylmethyl
trans-4-n-heptylcyclohexyl ether
- 21 trans-(4"-n-heptyl)-4'-phenylcyclohexylmethyl
trans-4-n-nonylcyclohexyl ether
- 22 trans-(4"-n-nonyl)-4'-phenylcyclohexylmethyl
20 trans-4-n-pentylcyclohexyl ether
- 23 trans-(4"-n-nonyl)-4'-phenylcyclohexylmethyl
trans-4-n-heptylcyclohexyl ether
- 24 trans-(4"-n-nonyl)-4'-phenylcyclohexylmethyl
trans-4-n-nonylcyclohexyl ether
- 25 25 trans-4'-methylcyclohexylmethyl trans-4-n-propyl-
cyclohexyl ether
- 26 trans-4'-n-propylcyclohexylmethyl trans-4-n-propyl-
cyclohexyl ether
- 27 trans-4'-n-pentylcyclohexylmethyl trans-4-n-propyl-
30 cyclohexyl ether
- 28 trans-4'-n-heptylcyclohexylmethyl trans-4-n-propyl-
cyclohexyl ether
- 29 trans-4'-n-nonylcyclohexylmethyl trans-4-n-propyl-
cyclohexyl ether
- 35 30 trans-4'-n-propylcyclohexylmethyl trans-4-methyl-
cyclohexyl ether
- 31 trans-4'-n-propylcyclohexylmethyl trans-4-n-pentyl-
cyclohexyl ether

- 32 trans-4'-n-propylcyclohexylmethyl trans-4-n-heptyl-cyclohexyl ether
- 33 trans-4'-propylcyclohexylmethyl trans-4-n-nonyl-cyclohexyl ether
- 34 trans-4'-methylcyclohexylmethyl trans-4-n-pentyl-cyclohexyl ether
- 5 35 trans-4'-n-pentylcyclohexylmethyl trans-4-n-pentyl-cyclohexyl ether
- 36 trans-4'-n-heptylcyclohexylmethyl trans-4-n-pentyl-cyclohexyl ether
- 37 trans-4'-n-nonylcyclohexylmethyl trans-4-n-pentyl-cyclohexyl ether
- 10 38 trans-4'-n-pentylcyclohexylmethyl trans-4-methyl-cyclohexyl ether
- 39 trans-4'-n-pentylcyclohexylmethyl trans-4-n-heptyl-cyclohexyl ether
- 15 40 trans-4'-n-pentylcyclohexylmethyl trans-4-n-nonyl-cyclohexyl ether
- 41 trans-4'-methylcyclohexylmethyl trans-4-n-heptyl-cyclohexyl ether
- 42 trans-4'-n-heptylcyclohexylmethyl trans-4-n-heptyl-cyclohexyl ether
- 20 43 trans-4'-n-nonylcyclohexylmethyl trans-4-n-heptyl-cyclohexyl ether
- 44 trans-4'-n-heptylcyclohexylmethyl trans-4-methyl-cyclohexyl ether
- 25 45 trans-4'-n-heptylcyclohexylmethyl trans-4-n-nonyl-cyclohexyl ether
- 46 trans-4'-methylcyclohexylmethyl trans-4-n-nonyl-cyclohexyl ether
- 47 trans-4'-n-nonylcyclohexylmethyl trans-4-n-nonyl-cyclohexyl ether
- 30 48 trans-4'-n-nonylcyclohexylmethyl trans-4-methyl-cyclohexyl ether
- 49 trans-4'-phenylcyclohexyl trans-4-ethoxycyclohexylmethyl ether
- 35 50 trans-4'-phenylcyclohexyl trans-4-n-butyloxycyclohexylmethyl ether

- 51 trans-4'-phenylcyclohexyl trans-4-n-hexyloxycyclohexylmethyl ether
- 52 trans-4'-phenylcyclohexyl trans-4-n-octyloxycyclohexylmethyl ether
- 53 trans-(4"-ethoxy)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether
- 5 54 trans-(4"-n-butyloxy)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether
- 55 trans-(4"-n-hexyloxy)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether
- 56 trans-(4"-n-octyloxy)-4'-phenylcyclohexylmethyl trans-4-n-propylcyclohexyl ether
- 10 57 trans-(4"-ethoxy)-4'-phenylcyclohexylmethyl trans-4-n-pentylcyclohexyl ether
- 58 trans-(4"-n-butyloxy)-4'-phenylcyclohexylmethyl trans-4-n-pentylcyclohexyl ether
- 15 59 trans-(4"-n-hexyloxy)-4'-phenylcyclohexylmethyl trans-4-n-pentylcyclohexyl ether
- 60 trans-(4"-n-octyloxy)-4'-phenylcyclohexylmethyl trans-4-n-pentylcyclohexyl ether
- 61 trans-4'-n-propylcyclohexylmethyl trans-4-n-pentylaminocyclohexyl ether
- 20 62 trans-4'-n-propylaminocyclohexylmethyl trans-4-n-pentylcyclohexyl ether
- 63 trans-4'-n-heptylaminocyclohexylmethyl trans-4-n-propylcyclohexyl ether
- 25 64 trans-4'-cyanocyclohexylmethyl trans-4-n-heptylcyclohexyl ether
- 65 trans-4'-n-heptylcyclohexylmethyl trans-4-cyanocyclohexyl ether
- 66 trans-4'-n-pentyl-4-bicyclohexyl trans-4"-n-propylcyclohexylmethyl ether
- 30 67 trans-4'-n-propyl-4-bicyclohexyl trans-4"-n-pentylcyclohexylmethyl ether
- 68 trans-4'-cyano-4-bicyclohexyl trans-4"-n-heptylcyclohexylmethyl ether
- 35 69 trans-4'-n-pentyl-4-bicyclohexyl trans-4"-cyano-cyclohexylmethyl ether

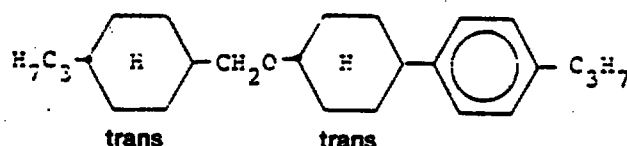
(31)

- 70 trans-4-n-propylcyclohexylmethyl trans-4'-[(trans-
4"-n-pentyl)-cyclohexyloxymethyl]-cyclohexyl ether
71 trans-4-n-pentylcyclohexylmethyl trans-4'-[(trans-
4"-n-propyl)-cyclohexyloxymethyl]-cyclohexyl ether
72 trans-4-cyanocyclohexylmethyl trans-4'-[(trans-4"-
n-heptyl)-cyclohexyloxymethyl]-cyclohexyl ether
5 73 trans-4-n-heptylcyclohexylmethyl trans-4'-[(trans-
4"-cyano)-cyclohexyloxymethyl]-cyclohexyl ether.

Example 74

Preparation of trans-4-n-propylcyclohexylmethyl trans-4"-propylphenyl-4'-trans-cyclohexyl ether (formula 35)

10



(35)

This compound was prepared by the method described in Example 1 by reduction of trans-(4"-n-propyl)-4'-phenyl-cyclohexyl trans-4-n-propylcyclohexanoate, the anisotropy of which can be seen from the values $T_k = 99.0^\circ\text{C}$, $T_s =$
15 100.5°C and $T_c = 102.0^\circ\text{C}$. The value T_s means the occurrence of a smectic phase corresponding to K 99.0 S 100.5 N 102.0 L.

The compound of Example 26 analogous to the compound (35), that is to say shortened by the phenylene
20 group, has an isotropy range which is analogous but lower by almost 100°C , corresponding to K 6.9 S 8.0 N 17.5 L.

It goes without saying that the new anisotropic compounds (1), amongst other things because of their low optical anisotropy and their comparatively low viscosity,
25 have an exceptionally wide application spectrum; depending on the choice of the substituents X and Y in formula (1) in the sense of stronger or weaker polarization of the molecule, the new anisotropic compounds (1) can fulfil different functions in LC mixtures for LC displays of the above-mentioned types; quite different LC mixtures can accor-
30 dingly be formed with the anisotropic compounds (1) - which can be used individually or in a mixture - and in particular either together with known components of LC mixtures or

0,030,761

- 15 -

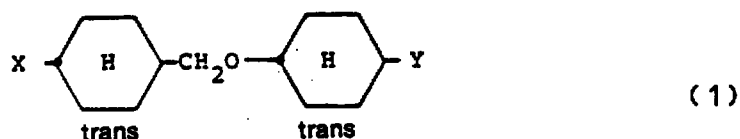
39

virtually only from the compounds (1).

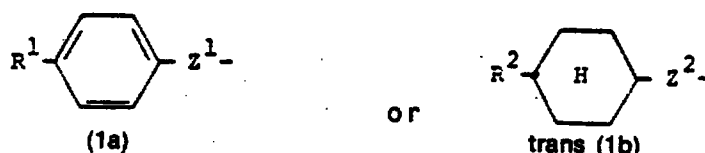
5 The preparation and use of LC mixtures for display cells of the abovementioned type, like the construction and operation of such cells, are otherwise part of the knowledge of experts and do not require more detailed description.

Claims

1. Anisotropic compounds of the formula (1)



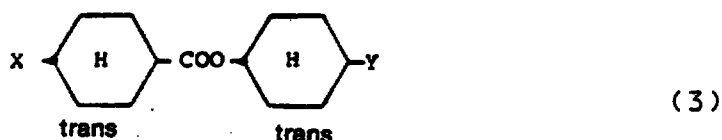
in which X and Y are each hydrogen atoms, alkyl groups with 1 to 12 C atoms, alkoxy groups with 1 to 12 C atoms, mono-alkylamino groups with 1 to 12 C atoms, nitrile groups, nitro groups or halogen atoms, or cyclic radicals of the formula (1a) or (1b)



in which R^1 and R^2 are hydrogen atoms, alkyl groups with 1 to 12 C atoms, alkoxy groups with 1 to 12 C atoms, mono-alkylamino groups with 1 to 12 C atoms, nitrile groups, nitro groups or halogen atoms and Z^1 and Z^2 are single covalent bonds or groups of the formulae $-COO-$, $-OOC-$, $-CH_2O-$ or $-OCH_2-$, with the proviso that only one of the groups X and Y is a cyclic radical of the formulae (1a) or (1b).

2. Liquid crystal mixture, characterized in that it contains at least one anisotropic compound of the formula (1) according to Claim 1, the symbols having the meanings given above for formula (1).

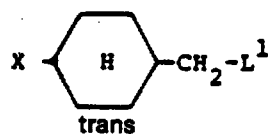
3. Process for the preparation of anisotropic compounds of the formula (1) according to Claim 1, characterized in that a corresponding cyclohexyl cyclohexanoate compound of the formula (3)



in which X and Y have the meanings given above for formula (1), is reduced, or the corresponding cyclohexylmethyl compound of the formula (3a)

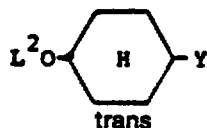


(41)



(3a)

in which X has the meaning given above for formula (1) and
in which L¹ is a leaving group, is condensed with the
corresponding cyclohexyl compound of the formula (3b)



(3b)

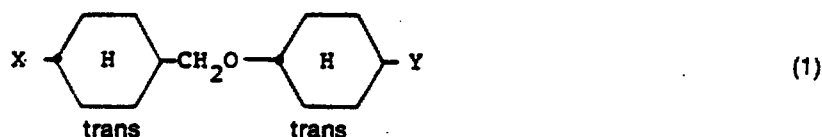
in which Y has the meaning given above for formula (1) and
in which L² is a leaving group, L¹-L² being split off.



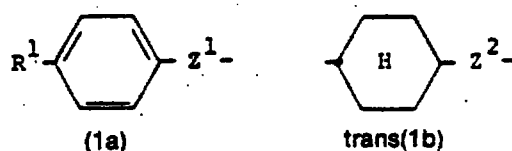
42

Claims

1. Anisotropic compounds of formula (1)



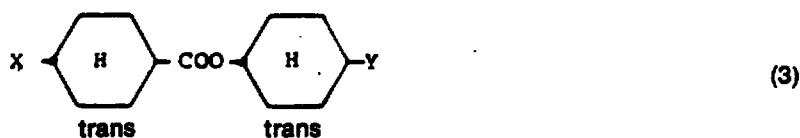
in which X and Y independently represent hydrogen, alkyl group with 1 to 12 C-atoms, alkoxy group with 1 to 12 C-atoms, monoalkylamino group with 1 to 12 C-atoms, nitrile group, nitro group, halogen, or cyclic radical of formula (1a) or (1b)



in which R¹ and R² represent hydrogen, alkyl group with 1 to 12 C-atoms, alkoxy group with 1 to 12 C-atoms, monoalkylamino group with 1 to 12 C-atoms, nitrile group, nitro group, or halogen, and Z¹ and Z² represent simple covalent bonds or groups of the formulas —COO—, —OOC—, —CH₂O— or —OCH₂—, with the requirement that only one of the groups X, Y can be a cyclic radical of formula (1a) or (1b).

2. A liquid crystal mixture, containing at least one anisotropic compound of formula (1) according to Claim 1, wherein the symbols have the meanings given above for formula (1).

3. A method of producing anisotropic compounds of formula (1) according to Claim 1, comprising the step of reducing a corresponding cyclohexyl cyclohexanoate of formula (3)



wherein X and Y have the meanings given above for formula (1), or the step of condensing the corresponding cyclohexylmethyl compound of formula (3a)



wherein X has the meaning given above for formula (1) and L¹ is a leaving group, with the corresponding cyclohexyl compound of formula (3b)

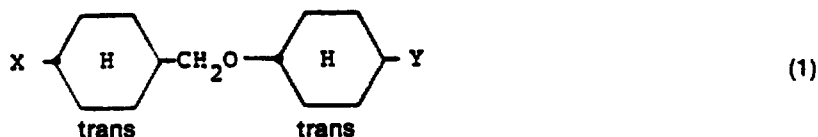


wherein Y has the meaning given above for formula (1) and L² is a leaving group, by splitting off L¹-L².

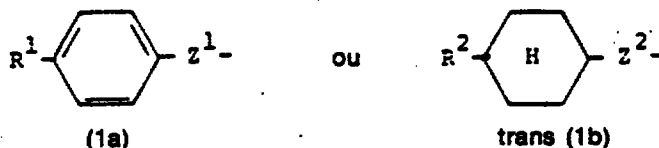


Revendications

1. Composés anisotropes de la formule (1)



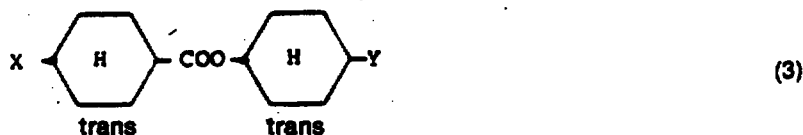
dans laquelle X et Y représentent des atomes d'hydrogène, des groupements alcoyles avec 1 à 12 atomes de C, des groupements alkoxy avec 1 à 12 atomes de C, des groupements monoalkylaminés avec 1 à 12 atomes de C, des groupements nitriles, des groupements nitro ou des atomes d'halogènes ou des radicaux cycliques de la formule (1a) ou (1b).



dans laquelle R¹ et R² représentent des atomes d'hydrogène, des groupements alcoyles avec 1 à 12 atomes de C, des groupements alkoxy avec 1 à 12 atomes de C, des groupements monoalkylaminés avec 1 à 12 atomes de C, des groupements nitriles, des groupements nitro ou des atomes d'halogènes et Z¹ et Z² de simples liaisons covalentes ou des groupements de formules —COO—, —OOC—, —CH₂O— ou —OCH₂—, étant entendu que seul un des groupements X, Y représente un radical cyclique des formules (1a) ou (1b).

2. Mélange de cristaux liquides, caractérisé par le fait qu'il contient au minimum un composé anisotrope de la formule (1) selon la revendication 1, les symboles ayant les significations indiquées ci-dessus pour la formule (1).

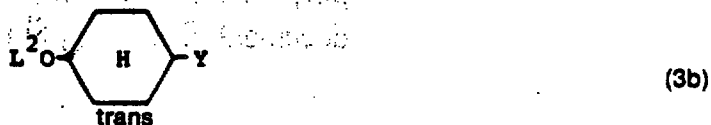
3. Procédé de fabrication de composés anisotropes de la formule (1) selon la revendication 1, caractérisé par le fait qu'est réduit un composé cyclohexylcyclohexanoate correspondant de la formule (3).



dans laquelle X et Y possèdent la signification indiquée ci-dessus pour la formule (1), ou que le composé cyclohexylméthyle correspondant de la formule (3a)



dans laquelle X et Y possèdent la signification indiquée ci-dessus pour la formule (1), et L¹ est un groupement éliminable, est condensé avec le composé cyclohexyle correspondant de la formule (3b)



dans laquelle Y possède la signification indiquée ci-dessus pour la formule (1) et L² est un groupement éliminable, L¹-L² étant éliminés.

