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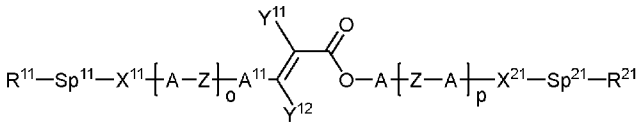
(54) Title: LIQUID CRYSTAL MIXTURE AND LIQUID CRYSTAL DISPLAY



I

(57) Abstract: The invention relates to a compound of formula I wherein R^{11}, R^{21}, A^{11}, A, Z, X^{11}, X^{21}, Y^{11}, Y^{12}, Sp^{11}, Sp^{21}, o and p have one of the meanings as given in claim 1. The invention further relates to method of production of a compound of formula I, to the use of said compounds in LC media and to LC media comprising one or more compounds of formula I. Further, the invention relates to a method of production of such LC media, to the use of such media in LC devices, and to LC device comprising a LC medium according to the present invention. The present invention further relates to a process for the fabrication such liquid crystal display and to the use of the liquid crystal mixtures according to the invention for the fabrication of such liquid crystal display.

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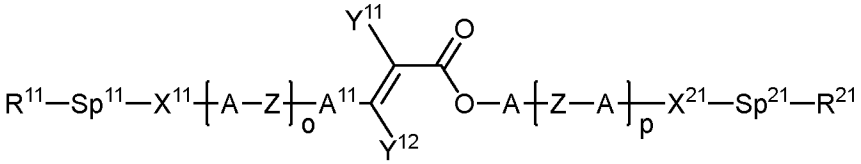
Liquid Crystal Mixture and Liquid Crystal Display

The invention relates to compounds of formula I,



I

wherein R^{11}, R^{21}, A^{11}, A, Z, X^{11}, X^{21}, Y^{11}, Y^{12}, Sp^{11}, Sp^{21}, o and p have one of the meanings as given in claim 1. The invention further relates to a method of production of said compounds, to the use of said compounds in LC media and to LC media comprising one or more compounds of formula I. Further, the invention relates to a method of production of such LC media, to the use of such media in LC devices, and to a LC device comprising a LC medium according to the present invention. The present invention further relates to a process for the fabrication such liquid crystal display and to the use of the liquid crystal mixtures according to the invention for the fabrication of such liquid crystal display.

Background and Prior Art

Liquid-crystalline media have been used for decades in electro-optical displays for information display. The liquid crystal displays used at present are usually those of the TN ("twisted nematic") type. However, these have the disadvantage of a strong viewing-angle dependence of the contrast.

In addition, so-called VA ("vertically aligned") displays are known which have a broader viewing angle. The LC cell of a VA display contains a layer of an LC medium between two transparent electrodes, where the LC medium usually has a negative value of the dielectric (DC) anisotropy. In the switched-off state, the molecules of the LC layer are aligned perpendicular to the electrode surfaces (homeotropically) or have a tilted homeotropic alignment. On application of an electrical voltage to the two

electrodes, a realignment of the LC molecules parallel to the electrode surfaces takes place. Furthermore, so-called IPS ("in plane switching") displays and later, FFS ("fringe-field switching") displays have been reported (see, inter alia, S.H. Jung et al., Jpn. J. Appl. Phys., Volume 43, No. 3, 2004, 1028), which contain two electrodes on the same substrate, one of which is structured in a comb-shaped manner and the other is unstructured. A strong, so-called "fringe field" is thereby generated, i.e. a strong electric field close to the edge of the electrodes, and, throughout the cell, an electric field which has both a strong vertical component and a strong horizontal component. FFS displays have a low viewing-angle dependence of the contrast. FFS displays usually contain an LC medium with positive dielectric anisotropy, and an alignment layer, usually of polyimide, which provides planar alignment to the molecules of the LC medium.

Furthermore, FFS displays have been disclosed (see S.H. Lee et al., Appl. Phys. Lett. 73(20), 1998, 2882-2883 and S.H. Lee et al., Liquid Crystals 39(9), 2012, 1141-1148), which have similar electrode design and layer thickness as FFS displays, but comprise a layer of an LC medium with negative dielectric anisotropy instead of an LC medium with positive dielectric anisotropy. The LC medium with negative dielectric anisotropy shows a more favorable director orientation that has less tilt and more twist orientation compared to the LC medium with positive dielectric anisotropy, as a result of which these displays have a higher transmission.

A further development are the so-called PS (polymer sustained) or PSA (polymer sustained alignment) displays, for which the term "polymer stabilised" is also occasionally used. The PSA displays are distinguished by the shortening of the response times without significant adverse effects on other parameters, such as, in particular, the favourable viewing-angle dependence of the contrast.

In these displays, a small amount (for example 0.3% by weight, typically < 1% by weight) of one or more polymerizable compound(s) is added to the LC medium and, after introduction into the LC cell, is polymerised or crosslinked *in situ*, usually by UV photopolymerization, between the electrodes with or without an applied electrical voltage. The addition of polymerizable mesogenic or liquid-crystalline compounds, also known as reactive mesogens or “RMs”, to the LC mixture has proven particularly suitable. PSA technology has hitherto been employed principally for LC media having negative dielectric anisotropy.

Unless indicated otherwise, the term "PSA" is used below as representative of PS displays and PSA displays.

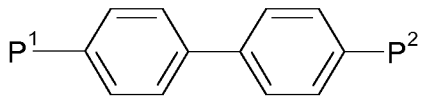
In the meantime, the PSA principle is being used in diverse classical LC displays. Thus, for example, PSA-VA, PSA-OCB, PSA-IPS, PSA-FFS and PSA-TN displays are known. The polymerisation of the polymerizable compound(s) preferably takes place with an applied electrical voltage in the case of PSA-VA and PSA-OCB displays, and with or without an applied electrical voltage in the case of PSA-IPS displays. As can be demonstrated in test cells, the PS(A) method results in a ‘pretilt’ in the cell. In the case of PSA-OCB displays, for example, it is possible for the bend structure to be stabilised so that an offset voltage is unnecessary or can be reduced. In the case of PSA-VA displays, the pretilt has a positive effect on the response times. A standard MVA or PVA pixel and electrode layout can be used for PSA-VA displays. In addition, however, it is also possible, for example, to manage with only one structured electrode side and no protrusions, which significantly simplifies production and at the same time results in very good contrast at the same time as very good light transmission.

PSA-VA displays are described, for example, in JP 10-036847 A, EP 1 170 626 A2, US 6,861,107, US 7,169,449, US 2004/0191428 A1,

US 2006/0066793 A1 and US 2006/0103804 A1. PSA-OCB displays are described, for example, in T.-J- Chen et al., Jpn. J. Appl. Phys. 45, 2006, 2702-2704 and S. H. Kim, L.-C- Chien, Jpn. J. Appl. Phys. 43, 2004, 7643-7647. PSA-IPS displays are described, for example, in US 6,177,972 and Appl. Phys. Lett. 1999, 75(21), 3264. PSA-TN displays are described, for example, in Optics Express 2004, 12(7), 1221. PSA-VA-IPS displays are disclosed, for example, in WO 2010/089092 A1.

Like the conventional LC displays described above, PSA displays can be operated as active-matrix or passive-matrix displays. In the case of active-matrix displays, individual pixels are usually addressed by integrated, non-linear active elements, such as, for example, transistors (for example thin-film transistors or "TFTs"), while in the case of passive-matrix displays, individual pixels are usually addressed by the multiplex method, both methods being known from the prior art.

In the prior art, polymerizable compounds of the following formula, for example, are used for PSA-VA:



in which P denotes a polymerizable group, usually an acrylate or methacrylate group, as described, for example, in US 7,169,449.

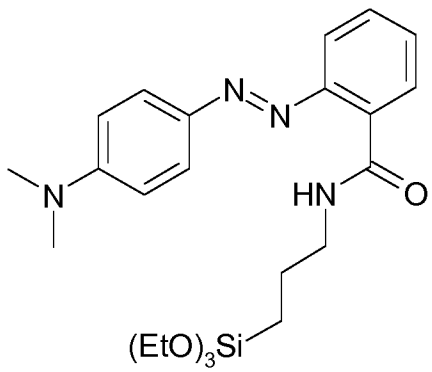
Below the polymer layer which induces the above mentioned pretilt, an orientation layer - usually a polyimide - provides the initial alignment of the liquid crystal regardless of the polymer stabilisation step of the production process.

The effort for the production of a polyimide layer, treatment of the layer and improvement with bumps or polymer layers is relatively great. A simplifying technology which on the one hand reduces production costs

and on the other hand helps to optimise the image quality (viewing-angle dependence, contrast, response times) would therefore be desirable. Rubbed polyimide has been used for a long time to align liquid crystals. The rubbing process causes a number of problems: mura, contamination, problems with static discharge, debris, etc.

Photoalignment is a technology for achieving liquid crystal (LC) alignment that avoids rubbing by replacing it with a light-induced orientational ordering of the alignment surface. This can be achieved through the mechanisms of photodecomposition, photodimerization, and photoisomerization (N.A. Clark et al. Langmuir **2010**, *26(22)*, 17482–17488, and literature cited therein) by means of polarised light. However, still a suitably derivatised polyimide layer is required that comprises the photoreactive group. A further improvement would be to avoid the use of polyimide at all. For VA displays this was achieved by adding a self-alignment agent to the LC that induces homeotropic alignment *in situ* by a self-assembling mechanism as disclosed in WO 2012/104008 and WO 2012/038026.

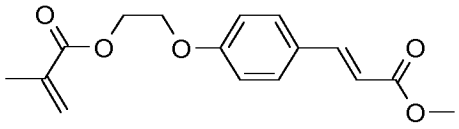
N.A. Clark et al. Langmuir **2010**, *26(22)*, 17482–17488 have shown that it is possible to self-assemble a compound of the following structure



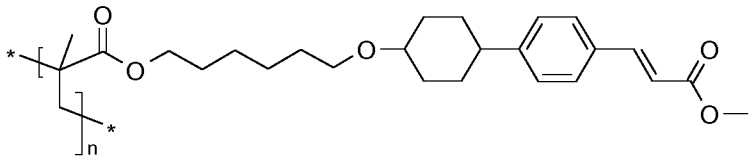
onto a substrate to give a monolayer that is able to be photoaligned to induce homogeneous alignment of a liquid crystal. However, a separate step of self-assembly before manufacture of the LC cell is required and

the nature of the azo-group causes reversibility of the alignment when exposed to light.

Another functional group known to enable photoalignment is the phenylethenylcarbonyloxy group (cinnamate). Photocrosslinkable cinnamates are known from the prior art, e.g. of the following structure

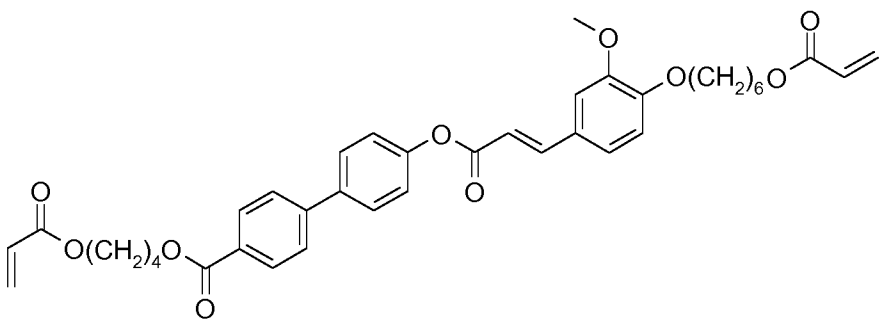


as disclosed in EP0763552. From such compounds, polymers can be obtained, for example the following

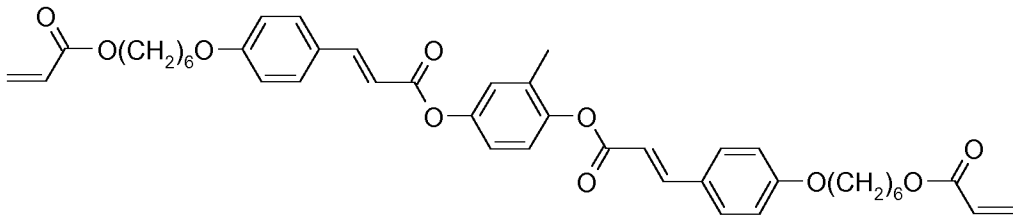


This material was used in a photoalignment process, as disclosed in WO 99/49360, to give an orientation layer for liquid crystals. A disadvantage of orientation layers obtained by this process is that they give lower voltage holding ratios (VHR) than polyimides.

In WO 00/05189 polymerizable direactive mesogenic cinnamates are disclosed for the use in polymerizable LC mixtures for e.g. optical retarders.

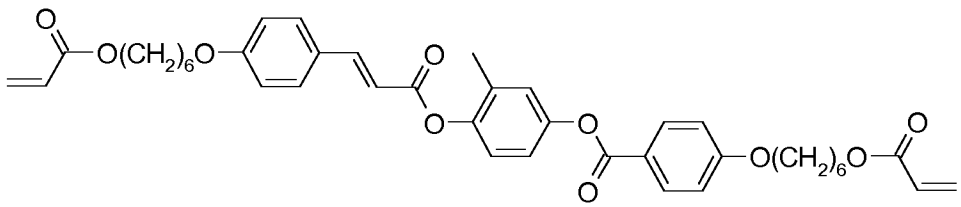


A structurally related compound of the following formula



comprising two cinnamic acid moieties is disclosed in GB 2 306 470 A for the use as component in liquid crystalline polymer films. This type of compound has not been used or proposed for the use as photoalignment agent.

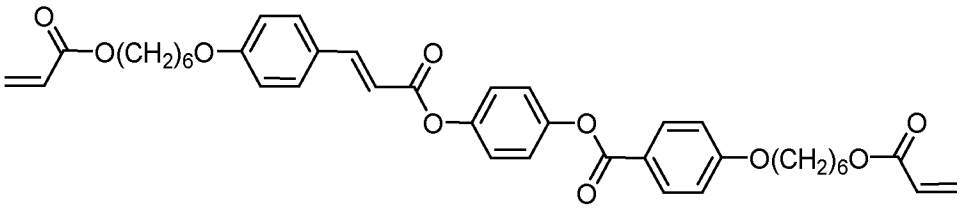
A very similar compound is published in B.M.I. van der Zande et al., Liquid Crystals, Vol. 33, No. 6, June 2006, 723–737, in the field of liquid crystalline polymers for patterned retarders, and has the following structure:



WO 2017/102068 A1 discloses the same structure for the purpose of a polyimide-free homogeneous photoalignment method.

Further, M.H. Lee et al. published in Liquid Crystals (https://doi.org/10.1080/02678292.2018.1441459) a polyimide-free homogeneous photoalignment method induced by polymerizable liquid

crystal containing cinnamate moiety of the following formula:



Thus, there is a great demand for new photoreactive mesogens that enable photoalignment of a liquid crystal mixture in *situ*, *i.e.* after assembly of the display, by means of linearly polarized light.

In addition to this requirement, the corresponding photoreactive mesogen should provide, preferably at the same time, a liquid crystal display having favourable high dark state and a favourable high voltage holding ratio. Furthermore, the amount of photoreactive mesogens in the nematic LC medium should be a low as possible and the process for the production should be obtainable from a process that is compatible with common mass production processes, e.g. in terms of favourable short processing times.

Other aims of the present invention are immediately evident to the person skilled in the art from the following detailed description.

Surprisingly, the inventors have found out that one or more of the above-mentioned aims can be achieved by providing a compound according to claim 1.

Terms and Definitions

A photoreactive group according to the present invention is a functional group of a molecule that causes a change of the geometry of the molecule either by bond rotation, skeletal rearrangement or atom- or group- transfer, or by dimerization, upon irradiation with light of a suitable wavelength that can be absorbed by the molecule.

The term "mesogenic group" as used herein is known to the person skilled in the art and described in the literature, and means a group which, due to the anisotropy of its attracting and repelling interactions, essentially contributes to causing a liquid-crystal (LC) phase in low-molecular-weight or polymeric substances. Compounds containing mesogenic groups (mesogenic compounds) do not necessarily have to have an LC phase themselves. It is also possible for mesogenic compounds to exhibit LC phase behaviour only after mixing with other compounds and/or after polymerisation. Typical mesogenic groups are, for example, rigid rod- or disc-shaped units. An overview of the terms and definitions used in connection with mesogenic or LC compounds is given in *Pure Appl. Chem.* 2001, 73(5), 888 and C. Tschierske, G. Pelzl, S. Diele, *Angew. Chem.* **2004**, 116, 6340-6368.

A photoreactive mesogen according to the present invention is a mesogenic compound comprising one or more photoreactive groups.

Examples of photoreactive groups are -C=C- double bonds and azo groups (-N=N-).

Examples of molecular structures and sub-structures comprising such photoreactive groups are stilbene, (1,2-difluoro-2-phenyl-vinyl)-benzene, cinnamate, 4-phenylbut-3-en-2-one, chalcone, coumarin, chromone, pentalenone and azobenzene.

According to the present application, the term "linearly polarised light" means light, which is at least partially linearly polarized. Preferably, the aligning light is linearly polarized with a degree of polarization of more than 5:1. Wavelengths, intensity and energy of the linearly polarised light are chosen depending on the photosensitivity of the photoalignable material. Typically, the wavelengths are in the UV-A, UV-B and/or UV-C range or in the visible range. Preferably, the linearly polarised light comprises light of wavelengths less than 450 nm, more preferably less than 420 nm at the same time the linearly polarised light preferably comprises light of wavelengths longer than 280nm, preferably more than 320nm, more preferably over 350nm.

The term "organic group" denotes a carbon or hydrocarbon group.

The term "carbon group" denotes a mono- or polyvalent organic group containing at least one carbon atom, where this either contains no further atoms (such as, for example, -C≡C-) or optionally contains one or more further atoms, such as, for example, N, O, S, P, Si, Se, As, Te or Ge (for example carbonyl, etc.). The term "hydrocarbon group" denotes a carbon group which additionally contains one or more H atoms and optionally one or more heteroatoms, such as, for example, N, O, S, P, Si, Se, As, Te or Ge.

"Halogen" denotes F, Cl, Br or I.

A carbon or hydrocarbon group can be a saturated or unsaturated group. Unsaturated groups are, for example, aryl, alkenyl or alkynyl groups. A carbon or hydrocarbon radical having 3 or more atoms can be straight-chain, branched and/or cyclic and may also contain spiro links or condensed rings.

The terms "alkyl", "aryl", "heteroaryl", etc., also encompass polyvalent groups, for example alkylene, arylene, heteroarylene, etc.

The term "aryl" denotes an aromatic carbon group or a group derived therefrom. The term "heteroaryl" denotes "aryl" as defined above, containing one or more heteroatoms.

Preferred carbon and hydrocarbon groups are optionally substituted alkyl, alkenyl, alkynyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy and alkoxycarbonyloxy having 1 to 40, preferably 1 to 25, particularly preferably 1 to 18, C atoms, optionally substituted aryl or aryloxy having 6 to 40, preferably 6 to 25, C atoms, or optionally substituted alkylaryl, arylalkyl, alkylaryloxy, arylalkyloxy, arylcarbonyl, aryloxycarbonyl, arylcarbonyloxy and aryloxycarbonyloxy having 6 to 40, preferably 6 to 25, C atoms.

Further preferred carbon and hydrocarbon groups are C_1-C_{40} alkyl, C_2-C_{40} alkenyl, C_2-C_{40} alkynyl, C_3-C_{40} allyl, C_4-C_{40} alkyldienyl, C_4-C_{40} polyenyl, C_6-C_{40} aryl, C_6-C_{40} alkylaryl, C_6-C_{40} arylalkyl, C_6-C_{40} alkylaryloxy, C_6-C_{40} arylalkyloxy, C_2-C_{40} heteroaryl, C_4-C_{40} cycloalkyl, C_4-C_{40} cycloalkenyl, etc. Particular preference is given to C_1-C_{22} alkyl, C_2-C_{22} alkenyl, C_2-C_{22} alkynyl, C_3-C_{22} allyl, C_4-C_{22} alkyldienyl, C_6-C_{12} aryl, C_6-C_{20} arylalkyl and C_2-C_{20} heteroaryl.

Further preferred carbon and hydrocarbon groups are straight-chain, branched or cyclic alkyl radicals having 1 to 40, preferably 1 to 25, C atoms, which are unsubstituted or mono- or polysubstituted by F, Cl, Br, I or CN and in which one more non-adjacent CH_2 groups may each be replaced, independently of one another, by $-C(R^z)=C(R^z)-$, $-C\equiv C-$, $-N(R^z)-$, -O-, -S-, -CO-, -CO-O-, -O-CO-, -O-CO-O- in such a way that O and/or S atoms are not linked directly to one another.

R^z preferably denotes H, halogen, a straight-chain, branched or cyclic alkyl chain having 1 to 25 C atoms, in which, in addition, one or more non-adjacent C atoms may be replaced by -O-, -S-, -CO-, -CO-O-, -O-CO- or -O-CO-O- and in which one or more H atoms may be replaced by fluorine, an optionally substituted aryl or aryloxy group having 6 to 40 C atoms, or an optionally substituted heteroaryl or heteroaryloxy group having 2 to 40 C atoms.

Preferred alkyl groups are, for example, methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, s-butyl, t-butyl, 2-methylbutyl, n-pentyl, s-pentyl, cyclopentyl, n-hexyl, cyclohexyl, 2-ethylhexyl, n-heptyl, cycloheptyl, n-octyl, cyclooctyl, n-nonyl, n-decyl, n-undecyl, n-dodecyl, trifluoromethyl, perfluoro-n-butyl, 2,2,2-trifluoroethyl, perfluorooctyl and perfluorohexyl.

Preferred alkenyl groups are, for example, ethenyl, propenyl, butenyl, pentenyl, cyclopentenyl, hexenyl, cyclohexenyl, heptenyl, cycloheptenyl, octenyl and cyclooctenyl.

Preferred alkynyl groups are, for example, ethynyl, propynyl, butynyl, pentynyl, hexynyl and octynyl.

Preferred alkoxy groups are, for example, methoxy, ethoxy, 2-methoxy-ethoxy, n-propoxy, i-propoxy, n-butoxy, i-butoxy, s-butoxy, t-butoxy, 2-methylbutoxy, n-pentoxy, n-hexoxy, n-heptoxy, n-octoxy, n-nonoxy, n-decoxy, n-undecoxy and n-dodecoxy.

Preferred amino groups are, for example, dimethylamino, methylamino, methylphenylamino and phenylamino.

Aryl and heteroaryl groups can be monocyclic or polycyclic, i.e. they can contain one ring (such as, for example, phenyl) or two or more rings, which may also be fused (such as, for example, naphthyl) or covalently

bonded (such as, for example, biphenyl), or contain a combination of fused and linked rings. Heteroaryl groups contain one or more heteroatoms, preferably selected from O, N, S and Se. A ring system of this type may also contain individual non-conjugated units, as is the case, for example, in the fluorene basic structure.

Particular preference is given to mono-, bi- or tricyclic aryl groups having 6 to 25 C atoms and mono-, bi- or tricyclic heteroaryl groups having 2 to 25 C atoms, which optionally contain fused rings and are optionally substituted. Preference is furthermore given to 5-, 6- or 7-membered aryl and heteroaryl groups, in which, in addition, one or more CH groups may be replaced by N, S or O in such a way that O atoms and/or S atoms are not linked directly to one another.

Preferred aryl groups are derived, for example, from the parent structures benzene, biphenyl, terphenyl, [1,1':3',1'']terphenyl, naphthalene, anthracene, binaphthyl, phenanthrene, pyrene, dihydropyrene, chrysene, perylene, tetracene, pentacene, benzopyrene, fluorene, indene, indenofluorene, spirobifluorene, etc.

Preferred heteroaryl groups are, for example, 5-membered rings, such as pyrrole, pyrazole, imidazole, 1,2,3-triazole, 1,2,4-triazole, tetrazole, furan, thiophene, selenophene, oxazole, isoxazole, 1,2-thiazole, 1,3-thiazole, 1,2,3-oxadiazole, 1,2,4-oxadiazole, 1,2,5-oxadiazole, 1,3,4-oxadiazole, 1,2,3-thiadiazole, 1,2,4-thiadiazole, 1,2,5-thiadiazole, 1,3,4-thiadiazole, 6-membered rings, such as pyridine, pyridazine, pyrimidine, pyrazine, 1,3,5-triazine, 1,2,4-triazine, 1,2,3-triazine, 1,2,4,5-tetrazine, 1,2,3,4-tetrazine, 1,2,3,5-tetrazine, or condensed groups, such as indole, isoindole, indolizine, indazole, benzimidazole, benzotriazole, purine, naphthimidazole, phenanthrimidazole, pyridimidazole, pyrazinimidazole, quinoxalinimidazole, benzoxazole, naphthoxazole, anthroxazole, phenanthroxazole, isoxazole, benzothiazole, benzofuran, isobenzofuran, dibenzofuran,

quinoline, isoquinoline, pteridine, benzo-5,6-quinoline, benzo-6,7-quinoline, benzo-7,8-quinoline, benzoisoquinoline, acridine, phenothiazine, phenoxazine, benzopyridazine, benzopyrimidine, quinoxaline, phenazine, naphthyridine, azacarbazole, benzocarboline, phenanthridine, phenanthroline, thieno[2,3b]thiophene, thieno[3,2b]thiophene, dithienothiophene, dihydrothieno [3,4-b]-1,4-dioxin, isobenzothiophene, dibenzothiophene, benzothiadiazothiophene, or combinations of these groups. The heteroaryl groups may also be substituted by alkyl, alkoxy, thioalkyl, fluorine, fluoroalkyl or further aryl or heteroaryl groups.

The (non-aromatic) alicyclic and heterocyclic groups encompass both saturated rings, i.e. those containing exclusively single bonds, and also partially unsaturated rings, i.e. those which may also contain multiple bonds. Heterocyclic rings contain one or more heteroatoms, preferably selected from Si, O, N, S and Se.

The (non-aromatic) alicyclic and heterocyclic groups can be monocyclic, i.e. contain only one ring (such as, for example, cyclohexane), or polycyclic, i.e. contain a plurality of rings (such as, for example, decahydronaphthalene or bicyclooctane). Particular preference is given to saturated groups. Preference is furthermore given to mono-, bi- or tricyclic groups having 3 to 25 C atoms, which optionally contain fused rings and are optionally substituted. Preference is furthermore given to 5-, 6-, 7- or 8-membered carbocyclic groups, in which, in addition, one or more C atoms may be replaced by Si and/or one or more CH groups may be replaced by N and/or one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S-.

Preferred alicyclic and heterocyclic groups are, for example, 5-membered groups, such as cyclopentane, tetrahydrofuran, tetrahydrothiofuran, pyrrolidine, 6-membered groups, such as cyclohexane, silinane,

cyclohexene, tetrahydropyran, tetrahydrothiopyran, 1,3-dioxane, 1,3-dithiane, piperidine, 7-membered groups, such as cycloheptane, and fused groups, such as tetrahydronaphthalene, decahydronaphthalene, indane, bicyclo[1.1.1]pentane-1,3-diyl, bicyclo[2.2.2]octane-1,4-diyl, spiro[3.3]heptane-2,6-diyl, octahydro-4,7-methanoindane-2,5-diyl.

The aryl, heteroaryl, carbon and hydrocarbon radicals optionally have one or more substituents, which are preferably selected from the group comprising silyl, sulfo, sulfonyl, formyl, amine, imine, nitrile, mercapto, nitro, halogen, C_{1-12} alkyl, C_{6-12} aryl, C_{1-12} alkoxy, hydroxyl, or combinations of these groups.

Preferred substituents are, for example, solubility-promoting groups, such as alkyl or alkoxy, and electron-withdrawing groups, such as fluorine, nitro or nitrile.

Preferred substituents, unless stated otherwise, also referred to as "L" above and below, are F, Cl, Br, I, -CN, $-NO_2$, -NCO, -NCS, -OCN, -SCN, $-C(=O)N(R^z)_2$, $-C(=O)Y^1$, $-C(=O)R^z$, $-N(R^z)_2$, in which R^z has the meaning indicated above, and Y^1 denotes halogen, optionally substituted silyl or aryl having 6 to 40, preferably 6 to 20, C atoms, and straight-chain or branched alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 25 C atoms, preferably 2 to 12, in which one or more H atoms may optionally be replaced by F or Cl.

"Substituted silyl or aryl" preferably means substituted by halogen, -CN, R^{y1}, $-OR^{y1}$, $-CO-R^{y1}$, $-CO-O-R^{y1}$, $-O-CO-R^{y1}$ or $-O-CO-O-R^{y1}$, in which R^{y1} has the meaning indicated above.

Particularly preferred substituents L are, for example, F, Cl, CN, CH_3, C_2H_5, $-CH(CH_3)_2$, OCH_3, OC_2H_5, CF_3, OCF_3, $OCHF_2$, OC_2F_5, furthermore phenyl.

Above and below "halogen" denotes F, Cl, Br or I.

Above and below, the terms "alkyl", "aryl", "heteroaryl", etc., also encompass polyvalent groups, for example alkylene, arylene, heteroarylene, etc.

The term "director" is known in prior art and means the preferred orientation direction of the long molecular axes (in case of calamitic compounds) or short molecular axes (in case of discotic compounds) of the liquid-crystalline molecules. In case of uniaxial ordering of such anisotropic molecules, the director is the axis of anisotropy.

The term “alignment” or “orientation” relates to alignment (orientation ordering) of anisotropic units of material such as small molecules or fragments of big molecules in a common direction named “alignment direction”. In an aligned layer of liquid-crystalline material, the liquid-crystalline director coincides with the alignment direction so that the alignment direction corresponds to the direction of the anisotropy axis of the material.

The term "planar orientation/alignment", for example in a layer of an liquid-crystalline material, means that the long molecular axes (in case of calamitic compounds) or the short molecular axes (in case of discotic compounds) of a proportion of the liquid-crystalline molecules are oriented substantially parallel (about 180°) to the plane of the layer.

The term "homeotropic orientation/alignment", for example in a layer of a liquid-crystalline material, means that the long molecular axes (in case of calamitic compounds) or the short molecular axes (in case of discotic compounds) of a proportion of the liquid-crystalline molecules are oriented

at an angle θ ("tilt angle") between about 80° to 90° relative to the plane of the layer.

The terms "uniform orientation" or "uniform alignment" of an liquid-crystalline material, for example in a layer of the material, mean that the long molecular axes (in case of calamitic compounds) or the short molecular axes (in case of discotic compounds) of the liquid-crystalline molecules are oriented substantially in the same direction. In other words, the lines of liquid-crystalline director are parallel.
The wavelength of light generally referred to in this application is 550 nm, unless explicitly specified otherwise.

The birefringence Δn herein is defined by the following equation

$$\Delta n = n_e - n_o$$

wherein n_e is the extraordinary refractive index and n_o is the ordinary refractive index and the effective average refractive index $n_{av.}$ is given by the following equation

$$n_{av.} = [(2\, n_o^2 + n_e^2)/3]^{1/2}$$

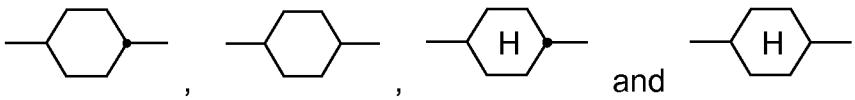
The extraordinary refractive index n_e and the ordinary refractive index n_o can be measured using an Abbe refractometer.

In the present application the term “dielectrically positive” is used for compounds or components with $\Delta\varepsilon > 3.0$, “dielectrically neutral” with $-1.5 \leq \Delta\varepsilon \leq 3.0$ and “dielectrically negative” with $\Delta\varepsilon < -1.5$. $\Delta\varepsilon$ is determined at a frequency of 1 kHz and at 20°C. The dielectric anisotropy of the respective compound is determined from the results of a solution of 10 % of the respective individual compound in a nematic host mixture. In case

the solubility of the respective compound in the host medium is less than 10 % its concentration is reduced by a factor of 2 until the resultant medium is stable enough at least to allow the determination of its properties. Preferably, the concentration is kept at least at 5 %, however, to keep the significance of the results as high as possible. The capacitance of the test mixtures are determined both in a cell with homeotropic and with homogeneous alignment. The cell gap of both types of cells is approximately 20 µm. The voltage applied is a rectangular wave with a frequency of 1 kHz and a root mean square value typically of 0.5 V to 1.0 V; however, it is always selected to be below the capacitive threshold of the respective test mixture.

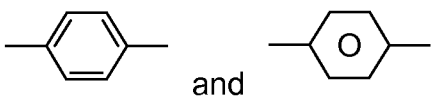
$\Delta\varepsilon$ is defined as ($\varepsilon_{||}$ - $\varepsilon_{\perp}$), whereas $\varepsilon_{av.}$ is ($\varepsilon_{||}$ + 2 $\varepsilon_{\perp}$) / 3. The dielectric permittivity of the compounds is determined from the change of the respective values of a host medium upon addition of the compounds of interest. The values are extrapolated to a concentration of the compounds of interest of 100 %. A typical host medium is ZLI-4792 or ZLI-2857 both commercially available from Merck, Darmstadt.

For the present invention,



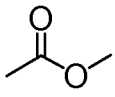
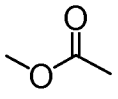
and

denote trans-1,4-cyclohexylene,



and

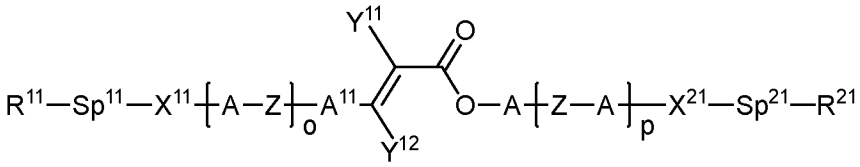
denote 1,4-phenylene.

For the present invention the groups -CO-O-, -COO- -C(=O)O- or -CO_2- denote an ester group of formula  , and the groups -O-CO- -OCO-, -OC(=O)-, -O_2C- or -OOC- denote an ester group of formula  .

Furthermore, the definitions as given in C. Tschierske, G. Pelzl and S. Diele, Angew. Chem. 2004, 116, 6340-6368 shall apply to non-defined terms related to liquid crystal materials in the instant application.

Detailed description

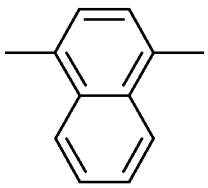
In detail, the present invention relates to photoreactive mesogens of formula I



I

wherein

A^{11} denotes a radical



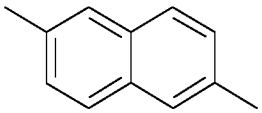
,

where, in addition, one or more H atoms in these radical may be replaced by L, and/or one or more and/or one or more CH groups may be replaced by N,

A denotes, independently of one another, in each occurrence

a) the group consisting of 1,4-phenylene and 1,3-phenylene, wherein, in addition, one or two CH groups may be replaced by N and wherein, in addition, one or more H atoms may be replaced by L,

b) the group consisting of saturated, partially unsaturated or fully unsaturated, and optionally substituted, polycyclic radicals having 5 to 20 cyclic C atoms, one or more of which may, in addition, be replaced by heteroatoms, preferably selected from the group consisting of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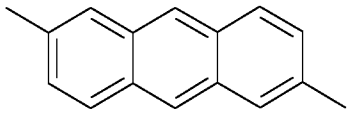
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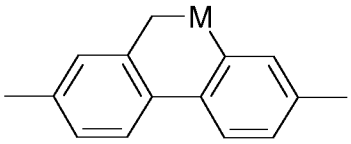

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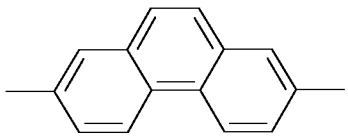
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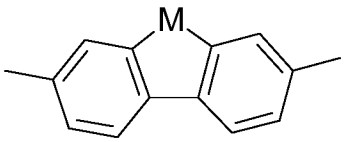

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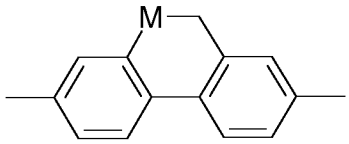

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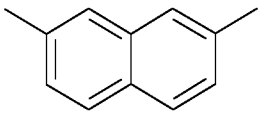
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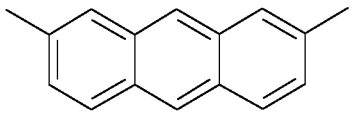
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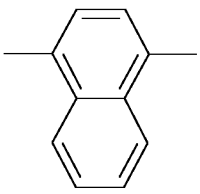
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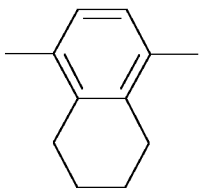
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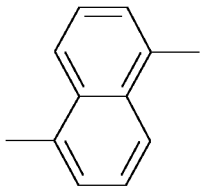


,

where, in addition, one or more H atoms in these radicals may be replaced by L, and/or one or more double bonds may be replaced by single bonds, and/or one or more CH groups may be replaced by N,

c) group consisting of trans-1,4-cyclohexylene, 1,4-cyclohexenylene, wherein, in addition, one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S- and wherein, in addition, one or more H atoms may be replaced by F, or

d) a group consisting of tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl, tetrahydrofuran-2,5-diyl, cyclobutane-1,3-diyl, piperidine-1,4-diyl, thiophene-2,5-diyl and selenophene-2,5-diyl,
each of which may also be mono- or polysubstituted by L,

L on each occurrence, identically or differently, denotes -OH, -F, -Cl, -Br, -I, -CN, $-NO_2$, SF_5, -NCO, -NCS, -OCN, -SCN, $-C(=O)N(R^z)_2$, $-C(=O)R^z$, $-N(R^z)_2$, optionally substituted silyl, optionally substituted aryl having 6 to 20 C atoms, or straight-chain or branched or cyclic alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 25 C atoms, preferably 1 to 12 C atoms, more preferably 1 to

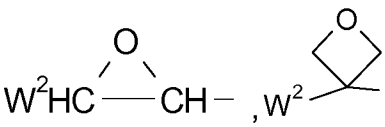
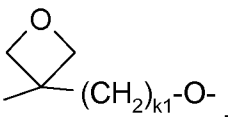
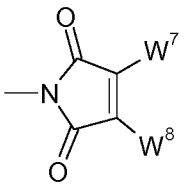
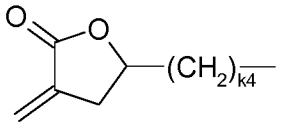
	6 C atoms, in which, in addition, one or more H atoms may be replaced by F or Cl, or X^{21}-Sp^{21}-R^{21},
M	denotes -O-, -S-, -CH_2-, -CHR^z- or -CR^yR^z-, and
R^y and R^z	each, independently of one another, denote H, CN, F or alkyl having 1-12 C atoms, wherein, in addition, one or more H atoms may be replaced by F, preferably H, methyl, ethyl, propyl, butyl, more preferably H or methyl, in particular H,
Y^{11} and Y^{12}	each, independently of one another, denote H, F, phenyl or optionally fluorinated alkyl having 1-12 C atoms, preferably H, methyl, ethyl, propyl, butyl, more preferably H or methyl, in particular H,
Z	denotes, independently of each other, in each occurrence, a single bond, -COO-, -OCO-, -O-CO-O-, -OCH_2-, -CH_2O-, -OCF_2-, -CF_2O-, -$(CH_2)_n$-, -CF_2CF_2-, -CH=CH-, -CF=CF-, -CH=CH-COO-, -OCO-CH=CH-, -CO-S-, -S-CO-, -CS-S-, -S-CS-, -S-CSS- or -C≡C-, preferably a single bond, -COO-,-OCO-, -OCF_2-, -CF_2O-, or -$(CH_2)_n$-, more preferably a single bond, -COO-,or -OCO-,
n	denotes an integer between 2 and 8, preferably 2,
o and p	denotes each and independently 0, 1 or 2, preferably 1,

	X^{11} and X^{21}	denote independently from one another, in each occurrence a single bond, -CO-O-, -O-CO-, -O-COO-, -O-, -CH=CH-, -C≡C-, $-CF_2-O-$, $-O-CF_2-$, $-CF_2-CF_2-$, $-CH_2-O-$, $-O-CH_2-$, -CO-S-, -S-CO-, -CS-S-, -S-CS-, -S-CSS- or -S-, preferably, a single bond, -CO-O-, -O-CO-, -O-COO-, or -O-, more preferably a single bond or -O-,
	Sp^{11} and Sp^{21}	denote each and independently, in each occurrence a single bond or a spacer group comprising 1 to 20 C atoms, wherein one or more non-adjacent and non-terminal CH_2 groups may also be replaced by -O-, -S-, -NH-, $-N(CH_3)-$, -CO-, -O-CO-, -S-CO-, -O-COO-, -CO-S-, -CO-O-, $-CF_2-$, $-CF_2O-$, $-OCF_2-$ -C(OH)-, -CH(alkyl)-, -CH(alkenyl)-,-CH(alkoxyl)-, -CH(oxaalkyl)-, -CH=CH- or -C≡C-, however in such a way that no two O-atoms are adjacent to one another and no two groups selected from -O-CO-, -S-CO-, -O-COO-, -CO-S-, -CO-O- and -CH=CH- are adjacent to each other, preferably alkylene having 1 to 20, preferably 1 to 12, C atoms, which is optionally mono- or polysubstituted by F, Cl, Br, I or CN, more preferably straight-chain ethylene, propylene, butylene, pentylene, hexylene, heptylene, octylene, nonylene, decylene, undecylene, dodecylene,
	R^{11}	denotes P,

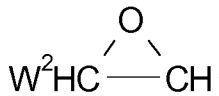
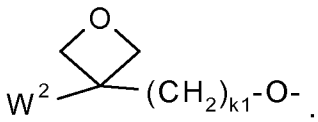
R^{21}	denotes P, or halogen, CN, optionally fluorinated alkyl or alkenyl with up to 15 C atoms in which one or more non- adjacent CH_2-groups may be replaced by -O-, -S-, -CO-, -C(O)O-, -O-C(O)-, O-C(O)-O-, preferably P,
P	each and independently from another in each occurrence a polymerizable group.

The polymerizable groups P are groups that are suitable for a polymerisation reaction, such as, for example, free-radical or ionic chain polymerisation, polyaddition or polycondensation, or for a polymer-analogous reaction, for example addition or condensation onto a main polymer chain. Particular preference is given to groups for chain polymerisation, in particular those containing a C=C double bond or -C≡C- triple bond, and groups which are suitable for polymerisation with ring opening, such as, for example, oxetane or epoxide groups.

Preferred groups P are selected from the group consisting of

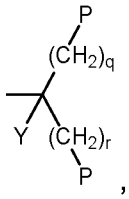
$CH_2=CW^1-CO-O-$, $CH_2=CW^1-CO-$,  ,  ,  ,  , $CH_2=CW^2-(O)_{k3}-$, $CW^1=CH-CO-(O)_{k3}-$, $CW^1=CH-CO-NH-$, $CH_2=CW^1-CO-NH-$, $CH_3-CH=CH-O-$, $(CH_2=CH)_2CH-OCO-$, $(CH_2=CH-CH_2)_2CH-OCO-$, $(CH_2=CH)_2CH-O-$, $(CH_2=CH-CH_2)_2N-$, $(CH_2=CH-CH_2)_2N-CO-$, $HO-CW^2W^3-$, $HS-CW^2W^3-$, HW^2N-, $HO-CW^2W^3-NH-$, $CH_2=CW^1-CO-NH-$, $CH_2=CH-(COO)_{k1}-Phe-(O)_{k2}-$, $CH_2=CH-(CO)_{k1}-Phe-(O)_{k2}-$, Phe-CH=CH-, HOOC-, OCN- and $W^4W^5W^6Si-$, wherein W^1 denotes H, F, Cl, CN, CF_3,

phenyl or alkyl having 1 to 5 C atoms, in particular H, F, Cl or CH_3, W^2 and W^3 each, independently of one another, denote H or alkyl having 1 to 5 C atoms, in particular H, methyl, ethyl or n-propyl, W^4, W^5 and W^6 each, independently of one another, denote Cl, oxaalkyl or oxacarbonylalkyl having 1 to 5 C atoms, W^7 and W^8 each, independently of one another, denote H, Cl or alkyl having 1 to 5 C atoms, Phe denotes 1,4-phenylene, which is optionally substituted by one or more radicals L as defined above which are other than P-Sp-, k_1, k_2 and k_3 each, independently of one another, denote 0 or 1, k_3 preferably denotes 1, and k_4 denotes an integer from 1 to 10.

Particularly preferred groups P and $P^{a,b}$ are selected from the group consisting of $CH_2=CW^1$-CO-O-, in particular CH_2=CH-CO-O-, $CH_2=C(CH_3)$-CO-O- and CH_2=CF-CO-O-, furthermore CH_2=CH-O-, $(CH_2=CH)_2$CH-O-CO-, $(CH_2=CH)_2$CH-O-,  and  .

Very particularly preferred groups P and $P^{a,b}$ are selected from the group consisting of acrylate, methacrylate, fluoroacrylate, furthermore vinyloxy, chloroacrylate, oxetane and epoxide groups, and of these preferably an acrylate or methacrylate group.

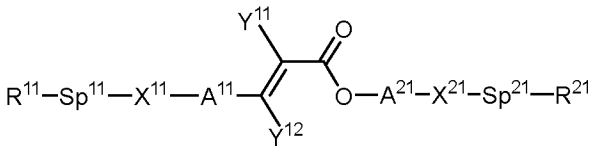
In another preferred embodiment, the polymerizable group P denotes the radical

 ,

wherein

Y	denotes H, F, phenyl or optionally fluorinated alkyl having 1-12 C atoms, preferably H, methyl, ethyl, propyl, butyl, more preferably H or methyl, in particular H,	
q and r	denotes each and independently an integer from 0 to 8, preferably $q+r \geq 1$ and ≤ 16, more preferably q and r each and independently denotes an integer from1 to 8, and	
P	denotes acrylate or methacrylate,	

The compounds of formula I are preferably selected from compounds of the sub-formulae I-1 to I-9.



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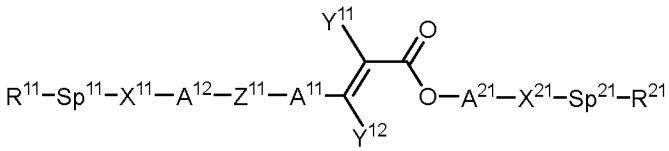
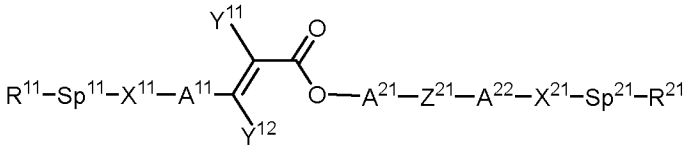
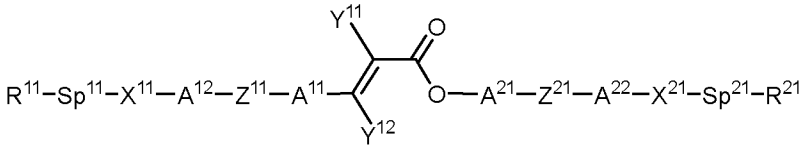


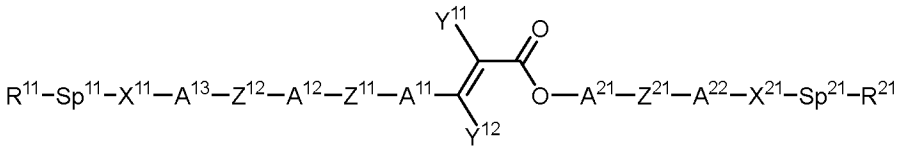
I-2



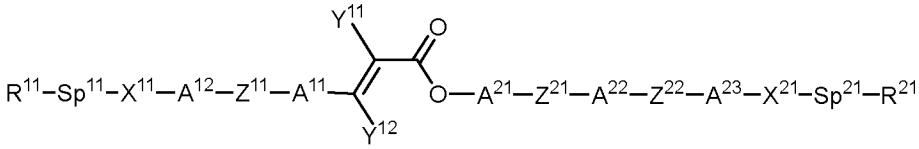
I-3



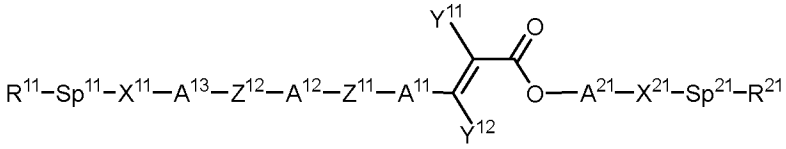
I-4



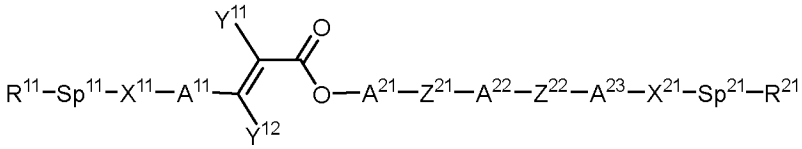
I-5



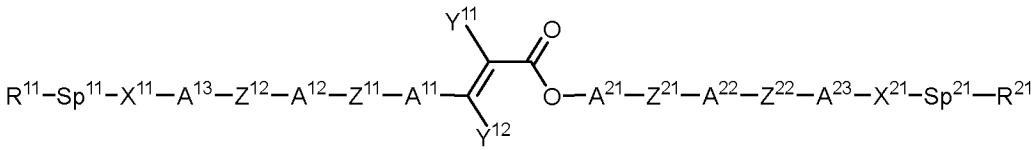
I-6



I-7



I-8

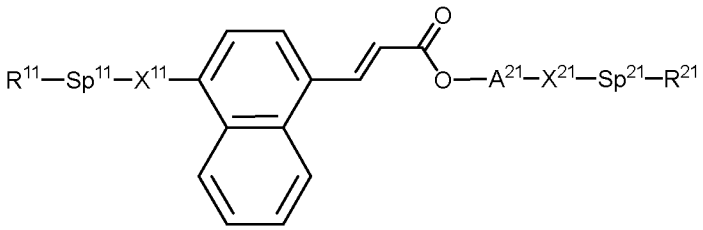


I-9

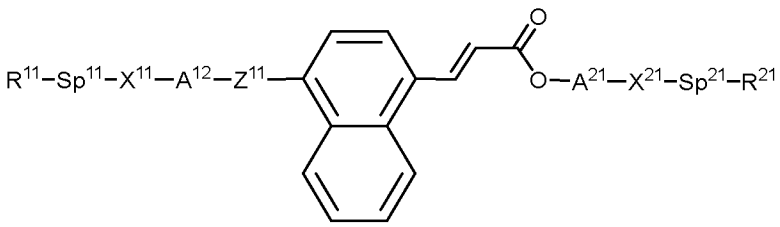
wherein R^{11}, R^{21}, A^{11}, X^{11}, X^{12}, Y^{11}, Y^{12}, Sp^{11}, and Sp^{12} have one of the meanings as given above in formula I, A^{12} to A^{23} have one of the meanings for A, and Z^{11} to Z^{22} have one of the meanings for Z as given above under formula I.

Further preferred compounds of formula I are selected from the compounds of formulae I-1 to I-3.

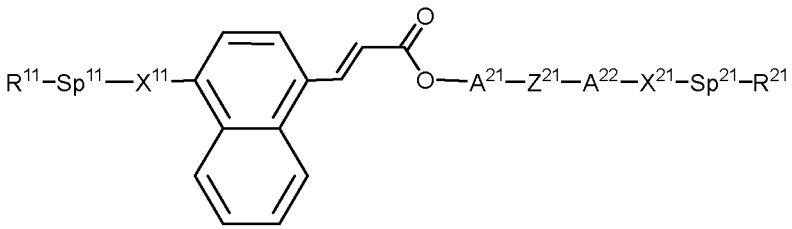
Preferred compounds of formula I-1 to I-3 are selected from compounds of formulae I-1a to I-3a:



I-1a



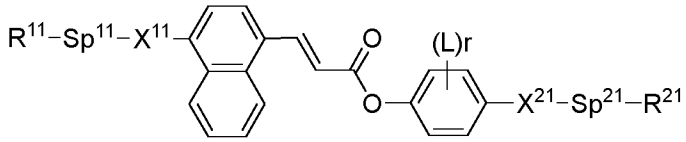
I-2a



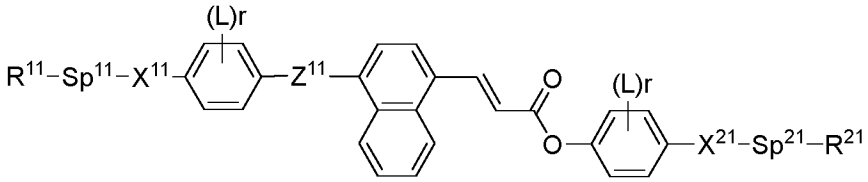
I-3a

wherein R^{11}, R^{21}, X^{11}, X^{21}, Sp^{11} and Sp^{21} have one of the meanings as given above in formula I, Z^{11} and Z^{21} have one of the meanings for Z as given above under formula I, and A^{12}, A^{21} and A^{22} have one of the meanings for A, preferably A^{12}, A^{21} and A^{22} denote each and independently a group consisting of 1,4-phenylene wherein one or two CH groups may be replaced by N and wherein, in addition, one or more H atoms may be replaced by L as given above under formula I, or a group consisting of trans-1,4-cyclohexylene, 1,4-cyclohexenylene, wherein, in addition, one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S- and wherein, in addition, one or more H atoms may be replaced by F.

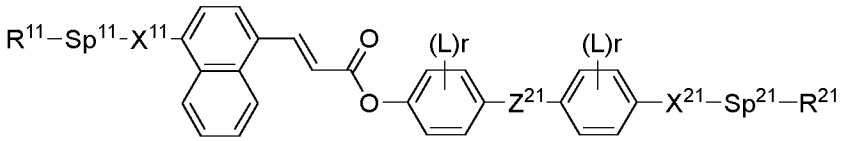
Further preferred compounds of formula I are compounds of the following sub-formula:



I-1a-1

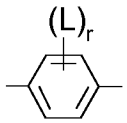


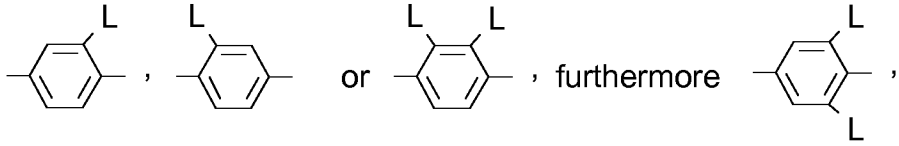
I-2a-1

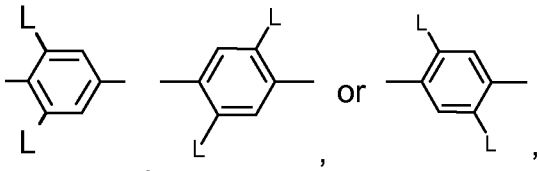


I-3a-1

R^{11}, R^{21}, X^{11}, X^{21}, Sp^{11} and Sp^{21} have one of the meanings as given above in formula I, Z^{11} and Z^{21} have one of the meanings for Z as given above under formula I. In the above given preferred subformulae,

the group  is each and independently  or

denotes 



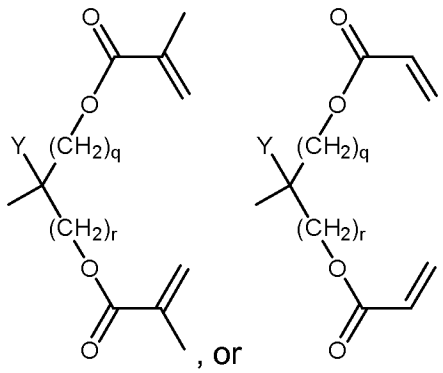
wherein L is preferably F, Cl, CH_3, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, such as methyl, ethyl, propyl, butyl, pentyl, hexyl, cyclopropyl, cylobutyl, cyclopentyl, cyclohexyl, or X^{21}-Sp^{21}-R^{21}.

Further preferred compounds of formulae I-2a-1 are those wherein Z^{11} denotes a single bond.

Further preferred compounds of formulae I-1a-1 to I-3a-1 are those wherein X^{11} and X^{21} denote each and independently a single bond, -O-, -CO-O- or -O-CO-, more preferably -O- or a single bond.

Further preferred compounds of formula I-1a-1 to I-3a-1 are those wherein Sp^{11} and Sp^{21} denote each and independently a single bond or $-(CH_2)_n-$ wherein n is an integer between 1 and 8, more preferably 2 and 6.

Further preferred compounds of formulae I-1a-1 to I-3a-1 are those wherein R^{11} and R^{21} denote each and independently acrylate, methacrylate or a group

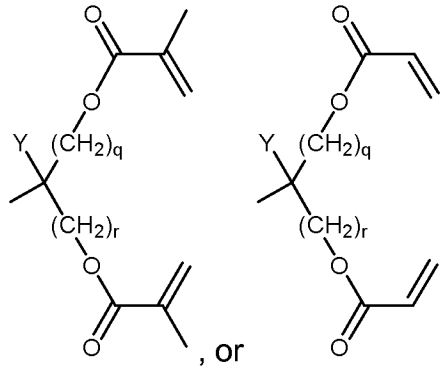


, or

wherein

Y	denotes H, F, phenyl or optionally fluorinated alkyl having 1-12 C atoms, preferably H, methyl, ethyl, propyl, butyl, more preferably H or methyl, in particular H,
q and r	denotes each and independently an integer from 0 to 8, preferably $q+r \geq 1$ and ≤ 16, more preferably q and r each and independently denotes an integer from1 to 8.

Further preferred compounds of formulae I-1a-1 to I-3a-1 are those wherein R^{11} denotes a group



, or

wherein

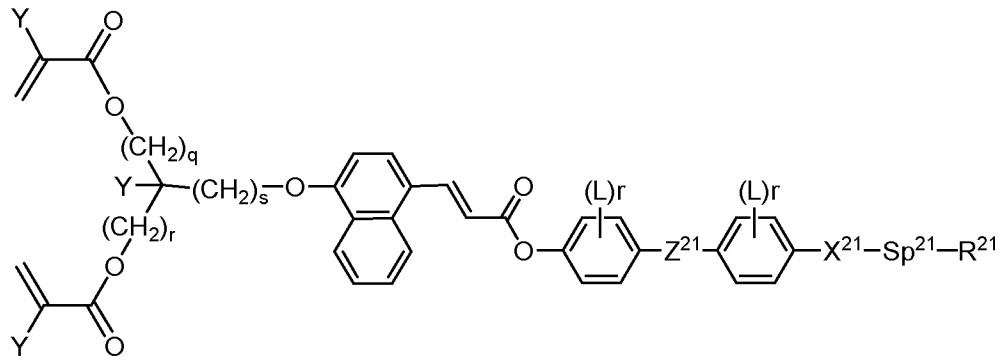
Y denotes H or methyl, in particular H,

q and r denotes each and independently an integer from1 to 8, preferably 1 or 2, and

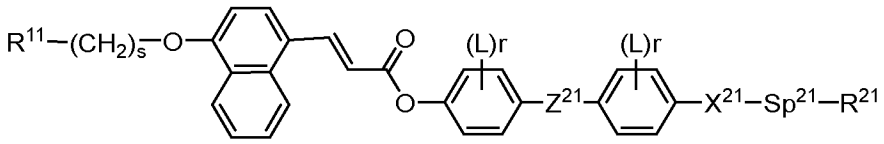
wherein R^{11} denotes acrylate or methacrylate.

Further preferred compounds of formulae I-I-1a-1 to I-3a-1 are those wherein both groups R^{11} and R^{21} denote acrylate or methacrylate.

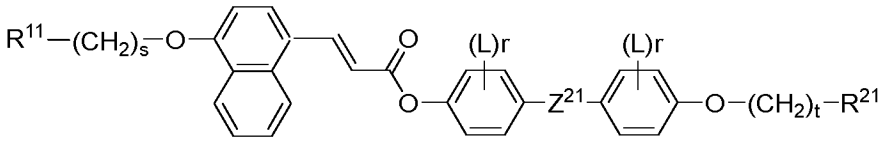
Preferred compounds of formulae I-3a-1 are compounds of the following sub-formulae:



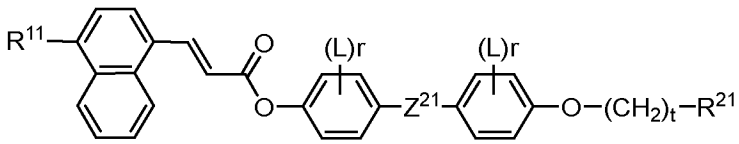
I-3a-1a



I-3a-1b

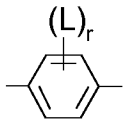
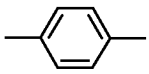


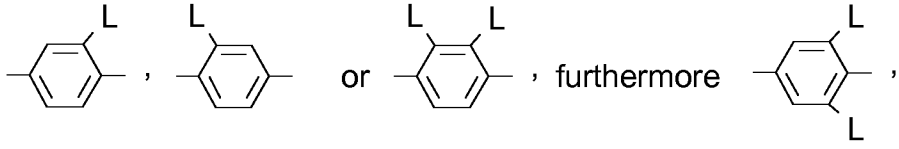
I-3a-1c

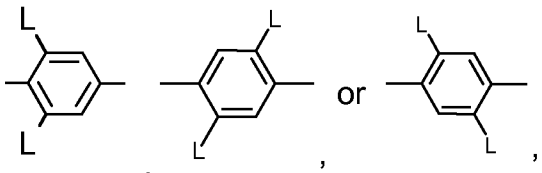


I-3a-1d

R^{11}, R^{21}, X^{21}, and Sp^{21} have one of the meanings as given above in formula I, Z^{21} has one of the meanings for Z as given above under formula I, r, s, t and q denote each and independently from another an integer from 1 to 8, Y denotes each and independently from each other methyl or H, and

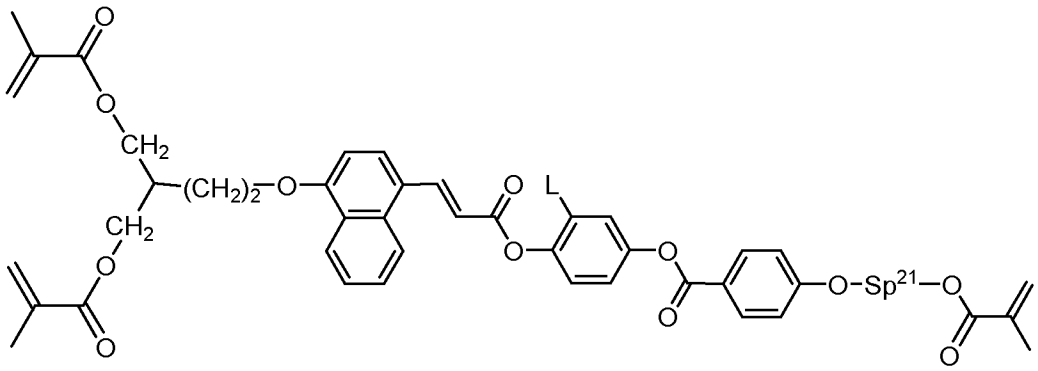
the group  is each and independently  or

denotes 

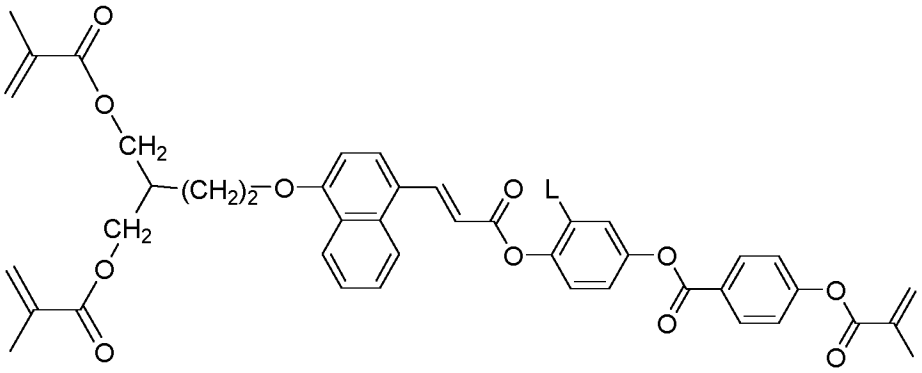


wherein L is preferably F, Cl, CH_3, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, such as methyl, ethyl, propyl, butyl, pentyl, hexyl, cyclopropyl, cylobutyl, cyclopentyl, cyclohexyl, or X^{21}-Sp^{21}-R^{21}.

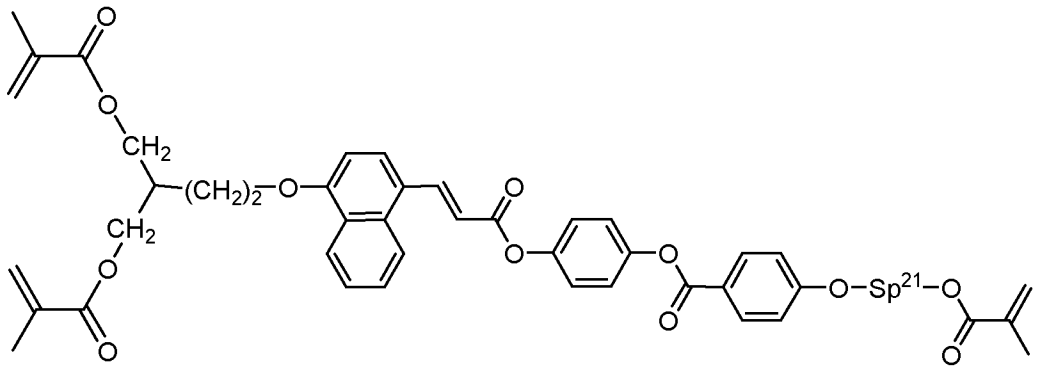
Further preferred compounds of formulae I-3a-1a are compounds of the following sub-formulae:



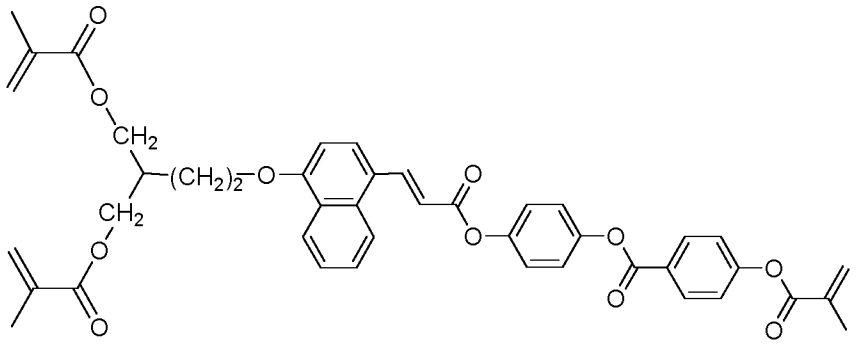
I-3a-1a-1



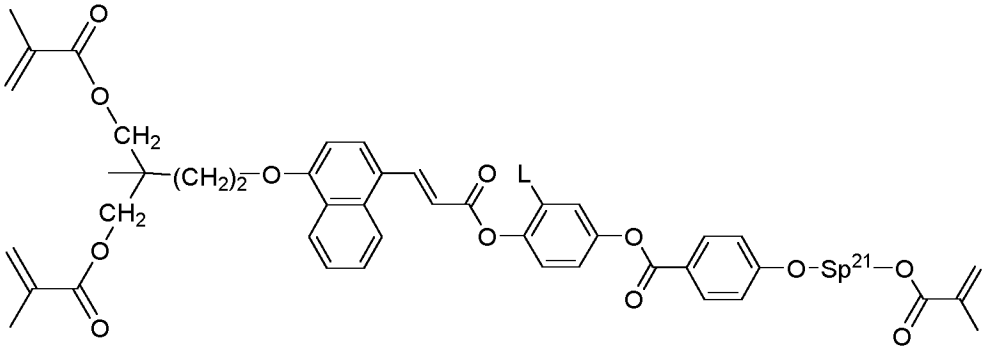
I-3a-1a-2



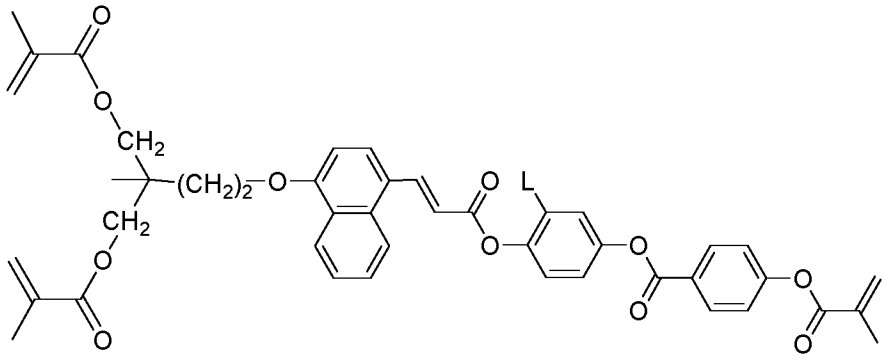
I-3a-1a-3



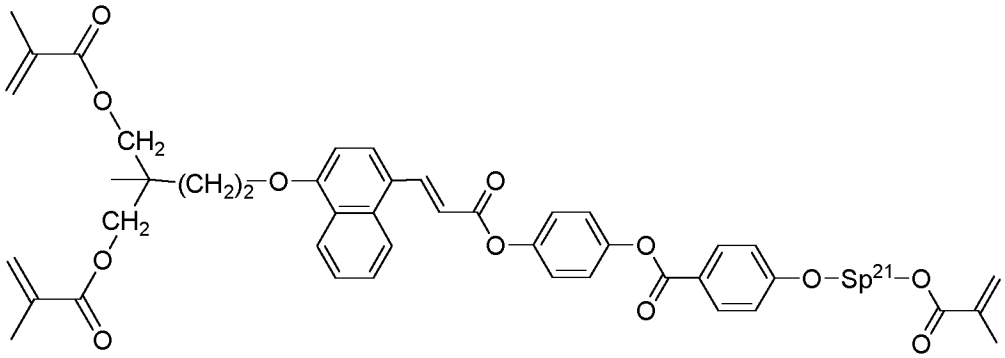
I-3a-1a-4



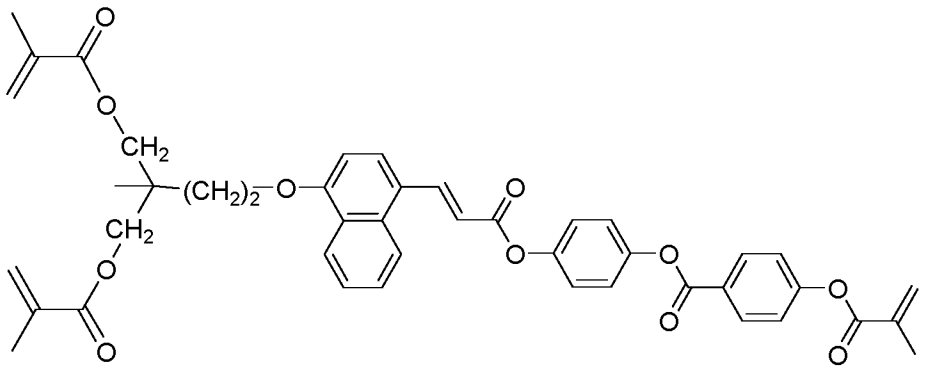
I-3a-1a-5



I-3a-1a-6



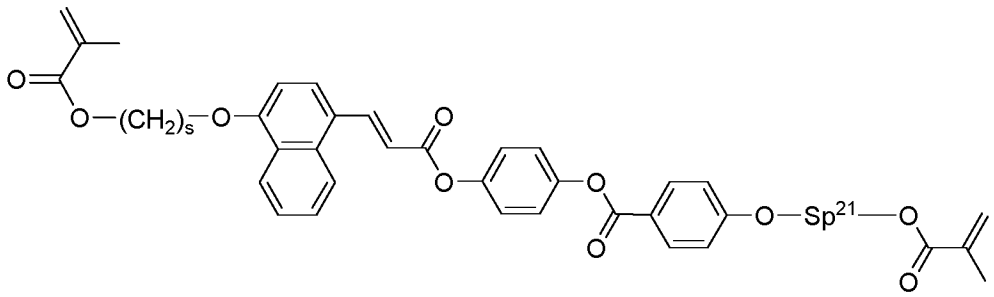
I-3a-1a-7



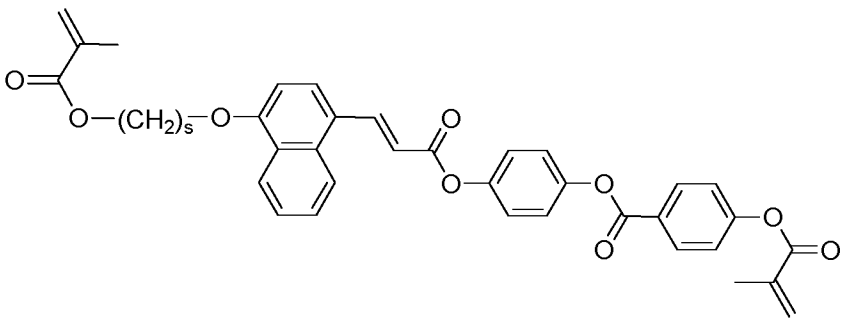
I-3a-1a-8

wherein Sp^{21} has one of the meanings as given above in formula I and L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, preferably methyl, ethyl, propyl, butyl, pentyl, hexyl, cyclopropyl, cylobutyl, cyclopentyl, or cyclohexyl.

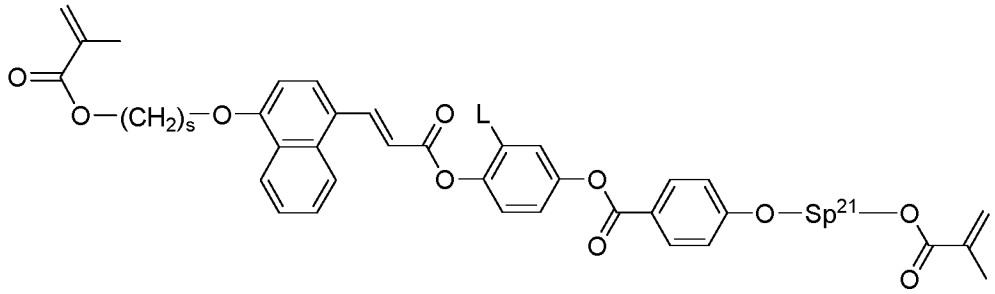
Further preferred compounds of formulae I-3a-1b are compounds of the following sub-formulae:



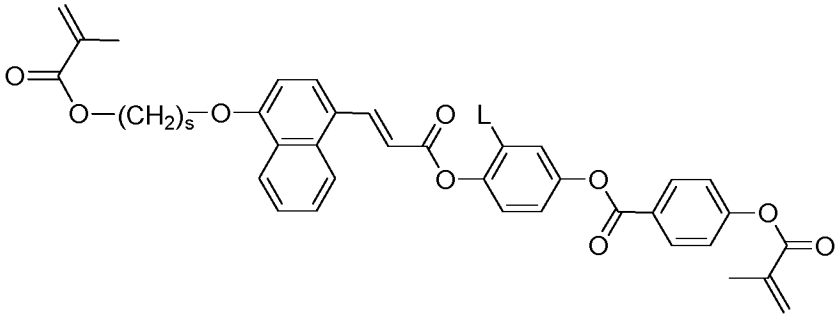
I-3a-1b-1



I-3a-1b-2



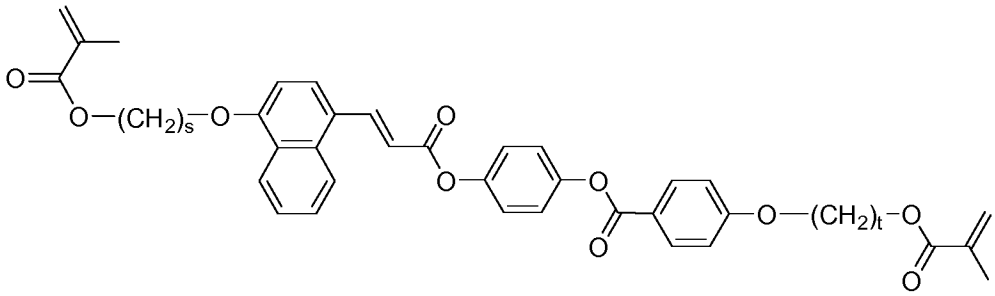
I-3a-1b-3



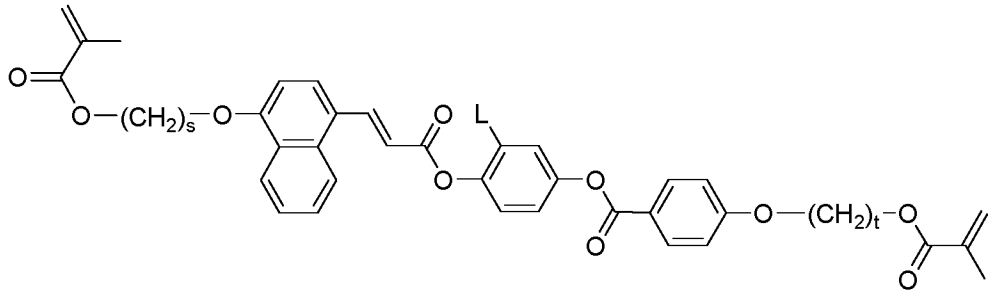
I-3a-1b-4

wherein Sp^{21} has one of the meanings as given above in formula I and L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, preferably methyl, ethyl, propyl, butyl, pentyl, hexyl, cyclopropyl, cylobutyl, cyclopentyl, or cyclohexyl and s denotes an integer from 1 to 8.

Further preferred compounds of formulae I-3a-1c are compounds of the following sub-formulae:



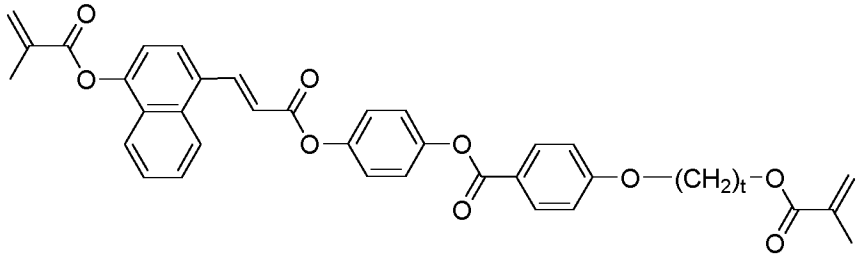
I-3a-1c-1



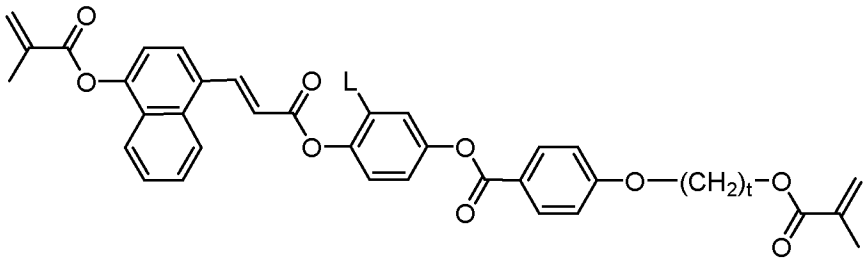
I-3a-1c-2

wherein L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, preferably methyl, ethyl, propyl, butyl, pentyl, hexyl, cyclopropyl, cylobutyl, cyclopentyl, or cyclohexyl, and
s and t denotes each and independently an integer from 1 to 8, preferably s and t are identical.

Further preferred compounds of formulae I-3a-1d are compounds of the following sub-formulae:



I-3a-1d-1

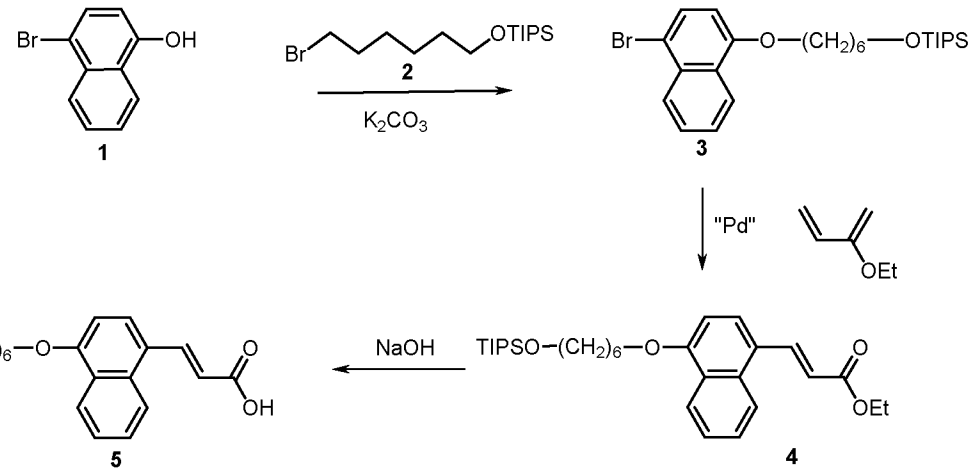


I-3a-1d-2

wherein L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, preferably methyl, ethyl, propyl, butyl, pentyl, hexyl, cyclopropyl, cylobutyl, cyclopentyl, or cyclohexyl, and
s and t denotes each and independently an integer from 1 to 8, preferably s and t are identical.

The compounds of formula I and subformulae thereof are preferably synthesised according to or in analogy to the procedures described in WO 2017/102068 and JP 2006-6232809.

Preferred intermediate compounds (**5**) from which the compounds of formula I are preferably synthesised, are obtainable or obtained according to or in analogy to the procedure described in the following scheme:



The compounds of formula I and subformulae thereof can be preferably utilized in a mixture comprising one or more mesogenic or liquid-crystalline compounds.

Therefore, the present invention relates to the use compounds of formula I and subformulae thereof in a liquid crystal mixture.

Further the present invention relates to liquid crystal mixtures comprising a photoalignment component A) comprising one or more photoreactive mesogens of formula I, and a liquid-crystalline component B), hereinafter also referred to as "LC host mixture", comprising one or more mesogenic or liquid-crystalline compounds.

The media according to the invention preferably comprise from 0.01 to 10%, particularly preferably from 0.05 to 5% and most preferably from 0.1

to 3% of component A) comprising compounds of formula I according to the invention.

The media preferably comprise one, two or three, more preferably one or two and most preferably one compound of the formula I according to the invention.

In a preferred embodiment component A) consists of compounds of formula I.

In a preferred embodiment, the LC-host mixture (component B) according to the present invention comprises one or more, preferably two or more, low-molecular-weight (i.e. monomeric or unpolymerized) compounds. The latter are stable or unreactive with respect to a polymerisation reaction or photoalignment under the conditions used for the polymerisation of the polymerizable compounds or photoalignment of the photoreactive mesogen of formula I.

In principle, a suitable host mixture is any dielectrically negative or positive LC mixture which is suitable for use in conventional VA, IPS or FFS displays.

Suitable LC mixtures are known to the person skilled in the art and are described in the literature. LC media for VA displays having negative dielectric anisotropy are described in for example EP 1 378 557 A1.

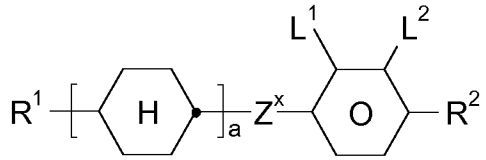
Suitable LC mixtures having positive dielectric anisotropy which are suitable for LCDs and especially for IPS displays are known, for example, from JP 07-181 439 (A), EP 0 667 555, EP 0 673 986, DE 195 09 410, DE 195 28 106, DE 195 28 107, WO 96/23 851, WO 96/28 521 and WO2012/079676.

Preferred embodiments of the liquid-crystalline medium having negative or positive dielectric anisotropy according to the invention are indicated below and explained in more detail by means of the working examples.

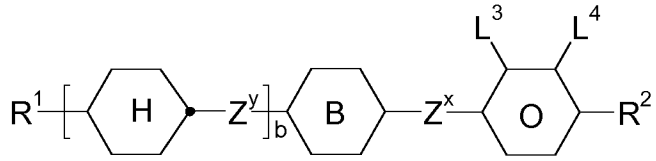
The LC host mixture is preferably a nematic LC mixture, and preferably does not have a chiral LC phase.

In a preferred embodiment of the present invention the LC medium contains an LC host mixture with negative dielectric anisotropy. In particular, LC media comprising the compounds of formula I and an LC host mixture with negative dielectric anisotropy exhibit excellent values to the voltage holding ration in comparison to similar compounds of formula I and an LC host mixture with negative dielectric anisotropy. Preferred embodiments of such an LC medium, and the corresponding LC host mixture, are those of sections a)-z) below:

a) LC medium which comprises one or more compounds of the formulae CY and/or PY:



CY

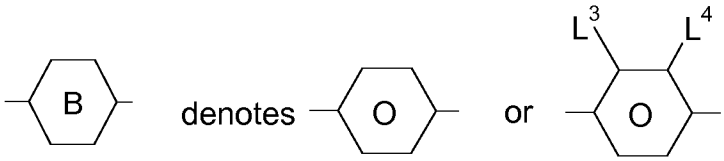


PY

wherein

a denotes 1 or 2,

b denotes 0 or 1,



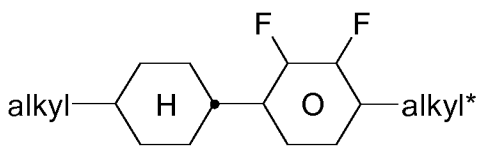
R^1 and R^2 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -OCO- or -COO- in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,

Z^x and Z^y each, independently of one another, denote $-CH_2CH_2-$, -CH=CH-, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, -CO-O-, -O-CO-, $-C_2F_4-$, -CF=CF-, -CH=CH-CH_2O- or a single bond, preferably a single bond,

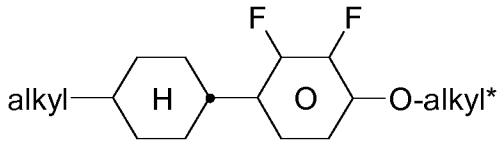
L^{1-4} each, independently of one another, denote F, Cl, OCF_3, CF_3, CH_3, CH_2F, CHF_2.

Preferably, both L^1 and L^2 denote F or one of L^1 and L^2 denotes F and the other denotes Cl, or both L^3 and L^4 denote F or one of L^3 and L^4 denotes F and the other denotes Cl.

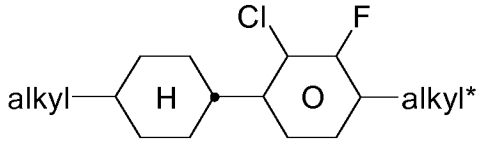
The compounds of the formula CY are preferably selected from the group consisting of the following sub-formulae:



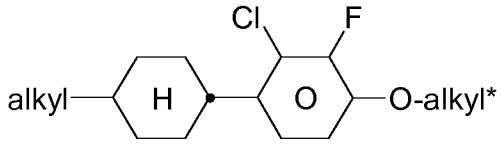
CY1



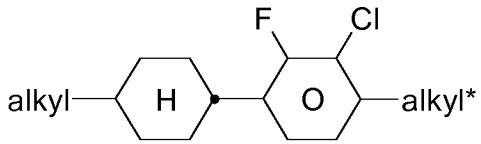
CY2



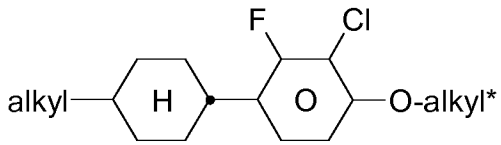
CY3



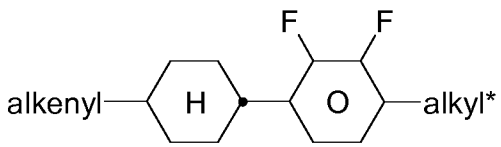
CY4



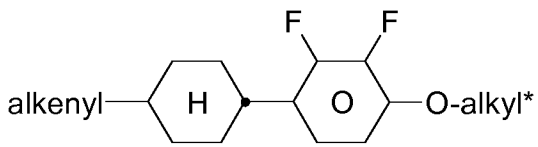
CY5



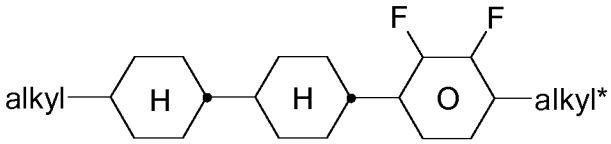
CY6



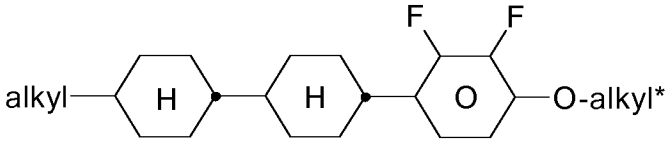
CY7



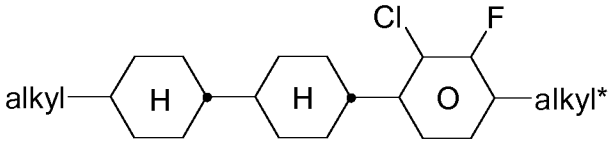
CY8



CY9



CY10



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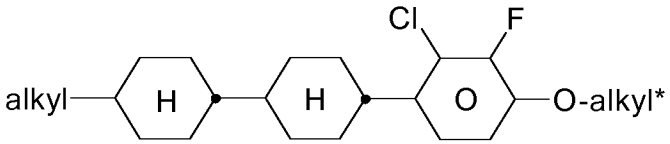

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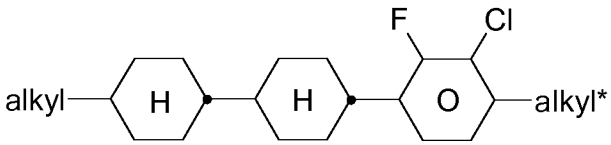

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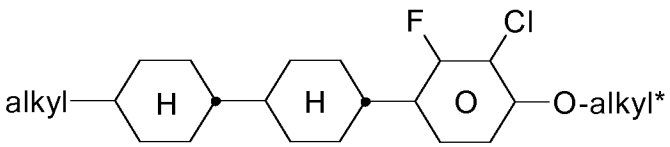

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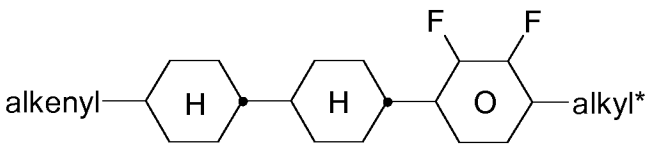

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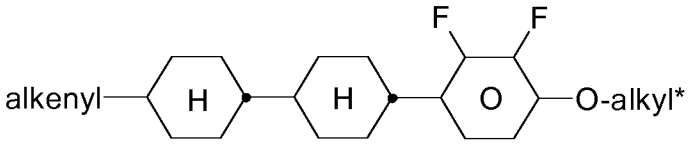

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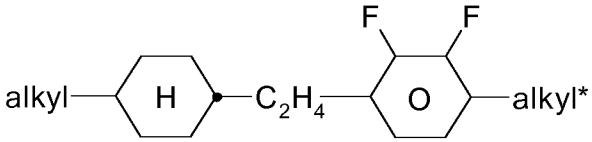

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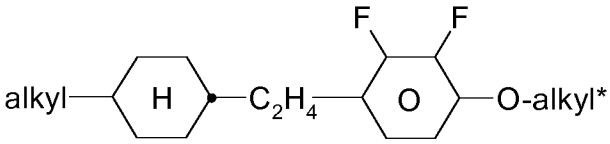

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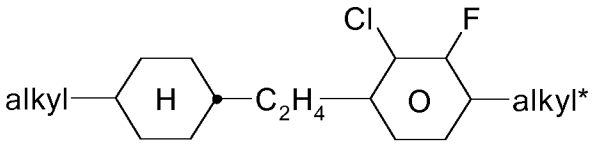

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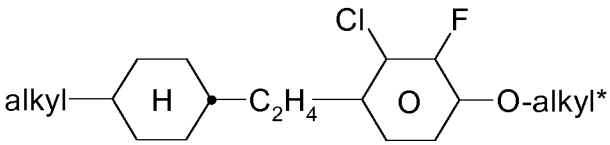

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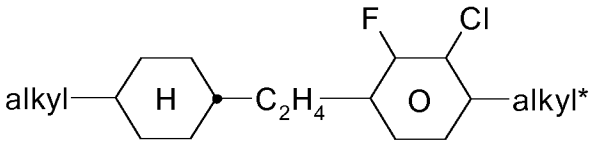

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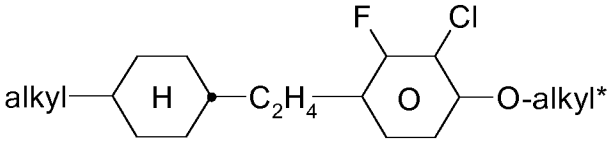

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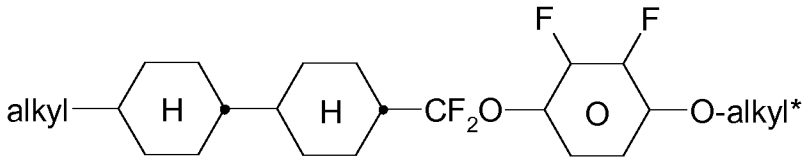

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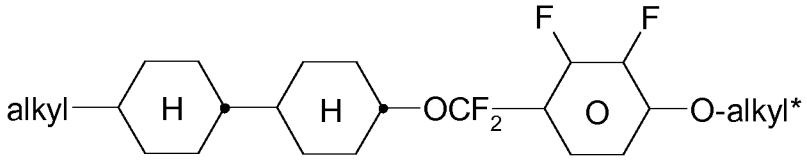

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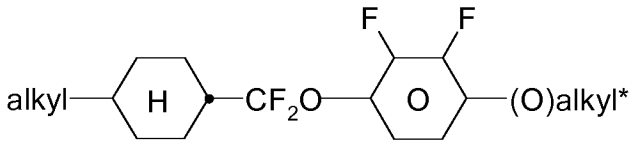

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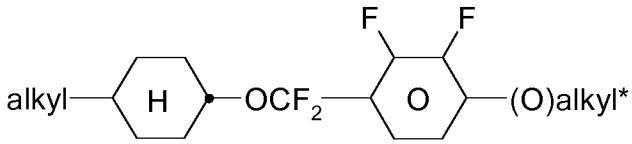

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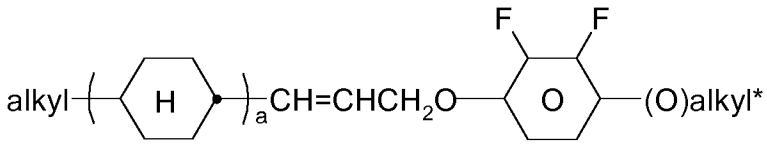

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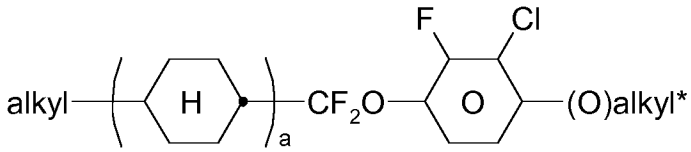

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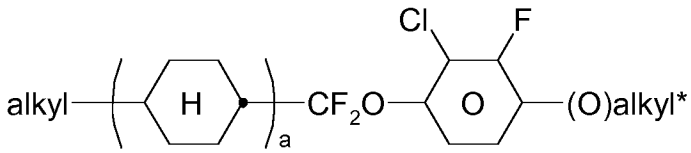

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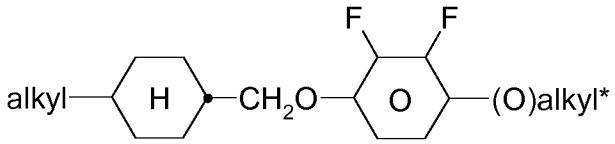

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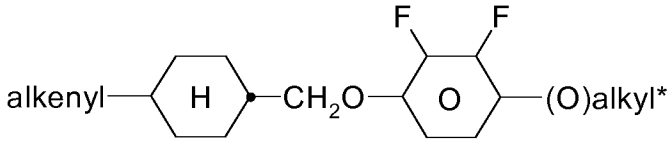

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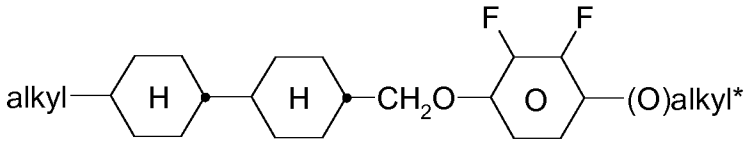

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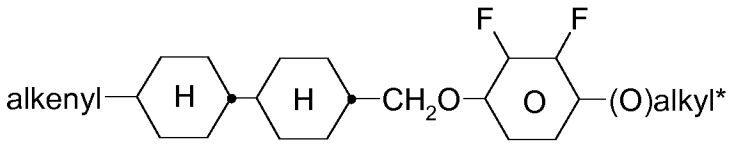
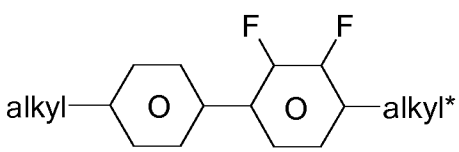


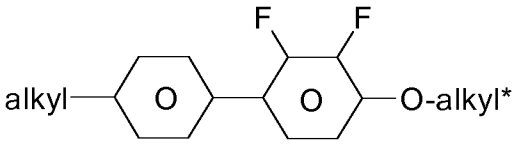
CY33

wherein a denotes 1 or 2, alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms, and (O) denotes an oxygen atom or a single bond. Alkenyl preferably denotes CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

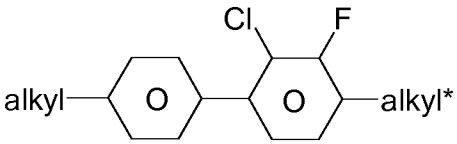
The compounds of the formula PY are preferably selected from the group consisting of the following sub-formulae:



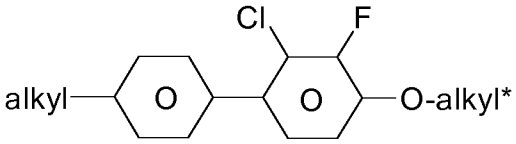
PY1



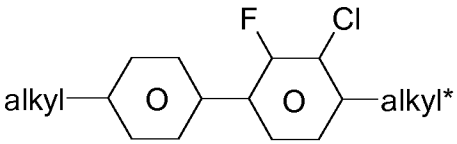
PY2



PY3



PY4



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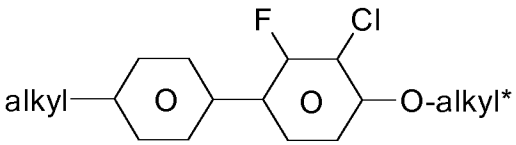
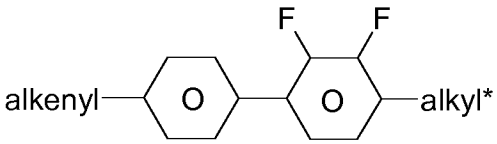


PY6



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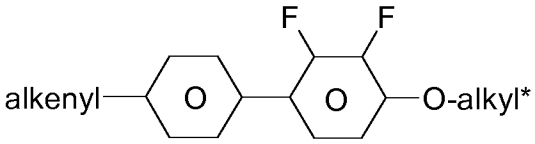
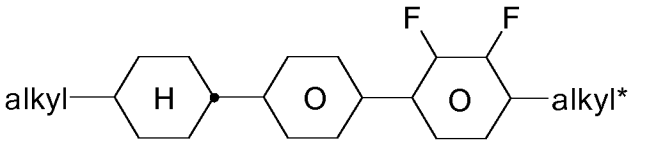
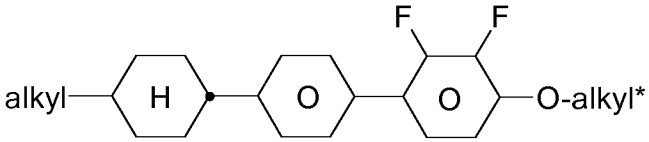


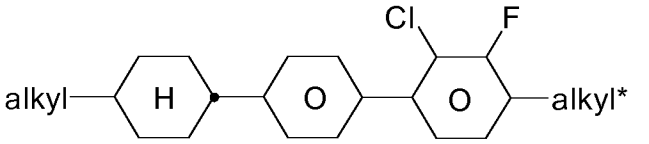
PY8



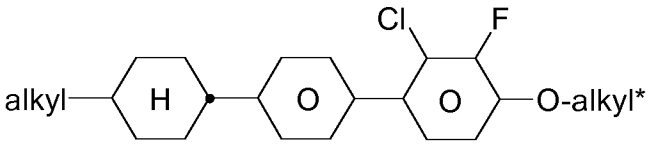
PY9



PY10



PY11



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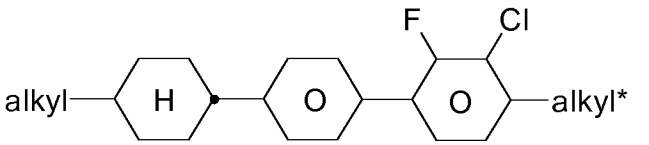

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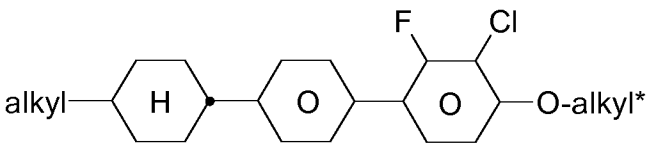
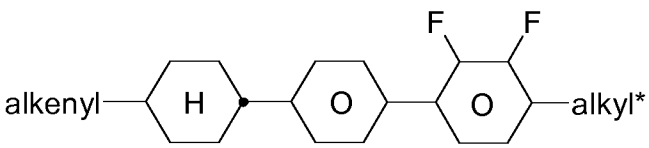


PY14



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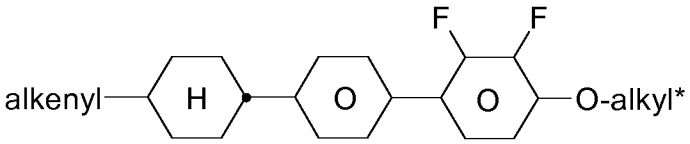
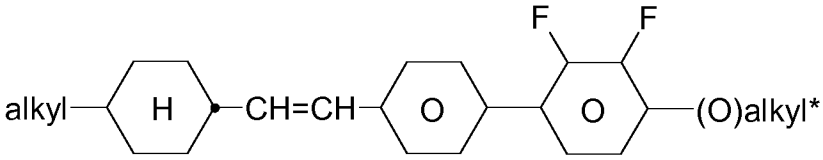
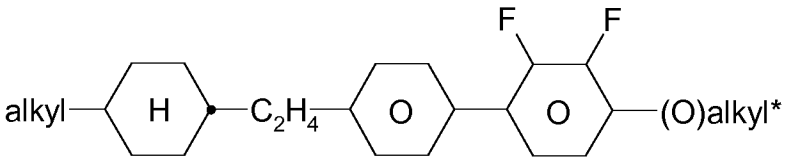


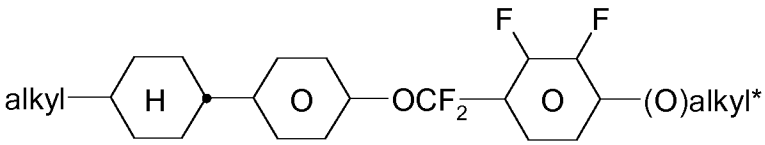
PY16



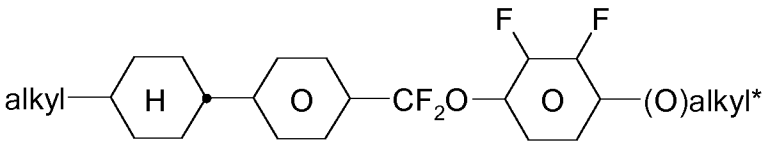
PY17



PY18



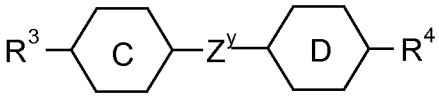
PY19



PY20

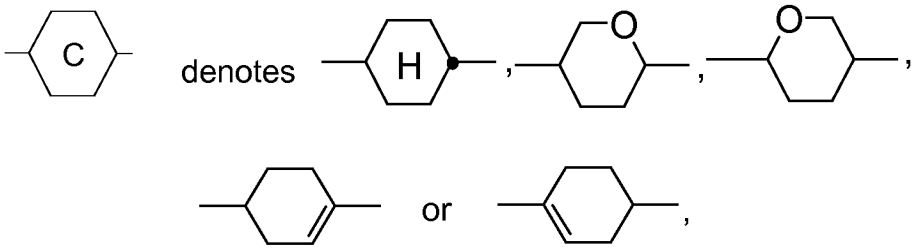
wherein alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms, and (O) denotes an oxygen atom or a single bond. Alkenyl preferably denotes CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

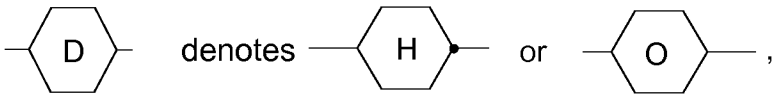
b) LC medium which additionally comprises one or more compounds of the following formula:



ZK

in which the individual radicals have the following meanings:

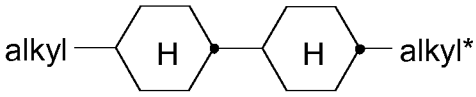




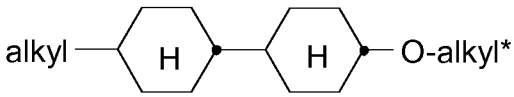
R^3 and R^4 each, independently of one another, denote alkyl having 1 to 12 C atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O- in such a way that O atoms are not linked directly to one another,

Z^y denotes $-CH_2CH_2-$, -CH=CH-, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, -CO-O-, -O-CO-, $-C_2F_4-$, -CF=CF-, -CH=CH-CH_2O- or a single bond, preferably a single bond.

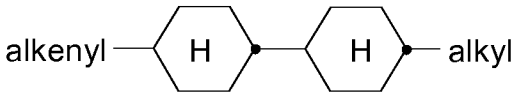
The compounds of the formula ZK are preferably selected from the group consisting of the following sub-formulae:



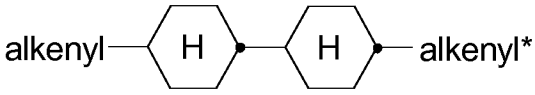
ZK1



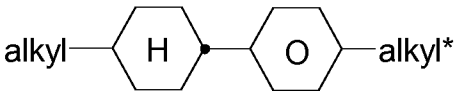
ZK2



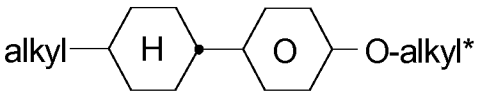
ZK3



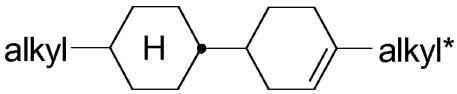
ZK4



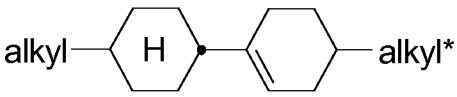
ZK5



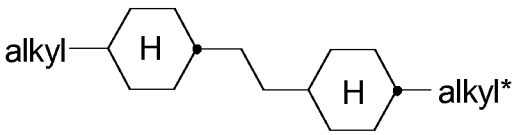
ZK6



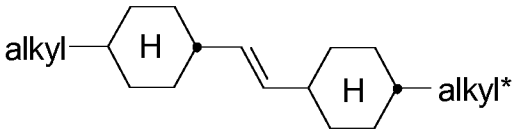
ZK7



ZK8



ZK9

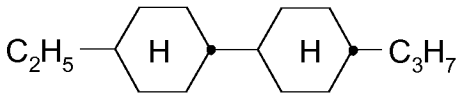


ZK10

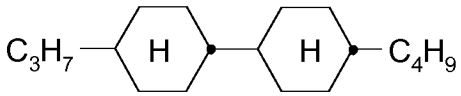
in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl preferably denotes CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

Especially preferred are compounds of formula ZK1 and ZK3.

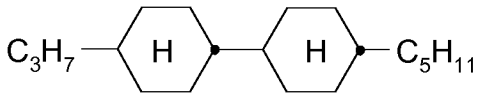
Particularly preferred compounds of formula ZK are selected from the following sub-formulae:



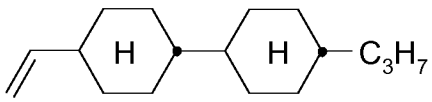
ZK1a



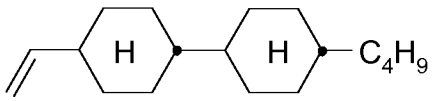
ZK1b



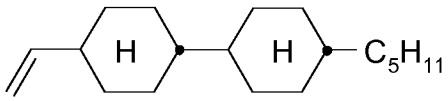
ZK1c



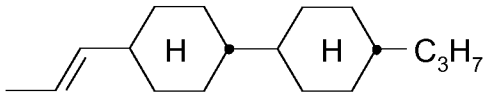
ZK3a



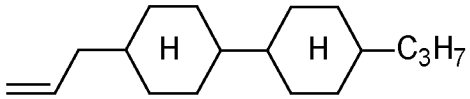
ZK3b



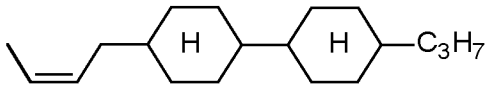
ZK3c



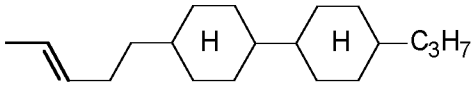
ZK3d



ZK3e



ZK3f



ZK3g

wherein the propyl, butyl and pentyl groups are straight-chain groups.

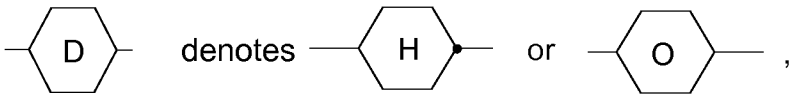
Most preferred are compounds of formula ZK1a and ZK3a.

c) LC medium which additionally comprises one or more compounds of the following formula:

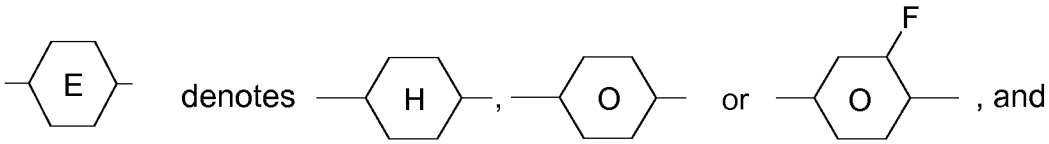
DK

in which the individual radicals on each occurrence, identically or differently, have the following meanings:

R^5 and R^6 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -OCO- or -COO- in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,



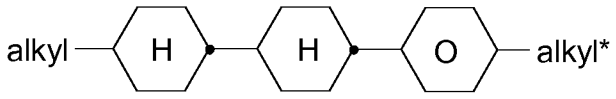
,



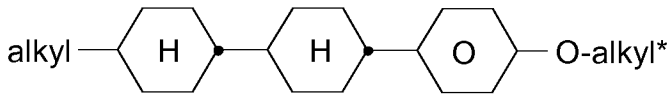
, and

e denotes 1 or 2.

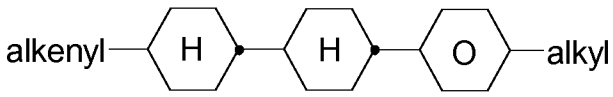
The compounds of the formula DK are preferably selected from the group consisting of the following sub-formulae:



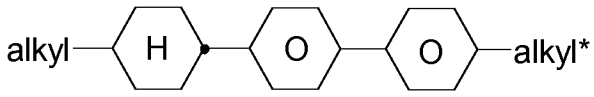
DK1



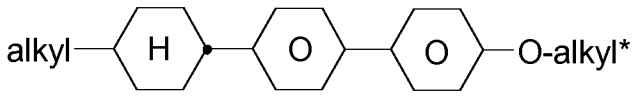
DK2



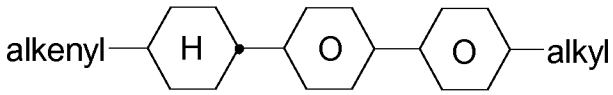
DK3



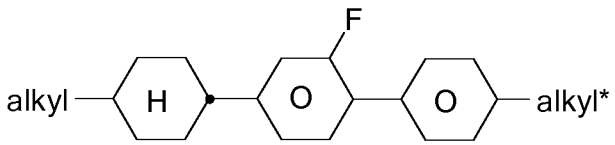
DK4



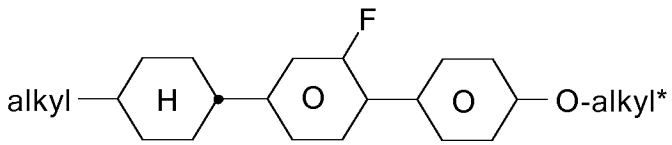
DK5



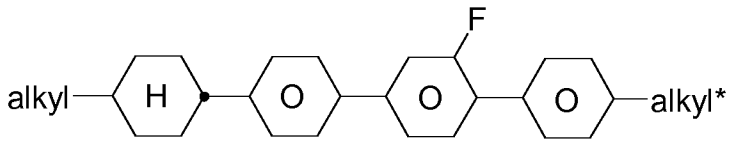
DK6



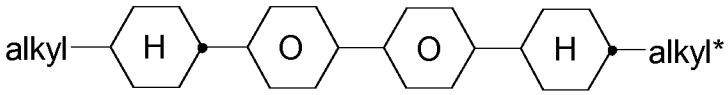
DK7



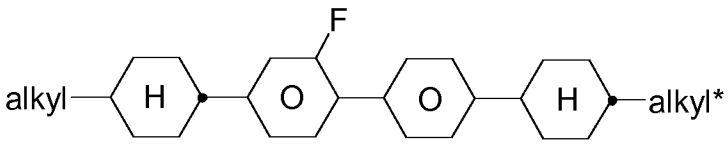
DK8



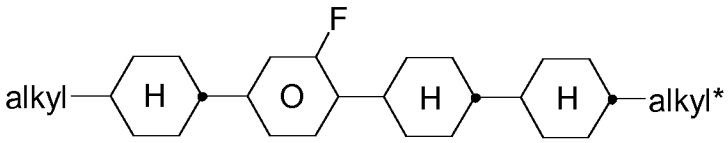
DK9



DK10



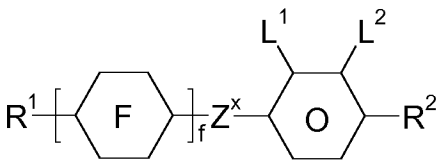
DK11



DK12

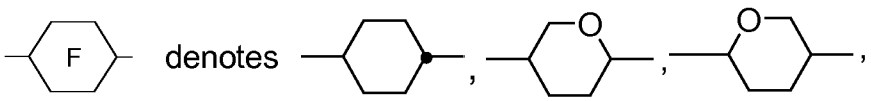
in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl preferably denotes CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

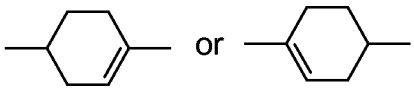
d) LC medium which additionally comprises one or more compounds of the following formula:



LY

in which the individual radicals have the following meanings:





with at least one ring F being different from cyclohexylene,

f denotes 1 or 2,

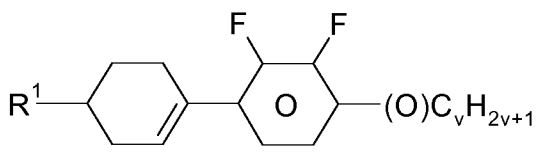
R^1 and R^2 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -OCO- or -COO- in such a way that O atoms are not linked directly to one another,

Z^x denotes $-CH_2CH_2-$, -CH=CH-, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, -CO-O-, -O-CO-, $-C_2F_4-$, -CF=CF-, -CH=CH-CH_2O- or a single bond, preferably a single bond,

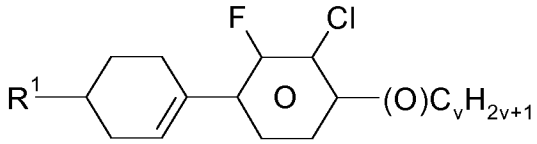
L^1 and L^2 each, independently of one another, denote F, Cl, OCF_3, CF_3, CH_3, CH_2F, CHF_2.

Preferably, both radicals L^1 and L^2 denote F or one of the radicals L^1 and L^2 denotes F and the other denotes Cl.

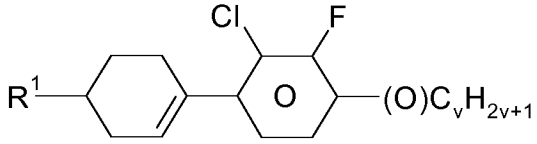
The compounds of the formula LY are preferably selected from the group consisting of the following sub-formulae:



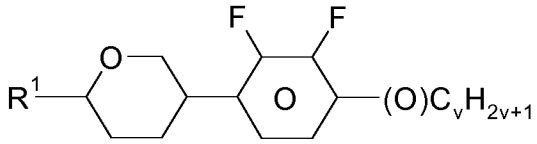
LY1



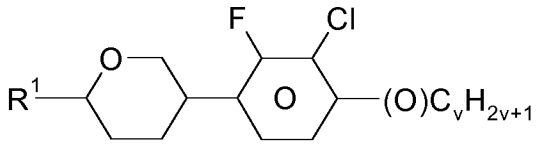
LY2



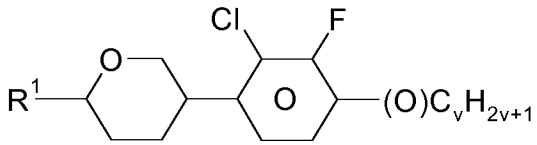
LY3



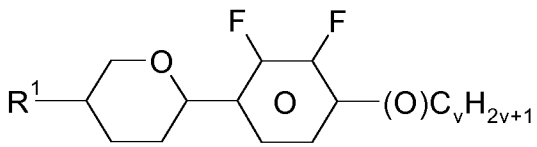
LY4



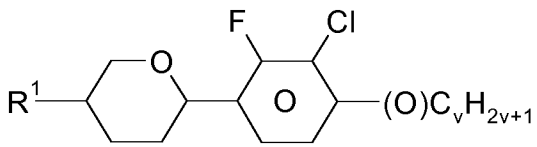
LY5



LY6



LY7



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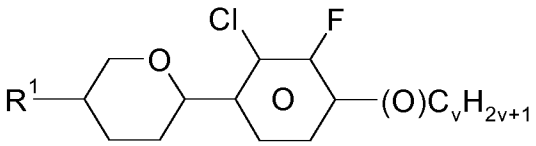

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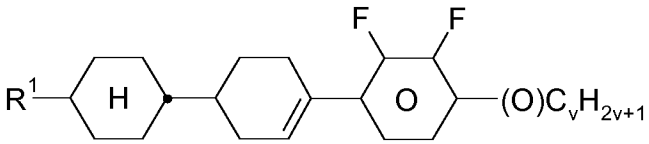

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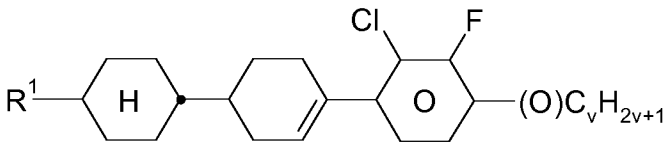

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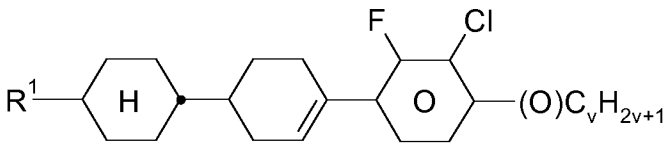

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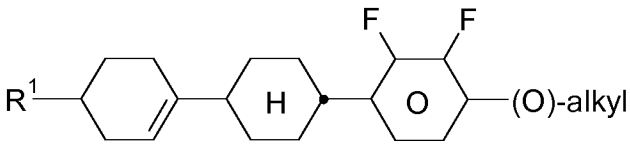

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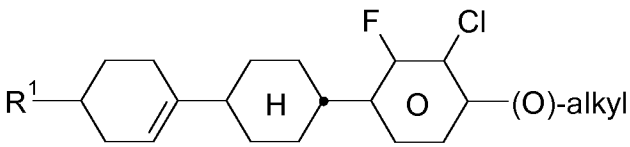

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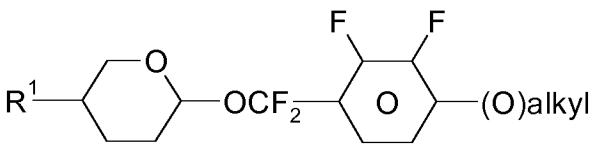

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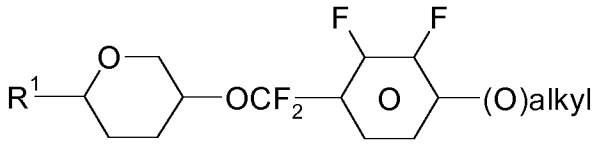
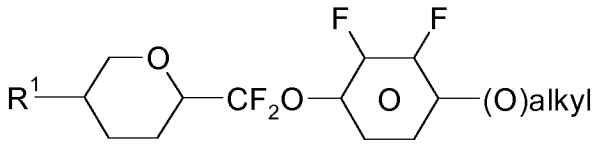
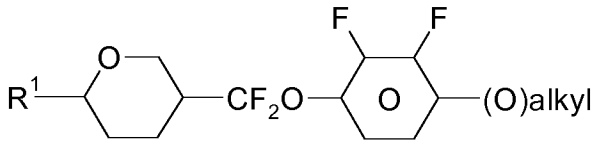


LY16



LY17



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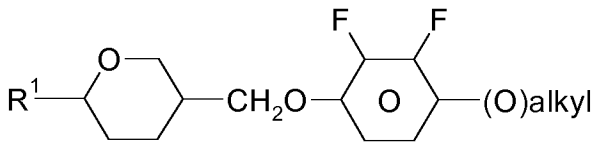
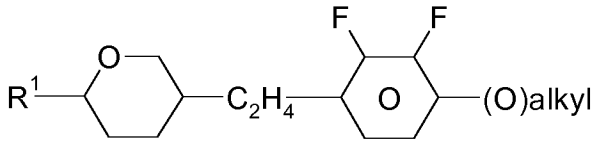


LY19



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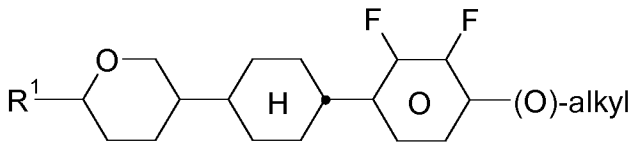

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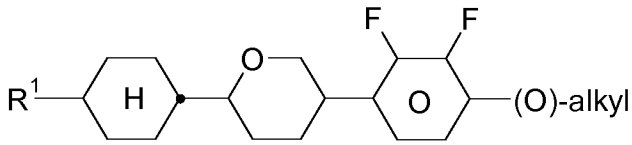
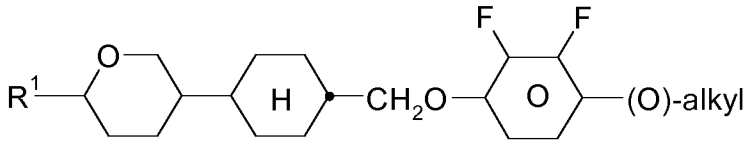
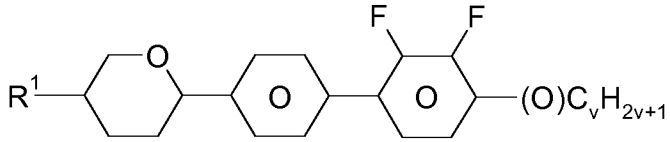


LY22



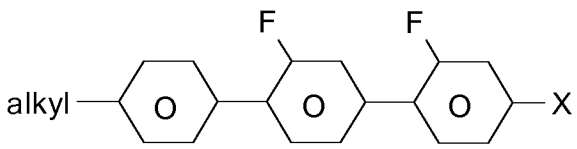
LY23



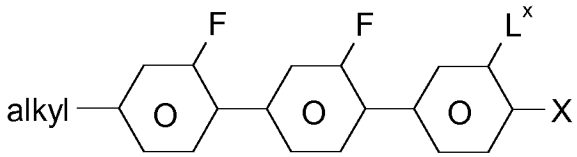
LY24

in which R^1 has the meaning indicated above, alkyl denotes a straight-chain alkyl radical having 1-6 C atoms, (O) denotes an oxygen atom or a single bond, and v denotes an integer from 1 to 6. R^1 preferably denotes straight-chain alkyl having 1 to 6 C atoms or straight-chain alkenyl having 2 to 6 C atoms, in particular CH_3, C_2H_5, n-C_3H_7, n-C_4H_9, n-C_5H_{11}, CH_2=CH-, CH_2=$CHCH_2CH_2$-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

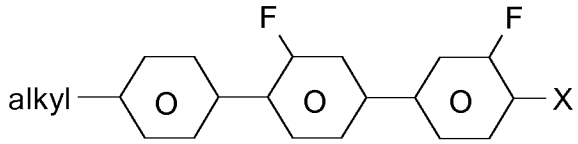
e) LC medium which additionally comprises one or more compounds selected from the group consisting of the following formulae:



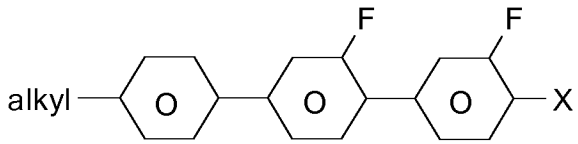
G1



G2



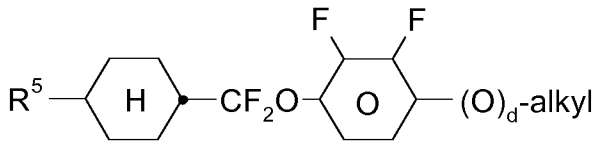
G3



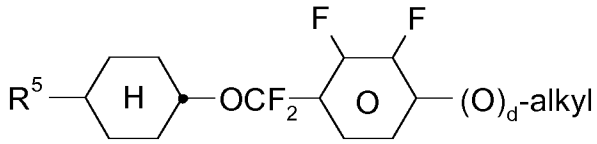
G4

in which alkyl denotes C_{1-6}-alkyl, L^x denotes H or F, and X denotes F, Cl, OCF_3, $OCHF_2$ or $OCH=CF_2$. Particular preference is given to compounds of the formula G1 in which X denotes F.

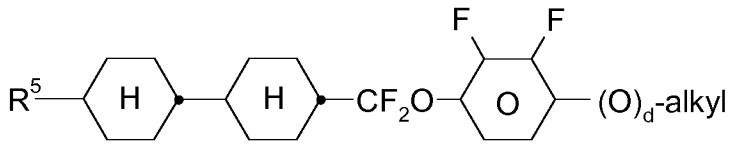
f) LC medium which additionally comprises one or more compounds selected from the group consisting of the following formulae:



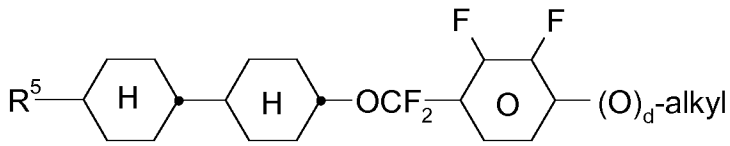
Y1



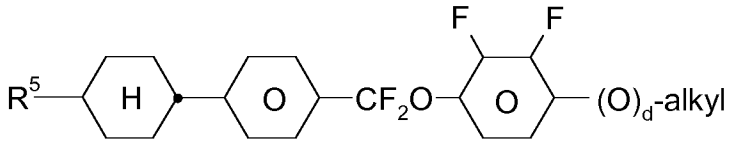
Y2



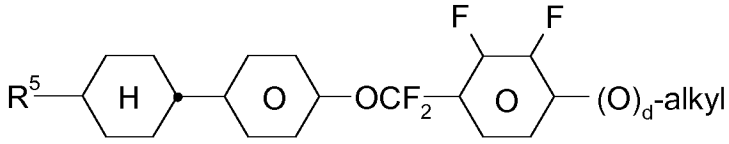
Y3



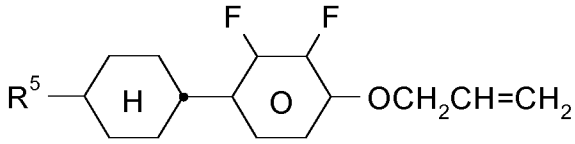
Y4



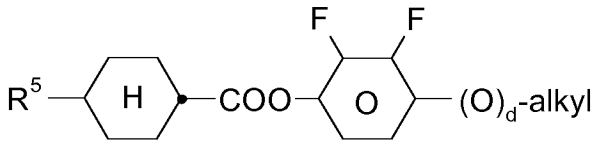
Y5



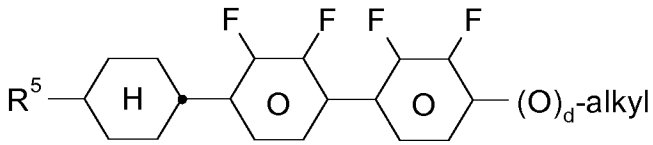
Y6



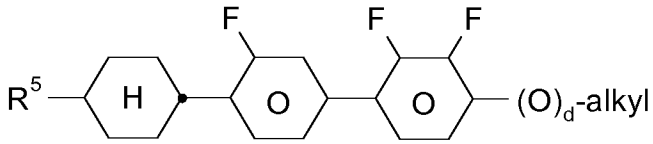
Y7



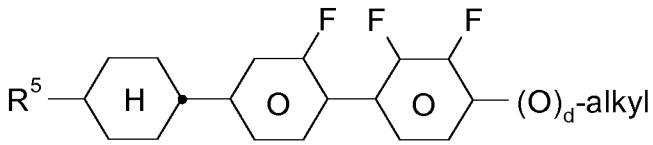
Y8



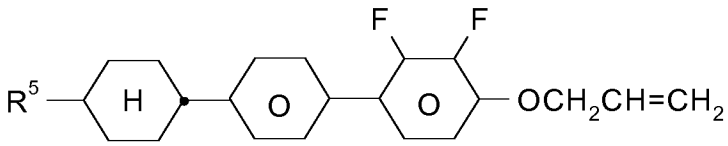
Y9



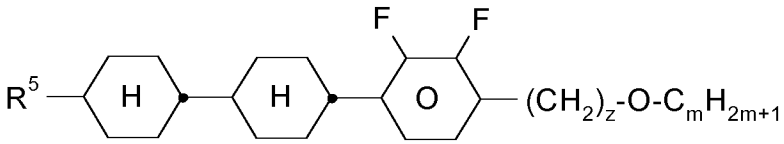
Y10



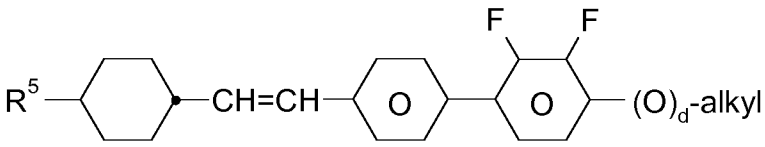
Y11



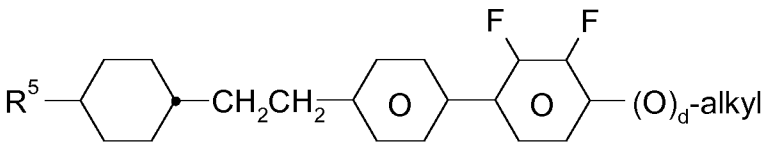
Y12



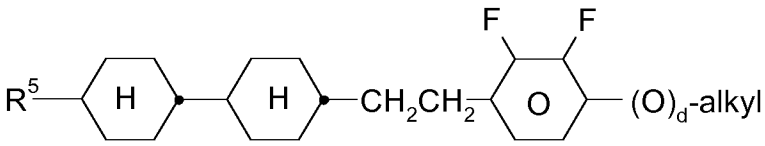
Y13



Y14



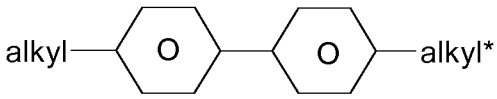
Y15



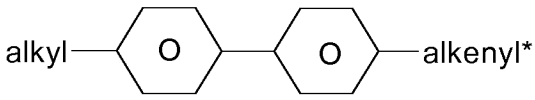
Y16

in which R^5 has one of the meanings indicated above for R^1, alkyl denotes C_{1-6}-alkyl, d denotes 0 or 1, and z and m each, independently of one another, denote an integer from 1 to 6. R^5 in these compounds is particularly preferably C_{1-6}-alkyl or -alkoxy or C_{2-6}-alkenyl, d is preferably 1. The LC medium according to the invention preferably comprises one or more compounds of the above-mentioned formulae in amounts of ≥ 5% by weight.

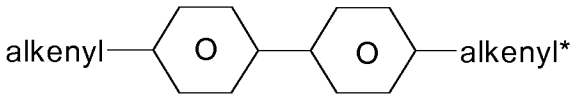
g) LC medium which additionally comprises one or more biphenyl compounds selected from the group consisting of the following formulae:



B1



B2



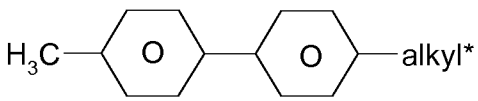
B3

in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl and alkenyl* preferably denote CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

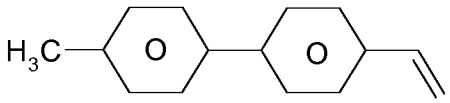
The proportion of the biphenyls of the formulae B1 to B3 in the LC mixture is preferably at least 3% by weight, in particular ≥ 5% by weight.

The compounds of the formula B2 are particularly preferred.

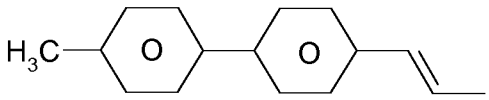
The compounds of the formulae B1 to B3 are preferably selected from the group consisting of the following sub-formulae:



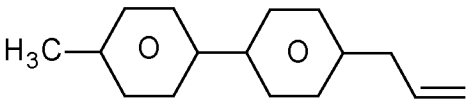
B1a



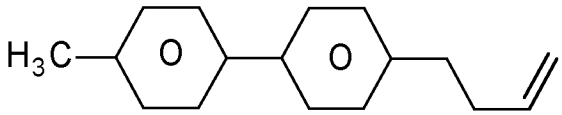
B2a



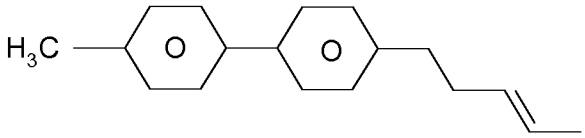
B2b



B2c



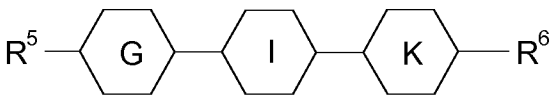
B2d



B2e

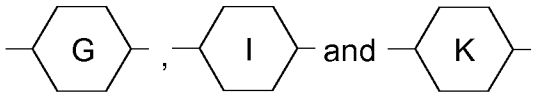
in which alkyl* denotes an alkyl radical having 1-6 C atoms. The medium according to the invention particularly preferably comprises one or more compounds of the formulae B1a and/or B2e.

h) LC medium which additionally comprises one or more terphenyl compounds of the following formula:

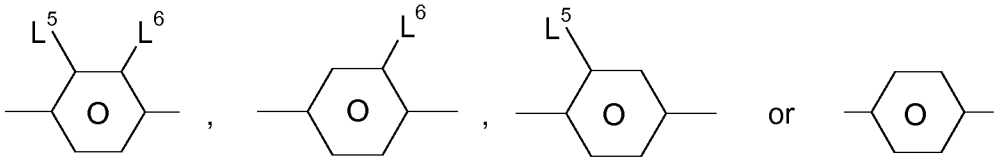


T

in which R^5 and R^6 each, independently of one another, have one of the meanings indicated above, and

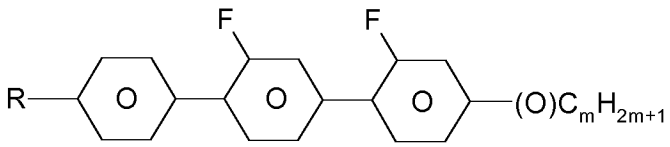


each, independently of one another, denote

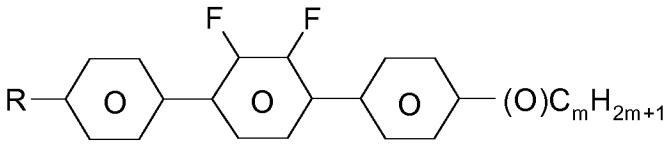


in which L^5 denotes F or Cl, preferably F, and L^6 denotes F, Cl, OCF_3, CF_3, CH_3, CH_2F or CHF_2, preferably F.

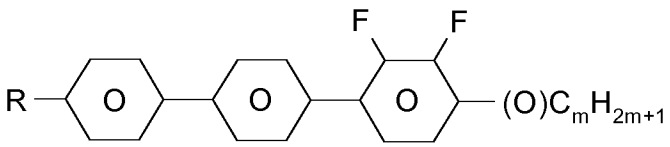
The compounds of the formula T are preferably selected from the group consisting of the following sub-formulae:



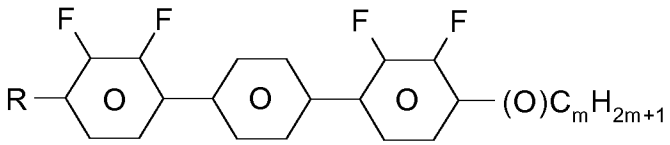
T1



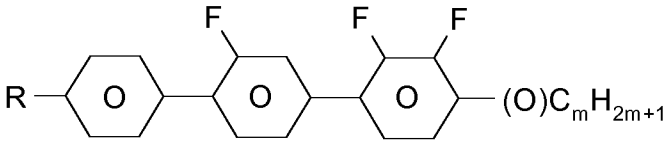
T2



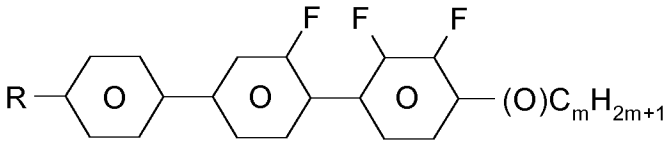
T3



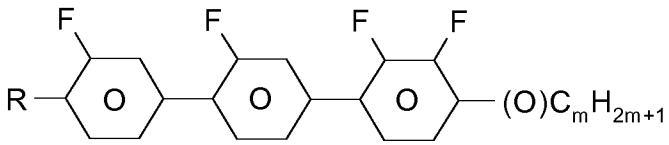
T4



T5



T6



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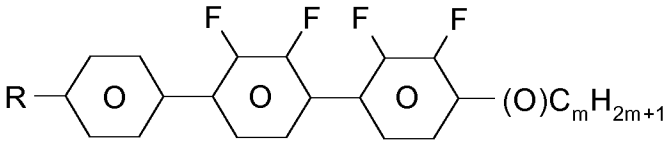

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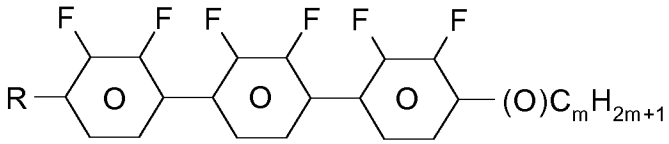

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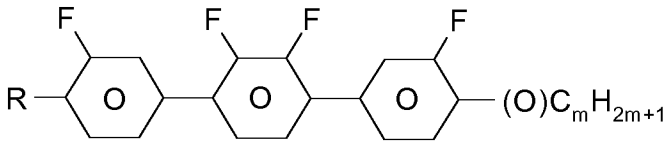

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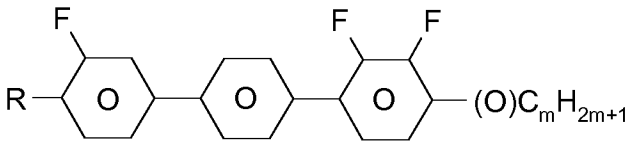

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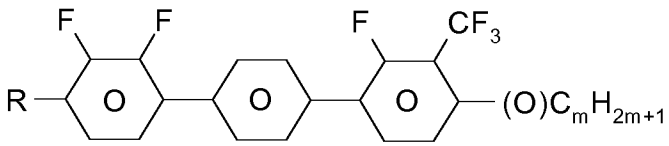

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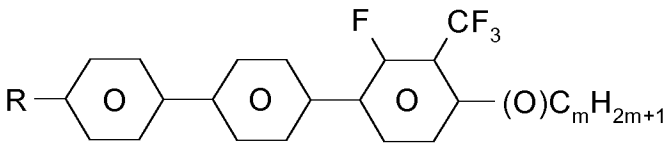

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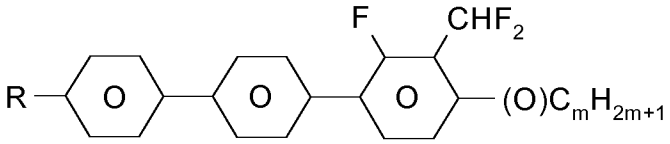

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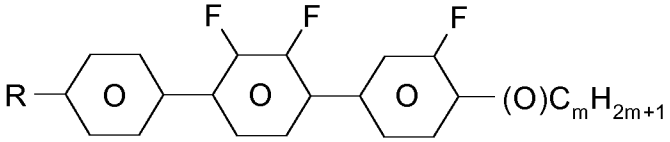

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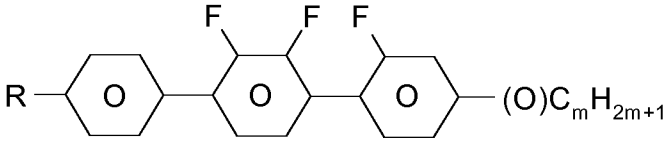

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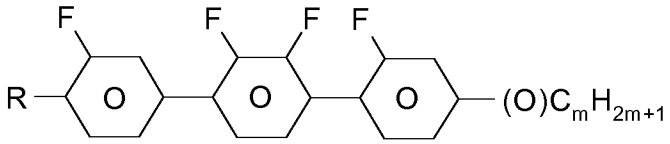

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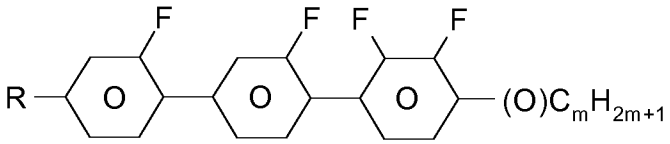

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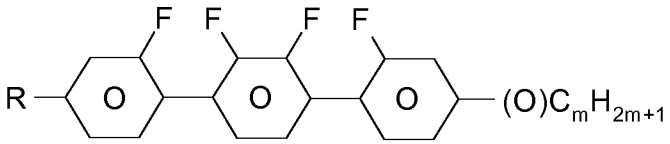

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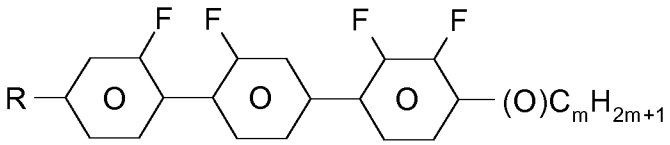

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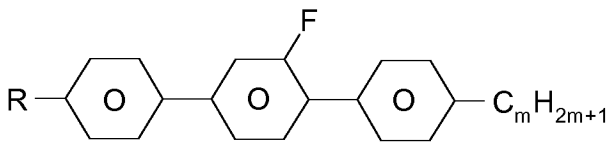

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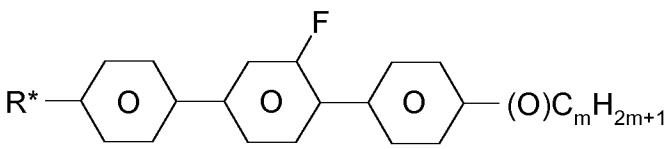

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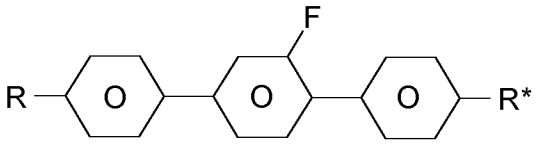

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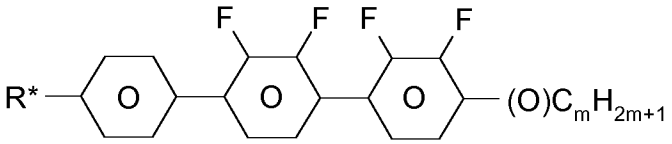

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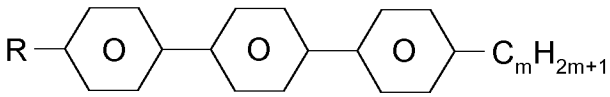
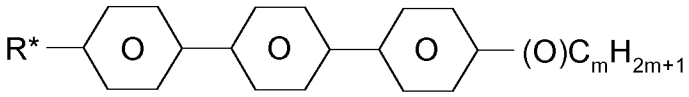
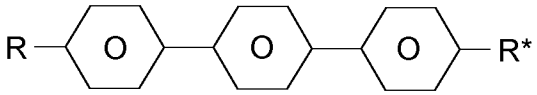


T25



T26



T27

in which R denotes a straight-chain alkyl or alkoxy radical having 1-7 C atoms, R* denotes a straight-chain alkenyl radical having 2-7 C atoms, (O) denotes an oxygen atom or a single bond, and m denotes an integer from 1 to 6. R* preferably denotes CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

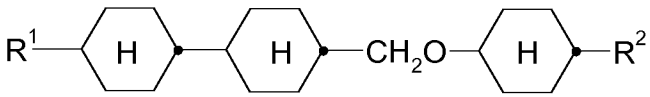
R preferably denotes methyl, ethyl, propyl, butyl, pentyl, hexyl, methoxy, ethoxy, propoxy, butoxy or pentoxy.

The LC medium according to the invention preferably comprises the terphenyls of the formula T and the preferred sub-formulae thereof in an amount of 0.5-30% by weight, in particular 1-20% by weight.

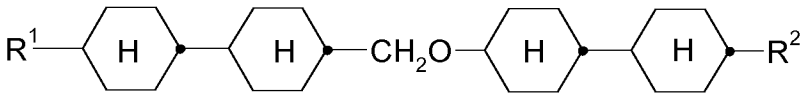
Particular preference is given to compounds of the formulae T1, T2, T3 and T21. In these compounds, R preferably denotes alkyl, furthermore alkoxy, each having 1-5 C atoms.

The terphenyls are preferably employed in mixtures according to the invention if the Δn value of the mixture is to be ≥ 0.1. Preferred mixtures comprise 2-20% by weight of one or more terphenyl compounds of the formula T, preferably selected from the group of compounds T1 to T22.

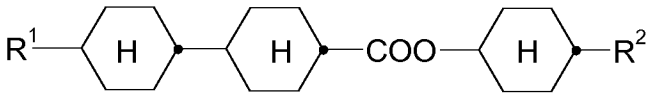
i) LC medium which additionally comprises one or more compounds selected from the group consisting of the following formulae:



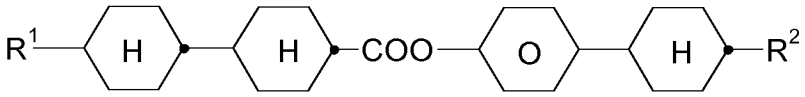
O1



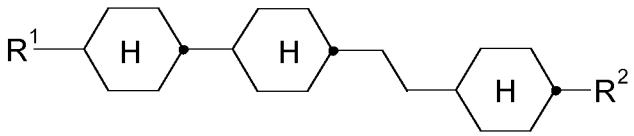
O2



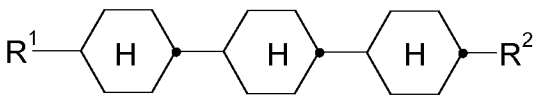
O3



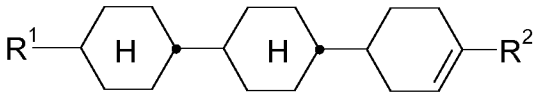
O4



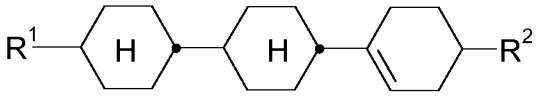
O5



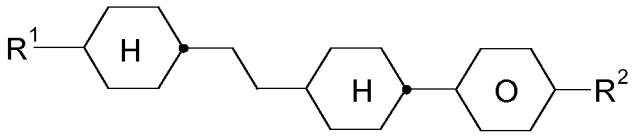
O6



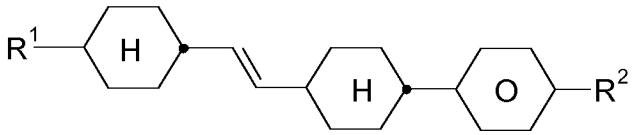
O7



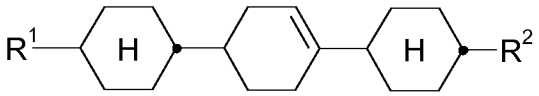
O8



O9



O10

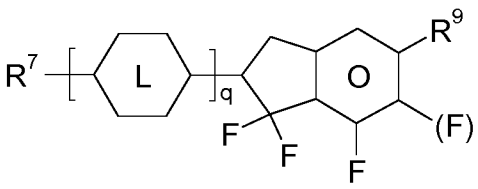


O11

in which R^1 and R^2 have the meanings indicated above and preferably each, independently of one another, denote straight-chain alkyl having 1 to 6 C atoms or straight-chain alkenyl having 2 to 6 C atoms.

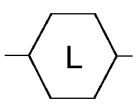
Preferred media comprise one or more compounds selected from the formulae O1, O3 and O4.

k) LC medium which additionally comprises one or more compounds of the following formula:

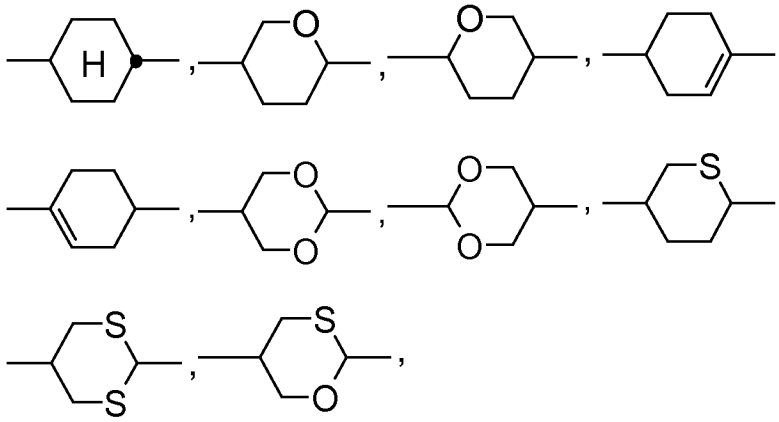


FI

in which

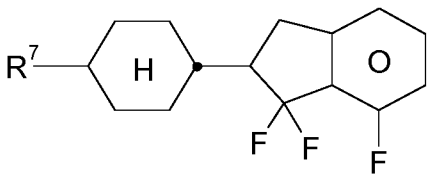


denotes

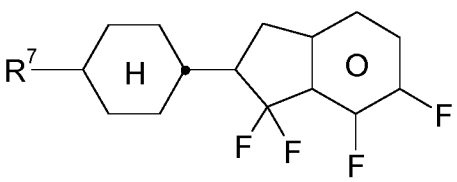


R^9 denotes H, CH_3, C_2H_5 or n-C_3H_7, (F) denotes an optional fluorine substituent, and q denotes 1, 2 or 3, and R^7 has one of the meanings indicated for R^1, preferably in amounts of > 3% by weight, in particular ≥ 5% by weight and very particularly preferably 5-30% by weight.

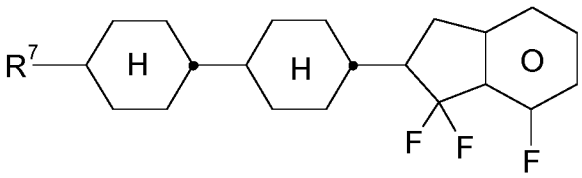
Particularly preferred compounds of the formula FI are selected from the group consisting of the following sub-formulae:



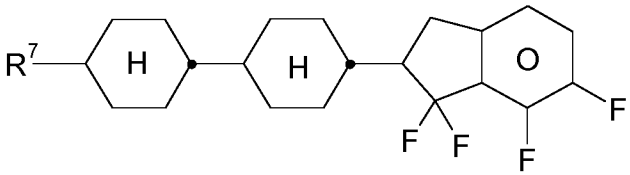
FI1



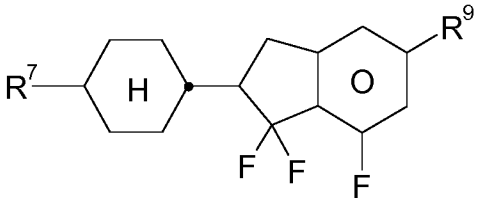
FI2



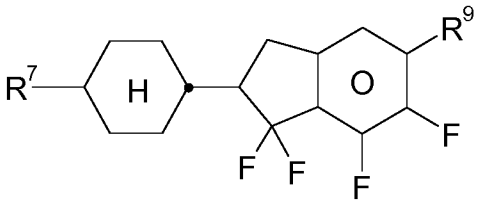
FI3



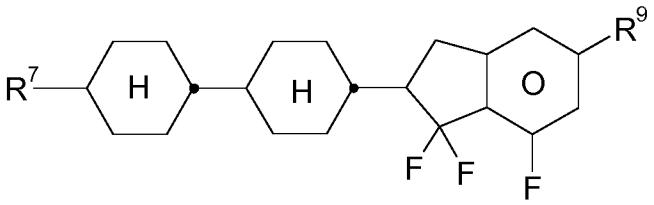
FI4



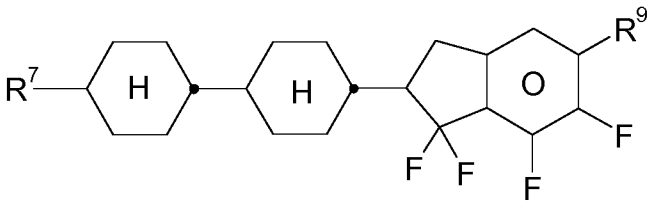
FI5



FI6



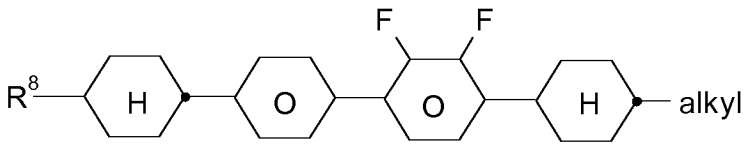
FI7



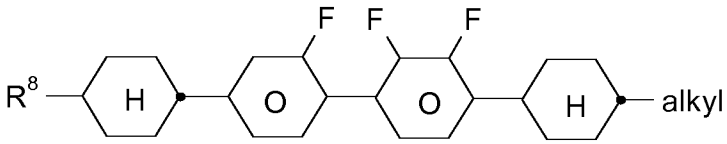
FI8

in which R^7 preferably denotes straight-chain alkyl, and R^9 denotes CH_3, C_2H_5 or n-C_3H_7. Particular preference is given to the compounds of the formulae FI1, FI2 and FI3.

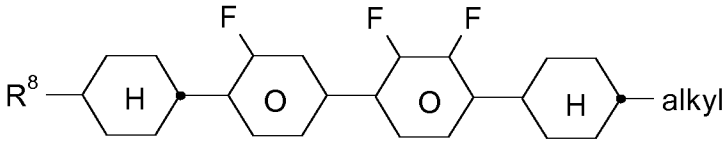
l) LC medium which additionally comprises one or more compounds selected from the group consisting of the following formulae:



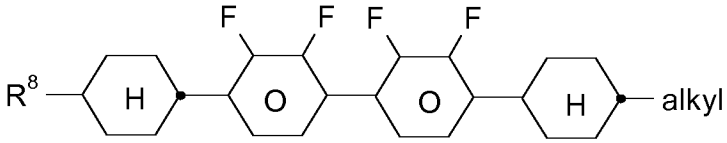
VK1



VK2



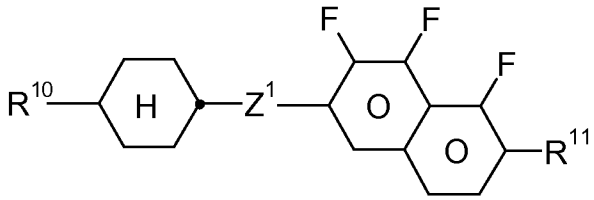
VK3



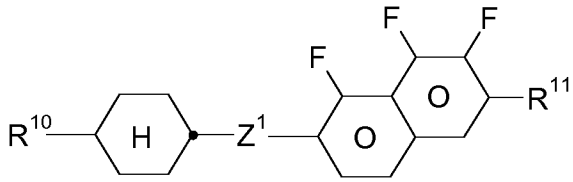
VK4

in which R^8 has the meaning indicated for R^1, and alkyl denotes a straight-chain alkyl radical having 1-6 C atoms.

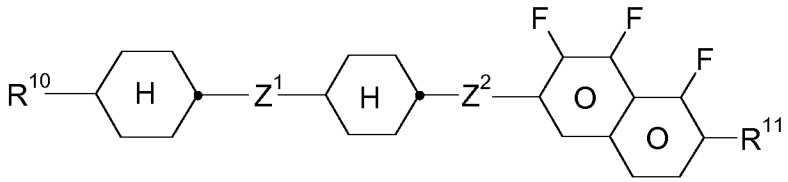
m) LC medium which additionally comprises one or more compounds which contain a tetrahydronaphthyl or naphthyl unit, such as, for example, the compounds selected from the group consisting of the following formulae:



N1



N2



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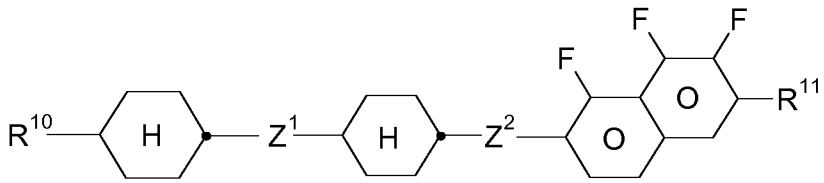

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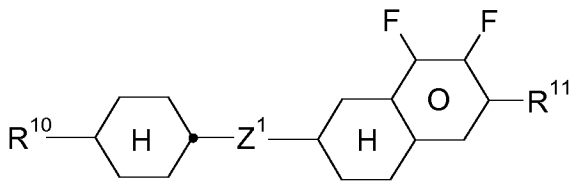
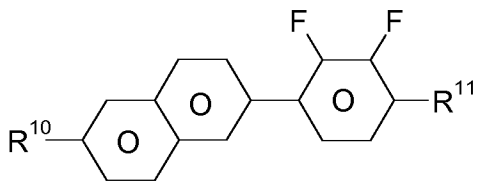


N5



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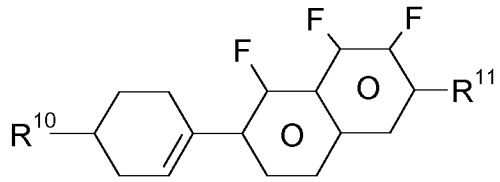
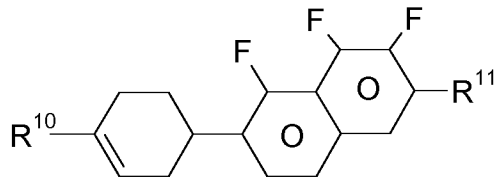
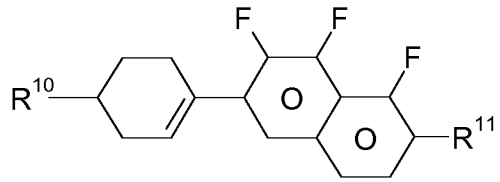


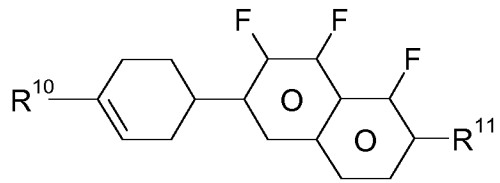
N7



N8



N9



N10

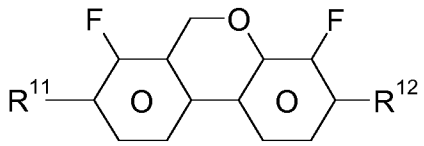
in which

R^{10} and R^{11} each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -OCO- or -COO- in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,

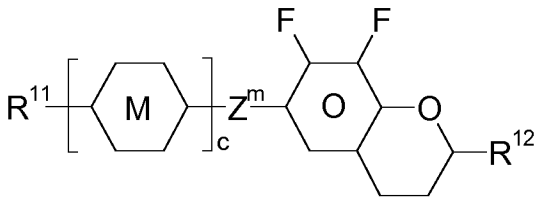
and R^{10} and R^{11} preferably denote straight-chain alkyl or alkoxy having 1 to 6 C atoms or straight-chain alkenyl having 2 to 6 C atoms, and

Z^1 and Z^2 each, independently of one another, denote $-C_2H_4-$, -CH=CH-, $-(CH_2)_4-$, $-(CH_2)_3O-$, $-O(CH_2)_3-$, -CH=CH-CH_2CH_2-, $-CH_2CH_2CH=CH-$, $-CH_2O-$, $-OCH_2-$, -CO-O-, -O-CO-, $-C_2F_4-$, -CF=CF-, -CF=CH-, -CH=CF-, $-CH_2-$ or a single bond.

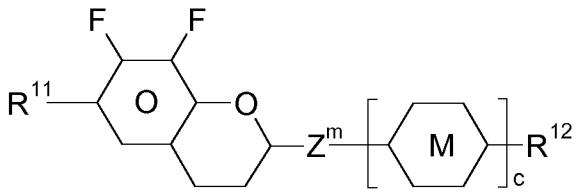
n) LC medium which additionally comprises one or more difluoro-dibenzochromans and/or chromans of the following formulae:



BC



CR



RC

in which

R^{11} and R^{12} each, independently of one another, have one of the meanings indicated above for R^{11} under formula N1

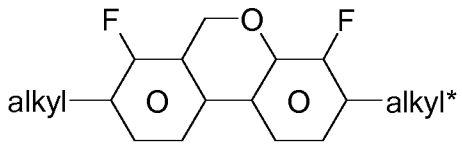
ring M is trans-1,4-cyclohexylene or 1,4-phenylene,

Z^m $-C_2H_4-$, $-CH_2O-$, $-OCH_2-$, -CO-O- or -O-CO-,

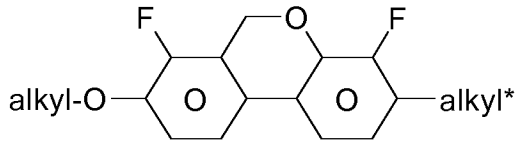
c is 0, 1 or 2,

preferably in amounts of 3 to 20% by weight, in particular in amounts of 3 to 15% by weight.

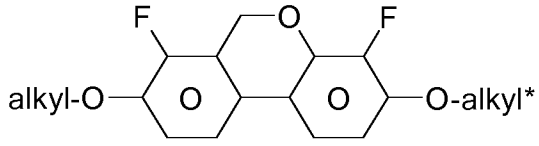
Particularly preferred compounds of the formulae BC, CR and RC are selected from the group consisting of the following sub-formulae:



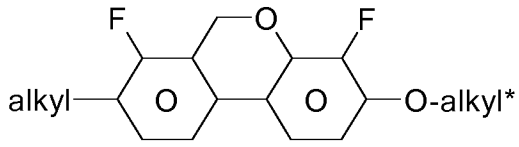
BC1



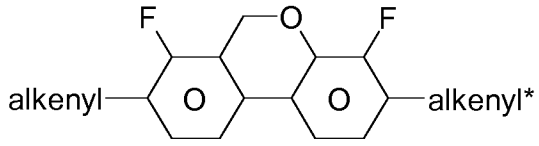
BC2



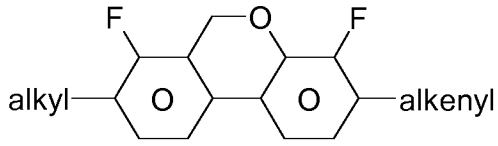
BC3



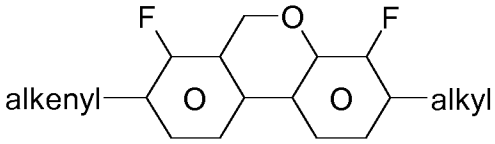
BC4



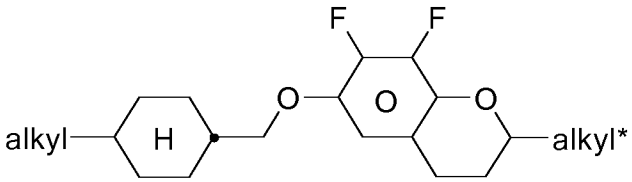
BC5



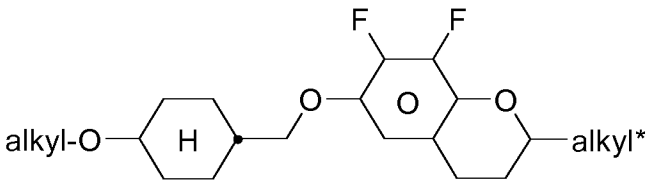
BC6



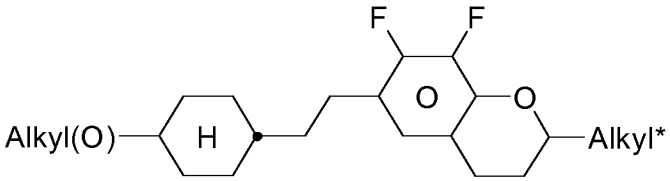
BC7



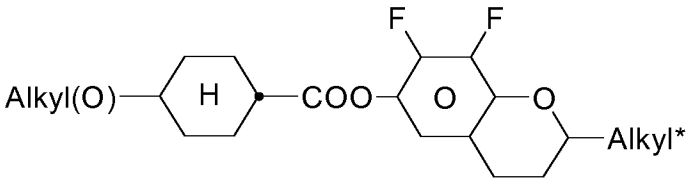
CR1



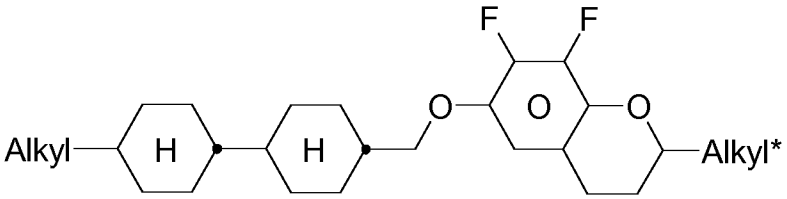
CR2



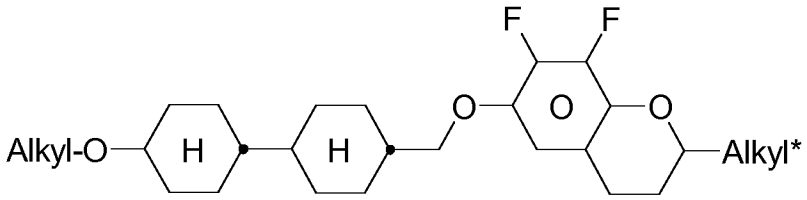
CR3



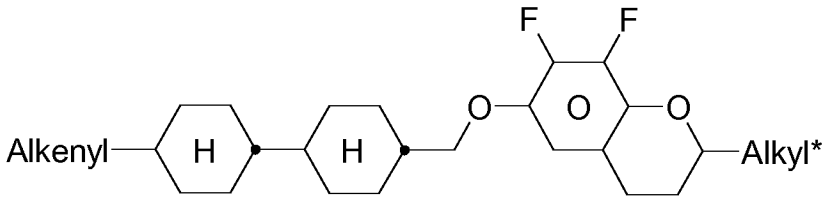
CR4



CR5



CR6



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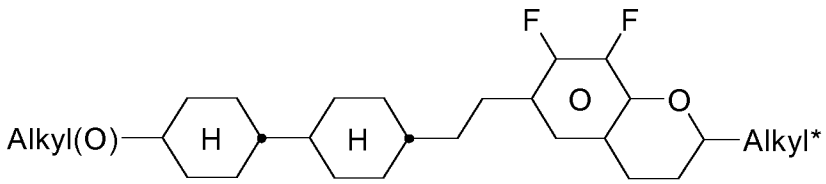
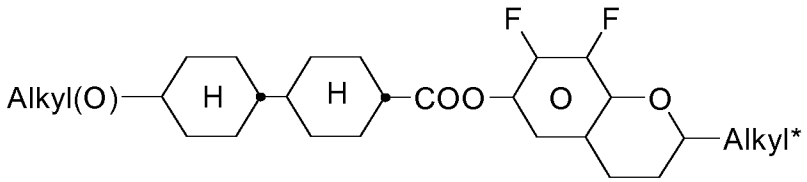
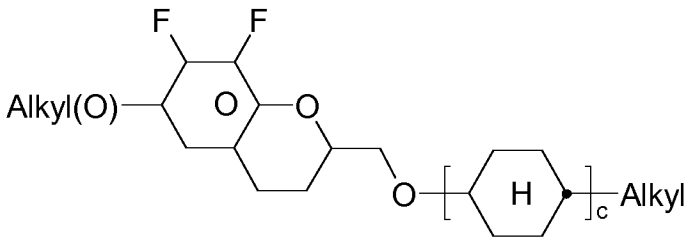


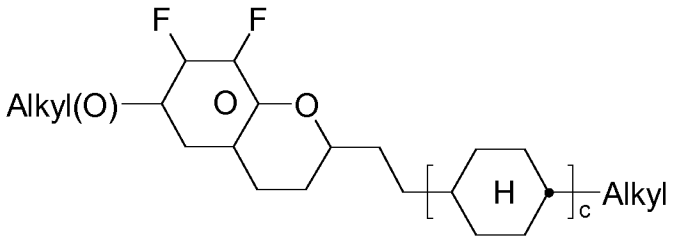
CR8



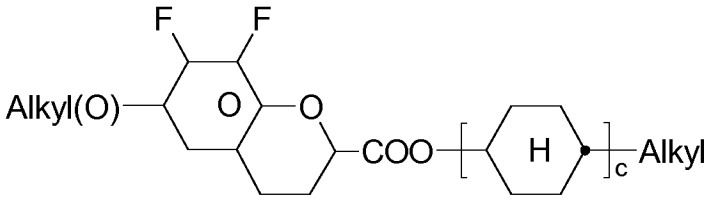
CR9



RC1



RC2

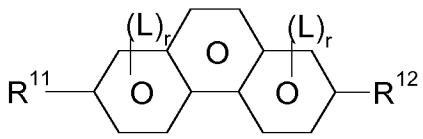


RC3

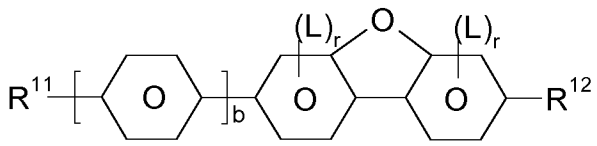
in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, (O) denotes an oxygen atom or a single bond, c is 1 or 2, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl and alkenyl* preferably denote CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

Very particular preference is given to mixtures comprising one, two or three compounds of the formula BC-2.

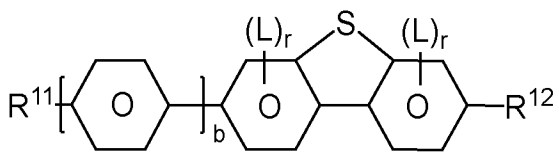
o) LC medium which additionally comprises one or more fluorinated phenanthrenes and/or dibenzofurans of the following formulae:



PH



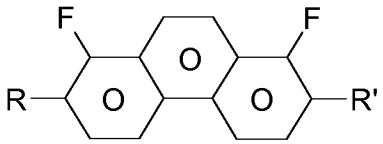
BF



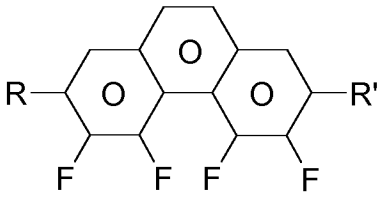
BS

in which R^{11} and R^{12} each, independently of one another, have one of the meanings indicated above for R^{11} under formula N1, b denotes 0 or 1, L denotes F, and r denotes 1, 2 or 3.

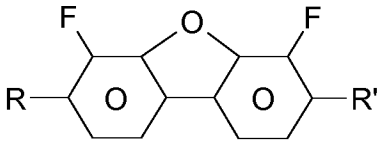
Particularly preferred compounds of the formulae PH and BF are selected from the group consisting of the following sub-formulae:



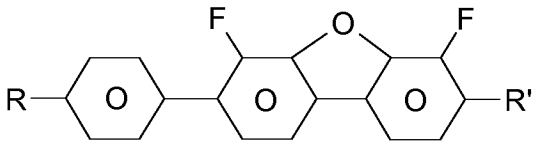
PH1



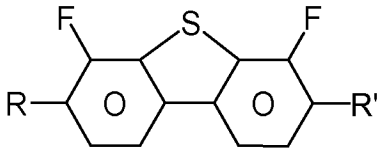
PH2



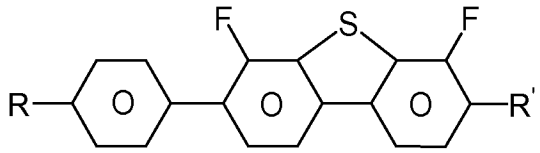
BF1



BF2



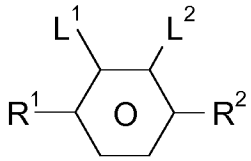
BS1



BS2

in which R and R' each, independently of one another, denote a straight-chain alkyl or alkoxy radical having 1-7 C atoms.

p) LC medium which additionally comprises one or more monocyclic compounds of the following formula



Y

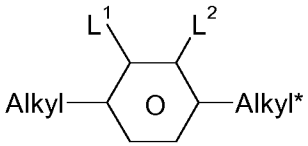
wherein

R^1 and R^2 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -OCO- or -COO- in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,

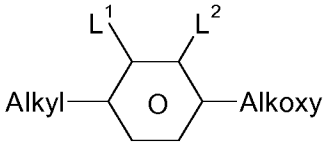
L^1 and L^2 each, independently of one another, denote F, Cl, OCF_3, CF_3, CH_3, CH_2F, CHF_2.

Preferably, both L^1 and L^2 denote F or one of L^1 and L^2 denotes F and the other denotes Cl,

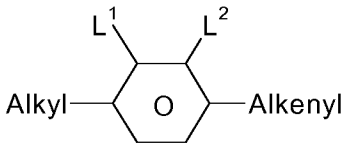
The compounds of the formula Y are preferably selected from the group consisting of the following sub-formulae:



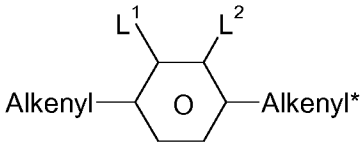
Y1



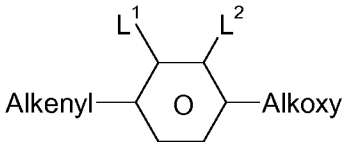
Y2



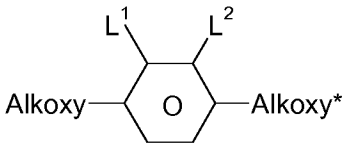
Y3



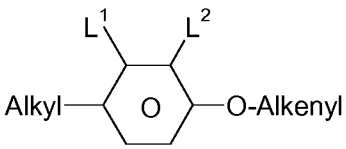
Y4



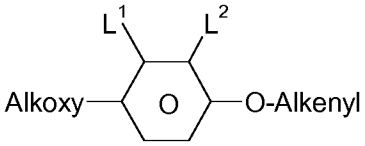
Y5



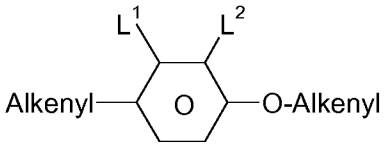
Y6



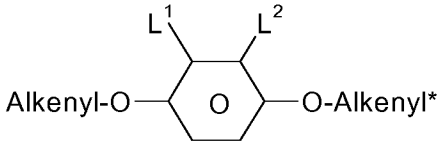
Y7



Y8



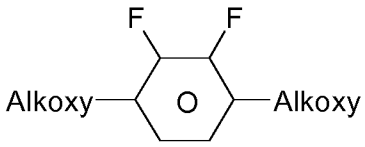
Y9



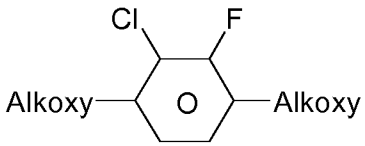
Y10,

in which, Alkyl and Alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, Alkoxy denotes a straight-chain alkoxy radical having 1-6 C atoms, Alkenyl and Alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-6 C atoms, and O denotes an oxygen atom or a single bond. Alkenyl and Alkenyl* preferably denote CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-, CH_3-$(CH_2)_3$-CH=CH- or CH_3-CH=CH-$(CH_2)_2$-.

Particularly preferred compounds of the formula Y are selected from the group consisting of the following sub-formulae:



Y6A



Y6B

wherein Alkoxy preferably denotes straight-chain alkoxy with 3, 4, or 5 C atoms.

q) LC medium which, apart from the stabilisers according to the invention, in particular of the formula I or sub-formulae thereof and the comonomers, comprises no compounds which contain a terminal vinyloxy group (-O-CH=CH_2).

r) LC medium which comprises 1 to 5, preferably 1, 2 or 3, stabilisers, preferably selected from stabilisers according to the invention, in particular of the formula I or sub-formulae thereof.

s) LC medium in which the proportion of stabilisers, in particular of the formula I or sub-formulae thereof, in the mixture as a whole is 1 to 1500ppm, preferably 100 to 1000ppm.

t) LC medium which comprises 1 to 8, preferably 1 to 5, compounds of the formulae CY1, CY2, PY1 and/or PY2. The proportion of these compounds in the mixture as a whole is preferably 5 to 60%, particularly preferably 10 to 35%. The content of these individual compounds is preferably in each case 2 to 20%.

u) LC medium which comprises 1 to 8, preferably 1 to 5, compounds of the formulae CY9, CY10, PY9 and/or PY10. The proportion of these compounds in the mixture as a whole is preferably 5 to 60%, particularly preferably 10 to 35%. The content of these individual compounds is preferably in each case 2 to 20%.

v) LC medium which comprises 1 to 10, preferably 1 to 8, compounds of the formula ZK, in particular compounds of the formulae ZK1, ZK2 and/or ZK6. The proportion of these compounds in the mixture as a

whole is preferably 3 to 25%, particularly preferably 5 to 45%. The content of these individual compounds is preferably in each case 2 to 20%.

w) LC medium in which the proportion of compounds of the formulae CY, PY and ZK in the mixture as a whole is greater than 70%, preferably greater than 80%.

x) LC medium in which the LC host mixture contains one or more compounds containing an alkenyl group, preferably selected from the group consisting of formula CY, PY and LY, wherein one or both of R^1 and R^2 denote straight-chain alkenyl having 2-6 C atoms, formula ZK and DK, wherein one or both of R^3 and R^4 or one or both of R^5 and R^6 denote straight-chain alkenyl having 2-6 C atoms, and formula B2 and B3, very preferably selected from formulae CY15, CY16, CY24, CY32, PY15, PY16, ZK3, ZK4, DK3, DK6, B2 and B3, most preferably selected from formulae ZK3, ZK4, B2 and B3. The concentration of these compounds in the LC host mixture is preferably from 2 to 70%, very preferably from 3 to 55%.

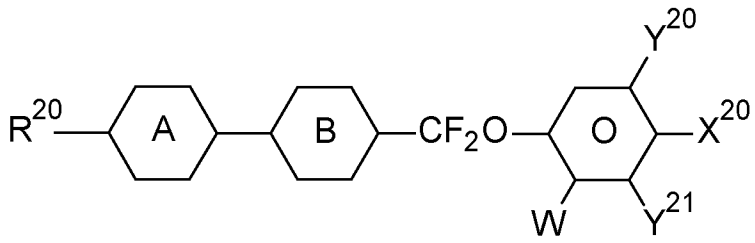
y) LC medium which contains one or more, preferably 1 to 5, compounds selected of formula PY1-PY8, very preferably of formula PY2. The proportion of these compounds in the mixture as a whole is preferably 1 to 30%, particularly preferably 2 to 20%. The content of these individual compounds is preferably in each case 1 to 20%.

z) LC medium which contains one or more, preferably 1, 2 or 3, compounds of formula T2. The content of these compounds in the mixture as a whole is preferably 1 to 20%.

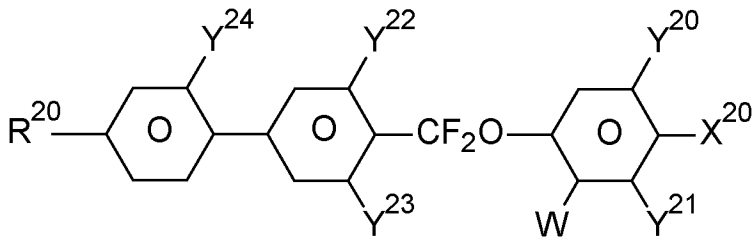
In another preferred embodiment of the present invention the LC medium contains an LC host mixture with positive dielectric anisotropy. Preferred

embodiments of such an LC medium, and the corresponding LC host mixture, are those of sections aa) - mmm) below:

aa) LC-medium, characterised in that it comprises one or more compounds selected from the group of compounds of the formulae II and III



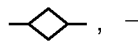
II



III

wherein

R^{20} each, identically or differently, denote a halogenated or unsubstituted alkyl or alkoxy radical having 1 to 15 C atoms, where, in addition, one or more CH_2 groups in these radicals may each be replaced, independently of one another,

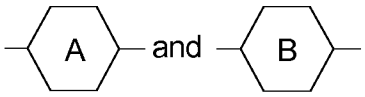
by -C≡C-, -CF_2O-, -CH=CH-,  ,  , -O-, -CO-O- or -O-CO- in such a way that O atoms are not linked directly to one another,

X^{20} each, identically or differently, denote F, Cl, CN, SF_5, SCN, NCS, a halogenated alkyl radical, a halogenated alkenyl

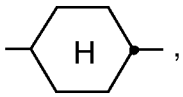
radical, a halogenated alkoxy radical or a halogenated alkenyloxy radical, each having up to 6 C atoms, and

Y^{20-24} each, identically or differently, denote H or F;

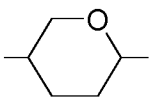
W denotes H or methyl,



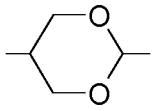
each, independently of one another, denote



,

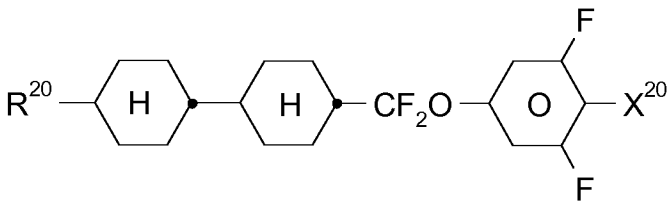


or

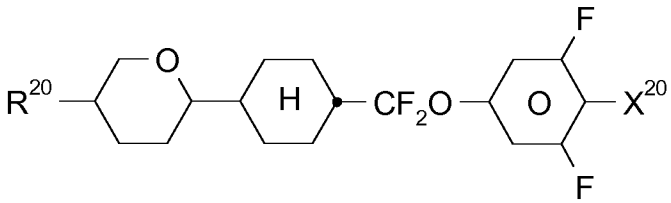


.

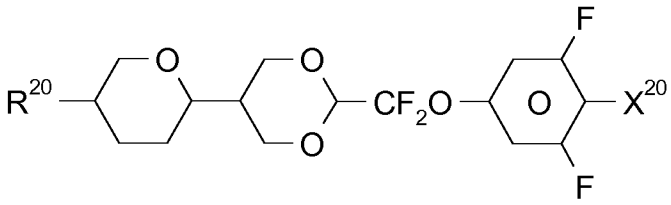
The compounds of the formula II are preferably selected from the following formulae:



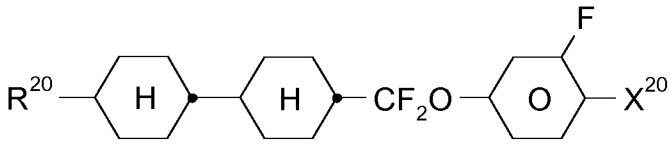
IIa



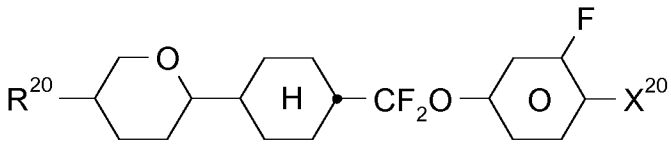
IIb



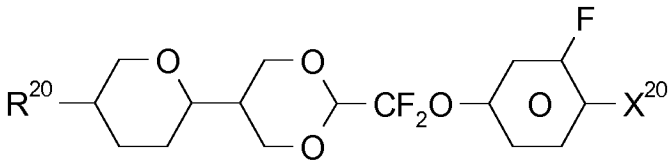
IIc



IId



IIe

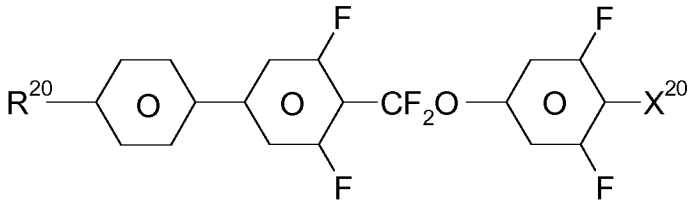


IIf

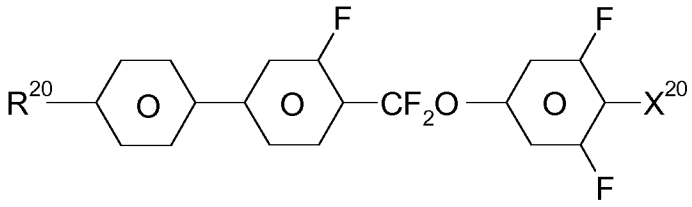
wherein R^{20} and X^{20} have the meanings indicated above.

R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F. Particular preference is given to compounds of the formulae IIa and IIb, in particular compounds of the formulae IIa and IIb wherein X denotes F.

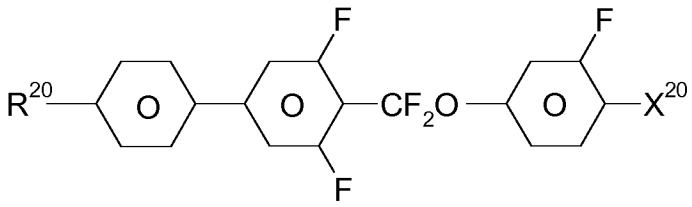
The compounds of the formula III are preferably selected from the following formulae:



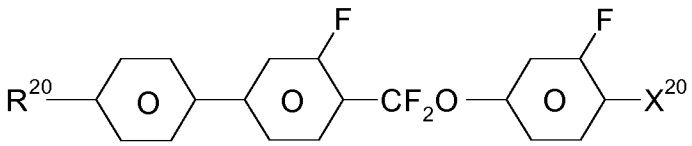
IIIa



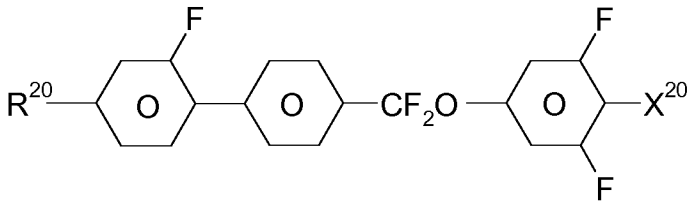
IIIb



IIIc



IIId

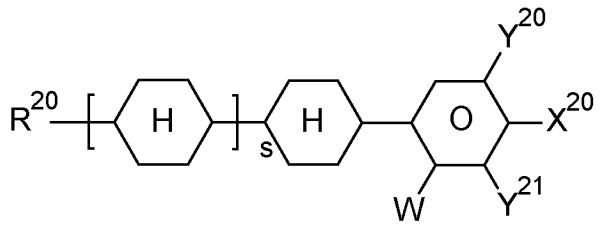


IIIe

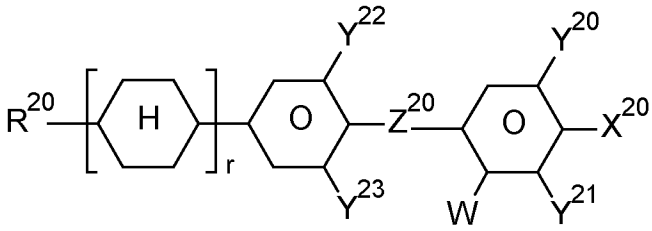
wherein R^{20} and X^{20} have the meanings indicated above.

R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F. Particular preference is given to compounds of the formulae IIIa and IIIe, in particular compounds of the formula IIIa;

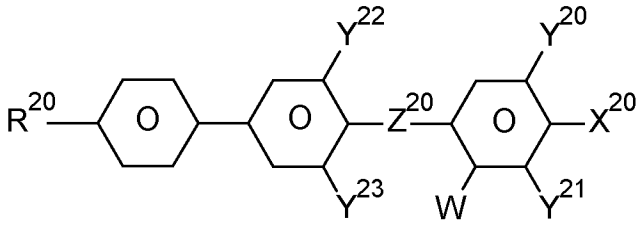
bb) LC-medium additionally comprising one or more compounds selected from the following formulae:



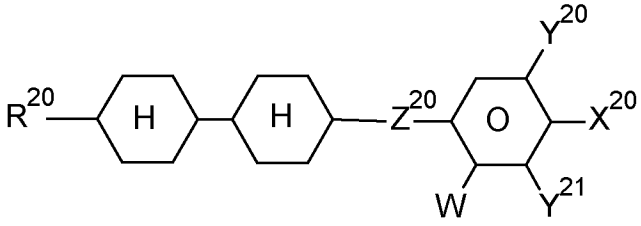
IV



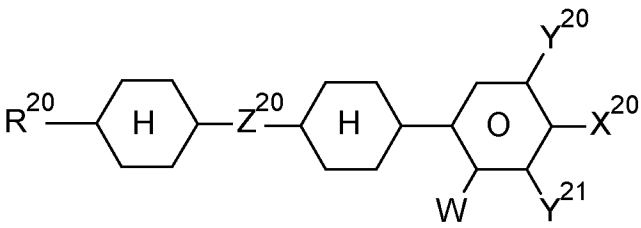
V



VI



VII



VIII

wherein

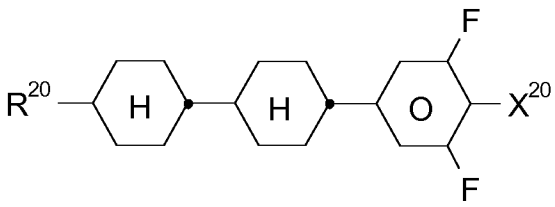
R^{20}, X^{20}, W and Y^{20-23} have the meanings indicated above under formula II, and

Z^{20} denotes $-C_2H_4-$, $-(CH_2)_4-$, -CH=CH-, -CF=CF, $-C_2F_4-$, $-CH_2CF_2-$, $-CF_2CH_2-$, $-CH_2O-$, $-OCH_2-$, -COO- or $-OCF_2-$, in formulae V and VI also a single bond, in formulae V and VIII also $-CF_2O-$,

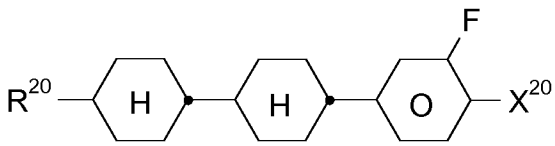
r denotes 0 or 1, and

s denotes 0 or 1;

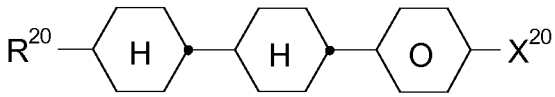
- The compounds of the formula IV are preferably selected from the following formulae:



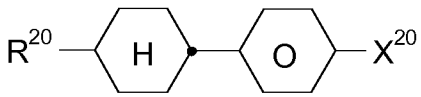
IVa



IVb



IVc

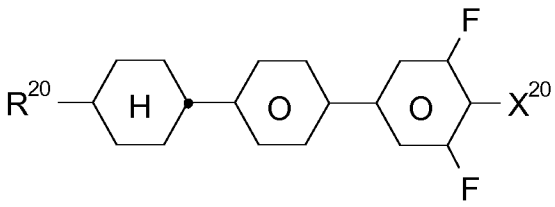


IVd

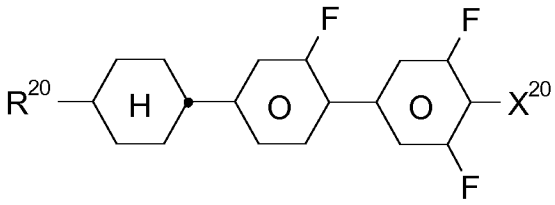
wherein R^{20} and X^{20} have the meanings indicated above.

R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F or OCF_3, furthermore $OCF=CF_2$ or Cl;

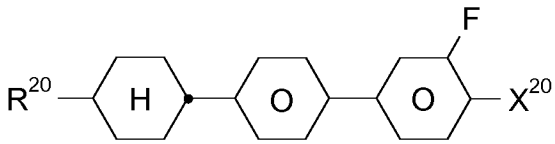
- The compounds of the formula V are preferably selected from the following formulae:



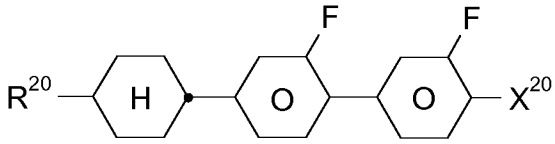
Va



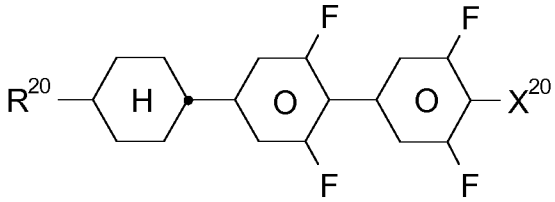
Vb



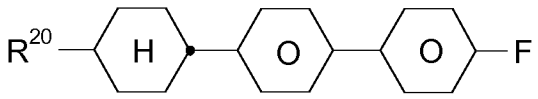
Vc



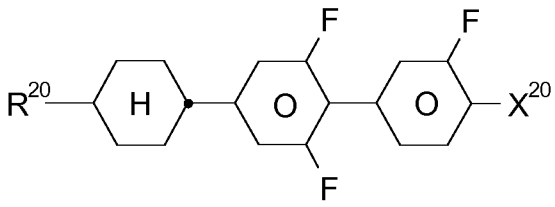
Vd



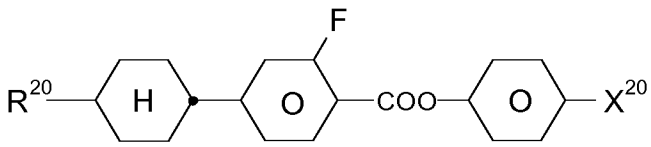
Ve



Vf



Vg

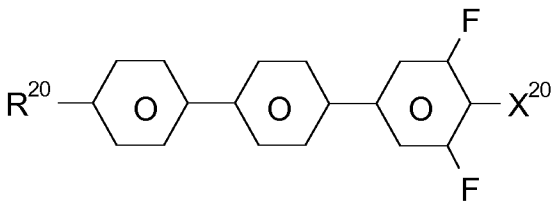


Vh

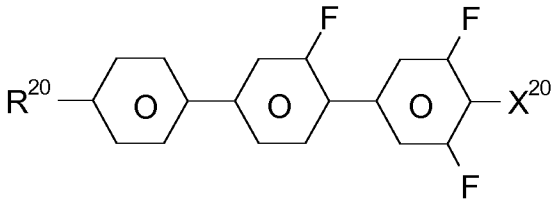
wherein R^{20} and X^{20} have the meanings indicated above.

R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F and OCF_3, furthermore $OCHF_2$, CF_3, $OCF=CF_2$ and $OCH=CF_2$;

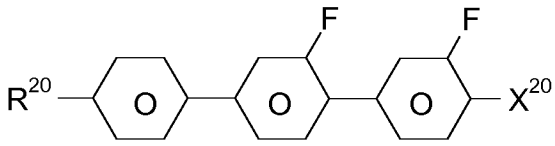
- The compounds of the formula VI are preferably selected from the following formulae:



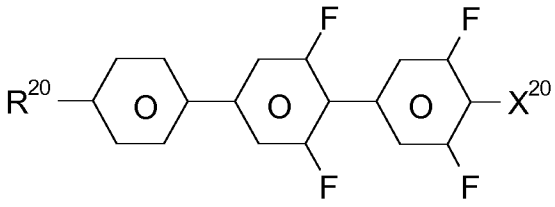
VIa



VIb



VIc

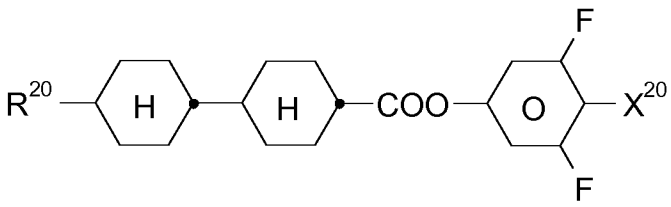


VId

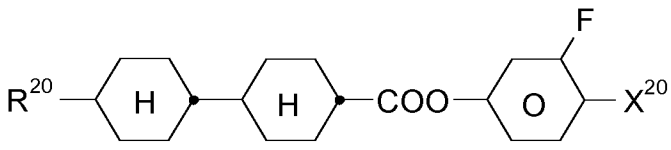
wherein R^{20} and X^{20} have the meanings indicated above.

R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F, furthermore OCF_3, CF_3, $CF=CF_2$, $OCHF_2$ and $OCH=CF_2$;

- The compounds of the formula VII are preferably selected from the following formulae:



VIIa



VIIb

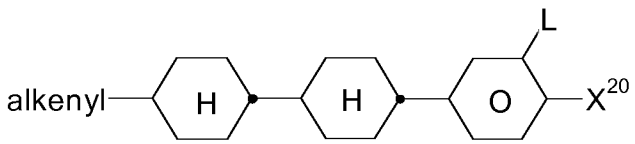
wherein R^{20} and X^{20} have the meanings indicated above.

R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F, furthermore OCF_3, $OCHF_2$ and $OCH=CF_2$.

cc) The medium additionally comprises one or more compounds selected from the formulae ZK1 to ZK10 given above. Especially preferred are compounds of formula ZK1 and ZK3. Particularly preferred compounds of formula ZK are selected from the sub-formulae ZK1a, ZK1b, ZK1c, ZK3a, ZK3b, ZK3c and ZK3d.

dd) The medium additionally comprises one or more compounds selected from the formulae DK1 to DK12 given above. Especially preferred compounds are DK3.

ee) The medium additionally comprises one or more compounds selected from the following formulae:



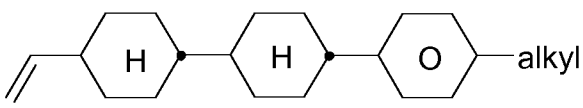
IX

wherein X^{20} has the meanings indicated above, and

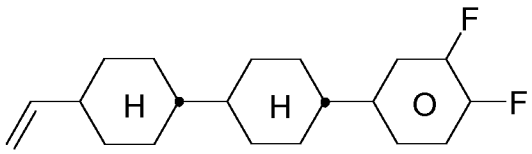
L denotes H or F,

"alkenyl" denotes C_{2-6}-alkenyl.

ff) The compounds of the formulae DK-3a and IX are preferably selected from the following formulae:



DK3a

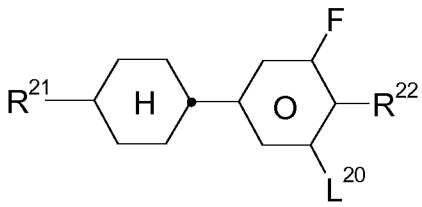


IXa

wherein "alkyl" denotes C_{1-6}-alkyl, preferably n-C_3H_7, n-C_4H_9 or n-C_5H_{11}, in particular n-C_3H_7.

gg) The medium additionally comprises one or more compounds selected from the formulae B1, B2 and B3 given above, preferably from the formula B2. The compounds of the formulae B1 to B3 are particularly preferably selected from the formulae B1a, B2a, B2b and B2c.

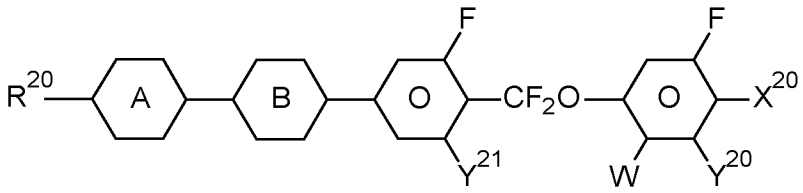
hh) The medium additionally comprises one or more compounds selected from the following formula:



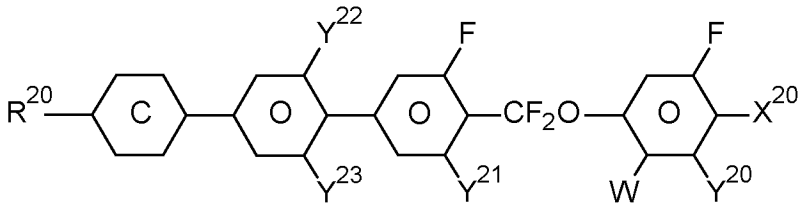
X

wherein L^{20} denotes H or F, and R^{21} and R^{22} each, identically or differently, denote n-alkyl, alkoxy, oxaalkyl, fluoroalkyl or alkenyl, each having up to 6 C atoms, and preferably each, identically or differently, denote alkyl having 1 to 6 C atoms.

ii) The medium comprises one or more compounds of the following formulae:

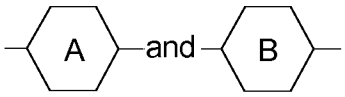


XI

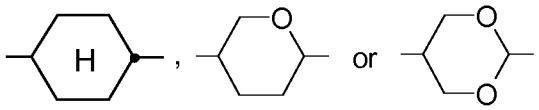


XII

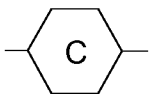
Wherein W, R^{20}, X^{20} and Y^{20-23} have the meanings indicated in formula III, and



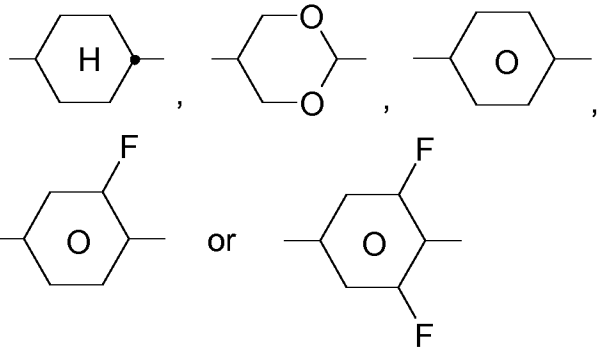
each, independently of one another, denote



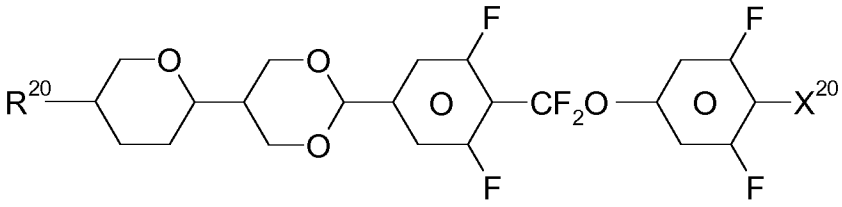
and



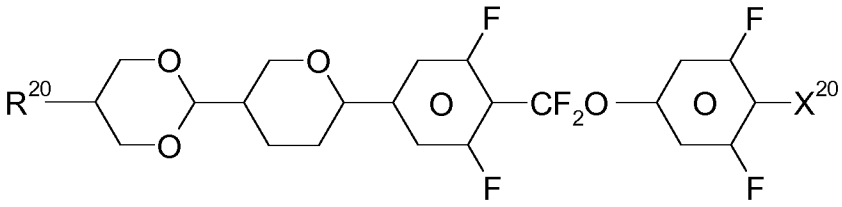
denotes



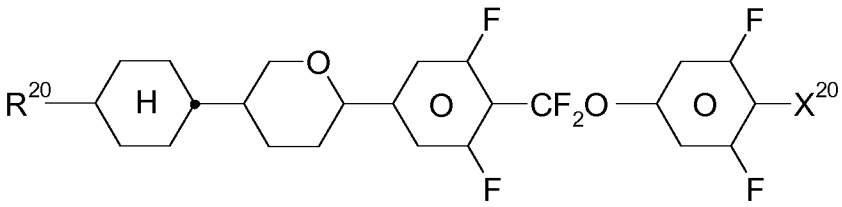
The compounds of the formulae XI and XII are preferably selected from the following formulae:



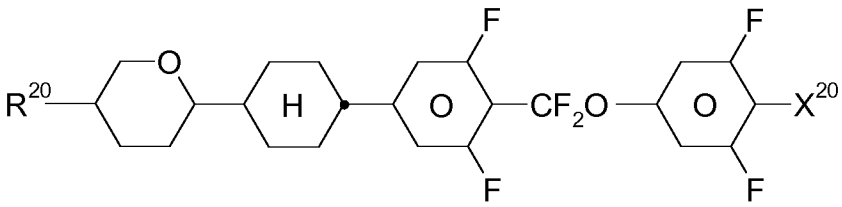
XIa



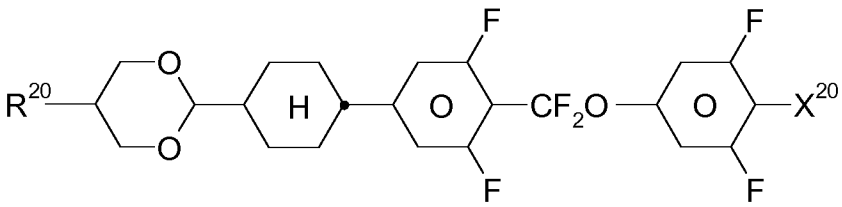
XIb



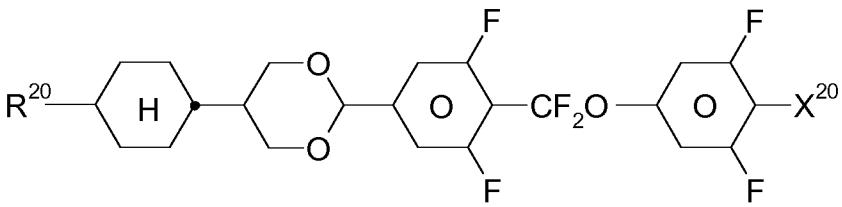
XIc



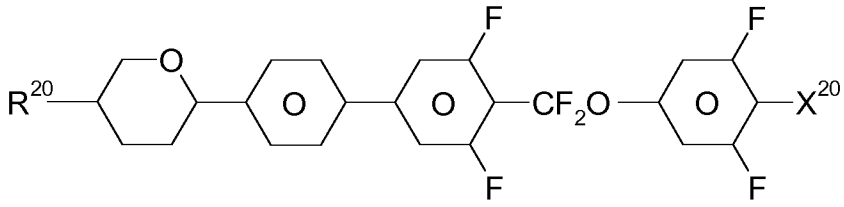
XId



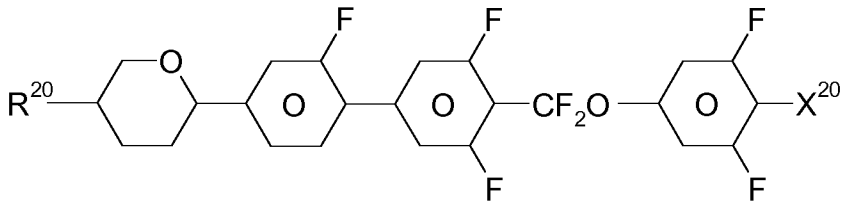
XIe



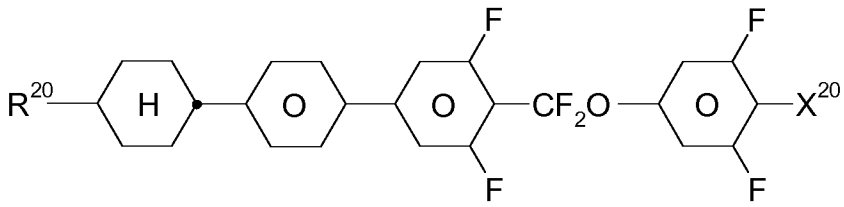
XIf



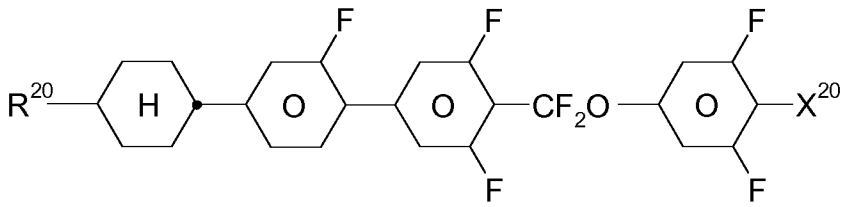
XIIa



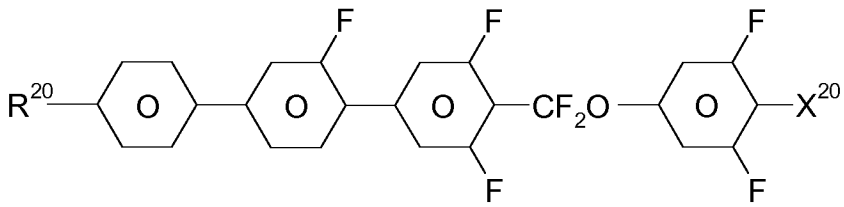
XIIb



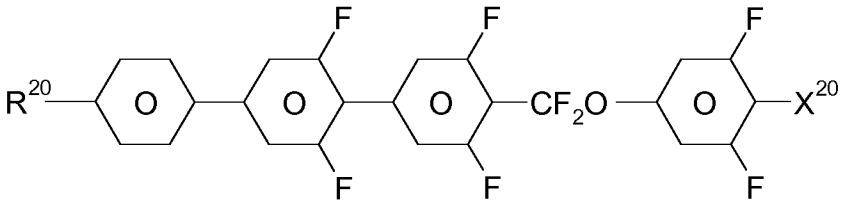
XIIc



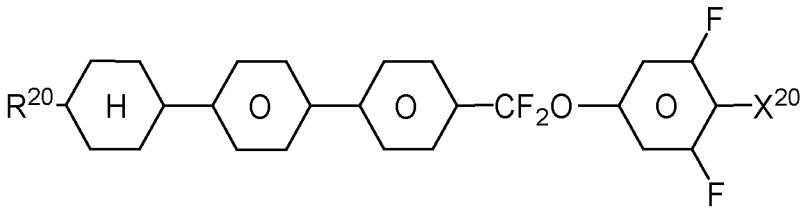
XIId



XIIe



XIIf



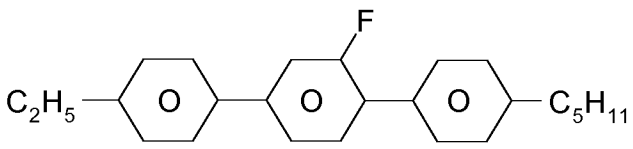
XIIg

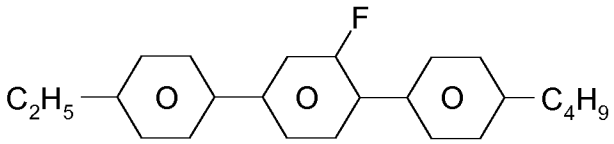
wherein R^{20} and X^{20} have the meaning indicated above and preferably R^{20} denotes alkyl having 1 to 6 C atoms and X^{20} denotes F.

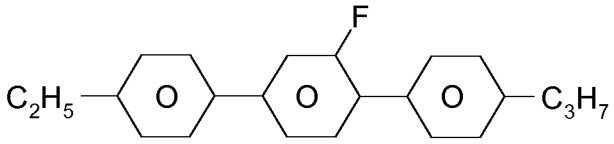
The mixture according to the invention particularly preferably comprises at least one compound of the formula XIIa and/or XIIe.

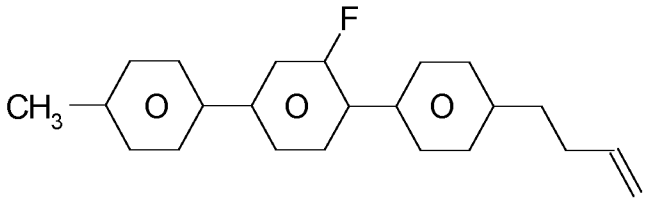
jj) The medium comprises one or more compounds of formula T given above, preferably selected from the group of compounds of the formulae T21 toT23 and T25 to T27.

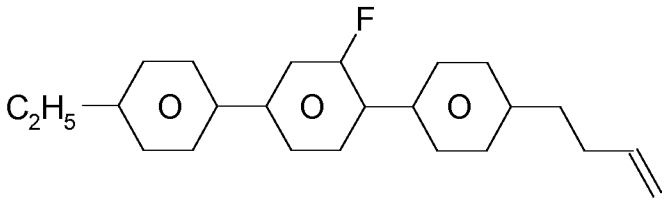
Particular preference is given to the compounds of the formulae T21 to T23. Very particular preference is given to the compounds of the formulae

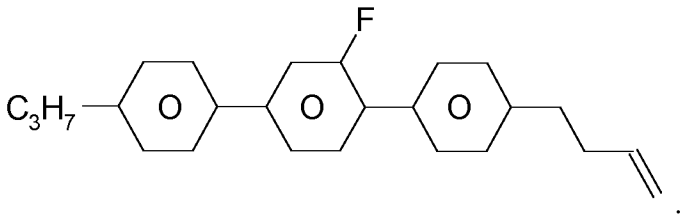






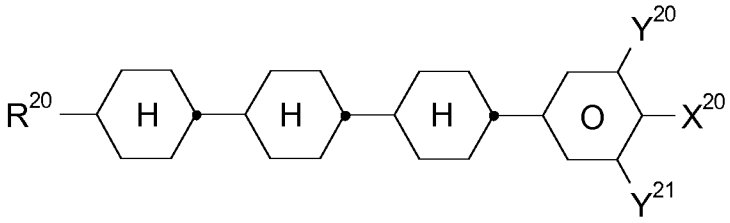




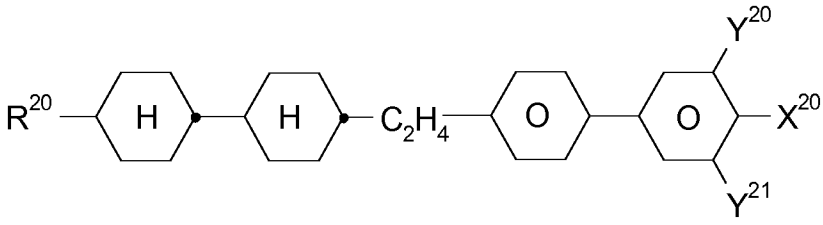


kk) The medium comprises one or more compounds selected from the group of formulae DK9, DK10 and DK11 given above.

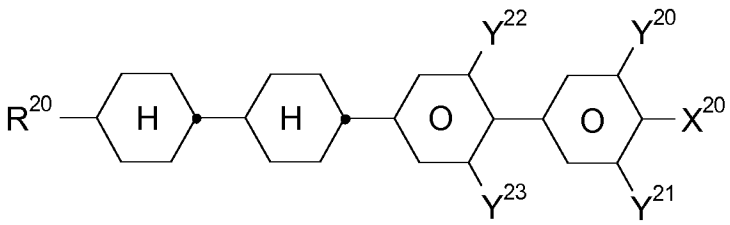
ll) The medium additionally comprises one or more compounds selected from the following formulae:



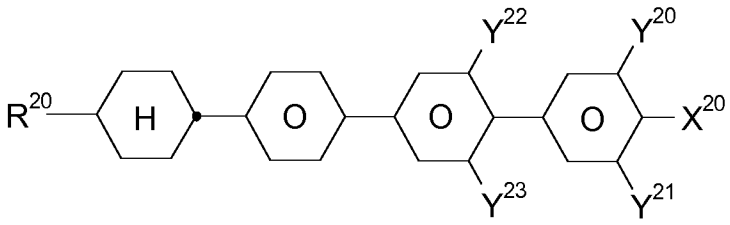
XIII



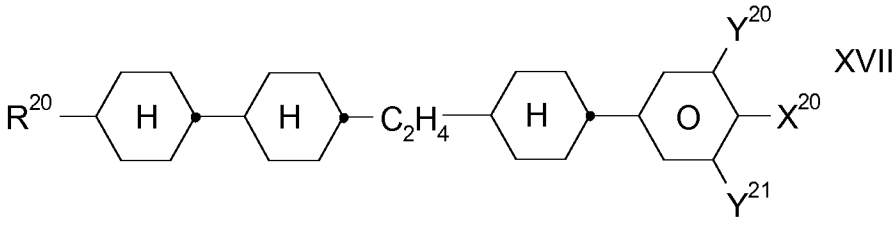
XIV



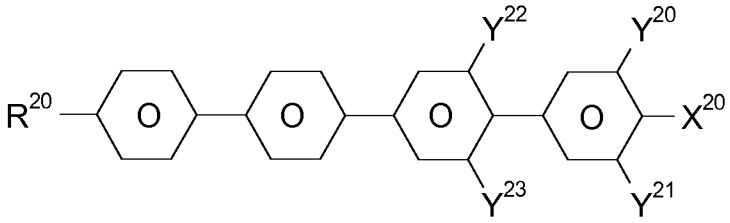
XV



XVI



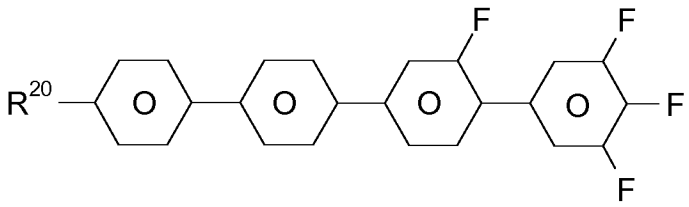
XVII



XVIII

wherein R^{20} and X^{20} each, independently of one another, have one of the meanings indicated above, and Y^{20-23} each, independently of one another, denote H or F. X^{20} is preferably F, Cl, CF_3, OCF_3 or $OCHF_2$. R^{20} preferably denotes alkyl, alkoxy, oxaalkyl, fluoroalkyl or alkenyl, each having up to 6 C atoms.

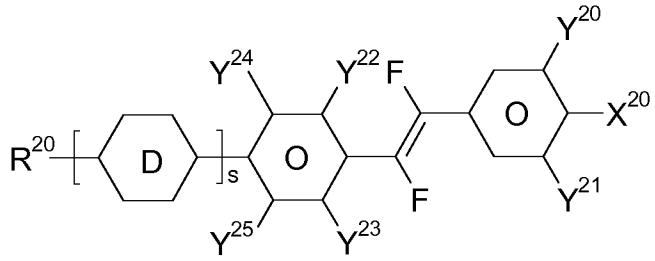
The mixture according to the invention particularly preferably comprises one or more compounds of the formula XVIII-a,



XVIII-a

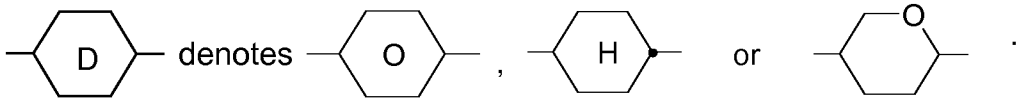
wherein R^{20} has the meanings indicated above. R^{20} preferably denotes straight-chain alkyl, in particular ethyl, n-propyl, n-butyl and n-pentyl and very particularly preferably n-propyl. The compound(s) of the formula XVIII, in particular of the formula XVIII-a, is (are) preferably employed in the mixtures according to the invention in amounts of 0.5-20% by weight, particularly preferably 1-15% by weight.

mm) The medium additionally comprises one or more compounds of the formula XIX,



XIX

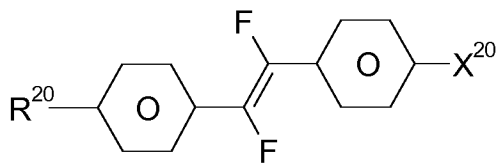
wherein R^{20}, X^{20} and Y^{20-25} have the meanings indicated in formula I, s denotes 0 or 1, and



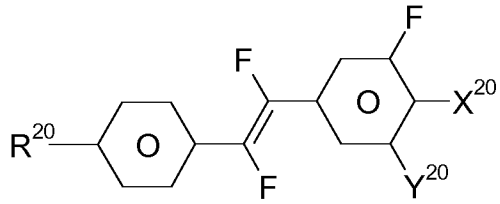
In the formula XIX, X^{20} may also denote an alkyl radical having 1-6 C atoms or an alkoxy radical having 1-6 C atoms. The alkyl or alkoxy radical is preferably straight-chain.

R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F;

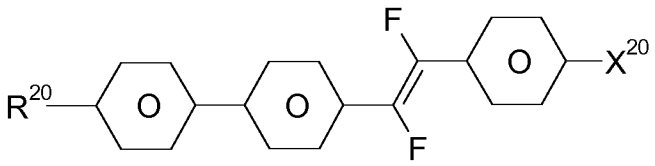
- The compounds of the formula XIX are preferably selected from the following formulae:



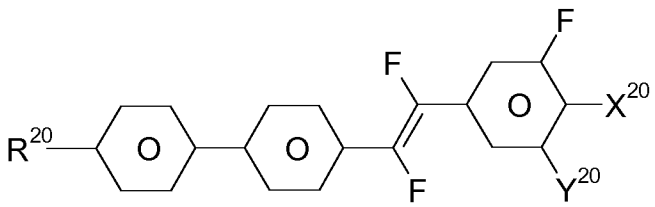
XIXa



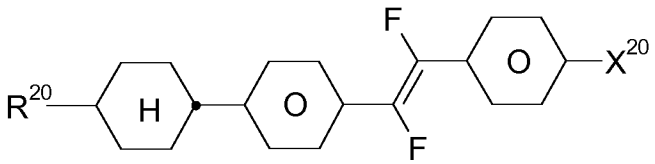
XIXb



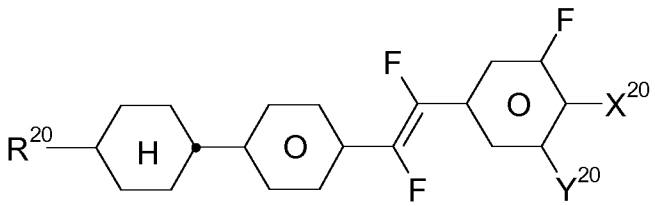
XIXc



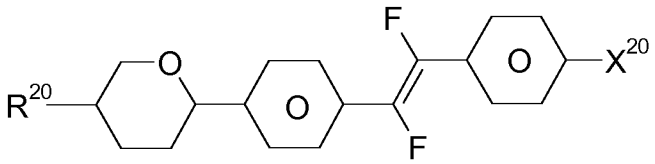
XIXd



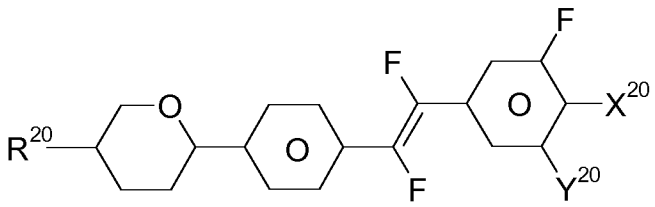
XIXe



XIXf

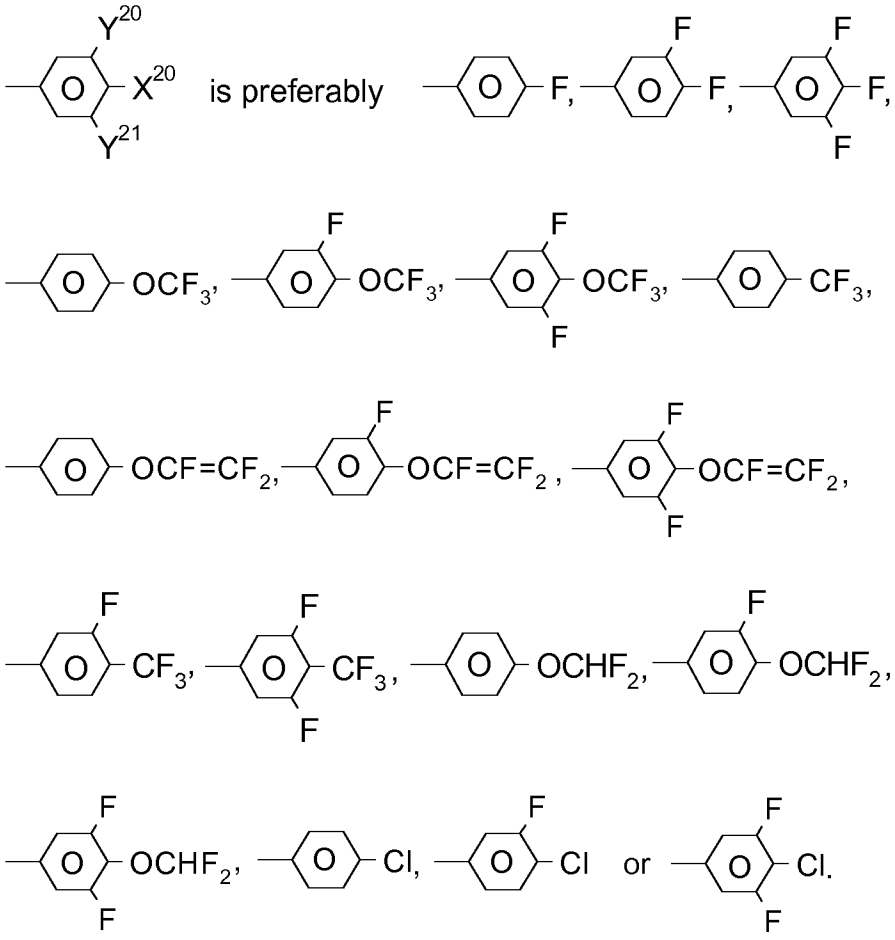


XIXg



XIXh

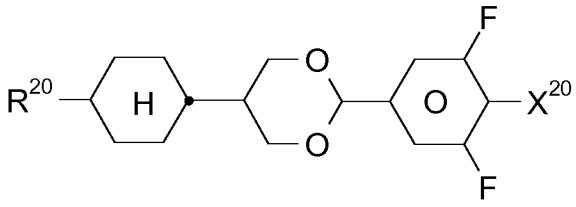
wherein R^{20}, X^{20} and Y^{20} have the meanings indicated above. R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F, and Y^{20} is preferably F;

- 

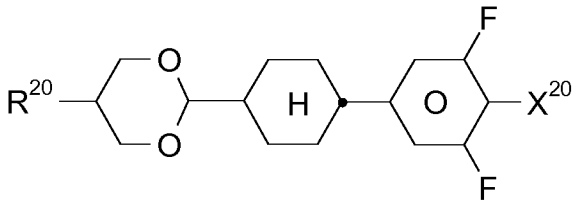
- R^{20} is straight-chain alkyl or alkenyl having 2 to 6 C atoms;

nn) The medium comprises one or more compounds of the formulae G1 to G4 given above, preferably selected from G1 and G2 wherein alkyl denotes C_{1-6}-alkyl, L^x denotes H and X denotes F or Cl. In G2, X particularly preferably denotes Cl.

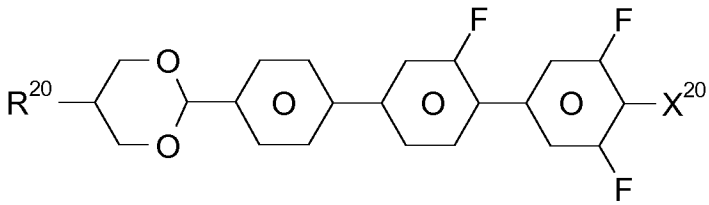
oo) The medium comprises one or more compounds of the following formulae:



XX



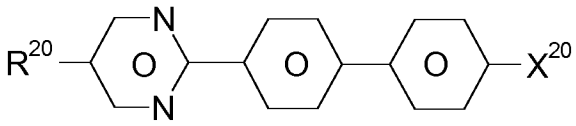
XXI



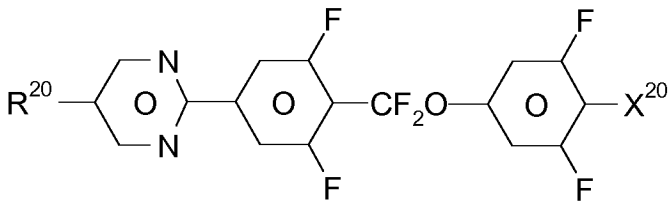
XXII

wherein R^{20} and X^{20} have the meanings indicated above. R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F. The medium according to the invention particularly preferably comprises one or more compounds of the formula XXII wherein X^{20} preferably denotes F. The compound(s) of the formulae XX - XXII is (are) preferably employed in the mixtures according to the invention in amounts of 1-20% by weight, particularly preferably 1-15% by weight. Particularly preferred mixtures comprise at least one compound of the formula XXII.

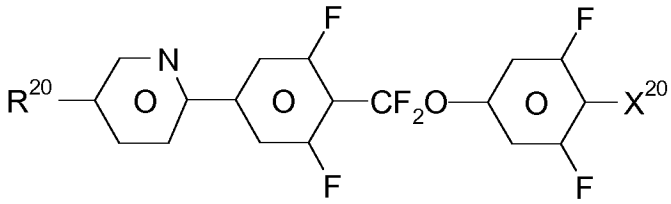
pp) The medium comprises one or more compounds of the following pyrimidine or pyridine compounds of the formulae



M-1



M-2



M-3

wherein R^{20} and X^{20} have the meanings indicated above. R^{20} preferably denotes alkyl having 1 to 6 C atoms. X^{20} preferably denotes F. The medium according to the invention particularly preferably comprises one or more compounds of the formula M-1, wherein X^{20} preferably denotes F. The compound(s) of the formulae M-1 - M-3 is (are) preferably employed in the mixtures according to the invention in amounts of 1-20% by weight, particularly preferably 1-15% by weight.

Further preferred embodiments are indicated below:

qq) The medium comprises two or more compounds of the formula XII, in particular of the formula XIIe;

rr) The medium comprises 2-30% by weight, preferably 3-20% by weight, particularly preferably 3-15% by weight, of compounds of the formula XII;

ss) Besides the compounds of the formulae XII, the medium comprises further compounds selected from the group of the compounds of the formulae II, III, IX-XIII, XVII and XVIII;

tt) The proportion of compounds of the formulae II, III, IX-XI, XIII, XVII and XVIII in the mixture as a whole is 40 to 95% by weight;

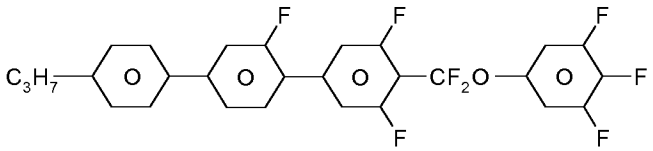
uu) The medium comprises 10-50% by weight, particularly preferably 12-40% by weight, of compounds of the formulae II and/or III;

vv) The medium comprises 20-70% by weight, particularly preferably 25-65% by weight, of compounds of the formulae IX-XIII;

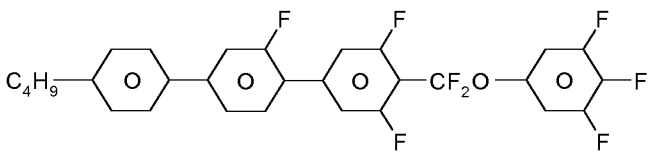
ww) The medium comprises 4-30% by weight, particularly preferably 5-20% by weight, of compounds of the formula XVII;

xx) The medium comprises 1-20% by weight, particularly preferably 2-15% by weight, of compounds of the formula XVIII;

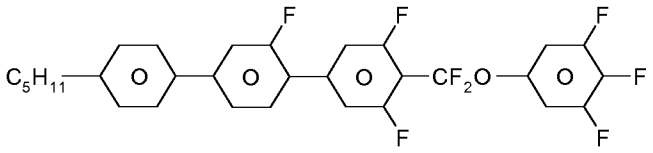
yy) The medium comprises at least two compounds of the formulae



XIIe-1

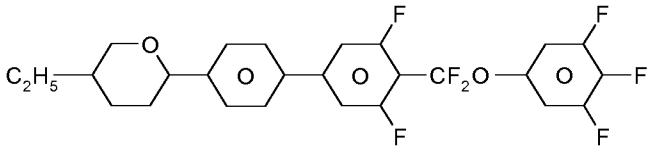


XIIe-2

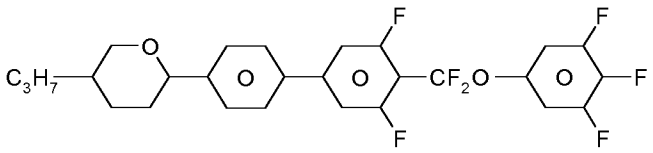


XIIe-3.

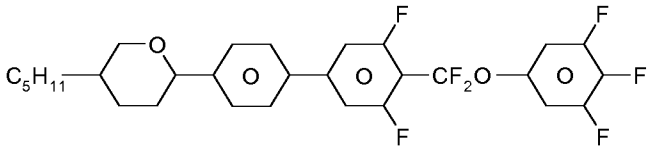
zz) The medium comprises at least two compounds of the formulae



XIIa-1



XIIa-2



XIIa-3.

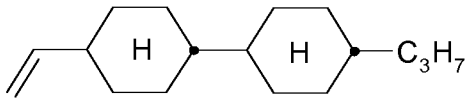
aaa) The medium comprises at least two compounds of the formula XIIa and at least two compounds of the formula XIIe.

bbb) The medium comprises at least one compound of the formula XIIa and at least one compound of the formula XIIe and at least one compound of the formula IIIa.

ccc) The medium comprises at least two compounds of the formula XIIa and at least two compounds of the formula XIIe and at least one compound of the formula IIIa.

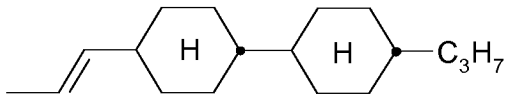
ddd) The medium comprises in total ≥ 25% by weight, preferably ≥ 30% by weight, of one or more compounds of the formula XII.

eee) The medium comprises ≥ 20% by weight, preferably ≥ 24% by weight, preferably 25-60% by weight, of compounds of the formula ZK3, in particular the compound of the formula ZK3a,



ZK3a

fff) The medium comprises at least one compound selected from the group of compounds ZK3a, ZK3b and ZK3c, preferably ZK3a, in combination with compound ZK3d



ZK3d

ggg) The medium comprises at least one compound of the formula DPGU-n-F.

hhh) The medium comprises at least one compound of the formula CDUQU-n-F.

iii) The medium comprises at least one compound of the formula CPU-n-OXF.

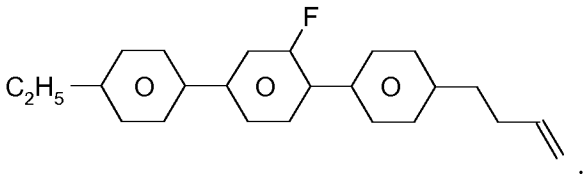
jjj) The medium comprises at least one compound of the formula CPGU-3-OT.

kkk) The medium comprises at least one compound of the formula PPGU-n-F.

lll) The medium comprises at least one compound of the formula

PGP-n-m, preferably two or three compounds.

mmm) The medium comprises at least one compound of the formula PGP-2-2V having the structure



In a preferred embodiment, the liquid crystal mixture according to the present invention further comprises a polymerizable component C) comprising one or more polymerizable compounds.

The polymerizable compounds can be selected from isotropic or mesogenic polymerizable compounds known to the skilled person in the art.

Preferably, the polymerizable component C) comprises one or more polymerizable compounds of formula P,

$$P^a\text{-}(Sp^a)_{s1}\text{-}A^2\text{-}(Z^a\text{-}A^1)_{n2}\text{-}(Sp^b)_{s2}\text{-}P^b \qquad P$$

wherein the individual radicals have the following meanings:

P^a, P^b	each, independently of one another, denote a polymerizable group,
Sp^a, Sp^b	on each occurrence, identically or differently, denote a spacer group,
s1, s2	each, independently of one another, denote 0 or 1,

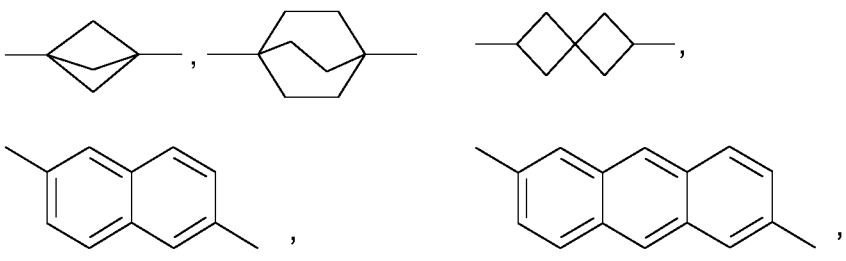
A^1, A^2 each, independently of one another, denote a radical selected from the following groups:

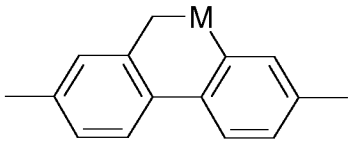
a) the group consisting of trans-1,4-cyclohexylene, 1,4-cyclohexenylene and 4,4´-bicyclohexylene, wherein, in addition, one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S- and wherein, in addition, one or more H atoms may be replaced by F,

b) the group consisting of 1,4-phenylene and 1,3-phenylene, wherein, in addition, one or two CH groups may be replaced by N and wherein, in addition, one or more H atoms may be replaced by L,

c) the group consisting of tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl, tetrahydrofuran-2,5-diyl, cyclobutane-1,3-diyl, piperidine-1,4-diyl, thiophene-2,5-diyl and selenophene-2,5-diyl, each of which may also be mono- or polysubstituted by L,

d) the group consisting of saturated, partially unsaturated or fully unsaturated, and optionally substituted, polycyclic radicals having 5 to 20 cyclic C atoms, one or more of which may, in addition, be replaced by heteroatoms, preferably selected from the group consisting of





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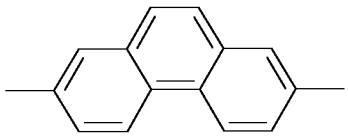
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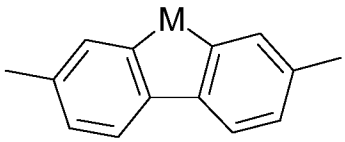

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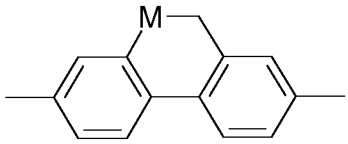

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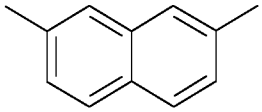
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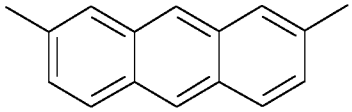
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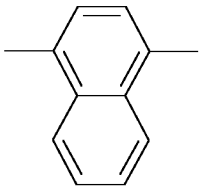
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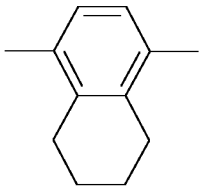
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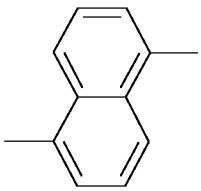
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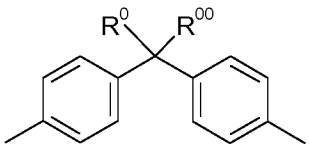


where, in addition, one or more H atoms in these radicals may be replaced by L, and/or one or more double bonds may be replaced by single bonds, and/or one or more CH groups may be replaced by N,

n2 denotes 0, 1, 2 or 3,

Z^a in each case, independently of one another, denotes -CO-O-, -O-CO-, -CH_2O-, -OCH_2-, -CF_2O-, -OCF_2-, or -$(CH_2)_n$-, where n is 2, 3 or 4, -O-, -CO-, -$C(R^yR^z)$-, -CH_2CF_2-, -CF_2CF_2- or a single bond,

L on each occurrence, identically or differently, denotes F, Cl, CN, SCN, SF_5 or straight-chain or branched, in each case optionally fluorinated, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 12 C atoms,

R^y, R^z each, independently of one another, denote H, F or straight-chain or branched alkyl having 1 to 12 C atoms, wherein, in addition, one or more H atoms may be replaced by F,

M denotes -O-, -S-, $-CH_2-$, $-CHY^1-$ or $-CY^1Y^2-$, and

Y^1 and Y^2 each, independently of one another, have one of the meanings indicated above for R^y or denote Cl or CN.

Preferred spacer groups $Sp^{a,b}$ are selected from the formula Sp"-X", so that the radicals P-Sp- and $P^{a/b}$-$Sp^{a/b}$- conforms to the formulae P-Sp"-X"- and $P^{a/b}$-Sp"-X"-, respectively, wherein

Sp" denotes alkylene having 1 to 20, preferably 1 to 12, C atoms, which is optionally mono- or polysubstituted by F, Cl, Br, I or CN and wherein, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by -O-, -S-, -NH-, $-N(R^0)-$, $-Si(R^{00}R^{000})-$, -CO-, -CO-O-, -O-CO-, -O-CO-O-, -S-CO-, -CO-S-, $-N(R^{00})-CO-O-$, $-O-CO-N(R^{00})-$, $-N(R^{00})-CO-N(R^{00})-$, -CH=CH- or -C≡C- in such a way that O and/or S atoms are not linked directly to one another,

X" denotes -O-, -S-, -CO-, -CO-O-, -O-CO-,

-O-CO-O-, -CO-N(R^{00})-, -N(R^{00})-CO-, -N(R^{00})-CO-N(R^{00})-, -OCH_2-, -CH_2O-, -SCH_2-, -CH_2S-, -CF_2O-, -OCF_2-, -CF_2S-, -SCF_2-, -CF_2CH_2-, -CH_2CF_2-, -CF_2CF_2-, -CH=N-, -N=CH-, -N=N-, -CH=CR^0-, -CY^3=CY^4-, -C≡C-, -CH=CH-CO-O-, -O-CO-CH=CH- or a single bond,

R^0, R^{00} and R^{000} each, independently of one another, denote H or alkyl having 1 to 12 C atoms, and

Y^3 and Y^4 each, identically or differently, denote H, F, Cl or CN.

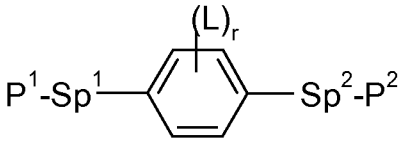
X" is preferably -O-, -S-, -CO-, -C(O)O-, -OC(O)-, -O-C(O)O-, -CO-NR^0-, -NR^0-CO-, -NR^0-CO-NR^0- or a single bond.

Typical spacer groups Sp" are, for example, -$(CH_2)_{p1}$-, -$(CH_2CH_2O)_{q1}$-CH_2CH_2-, -CH_2CH_2-S-CH_2CH_2-, -CH_2CH_2-NH-CH_2CH_2- or -$(SiR^{00}R^{000}$-O$)_{p1}$-, wherein p1 is an integer from 1 to 12, q1 is an integer from 1 to 3, and R^{00} and R^{000} have the meanings indicated above.

Particularly preferred groups -Sp"-X"- are -$(CH_2)_{p1}$-, -$(CH_2)_{p1}$-O-, -$(CH_2)_{p1}$-O-CO-, -$(CH_2)_{p1}$-O-CO-O-, wherein p1 and q1 have the meanings indicated above.

Particularly preferred groups Sp" are, for example, in each case straight-chain ethylene, propylene, butylene, pentylene, hexylene, heptylene, octylene, nonylene, decylene, undecylene, dodecylene, octadecylene, ethyleneoxyethylene, methyleneoxybutylene, ethylenethioethylene, ethylene-N-methyliminoethylene, 1-methylalkylene, ethenylene, propenylene and butenylene.

Particularly preferred monomers of formula P are the following:



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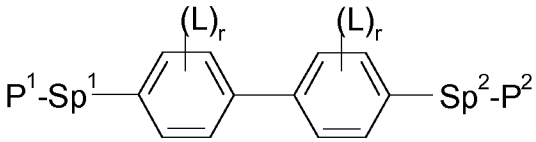

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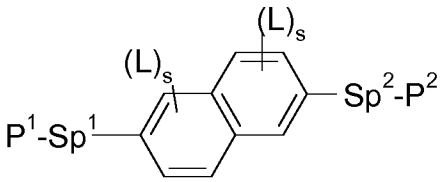

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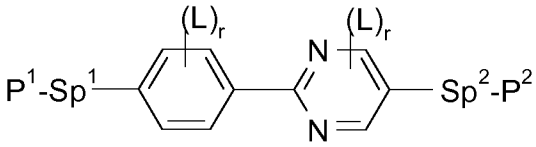

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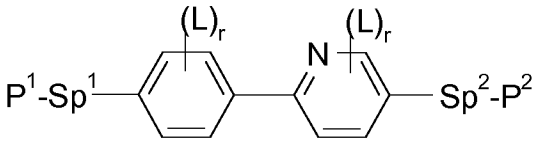

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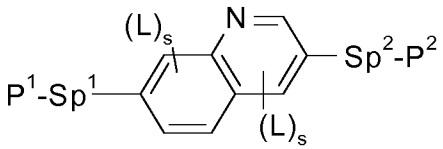

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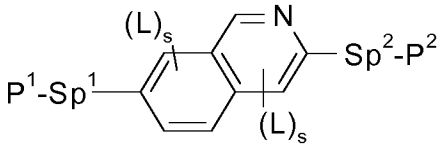

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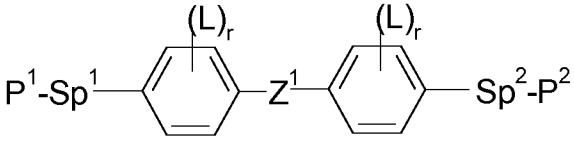

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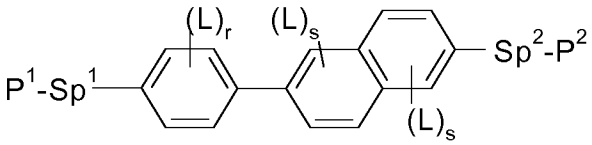

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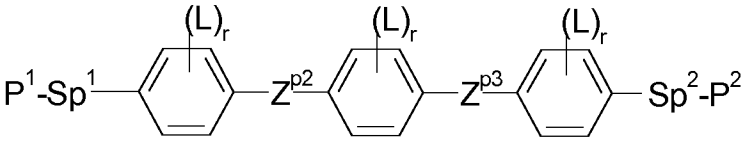

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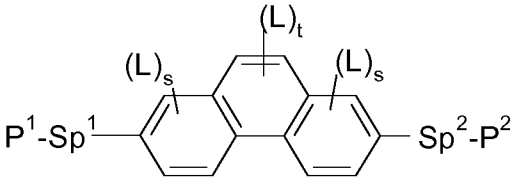

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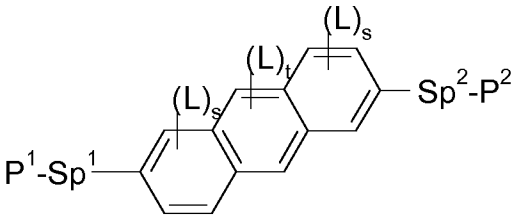

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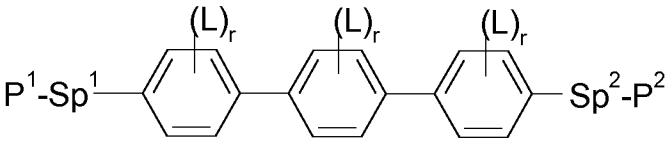

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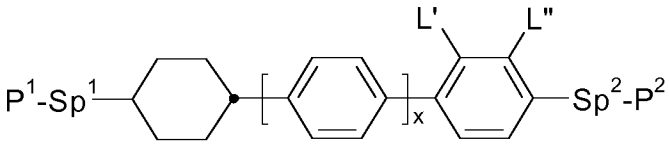

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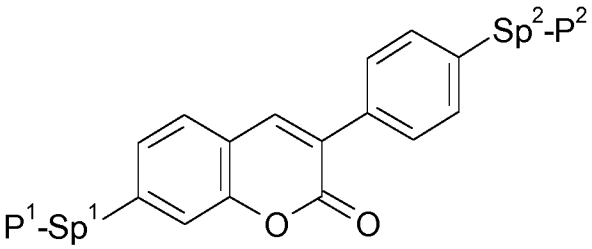

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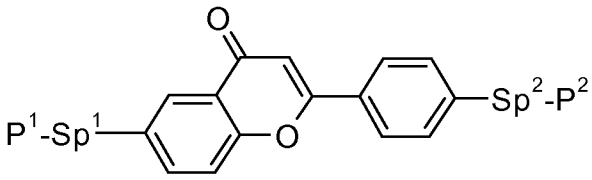

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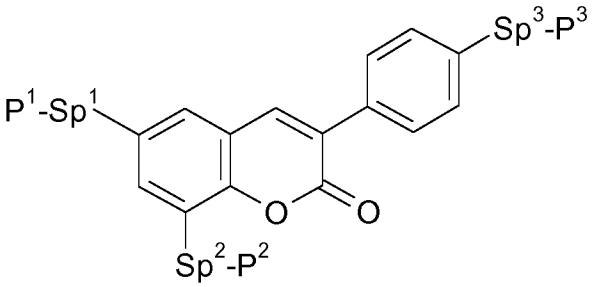

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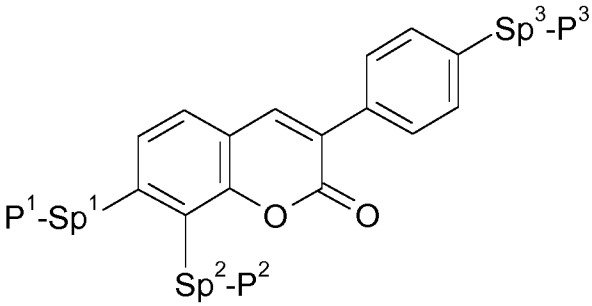

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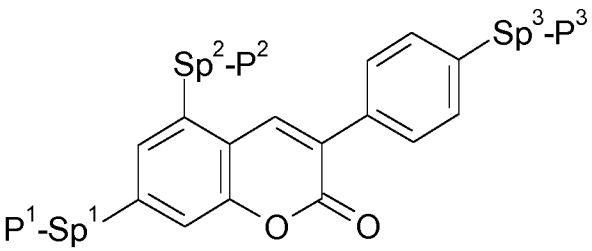

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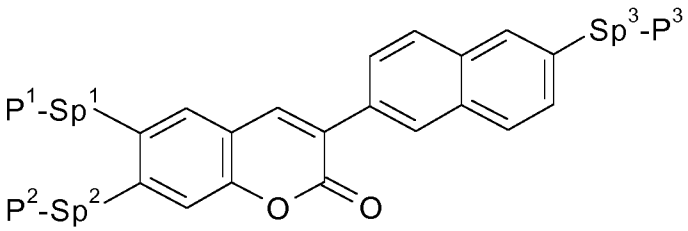

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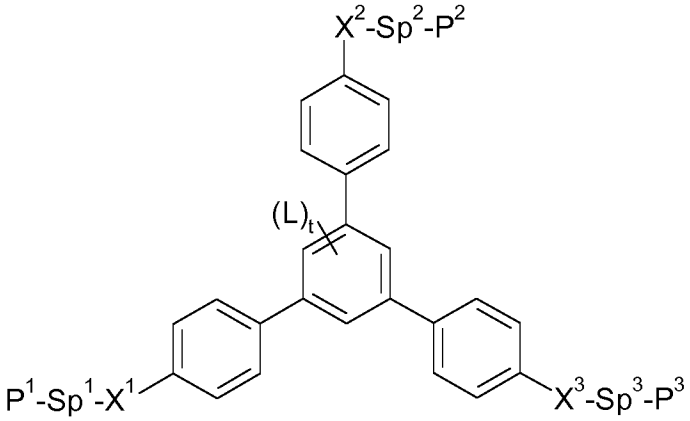

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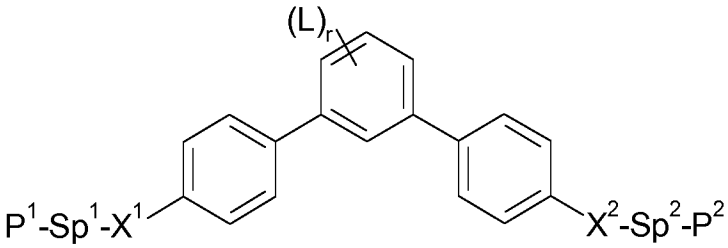

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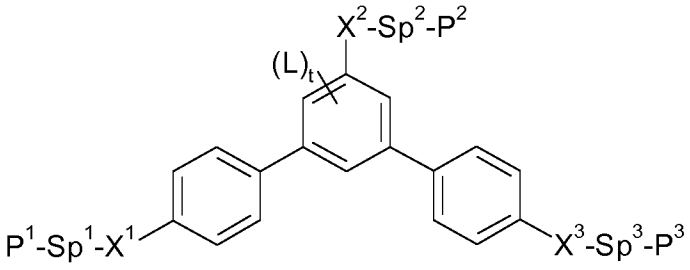

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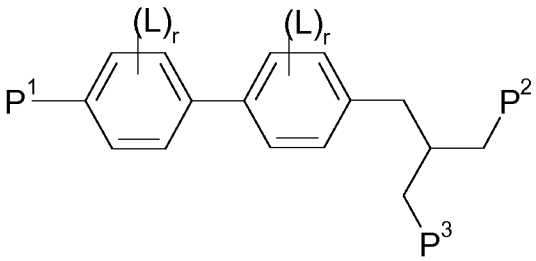

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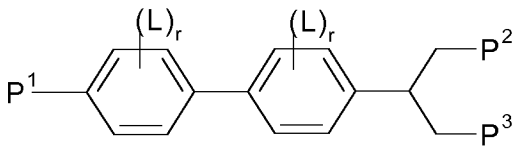

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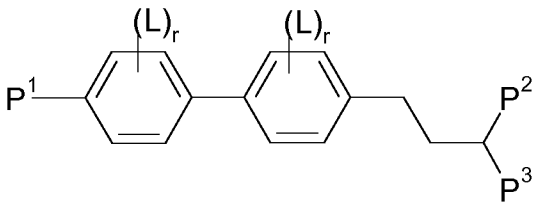

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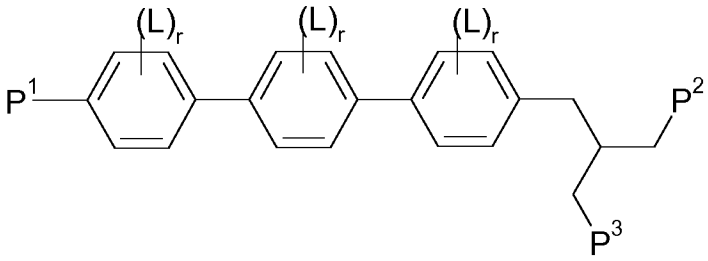

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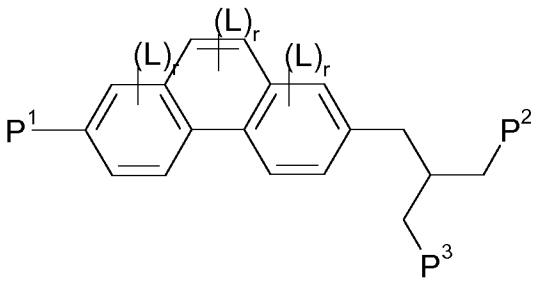

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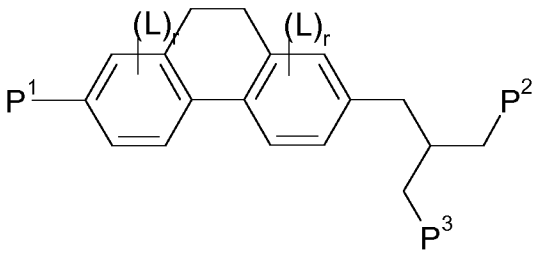

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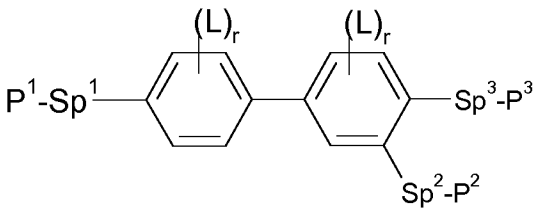

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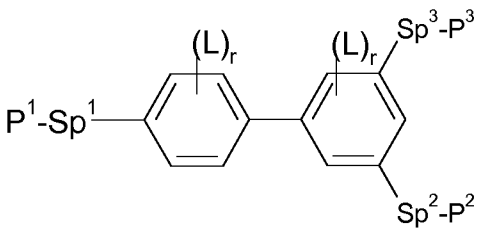


P31

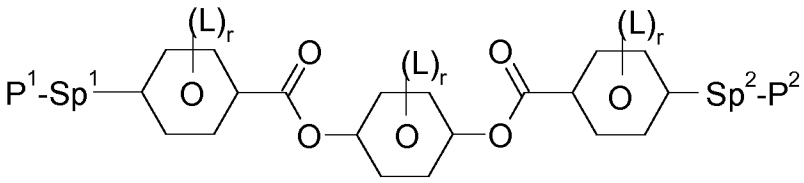
wherein the individual radicals have the following meanings:

P^1 to P^3 each, independently of one another, denote a polymerizable group as defined for formula P, preferably an acrylate, methacrylate, fluoroacrylate, oxetane, vinyloxy or epoxide group,

Sp^1 to Sp^3	each, independently of one another, denote a single bond or a spacer group, preferably having one of the meanings indicated above and below for Sp^a, and particularly preferably $-(CH_2)_{p1}-$, $-(CH_2)_{p1}-O-$, $-(CH_2)_{p1}-CO-O-$ or $-(CH_2)_{p1}-O-CO-O-$, wherein p1 is an integer from 1 to 12, and where the linking to the adjacent ring in the last-mentioned groups takes place via the O atom,
	where, in addition, one or more of the radicals P^1-Sp^1-, P^2-Sp^2- and P^3-Sp^3- may denote a radical R^{aa}, with the proviso that at least one of the radicals P^1-Sp^1-, P^2-Sp^2- and P^3-Sp^3- present does not denote R^{aa},
R^{aa}	denotes H, F, Cl, CN or straight-chain or branched alkyl having 1 to 25 C atoms, wherein, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by $C(R^0)=C(R^{00})-$, $-C\equiv C-$, $-N(R^0)-$, $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$, $-O-CO-O-$ in such a way that O and/or S atoms are not linked directly to one another, and wherein, in addition, one or more H atoms may be replaced by F, Cl, CN or P^1-Sp^1-, particularly preferably straight-chain or branched, optionally mono- or polyfluorinated alkyl, alkoxy, alkenyl, alkynyl, alkylcarbonyl, alkoxycarbonyl or alkylcarbonyloxy having 1 to 12 C atoms (where the alkenyl and alkynyl radicals have at least two C atoms and the branched radicals have at least three C atoms),
R^0, R^{00}	each, independently of one another, denote H or alkyl having 1 to 12 C atoms,
R^y and R^z	each, independently of one another, denote H, F, CH_3 or CF_3,
Z^{p1}	denotes -O-, -CO-, $-C(R^yR^z)-$ or $-CF_2CF_2-$,

	Z^{p2} and Z^{p3}	each, independently of one another, denote -CO-O-, -O-CO-, -CH_2O-, -OCH_2-, -CF_2O-, -OCF_2- or -$(CH_2)_{n3}$-, where n3 is 2, 3 or 4,
	L	on each occurrence, identically or differently, denotes F, Cl, CN, SCN, SF_5 or straight-chain or branched, optionally mono- or polyfluorinated alkyl, alkoxy, alkenyl, alkynyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 12 C atoms, preferably F,
	L' and L"	each, independently of one another, denote H, F or Cl,
	r	denotes 0, 1, 2, 3 or 4,
	s	denotes 0, 1, 2 or 3,
	t	denotes 0, 1 or 2, and
	x	denotes 0 or 1.

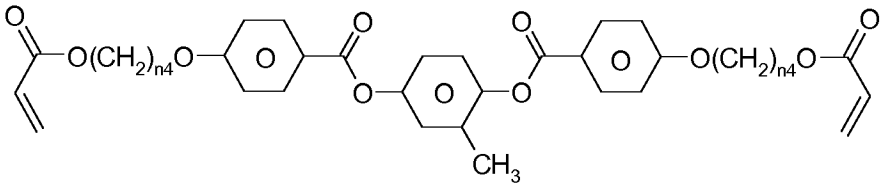
In a particularly preferred embodiment of the present invention the LC mixture, or component C), comprises one or more compounds of formula P10-1.



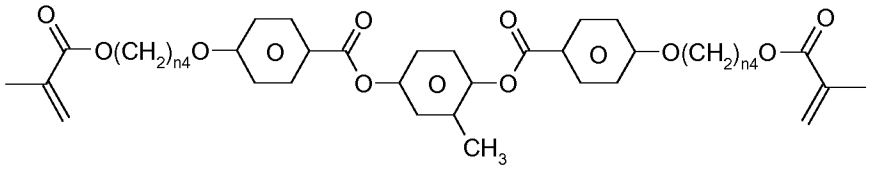
P10-1

wherein the parameters are defined as described above and P^1 and P^2 preferably denote acrylate or methacrylate.

Particularly preferred compounds of formula P10-1 are selected from the group of the following subformulae



P10-1-1



P10-1-2

wherein each n4 denote independently of each other an integer between 2 and 10, preferably 3,4,5 or 6.

The polymerizable compounds of formulae I and P are also suitable for polymerisation without an initiator, which is associated with considerable advantages, such as, for example, lower material costs and, in particular, reduced contamination of the LC medium by possible residual amounts of the initiator or degradation products thereof. The polymerisation can thus also be carried out without addition of an initiator. The LC medium thus, in a preferred embodiment, comprises no polymerisation initiator.

The polymerizable component C) or the LC medium as a whole may also comprise one or more stabilisers in order to prevent undesired spontaneous polymerisation of the RMs, for example during storage or transport. Suitable types and amounts of stabilisers are known to the person skilled in the art and are described in the literature. Particularly suitable are, for example, the commercially available stabilisers from the Irganox® series (BASF SE), such as, for example, Irganox® 1076. If stabilisers are employed, their proportion, based on the total amount of the RMs or the polymerizable component, is preferably 10 - 10,000 ppm, particularly preferably 50 - 1000 ppm.

The media according to the invention preferably comprise from 0.01 to 10%, particularly preferably from 0.05 to 7.5% and most preferably from 0.1 to 5% of the compounds of component C) comprising compounds of formula P according to the invention. The media preferably comprise one, two or three, more preferably one or two and most preferably one compound of the formula P according to the invention.

By means of suitable additives, the liquid-crystalline phases of the present invention can be modified in such a way that they can be used in all types of liquid-crystal display element that have been disclosed hitherto. Additives of this type are known to the person skilled in the art and are described in detail in the literature (H. Kelker/ R. Hatz, Handbook of Liquid Crystals, Verlag Chemie, Weinheim, 1980). For example, pleochroic dyes can be added for the production of coloured guest-host systems or substances can be added in order to modify the dielectric anisotropy, the viscosity and/or the alignment of the nematic phases.

The media according to the invention are prepared in a manner conventional per se. In general, the components are dissolved in one another, preferably at elevated temperature.

Accordingly the present invention relates further to method for the production of an LC medium according to the present invention, comprising the step of mixing one or more compounds of formula I with a liquid-crystalline component B) comprising one or more mesogenic or liquid-crystalline compounds as described above.

The present invention further relates to a process for the fabrication of liquid crystal displays comprising at least the steps of:

- providing a first substrate which includes a pixel electrode and a common electrode for generating an electric field substantially parallel to a surface of the first substrate in the pixel region;

- providing a second substrate, the second substrate being disposed opposite to the first substrate;
- interposing a liquid crystal mixture between the first substrate and the second substrate, the liquid crystal mixture comprising one or more compounds of formula I, component B) and optionally component C);
- irradiating the liquid crystal mixture with linearly polarised light causing photoalignment of the liquid crystal;
- curing the polymerizable compounds of the liquid crystal mixture by irradiation with ultraviolet light or visible light having a wavelength of 450nm or below.

The present invention further relates to the use of the liquid crystal mixtures according to the invention for the fabrication of a liquid crystal display.

The present invention further relates to liquid crystal displays fabricated by the process described above.

In the following, the production process according to the present invention is described in greater detail.

The first substrate includes a pixel electrode and a common electrode for generating an electric field substantially parallel to a surface of the first substrate in the pixel region. Various kinds of displays having at least two electrodes on one substrate are known to the skilled person wherein the most significant difference is that either both the pixel electrode and the common electrode are structured, as it is typical for IPS displays, or only the pixel electrode is structured and the common electrode is unstructured, which is the case for FFS displays.

It has to be understood that the present invention refers to any kind of electrode configurations suitable for generating an electric field substantially parallel to a surface of the first substrate in the pixel region; mentioned above, *i.e.* IPS as well as FFS displays.

The process according to the present invention is independent of the kind of substrate or material of the surface which is in contact with the liquid crystal mixture according to the invention, during and after this process. Examples of materials used for the substrates or surfaces are organic polymers including polyimide, indium tin oxide (ITO), indium zinc oxide (IZO), silicon nitride (SiN_x) and silicon dioxide(SiO_2). The process is especially suitable for the use in displays containing substrates that do not have a polyimide layer on one or more of the surfaces that are in contact with the liquid crystal.

In case one or more substrates contain a polyimide layer, the polyimide can be rubbed or not rubbed, preferably not rubbed.

Hence, the invention relates to a display produced by the process according to the invention in which the substrates contain a rubbed or unrubbed polyimide layer, preferably an unrubbed polyimide layer.

The invention further relates to a display produced by the process according to the invention in which none or only one of the top and bottom substrates contains a polyimide layer.

In one embodiment of the present invention the liquid crystal composition is injected between the first and second substrates or is filled into the cell by capillary force after combining the first and second substrates. In an alternative embodiment, the liquid crystal composition may be interposed between the first and second substrates by combining the second substrate to the first substrate after loading the liquid crystal composition

on the first substrate. Preferably, the liquid crystal is dispensed dropwise onto a first substrate in a process known as “one drop filling” (ODF) process, as disclosed in for example JPS63-179323 and JPH10-239694, or using the Ink Jet Printing (IJP) method.

In a preferred embodiment, the process according to the invention contains a process step where the liquid crystal inside the display panel is allowed to rest for a period of time in order to evenly redistribute the liquid crystal medium inside the panel (herein referred to as “annealing”).

However it is likewise preferred that the annealing step is combined with a previous step, such as edge sealant pre-curing. In which case a ‘separate’ annealing step may not be necessary at all.

For the production of the displays according to the present invention, the photoreactive mesogen of formula I is preferably allowed to redistribute in the panel. After filling and assembly, the display panel is annealed for a time between 1 min and 3h, preferably between 2 min and 1h and most preferably between 5 min and 30 min. The annealing is preferably performed at room temperature.

In an alternative embodiment, the annealing is performed at elevated temperature, preferably at above 20°C and below 140°C, more preferably above 40°C and below 100°C and most preferably above 50°C and below 80°C.

In a preferred embodiment, one or more of the process steps of filling the display, annealing, photoalignment and curing of the polymerizable compound is performed at a temperature above the clearing point of the liquid crystal host mixture.

During the photoalignment of the liquid crystal inside the liquid crystal panel, anisotropy is induced by exposing the display or the liquid crystal layer to linearly polarised light.

In a preferred embodiment of the present invention the photoreactive component A) comprising one or more compounds of formula I, is photoaligned in a first step using linearly polarised light and in a second step further cured using linearly polarized or unpolarised UV light. In the second step the optional component C) is also further cured.

In another preferred embodiment, the linearly polarised light applied according to the inventive process is ultraviolet light which enables simultaneous photoalignment and photocuring of the photoreactive component A) comprising one or more compounds of formula I, and, if present, photocuring of the polymerizable component C).

Photoalignment of the photoreactive compounds of formula I and curing of the polymerizable groups of compounds of formula I and the curing of the optional polymerizable compounds of formula P can be performed simultaneously or stepwise. In case the process is split into different steps, the individual steps can be performed at the same temperature or at different temperatures.

After the photoalignment and curing step(s) a so-called “post-curing” step can optionally be performed by irradiation with UV-light and/or visible light (both either linearly or unpolarised) at reduced temperature in order to remove unreacted polymerizable compounds. The post-curing is preferably performed at above 0°C and below the clearing point of the utilized LC mixture, preferably 20°C and below 60°C°C, and most preferably above 20°C and below 40°C.

The polymerizable compounds are optionally polymerised or crosslinked (if a polymerizable compound contains two or more polymerizable groups) with the application of an electrical field. The polymerisation can be carried out in one or more steps.

Suitable and preferred polymerisation methods for component C) are, for example, thermal or photopolymerization, preferably photopolymerization, in particular UV photopolymerization. One or more initiators can optionally also be added here. Suitable conditions for the polymerisation and suitable types and amounts of initiators are known to the person skilled in the art and are described in the literature. Suitable for free-radical polymerisation are, for example, the commercially available photoinitiators Irgacure651®, Irgacure184®, Irgacure907®, Irgacure369® or Darocure1173® (BASF SE). If an initiator is employed, its proportion is preferably 0.001 to 5% by weight, particularly preferably 0.001 to 1% by weight.

The present invention also relates to electro-optical liquid-crystal display elements containing a liquid-crystalline medium according to the invention, which is preferably homogeneously aligned. In a preferred embodiment the liquid crystal display is of the IPS or FFS mode.

Further combinations of the embodiments and variants of the invention in accordance with the description arise from the claims.

The invention is explained in greater detail below with reference to working examples, but without intending to be restricted thereby. The person skilled in the art will be able to glean from the examples working details that are not given in detail in the general description, generalise them in accordance with general expert knowledge and apply them to a specific problem.

Besides the usual and well-known abbreviations, the following abbreviations are used:
C: crystalline phase; N: nematic phase; Sm: smectic phase; I: isotropic phase. The numbers between these symbols show the transition temperatures of the substance concerned.
Temperature data are in °C, unless indicated otherwise.

Physical, physicochemical or electro-optical parameters are determined by generally known methods, as described, inter alia, in the brochure "Merck Liquid Crystals - Licristal® - Physical Properties of Liquid Crystals – Description of the Measurement Methods", 1998, Merck KGaA, Darmstadt.

Above and below, Δn denotes the optical anisotropy (589 nm, 20°C) and $\Delta\varepsilon$ denotes the dielectric anisotropy (1 kHz, 20°C). The dielectric anisotropy $\Delta\varepsilon$ is determined at 20°C and 1 kHz. The optical anisotropy Δn is determined at 20°C and a wavelength of 589.3 nm.

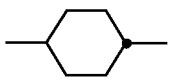
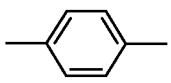
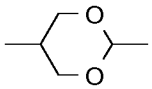
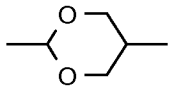
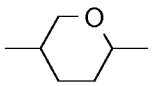
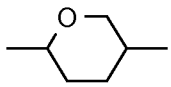
The $\Delta\varepsilon$ and Δn values and the rotational viscosity (γ_1) of the compounds according to the invention are obtained by linear extrapolation from liquid-crystalline mixtures consisting of 5 to 10% of the respective compound according to the invention and 90-95% of the commercially available liquid-crystal mixture ZLI-2857 (for $\Delta\varepsilon$) or ZLI-4792 (for Δn, γ_1) (mixtures, Merck KGaA, Darmstadt).

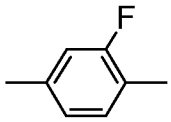
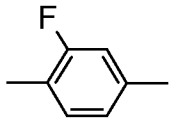
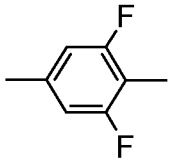
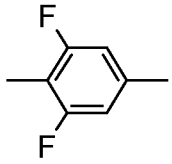
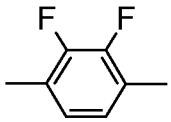
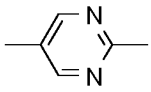
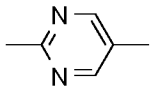
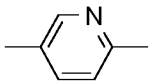
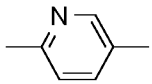
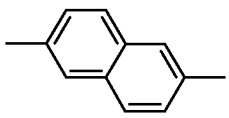
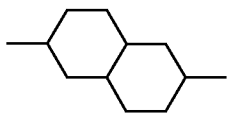
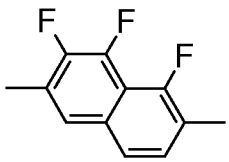
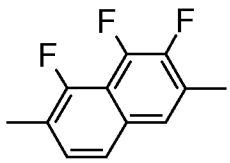
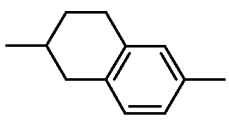
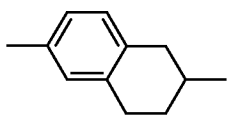
The compounds used in the present invention are prepared by methods known per se, as described in the literature (for example in the standard works, such as Houben-Weyl, Methoden der organischen Chemie [Methods of Organic Chemistry], Georg-Thieme-Verlag, Stuttgart), to be precise under reaction conditions which are known and suitable for the

said reactions. Use can also be made here of variants known per se, which are not mentioned here in greater detail.

In the present invention and especially in the following examples, the structures of the mesogenic compounds are indicated by means of abbreviations, also called acronyms. In these acronyms, the chemical formulae are abbreviated as follows using Tables A to C below. All groups C_nH_{2n+1}, C_mH_{2m+1} and C_lH_{2l+1} or C_nH_{2n-1}, C_mH_{2m-1} and C_lH_{2l-1} denote straight-chain alkyl or alkenyl, preferably 1E-alkenyl, each having n, m and l C atoms respectively. Table A lists the codes used for the ring elements of the core structures of the compounds, while Table B shows the linking groups. Table C gives the meanings of the codes for the left-hand or right-hand end groups. The acronyms are composed of the codes for the ring elements with optional linking groups, followed by a first hyphen and the codes for the left-hand end group, and a second hyphen and the codes for the right-hand end group. Table D shows illustrative structures of compounds together with their respective abbreviations.

Table A: Ring elements

C			
P			
D		**DI**	
A		**AI**	

G		**Gl**	
U		**Ul**	
Y			
M		**Ml**	
N		**Nl**	
Np		**dH**	
N3f		**N3fl**	
tH		**tHl**	

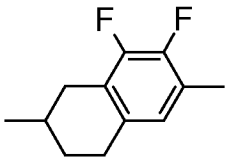
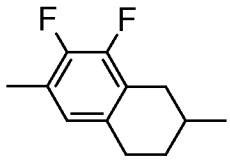
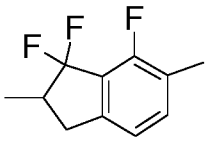
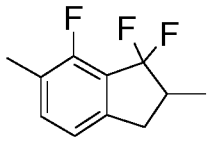
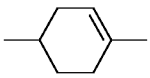
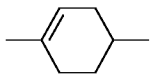
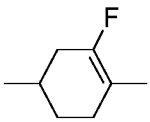
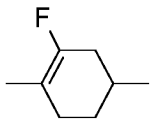
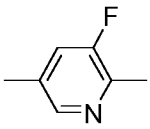
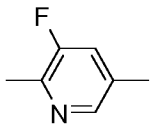
	tH2f		**tH2fI**	
	K		**KI**	
	L		**LI**	
	F		**FI**	
	Nf		NfI	

Table B: Linking groups

E	$-CH_2CH_2-$	**Z**	-CO-O-
V	-CH=CH-	**ZI**	-O-CO-
X	-CF=CH-	**O**	$-CH_2-O-$
XI	-CH=CF-	**OI**	$-O-CH_2-$
B	-CF=CF-	**Q**	$-CF_2-O-$
T	-C≡C-	**QI**	$-O-CF_2-$
W	$-CF_2CF_2-$	**T**	-C≡C-

Table C: End groups

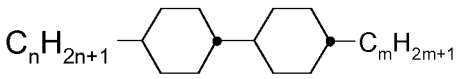
Left-hand side		Right-hand side	
Use alone			
-n-	C_nH_{2n+1}-	**-n**	--C_nH_{2n+1}
-nO-	C_nH_{2n+1}-O-	**-nO**	-O-C_nH_{2n+1}
-V-	CH_2=CH-	**-V**	-CH=CH_2
-nV-	C_nH_{2n+1}-CH=CH-	**-nV**	-C_nH_{2n}-CH=CH_2
-Vn-	CH_2=CH- C_nH_{2n+1}-	**-Vn**	-CH=CH-C_nH_{2n+1}
-nVm-	C_nH_{2n+1}-CH=CH-C_mH_{2m}-	**-nVm**	-C_nH_{2n}-CH=CH-C_mH_{2m+1}
-N-	N≡C-	**-N**	-C≡N
-S-	S=C=N-	**-S**	-N=C=S
-F-	F-	**-F**	-F
-CL-	Cl-	**-CL**	-Cl
-M-	CFH_2-	**-M**	-CFH_2
-D-	CF_2H-	**-D**	-CF_2H
-T-	CF_3-	**-T**	-CF_3
-MO-	CFH_2O -	**-OM**	-OCFH_2
-DO-	CF_2HO -	**-OD**	-OCF_2H
-TO-	CF_3O -	**-OT**	-OCF_3
-FXO-	CF_2=CH-O-	**-OXF**	-O-CH=CF_2
-A-	H-C≡C-	**-A**	-C≡C-H
-nA-	C_nH_{2n+1}-C≡C-	**-An**	-C≡C-C_nH_{2n+1}
-NA-	N≡C-C≡C-	**-AN**	-C≡C-C≡N
Use together with one another and with others			
-…A…-	-C≡-	**-…A…**	-C≡-
-…V…-	CH=CH-	**-…V…**	-CH=CH-
-…Z…-	-CO-O-	**-…Z…**	-CO-O-
-…Zl…-	-O-CO-	**-…Zl…**	-O-CO-
-…K…-	-CO-	**-…K…**	-CO-

-...W...- -CF=CF- **-...W...** -CF=CF-

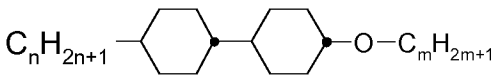
wherein n and m each denote integers, and the three dots "..." are place-holders for other abbreviations from this table.

The following table shows illustrative structures together with their respective abbreviations. These are shown in order to illustrate the meaning of the rules for the abbreviations. They furthermore represent compounds which are preferably used.

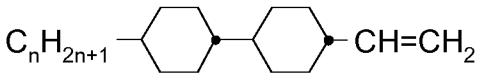
Table D: Illustrative structures



CC-n-m



CC-n-Om



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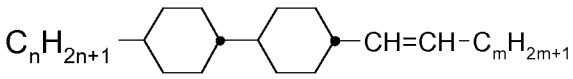

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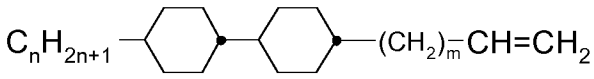

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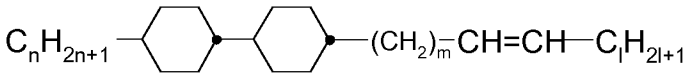
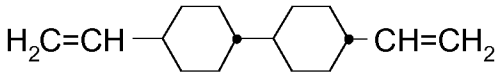
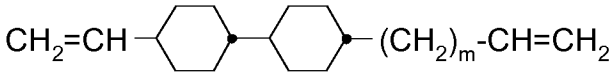


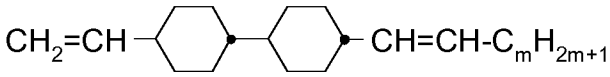
CC-n-mVl



CC-V-V



CC-V-mV



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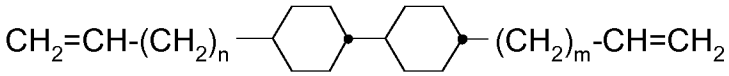

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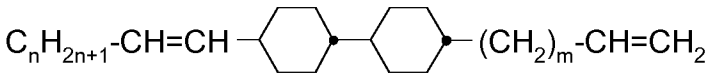

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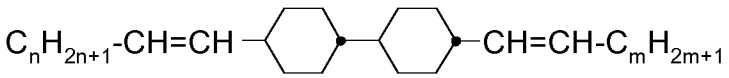

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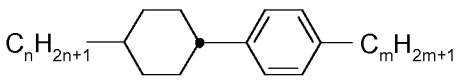

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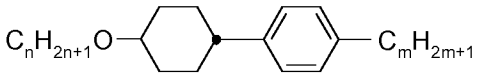

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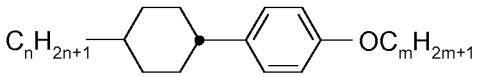

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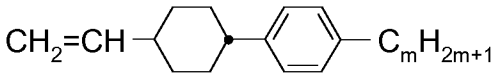

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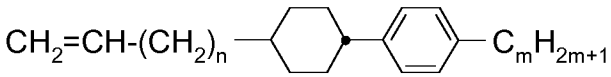

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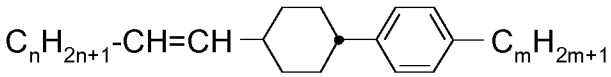

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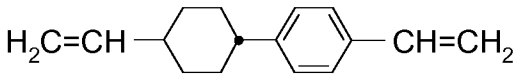

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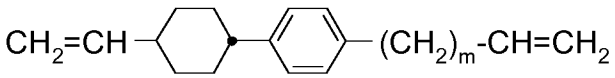

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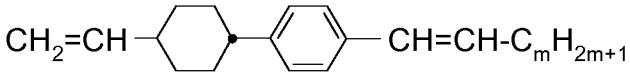

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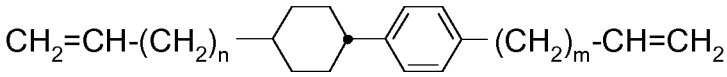

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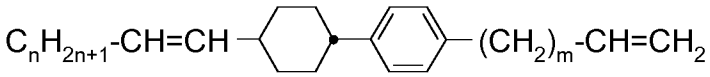

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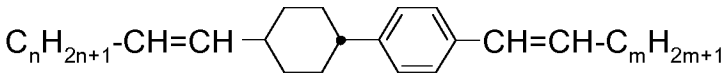

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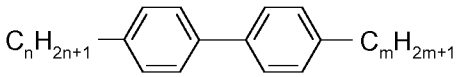

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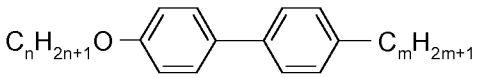

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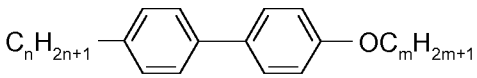

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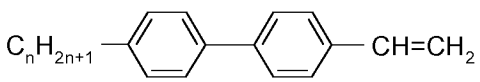

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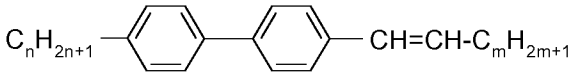

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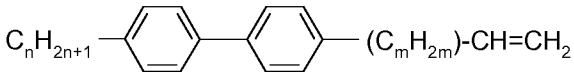

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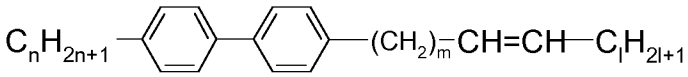

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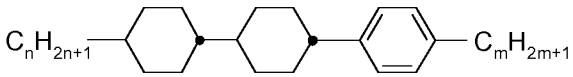

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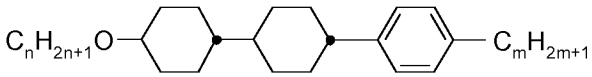

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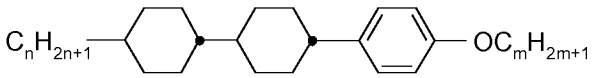

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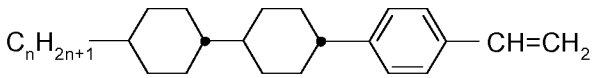

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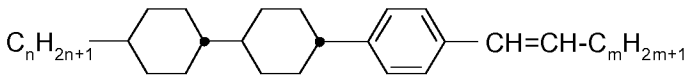

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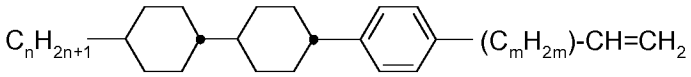

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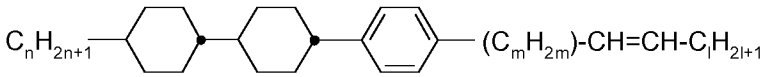

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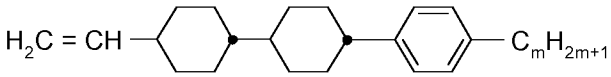

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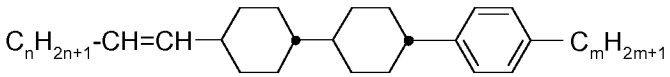

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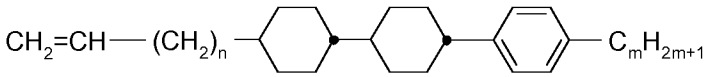

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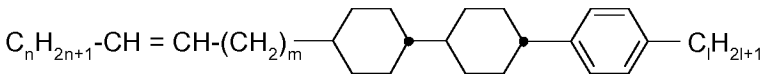

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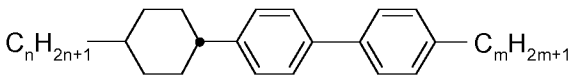

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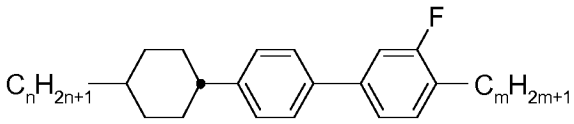

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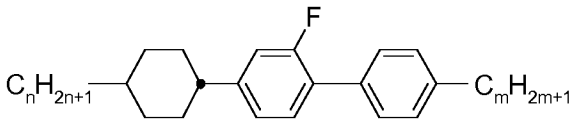

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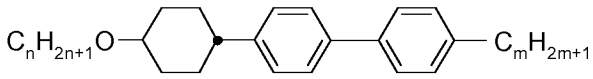

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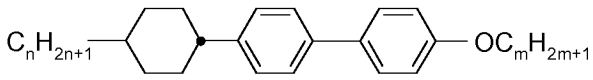

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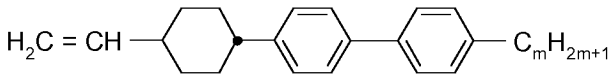

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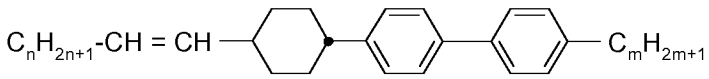

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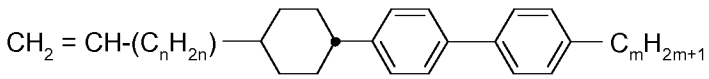

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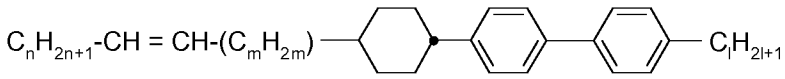

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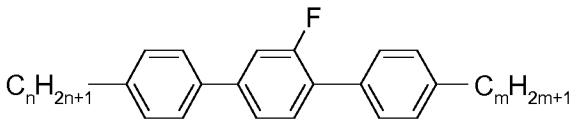

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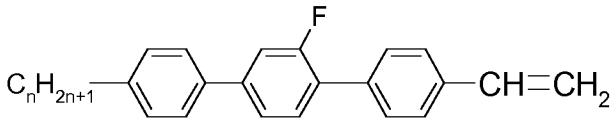

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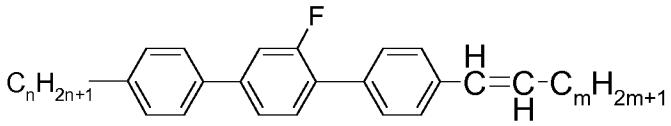

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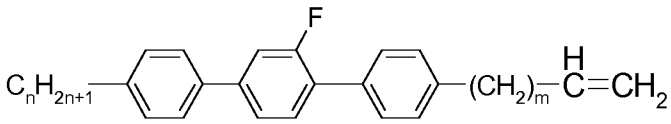

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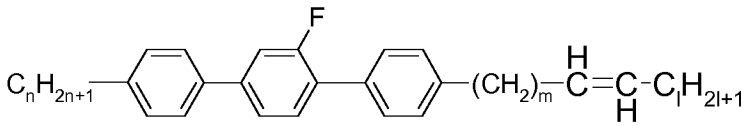

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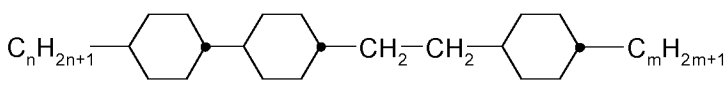

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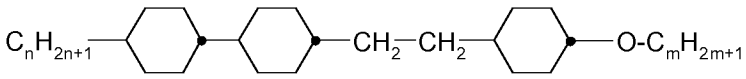

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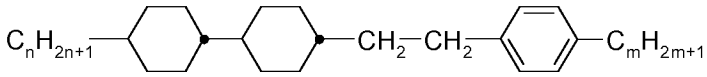

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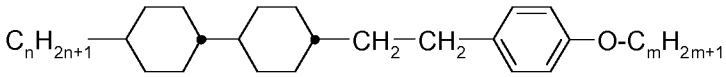

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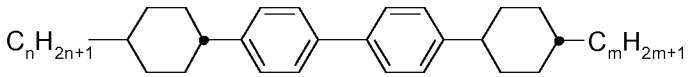

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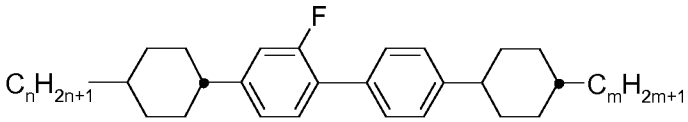

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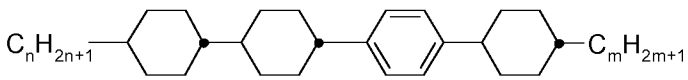

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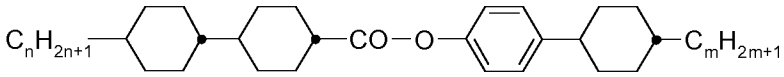

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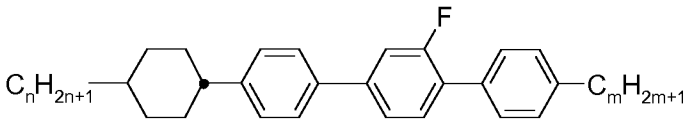

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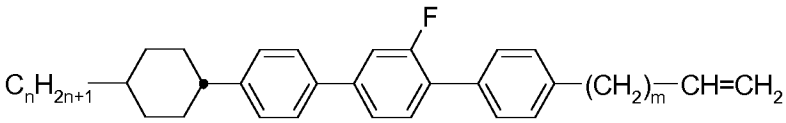

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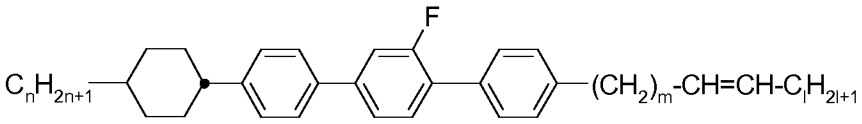

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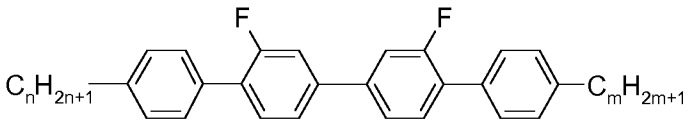

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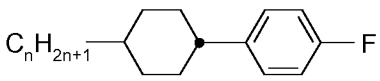

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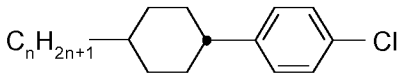

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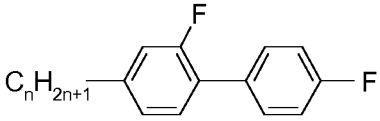

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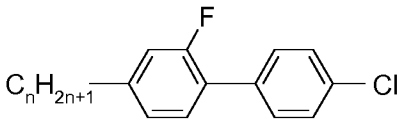

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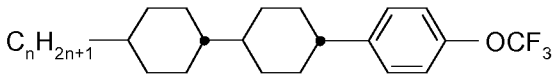

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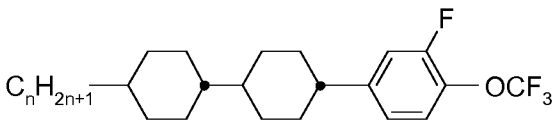

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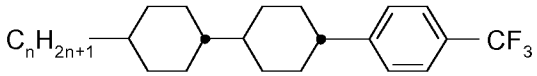

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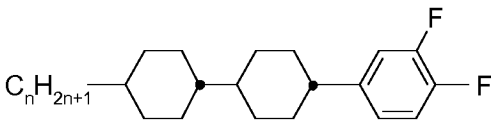

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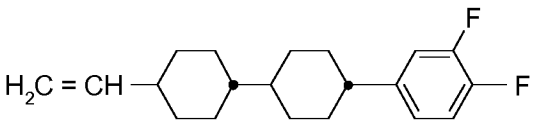

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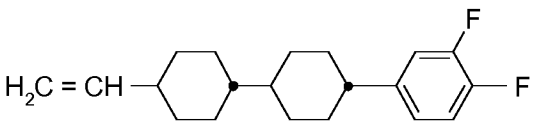

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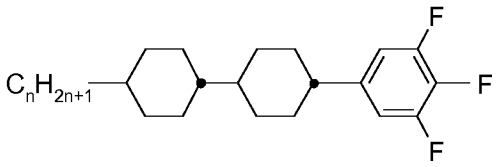

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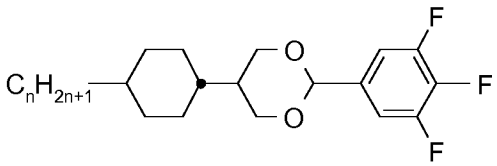

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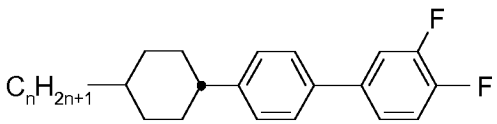

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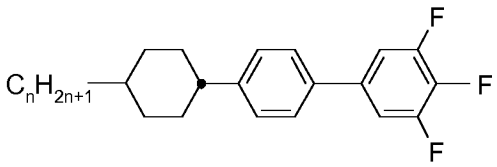

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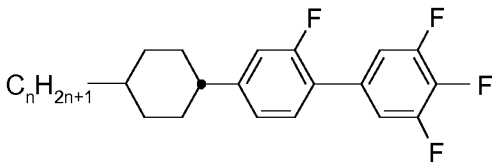

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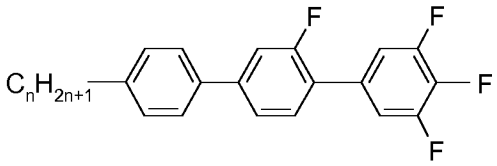

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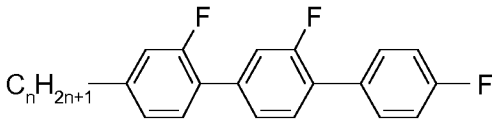

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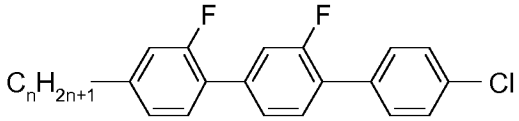

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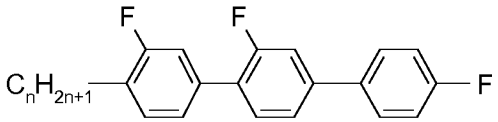

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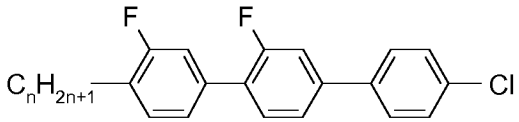

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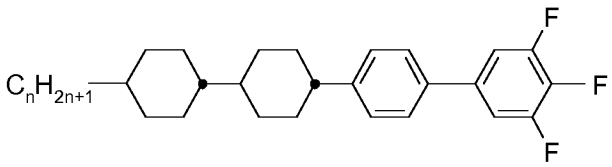

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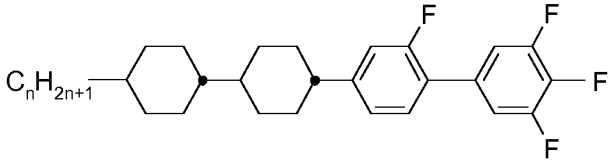

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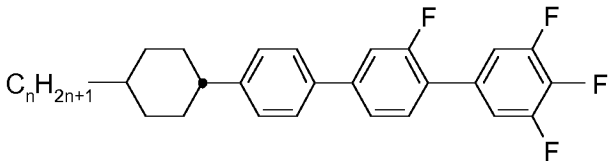

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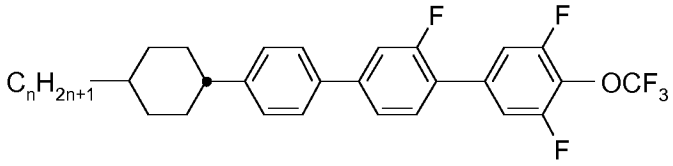

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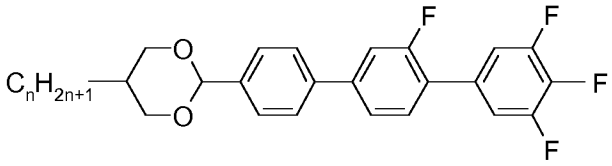

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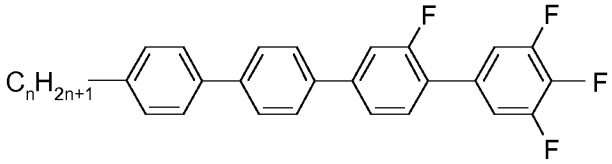

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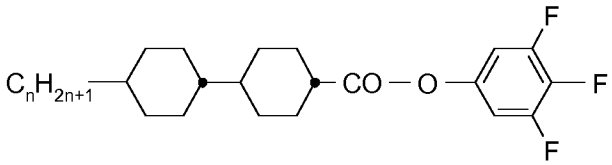

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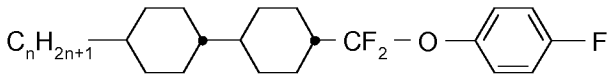

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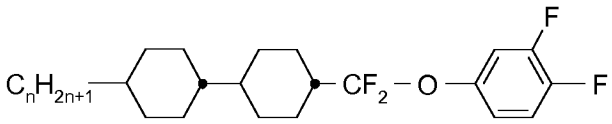

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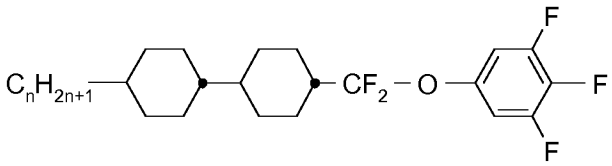

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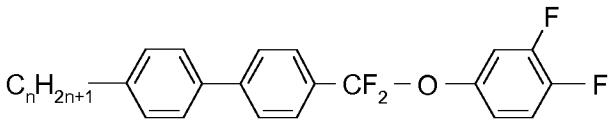

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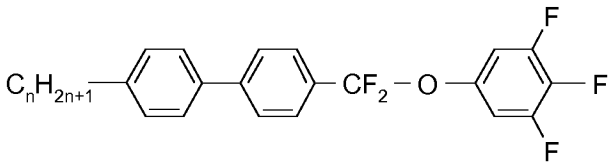

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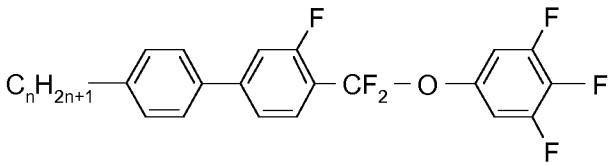

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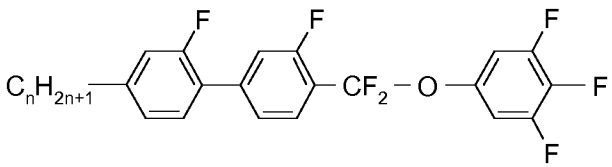

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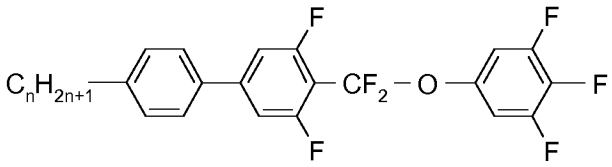

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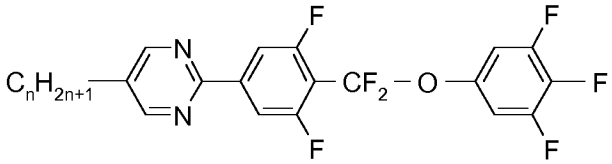

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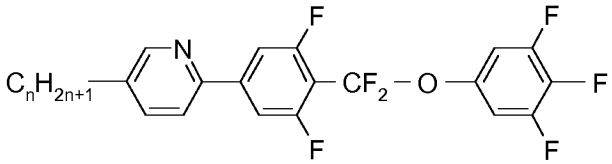

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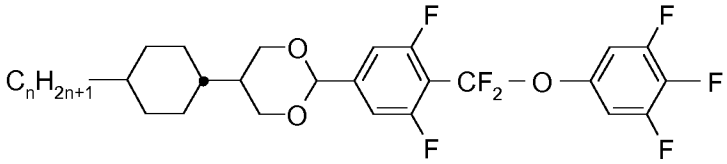

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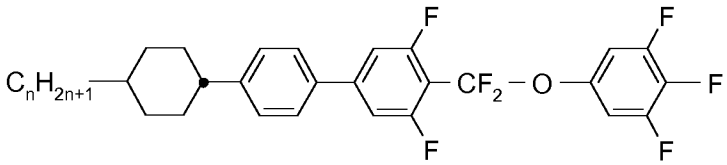

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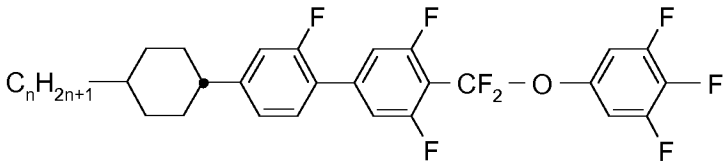

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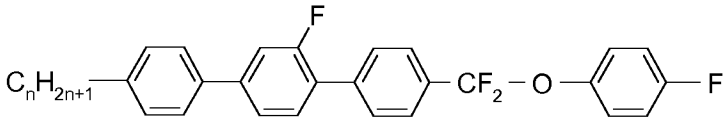

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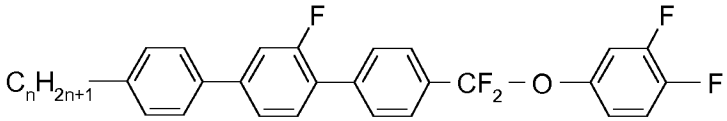

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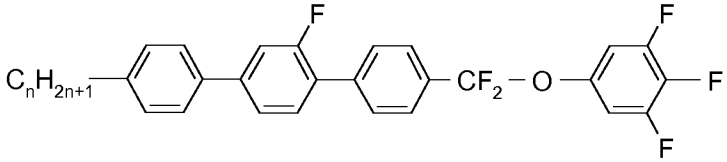

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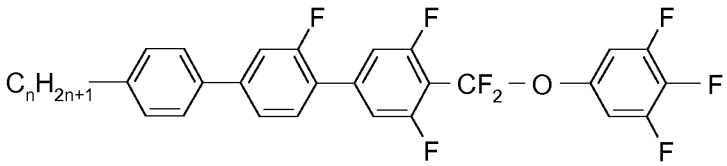

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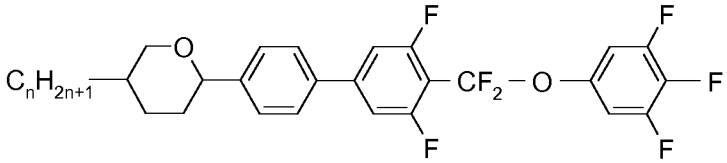

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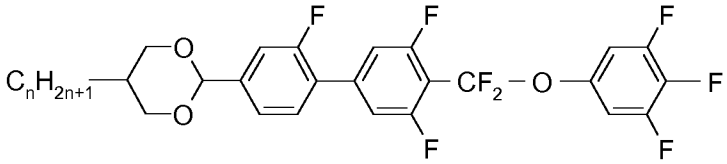

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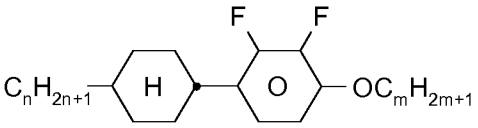

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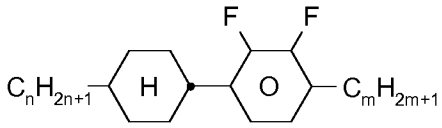

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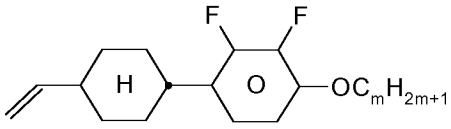

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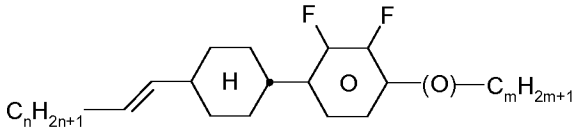

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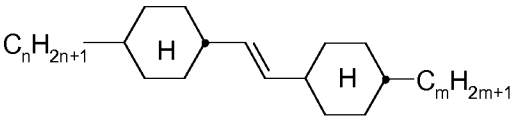

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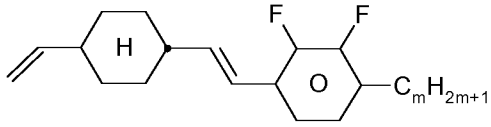

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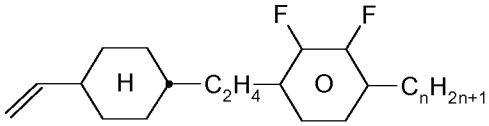

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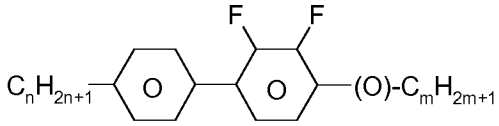

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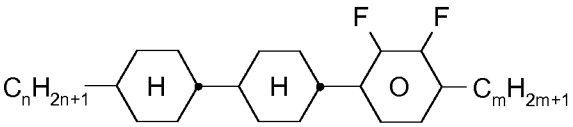

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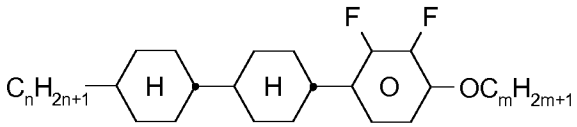

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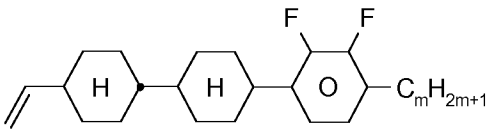

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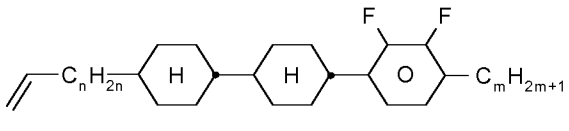

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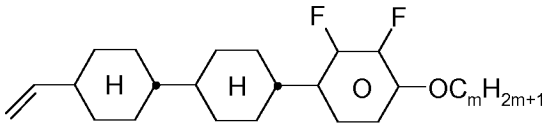

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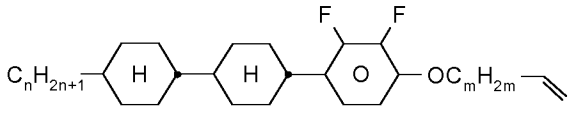

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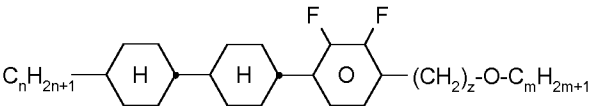

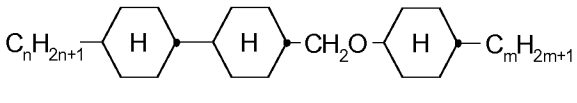

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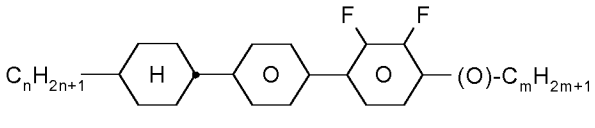

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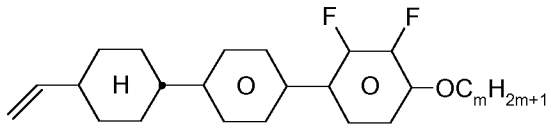

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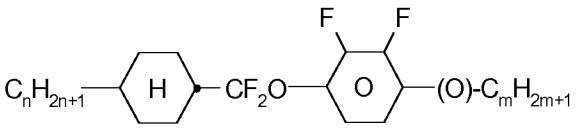

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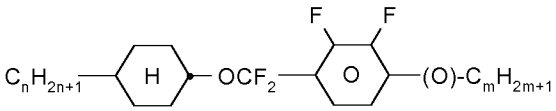

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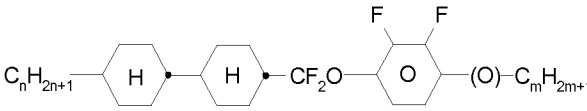

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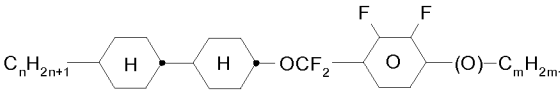

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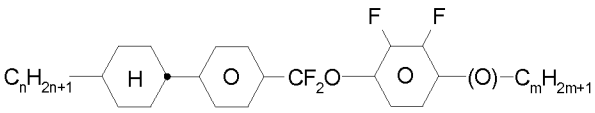

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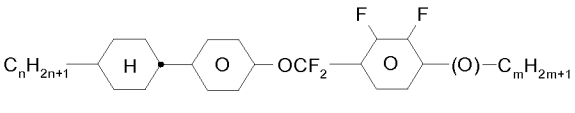

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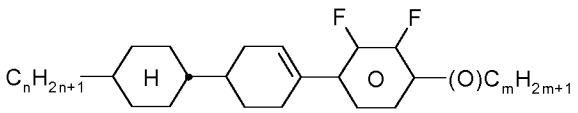

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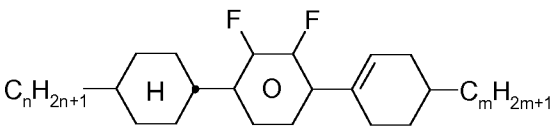

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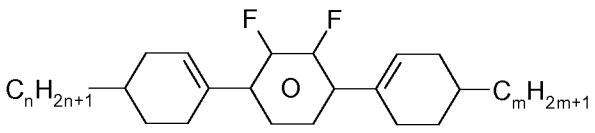

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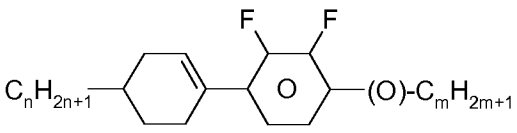

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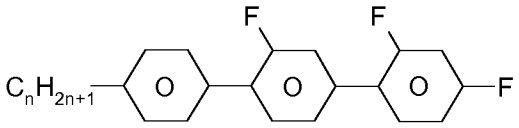

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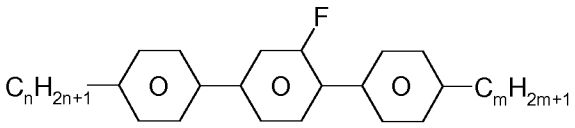

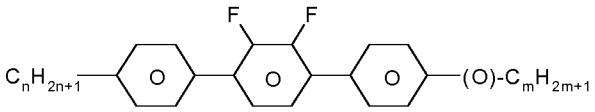

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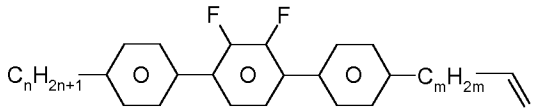
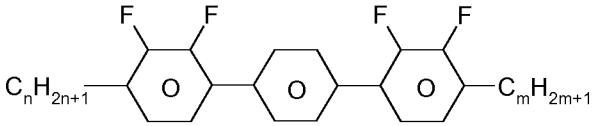
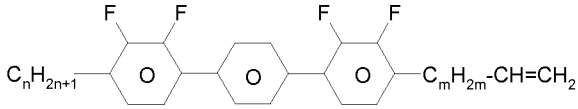


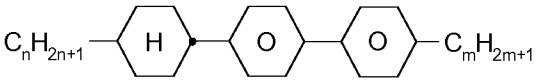
PYP-n-mV



YPY-n-m



YPY-n-mV



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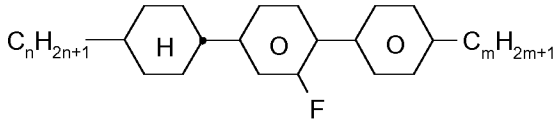

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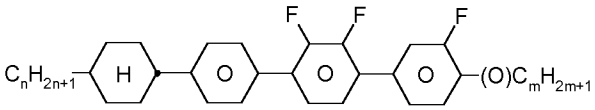
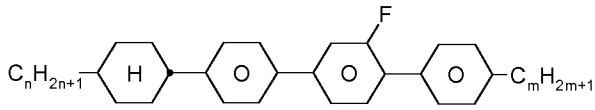


CPYP-n-(O)m



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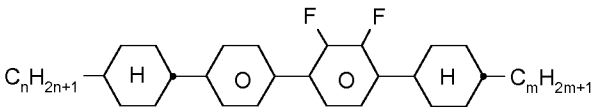

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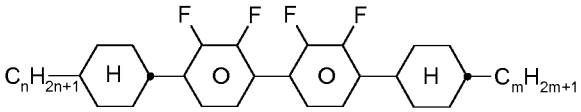

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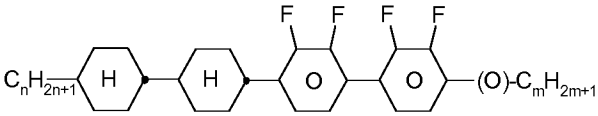

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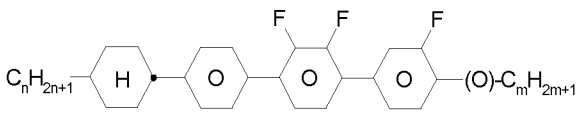

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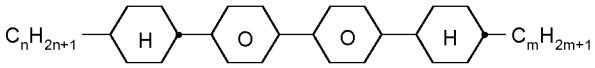
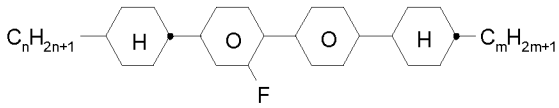


CBC-nm



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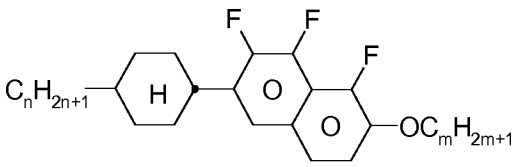
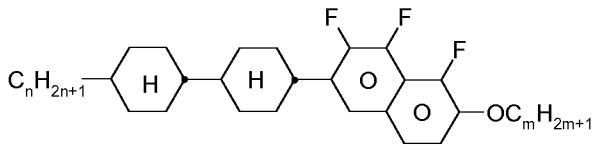
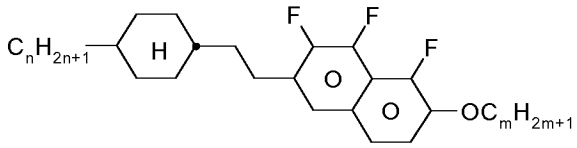




CNap-n-Om



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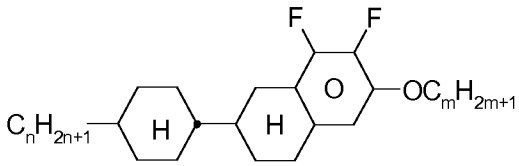

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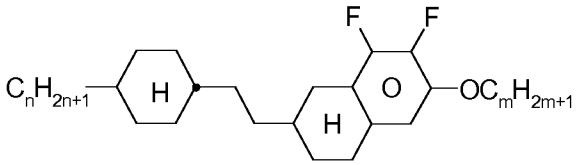

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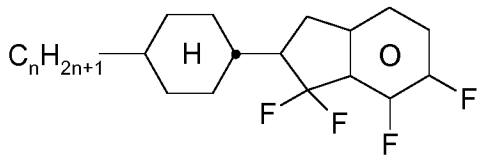

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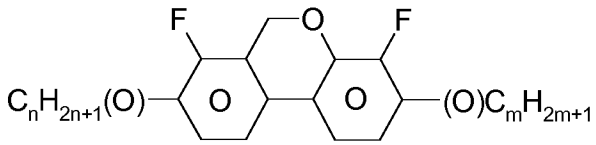
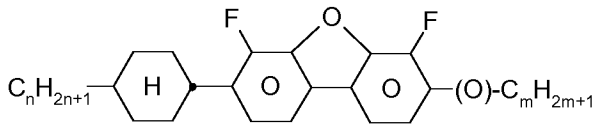


CK-n-F



DFDBC-n(O)-(O)m

C-DFDBF-n-(O)m

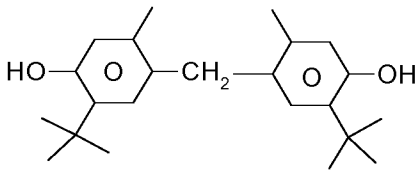
wherein n, m and l preferably, independently of one another, denote 1 to 7.

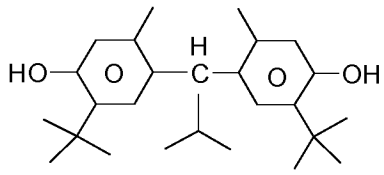
The following table, Table E, shows illustrative compounds which can be used as additional stabilisers in the mesogenic media according to the present invention.

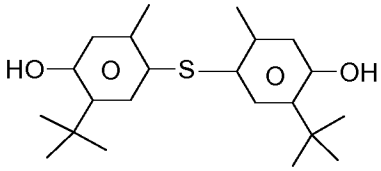
Table E

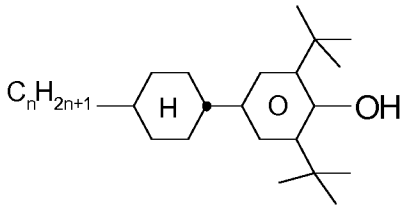
Table E shows possible stabilisers which can be added to the LC media according to the invention.

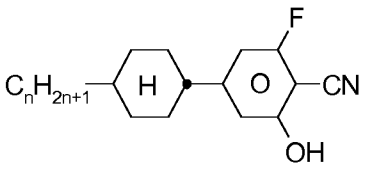
(n here denotes an integer from 1 to 12, preferably 1, 2, 3, 4, 5, 6, 7 or 8, terminal methyl groups are not shown).

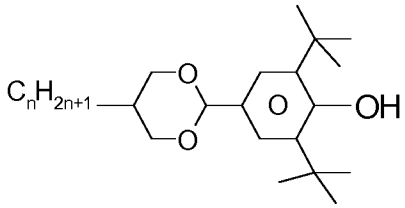

HO
O
CH2
O
OH

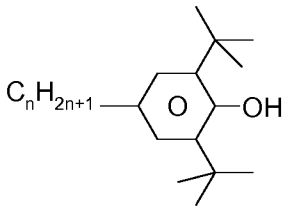

HO
O
H
C
O
OH

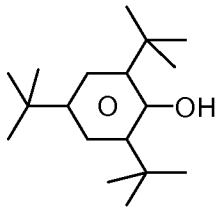

HO
O
S
O
OH

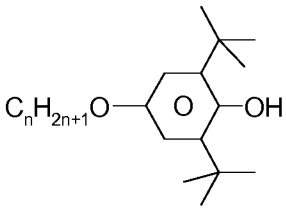

CnH2n+1
H
O
OH

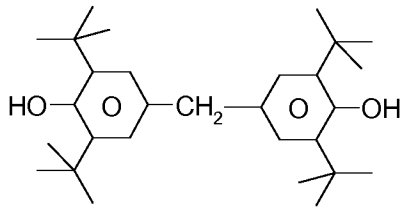

F
CnH2n+1
H
O
CN
OH

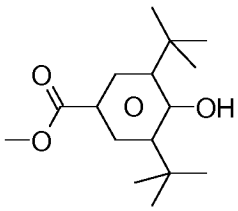

CnH2n+1
O
O
O
OH

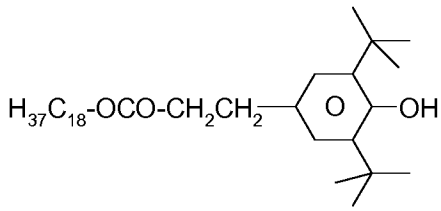

CnH2n+1
O
OH

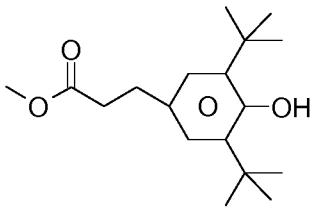

O
OH

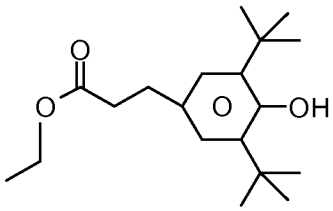

CnH2n+1O
O
OH

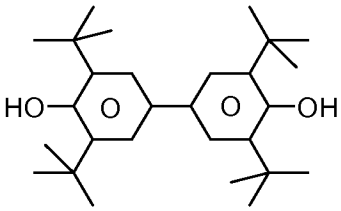

HO
O
CH2
O
OH

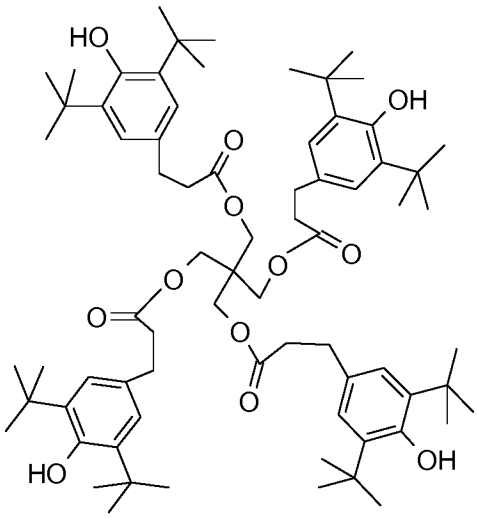

O
O
O
OH

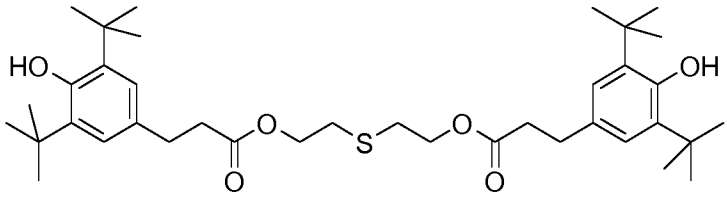

H37C18-OCO-CH2CH2
O
OH

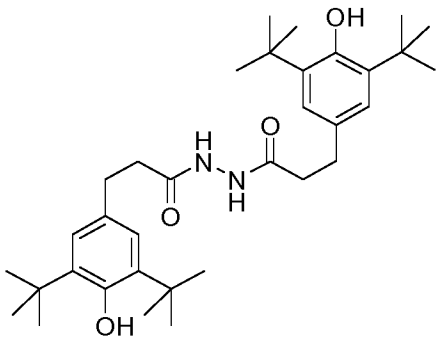


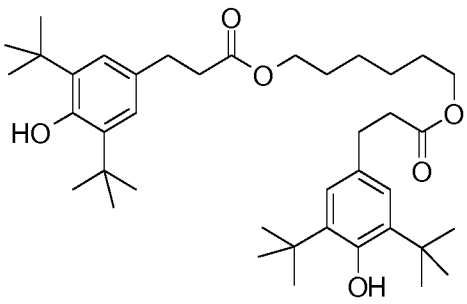


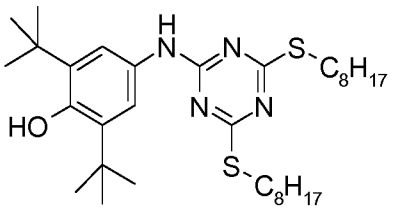


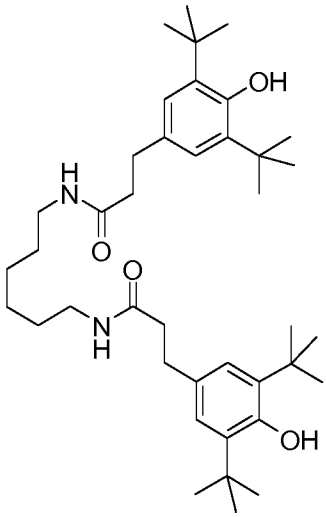


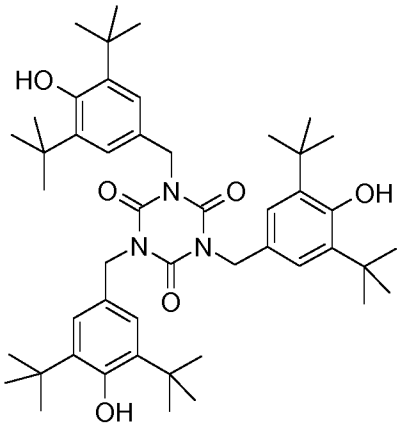


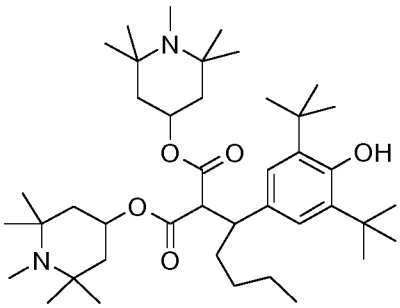


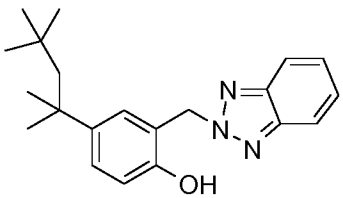


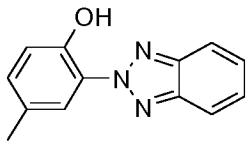


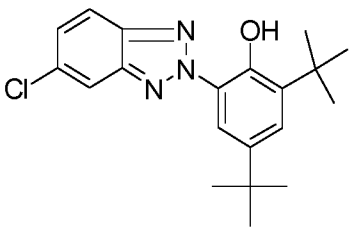


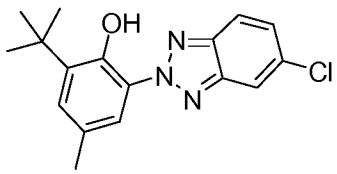


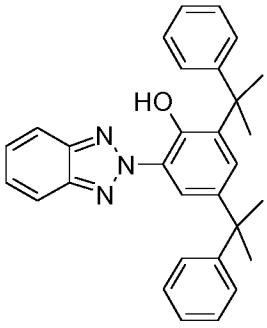


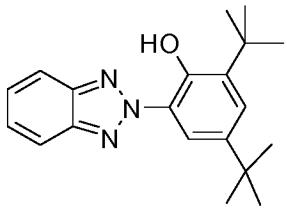


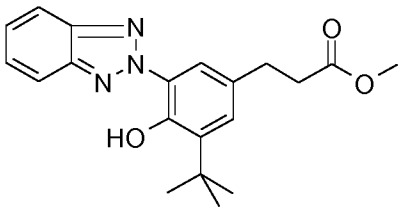


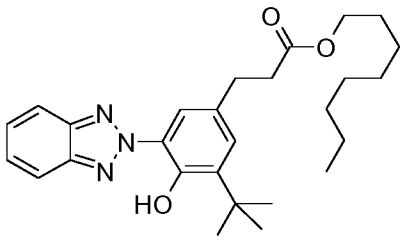


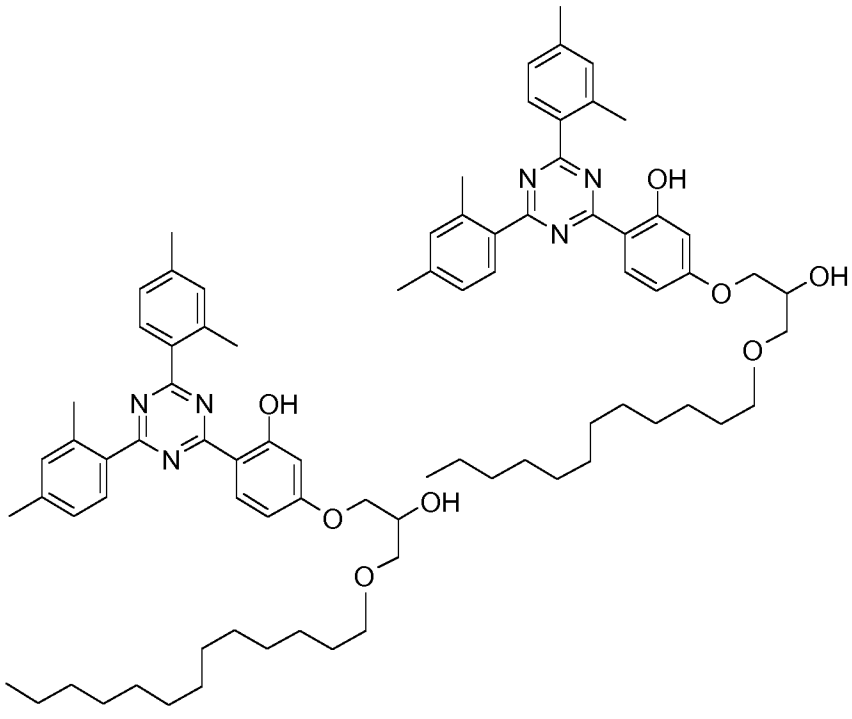


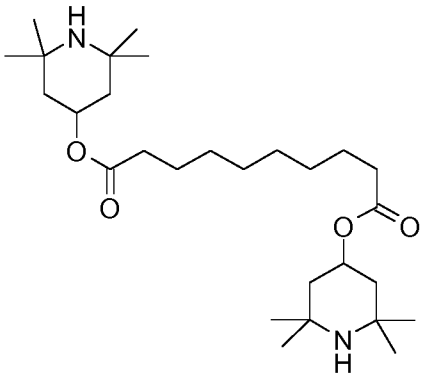


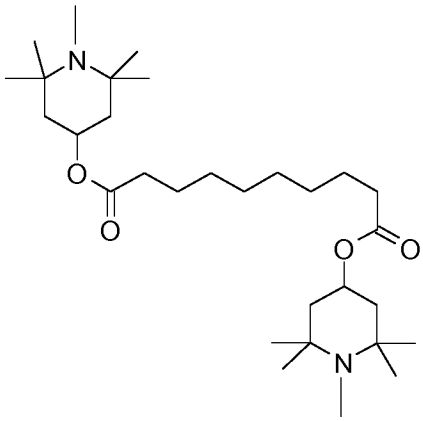


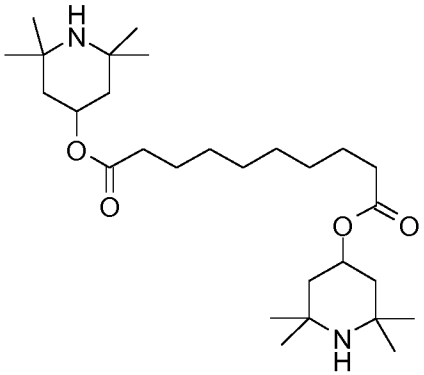


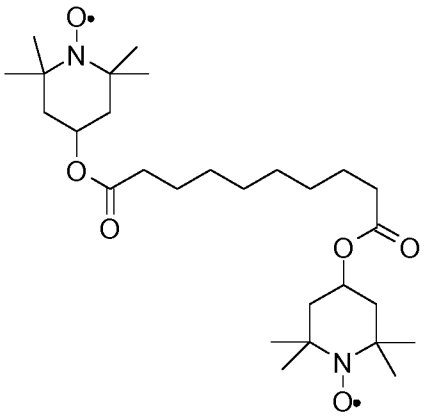


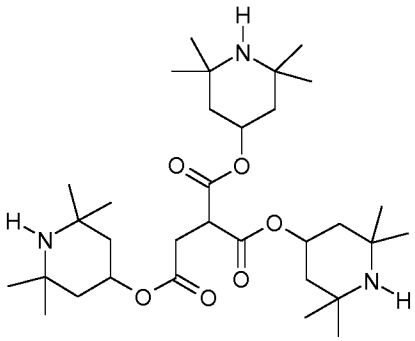


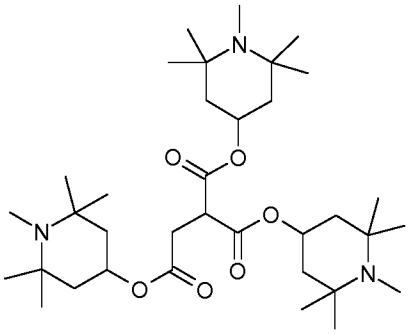


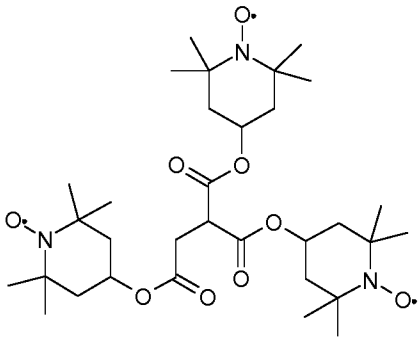


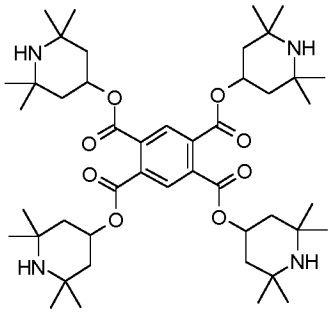


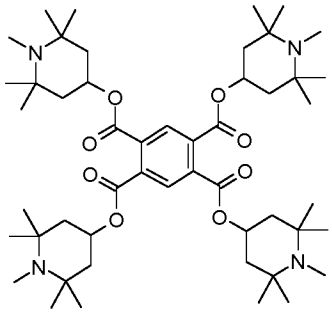


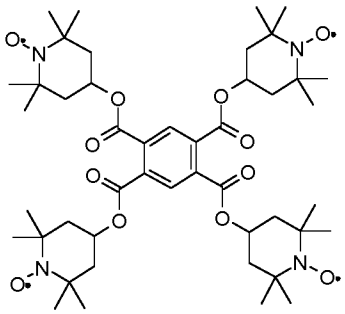


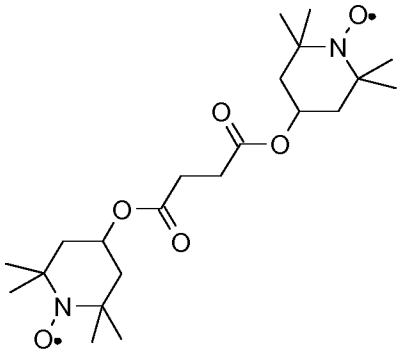


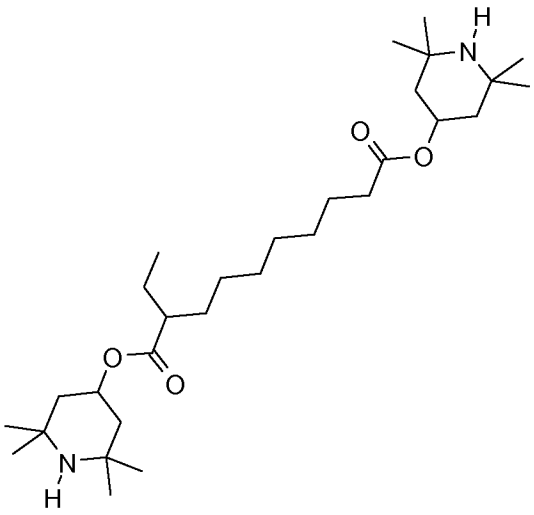


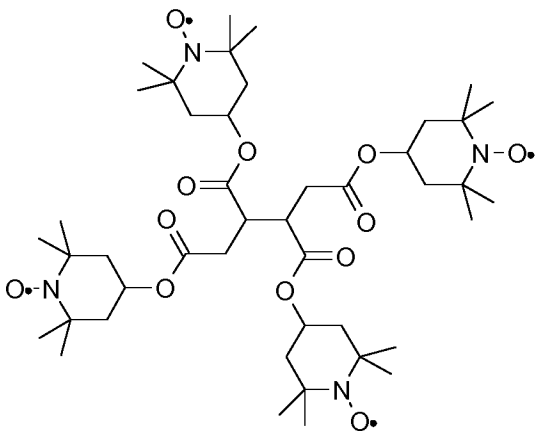








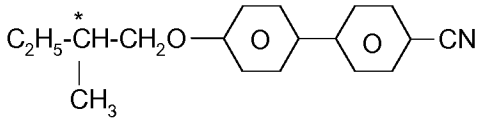




The LC media preferably comprise 0 to 10% by weight, in particular 1 ppm to 5% by weight, particularly preferably 1 ppm to 1% by weight, of stabilisers.

Table F below shows illustrative compounds which can preferably be used as chiral dopants in the mesogenic media according to the present invention.

Table F



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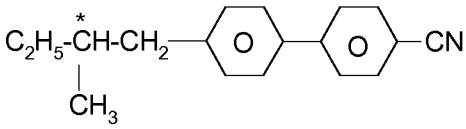

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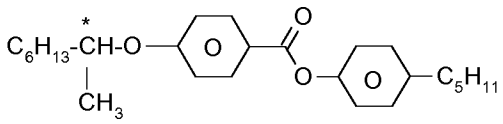

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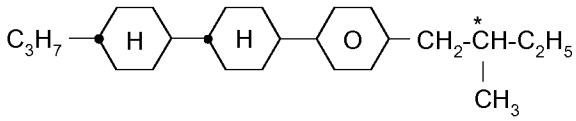

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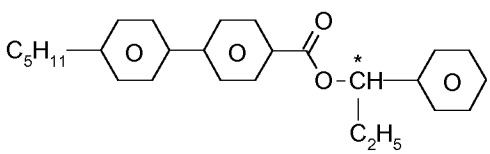

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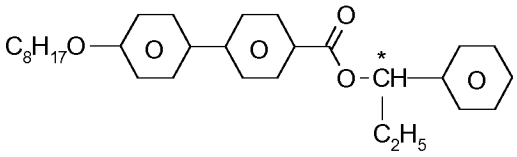
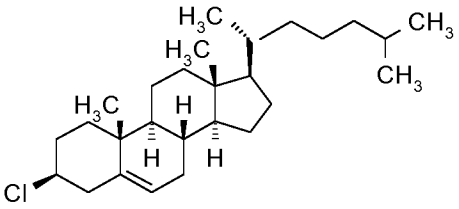
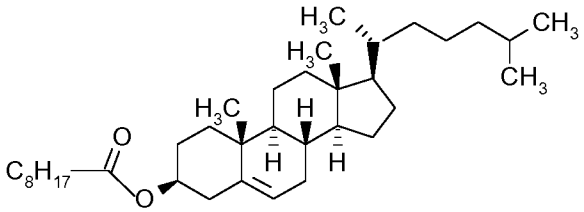


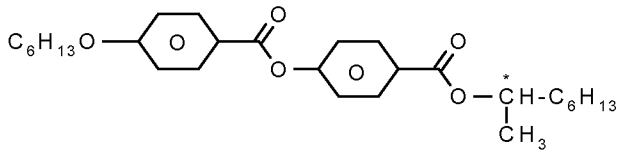
CM 47



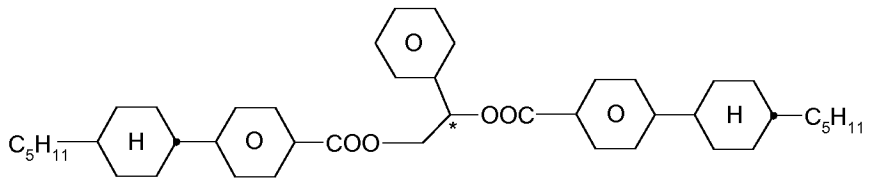
CC



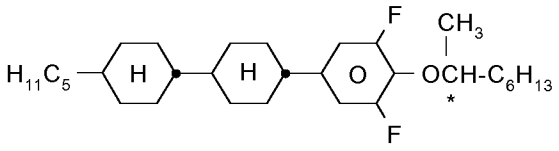
CN



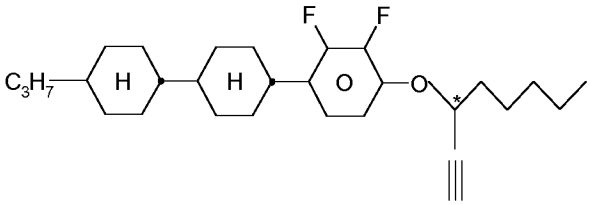
R/S-811



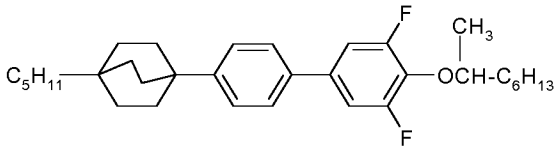
R/S-1011



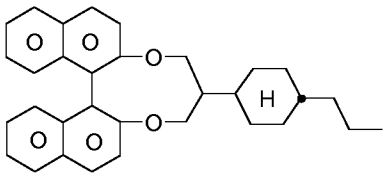
R/S-2011



R/S-3011



R/S-4011



R/S-5011

In a preferred embodiment of the present invention, the mesogenic media comprise one or more compounds selected from the group of the compounds from Table F.

The mesogenic media according to the present application preferably comprise two or more, preferably four or more, compounds selected from the group consisting of the compounds from the above tables.

The liquid-crystal media according to the present invention preferably comprise

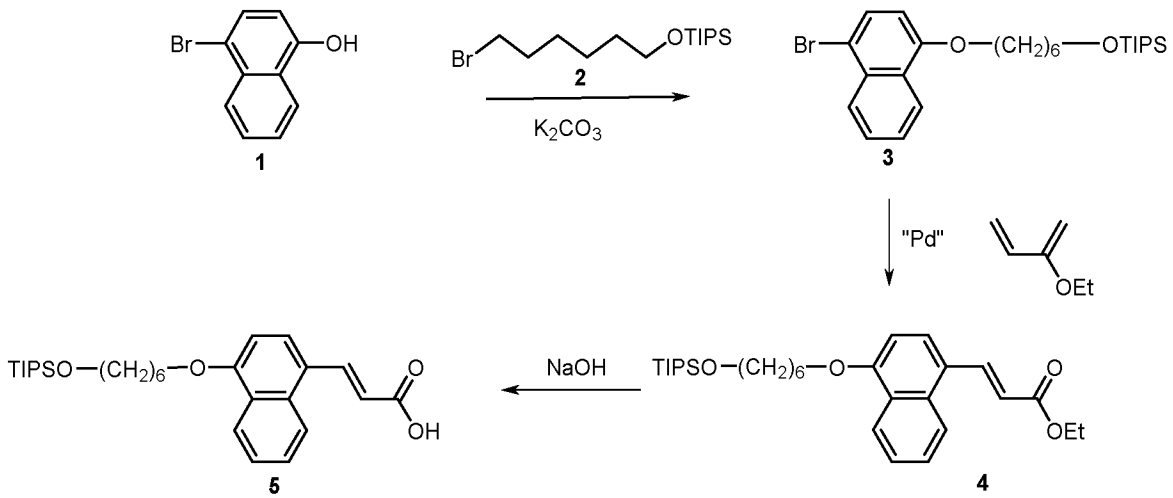
- seven or more, preferably eight or more, individual compounds, preferably of three or more, particularly preferably of four or more, different formulae, selected from the group of the compounds from Table D.

Hereinafter, the present invention is described in more detail and specifically with reference to the Examples, which however are not intended to limit the present invention.

Examples

Compound Examples

1.1. Synthesis of TIPS protected (E)-3-[4-(6-hydroxyhexoxy)-1-naphthyl]prop-2-enoic acid **5**



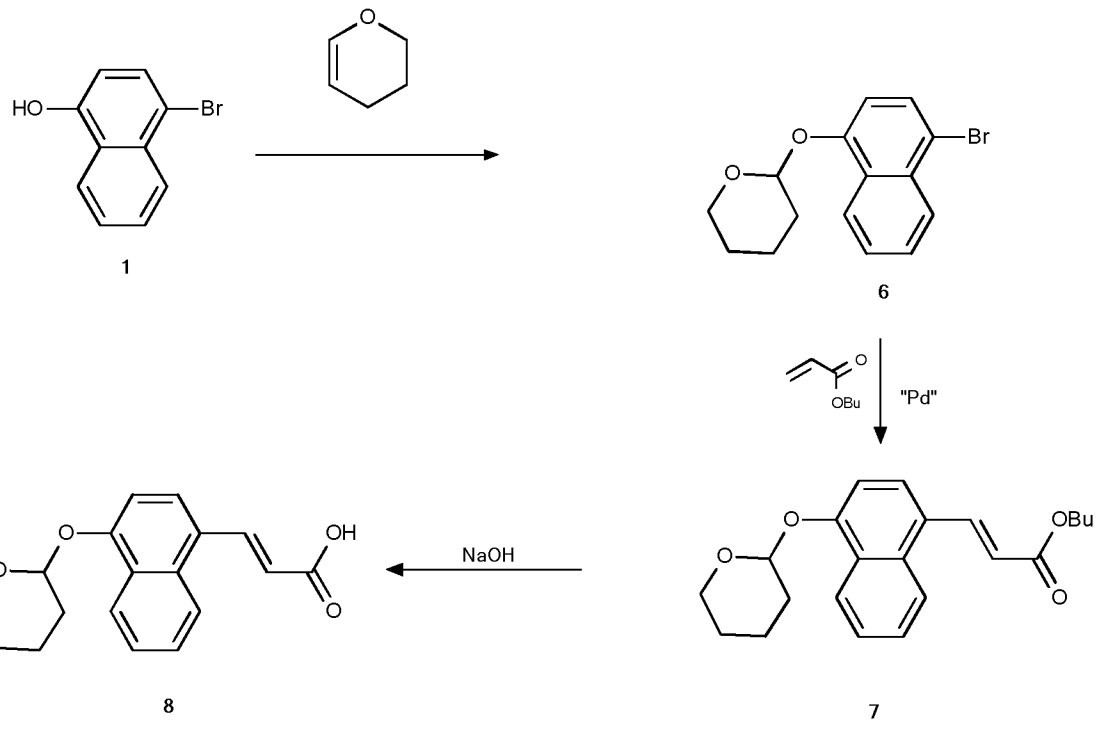
25 g (97%, 109 mmol) 4-bromonaphthalen-1-ol **1**, 41 g (91%, 109 mmol) of TIPS protected 6-bromohexan-1-ol **2** is dissolved in 200 ml DMF. 19 g (130 mmol) potassium carbonate are added und the mixture is stirred for 16 h at 80°C. The cooled mixture is filtrated. The filtrate is poured into 0°C cold water and diluted with MTB-Ether. The organic layer is dried with sodium sulfate and the solved is evaporated. The residue is purified by silica chromatography (n-heptane/toluene 9/1. Yield: 43 g (99%) and gives the corresponding TIPS protected 1-bromo-4-heptoxy-naphthalene **3** as a colorless solid .

5 g (10 mmol) of the TIPS protected 1-bromo-4-heptoxy-naphthalene **3**, 1,2 ml (11 mmol) ethyl acrylate and 3 ml (21 mmol) tzriethylamine are dissolved in in 40 ml acetonitrile, treated with 70 mg (0.3 mmol) Palladium(II)acetate und 160 mg (0.5 mmol) tri(o-tolyl)-phosphine and heated to reflux for 15. The cooled mixture is diluted with water and MTB-ether is added. The

organic layer is dried with sodium sulfate and the solved is evaporated. The residue is purified by silica chromatography (n-heptane/toluene 1/1 -> toluene; chloro butane) and gives the TIPS protected ethyl (E)-3-[4-(6-hydroxyhexoxy)-1-naphthyl]prop-2-enoate **4** as a yellowish oil.

3.1 g (6 mmol) of the ester TIPS protected ethyl (E)-3-[4-(6-hydroxyhexoxy)-1-naphthyl]prop-2-enoate **4** is dissolved in 3 ml MeOH and 20 ml THF, treated with 7 ml 2N caustic soda and stirred for 15h at 40°C. The mixture is poured into 300 ml saturated ammonia chloride, diluted with MTB-ether and pH 3 is adjusted using 1N hydrochloric acid. The organic layer is dried with sodium sulfate and the solvent is evaporated. The residue is treated with boiling acetonitrile. The solid is separated and gives TIPS protected (E)-3-[4-(6-hydroxyhexoxy)-1-naphthyl]prop-2-enoic acid **5**

1.2. Synthesis of THP protected (E)-3-[4-(6-hydroxyhexoxy)-1-naphthyl]prop-2-enoic acid **8**

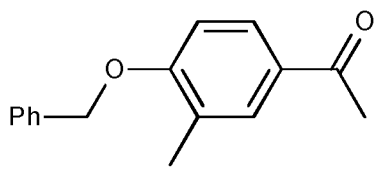


15 g (95%, 64 mmol) **1** und 2.4 g Toluene-4-sulfonate pyridinium (10 mmol) are suspended in 40 ml DCM, treated with 11 ml (128 mmol) THP dissolved in 20 ml DCM and stirred overnight at room temperature. The mixture is diluted with water, the aqueous layer is extracted with DCM. The combined organic layers are dried with sodium sulfate and filtered through silica gel (DCM) gives **6** as a yellowish oil .

A mixture of 18.8 g (90%, 55 mmol) of the bromide **6**, 7.8 ml (55 mmol) butyl acrylate, 11 ml (79 mmol) tzriethylamine and 190 ml acetonitrile are treated with 350 mg (1.6 mmol) Palladium(II)acetate und 800 mg (2.6 mmol) tri(o-tolyl)-phosphine and heated to reflux for 4 h. The cold mixture is diluted with water and MTB-ether. The organic layer is dried with sodium sulfate and the solvent is evaporated. The residue is purified by silica chromatography (chloro butane) and gives **7** as a yellow solid.

16.4 g (92%, 43 mmol) of the ester **7** is dissolved in 20 ml MeOH and 130 ml THF, treated with 43 ml 2N caustic soda and stirred for 5h at 30°C. The mixture is poured into 1000 ml saturated ammonia chloride, diluted with MTB-ether and pH 4.5 is adjusted using 1N hydrochloric acid. The organic layer is dried with sodium sulfate and the solvent is evaporated. The residue is treated twice with DCM which is evaporated. The residue is treated with acetonitrile, cooled to 6°C. The solid is separated and gives **8.**

1.3. Synthesis of 1-[4-(benzyloxy)-3-methylphenyl]ethan-1-one **9**

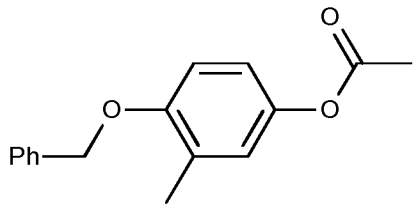


9

12.7 g (85.0 mmol) of 1-(4-hydroxy-3-methyl-phenyl)-ethanone, 12.7 mL (107 mmol) benzyl bromide and 7.62 g (55.0 mmol) potassium carbonate

are dissolved / suspended in methyl(ethyl)ketone and stirred for 18 h under reflux. The reaction mixture is cooled down to room temperature (RT) and the precipitating solid is filtered and washed with methyl tertiary-butyl ether (MTB-E). The product is further crystallized out of heptane at 5°C and is directly used in the next synthesis step.

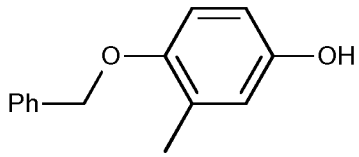
1.4 Synthesis of 4-(benzyloxy)-3-methylphenyl acetate **10**



10

39.1 mL (0.165 mmol) m-chloroperbenzoic acid are suspended in in 102 mL methylene chloride and a solution of 19.3 g (80.0 mmol) of ketone **9** in 72 mL methylene chloride is added dropwise to the reaction mixture. The yellow reaction mixture is then stepwise heated up to reflux and stirred for 16 h. The reaction mixture is cooled to room temperature (RT) and poured onto ice water. The organic layer is filtered off from precipitated 3-chlorobenzoic acid, washed with sodium hydrogen carbonate, tested for peroxide remnants (with ammonia iron(II) sulfate solution), dried over sodium sulfate, filtered and evaporated under vacuum. The crude product is filtered through 900g silica gel with toluene and ethyl acetate (95:5) to give the product as a yellow oil.

1.5. Synthesis of 4-(benzyloxy)-3-methylphenol **11**



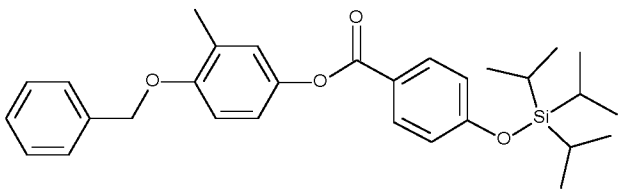
11

23.4 g (91.0 mmol) acetate **10** are solved in 181.0 mL ethanol and 5.84 mL (197.0 mmol) sodium hydroxide solution (32%) are added dropwise to the solution (the reaction solution turned to red color). The reaction mixture is stirred for 2h at ambient temperature and then poured onto ice water and treated with HCl solution till a pH value of 1 is achieved. The reaction mixture is extracted with methyl tertiary-butyl ether (MTB-E), the organic layer dried over sodium sulfate, filtered and evaporated under vacuum. The black oil is filtered over silica gel with methylene chloride and the obtained solid is then crystallized out of heptane at -25°C to give slightly brown colored crystals.

^{1}H NMR (500 MHz, DMSO-d6)

δ = 2.13 ppm (s, 3 H, CH_3), 4.99 (s, 2 H, CH_2-O), 6.51 (dd, *J* = 2.86, 8.62 Hz, 1 H), 6.58 (d, *J* = 2.49 Hz, 1 H), 6.81 (d, *J* = 8.70 Hz, 1 H), 7.32 (d, *J* = 7.23 Hz, 1 H), 7.39 (t, *J* = 7.71 Hz, 2 H), 7.44 (d, *J* = 8.70 Hz, 2 H).

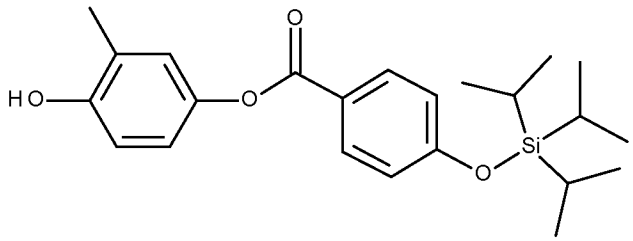
1.6. Synthesis of (4-benzyloxy-3-methyl-phenyl) 4-triisopropylsilyloxybenzoate (**12**)



12

A solution of 21.1 g (98 mmol) **11** and 29 g (98 mmol) 4-triisopropylsilyloxybenzoic acid in 900 ml dichloro methane is treated with 600 mg DMAP and 22.6 g (118 mmol) N-(3-dimethylamino propyl)-N`-ethyl carbodiimide hydrochloride and stirred overnight at room temperature. The mixture was filtered through silica gel (dichloromethane). The solvent of the product containing fraction is evaporated to give **12.**

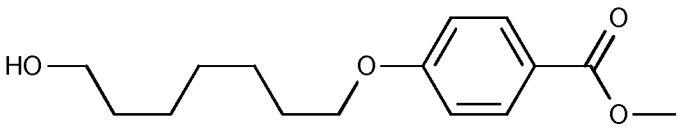
1.8. Synthesis of (4-hydroxy-3-methyl-phenyl) 4-triisopropylsilyloxybenzoate (**13**)



13

A solution of 35 g (71 mmol) **12** in 350 ml THF is hydrogenated with Pd-C-5% (51.4% water) at room temperature. The solvent is evaporated to give **13.**

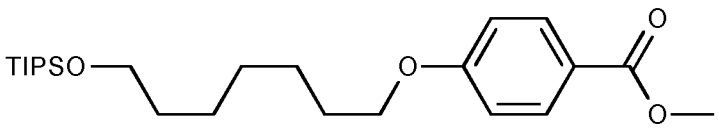
1.9. Synthesis of methyl 4-[(6-hydroxyhexyl)oxy]benzoate **14**



14

40.0 g (263 mmol) methyl 4-hydroxybenzoate and 43.6 g (315 mmol) are dissolved in 150 mL methyl(ethyl)ketone and 49.9 g (276 mmol) 6-bromohexan-1-ol are added and the reaction mixture is heated up to reflux and stirred for 16 h. The reaction mixture is then cooled to room temperature (RT) and the precipitating residue is filtered off, is washed with acetone and dried under vacuum. The crude product is crystallized at 5°C out of toluene and the product can be used in the next step without further purification.

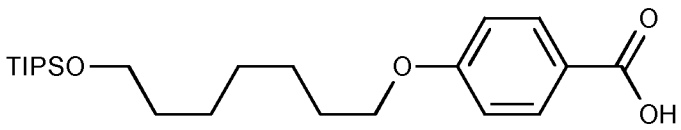
1.10. Synthesis of methyl 4-[(6-{[tris(propan-2-yl)silyl]oxy}hexyl)oxy]benzoate **15**



15

18.8 g (74.51 mmol) ester **14** and 0.45 g (3.73 mmol) 4-dimethylaminopyridine are solved in 90 mL N, N-dimethylformamide (DMF). 15.8 g (81.96 mmol) chloro-triisopropylsilane (dissolved in 30 mL DMF) are added dropwise to the reaction mixture at room temperature (RT) and stirred for 16 h. The reaction mixture is diluted with methyl tertiary-butyl ether (MTB-E) and poured in ice water. The organic layer is dried over sodium sulfate, filtered and evaporated under vacuum to give the product as an oil which is further purified by column chromatography with silica gel and chloro butane as a solvent. The product is a slightly yellow oil.

1.11. Synthesis of 4-[(6-{[tris(propan-2-yl)silyl]oxy}hexyl)oxy]benzoic acid **16**



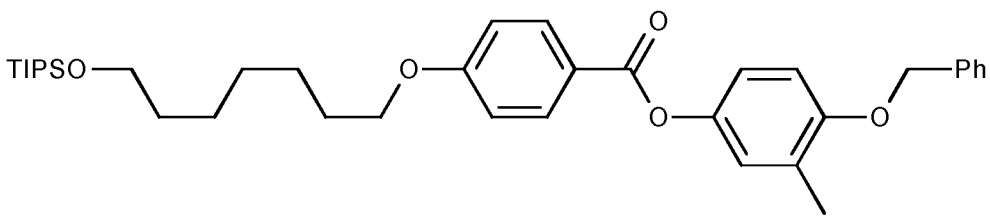
16

27.0 g (66.0 mmol) of ester **15** are dissolved in a mixture of 160 mL methanol and 80 mL tetrahydrofuran and 90 mL NaOH (2N). The reaction mixture is stirred for 2 h at 40°C. The reaction mixture is cooled to room temperature (RT), poured cautiously in ice water, neutralized with HCl (2N) and extracted with ethyl acetate. The organic layer is washed with brine, dried over sodium sulfate, filtered and evaporated under vacuum to give the product as a white solid which is purified by crystallization out of ethyl acetate at 3°C to give white crystalline solid.

^{1}H NMR (500 MHz, DMSO-d6)

δ = 1.02 ppm (m_c, 21 H, Si-(C_3H_7)$_3$), 1.34 -1.47 (m, 4H, CH_2), 1.51 (quint, *J* = 6.57 Hz, 2 H, CH_2), 1.73 (quint, *J* = 6.01 Hz, 2 H, CH_2), 3.69 (t, *J* = 6.33 Hz, 2 H, CH_2), 4.02 (t, *J* = 6.45 Hz, 2 H, CH_2), 6.98 (d, *J* = 8.91 Hz, 2 H), 7.87 (*J* = 8.89 Hz, 2 H).

1.12. Synthesis of 4-(benzyloxy)-3-methylphenyl 4-[(6-{[tris(propan-2-yl)silyl]oxy}hexyl)oxy]benzoate **17**

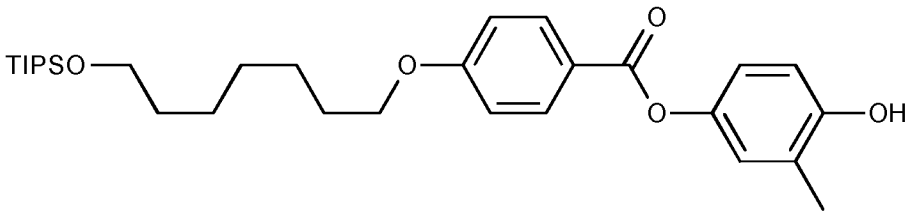


17

28.0g (70.7 mmol) of acid **16**, 15.5 g (72.18 mmol) phenol **11** and 1.72 g (14.15 mmol) 4-dimethylaminopyridine are solved in 280 mL methylene

chloride. The reaction mixture is treated successively with 16.2 g (84.89 mmol) N-(3-dimethylaminoproyl)-N`-ethylcarbodiimide hydrochloride and stirred for 16 h at room temperature (RT). The reaction mixture is diluted with water and extracted with methylene chloride. The combined organic layers are washed with brine, dried over sodium sulfate, filtered and evaporated under vacuum to yield a yellow solid. The crude product is purified via column chromatography with silica gel and heptane / ethyl acetate (8:2) to give a colorless solid.

1.13. Synthesis of 4-hydroxy-3-methylphenyl 4-[(6-{[tris(propan-2-yl)silyl]oxy}hexyl)oxy]benzoate **18**



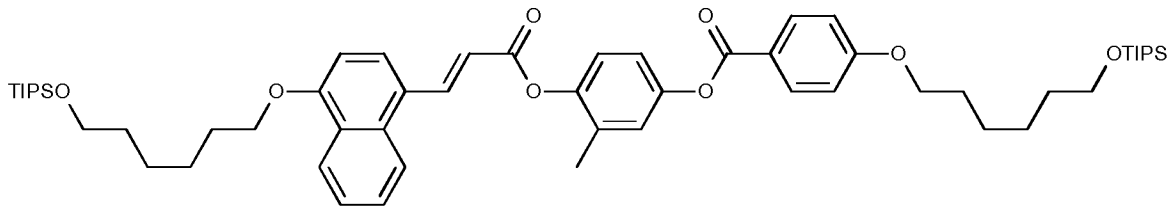
18

39.0 g (65.8 mmol) of compound **17** are dissolved in 390 mL tetrahydrofuran and 15.0 g (140.9 mmol) Pd-C (5% basic) are added and the reaction mixture is treated with hydrogen atmosphere under normal pressure and room temperature for 45 min. The catalyst was filtered off and the reaction mixture was evaporated under vacuum. The crude product (oil which crystallizes) is purified via column chromatography with 1-chlorbutane and ethyl acetate (8:2). The resulting product is crystallized with acetonitrile.

^{1}H NMR (500 MHz, $CDCl_3$)

δ = 1.06 (m_c, 21 H, Si-(C_3H_7)$_3$), 1.40 – 1.53 (m, 2 H, CH_2), 1.56 (quint, J = 7.73 Hz, 2 H, CH_2), 1.83 (7.82 Hz, 2 H, CH_2), 2.25 (s, 3 H, CH_3), 3.70 (t, J = 6.46 Hz, 2H, CH_2), 4.04 (t, J = 6.53 Hz, 2H , CH_2), 4.78 (s, 1 H, OH), 6.76 (d, J = 8.58 Hz, 1 H), 6.88 (dd, J = 2.76, 8.56 Hz, 1 H), 6.95 (m_c, 3 H), 8.12 (d, J = 8.91 Hz).

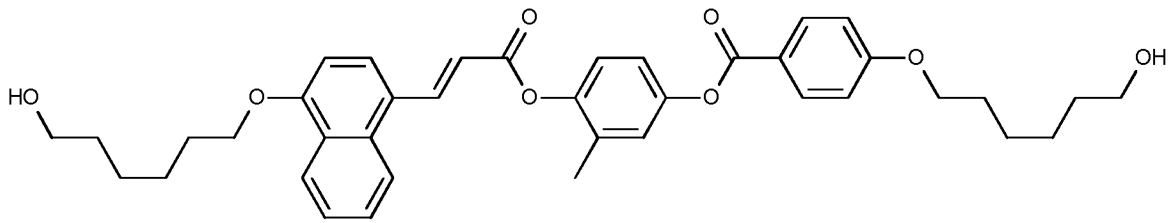
1.14. Synthesis of **19**



19

A solution of 5.4 g (11.3 mmol) **5** and 5.5 g (10.3 mmol) **18** in 60 ml dichloro methane is treated with 60 mg DMAP and 2.3 g (12 mmol) N-(3-dimethylamino propyl)-N`-ethyl carbodiimide hydrochloride and stirred overnight at room temperature. The mixture was filtered through silica gel (dichloro methane). The solvent of the product containing fraction is evaporated to give **19.**

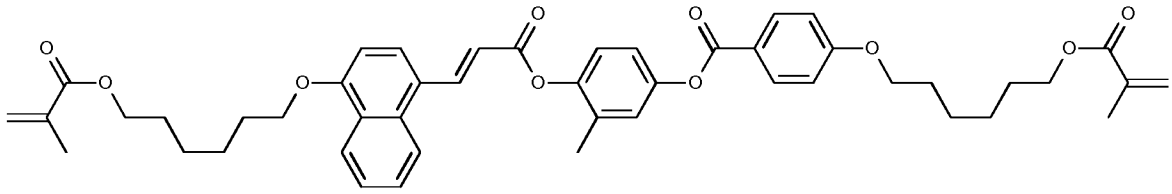
1.15. Synthesis of **20**



20

A solution of 4.0 g (4.2 mmol) **19** in 80 ml THF is treated with 10 ml 2N hydrochloric acid at a temperature below 5°C. The reaction mixture is stirred overnight at room temperature and diluted with MTB ether. The organic layers are dried with sodium sulfate, the solvent is evaporated. The product containing fraction are combined and the solvent is evaporated. The residue is suspended in 20 ml acetonitrile and stirred at room temperature. The mixture is cooled to 6°C. The precipitate is isolated to give **20.**

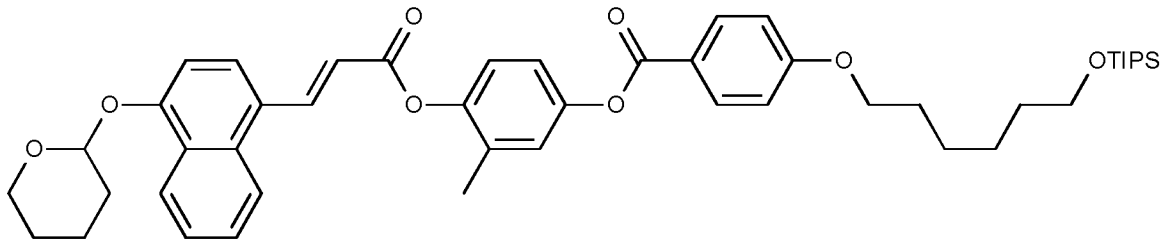
1.16. Synthesis of **21**



21

A mixture of 2.6 g (4 mmol) **20** and 50 ml dichloro methane is treated with 1.0 ml (12 mmol) methacrylic acid and 100 mg DMAP. At 5°C 2.8 ml (16 mmol) N-(3-dimethylamino propyl)-N`-ethyl dissolved in 25 ml DCM are added. After 1h stirring at this temperature stirring is continued at room temperature overnight. The reaction mixture is purified by silica chromatography (dichloro methane/acetonitrile 1:9). Further purification by by treating a DCM solution with activated charcoal and subsequent evaporation of the solvent gives **21.**

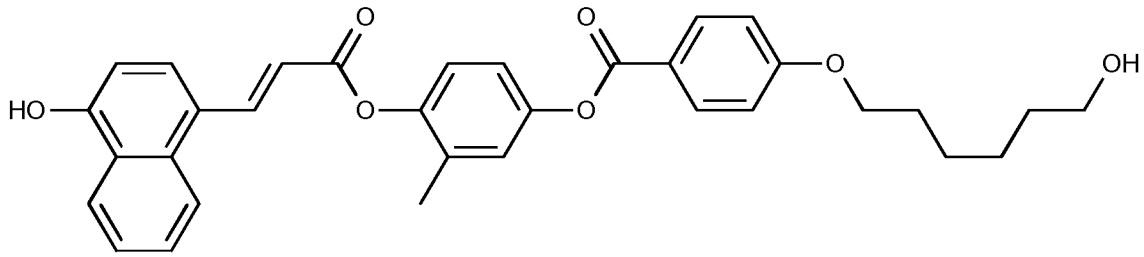
1.17. Synthesis of **22**



22

A solution of 3.5 g (11.7 mmol) **8** and 6 g (11.9 mmol) **18** in 70 ml dichloro methane is treated with 73 mg DMAP and 2.8 g (14.6 mmol) N-(3-dimethylamino propyl)-N`-ethyl carbodiimide hydrochloride and stirred overnight at room temperature. The mixture was purified by silica gel chromatography (dichloro methane). The solvent of the product containing fraction is evaporated and gives **22.**

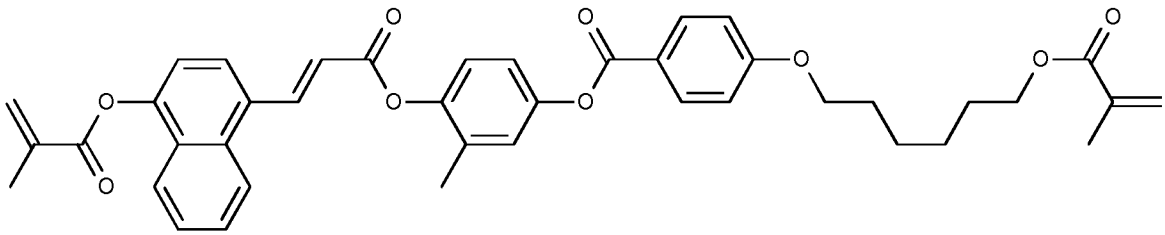
1.18. Synthesis of **23**



23

A solution of 5.1 g (6.5 mmol) **22** in 80 ml THF is treated with 8.5 ml 2N hydrochloric acid at a temperature below 25°C. The reaction mixture is stirred 4h at room temperature and diluted with MTB ether. The organic layers are dried with sodium sulfate, the solvent is evaporated. The product containing fraction are combined and the solvent is evaporated. The residue mix is purified by silica chromatography (dichloro methane/ethyl acetate, gradient 0-30%) gives **23.**

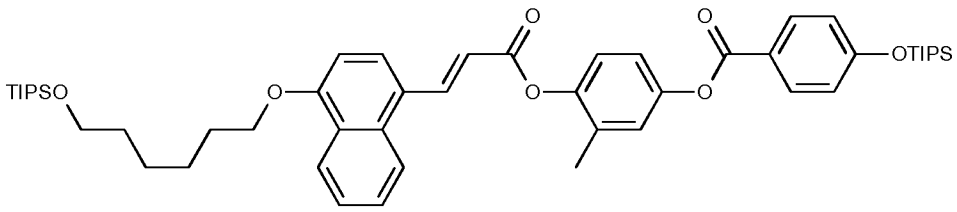
1.19. Synthesis of **24 (RM-1)**



24

A mixture of 0.8 g (90%, 1.3 mmol) **23** and 5 ml dichloro methane is treated with 0.6 ml (7 mmol) methacrylic acid and 100 mg DMAP. At 5°C 2.8 ml (16 mmol) 1-(3-dimethylamino propyl)-N`-ethyl carbodiimide dissolved in 5 ml DCM are added. After 1h stirring at this temperature stirring is continued at room temperature overnight. The reaction mixture is purified by silica chromatography (dichloro methane/ethyl acetate, gradient 0-0.3%) gives **24.**

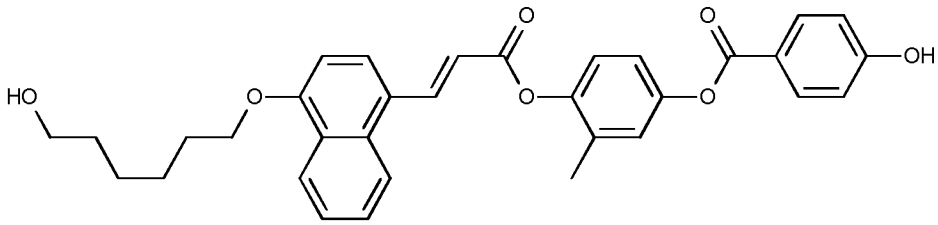
1.20. Synthesis of **25**



25

A solution of 3.4 g (98%, 7.1 mmol) **5** and 2.6 g (6.5 mmol) **13** in 40 ml dichloro methane is treated with 35 mg DMAP and 1.5 g (7.8 mmol) N-(3-dimethylamino propyl)-N`-ethyl carbodiimide hydrochloride and stirred overnight at room temperature. The mixture was filtered through silica gel (dichloro methane). The solvent of the product containing fraction is evaporated and gives a yellow oil **25.**

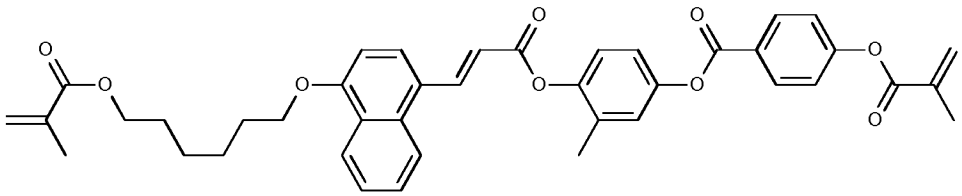
1.21. Synthesis of **26**



26

A solution of 5.3 g (98%, 6.1 mmol) **25** in 50 ml THF is treated with 5 ml hydrogen fluoride in triethylamine at a temperature below 5°C. The reaction mixture is stirred overnight at room temperature and purified by silica chromatography (DCM/THF gradient 10% - 20%) to give **26.**

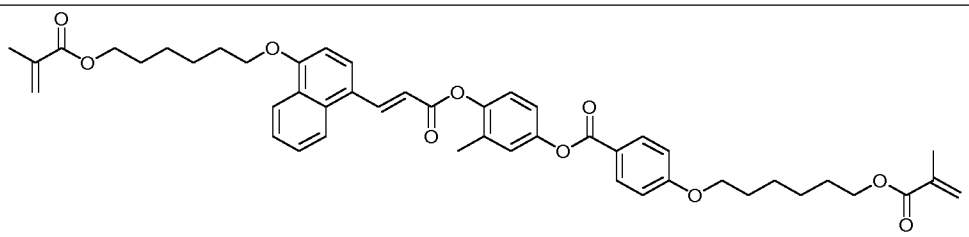
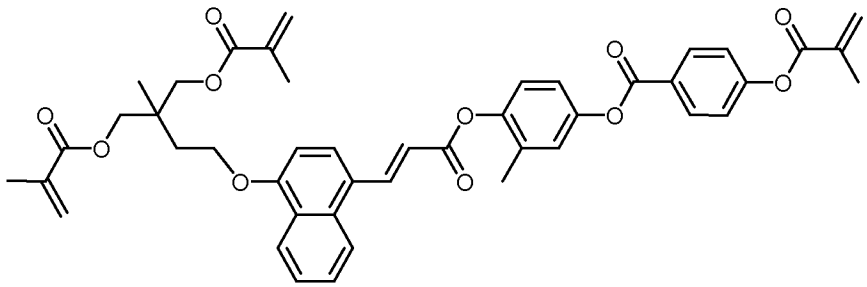
1.22. Synthesis of **27 (RM-2)**



27

A mixture of 3.3 g (95%, 5.8 mmol) **26** and 20 ml dichloro methane is treated with 2.7 ml (32 mmol) methacrylic acid and 70 mg DMAP. At 5°C 2.8 ml (16 mmol) N-(3-dimethylamino propyl)-N`-ethyl dissolved in 10 ml DCM are added. After 1h stirring at this temperature stirring is continued at room temperature overnight. The reaction mixture is purified by silica chromatography (DCM). Further purification by treating a solution in acetone with activated charcoal. Crystallisation from acetone gives **27 (**RM-2).

In accordance or in analogy to the above described procedures or in analogy to the procedures described in WO 2017/102068 and JP 2006-6232809, the following compounds are obtained:

No.	Structure
RM-3	
	Tg -14 K 97 N (86.3) I , decomp. > 105
RM-4	
	Tg 15 K 68 I , decomp. > 120

Nematic host mixtures

The following nematic LC host mixture are prepared as indicated in the following tables:

Mixture N-1:

Composition [%-w/w]		Physical properties	
CC-3-V	36.00		
CC-3-V1	5.00	Clearing Point [°C]:	78
CCP-V-1	8.00	n_e [589 nm, 20°C]:	1.5907
PGP-2-2V	3.00	Δn [589 nm, 20°C]:	0.1095
CCQU-3-F	9.5	$\varepsilon_{\parallel}$ [1 kHz, 20°C]:	16.6
PUQU-3-F	8.5	$\varepsilon_{\perp}$ [1 kHz, 20°C]:	3.7
APUQU-2-F	5.00	$\Delta\varepsilon$ [1 kHz, 20°C]:	12.9
APUQU-3-F	8.00	K_1 [pN, 20°C]:	12.1
PGUQU-3-F	4.00	K_3 [pN, 20°C]:	13.4
PGUQU-4-F	8.00	K_3/K_1 [pN, 20°C]:	1.11
PGUQU-5-F	5.00	V_0 [V, 20°C]:	1.01
Σ	100.0	LTS bulk [h, -20°C]:	1000

Mixture N-2:

Composition [%-w/w]		Physical properties	
CY-3-O2	15.00	Clearing Point [°C]:	79.1
CY-5-O2	9.50	n_e [589 nm, 20°C]:	1.5744
CCY-3-O1	4.00	Δn [589 nm, 20°C]:	0.0944
CCY-3-O2	6.00	$\varepsilon_{\parallel}$ [1 kHz, 20°C]:	3.7
CCY-3-O3	4.50	$\varepsilon_{\perp}$ [1 kHz, 20°C]:	7.7
CCY-4-O2	6.00	$\Delta\varepsilon$ [1 kHz, 20°C]:	-4.0
CCY-5-O2	4.00	K_1 [pN, 20°C]:	13.4
CPY-2-O2	8.00	K_3 [pN, 20°C]:	15.4
CPY-3-O2	9.00	LTS bulk [h, -20°C]:	1000
PYP-2-4	2.00		
CC-3-V	32.00		
Σ	100.0		

Fabrication of display cells

Unless explicitly stated otherwise, the display cells are made with Corning AF glass of 0.7mm thickness using 6.4 µm spacer beads and XN-1500T sealant.

For measurement of electro-optics 3 µm thick PI-free IPS cells are made of substrates commercially available from SD-tech and constructed into cells using ITO electrodes having 5µm electrode spacing and a 3µm electrode width.

The cells are assembled by hand and then cured using a Omnicure 2000 Mercury lamp with with 35 mW/cm^2 the irradiation power is thereby measured by an Opsytec UV pad-e spectroradiometer.

Mixture examples

Nematic LC mixtures M-1 to M-24 according to the invention are prepared from the nematic host mixtures N-1 to N-9 listed above and photoalignment additives of formula I, according to the compositions given in the following table.

Mixture example	Host Mixture	c [%] of Host Mixture	Photoalignment additive	
			Compound	c [%]
M-1	N-1	99.70	RM-1	0.50
M-2	N-1	99.50	RM-2	0.50
M-3	N-1	99.00	RM-3	0.30
M-4	N-2	99.50	RM-2	0.50
M-5	N-2	99.70	RM-4	0.30
M-6	N-1	99.70	RM-4	0.30

Cell filling and curing

Unless explicitly stated otherwise, the selected LC mixtures are capillary filled using capillary action at room temp., annealed for 1 h at 100°C and then irradiated at the same temperature with linearly polarised UV light (35 mW/cm^2) for the given time . The cells are then cooled to room temperature. Next, the alignment quality is studied between crossed polarisers on a light box.

Example	Host mixture		Compound		Curing time	Alignment
		[%]		[%]	[s]	
M-1	N-1	99.50	RM-1	0.50	120	++
M-1	N-1	99.50	RM-1	0.50	180	++
M-2	N-1	99.50	RM-2	0.50	180	++
M-3	N-1	99.70	RM-3	0.30	180	+
M-4	N-2	99.50	RM-2	0.30	180	++
M-5	N-2	99.70	RM-4	0.30	180	++
M-6	N-1	99.70	RM-4	0.30	180	++

Alignment quality: (++) excellent, (+) good, (o) acceptable, (-) poor

At least good uniform planar alignment is achieved with all mixtures

VHR measurements

Unless explicitly stated otherwise, the selected LC mixtures are capillary filled using capillary action at room temp., annealed for 1 h at 100°C and then irradiated at the same temperature with linearly polarised UV light (35 mW/cm2) from an Omnicure S2000 mercury lamp with a built in 320-500nm filter utilizing an additional 360 nm long pass filter (cuts off shorter wavelengths from 320-360nm) .

The cells are then cooled to room temperature and then irradiated with linearly polarised UV light (35 mW/cm2) from an Omnicure S2000 mercury lamp with a built in 320-500nm filter utilizing an additional 360 nm long pass filter (cuts off shorter wavelengths from 320-360nm) for 10 minutes.

Next, the VHR is studied using Toyo LCM-1 LC Material Characteristics Measurement System. Unless described otherwise, the measurement of the VHR is carried out as described in T. Jacob, U. Finkenzeller in "Merck Liquid Crystals - Physical Properties of Liquid Crystals", 1997.

VHR measured at 60°C, 1 Hz and 1 V after curing with 360 nm cut off filter

Example	**Host mixture**		**Photoalignment compound**		**VHR**
		[%]		[%]	[%]
M-4	N-2	99.50	RM-2	0.50	89.7
M-5	N-2	99.70	RM-4	0.30	90.5

VHR measured at 60°C, 3 Hz and 1 V after curing with 360 nm cut off filter

Example	Host mixture		Photoalignment compound		VHR
		[%]		[%]	[%]
M-2	N-1	99.50	RM-2	0.50	94.5
M-6	N-1	99.70	RM-4	0.30	95.1

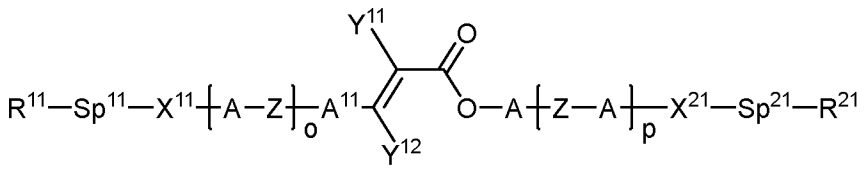
VHR measured at 60°C, 60 Hz and 1 V after curing with 360 nm cut off filter

Example	Host mixture		Photoalignment compound		VHR
		[%]		[%]	[%]
M-1	N-1	99.50	RM-1	0.50	85.9
M-2	N-1	99.50	RM-2	0.50	97.9
M-4	N-2	99.50	RM-2	0.50	92.8
M-5	N-1	99.70	RM-4	0.30	99.2
M-6	N-1	99.70	RM-4	0.30	98.9

As can be seen from the above-given tables the VHR of test cells in accordance with the present invention show excellent values. In particular, the combination of RM-2 and RM-4 with a LC host mixture N-2 having a negative dielectric anisotropy shows unexpectedly favourable values for the VHR.

Patent Claims

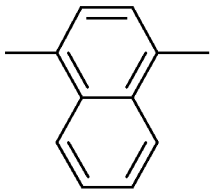
1. Compound of formula I,



I

wherein

A^{11} denotes a radical



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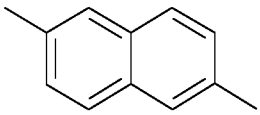
where, in addition, one or more H atoms in these radical may be replaced by L, and/or one or more and/or one or more CH groups may be replaced by N,

A denotes, independently of one another, in each occurrence

a) the group consisting of 1,4-phenylene and 1,3-phenylene, wherein, in addition, one or two CH groups may be replaced by N and wherein, in addition, one or more H atoms may be replaced by L,

b) the group consisting of saturated, partially unsaturated or fully unsaturated, and optionally substituted, polycyclic radicals having 5 to 20 cyclic C atoms, one or more of which may, in addition, be replaced by heteroatoms, selected from the group consisting of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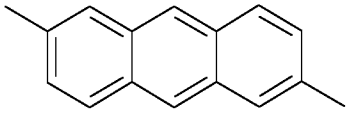
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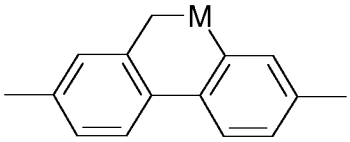
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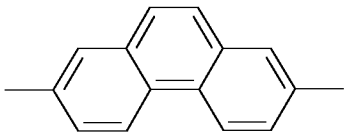
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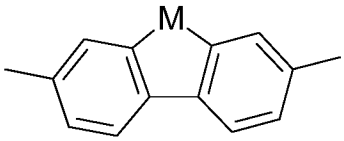
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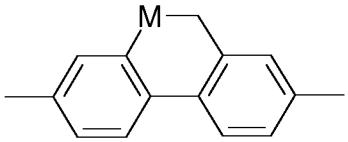
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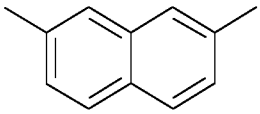
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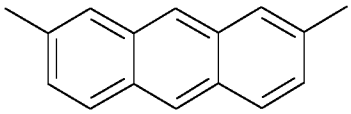
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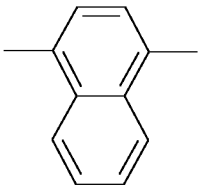
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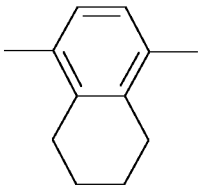
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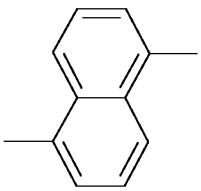
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where, in addition, one or more H atoms in these radicals may be replaced by L, and/or one or more double bonds may be replaced by single bonds, and/or one or more CH groups may be replaced by N,

c) group consisting of trans-1,4-cyclohexylene, 1,4-cyclohexenylene, wherein, in addition, one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S- and wherein, in addition, one or more H atoms may be replaced by F, or

d) a group consisting of tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl, tetrahydrofuran-2,5-diyl, cyclobutane-1,3-diyl, piperidine-1,4-diyl, thiophene-2,5-diyl and selenophene-2,5-diyl,
each of which may also be mono- or polysubstituted by L,

L on each occurrence, identically or differently, denotes -OH, -F, -Cl, -Br, -I, -CN, $-NO_2$, SF_5, -NCO, -NCS, -OCN, -SCN, $-C(=O)N(R^z)_2$, $-C(=O)R^z$, $-N(R^z)_2$, optionally substituted silyl, optionally substituted aryl having 6 to 20 C atoms, or straight-chain or branched or cyclic alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 25 C atoms, preferably 1 to 12 C atoms, more preferably 1 to 6 C atoms , in which, in addition, one or more H atoms may be replaced by F or Cl, or X^{21}-Sp^{21}-R^{21},

M denotes -O-, -S-, $-CH_2-$, $-CHR^z-$ or $-CR^yR^z-$, and

R^y and R^z each, independently of one another, denote H, CN, F or alkyl having 1-12 C atoms,wherein, in addition, one or more H atoms may be replaced by F,

Y^{11} and Y^{12} each, independently of one another, denote H, F, phenyl or optionally fluorinated alkyl having 1-12 C atoms,

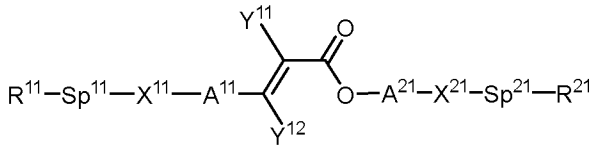
Z denotes, independently of each other, in each occurrence, a single bond, -COO-, -OCO-, -O-CO-O-, $-OCH_2-$, $-CH_2O-$, $-OCF_2-$, $-CF_2O-$, $-(CH_2)_n-$,

		$-CF_2CF_2-$, -CH=CH-, -CF=CF-, -CH=CH-COO-, -OCO-CH=CH-, -CO-S-, -S-CO-, -CS-S-, -S-CS-, -S-CSS- or -C≡C-,
	n	denotes an integer between 2 and 8,
	o and p	denotes each and idependently 0, 1 or 2,
	X^{11} and X^{21}	denote independently from one another,in each occurence a single bond, -CO-O-, -O-CO-, -O-COO-, -O-, -CH=CH-, -C≡C-, $-CF_2-O-$, $-O-CF_2-$, $-CF_2-CF_2-$, $-CH_2-O-$, $-O-CH_2-$, -CO-S-, -S-CO-, -CS-S-, -S-CS-, -S-CSS- or -S-,
	Sp^{11} and Sp^{21}	denote each and independently,in each occurence a single bond or a spacer group comprising 1 to 20 C atoms, wherein one or more non-adjacent and non-terminal CH_2 groups may also be replaced by -O-, -S-, -NH-, $-N(CH_3)-$, -CO-, -O-CO-, -S-CO-, -O-COO-, -CO-S-, -CO-O-, $-CF_2-$, $-CF_2O-$, $-OCF_2-$ -C(OH)-, -CH(alkyl)-, -CH(alkenyl)-,-CH(alkoxyl)-, -CH(oxaalkyl)-, -CH=CH- or -C≡C-, however in such a way that no two O-atoms are adjacent to one another and no two groups selected from -O-CO-, -S-CO-, -O-COO-, -CO-S-, -CO-O- and -CH=CH- are adjacent to each other,
	R^{11}	denotes P,

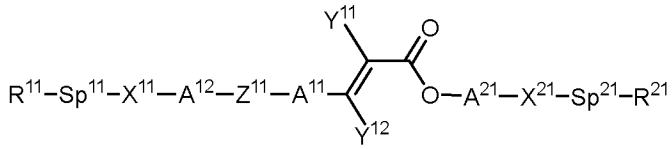
R^{21} denotes P, or halogen, CN, optionally fluorinated alkyl or alkenyl with up to 15 C atoms in which one or more non adjacent CH_2-groups may be replaced by -O-, -S-, -CO-, -C(O)O-, -O-C(O)-, O-C(O)-O-,

P each and independently from another in each occurrence a polymerisable group.

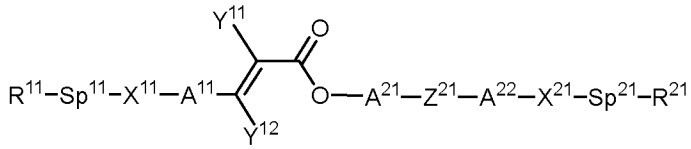
2. Compound according to claim 1, characterized in that the compound is selected selected from compounds of the sub-formulae I-1 to I-9.



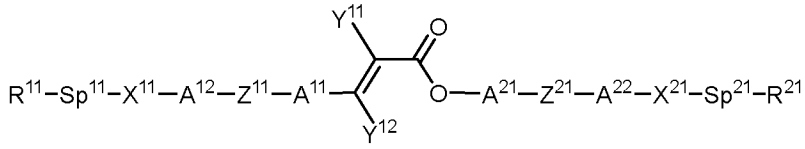
I-1



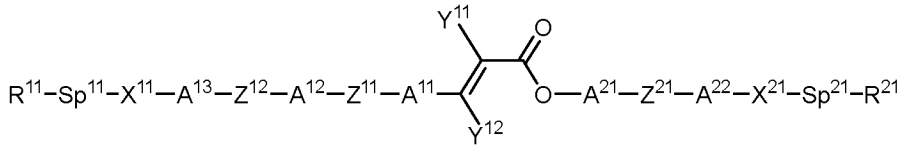
I-2



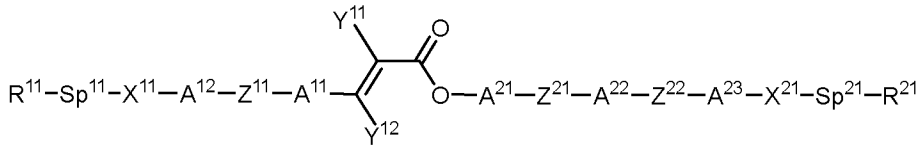
I-3



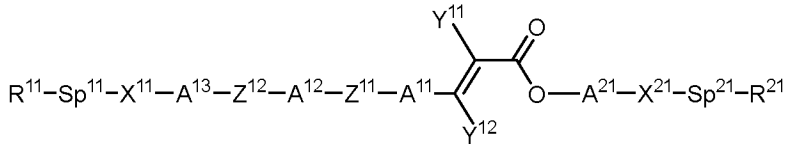
I-4



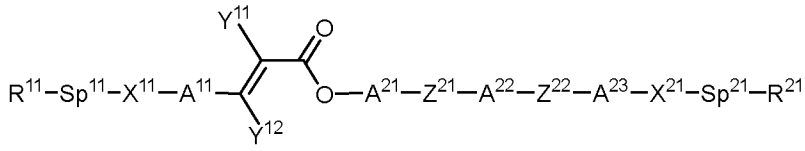
I-5



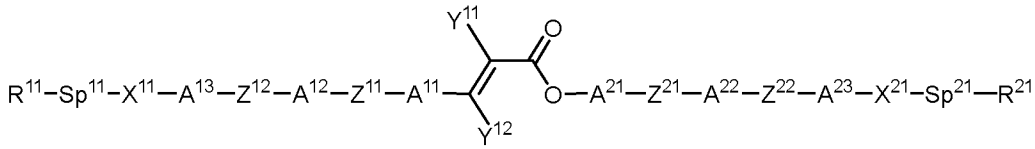
I-6



I-7



I-8

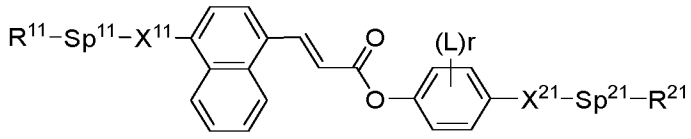


I-9

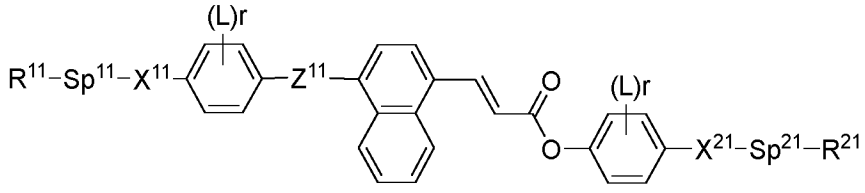
wherein

R^{11}, R^{21}, A^{11}, X^{11}, X^{12}, Y^{11}, Y^{12}, Sp^{11}, and Sp^{12} have one of the meanings as given above in claim 1, A^{12} to A^{23} have one of the meanings for A as given in claim 1 , and Z^{11} to Z^{22} have one of the meanings for Z as given above in claim 1.

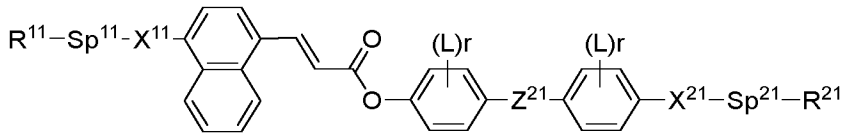
3. Compound according to claim 1 or 2, characterized in that the compound is selected from compounds of the following sub-formulae,



I-1a-1



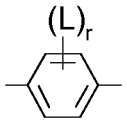
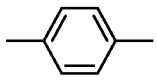
I-2a-1

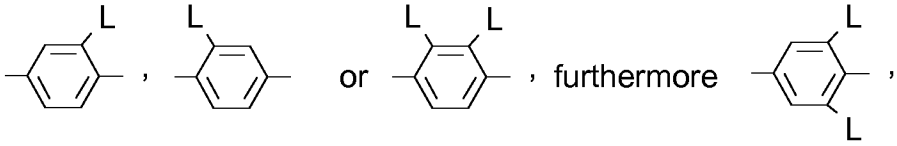


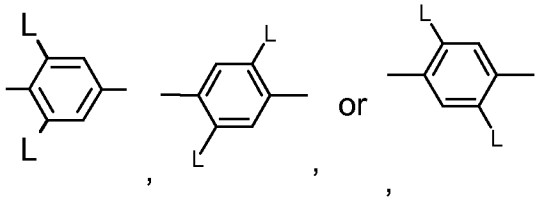
I-3a-1

wherein

R^{11}, R^{21}, X^{11}, X^{21}, Sp^{11} and Sp^{21} have one of the meanings as given above in claim 1I, Z^{11} and Z^{21} have one of the meanings for Z as given above in claim 1 and

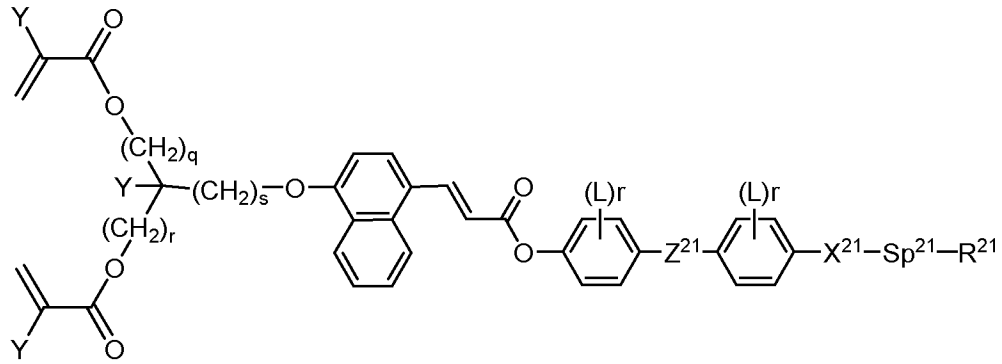
the group  is each and idependently  or

denotes 

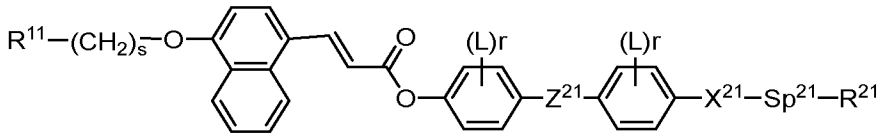


wherein L is F, Cl, CH_3, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, or X^{21}-Sp^{21}-R^{21}.

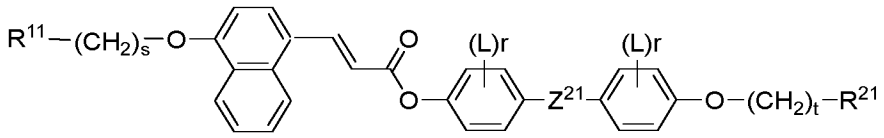
4. Compound according to one or more of claims 1 to 3, characterized in that it is selected from compounds of the following sub-formulae,



I-3a-1a

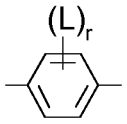
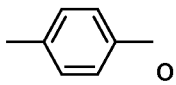


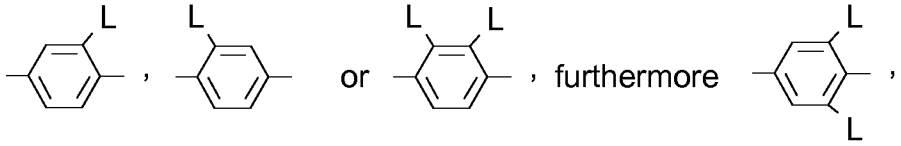
I-3a-1b

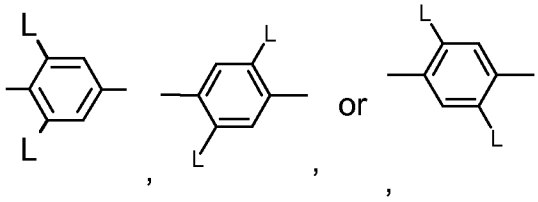


I-3a-1c

R^{11}, R^{21}, X^{21}, and Sp^{21} have one of the meanings as given above in claim 1, Z^{21} has one of the meanings for Z as given above under claim 1, r,s, t and q denote each and idependently from another an integer from 1 to 8, Y denotes each and idependently from each other methyl or H, and

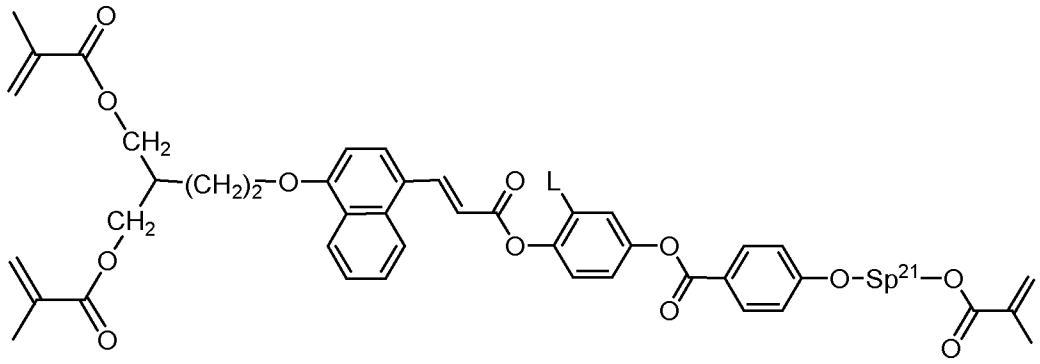
the group  is each and idependently  or

denotes 

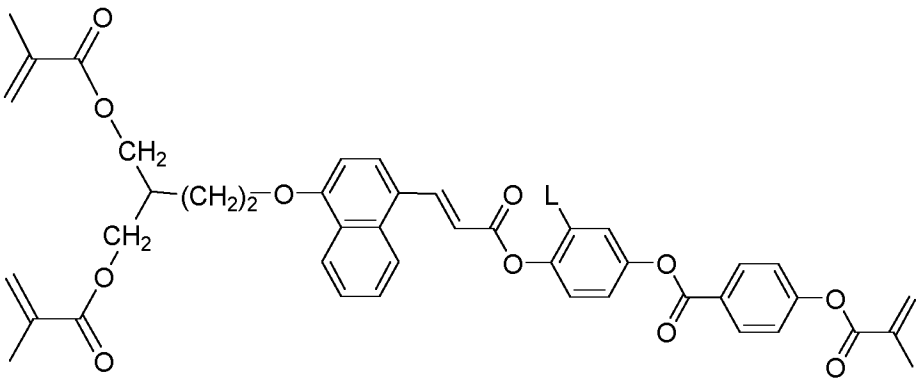


wherein L is F, Cl, CH_3, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms, or X^{21}-Sp^{21}-R^{21}.

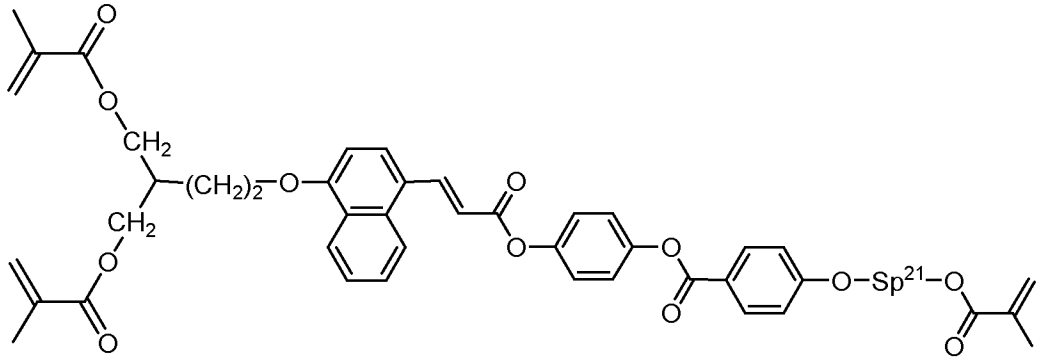
5. Compound according to one or more of claims 1 to 4, characterized in that it is selected from compounds of the following sub-formulae,



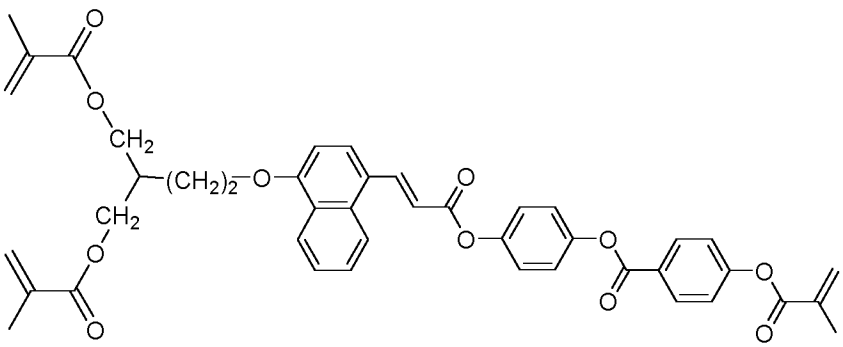
I-3a-1a-1



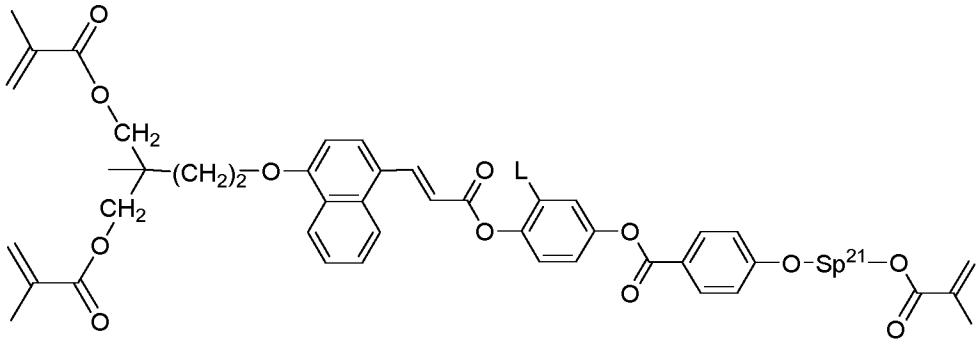
I-3a-1a-2



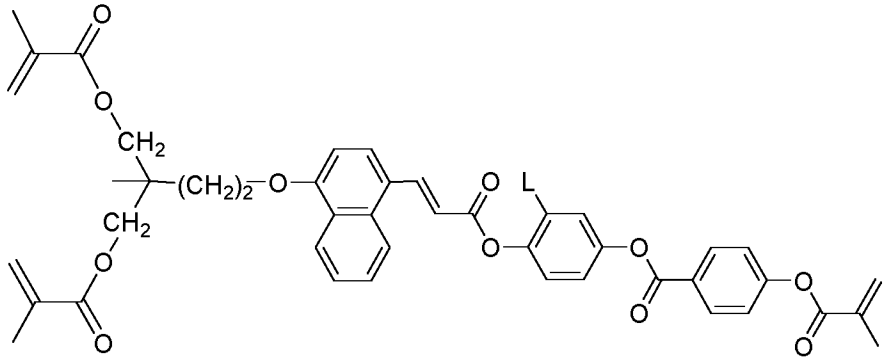
I-3a-1a-3



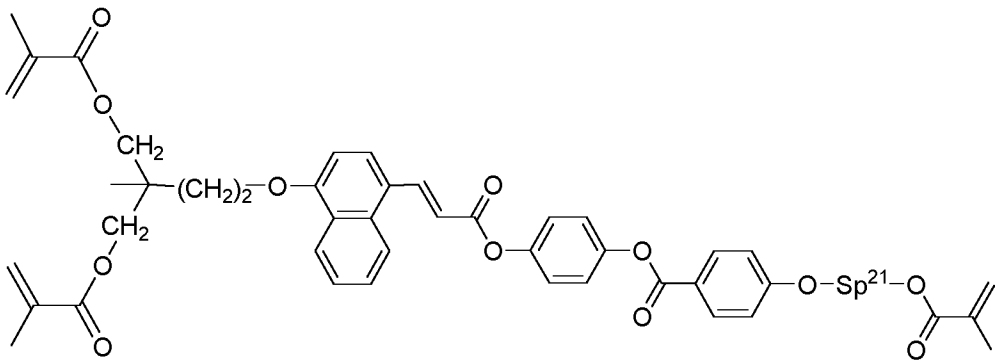
I-3a-1a-4



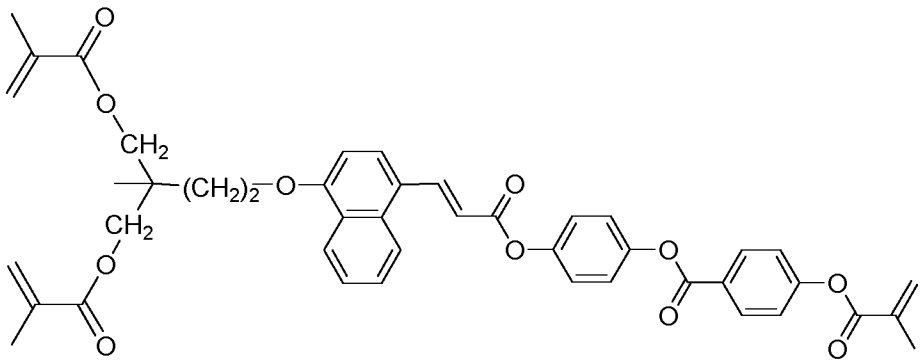
I-3a-1a-5



I-3a-1a-6



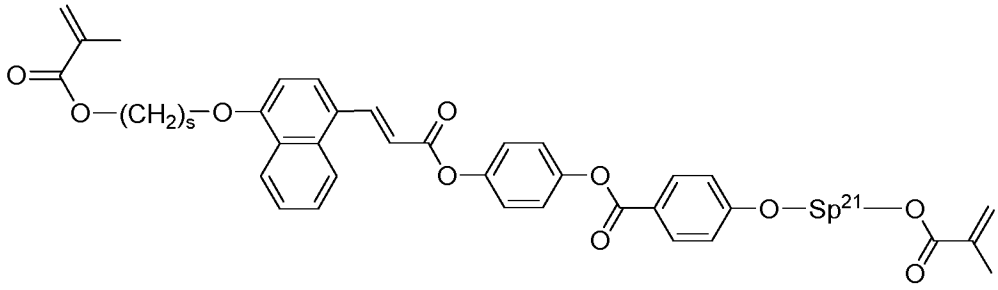
I-3a-1a-7



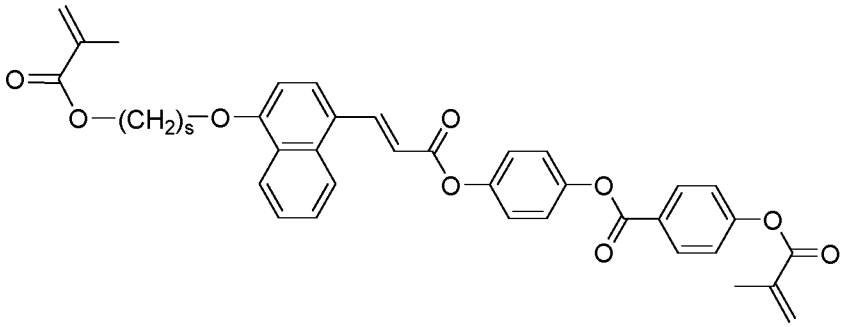
I-3a-1a-8

wherein Sp^{21} has one of the meanings as given above in formula I and L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms and s denotes an integer from 1 to 8,.

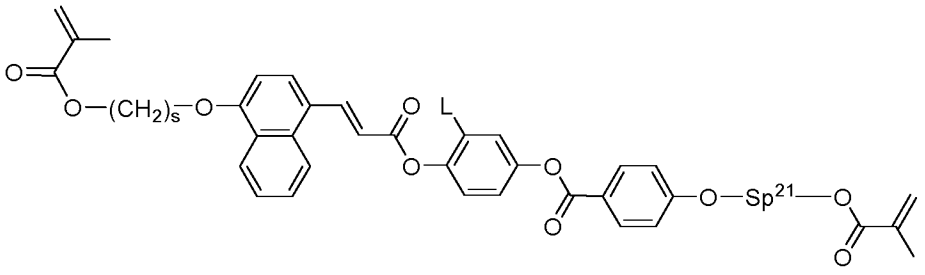
6. Compound according to one or more of claims 1 to 4, characterized in that it is selected from compounds of the following sub-formulae,



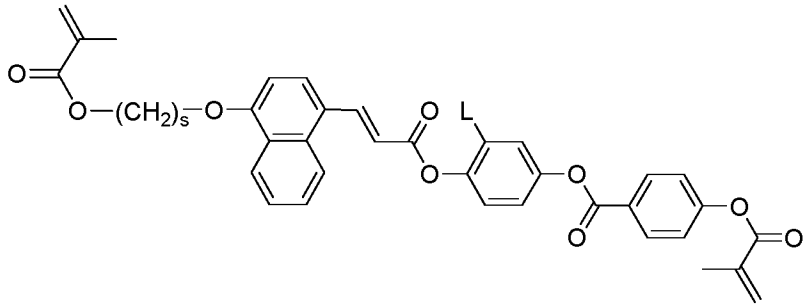
I-3a-1b-1



I-3a-1b-2



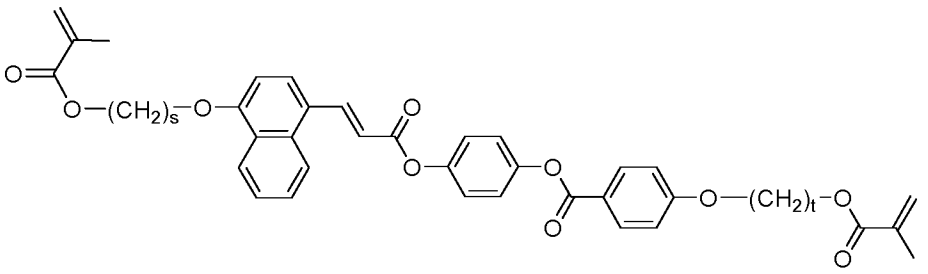
I-3a-1b-3



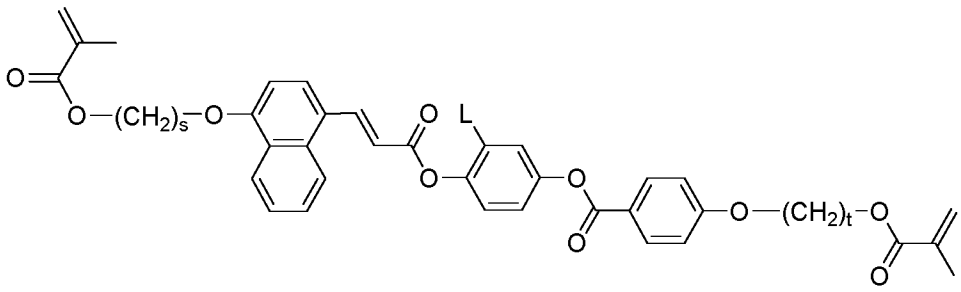
I-3a-1b-4

wherein Sp^{21} has one of the meanings as given above in formula I and L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms and s denotes an integer from 1 to 8.

7. Compound according to one or more of claims 1 to 4, characterized in that it is selected from compounds of the following sub-formulae,



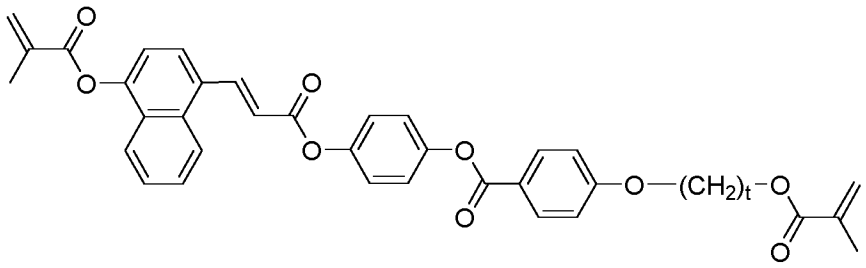
I-3a-1c-1



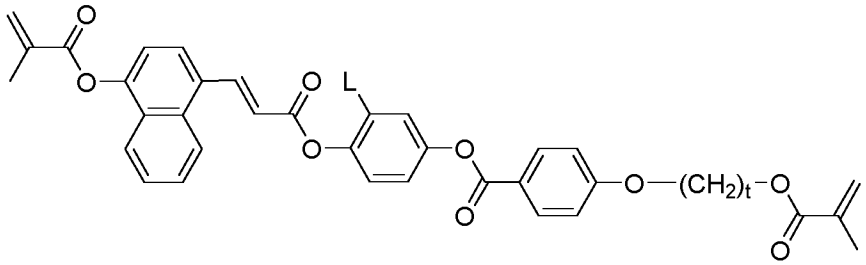
I-3a-1c-2

wherein L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms and s and t denote each and independently from another an integer from 1 to 8.

8. Compound according to one or more of claims 1 to 4, characterized in that it is selected from compounds of the following sub-formulae,



I-3a-1d-1



I-3a-1d-2

wherein L denotes F, Cl, OCH_3 and $COCH_3$ or alkylene having 1 to 6 C Atoms and t denotes an integer from 1 to 8.

9. Use of compounds of formula I according to one or more of claims 1 to 8 in a liquid crystal mixture.

10. Liquid crystal mixture, characterised in that it comprises a component A) comprising one or more compounds of formula I according to one or more of claims 1 to 8 and a liquid-crystalline component B), comprising one or more mesogenic or liquid-crystalline compounds.

11. Liquid crystal mixture according to claim 10 characterised in that the total concentration of compounds of formula I in the mixture is in the range of from 0.01 to 10% by weight.

12. Liquid crystal mixture according to one or more of claims 10 or 11, characterised in that it additionally comprises a polymerizable component C) comprising one or more polymerizable mesogenic or polymerizable isotropic compounds.

13. Liquid crystal mixture according to claim 12, characterised in that the concentration of polymerizable mesogenic or polymerizable isotropic compounds is in the range of from 0.01 to 10% by weight.

14. Liquid crystal mixture according to claim 12 or 13, characterised in that it comprises one or more compounds of formula P

$$P^a\text{-}(Sp^a)_{s1}\text{-}A^2\text{-}(Z^1\text{-}A^1)_{n2}\text{-}(Sp^b)_{s2}\text{-}P^b \qquad P$$

wherein

P^a, P^b each, independently of one another, denote a polymerisable group,

Sp^a, Sp^b on each occurrence, identically or differently, denote a spacer group,

s1, s2 each, independently of one another, are 0 or 1,

A^1, A^2 each, independently of one another, denote a radical selected from the following groups:

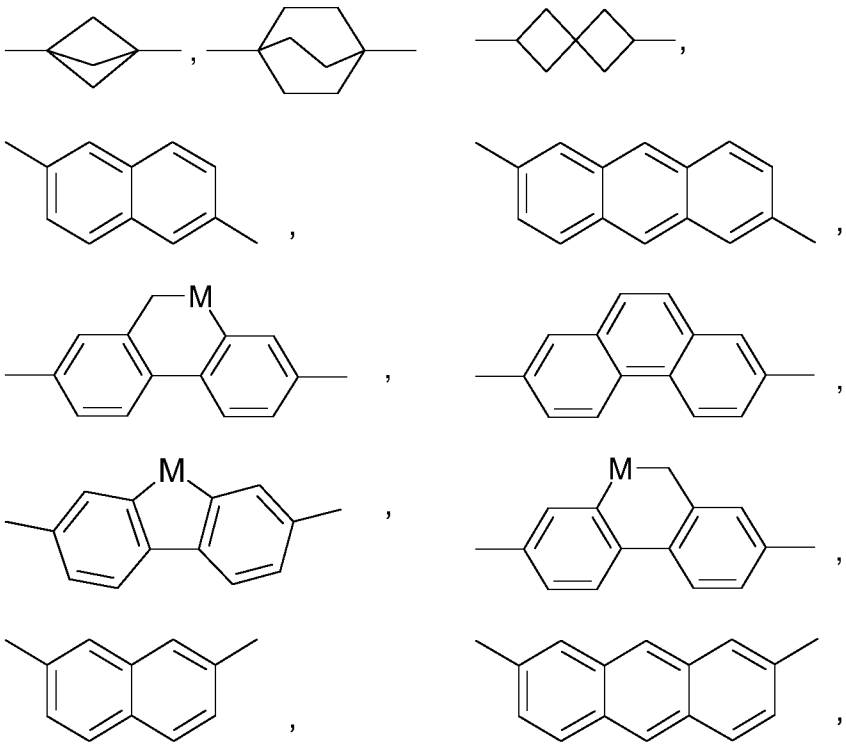
a) the group consisting of trans-1,4-cyclohexylene, 1,4-cyclohexenylene and 4,4´-bicyclohexylene, wherein, in addition, one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S- and wherein, in addition, one or more H atoms may be replaced by F,

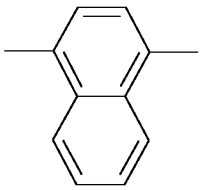
b) the group consisting of 1,4-phenylene and 1,3-phenylene, wherein, in addition, one or two CH groups may be

replaced by N and wherein, in addition, one or more H atoms may be replaced by L,

c) the group consisting of tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl, tetrahydrofuran-2,5-diyl, cyclobutane-1,3-diyl, piperidine-1,4-diyl, thiophene-2,5-diyl and selenophene-2,5-diyl, each of which may also be mono- or polysubstituted by L,

d) the group consisting of saturated, partially unsaturated or fully unsaturated, and optionally substituted, polycyclic radicals having 5 to 20 cyclic C atoms, one or more of which may, in addition, be replaced by heteroatoms, that are selected from:

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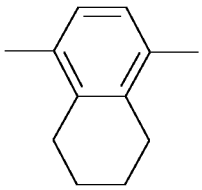
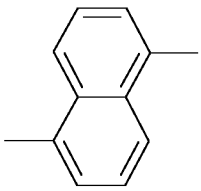

,

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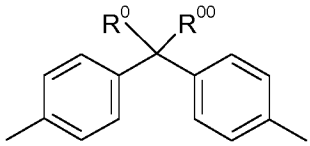


where, in addition, one or more H atoms in these radicals may be replaced by L, and/or one or more double bonds may be replaced by single bonds, and/or one or more CH groups may be replaced by N,

n2 is 0, 1, 2 or 3,

Z^1 in each case, independently of one another, denotes -CO-O-, -O-CO-, -CH_2O-, -OCH_2-, -CF_2O-, -OCF_2-, or -$(CH_2)_n$-, where n is 2, 3 or 4, -O-, -CO-, -C(R^0R^{00})-, -CH_2CF_2-, -CF_2CF_2- or a single bond,

L on each occurrence, identically or differently, denotes F, Cl, CN, SCN, SF_5 or straight-chain or branched, in each case optionally fluorinated, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having up to 12 C atoms,

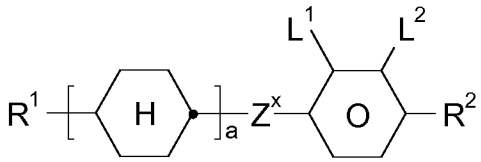
R^0, R^{00} each, independently of one another, denote H, F or straight-chain or branched alkyl having 1 to 12 C atoms, wherein, in addition, one or more H atoms may be replaced by F,

M denotes -O-, -S-, $-CH_2-$, $-CHY^1-$ or $-CY^1Y^2-$, and

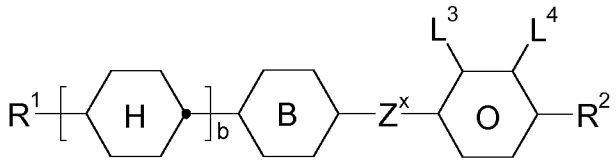
Y^1 and Y^2 each, independently of one another, have one of the meanings indicated above for R^0 or denote Cl or CN.

15. Liquid crystal mixture according to one or more of claims 10 to 14, characterized in that the LC host mixture has negative dielectric anisotropy.

16. Liquid crystal mixture according to claim 15, characterised in that the LC host mixture comprises one or more compounds selected from the following formulae:



CY

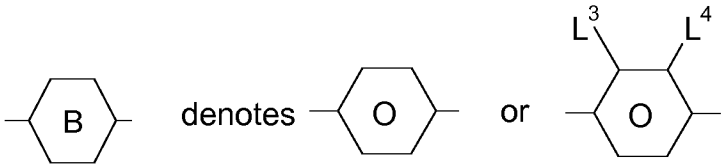


PY

wherein

a is 1 or 2,

b is 0 or 1,



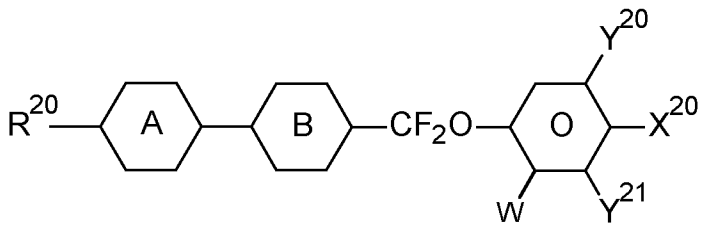
R^1 and R^2 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O- in such a way that O atoms are not linked directly to one another,

Z^x denotes -CH=CH- , $-CH_2O-$, $-OCH_2-$, $-CF_2O-$, $-OCF_2-$, -O-, $-CH_2-$, $-CH_2CH_2-$ or a single bond,

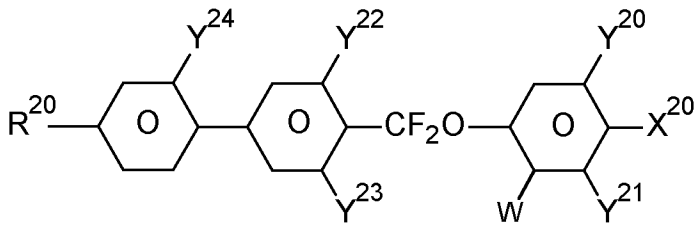
L^{1-4} each, independently of one another, denote F, Cl, OCF_3, CF_3, CH_3, CH_2F, CHF_2.

17. Liquid crystal mixture according to one or more of claims 10 to 14, characterised in that the LC host mixture has positive dielectric anisotropy.

18. Liquid crystal mixture according to claim 17, characterised in that the LC host mixture comprises one or more compounds selected from the group consisting of the compounds of the formulae II and III,



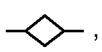
II



III

wherein

R^{20} each, identically or differently, denote a halogenated or unsubstituted alkyl or alkoxy radical having 1 to 15 C atoms, where, in addition, one or more CH_2 groups in these radicals may each be replaced, independently of one another,

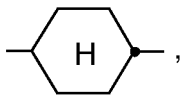
by -C≡C-, -CF_2O-, -CH=CH-,  ,  , -O-, -CO-O- or -O-CO- in such a way that O atoms are not linked directly to one another,

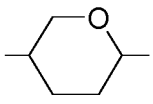
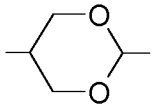
X^{20} each, identically or differently, denote F, Cl, CN, SF_5, SCN, NCS, a halogenated alkyl radical, a halogenated alkenyl radical, a halogenated alkoxy radical or a halogenated alkenyloxy radical, each having up to 6 C atoms, and

Y^{20-24} each, identically or differently, denote H or F,

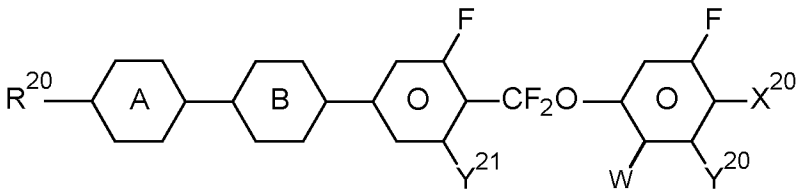
W denotes H or methyl,

 and  each, identically or differently, denote

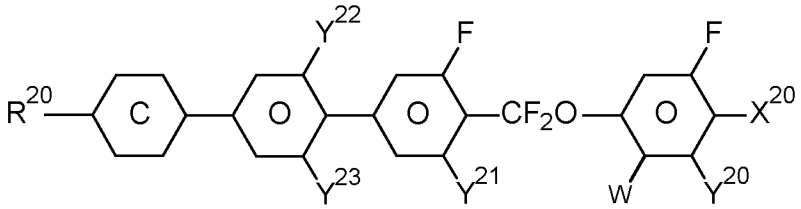
 ,

 or  .

19. Liquid crystal mixture according to claim 17 or 18, characterised in that it comprises one or more compounds selected from the group consisting of compounds of formulae XI and XII

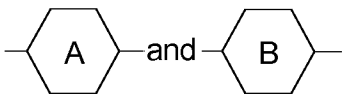


XI

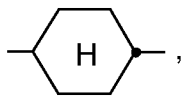


XII

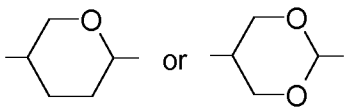
wherein R^{20}, X^{20}, W and Y^{20-23} have the meanings indicated in formula III in claim 16, and



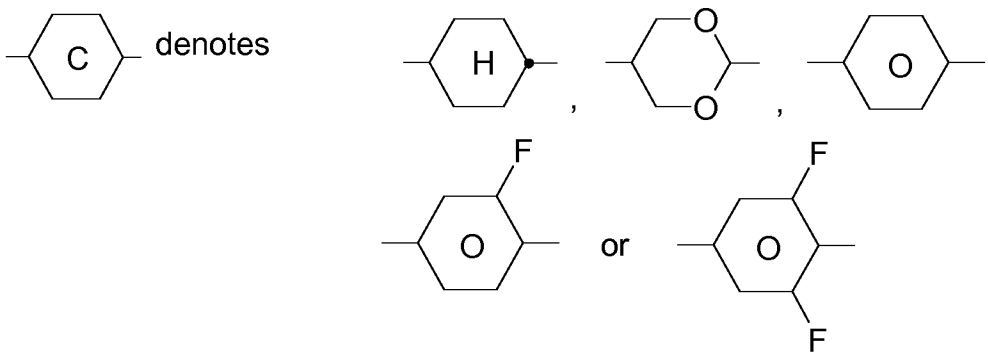
each, independently of one another, denote



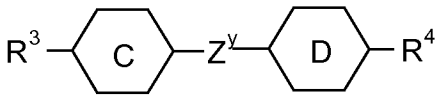
,



and

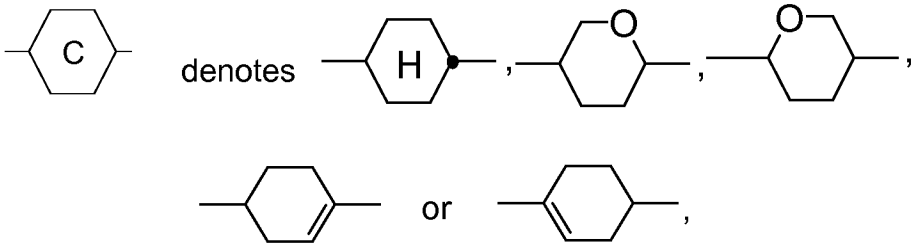


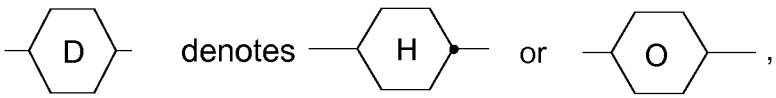
20. Liquid crystal mixture according to one or more of claims 10 to 19, characterised in that the LC host mixture comprises one or more compounds of the following formula:



ZK

in which the individual radicals have the following meanings:



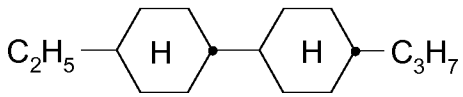


R^3 and R^4 each, independently of one another, denote alkyl having 1 to 12 C atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced

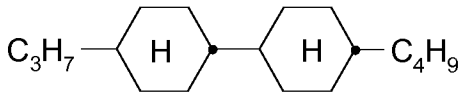
by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O- in such a way that O atoms are not linked directly to one another,

Z^y denotes $-CH_2CH_2-$, -CH=CH-, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, -CO-O-, -O-CO-, $-C_2F_4-$, -CF=CF-, -CH=CH-CH_2O- or a single bond.

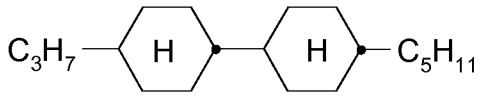
21. Liquid crystal mixture according to one or more of claims 10 to 20, characterised in that the LC host mixture comprises one or more compounds of the following formula



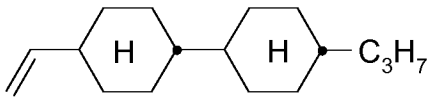
ZK1a



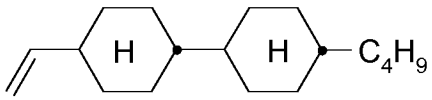
ZK1b



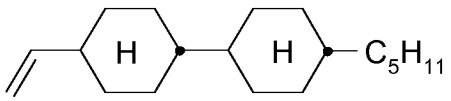
ZK1c



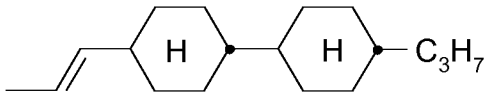
ZK3a



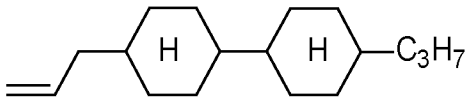
ZK3b



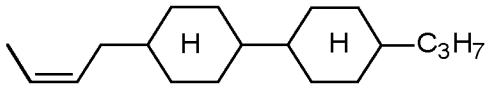
ZK3c



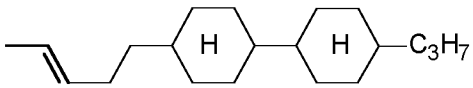
ZK3d



ZK3e



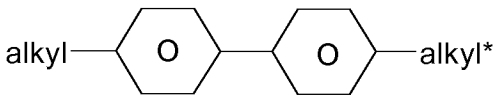
ZK3f



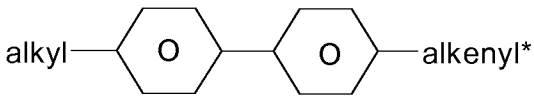
ZK3g

wherein the propyl, butyl and pentyl groups are straight-chain groups.

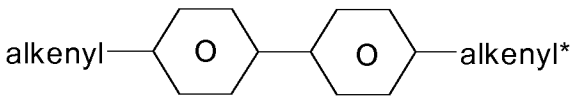
22. Liquid crystal mixture according to one or more of claims 10 to 21, characterised in that the LC host mixture comprises one or more compounds selected from the following formulae:



B1



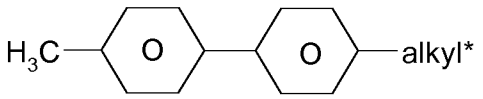
B2



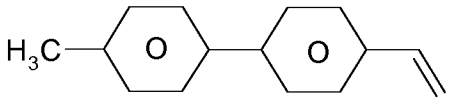
B3

in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-6 C atoms.

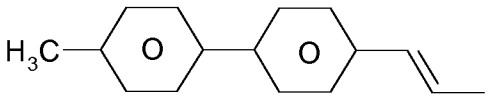
23. Liquid crystal mixture according to one or more of claims 10 to 22, characterised in that the LC host mixture comprises one or more compounds selected from the following formulae:



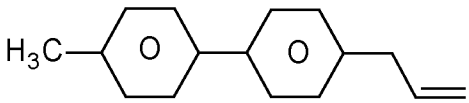
B1a



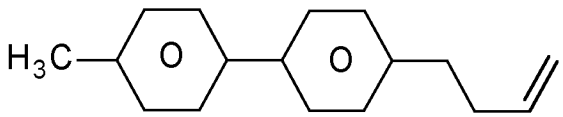
B2a



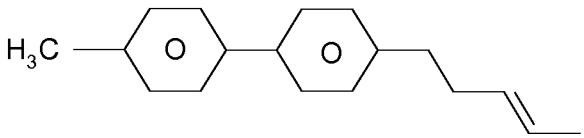
B2b



B2c



B2d



B2e

in which alkyl* denotes an alkyl radical having 1-6 C atoms.

24. Use of the liquid crystal mixture according to one or more of claims 10 to 23 for the fabrication of a liquid crystal display.

25. Process for the fabrication of a liquid crystal display, comprising at least the steps of:
    - providing a first substrate which includes a pixel electrode and a common electrode for generating an electric field substantially parallel to a surface of the first substrate in the pixel region;
    - providing a second substrate, the second substrate being disposed opposite to the first substrate;
    - interposing a liquid crystal mixture according to one or more of claims 10 to 23;
    - irradiating the liquid crystal mixture with linearly polarised light causing photoalignment of the liquid crystal;
    - curing the polymerizable compounds of the liquid crystal mixture by irradiation with ultraviolet light or visible light having a wavelength of 450 nm or below.

26. Process according to claim 25, characterised in that the linearly polarised light is ultraviolet light or visible light having a wavelength of 450nm or below.

27. Display, obtainable by a process according to claim 25 or 26.

28. Display according to claim 27, wherein the LC host mixture is homogeneously aligned without the application of an electric field.

29. Display according to claim 27 or 28, wherein the display is an IPS or FFS display.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/077076

A. CLASSIFICATION OF SUBJECT MATTER
INV. C09K19/20 C09K19/32 C09K19/04 C09K19/30 C09K19/12
C09K19/34
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/102259 A1 (GOTOH YASUYUKI [JP] ET AL) 16 April 2015 (2015-04-16)	1-3,9-29
A	paragraphs [0001], [0037], [0038], [0090] - [0094], [0177]; claims; examples; compounds 70,75,76,87,96	4-8
X	JP 2012 082350 A (DAINIPPON INK & CHEMICALS) 26 April 2012 (2012-04-26)	1-4,9-29
A	pages 22-23; claims; examples; compounds (IIIb-22),(IIIb-23),(IIIb-27),(IIIb-28),(IIIb-30)	5-8
A	JP 2014 097938 A (JNC CORP; JNC PETROCHEMICAL CORP) 29 May 2014 (2014-05-29) compounds 117,141,188	1-29

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 December 2019	19/12/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schoenhentz, Jérôme

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2017/102068 A1 (MERCK PATENT GMBH [DE]) 22 June 2017 (2017-06-22) cited in the application claims; examples; compounds 1-32 -----	1-29

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2019/077076

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015102259 A1	16-04-2015	JP 6343902 B2	20-06-2018
		JP 2015078282 A	23-04-2015
		US 2015102259 A1	16-04-2015
JP 2012082350 A	26-04-2012	JP 5751466 B2	22-07-2015
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JP 2014097938 A	29-05-2014	JP 5978938 B2	24-08-2016
		JP 2014097938 A	29-05-2014
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		EP 3390570 A1	24-10-2018
		JP 2019508511 A	28-03-2019
		KR 20180096688 A	29-08-2018
		TW 201736581 A	16-10-2017
		WO 2017102068 A1	22-06-2017