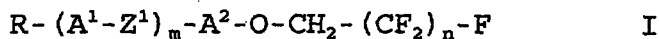


The present invention relates to fluorinated alkoxy compounds of the formula I



in which

5 R is H or a straight-chain, unsubstituted alkyl or alkenyl radical having 1 to 15 carbon atoms, it also being possible for one or more CH₂ groups in these radicals, in each case independently of one another, to be replaced by -O-,
10 -CO-, -CO-O-, -O-CO- or -O-CO-O- in such a way that O atoms are not linked directly to one another,

A¹ and A² are each, independently of one another, a
15 (a) trans-1,4-cyclohexylene radical in which, in addition, one or more non-adjacent CH₂ groups may be replaced by -O- and/or -S-,

(b) 1,4-phenylene radical in which, in addition, one or two CH groups may be replaced by N,

20 (c) radical from the group consisting of 1,4-cyclohexenylene, 1,4-bicyclo(2,2,2)octylene, piperidine-1,4-diyl, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl and 1,2,3,4-tetrahydronaphthalene-2,6-diyl,

where the radicals (a) and (b) may be substituted by CN
25 or fluorine,

Z¹ are in each case, independently of one another, -CH₂O-, -OCH₂-, -CH₂CH₂-, -CH=CH-, -C≡C- or a single bond,

m is 1, 2 or 3, and

n is 1 to 16.

The invention furthermore relates to the use of these compounds as components of liquid-crystalline phases and to liquid-crystal and electro-optical display elements which contain the liquid-crystalline phases according to the invention.

EP-A-0 255 236 discloses similar compounds, but these all contain a chiral wing group and are thus employed in ferroelectric mixtures.

10 The reference Chemical Abstracts, Vol. 108, 1988, No. 13950h discloses phenyl cyclohexanoates which contain a similar wing group, but which, due to their thermal instability, cannot entirely satisfy the high requirements made today of nematic mixtures.

15 The compounds of the formula I can be used as components of liquid-crystalline 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.

20 The invention has the object of finding novel, stable, liquid-crystalline or mesogenic compounds which are suitable as components of liquid-crystalline phases and have, in particular, relatively low viscosity and relatively high dielectric anisotropy.

25 It has now been found that compounds of the formula I are eminently suitable as components of liquid-crystalline phases. In particular, they have relatively low viscosities. They can be used to give stable liquid-crystalline phases having a broad mesophase range and advantageous values for the optical and dielectric anisotropy.

30 In addition, the provision of the compounds of the formula I very generally considerably broadens the range of liquid-crystalline substances which are suitable from various applicational points of view for the preparation of liquid-crystalline mixtures.

35 The compounds of the formula I have a broad range of applications. Depending on the choice of substituents, these compounds can be used as base material from which

liquid-crystalline phases are predominantly composed; however, it is also possible to add compounds of the formula I to liquid-crystalline base material from other classes of compounds in order, for example, to modify the dielectric and/or optical anisotropy of the dielectric of this type and/or to optimize its threshold voltage and/or its viscosity.

In the pure state, the compounds of the formula I are colourless and form liquid-crystalline mesophases in a temperature range which is favourably located for electro-optical use. They are stable chemically, thermally and to light.

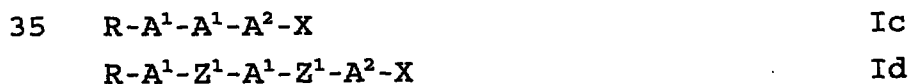
The invention thus relates to compounds of the formula I and to the use of these compounds as components of liquid-crystalline phases. The invention furthermore relates to liquid-crystalline phases containing at least one compound of the formula I and to liquid-crystal display elements, in particular electro-optical display elements, which contain phases of this type.

For reasons of simplicity, X below denotes $O-CH_2-(CF_2)_n-F$, Cyc denotes a 1,4-cyclohexylene radical, Che denotes a 1,4-cyclohexenylene radical, Dio denotes a 1,3-dioxane-2,5-diyl radical, Dit denotes a 1,3-dithiane-2,5-diyl radical, Phe denotes a 1,4-phenylene radical, Pyd denotes a pyridine-2,5-diyl radical, Pyr denotes a pyrimidine-2,5-diyl radical and Bi denotes a bicyclo(2,2,2)octylene radical, where Cyc and/or Phe may be unsubstituted or monosubstituted or disubstituted by F or CN.

Accordingly, the compounds of the formula I include bicyclic compounds of the sub-formulae Ia and Ib:



tricyclic compounds of the sub-formulae Ic to If:



R-A ¹ -Z ¹ -A ¹ -A ² -X	Ie
R-A ¹ -A ¹ -Z ¹ -A ² -X	If

and tetracyclic compounds of the sub-formulae Ig to In:

	R-A ¹ -A ¹ -A ¹ -A ² -X	Ig
5	R-A ¹ -Z ¹ -A ¹ -A ¹ -A ² -X	Ih
	R-A ¹ -A ¹ -Z ¹ -A ¹ -A ² -X	Ii
	R-A ¹ -A ¹ -A ¹ -Z ¹ -A ² -X	Ij
	R-A ¹ -Z ¹ -A ¹ -Z ¹ -A ¹ -A ² -X	Ik
	R-A ¹ -Z ¹ -A ¹ -A ¹ -A ¹ -Z ¹ -A ² -X	Il
10	R-A ¹ -A ¹ -Z ¹ -A ¹ -Z ¹ -A ² -X	Im
	R-A ¹ -Z ¹ -A ¹ -Z ¹ -A ¹ -Z ¹ -A ² -X	In

Of these, particular preference is given to those of the sub-formulae Ia, Ib, Ic, Id, Ie, If, Ii and Il.

The preferred compounds of the sub-formula Ia include those of the sub-formulae Iaa to Iag:

	R-Phe-Phe-X	Iaa
	R-Phe-Cyc-X	Iab
	R-Dio-Phe-X	Iac
	R-Pyr-Phe-X	Iad
20	R-Pyd-Phe-X	Iae
	R-Cyc-Phe-X	Iaf
	R-Che-Phe-X	Iag

Of these, those of the formulae Iaa, Iab, Iac, Iad and Iaf are particularly preferred.

The preferred compounds of the sub-formula Ib include those of the sub-formulae Iba to Ibg:

	R-Phe-CH ₂ CH ₂ -Phe-X	Iba
	R-Phe-OCH ₂ -Phe-X	Ibb
	R-Cyc-CH ₂ CH ₂ -Phe-X	Ibc
30	R-A ¹ -CH ₂ CH ₂ -Phe-X	Ibd
	R-A ¹ -CH ₂ O-Phe-X	Ibe
	R-A ¹ -OCH ₂ -Phe-X	Ibf
	R-Che-CH ₂ CH ₂ -Phe-X	Ibg

The preferred compounds of the sub-formula Ic include those of the sub-formulae Ica to Icj:

	R-Phe-Phe-Phe-X	Ica
	R-Phe-Phe-Cyc-X	Icb
5	R-Phe-Dio-Phe-X	Icc
	R-Cyc-Cyc-Phe-X	Icd
	R-Pyd-Phe-Phe-X	Ice
	R-Pyr-Phe-Phe-X	Icf
	R-Cyc-Phe-Phe-X	Icg
10	R-Dio-Phe-Phe-X	Ich
	R-Che-Phe-Phe-X	Ici
	R-Phe-Che-Phe-X	Icj

Of these, those of the formulae Icd and Icg are particularly preferred.

15 The preferred compounds of the sub-formula Id include those of the sub-formulae Ida to Idk:

	R-Phe-Z ¹ -Phe-Z ¹ -Phe-X	Ida
	R-Phe-Z ¹ -Phe-Z ¹ -Cyc-X	Idb
	R-Phe-Z ¹ -Dio-Z ¹ -Phe-X	Idc
20	R-Cyc-Z ¹ -Cyc-Z ¹ -Phe-X	Idd
	R-Pyd-Z ¹ -Phe-Z ¹ -Phe-X	Ide
	R-Phe-Z ¹ -Pyr-Z ¹ -Phe-X	Idf
	R-Pyr-Z ¹ -Phe-Z ¹ -Phe-X	Idg
	R-Phe-Z ¹ -Pyr-Z ¹ -Phe-X	Idh
25	R-Phe-Z ¹ -Cyc-Z ¹ -Phe-X	Idi
	R-Dio-Z ¹ -Phe-Z ¹ -Phe-X	Idj
	R-Che-Z ¹ -Phe-Z ¹ -Phe-X	Idk

The preferred compounds of the sub-formula Ie include those of the sub-formulae Iea to Iej:

30	R-Pyr-Z ¹ -Phe-Phe-X	Iea
	R-Pyr-Z ¹ -Phe-Cyc-X	Ieb
	R-Dio-Z ¹ -Phe-Phe-X	Iec
	R-Cyc-Z ¹ -Phe-Phe-X	Ied
	R-Phe-Z ¹ -Cyc-Phe-X	Iee

	R-Cyc-Z ¹ -Cyc-Phe-X	Ief
	R-Phe-Z ¹ -Dio-Phe-X	Ieg
	R-Pyd-Z ¹ -Phe-Phe-X	Ieh
	R-Phe-Z ¹ -Pyr-Phe-X	Iei
5	R-Phe-Z ¹ -Che-Phe-X	Iej

The preferred compounds of the sub-formula If include those of the sub-formulae Ifa to Ifm:

	R-Pyr-Phe-Z ¹ -Phe-X	Ifa
	R-Pyr-Phe-OCH ₂ -Phe-X	Ifb
10	R-Phe-Phe-Z ¹ -Phe-X	Ifc
	R-Phe-Phe-Z ¹ -Cyc-X	Ifd
	R-Cyc-Cyc-Z ¹ -Phe-X	Ife
	R-Cyc-Cyc-CH ₂ CH ₂ -Phe-X	Iff
	R-Pyd-Phe-Z ¹ -Phe-X	Ifg
15	R-Dio-Phe-Z ¹ -Phe-X	Ifh
	R-Phe-Cyc-Z ¹ -Phe-X	Ifi
	R-Phe-Pyd-Z ¹ -Phe-X	Ifj
	R-Che-Phe-Z ¹ -Phe-X	Ifk
	R-Phe-Che-Z ¹ -Phe-X	Ifl
20	R-Cyc-Phe-Z ¹ -Phe-X	Ifm

The preferred compounds of the sub-formulae Ig to In include those of the sub-formulae Io to It:

	R-Cyc-Cyc-Phe-Phe-X	Io
	R-A ¹ -CH ₂ O-A ¹ -A ¹ -Phe-X	Ip
25	R-Cyc-Cyc-Z ¹ -A ¹ -Phe-X	Iq
	R-A ¹ -A ¹ -A ¹ -CH ₂ CH ₂ -Phe-X	Ir
	R-Phe-Z ¹ -Phe-Z ¹ -Dio-Phe-X	Is
	R-Phe-Z ¹ -Phe-Phe-Z ¹ -Phe-X	It

30 In the compounds of the formulae above and below, X is preferably -O-CH₂-(CF₂)_n-F, in which n is 1 to 12, preferably 1 to 6. n is particularly preferably 1, 2, 3 and [sic] 4.

R is preferably alkyl or alkenyl, furthermore alkoxy. A¹ is preferably Phe, Cyc, Che, Pyr or Dio. The

compounds of the formula I preferably contain not more than one of the radicals Bi, Pyd, Pyr, Dio or Dit. A² is preferably Phe, Cyc, Pyr or Dio. A² is very particularly preferably Phe and [sic] Cyc.

5 Preference is also given to compounds of the formula I and of all sub-formulae in which A¹ and/or A² is 1,4-phenylene which is monosubstituted or disubstituted by F or monosubstituted by CN. In particular, these are 2-fluoro-1,4-phenylene, 3-fluoro-1,4-phenylene and
10 2,3-difluoro-1,4-phenylene, and 2-cyano-1,4-phenylene and 3-cyano-1,4-phenylene.

Z¹ is preferably a single bond or -CH₂CH₂-, secondarily preferably -CH₂O- and [sic] -OCH₂-.

If R is an alkyl radical and/or an alkoxy radical,
15 this preferably has 2, 3, 4, 5, 6 or 7 carbon atoms and accordingly is preferably ethyl, propyl, butyl, pentyl, hexyl, heptyl, ethoxy, propoxy, butoxy, pentoxy, hexoxy or heptoxy, furthermore methyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, penta-
20 decyl, methoxy, octoxy, nonoxy, decoxy, undecoxy, dodecoxy, tridecoxy or tetradecoxy.

Oxaalkyl is preferably straight-chain 2-oxapropyl (= methoxymethyl), 2- (= ethoxymethyl) or 3-oxabutyl (= 2-methoxyethyl), 2-, 3- or 4-oxapentyl, 2-, 3-, 4- or
25 5-oxahexyl, 2-, 3-, 4-, 5- or 6-oxaheptyl, 2-, 3-, 4-, 5-, 6- or 7-oxaoctyl, 2-, 3-, 4-, 5-, 6-, 7- or 8-oxa-nonyl, or 2-, 3-, 4-, 5-, 6-, 7-, 8- or 9-oxadecyl.

If R is an alkyl radical in which one CH₂ group has been replaced by -CH=CH*, this preferably has 2 to 10
30 carbon atoms. Accordingly, it is in particular vinyl prop-1-, or prop-2-enyl, but-1-, 2- or but-3-enyl, pent-1-, 2-, 3- or pent-4-enyl, hex-1-, 2-, 3-, 4- or hex-5-enyl, hept-1-, 2-, 3-, 4-, 5- or hept-6-enyl, oct-1-, 2-, 3-, 4-, 5-, 6- or oct-7-enyl, non-1-, 2-, 3-, 4-, 5-,
35 6-, 7- or non-8-enyl, or dec-1-, 2-, 3-, 4-, 5-, 6-, 7-, 8- or dec-9-enyl.

If R is an alkyl radical in which one CH₂ group has been replaced by -O- and another has been replaced by -CO-, these are preferably adjacent. These thus contain

an acyloxy group -CO-O- or an oxycarbonyl group -O-CO-. These preferably have 2 to 6 carbon atoms. Accordingly, they are in particular acetyloxy, propionyloxy, butyryloxy, pentanoyloxy, hexanoyloxy, acetyloxymethyl, propionyloxymethyl, butyryloxymethyl, pentanoyloxymethyl, 2-acetyloxyethyl, 2-propionyloxyethyl, 2-butyryloxyethyl, 3-acetyloxypropyl, 3-propionyloxypropyl, 4-acetyloxybutyl, methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl, butoxycarbonyl, pentoxycarbonyl, methoxycarbonylmethyl, ethoxycarbonylmethyl, propoxycarbonylmethyl, butoxycarbonylmethyl, 2-(methoxycarbonyl)ethyl, 2-(ethoxycarbonyl)ethyl, 2-(propoxycarbonyl)ethyl, 3-(methoxycarbonyl)propyl, 3-(ethoxycarbonyl)propyl or 4-(methoxycarbonyl)butyl.

If R is an alkyl radical in which one CH₂ group has been replaced by -CH=CH- and an adjacent CH₂ group has been replaced by CO or CO-O or O-CO, this preferably has 4 to 13 carbon atoms. Accordingly, it is in particular acryloyloxymethyl, 2-acryloyloxyethyl, 3-acryloyloxypropyl, 4-acryloyloxybutyl, 5-acryloyloxypropyl, 6-acryloyloxyhexyl, 7-acryloyloxyheptyl, 8-acryloyloxyoctyl, 9-acryloyloxynonyl, 10-acryloyloxydecyl, methacryloyloxymethyl, 2-methacryloyloxyethyl, 3-methacryloyloxypropyl, 4-methacryloyloxybutyl, 5-methacryloyloxypropyl, 6-methacryloyloxyhexyl, 7-methacryloyloxyheptyl, 8-methacryloyloxyoctyl or 9-methacryloyloxynonyl.

Compounds of the formula I which contain wing groups R which are suitable for polymerization reactions are suitable for the preparation of liquid-crystalline polymers.

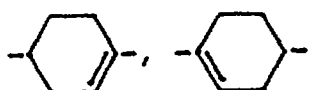
Compounds of the formula I which contain wing groups R which are suitable for polycondensations are suitable for the preparation of liquid-crystalline polycondensates.

Of these compounds of the formula I and of the sub-formulae, particular preference is given to those in which at least one of the radicals present therein has one of the preferred meanings indicated.

In the compounds of the formula I, preferred

stereoisomers are those in which the rings Cyc and piperidine are trans-1,4-disubstituted. Those of the abovementioned formulae which contain one or more Pyd, Pyr and/or Dio groups in each case include the two
5 2,5-positional isomers.

The 1,4-cyclohexenylene group preferably has the following structures:



The compounds of the formula I are prepared by methods known per se and described in the literature (for
10 example in the standard works such as Houben-Weyl, Methoden der Organischen Chemie, Georg-Thieme-Verlag, Stuttgart Vol. IX, pp. 867 ff.), to be precise under reaction conditions which are known and suitable for said reactions. Use may also be made here of variants which
15 are known per se, but are not described here in greater detail.

The fluorinated alkoxy compounds according to the invention are prepared, for example, by reacting corresponding nitro- or fluorobenzenes carrying at least one
20 electron-withdrawing substituent directly with alkali metal fluoroalkoxy compounds, where F or NO₂ is replaced by the fluoroalkoxy radical [J.P. Idoux, et al., J. Org. Chem. 50, 1976 (1985)].

If desired, the starting materials can also be
25 prepared in situ by not isolating them from the reaction mixture, but instead immediately converting them further into the compounds of the formula I.

Thus, the compounds of the formula I can be prepared by reducing a compound which conforms to the
30 formula I, but contains one or more reducible groups and/or C-C bonds in place of H atoms.

Suitable reducible groups are preferably carbonyl groups, in particular keto groups, furthermore, for example, free or esterified hydroxyl groups or

aromatically bonded halogen atoms. Preferred starting materials for the reduction conform to the formula I, but contain a cyclohexene ring or cyclohexanone ring in place of a cyclohexane ring or contain a $-\text{CH}=\text{CH}-$ group in place of a $-\text{CH}_2\text{CH}_2-$ group and/or contain a $-\text{CO}-$ group in place of a $-\text{CH}_2-$ group and/or contain a free or functionally modified (for example in the form of its p-toluene-sulphonate) OH group in place of an H atom.

The reduction can be carried out, for example, by catalytic hydrogenation at temperatures between about 0° and about 200° and at pressures between about 1 and 200 bar in an inert solvent, for example an alcohol, such as methanol, ethanol or isopropanol, an ether, such as tetrahydrofuran (THF) or dioxane, an ester, such as ethyl acetate, a carboxylic acid, such as acetic acid, or a hydrocarbon, such as cyclohexane. Suitable catalysts are expediently noble metals, such as Pt or Pd, which can be employed in the form of oxides (for example PtO_2 or PdO), on a support (for example Pd on charcoal, calcium carbonate or strontium carbonate) or in finely divided form.

Ketones can also be reduced by the methods of Clemmensen (using zinc, zinc amalgam or tin and hydrochloric acid, expediently in aqueous-alcoholic solution or in the heterogeneous phase with water/toluene at temperatures between about 80 and 120°) or Wolff-Kishner (using hydrazine, expediently in the presence of alkali such as KOH or NaOH, in a high-boiling solvent, such as diethylene glycol or triethylene glycol, at temperatures between about 100 and 200°) to give the corresponding compounds of the formula I which contain alkyl groups and/or $-\text{CH}_2\text{CH}_2-$ bridges.

Furthermore, reductions using complex hydrides are possible. For example, arylsulphonyloxy groups can be removed reductively using LiAlH_4 , in particular p-toluenesulphonyloxymethyl groups can be reduced to methyl groups, expediently in an inert solvent, such as diethyl ether or THF, at temperatures between about 0 and 100° . Double bonds can be hydrogenated using NaBH_4 or

tributyltin hydride in methanol.

Compounds of the formula I which conform to the formula I, but contain 1,4-cyclohexenylene radicals in place of 1,4-phenylene radicals can be oxidized, for example using DDQ (dichlorodicyanobenzoquinone) in a suitable solvent.

Esters of the formula I can also be obtained by esterification of corresponding carboxylic acids (or reactive derivatives thereof) using alcohols or phenols (or reactive derivatives thereof) or by the DCC method (DCC = dicyclohexylcarbodiimide).

The corresponding carboxylic acids and alcohols or phenols are known or can be prepared analogously to known processes.

Suitable reactive derivatives of the said carboxylic acids are, in particular, the acid halides, in particular the chlorides and bromides, furthermore the anhydrides, for example also mixed anhydrides, azides or esters, in particular alkyl esters having 1 - 4 carbon atoms in the alkyl group.

Suitable reactive derivatives of the said alcohols or phenols are, in particular, the corresponding metal alkoxides or phenoxides, preferably of an alkali metal, such as sodium or potassium.

The esterification is advantageously carried out in the presence of an inert solvent. Particularly highly suitable are ethers, such as, for example, diethyl ether, di-n-butyl ether, THF, dioxane or anisole, ketones, such as, for example, acetone, butanone or cyclohexanone, amides, such as, for example DMF or hexamethylphosphoric triamide, hydrocarbons, such as, for example, benzene, toluene or xylene, halogenated hydrocarbons, such as, for example, carbon tetrachloride, dichloromethane or tetrachloroethylene, and sulphoxides, such as, for example, dimethyl sulphoxide or sulpholane.

Ethers of the formula I can be obtained by etherification of corresponding hydroxyl compounds, preferably corresponding phenols, where the hydroxyl compound is expediently first converted into a

corresponding metal derivative, for example into the corresponding alkali metal alkoxide or alkali metal phenoxide by treatment with NaH, NaNH₂, NaOH, KOH, Na₂CO₃ or K₂CO₃. This metal derivative can then be reacted with
5 the corresponding alkyl halide, alkyl sulphonate or dialkyl sulphate, expediently in an inert solvent, such as, for example, acetone, 1,2-dimethoxyethane, DMF or dimethyl sulphoxide, or alternatively with an excess of aqueous or aqueous-alcoholic NaOH or KOH, at temperatures
10 between about 20° and 100°.

Compounds of the formula I in which A¹ is substituted by at least one F atom and/or one CN group can also be obtained from the corresponding diazonium salts by replacement of the diazonium group by a fluorine atom
15 or by a CN group, for example by the method of Schiemann or Sandmeyer.

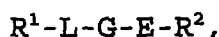
Dioxane derivatives or dithiane derivatives of the formula I are expediently prepared by reaction of a corresponding aldehyde (or a reactive derivative thereof)
20 with an appropriate 1,3-diol (or a reactive derivative thereof) or an appropriate 1,3-dithiol, preferably in the presence of an inert solvent, such as, for example, benzene or toluene, and/or in the presence of a catalyst, for example a strong acid, such as sulphuric acid, benzene-
25 or p-toluenesulphonic acid, at temperatures between about 20° and about 150°, preferably between 80° and 120°. Suitable reactive derivatives of the starting materials are primarily acetals.

Some of the said aldehydes and 1,3-diols or
30 1,3-dithiols and the reactive derivatives thereof are known, and some can be prepared without difficulties by standard methods of organic chemistry from compounds known from the literature. For example, the aldehydes can be obtained by oxidation of corresponding alcohols or by
35 reduction of corresponding carboxylic acids or derivatives thereof, the diols by reduction of corresponding diesters, and the dithiols by reaction of corresponding dihalides with NaSH.

The liquid-crystalline phases according to the

invention generally comprise 2 to 25, preferably 3 to 15 components, including at least one compound of the formula I. In individual cases, however, more than 25 components may be constituents of a phase according to the invention, for example up to 50 components or more. The other constituents are preferably selected from nematic or nematogenic substances, in particular known substances, from the classes comprising the azoxybenzenes, benzylideneanilines, biphenyls, terphenyls, phenyl or cyclohexyl benzoates, phenyl or cyclohexyl cyclohexanecarboxylates, phenylcyclohexanes, cyclohexylbiphenyls, cyclohexylcyclohexanes, cyclohexylnaphthalenes, 1,4-biscyclohexylbenzenes, 4,4'-biscyclohexylbiphenyls, phenyl- or cyclohexylpyrimidines, phenyl- or cyclohexyldioxanes, phenyl- or cyclohexyldithianes, 1,2-diphenylethanes, 1,2-dicyclohexylethanes, 1-phenyl-2-cyclohexylethanes, optionally halogenated stilbenes, benzyl phenyl ethers, tolans and substituted cinnamic acids.

The most important compounds which are suitable as constituents of liquid-crystalline phases according to the invention can be characterized by the formula II



II

in which 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 tetrahydronaphthalene, quinazoline and tetrahydroquinazoline,

30	G is	-CH=CH-	-N(O)=N-
		-CH=CY-	-CH=N(O)-
		-C≡C-	-CH ₂ -CH ₂ -
		-CO-O-	-CH ₂ -O-
		-CO-S-	-CH ₂ -S-
35		-CH=N-	-COO-Phe-COO-

or a C-C single bond,

Y is halogen, preferably chlorine, or -CN, and R¹ and R² are alkyl, alkoxy, alkanoyloxy or alkoxycarbonyloxy having up to 18, preferably up to 8, carbon atoms, or one
5 of these radicals is alternatively CN, NO₂, CF₃, F, Cl or Br.

In most of these compounds, R¹ and R² are different from one another, one of these radicals usually being an alkyl or alkoxy group. However, other variants
10 of the proposed substituents are also common. Many such substances or mixtures thereof are commercially available. All these substances can be prepared by methods which are known from the literature or analogously thereto.

The liquid-crystalline phases according to the invention contain about 0.1 to 99 %, preferably 10 to 95 %, of one or more compounds of the formula I. Additionally preferred liquid-crystalline phases are those which contain
15 0.1 - 50 %, particularly 0.5 - 30 %, of one or more compounds of the formula I. Isotropic compounds of the formula I can be used in the phases according to the invention.

The liquid-crystalline phases according to the invention are prepared in a manner which is customary per se. In general, the components are dissolved in one
20 another, expediently at elevated temperature.

By means of suitable additives, the liquid-crystalline phases according to the invention can be modified in a manner such that they can be used in all types of liquid-crystal display elements which have been disclosed
25 hitherto.

Additives of this type are known to those skilled in the art and are described in detail in the literature. For example, conductive salts, preferably ethyldimethyldodecylammonium 4-hexyloxybenzoate, tetrabutylammonium
30 tetraphenylborate or complex salts of crown ethers (cf., for example, I. Haller et al., Mol. Cryst. Liq. Cryst. Volume 24, pages 249-258 (1973)) can be added in order to improve the conductivity, dichroic dyes can be added to

produce coloured guest-host systems or substances can be added to modify the dielectric anisotropy, the viscosity and/or the orientation of the nematic phases. Substances of this type are described, for example, in German Offenlegungsschriften 2,209,127, 2,240,864, 2,321,632, 5 2,338,281, 2,450,088, 2,637,430, 2,853,728 and 2,902,177.

The examples below are intended to illustrate the invention without representing a limitation. Above and below, percentages are per cent by weight. All temperatures are given in degrees Celsius. m.p. denotes melting point, 10 c.p. = clearing point. Furthermore, C = crystalline state, N = nematic phase, S = smectic phase and I = isotropic phase. The numbers between these symbols represent the transition temperatures.

15 "Customary work-up" means that water is added, if required, the mixture is extracted with methylene chloride, diethyl ether or toluene, the organic phase is separated off, dried and evaporated, and the product is purified by distillation under reduced pressure or by crystallization and/or chromatography. The following abbreviations are used:

DCC	Dicyclohexylcarbodiimide
DDQ	Dichlorodicyanobenzoquinone
THF	Tetrahydrofuran
25 POT	Potassium tertiary-butoxide
pTSOH	p-Toluenesulphonic acid

Example 1

4-{2-[4-(1H,1H-Trifluoroethoxy)phenyl]ethenyl}-4'-pentyl-trans,trans-bicyclohexyl

30 0.09 mol of 4-(1H,1H-trifluoroethoxy)benzaldehyde (cf. literature reference in Example 1 [sic]) and 0.08 mol of POT are added with ice-cooling to a suspension of 0.08 mol of 4'-pentyl-trans,trans-bicyclohexyl-4-methyltriphenylphosphonium iodide in 250 ml of THF. The mixture is stirred at 5°C for 1 hour. 2 N HCl is then added until the 35 aqueous phase is neutral and water is added until the precipitate dissolves. The organic phase is separated off, dried over Na₂SO₄ and evaporated. The residue is

chromatographed on a silica gel column using petroleum ether/ethyl acetate 9:1 as eluent, giving colourless crystals.

The following are prepared analogously:

- 5 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethenyl}-4'-ethyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethenyl}-4'-propyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethenyl}-4'-butyl-trans,trans-bicyclohexyl
10 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethenyl}-4'-hexyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethenyl}-4'-heptyl-trans,trans-bicyclohexyl
15 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethenyl}-4'-octyl-trans,trans-bicyclohexyl
- 4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethenyl}-4'-ethyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethenyl}-4'-propyl-trans,trans-bicyclohexyl
20 4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethenyl}-4'-butyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethenyl}-4'-pentyl-trans,trans-bicyclohexyl
25 4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethenyl}-4'-hexyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethenyl}-4'-heptyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethenyl}-4'-octyl-trans,trans-bicyclohexyl
30 4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-ethyl-trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-propyl-trans,trans-bicyclohexyl
35 4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-butyl-trans,trans-bicyclohexyl

- 4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-pentyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-hexyl-
trans,trans-bicyclohexyl
5 4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-heptyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-octyl-
trans,trans-bicyclohexyl

Example 2

- 10 4-{2-[4-(1H,1H-Trifluoroethoxy)phenyl]ethyl}-4'-pentyl-
trans,trans-bicyclohexyl

10 g of Pd/C (5% of Pd) are added to a solution of
0.038 mol of the product 3 [sic] in 150 ml of ethyl
acetate, and the mixture is hydrogenated at room
15 temperature and atmospheric pressure. The catalyst is
filtered off, the filtrate is evaporated and the residue is
recrystallized from ethanol, giving colourless crystals.
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The following are prepared analogously:

- 20 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-4'-ethyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-4'-propyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-4'-butyl-
25 trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-4'-hexyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-4'-heptyl-
trans,trans-bicyclohexyl
30 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-4'-octyl-
trans,trans-bicyclohexyl

4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethyl}-4'-ethyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethyl}-4'-propyl-
35 trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethyl}-4'-butyl-

- trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethyl}-4'-pentyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethyl}-4'-hexyl-
5 trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethyl}-4'-heptyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-pentafluoropropoxy)phenyl]ethyl}-4'-octyl-
trans,trans-bicyclohexyl
- 10 4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethyl}-4'-ethyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethyl}-4'-propyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-butyl-
15 trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-pentyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-hexyl-
trans,trans-bicyclohexyl
20 4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-heptyl-
trans,trans-bicyclohexyl
4-{2-[4-(1H,1H-heptafluorobutoxy)phenyl]ethenyl}-4'-octyl-
trans,trans-bicyclohexyl

Example 3

- 25 1H,1H-Trifluoroethoxy-4-(5-ethyl-1,3-dioxan-2-yl)benzene
0.1 mol of 4-(1H,1H-trifluoroethoxy)benzaldehyde,
0.1 mol of ethylpropanediol and 0.2 g of p-TsOH are boiled
for 2 hours in 100 ml of toluene. After the solvent has
been evaporated, the product is distilled under reduced
30 pressure, giving colourless crystals.

The following are prepared analogously:

- 1H,1H-trifluoroethoxy-4-(5-propyl-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-butyl-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-pentyl-1,3-dioxan-2-yl)benzene
35 1H,1H-trifluoroethoxy-4-(5-hexyl-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-heptyl-1,3-dioxan-2-yl)benzene

- 1H,1H-trifluoroethoxy-4-(5-octyl-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-nonyl-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-decyl-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-methoxy-1,3-dioxan-2-yl)benzene
5 1H,1H-trifluoroethoxy-4-(5-ethoxy-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-propoxy-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-butoxy-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-pentoxo-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-hexoxy-1,3-dioxan-2-yl)benzene
10 1H,1H-trifluoroethoxy-4-(5-heptoxy-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-octoxy-1,3-dioxan-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-nonoxo-1,3-dioxan-2-yl)benzene

1H,1H-pentafluoropropoxy-4-(5-propyl-1,3-dioxan-2-yl)benzene
15 1H,1H-pentafluoropropoxy-4-(5-ethyl-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-butyl-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-pentyl-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-hexyl-1,3-dioxan-2-yl)benzene
20 1H,1H-pentafluoropropoxy-4-(5-heptyl-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-octyl-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-nonyl-1,3-dioxan-2-yl)benzene
H,1H-pentafluoropropoxy-4-(5-decyl-1,3-dioxan-2-yl)benzene
25 1H,1H-pentafluoropropoxy-4-(5-methoxy-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-ethoxy-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-propoxy-1,3-dioxan-2-yl)benzene
30 1H,1H-pentafluoropropoxy-4-(5-butoxy-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-pentoxo-1,3-dioxan-2-yl)benzene
35 1H,1H-pentafluoropropoxy-4-(5-hexoxy-1,3-dioxan-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-heptoxy-1,3-dioxan-2-yl)benzene

- 1H, 1H-pentafluoropropoxy-4-(5-octoxy-1,3-dioxan-2-yl)benzene
1H, 1H-pentafluoropropoxy-4-(5-nonoxy-1,3-dioxan-2-yl)benzene
- 5 1H, 1H-heptafluorobutoxy-4-(5-propyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-ethyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-butyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-pentyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-hexyl-1,3-dioxan-2-yl)benzene
- 10 1H, 1H-heptafluorobutoxy-4-(5-heptyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-octyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-nonyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-decyl-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-methoxy-1,3-dioxan-2-yl)benzene
- 15 zene
1H, 1H-heptafluorobutoxy-4-(5-ethoxy-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-propoxy-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-butoxy-1,3-dioxan-2-yl)benzene
- 20 1H, 1H-heptafluorobutoxy-4-(5-pentoxy-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-hexoxy-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-heptoxy-1,3-dioxan-2-yl)benzene
- 25 1H, 1H-heptafluorobutoxy-4-(5-octoxy-1,3-dioxan-2-yl)benzene
1H, 1H-heptafluorobutoxy-4-(5-nonoxy-1,3-dioxan-2-yl)benzene

Example 4

- 1H, 1H-Trifluoroethoxy-4-(5-heptyl-1,3-pyrimidin-2-yl)benzene
- 30 A mixture of 0.1 mol of p-1H, 1H-trifluoroethoxybenzimidamide hydrochloride (obtainable from the nitrile (cf. literature reference in Example 1 [sic]) via the corresponding ethyl benzimidate hydrochloride) and 0.1 mol of heptylmalonaldehyde bis(diethyl acetal) is stirred at
- 35 150°C for 15 hours. After cooling, the mixture is subjected to customary work-up.

The following are prepared analogously

- 1H,1H-trifluoroethoxy-4-(5-ethyl-1,3-pyrimidin-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-propyl-1,3-pyrimidin-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-butyl-1,3-pyrimidin-2-yl)benzene
5 1H,1H-trifluoroethoxy-4-(5-pentyl-1,3-pyrimidin-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-hexyl-1,3-pyrimidin-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-methoxy-1,3-pyrimidin-2-yl)benzene
10 1H,1H-trifluoroethoxy-4-(5-propoxy-1,3-pyrimidin-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-butoxy-1,3-pyrimidin-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-pentoxy-1,3-pyrimidin-2-yl)benzene
15 1H,1H-trifluoroethoxy-4-(5-hexoxy-1,3-pyrimidin-2-yl)benzene
1H,1H-trifluoroethoxy-4-(5-heptoxy-1,3-pyrimidin-2-yl)benzene
20 1H,1H-pentafluoropropoxy-4-(5-ethyl-1,3-pyrimidin-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-propyl-1,3-pyrimidin-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-butyl-1,3-pyrimidin-2-yl)benzene
25 1H,1H-pentafluoropropoxy-4-(5-pentyl-1,3-pyrimidin-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-hexyl-1,3-pyrimidin-2-yl)benzene
30 1H,1H-pentafluoropropoxy-4-(5-heptyl-1,3-pyrimidin-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-methoxy-1,3-pyrimidin-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-propoxy-1,3-pyrimidin-2-yl)benzene
35 1H,1H-pentafluoropropoxy-4-(5-butoxy-1,3-pyrimidin-2-yl)benzene
1H,1H-pentafluoropropoxy-4-(5-pentoxy-1,3-pyrimidin-2-yl)benzene

benzene

1H,1H-pentafluoropropoxy-4-(5-hexoxy-1,3-pyrimidin-2-yl)-
benzene

5 1H,1H-pentafluoropropoxy-4-(5-heptoxy-1,3-pyrimidin-2-yl)-
benzene

Example 5

4-(4-Propylcyclohexen-1-yl)-1H,1H-trifluoroethoxybenzene

A solution of 0.1 mol of 4-bromo-1H,1H-trifluoroethoxybenzene [obtainable from the 4-nitro compound by
10 reduction and subsequent Sandmeyer reaction (cf. Organikum
VEB Deutscher Verlag der Wissenschaften, Berlin 1977, pp.
662-665)] at room temperature [sic] in 50 ml of an-
hydrous THF is added dropwise to a suspension of 0.12 mol
of magnesium turnings in 50 ml of anhydrous THF. A solution
15 of 0.1 mol of 4-propylcyclohexanone in 100 ml of THF is
subsequently added dropwise, and the mixture is then
stirred at room temperature for 2 hours, and subsequently
at the boil for 2 hours. The cooled mixture is poured into
cold dilute HCl (2 N), and the product is extracted with
20 diethyl ether. After the solvent has been stripped off, the
residue is dissolved in 150 ml of toluene and, after
addition of 0.006 mol of p-TsOH, boiled for 4 hours and
subjected to customary work-up.

The following are prepared analogously:

25 4-(4-ethylcyclohexen-1-yl)-1H,1H-trifluoroethoxybenzene
4-(4-butylcyclohexen-1-yl)-1H,1H-trifluoroethoxybenzene
4-(4-pentylcyclohexen-1-yl)-1H,1H-trifluoroethoxybenzene
4-(4-hexylcyclohexen-1-yl)-1H,1H-trifluoroethoxybenzene
4-(4-heptylcyclohexen-1-yl)-1H,1H-trifluoroethoxybenzene
30 4-(4-octylcyclohexen-1-yl)-1H,1H-trifluoroethoxybenzene

4-(4-ethylcyclohexen-1-yl)-1H,1H-pentafluoropropoxybenzene
4-(4-propylcyclohexen-1-yl)-1H,1H-pentafluoropropoxybenzene
4-(4-butylcyclohexen-1-yl)-1H,1H-pentafluoropropoxybenzene
4-(4-pentylcyclohexen-1-yl)-1H,1H-pentafluoropropoxybenzene
35 4-(4-hexylcyclohexen-1-yl)-1H,1H-pentafluoropropoxybenzene
4-(4-heptylcyclohexen-1-yl)-1H,1H-pentafluoropropoxybenzene

4-(4-octylcyclohexen-1-yl)-1H,1H-pentafluoropropoxybenzene

4-(4-ethylcyclohexen-1-yl)-1H,1H-heptafluorobutoxybenzene

4-(4-propylcyclohexen-1-yl)-1H,1H-heptafluorobutoxybenzene

4-(4-butylcyclohexen-1-yl)-1H,1H-heptafluorobutoxybenzene

5 4-(4-pentylcyclohexen-1-yl)-1H,1H-heptafluorobutoxybenzene

4-(4-hexylcyclohexen-1-yl)-1H,1H-heptafluorobutoxybenzene

4-(4-heptylcyclohexen-1-yl)-1H,1H-heptafluorobutoxybenzene

4-(4-octylcyclohexen-1-yl)-1H,1H-heptafluorobutoxybenzene

Example 6

10 4-(trans-4-Propylcyclohexyl)-1H,1H-trifluoroethoxybenzene

Hydrogen is passed at room temperature into a solution, containing 5 g of suspended Pd/C, of 0.13 mol of product from Example 6 [sic] in 100 ml of THF until the solution is saturated. After stirring for 3 hours, the mixture is subjected to customary work-up.

15

The following are prepared analogously

4-(trans-4-ethylcyclohexyl)-1H,1H-trifluoroethoxybenzene

4-(trans-4-butylcyclohexyl)-1H,1H-trifluoroethoxybenzene

4-(trans-4-pentylcyclohexyl)-1H,1H-trifluoroethoxybenzene

20 4-(trans-4-hexylcyclohexyl)-1H,1H-trifluoroethoxybenzene

4-(trans-4-heptylcyclohexyl)-1H,1H-trifluoroethoxybenzene

4-(trans-4-octylcyclohexyl)-1H,1H-trifluoroethoxybenzene

4-(trans-4-ethylcyclohexyl)-1H,1H-pentafluoropropoxybenzene

25 4-(trans-4-propylcyclohexyl)-1H,1H-pentafluoropropoxybenzene

4-(trans-4-butylcyclohexyl)-1H,1H-pentafluoropropoxybenzene

4-(trans-4-pentylcyclohexyl)-1H,1H-pentafluoropropoxybenzene

4-(trans-4-hexylcyclohexyl)-1H,1H-pentafluoropropoxybenzene

30 4-(trans-4-heptylcyclohexyl)-1H,1H-pentafluoropropoxybenzene

4-(trans-4-octylcyclohexyl)-1H,1H-pentafluoropropoxybenzene

4-(trans-4-ethylcyclohexyl)-1H,1H-nonafluoropentoxxybenzene

4-(trans-4-propylcyclohexyl)-1H,1H-nonafluoropentoxxybenzene

- 4-(trans-4-butylcyclohexyl)-1H,1H-nonafluoropentoxybenzene
4-(trans-4-pentylcyclohexyl)-1H,1H-nonafluoropentoxybenzene
4-(trans-4-hexylcyclohexyl)-1H,1H-nonafluoropentoxybenzene
4-(trans-4-heptylcyclohexyl)-1H,1H-nonafluoropentoxybenzene
5 4-(trans-4-octylcyclohexyl)-1H,1H-nonafluoropentoxybenzene
- 4-[trans-4-(trans-4-ethylcyclohexyl)cyclohexyl]-1H,1H-tri-
fluoroethoxybenzene
4-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-1H,1H-tri-
fluoroethoxybenzene
10 4-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]-1H,1H-tri-
fluoroethoxybenzene
4-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-1H,1H-tri-
fluoroethoxybenzene
4-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]-1H,1H-tri-
15 fluoroethoxybenzene
4-[trans-4-(trans-4-octylcyclohexyl)cyclohexyl]-1H,1H-tri-
fluoroethoxybenzene
- 4-[trans-4-(trans-4-ethylcyclohexyl)cyclohexyl]-
1H,1H-pentafluoropropoxybenzene
20 4-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-
1H,1H-pentafluoropropoxybenzene
4-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]-
1H,1H-pentafluoropropoxybenzene
4-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-
25 1H,1H-pentafluoropropoxybenzene
4-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]-
1H,1H-pentafluoropropoxybenzene
4-[trans-4-(trans-4-octylcyclohexyl)cyclohexyl]-
1H,1H-pentafluoropropoxybenzene
- 30 4-[trans-4-(trans-4-ethylcyclohexyl)cyclohexyl]-
1H,1H-heptafluorobutoxybenzene
4-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-
1H,1H-heptafluorobutoxybenzene
4-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]-
35 1H,1H-heptafluorobutoxybenzene
4-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-

- 1H,1H-heptafluorobutoxybenzene
4-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]-
1H,1H-heptafluorobutoxybenzene
4-[trans-4-(trans-4-octylcyclohexyl)cyclohexyl]-
5 1H,1H-heptafluorobutoxybenzene

Example 7

4-Propyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl

A solution of 0.1 mol of the product from Example
7 [sic] and 0.2 mol of DDQ in 800 ml of toluene is boiled
10 for 2 hours. After cooling, the mixture is subjected to
customary work-up.

The following are prepared analogously:

- 4-ethyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-propyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
15 4-butyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-pentyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
m.p. 107°C
4-hexyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-heptyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
20 4-octyl-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-methoxy-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-ethoxy-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-propoxy-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-butoxy-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
25 4-pentoxo-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-heptoxo-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl
4-nonoxo-4'-1H,1H-trifluoroethoxy-1,1'-biphenyl

4-ethyl-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
4-propyl-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
30 4-butyl-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
4-pentyl-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
4-hexyl-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
4-heptyl-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
4-octyl-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
35 4-methoxy-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
4-ethoxy-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl

4-propoxy-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
 4-butoxy-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
 4-pentoxy-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
 4-heptoxy-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl
 5 4-nonoxy-4'-1H,1H-pentafluoropropoxy-1,1'-biphenyl

4-ethyl-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-propyl-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-butyl-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-pentyl-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 10 4-hexyl-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-heptyl-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-octyl-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-methoxy-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-ethoxy-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 15 4-propoxy-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-butoxy-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-pentoxy-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-heptoxy-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl
 4-nonoxy-4'-1H,1H-heptafluorobutoxy-1,1'-biphenyl

20 4-(trans-4-ethylcyclohexyl)-1H,1H-trifluoroethoxy-
 1,1'-biphenyl
 4-(trans-4-propylcyclohexyl)-1H,1H-trifluoroethoxy-
 1,1'-biphenyl
 4-(trans-4-butylcyclohexyl)-1H,1H-trifluoroethoxy-
 25 1,1'-biphenyl
 4-(trans-4-heptylcyclohexyl)-1H,1H-heptafluorobutoxy-
 1,1'-biphenyl
 4-(trans-4-octylcyclohexyl)-1H,1H-heptafluorobutoxy-
 1,1'-biphenyl

30 The following Example relates to a liquid-crystal-
 line phase according to the invention.

A liquid-crystalline phase comprising

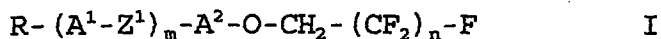
8 % of 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-
 4'-propyl-trans,trans-bicyclohexyl
 35 8 % of 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-

- 4'-pentyl-trans,trans-bicyclohexyl
- 8 % of 4-{2-[4-(1H,1H-trifluoroethoxy)phenyl]ethyl}-
4'-heptyl-trans,trans-bicyclohexyl
- 15 % of trans-1-p-methoxyphenyl-4-propylcyclohexane
- 5 15 % of trans-1-p-ethoxyphenyl-4-propylcyclohexane
- 14 % of trans-1-p-butoxyphenyl-4-propylcyclohexane
- 5 % of 4-{2-[4-methylphenyl]ethyl}-4'-propyl-trans,trans-
bicyclohexyl
- 5 % of 4-{2-[4-ethylphenyl]ethyl}-4'-propyl-trans,trans-
10 bicyclohexyl
- 5 % of 4-{2-[4-propylphenyl]ethyl}-4'-propyl-trans,trans-
bicyclohexyl
- 5 % of 4-{2-[4-pentylphenyl]ethyl}-4'-propyl-trans,trans-
bicyclohexyl
- 15 4 % of 4-(trans-4-propylcyclohexyl-2'-fluoro-4'-(trans-
4-propylcyclohexyl)biphenyl
- 4 % of 2-fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-
4-propylcyclohexyl)biphenyl
- and
- 20 4 % of 4-(trans-4-pentylcyclohexyl)-2'-fluoro-4'-(trans-
4-pentylcyclohexyl)biphenyl
- has a melting point of 11.9°C, a clearing point of 94°C and
a viscosity of 16 mm²/s at 20°C.



Patent Claims

1. Fluorinated alkoxy compounds of the formula I



in which

5 R is H or a straight-chain, unsubstituted alkyl or alkenyl radical having 1 to 15 carbon atoms, it also being possible for one or more CH_2 groups in these radicals, in each case independently of one another, to be replaced by -O-, -CO-,
10 -CO-O-, -O-CO- or -O-CO-O- in such a way that O atoms are not linked directly to one another,

A^1 and A^2 are each, independently of one another, a
(a) trans-1,4-cyclohexylene radical in which, in addition, one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S-,
15

(b) 1,4-phenylene radical in which, in addition, one or two CH groups may be replaced by N,

(c) radical from the group consisting of 1,4-cyclohexenylene, 1,4-bicyclo(2,2,2)octylene, piperidine-1,4-diyl, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl and 1,2,3,4-tetrahydronaphthalene-2,6-diyl,
20

where the radicals (a) and (b) may be substituted by CN or fluorine,

25 Z^1 are in each case, independently of one another, - CH_2O -, - OCH_2 -, - CH_2CH_2 -, - $CH=CH$ -, - $C\equiv C$ - or a single bond,

m is 1, 2 or 3, and

n is 1 to 16.



2. Fluorinated alkoxy compounds of the formula I according to Claim 1, in which A² is 1,4-phenylene which is monosubstituted or disubstituted by F.

3. Fluorinated alkoxy compounds of the formula I
5 according to Claim 2, in which A¹ is 1,4-phenylene which is monosubstituted or disubstituted by F.

4. Fluorinated alkoxy compounds according to Claim 1, which conform to the formulae

	R-Cyc-Z ¹ -Phe-Phe-X	Ied
10	R-Cyc-Z ¹ -Cyc-Z ¹ -Phe-X	Idd
	R-Cyc-Phe-Z ¹ -Phe-X	Ifm

in which R and Z¹ are as defined in Claim 1, Cyc is trans-1,4-cyclohexylene, Phe is 1,4-phenylene which is unsubstituted or monosubstituted or disubstituted by F, and X is
15 -O-CH₂-(CF₂)_n-F, where n = 1 - 16.

5. Fluorinated alkoxy compounds according to Claim 1, which conform to the formula

	R-A ¹ -CH ₂ CH ₂ -Phe-X	Ibd
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in which R and A¹ are as defined in Claim 1, Phe is
20 1,4-phenylene which is unsubstituted or monosubstituted or disubstituted by F, and X is -O-CH₂-(CF₂)_n-F, where n = 1 - 16.

6. Fluorinated alkoxy compounds according to Claim 1, which conform to the formulae

25	R-Phe-Phe-X	Iaa
	R-Phe-Cyc-X	Iab
	R-Dio-Phe-X	Iac
	R-Pyr-Phe-X	Iad
	R-Cyc-Phe-X	Iaf

30 in which R is as defined in Claim 1, Cyc is trans-1,4-cyclohexylene, Dio is 1,3-dioxane-2,5-diyl, Pyr is pyrimidine-2,5-diyl, Phe is 1,4-phenylene which is unsubstituted or monosubstituted or disubstituted by F, and X is -O-CH₂-(CF₂)_n-F, where n = 1 - 16.

35 7. Fluorinated alkoxy compounds according to at least one of Claims 1 - 6, in which n = 1 in the -O-CH₂-(CF₂)_n-F group.

8. Use of compounds of the formula I as components of liquid-crystalline phases.



9. Liquid-crystalline phase having at least two liquid-crystalline components, characterized in that it contains at least one compound of the formula I.
10. Liquid-crystal display element, characterized in
5 that it contains, as dielectric, a liquid-crystalline phase according to Claim 9.
11. Electro-optical display element, characterized in that it contains, as dielectric, a liquid-crystalline phase according to Claim 9.