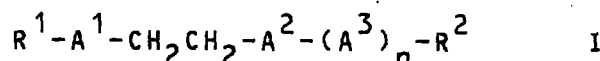


- 1 -

The invention relates to ethane derivatives of the formula I



5

wherein

R^1 is H, an alkyl group with 1 - 12 C atoms, in which one or two non-adjacent CH_2 groups can also be replaced by O atoms and/or CO groups and/or -O-CO- groups and/or -CO-O- groups, F, Cl or Br,

10

R^2 is -CN or $-Z^2-...^4-CN$ (sic),

A^1 is -A-, -A- A^5 - or - A^5 -A-,

A^2 is a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH_3 groups and/or CN groups and in which one or two CH groups can also be replaced by N atoms,

15

A is a 1,4-cyclohexylene group, in which one or two non-adjacent CH_2 groups can also be replaced by O atoms, or is a 1,3-dithiane-2,5-diyl group or 1,4-bi-cyclo(2,2,2)-octylene group,

20

A^3 , A^4 and A^5 are each a 1,4-cyclohexylene group, in which one or two non-adjacent CH_2 groups can also be replaced by O atoms, or are each a 1,3-dithiane-2,5-diyl group, or a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH_3 groups and/or CN groups, and in which one or two CH groups can also be replaced by N atoms,

25

30

n is 0 or 1, and

Z^2 is $-CH_2CH_2-$, $-CH_2O-$, $-OCH_2-$, $-O-CO-$ or a single bond and

35 with the proviso that

(a) if $A^2 = A^3 = 1,4$ -phenylene ($n = 1$) and/or if $R^1-A^1 = p$ -(trans-4-alkylcyclohexyl)-phenyl, at least one of the groups A^2 and/or A^3 is laterally

26

- substituted, and
- (b) if $A^1 = A$ and/or $R^1-A^1 = \text{trans-4-(trans-4-alkyl-cyclohexyl)-cyclohexyl}$, n is 1 and A^3 is a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH_3 groups and/or CN groups and
- (c) p-[2-[trans-4-(p-alkylphenyl or p-alkoxyphenyl)-cyclohexyl]-ethyl]benzonitriles are excluded.

For simplicity, in the following text Phe is a 1,4-phenylene group, Cy is a 1,4-cyclohexylene group, Dio is a 1,3-dioxane-2,4-diyl group, Diti is a 1,3-dithiane-2,5-diyl group, Bi is a bicyclo(2,2,2)-octylene group, Pip is a piperidine-1,4-diyl group, Pyn is a pyridazine-3,6-diyl group and Pyr is a pyrimidine-2,5-diyl group, it being possible for these groups, in particular the 1,4-phenylene group, to be unsubstituted or substituted by one or two F and/or Cl atoms and/or CH_3 groups and/or CN groups.

The compounds of the formula I can be used as components of liquid crystal phases, in particular for displays based on the principle of the twisted cell, the guest-host effect, the effect of deformation of aligned phases or the effect of dynamic scattering.

The invention was based on the object of discovering new stable liquid crystal or mesogenic compounds which are suitable as components of liquid crystal phases.

In EP-A-0,097,033, heterocyclic ethane derivatives are described which, however, show substantially lower clear points than the compounds of the formula I. The documents GB-A-2,092,169 and EP-A-0,056,501 describe special liquid crystal mixtures which contain known components and are suitable for cells in multiplex operation. For the dielectrically positive components of these mixtures, a very broad general formula is given which in some respects also covers the ethane derivatives of the formula I. However, none of the mixtures described contains an ethane derivative of the formula I. Liquid crystal compounds of similar structure are described in EP-A-0,125,663

(trans,trans-4-[2-p-(trans-4-cyanocyclohexyl)-phenylethyl]-4'-alkylbicyclohexyl) and in EP-A-0,129,177 (p-[2-[trans-4-(p-alkylphenyl and p-alkoxyphenyl)-cyclohexyl]-ethyl]-benzonitriles).

5 It has been found that the compounds of the formula I are outstandingly suitable as components of liquid crystal dielectrics. In particular, liquid crystal phases with small k_{33}/k_{11} values, a very low viscosity and a comparatively low optical anisotropy can be prepared with
10 the aid of these compounds. Some of the compounds of the formula I are furthermore suitable as components of smectic phases (for example for the memory effect).

 In addition, by providing the compounds of the formula I, the range of liquid crystal substances which
15 are suitable, from various technological viewpoints, for the preparation of nematic mixtures is quite generally considerably extended.

 The compounds of the formula I have a wide range of application. Depending on the choice of the substituents, these compounds can be used as base materials from
20 which liquid crystal dielectrics are predominantly composed; however, compounds of the formula I can also be added to liquid crystal base materials from other classes of compounds, for example in order to reduce the dielectric and/or optical anisotropy of such a dielectric.
25 The compounds of the formula I are furthermore suitable as intermediates for the preparation of other substances which can be used as constituents of liquid crystal dielectrics.

30 The compounds of the formula I are colourless in the pure state and form liquid crystal mesophases in a temperature range which is advantageously located for electrooptical use. They are very stable towards chemicals, changes in temperature and light.

35 The invention thus relates to the compounds of the formula I and to a process for their preparation, characterised in that a corresponding carboxylic acid amide is dehydrated or a corresponding carboxylic acid halide

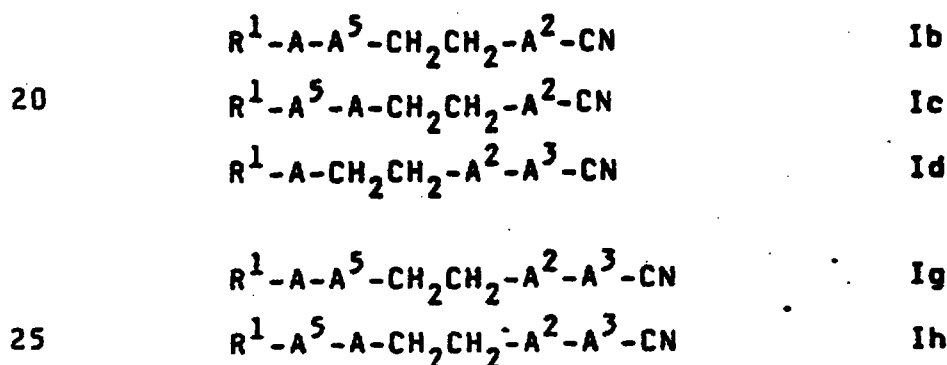


is reacted with sulfamide, or in that a corresponding bromine or chlorine compound is reacted with a cyanide.

The invention furthermore relates to the use of the compounds of the formula I as components of liquid crystal phases. The invention moreover relates to liquid crystal phases containing at least one compound of the formula I, and to liquid crystal display elements, in particular electrooptical display elements, containing such phases.

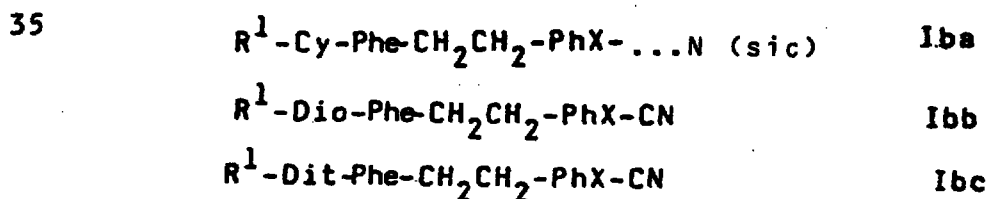
R^1 , R^2 , A^1 , A^2 , A^3 , A^4 , A^5 , A and Z² above and below have the meaning given, unless expressly indicated otherwise.

The compounds of the formula I accordingly include compounds of the part formulae Ib to Id (with in each case three rings) and Ig to Ih (with four rings).



30

The preferred compounds of the part formula Ib include those of the part formulae Iba to Ibc:



Amongst these, those of the part formula Iba are particularly preferred.

In the formulae above and below, PhX is a 1,4-phenylene group which is substituted by one or two F and/or Cl atoms and/or CH₃ groups and/or CN groups.

The preferred compounds of the part formula Id include those of the part formulae Ida to Idi:

10	$R^1-A-CH_2CH_2-Pyr-Phe-CN$	Ida
	$R^1-A-CH_2CH_2-Pyr-PhX-CN$	Idb
	$R^1-A-CH_2CH_2-PhX-Phe-CN$	Idc
	$R^1-A-CH_2CH_2-Phe-PhX-CN$	Idc
15	$R^1-A-CH_2CH_2-PhX-Cy-CN$	Idf
	$R^1-A-CH_2CH_2-Pyn-Phe-CN$	Idg
	$R^1-A-CH_2CH_2-Pyn-Cy-CN$	Idh
20	$R^1-A-CH_2CH_2-Phe-Cy-CN$	Idi

Of these, those of the part formulae Ida to Idf, in particular Idb to Ide, are particularly preferred. Idi is also preferred. Compounds of the formulae Idc and Ide wherein A is trans-1,4-cyclohexylene and R¹ is alkyl with 1 - 12 C atoms are particularly preferred.

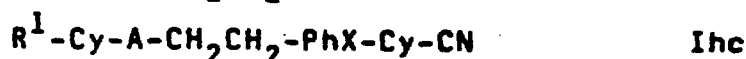
The preferred compounds of the part formula Ig include those of the part formulae Iga to Igh:

30	$R^1-A-Phe-CH_2CH_2-PhX-Phe-CN$	Iga
	$R^1-A-Phe-CH_2CH_2-Phe-PhX-CN$	Igb
	$R^1-A-Phe-CH_2CH_2-Phe-PhX-CN$	Igc
	$R^1-A-Phe-CH_2CH_2-PhX-Cy-CN$	Igd
35	$R^1-A-PhX-CH_2CH_2-Phe-Cy-CN$	Ige
	$R^1-A-Phe-CH_2CH_2-Pyr-Phe-CN$	Igf
	$R^1-A-Phe-CH_2CH_2-Pyn-Phe-CN$	Igh

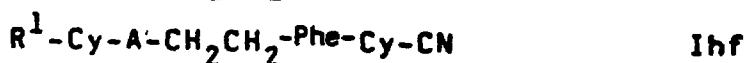
Of these, those of the part formulae Iga to Igc are particularly preferred.

The preferred compounds of the part formula Ih include those of the part formulae Iha to Ihf:

5



10



15 Of these, those of the part formulae Iha and Ihb are particularly preferred. Ihf is also preferred.

In the compounds of the formulae above and below, R^1 is preferably alkyl, and furthermore alkoxy or another oxaalkyl group. R^2 is preferably $-CN_1$.

A^1 is preferably $-A-$ or $-A-A^5$.

20

A is preferably Cy, Dio or Dit, in particular Cy.

A^2 is preferably Ph, PhX, Pyr, Pyn or a pyridine-2,5-diyl group, in particular Ph or PhX.

PhX is preferably a 1,4-phenylene group which is substituted in the 2- or 3-position by F, Cl or CH_3 , in particular F or CH_3 .

25

A^3 , A^4 and A^5 are preferably Ph, PhX, Cy or Dio, and furthermore preferably Dit, Pyr or Pyn.

A^3 and A^4 are preferably Ph and Cy.

30 The compound of the formula I preferably contains not more than one of the radicals Dio, Dit, PhX, Pyr or Pyn.

Z^2 is preferably a single bond, or, secondly, preferably an $-O-CO-$ or $-CH_2-CH_2-$ group.

35 If R^1 is an alkyl radical in which one ("alkoxy" or "oxaalkyl") or two ("alkoxyalkoxy" or "di-oxaalkyl") non-adjacent CH_2 groups can be replaced by O atoms, it can be straight-chain or branched. Preferably, it is straight-chain and has 2, 3, 4, 5, 6 or 7 C atoms,

and accordingly is preferably ethyl, propyl, butyl, pentyl, hexyl, heptyl, ethoxy, propoxy, butoxy, pentoxy, hexoxy, heptoxy, 2-oxapropyl (= methoxymethyl), 2- (= ethoxy-methyl) or 3-oxabutyl (= 2-methoxyethyl), 2-, 3- or 4-oxapentyl, 2-, 3-, 4- or 5-oxahexyl, 2-, 3-, 4-, 5- or 6-oxaheptyl, or furthermore methyl, octyl, nonyl, decyl, methoxy, octoxy, nonoxy, decoxy, 2-, 3-, 4-, 5-, 6- or 7-oxaoctyl, 2-, 3-, 4-, 5-, 6-, 7- or 8-oxanonyl, 2-, 3-, 4-, 5-, 6-, 7-, 8- or 9-oxadecyl, 1,3-dioxabutyl (= methoxymethoxy), 1,3-, 1,4- or 2,4-dioxapentyl, 1,3-, 1,4-, 1,5-, 2,4-, 2,5- or 3,5-dioxaheptyl or 1,3-, 1,4-, 1,5-, 1,6-, 2,4-, 2,5-, 2,6-, 3,5-, 3,6- or 4,6-dioxaheptyl.

Compounds of the formula I with a branched end group substituent R^1 may occasionally be of importance because of a better solubility in the usual liquid crystal base materials, but in particular as chiral doping substances, if they are optically active. Chiral compounds of the formula I are furthermore suitable for the preparation of smectic S_c^* phases. Branched groups of this type as a rule contain not more than one chain-branching. Preferred branched radicals R^1 are isopropyl, 2-butyl (= 1-methylpropyl), isobutyl (= 2-methylpropyl), 2-methylbutyl, isopentyl (= 3-methylbutyl), 2-methylpentyl, 3-methylpentyl, 2-ethylhexyl, 2-propylpentyl, 2-octyl, isopropoxy, 2-methylpropoxy, 2-methylbutoxy, 3-methylbutoxy, 2-methylpentoxy, 3-methylpentoxy, 2-ethylhexoxy, 1-methylhexoxy, 1-methylheptoxy, 2-octyloxy, 2-oxa-3-methylbutyl and 3-oxa-4-methylpentyl.

Of the compounds of the formula I, those in which at least one of the radicals contained therein has one of the preferred meanings given are preferred.

Compounds of the formula I wherein A^2 or A^3 , in particular A^3 , is a 1,4-phenylene group which is substituted by one or two F and/or Cl atoms and/or CH_3 groups and/or CN groups, in particular by one or two F atoms or CH_3 groups, and compounds of the formula I wherein A is a 1,4-cyclohexylene group, are also preferred.

Of the compounds of the formula I, those stereoisomers in which the cycloaliphatic radicals (for example Cy, Dio and Dit) are trans-1,4-disubstituted are preferred.

5 Those of the abovementioned formulae which contain one or more of the groups Dio, Dit and/or Pyr in each case include the two possible 2,5-position isomers.

Particularly preferred compounds of the formula I and of the above part formulae are those wherein R¹ is
10 a straight-chain alkyl group or alkoxy group with in each case 1 to 10 C atoms.

Compounds of the formula I wherein at least one of the groups A², A³, A⁴ and A⁵ is Pyr, Pyn or pyrazine-2,5-diyl, in particular Pyr (that is to say 1,4-
15 phenylene, wherein two CH groups are replaced by N atoms) are also preferred.

The compounds of the formula I are prepared by methods which are known per se, such as those described in the literature (for example in the standard works,
20 such as Houben-Weyl, Methoden der Organischen Chemie (Methods of Organic Chemistry), Georg Thieme-Verlag, Stuttgart), and in particular under reaction conditions which are known and suitable for the reactions mentioned. Variants which are known per se and are not mentioned
25 in more detail here can also be used.

The expert can find corresponding synthesis methods by routine methods from the prior art (for example German Offenlegungsschriften 2,344,732, 2,450,088, 2,429,093, 2,502,904, 2,636,684, 2,701,591 and 2,752,975,
30 in respect of compounds with 1,4-cyclohexylene and 1,4-phenylene groups; German Patent Specification 2,641,724, in respect of compounds with pyrimidine-2,5-diyl groups; German Offenlegungsschrift 3,228,350, in respect of compounds with pyridazine-3,6-diyl groups; Japanese Published Application 58-43,961, in respect of compounds with
35 pyrazine-2,5-diyl groups; German Offenlegungsschriften 2,944,905 and 3,227,916, in respect of compounds with 1,3-dioxane-2,5-diyl groups; East German Patent 160,061,

in respect of compounds with 1,3-dithiane-2,5-diyl groups;
U.S. Patent Specifications 4,261,652 and 4,219,256, in
respect of compounds with 1,4-bicyclo(2,2,2)octylene
groups; German Offenlegungsschrift 3,150,312, in respect
5 of compounds with decahydronaphthalene-2,6-diyl groups;
German Offenlegungsschrift 2,949,080, in respect of com-
pounds with 1,2,3,4-tetrahydronaphthalene-2,6-diyl groups;
German Offenlegungsschrift 3,208,089, German Offenlegungs-
schrift 3,117,152, German Offenlegungsschrift 3,042,391
10 and European Published Application 84,194, in respect of
laterally substituted compounds; and German Offenle-
gungsschrift 3,201,721, in respect of compounds with $-\text{CH}_2-$
 CH_2- bridge members).

If desired, the starting substances can also be
15 formed in situ, in a manner such that they are not iso-
lated from the reaction mixture but are immediately fur-
ther reacted to give the compounds of the formula I.

The compounds of the formula I can thus be pre-
pared by dehydrating a corresponding carboxylic acid
20 amide or reacting a corresponding carboxylic acid halide
with sulfamide. The amides can be obtained, for example,
from corresponding esters or acid halides by reaction
with ammonia. Examples of suitable dehydrating agents
are inorganic acid chlorides, such as SOCl_2 , PCl_3 , PCl_5 ,
25 POCl_3 , SO_2Cl_2 and COCl_2 , and furthermore P_2O_5 , P_2S_5
 AlCl_3 (for example as a double compound with NaCl) and
aromatic sulfonic acids and sulfonic acid halides. The
dehydration can be carried out in the presence or absence
of an inert solvent at temperatures between about 0° and
30 150° ; examples of possible solvents are bases, such as
pyridine or triethylamine, aromatic hydrocarbons, such
as benzene, toluene or xylene, or amides, such as di-
methylformamide.

To prepare the ethane derivatives of the formula
35 I, it is also possible to react corresponding acid hal-
ides, preferably the chlorides, with sulfamide, advan-
tageously in an inert solvent, such as tetramethylene
sulfone, at temperatures between about 80° and 150° ,

preferably at 120°. After customary working up, the nitriles can be isolated directly.

For the starting substances, the expert can find corresponding synthesis methods from the prior art.

- 5 Benzoic acid halides (corresponding to formula I, wherein $-A^2-R^2 = -Ph-COHalogen$, $-A^2-Ph-COHalogen$, $-A^3-Z^2-Ph-COHalogen$, $-PhX-COHalogen$, $-A^2PhX-COHalogen$ or $-A^3-Z^2-PhX-COHalogen$) can be prepared, for example, from corresponding benzene derivatives (for example those which contain
10 an H atom instead of the COHalogen radical) by reaction with oxalyl halide, preferably oxalyl chloride, under Friedel-Crafts conditions (British Patent Application 8,206,265).

- Corresponding cyclohexanecarboxylic acid derivatives (for example acid halides or esters; corresponding
15 to formula I, wherein $-A^2-R^2$ is, for example, $-A^3-Cy-CN$) are accessible, for example, from halogen compounds, preferably bromides or chlorides) corresponding to formula I, wherein $-A^2-R^2$ is $-A^3-halogen$, by Grignard reaction
20 with 4-(4,5-dihydro-4,4-dimethyl-2-oxazolyl)-cyclohexanone, detachment of water, with simultaneous removal of the oxazolyl protective group, by boiling with ethanolic H_2SO_4 , hydrogenation of the double bond and, if appropriate, conversion of the ethyl ester into the desired
25 acid derivative by methods which are known from the literature.

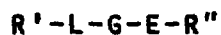
- To prepare ethane derivatives of the formula I, it is also possible to react corresponding chlorine or bromine compounds with a cyanide by methods which are
30 known from the literature, advantageously with a metal cyanide, such as NaCN, KCN or $Cu_2(CN)_2$, for example in the presence of pyridine in an inert solvent, such as dimethylformamide or N-methylpyrrolidone, at temperatures between 20° and 200°.

- 35 For the chlorine or bromine compounds, the expert can find appropriate synthesis methods from the prior art. For example, these compounds are accessible by halogenation of the benzene derivatives described above.

The liquid crystal phases according to the invention consist of 2 to 15, preferably 3 to 12, components, at least one of which is a compound of the formula I. The other constituents are preferably chosen from the nematic or nematogenic substances, in particular the known substances, from the classes of azoxybenzenes, benzyldeneanilines, biphenyls, terphenyls, phenyl or cyclohexyl benzoates, phenyl or cyclohexyl cyclohexanecarboxylates, phenylcyclohexanes, cyclohexylbiphenyls, cyclohexylcyclohexanes, cyclohexylnaphthalenes, 1,4-bis-cyclohexylbenzenes, 4,4'-bis-cyclohexylbiphenyls, phenyl- or cyclohexyl-pyrimidines, phenyl- or cyclohexyl-dioxanes, phenyl- or cyclohexyl-1,3-dithianes, 1,2-diphenylethanes, 1,2-dicyclohexylethanes, 1-cyclohexyl-2-phenylethanes, optionally halogenated stilbenes, benzyl phenyl ethers, tolanes and substituted cinnamic acids.

The most important compounds which are possible constituents of liquid crystal phases of this type can be characterised by the formula II

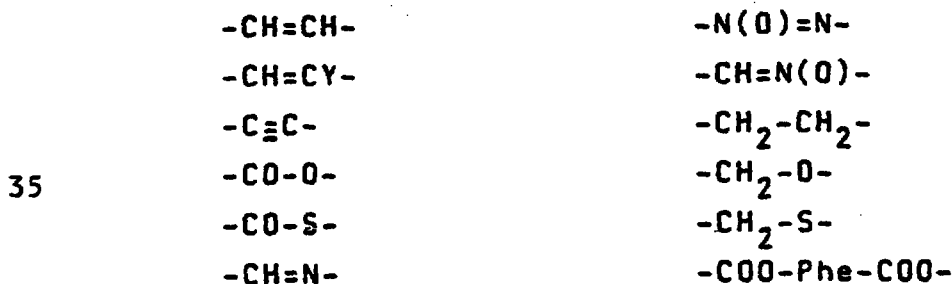
20



II

wherein L and E are each a carbocyclic or heterocyclic ring system from the group comprising 1,4-disubstituted benzene and cyclohexane rings, 4,4'-disubstituted biphenyl, phenylcyclohexane and cyclohexylcyclohexane systems, 2,5-disubstituted pyrimidine and 1,3-dioxane rings, 2,6-disubstituted naphthalene, di- and tetra-hydronaphthalene, quinazoline and tetrahydroquinazoline, G is

30



35

or a C-C single bond, Y is halogen, preferably chlorine, or -CN, and R' and R'' are alkyl, alkoxy, alkanoyloxy or alkoxy-carbonyloxy with up to 18, preferably up to 8, carbon atoms, or one of these radicals is also CN, NC, NO₂, CF₃, F, Cl or Br.

In most of these compounds, R' and R'' differ, one of these radicals usually being an alkyl or alkoxy group. However, other variants of the envisaged substituents can also be used. Many such substances or mixtures thereof are commercially available. All of these substances can be prepared by methods which are known from the literature.

The phases according to the invention contain about 0.1 to 99%, preferably 10 to 95%, of one or more compounds of the formula I.

Dielectrics according to the invention containing 0.1 to 40%, preferably 0.5 to 30%, of one or more compounds of the formula I are also preferred.

The dielectrics according to the invention are prepared in a manner which is customary per se. As a rule, the components are dissolved in one another, advantageously at elevated temperature.

The liquid crystal dielectrics according to the invention can be modified by suitable additives so that they can be used in all the types of liquid crystal display elements which have hitherto been disclosed.

Such additives are known to the expert and are described in detail in the literature. For example, it is possible to add conductive salts, preferably ethyl-dimethyl-dodecyl-ammonium 4-hexyloxybenzoate, tetrabutyl-ammonium tetraphenylboronate or complex salts of crown ethers (compare, for example, I. Haller et al., Mol. Cryst. Liq. Cryst. Volume 24, pages 249-258 (1973)), to improve the conductivity, dichroic dyestuffs, for the preparation of coloured guest-host systems, or substances for modifying the dielectric anisotropy, the viscosity and/or the orientation of the nematic phases. Such substances are described, for example, in German

Offenlegungsschriften 2,209,127, 2,240,864, 2,321,632, 2,338,281, 2,450,088, 2,637,430, 2,853,728 and 2,902,177.

The following examples are intended to illustrate the invention without limiting it. M.p. = melting point, C.p. = clear point. Percentages above and below are percentages by weight; all the temperatures are given in degrees Celsius. "Customary working-up" means: water is added, the mixture is extracted with methylene chloride, the organic phase is separated off, dried and evaporated and the product is purified by crystallisation and/or chromatography.

Example 1

36.7 g of 1-[4-(trans-4-n-propylcyclohexyl)-phenyl]-2-(4-carbamoyl-3-fluorophenyl)-ethane are suspended in 200 ml of methylene chloride and, after addition of 20 g of thionyl chloride and 3.5 ml of dimethylformamide, the mixture is boiled for 4 hours. After cooling, 500 ml of ice-water are added, the organic phase is separated off and worked up in the customary manner. After recrystallisation from methanol, 18.1 g (52%) of 1-[4-(trans-4-n-propylcyclohexyl)-phenyl]-2-(4-cyano-3-fluorophenyl)-ethane are obtained.

The following compounds are prepared analogously:

- 1-[p-(trans-4-ethylcyclohexyl)-phenyl]-2-(4-cyano-3-fluorophenyl)-ethane
- 1-[p-(trans-4-butylcyclohexyl)-phenyl]-2-(4-cyano-3-fluorophenyl)-ethane
- 1-[p-(trans-4-pentylcyclohexyl)-phenyl]-2-(4-cyano-3-fluorophenyl)-ethane
- 1-[p-(trans-4-heptylcyclohexyl)-phenyl]-2-(4-cyano-3-fluorophenyl)-ethane
- 1-[p-(trans-4-ethylcyclohexyl)-phenyl]-2-(4-cyano-3-methylphenyl)-ethane
- 1-[p-(trans-4-propylcyclohexyl)-phenyl]-2-(4-cyano-3-methylphenyl)-ethane
- 1-[p-(trans-4-butylcyclohexyl)-phenyl]-2-(4-cyano-3-methylphenyl)-ethane

- 1-[p-(trans-4-pentylcyclohexyl)-phenyl]-2-(4-cyano-3-methylphenyl)-ethane
1-[p-(trans-4-heptylcyclohexyl)-phenyl]-2-(4-cyano-3-methylphenyl)-ethane
5 1-[p-(trans-4-ethylcyclohexyl)-phenyl]-2-(4-cyano-2-fluorophenyl)-ethane
1-[p-(trans-4-propylcyclohexyl)-phenyl]-2-(4-cyano-2-fluorophenyl)-ethane
1-[p-(trans-4-butylcyclohexyl)-phenyl]-2-(4-cyano-2-fluorophenyl)-ethane
10 1-[p-(trans-4-pentylcyclohexyl)-phenyl]-2-(4-cyano-2-fluorophenyl)-ethane
1-[p-(trans-4-heptylcyclohexyl)-phenyl]-2-(4-cyano-2-fluorophenyl)-ethane
15 1-[4-(trans-4-ethylcyclohexyl)-2-fluorophenyl]-2-(4-cyanophenyl)-ethane
1-[4-(trans-4-propylcyclohexyl)-2-fluorophenyl]-2-(4-cyanophenyl)-ethane
1-[4-(trans-4-butylcyclohexyl)-2-fluorophenyl]-2-(4-cyanophenyl)-ethane
20 1-[4-(trans-4-pentylcyclohexyl)-2-fluorophenyl]-2-(4-cyanophenyl)-ethane
1-[4-(trans-4-heptylcyclohexyl)-2-fluorophenyl]-2-(4-cyanophenyl)-ethane
25 1-[4-(trans-4-ethylcyclohexyl-3-fluorophenyl]-2-(4-cyanophenyl)-ethane
1-[4-(trans-4-propylcyclohexyl-3-fluorophenyl]-2-(4-cyanophenyl)-ethane
1-[4-(trans-4-butylcyclohexyl-3-fluorophenyl]-2-(4-cyanophenyl)-ethane
30 1-[4-(trans-4-pentylcyclohexyl-3-fluorophenyl]-2-(4-cyanophenyl)-ethane
1-[4-(trans-4-heptylcyclohexyl-3-fluorophenyl]-2-(4-cyanophenyl)-ethane
35 1-[4-(trans-4-ethylcyclohexyl)-2-methylphenyl]-2-(4-cyanophenyl)-ethane
1-[4-(trans-4-propylcyclohexyl)-2-methylphenyl]-2-(4-cyanophenyl)-ethane

1-[4-(trans-4-butylcyclohexyl)-2-methylphenyl]-2-(4-cyanophenyl)-ethane

1-[4-(trans-4-pentylcyclohexyl)-2-methylphenyl]-2-(4-cyanophenyl)-ethane

5 1-[4-(trans-4-heptylcyclohexyl)-2-methylphenyl]-2-(4-cyanophenyl)-ethane

1-[4-(trans-4-ethylcyclohexyl)-2-chlorophenyl]-2-(4-cyanophenyl)-ethane

10 1-[4-(trans-4-propylcyclohexyl)-2-chlorophenyl]-2-(4-cyanophenyl)-ethane

1-[4-(trans-4-butylcyclohexyl)-2-chlorophenyl]-2-(4-cyanophenyl)-ethane

1-[4-(trans-4-pentylcyclohexyl)-2-chlorophenyl]-2-(4-cyanophenyl)-ethane

15 1-[4-(trans-4-heptylcyclohexyl)-2-chlorophenyl]-2-(4-cyanophenyl)-ethane.

Example 2

A mixture of 38.4 g of 1-(trans-4-n-propylcyclohexyl)-2-(4'-bromo-2'-fluorobiphenyl-4-yl)-ethane (M.p. 61.1°, C.p. 114.7°), 10 g of Cu₂(CN)₂, 120 ml of pyridine and 60 ml of N-methylpyrrolidone is heated at 160° for 2 hours. The mixture is cooled, a solution of 120 g of FeCl₃ · 6 H₂O in 600 ml of 20% hydrochloric acid is added and the mixture is warmed at 70° for 1.5 hours, with stirring, and worked up in the customary manner to give 1-(trans-4-n-propylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane, M.p. 89.4°, C.p. 168.4°.

Example 3

30 1-(trans-4-n-Pentylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane, M.p. 76.0°, C.p. 165.6°, is obtained analogously to Example 2 from 1-(trans-4-n-pentylcyclohexyl)-2-(4'-bromo-2'-fluorobiphenyl-4-yl)-ethane (M.p. 57.5°, C.p. 113.7°).

Example 4

35 1-(trans-4-n-Heptylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane, M.p. 74.5°, C.p. 157.4°, S_A/N 108.0°, is obtained analogously to Example 2 from 1-(trans-4-n-heptylcyclohexyl)-2-(4'-bromo-2'-fluorobi-

phenyl-4-yl)-ethane (M.p. 54.0°, C.p. 113.0°).

The following compounds are prepared analogously:

- 1-(trans-4-methylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
- 5 1-(trans-4-ethylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
1-(trans-4-butylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
1-(trans-4-octylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
- 10 1-(trans-4-nonylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
1-(trans-4-decylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
- 15 1-(trans-4-methylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane
1-(trans-4-ethylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane
1-(trans-4-propylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane, M.p. 65.4°, C.p. 161.3°,
- 20 1-(trans-4-butylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane
1-(trans-4-pentylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane, M.p. 71.4°, C.p. 157.3°
- 25 1-(trans-4-heptylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane, M.p. 72.9°, C.p. 149.5°
1-(trans-4-octylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane
1-(trans-4-nonylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane
- 30 1-(trans-4-decylcyclohexyl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane
1-(trans-4-ethylcyclohexyl)-2-(4'-cyano-2-methylbiphenyl-4-yl)-ethane
- 35 1-(trans-4-propylcyclohexyl)-2-(4'-cyano-2-methylbiphenyl-4-yl)-ethane
1-(trans-4-butylcyclohexyl)-2-(4'-cyano-2-methylbiphenyl-4-yl)-ethane

1-(trans-4-pentylcyclohexyl)-2-(4'-cyano-2-methylbiphenyl-4-yl)-ethane

1-(trans-4-heptylcyclohexyl)-2-(4'-cyano-2-methylbiphenyl-4-yl)-ethane.

5 Example 5

A mixture of 43.0 g of 1-(trans-4-n-pentylcyclohexyl)-2-(4'-bromo-3'-fluorobiphenyl-4-yl)-ethane (M.p. 62.3°, C.p. 123.2°), 10 g of $\text{Cu}_2(\text{CN})_2$, 120 ml of pyridine and 60 ml of N-methylpyrrolidone is heated at 160° for 2 hours and further processed analogously to Example 2. 1-(trans-4-n-Pentylcyclohexyl)-2-4'-cyano-3'-fluorobiphenyl-4-yl)-ethane, M.p. 58.5°, C.p. 149.7°, is obtained.

The following compounds are prepared analogously:

15 1-(trans-4-methylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

1-(trans-4-ethylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

20 1-(trans-4-propylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

1-(trans-4-butylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

1-(trans-4-heptylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

25 1-(trans-4-octylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

1-(trans-4-nonylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

30 1-(trans-4-decylcyclohexyl)-2-(4'-cyano-3'-fluorobiphenyl-4-yl)-ethane

1-[4-(trans-4-ethylcyclohexyl)-phenyl]-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane

1-[4-(trans-4-propylcyclohexyl)-phenyl]-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane

35 1-[4-(trans-4-butylcyclohexyl)-phenyl]-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane

1-[4-(trans-4-pentylcyclohexyl)-phenyl]-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane

- 1-[4-(trans-4-heptylcyclohexyl)-phenyl]-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane
1-[4-(trans-4-ethylcyclohexyl)-phenyl]-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
5 1-[4-(trans-4-propylcyclohexyl)-phenyl]-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
1-[4-(trans-4-butylcyclohexyl)-phenyl]-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
1-[4-(trans-4-pentylcyclohexyl)-phenyl]-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
10 1-[4-(trans-4-heptylcyclohexyl)-phenyl]-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane
1-[4-(trans-4-ethylcyclohexyl)-phenyl]-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane
15 1-[4-(trans-4-propylcyclohexyl)-phenyl]-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane
1-[4-(trans-4-butylcyclohexyl)-phenyl]-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane
1-[4-(trans-4-pentylcyclohexyl)-phenyl]-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane
20 1-[4-(trans-4-heptylcyclohexyl)-phenyl]-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane
1-[4-(trans-4-ethylcyclohexyl)-phenyl]-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane
25 1-[4-(trans-4-propylcyclohexyl)-phenyl]-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane
1-[4-(trans-4-butylcyclohexyl)-phenyl]-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane
1-[4-(trans-4-pentylcyclohexyl)-phenyl]-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane
30 1-[4-(trans-4-heptylcyclohexyl)-phenyl]-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane
1-(trans, trans-4-ethylbicyclohex-4'-yl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane (sic)
35 1-(trans, trans-4-propylbicyclohex-4'-yl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane (sic)
1-(trans, trans-4-butylbicyclohex-4'-yl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane (sic)

- 1-(trans, trans-4-pentylbicyclohex-4'-yl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-heptylbicyclohex-4'-yl)-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane (sic)
- 5 1-(trans, trans-4-ethylbicyclohex-4'-yl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-propylbicyclohex-4'-yl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-butylbicyclohex-4'-yl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane (sic)
- 10 1-(trans, trans-4-pentylbicyclohex-4'-yl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-heptylbicyclohex-4'-yl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane (sic)
- 15 1-(trans, trans-4-ethylbicyclohex-4'-yl)-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-propylbicyclohex-4'-yl)-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-butylbicyclohex-4'-yl)-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane (sic)
- 20 1-(trans, trans-4-pentylbicyclohex-4'-yl)-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-heptylbicyclohex-4'-yl)-2-(4'-cyano-2'-chlorobiphenyl-4-yl)-ethane (sic)
- 25 1-(trans, trans-4-ethylbicyclohex-4'-yl)-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-propylbicyclohex-4'-yl)-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-butylbicyclohex-4'-yl)-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane (sic)
- 30 1-(trans, trans-4-pentylbicyclohex-4'-yl)-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane (sic)
- 1-(trans, trans-4-heptylbicyclohex-4'-yl)-2-(4'-cyano-2'-methylbiphenyl-4-yl)-ethane (sic).
- 35 Example 6

A mixture of 3.6 g of (trans-4-n-pentylcyclohexyl)-ethylmalondialdehyde bis-diethyl acetal and 2.1 g of the carboximide-amide of ethyl 4-cyano-2-fluoro-benzoate is

heated at 145° for 20 hours. After cooling, the residue is dissolved in ethanol, the solution is worked up in the customary manner and the resulting ester is converted into the nitrile in the customary manner. 2-(4-cyano-3-fluorophenyl)-5-[2-(trans-4-n-pentylcyclohexyl)-ethyl]-pyrimidine is obtained.

The following compounds are prepared analogously:

- 2-(4-cyano-3-fluorophenyl)-5-[2-(trans-4-ethylcyclohexyl)-ethyl]-pyrimidine
- 10 2-(4-cyano-3-fluorophenyl)-5-[2-(trans-4-propylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyano-3-fluorophenyl)-5-[2-(trans-4-butylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyano-3-fluorophenyl)-5-[2-(trans-4-heptylcyclohexyl)-ethyl]-pyrimidine
- 15 2-(4-cyano-3-methylphenyl)-5-[2-(trans-4-ethylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyano-3-methylphenyl)-5-[2-(trans-4-propylcyclohexyl)-ethyl]-pyrimidine
- 20 2-(4-cyano-3-methylphenyl)-5-[2-(trans-4-butylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyano-3-methylphenyl)-5-[2-(trans-4-pentylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyano-3-methylphenyl)-5-[2-(trans-4-heptylcyclohexyl)-ethyl]-pyrimidine
- 25 2-(4-cyanophenyl)-5-[2-(trans-4-ethylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyanophenyl)-5-[2-(trans-4-propylcyclohexyl)-ethyl]-pyrimidine
- 30 2-(4-cyanophenyl)-5-[2-(trans-4-butylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyanophenyl)-5-[2-(trans-4-pentylcyclohexyl)-ethyl]-pyrimidine
- 2-(4-cyanophenyl)-5-[2-(trans-4-heptylcyclohexyl)-ethyl]-pyrimidine
- 35 2-(4-cyanophenyl)-5-[2-(trans-4-ethylcyclohexyl)-ethyl]-pyrazine

2-(4-cyanophenyl)-5-[2-(trans-4-propylcyclohexyl)-ethyl]-pyrazine

2-(4-cyanophenyl)-5-[2-(trans-4-butylcyclohexyl)-ethyl]-pyrazine

5 2-(4-cyanophenyl)-5-[2-(trans-4-pentylcyclohexyl)-ethyl]-pyrazine

2-(4-cyanophenyl)-5-[2-(trans-4-heptylcyclohexyl)-ethyl]-pyrazine.

10 The following examples relate to liquid crystal phases according to the invention:

Example A

A mixture is prepared from

- 15% of p-trans-4-propylcyclohexyl-benzonitrile,
- 27% of trans-1-p-ethylphenyl-4-propylcyclohexane,
- 15 10% of trans-2-p-ethoxyphenyl-4-propylcyclohexane,
- 7% of 4-cyano-4'-(trans-4-pentylcyclohexyl)-bi-biphenyl,
- 10% of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl,
- 8% of p-propylphenyl p-trans-4-propylcyclohexyl-
- 20 benzoate,
- 6% of p-propylphenyl p-trans-4-pentylcyclohexyl-benzoate and
- 17% of 2-(4-cyano-2-fluorophenyl)-5-[2-(trans-4-pentylcyclohexyl)-ethyl]-pyrimidine.

25 Example B

A mixture is prepared from

- 15% of p-trans-4-propylcyclohexyl-benzonitrile,
- 12% of p-trans-4-butylcyclohexyl-benzonitrile,
- 14% of trans-1-p-ethylphenyl-4-propylcyclohexane,
- 30 10% of trans-1-p-ethoxyphenyl-4-propylcyclohexane,
- 6% of 4-cyano-4'-(trans-4-pentylcyclohexyl)-bi-phenyl,
- 4% of 4,4'-bis-(trans-4-propylcyclohexyl)-bi-phenyl,
- 35 6% of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl,
- 8% of p-propylphenyl p-trans-4-propylcyclohexyl-benzoate,

16% of p-propylphenyl p-trans-4-pentylcyclohexyl-benzoate and

9% of 1-[4-(4-trans-pentylcyclohexyl)-2-fluorophenyl]-2-(4-cyanophenyl)-ethane.

5 Example C

A mixture is prepared from

19.0% of 4-(trans-4-n-propylcyclohexyl)-benzonitrile,

29.0% of 4-(trans-4-n-pentylcyclohexyl)-benzonitrile,

20.0% of 4-(trans-4-n-heptylcyclohexyl)-benzonitrile,

12.0% of trans-4-n-pentyl-(4'-cyanobiphenyl-4)-cyclohexane,

15 8.5% of 4,4'-bis-(trans-4-propylcyclohexyl)-biphenyl,

11.0% of 2-p-cyanophenyl-4'-heptyl-1,3-dioxane and

0.5% of 1-[p-(4-trans-butylcyclohexyl)-phenyl]-2-(4-cyano-2-fluorophenyl)-ethane.

Example D

A mixture is prepared from

19% of 4-(trans-4-n-propylcyclohexyl)-benzonitrile,

25 28% of 4-(trans-4-n-pentylcyclohexyl)-benzonitrile,

11% of trans-4-n-pentyl-(4'-cyanobiphenyl-4)-cyclohexane,

10% of 4-propylphenyl 4-(trans-4-n-propylcyclohexyl)-benzoate,

12% of trans-4-n-propylcyclohexyl 4-(trans-4-n-propylcyclohexyl)-benzoate,

12% of 1-(4-trans-pentylcyclohexyl)-2-(4'-cyano-2'-fluorobiphenyl-4-yl)-ethane,

35 7% of 2-(4-cyanophenyl)-5-[2-(trans-4-pentylcyclohexyl)-ethyl]-pyrimidine and

1% of 1-[p-(4-trans-pentylcyclohexyl)-phenyl]-2-(4'-cyano-2-fluorobiphenyl-4-yl)-ethane.

Example E

A mixture is prepared from

- 3% of 4-ethyl-4'-(trans-4-propylcyclohexyl)-
biphenyl,
5 5% of 4-ethyl-4'-(trans-4-pentylcyclohexyl)-
biphenyl,
5% of 2-p-pentyloxyphenyl-5-hexylpyrimidine,
5% of 2-p-hexyloxyphenyl-5-hexylpyrimidine,
6% of 2-p-heptyloxyphenyl-5-hexylpyrimidine,
10 8% of 2-p-nonyloxyphenyl-5-hexylpyrimidine,
8% of 2-p-undecyloxyphenyl-5-hexylpyrimidine,
7% of p-methoxyphenyl trans-4-propylcyclohexane-
carboxylate,
5% p-methoxyphenyl trans-4-butylcyclohexane-
15 carboxylate,
4% of p-methoxyphenyl trans-4-pentylcyclohexane-
carboxylate,
18% of 2-(4-cyano-2-fluorophenyl)-5-[2-(trans-4-
pentylcyclohexyl)-ethyl]-pyrimidine and
20 12% of 2-(4-cyanophenyl)-5-[2-(trans-4-propyl-
cyclohexyl)-ethyl]-pyrimidine.
10% of trans-1-p-ethylphenyl-4-pentylcyclohexane
and
4% of p-trans-4-propylcyclohexylphenyl butyrate.
25 This mixture is particularly suitable as a di-
electric for liquid crystal display elements with a high
multiplex ratio.

Example F

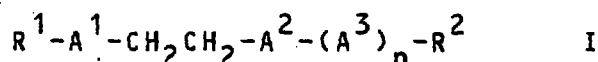
A mixture is prepared from

- 30 15% of p-trans-4-propylcyclohexylbenzonitrile,
27% of trans-1-p-ethylphenyl-4-propylcyclohexane,
10% of trans-2-p-ethoxyphenyl-4-propylcyclohexane,
7% of 4-cyano-4'-(trans-4-pentylcyclohexyl)-
biphenyl,
35 10% of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-
propylcyclohexyl)-biphenyl,
8% of p-propylphenyl p-trans-4-propylcyclohexyl-
benzoate,

- 6% of p-propylphenyl p-trans-4-pentylcyclohexyl-
benzoate,
- 8% of 1-(trans-4-propylcyclohexyl)-2-(4'-cyano-
2'-fluorobiphenyl-4-yl)-ethane,
- 5 5% of 1-(trans-4-pentylcyclohexyl)-2-(4'-cyano-
2'-fluorobiphenyl-4-yl)-ethane and
- 4% of 1-(trans-4-heptylcyclohexyl)-2-(4'-cyano-
2'-fluorobiphenyl-4-yl)-ethane.

Patent claims:

1. Ethane derivatives of the formula I



wherein

- R^1 is H, an alkyl group with 1 - 12 C atoms, in which one or two non-adjacent CH_2 groups can also be replaced by O atoms and/or CO- groups and/or -O-CO- groups and/or -CO-O groups, F, Cl or Br,
- R^2 is -CN or $-Z^2-A^4-CN$,
- A^1 is -A-, $-A-A^5-$ or $-A^5-A-$,
- A^2 is a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH_3 groups and/or CN groups and in which one or two CH groups can also be replaced by N atoms,
- A is a 1,4-cyclohexylene group, in which one or two non-adjacent CH_2 groups can also be replaced by O atoms, or is a 1,3-dithiane-2,5-diyl group or 1,4-bi-cyclo(2,2,2)-octylene group,
- A^3 , A^4 and A^5 are each a 1,4-cyclohexylene group, in which one or two non-adjacent CH_2 groups can also be replaced by O atoms, or are each a 1,3-dithiane-2,5-diyl group, or a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH_3 groups and/or CN groups, and in which one or two CH groups can also be replaced by N atoms,
- n is 0 or 1,
- Z^2 is $-CH_2CH_2-$, $-CH_2O-$, $-OCH_2-$, $-O-CO-$ or a single bond and

with the proviso that

- (a) if $A^2 = A^3 = 1,4\text{-phenylene}$ ($n = 1$) and/or if $R^1-A^1 = p\text{-(trans-4-alkylcyclohexyl)-phenyl}$, at least one of the groups A^2 and/or A^3 is laterally substituted, and
- (b) if $A^1 = A$ and/or $R^1-A^1 = \text{trans-4-(trans-4-alkyl-}$



cyclohexyl)-cyclohexyl, n is 1 and A³ is a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH₃ groups and/or CN groups and

(c) p-[2-[trans-4-(p-alkylphenyl or p-alkoxyphenyl)-cyclohexyl]-ethyl]benzonitriles are excluded.

2. Process for the preparation of ethane derivatives of the formula I, characterised in that a corresponding carboxylic acid amide is dehydrated or a corresponding carboxylic acid halide is reacted with sulfamide, or in that a corresponding bromine or chlorine compound is reacted with a cyanide.

3. Use of the ethane derivatives of the formula I according to Claim 1 as components of liquid crystal phases.

4. Liquid crystal phase with at least two liquid crystal components, characterised in that at least one component is an ethane derivative of the formula I according to Claim 1.

5. Liquid crystal display element, characterised in that it contains a phase according to Claim 4.

6. Electrooptical display element according to Claim 5, characterised in that it contains a phase according to Claim 4 as a dielectric.



As printed.

Claims

1. Ethane derivatives of the formula I



wherein

R¹ is H, an alkyl group with 1-12 C atoms, in which one or two CH₂ non adjacent groups can also be replaced by O atoms and/or CO-groups and/or —O—CO-groups and/or —CO—O-groups, F, Cl, Br,

R² is —CN or —Z²—A⁴—CN,

A¹ is —A—, —A—A⁵— or —A⁵—A—,

A² is a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH₃ groups and/or CN groups and in which one or two CH groups can also be replaced by N atoms,

A is a 1,4-cyclohexylene group, in which one or two non adjacent CH₂ groups can also be replaced by O atoms, or is a 1,3-dithiane-2,5-diyl group or 1,4-bicyclo(2,2,2)-octylene group,

A³, A⁴ and A⁵ are each a 1,4-cyclohexylene group, in which one or two non adjacent CH₂ groups can also be replaced by O atoms, or are each a 1,3-dithiane-2,5-diyl group, or a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH₃ groups and/or CN groups, and in which one or two CH groups can also be replaced by N atoms,

n is 0 or 1,

Z² is —CH₂CH₂—, —CH₂O—, —OCH₂—, —O—CO— or a single bond and with the proviso that

a) if A² = A³ = 1,4-phenylene (n = 1) and/or if R¹—A¹ = p-(trans-4-alkylcyclohexyl)-phenyl, at least one of the groups A² and/or A³ is laterally substituted,

b) if A¹ = A and/or R¹—A¹ = trans-4-(trans-4-alkylcyclohexyl)-cyclohexyl, n is 1 and A³ is a 1,4-phenylene group which is unsubstituted or substituted by one or two F and/or Cl atoms and/or CH₃ groups and/or CN groups, and

c) p-[2-[trans-4-(p-alkylphenyl or p-alkoxyphenyl) cyclohexyl]-ethyl]benzonitriles are excluded.

2. Process for the preparation of ethane derivatives of the formula I, characterised in that a corresponding carboxylic acid amide is dehydrated or a corresponding carboxylic acid halide is reacted with sulfamide, or in that a corresponding bromine or chlorine compound is reacted with a cyanide.

3. Use of the ethane derivatives of the formula I according to Claim 1 as components of liquid crystal phases.

4. Liquid crystal phase with at least two liquid crystal components, characterised in that at least one component is an ethane derivative of the formula I according to Claim 1.

5. Liquid crystal display element, characterised in that it contains a phase according to Claim 4.

6. Electrooptical display element according to Claim 5, characterised in that it contains a phase according to Claim 4 as a dielectric.

Revendications

1. La présente invention concerne des dérivés d'éthane de formule I



où

R¹ représente H, un groupe alcoyle en C₁-C₁₂, où encore un ou deux groupes CH₂ non voisins peuvent être remplacés par des atomes d'oxygène et/ou des groupes CO et/ou des groupes —O—CO— et/ou des groupes —CO—O, F, Cl, Br

R² représente —CN ou —Z²—A⁴—CN

A¹ représente —A—, —A—A⁵, ou —A⁵—A—,

A² représente un groupe 1,4-phénylène non substitué ou substitué par un ou deux atomes de F et/ou Cl et/ou groupe CH₃ et/ou groupe CN, où encore un ou deux groupes CH peuvent être remplacés par des atomes de N,

A représente un groupe 1,4-cyclohexylène, où encore un ou deux groupes CH₂ non voisins peuvent être remplacés par des atomes d'oxygène, un groupe 1,3-dithian-2,5-diyle ou un groupe 1,4-bicyclo-2,2,2-octylène,

A³, A⁴ et A⁵ représentent chacun un groupe 1,4-cyclo-hexylène où encore un ou deux groupes CH₂ non voisins peuvent être remplacés par des atomes d'oxygène, un groupe 1,3-dithian-2,5-diyle, un groupe 1,4-phénylène non substitué ou substitué par un ou deux atomes de F et/ou Cl et/ou groupe CH₃ et/ou groupe CN, où encore un ou deux groupes CH peuvent être remplacés par des atomes de N,

n vaut 0 ou 1,

Z² représente —CH₂CH₂—, —CH₂O—, —OCH₂—, —O—CO— ou une liaison simple, et avec la précision que :



a) dans le cas où $A^2 = A^3 = 1,4\text{-phénylène}$ ($n = 1$) et/ou dans le cas où $R^1-A^1 = p\text{-(trans-4-alcylcyclohexyl)-phényle}$ au moins l'un des groupes A^2 ou A^3 est substitué latéralement, et

b) dans le cas où $A^1 = A$ et/ou $R^1-A^1 = (\text{trans-4-(trans-alcylcyclohexyl)-cyclohexyle})$, n vaut 1 et A^3 représente un groupe 1,4-phénylène non substitué ou substitué par un ou deux atomes de F et/ou Cl et/ou groupes CH_3 et/ou groupes CN et

c) $p\text{-[2-(trans-4-alcylphényle ou p-alcylphényl) cyclohexyl]-éthyl}benzonitriles$, étant exclus.

2. Procédé de préparation de dérivés d'éthane de formule I, caractérisé en ce qu'on déshydrate un amide d'acide carboxylique correspondant ou en ce qu'on fait réagir un halogénure d'acide carboxylique correspondant avec un sulfamide, ou en ce qu'on fait réagir un composé de brome ou chlore correspondant avec un cyanure.

3. Application des dérivés d'éthane de formule I selon la revendication 1 comme composants de phases à cristaux liquides.

4. Phase à cristaux liquides ayant au moins deux composants à cristaux liquides, caractérisée en ce qu'au moins un composant est un dérivé d'éthane de formule I selon la revendication 1.

5. Élément d'affichage à cristaux liquides caractérisé en ce qu'il contient une phase selon la revendication 4.

6. Élément d'affichage électro-optique selon la revendication 5, caractérisé en ce qu'il contient comme diélectrique une phase selon la revendication 4.

