(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 July 2020 (30.07.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/152206 A1

(51) International Patent Classification:
C09K 19/60 (2006.01) *C09K 19/12* (2006.01)
C09K 19/58 (2006.01) *C09K 19/18* (2006.01)
C09K 19/30 (2006.01) *C09K 19/54* (2006.01)

(21) International Application Number:
PCT/EP2020/051480

(22) International Filing Date:
22 January 2020 (22.01.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
19153700.0 25 January 2019 (25.01.2019) EP

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

WO 2020/152206 A1

(54) Title: LIQUID-CRYSTALLINE MEDIUM

(57) Abstract: The invention relates to a liquid-crystalline medium having negative dielectric anisotropy comprising a nematic liquid-crystal host having negative dielectric anisotropy, one or more dichroic dyes, and one or more ionic liquids of formula (I): A^+B^-, in which A^+ denotes an organic cation, B^- denotes an organic or inorganic anion, with a melting point below 100°C, to the use of said medium in devices such as light shutters or switchable windows and to devices containing the liquid crystalline medium according to the invention.

Liquid-crystalline medium

The invention relates to a liquid-crystalline medium having negative dielectric anisotropy, a guest-host liquid crystal medium derived therefrom and the use of said medium in devices such as light shutters, switchable windows or switchable mirrors.

Liquid crystals are used in particular as dielectrics in display devices, since the optical properties of such substances can be influenced by an applied voltage. Electro-optical devices based on liquid crystals are known to the person skilled in the art and can be based on various effects. Devices of this type are, for example, cells having dynamic scattering, DAP (deformation of aligned phases) cells, TN cells having a twisted nematic structure, STN ("supertwisted nematic") cells, SBE ("superbirefringence effect") cells, OMI ("optical mode interference") cells and guest-host cells.

The last-mentioned devices based on the guest-host effect were described for the first time by Heilmeier and Zanoni (G. H. Heilmeier et al., Appl. Phys. Lett., 1968, 13, 91f) and have since then found widespread use, principally in LC display elements. In a guest-host system, the LC medium comprises one or more dichroic dyes in addition to the liquid crystal. Owing to the directional dependence of the absorption by the dye molecules, the transparency of the liquid crystal to light can be modulated if the dyes change their alignment together with the liquid crystal, *i.e.* the maximum contrast between the clear and dark states of an LC cell depends on the alignment of the dichroic dyes. Dichroic dyes have the ability to align themselves with nematic liquid crystal molecules when mixed together. When an electric field is applied to such a guest-host mixture, the nematic liquid crystal host molecules reorient and align either with or perpendicular to the electric field in order to minimize the torque they experience from the electric field. The dichroic dye (guest) molecules may not be directly affected by the external electric field but can align themselves with the liquid crystal host molecules. It is their interaction with the liquid crystal molecules that forces them to reorient.

Especially initial bright state liquid crystal cells switching from bright to dark using negative delta-epsilon LC are desirable because of their transparent (bright) state when no voltage is applied, making this mode particularly useful for windows that are usually transparent and only dimmed on demand for a comparatively short period of time. This mode is therefore more energy efficient compared to a mode that consumes energy when a transparent state has to be actively switched on.

Using liquid crystalline media with negative dielectric anisotropy enables a liquid crystal cell where
(i) in the absence of an electrical field across the substrates, the long axes of the liquid crystal and dye molecules line up relative to the substrates in a way which causes the dye molecules not to absorb most of the light that is directed through the guest-host liquid crystal mixture normal to the substrates, whether the light passing therethrough is polarized or not, whereby the liquid crystal cell remains in a relatively clear state in the absence of the electric field, and
(ii) in the presence of the electric field across the substrates, the long axes of the liquid crystal and dye molecules line up relative to the substrates in a way which causes the dye molecules to absorb at least some light that is directed through the guest-host liquid crystal mixture normal to the substrates, so long as the last mentioned light is polarized along the long axes of the dye molecules, whereby the liquid crystal cell darkens in the presence of the electric field.

A guest-host vertical alignment LC display is described for example in JP 2001100253, and US 357,374.

Besides use in LC displays, devices of this type are known as switching elements for regulating the passage of light or energy (light shutter), for example from WO 2009/141295 and WO 2010/118422; an example of an application are switchable windows that can be darkened on demand by means of an electrical field. Furthermore, switchable mirrors e.g. for rear view mirrors for automotive applications using guest-host liquid crystals are proposed in DE 3340670.

In addition to the change in transmission achieved by guest-host devices it has been proposed in US 2014/0226096 to combine this effect with the ability of a device to switch to an opaque state as known from e.g. dynamic scattering mode (DSM) devices. Therein, the liquid crystal-dichroic dye mixture further contains small amounts of salt as for example cetyl trimethyl ammonium bromide, Conducting Salt 235, dodecylethyldimethylammonium-4-hexyloxybenzoate, etc. The salt has to have sufficient solubility in the liquid crystal host and a high electrochemical stability. The solubilty in an amount sufficient to show the desired effect often causes problems as salts by their highly polar nature usually have a low solubilty in the highly lipophilic liquid-crystal materials. In addition, the added salt can cause reliability problems in the dye doped liquid crystal as it might trigger decomposition processes especially under heat or light stress. Upon cooling, crystallisation of the salt might occur.

The object of the present invention is to provide a dye-doped liquid crystal that can be switched to a scattering state, having high reliability and high stability towards high or low temperature and light.

To solve the problem, the present invention provides a liquid-crystalline medium according to claim 1.

Advantageous embodiments of the invention are subject of the dependent claims and can also be taken from the description.

The liquid-crystalline media according to the invention comprise

- a nematic liquid-crystal host having negative dielectric anisotropy,
- a dichroic dye, and
- one or more ionic liquids of formula I

$A^+ B^-$ (I)

in which

A^+ denotes an organic cation,

B^- denotes an organic or inorganic anion, preferably an organic anion.

These media enable switching of an electrooptical device from a first transparent state with a first transmission value to a second transparent state with a lower transmission value than the first transmission value, and switching from said second transparent state to a third opaque state.

The mixtures according to the invention are distinguished by a high solubility of dichroic dyes and a high solubility of the ionic liquid therein. The ionic liquid in the liquid crystal is highly electrochemically stable inside the device under applied voltage, especially under additional heat or light stress, in particular under UV load. The opaque state is highly scattering and enables devices with no or very low transmission, suffiently low for applications e.g. in privacy windows.

The invention furthermore relates to an electro-optical device based on the guest host effect containing a liquid crystalline medium according to the invention, such as light shutter, switchable windows, switchable mirrors, automotive mirrors, sun roof, augmented or virtual reality devices such as glasses or goggles or the like.

The invention further relates to the use of the medium in said devices, where the medium can be switched from a first transparent state with low haze to a second transparent state with low haze and less transmission than the first transparent state at a first voltage, and where the medium can be switched to an opaque state with high haze at a second voltage higher than the first voltage.

Brief description of the drawings:
Fig. 1 shows the change of the total transmittance of a test cell with the applied voltage.
Fig. 2 shows the change of the haze of a test cell with the applied voltage.

Halogen denotes F, Cl, Br or I.

Herein, an alkyl radical and/or an alkoxy radical is taken to mean straight-chain or branched alkyl. It is preferably straight-chain, has 2, 3, 4, 5, 6 or 7 C atoms and accordingly preferably denotes ethyl, propyl, butyl, pentyl,

hexyl, heptyl, ethoxy, propoxy, butoxy, pentoxy, hexyloxy or heptyloxy, furthermore methyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, methoxy, octyloxy, nonyloxy, decyloxy, undecyloxy, dodecyloxy, tridecyloxy or tetradecyloxy.

Herein, oxaalkyl preferably denotes straight-chain 2-oxapropyl (= methoxymethyl), 2- (= ethoxymethyl) or 3-oxabutyl (= 2-methoxyethyl), 2-, 3- or 4-oxapentyl, 2-, 3-, 4- or 5-oxahexyl, 2-, 3-, 4-, 5- or 6-oxaheptyl, 2-, 3-, 4-, 5-, 6- or 7-oxaoctyl, 2-, 3-, 4-, 5-, 6-, 7- or 8-oxanonyl, 2-, 3-, 4-, 5-, 6-, 7-, 8- or 9-oxadecyl.

Herein, alkenyl, i.e. an alkyl radical in which one CH_2 group has been replaced by -CH=CH- , may be straight-chain or branched. It is preferably straight-chain and has 2 to 10 C atoms. Accordingly, it denotes, in particular, vinyl, prop-1- or -2-enyl, but-1-, -2- or -3-enyl, pent-1-, -2-, -3- or -4-enyl, hex-1-, -2-, -3-, -4- or -5-enyl, hept-1-, -2-, -3-, -4-, -5- or -6-enyl, oct-1-, -2-, -3-, -4-, -5-, -6- or -7-enyl, non-1-, -2-, -3-, -4-, -5-, -6-, -7- or -8-enyl, dec-1-, -2-, -3-, -4-, -5-, -6-, -7-, -8- or -9-enyl.

Herein, an alkyl or alkenyl radical which is at least monosubstituted by halogen, is preferably straight-chain, and halogen is preferably F or Cl. In the case of polysubstitution, halogen is preferably F. The resultant radicals also include perfluorinated radicals. In the case of monosubstitution, the fluorine or chlorine substituent may be in any desired position, but is preferably in the ω-position.

Herein, a mono- or polyfluorinated alkyl or alkoxy radical having 1, 2 or 3 C atoms or a mono- or polyfluorinated alkenyl radical having 2 or 3 C atoms is particularly preferably F, Cl, CF_3, CHF_2, OCF_3, $OCHF_2$, $OCFHCF_3$, $OCFHCHF_2$, $OCFHCHF_2$, OCF_2CH_3, OCF_2CHF_2, OCF_2CHF_2, $OCF_2CF_2CHF_2$, $OCF_2CF_2CHF_2$, $OCFHCF_2CF_3$, $OCFHCF_2CHF_2$, $OCF_2CF_2CF_3$, $OCF_2CF_2CClF_2$, $OCClFCF_2CF_3$, $OCH=CF_2$ or $CH=CF_2$, very particularly preferably F or OCF_3, furthermore CF_3, $OCF=CF_2$, $OCHF_2$ or $OCH=CF_2$.

Liquid-crystal hosts with negative dielectric anisotropy are widely used in displays for example of the vertical alignment (VA) mode (Song, J. (2014). Vertical alignment Liquid Crystal mode. In Handbook of Liquid Crystals (eds J. W. Goodby, C. Tschierske, P. Raynes, H. Gleeson, T. Kato and P. J. Collings). doi:10.1002/9783527671403.hlc126). Suitable media are well described in the literature such as for example in US 20030071244 A1 or US 20100134751 A1.

Herein, a dichroic dye is taken to mean a compound having an elongated molecular structure which is dissolved in a host liquid crystal with the purpose of absorbing light, where the dye molecule ist aligned with the liquid crystal an can be oriented with the liquid crystal molecules upon application of an electric field. Preferably, the dichroic dyes used herein have an absorption maximum in the visible wavelength range. Dychroic dyes are known to the skilled person and well described in the literature, e.g. in Liquid Crystals: Applications and Uses, Volumes 1-3, edited by Birenda Bahadur, World Scientific, 1992. Chapter 11: Dichroic Liquid Crystal Displays.

The absorption maximum of the dichroic dye or dyes used in the liquid crystalline media according to the present invention is not specifically limited, but it is preferred to have an absorption maximum in the yellow region (Y), magenta region (M), or cyan region (C). The dichroic dye used in the liquid crystal medium of the present invention may be a single compound or a combination of a plurality of dyes. When several dyes are mixed it is preferred to use a mixture of the dichroic dyes having absorption maxima in the Y, M, and C regions, respectively. Dichroic dyes are known to the person skilled in the art and are reviewed in for example Cowling, Stephen J., Liquid Crystal Dyes, in: Handbook of Liquid Crystals, Wiley-VCH Verlag GmbH & Co. KGaA (2014). Methods of displaying a full colour by mixing a yellow dye, a magenta dye and a cyan dye is specifically described in "Colour Chemistry" (by Sumio Tokita, Maruzen Company, Limited, 1982). The yellow region is the range of 430 to 490 nm, the magenta region is the range of 500 to 580 nm, and the cyan region is the range of 600 to 700 nm.

The chromophore used in the dichroic dye is not particularly limited, but it is preferred to use azo dyes, azulene dyes, anthraquinone dyes, benzoquinone dyes, napthoquinone dyes, benzothiazole dyes, dithiobenzoquinone, perylene dyes, merocyanine dyes, azomethine dyes, phthaloperylene dyes, indigo dyes, azulene dyes, dioxazine dyes, tetrazine dyes, polythiophene dyes, naphthimidazo-4,9-dione dyes and phenoxazine dyes.

Preferred dyes according to the present invention are azo dyes, perylene dyes, anthraquinone dyes, and benzothiazole dyes, particularly preferred azo dyes.

The azo dyes may contain any number of azo groups such as monoazo dyes, bisazo dyes, trisazo dyes, tetrakisazo dyes, and pentakisazo dyes, and preferably monoazo dyes, bisazo dyes, and trisazo dyes.

Cyclic structures contained in the azo dyes are aryl groups and/or heteroaryl groups.

Preferred aryl groups are derived, for example, from the parent structures benzene, biphenyl, terphenyl, naphthalene, anthracene, phenanthrene, pyrene, dihydropyrene, chrysene, perylene, fluorene, indene, etc.

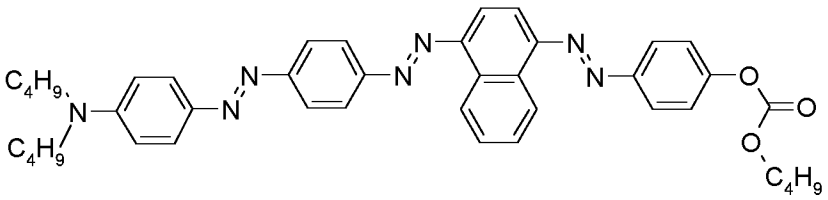
Preferred heteroaryl groups are, for example, 5-membered rings, such as pyrrole, pyrazole, imidazole, 1,2,3-triazole, 1,2,4-triazole, furan, thiophene, oxazole, isoxazole, 1,2-thiazole, 1,3-thiazole, 1,2,3-oxadiazole, 1,2,4-oxadiazole, 1,2,5-oxadiazole, 1,3,4-oxadiazole, 1,2,3-thiadiazole, 1,2,4-thiadiazole, 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,benzimidazole, benzotriazole, purine, naphthimidazole, phenanthrimidazole, pyridimidazole, pyrazinimidazole, quinoxalinimidazole, benzoxazole, naphthoxazole, anthroxazole, phenanthroxazole, isoxazole, benzothiazole, benzofuran, isobenzofuran, dibenzofuran, quinoline, isoquinoline, 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.

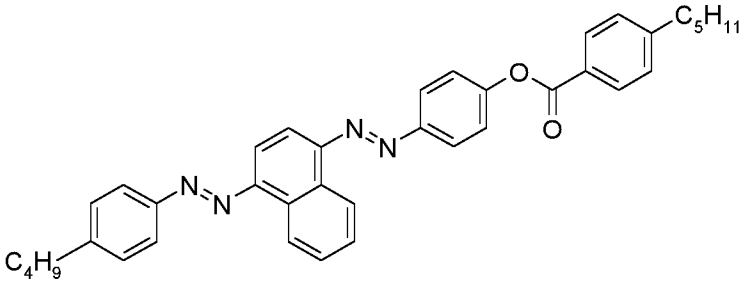
The aryl and heteroaryl groups may also be substituted by alkyl, cycloalkyl, alkoxy, thioalkyl, alkylamino, dialkylamino, fluorine, fluoroalkyl or further aryl or heteroaryl groups.

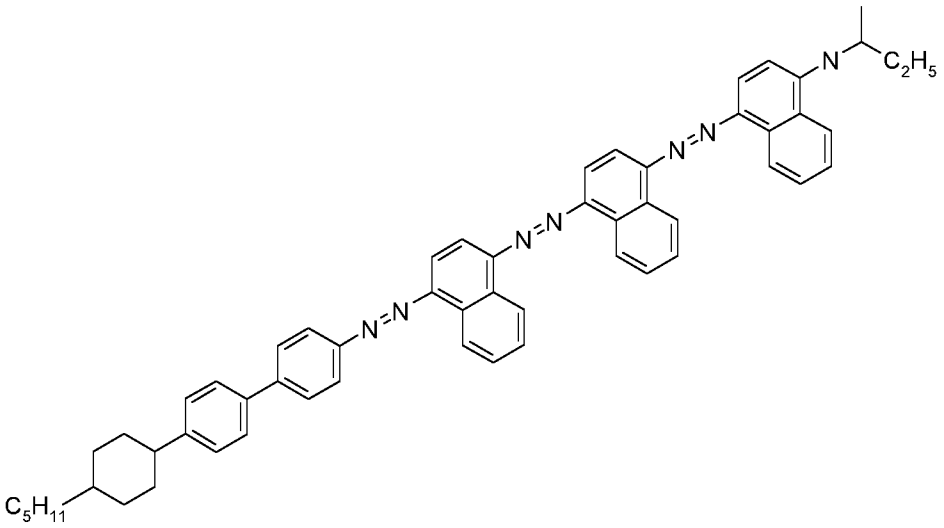
Examples of especially suitable and preferred dyes are the azo dyes F355®, F357® and F593® (from Nippon Kankoh Shikiso Kenkyusho Ltd., Okayama, Japan) of the following structures:

Dye-1



Dye-2





Dye-3,

but the present invention is not limited thereto, and other types of dyes known to have an equivalent effect to the above-described dyes may also be used.

The concentration of the dichroic dye or dyes in the medium is preferably 1% by weight or more, particularly preferably 1.5% by weight or more and very particularly 2% by weight or more.

Ionic liquids are salts with a melting point below 100° C. According to the invention, preference is given to using ionic liquids with low melting points, that are particularly preferably liquid at room temperature.

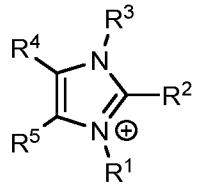
Preferably, the liquid-crystal media according to the invention comprise one or more ionic liquids having a melting point in the range of from 10°C to 99°C, more preferably from 15°C to 95° C, particularly preferably from 20°C to 90°C to and in particular from 25°C to 80°C.

Ionic liquids are characterized by their special properties, such as a practically non-existent vapor pressure, a low viscosity and high electrochemical stability.

Ionic liquids are salts and thus comprise at least one cation and at least one anion. In preferred embodiments of the present invention, the cation of

the ionic liquid(s) is an organic cation. Suitable counterions are organic and/or inorganic anions. Overall, liquid-crystal media according to the invention are preferred in which the ionic liquid comprises an organic cation A^+ and an organic and / or inorganic, preferably organic anion B^-. Preferred cations A^+ are those from the groups imidazolium, pyridinium, pyrrolidinium, phosphonium, ammonium, in particular pyrrolidinium, guanidinium and isuronium.

Especially preferred cations for ionic liquids are selected from the group of imidazolium ions of formula A-1



A-1

in which

R^1, R^2, R^3, R^4 and R^5, identically or differently, denote H or straight chain or branched alkyl, alkenyl or arylalkyl, each having 1 to 20 C atoms, and in which one or more non-adjacent CH_2 groups are optionally replaced with -O- and one or more H atoms are optionally replaced with halogen or CN.

In formula A-1, R^1 and R^3 preferably denote alkyl having 1 to 12 C atoms, R^2 preferably denotes H or alkyl having 1 to 3 C atoms, more preferably H or methyl, in particular H, and R^4 and R^5 preferably denote H.

Very preferred examples are 1-methyl-imidazolium, 1-ethyl-imidazolium, 1-propyl-imidazolium, 1-Isopropyl-imidazolium, 1-butyl-imidazolium, 1-pentyl-imidazolium, 1-hexylimidazolium, 1-heptyl-imidazolium, 1-octyl-imidazolium, 1-nonyl-imidazolium, 1-decylimidazolium, 1-undecyl-imidazolium, 1-dodecyl-imidazolium, 1-tridecyl-imidazolium, 1-tetradecyl-imidazolium, 1-pentadecyl-imidazolium, 1-hexadecyl-imidazolium, 1-heptadecylimidazolium, 1-octadecyl-imidazolium, 1-nonadecyl-imidazolium, 1,3-dimethyl-imidazolium, 1,3-diethylimidazolium, 1,3-dipropyl-imidazolium, 1,3-di-isopropyl-imidazolium, 1,3-dibutylimidazolium, 1,3-dipentyl-imidazolium, 1,3-dihexyl-imidazolium, 1,3-diheptyl-imidazolium, 1,3-dioctyl-

imidazolium, 1,3-dinonyl-imidazolium, 1,3-didecyl-imidazolium, 1,3-diundecylimidazolium, 1,3-didodecyl-imidazolium, 1,3-ditridecyl-imidazolium, 1,3-ditetradecyl-imidazolium, 1,3-dipentadecyl-imidazolium, 1,3-dihexadecyl-imidazolium, 1,3-diheptadecyl-imidazolium, 1,3-dioctadecyl-imidazolium, 1,3-dinonadecyl-imidazolium, 1-ethyl-3-methyl-imidazolium, 1-propyl-3-methyl-imidazolium, 1-Isopropyl-3-methyl-imidazolium, 1-butyl-3-methyl-imidazolium, 1-pentyl-3-methyl-imidazolium, 1-hexyl-3-methyl-imidazolium, 1-heptyl-3-methyl-imidazolium, 1-octyl-3-methyl-imidazolium, 1-nonyl-3-methyl-imidazolium, 1-decyl-3-methyl-imidazolium, 1-undecyl-3-methyl-imidazolium, 1-dodecyl-3-methyl-imidazolium, 1-tridecyl-3-methyl-imidazolium, 1-tetradecyl-3-methyl-imidazolium, 1-pentadecyl-3-methylimidazolium, 1-hexadecyl-3-methyl-imidazolium, 1-heptadecyl-3-methyl-imidazolium, 1-octadecyl-3-methyl-imidazolium, 1-nonadecyl-3-methyl-imidazolium, 1-methyl-3-ethyl-imidazolium, 1-ethyl-3-ethyl-imidazolium, 1-propyl-3-ethyl-imidazolium, 1-Isopropyl-3-ethyl-imidazolium, 1-butyl-3-ethyl-imidazolium, 1-pentyl-3-ethyl-imidazolium, 1-hexyl-3-ethyl-imidazolium, 1-heptyl-3-ethyl-imidazolium, 1-octyl-3-ethyl-imidazolium, 1-nonyl-3-ethylimidazolium, 1-decyl-3-ethyl-imidazolium, 1-undecyl-3-ethyl-imidazolium, 1-dodecyl-3-ethylimidazolium, 1-tridecyl-3-ethyl-imidazolium, 1-tetradecyl-3-ethyl-imidazolium, 1-pentadecyl-3-ethyl-imidazolium, 1-hexadecyl-3-ethyl-imidazolium, 1-heptadecyl-3-ethyl-imidazolium, 1-octadecyl-3-ethyl-imidazolium, 1-nonadecyl-3-ethyl-imidazolium, 1-methyl-3-propyl-imidazolium, 1-ethyl-3-propyl-imidazolium, 1-propyl-3-propyl-imidazolium, 1-Isopropyl-3-propyl-imidazolium, 1-butyl-3-propyl-imidazolium, 1-pentyl-3-propyl-imidazoliu m, 1-hexyl-3-propyl-imidazolium, 1-heptyl-3-propyl-imidazolium, 1-octyl-3-propyl-imidazolium, 1-nonyl-3-propyl-imidazolium, 1-decyl-3-propyl-imidazolium, 1-undecyl-3-propyl-imidazolium, 1-dodecyl-3-propyl-imidazolium, 1-tridecyl-3-propyl-imidazolium, 1-tetradecyl-3-propylimidazolium, 1-pentadecyl-3-propyl-imidazolium, 1-hexadecyl-3-propyl-imidazolium, 1-heptadecyl-3-propyl-imidazolium, 1-octadecyl-3-propyl-imidazolium, 1-nonadecyl-3-propylimidazolium, 1-methyl-3-isopropyl-im idazolium, 1-ethyl-3-isopropyl-imidazolium, 1-propyl-3-isopropylimidazolium, 1-Isopropyl-3-isopropyl-imidazolium, 1-butyl-3-isopropyl-imidazolium, 1-pentyl-3-isopropyl-imidazolium, 1-hexyl-3-isopropyl-imidazolium, 1-heptyl-3-isopropyl-imidazolium, 1-octyl-3-

isopropyl-imidazolium, 1-nonyl-3-isopropyl-imidazolium, 1-decyl-3-isopropyl-imidazolium, 1-undecyl-3-isopropyl-imidazolium, 1-dodecyl-3-isopropyl-imidazolium, 1-tridecyl-3-isopropylimidazolium, 1-tetradecyl-3-isopropyl-imidazolium, 1-pentadecyl-3-isopropyl-imidazolium, 1-hexadecyl-3-isopropyl-imidazolium, 1-heptadecyl-3-isopropyl-imidazolium, 1-octadecyl-3-isopropyl-imidazolium, 1-nonadecyl-3-isopropyl-imidazolium, 1-methyl-3-butyl-imidazolium, 1-ethyl-3-butyl-imidazolium, 1-propyl-3-butyl-imidazolium, 1-Isopropyl-3-butyl-imidazolium, 1-butyl-3-butyl-imidazolium, 1-pentyl-3-butyl-imidazolium, 1-hexyl-3-butyl-imidazolium, 1-heptyl-3-butyl-imidazolium, 1-octyl-3-butyl-imidazolium, 1-nonyl-3-butylimidazolium, 1-decyl-3-butyl-imidazolium, 1-undecyl-3-butyl-imidazolium, 1-dodecyl-3-butylimidazolium, 1-tridecyl-3-butyl-imidazolium, 1-tetradecyl-3-butyl-imidazolium, 1-pentadecyl-3-butyl-imidazolium, 1-hexadecyl-3-butyl-imidazolium, 1-heptadecyl-3-butyl-imidazolium, 1-octadecyl-3-butyl-imidazolium, 1-nonadecyl-3-butyl-imidazolium, 1-methyl-3-pentyl-imidazolium, 1-ethyl-3-pentyl-imidazolium, 1-propyl-3-pentyl-imidazoliu m, 1-isopropyl-3-pentyl-imidazolium, 1-butyl-3-pentyl-imidazolium, 1-pentyl-3-pentyl-imidazolium, 1-hexyl-3-pentyl-imidazolium, 1-heptyl-3-pentyl-imidazolium, 1-octyl-3-pentyl-imidazolium, 1-nonyl-3-pentyl-imidazolium, 1-decyl-3-pentyl-imidazolium, 1-undecyl-3-pentyl-imidazolium, 1-dodecyl-3-pentyl-imidazolium, 1-tridecyl-3-pentyl-imidazolium, 1-tetradecyl-3-pentyl-imidazolium, 1-pentadecyl-3-pentyl-imidazolium, 1-hexadecyl-3-pentyl-imidazolium, 1-heptadecyl-3-pentylimidazolium, 1-octadecyl-3-pentyl-imidazolium, 1-nonadecyl-3-pentyl-imidazolium, 1-methyl-3-hexyl-imidazolium, 1-ethyl-3-hexyl-imidazolium, 1-propyl-3-hexyl-imidazolium, 1-Isopropyl-3-hexyl-imidazolium, 1-butyl-3-hexyl-imidazolium, 1-pentyl-3-hexyl-imidazolium, 1-hexyl-3-hexyl-imidazolium, 1-heptyl-3-hexyl-imidazolium, 1-octyl-3-hexyl-imidazolium, 1-nonyl-3-hexyl-imidazolium, 1-decyl-3-hexyl-imidazolium, 1-undecyl-3-hexyl-imidazolium, 1-dodecyl-3-hexyl-imidazolium, 1-tridecyl-3-hexyl-imidazolium, 1-tetradecyl-3-hexyl-imidazolium, 1-pentadecyl-3-hexyl-imidazolium, 1-hexadecyl-3-hexyl-imidazolium, 1-heptadecyl-3-hexylimidazolium, 1-octadecyl-3-hexyl-imidazolium, 1-nonadecyl-3-hexyl-imidazolium, 1-methyl-3-heptyl-imidazolium, 1-ethyl-3-heptyl-imidazolium, 1-propyl-3-heptyl-imidazolium, 1-Isopropyl-3-heptyl-imidazolium, 1-butyl-3-heptyl-imidazolium, 1-pentyl-3-heptyl-imidazolium, 1-hexyl-3-heptyl-imidazolium, 1-heptyl-3-heptyl-

imidazolium, 1-octyl-3-heptyl-imidazolium, 1-nonyl-3-heptyl-imidazolium, 1-decyl-3-heptyl-imidazolium, 1-undecyl-3-heptyl-imidazolium, 1-dodecyl-3-heptyl-imidazolium, 1-tridecyl-3-heptyl-imidazolium, 1-tetradecyl-3-heptyl-imidazolium, 1-pentadecyl-3-heptyl-imidazolium, 1-hexadecyl-3-heptyl-imidazolium, 1-heptadecyl-3-heptylimidazolium, 1-octadecyl-3-heptyl-imidazolium, 1-nonadecyl-3-heptyl-imidazolium, 1-methyl-3-octyl-imidazolium, 1-ethyl-3-octyl-imidazolium, 1-propyl-3-octyl-imidazolium, 1-Isopropyl-3-octyl-imidazolium, 1-butyl-3-octyl-imidazolium, 1-pentyl-3-octyl-imidazolium, 1-hexyl-3-octyl-imidazolium, 1-heptyl-3-octyl-imidazolium, 1-octyl-3-octyl-imidazolium, 1-nonyl-3-octylimidazolium, 1-decyl-3-octyl-imidazolium, 1-undecyl-3-octyl-imidazolium, 1-dodecyl-3-octylimidazolium, 1-tridecyl-3-octyl-imidazolium, 1-tetradecyl-3-octyl-imidazolium, 1-pentadecyl-3-octyl-imidazolium, 1-hexadecyl-3-octyl-imidazolium, 1-heptadecyl-3-octyl-imidazolium, 1-octadecyl-3-octyl-imidazolium, 1-nonadecyl-3-octyl-imidazolium, 1-methyl-3-nonyl-imidazolium, 1-ethyl-3-nonyl-imidazolium, 1-propyl-3-nonyl-imidazolium, 1-Isopropyl-3-nonyl-imidazolium, 1-butyl-3-nonyl-imidazolium, 1-pentyl-3-nonyl-imidazolium, 1-hexyl-3-nonyl-imidazolium, 1-heptyl-3-nonyl-imidazolium, 1-octyl-3-nonyl-imidazolium, 1-nonyl-3-nonyl-imidazolium, 1-decyl-3-nonyl-imidazolium, 1-undecyl-3-nonyl-imidazolium, 1-dodecyl-3-nonyl-imidazolium, 1-tridecyl-3-nonyl-imidazolium, 1-tetradecyl-3-nonyl-imidazolium, 1-pentadecyl-3-nonyl-imidazolium, 1-hexadecyl-3-nonyl-imidazolium, 1-heptadecyl-3-nonylimidazolium, 1-octadecyl-3-nonyl-imidazolium, 1-nonadecyl-3-nonyl-imidazolium, 1-methyl-3-decyl-imidazolium, 1-ethyl-3-decyl-imidazolium, 1-propyl-3-decyl-imidazolium, 1-Isopropyl-3-decyl-imidazolium, 1-butyl-3-decyl-imidazolium, 1-pentyl-3-decyl-imidazolium, 1-hexyl-3-decyl-imidazolium, 1-heptyl-3-decyl-imidazolium, 1-octyl-3-decyl-imidazolium, 1-nonyl-3-decyl-imidazolium, 1-decyl-3-decyl-imidazolium, 1-undecyl-3-decyl-imidazolium, 1-dodecyl-3-decyl-imidazolium, 1-tridecyl-3-decyl-imidazolium, 1-tetradecyl-3-decyl-imidazolium, 1-pentadecyl-3-decyl-imidazolium, 1-hexadecyl-3-decyl-imidazolium, 1-heptadecyl-3-decylimidazolium, 1-octadecyl-3-decyl-imidazolium, 1-nonadecyl-3-decyl-imidazolium, 1-methyl-3-undecyl-imidazolium, 1-ethyl-3-undecyl-imidazolium, 1-propyl-3-undecyl-imidazolium, 1-Isopropyl-3-undecyl-imidazolium, 1-butyl-3-undecyl-imidazolium, 1-pentyl-3-undecylimidazolium, 1-hexyl-3-undecyl-imidazolium, 1-heptyl-3-undecyl-

imidazolium, 1-octyl-3-undecylimidazolium, 1-nonyl-3-undecyl-imidazolium, 1-decyl-3-undecyl-imidazolium, 1-undecyl-3-undecyl-imidazolium, 1-dodecyl-3-undecyl-imidazolium, 1-tridecyl-3-undecyl-imidazolium, 1-tetradecyl-3-undecyl-imidazolium, 1-pentadecyl-3-undecyl-imidazolium, 1-hexadecyl-3-undecylimidazolium, 1-heptadecyl-3-undecyl-imidazolium, 1-octadecyl-3-undecyl-imidazolium, 1-nonadecyl-3-undecyl-imidazolium, 1-methyl-3-dodecyl-imidazolium, 1-ethyl-3-dodecyl-imidazolium, 1-propyl-3-dodecyl-imidazolium, 1-Isopropyl-3-dodecyl-imidazolium, 1-butyl-3-dodecyl-imidazolium, 1-pentyl-3-dodecylimidazolium, 1-hexyl-3-dodecyl-imidazolium, 1-heptyl-3-dodecyl-imidazolium, 1-octyl-3-dodecylimidazolium, 1-nonyl-3-dodecyl-imidazolium, 1-decyl-3-dodecyl-imidazolium, 1-undecyl-3-dodecyl-imidazolium, 1-dodecyl-3-dodecyl-imidazolium, 1-tridecyl-3-dodecyl-imidazolium, 1-tetradecyl-3-dodecyl-imidazolium, 1-pentadecyl-3-dodecyl-imidazolium, 1-hexadecyl-3-dodecylimidazolium, 1-heptadecyl-3-dodecyl-imidazolium, 1-octadecyl-3-dodecyl-imidazolium, 1-nonadecyl-3-dodecyl-imidazolium, 1-methyl-3-tridecyl-imidazolium, 1-ethyl-3-tridecyl-imidazolium, 1-propyl-3-tridecyl-imidazolium, 1-Isopropyl-3-tridecyl-imidazolium, 1-butyl-3-tridecyl-imidazolium, 1-pentyl-3-tridecyl-imidazolium, 1-hexyl-3-tridecyl-imidazoli um, 1-heptyl-3-tridecyl-imidazolium, 1-octyl-3-tridecyl-imidazolium, 1-nonyl-3-tridecyl-imidazolium, 1-decyl-3-tridecyl-imidazolium, 1-undecyl-3-tridecyl-imidazolium, 1-dodecyl-3-tridecyl-imidazolium, 1-tridecyl-3-tridecyl-imidazolium, 1-tetradecyl-3-tridecyl-imidazolium, 1-pentadecyl-3-tridecyl-imidazolium, 1-hexadecyl-3-tridecyl-imidazolium, 1-heptadecyl-3-tridecyl-imidazolium, 1-octadecyl-3-tridecyl-imidazolium, 1-nonadecyl-3-tridecylimidazolium, 1-methyl-3-tetradecyl-imidazolium, 1-ethyl-3-tetradecyl-imidazoli um, 1-propyl-3-tetradecylimidazolium, 1-Isopropyl-3-tetradecyl-imidazolium, 1-butyl-3-tetradecyl-imidazolium, 1-pentyl-3-tetradecyl-imidazolium, 1-hexyl-3-tetradecyl-imidazolium, 1-heptyl-3-tetradecyl-imidazolium, 1-octyl-3-tetradecyl-imidazolium, 1-nonyl-3-tetradecyl-imidazolium, 1-decyl-3-tetradecylimidazolium, 1-undecyl-3-tetradecyl-imidazolium, 1-dodecyl-3-tetradecyl-imidazolium, 1-tridecyl-3-tetradecyl-imidazoli um, 1-t etradecyl-3-tetradecyl-imidazoliu m, 1-pentadecyl-3-tetradecylimidazolium, 1-hexadecyl-3-tetradecyl-imidazolium, 1-heptadecyl-3-tetradecyl-imidazolium, 1-octadecyl-3-tetradecyl-imidazolium, 1-nonadecyl-3-tetradecyl-imidazolium, 1-methyl-3-pentadecyl-

imidazolium, 1-ethyl-3-pentadecyl-imidazolium, 1-propyl-3-pentadecylimidazolium, 1-Isopropyl-3-pentadecyl-imidazolium, 1-butyl-3-pentadecyl-imidazolium, 1-pentyl-3-pentadecyl-imidazoliu m, 1-hexyl-3-pentadecyl-imidazoliu m, 1-heptyl-3-pentadecyl-imidazolium, 1-octyl-3-pentadecyl-imidazolium, 1-nonyl-3-pentadecyl-imidazolium, 1-decyl-3-pentadecylimidazolium, 1-undecyl-3-pentadecyl-imidazolium, 1-dodecyl-3-pentadecyl-imidazolium, 1-tridecyl-3-pentadecyl-imidazolium, 1-t etradecyl-3-pentadecyl-imidazolium, 1-pentadecyl-3-pentadecyl-imidazolium, 1-hexadecyl-3-pentadecyl-imidazolium, 1-heptadecyl-3-pentadecylimidazolium, 1-octadecyl-3-pentadecyl-imidazolium, 1-nonadecyl-3-pentadecyl-imidazolium, 1-methyl-3-hexadecyl-imidazolium, 1-ethyl-3-hexadecyl-imidazolium, 1-propyl-3-hexadecylimidazolium, 1-Isopropyl-3-hexadecyl-imidazolium, 1-butyl-3-hexadecyl-imidazolium, 1-pentyl-3-hexadecyl-imidazolium, 1-hexyl-3-hexadecyl-imidazolium, 1-heptyl-3-hexadecyl-imidazolium, 1-octyl-3-hexadecyl-imidazolium, 1-nonyl-3-hexadecyl-imidazolium, 1-decyl-3-hexadecylimidazolium, 1-undecyl-3-hexadecyl-imidazolium, 1-dodecyl-3-hexadecyl-imidazolium, 1-tridecyl-3-hexadecyl-imidazolium, 1-tetradecyl-3-hexadecyl-imidazoliu m, 1-pentadecyl-3-hexadecylimidazolium, 1-hexadecyl-3-hexadecyl-imidazolium, 1-heptadecyl-3-hexadecyl-imidazolium, 1-octadecyl-3-hexadecyl-imidazolium, 1-nonadecyl-3-hexadecyl-imidazolium, 1-methyl-3-heptadecyl-imidazolium, 1-ethyl-3-heptadecyl-imidazolium, 1-propyl-3-heptadecylimidazolium, 1-Isopropyl-3-heptadecyl-imidazolium, 1-butyl-3-heptadecyl-imidazolium, 1-pentyl-3-heptadecyl-imidazolium, 1-hexyl-3-heptadecyl-imidazolium, 1-heptyl-3-heptadecyl-imidazolium, 1-octyl-3-heptadecyl-imidazolium, 1-nonyl-3-heptadecyl-imidazolium, 1-decyl-3-heptadecylimidazolium, 1-undecyl-3-heptadecyl-imidazolium, 1-dodecyl-3-heptadecyl-imidazolium, 1-tridecyl-3-heptadecyl-imidazolium, 1-tetradecyl-3-heptadecyl-imidazolium, 1-pentadecyl-3-heptadecyl-imidazolium, 1-hexadecyl-3-heptadecyl-imidazolium, 1-heptadecyl-3-heptadecylimidazolium, 1-octadecyl-3-heptadecyl-imidazolium, 1-nonadecyl-3-heptadecyl-imidazolium, 1-methyl-3-octadecyl-imidazolium, 1-ethyl-3-octadecyl-imidazolium, 1-propyl-3-octadecylimidazolium, 1-Isopropyl-3-octadecyl-imidazolium, 1-butyl-3-octadecyl-imidazolium, 1-pentyl-3-octadecyl-imidazolium, 1-hexyl-3-octadecyl-imidazolium, 1-heptyl-3-octadecyl-imidazolium, 1-octyl-3-octadecyl-imidazolium, 1-nonyl-3-

octadecyl-imidazolium, 1-decyl-3-octadecylimidazolium, 1-undecyl-3-octadecyl-imidazolium, 1-dodecyl-3-octadecyl-imidazolium, 1-tridecyl-3-octadecyl-im idazolium, 1-t etradecyl-3-octadecyl-imidazolium, 1-pentadecyl-3-octadecylimidazolium, 1-hexadecyl-3-octadecyl-imidazolium, 1-heptadecyl-3-octadecyl-imidazolium, 1-octadecyl-3-octadecyl-imidazolium, 1-nonadecyl-3-octadecyl-imidazolium, 1-methyl-3-nonadecyl-imidazolium, 1-ethyl-3-nonadecyl-imidazolium, 1-propyl-3-nonadecylimidazolium, 1-Isopropyl-3-nonadecyl-imidazolium, 1-butyl-3-nonadecyl-imidazolium, 1-pentyl-3-nonadecyl-imidazolium, 1-hexyl-3-nonadecyl-imidazolium, 1-heptyl-3-nonadecyl-imidazolium, 1-octyl-3-nonadecyl-imidazolium, 1-nonyl-3-nonadecyl-imidazolium, 1-decyl-3-nonadecylimidazolium, 1-undecyl-3-nonadecyl-imidazolium, 1-dodecyl-3-nonadecyl-imidazolium, 1-tridecyl-3-nonadecyl-imidazolium, 1-tetradecyl-3-nonadecyl-imidazolium, 1-pentadecyl-3-nonadecyl-imidazolium, 1-hexadecyl-3-nonadecyl-imidazolium, 1-heptadecyl-3-nonadecylimidazolium, 1-octadecyl-3-nonadecyl-imidazolium, 1-nonadecyl-3-nonadecyl-imidazolium, 1-methyl-3-phenyl-imidazolium, 1-ethyl-3-phenyl-imidazolium, 1-propyl-3-phenyl-imidazolium, 1-Isopropyl-3-phenyl-imidazolium, 1-butyl-3-phenyl-imidazolium, 1-pentyl-3-phenyl-imidazolium, 1-hexyl-3-phenyl-imidazolium, 1-heptyl-3-phenyl-imidazolium, 1-octyl-3-phenyl-imidazolium, 1-nonyl-3-phenyl-imidazolium, 1-decyl-3-phenyl-imidazolium, 1-undecyl-3-phenyl-imidazolium, 1-dodecyl-3-phenyl-imidazolium, 1-tridecyl-3-phenyl-imidazolium, 1-tetradecyl-3-phenylimidazolium, 1-pentadecyl-3-phenyl-imidazolium, 1-hexadecyl-3-phenyl-imidazolium, 1-heptadecyl-3-phenyl-imidazolium, 1-octadecyl-3-phenyl-imidazolium, 1-nonadecyl-3-phenylimidazolium, 1-methyl-3-benzyl-imidazolium, 1-ethyl-3-benzyl-imidazolium, 1-propyl-3-benzyl-imidazolium, 1-Isopropyl-3-benzyl-imidazolium, 1-butyl-3-benzyl-imidazolium, 1-pentyl-3-benzyl-imidazolium, 1-hexyl-3-benzyl-imidazolium, 1-heptyl-3-benzyl-imidazolium, 1-octyl-3-benzyl-imidazolium, 1-nonyl-3-benzyl-imidazolium, 1-decyl-3-benzyl-imidazolium, 1-undecyl-3-benzyl-imidazolium, 1-dodecyl-3-benzyl-imidazolium, 1-tridecyl-3-benzyl-imidazolium, 1-tetradecyl-3-benzylimidazolium, 1-pentadecyl-3-benzyl-imidazolium, 1-hexadecyl-3-benzyl-imidazolium, 1-heptadecyl-3-benzyl-imidazolium, 1-octadecyl-3-benzyl-imidazolium, 1-nonadecyl-3-benzylimidazolium, 1-methyl-3-phenylpropyl-imidazolium, 1-ethyl-3-phenylpropyl-imidazolium, 1-propyl-3-

phenylpropyl-imidazolium, 1-Isopropyl-3-phenylpropyl-imidazolium, 1-butyl-3-phenylpropylimidazolium, 1-pentyl-3-phenylpropyl-imidazolium, 1-hexyl-3-phenylpropyl-imidazolium, 1-heptyl-3-phenylpropyl-imidazolium, 1-octyl-3-phenylpropyl-imidazolium, 1-nonyl-3-phenylpropylimidazolium, 1-decyl-3-phenylpropyl-imidazolium, 1-undecyl-3-phenylpropyl-imidazolium, 1-dodecyl-3-phenylpropyl-imidazolium, 1-tridecyl-3-phenylpropyl-imidazolium, 1-tetradecyl-3-phenylpropyl-imidazolium, 1-pentadecyl-3-phenylpropyl-imidazolium, 1-hexadecyl-3-phenylpropyl-imidazolium, 1-heptadecyl-3-phenylpropyl-imidazolium, 1-octadecyl-3-phenylpropylimidazolium, 1-nonadecyl-3-phenylpropyl-imidazolium, etc.

Preferred anions are selected from the groups of halides, sulfates, sulfonates, amides, imides and methanes, borates, phosphates and antimonates, anions of fatty acids, trifluoroacetates and cobalt tetracarbonyl.

Preferred anions are chloride, bromide, iodide, methylsulfate, ethylsulfate, propylsulfate, butylsulfate, hexylsulfate, octylsulfate, trifluoromethanesulfonate, tosylate, dicyanamide, bis(trifluoromethyl)imide, bis(trifluoromethylsulfonyl)imide, bis(trifluoromethylsulfonyl)methane, tris(trifluoromethylsulfonyl)methide, tetrafluoroborate, tetracyanoborate, bis[1,2-benzenediolato(2-)O,O']-borate, [salicylato(2-)] borate, bis[malonato(2-)]borate, bis[oxalato(2-)]borate, bis[2,2'-biphenyldiolato(2-)-O,O']-borate, hexafluorophosphate, bis(pentafluoroethyl)phosphinate, tris(pentafluoroethyl)trifluorophosphate, tris(heptafluoropropyl) trifluorophosphate, tris(nonafluorobutyl) trifluorophosphate, bis(2,4,4-trimethylpentyl) phosphinate, hexafluoroantimonate, diethyl phosphate.

All of the above-mentioned cations can be combined with all of the above-mentioned anions to give ionic liquids which can be used according to the invention. Examples are 1-methyl-imidazolium tosylate, 1-methyl-imidazolium tetrafluoroborate, 1-methyl-imidazolium hexafluorophosphate, 1-methyl-imidazolium trifluoromethansulfonate, 1-methyl-3-octylimidazolium chloride, 3-methyl-1-octylimidazolium bromide, 3-methyl-1-octylimidazolium chloride, 3-methyl-1-octylimidazolium octylsulfate, 3-methyl-1-octylimidazolium methylsulfate, 3-methyl-1-octylimidazolium

tetrafluoroborate, 3-methyl-1-octylimidazolium hexafluorophosphate, 3-methyl-1-octylimidazolium hexafluoroantimonate, 3-methyl-1-octylimidazolium trifluoromethansulfonate, 3-methyl-1-octylimidazolium bis-trifluoromethylsulfonyl)imid, 3-methyl-1-octylimidazolium bis-trifluoromethylsulfonyl)methan, 3-methyl-1-tetradecylimidazolium chloride, 3-methy-1-tetradecylimidazolium tris-pentafluoroethyl)trifluorophosphate, 3-methyl-1-tetradecylimidazolium haxafluorophosphate, 3-methyl-1-tetradecylimidazolium tetrafluoroborate, 4-methyl-n-butylpyridinium chloride, 4-methyl-n-butylpyridinium bromide, 4-methyl-n-butylpyridinium tetrafluoroborate, 4-methyl-n-butylpyridinium hexafluorophosphate, 3-methyl-n-hexylpyridinium chloride, 4-methyl-n-hexylpyridinium chloride, 3-methyl-n-octylpyridinium chloride, 4-methyl-n-octylpyridinium chloride, 1,3-dimethyl-imidazolium methylsulfate,1,3-dimethyl-imidazolium dimethylphosphate, 1,3-dimethyl-imidazolium trifluoromethansulfonate, 1,3-dimethyl-imidazolium bis(pentafluoroethyl)phosphinate, 1-ethyl-3-methyl-imidazolium chloride, 1-ethyl-3-methyl-imidazolium bromide, 1-ethyl-3-methyl-imidazolium tetrafluoroborate, 1-ethyl-3-methyl-imidazolium tosylate, 1-ethyl-3-methyl-imidazolium dicyanamid, 1-ethyl-3-methyl-imidazolium trifluoromethansulfonate, 1-ethyl-3-methyl-imidazolium hexafluorophosphate, 1-ethyl-3-methyl-imidazolium hexafluoroantimonate, 1-ethyl-3-methyl-imidazolium bis(pentafluoroethyl)phosphinate, 1-ethyl-3-methyl-imidazolium bis[oxalato(2-)]-borate, 1-ethyl-3methyl-imidazolium bis[1,2-benzenediolato(2-)-O,O']-borate, 1-ethyl-3-methyl-imidazolium bis(trifluoromethyl)imid, 1-ethyl-3-methyl-imidazolium cobalt tetracarbonyl, 1-ethyl-3-methylimidazolium diethylphosphate, 1-ethyl-3-methylimidazolium ethylsulfate, 1-ethyl-3-methylimidazolium butylsulfate, 1-ethyl-3-methylimidazolium hexylsulfate, 1-ethyl-2, 3-dimethylimidazolium chloride, 1-ethyl-2,3-dimethylimidazolium bromide, 1-ethyl-2,3-dimethylimidazolium methylsulfate, 1-ethyl-2,3-dimethylimidazolium tosylate, 1-ethyl-2,3-dimethylimidazolium hexafluorophosphate, 1-ethyl-2,3-dimethylimidazolium hexafluoroantimonate, 1-ethyl-2,3-dimethylimidazolium tetrafluoroborate, 1-ethyl-2,3-dimethyl imidazolium trifluoromethansulfonate, 1-ethyl-1-methyl-pyrrolidinium bromide, 1-ethyl-1-methyl-pyrrolidinium hexafluorophosphate, 1-ethyl-1-methyl-pyrrolidinium hexafluoroantimonate, 1-ethyl-1-methyl-pyrrolidinium tetrafluoroborate, 1-ethyl-1-methyl-pyrrolidinium trifluoromethansulfonate, 1-ethyl-1-methyl-pyrrolidinium methylsulfate,

1-ethyl-1-methyl-pyrrolidinium bis(trifluoromethyl)imid, 3-ethyl-n-butylpyridinium chloride, 3-ethyl-n-butylpyridinium bromide, 3-ethyl-n-butylpyridinium hexafluorophosphate, 3-ethyl-n-butylpyridinium hexafluoroantimonate, 3-ethyl-n-butylpyridinium tetrafluoroborate, 3-ethyl-n-butylpyridinium trifluoromethansulfonate, 3-ethyl-n-butylpyridinium methylsulfate, n-ethylpyridinium chloride, n-ethylpyridinium bromide, n-ethyl-3-hydroxymethylpyridinium ethylsulfate, n-ethyl-3-methylpyridinium ethylsulfate, 1-propyl-2,3-dimethylimidazolium chloride, 1-butyl-imidazolium tosylate, 1-butyl-imidazolium tetrafluoroborate, 1-butyl-imidazolium hexafluorophosphate, 1-butyl-imidazolium trifluoromethansulfonate, 1-butyl-3-methylimidazolium iodidee, 1-butyl-3-methylimidazolium chloride, 1-butyl-3-methylimidazolium bromide, 1-butyl-3-methylimidazolium tetrafluoroborate, 1-butyl-3-methylimidazolium tosylate, 1-butyl-3-methylimidazolium trifluoromethansulfonate, 1-butyl-3-methylimidazolium methylsulfate, 1-butyl-3-methylimidazolium dicyanamid, 1-butyl-3-methylimidazolium hexafluorophosphate, 1-butyl-3-methylimidazolium hexafluoroantimonate, 1-butyl-3-methylimidazolium bis-(trifluoromethyl)imid, 1-butyl-3-methylimidazolium cobalt- tetracarbonyl, 1-butyl-3-methylimidazolium trifluoroacetate, 1-butyl-3-methylimidazolium octylsulfate, 1-butyl-3-methylimidazolium 2(2-methoxy)ethylsulfate, 1-butyl-3-methylimidazolium 2(2-methoxyethoxy)ethylsulfate, 1-butyl-2,3-dimethylimidazolium iodide, 1-butyl-2,3-dimethylimidazolium octylsulfate, 1-butyl-2,3-dimethylimidazolium bromide, 1-butyl-2,3-dimethylimidazolium methylsulfate, 1-butyl-2,3-dimethylimidazolium tosylate, 1-butyl-2,3-dimethylimidazolium tetrafluoroborate, 1-butyl-2,3-dimethylimidazolium hexafluorophosphate, 1-butyl-2,3-dimethylimidazolium hexafluoroantimonate, 1-butyl-2,3-dimethylimidazolium trifluoromethansulfonate, n-butylpyridinium chloride, n-butylpyridinium bromide, n-butylpyridinium methylsulfate,n-butylpyridinium tetrafluoroborate, n-butylpyridinium trifluoromethansulfonate, n-butylpyridinium hexafluorophosphate, n-butylpyridinium hexafluoroantimonate, n-butylpyridinium bis(trifluoromethyl)imid, n-butyl-3-methylpyridinium chloride, n-butyl-3-methylpyridinium bromide, n-butyl-3-methyl pyridinium methylsulfate, n-butyl-3-methylpyridinium hexafluorophosphate, n-butyl-3-methylpyridinium hexafluoroantimonate, n-butyl-3-methylpyridinium tetrafluoroborate, n-butyl-3-methylpyridinium

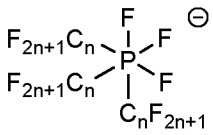
trifluoromethansulfonate, n-butyl-3-ethylpyridinium chloride, n-butyl-3-ethylpyridinium bromide, n-butyl-3-ethylpyridinium hexafluorophosphate, n-butyl-3-ethylpyridinium hexafluoroantimonate, n-butyl-3-ethylpyridinium tetrafluoroborate, n-butyl-3-ethylpyridinium trifluoromethanesulfonate, n-butyl-n-methylpyrrolidinium chloride, n-butyl-n-methylpyrrolidinium bromide, n-butyl-n-methylpyrrolidinium hexafluorophosphate, n-butyl-N-methylpyrrolidinium hexafluoroantimonate, n-butyl-N-methylpyrrolidinium tetrafluoroborate, n-butyl-N-methylpyrrolidinium trifluoromethanesulfonate, n-butyl-N-methylpyrrolidinium bistrifluoromethanesulfonate, n-butylpyridinium hexafluorophosphate, n-butylpyridinium hexafluoroantimonate, n-butylpyridinium tetrafluoroborate, n-butylpyridinium trifluoromethanesulfonate, n-butyl-3,4-dimethylpyridinium chloride, n-butyl-3,5-dimethylpyridinium chloride, 1-pentyl-3-methyl-imidazolium tris(pentafluoroethyl)trifluorophosphate, 1-pentyl-3-methyl-imidazolium tris(nonafluorobutyl)trifluorophosphate, 1-pentyl-3-methyl-imidazolium trifluoromethansulfonate, 1-hexyl-3-methylimidazolium chloride, 1-hexyl-3-methylimidazolium bromide, 1-hexyl-3-methylimidazolium hexafluorophosphate, 1-hexyl-3-methylimidazolium hexafluoroantimonate, 1-hexyl-3-methylimidazolium tetrafluoroborate, 1-hexyl-3-methylimidazolium trifluoromethanesulfonate, 1-hexyl-3-methylimidazolium bistrifluoromethanesulfonate, 1-hexyl-2, 3-dimethylimidazolium tetrafluoroborate, 1-hexyl-2,3-dimethylimidazolium trifluoromethansulfonate, 1-hexyl-2, 3-dimethylimidazolium chloride, 1-hexyl-2,3-dimethylimidazolium bromide, 1-hexyl-2,3-dimethylimidazolium tris-(pentafluoroethyl)trifluorophosphate, n-hexylpyridinium chloride, n-hexylpyridinium bromide, n-hexylpyridinium tetrafluoroborate, n-hexylpyridinium hexafluorophosphate, n-hexylpyridinium trifluoromethansulfonate, n-hexylpyridinium bis-(trifluoromethylsulfonyl)methan, n-hexylpyridinium bis-(trifluoromethylsulfonyl)imid, 1-octyl-3-methylimidazolium chloride, 1-octyl-3-methylimidazolium bromide, 1-octyl-3-methylimidazolium hexafluorophosphate, 1-octyl-3-methylimidazolium hexafluoroantimonate, 1-octyl-3-methylimidazolium tetrafluoroborate, 1-octyl-3-methylimidazolium trifluoromethanesulfonate, 1-octyl-3-methylimidazolium bistrifluoromethanesulfonate n-octylpyridinium chloride, n-octylpyridinium tris-(trifluoromethylsulfonyl)methan, n-octylpyridinium bis-

(trifluoromethylsulfonyl)imide, 1-decyl-3-methylimidazolium chloride, 1-decyl-3-methylimidazolium bromide, 1-decyl-3-methylimidazolium tris-(pentafluoroethyl)trifluorophosphate, 1-decyl-3methylimidazolium hexafluorophosphate, 1-decyl-3-methylimidazolium tetrafluoroborate, 1-dodecyl-3-methylimidazolium tetrafluoroborate, 1-dodecyl-3-methylimidazolium hexafluorophosphate, 1-dodecyl-3-methylimidazolium tris-(pentafluoroethyl)trifluorophosphate, 1-dodecyl-3-methylimidazolium chloride, 1-hexadecyl-3-methylimidazolium chloride, 1-hexadecyl-2,3-dimethylimidazolium chloride, 1-hexadecyl-2,3-dimethylimidazolium iodide, 1-hexadecyl-2,3-dimethylimidazolium tetrafluoroborate, 1-benzyl-3-methylimidazolium chloride, 1-benzyl-3-methylimidazolium bromide, 1-benzyl-3-methylimidazolium hexafluorophosphate, 1-benzyl-3-methylimidazolium hexafluoroantimonate, 1-benzyl-3-methylimidazolium tetrafluoroborate, 1-benzyl-3-methylimidazolium trifluoromethanesulfonate, 1-phenylpropyl-3-methyl-imidazolium chloride 1-phenylpropyl-3-methyl-imidazolium bromide, 1-phenylpropyl-3-methyl-imidazolium hexafluorophosphate, 1-phenylpropyl-3-methyl-imidazolium hexafluoroantimonate, 1-phenylpropyl-3-methyl-imidazolium tetrafluoroborate, 1-phenylpropyl-3-methyl-imidazolium trifluoromethansulfonate, tetrabutylphosphonium chloride, tetrabutylphosphonium bromide, tetra butyl phosphonium tris-(pentafluoroethyl)trifluorophosphate, tetrabutylphosphonium tetracyanoborate, tetrabutylphosphonium bis[oxalato(2-)]-borate, tetrabutylphosphonium bis[1,2-benzenediolato(2-)-O,O']-borate, tetrabutylphosphonium bis-(trifluoromethyl)imide, trihexyl(tetradecyl)phosphonium chloride, trihexyl(tetradecyl)phosphonium bromide, trihexyl(tetradecyl)phosphonium dicyanamide, trihexyl(tetradecyl)phosphonium tetrafluoroborate, trihexyl(tetradecyl)phosphonium bis-(trifluoromethylsulfonyl)imide, trihexyl(tetradecyl)phosphonium bis-(2,4,4-trimethylpentyl)phosphinate, trihexyl(tetradecyl)phosphonium tris-(pentafluoroethyl)trifluorophosphate, trihexyl(tetradecyl)phosphonium hexafluorophosphate, trihexyl(tetradecyl)phosphonium decanoate, trihexyl(tetradecyl)phosphonium tetracyanoborate, trihexyl(tetradecyl)phosphonium bis-[oxalato(2-)]-borate, trihexyl(tetradecyl)phosphonium bis-[1,2-benzenediolato(2-)-O,O']-borate,

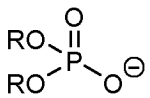
trihexyl(tetradecyl)phosphonium bis-(trifluoromethylsulfonyl)methan, tri-iso-butyl(methyl)-phosphonium tosylate, benzyltriphenylphosphonium bis(trifluoromethyl)-imide, ethyl(tributyl)phosphonium diethylphosphate, methyl(tributyl)phosphonium methylsulfate, tributyl(tetradecyl)phosphonium chloride, tributyl(hexadecyl)phosphonium chloride, tetraoctylphosphonium bromide, (2-hydroxyethyl)trimethylammonium dimethylphosphate, tributylmethyphosphonium dimethylphosphate, tributylmethyphosphonium diethylphosphate, cyclohexyltrimethylammonium bis(trifluormethylsulfonyl)imide, methyltrioctylammonium bis(trifluoromethylsulfonyl)imide, (2-hydroxyethyl)trimethylammonium dimethylphosphate, tributylmethyphosphonium dimethylphosphate, lithium bis(trifluoromethylsulfonyl)imide, tetramethylammonium bis-(trifluoromethylsulfonyl)imide, tetramethylammonium bis-(trifluoromethyl)imide, tetramethylammonium tris-(pentafluoroethyl)trifluorophosphate, tetramethylammonium bis[oxalato-(2-)]-borate, tetraethylammonium bis-(trifluoromethyl)imide, tetraethylammonium bis-(trifluoromethylsulfonyl)imide, tetraethylammonium tris-(pentafluoroethyl)trifluorophosphate, tetraethylammonium bis[1,2-benzenediolato(2-}-O,O']-borate, tetraethylammonium bis[salicylato-(2-)]-borate, tetraethylammonium bis[2,2 '-biphenyldiolato(2-)-O,O']-borate, tetraethylammonium bis[malonato-(2-)]-borate, tetrabutylammonium bromide, tetrabutylammonium bis-(trifluoromethylsulfonyl)imide, tetrabutylammonium tris-(pentafluoroethyl)trifluorophosphate, tetrabutylammonium bis-(trifluoromethyl)imide, tetrabutylammonium tetracyanoborate, methyltrioctylammonium bis-(trifluoromethylsulfonyl)imide, methyltrioctylammonium trifluoroacetate, methyltrioctylammonium trifluoromethansulfonate, 1,1-dimethyl-pyrrolidinium tris(pentafluoroethyl}trifluorophosphate, 1,1-dipropylpyrrolidinium bis-(trifluoromethylsulfonyl)imide, 1-butyl-1-methyl-pyrrolidinium chloride, 1-butyl-1-methyl-pyrrolidinium bromide, 1-butyl-1-methyl-pyrrolidinium methylsulfate, 1-butyl-1-methyl-pyrrolidinium trifluoromethansulfonate, 1-butyl-1-methyl-pyrrolidinium tetrafluoroborate, 1-butyl-1-methyl-pyrrolidinium hexafluorophosphate, 1-butyl-1-methyl-pyrrolidinium hexafluoroantimonate, 1-butyl-1-methyl-pyrrolidinium dicyanamide, 1-butyl-1-methyl-pyrrolidinium bis(trifluoromethylsulfonyl)imide, 1-butyl-1-methyl-pyrrolidinium

tris(pentafluoroethyl}trifluorophosphate, 1-butyl-1-ethyl-pyrrolidinium bromide, 1,1-dibutylpyrrolidinium bis-(trifluoromethylsulfonyl)imide, 1-hexyl-1-methyl-pyrrolidinium chloride, 1-hexyl-1-methyl-pyrrolidinium bis(trifluoromethylsulfonyl)imide, 1-hexyl-1-methyl-pyrrolidinium dicyanamide, 1,1-dihexylpyrrolidinium bis-(trifluoromethylsulfonyl)imide, 1-octyl-1-methyl-pyrrolidinium chloride, guanidinium tris(pentafluoroethyl}trifluorophosphate, guanidinium trifluoromethansulfonate, N,N,N',N'-tetramethyl-N''-ethylguanidinium tris(pentafluoroethyl) trifluorophosphate, N,N,N',N'-tetramethyl-N''-ethylguanidinium trifluoromethansulfonate, N-pentamethyl-N-isopropylguanidinium tris(pentafluoroethyl) trifluorophosphate, N-pentamethyl-N-isopropylguanidinium trifluoromethansulfonate, N-pentamethyl-N-propylguanidinium tris(pentafluoroethyl) trifluorophosphate, N-pentamethyl-N-propylguanidinium trifluoromethansulfonate, hexamethylguanidinium tris(pentafluoroethyl) trifluorophosphate, hexamethylguanidinium trifluoromethansulfonate, O-methyl-N,N,N',N'-tetramethylisouronium tris(pentafluoroethyl)trifluorophosphate, O-methyl-N,N,N',N'-tetramethylisouronium trifluoromethansulfonate, O-Ethyl-N,N,N',N'-tetramethylisouronium tris(pentafluoroethyl) trifluorophosphate, N,N,N',N'-tetramethylisouronium trifluoromethanesulfonate, S-Ethyl-N,N,N',N'-tetramethylisothiouronium tris(pentafluoroethyl)trifluorophosphat.

Especially preferred anions for ionic liquids for use according to the present invention are selected from the group of ions of formulae B-1 to B-7, in particular B-1:



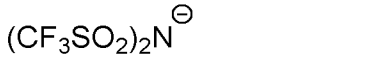
B-1



B-2

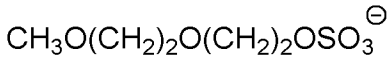
$C_mF_{2m+1}SO_3^{\ominus}$ B-3

$ROSO_3^{\ominus}$ B-4



B-5

B-6



B-7

in which

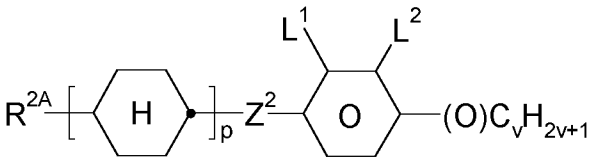
n is an integer from 1 to 6, preferably 2,

m is an integer from 1 to 10, preferably 1,

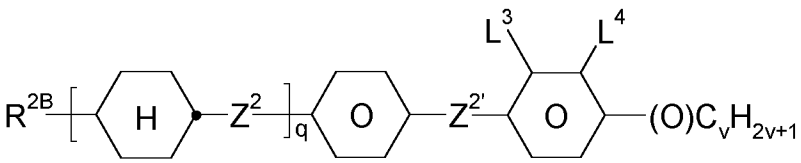
R denotes alkyl having 1 to 6 C atoms, preferably 1 C atom.

In particular it is preferred that the medium according to the invention comprises one or more ionic liquids comprising a cation of formula A-1 and an anion selected from the anoins of formulae B-1 to B-7 defined above.

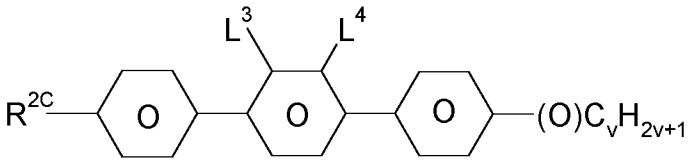
Preferably, the nematic host comprises one or more compounds selected from the group of the compounds of the formulae IIA, IIB and IIC,



IIA



IIB



IIC

in which

R^{2A}, R^{2B} and R^{2C}		each, independently of one another, denote H, an alkyl or alkenyl radical having up to 15 C atoms which is unsubstituted, monosubstituted by CN or CF_3 or at least monosubstituted by halogen, where, in addition, one or more CH_2 groups in these radicals may be replaced by -O-, -S-, -C≡C-, -CF_2O-, -OCF_2-, -OC-O- or -O-CO- in such a way that O atoms are not linked directly to one another, or a cycloalkyl ring having 3 to 6 C atoms,
L^{1-4}		each, independently of one another, denote F, Cl, CF_3 or CHF_2,
Z^2 and $Z^{2'}$		each, independently of one another, denote a single bond, -CH_2CH_2-, -CH=CH-, -C≡C-, -CF_2O-, -OCF_2-, -CH_2O-, -OCH_2-, -C(O)O-, -OC(O)-, -C_2F_4-, -CF=CF-, -CH=CHCH_2O-,
p		denotes 1 or 2,
q		denotes 0 or 1, and
v		denotes 1 to 6.

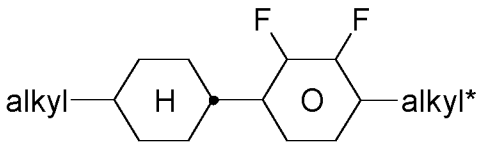
In the compounds of the formulae IIA and IIB, Z^2 may have identical or different meanings. In the compounds of the formula IIB, Z^2 and $Z^{2'}$ may have identical or different meanings.

In the compounds of the formulae IIA, IIB and IIC, R^{2A}, R^{2B} and R^{2C} each preferably denote alkyl having 1-6 C atoms, in particular CH_3, C_2H_5, n-C_3H_7, n-C_4H_9, n-C_5H_{11}.

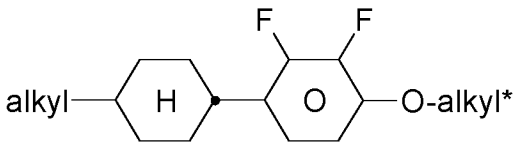
In the compounds of the formulae IIA and IIB, L^1, L^2, L^3 and L^4 preferably denote $L^1 = L^2 = F$ and $L^3 = L^4 = F$, furthermore $L^1 = F$ and $L^2 = Cl$, $L^1 = Cl$ and $L^2 = F$, $L^3 = F$ and $L^4 = Cl$, $L^3 = Cl$ and $L^4 = F$. Z^2 and $Z^{2'}$ in the formulae IIA and IIB preferably each, independently of one another, denote a single bond, furthermore a $-C_2H_4-$ or $-CH_2O-$ bridge.

If in the formula IIB Z^2 denotes $-C_2H_4-$ or $-CH_2O-$, $Z^{2'}$ is preferably a single bond or, if $Z^{2'}$ denotes $-C_2H_4-$ or $-CH_2O-$, Z^2 is preferably a single bond. In the compounds of the formulae IIA and IIB, $(O)C_vH_{2v+1}$ preferably denotes OC_vH_{2v+1}, furthermore C_vH_{2v+1}. In the compounds of the formula IIC, $(O)C_vH_{2v+1}$ preferably denotes C_vH_{2v+1}. In the compounds of the formula IIC, L^3 and L^4 preferably each denote F.

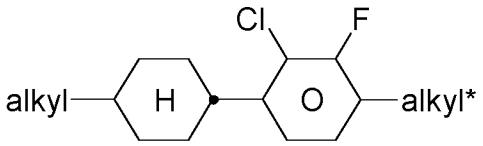
Preferred compounds of the formulae IIA, IIB and IIC are indicated below:



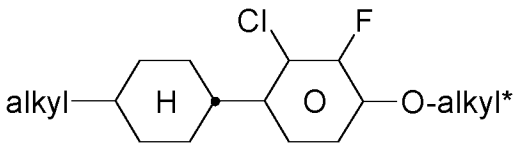
IIA-1



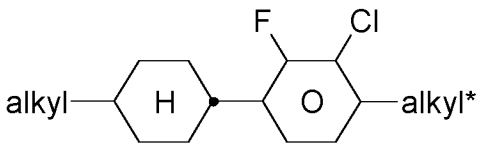
IIA-2



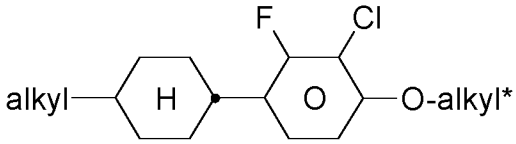
IIA-3



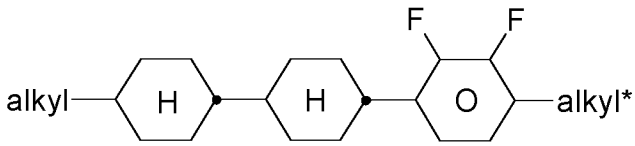
IIA-4



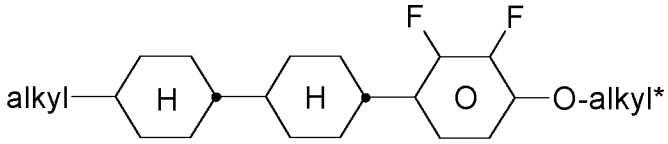
IIA-5



IIA-6



IIA-7



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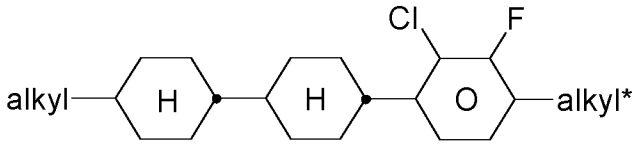

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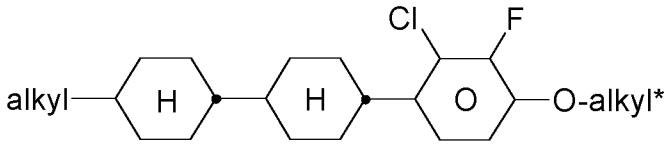

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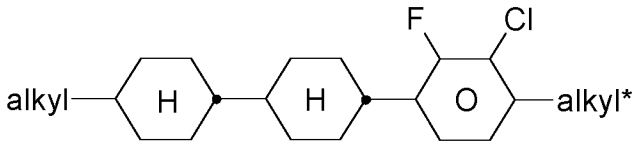

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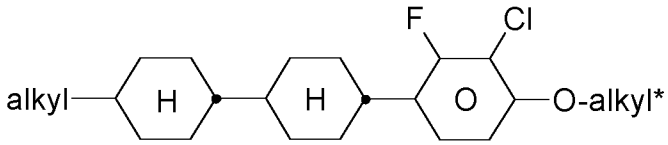

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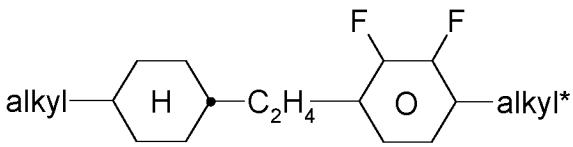

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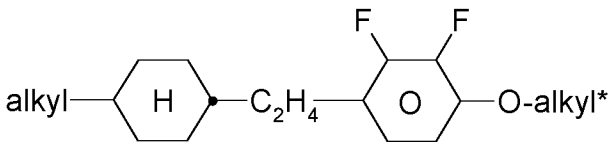

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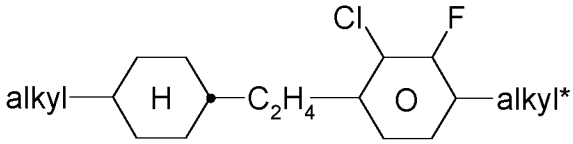

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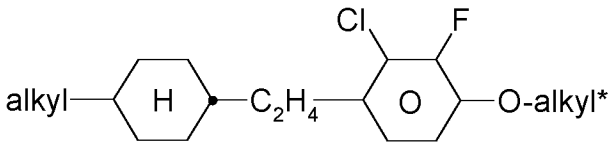

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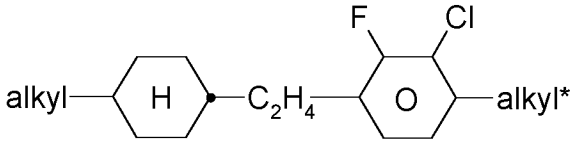

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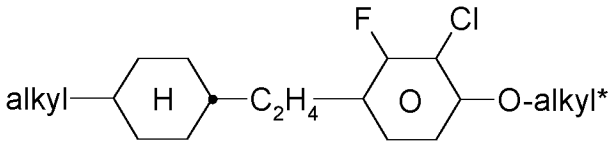

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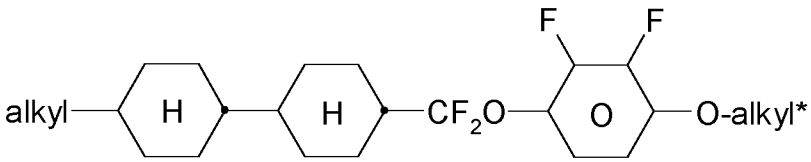

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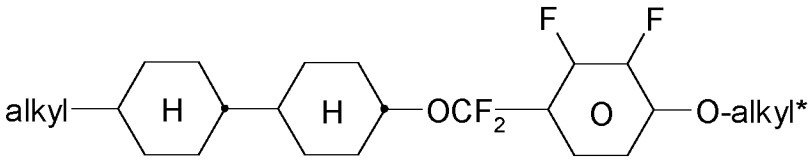

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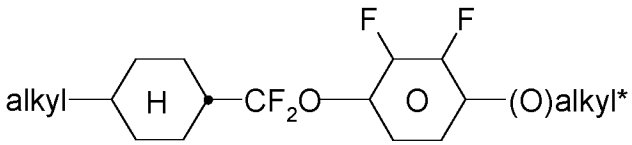

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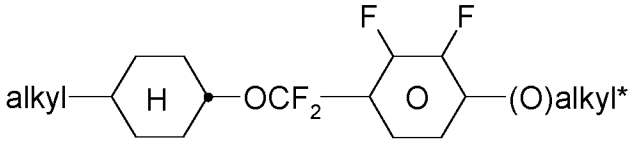

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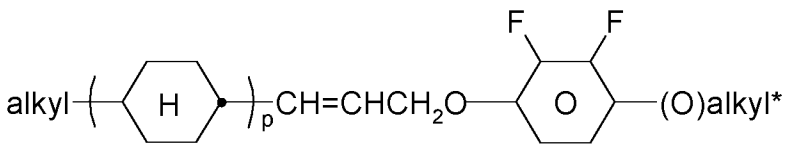

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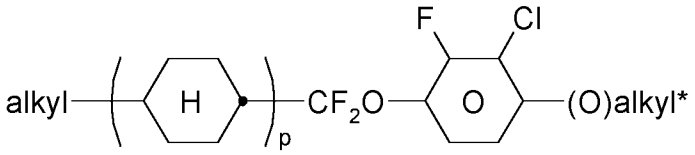

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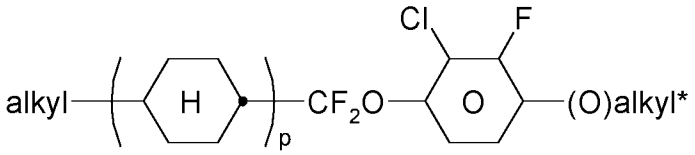

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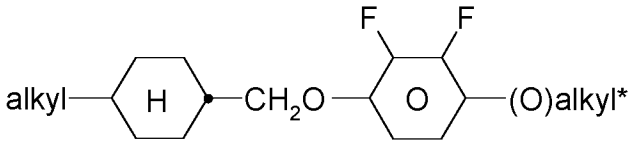

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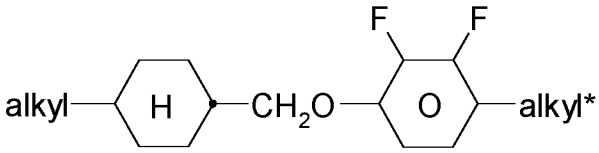

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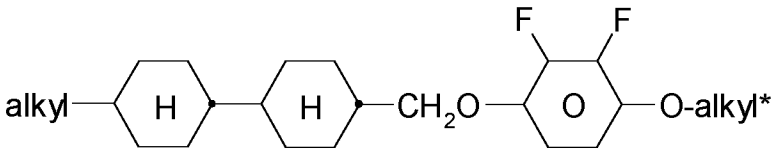

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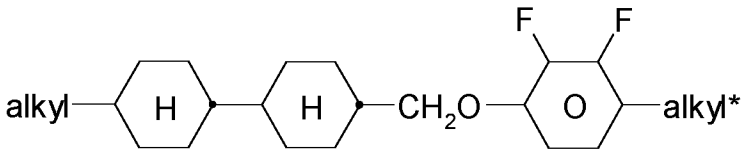

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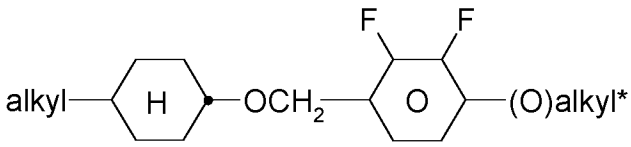

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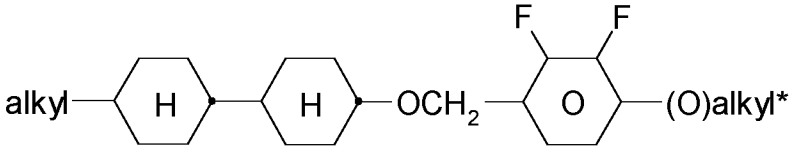

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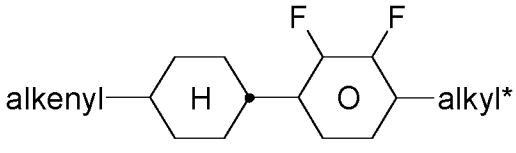

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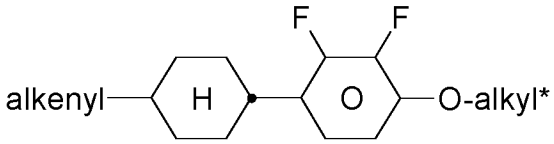

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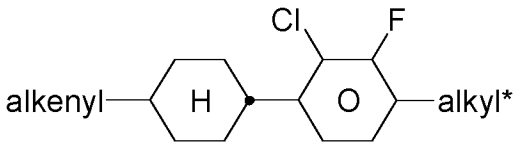

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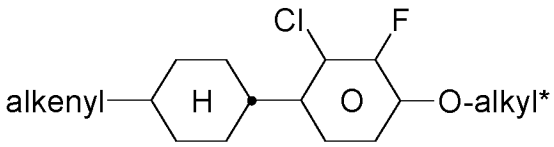

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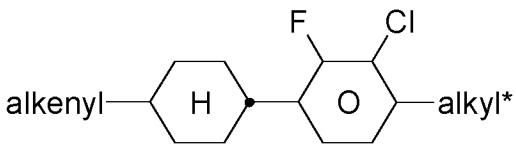

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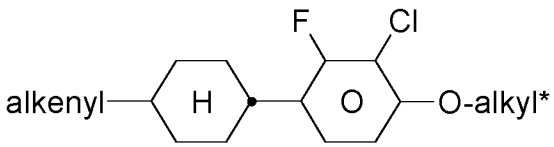

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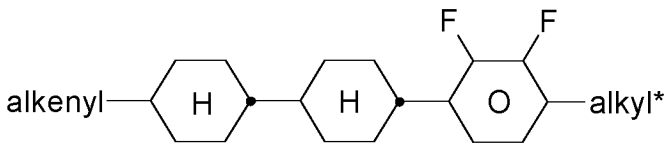

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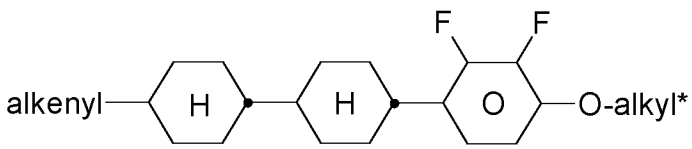

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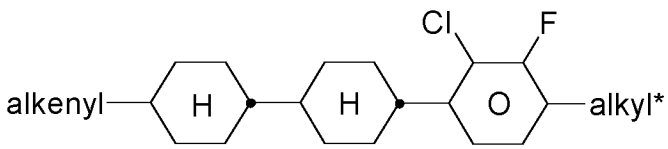

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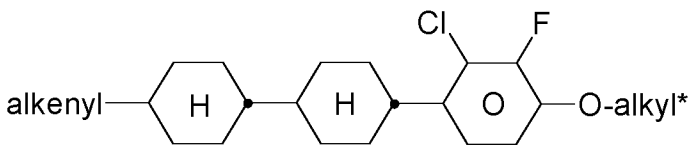

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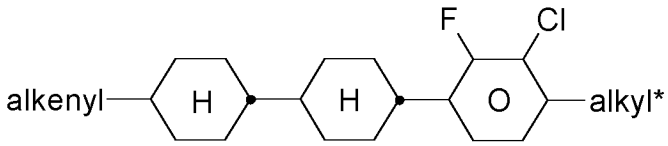

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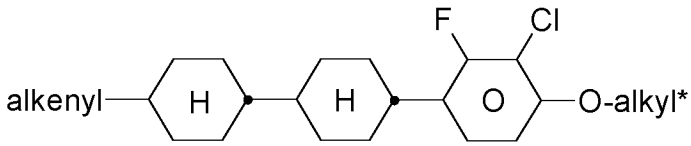

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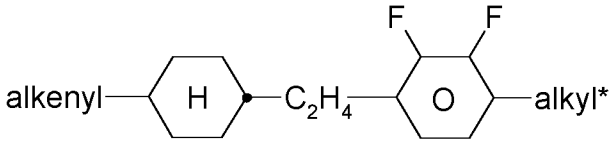

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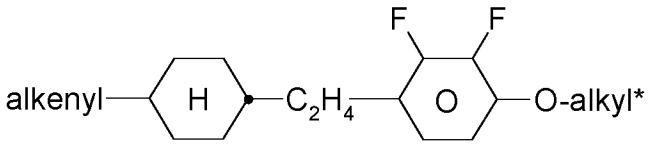

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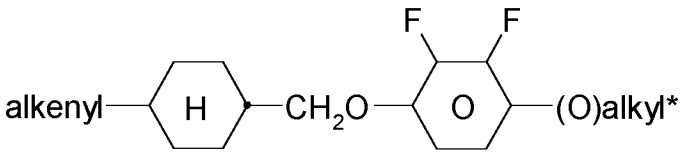

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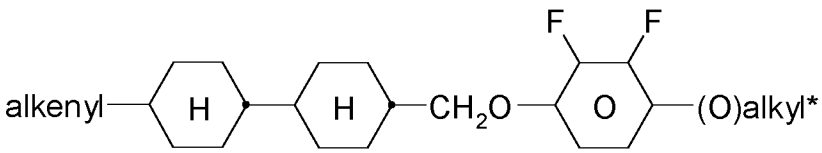

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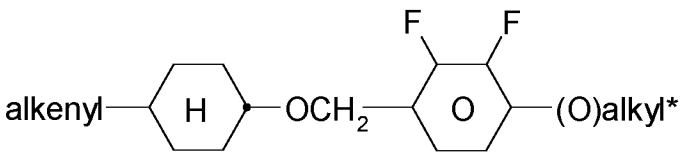

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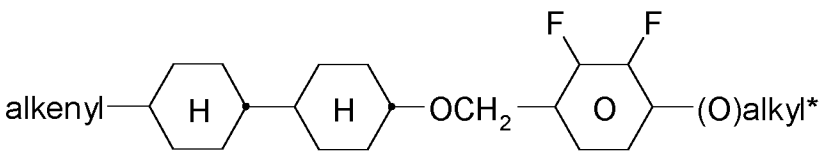

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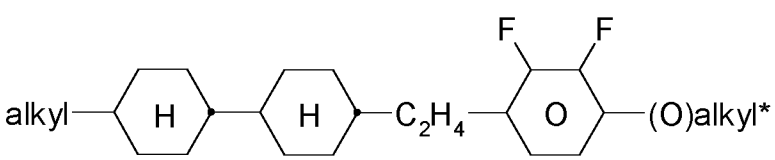

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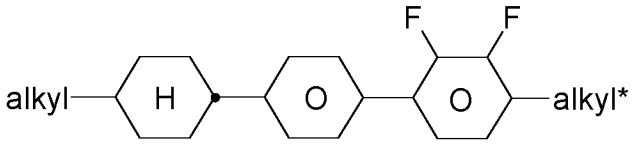

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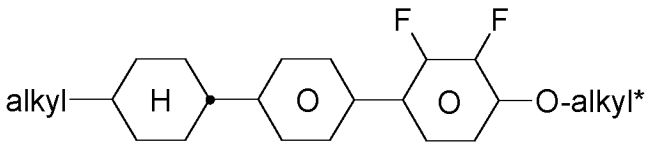

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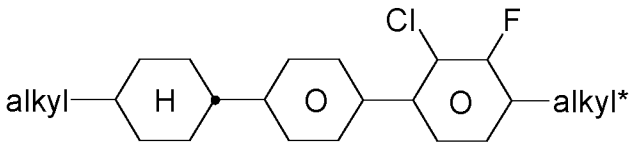

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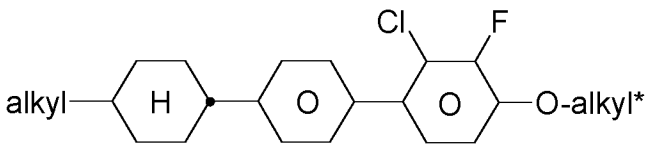

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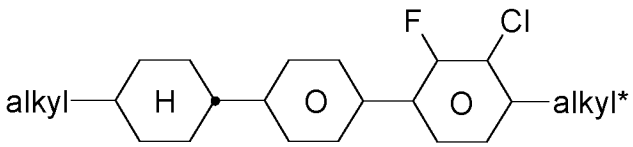

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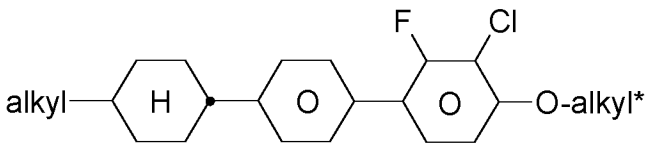

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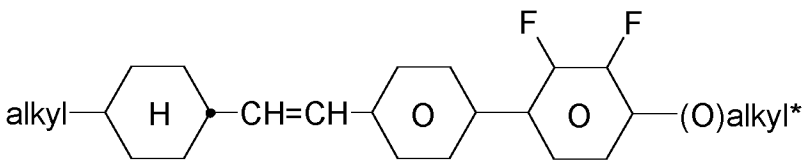

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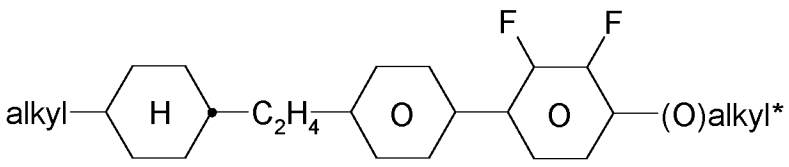

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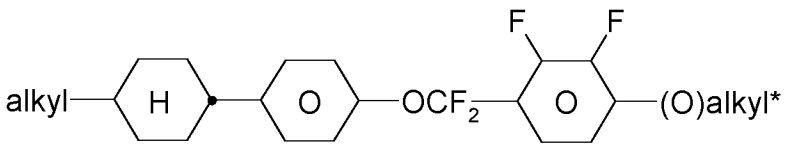

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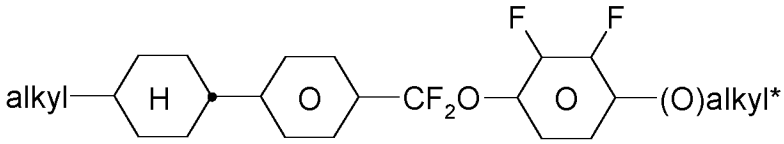

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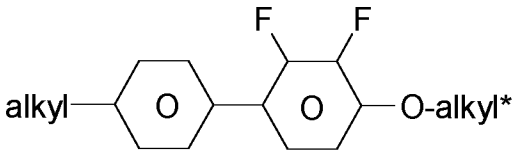

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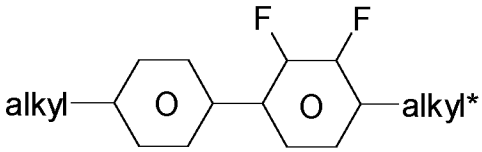

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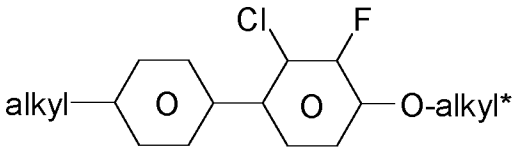

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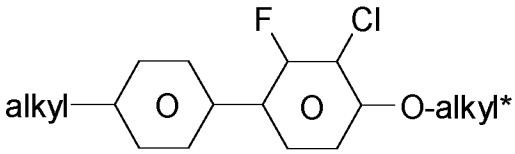

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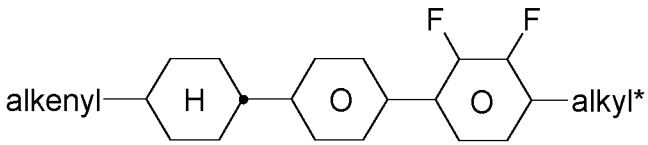

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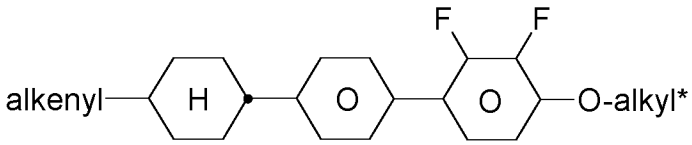
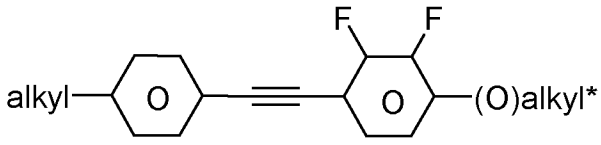
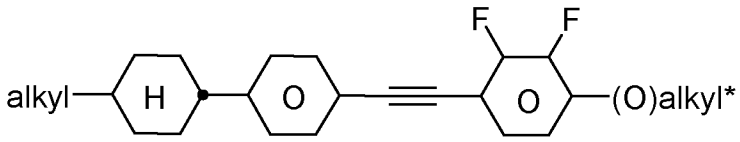


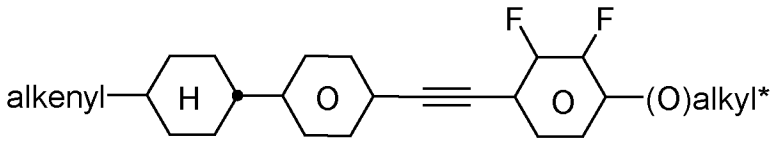
IIB-16



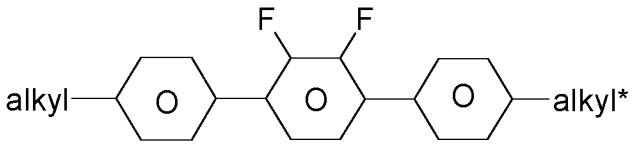
IIB-17



IIB-18



IIB-19



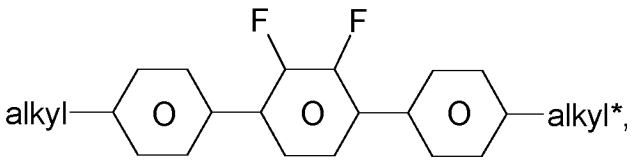
IIC-1,

wherein alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-7 C atoms,
alkenyl denotes a straight chain alkenyl radical having 2 to 7 C atoms, and (O) denotes -O- or a single bond.

Particularly preferred mixtures according to the invention comprise one or more compounds of the formulae IIA-2, IIA-8, IIA-14, IIA-26, IIA-28, IIA-33, IIA-39, IIA-45, IIA-46, IIA-47, IIB-2, IIB-11, IIB-16, IIB-17, IIB-18 and IIC-1.

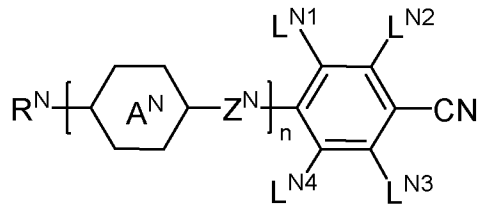
The proportion of compounds of the formulae IIA and/or IIB in the mixture as a whole is preferably at least 20% by weight.

Particularly preferred media according to the invention comprise at least one compound of the formula IIC-1,



in which alkyl and alkyl* have the meanings indicated above, preferably in amounts of > 3% by weight, in particular > 5% by weight, preferably in the range of from 10 to 40%, particularly preferably from 20 to 30% by weight.

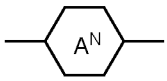
Preferably, the medium according to the invention comprises one or more compounds of formula N,



N

wherein

R^N denotes alkyl or alkenyl having up to 12 C atoms, wherein one or more non adjacent CH_2 groups may be replaced by -O- and/or a cycloalkyl ring having 3 to 5 C atoms, and wherein one or more H atoms may be replaced by F,



on each occurrence, identically or differently, denotes

(a) a trans-1,4-cyclohexylene radical, in which one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S-,

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

(c) trans-1,4-cyclohexenylene,

(d) a radical from the group consisting of 1,4-bicyclo[2.2.2]octylene, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl and 1,2,3,4-tetra-hydronaphthalene-2,6-diyl,

where the radicals (a) to (d) may be substituted by one or two fluorine atoms,

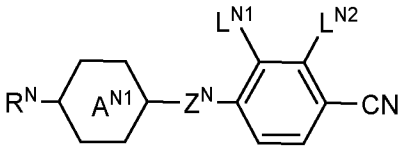
Z^N on each occurrence, independently of one another, -CO-O-, -O-CO-, $-CH_2O-$, $-OCH_2-$, $-CH_2CH_2-$, -CH=CH-, $-C\equiv C-$, $-(CH_2)_4-$, $-OCF_2-$, $-CF_2O-$, $-CF_2CF_2-$, or a single bond,

L^{N1}, L^{N2},

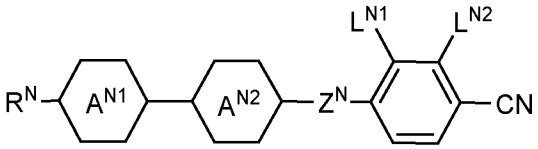
L^{N3} and L^{N4} each, independently of one another, denote H, Cl, or F,

n is 1, 2 or 3.

Preferred compounds of formula N are selected from the group of compounds of the formulae N-1 and N-2:



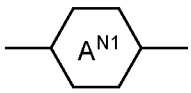
N-1



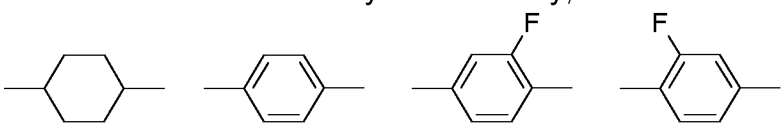
N-2

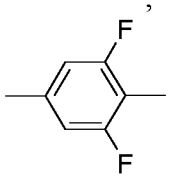
in which

R^N denotes alkyl or alkenyl having up to 7 C atoms,


and

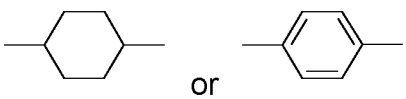
identically or differently, denote





or

preferably

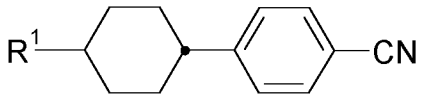


or

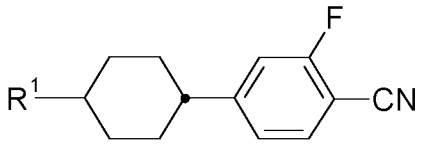
L^{N1} and L^{N2} independently of one another, denote H or F, and

Z^N denotes -CO-O-, -O-CO-, $-CH_2O-$, $-OCH_2-$, $-CH_2CH_2-$, $-OCF_2-$, $-CF_2O-$, or a single bond, preferably a single bond.

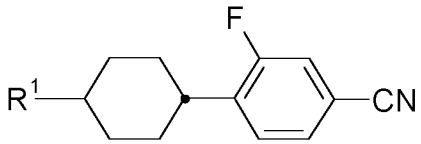
Particularly preferred compounds of formula N are selected from the group of compounds of formulae N-1 to N-8, very particularly preferred of formula N-1:



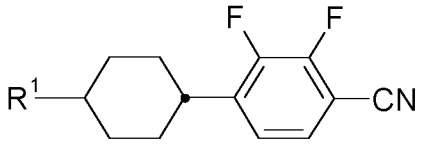
N-1



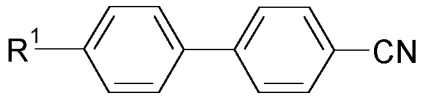
N-2



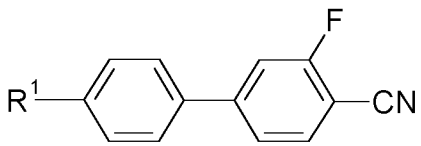
N-3



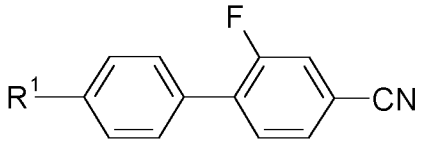
N-4



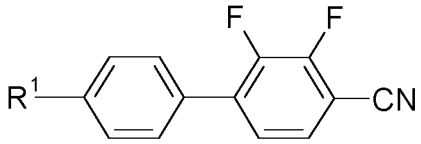
N-5



N-6



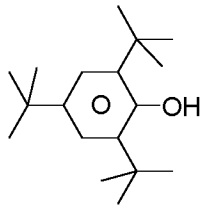
N-7



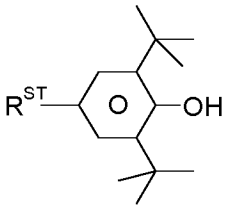
N-8

In a preferred embodiment of the present invention the liquid-crystalline

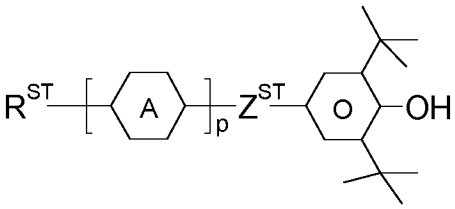
medium comprises one or more stabilisers, preferably selected from the group consisting of compounds of the formulae ST-1 to ST-18.



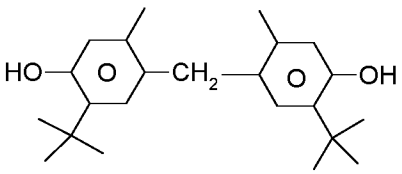
ST-1



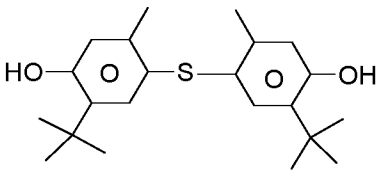
ST-2



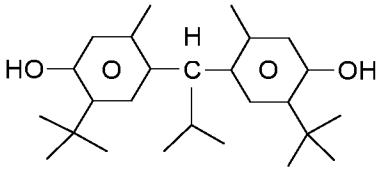
ST-3



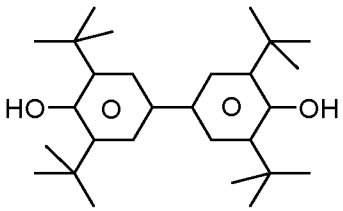
ST-4



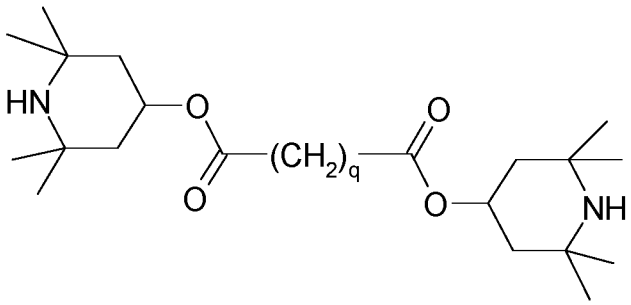
ST-5



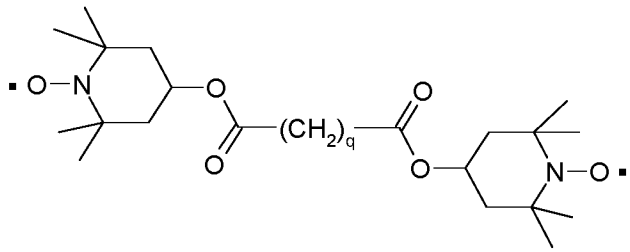
ST-6



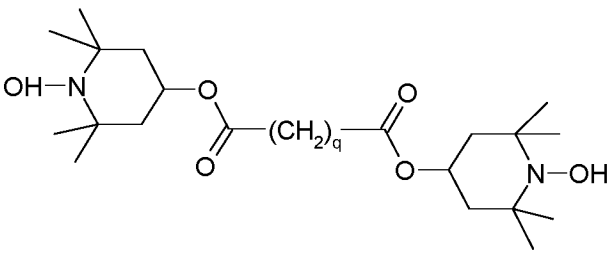
ST-7



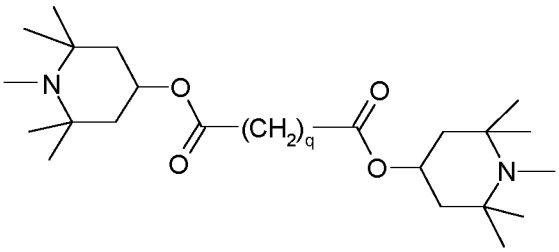
ST-8



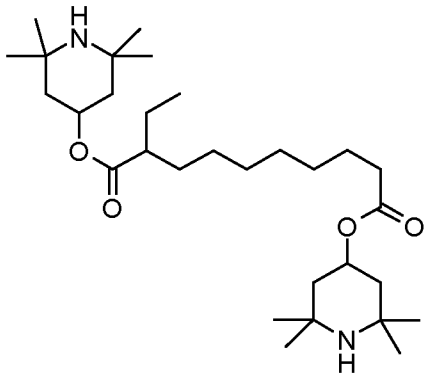
ST-9



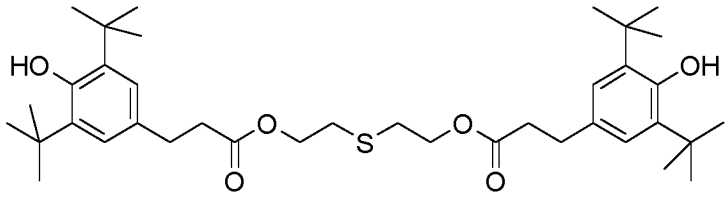
ST-10



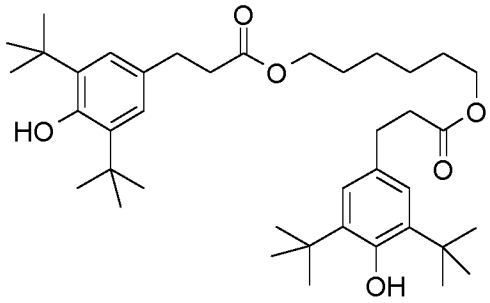
ST-11



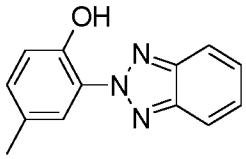
ST-12



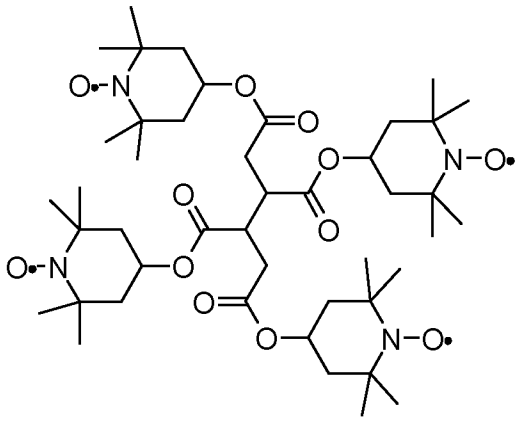
ST-13



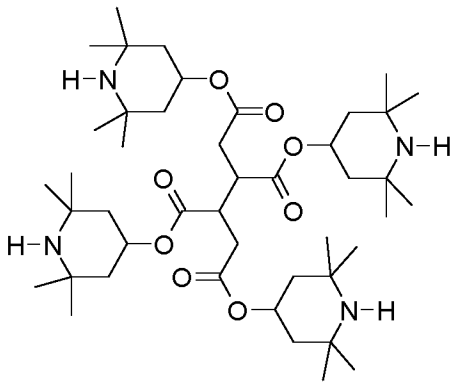
ST-14



ST-16



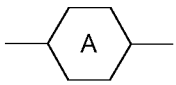
ST-17

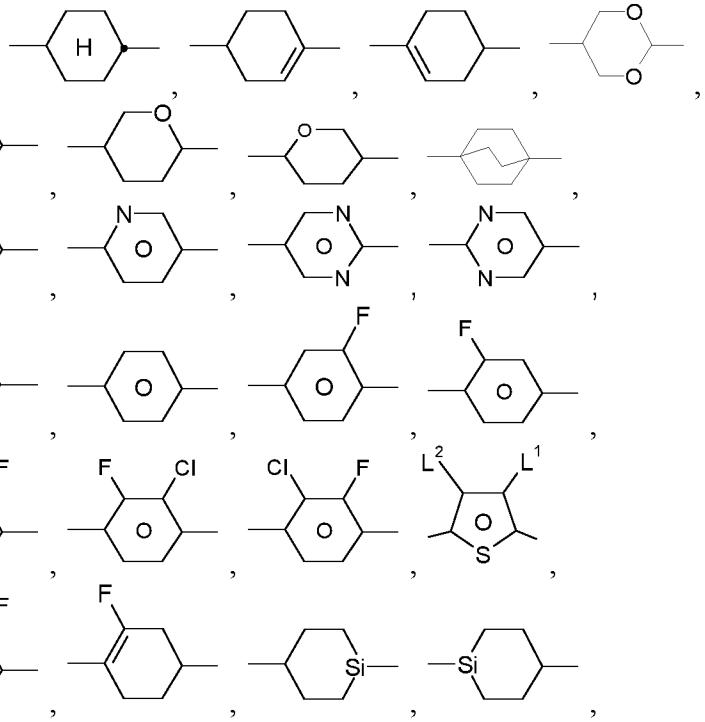


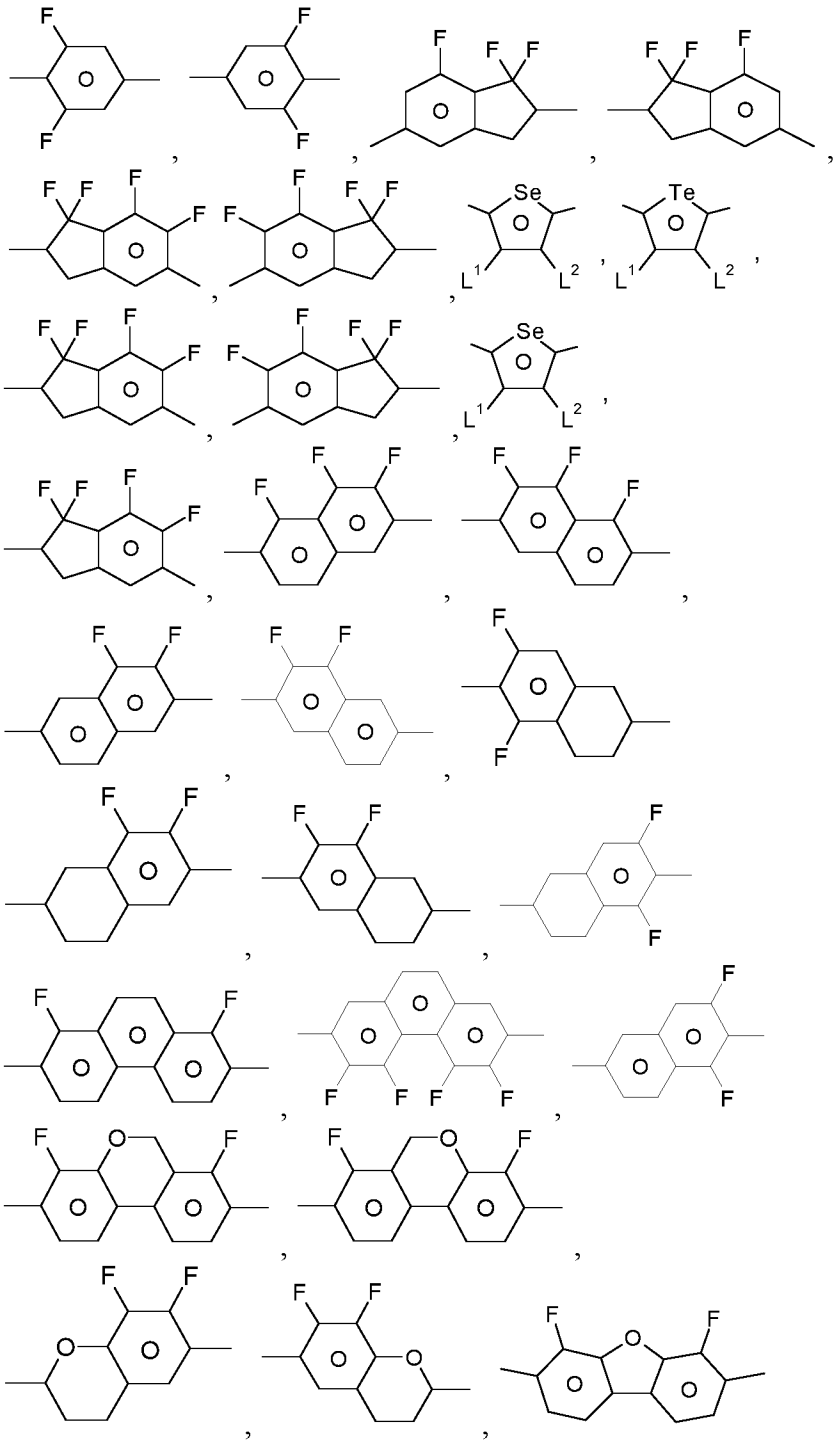
ST-18

in which

R^{ST} denotes H, an 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-, $-CF_2O-$, $-OCF_2-$, -CH=CH-,  ,  , -O-, -CO-O-, or -O-CO- in such a way that O atoms are not linked directly to one another, and in which, in addition, one or more H atoms may each be replaced by halogen,



denotes 



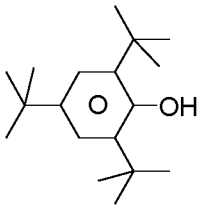
Z^{ST} each, independently of one another, denote -CO-O-, -O-CO-, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, $-CH_2-$, $-CH_2CH_2-$, $-(CH_2)_4-$, $-CH=CH-CH_2O-$, $-C_2F_4-$, $-CH_2CF_2-$, $-CF_2CH_2-$, -CF=CF-, -CH=CF-, -CF=CH-, -CH=CH-, -C≡C- or a single bond,

L^1 and L^2 each, independently of one another, denote F, Cl, CF_3 or CHF_2,

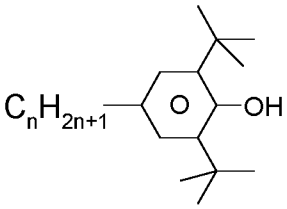
p denotes 1 or 2,

q denotes 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10.

Of the compounds of the formulae ST-1 to ST-17, special preference is given to the compounds of the formulae

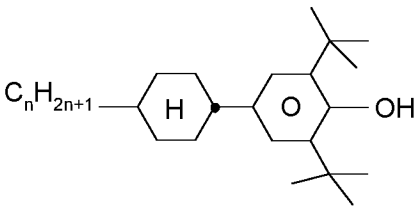


ST-1



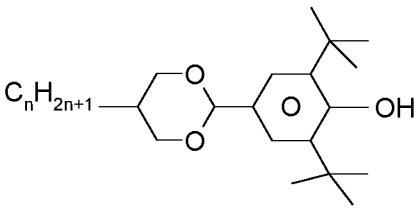
ST-2a

where n = 1, 2, 3, 4, 5, 6 or 7, preferably n = 1 or 7



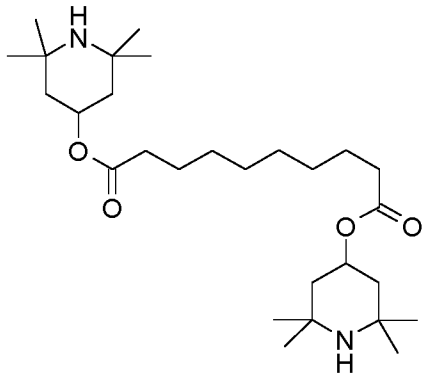
ST-3a

where n = 1, 2, 3, 4, 5, 6 or 7, preferably n = 3

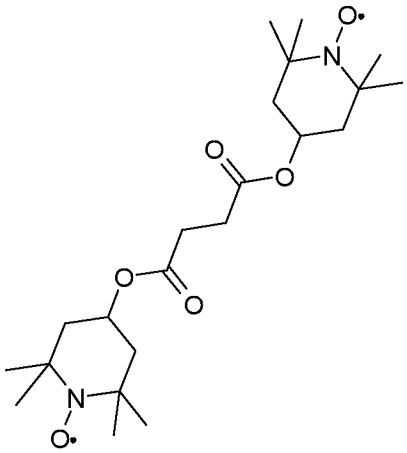


ST-3b

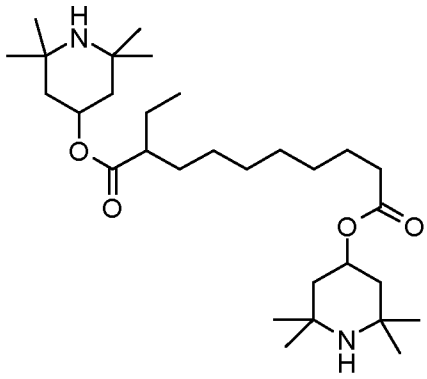
where n = 1, 2, 3, 4, 5, 6 or 7, preferably n = 3



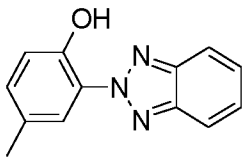
ST-8-1



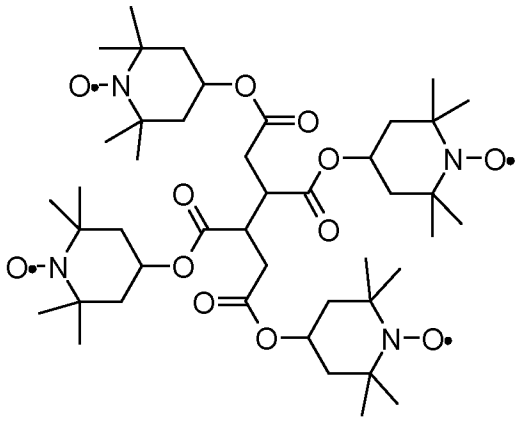
ST-9-1



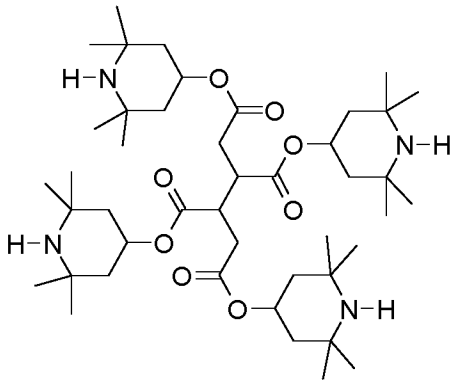
ST-12



ST-15



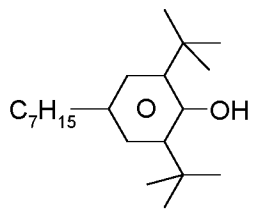
ST-16



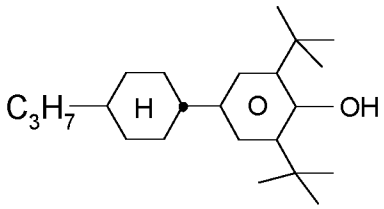
ST-17

In the compounds of the formulae ST-3a and ST-3b, n preferably denotes 3. In the compounds of the formula ST-2a, n preferably denotes 7.

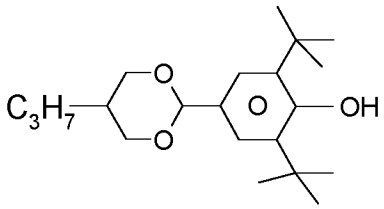
Very particularly preferred mixtures according to the invention comprise one or more stabilizers from the group of the compounds of the formulae ST-2a-1, ST-3a-1, ST-3b-1, ST-8-1, ST-9-1 and ST-12:



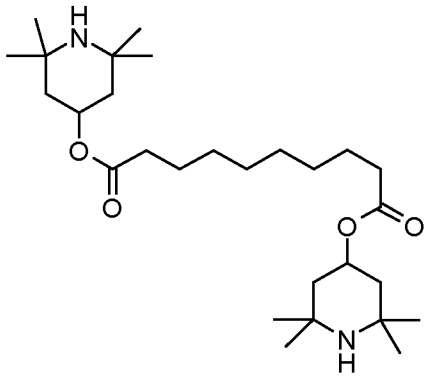
ST-2a-1



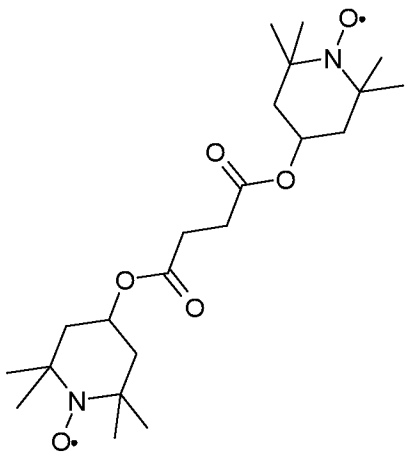
ST-3a-1



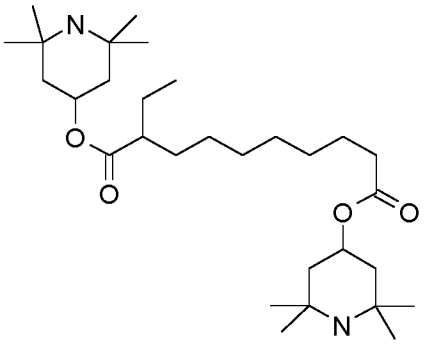
ST-3b-1



ST-8-1



ST-9-1



ST-12

The compounds of the formulae ST-1 to ST-18 are preferably each present in the liquid-crystal mixtures according to the invention in amounts of 0.005 – 0.5%, based on the mixture.

If the mixtures according to the invention comprise two or more compounds from the group of the compounds of the formulae ST-1 to ST-17, the concentration correspondingly increases to 0.01 – 1% in the case of two compounds, based on the mixtures.

However, the total proportion of the compounds of the formulae ST-1 to ST-17, based on the mixture according to the invention, should not exceed 2%.

In a preferred embodiment, the medium according to the invention comprises one or more chiral dopants and thus shows a cholesteric phase.

Preferably these chiral dopants have an absolute value of the helical twisting power (short: HTP) in the range of from 1 μm^{-1} to 150 μm^{-1}, preferably in the range of from 10 μm^{-1} to 100 μm^{-1}. In case the media comprise two or more chiral dopants, these may have opposite signs of their HTP-values. This condition is preferred for some specific embodiments, as it allows to compensate the chirality of the respective compounds to some degree and, thus, may be used to compensate various temperature dependent properties of the resulting media in the devices. Generally, however, it is preferred that most, preferably all of the chiral compounds present in the media according to the present invention have the same sign of their HTP-values.

Preferably the chiral dopants present in the media according to the instant

application are mesogenic compounds and most preferably they exhibit a mesophase on their own.

The temperature dependence of the HTP of the individual compounds may be high or low. The temperature dependence of the pitch of the medium can be compensated by mixing compounds having different temperature dependence of the HTP in corresponding ratios.

For the optically active component, a large variety of chiral dopants, some of which are commercially available, is available to the person skilled in the art, such as, for example, cholesteryl nonanoate, R- and S-811, R- and S-1011, R- and S-2011, R- and S-3011 R- and S-4011, B(OC)2C*H-C-3 or CB15 (all Merck KGaA, Darmstadt).

Particularly suitable dopants are compounds which contain one or more chiral groups and one or more mesogenic groups, or one or more aromatic or alicyclic groups which form a mesogenic group with the chiral group.

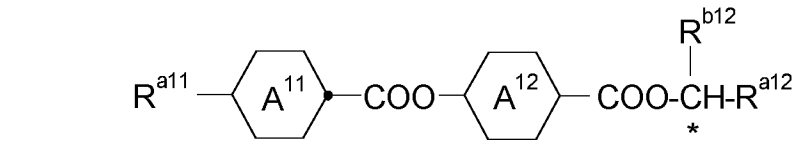
Suitable chiral groups are, for example, chiral branched hydrocarbon radicals, chiral ethanediols, binaphthols or dioxolanes, furthermore mono- or polyvalent chiral groups selected from the group consisting of sugar derivatives, sugar alcohols, sugar acids, lactic acids, chiral substituted glycols, steroid derivatives, terpene derivatives, amino acids or sequences of a few, preferably 1-5, amino acids.

Preferred chiral groups are sugar derivatives, such as glucose, mannose, galactose, fructose, arabinose and dextrose; sugar alcohols, such as, for example, sorbitol, mannitol, iditol, galactitol or anhydro derivatives thereof, in particular dianhydrohexitols, such as dianhydrosorbide (1,4:3,6-dianhydro-D-sorbide, isosorbide), dianhydromannitol (isosorbitol) or dianhydroiditol (isoiditol); sugar acids, such as, for example, gluconic acid, gulonic acid and ketogulonic acid; chiral substituted glycol radicals, such as, for example, mono- or oligoethylene or propylene glycols, in which one or more CH_2 groups are substituted by alkyl or alkoxy; amino acids, such as, for example, alanine, valine, phenylglycine or phenylalanine, or sequences of from 1 to 5 of these amino acids; steroid derivatives, such as, for

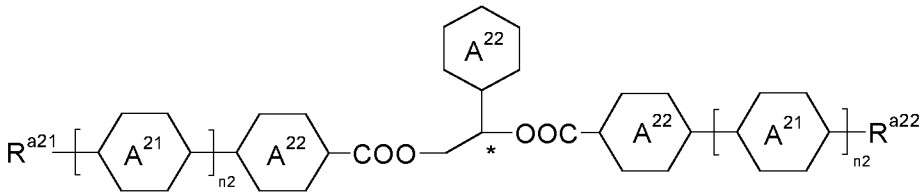
example, cholesteryl or cholic acid radicals; terpene derivatives, such as, for example, menthyl, neomenthyl, campheyl, pineyl, terpineyl, isolongifolyl, fenchyl, carreyl, myrthenyl, nopyl, geraniyl, linaloyl, neryl, citronellyl or dihydrocitronellyl.

Suitable chiral groups and mesogenic chiral compounds are described, for example, in DE 34 25 503, DE 35 34 777, DE 35 34 778, DE 35 34 779 and DE 35 34 780, DE 43 42 280, EP 01 038 941 and DE 195 41 820. Examples are also compounds listed in Table B below.

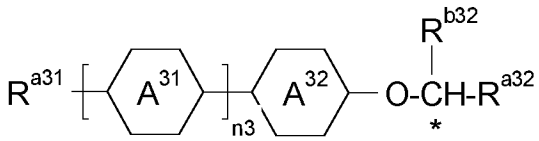
Particular preference is given to chiral dopants selected from the group consisting of compounds of the following formulae A-I to A-III and A-Ch:



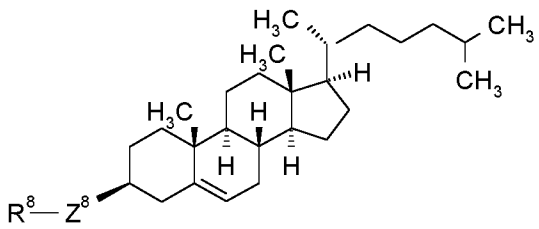
A-I



A-II



A-III



A-Ch

in which

R^{a11} ,R^{a12} and R^{b12}, independently of one another, denote alkyl having 1 to 15 C atoms, in which, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by -C(R^z)=C(R^z)-, -C≡C-, -O-, -S-, -CO-, -CO-O-, -O-CO- or -O-CO-O- in such a way that O and/or S atoms are not linked directly to one another, and in which, in addition, one or more H atoms may each be replaced by F, Cl, Br, I or CN,
preferably alkyl, more preferably n-alkyl,
with the proviso that R^{a12} is different from R^{b12},

R^{a21} and R^{a22}, independently of one another, denote alkyl having 1 to 15 C atoms, in which, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by -C(R^z)=C(R^z)-, -C≡C-, -O-, -S-, -CO-, -CO-O-, -O-CO- or -O-CO-O- in such a way that O and/or S atoms are not linked directly to one another, and in which, in addition, one or more H atoms may each be replaced by F, Cl, Br, I or CN,
preferably both are alkyl, more preferably n-alkyl,

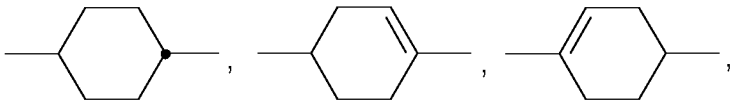
R^{a31}, R^{a32} and R^{b32}, independently of one another, denote straight-chain or branched alkyl having 1 to 15 C atoms, in which, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by -C(R^z)=C(R^z)-, -C≡C-, -O-, -S-, -CO-, -CO-O-, -O-CO- or -O-CO-O- in such a way that O and/or S atoms are not linked directly to one another, and in which, in addition, one or more H atoms may each be replaced by F, Cl, Br, I or CN,
preferably alkyl, more preferably n-alkyl,
with the proviso that R^{a32} is different from R^{b32};

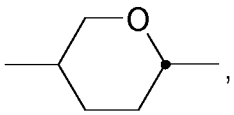
R^z denotes H, CH_3, F, Cl, or CN, preferably H or F,

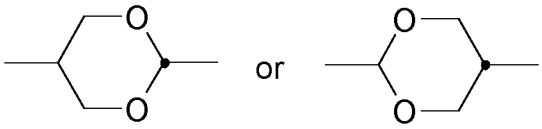
R^8 has one of the meanings of R^{a11} given above, preferably alkyl, more preferably n-alkyl having 1 to 15 C atoms,

Z^8 denotes- C(O)O-, CH_2O, CF_2O or a single bond, preferably -C(O)O-,

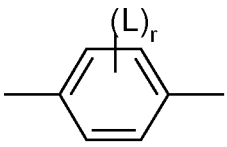
A^{11} is defined as A^{12} below, or alternatively denotes



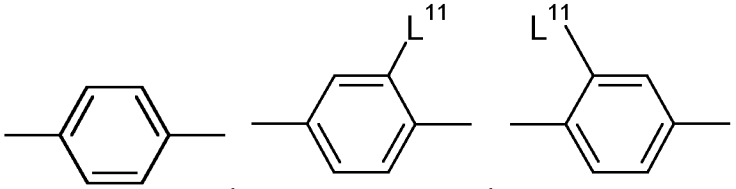


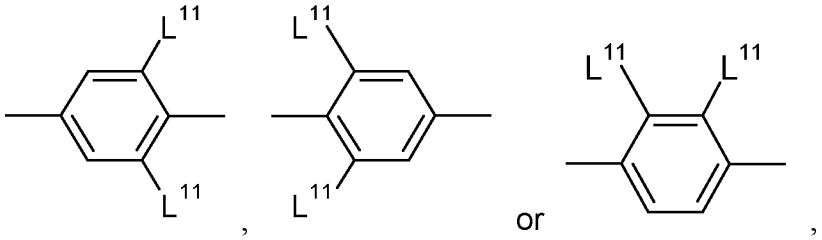


A^{12} denotes



preferably





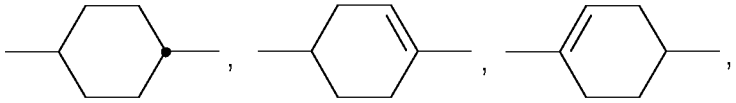
in which

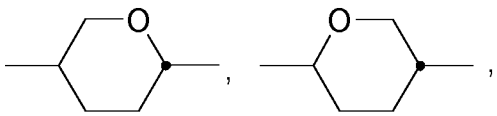
r is 0, 1, 2, 3 or 4,

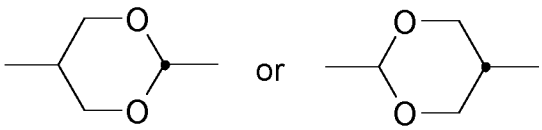
L and L^{11}, on each occurrence, independently of one another, denote alkyl, alkenyl or alkoxy having up to 12 C

atoms, in which one or more H atoms are optionally replaced with halogen, halogen, SF_5 or CN, preferably Me (methyl), Et (ethyl), Cl or F, particularly preferably F.

A^{21} denotes



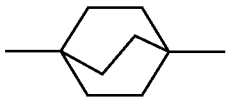




,

A^{22} has the meanings given for A^{12}

A^{31} has the meanings given for A^{11}, or alternatively denotes

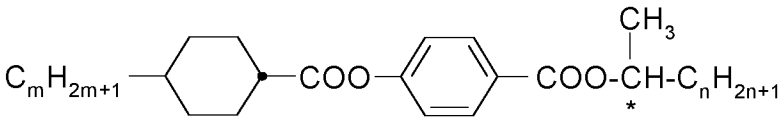


A^{32} has the meanings given for A^{12},

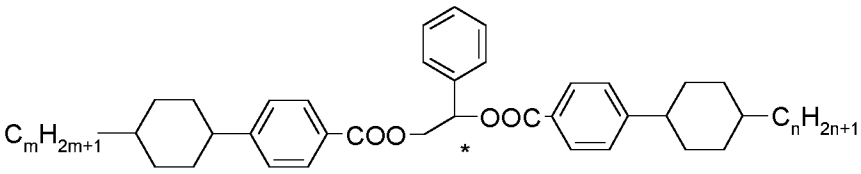
n2 on each occurrence, identically or differently, is 0, 1 or 2, and

n3 is 1, 2 or 3.

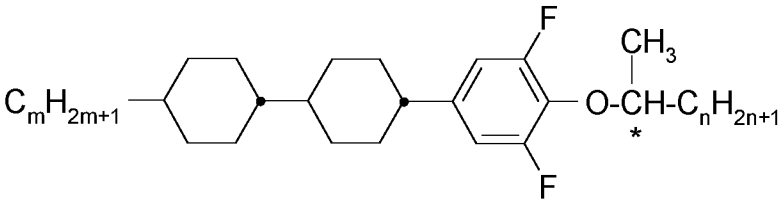
Particular preference is given to dopants selected from the group consisting of the compounds of the following formulae:



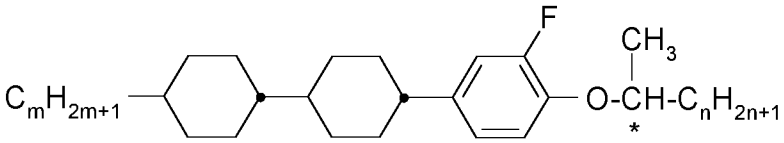
A-I-1



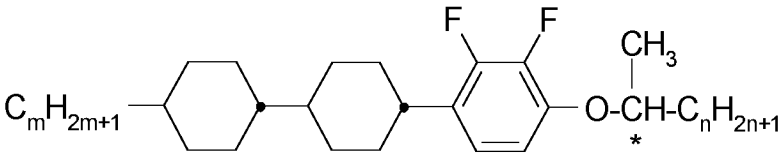
A-II-1



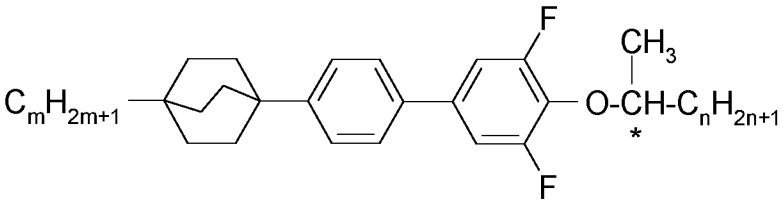
A-III-1



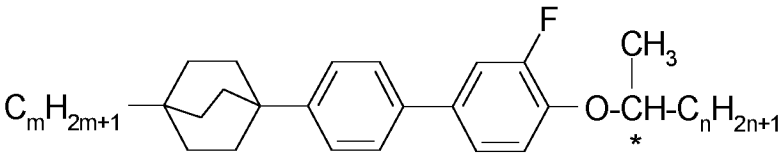
A-III-2



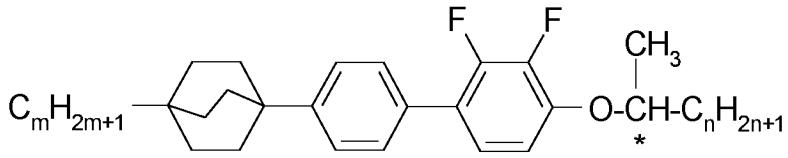
A-III-3



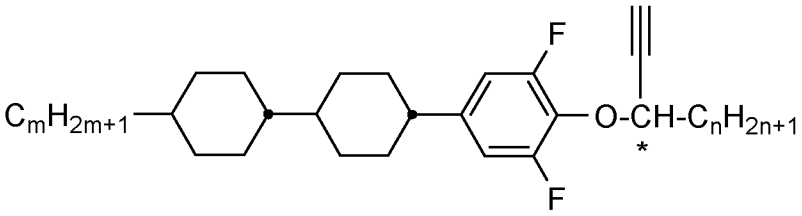
A-III-4



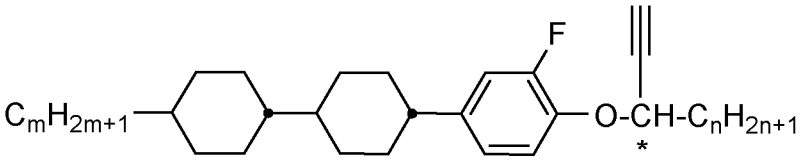
A-III-5



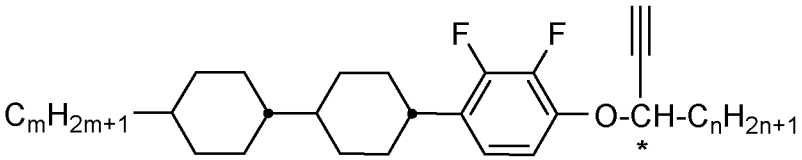
A-III-6



A-III-7



A-III-8



A-III-9

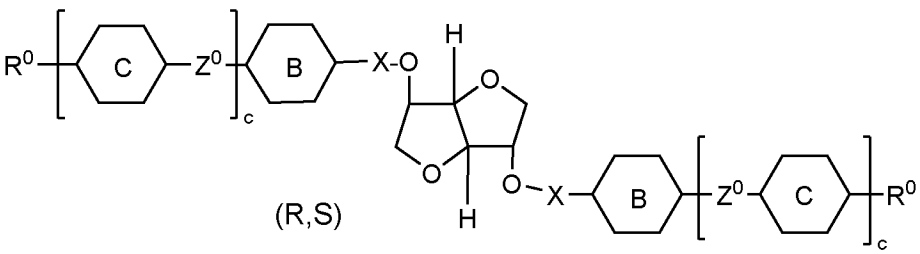
in which

m is, on each occurrence, identically or differently, an integer from 1 to 9 and

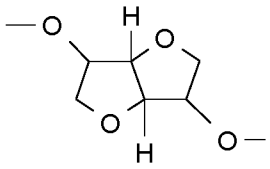
n is, on each occurrence, identically or differently, an integer from 2 to 9.

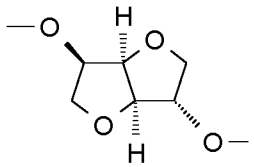
Particularly preferred compounds of formula A are compounds of formula A-III.

Further preferred dopants are derivatives of the isosorbide, isomannitol or isoiditol of the following formula A-IV:

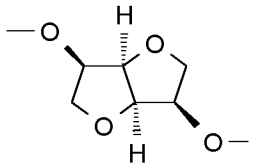


A-IV

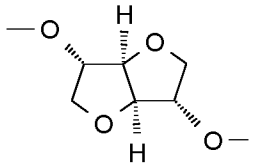
in which the group  is



(dianhydrosorbitol),



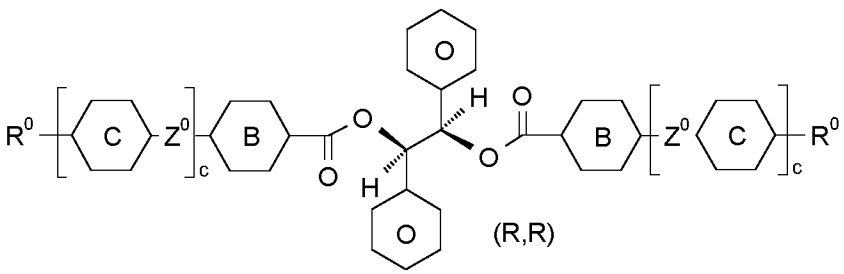
(dianhydromannitol), or



(dianhydroiditol),

preferably dianhydrosorbitol.

Further preferred dopants are chiral ethanediols, such as, for example, diphenylethanediol (hydrobenzoin), in particular mesogenic hydrobenzoin derivatives of the following formula A-V:



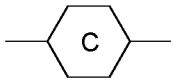
A-V

(R,R)

including the (R,S), (S,R), (R,R) and (S,S) enantiomers, which are not shown,

in which

and



are each, independently of one another, 1,4-phenylene, which may also be mono-, di- or trisubstituted by L, or 1,4-cyclohexylene,

L is H, F, Cl, CN or optionally halogenated alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl or alkoxycarbonyloxy having 1-7 carbon atoms,

c is 0 or 1,

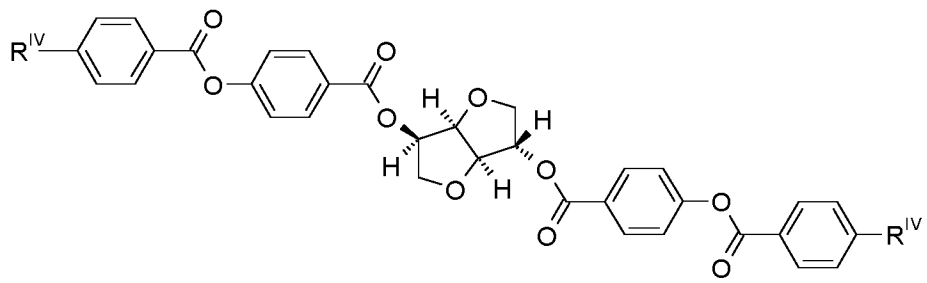
X is CH_2 or -C(O)-,

Z^0 is -COO-, -OCO-, $-CH_2CH_2-$ or a single bond, and

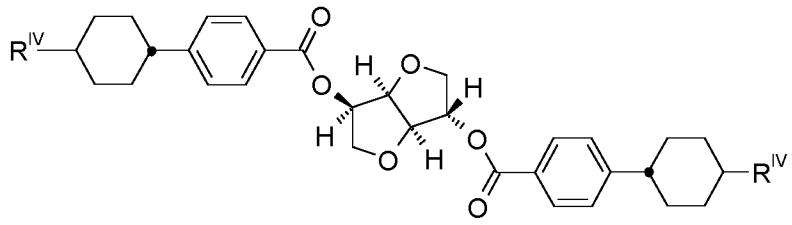
R^0 is alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl or alkylcarbonyl-oxy having 1-12 carbon atoms.

Chiral compounds preferably used according to the present invention are selected from the group consisting of the formulae shown below.

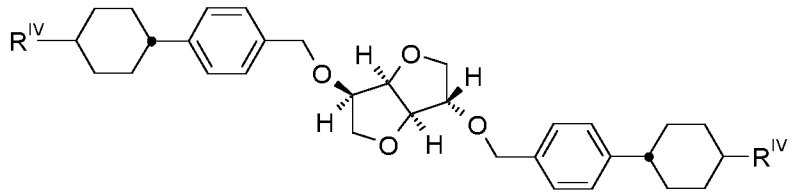
Examples of compounds of formula A-IV are:



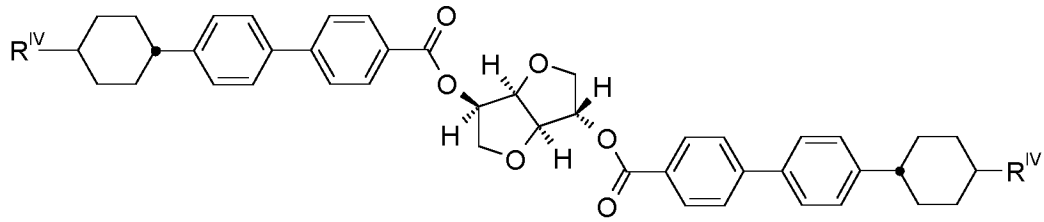
A-IV-1



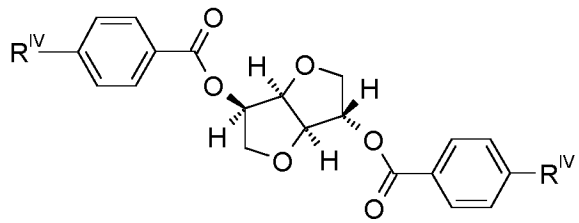
A-IV-2



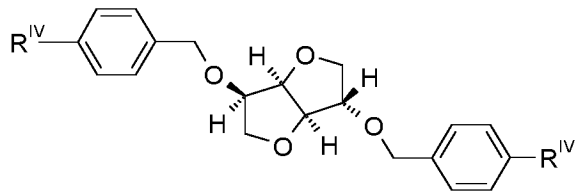
A-IV-3



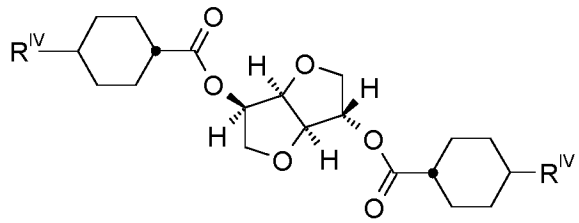
A-IV-4



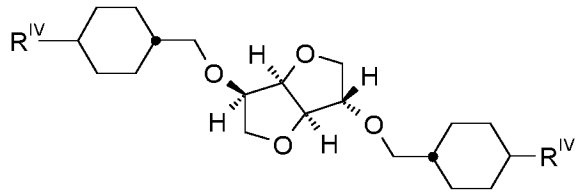
A-IV-5



A-IV-6



A-IV-7

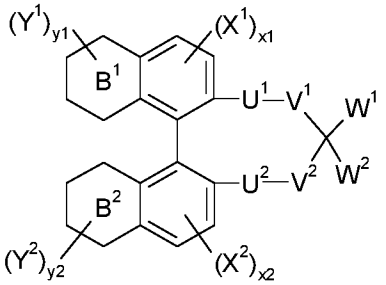


A-IV-8

The compounds of the formula A-V are described in GB-A-2,328,207.

Very particularly preferred dopants are chiral binaphthyl derivatives, as described in WO 02/94805, chiral binaphthol acetal derivatives, as described in WO 02/34739, chiral TADDOL derivatives, as described in WO 02/06265, and chiral dopants having at least one fluorinated bridging group and a terminal or central chiral group, as described in WO 02/06196 and WO 02/06195.

Particular preference is given to chiral compounds of the formula A-VI



A-VI

in which

X^1, X^2, Y^1 and Y^2 are each, independently of one another, F, Cl, Br, I, CN, SCN, SF_5, straight-chain or branched alkyl having from 1 to 25 carbon atoms, which is unsubstituted or monosubstituted or polysubstituted by F, Cl, Br, I or CN and in which, in addition, one or more non-adjacent CH_2 groups may each, independently of one another, be replaced by -O-, -S-, -NH-, NR^0-, -CO-, -COO-, -OCO-, -OCOO-, -S-CO-, -CO-S-, -CH=CH- or -C≡C- in such a way that O and/or S atoms are not bonded directly to one another, a polymerizable group or cycloalkyl or aryl having up to 20 carbon atoms, which may optionally be monosubstituted or

polysubstituted by halogen, preferably F, or by a polymerizable group,

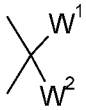
R^0 is H or alkyl having 1 to 12 C atoms,

x^1 and x^2 are each, independently of one another, 0, 1 or 2,

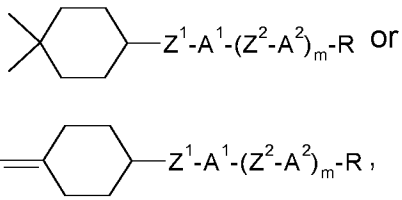
y^1 and y^2 are each, independently of one another, 0, 1, 2, 3 or 4,

B^1 and B^2 are each, independently of one another, an aromatic or partially or fully saturated aliphatic six-membered ring in which one or more CH groups may each be replaced by N and one or more non-adjacent CH_2 groups may each be replaced by O or S,

W^1 and W^2 are each, independently of one another, $-Z^1-A^1-(Z^2-A^2)_m-R$, and one of the two is alternatively R^1 or A^3, but both are not simultaneously H, or

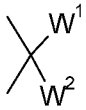


is

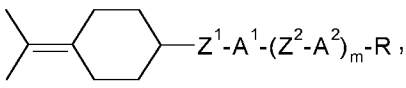


U^1 and U^2 are each, independently of one another, CH_2, O, S, CO or CS,

V^1 and V^2 are each, independently of one another, $(CH_2)_n$, in which from one to four non-adjacent CH_2 groups may each be replaced by O or S, and one of V^1 and V^2 and, in the case where



is



, both are a single bond,

n is 1, 2 or 3,

Z^1 and Z^2 are each, independently of one another, -O-, -S-, -CO-, -COO-, -OCO-, -O-COO-, $-CO-NR^0-$, $-NR^0-CO-$, $-O-CH_2-$, $-CH_2-O-$, -S-

CH_2-, -CH_2-S-, -CF_2-O-, -O-CF_2-, -CF_2-S-, -S-CF_2-, -CH_2-CH_2-, -CF_2-CH_2-, -CH_2-CF_2-, -CF_2-CF_2-, -CH=N-, -N=CH-, -N=N-, -CH=CH-, -CF=CH-, -CH=CF-, -CF=CF-, -C≡C-, a combination of two of these groups, where no two O and/or S and/or N atoms are bonded directly to one another (preferably -CH=CH-COO-, or -COO-CH=CH-), or a single bond,

A^1, A^2 and A^3 are each, independently of one another, 1,4-phenylene, in which one or two non-adjacent CH groups may each be replaced by N, 1,4-cyclohexylene, in which one or two non-adjacent CH_2 groups may each be replaced by O or S, 1,3-dioxolane-4,5-diyl, 1,4-cyclohexenylene, 1,4-bicyclo[2.2.2]octylene, piperidine-1,4-diyl, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl or 1,2,3,4-tetrahydro-naphthalene-2,6-diyl, where each of these groups is unsubstituted or monosubstituted or polysubstituted by L, and in addition A^1 can be a single bond,

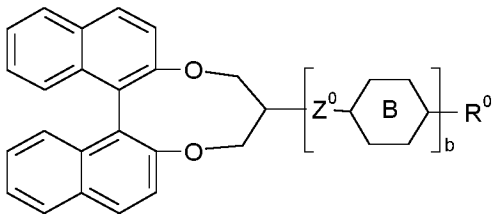
L is a halogen atom, preferably F, CN, NO_2, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl or alkoxycarbonyloxy having 1-7 carbon atoms, in which one or more H atoms may each be replaced by F or Cl,

m is in each case, independently, 0, 1, 2 or 3, and

R and R^1 are each, independently of one another, H, F, Cl, Br, I, CN, SCN, SF_5, straight-chain or branched alkyl having from 1 or 3 to 25 carbon atoms respectively, which may optionally be mono-substituted or polysubstituted by F, Cl, Br, I or CN, and in which one or more non-adjacent CH_2 groups may each be replaced by -O-, -S-, -NH-, -NR^0-, -CO-, -COO-, -OCO-, -O-COO-, -S-CO-, -CO-S-, -CH=CH- or -C≡C-, where no two O and/or S atoms are bonded directly to one another, or a polymerizable group.

Particular preference is given to chiral binaphthyl derivatives of the formula

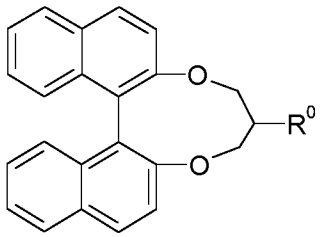
A-VI-1



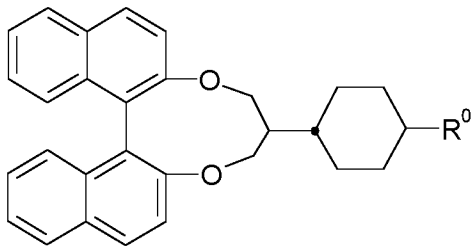
A-VI-1

in which ring B, R^0 and Z^0 are as defined for the formulae A-IV and A-V, and b is 0, 1, or 2,

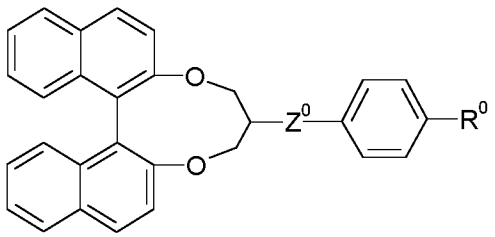
in particular those selected from the following formulae A-VI-1a to A-VI-1c:



A-VI-1a



A-VI-1b



A-VI-1c

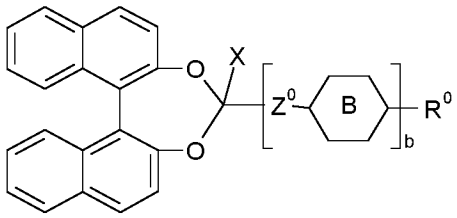
in which ring B, R^0 and Z^0 are as defined for the formula A-VI-1, and

R^0 as defined for formula A-IV or H or alkyl having from 1 to 4 carbon atoms, and

b is 0, 1 or 2,

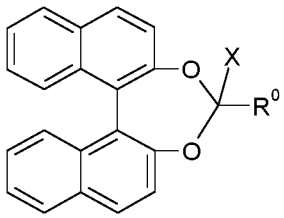
and Z^0 is, in particular, -OCO- or a single bond.

Particular p reference is furthermore given to chiral binaphthyl derivatives of the formula A-VI-2

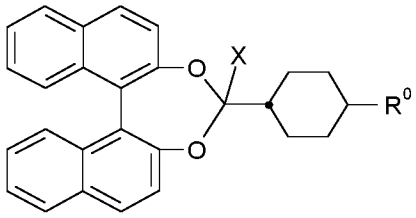


A-VI-2

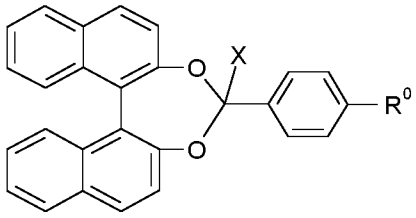
in particular those selected from the following formulae A-VI-2a to A-VI-2f:



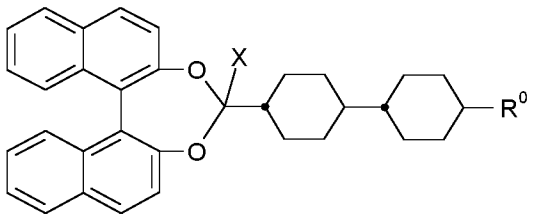
A-VI-2a



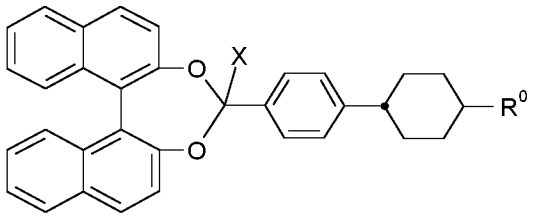
A-VI-2b



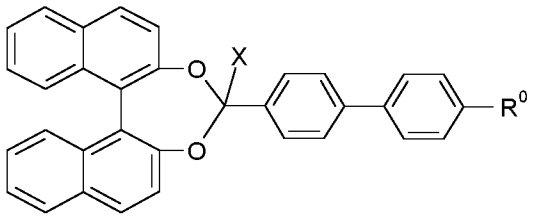
A-VI-2c



A-VI-2d



A-VI-2e



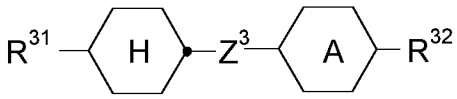
A-VI-2f

in which R^0 is as defined for the formula A-VI, and X is H, F, Cl, CN or R^0, preferably F.

The concentration of the one or more chiral dopant(s), in the LC medium is preferably in the range from 0.001 % to 20 %, preferably from 0.05 % to 5 %, more preferably from 0.1 % to 2 %, and, most preferably from 0.5 % to 1.5 %. These preferred concentration ranges apply in particular to the chiral dopant S-4011 or R-4011 (both from Merck KGaA) and for chiral dopants having the same or a similar HTP. For chiral dopants having either a higher or a lower absolute value of the HTP compared to S-4011, these preferred concentrations have to be decreased, respectively increased, proportionally according to the ratio of their HTP values relatively to that of S-4011.

Preferred embodiments of the liquid-crystalline medium according to the invention are indicated below:

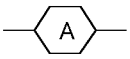
a) Liquid-crystalline medium which additionally comprises one or more compounds of the formula III,

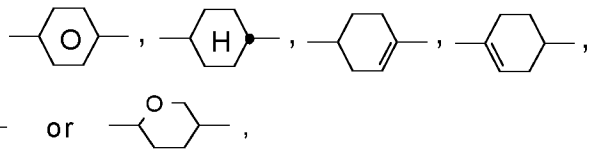


III

in which

R^{31} and R^{32} each, independently of one another, denote a straight-chain alkyl, alkenyl, alkoxyalkyl or alkoxy radical having up to 12 C atoms, and

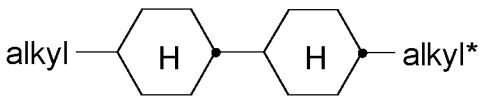


denotes 

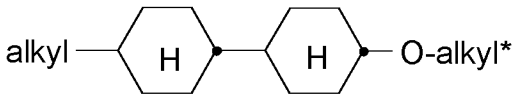
or ,

Z^3 denotes a single bond, $-CH_2CH_2-$, $-CH=CH-$, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, $-COO-$, $-OCO-$, $-C_2F_4-$, $-C_4H_8-$, $-CF=CF-$.

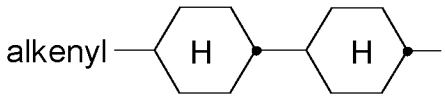
Preferred compounds of formula III are selected from the group of compounds of the following sub-formulae:



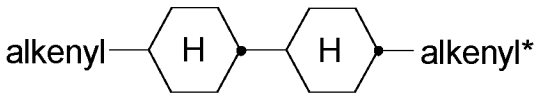
III-1



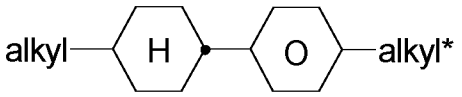
III-2



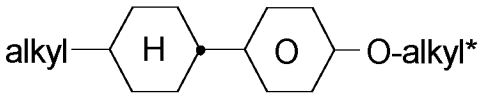
III-3



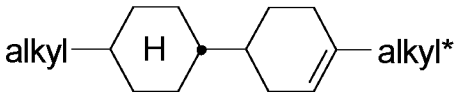
III-4



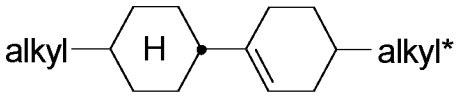
III-5



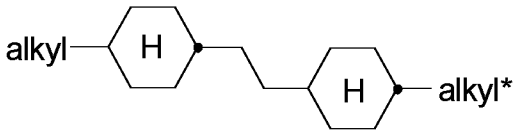
III-6



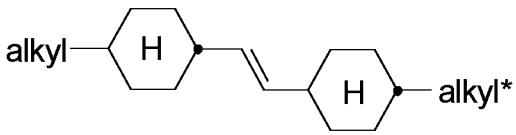
III-7



III-8



III-9



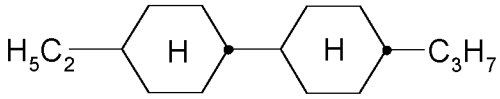
III-10

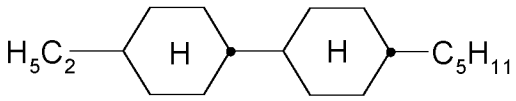
in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl preferably denotes CH_2=CH-, CH_2=CHCH_2CH_2-, CH_3-CH=CH-, CH_3-CH_2-CH=CH-, CH_3-$(CH_2)_2$-CH=CH-,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

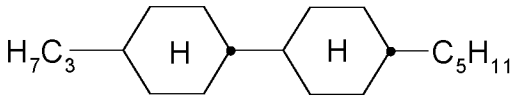
Especially preferred are compounds of formula III-1 and III-3.

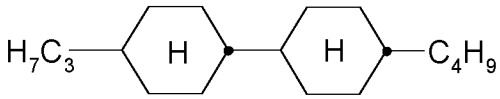
The proportion of compounds of the formula III in the mixture as a whole is preferably at least 5% by weight.

Particularly preferred compounds of the formula III-1 are the following:

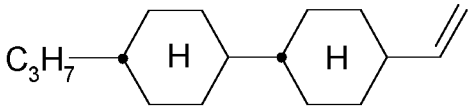

III-1a

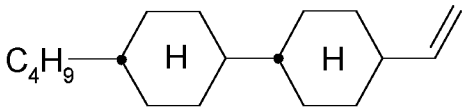

III-1b

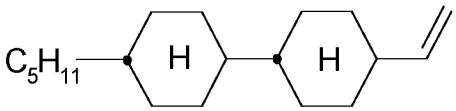

III-1c

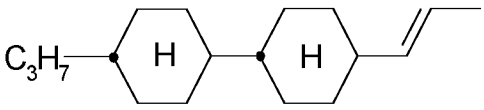

III-1d

Particularly preferred compounds of the formula III-3 are the following:

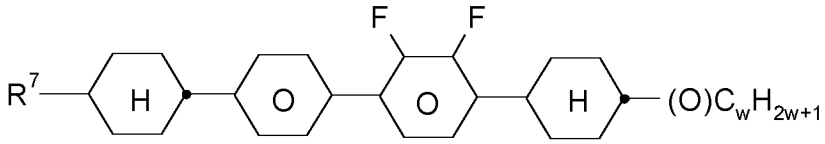

III-3a


III-3b

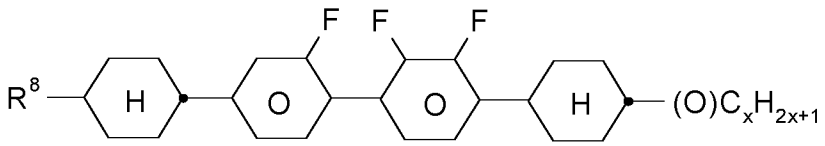

III-3c


III-3d

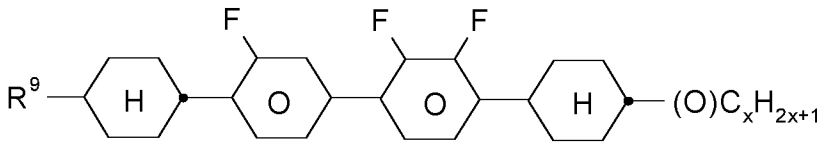
b) Liquid-crystalline medium which additionally comprises one or more tetracyclic compounds of the formulae



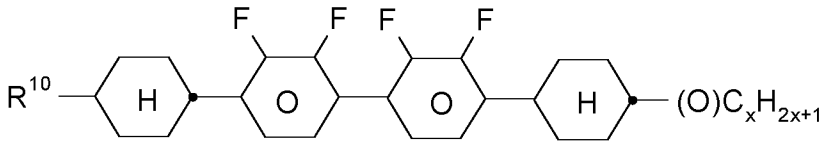
V-1



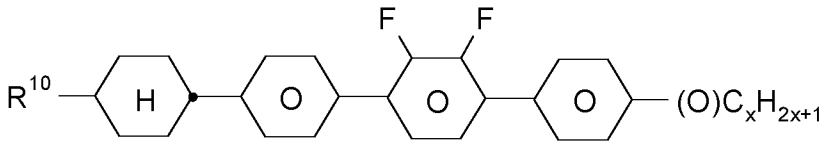
V-2



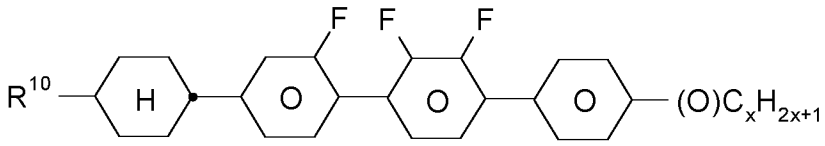
V-3



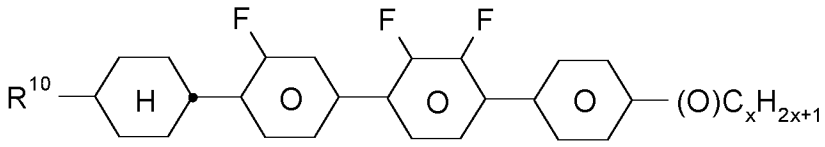
V-4



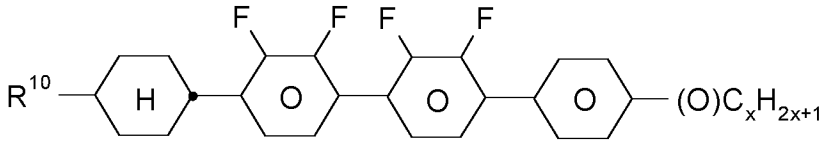
V-5



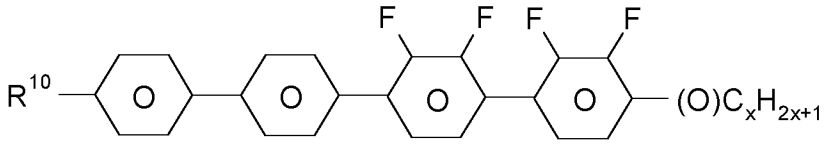
V-6



V-7



V-8



V-9

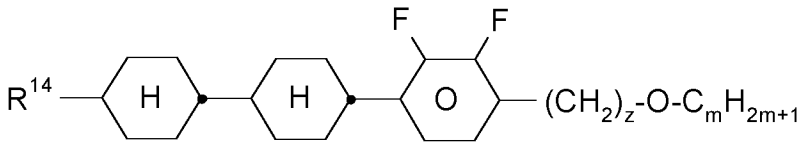
in which

R^{7-10} each, independently of one another, have one of the meanings indicated for R^{2A} of formula IIA, and

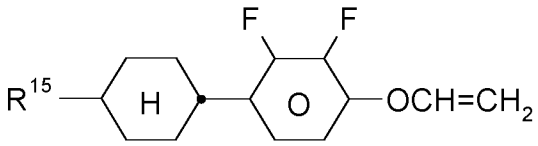
w and x each, independently of one another, denote 1 to 6.

Particular preference is given to mixtures comprising at least one compound of the formula V-9.

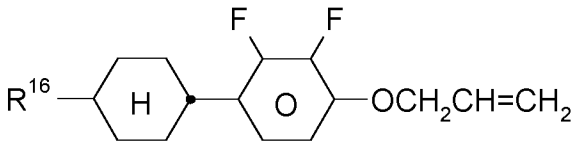
c) Liquid-crystalline medium which additionally comprises one or more compounds of the formulae Y-1 to Y-6,



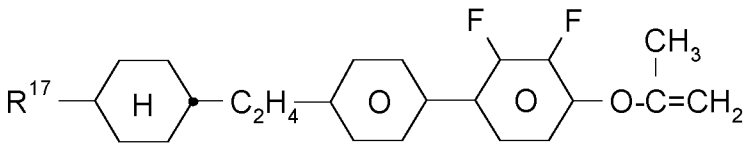
Y-1



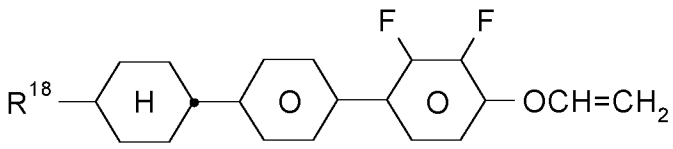
Y-2



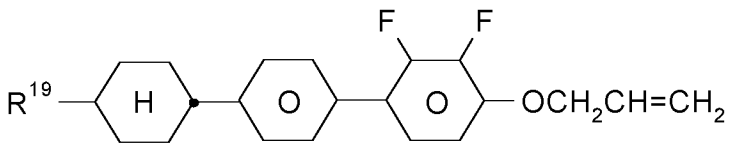
Y-3



Y-4



Y-5

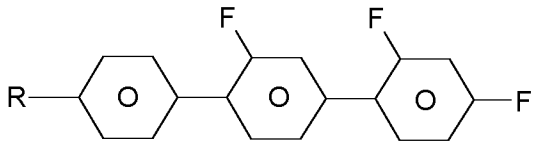


Y-6

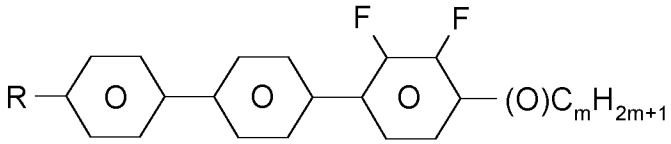
in which R^{14}-R^{19} each, independently of one another, denote an alkyl or alkoxy radical having 1-6 C atoms; z and m each, independently of one another, denote 1-6; x denotes 0, 1, 2 or 3.

The medium according to the invention particularly preferably comprises one or more compounds of the formulae Y-1 to Y-6, preferably in amounts of ≥ 5% by weight.

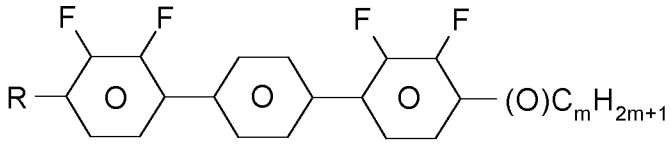
d) Liquid-crystalline medium additionally comprising one or more fluorinated terphenyls of the formulae T-1 to T-21,



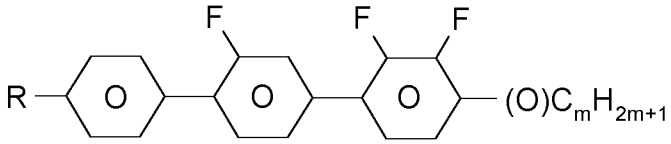
T-1



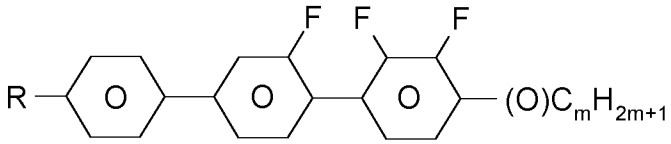
T-2



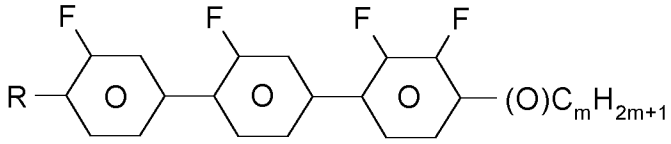
T-3



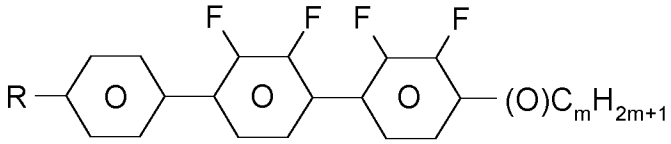
T-4



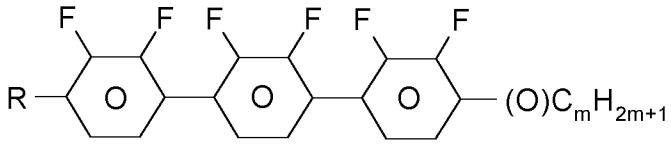
T-5



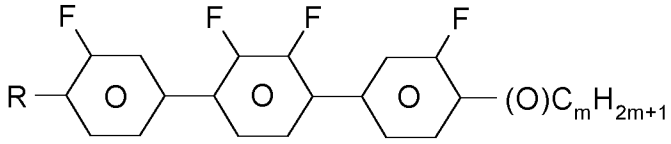
T-6



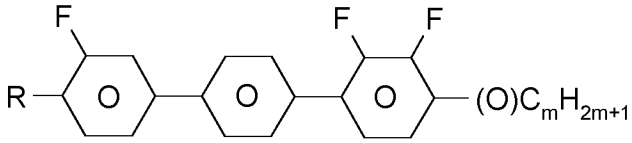
T-7



T-8



T-9



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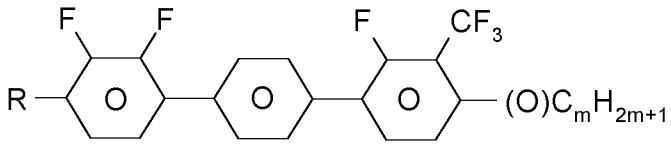
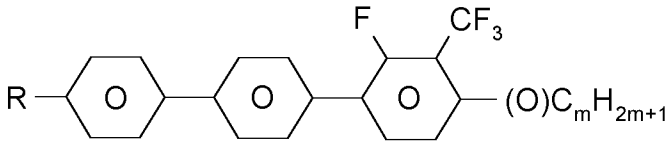
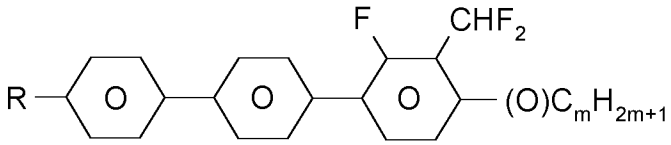


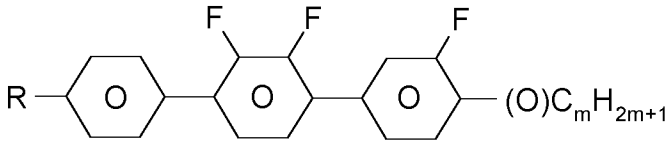
T-11



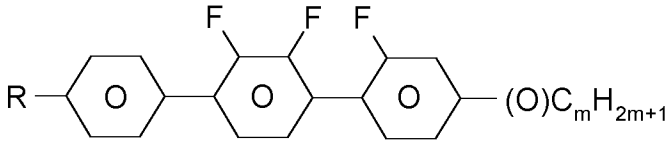
T-12



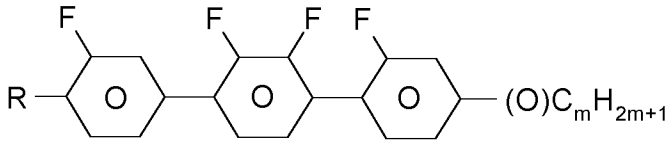
T-13

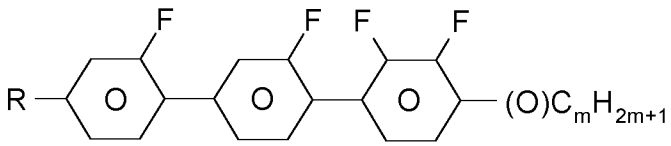


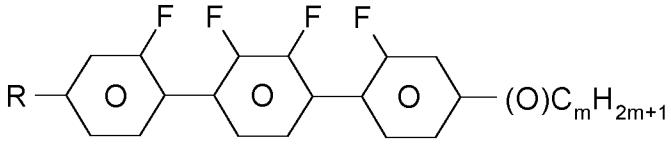
T-14

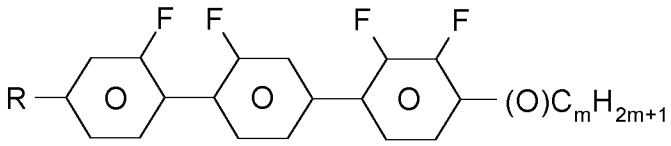


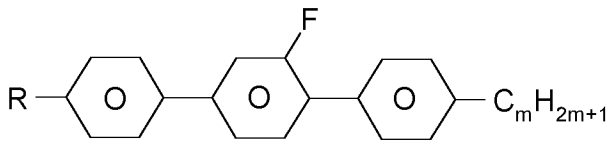
T-15

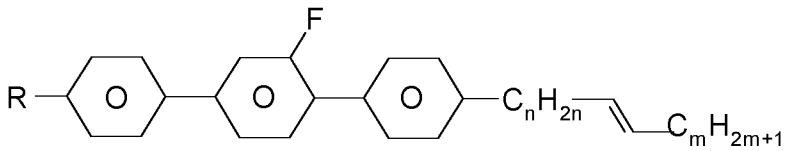

T-16


T-17


T-18


T-19


T-20


T-21

in which

R denotes a straight-chain alkyl or alkoxy radical having 1-7 C atoms or alkenyl having 2-7 C atoms,
and m = 0, 1, 2, 3, 4, 5 or 6 and n denotes 0, 1, 2, 3 or 4.

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

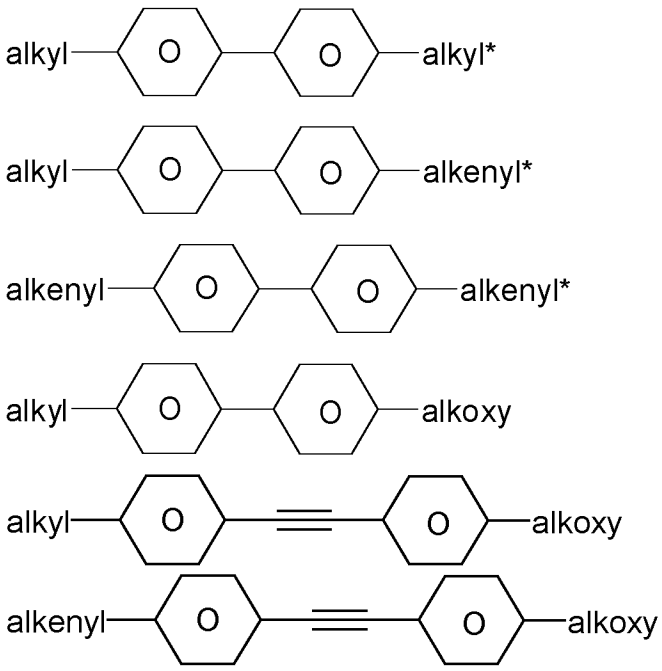
The medium according to the invention preferably comprises the terphenyls of the formulae T-1 to T-21 in amounts of 2-30% by weight, in particular 5-20% by weight.

Particular preference is given to compounds of the formulae T-1, T-2, T-20 and T-21, very particularly T-1. In these compounds, R preferably denotes alkyl, furthermore alkoxy, each having 1-5 C atoms. In the compounds of the formula T-20, R preferably denotes alkyl or alkenyl, in particular alkyl. In the compound of the formula T-21, R preferably denotes alkyl.

The terphenyls are preferably employed in the 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 selected from the group of the compounds T-1 to T-21.

Preferably, the medium according to the invention comprises one or more compounds of formula T-1 in a total concentration in the range of from 3% to 15%, more preferably from 5% to 10%.

e) Liquid-crystalline medium additionally comprising one or more biphenyls of the formulae B-1 to B-6,



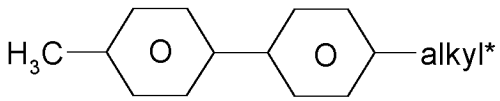
in which

alkyl and alkyl*	each, independently of one another, denote a straight-chain alkyl 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
alkoxy	denotes a straight-chain alkoxy radical having 1-6 C atoms.

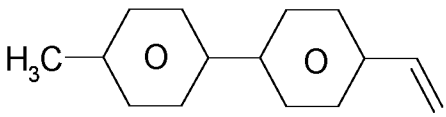
The proportion of the biphenyls of the formulae B-1 to B-6, preferably B-5, in the mixture as a whole is preferably at least 3% by weight, in particular ≥ 5% by weight, preferably in the range of from 7% to 15%.

Of the compounds of the formulae B-1 to B-4, the compounds of the formula B-2 are particularly preferred.

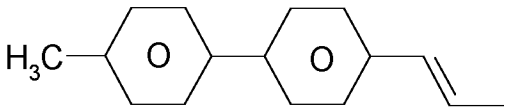
Very particularly preferred biphenyls are



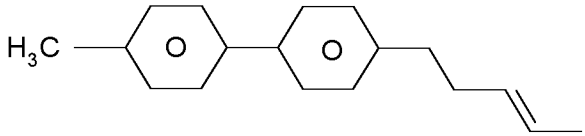
B-1a



B-2a



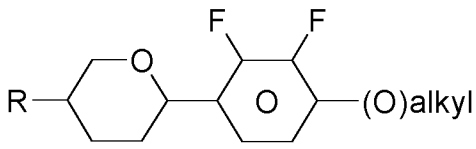
B-2b



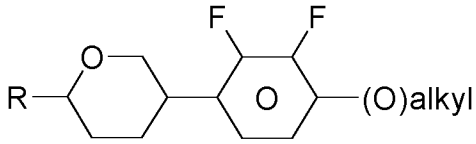
B-2c,

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 B-1a and/or B-2c.

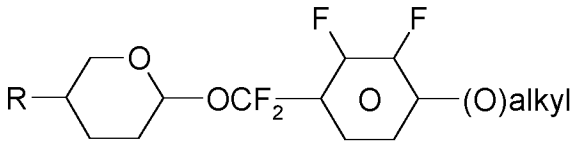
f) Liquid-crystalline medium comprising at least one compound of the formulae Z-1 to Z-7,



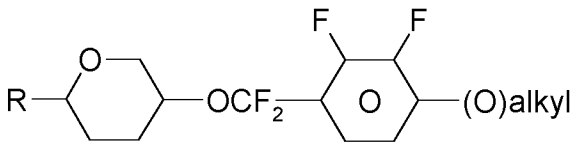
Z-1



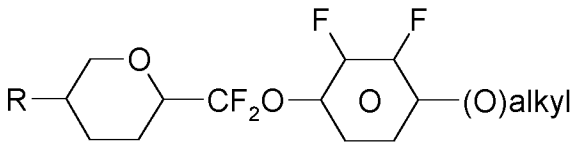
Z-2



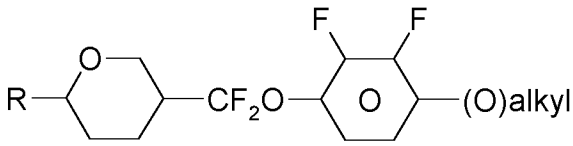
Z-3



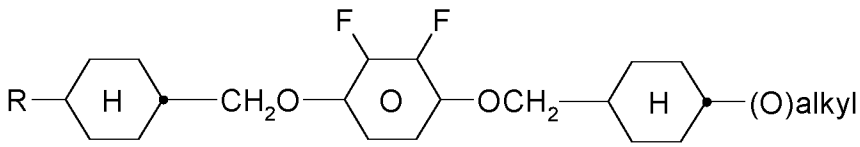
Z-4



Z-5



Z-6

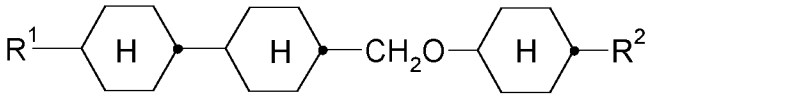


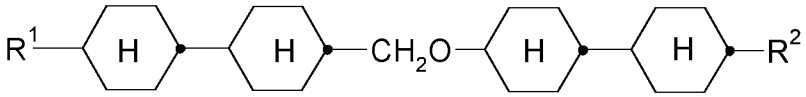
Z-7

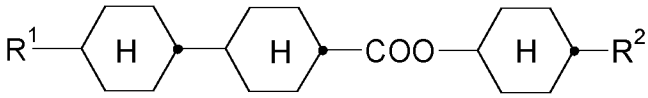
in which

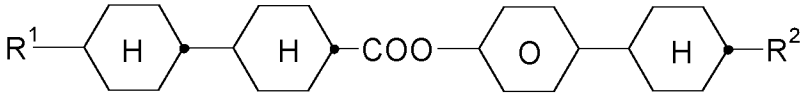
R		denotes a straight-chain alkyl or alkoxy radical having 1-7 C atoms or an alkenyl radical having 2-7 C atoms,
alkyl		denotes an alkyl radical having 1-6 C atoms, and
(O)alkyl		denotes alkyl or Oalkyl (alkoxy).

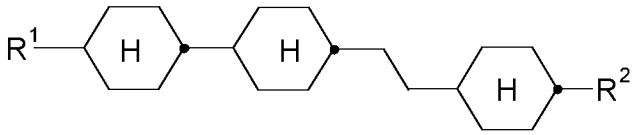
g) Liquid-crystalline medium comprising at least one compound of the formulae O-1 to O-16,

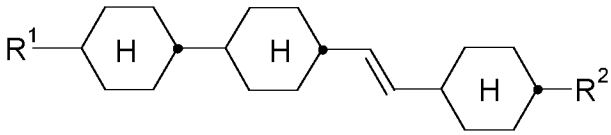

O-1

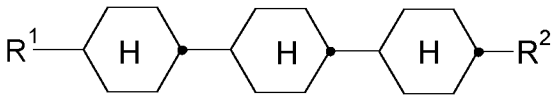

O-2

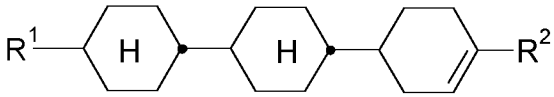

O-3

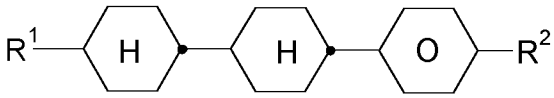

O-4

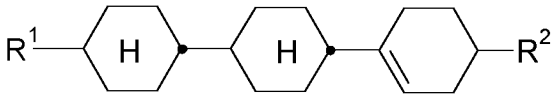

O-5

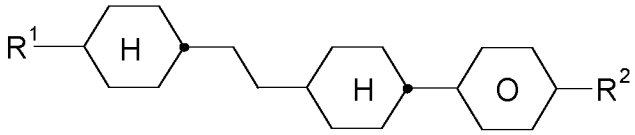

O-6


O-7

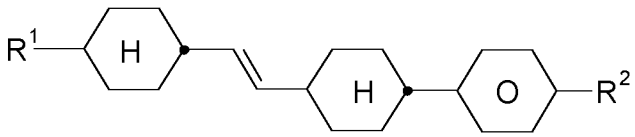

O-8


O-9

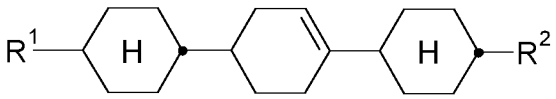

O-10



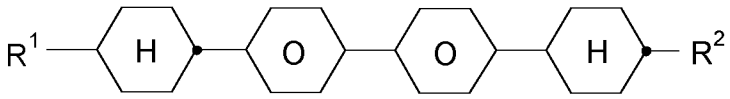
O-11



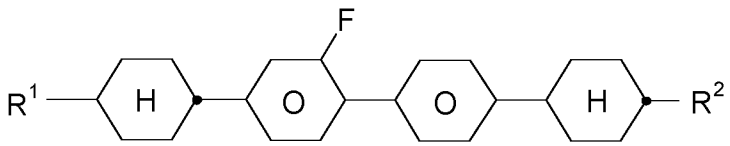
O-12



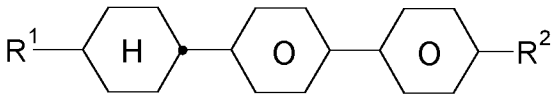
O-13



O-14



O-15



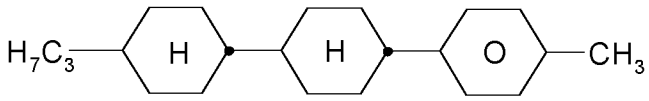
O-16

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

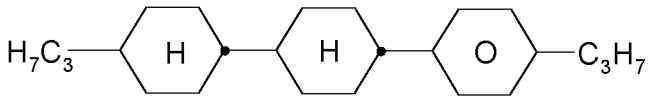
Preferred media comprise one or more compounds of the formulae O-1, O-3, O-4, O-5, O-9, O-12, O-14, O-15, and/or O-16.

Mixtures according to the invention very particularly preferably comprise the compounds of the formulae O-9, O-12 and/or O-16 in particular in amounts of 5-30%.

Preferred compounds of the formula O-9 are indicated below:

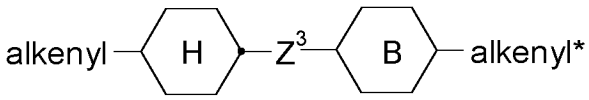


O-9a



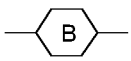
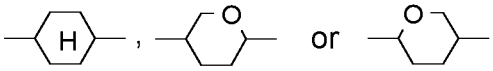
O-9b

h) Liquid-crystalline medium comprising one or more compounds of the formula BA

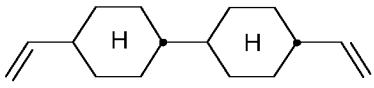


BA

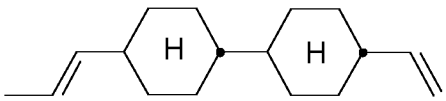
in which

alkenyl und alkenyl*	each, independently of one another, denote a straight-chain alkenyl radical having 2-12 C atoms,
	denotes  ,
Z^3	denotes a single bond, $-CH_2CH_2-$, $-CH=CH-$, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, $-COO-$, $-OCO-$, $-C_2F_4-$, $-C_4H_8-$, $-CF=CF-$.

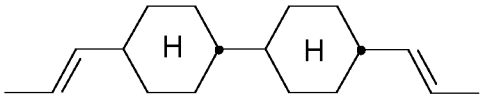
Preferred compounds of the formula BA are indicated below:



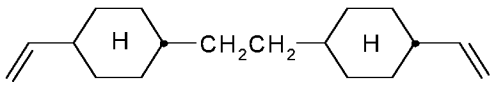
BA-1



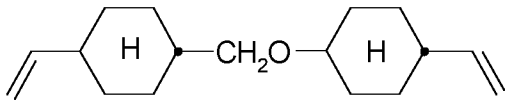
BA-2



BA-3

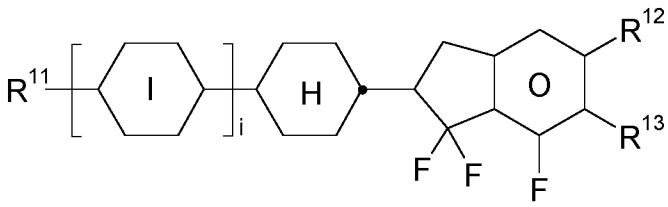


BA-4



BA-5.

i) Preferred mixtures comprise one or more indane compounds of the formula In,



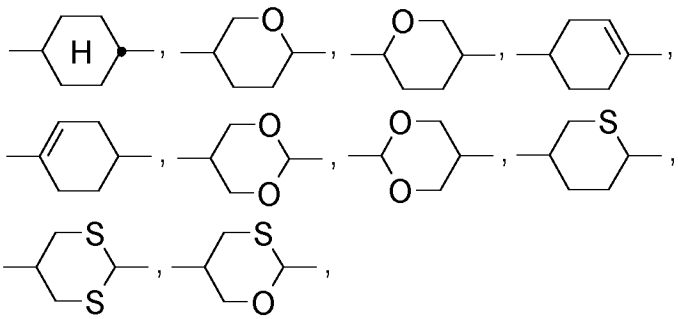
In

in which

R^{11}, R^{12}, R^{13} each, independently of one another, denote a straight-chain alkyl, alkoxy, alkoxyalkyl or alkenyl radical having 1-6 C atoms or 2-6 C atoms respectively,

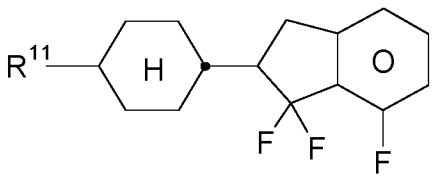
R^{12} and R^{13} additionally denote halogen, preferably F,

 denotes

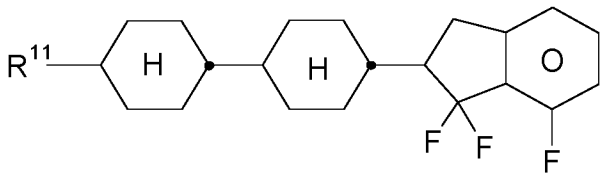


i denotes 0, 1 or 2.

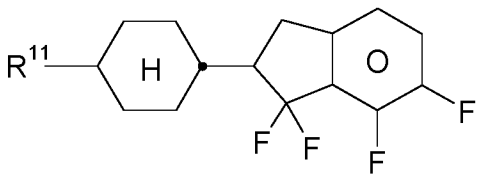
Preferred compounds of the formula In are the compounds of the formulae In-1 to In-16 indicated below:



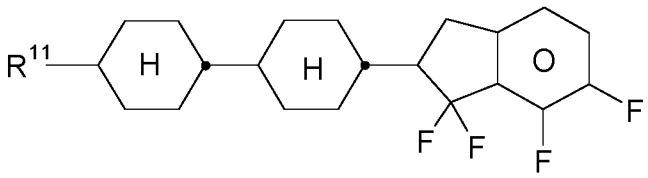
In-1



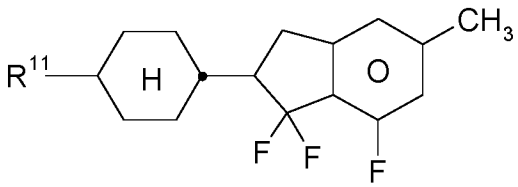
In-2



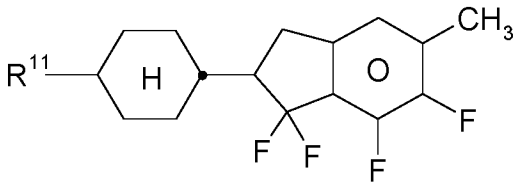
In-3



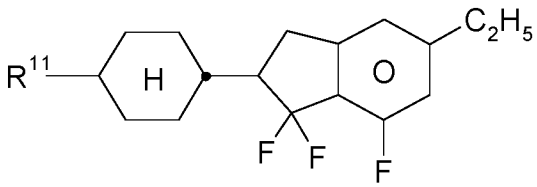
In-4



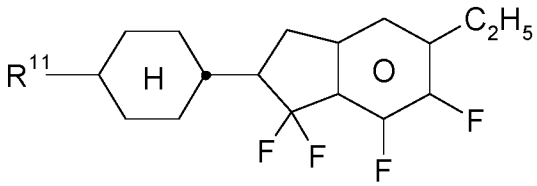
In-5



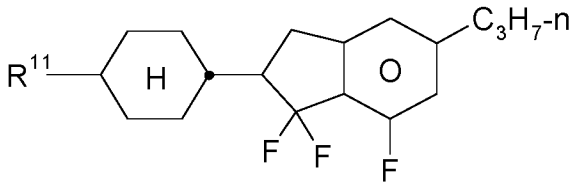
In-6



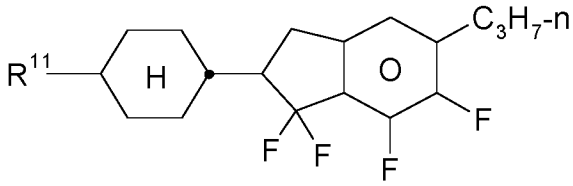
In-7



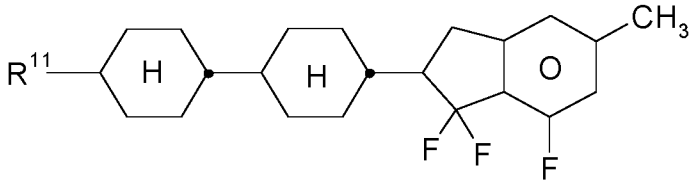
In-8



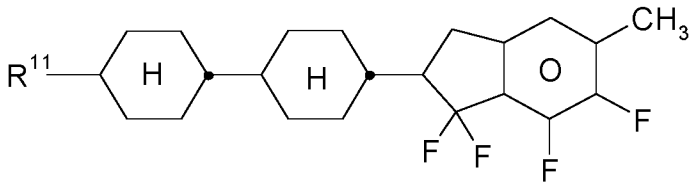
In-9



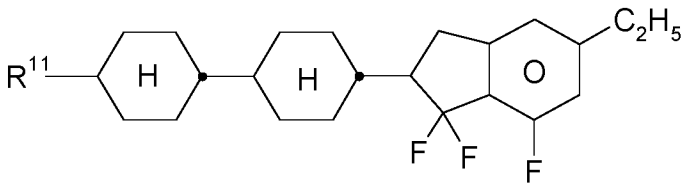
In-10



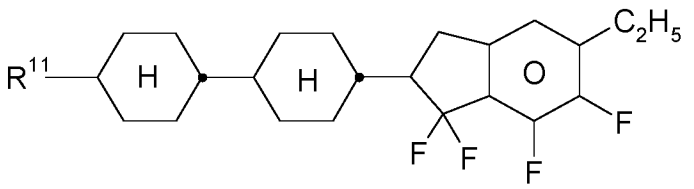
In-11



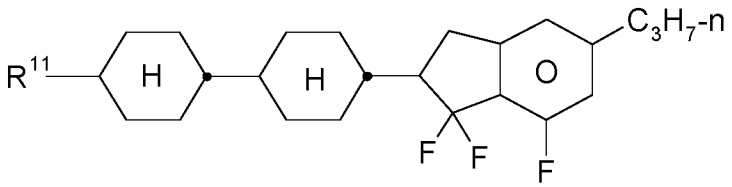
In-12



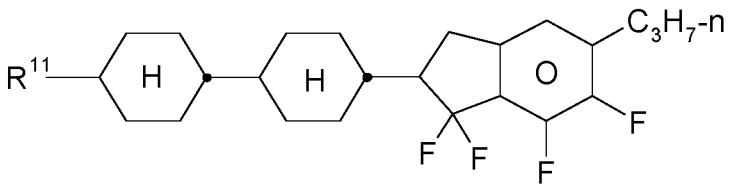
In-13



In-14



In-15

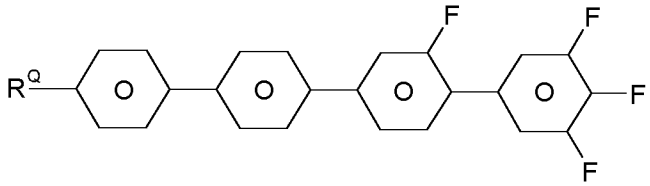


In-16

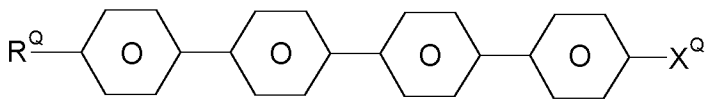
Particular preference is given to the compounds of the formulae In-1, In-2, In-3 and In-4.

The compounds of the formula In and the sub-formulae In-1 to In-16 are preferably employed in the mixtures according to the invention in concentrations ≥ 5% by weight, in particular 5 - 30% by weight and very particularly preferably 5 - 25% by weight.

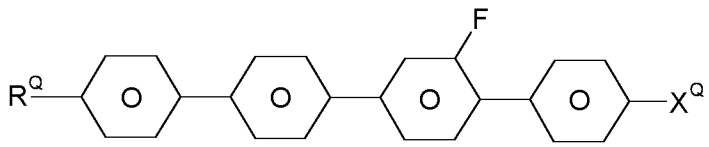
j) The medium additionally comprises one or more compounds selected from the following formulae:



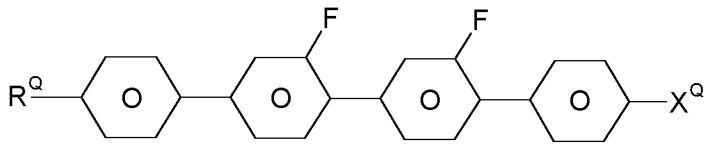
Q-1



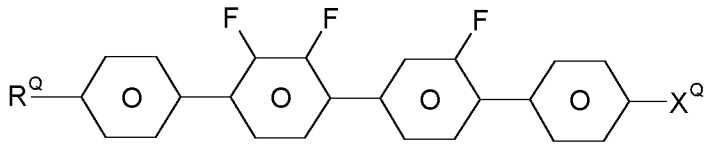
Q-2



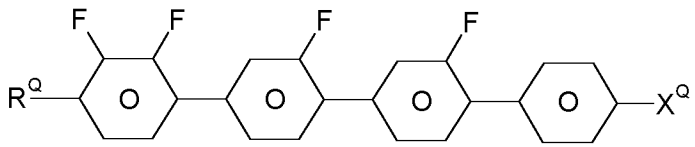
Q-3



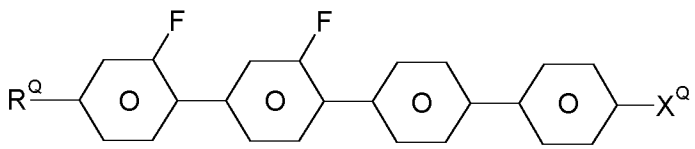
Q-4



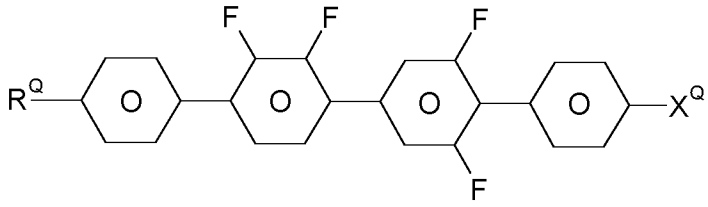
Q-5



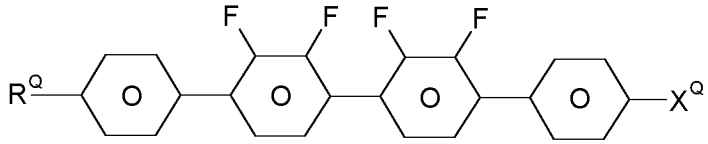
Q-6



Q-7



Q-8



Q-9.

In the compounds of the formulae Q-1 to Q-9, R^Q and X^Q each, independently of one another, have the meanings of R^{2A} in Claim 2. R^Q and X^Q preferably denote a straight-chain alkyl radical having 1-6 C atoms, in particular having 2-5 C atoms.

Particularly preferred mixture concepts are indicated below: (the acronyms used are explained in Tables 1-3 and in Table A. n and m here each, independently of one another, are an integer from 1 to 6).

The mixtures according to the invention preferably comprise

- the compound of the formula N in combination with one or more compounds of the formula IIB, preferably CPY-n-Om, in particular CPY-2-O2, CPY-3-O2 and/or CPY-5-O2, preferably in concentrations > 5%, in the range of from 20 to 60%, very particularly from 30 to 50,

and/or

- CY-n-Om, preferably CY-3-O2, CY-3-O4, CY-5-O2 and/or CY-5-O4, preferably in concentrations > 5%, in particular 5-25%, very particularly 10-15%,

and/or

- CCY-n-Om, preferably CCY-4-O2, CCY-3-O2, CCY-3-O3, CCY-3-O1 and/or CCY-5-O2, preferably in concentrations > 5%, preferably in the range of from 10% to 30%,

- CPY-n-Om and in addition optionally PTY-n-Om, preferably in a total concentration in the range of from 5% to 50%, more preferably from 10% to 40%, particularly preferably from 20% to 30%,

and/or

- CPY-n-Om and PY-n-Om, preferably CPY-2-O2 and/or CPY-3-O2 and PY-3-O2, preferably in concentrations of 10 - 40%,

and/or

- CBCnm and/or CBC-nmF in a total concentration of 2 to 10%,

and/or

- PGIY-n-Om, preferably in a total concentration in the range of from 3 to 15%,

and/or

- PGIGI-n-F, preferably in a total concentration in the range of from 3 to 15%,

and/or

- PTP-n-Om, preferably in a total concentration in the range of from 5 to 15%,

The amount of ionic liquid in the medium according to the invention must be large enough to induce significant dynamic scattering but not too much so as to destroy the liquid crystal orientation in the absence of an electric field. As known in the art, this concentration depends on the cell

configurations, alignment layers in the cell, liquid crystal material and voltage waveforms. The acceptable amount is determined by noting presence of significant dynamic scattering (haze greater than 15%) in the presence of a voltage having a wave form without any effect on the alignment of liquid crystal in the absence of an applied voltage. It should be noted that at sufficiently high frequency voltage waveforms, the migration is minimized and the overall dynamic scattering performance is reduced.

Preferably, the concentration of ionic liquid of formula I in the medium is 0.25% or less, more preferably 0.2% or less, particularly preferably 0.1% or less.

Preferably, the concentration of ionic liquid of formula I in the medium is in the range of from 0.0001% to 1%, more preferably, from 0.0005% to 0.5%, very preferably from 0.001% to 0.2% and in particular from 0.001% to 0.1%.

In a preferred embodiment of the present invention the concentration of ionic liquid of formula I in the medium is in the range of from 0.005% to 0.02%.

The mixtures according to the invention or the nematic host preferably exhibit very broad nematic phase ranges with clearing points ≥ 85°C, preferably ≥ 95°C, in particular ≥ 100°C, very favourable values of the capacitive threshold, relatively high values of the holding ratio and at the same time very good low-temperature stabilities at -20°C and -30°C, as well as low rotational viscosities and short response times. The mixtures according to the invention are furthermore distinguished by the fact that, in addition to the improvement in the rotational viscosity γ_1, relatively high values of the elastic constants K_{33} for improving the response times can be observed.

The liquid-crystalline medium according to the invention preferably has a nematic phase from ≤ -20°C to ≥ 85°C, particularly preferably from ≤ -30°C to ≥ 95°C, very particularly preferably from ≤ -40°C to ≥ 100°C.

The expression "to have a nematic phase" here means on the one hand that no smectic phase and no crystallisation are observed at low temperatures at the corresponding temperature and on the other hand that

clearing still does not occur on heating from the nematic phase. The investigation at low temperatures is carried out in a flow viscometer at the corresponding temperature and checked by storage in test cells having a layer thickness corresponding to the electro-optical use for at least 100 hours. If the storage stability at a temperature of -20°C in a corresponding test cell is 1000 h or more, the medium is referred to as stable at this temperature. At temperatures of -30°C and -40°C, the corresponding times are 500 h and 250 h respectively. At high temperatures, the clearing point is measured by conventional methods in capillaries.

The liquid-crystal mixture preferably has a nematic phase range of at least 60 K.

The values of the birefringence Δn in the liquid-crystal mixture are generally between 0.07 and 0.25, preferably between 0.10 and 0.20.

The medium preferably has a birefringence Δn of 0.180 or more, more preferably of 0.190 or more, particularly preferably of 0.200 or more.

The liquid-crystal mixture according to the invention has a $\Delta\varepsilon$ of -0.5 to -8.0, in particular -1.0 to -6.0, where $\Delta\varepsilon$ denotes the dielectric anisotropy. The rotational viscosity γ_1 at 20°C is preferably $\leq$ 500 mPa·s, in particular $\leq$ 250 mPa·s.

The liquid-crystal media according to the invention have relatively small values for the threshold voltage (V_0). They are preferably in the range from 1.7 V to 4.0 V, particularly preferably $\leq$ 3.0 V and very particularly preferably $\leq$ 2.7 V.

For the present invention, the term "threshold voltage" relates to the capacitive threshold (V_0), also known as the Freedericks threshold, unless explicitly indicated otherwise.

In addition, the liquid-crystal media according to the invention have high values for the voltage holding ratio in liquid-crystal cells.

In general, liquid-crystal media having a low addressing voltage or threshold voltage exhibit a lower voltage holding ratio than those having a higher addressing voltage or threshold voltage and vice versa.

For the present invention, the term "dielectrically positive compounds" denotes compounds having a $\Delta\varepsilon > 1.0$, the term "dielectrically neutral compounds" denotes those where $-1.0 \leq \Delta\varepsilon \leq 1.0$ and the term "dielectrically negative compounds" denotes those having $\Delta\varepsilon < -1.0$. The dielectric anisotropy of the compounds is determined here by dissolving 10% of the compounds in a liquid-crystalline host and determining the capacitance of the resultant mixture in at least one test cell in each case having a layer thickness of 20 µm with homeotropic and with homogeneous surface alignment at 1 kHz. The measurement voltage is typically 0.5 V to 1.0 V, but is always lower than the capacitive threshold of the respective liquid-crystal mixture investigated.

All temperature values indicated for the present invention are in °C.

Besides one or more compounds of the formula I, the phases preferably comprise 4 to 15, in particular 5 to 12, and particularly preferably < 10, compounds of the formulae IIA, IIB and/or IIC.

Besides compounds of the formula I and the compounds of the formulae IIA, IIB and/or IIC, other constituents may also be present, for example in an amount of up to 45% of the mixture as a whole, but preferably up to 35%, in particular up to 10%.

In addition, these liquid-crystal phases may also comprise more than 18 components, preferably 18 to 25 components.

The other constituents are preferably selected from nematic or nematogenic substances, in particular known substances, from the classes of the azoxybenzenes, benzylideneanilines, biphenyls, terphenyls, phenyl or cyclohexyl benzoates, phenyl or cyclohexyl cyclohexanecarboxylates, phenylcyclohexanes, cyclohexylbiphenyls, cyclohexylcyclohexanes, cyclohexylnaphthalenes, 1,4-biscyclohexylbiphenyls or cyclohexylpyrimidines,

phenyl- or cyclohexyldioxanes, optionally halogenated stilbenes, benzyl phenyl ethers, tolans and substituted cinnamic acid esters.

The most important compounds which are suitable as constituents of liquid-crystal phases of this type can be characterised by the formula IV,

R^{20}-L-G-E-R^{21} IV

in which L and E each denote a carbo- or heterocyclic ring system from the group formed by 1,4-disubstituted benzene and cyclohexane rings, 4,4'-disubstituted biphenyl, phenylcyclohexane and cyclohexylcyclohexane systems, 2,5-disubstituted pyrimidine and 1,3-dioxane rings, 2,6-disubstituted naphthalene, di- and tetrahydronaphthalene, quinazoline and tetrahydroquinazoline,

G denotes		
	-CH=CH-	-N(O)=N-
	-CH=CQ-	-CH=N(O)-
	-C≡C-	$-CH_2-CH_2-$
	-CO-O-	$-CH_2-O-$
	-CO-S-	$-CH_2-S-$
	-CH=N-	-COO-Phe-COO-
	$-CF_2O-$	-CF=CF-
	$-OCF_2-$	$-OCH_2-$
	$-(CH_2)_4-$	$-(CH_2)_3O-$

or a C-C single bond, Q denotes halogen, preferably chlorine, or -CN, and R^{20} and R^{21} each denote alkyl, alkenyl, alkoxy, alkoxyalkyl or alkoxycarbonyloxy having up to 18, preferably up to 8, carbon atoms, or one of these radicals alternatively denotes CN, NC, NO_2, NCS, CF_3, SF_5, OCF_3, F, Cl or Br.

In most of these compounds, R^{20} and R^{21} are different from one another, one of these radicals usually being an alkyl or alkoxy group. Other variants of the proposed substituents are also common. Many such substances or also mixtures thereof are commercially available. All these substances can be prepared by methods known from the literature.

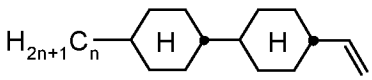
It goes without saying for the person skilled in the art that the liquid crystalline according to the invention may also comprise compounds in which, for example, H, N, O, Cl and F have been replaced by the corresponding isotopes.

Polymerisable compounds, either non-mesogenic or mesogenic, the latter referred to as reactive mesogens (RMs), for example as disclosed in US 6,861, 107, preferably non-mesogenic, may furthermore be added to the mixtures according to the invention in concentrations of preferably 10 - 50 % by weight, particularly preferably 20 - 40% by weight, based on the mixture. The polymerisable compounds are preferably selected from 2-ethylhexyl acrylate (EHA), 1,3,3-trimethylhexyl acrylate (TMHA), trimethylol propane triacrylatehexanediol diacrylate (HDDA), hexanediol dimethacrylate (HDDMA), and the like, and also from metylmethacrylate (MMA), ethylacrylate (EA), ethylmethacrylate (EMA) and 6-(4'-cyanobiphenyl-4-yloxy)hexyl acrylate (6CBA), a mesogenic monomer. These mixtures may optionally also comprise an initiator, as described, for example, in U.S. 6,781,665. The initiator, for example Irganox-1076 from BASF, is preferably added to the mixture comprising polymerisable compounds in amounts of 0-1%. Mixtures of this type can be used for so-called guest-host polymer dispersed liquid crystals (GHPDLC). A GHPDLC display is described in JP 06-324309 A. A GHPDLC polymer film is published in P. Malik, K.K. Raina, Physica B 405 (2010) 161–166.

The prerequisite for this is that the liquid-crystal mixture itself comprises no polymerisable components which likewise polymerise under the conditions where the compounds of the formula M polymerise.

The polymerisation is preferably carried out under the following conditions: the polymerisable components are polymerised in a cell using a UV-A lamp of defined intensity for a defined period and applied voltage (typically 10 to 30 V alternating voltage, frequencies in the range from 60 Hz to 1 kHz). The UV-A light source employed is typically a metal-halide vapour lamp or high-pressure mercury lamp having an intensity of 50 mW/cm^2. These are conditions where, for example, liquid-crystalline compounds containing an

alkenyl or alkenyloxy side chain, such as, for example, the compounds of the formula



where n = 2, 3, 4, 5 or 6,

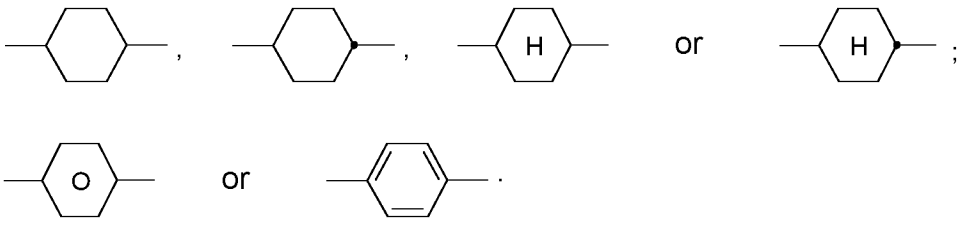
do not polymerise.

The mixtures according to the invention may furthermore comprise conventional additives, such as, for example, stabilisers, antioxidants, UV absorbers, nanoparticles, microparticles, etc.

In a preferred embodiment of the present invention the liquid crystalline medium comprises one or more chiral dopants.

The following examples are intended to explain the invention without limiting it. Above and below, per cent data denote per cent by weight; all temperatures are indicated in degrees Celsius.

Throughout the patent application, 1,4-cyclohexylene rings and 1,4-phenylene rings are depicted as follows:

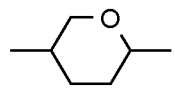


The cyclohexylene rings are trans-1,4-cyclohexylene rings.

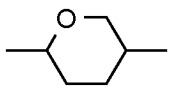
Throughout the patent application and in the working examples, the structures of the liquid-crystal compounds are indicated by means of acronyms. Unless indicated otherwise, the transformation into chemical formulae is carried out in accordance with Tables 1-3. All radicals C_nH_{2n+1}, C_mH_{2m+1}

and $C_{m'}H_{2m'+1}$ or C_nH_{2n} and C_mH_{2m} are straight-chain alkyl radicals or alkylene radicals, in each case having n, m, m' or z C atoms respectively. n, m, m' and z each, independently of one another, denote 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 or 12, preferably 1, 2, 3, 4, 5 or 6. In Table 1 the ring elements of the respective compound are coded, in Table 2 the bridging members are listed and in Table 3 the meanings of the symbols for the left-hand or right-hand side chains of the compounds are indicated.

Table 1: Ring elements



A



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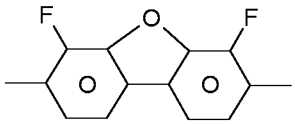
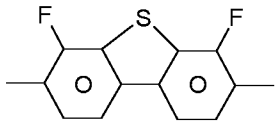
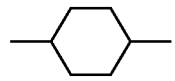


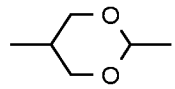
B



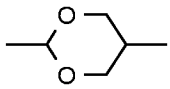
B(S)



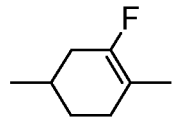
C



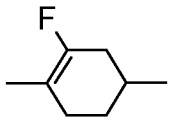
D



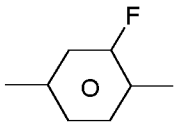
DI



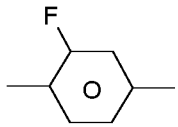
F



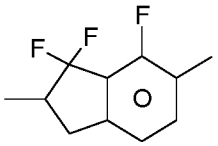
FI



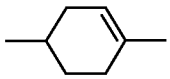
G



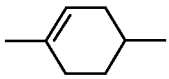
GI



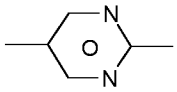
K



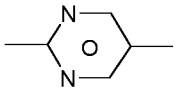
L



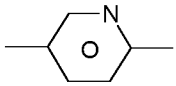
LI



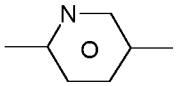
M



MI



N



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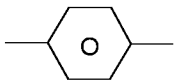

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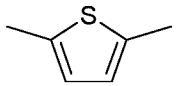

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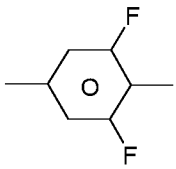
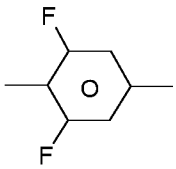
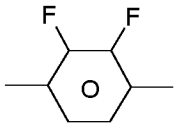


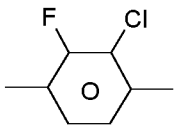
U



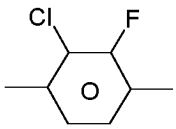
UI



Y



Y(F,Cl)



Y(Cl,F)

Table 2: Bridging members

E	$-CH_2CH_2-$			
V	-CH=CH-			
T	-C≡C-			
W	$-CF_2CF_2-$			
Z	-COO-	**ZI**	-OCO-	
O	$-CH_2O-$	**OI**	$-OCH_2-$	
Q	$-CF_2O-$	**QI**	$-OCF_2-$	

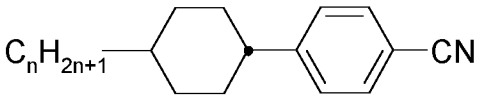
Table 3: Side chains

Left-hand side chain		Right-hand side chain	
n-	$C_nH_{2n+1}-$	**-n**	$-C_nH_{2n+1}$
nO-	$C_nH_{2n+1}-O-$	**-On**	$-O-C_nH_{2n+1}$
V-	$CH_2=CH-$	**-V**	$-CH=CH_2$
nV-	$C_nH_{2n+1}-CH=CH-$	**-nV**	$-C_nH_{2n}-CH=CH_2$
Vn-	$CH_2=CH-\ C_nH_{2n}-$	**-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
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**	$-OCF_3$
T-	CF_3-	**-T**	$-CF_3$
A-	H-C≡C-	**-A**	-C≡C-H

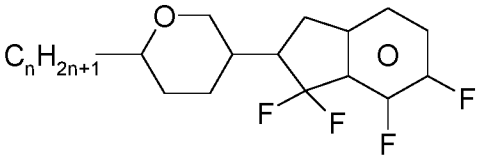
Besides the compounds of the formulae IIA and/or IIB and/or IIC and one or more compounds of the formula I, the mixtures according to the invention preferably comprise one or more of the compounds from Table A indicated below.

Table A

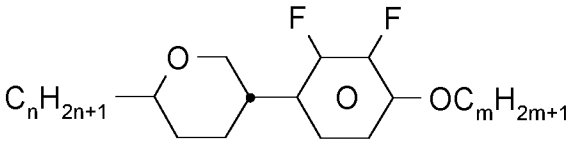
The following abbreviations are used:
(n, m, m', z: each, independently of one another, 1, 2, 3, 4, 5 or 6;
$(O)C_mH_{2m+1}$ means OC_mH_{2m+1} or C_mH_{2m+1})



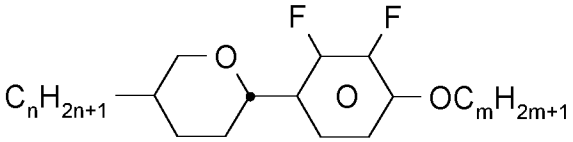
PCH-n



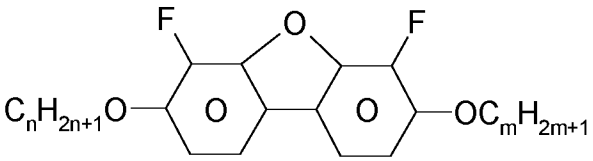
AIK-n-F



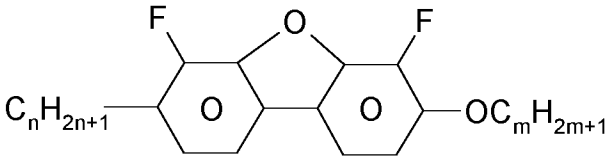
AIY-n-Om



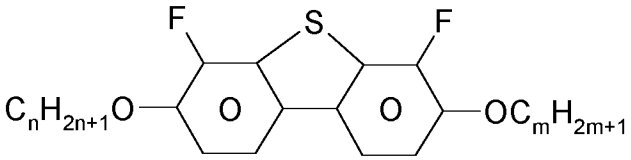
AY-n-Om



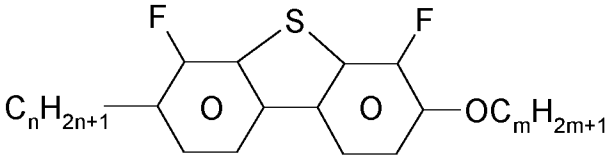
B-nO-Om



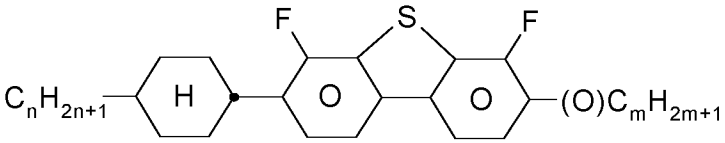
B-n-Om



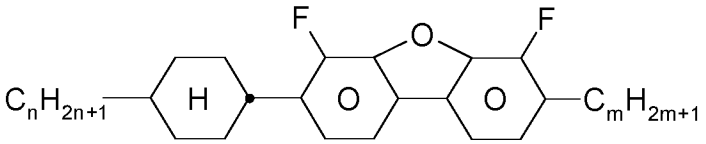
B(S)-nO-Om



B(S)-n-Om



CB(S)-n-(O)m



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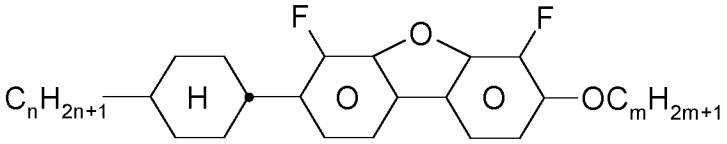

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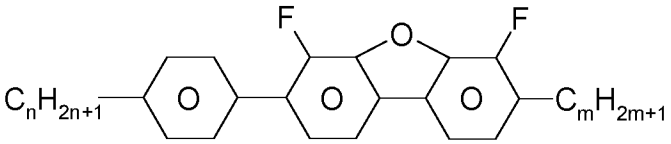

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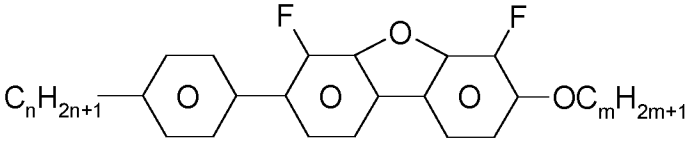

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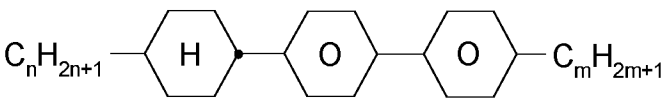

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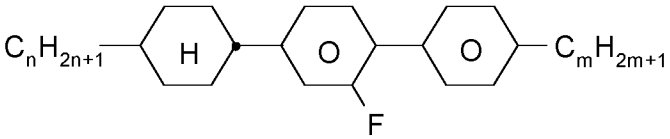

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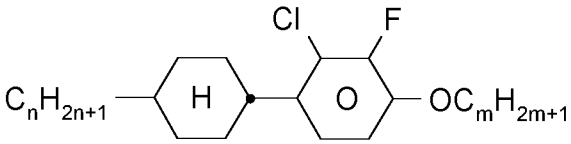

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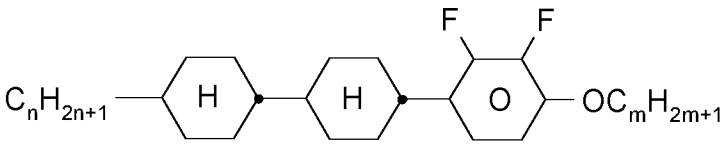

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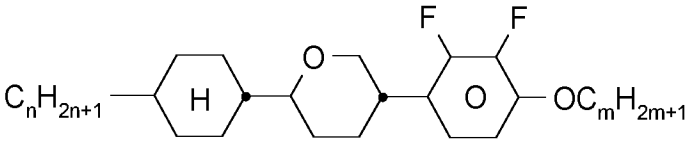

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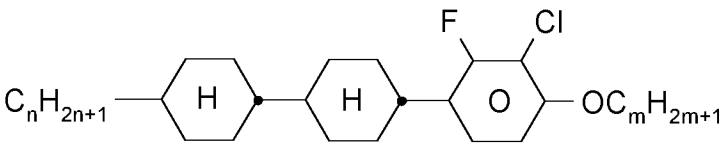

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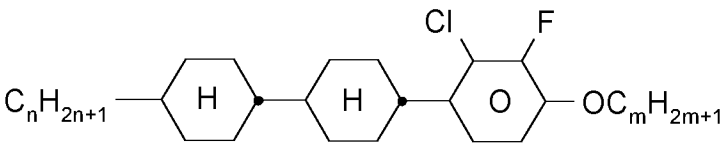

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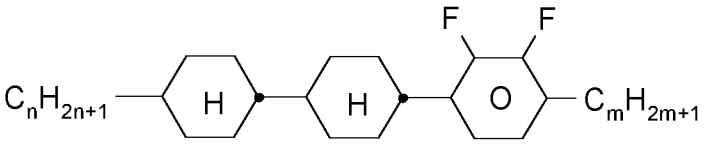

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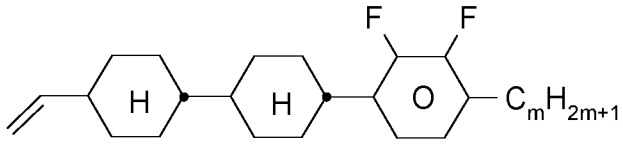

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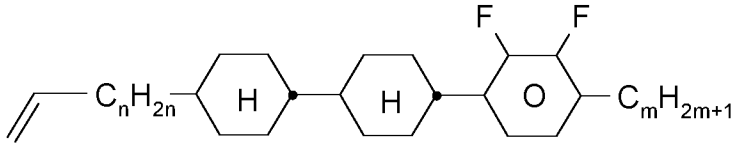

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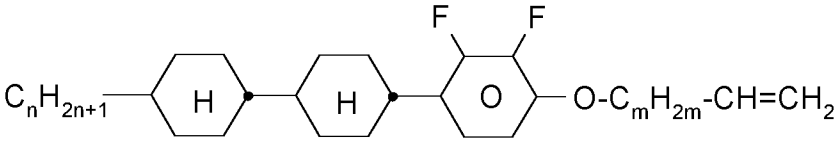

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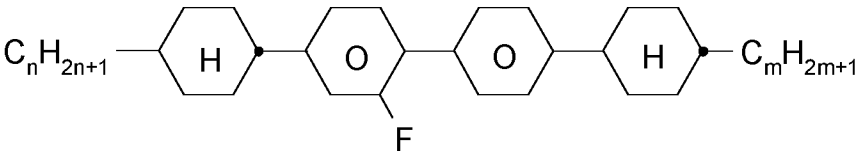

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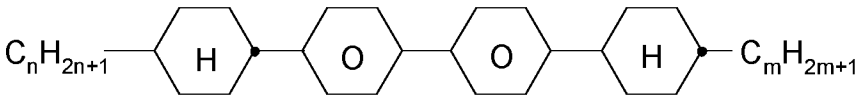

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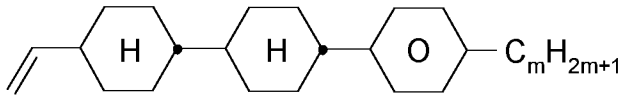

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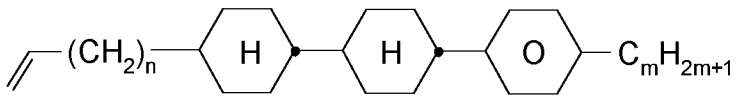

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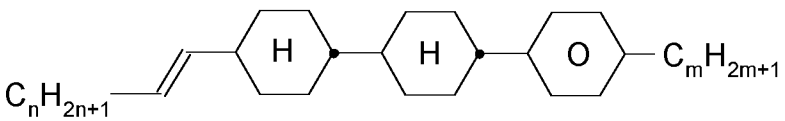

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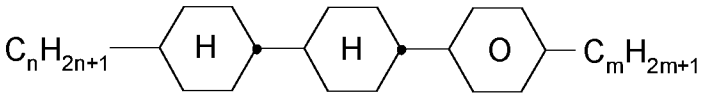

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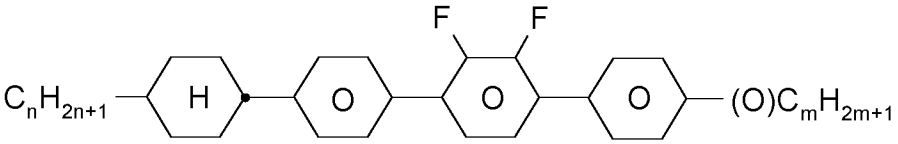

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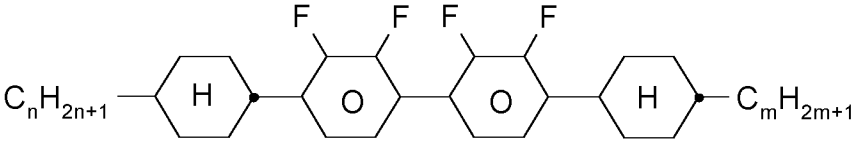

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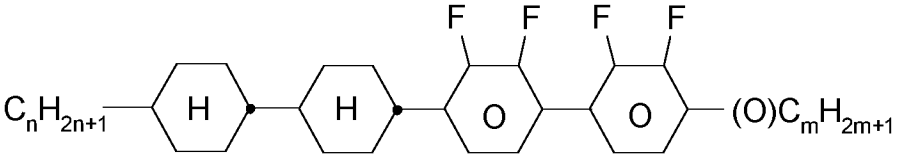

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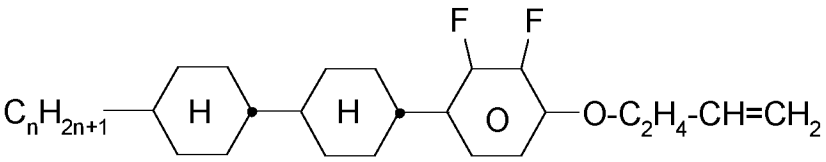

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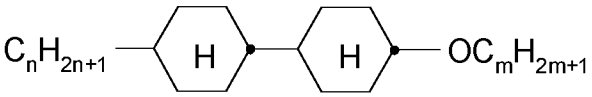

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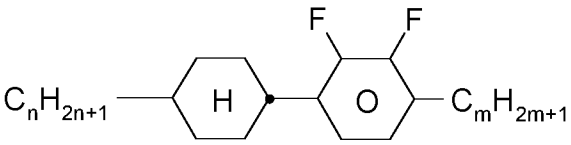

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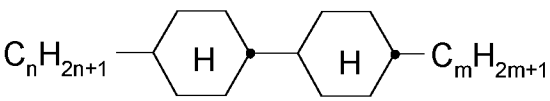

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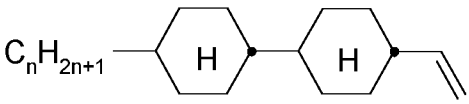

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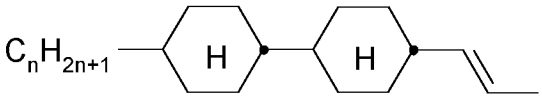

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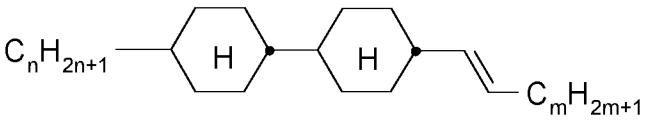

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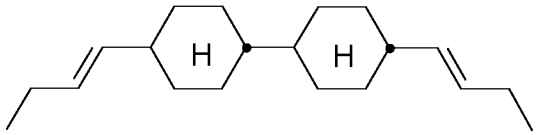

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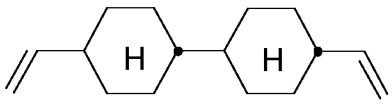

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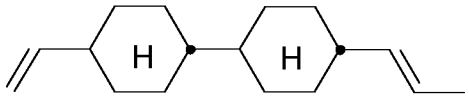

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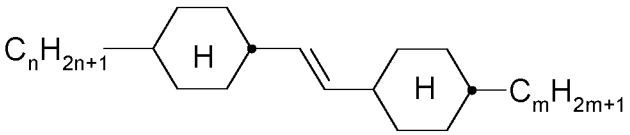

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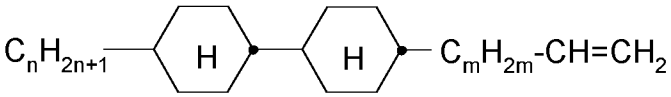

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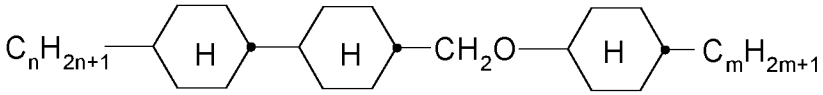

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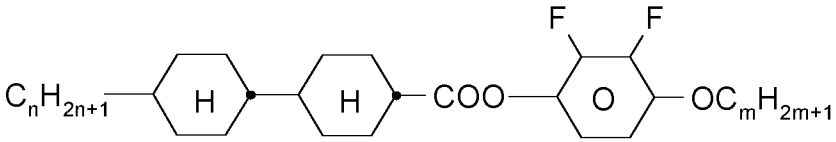

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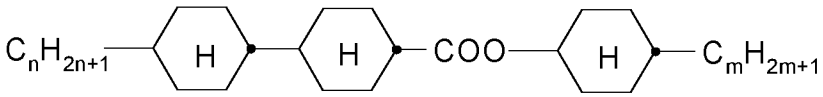

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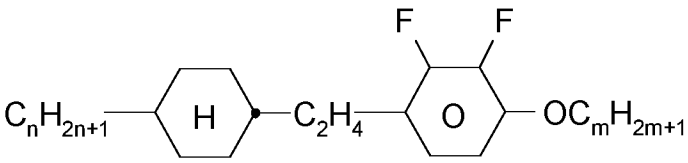

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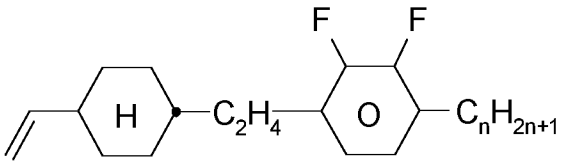

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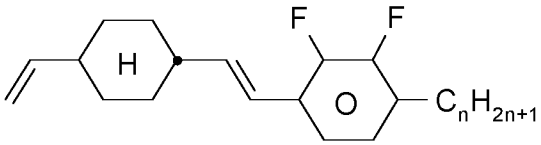

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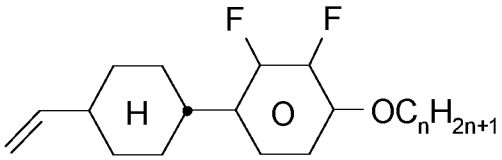

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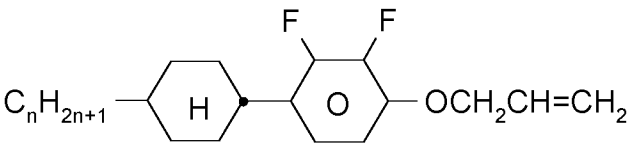

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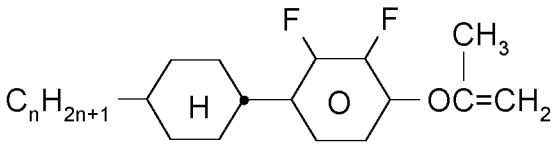

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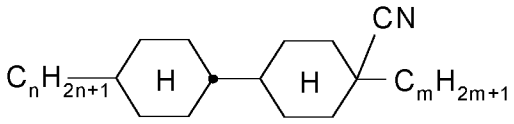

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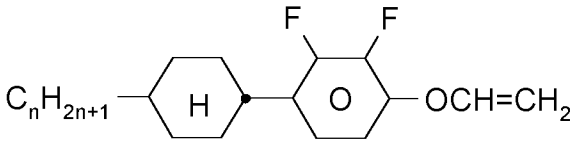

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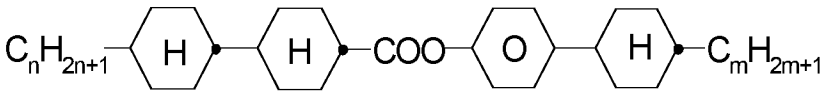

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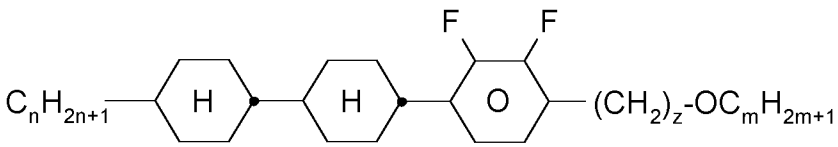

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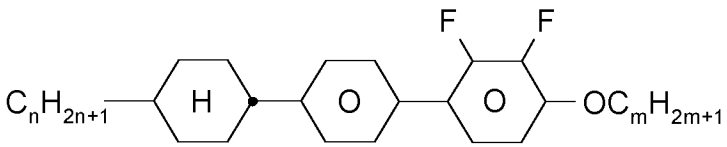

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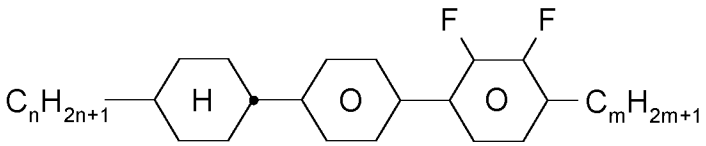

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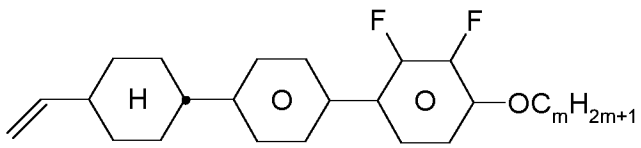

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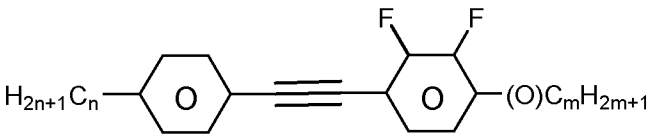

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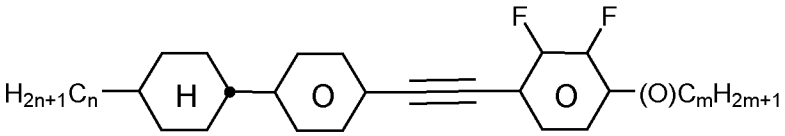

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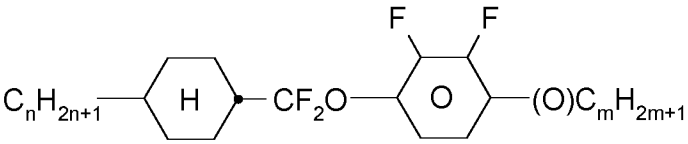

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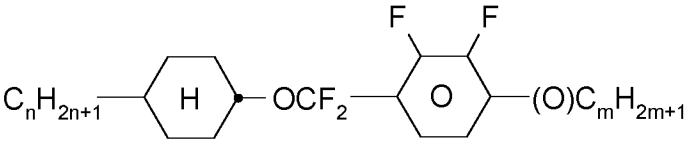

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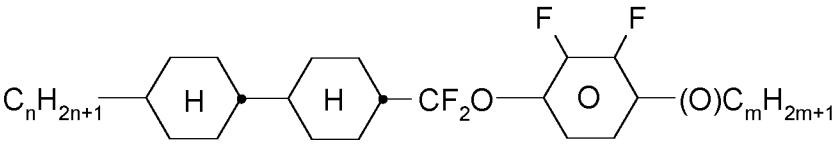

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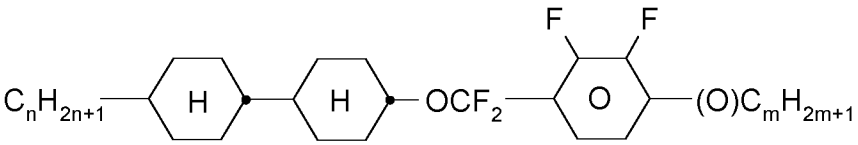

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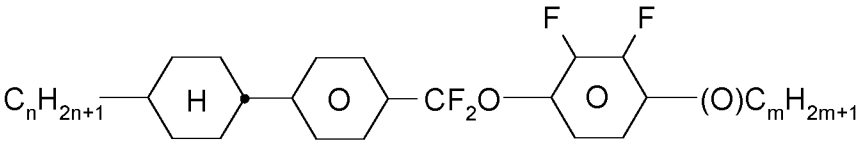

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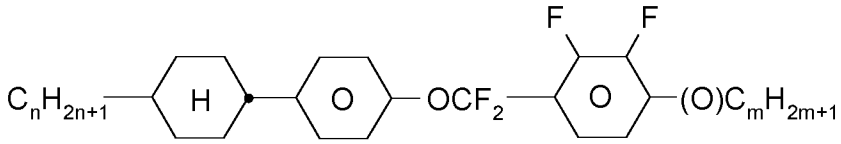

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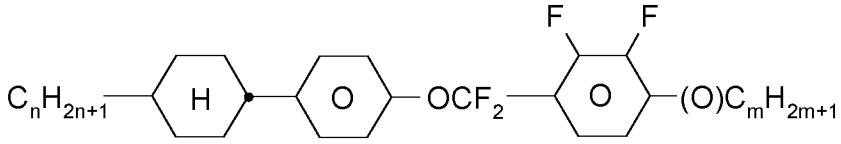

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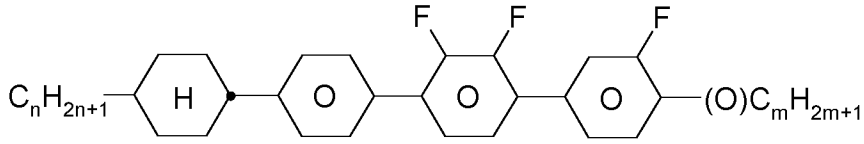

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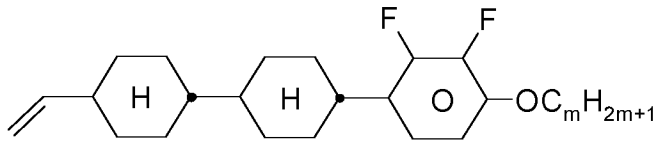

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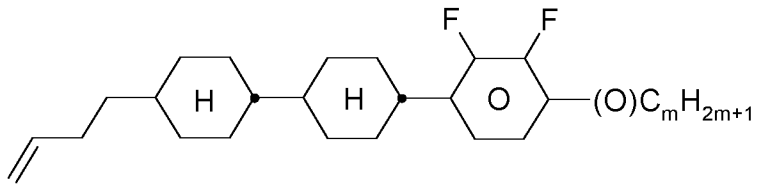

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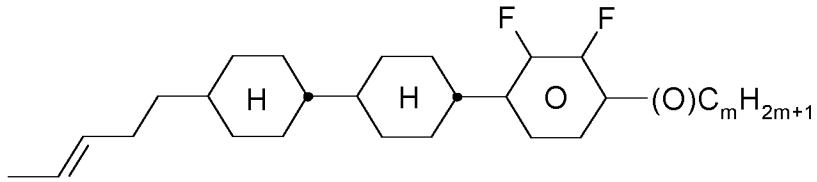

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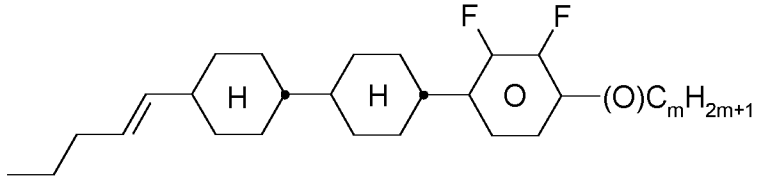

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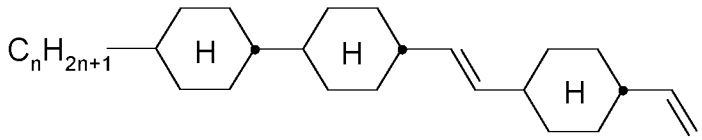

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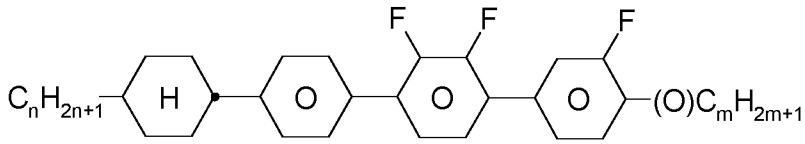

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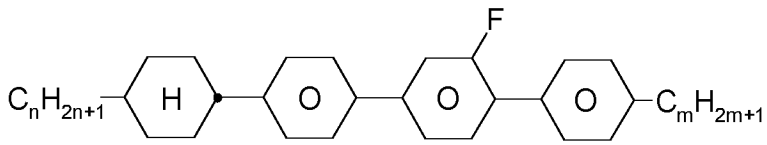

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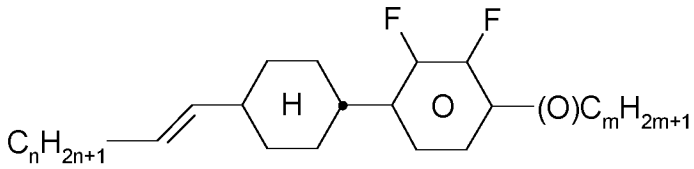

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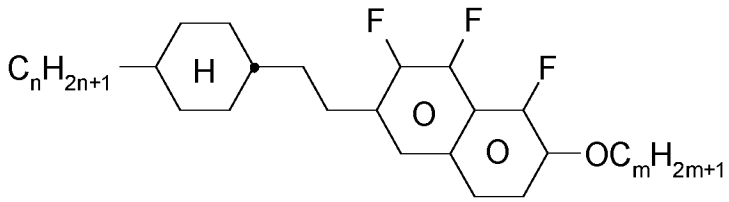

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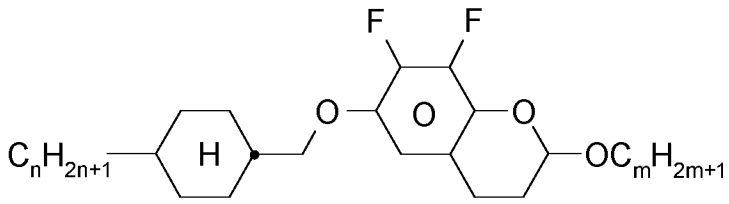

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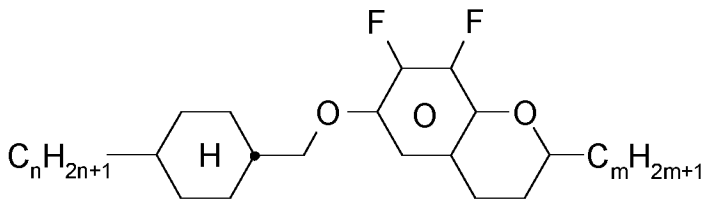

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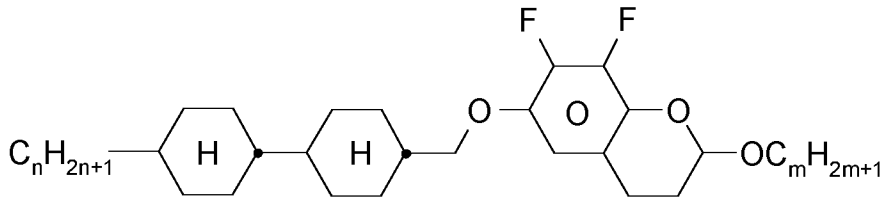

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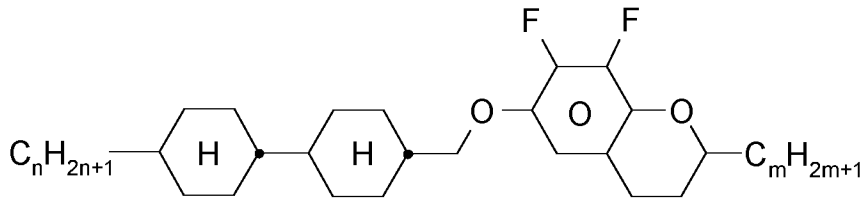

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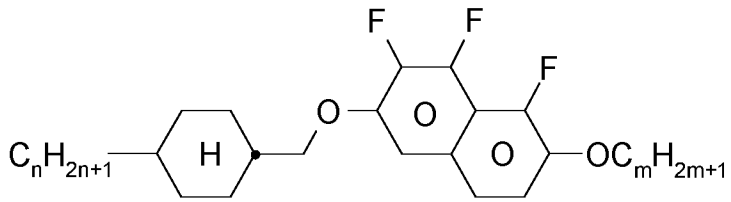

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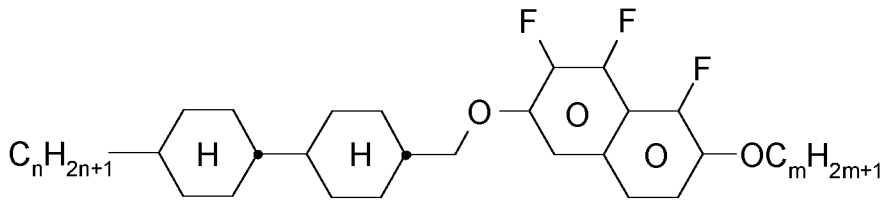

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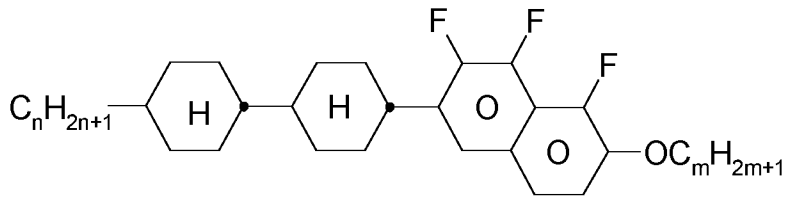

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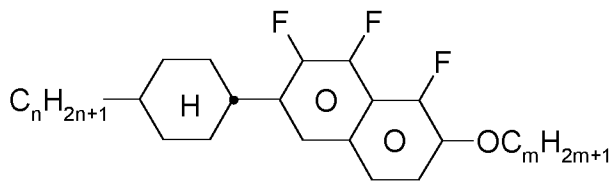

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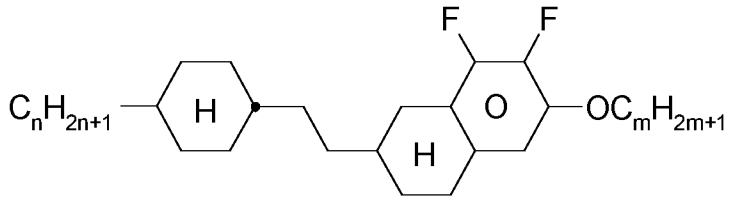

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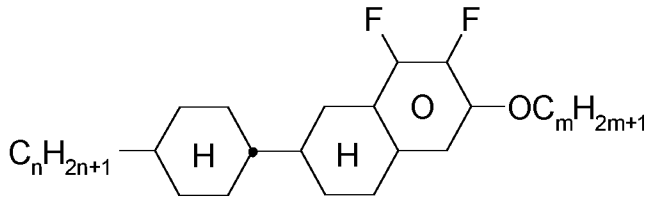

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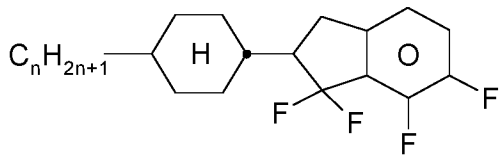

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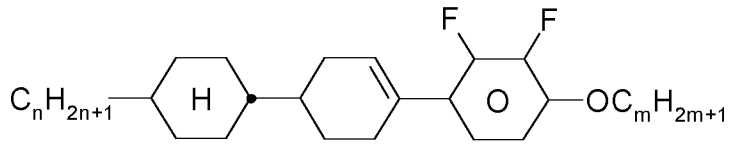

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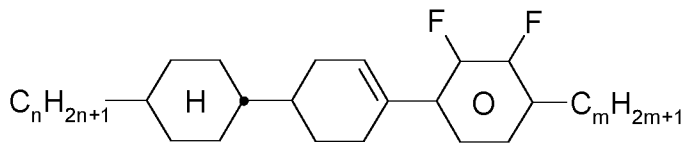

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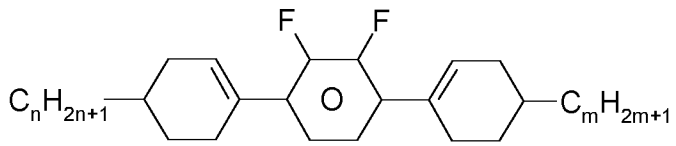

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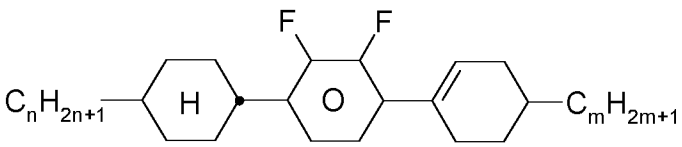

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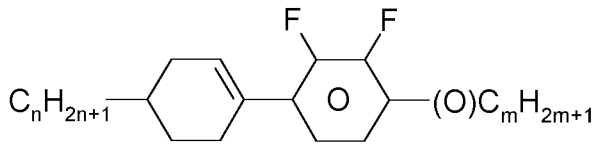

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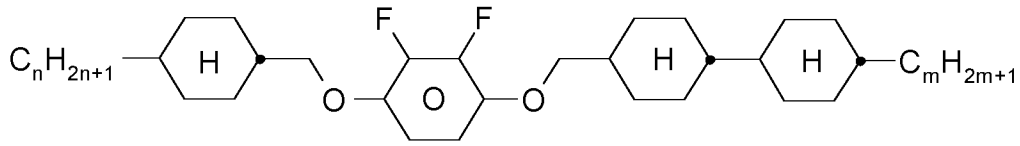

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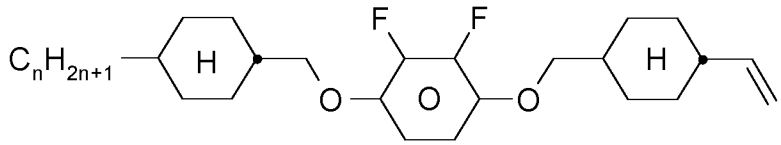

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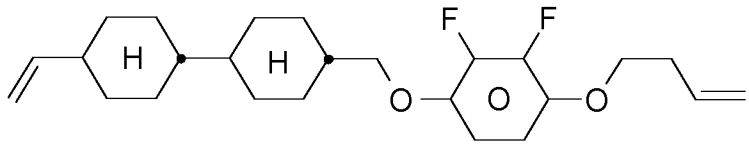

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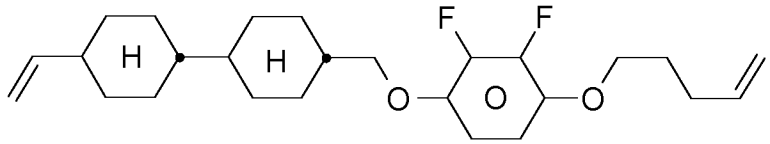

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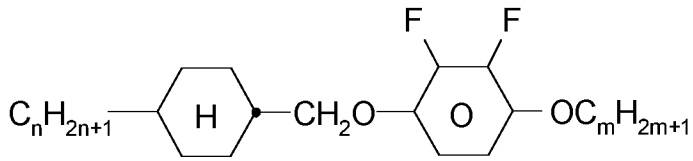

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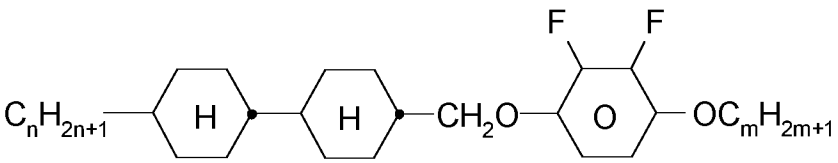

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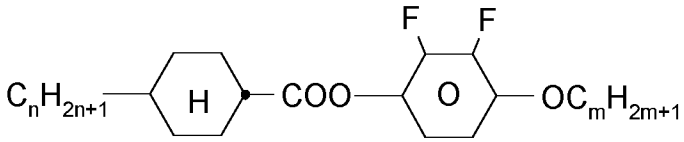

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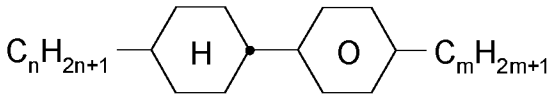

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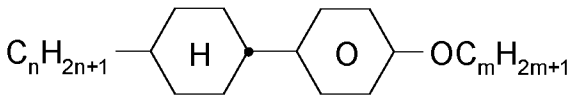

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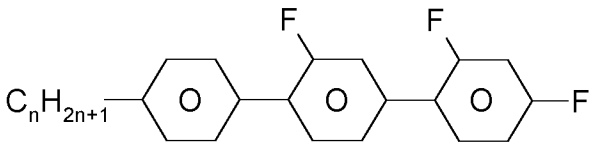

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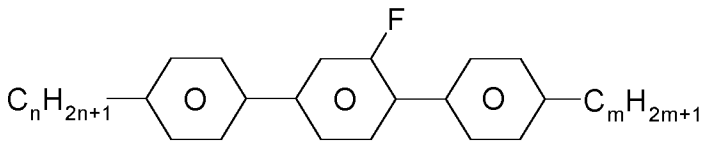

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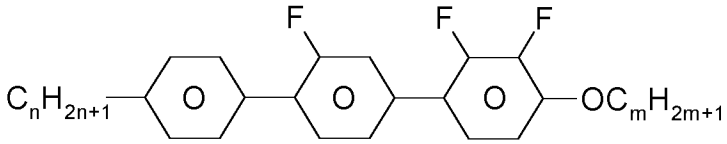

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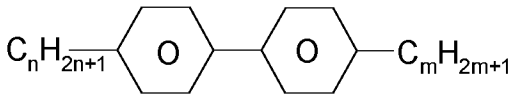

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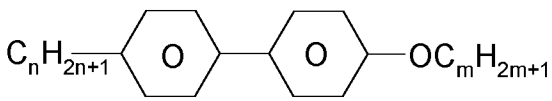

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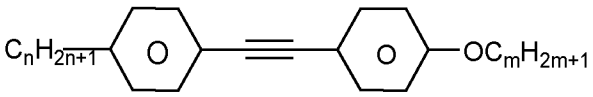

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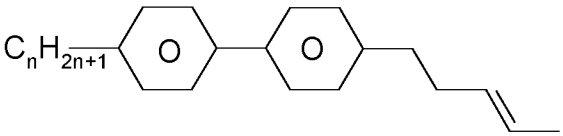

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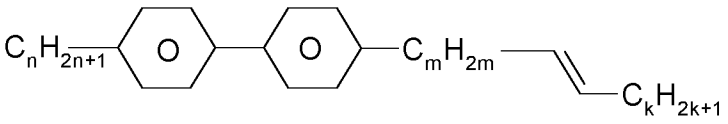

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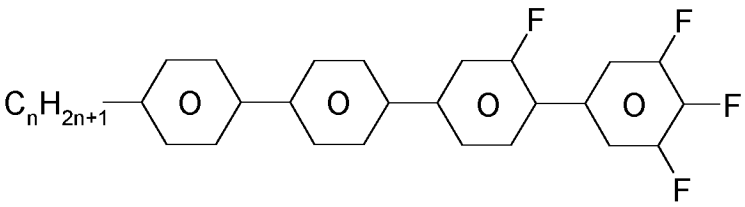

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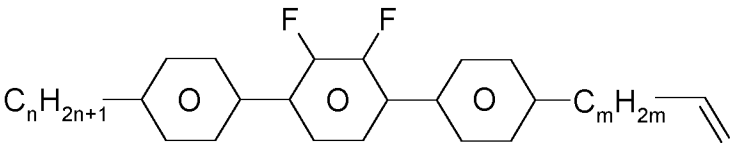

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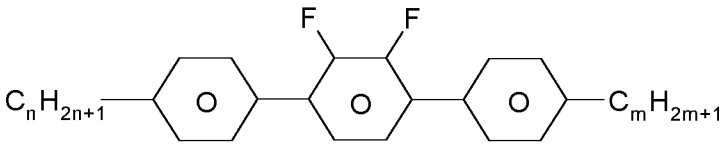

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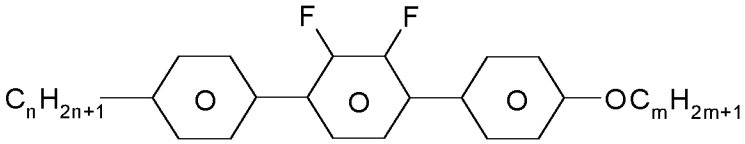

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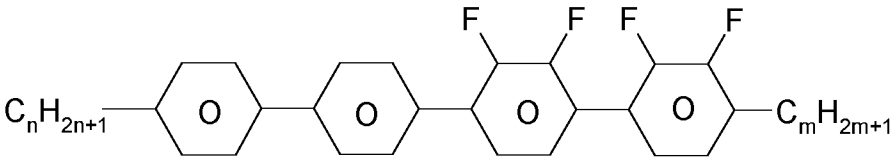

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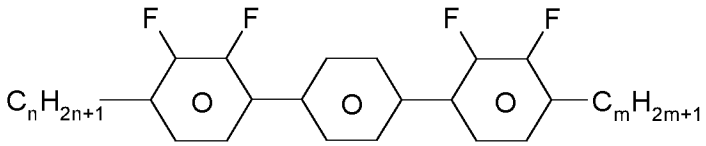

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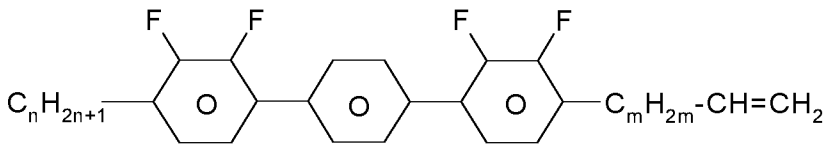

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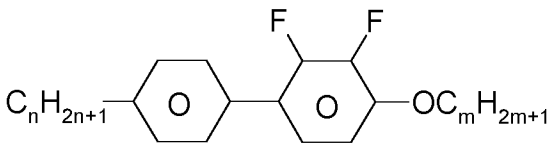

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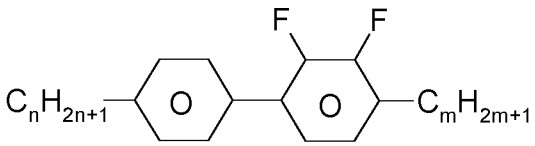

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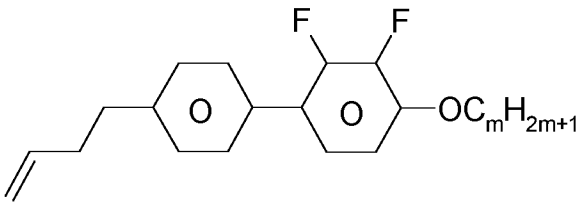

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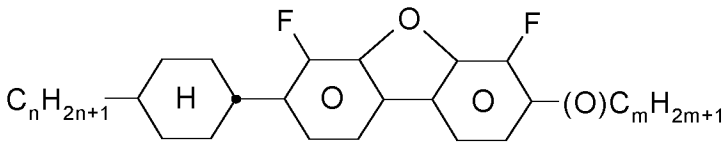

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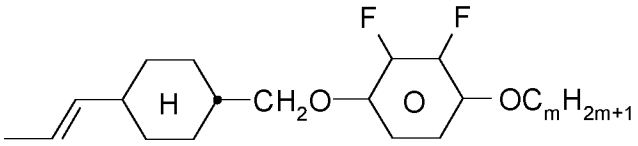

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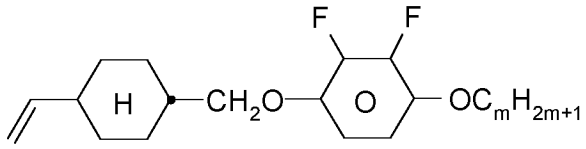

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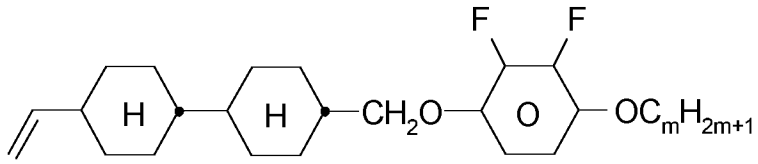

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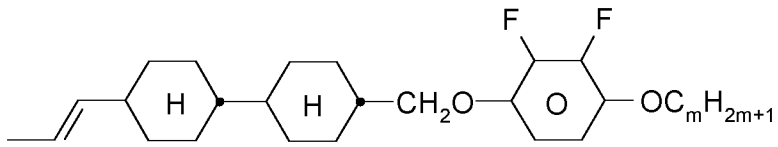

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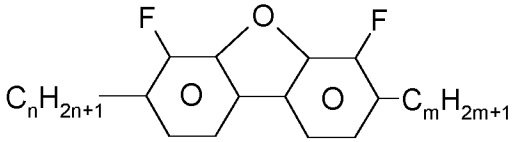
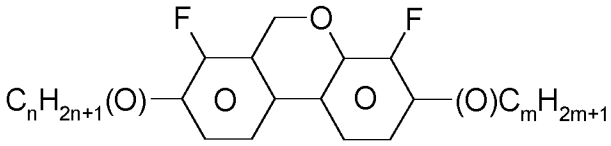
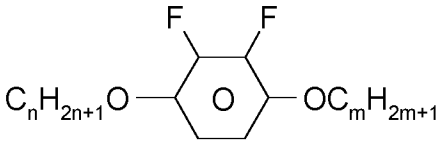


B-n-m



DFDBC-n(O)-(O)m



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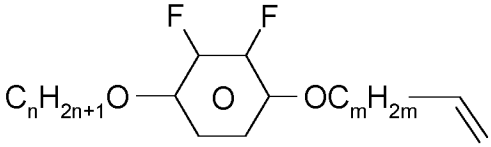

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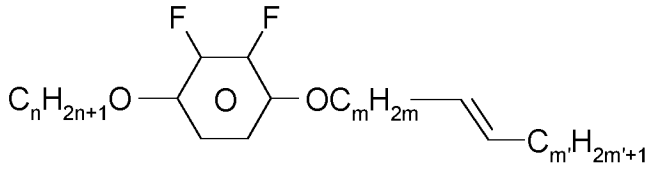

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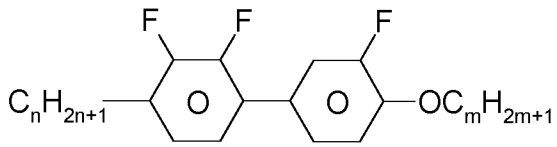

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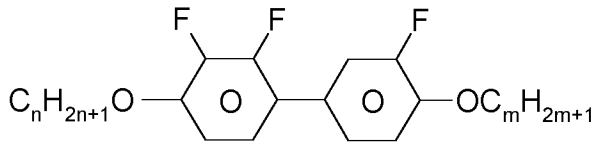

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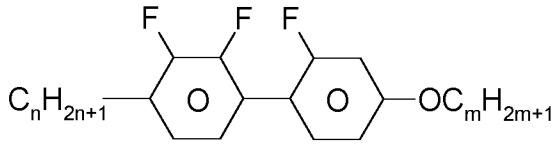

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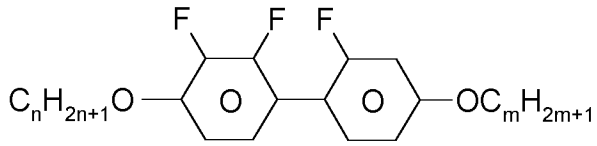

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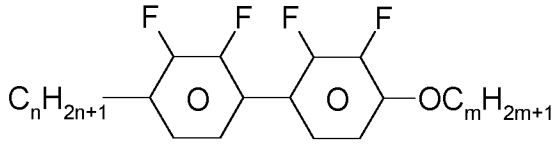

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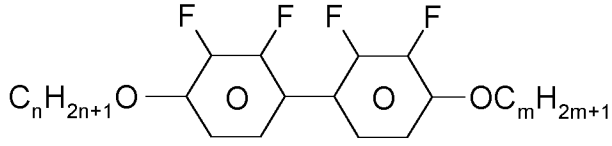

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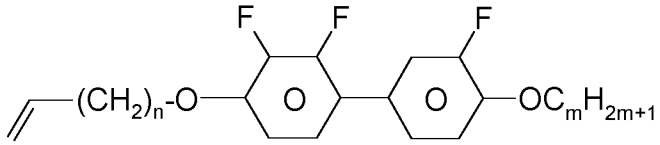

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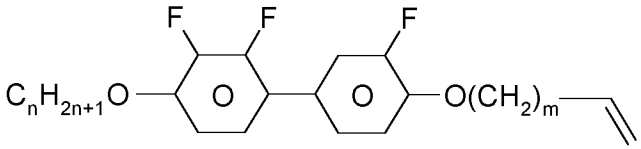

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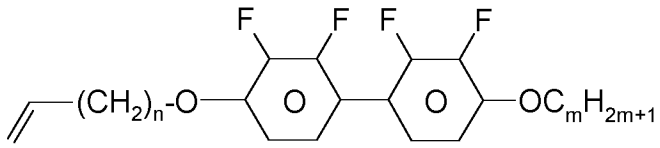

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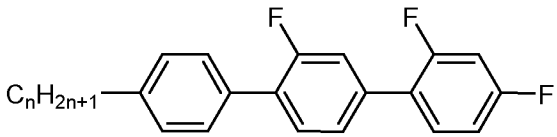


PGIGI-n-F

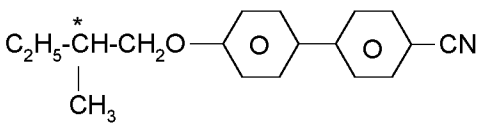
The liquid-crystal mixtures which can be used in accordance with the invention are prepared in a manner which is conventional per se. In general, the desired amount of the components used in lesser amount is dissolved in the components making up the principal constituent, advantageously at elevated temperature. It is also possible to mix solutions of the components in an organic solvent, for example in acetone, chloroform or methanol, and to remove the solvent again, for example by distillation, after thorough mixing.

The dielectrics may also comprise further additives known to the person skilled in the art and described in the literature, such as, for example, UV absorbers, antioxidants, nanoparticles and free-radical scavengers. For example, stabilisers or chiral dopants may be added. Suitable stabilisers for the mixtures according to the invention are, in particular, those listed in Table B.

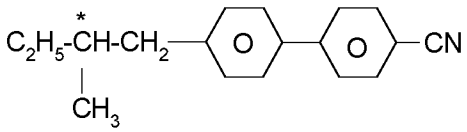
For example, conductive salts, preferably ethyldimethyldodecylammonium 4-hexoxybenzoate, tetrabutylammonium tetraphenylboranate or complex salts of crown ethers (cf., for example, Haller et al., Mol. Cryst. Liq. Cryst., Volume 24, pages 249-258 (1973)), may be added in order to improve the conductivity or substances may be added in order to modify the dielectric anisotropy, the viscosity and/or the alignment of the nematic phases. Substances of this type are described, for example, in DE-A 22 09 127, 22 40 864, 23 21 632, 23 38 281, 24 50 088, 26 37 430 and 28 53 728.

Table B

Table B shows possible dopants which are generally added to the mixtures according to the invention. The mixtures preferably comprise 0-10% by weight, in particular 0.01-5% by weight and particularly preferably 0.01-3% by weight of dopants. If the mixtures comprise only one dopant, it is employed in amounts of 0.01-4% by weight, preferably 0.1-1.0% by weight.



C 15



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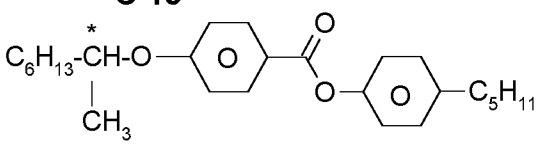
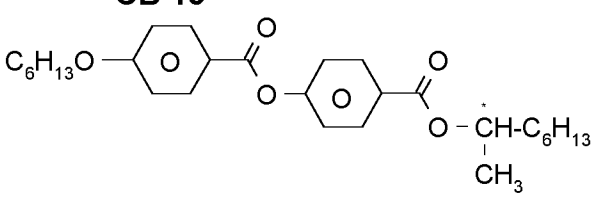
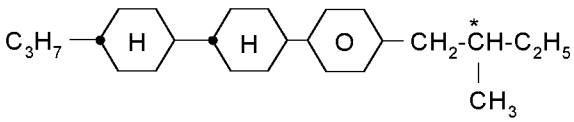


CM 21



R/S-811



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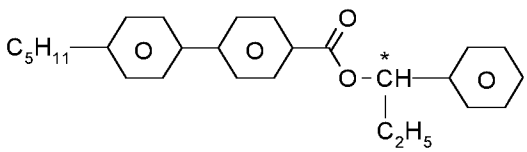
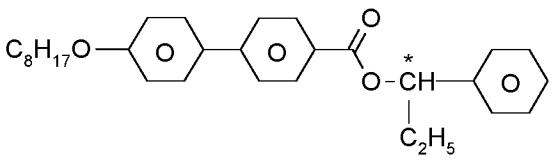


CM 45



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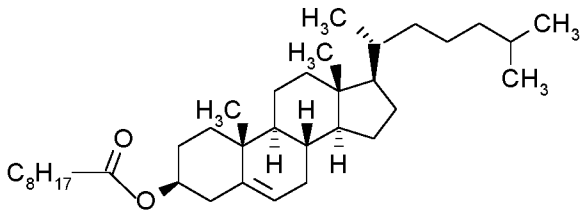

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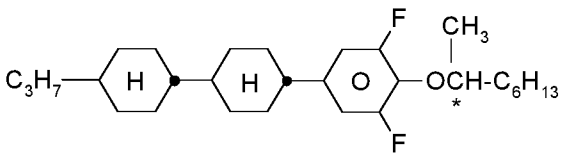
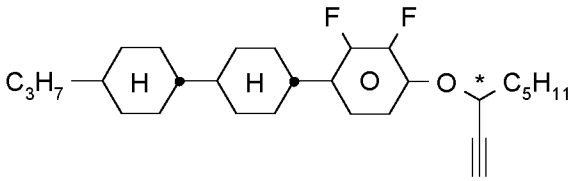


R/S-2011



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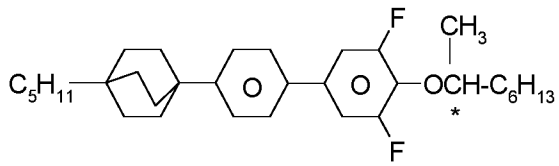

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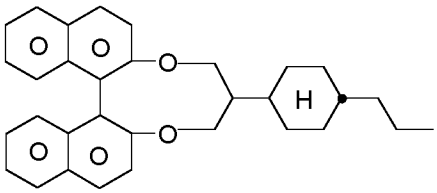
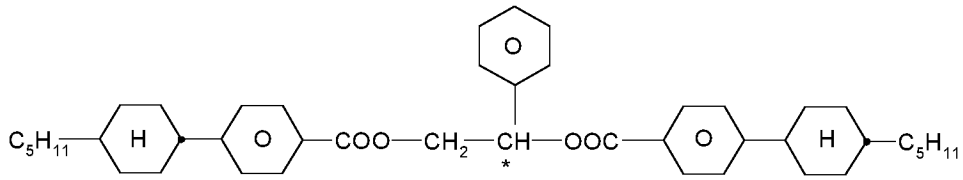


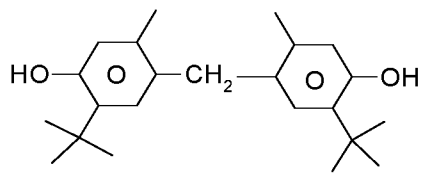
R/S-5011

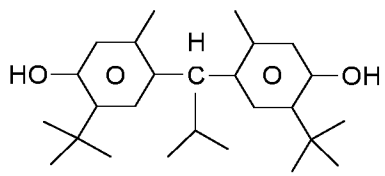


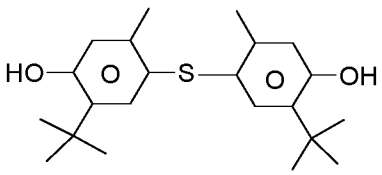
R/S-1011

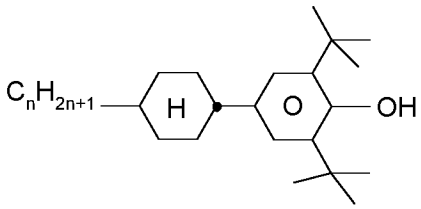
Table C

Stabilisers which can be added, for example, to the mixtures according to the invention in amounts of 0-10% by weight are shown below.

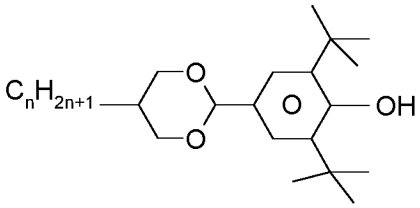








n = 1, 2, 3, 4, 5, 6 or 7



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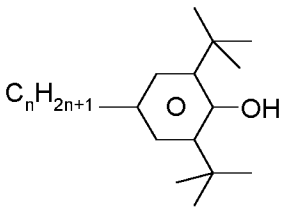

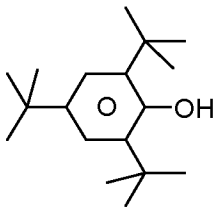

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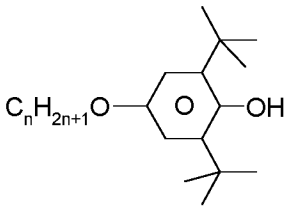
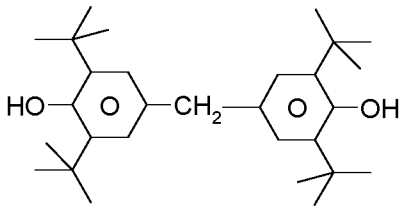
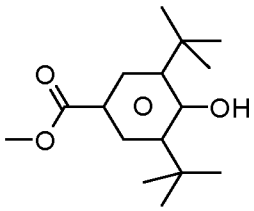
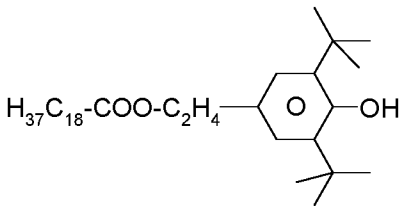
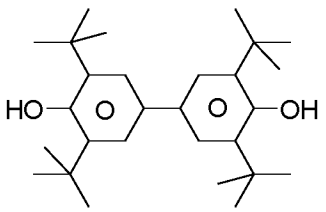
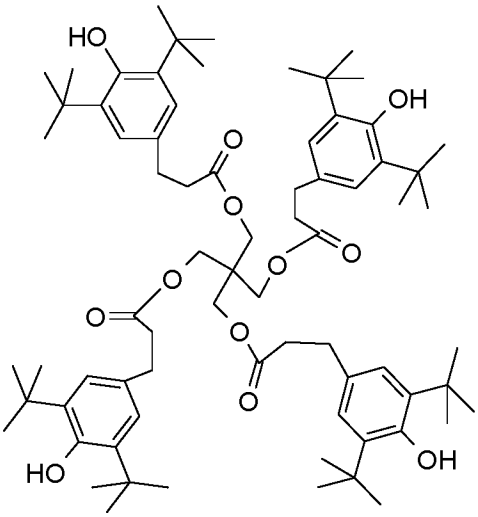


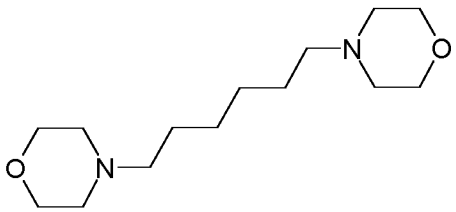


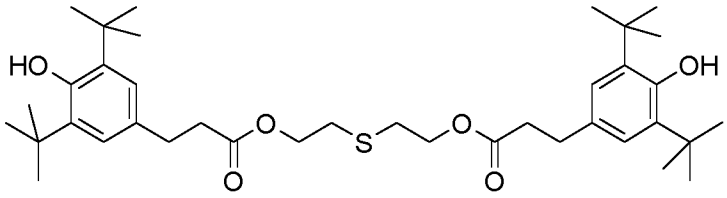


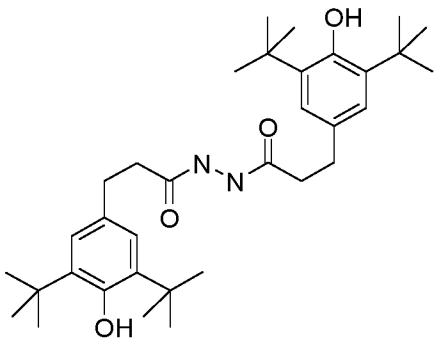


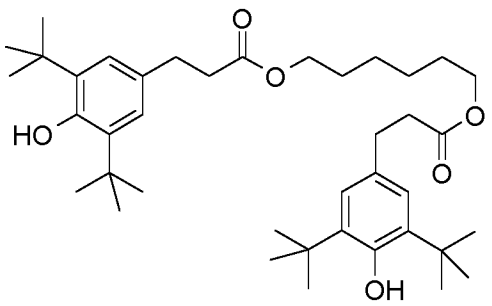


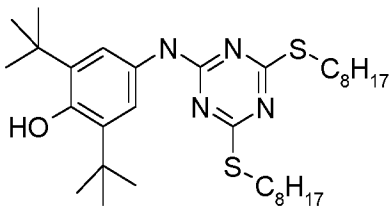


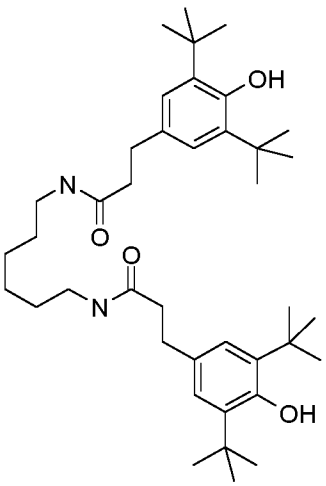


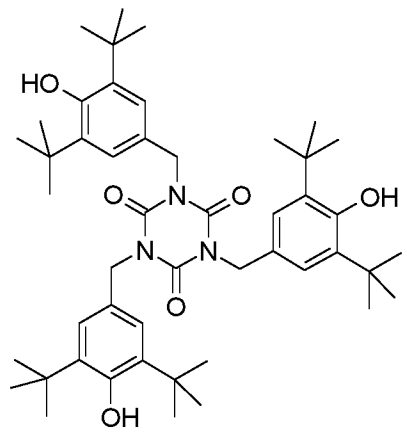


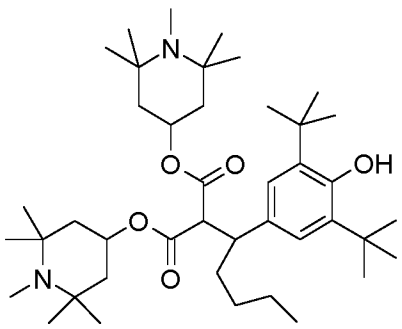


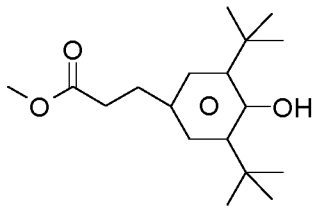


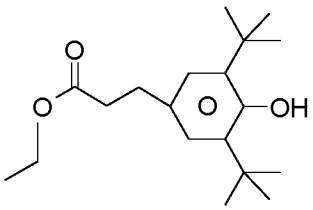


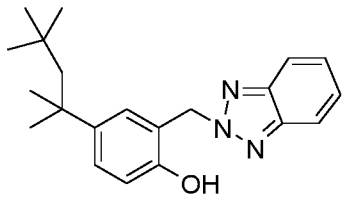


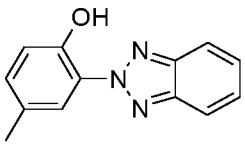


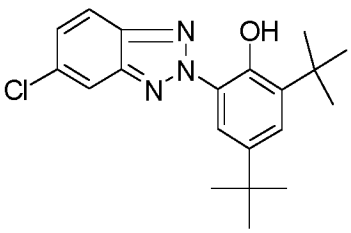


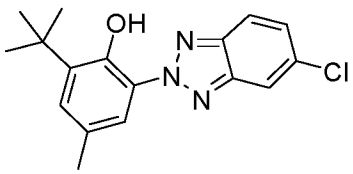


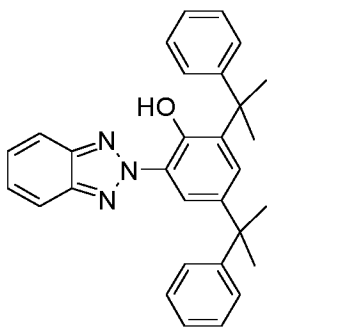


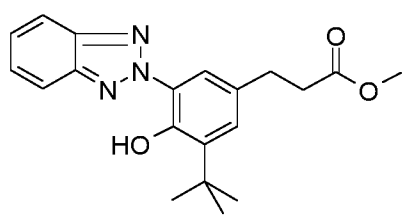


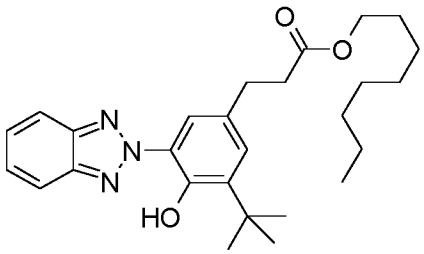


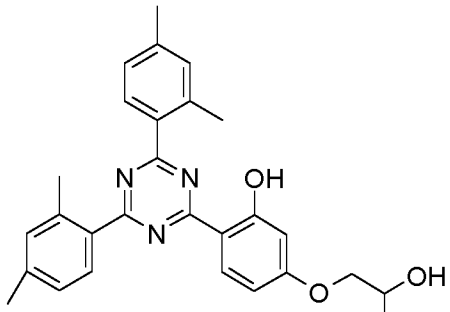


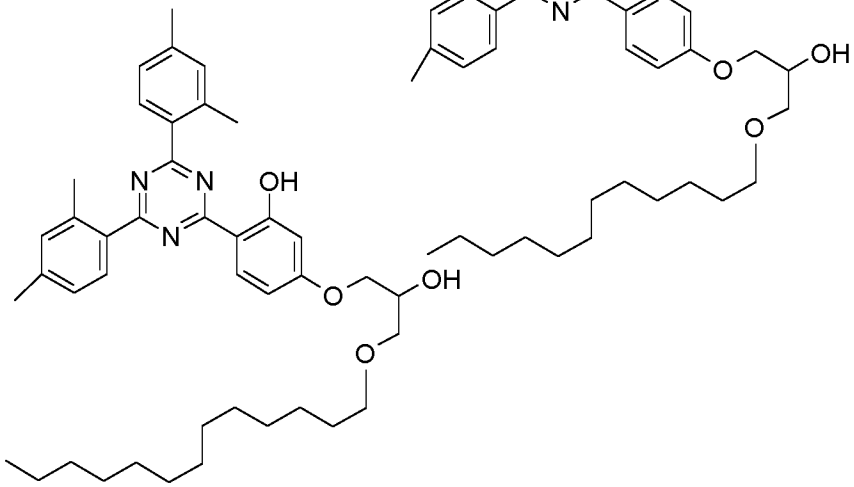


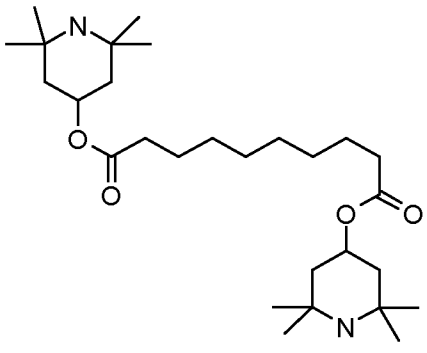


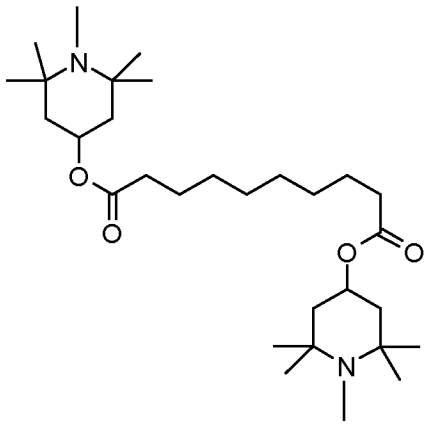


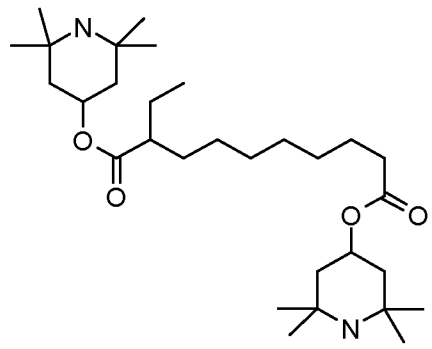


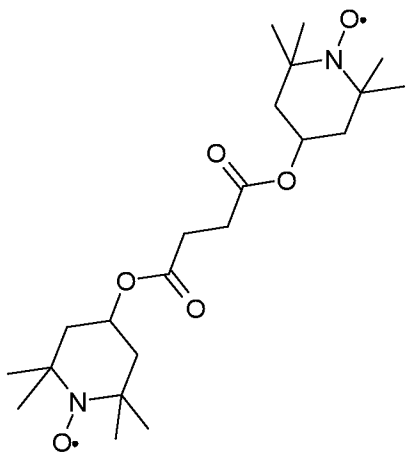


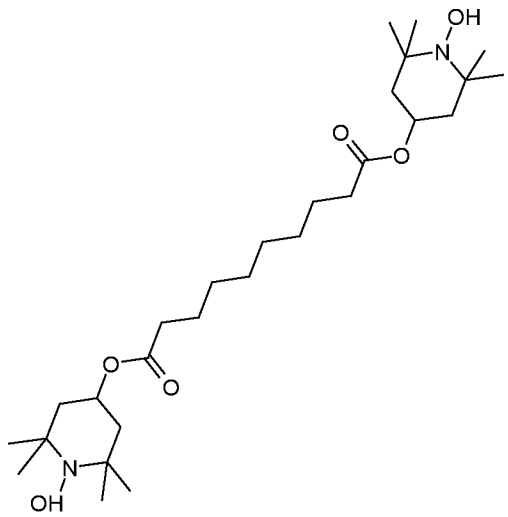








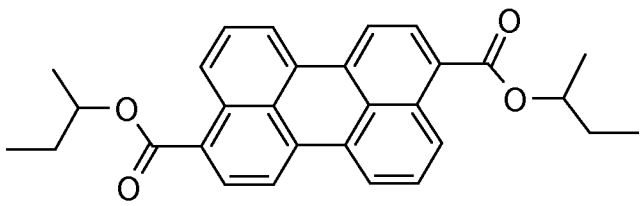


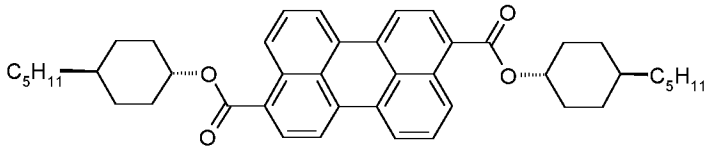


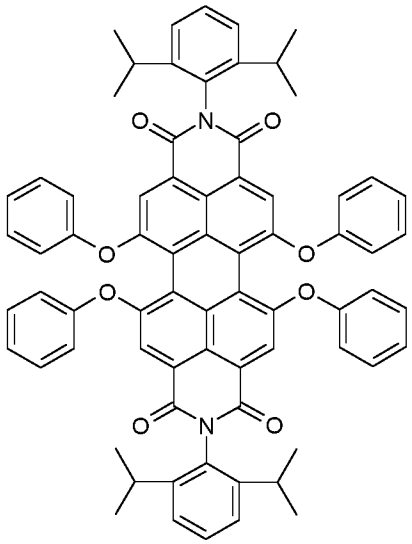
The medium according to the invention particularly preferably comprises Tinuvin® 770 (bis(2,2,6,6-tetramethyl-4-piperidyl) sebacate), preferably in amounts of 0.001 – 5% by weight, based on the liquid-crystalline medium.

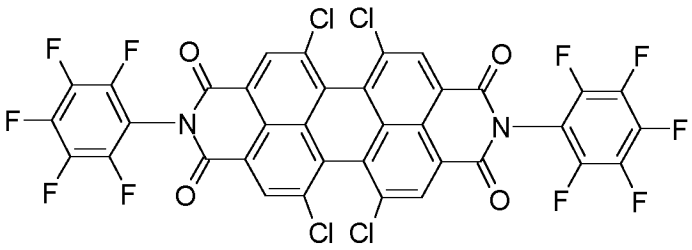
Examples of preferred further dichroic dyes which may be used in the liquid crystalline media according to the invention are listed in Table D:

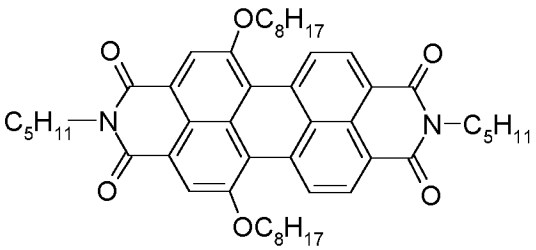
Table D

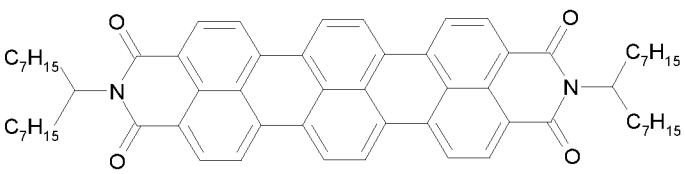


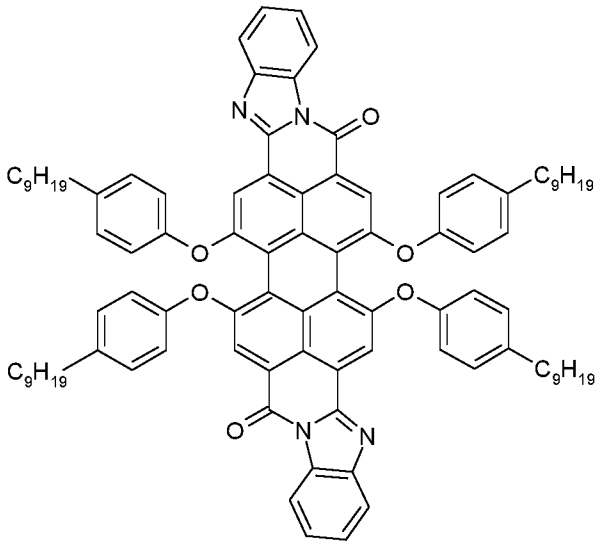


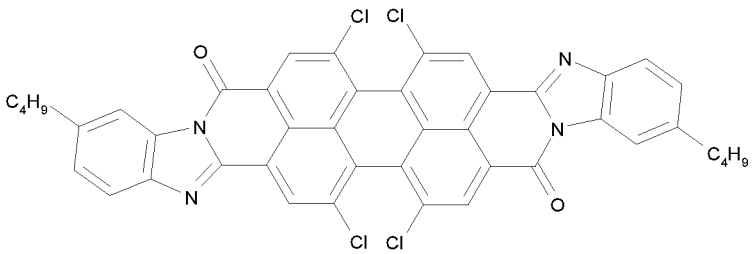


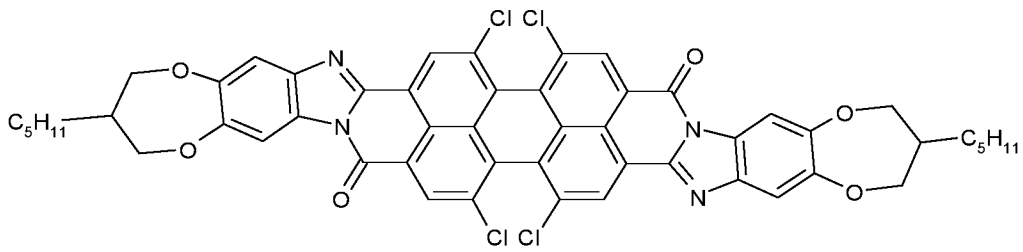


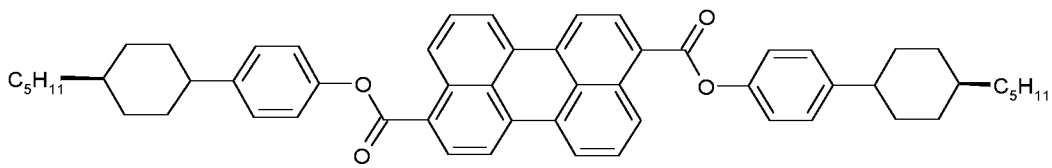


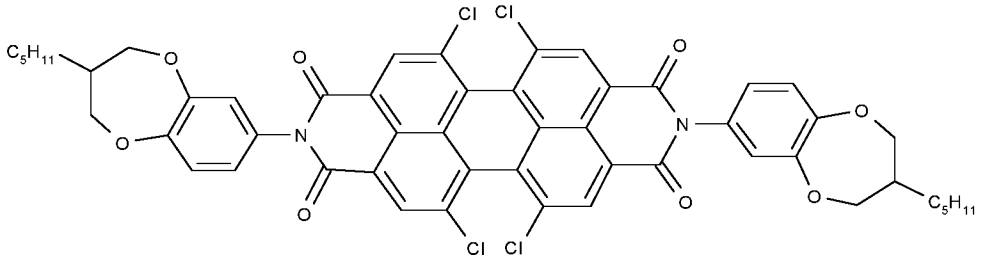


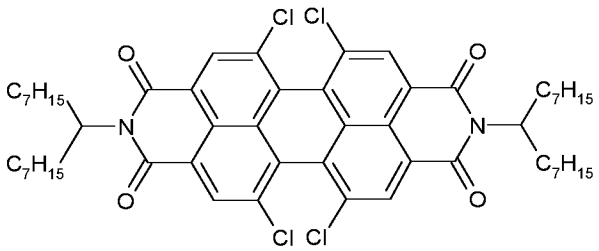


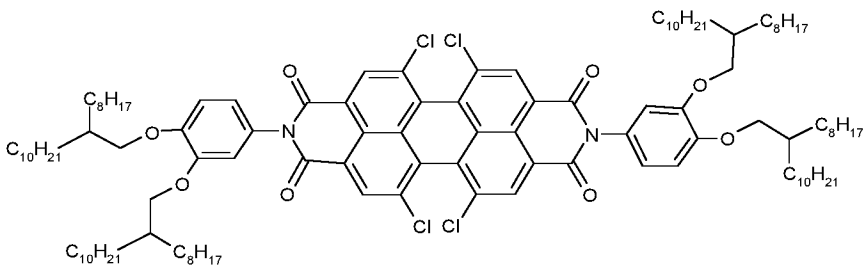


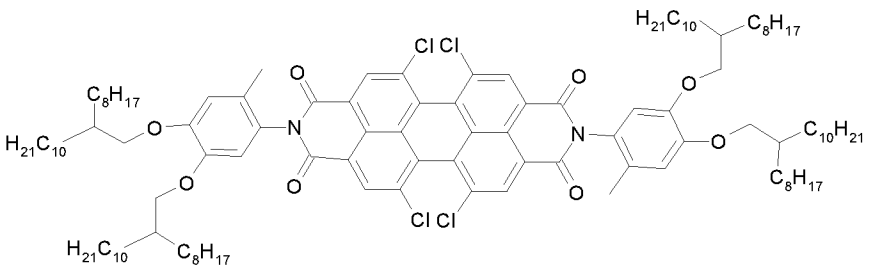


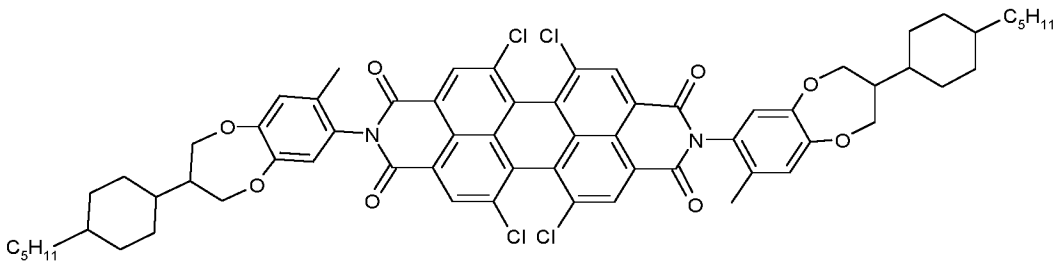


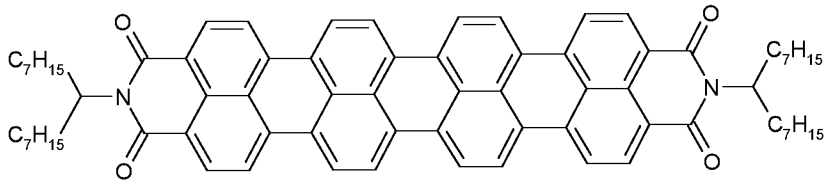


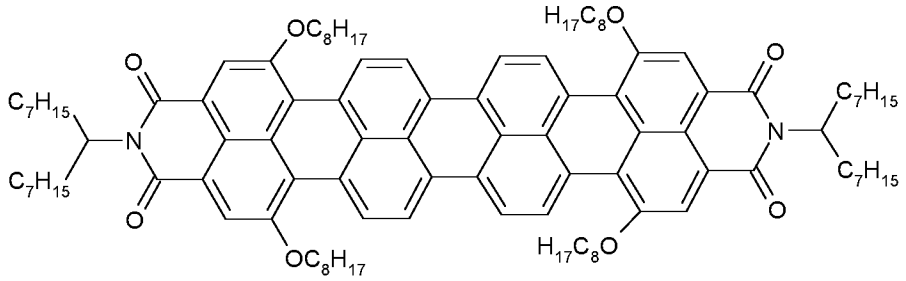


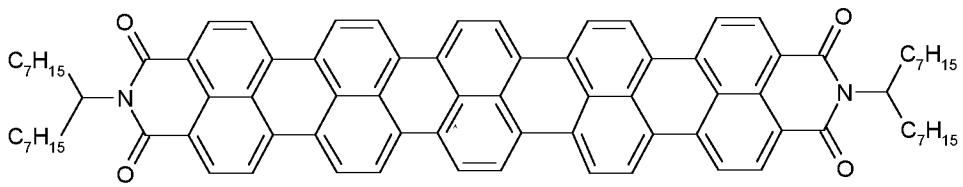


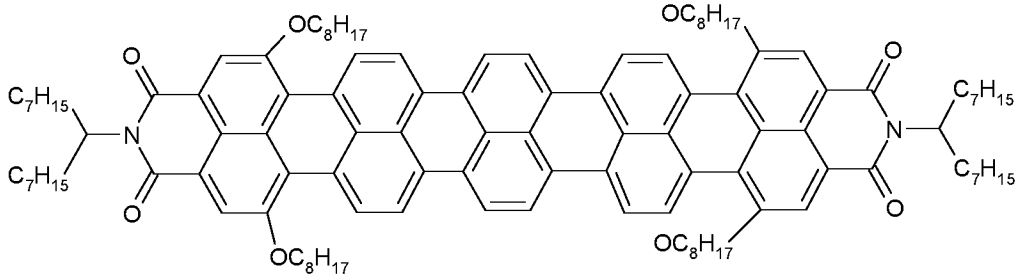


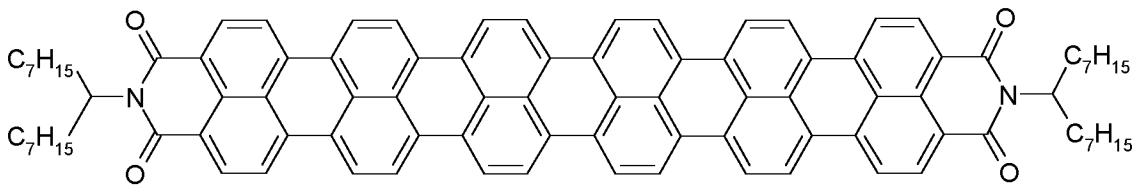


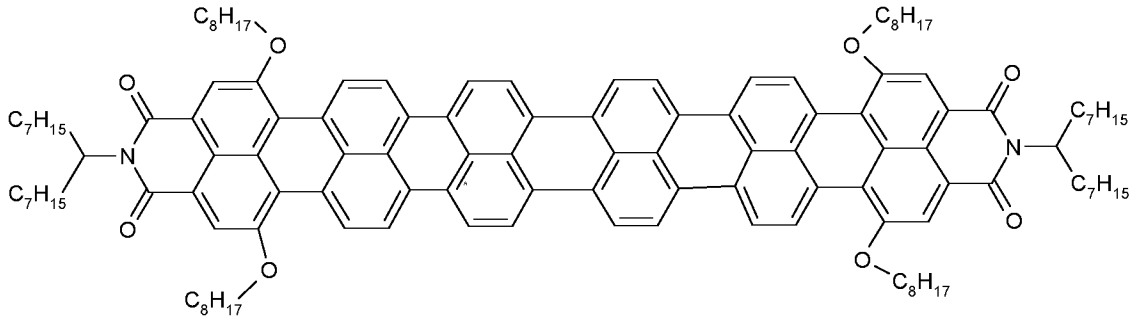


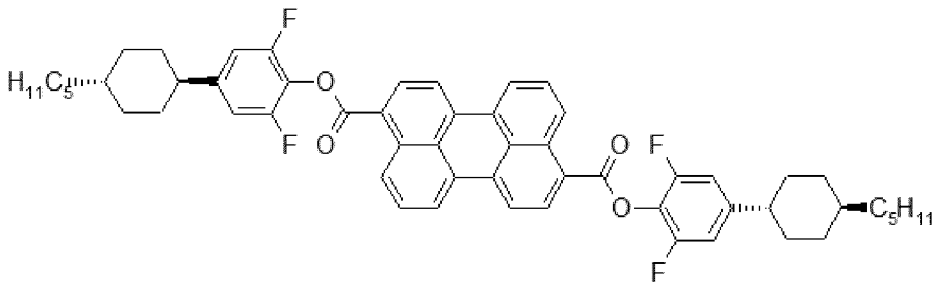


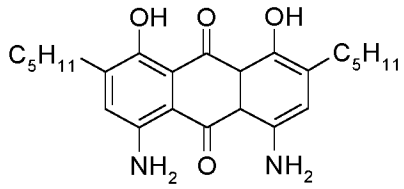


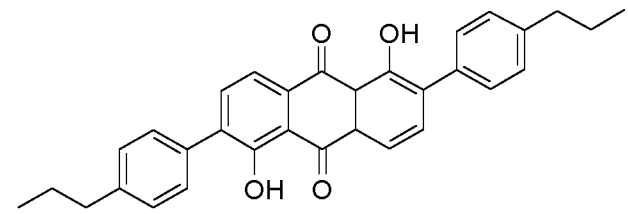


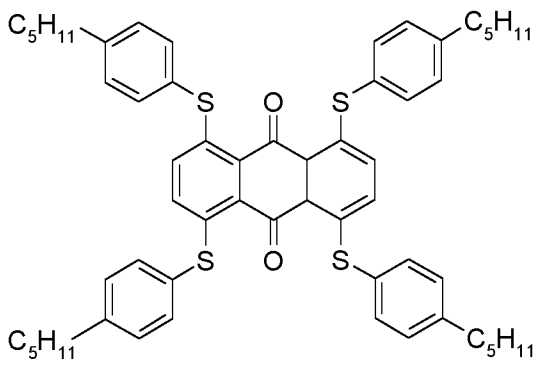


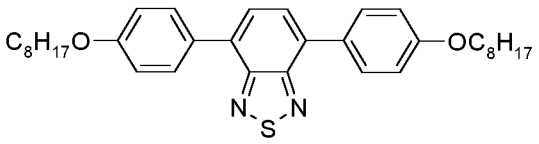


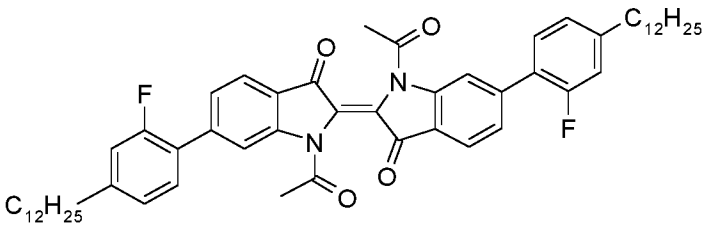












Working examples:

The following examples are intended to explain the invention without limiting it. In the examples, m.p. denotes the melting point and C denotes the clearing point of a liquid-crystalline substance in degrees Celsius; boiling temperatures are denoted by b.p. Furthermore:

C denotes crystalline solid state, S denotes smectic phase (the index denotes the phase type), N denotes nematic state, Ch denotes cholesteric phase, I denotes isotropic phase, T_g denotes glass-transition temperature. The number between two symbols indicates the conversion temperature in degrees Celsius.

The host mixture used for determination of the optical anisotropy Δn of the compounds of the formula I is the commercial mixture ZLI-4792 (Merck KGaA). The dielectric anisotropy $\Delta\varepsilon$ is determined using commercial mixture ZLI-2857. The physical data of the compound to be investigated are obtained from the change in the dielectric constants of the host mixture after addition of the compound to be investigated and extrapolation to 100% of the compound employed. In general, 10% of the compound to be investigated are dissolved in the host mixture, depending on the solubility.

Unless indicated otherwise, parts or per cent data denote parts by weight or per cent by weight based on the mixture as a whole.

Above and below, the symbols and abbreviations have the following meanings:

V_o	threshold voltage, capacitive [V] at 20°C
Δn	the optical anisotropy measured at 20°C and 589 nm
$\Delta\varepsilon$	the dielectric anisotropy at 20°C and 1 kHz
cl.p.	clearing point [°C]
K_1	elastic constant, "splay" deformation at 20°C [pN]
K_3	elastic constant, "bend" deformation at 20°C [pN]
γ_1	rotational viscosity measured at 20°C [mPa·s], determined by the rotation method in a magnetic field
LTS	low-temperature stability (nematic phase), determined in test cells.

The display used for measurement of the threshold voltage has two plane-parallel outer plates at a separation of 20 µm and electrode layers with alignment layers comprising SE-1211 (Nissan Chemicals) on top on the insides of the outer plates, which effect a homeotropic alignment of the liquid crystals.

All concentrations in this application, unless explicitly indicated otherwise, relate to the corresponding mixture or mixture component. All physical properties are determined in accordance with "Merck Liquid Crystals, Physical Properties of Liquid Crystals", status November 1997, Merck KGaA, Germany, and apply to a temperature of 20°C, unless explicitly indicated otherwise.

Mixture Examples

The nematic host mixtures H1 to H5 are prepared as follows:

Mixture H1

CBC-33	3.0 %	Clearing point [°C]:	112.5
CBC-33F	3.0 %	Δn [589 nm, 20°C]:	0.1995
CCY-3-O1	3.0 %	$\Delta\varepsilon$ [1 kHz, 20°C]:	-4.9
CCY-3-O2	11.0 %	$\varepsilon_{\parallel}$ [1 kHz, 20°C]:	4.1
CPY-2-O2	12.0 %	K_1 [pN, 20°C]:	18.0
CPY-3-O2	12.0 %	K_3 [pN, 20°C]:	22.8
PGIGI-3-F	8.0 %		
PY-3-O2	20.0 %		
PYP-2-3	14.0 %		
PYP-2-4	14.0 %		

Mixture H2

PCH-3	10.0 %	Clearing point [°C]:	100.5
CBC-33	3.0 %	Δn [589 nm, 20°C]:	0.1865
CBC-33F	2.0 %	$\Delta\varepsilon$ [1 kHz, 20°C]:	-1.4
CCY-3-O1	3.0 %	$\varepsilon_{\parallel}$ [1 kHz, 20°C]:	7.4
CCY-3-O2	10.0 %	K_1 [pN, 20°C]:	13.5
CPY-2-O2	11.0 %	K_3 [pN, 20°C]:	18.8
CPY-3-O2	11.0 %	γ_1 [mPa·s, 20°C]:	65
PGIGI-3-F	7.0 %		
PY-3-O2	18.0 %		
PYP-2-3	13.0 %		
PYP-2-4	12.0 %		

Mixture H3

PCH-3	6.0 %	Clearing point [°C]:	102
CCY-3-O1	8.0 %	Δn [589 nm, 20°C]:	0.1880
CCY-3-O2	11.0 %	$\Delta\varepsilon$ [1 kHz, 20°C]:	-3.1

	CPY-2-O2	12.0 %	$\varepsilon_{\parallel}$ [1 kHz, 20°C]:	6.2
	CPY-3-O2	12.0 %	K_1 [pN, 20°C]:	13.9
	PGIGI-3-F	8.0 %	K_3 [pN, 20°C]:	19.3
	PY-3-O2	15.0 %	V_0 [20°C, V]:	2.65
	PYP-2-3	14.0 %		
	PYP-2-4	14.0 %		

Mixture H4

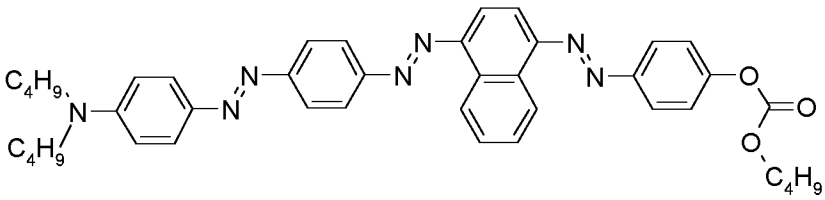
	PCH-3	6.0 %	Clearing point [°C]:	102
	CCY-3-O2	8.0 %	Δn [589 nm, 20°C]:	0.2252
	CPTY-3-O2	8.0 %	$\Delta\varepsilon$ [1 kHz, 20°C]:	-2.8
	CPTY-5-O2	7.0 %	$\varepsilon_{\parallel}$ [1 kHz, 20°C]:	6.3
	CPY-2-O2	6.0 %		
	CPY-3-O2	6.0 %		
	CY-3-O2	12.0 %		
	PYP-2-3	12.0 %		
	PYP-2-4	10.0 %		
	PTP-1-O2	5.0 %		
	PTP-2-O1	5.0 %		
	PTY-3-O2	15.0 %		

Mixture H5

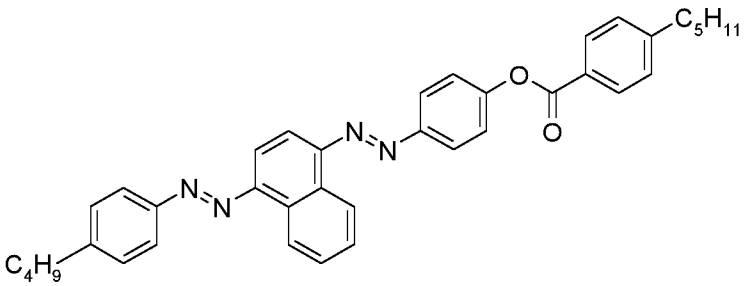
	PCH-3	6.0 %	Clearing point [°C]:	111
	CCY-3-O1	8.0 %	Δn [589 nm, 20°C]:	0.1912
	CCY-3-O2	11.0 %	$\Delta\varepsilon$ [1 kHz, 20°C]:	-2.9
	CPY-2-O2	12.0 %	$\varepsilon_{\parallel}$ [1 kHz, 20°C]:	6.1
	CPY-3-O2	15.0 %		
	PGIGI-3-F	8.0 %		
	PY-3-O2	10.0 %		
	PYP-2-3	15.0 %		
	PYP-2-4	15.0 %		

From the host mixtures H1 to H5, Mixture Examples M1 to M9 are prepared having the compositions given in the tables below, using a dye

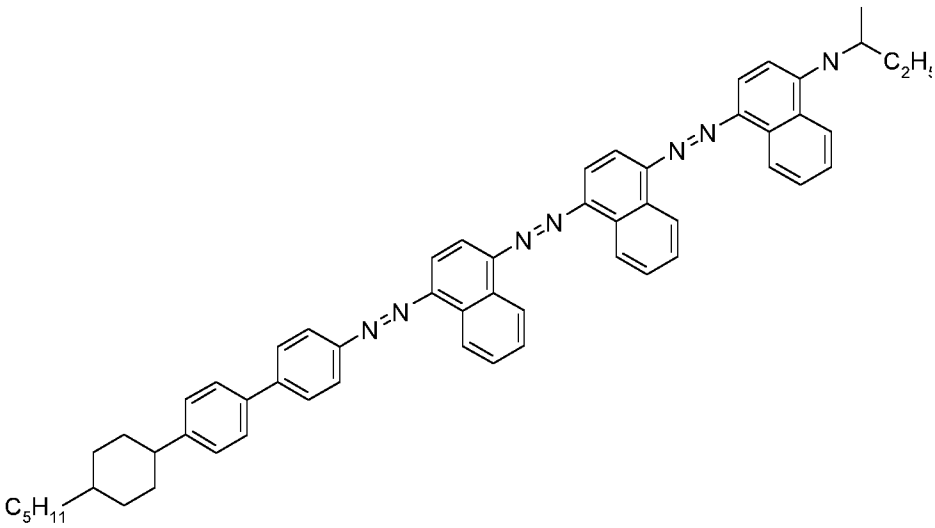
mixture consisting of the following components Dye-1, Dye-2 and Dye-3, whose different absorption characteristics together result in a black colour, and further the ionic liquids IL-1 or IL-2, and stabiliser additives Add-1 or Add-2.



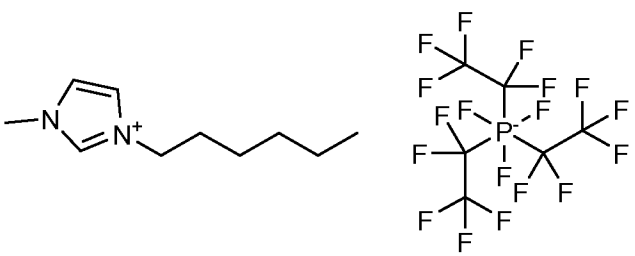
Dye-1



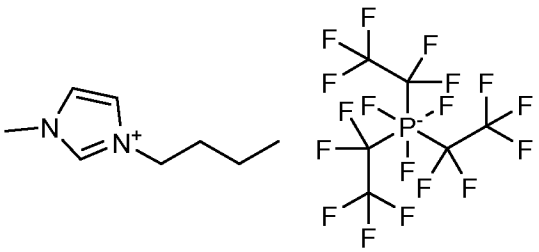
Dye-2



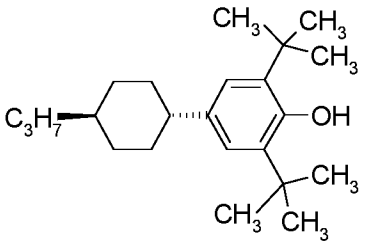
Dye-3



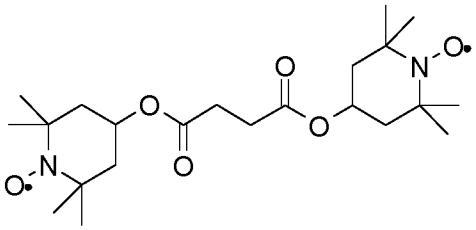
IL-1



IL-2



ST-3a-1



ST-9-1

Example M1

component	weight proportion
H1	100.0
Dye-1	0.338
Dye-2	0.511
Dye-3	0.950
IL-1	0.010

Example M2

component	weight proportion
H2	100.0
Dye-1	0.338
Dye-2	0.511
Dye-3	0.950
IL-1	0.010

Example M3

component	weight proportion
H3	100.0
Dye-1	0.338
Dye-2	0.511
Dye-3	0.950
IL-1	0.100

Example M4

component	weight proportion
H4	100.0
Dye-1	0.338
Dye-2	0.511
Dye-3	0.950
IL-1	0.010

Example M5

component	weight proportion
H5	100.0
Dye 1	0.338
Dye 2	0.511
Dye 3	0.950
IL-1	0.001

Example M6

component	weight proportion
H5	100.0
Dye 1	0.338
Dye 2	0.511
Dye 3	0.950
IL-1	0.010

Example M7

component	weight proportion
H5	100.0
Dye 1	0.338
Dye 2	0.511
Dye 3	0.950
IL-1	0.100

Example M8

component	weight proportion
H5	100.0
Dye 1	0.338
Dye 2	0.511
Dye 3	0.950
IL-1	0.010
ST-3a-1	0.100

Example M9

component	weight proportion
H5	100.0
Dye 1	0.338
Dye 2	0.511
Dye 3	0.950
IL-1	0.010
ST-9-1	0.100

Use Examples

Transmittance and haze are measured using a commercially available hazemeter (Model NDH7000SP II, Nippon Denshoku Industries Co., Ltd., Tokyo, Japan). A test cell (Cell gap: 10µm (spacer in cell area), cell size: 35 x 35 mm, electrode: patterned ITO (24x24) with orientation layers for homeotropic orientation (JALS 2096-R1, from JSR (Japan Synthetic Rubber, Japan)) is filled with the mixture M3 and the transmittance and haze are measured depending on the applied voltage (square wave, 60Hz, rms). The results is shown in Fig. 1 and Fig. 2.

The following values are observed:

total transmittance at 0V	64.6%
total transmittance at 60V	17.7%
total transmittance at 100V	13.4%
haze at 60V	95.8%
haze at 100V	95.7%
diffenrence in transmittance between on/off from 0V to 60V	49.9%
diffenrence in transmittance between on/off from 0V to 100V	51.2%

At a threshold voltage of 10V, switching from a transparent state with approx. 70% transmittance occurs. The transparency becomes less with increasing voltage and reaches a saturation level of ca. 40% to 35% transmittance at 20V to 60V. Here, virtually no haze is observed. At 60 V a second transition occurs where the haze increases from 0% to 95% at 80 V, which adds up to only 20% transmittance.

This effect is used to achieve for example a switchable window that can be dimmed from a first bright transparent state to a second darker transparent state and which can then further be switched to an opaque state useful e.g. in a privacy window with a relatively bright but instransparent third state.

The liquid-crystalline medium according to the invention comprising ionic liquids shows improved reliability compared to conventional media for dynamic scattering mode displays known from the state of the art.

Patent Claims

1. A Liquid-crystalline medium comprising
   - a nematic liquid-crystal host having negative dielectric anisotropy,
   - one or more dichroic dyes, and
   - one or more ionic liquids of formula I with a melting point below 100°C

$$A^+ B^- \qquad I$$

   in which

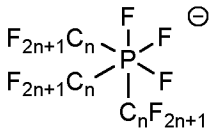
   A^+ denotes an organic cation,

   B^- denotes an organic or inorganic anion.

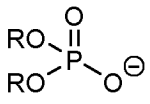
2. The liquid-crystalline medium according to claim 1, wherein the total concentration of the one or more ionic liquids of formula I is 0.25 % by weight or less.

3. The liquid-crystalline medium according to claim 1 or 2, wherein the one or more ionic liquids of formula I comprise a cation A^+ selected from the group consisting of imidazolium, pyridinium, pyrrolidinium, phosphonium, ammonium, guanidinium and isuronium.

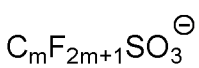
4. The liquid-crystalline medium according to one or more of claims 1 to 3, wherein the one or more ionic liquids of formula I comprise one or more anions of formulae B-1 to B-7



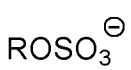
B-1



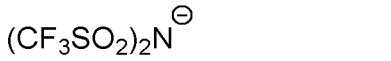
B-2



B-3

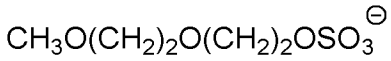


B-4



B-5

B-6



B-7

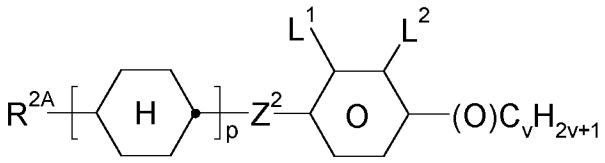
in which

n is an integer from 1 to 6,

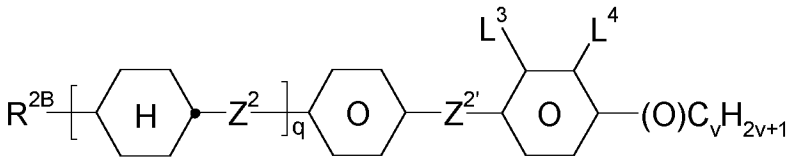
m is an integer from 1 to 10,

R denotes alkyl having 1 to 6 C atoms.

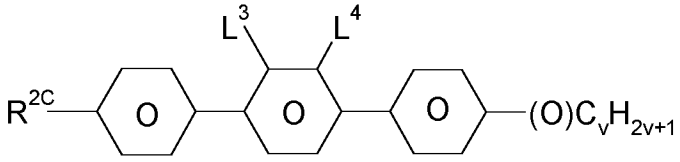
5. The liquid-crystalline medium according to one or more of claims 1 to 4, wherein the medium comprises one or more compounds selected from the group of the compounds of the formulae IIA, IIB and IIC,



IIA



IIB



IIC

in which

R^{2A}, R^{2B} and R^{2C} each, independently of one another, denote H, an alkyl or alkenyl radical having up to 15 C atoms which is unsubstituted, monosubstituted by CN or CF_3 or at least monosubstituted by halogen, where, in addition, one or

more CH_2 groups in these radicals may be replaced by -O-, -S-, -C≡C-, -CF_2O-, -OCF_2-, -OC-O- or -O-CO- in such a way that O atoms are not linked directly to one another, or a cycloalkyl ring having 3 to 6 C atoms,

L^{1-4} each, independently of one another, denote F, Cl, CF_3 or CHF_2,

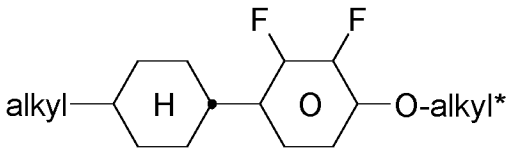
Z^2 and $Z^{2'}$ each, independently of one another, denote a single bond, -CH_2CH_2-, -CH=CH-, -C≡C-, -CF_2O-, -OCF_2-, -CH_2O-, -OCH_2-, -C(O)O-, -OC(O)-, -C_2F_4-, -CF=CF-, -CH=CHCH_2O-,

p denotes 1 or 2,

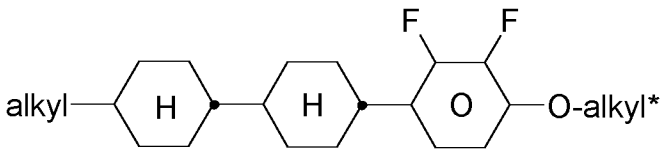
q denotes 0 or 1, and

v denotes 1 to 6.

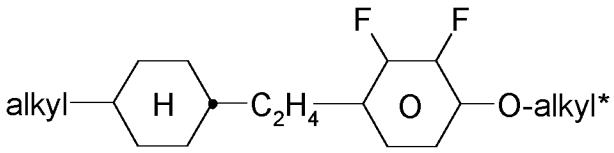
6. Liquid-crystalline medium according to one or more of claims 1 to 5, wherein the medium comprises one or more compounds of the following formulae:



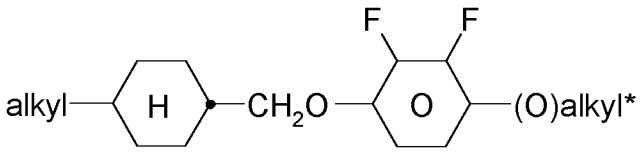
IIA-2



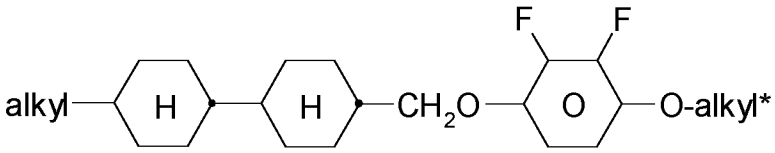
IIA-8



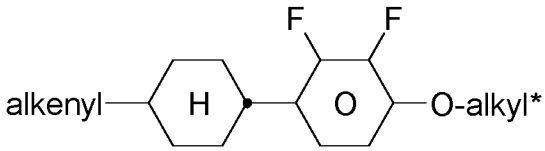
IIA-14



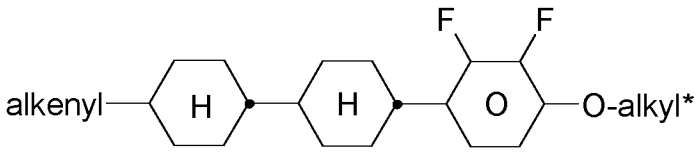
IIA-26



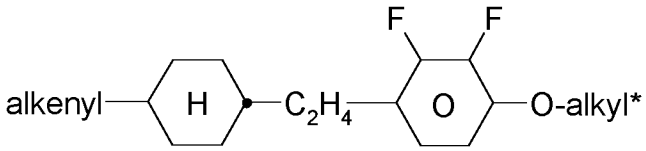
IIA-28



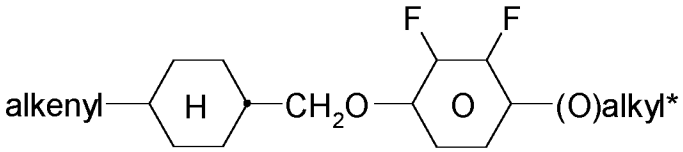
IIA-33



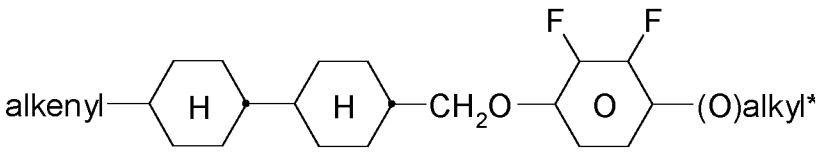
IIA-39



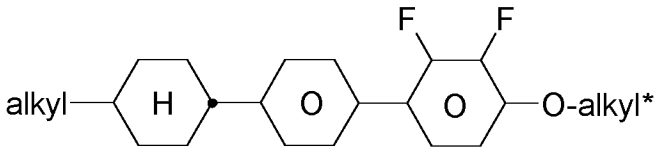
IIA-45



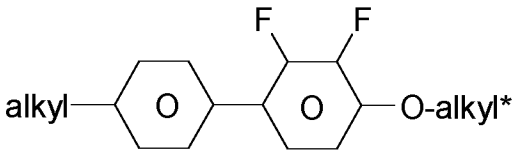
IIA-46



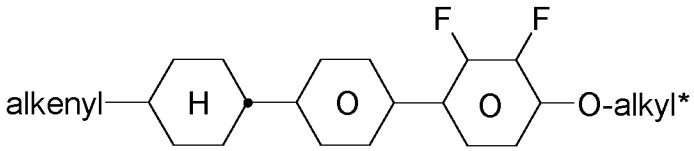
IIA-47



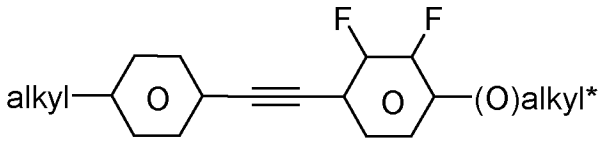
IIB-2



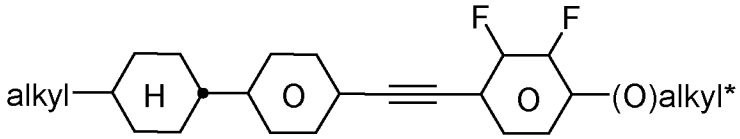
IIB-11



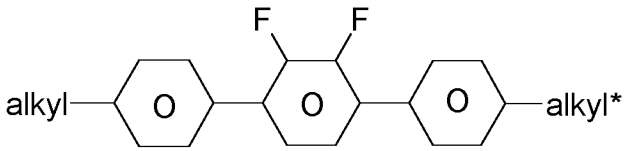
IIB-16



IIB-17



IIB-18

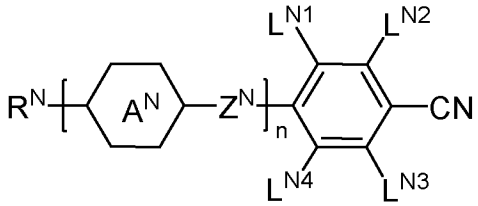


IIC-1

wherein

alkyl and alkyl*	each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms,
alkenyl	denotes a straight chain alkenyl radical having 2 to 6 C atoms, and
(O)	denotes -O- or a single bond.

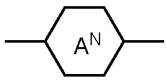
7. Liquid-crystalline medium according to one or more of claims 1 to 6, wherein the medium comprises one or more compounds of formula N,



N

wherein

R^N denotes alkyl or alkenyl having up to 12 C atoms, wherein one or more non adjacent CH_2 groups may be replaced by -O- and/or a cycloalkyl ring having 3 to 5 C atoms, and wherein one or more H atoms may be replaced by F,



on each occurrence, identically or differently, denotes

(a) a trans-1,4-cyclohexylene radical, in which one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S-,

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

(c) trans-1,4-cyclohexenylene,

(d) a radical from the group consisting of 1,4-bicyclo[2.2.2]octylene, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl and 1,2,3,4-tetra-hydronaphthalene-2,6-diyl,

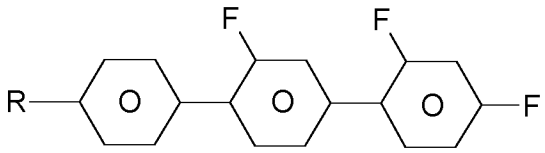
where the radicals (a) to (d) may be substituted by one or two fluorine atoms,

Z^N on each occurrence, independently of one another, -CO-O-, -O-CO-, $-CH_2O-$, $-OCH_2-$, $-CH_2CH_2-$, -CH=CH-, $-C\equiv C-$, $-(CH_2)_4-$, $-OCF_2-$, $-CF_2O-$, $-CF_2CF_2-$, or a single bond,

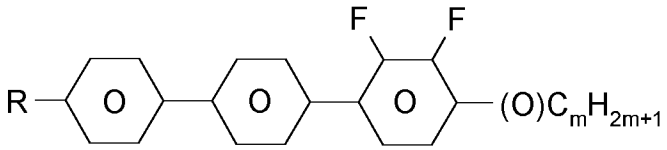
L^{N1}, L^{N2}, L^{N3} and L^{N4} each, independently of one another, denote H, Cl, or F,

n is 1, 2 or 3.

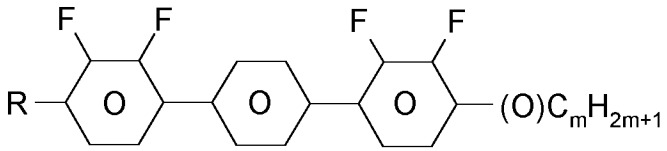
8. Liquid-crystalline medium according to one or more of Claims 1 to 7, characterised in that the medium additionally comprises one or more terphenyls of the formulae T-1 to T-21,



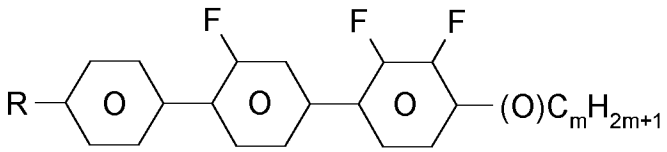
T-1



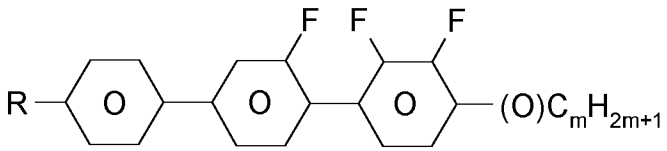
T-2



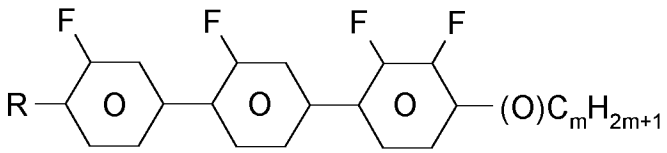
T-3



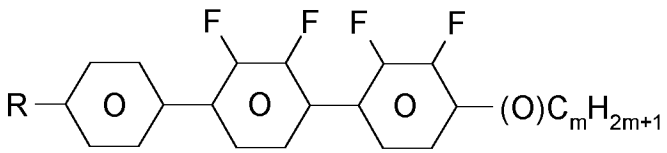
T-4



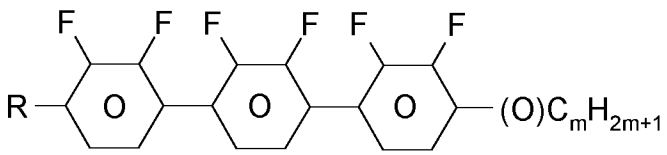
T-5



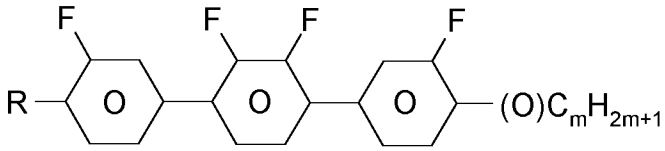
T-6



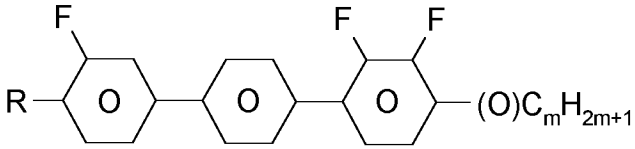
T-7



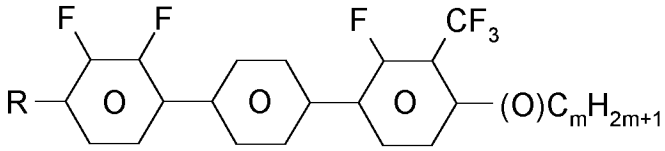
T-8



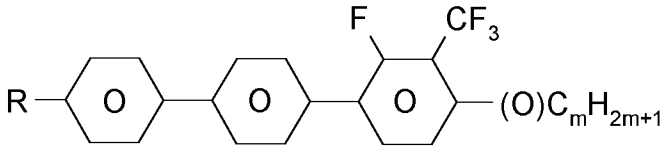
T-9



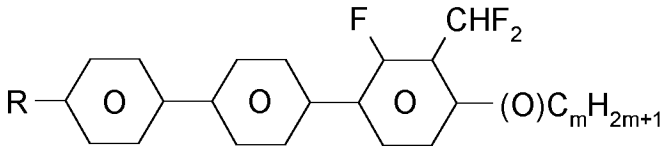
T-10



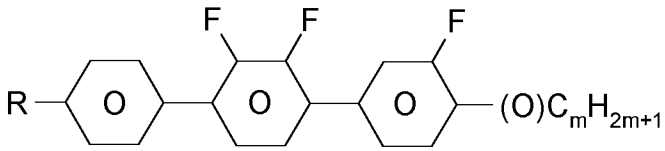
T-11



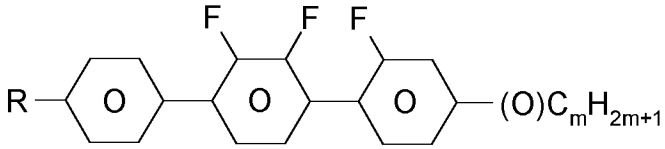
T-12



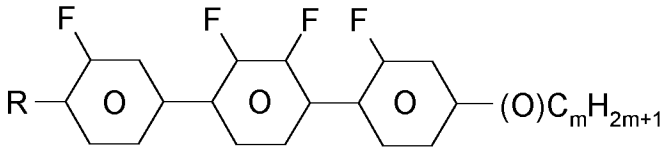
T-13



T-14



T-15



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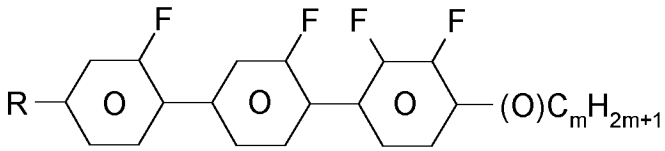

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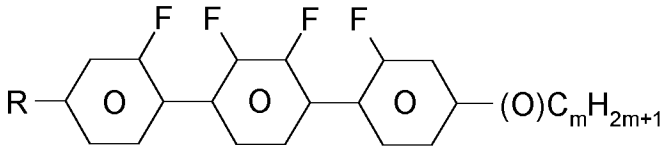
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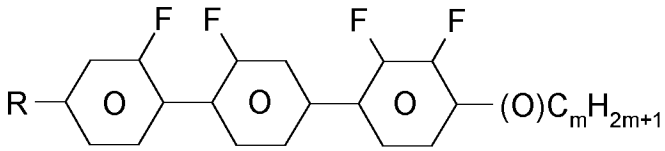
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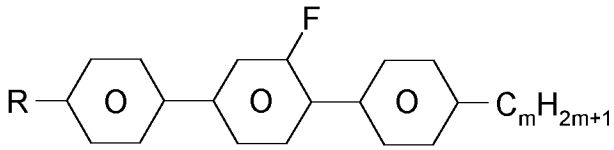
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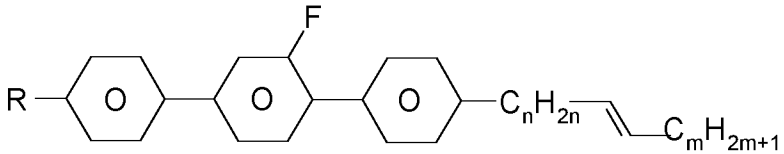
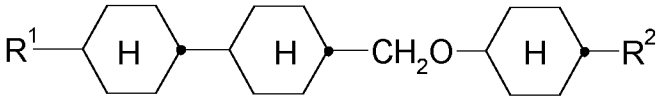

T-21

in which

R denotes a straight-chain alkyl or alkoxy radical having 1-7 C atoms or straight-chain alkenyl radical having 2-7 C atoms, and

m is an integer from 1 to 6.

9. Liquid-crystalline medium according to one or more of Claims 1 to 8, characterised in that the medium additionally comprises one or more compounds of the formulae O-1 to O-17,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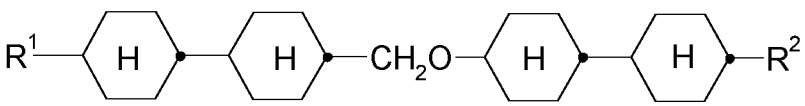
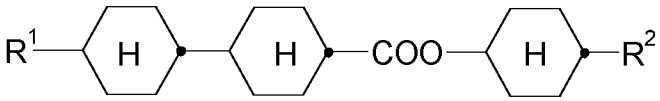

O-2



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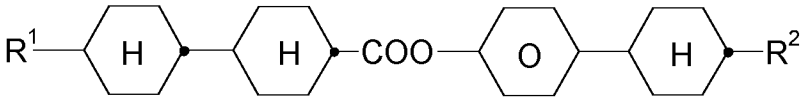

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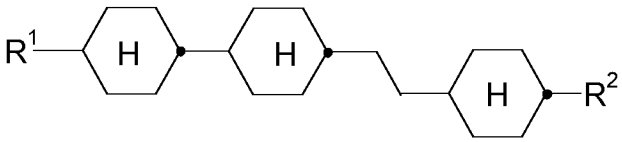
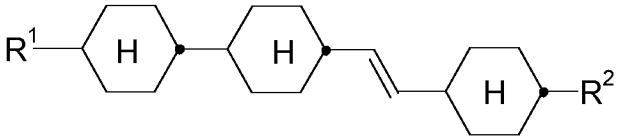
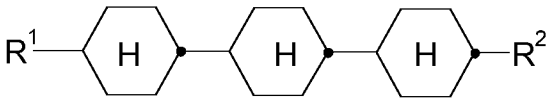


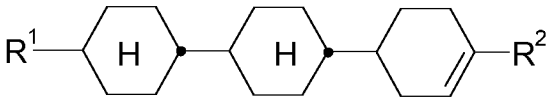
O-5



O-6



O-7



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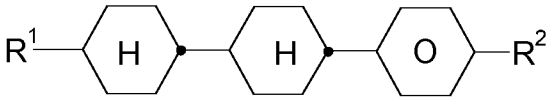

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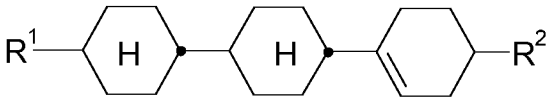
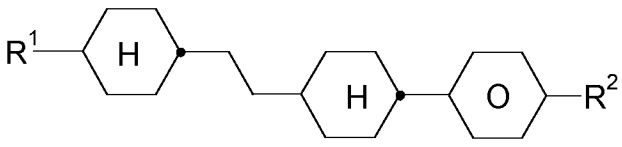
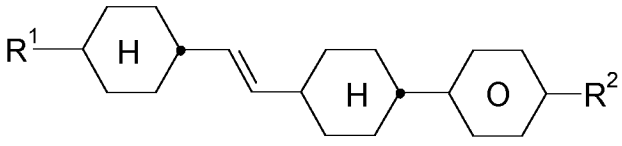


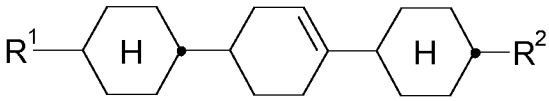
O-10



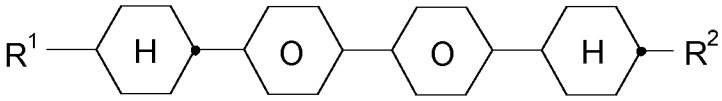
O-11



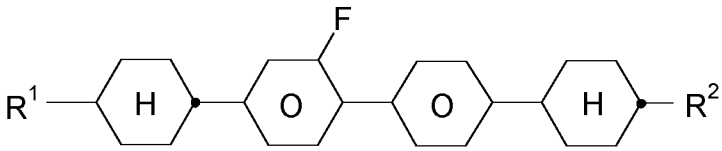
O-12



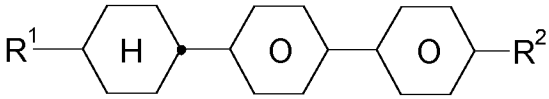
O-13



O-14



O-15

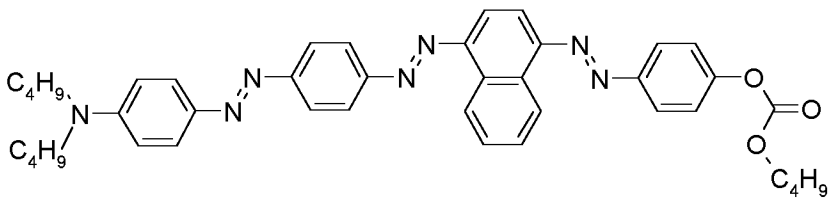


O-16

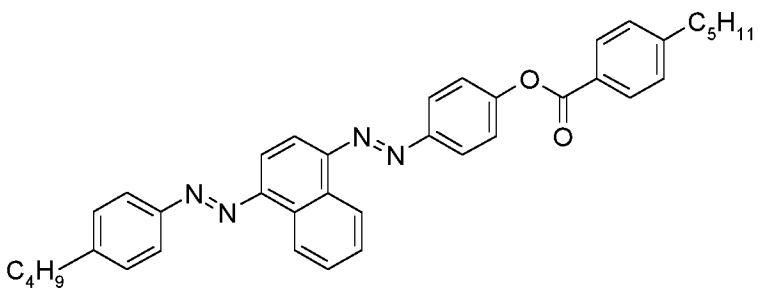
in which

R^1 and R^2 each, independently of one another, have the meanings indicated for R^{2A} in Claim 1.

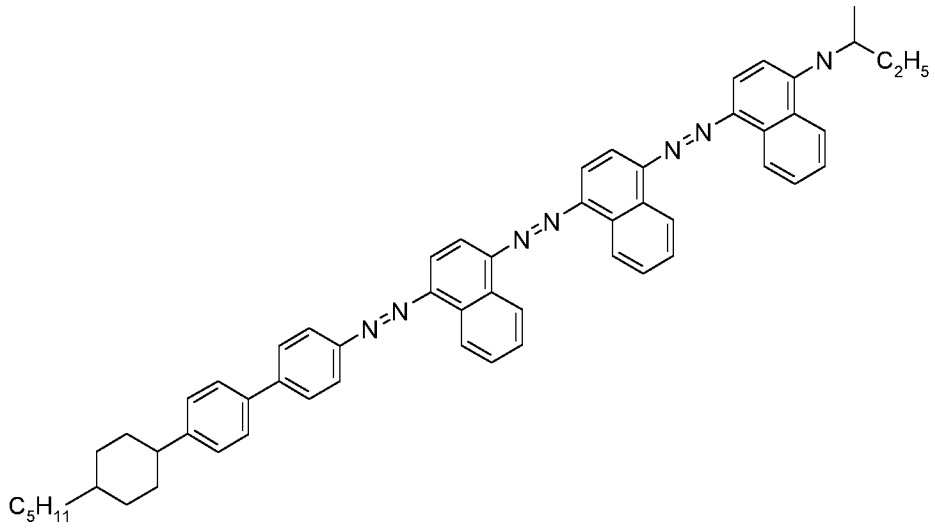
10. Liquid-crystalline medium according to one or more of claims 1 to 9, wherein the medium comprises one or more dichroic dyes selected from the group of compounds of the formulae



Dye-1

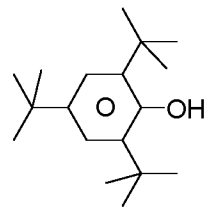


Dye-2

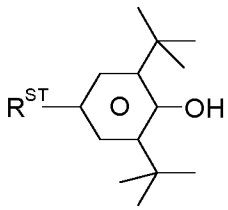


Dye-3.

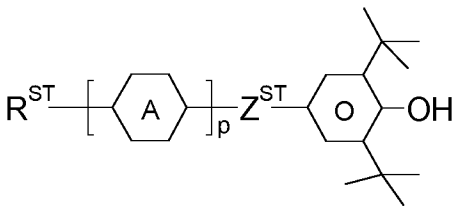
11. Liquid-crystalline medium according to one or more of claims 1 to 10, wherein the medium comprises one or more stabilisers selected from the group of compouns of formulae ST-1 to ST-17



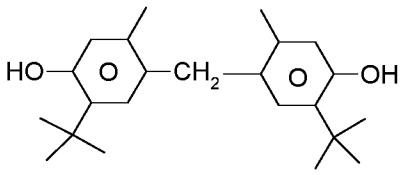
ST-1



ST-2



ST-3



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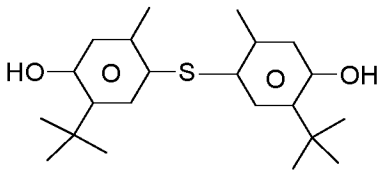
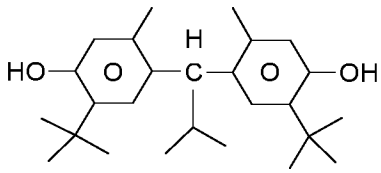
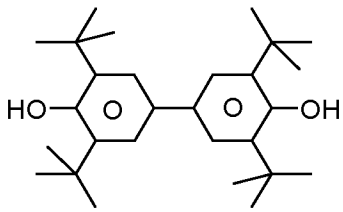


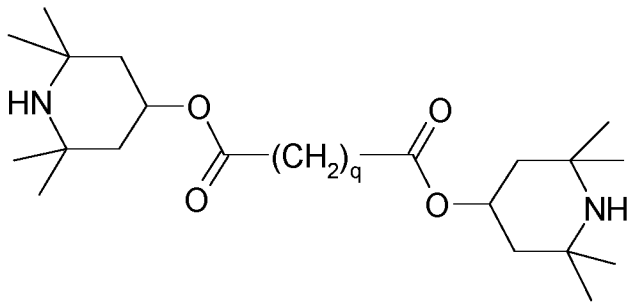
ST-5



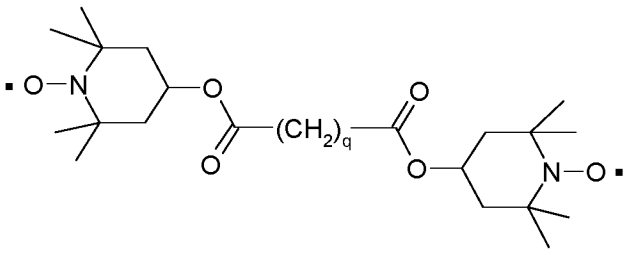
ST-6



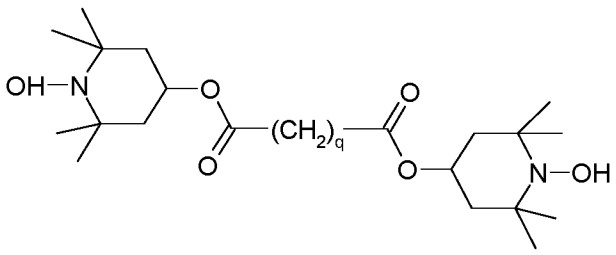
ST-7



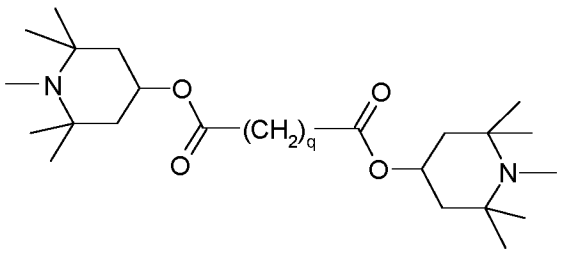
ST-8



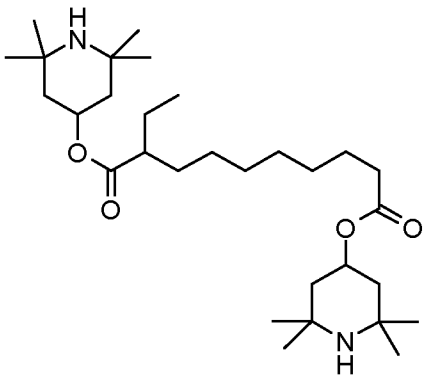
ST-9



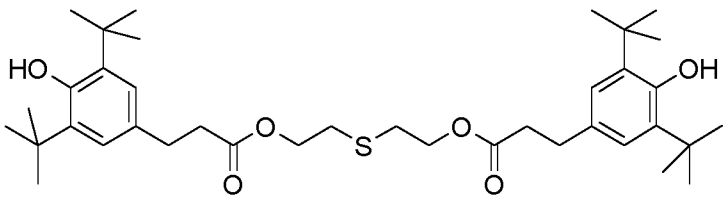
ST-10



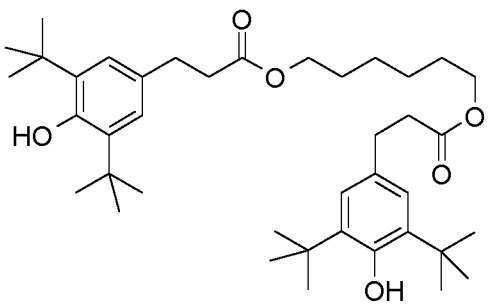
ST-11



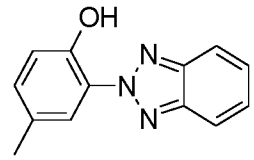
ST-12



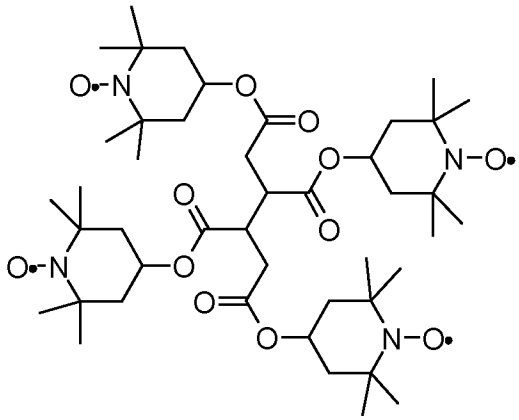
ST-13



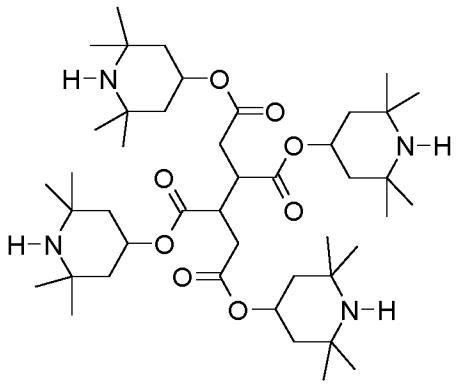
ST-14



ST-15



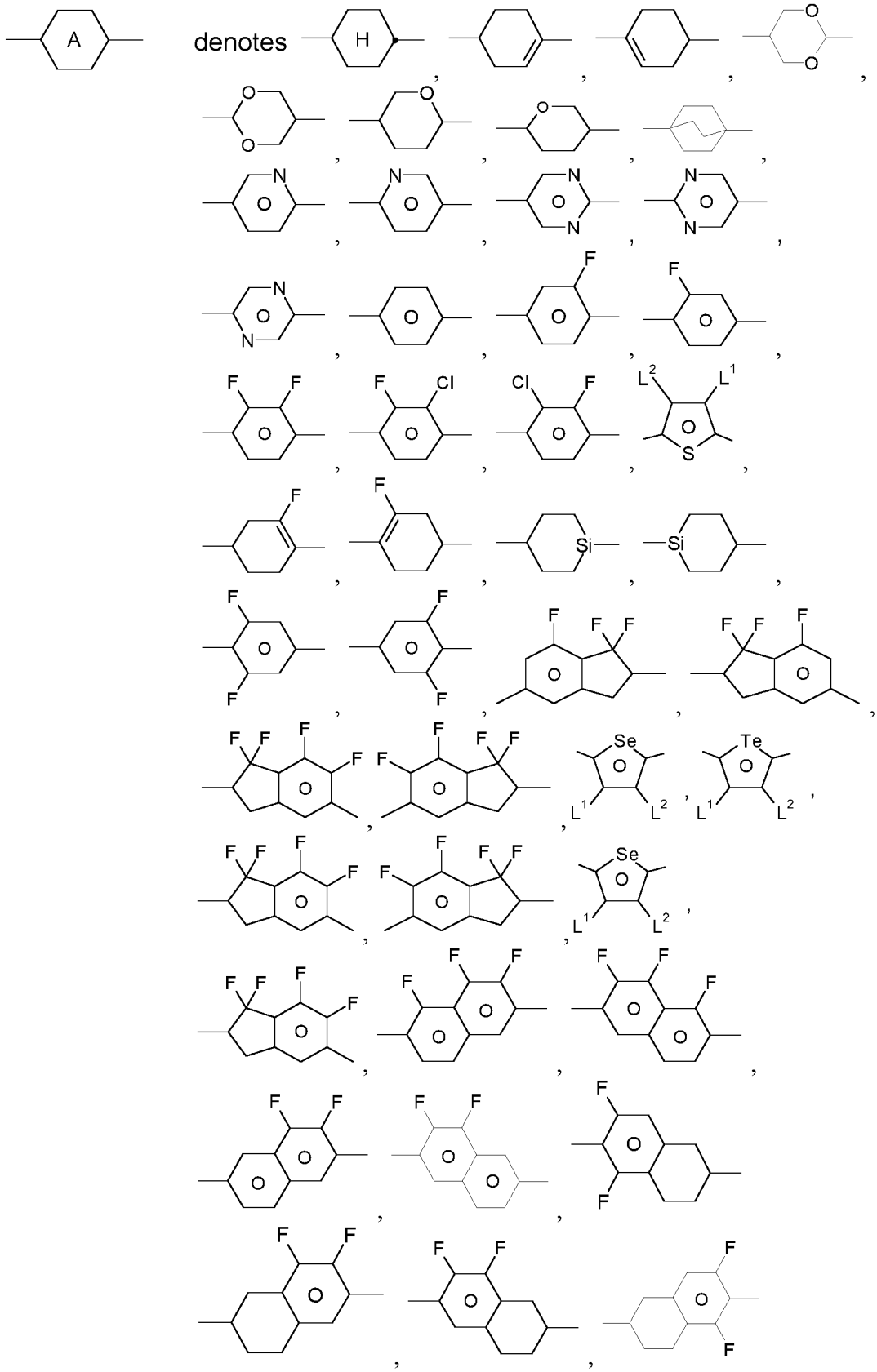
ST-16

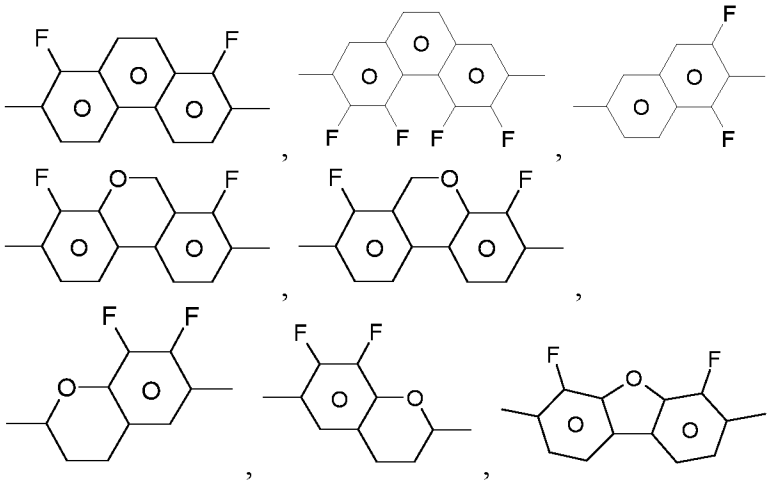


ST-17

in which

R^{ST} denotes H, an 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-, -OCF_2-, -CH=CH-,  ,  , -O-, -CO-O-, or -O-CO- in such a way that O atoms are not linked directly to one another, and in which, in addition, one or more H atoms may each be replaced by halogen,


A
denotes
H
O
N
F
Cl
Si
L2
L1
S
Se
Te



Z^{ST} each, independently of one another, denote -CO-O-, -O-CO-, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, $-CH_2-$, $-CH_2CH_2-$, $-(CH_2)_4-$, $-CH=CH-CH_2O-$, $-C_2F_4-$, $-CH_2CF_2-$, $-CF_2CH_2-$, -CF=CF-, -CH=CF-, -CF=CH-, -CH=CH-, -C≡C- or a single bond,

L^1 and L^2 each, independently of one another, denote F, Cl, CF_3 or CHF_2,

p is 1 or 2,

q is 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10.

12. Liquid-crystalline medium according to one or more of claims 1 to 11, wherein the medium comprises a chiral dopant.

13. Use of the liquid-crystalline medium according to one or more of Claims 1 to 12 in an electrooptic device, where the medium can be switched from a first transparent state with low haze to a second transparent state with low haze and less transmission than the first transparent state at a first voltage, and where the medium can be switched to an opaque state with high haze at a second voltage higher than the first voltage.

14. Electro-optical device, characterised in that it contains a liquid-crystalline medium according to one or more of Claims 1 to 12.

15. Device according to claim 13, wherein the device is a light shutter, switchable window, automotive mirror, sun roof, or augmented or virtual reality device.

Figures

Fig. 1

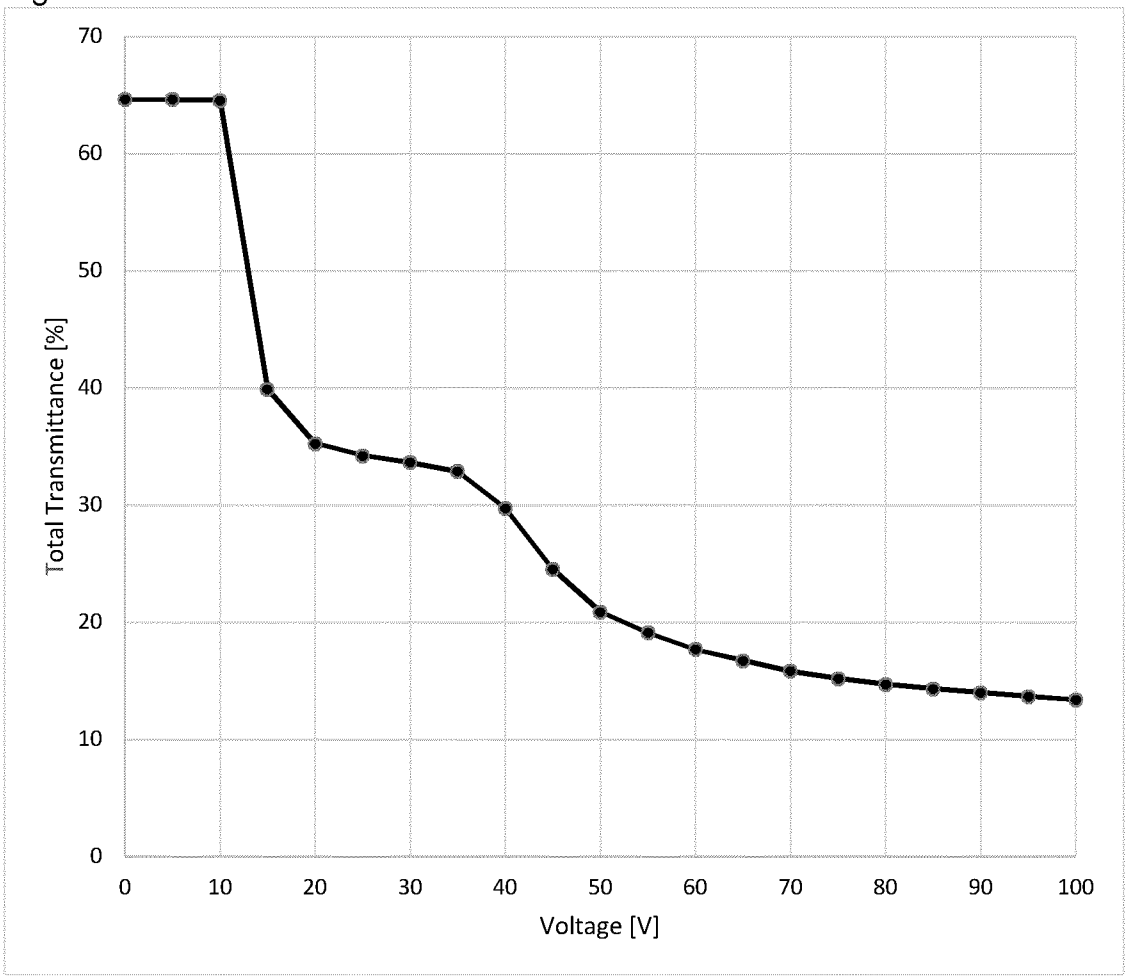
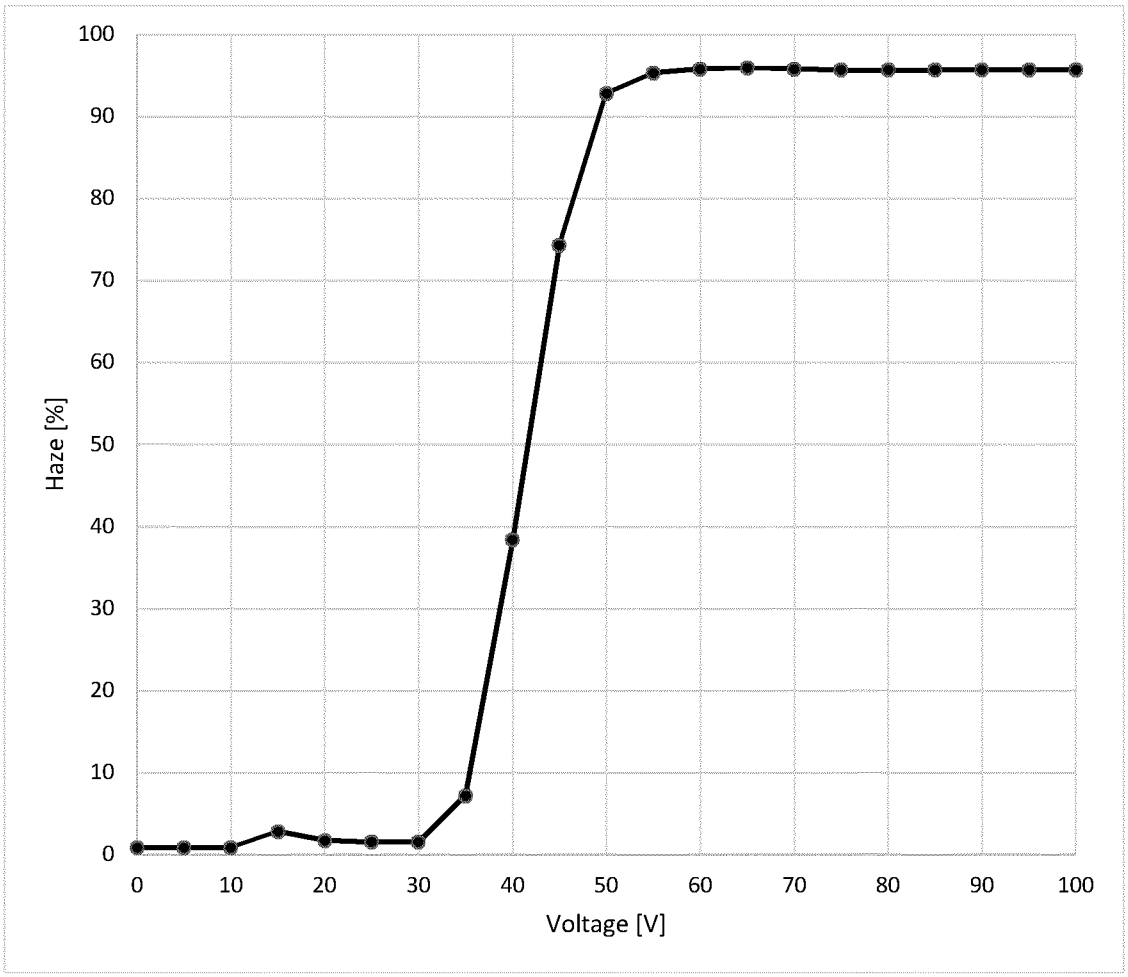


Fig.2



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/051480

A. CLASSIFICATION OF SUBJECT MATTER
INV. C09K19/60 C09K19/58 C09K19/30 C09K19/12 C09K19/18
C09K19/54
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 Y A	JP S56 80027 A (CASIO COMPUTER CO LTD) 1 July 1981 (1981-07-01) the whole document	1-3,14 1-3,5-15 4

X	US 2016/018681 A1 (CHIEN LIANG-CHY [US] ET AL) 21 January 2016 (2016-01-21) paragraph [0039]; claims; examples; compounds 1-butyl-3-methyl-imidazolium chloride	1-3,14

Y	WO 2018/073160 A1 (MERCK PATENT GMBH [DE]) 26 April 2018 (2018-04-26) claims; examples; compounds	1-3,5-15

☐ Further documents are listed in the continuation of Box C.

☒ 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
3 April 2020	20/04/2020

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	Serbetsoglou, A

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2020/051480

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP S5680027 A	01-07-1981	NONE	
US 2016018681 A1	21-01-2016	US 2016018681 A1	21-01-2016
		US 2018059457 A1	01-03-2018
WO 2018073160 A1	26-04-2018	CN 109804049 A	24-05-2019
		EP 3529334 A1	28-08-2019
		JP 2019533052 A	14-11-2019
		KR 20190069513 A	19-06-2019
		TW 201816094 A	01-05-2018
		US 2019316037 A1	17-10-2019
		WO 2018073160 A1	26-04-2018