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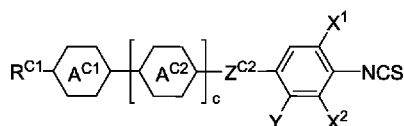
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(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, 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).

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(54) Title: AROMATIC ISOTHIOCYANATES



(57) Abstract: The present invention relates to a liquid crystal medium comprising aromatic isothiocyanates of formula C as defined in claim 1, and to high-frequency components comprising these media, especially microwave components for high-frequency devices, such as devices for shifting the phase of microwaves, tunable filters, tunable metamaterial structures, and electronic beam steering antennas, e.g. phased array antennas.



Aromatic Isothiocyanates

5 The present invention relates to aromatic isothiocyanates, liquid-crystalline media comprising same, and to high-frequency components comprising these media, especially microwave components for high-frequency devices, such as devices for shifting the phase of microwaves, tunable filters, tunable metamaterial structures, and electronic beam steering antennas (e.g. phased array antennas), and to devices comprising said components.

10 Liquid-crystalline media have been used for many years in electro-optical displays (liquid crystal displays: LCDs) in order to display information. More recently, however, liquid-crystalline media have also been proposed for use in components for microwave technology, such as, for example, in DE 10 2004 029 429.1 A and in JP 2005-120208 (A).

15 A. Gaebler, F. Goelden, S. Müller, A. Penirschke and R. Jakoby "Direct Simulation of Material Permittivities using an Eigen-Susceptibility Formulation of the Vector Variational Approach", 12MTC 2009 – International Instrumentation and Measurement Technology Conference, Singapore, 2009 (IEEE), pp. 463-467, describe the
20 corresponding properties of the known liquid-crystal mixture E7 (Merck KGaA, Germany).

DE 10 2004 029 429 A describes the use of liquid-crystal media in microwave technology, inter alia in phase shifters. Therein, liquid-crystalline media with respect to
25 their properties in the corresponding frequency range have been discussed and liquid-crystalline media based on mixtures of mostly aromatic nitriles and isothiocyanates have been shown.

30 Fluorine atoms are commonly used in mesogenic compounds to introduce polarity. Especially in combination with a terminal NCS group high dielectric anisotropy values can be achieved.

In EP 2 982 730 A1, mixtures are described that completely consist of isothiocyanate compounds.

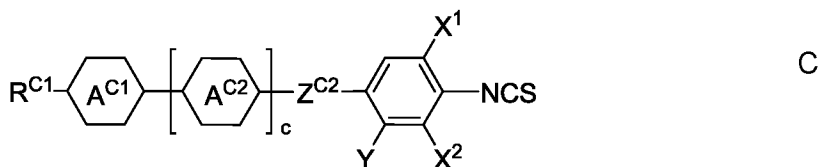
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However, compositions available for the use in microwave applications are still afflicted with several disadvantages. It is required to improve these media with respect to their general physical properties, the shelf life and the stability under operation in a device. In view of the multitude of different parameters which have to be considered and improved for the development of liquid crystalline media for microwave application it is desirable to have a broader range of possible mixture components for the development of such liquid-crystalline media.

An object of the present invention is to provide a compound for the use in liquid crystalline media with improved properties relevant for the application in the microwave range of the electromagnetic spectrum.

To solve the problem, a compound of formula C shown below is provided and a liquid crystalline medium comprising the compound.

The present invention relates to a liquid crystal medium comprising
a) a compound of formula C



in which

R^{C1} denotes H, straight-chain or branched alkyl having 1 to 12 C atoms or alkenyl having 2 to 12 C atoms, in which one or more CH_2 -groups may be

replaced by , , , or , where one or more non adjacent CH_2 -groups may be replaced

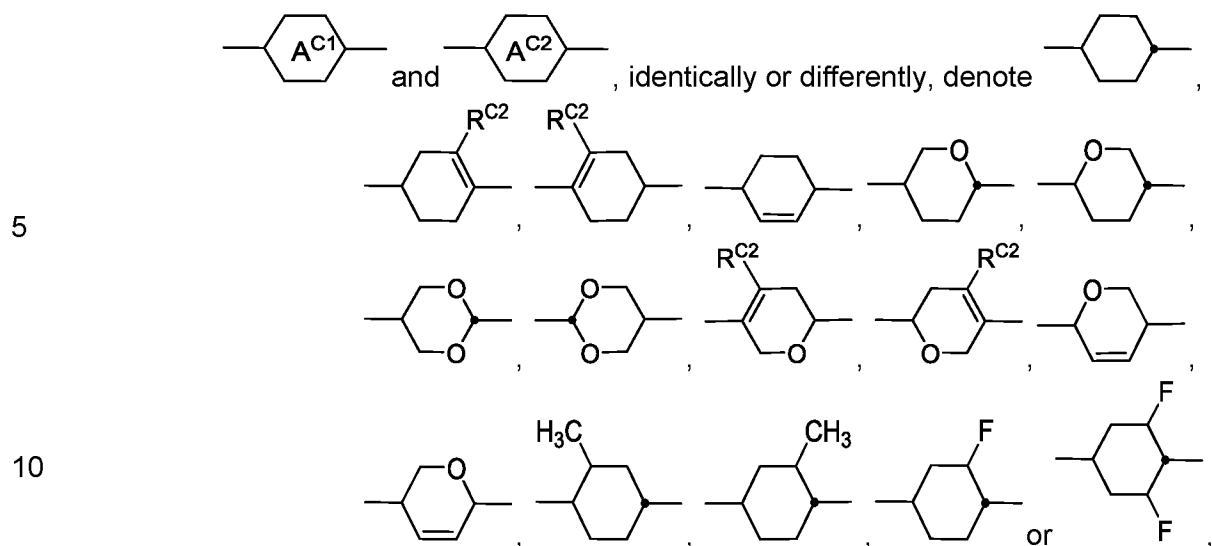
by O and where one or more H atoms may be replaced by F,

Z^{C2} identically or differently, denotes $-CH=CH-$, $-CF=CF-$, $-CH=CF-$, $-CF=CH-$ or $-C\equiv C-$, preferably $-C\equiv C-$,

X^1, X^2 identically or differently, denote H, Cl or F or methyl, preferably F,

Y denotes H, Cl, F, alkyl or alkoxy each having 1 to 6 C atoms, preferably, H, F, CH_3 or C_2H_5 , very preferably H,

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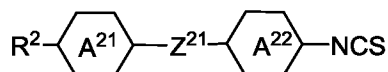
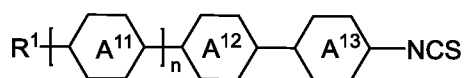
R^{C2} denotes H, CH_3 or F, preferably H or CH_3 , and
 c is 0 or 1, preferably 1;

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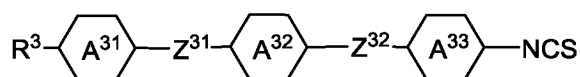
and

b) one or more compounds selected from the group of the formulae I, II and III:

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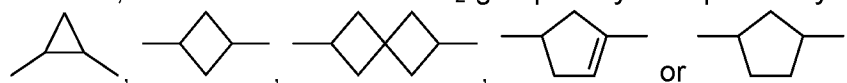
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in which

R^1 denotes H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17, preferably 2 to 10 C atoms, or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, in which one or more CH_2 -groups may be replaced by

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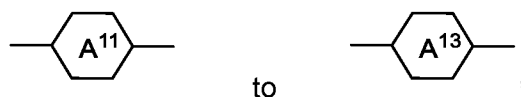


preferably unfluorinated alkyl or unfluorinated alkenyl,

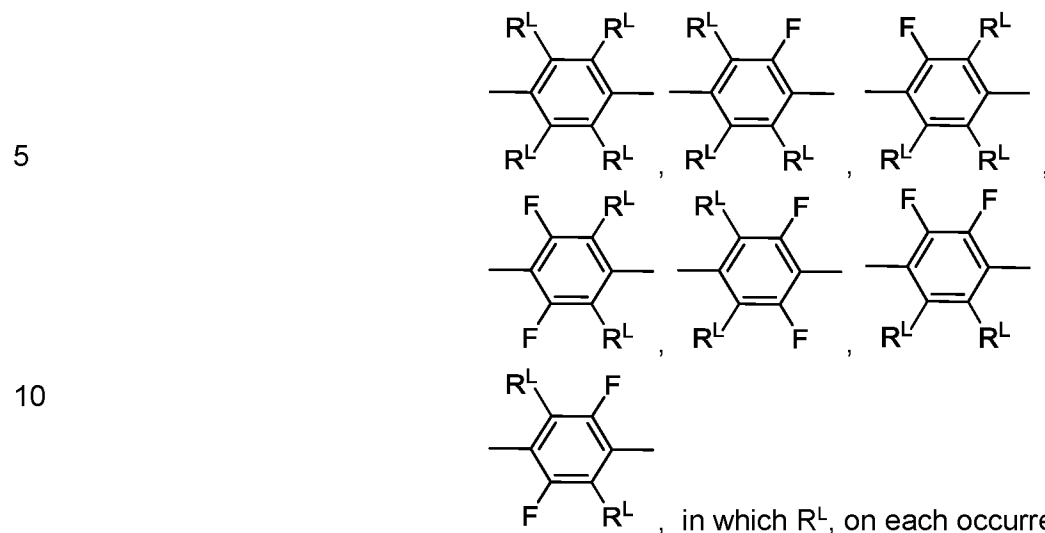
n

is 0, 1 or 2,

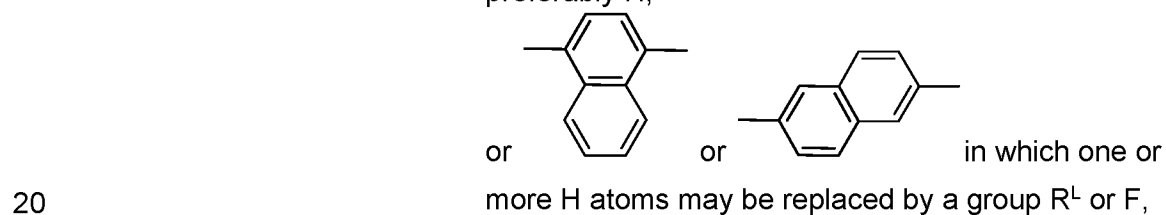
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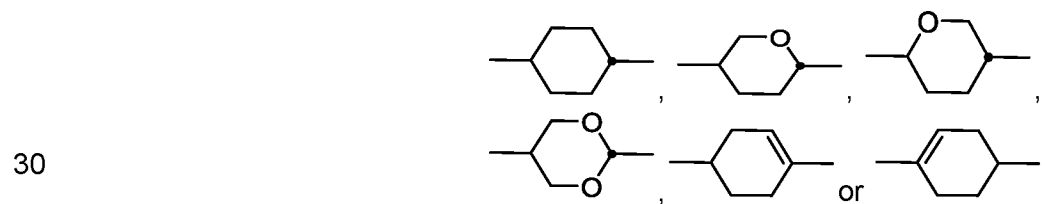
on each occurrence, independently of one another, denote



identically or differently, denotes H or alkyl having 1 to 6 C atoms, preferably H, methyl or ethyl, particularly preferably H,



alternatively denotes

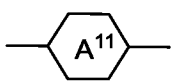
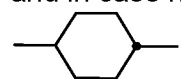


preferably

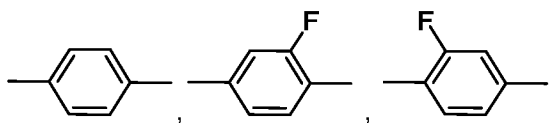


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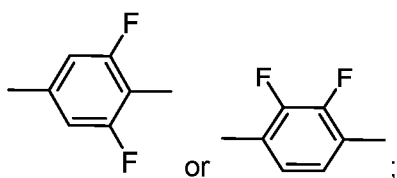
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and in case $n = 2$, one of  preferably denotes
 and the other preferably denotes

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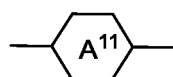


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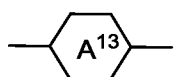


preferably

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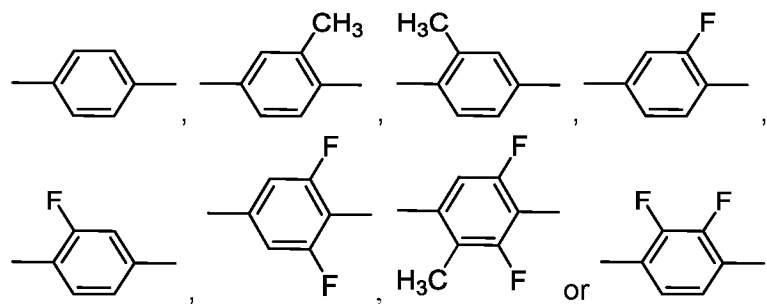


to



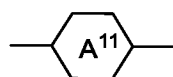
independently of one another, denote

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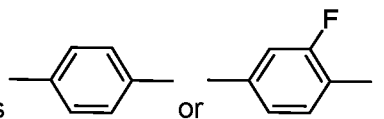


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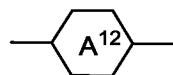
more preferably



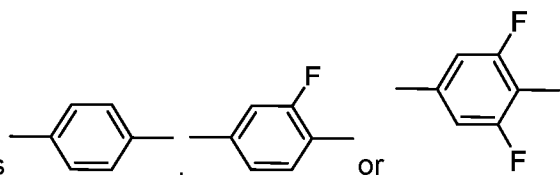
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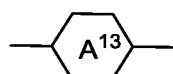
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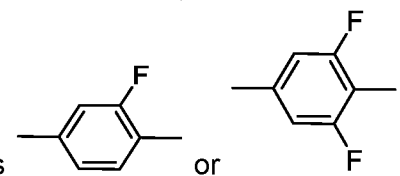
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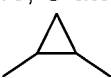
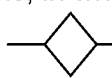
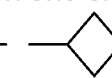
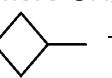


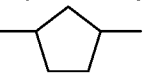
denotes



R²

denotes H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17, preferably 2 to 10 C atoms, or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, in which one or more CH₂-groups may

be replaced by , , , ,

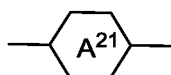
or ,

preferably unfluorinated alkyl or unfluorinated alkenyl,

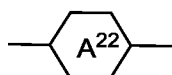
Z²¹

denotes *trans*-CH=CH-, *trans*-CF=CF- or -C≡C-, preferably -C≡C- or *trans*-CH=CH-, and

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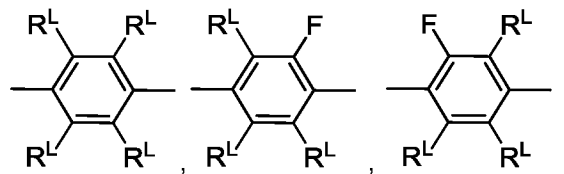


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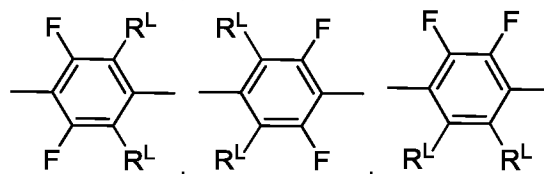


independently of one another, denote

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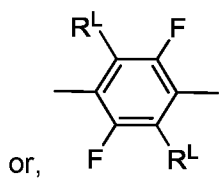
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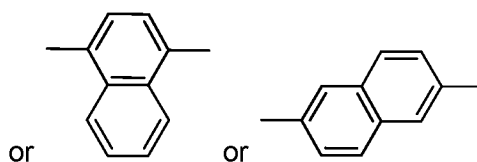
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in which R^L , on each occurrence, identically or differently, denotes H or alkyl having 1 to 6 C atoms, preferably H, methyl or ethyl, particularly preferably H,

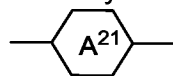
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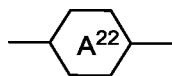
in which one or more H atoms may be replaced by a group R^L or F,

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preferably

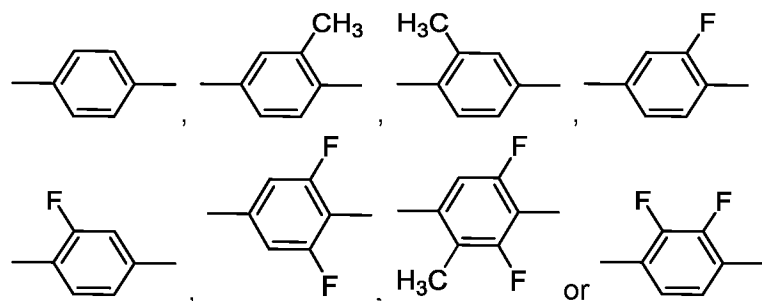


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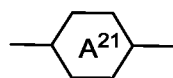


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independently of one another, denote

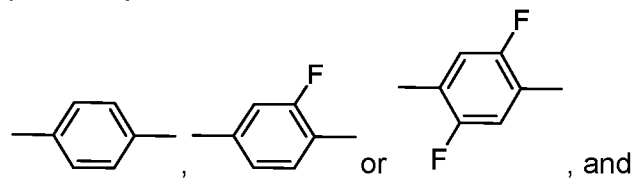


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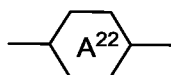


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preferably denotes

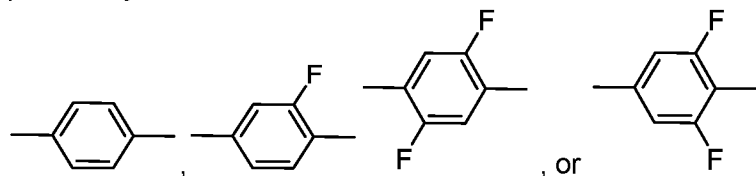


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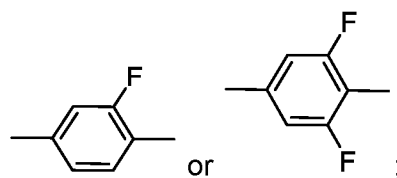
preferably denotes

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more preferably

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R^3

denotes H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17, preferably 2 to 10 C atoms, or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, in which one or more CH_2 -groups may

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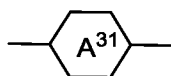
or

preferably unfluorinated alkyl or unfluorinated alkenyl,

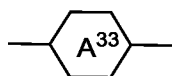
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one of Z^{31} and Z^{32} , preferably Z^{32} ; denotes *trans*-CH=CH-, *trans*-CF=CF- or -C≡C- and the other one, independently thereof, denotes -C≡C-, *trans*-CH=CH-, *trans*-CF=CF- or a single bond, preferably one of them, preferably Z^{32} ; denotes -C≡C- or *trans*-CH=CH- and the other denotes a single bond, and

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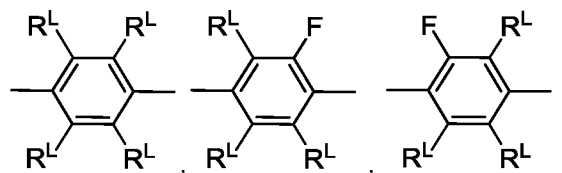


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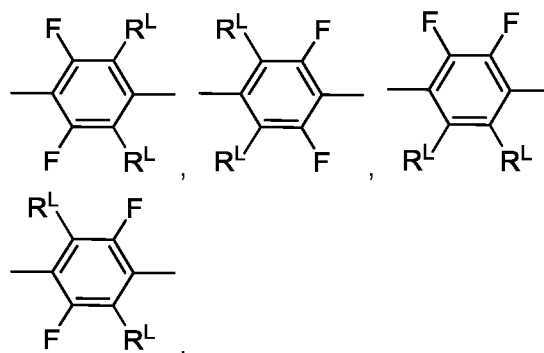


independently of one another, denote

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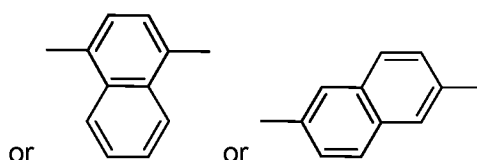
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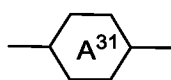
in which R^L , on each occurrence, identically or differently, denotes H or alkyl having 1 to 6 C atoms, preferably H, methyl or ethyl, particularly preferably H,

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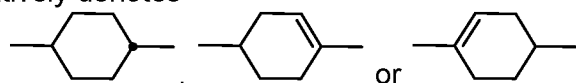


in which one or more H atoms may be replaced by a group R^L or F, and wherein

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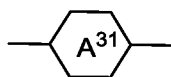


alternatively denotes

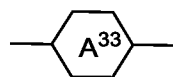


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preferably

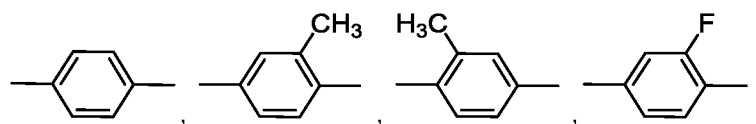


to



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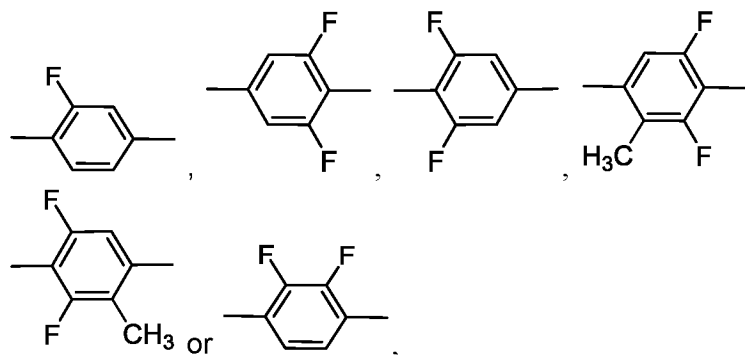
independently of one another, denote



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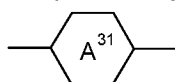
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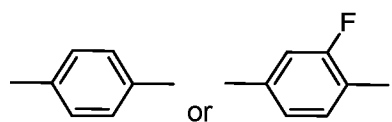


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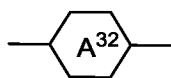
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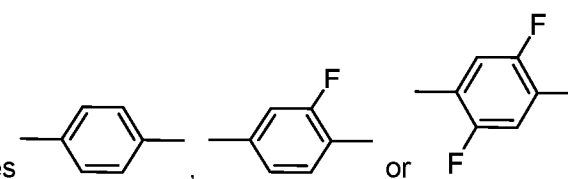
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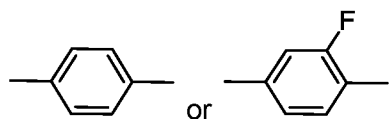


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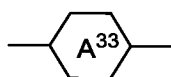


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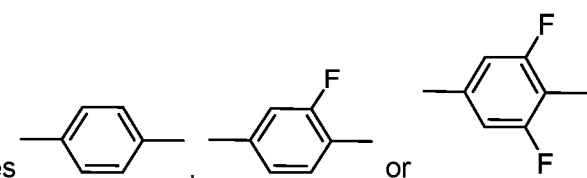
in particular



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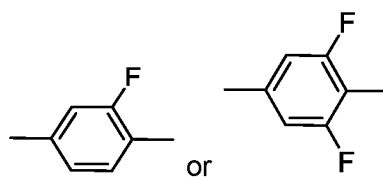


denotes



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in particular

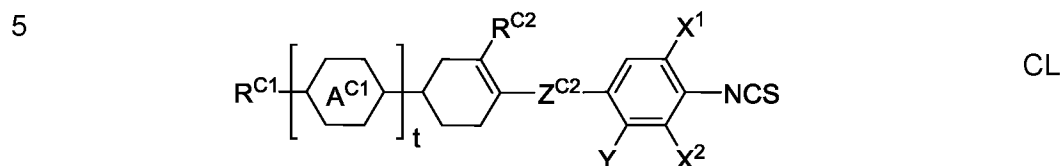


In the compounds of the formulae I, II and III, R^L preferably denotes H.

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In another preferred embodiment, in the compounds of formulae I, II and III, one or two groups R^L , preferably one group R^L is different from H.

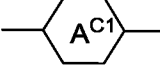
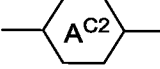
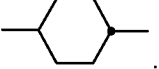
Preferably, the medium according to the invention comprises a compound of formula C selected from the sub-formula CL



10 in which the occurring groups have the meanings defined above for formula C, and
t is 0 or 1, preferably 1.

The present invention further relates to said compound of formula CL.

15 The present invention further relates to a compound of formula C as defined above, and in which at least one of X^1 and X^2 is different from H, and preferably Z^{C2}

denotes $-C\equiv C-$ and both  and , denote .

20 The present invention further relates to a liquid-crystalline medium comprising a compound of formula C and to the use of a liquid-crystalline medium comprising a compound of formula C in a component for high-frequency technology.

25 According to another aspect of the present invention there is provided a component and a device comprising said component, both operable in the microwave region of the electromagnetic spectrum. Preferred components are phase shifters, varactors, wireless and radio wave antenna arrays, matching circuits and adaptive filters.

30 Preferred embodiments of the present invention are subject-matter of the dependent claims or can also be taken from the description.

35 Surprisingly, it has been found that it is possible to achieve liquid-crystalline media having excellent stability and at the same time a high dielectric anisotropy, suitably fast switching times, a suitable, nematic phase range, high tunability and low dielectric loss, by using compounds of formula C in liquid-crystalline media.

The media according to the present invention are distinguished by a high clearing temperature, a broad nematic phase range and excellent low-temperature stability (LTS). As a result, devices containing the media are operable under extreme temperature conditions.

5

The media are further distinguished by high values of the dielectric anisotropy and low rotational viscosities. As a result, the threshold voltage, i.e. the minimum voltage at which a device is switchable, is very low. A low operating voltage and low threshold voltage is desired in order to enable a device having improved switching characteristics and high energy efficiency. Low rotational viscosities enable fast switching of the devices according to the invention.

10

These properties as a whole make the media particularly suitable for use in components and devices for high-frequency technology and applications in the microwave range, in particular devices for shifting the phase of microwaves, tunable filters, tunable metamaterial structures, and electronic beam steering antennas (e.g. phased array antennas).

15

Herein, "high-frequency technology" means applications of electromagnetic radiation having frequencies in the range of from 1 MHz to 1 THz, preferably from 1 GHz to 500 GHz, more preferably 2 GHz to 300 GHz, particularly preferably from about 5 GHz to 150 GHz.

20

As used herein, halogen is F, Cl, Br or I, preferably F or Cl, particularly preferably F.

25

Herein, alkyl is straight-chain or branched or cyclic and has 1 to 15 C atoms, is preferably straight-chain and has, unless indicated otherwise, 1, 2, 3, 4, 5, 6 or 7 C atoms and is accordingly preferably methyl, ethyl, n-propyl, n-butyl, n-pentyl, n-hexyl or n-heptyl.

30

Herein, branched alkyl is preferably isopropyl, s-butyl, isobutyl, isopentyl, 2-methylhexyl or 2-ethylhexyl.

As used herein, cyclic alkyl is taken to mean straight-chain or branched alkyl or alkenyl having up to 12 C atoms, preferably alkyl having 1 to 7 C atoms, in which a group CH₂ is replaced with a carbocyclic ring having 3 to 5 C atoms, very preferably selected from

35

the group consisting of cyclopropylalkyl, cyclobutylalkyl, cyclopentylalkyl and cyclopentenylalkyl.

5 Herein, an alkoxy radical is straight-chain or branched and contains 1 to 15 C atoms. It is preferably straight-chain and has, unless indicated otherwise, 1, 2, 3, 4, 5, 6 or 7 C atoms and is accordingly preferably methoxy, ethoxy, n-propoxy, n-butoxy, n-pentoxo, n-hexoxy or n-heptoxy.

10 Herein, an alkenyl radical is preferably an alkenyl radical having 2 to 15 C atoms, which is straight-chain or branched and contains at least one C-C double bond. It is preferably straight-chain and has 2 to 7 C atoms. Accordingly, it is preferably 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. If the two C atoms of the C-C double bond are substituted, the alkenyl radical can be in the form of E and/or Z isomer
15 (trans/cis). In general, the respective E isomers are preferred. Of the alkenyl radicals, prop-2-enyl, but-2- and -3-enyl, and pent-3- and -4-enyl are particularly preferred.

Herein, alkynyl is taken to mean an alkynyl radical having 2 to 15 C atoms, which is straight-chain or branched and contains at least one C-C triple bond. 1- and 2-propynyl
20 and 1-, 2- and 3-butynyl are preferred.

In case R^F denotes a halogenated alkyl-, alkoxy-, alkenyl or alkenyloxy it can be branched or unbranched. Preferably it is unbranched, mono- poly or perfluorinated, preferably perfluorinated and has 1, 2, 3, 4, 5, 6 or 7 C atoms, in case of alkenyl 2, 3, 4,
25 5, 6 or 7 C atoms.

R^P preferably denotes CN, NCS, Cl, F, $-(CH_2)_n-CH=CF_2$, $-(CH_2)_n-CH=CHF$, $-(CH_2)_n-CH=Cl_2$, $-C_nF_{2n+1}$, $-(CF_2)_n-CF_2H$, $-(CH_2)_n-CF_3$, $-(CH_2)_n-CHF_2$, $-(CH_2)_nCH_2F$, $-CH=CF_2$, $-O(CH_2)_n-CH=CF_2$, $-O(CH_2)_nCHCl_2$, $-OC_nF_{2n+1}$, $-O(CF_2)_n-CF_2H$, $-O(CH_2)_nCF_3$, $-O(CH_2)_n-CHF_2$, $-O(CF)_nCH_2F$, $-OCF=CF_2$, $-SC_nF_{2n+1}$, $-S(CF)_n-CF_3$, wherein n is an integer from 0
30 to 7.

An example of a compound of formula C is shown in WO 2019/206185 A1 as a co-component in a medium for a display device. The compounds of the general formula C
35 are prepared by methods known per se, as described in the literature (for example in the standard works, such as Houben-Weyl, Methoden der organischen Chemie

[Methods of Organic Chemistry], Georg-Thieme-Verlag, Stuttgart), to be precise under reaction conditions which are known and are suitable for said reactions. Use can be made here of variants which are known per se, but are not mentioned here in greater detail.

5

If desired, the starting materials can also be formed in situ by not isolating them from the reaction mixture, but instead by immediately reacting them further into the compounds of the general formula C.

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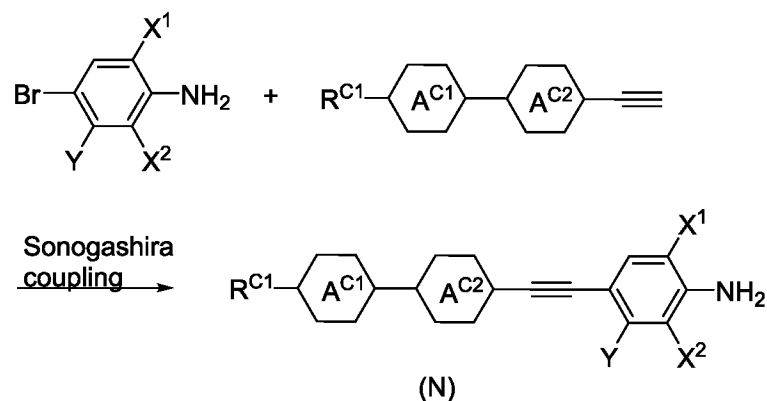
Preferred synthetic pathways towards compounds according to the invention are exemplified in the schemes below, and are further illustrated by means of the working examples. Suitable syntheses are also published for example in Juanli Li, Jian Li, Minggang Hu, Zhaoyi Che, Lingchao Mo, Xiaozhe Yang, Zhongwei An & Lu Zhang (2017) The effect of locations of triple bond at terphenyl skeleton on the properties of isothiocyanate liquid crystals, *Liquid Crystals*, 44:9, 1374-1383 and can be adapted to the particular desired compounds of the general formula C by choice of suitable starting materials.

15

20

Preferred intermediates are 4-bromo-2,6-difluoroaniline, 4-bromo-2,6-dichloroaniline and 4-bromo-2-chloro-6-fluoroaniline, all described in the literature, which can be reacted to give compounds of the formula N (scheme 1) for example by cross coupling reactions commonly known as Sonogashira reactions, and the like. Preferred pathways are exemplified in schemes 1 to 4, in which the groups and parameters have the meanings defined in claim 1.

25



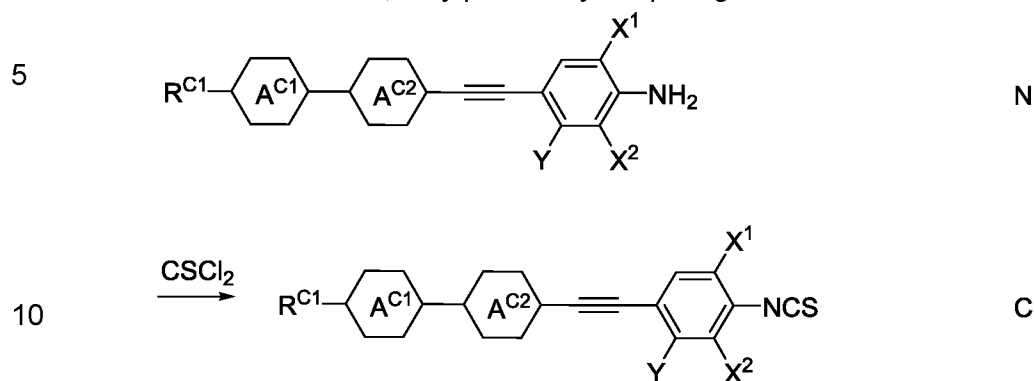
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Scheme 1

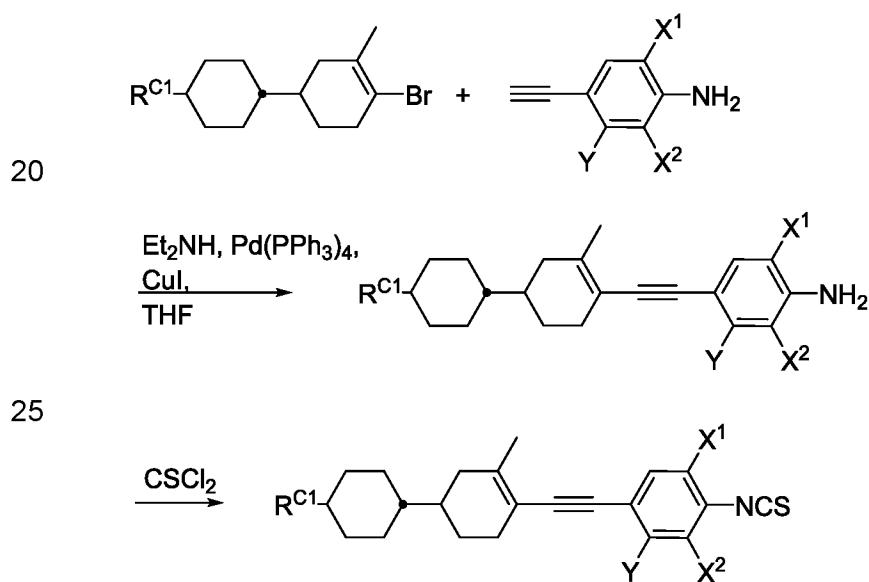
Preferred reagents for the process according to the invention for the transformation of compounds of the formula N into compounds of the formula C (scheme 2) are carbon

disulfide, thiophosgene, thiocarbonyl diimidazole, di-2-pyridyl thionocarbonate, bis(dimethylthiocarbamoyl) disulfide, dimethylthiocarbamoyl chloride and phenyl chlorothionoformate, very preferably thiophosgene.



Scheme 2

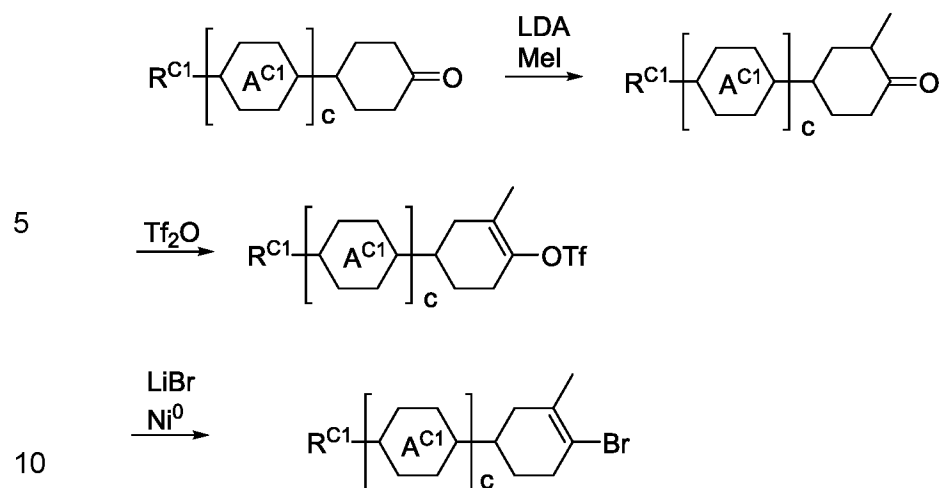
Compounds of formula CL with a 2-(cyclohexen-1-yl)ethynylbenzene partial structure are proposed for the use in liquid crystalline media for example in DE 3710069 A1. A preferred synthetic pathway is shown in scheme 3 by way of example of a compound of formula CL-1 below.



Scheme 3

30

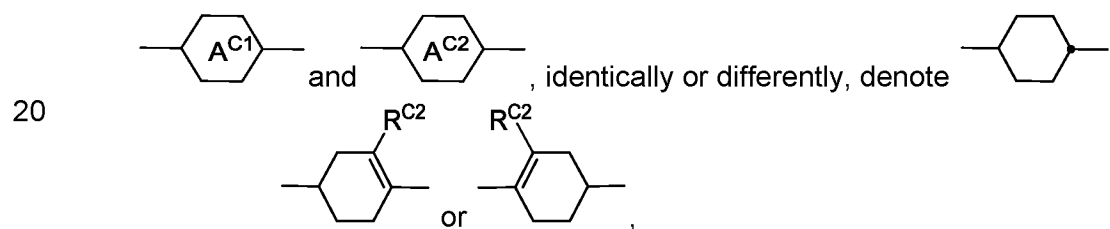
An access to the cyclohexenylbromide precursors starting from ketones is shown in scheme 4 making use of a Nickel catalysed transformation of enol triflates described in the article Hofstra, Julie L.; Poremba, Kelsey E.; Shimozone, Alex M.; Reisman, Sarah E., Angewandte Chemie, International Edition Volume 58, Issue 42, Pages 14901-14905, DOI:10.1002/anie.201906815.



Scheme 4

The reactions described should only be regarded as illustrative. The person skilled in the art can carry out corresponding variations of the syntheses described and also follow other suitable synthetic routes in order to obtain compounds of the formula C.

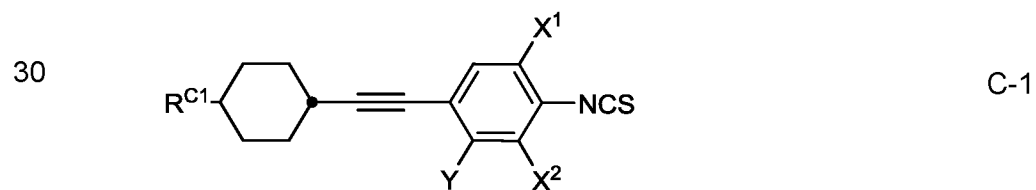
15 The compounds of formula C are preferably selected from the compounds in which the groups

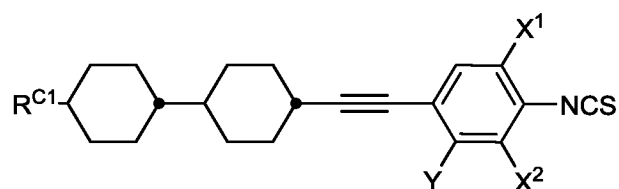


in which R^{C2} denotes H or CH_3 .

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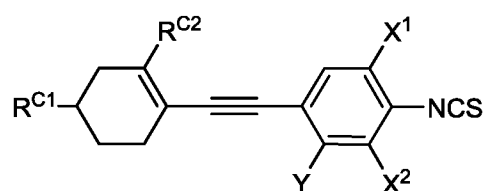
Very preferred compounds of formula C are selected from the compounds of formulae C-1, C-2, CL-1 and CL-2:





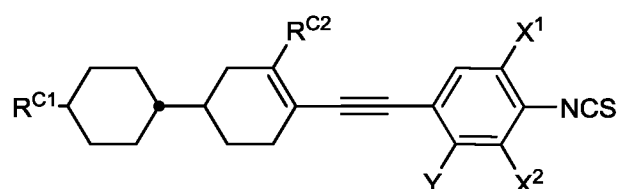
C-2

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CL-1

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CL-2

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in which the occurring groups have the meanings given above for formula C and preferably

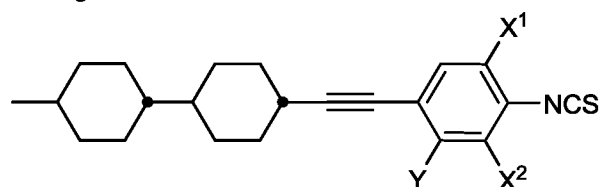
Y denotes H,

20

X¹ and X², identically or differently denote H, F, Cl, or methyl, preferably H or F, and R² denotes H or CH₃. Preferably, at least one of X¹ and X² is different from H.

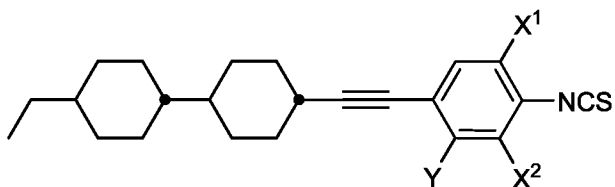
The compounds of the formulae C-2 and CL-2 are preferably selected from the following sub-formulae:

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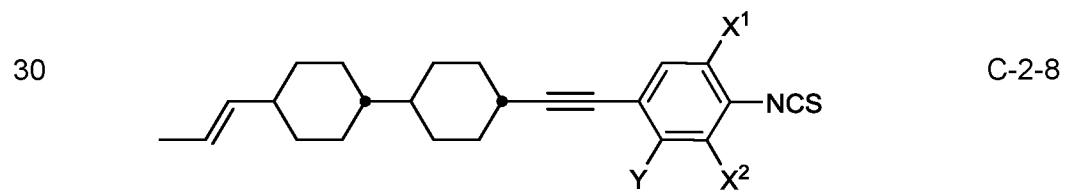
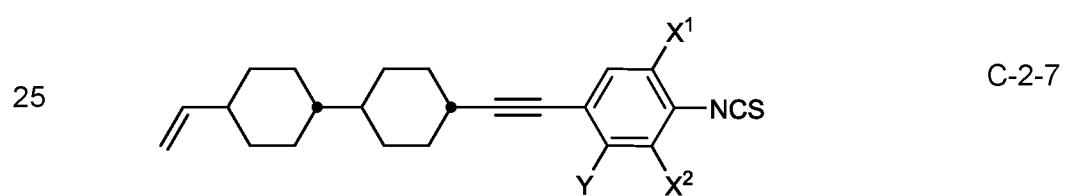
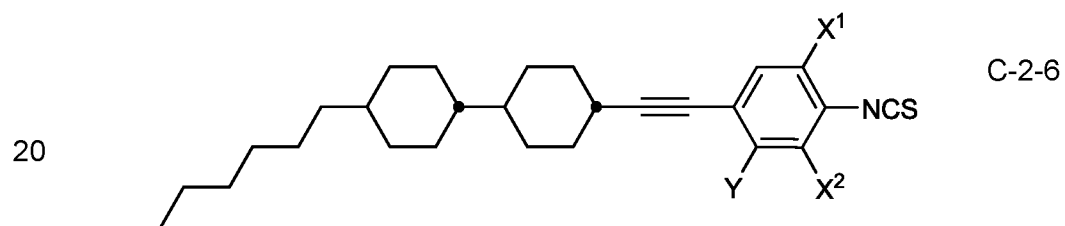
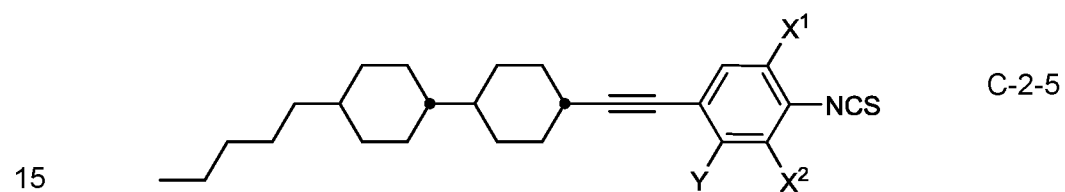
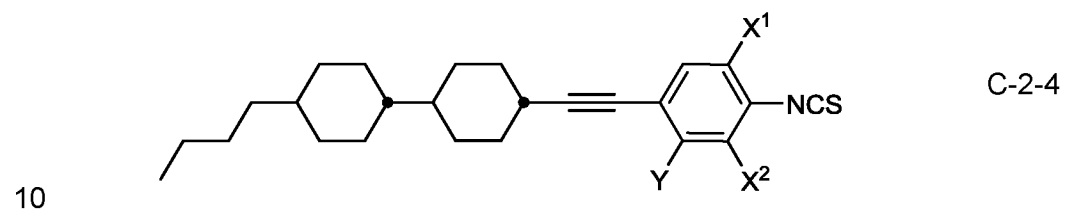
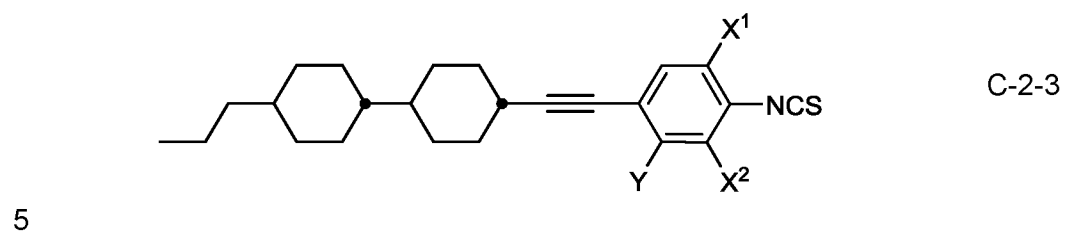
C-2-1

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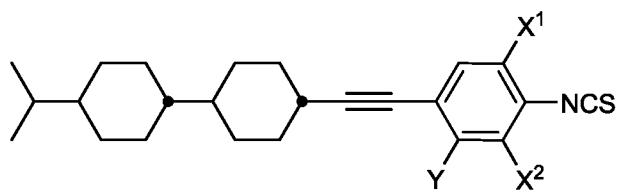


C-2-2

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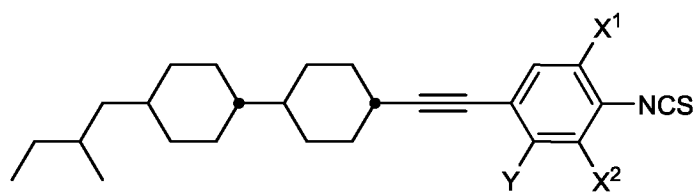


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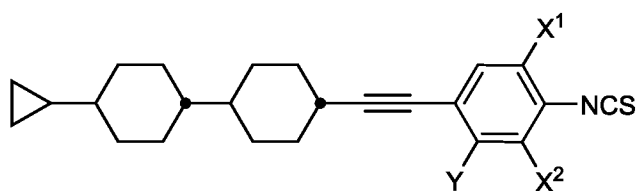
C-2-9

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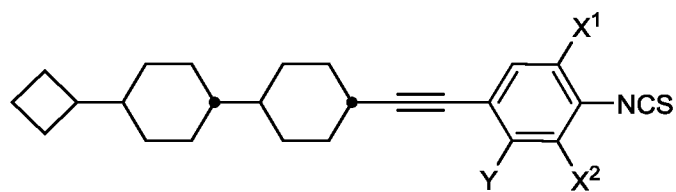
C-2-10

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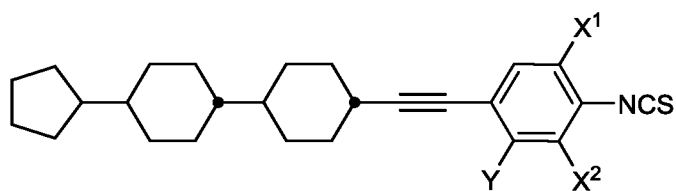
C-2-11

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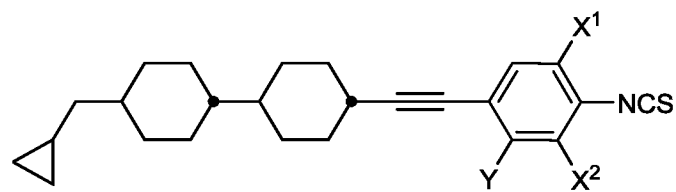
C-2-12

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C-2-13

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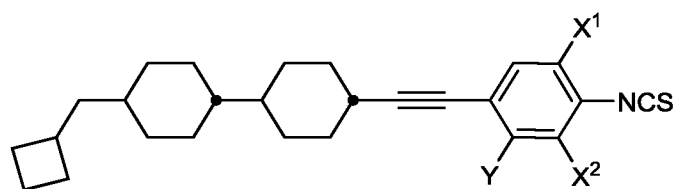


C-2-14

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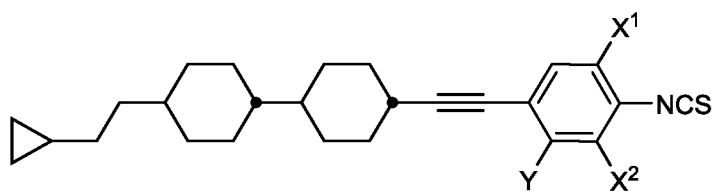
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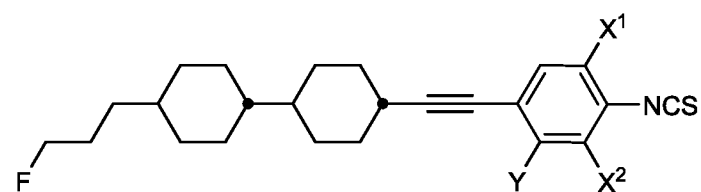
C-2-15

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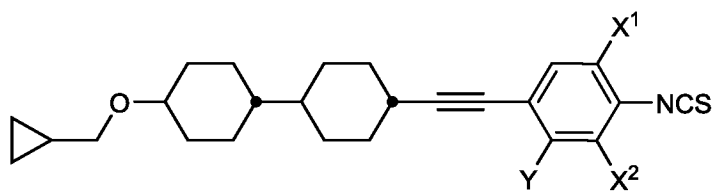
C-2-16

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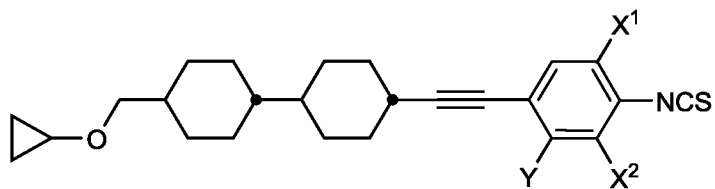
C-2-17

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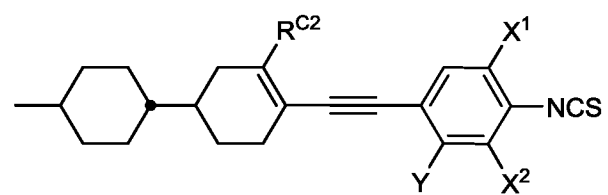
C-2-18

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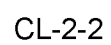
C-2-19

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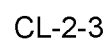


CL-2-1

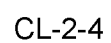
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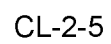
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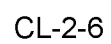
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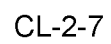
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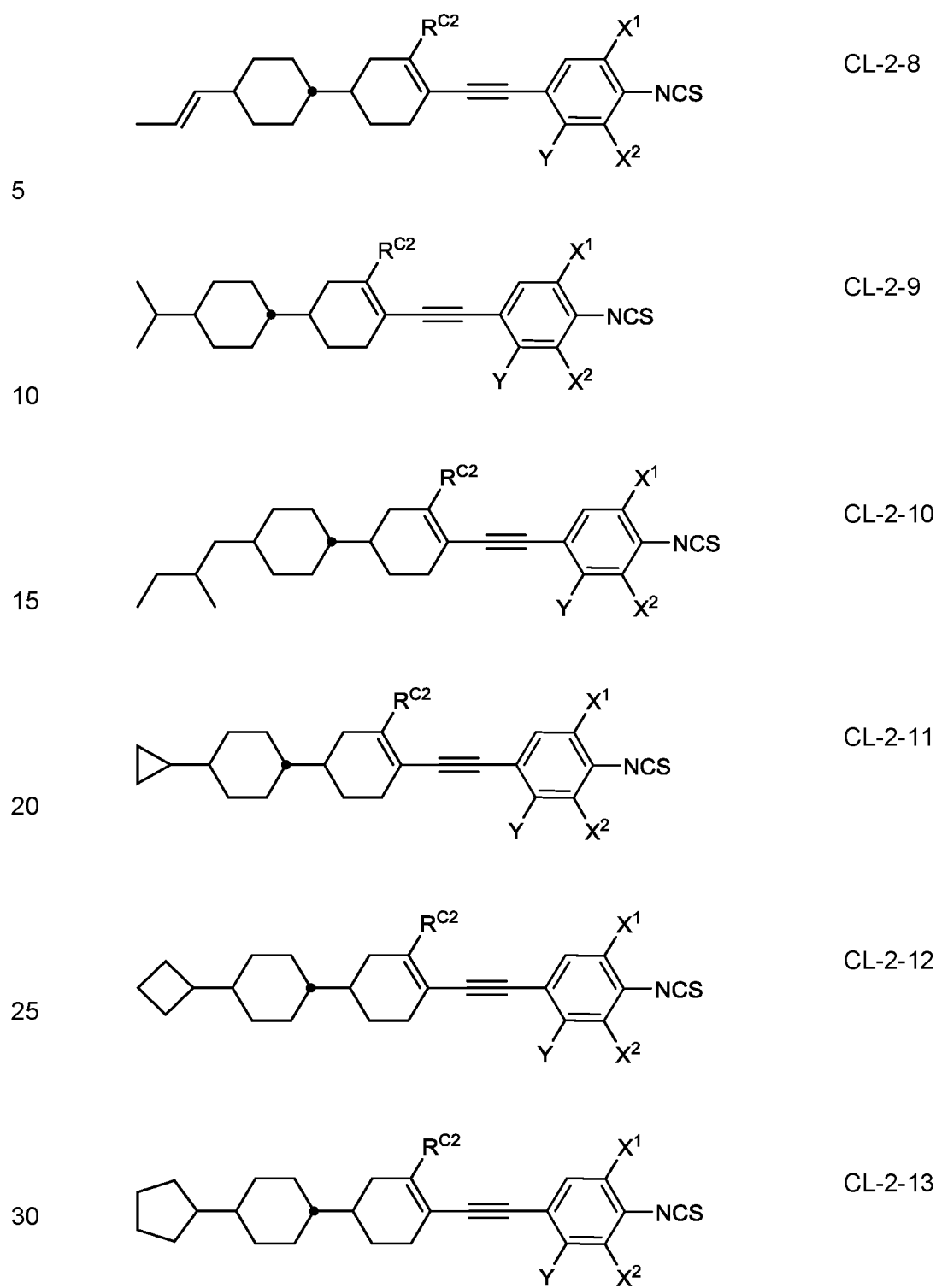


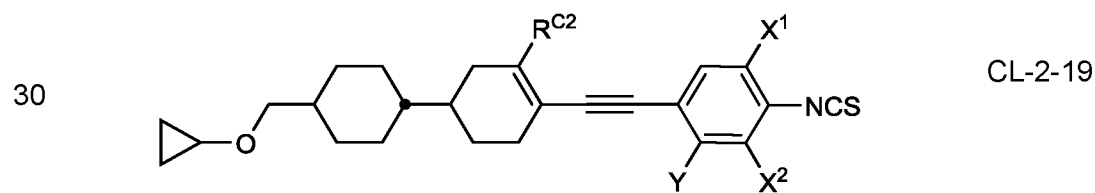
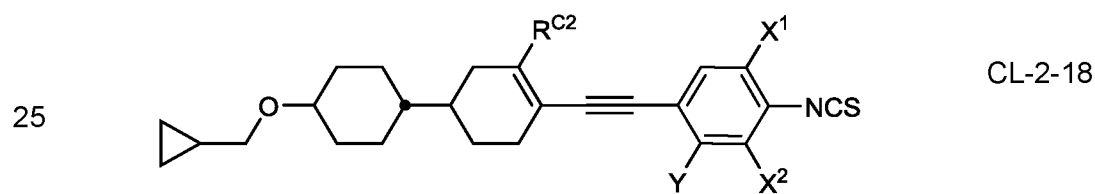
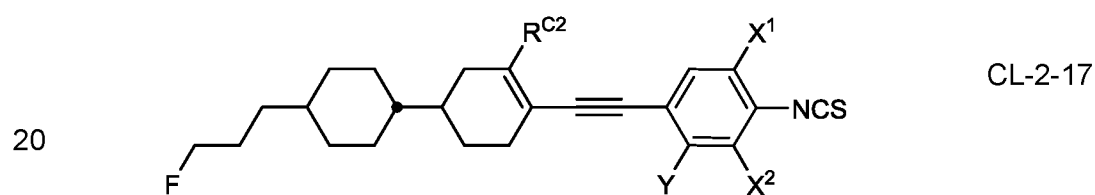
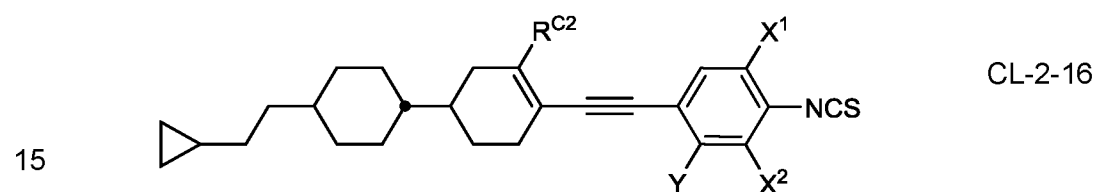
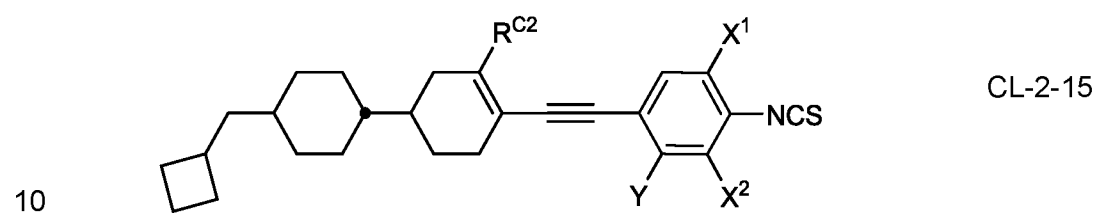
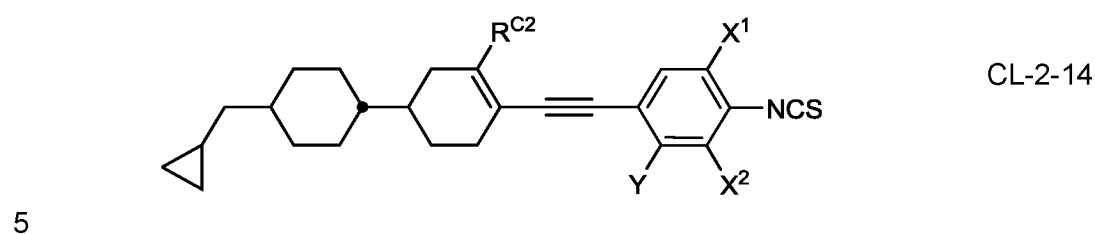
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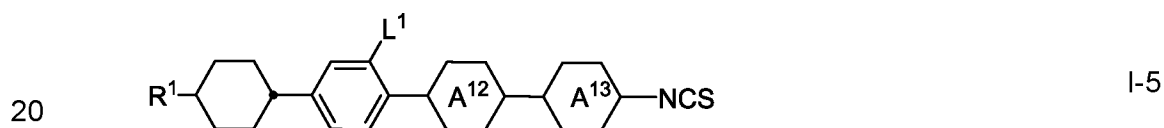
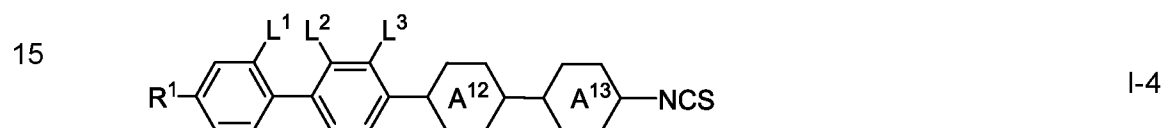
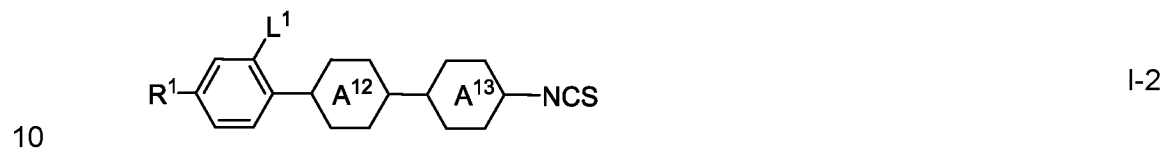
35





35 in which the occurring groups have the meanings given above for formulae C-2 and CL-2.

In a preferred embodiment of the present invention, the compounds of formula I are selected from the group of compounds of the formulae I-1 to I-5:



in which

L¹, L² and L³ on each occurrence, identically or differently, denote H or F, and the other groups have the respective meanings indicated above for formula I and

25 preferably

R¹ denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms.

Preferably, the total amount of compounds of the formula I-1 and/or Cy-1



35 in which the occurring groups have the meanings given above for formula I-1, in the medium according to the invention is less than 10%, more preferably less than

5%, and in particular less than 2%. Particularly preferably, the medium contains no compound of formula Cy-1.

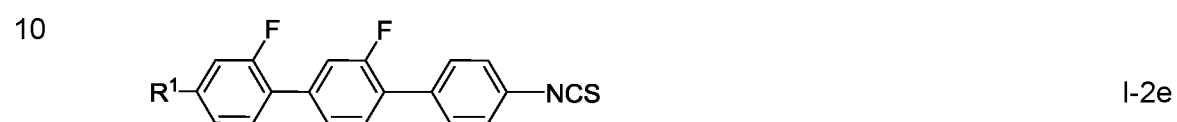
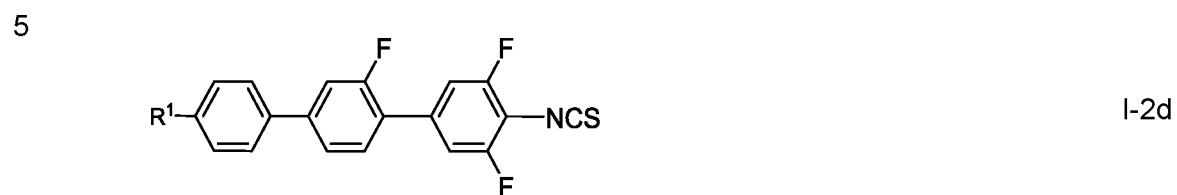
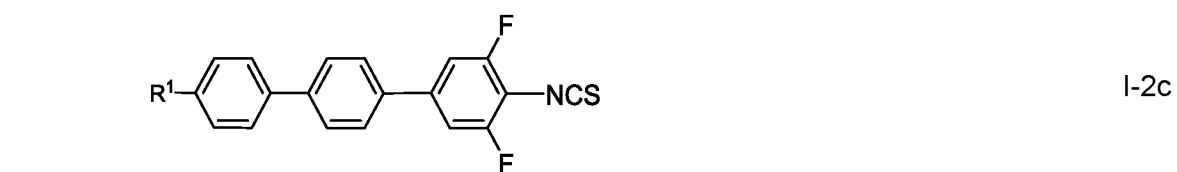
The media preferably comprise one or more compounds of formula I-1, which are preferably selected from the group of the compounds of the formulae I-1a to I-1d, preferably of formula I-1b:



in which R¹ has the meaning indicated above for formula I and preferably denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms.

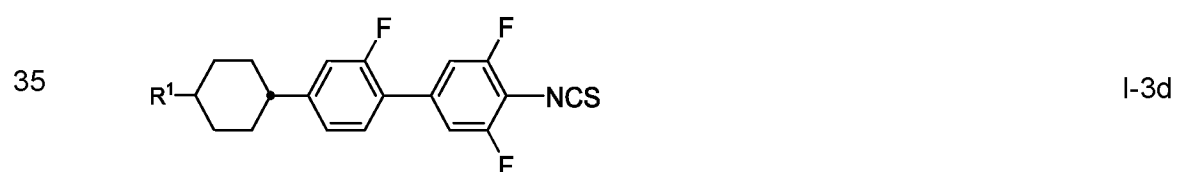
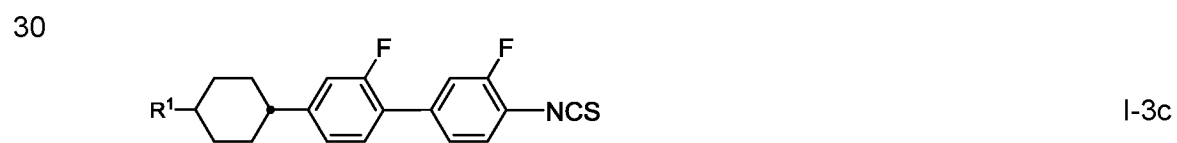
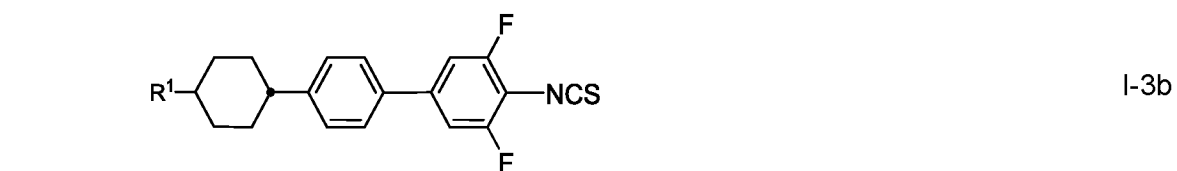
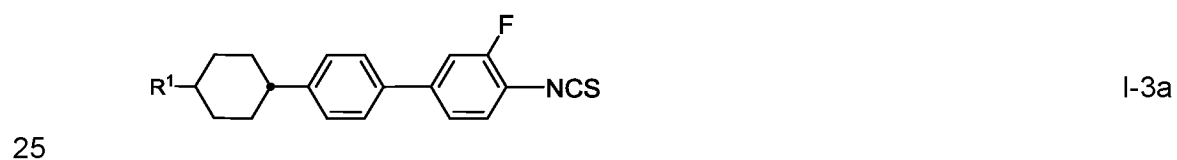
25 The media preferably comprise one or more compounds of formula I-2, which are preferably selected from the group of the compounds of the formulae I-2a to I-2e, preferably of formula I-2c:





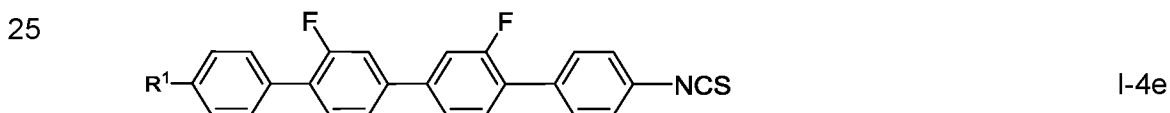
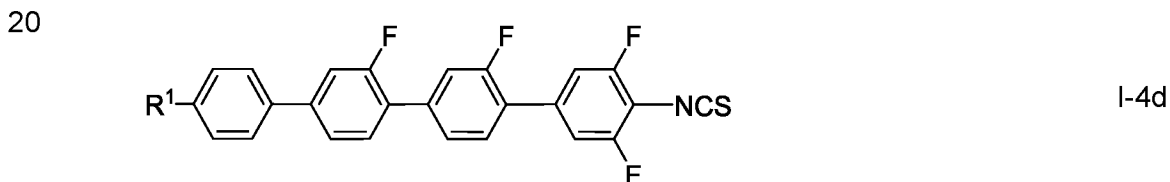
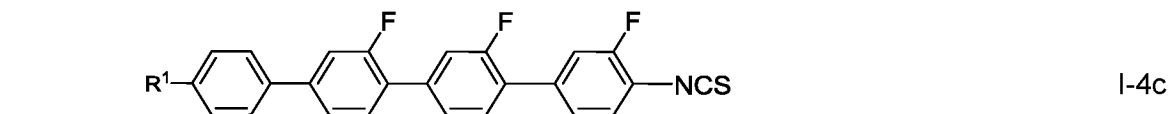
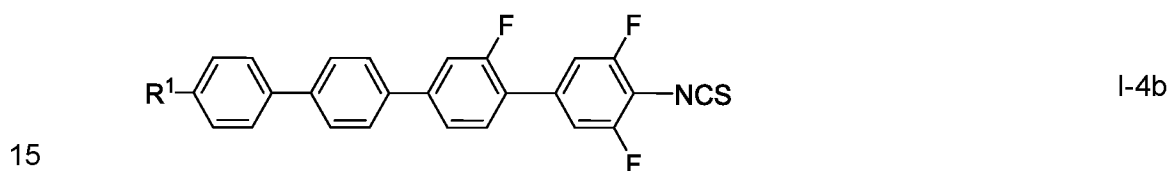
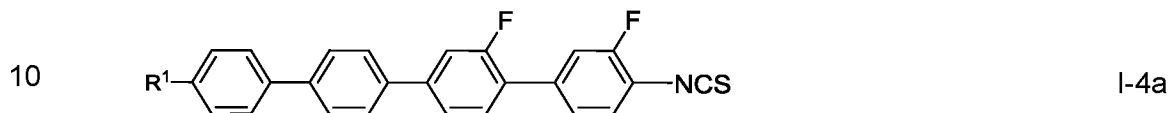
in which R¹ has the meaning indicated above for formula I and preferably denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms.

The media preferably comprise one or more compounds of formula I-3, which are preferably selected from the group of the compounds of the formulae I-3a to I-3d , particularly preferably of formula I-3b:



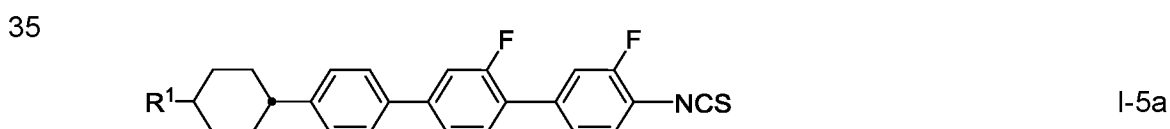
in which R¹ has the meaning indicated above for formula I and preferably denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms.

- 5 The media preferably comprise one or more compounds of formula I-4, which are preferably selected from the group of the compounds of the formulae I-4a to I-4e, particularly preferably of formula I-4b:

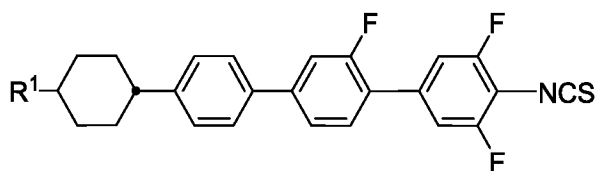


in which R¹ has the meaning indicated above for formula I and preferably denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms.

The media preferably comprise one or more compounds of formula I-5, which are preferably selected from the group of the compounds of the formulae I-5a to I-5d, particularly preferably of formula I-5b:

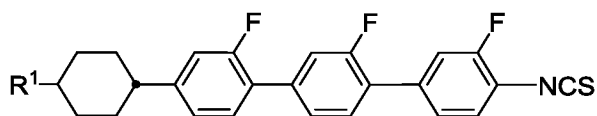


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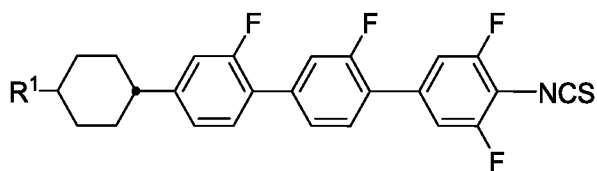


I-5b

10



I-5c



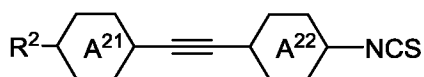
I-5d

15

in which R¹ has the meaning indicated above for formula I and preferably denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms.

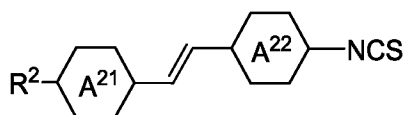
20

The media preferably comprise one or more compounds of formula II, which are preferably selected from the group of the compounds of the formulae II-1 to II-3, preferably selected from the group of the compounds of the formulae II-1 and II-2:



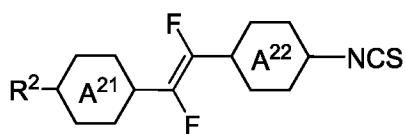
II-1

25



II-2

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II-3

in which the occurring groups have the meanings given under formula II above and

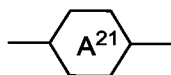
preferably

35

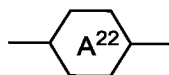
R² denotes unfluorinated alkyl or alkoxy having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms,

and one of

5

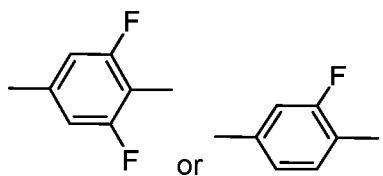


and



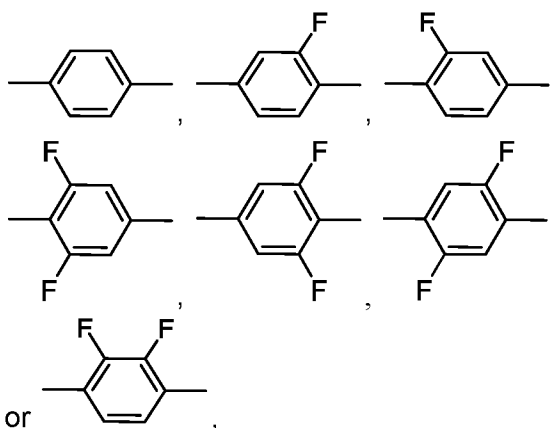
denotes

10



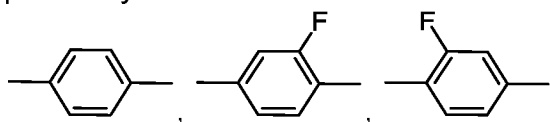
and the other, independently denotes

15



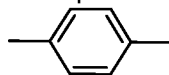
20

preferably



25

most preferably



30

and preferably
 R^2

denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

n

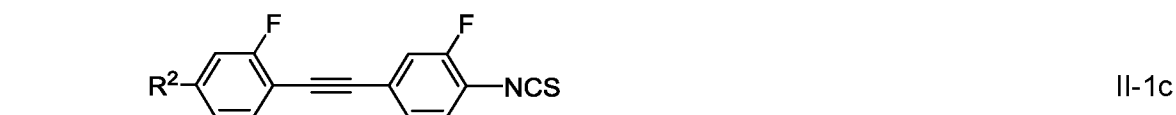
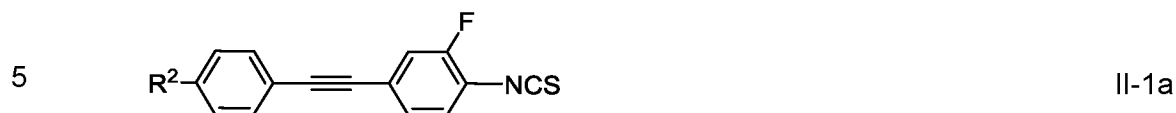
denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

35

z

denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The compounds of formula II-1 are preferably selected from the group of the compounds of the formulae II-1a to II-1e:



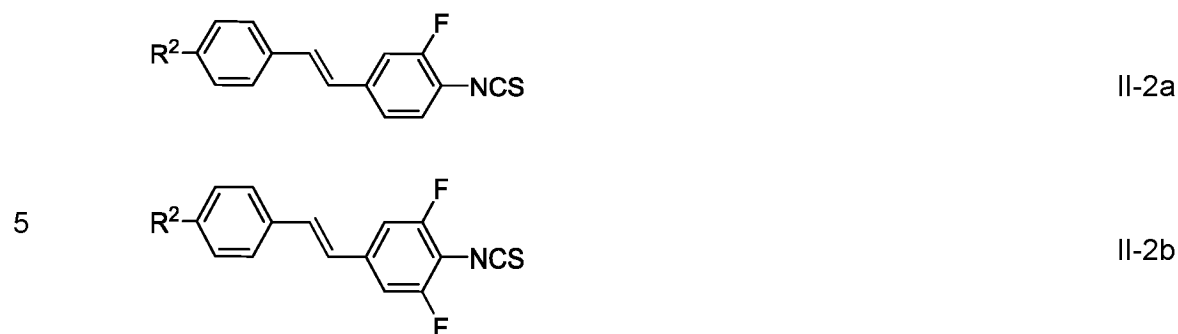
25 in which

R^2 has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

30 n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

35 The compounds of formula II-2 are preferably selected from the group of the compounds of the formulae II-2a and II-2b:

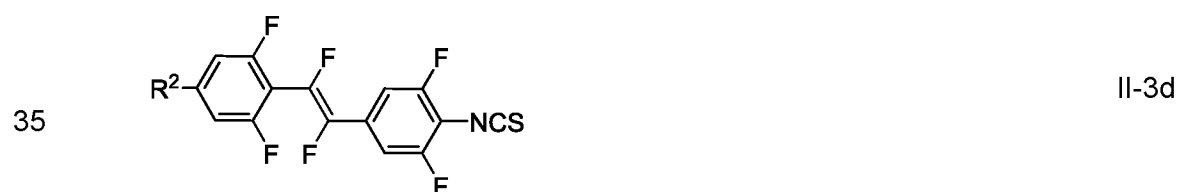
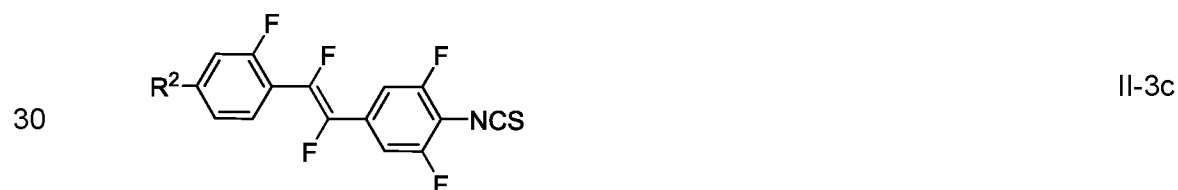
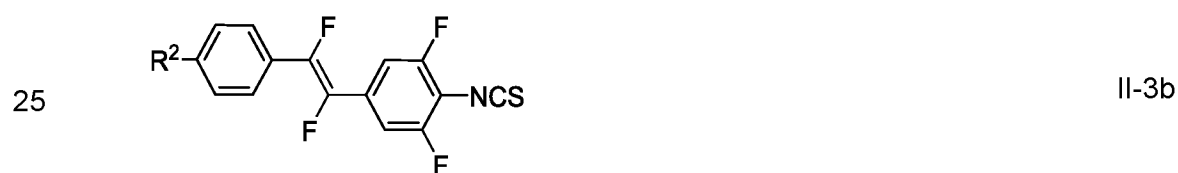
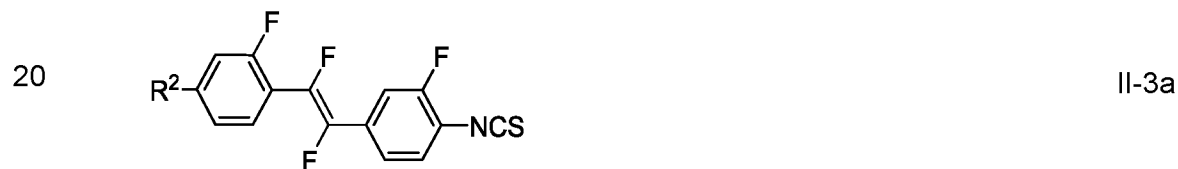


in which

- 10 R^2 has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$,
 n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and
 z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

15

The compounds of formula II-3 are preferably selected from the group of the compounds of the of formulae II-3a to II-3d:



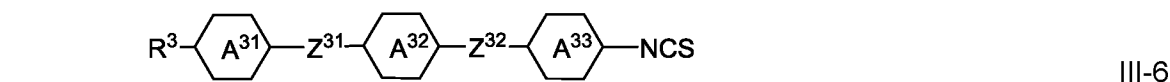
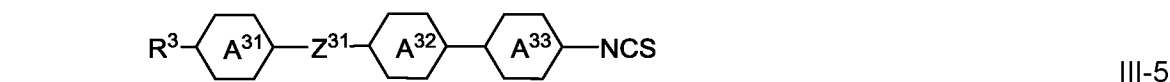
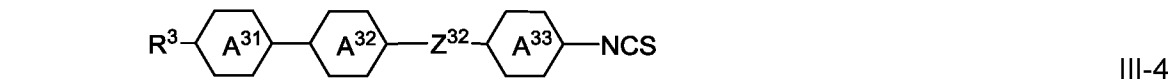
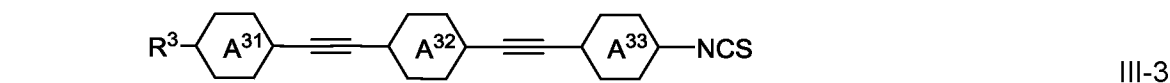
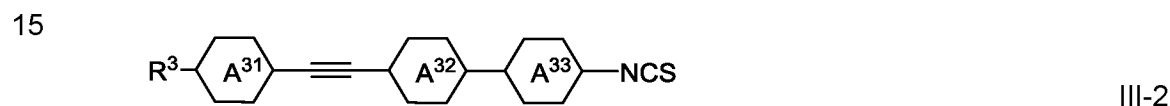
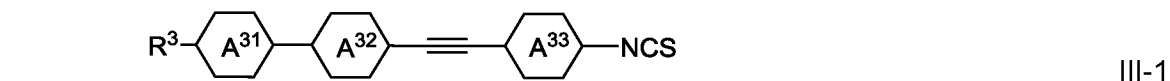
in which

R^2 has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$,

n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The compounds of formula III are preferably selected from the group of the compounds of the formulae III-1 to III-6, more preferably of the formulae selected from the group of the compounds of the formulae III-1, III-2, III-3 and III-4, and particularly preferably of formula III-1:



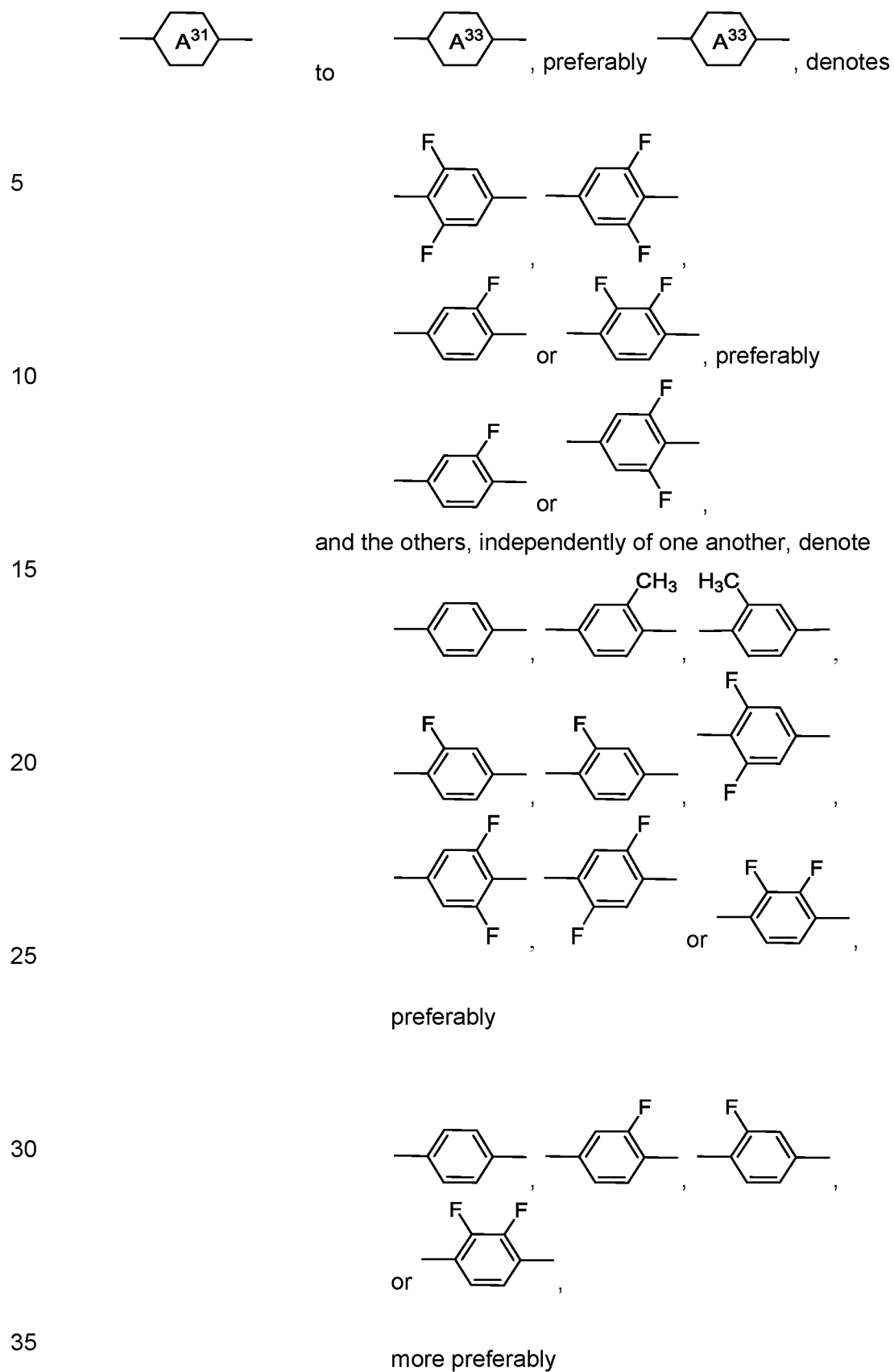
in which

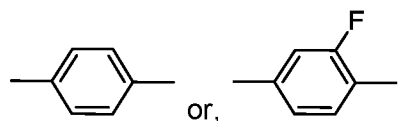
Z^{31} and Z^{32} independently of one another denote *trans*-CH=CH- or *trans*-CF=CF-, preferably *trans*-CH=CH-, and in formula III-6 alternatively one of Z^{31} and Z^{32} may denote -C≡C- and the other groups have the meaning given above under formula III,

and preferably

R^3 denotes unfluorinated alkyl or alkoxy having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms,

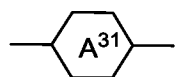
and one of



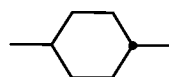


5

where



alternatively denotes



10

and preferably

R³denotes C_nH_{2n+1} or CH₂=CH-(CH₂)_z,

n

denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

15

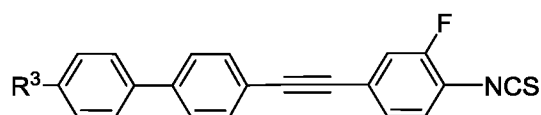
z

denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

20

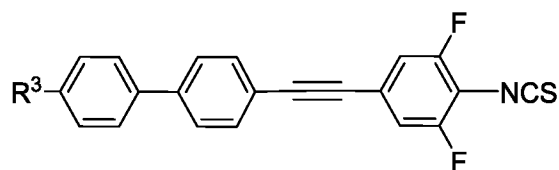
The compounds of formula III-1 are preferably selected from the group of the compounds of the formulae III-1a to III-1k, more preferably selected from the group of the compounds of the formulae III-1a, III-1b, III-1g and III-1h, particularly preferably of formula III-1b and/or III-1h:

25



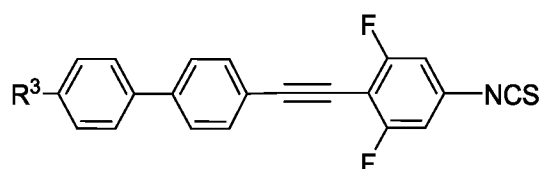
III-1a

30

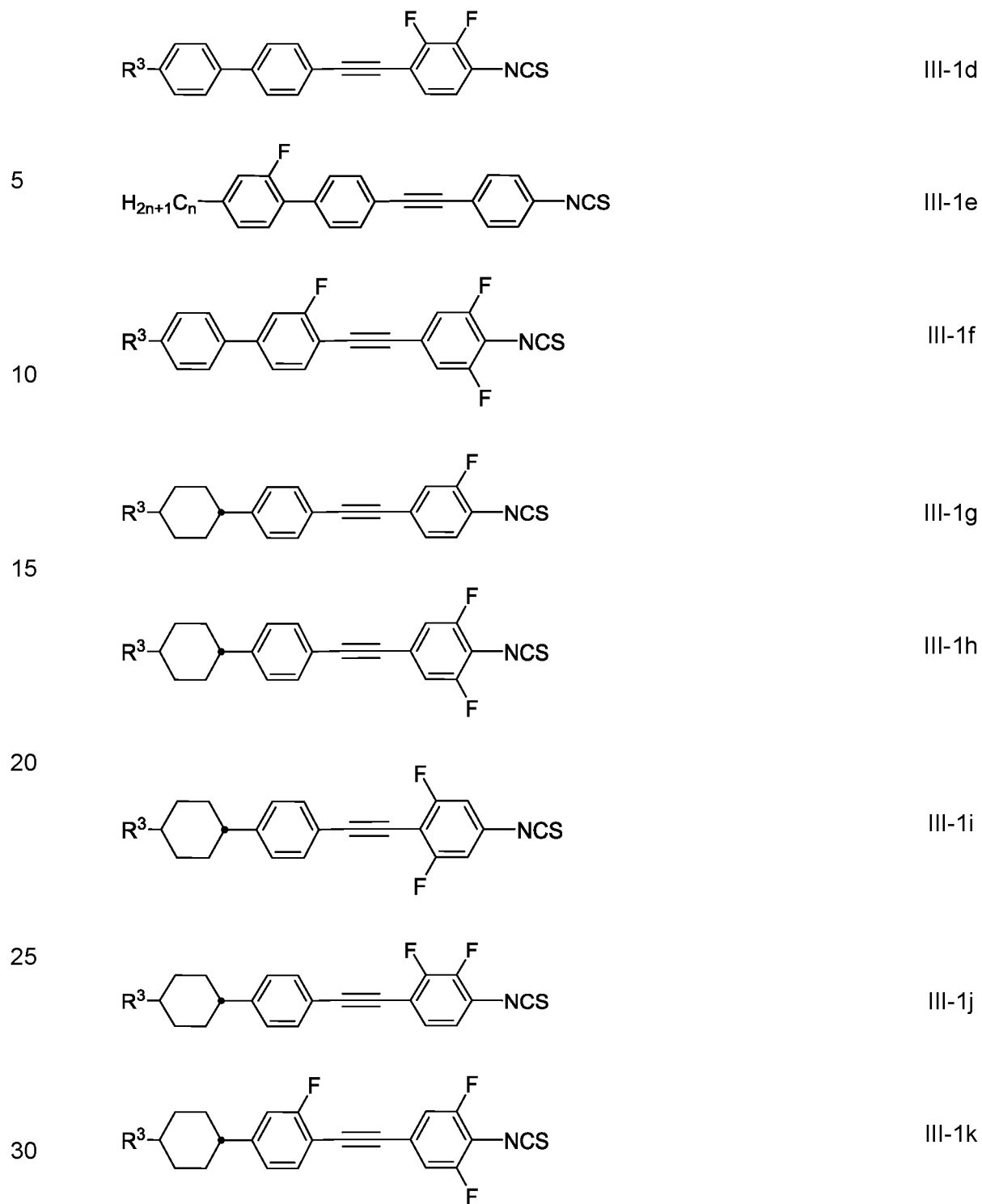


III-1b

35



III-1c



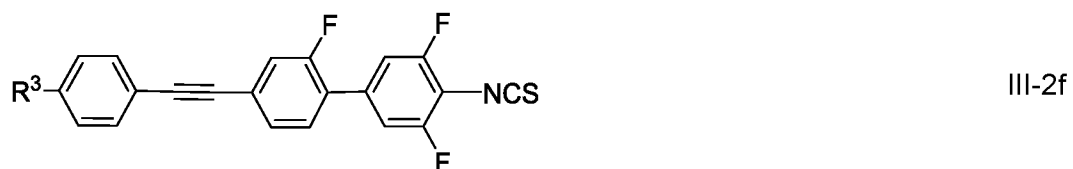
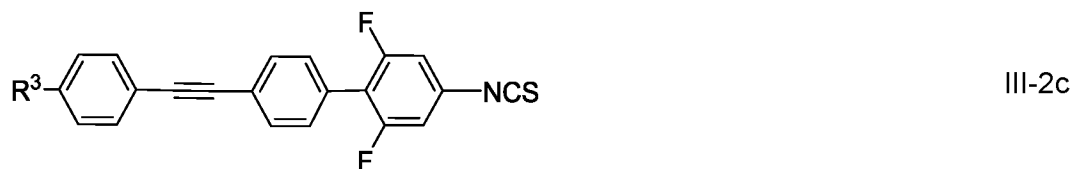
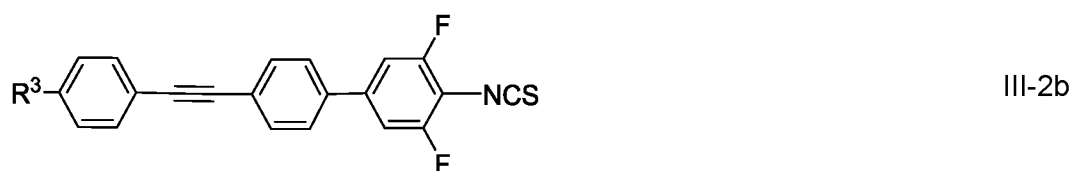
in which

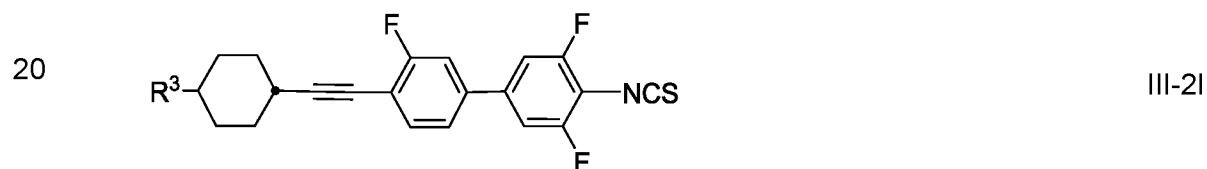
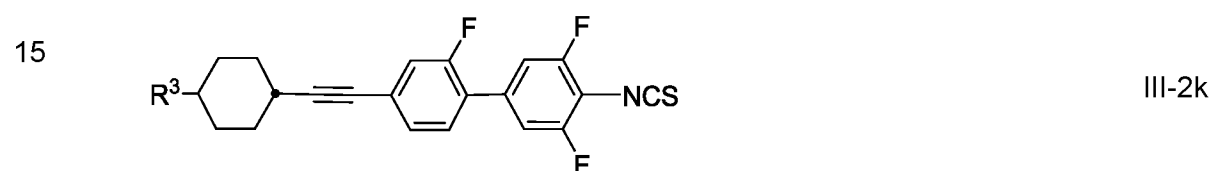
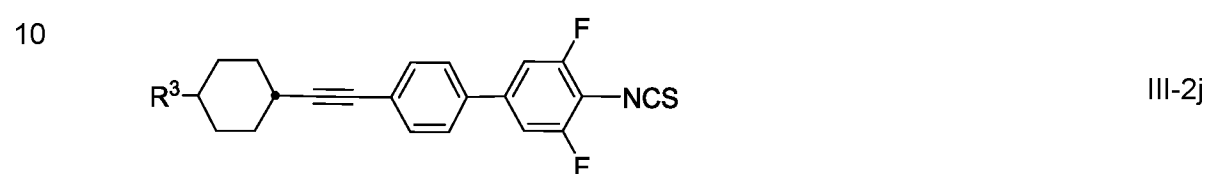
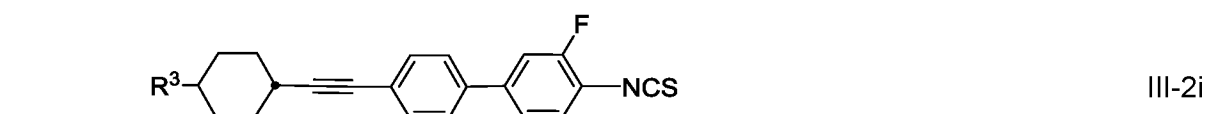
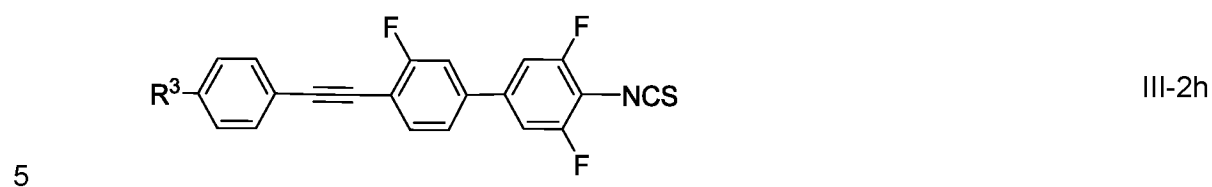
35 R^3 has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_Z$,

n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The compounds of formula III-2 are preferably compounds of formula III-2a to III-2l, very preferably III-2b and/or III-2j:





in which

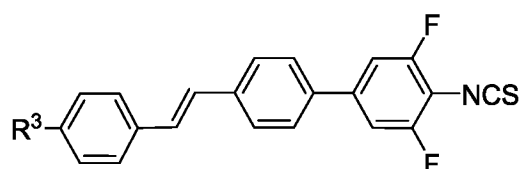
25 R^3 has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$,

30 n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

35 z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The compounds of formula III-5 are preferably selected from the compounds of formula III-5a:

35



III-5a

5

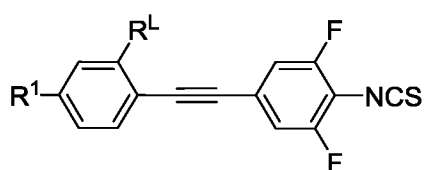
R^3 has the meaning indicated above for formula III-5 and preferably denotes C_nH_{2n+1} , in which

n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6.

10

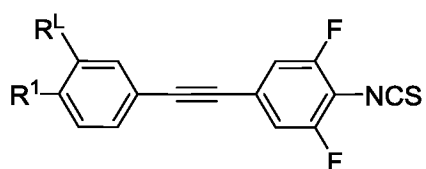
In a preferred embodiment, the media according to the invention comprise one or more compounds selected from the group of compounds of the formulae IIA-1-1 to IIA-1-12, very preferably IIA-1-1 or IIA-1-2:

15



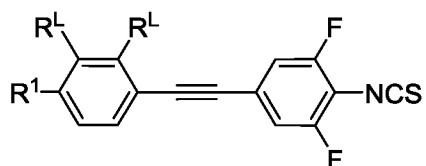
IIA-1-1

20



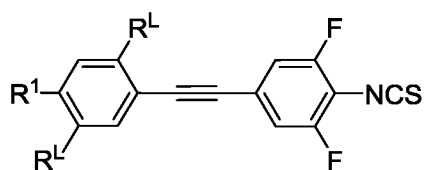
IIA-1-2

25



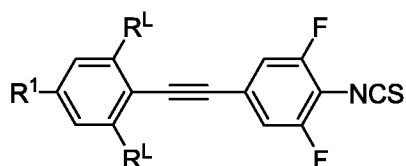
IIA-1-3

30

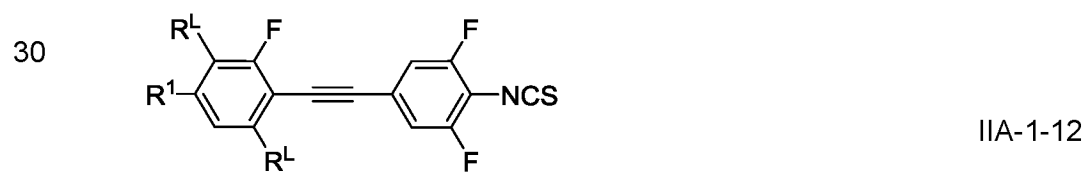
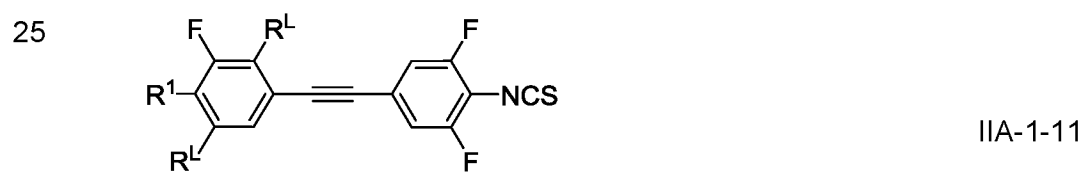
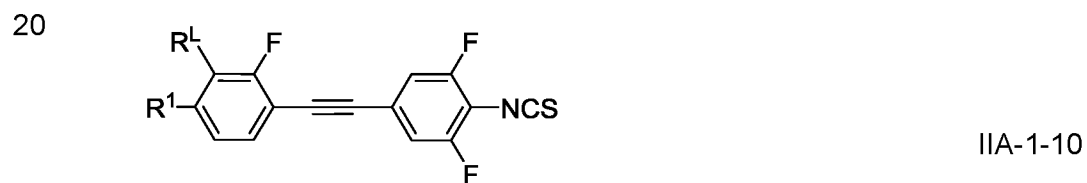
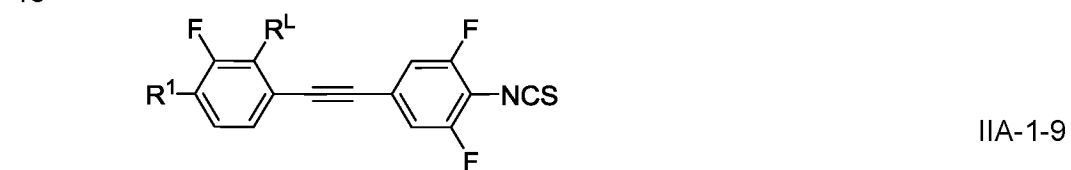
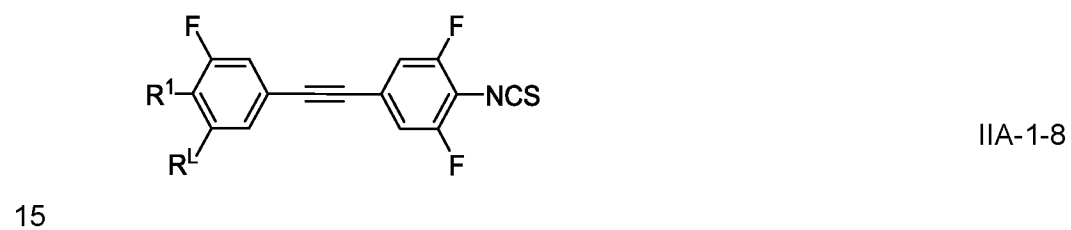
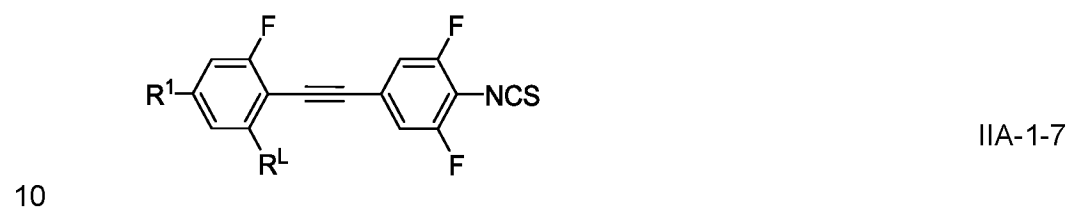
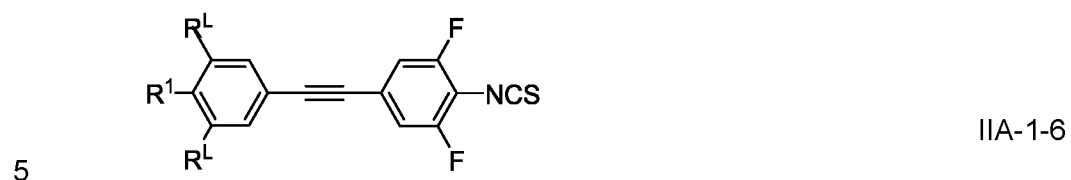


IIA-1-4

35



IIA-1-5



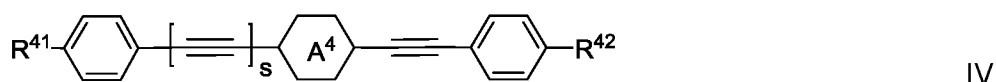
in which

R¹ denotes alkyl or alkenyl having up to 7 C atoms, preferably ethyl, n-propyl, n-butyl or n-pentyl, n-hexyl,

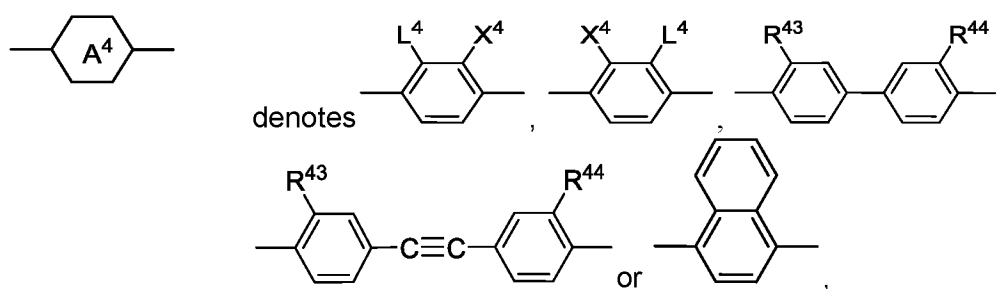
R^L on each occurrence, the same or differently, denotes alkyl or alkenyl having 1 to 5 C atoms, or cycloalkyl or cycloalkenyl each having 3 to 6 C atoms, preferably methyl, ethyl, n-propyl, n-butyl, isopropyl, cyclopropyl, cyclobutyl, cyclopentyl or cyclopent-1-enyl, very preferably ethyl,

and from which the compounds of formula II-1 are excluded.

Additionally, the liquid-crystalline media according to the present invention in a certain embodiment, which may be the same or different from the previous preferred embodiments preferably comprise one or more compounds of formula IV,

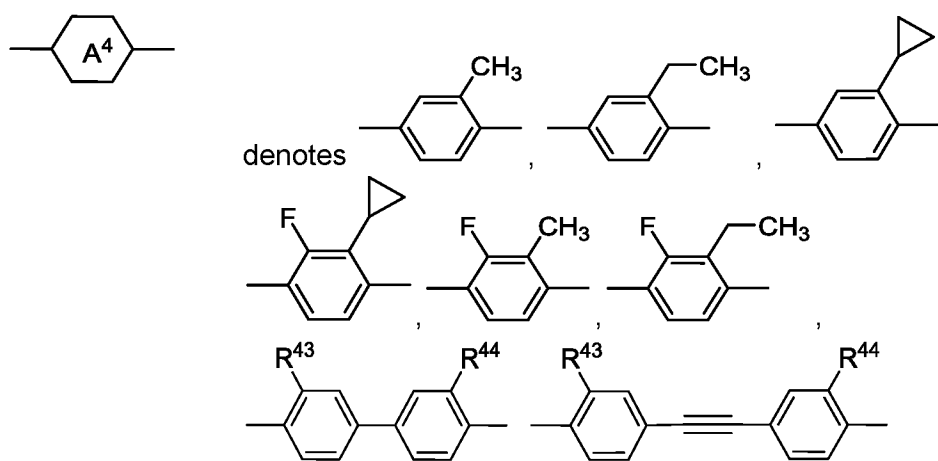


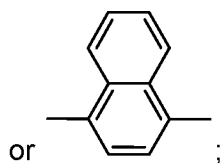
in which



s is 0 or 1, preferably 1, and

preferably

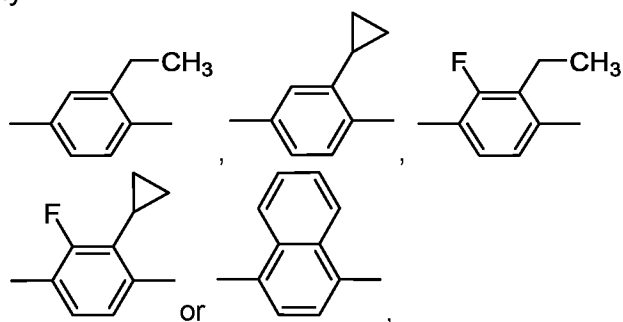




5

particularly preferably

10



15

 L^4

denotes H or alkyl having 1 to 6 C atoms, cycloalkyl having 3 to 6 C atoms or cycloalkenyl having 4 to 6 C atoms, preferably CH_3 , C_2H_5 , $n-C_3H_7$, $i-C_3H_7$, cyclopropyl, cyclobutyl, cyclohexyl, cyclopent-1-enyl or cyclohex-1-enyl, and particularly preferably CH_3 , C_2H_5 , cyclopropyl or cyclobutyl,

20

 X^4

denotes H, alkyl having 1 to 3 C atoms or halogen, preferably H, F or Cl, more preferably H or F and very particularly preferably F,

25

 R^{41} to R^{44} ,

independently of one another, denote unfluorinated alkyl or unfluorinated alkoxy, each having 1 to 15 C atoms, unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl, each having 2 to 15 C atoms, or cycloalkyl, alkylcycloalkyl, cycloalkenyl, alkylcycloalkenyl, alkylcycloalkylalkyl or alkylcycloalkenylalkyl, each having up to 15 C atoms, and alternatively one of R^{43} and R^{44} or both also denote H,

30

preferably

 R^{41} and R^{42} ,

independently of one another, denote unfluorinated alkyl or unfluorinated alkoxy, each having 1 to 7 C atoms, or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl, each having 2 to 6 C atoms,

35

particularly preferably

R^{41} denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl, each having 2 to 6 C atoms, and

5

particularly preferably

R^{42} denotes unfluorinated alkyl or unfluorinated alkoxy, each having 1 to 7 C atoms, and

10

preferably

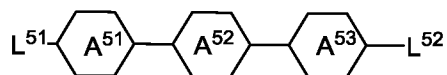
R^{43} and R^{44} denote H, unfluorinated alkyl having 1 to 5 C atoms, unfluorinated cycloalkyl or cycloalkenyl having 3 to 7 C atoms, unfluorinated alkylcyclohexyl or unfluorinated cyclohexylalkyl, each having 4 to 12 C atoms, or unfluorinated alkylcyclohexylalkyl having 5 to 15 C atoms, particularly preferably cyclopropyl, cyclobutyl or cyclohexyl, and very particularly preferably at least one of R^{43} and R^{44} denotes *n*-alkyl, particularly preferably methyl, ethyl or *n*-propyl, and the other denotes H or *n*-alkyl, particularly preferably H, methyl, ethyl or *n*-propyl.

15

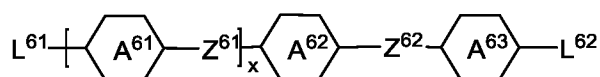
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In a preferred embodiment of the present invention, the liquid-crystal medium additionally comprises one or more compounds selected from the group of compounds of the formulae V, VI, VII, VIII and IX:

25

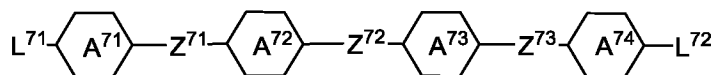


V

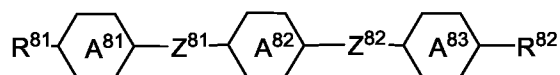


VI

30

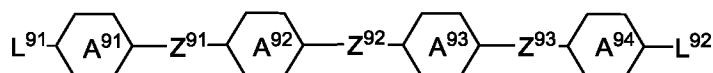


VII



VIII

35



IX

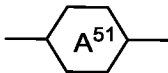
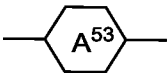
in which

L^{51} denotes R^{51} or X^{51} ,

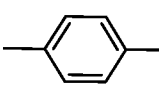
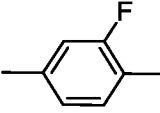
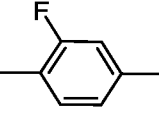
5 L^{52} denotes R^{52} or X^{52} ,

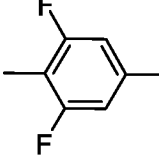
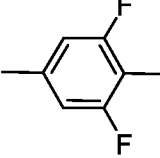
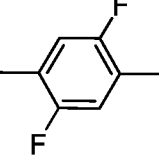
R^{51} and R^{52} , independently of one another, denote H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17, preferably 2 to 10, C atoms or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, preferably alkyl or unfluorinated alkenyl,

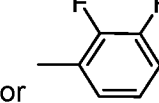
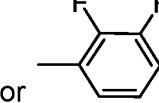
X^{51} and X^{52} , independently of one another, denote H, F, Cl, -CN, SF_5 , fluorinated alkyl or fluorinated alkoxy having 1 to 7 C atoms or fluorinated alkenyl, fluorinated alkenyloxy or fluorinated alkoxyalkyl having 2 to 7 C atoms, preferably fluorinated alkoxy, fluorinated alkenyloxy, F or Cl, and

20  to ,

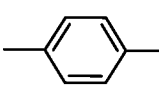
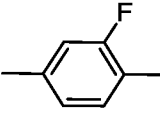
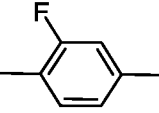
independently of one another, denote

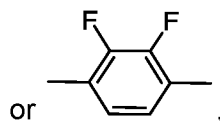
25 , , ,

, , ,

30  or ,

preferably

35 , , ,



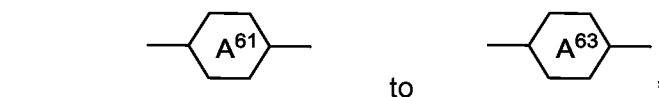
5 L^{61} denotes R^{61} and, in the case where Z^{61} and/or Z^{62} denote *trans*-CH=CH- or *trans*-CF=CF-, alternatively also denotes X^{61} ,

L^{62} denotes R^{62} and, in the case where Z^{61} and/or Z^{62} denote *trans*-CH=CH- or *trans*-CF=CF-, alternatively also denotes X^{62} ,

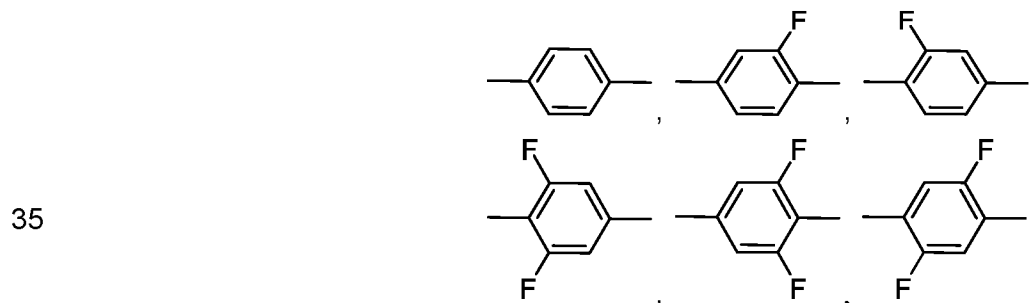
10 R^{61} and R^{62} , independently of one another, denote H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17, preferably 2 to 10, C atoms or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, preferably alkyl or unfluorinated alkenyl,

15 X^{61} and X^{62} , independently of one another, denote F or Cl, -CN, SF₅, fluorinated alkyl or alkoxy having 1 to 7 C atoms or fluorinated alkenyl, alkenyloxy or alkoxyalkyl having 2 to 7 C atoms,

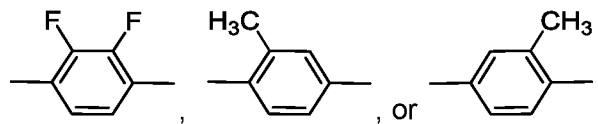
20 one of Z^{61} and Z^{62} denotes *trans*-CH=CH-, *trans*-CF=CF- or -C≡C- and the other, independently thereof, denotes *trans*-CH=CH-, *trans*-CF=CF- or a single bond, preferably one of them denotes -C≡C- or *trans*-CH=CH- and the other denotes a single bond, and



30 independently of one another, denote

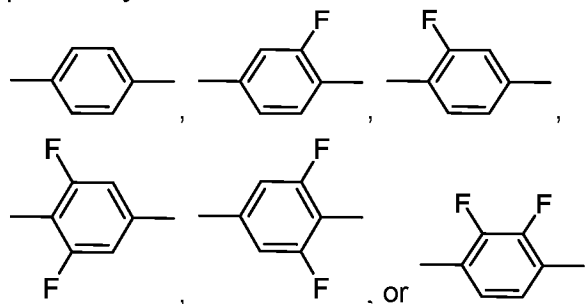


- 45 -



5

preferably



10

and

x

denotes 0 or 1;

15

 L^{71} denotes R^{71} or X^{71} , L^{72} denotes R^{72} or X^{72} ,

20

 R^{71} and R^{72} ,

independently of one another, denote H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17, preferably 2 to 10, C atoms or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, preferably alkyl or unfluorinated alkenyl,

25

 X^{71} and X^{72} ,

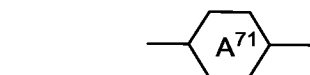
independently of one another, denote H, F, Cl, -CN, -NCS, -SF₅, fluorinated alkyl or fluorinated alkoxy having 1 to 7 C atoms or fluorinated alkenyl, unfluorinated or fluorinated alkenyloxy or unfluorinated or fluorinated alkoxyalkyl having 2 to 7 C atoms, preferably fluorinated alkoxy, fluorinated alkenyloxy, F or Cl, and

30

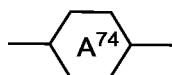
 Z^{71} to Z^{73} ,

independently of one another, denote *trans*-CH=CH-, *trans*-CF=CF-, -C≡C- or a single bond, preferably one or more of them denote a single bond, particularly preferably all denote a single bond and

35

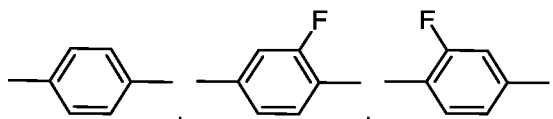


to

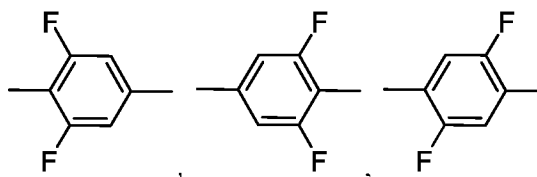


independently of one another, denote

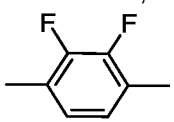
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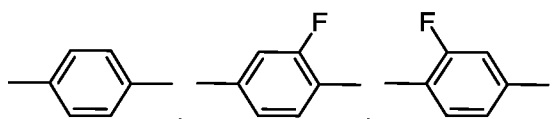
or



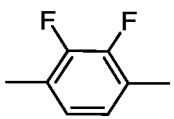
15

preferably

20



or

R⁸¹ and R⁸²,

25

independently of one another, denote H, unfluorinated alkyl or alkoxy having 1 to 15, preferably 2 to 10, C atoms or unfluorinated alkenyl, alkenyloxy or alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, preferably unfluorinated alkyl or alkenyl,

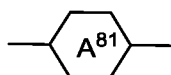
one of

30

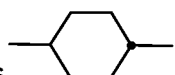
Z⁸¹ and Z⁸²

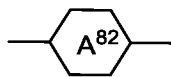
denotes *trans*-CH=CH-, *trans*-CF=CF- or -C≡C- and the other, independently thereof, denotes *trans*-CH=CH-, *trans*-CF=CF- or a single bond, preferably one of them denotes -C≡C- or *trans*-CH=CH- and the other denotes a single bond, and

35

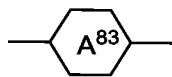


denotes





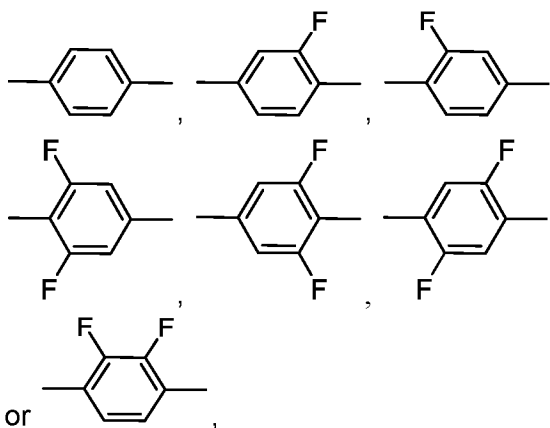
and



,

5

independently of one another, denote



10

15

 L^{91} denotes R^{91} or X^{91} , L^{92} denotes R^{92} or X^{92} ,

20

 R^{91} and R^{92} ,

independently of one another, denote H, unfluorinated alkyl or alkoxy having 1 to 15, preferably 2 to 10, C atoms or unfluorinated alkenyl, alkenyloxy or alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, preferably unfluorinated alkyl or alkenyl,

25

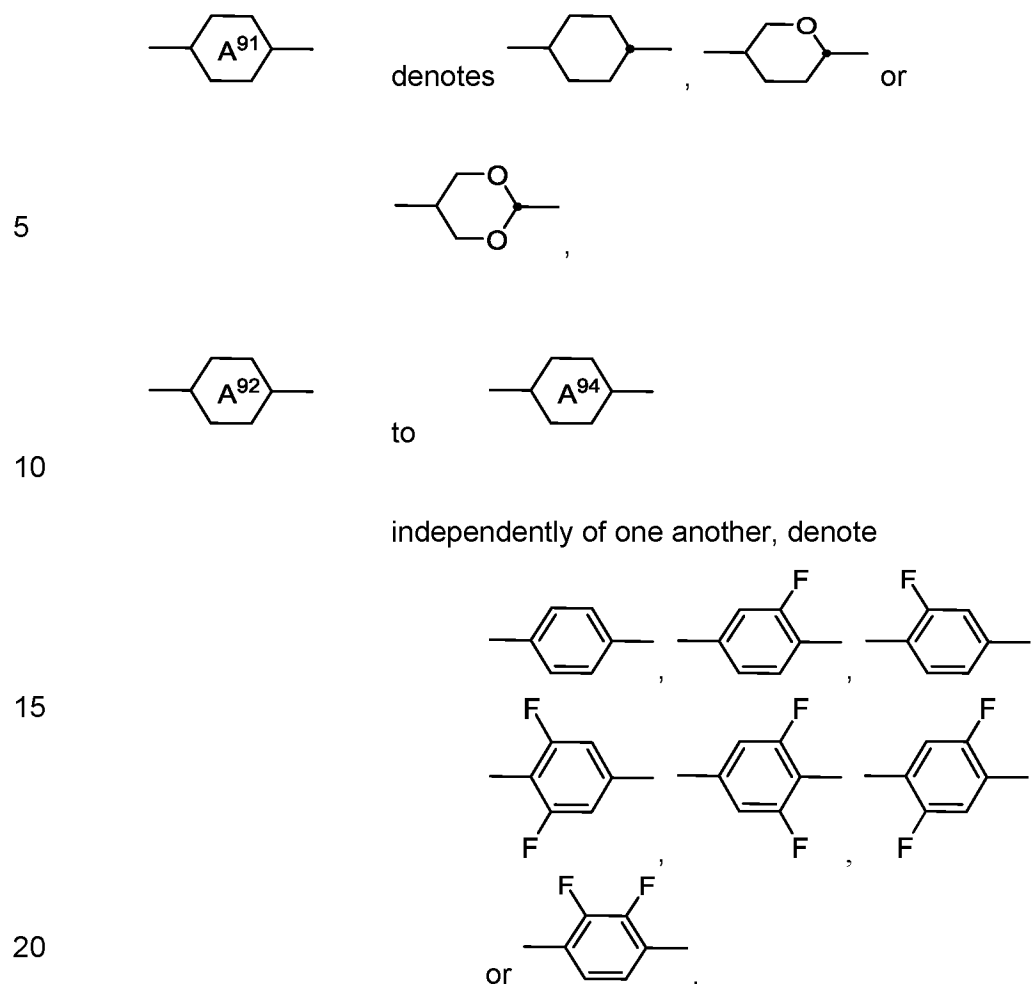
 X^{91} and X^{92} ,independently of one another, denote H, F, Cl, -CN, -NCS, -SF₅, fluorinated alkyl or fluorinated alkoxy having 1 to 7 C atoms or fluorinated alkenyl, unfluorinated or fluorinated alkenyloxy or unfluorinated or fluorinated alkoxyalkyl having 2 to 7 C atoms, preferably fluorinated alkoxy, fluorinated alkenyloxy, F or Cl, and

30

 Z^{91} to Z^{93} ,independently of one another, denote *trans*-CH=CH-, *trans*-CF=CF-, -C≡C- or a single bond, preferably one or more of them denotes a single bond, and particularly preferably all denote a single bond,

35

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25

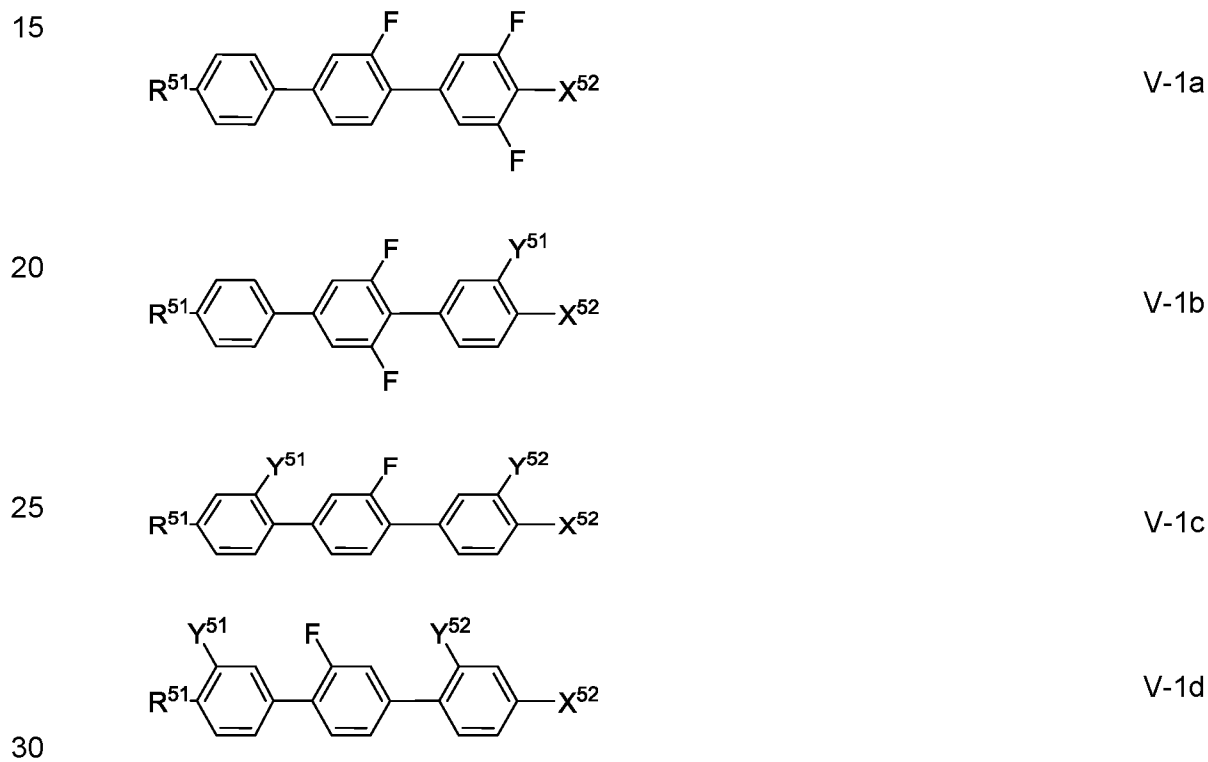
In a preferred embodiment of the present invention, the liquid-crystal medium comprises one or more compounds of the formula V, preferably selected from the group of the compounds of the formulae V-1 to V-3, preferably of the formulae V-1 and/or V-2 and/or V-3, preferably of the formulae V-1 and V-2:



in which the occurring groups have the respective meanings indicated above for formula V and preferably

- R^{51} denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms,
- 5 R^{52} denotes unfluorinated alkyl having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms or unfluorinated alkoxy having 1 to 7 C atoms,
- 10 X^{51} and X^{52} , independently of one another, denote F, Cl, $-OCF_3$, $-CF_3$, $-CN$ or $-SF_5$, preferably F, Cl, $-OCF_3$ or $-CN$.

The compounds of the formula V-1 are preferably selected from the group of the compounds of the formulae V-1a to V-1d, preferably V-1c and V-1d :



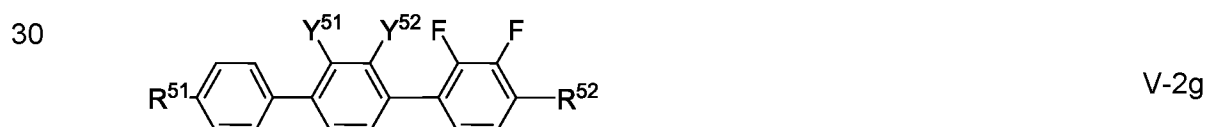
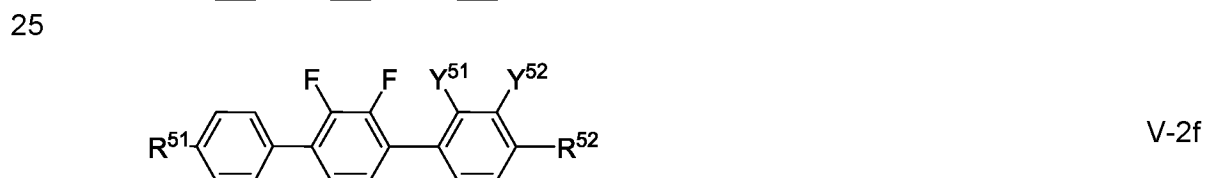
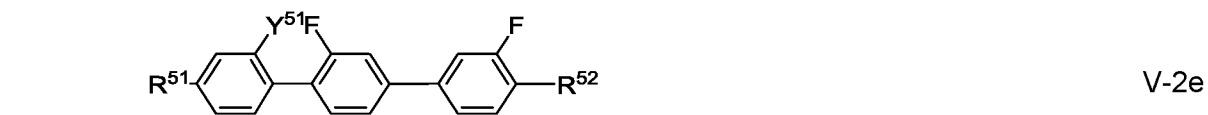
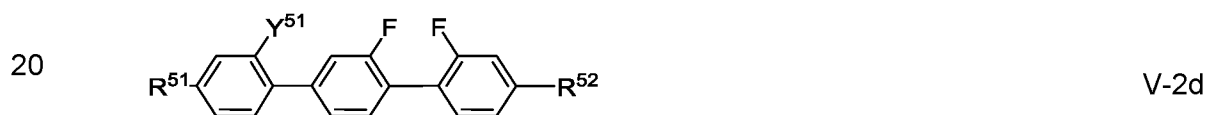
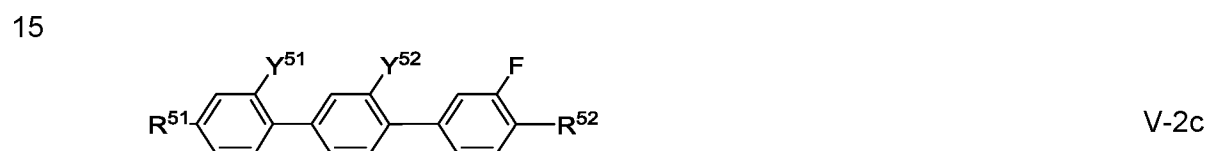
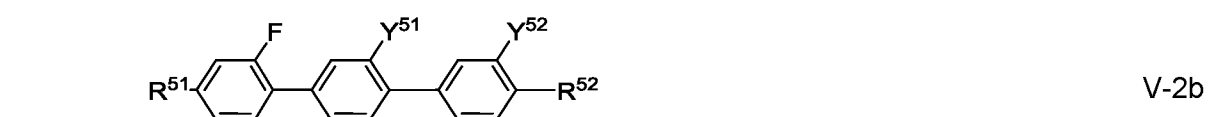
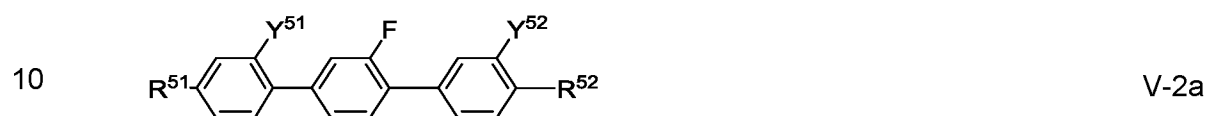
in which the parameters have the respective meanings indicated above for formula V-1 and in which

- 35 Y^{51} and Y^{52} , in each case independently of one another, denote H or F, and preferably

R^{51} denotes alkyl or alkenyl, and

X^{51} denotes F, Cl or $-OCF_3$.

5 The compounds of the formula V-2 are preferably selected from the group of the compounds of the formulae V-2a to V-2e and/or from the group of the compounds of the formulae V-2f and V-2g:



35 where in each case the compounds of the formula V-2a are excluded from the compounds of the formulae V-2b and V-2c, the compounds of the formula V-2b are excluded from the compounds of the formula V-2c and the compounds of the formula V-2f are excluded from the compounds of the formula V-2g, and

in which the parameters have the respective meanings indicated above for formula V-1
and in which

5 Y^{51} and Y^{52} , in each case independently of one another, denote H or F, and preferably

Y^{51} and Y^{52} denotes H and the other denotes H or F, preferably likewise denotes H.

10 The compounds of the formula V-3 are preferably compounds of the formula V-3a:

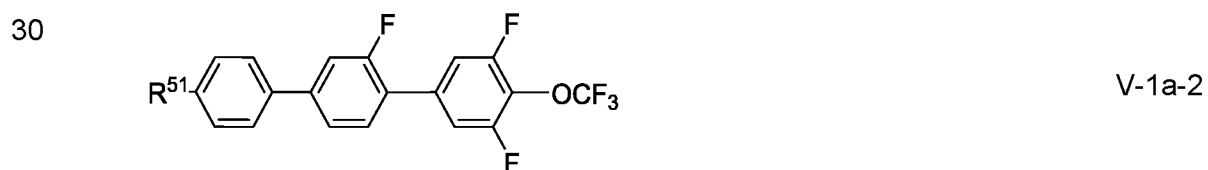
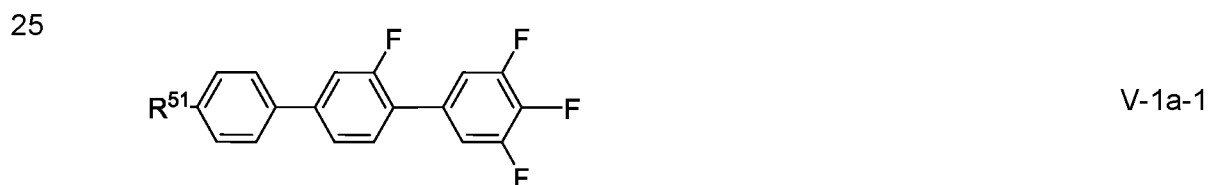


15 in which the parameters have the respective meanings indicated above for formula V-1
and in which preferably

X^{51} denotes F, Cl, preferably F,

20 X^{52} denotes F, Cl or $-OCF_3$, preferably $-OCF_3$.

The compounds of the formula V-1a are preferably selected from the group of the
compounds of the formulae V-1a-1 and V-1a-2:



in which

35 R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} ,
in which

n denotes an integer in the range from 1 to 7, preferably in the range from 1 to 6 and particularly preferably 3 to 5.

5 The compounds of the formula V-1b are preferably compounds of the formula V-1b-1:



10

in which

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} , in which

15

n denotes an integer in the range from 1 to 7, preferably in the range from 1 to 6 and particularly preferably 3 to 5.

20

The compounds of the formula V-1c are preferably selected from the group of the compounds of the formulae V-1c-1 to V-1c-4, particularly preferably selected from the group of the compounds of the formulae V-1c-1 and V-1c-2:



25



30



35

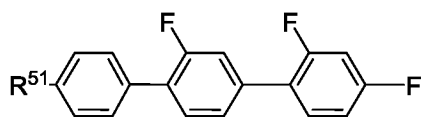
in which

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} ,
in which

5 n denotes an integer in the range from 1 to 7, preferably in the range
from 1 to 6 and particularly preferably 3 to 5.

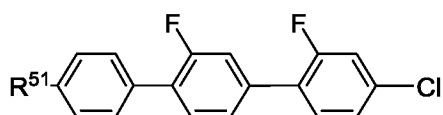
The compounds of the formula V-1d are preferably selected from the group of the
compounds of the formulae V-1d-1 and V-1d-2, particularly preferably the compound of
the formula V-1d-2:

10



V-1d-1

15



V-1d-2

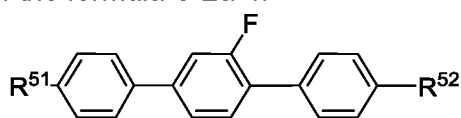
in which

20 R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} ,
in which

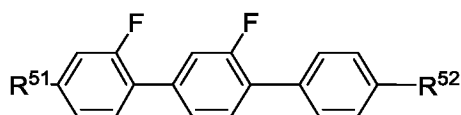
n denotes an integer in the range from 1 to 7, preferably in the range
from 1 to 6 and particularly preferably 3 to 5.

25 The compounds of the formula V-2a are preferably selected from the group of the
compounds of the formulae V-2a-1 and V-2a-2, particularly preferably the compounds
of the formula V-2a-1:

30



V-2a-1



V-2a-2

in which

35

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1}
or $CH_2=CH-(CH_2)_Z$, and

R^{52} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_Z-CH=CH_2$, and in which

5 n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 1 to 6 and particularly preferably 3 to 5, and

10 z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

Preferred combinations of (R^{51} and R^{52}), in particular in the case of formula V-2a-1, are (C_nH_{2n+1} and C_mH_{2m+1}), (C_nH_{2n+1} and $O-C_mH_{2m+1}$), $(CH_2=CH-(CH_2)_Z$ and C_mH_{2m+1}), $(CH_2=CH-(CH_2)_Z$ and $O-C_mH_{2m+1}$) and (C_nH_{2n+1} and $(CH_2)_Z-CH=CH_2$).

15 Preferred compounds of the formula V-2b are the compounds of the formula V-2b-1:



20 in which

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_Z$, and

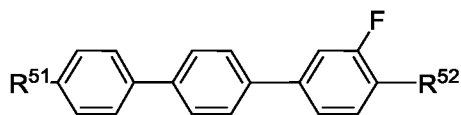
25 R^{52} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_Z-CH=CH_2$, and in which

30 n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 1 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combination of (R^{51} and R^{52}) here is, in particular, (C_nH_{2n+1} and C_mH_{2m+1}).

35 Preferred compounds of the formula V-2c are the compounds of the formula V-2c-1:



V-2c-1

5 in which

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

10 R^{52} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 1 to 6 and particularly preferably 3 to 5, and

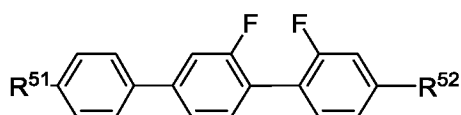
15

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combination of (R^{51} and R^{52}) here is, in particular, (C_nH_{2n+1} and C_mH_{2m+1}).

20

Preferred compounds of the formula V-2d are the compounds of the formula V-2d-1:



V-2d-1

25 in which

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

30 R^{52} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 1 to 6 and particularly preferably 3 to 5, and

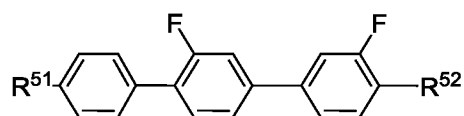
35

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combination of (R^{51} and R^{52}) here is, in particular, (C_nH_{2n+1} and C_mH_{2m+1}).

Preferred compounds of the formula V-2e are the compounds of the formula V-2e-1:

5



V-2e-1

in which

10

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

R^{52} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

15

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

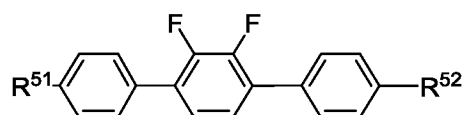
20

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combination of (R^{51} and R^{52}) here is, in particular, (C_nH_{2n+1} and $O-C_mH_{2m+1}$).

25

Preferred compounds of the formula V-2f are the compounds of the formula V-2f-1:



V-2f-1

30

in which

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

35

R^{52} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

5 z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combinations of (R^{51} and R^{52}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

10 Preferred compounds of the formula V-2g are the compounds of the formula V-2g-1:



15 in which

R^{51} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

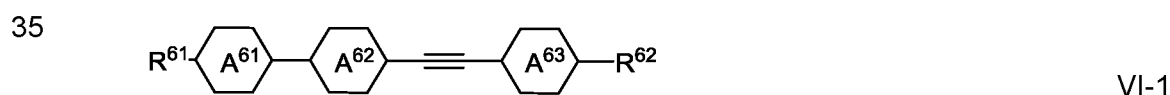
20 R^{52} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

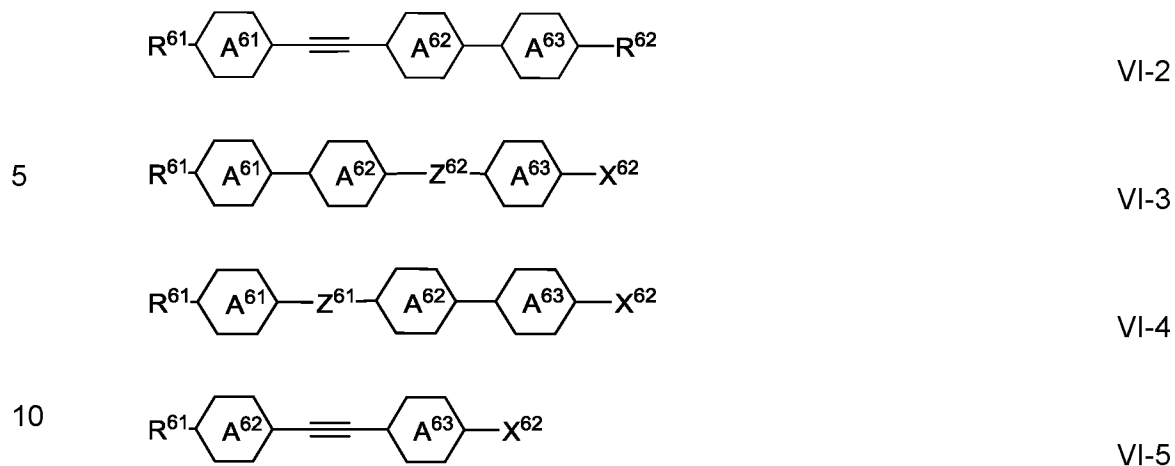
25 n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

30 The preferred combinations of (R^{51} and R^{52}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and $O-C_mH_{2m+1}$).

The compounds of the formula VI are preferably selected from the group of the compounds of the formulae VI-1 to VI-5:

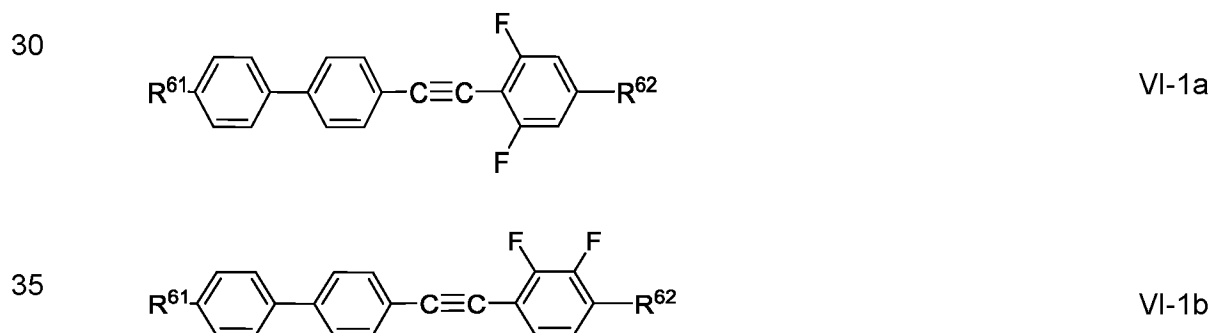




in which

- 15 Z^{61} and Z^{62} denote $-C\equiv C-$, *trans*- $CH=CH-$ or *trans*- $CF=CF-$, preferably $-C\equiv C-$ or *trans*- $CH=CH-$, and the other occurring groups and parameters have the meaning given above under formula VI, and preferably
- 20 R^{61} and R^{62} , independently of one another, denote H, unfluorinated alkyl or alkoxy having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms,
- 25 X^{62} denotes F, Cl, $-OCF_3$ or $-CN$,

The compounds of the formula VI-1 are preferably selected from the group of the compounds of the formulae VI-1a and VI-1b, more preferably selected from compounds of the formula VI-1a:



in which

R^{61} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

5

R^{62} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

10

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

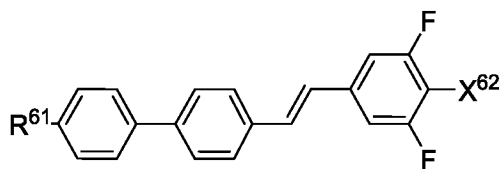
15

The preferred combinations of (R^{61} and R^{62}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), in the case of formula VI-1a particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}) and in the case of formula VI-1b particularly preferably (C_nH_{2n+1} and $O-C_mH_{2m+1}$).

20

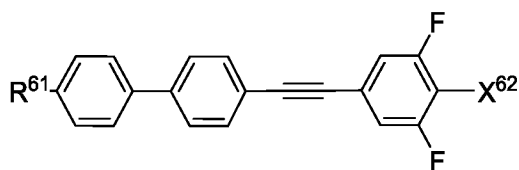
The compounds of the formula VI-3 are preferably selected from the compounds of the formula VI-3a to VI-3e:

25



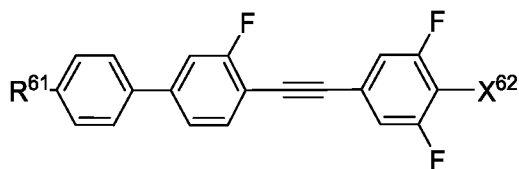
VI-3a

30

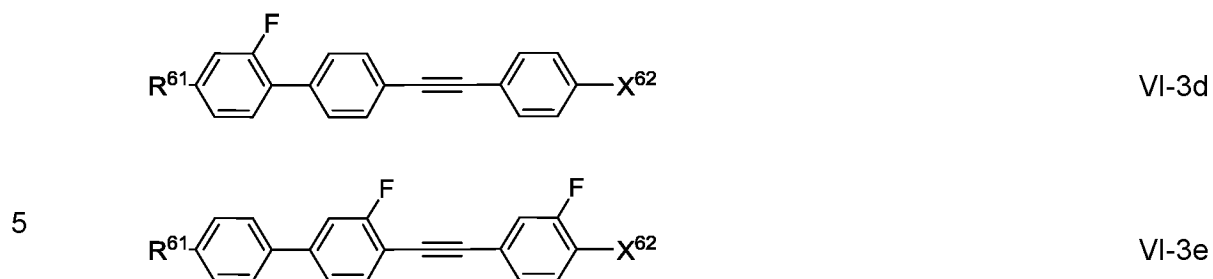


VI-3b

35



VI-3c



in which the parameters have the meaning given above under formula VI-3 and preferably

10

R^{61} has the meaning indicated above and preferably denotes C_nH_{2n+1} , in which

15

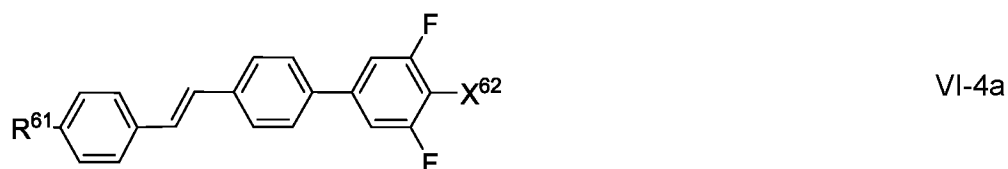
n denotes an integer in the range from 1 to 7, preferably in the range from 1 to 5, and

X^{62} denotes -F, -Cl, -OCF₃, or -CN.

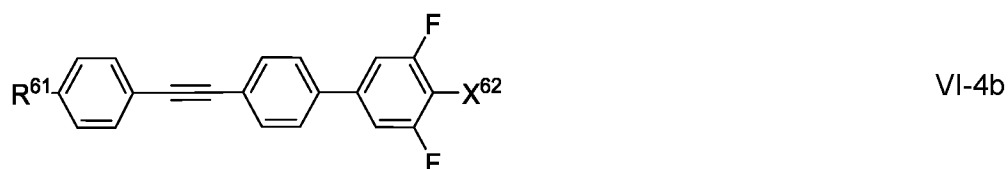
20

The compounds of the formula VI-4 are preferably selected from compounds of the formulae VI-4a to VI-4e:

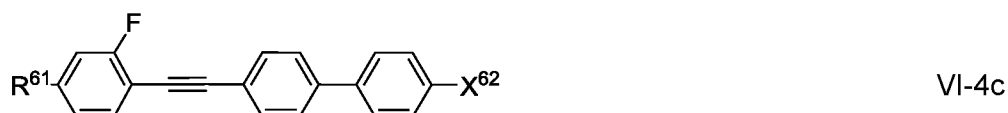
25

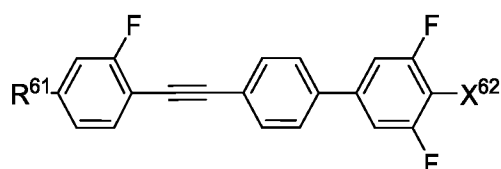


30



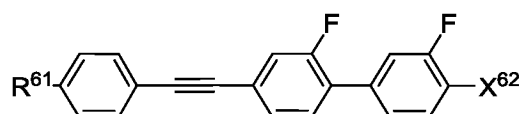
35





VI-4d

5



VI-4e

10

in which the parameters have the meaning given above under formula VI-4 and preferably

R^{61} has the meaning indicated above and preferably denotes C_nH_{2n+1} , in which

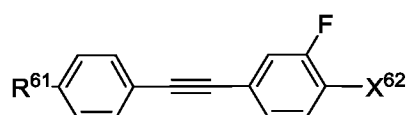
15

n denotes an integer in the range from 1 to 7, preferably in the range from 1 to 5, and

X^{62} denotes F, Cl, OCF_3 , or $-CN$.

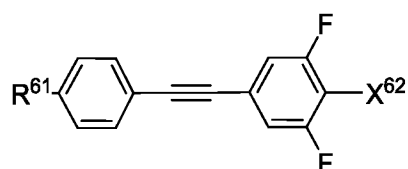
20

The compounds of the formula VI-5 are preferably selected from the compounds of the formulae VI-5a to VI-5d, preferably VI-5b:



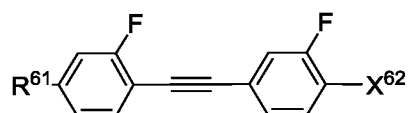
VI-5a

25



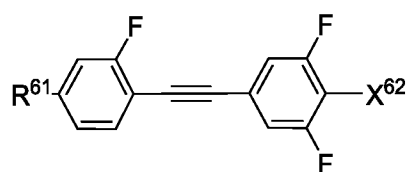
VI-5b

30



VI-5c

35



VI-5d

5

in which the parameters have the meaning given above under formula VI-5 and preferably

10

R^{61} has the meaning indicated above and preferably denotes C_nH_{2n+1} , in which

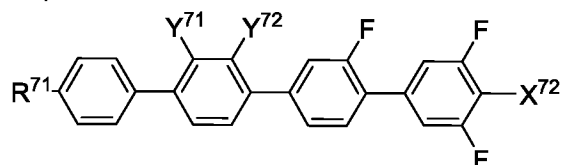
n denotes an integer in the range from 1 to 7, preferably in the range from 1 to 5, and

15

X^{62} denotes -F, -Cl, -OCF₃, or -CN, particularly preferably -OCF₃.

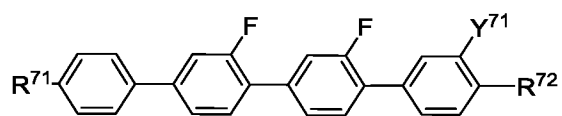
The compounds of the formula VII are preferably selected from the group of the compounds of the formulae VII-1 to VII-6:

20

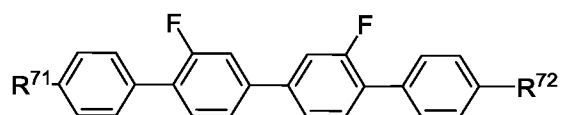


VII-1

25

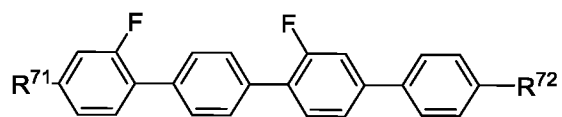


VII-2



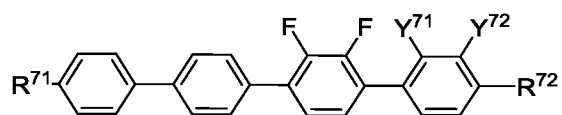
VII-3

30

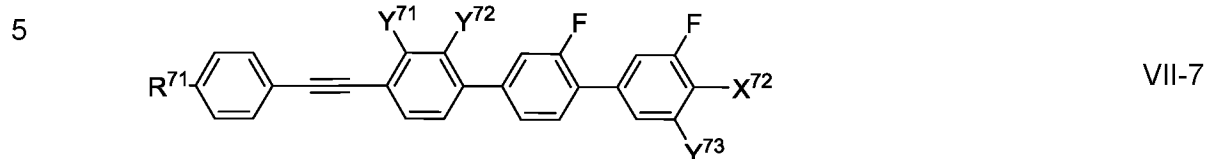
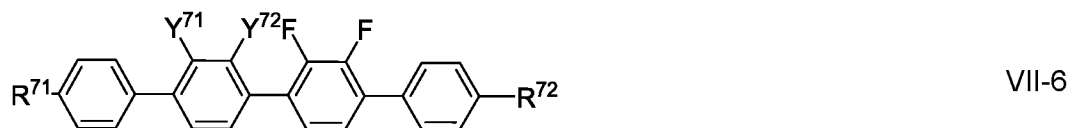


VII-4

35



VII-5



10 where the compounds of the formula VII-5 are excluded from the compounds of the formula VII-6, and

in which the parameters have the respective meanings indicated above for formula VII,

15 Y^{71} , Y^{72} , Y^{73} independently from one another, denote H or F,

and preferably

20 R^{71} denotes unfluorinated alkyl or alkoxy, each having 1 to 7 C atoms, or unfluorinated alkenyl having 2 to 7 C atoms,

R^{72} denotes unfluorinated alkyl or alkoxy, each having 1 to 7 C atoms, or unfluorinated alkenyl having 2 to 7 C atoms,

25 X^{72} denotes F, Cl; NCS or $-OCF_3$, preferably F or NCS, and

particularly preferably

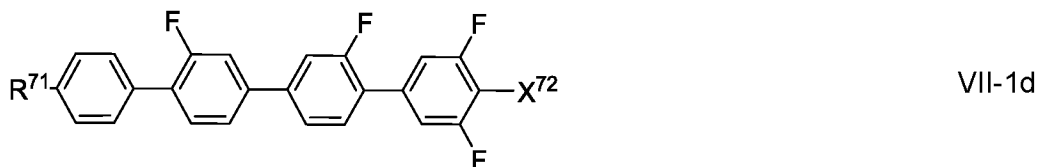
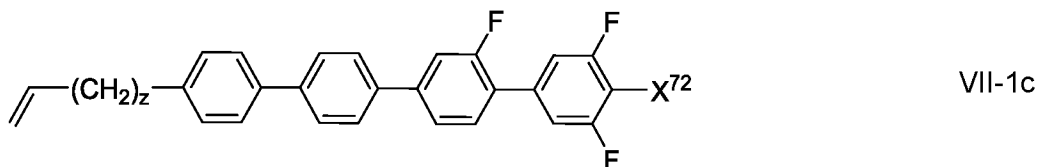
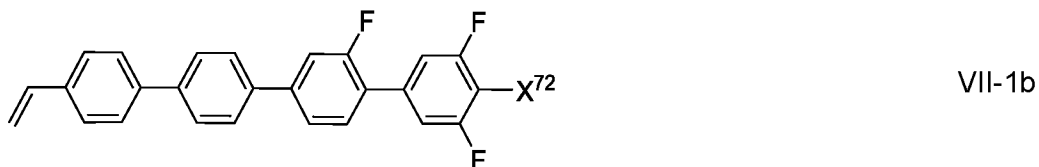
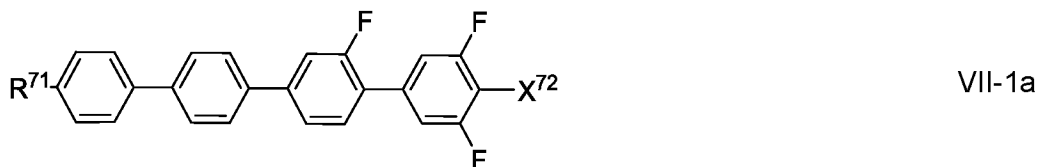
30 R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_Z$, and

R^{72} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_Z-CH=CH_2$, and in which

35 n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The compounds of the formula VII-1 are preferably selected from the group of the compounds of the formulae VII-1a to VII-1d:



in which X^{72} has the meaning given above for formula VII-2 and

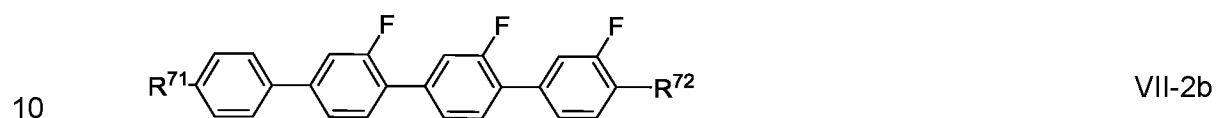
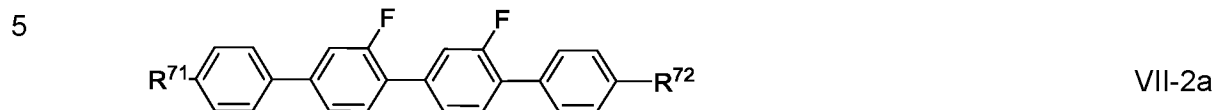
R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} , in which

n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2, and

X^{72} preferably denotes F.

The compounds of the formula VII-2 are preferably selected from the group of the compounds of the formulae VII-2a and VII-2b, particularly preferably of the formula VII-2a:



in which

15 R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

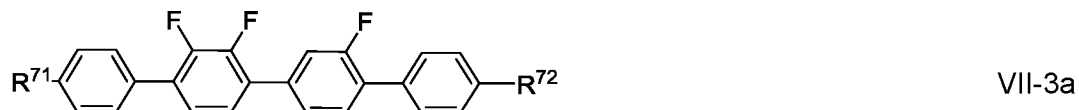
R^{72} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

20 n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

25 z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combinations of (R^{71} and R^{72}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

30 The compounds of the formula VII-3 are preferably compounds of the formula VII-3a:



35 in which

R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

5 R^{72} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

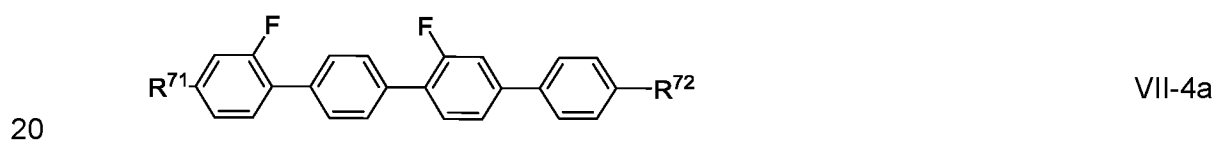
10

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combinations of (R^{71} and R^{72}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

15

The compounds of the formula VII-4 are preferably compounds of the formula VII-4a:



in which

25 R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

R^{72} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

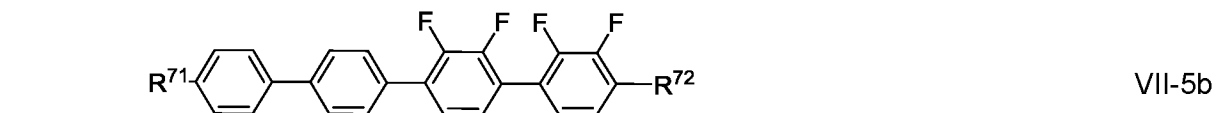
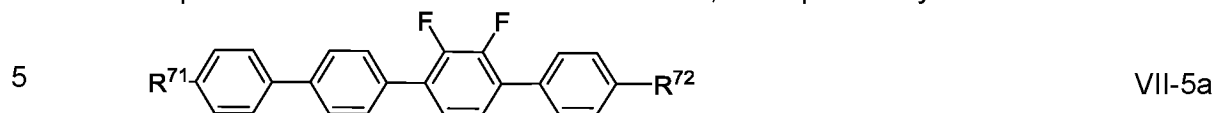
30 n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

35

The preferred combinations of (R^{71} and R^{72}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

The compounds of the formula VII-5 are preferably selected from the group of the compounds of the formulae VII-5a and VII-5b, more preferably of the formula VII-5a:



in which

15 R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

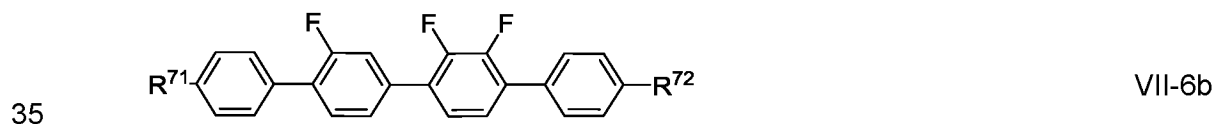
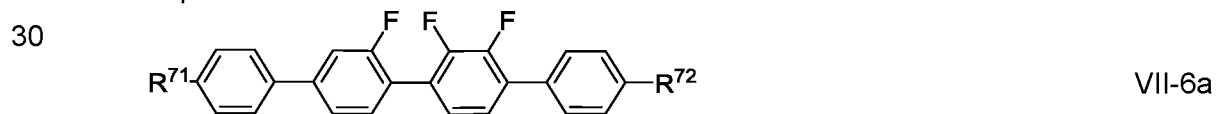
R^{72} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

20 n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

25 The preferred combinations of (R^{71} and R^{72}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

The compounds of the formula VII-6 are preferably selected from the group of the compounds of the formulae VII-6a and VII-6b:



in which

R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

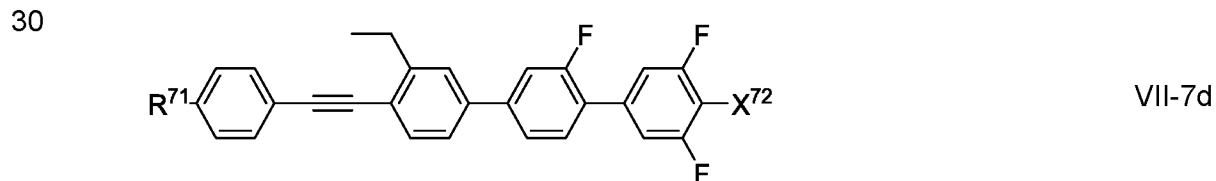
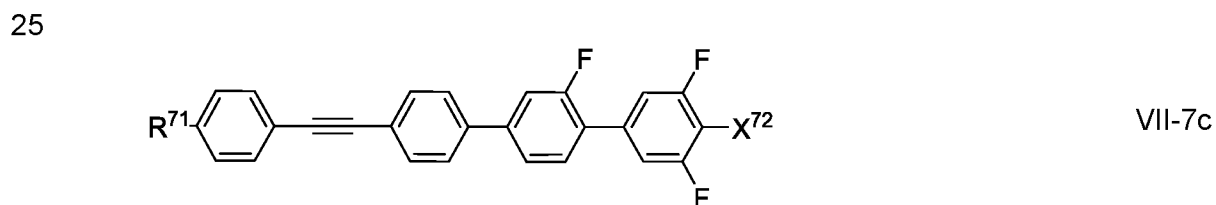
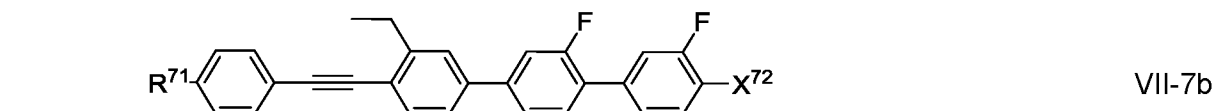
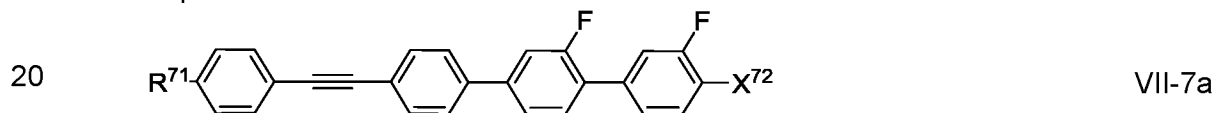
5 R^{72} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

10 n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

15 The preferred combinations of (R^{71} and R^{72}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

The compounds of the formula VII-7 are preferably selected from the group of the compounds of the formulae VII-7a to VII-7d:



35 in which

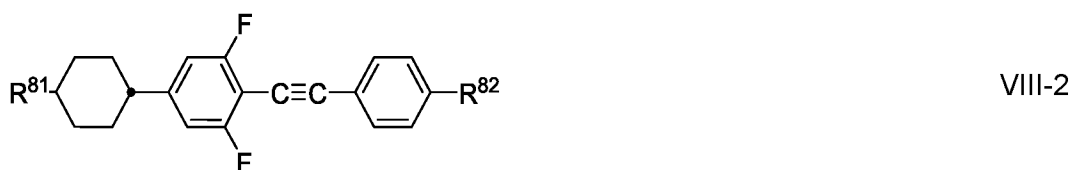
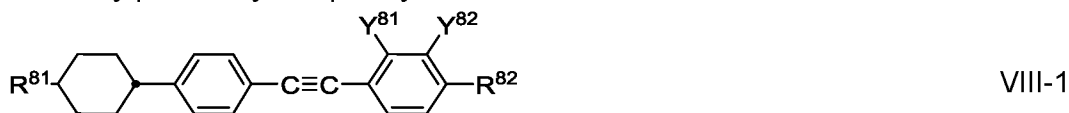
R^{71} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_Z$,

X^{72} denotes F, $-OCF_3$ or $-NCS$,

n denotes an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The compounds of the formula VIII are preferably selected from the group of the compounds of the formulae VIII-1 to VIII-3, more preferably these compounds of the formula VIII predominantly consist, even more preferably essentially consist and very particularly preferably completely consist thereof:



in which

one of

Y^{81} and Y^{82} denotes H and the other denotes H or F, and

R^{81} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_Z$, and

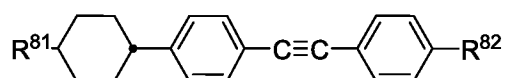
R^{82} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_Z-CH=CH_2$, and in which

n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

5 z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

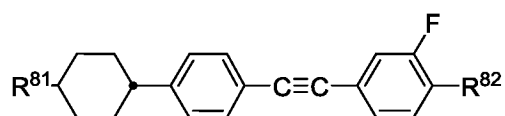
The preferred combinations of (R^{81} and R^{82}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

10 The compounds of the formula VIII-1 are preferably selected from the group of the compounds of the formulae VIII-1a to VIII-1c:



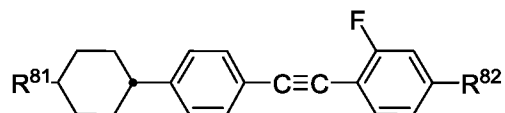
VIII-1a

15



VIII-1b

20



VIII-1c

in which

25 R^{81} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

R^{82} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

30

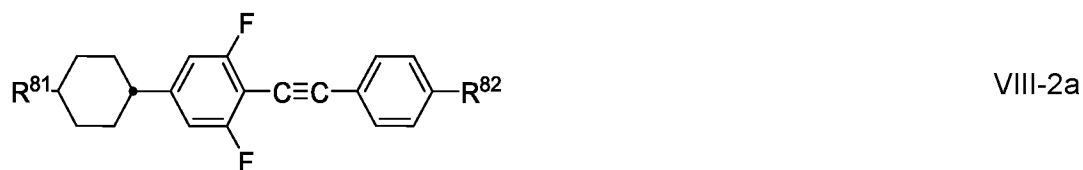
n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

35 z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combinations of (R^{81} and R^{82}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

The compounds of the formula VIII-2 are preferably compounds of the formula VIII-2a:

5



10

in which

R^{81} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

15

R^{82} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

20

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

25

The preferred combinations of (R^{81} and R^{82}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}), (C_nH_{2n+1} and $O-C_mH_{2m+1}$) and ($CH_2=CH-(CH_2)_z$ and C_mH_{2m+1}), particularly preferably (C_nH_{2n+1} and C_mH_{2m+1}).

The compounds of the formula VIII-3 are preferably compounds of the formula VIII-3a:

30



in which

35

R^{81} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

5 R^{82} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

10

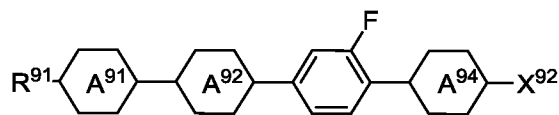
z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combinations of (R^{81} and R^{82}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$).

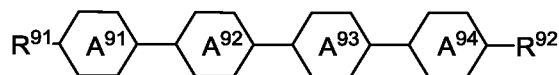
15

The compounds of the formula IX are preferably selected from the group of the compounds of the formulae IX-1 to IX-3:

20

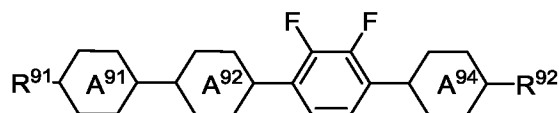


IX-1



IX-2

25

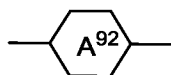


IX-3

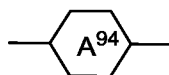
in which the parameters have the respective meaning indicated above under formula IX and preferably

30

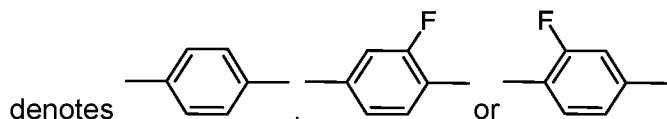
one of



to



35



and

in which

5

R^{91} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

10

R^{92} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

n and m , independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

15

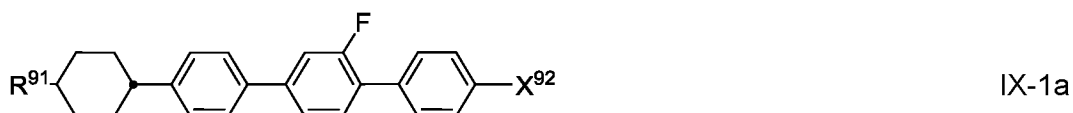
z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combinations of (R^{91} and R^{92}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$).

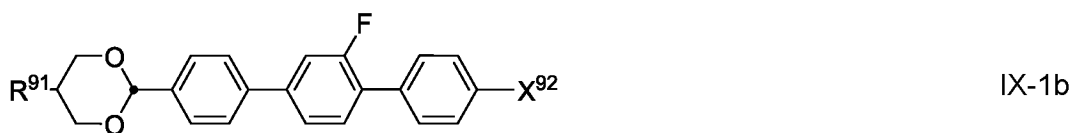
20

The compounds of the formula IX-1 are preferably selected from the group of the compounds of the formulae IX-1a to IX-1e:

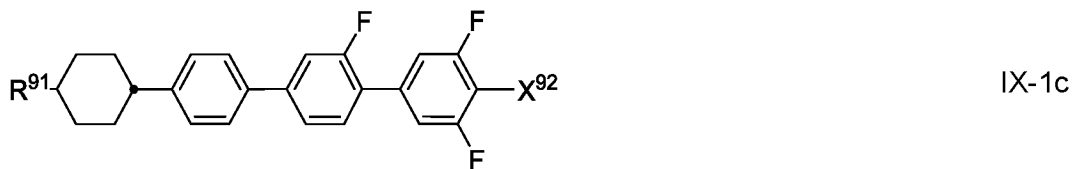
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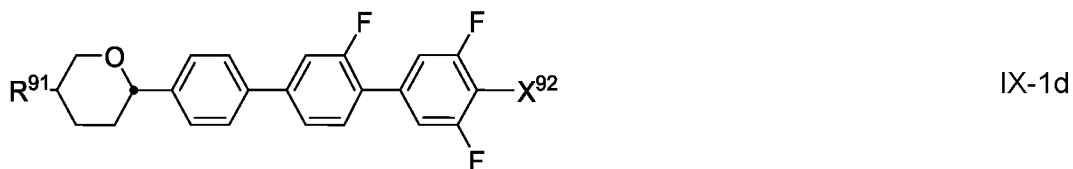


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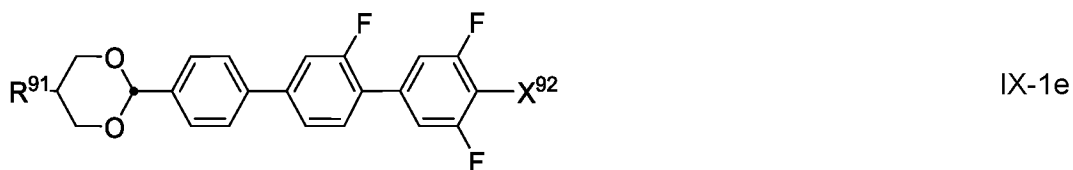


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in which the parameters have the meaning given above and preferably

R^{91} has the meaning indicated above and preferably denotes C_nH_{2n+1} , and

15

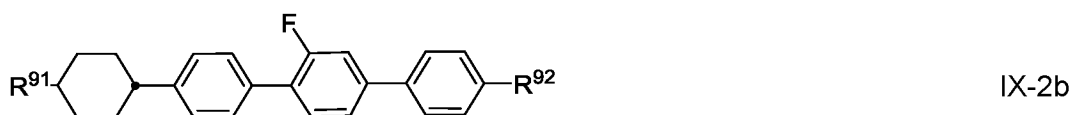
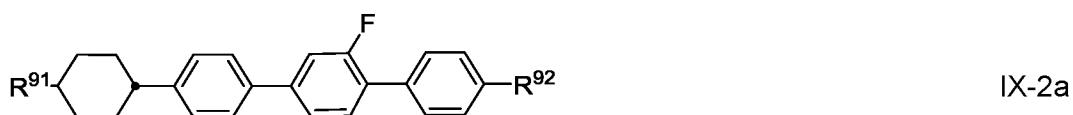
n denotes an integer in the range from 0 to 15, preferably in the range from 1 to 7 and particularly preferably 1 to 5, and

X^{92} preferably denotes F or Cl.

20

The compounds of the formula IX-2 are preferably selected from the group of the compounds of the formulae IX-2a and IX-2b:

25



30

in which

R^{91} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_Z$, and

35

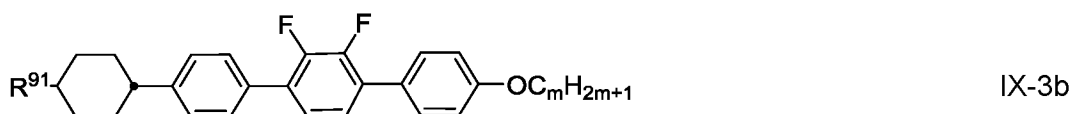
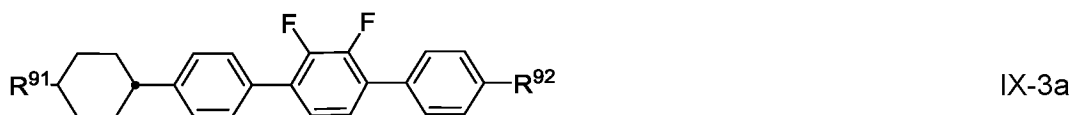
R^{92} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_Z-CH=CH_2$, and in which

n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combination of (R^{91} and R^{92}) here is, in particular, (C_nH_{2n+1} and C_mH_{2m+1}).

The compounds of the formula IX-3 are preferably compounds of the formulae IX-3a and IX-3b:



in which

R^{91} has the meaning indicated above and preferably denotes C_nH_{2n+1} or $CH_2=CH-(CH_2)_z$, and

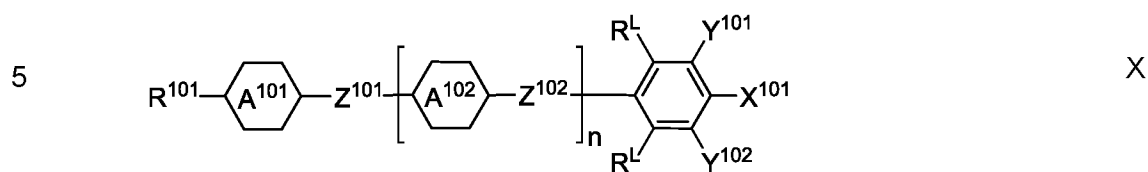
R^{92} has the meaning indicated above and preferably denotes C_mH_{2m+1} or $O-C_mH_{2m+1}$ or $(CH_2)_z-CH=CH_2$, and in which

n and m, independently of one another, denote an integer in the range from 1 to 7, preferably in the range from 2 to 6 and particularly preferably 3 to 5, and

z denotes 0, 1, 2, 3 or 4, preferably 0 or 2.

The preferred combinations of (R^{91} and R^{92}) here are, in particular, (C_nH_{2n+1} and C_mH_{2m+1}) and (C_nH_{2n+1} and $O-C_mH_{2m+1}$), particularly preferably (C_nH_{2n+1} and $O-C_mH_{2m+1}$).

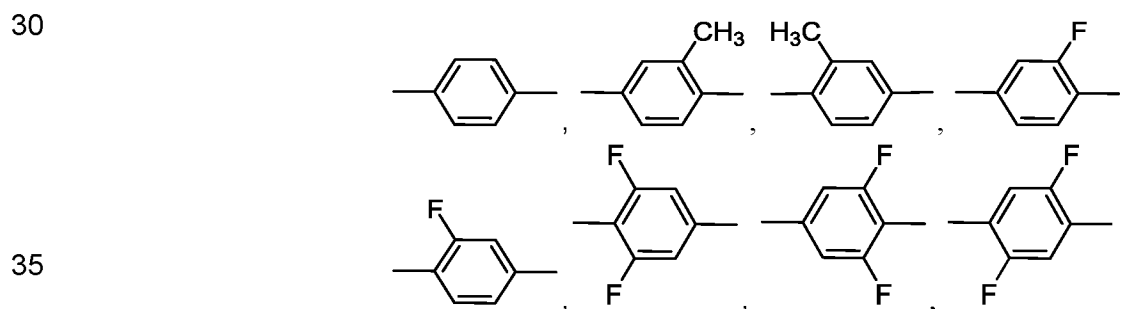
In a preferred embodiment of the present invention the medium comprises one or more compounds of formula X

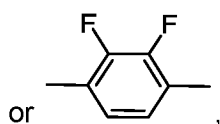


in which

- 10 R^{101} denotes H, alkyl or alkoxy having 1 to 15, preferably 2 to 10, C atoms or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15, preferably 3 to 10, C atoms, preferably alkyl or alkenyl,
- 15 X^{101} denotes H, F, Cl, -CN, SF_5 , NCS, fluorinated alkyl or fluorinated alkoxy having 1 to 7 C atoms or fluorinated alkenyl, fluorinated alkenyloxy or fluorinated alkoxyalkyl having 2 to 7 C atoms, preferably fluorinated alkoxy, fluorinated alkenyloxy, F, Cl or NCS, particularly preferably NCS,
- 20 Y^{101} denotes methyl, ethyl or Cl,
- Y^{102} denotes H, methyl, ethyl, F or Cl, preferably H or F,
- 25 Z^{101}, Z^{102} identically or differently, denote a single bond, -CH=CH-, -CF=CF- or -C≡C-,

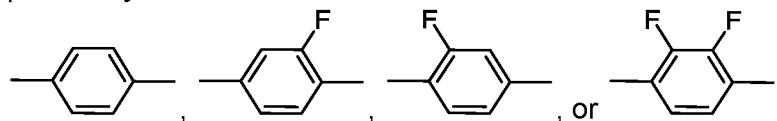
30 and independently of one another, denote





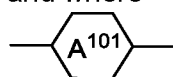
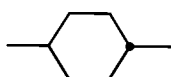
5

preferably



10

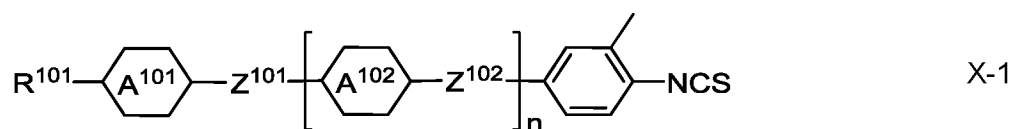
and where

alternatively denotes  , and

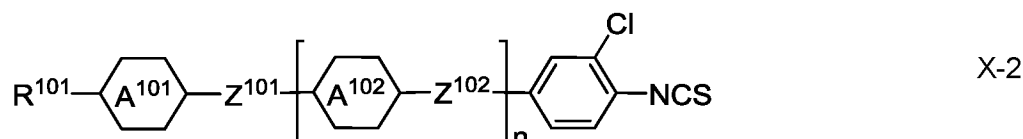
n is 0 or 1.

15

Preferably, the compounds of formula X are selected from the sub-formulae X-1 and X-2



20



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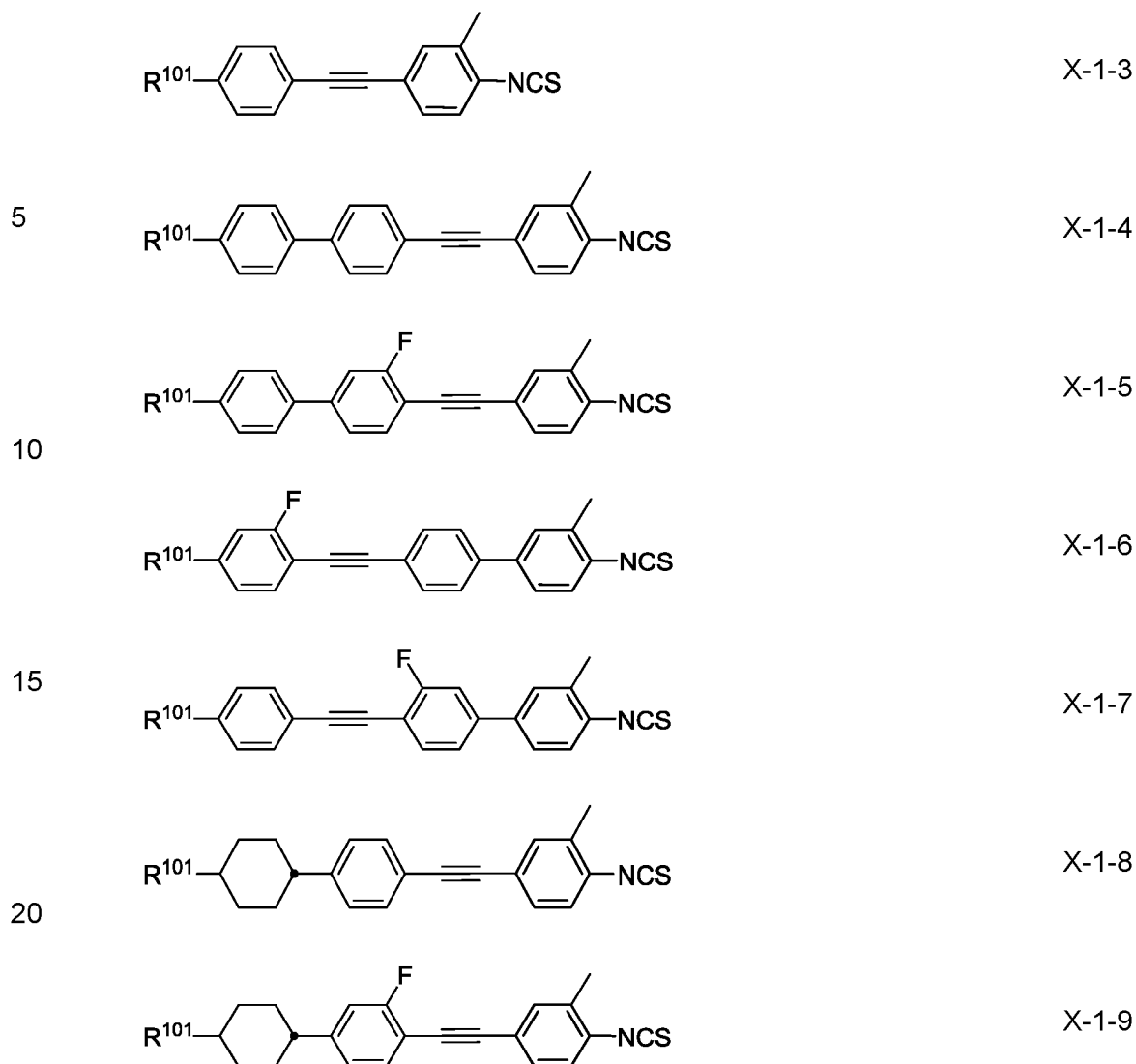
in which the occurring groups and parameters have the meanings given above for formula X.

30

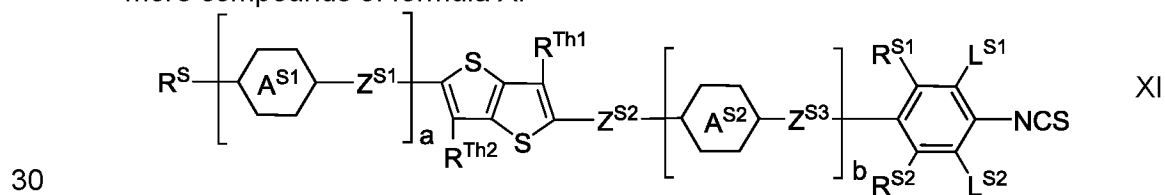


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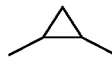
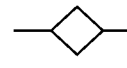
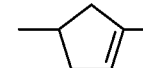
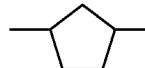




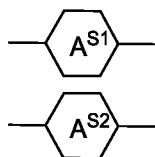
25 In a preferred embodiment, the medium according to the invention comprises one or more compounds of formula XI



in which

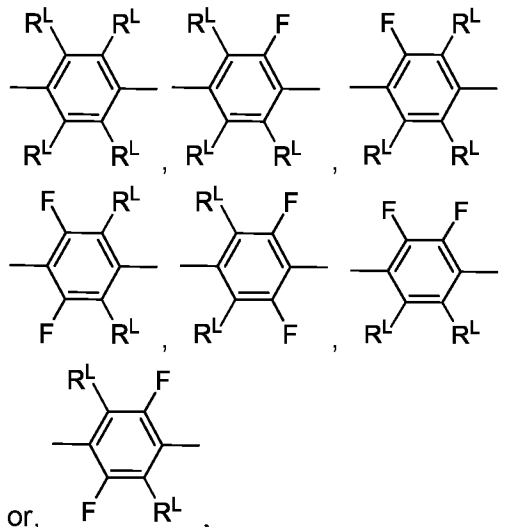
35 R^S denotes H, alkyl or alkoxy having 1 to 12 C atoms, or alkenyl, alkenyloxy or alkoxyalkyl having 2 to 12 C atoms, in which one or more CH_2 -groups may be replaced by , , ,  or , and in which one or

more H atoms may be replaced by F,



and

, on each occurrence, independently of one another, denote



or,

in which R^L, on each occurrence identically or differently, denotes H, Cl or straight-chain, branched or cyclic alkyl having 1 to 6 C atoms,

L^{S1}, L^{S2} identically or differently, denote H, Cl or F,

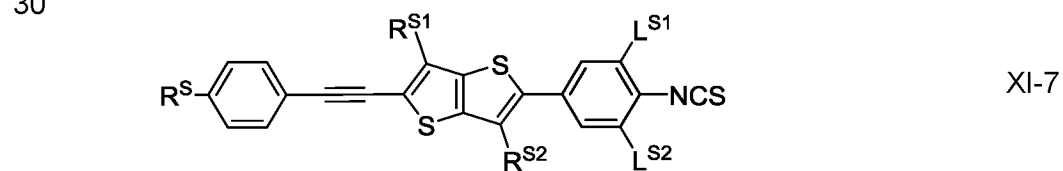
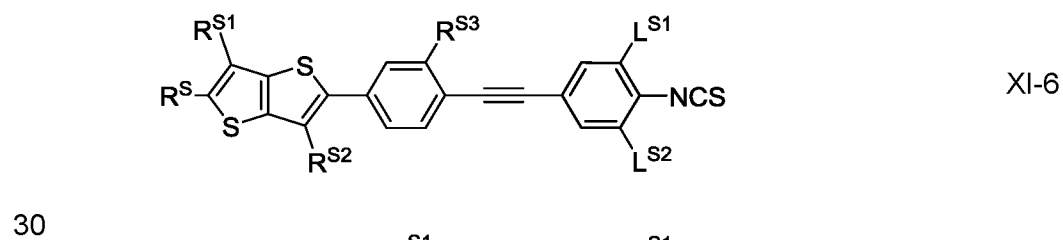
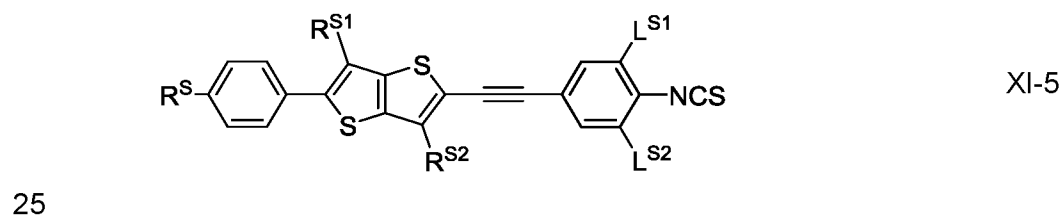
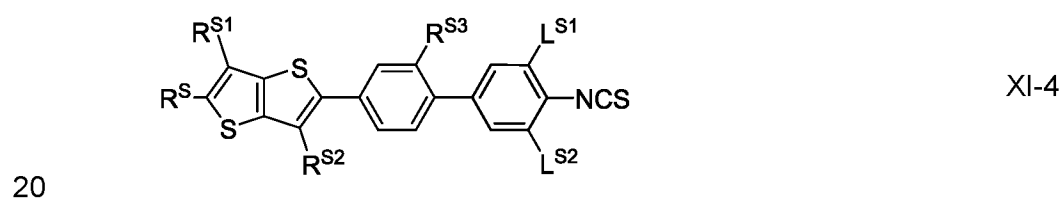
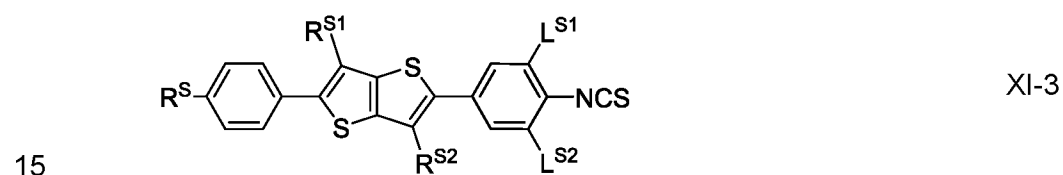
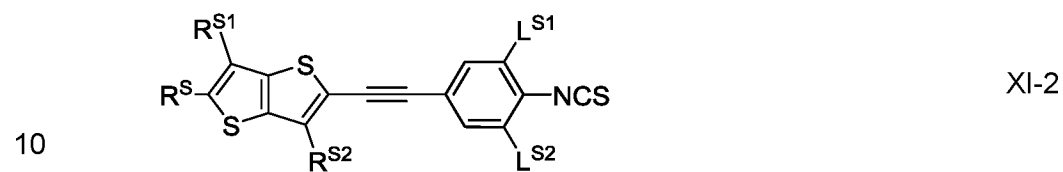
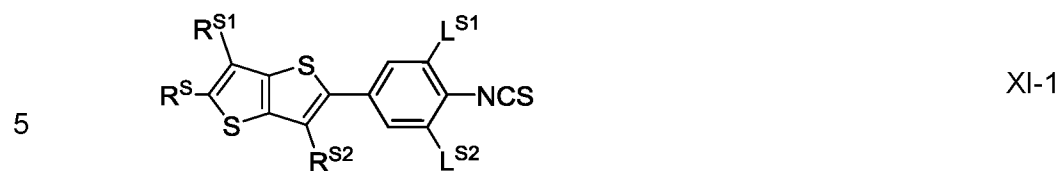
R^{S1}, R^{S2}, identically or differently, denote H, alkyl or alkenyl, having up to 6 C atoms, or cyclopropyl, cyclobutyl, cyclopentenyl, or cyclopentyl,

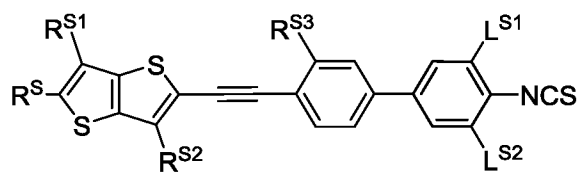
R^{Th1}, R^{Th2} identically or differently, denote H, alkyl or alkenyl or alkoxy, having up to 6 C atoms, or cyclopropyl, cyclobutyl, cyclopentenyl or cyclopentyl,

Z^{S1}, Z^{S2}, Z^{S3} identically or differently, denote -CH=CH-, -CH=CF-, -CF=CH-, -CF=CF-, -C≡C-, or a single bond,

a, b identically or differently, are 0 or 1.

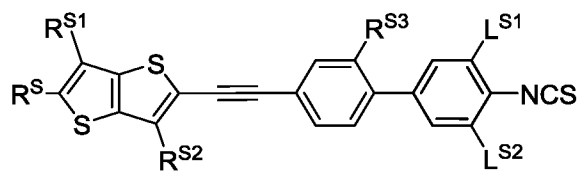
Preferably, the compounds of formula XI are selected from the group of compounds of the formulae XI-1 to XI-24:





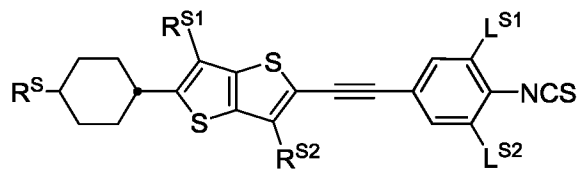
XI-8

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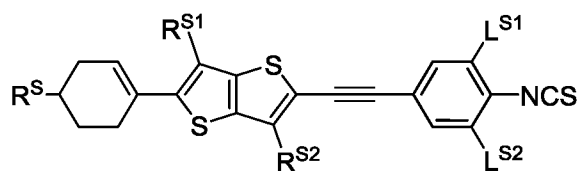
XI-9

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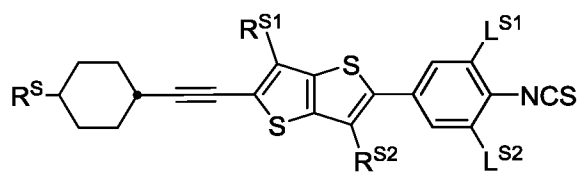
XI-10

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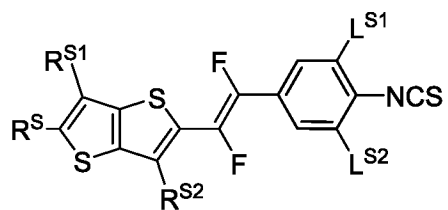
XI-11

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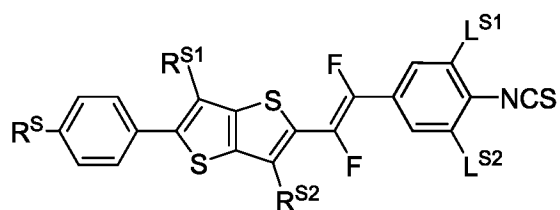
XI-12

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XI-13

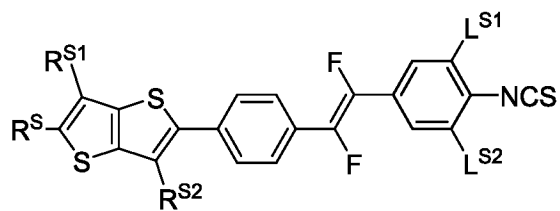
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XI-14

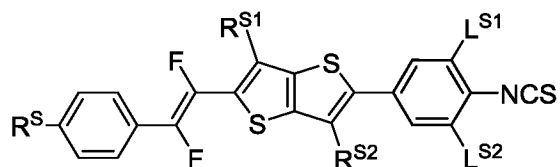
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5



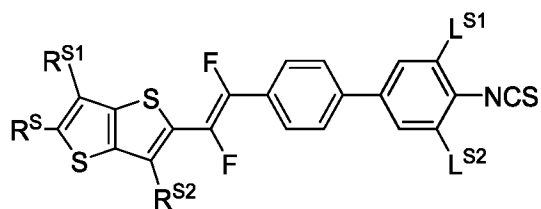
XI-15

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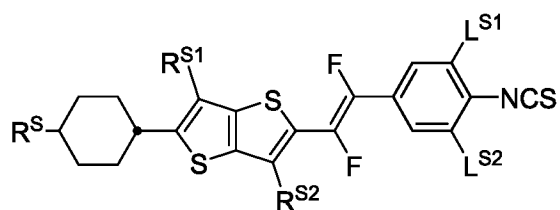
XI-16

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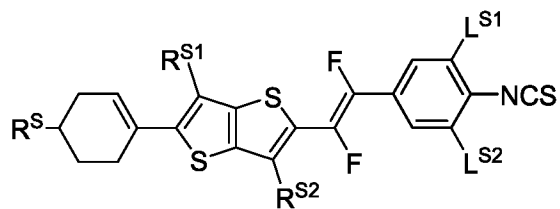
XI-17

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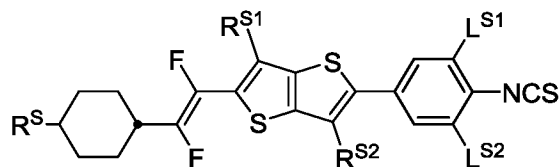
XI-18

25



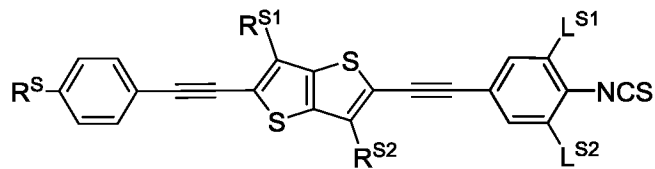
XI-19

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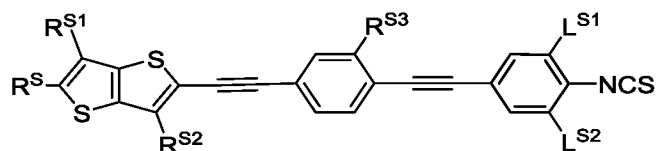


XI-20

35

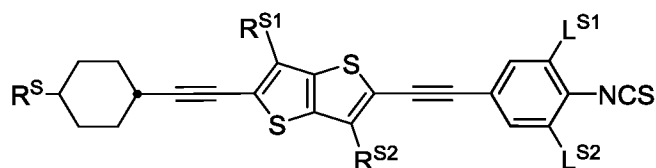


XI-21



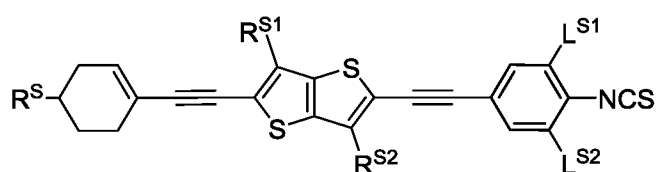
XI-22

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XI-23

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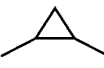
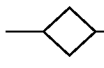
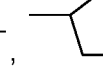
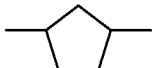


XI-24

15

in which the occurring groups have the meanings given above for formula XI and preferably

20

R^S denotes alkyl or alkenyl having 2 to 6 C atoms, in which one or more CH_2 -groups may be replaced by , ,  or ,

25

R^{S1} and R^{S2} identically or differently, denote H or alkyl having 1 to 6 C atoms, preferably H,

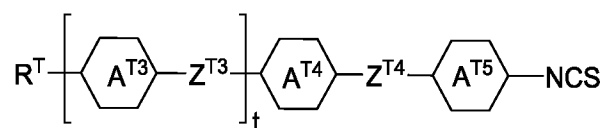
R^{S3} denotes H, F or alkyl, having up to 6 C atoms, or cyclopropyl, preferably H, F or ethyl, very preferably H,

30

L^{S1} and L^{S2} identically or differently, denote H or F, preferably F.

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

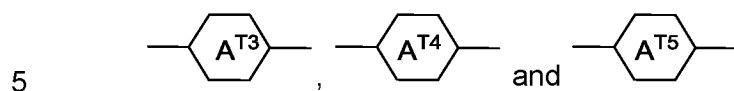
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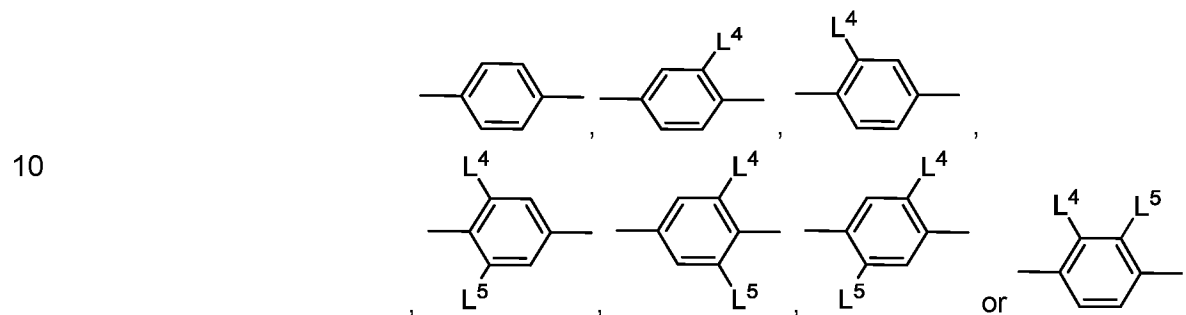
T

in which

R^T denotes halogen, CN, NCS, R^F , R^F-O- or R^F-S- , wherein
 R^F denotes fluorinated alkyl or fluorinated alkenyl having up to 12 C atoms,



on each occurrence, independently of one another, denote



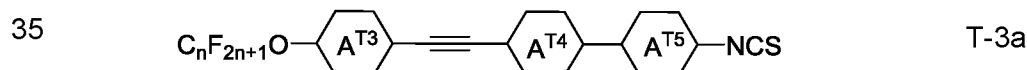
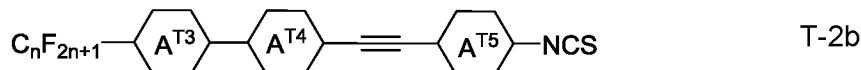
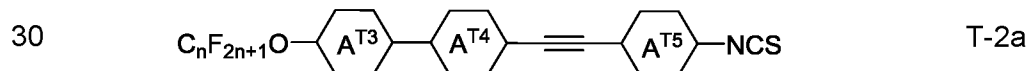
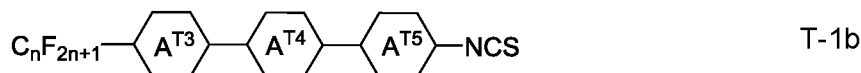
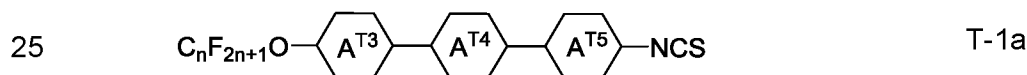
15 L^4 and L^5 identically or differently, denote F, Cl or straight-chain or branched or cyclic alkyl or alkenyl each having up to 12 C atoms;

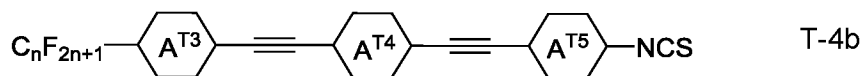
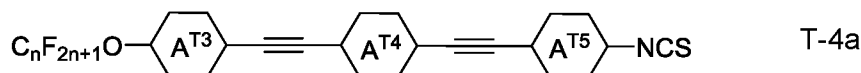
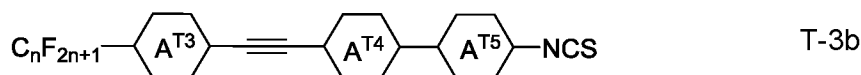
Z^{T3} , Z^{T4} identically or differently, denote $-CH=CH-$, $-CF=CF-$,
 $-CH=CF-$, $-CF=CH-$, $-C\equiv C-$ or a single bond, and

t is 0 or 1.

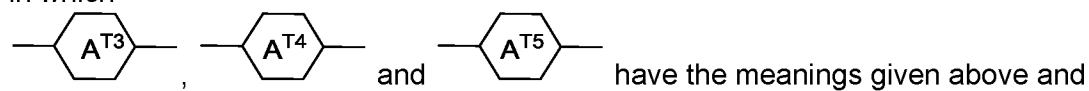
20

In a preferred embodiment, the liquid crystalline media according to the invention comprise one or more compounds selected from the group of compounds of the formulae T-1a to T-3b below:





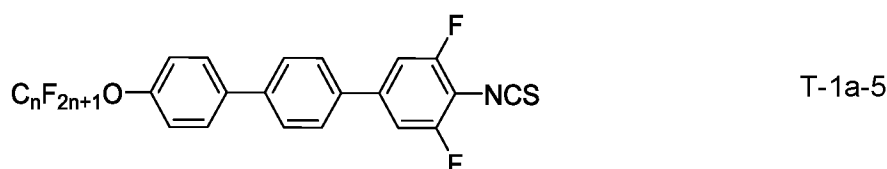
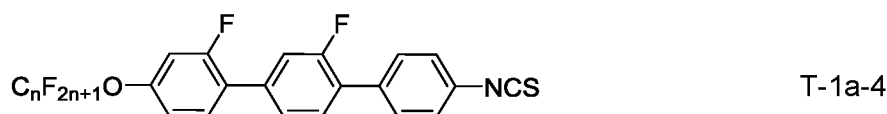
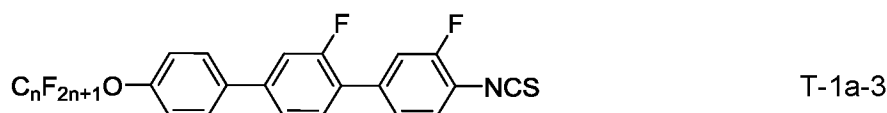
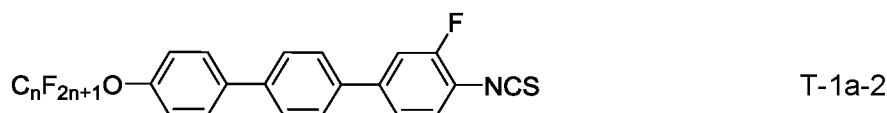
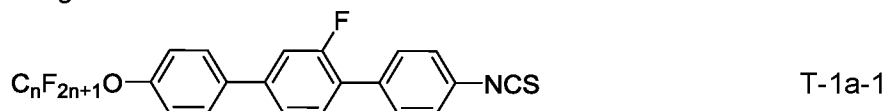
in which

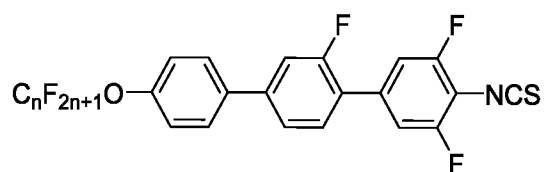


n is 1, 2, 3, 4, 5, 6 or 7, preferably 1, 2, 3 or 4, particularly preferably 1.

In a particularly preferred embodiment of the present invention the media comprise one or more compounds selected from the compounds of the formulae T-1a and T-2a.

Preferred compounds of formula T-1a are selected from the group of compounds of the following sub-formulae:





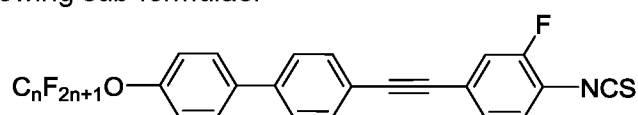
T-1a-6

5

in which n is 1, 2, 3 or 4, preferably 1.

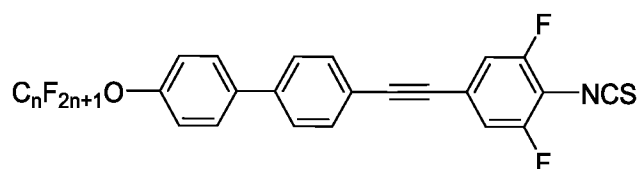
Preferred compounds of formula T-2a are selected from the group of compounds of the following sub-formulae:

10



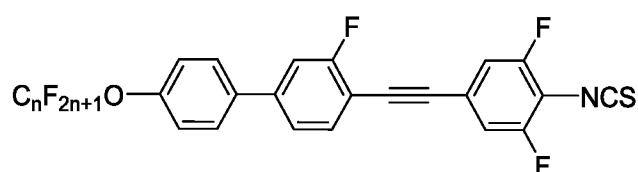
T-2a-1

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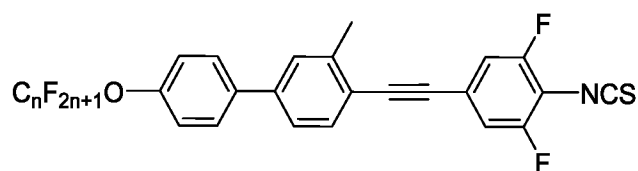
T-2a-2

20



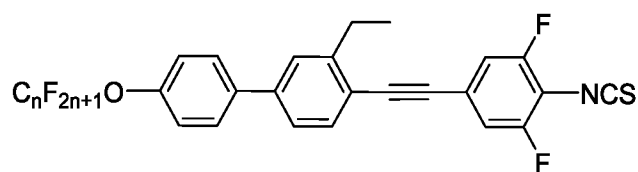
T-2a-3

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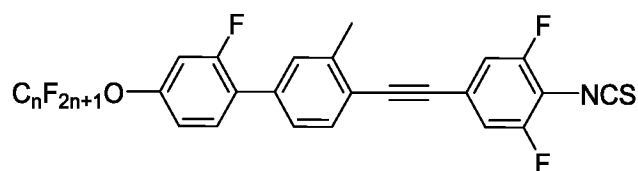
T-2a-4

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T-2a-5

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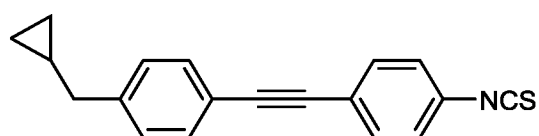
T-2a-6

in which n is 1, 2, 3 or 4, preferably 1.

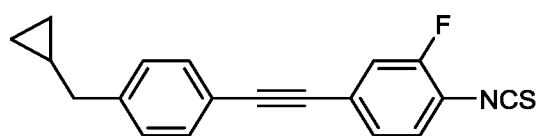
Very preferably, the medium according to the invention comprises one or more compounds of formula T-1a-5.

5 In an embodiment, the medium according to the invention comprises one or more compounds of formula I, II, III, IV, V, VI, VII, VIII, IX, X in which the radical R^1 , R^2 , R^3 , R^{41} , R^{42} , R^{51} , R^{52} , R^{61} , R^{62} , R^{71} , R^{72} , R^{81} , R^{82} , R^{91} , R^{92} , R^{101} , R^{102} and R^S , respectively, is a cyclic alkyl group.

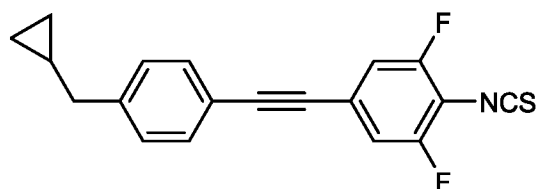
10 Very preferred compounds comprising a cyclic alkyl group are selected from the compounds of the formulae Cy-1 to Cy-14



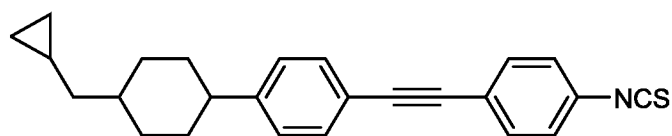
Cy-1



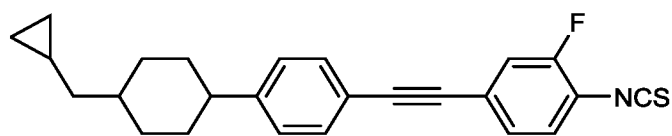
Cy-2



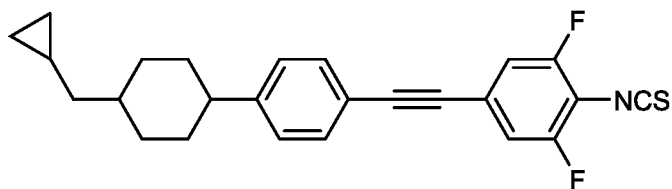
Cy-3



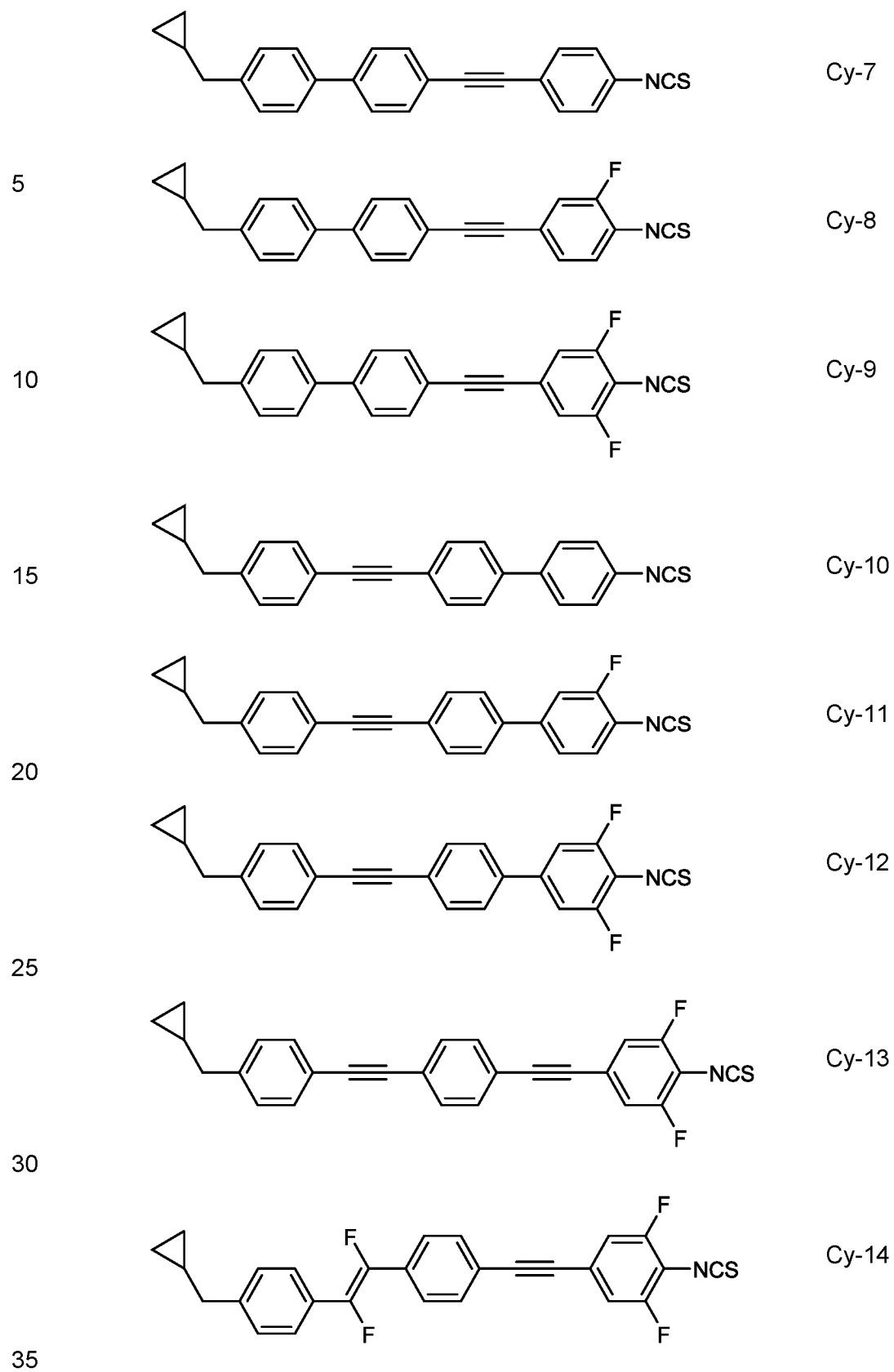
Cy-4



Cy-5

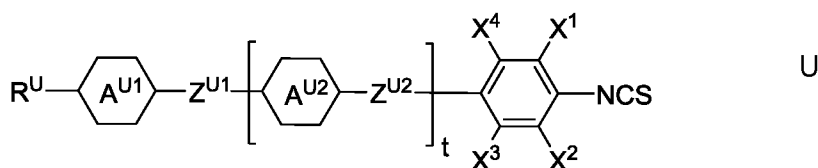


Cy-6



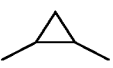
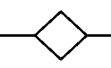
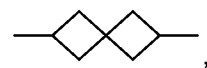
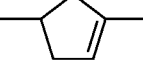
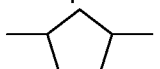
The media according to the present invention comprise one or more chiral dopants. Preferably these chiral dopants have an absolute value of the helical twisting power (HTP) in the range of from $1 \mu\text{m}^{-1}$ to $150 \mu\text{m}^{-1}$, preferably in the range of from $10 \mu\text{m}^{-1}$ to $100 \mu\text{m}^{-1}$. 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.

Preferably, the medium comprises one or more compounds of formula U



in which

R^{U} denotes H, alkyl or alkoxy having 1 to 12 C atoms, or alkenyl, alkenyloxy or alkoxyalkyl having 2 to 12 C atoms, in which one or more CH_2 -groups may

be replaced by , , ,  or , or denotes a group R^{P} ,

R^{P} denotes halogen, CN, NCS, R^{F} , $\text{R}^{\text{F}}\text{-O-}$ or $\text{R}^{\text{F}}\text{-S-}$, wherein

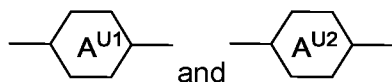
R^{F} denotes fluorinated alkyl or fluorinated alkenyl having up to 9 C atoms,

$\text{Z}^{\text{U1}}, \text{Z}^{\text{U2}}$ identically or differently, denote $-\text{CH}=\text{CH}-$, $-\text{CF}=\text{CF}-$, $-\text{CH}=\text{CF}-$, $-\text{CF}=\text{CH}-$, $-\text{C}\equiv\text{C}-$ or a single bond, preferably $-\text{C}\equiv\text{C}-$ or a single bond,

X^1, X^2 ,

X^3 and X^4 identically or differently, denote Cl or F, preferably F,

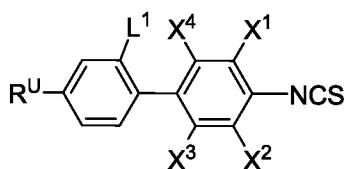
t is 0 or 1, and



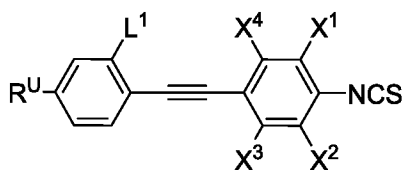
denote a radical selected from the following groups:

- a) the group consisting of 1,4-phenylene, 1,4-naphthylene, and 2,6-naphthylene, in which one or two CH groups may be replaced by N and in which one or more H atoms may be replaced by L, wherein tetrafluoro-1,4-phenylene is excluded,
 - b) the group consisting of trans-1,4-cyclohexylene, 1,4-cyclohexenylene, bicyclo[1.1.1]pentane-1,3-diyl, 4,4'-bicyclohexylene, bicyclo[2.2.2]octane-1,4-diyl, spiro[3.3]heptane-2,6-diyl, in which one or more non-adjacent CH₂ groups may be replaced by -O- and/or -S- and in which one or more H atoms may be replaced by F,
 - c) the group consisting of thiophene-2,5-diyl, thieno[3,2-b]thiophene-2,5-diyl, selenophene-2,5-diyl, each of which may also be mono- or polysubstituted by L,
- L on each occurrence, identically or differently, denotes F, Cl, CN, SCN, SF₅ or straight-chain or branched, in each case optionally fluorinated, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 12 C atoms.

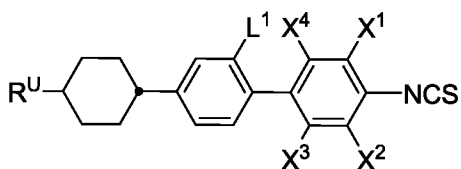
The compounds of formula U are preferably selected from the compounds of the subformulae U-1 to U-11:



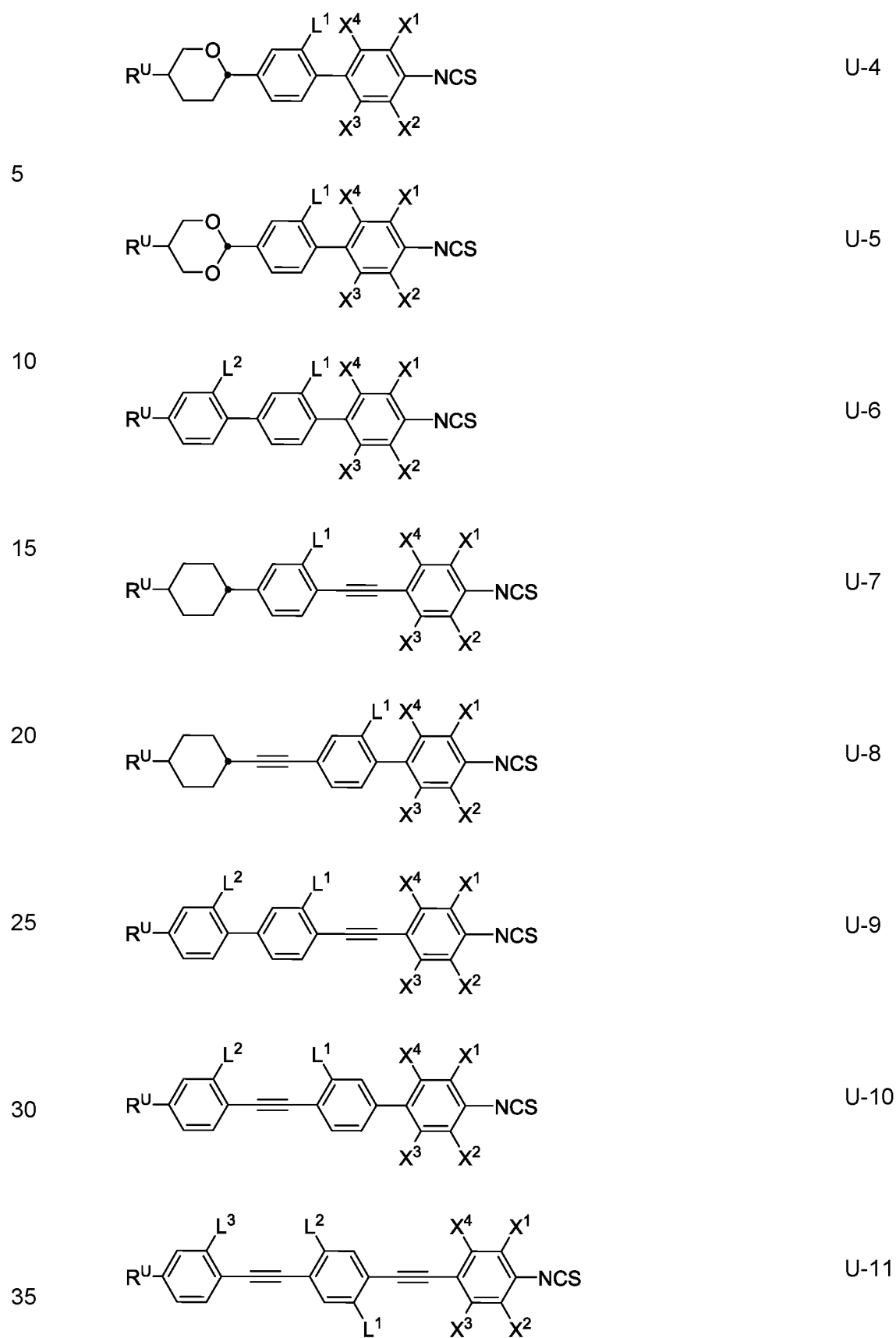
U-1



U-2



U-3



L¹, L² and L³ identically or differently, denote H, F, Cl, methyl, ethyl, n-propyl, isopropyl, cyclopropyl, cyclobutyl, cyclopentyl or cyclopentenyl, and

5

R^U, X¹, X², X³ and X⁴ have the meanings given above for formula U.

Very preferably, the medium comprises a compound of formula U-3, in which the occurring groups have the meanings given above and particularly preferably L¹ denotes H, X¹, X², X³ and X⁴ denote F and R^U denotes alkyl having 1 to 7 C atoms.

10

In a preferred embodiment of the present invention, the medium comprises two or more chiral compounds which all have the same algebraic sign of the HTP.

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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 dependencies of the HTP in corresponding ratios.

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For the optically active component, a multitude 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, or CB15 (all Merck KGaA, Darmstadt).

25

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.

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Suitable chiral groups are, for example, chiral branched hydrocarbon radicals, chiral ethane diols, 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.

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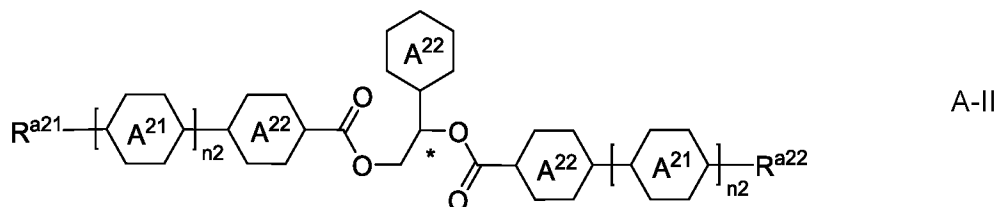
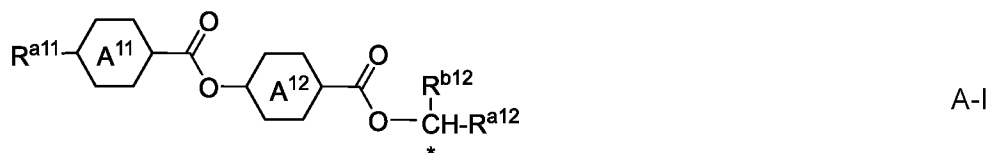
Preferred chiral groups are sugar derivatives, such as glucose, mannose, galactose, fructose, arabinose and dextrose; sugar alcohols, such as, for example, sorbitol,

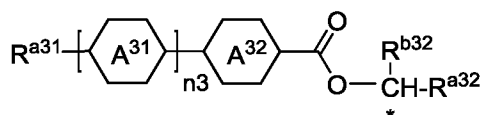
mannitol, iditol, galactitol or anhydro derivatives thereof, in particular dianhydrohexitols, such as dianhydrosorbide (1,4:3,6-dianhydro-D-sorbide, isosorbide), dianhydromannitol (isosorbitol) or dianhydroiditol (isoiditol); sugar acids, such as, for example, gluconic acid, gulonic acid and ketogulonic acid; chiral substituted glycol radicals, such as, for example, mono- or oligoethylene or propylene glycols, in which one or more CH₂ 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, carreyll, myrthenyl, nopyl, geraniyl, linaloyl, neryl, citronellyl or dihydrocitronellyl.

The media according to the present invention preferably comprise chiral dopants which are selected from the group of known chiral dopants. 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 F below.

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

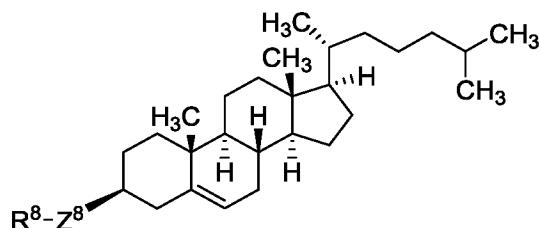
Particular preference is given to chiral dopants selected from the group consisting of compounds of the following formulae A-I to A-III and A-Ch:





A-III

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A-Ch

10

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 $-C(R^Z)=C(R^Z)-$, $-C\equiv C-$, $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$ 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} ,

15

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 $-C(R^Z)=C(R^Z)-$, $-C\equiv C-$, $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$ 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 be replaced by F, Cl, Br, I or CN, preferably both are alkyl, more preferably n-alkyl,

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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 $-C(R^Z)=C(R^Z)-$, $-C\equiv C-$, $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$ 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 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} ,

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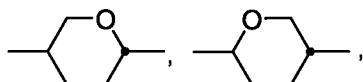
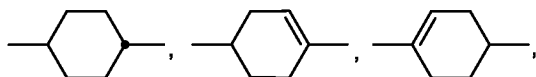
R^Z denotes H, CH_3 , F, Cl, or CN, preferably H or F,

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

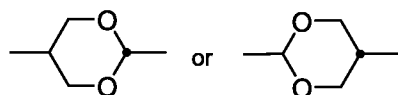
Z^8 denotes- C(O)O-, CH₂O, CF₂O or a single bond, preferably -C(O)O-,

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

5

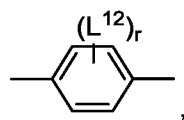


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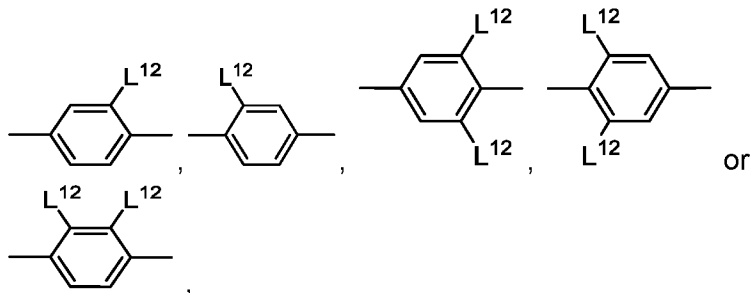
A^{12} denotes

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preferably

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in which

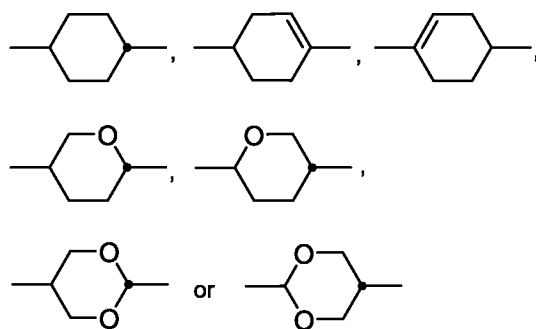
L^{12} on each occurrence, independently of one another, denotes halogen, CN, or alkyl, alkenyl, alkoxy or alkenyloxy having up to 12 C atoms and in which one or more H atoms are optionally replaced with halogen, preferably methyl, ethyl, Cl or F, particularly preferably F,

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A^{21} denotes

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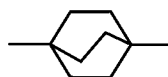
5



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

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



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

n_2 on each occurrence, identically or differently, is 0, 1 or 2, and

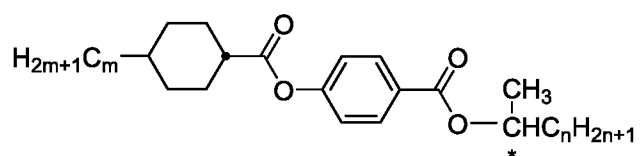
n_3 is 1, 2 or 3, and

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

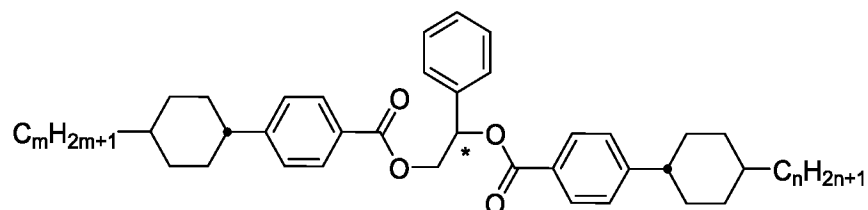
Particular preference is given to dopants selected from the group consisting of the compounds of the following formulae:

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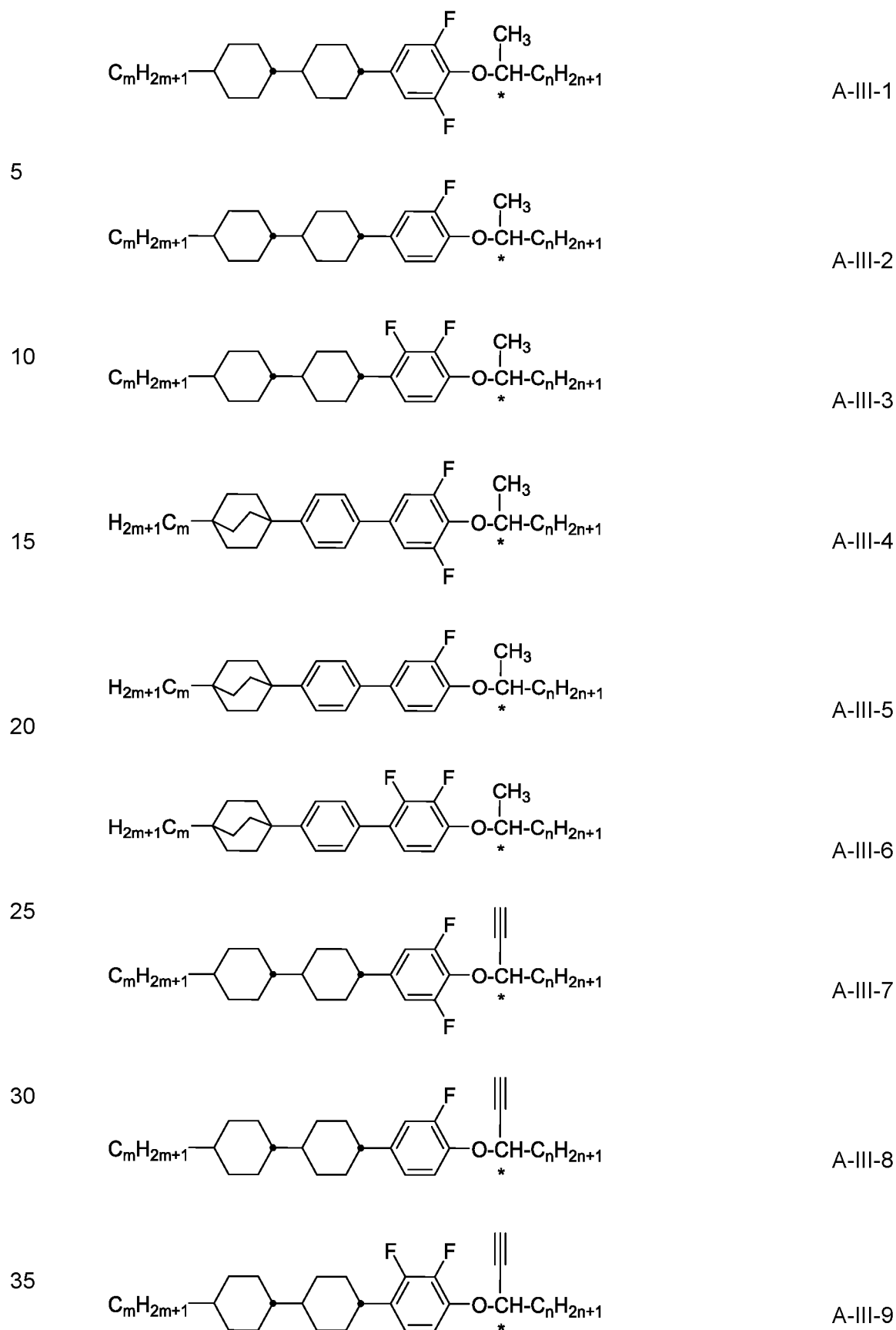
A-I-1

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A-II-1

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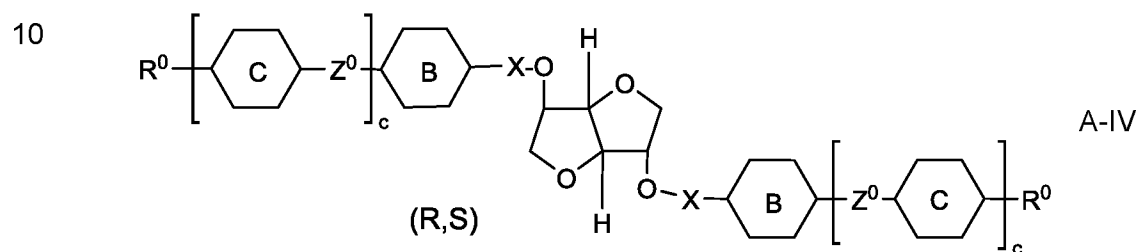
in which

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.

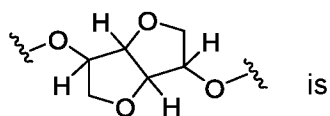
5 Particularly preferred compounds of formula A are compounds of formula A-III.

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

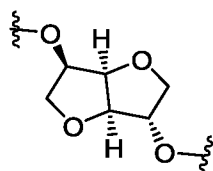


15

in which the group

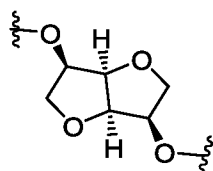


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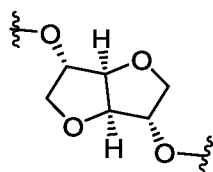
(dianhydrosorbitol),

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(dianhydromannitol), or

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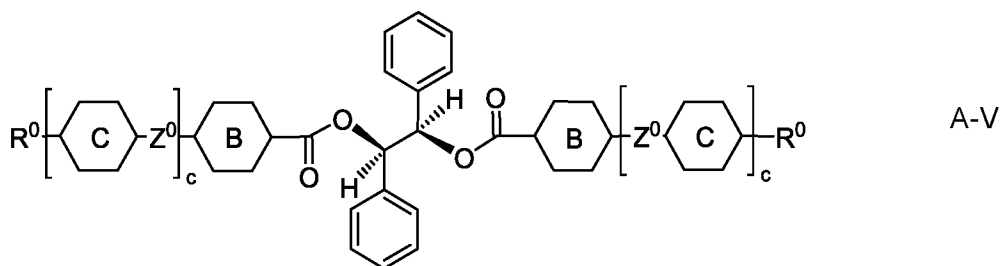


(dianhydroiditol),

preferably dianhydrosorbitol,

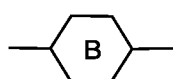
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and chiral ethane diols, such as, for example, diphenylethanediol (hydrobenzoin), in particular mesogenic hydrobenzoin derivatives of the following formula A-V:

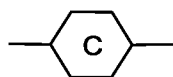


including the (S,S) enantiomers, which are not shown,

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, alkoxy carbonyl or alkoxy carbonyloxy having 1-7 carbon atoms,

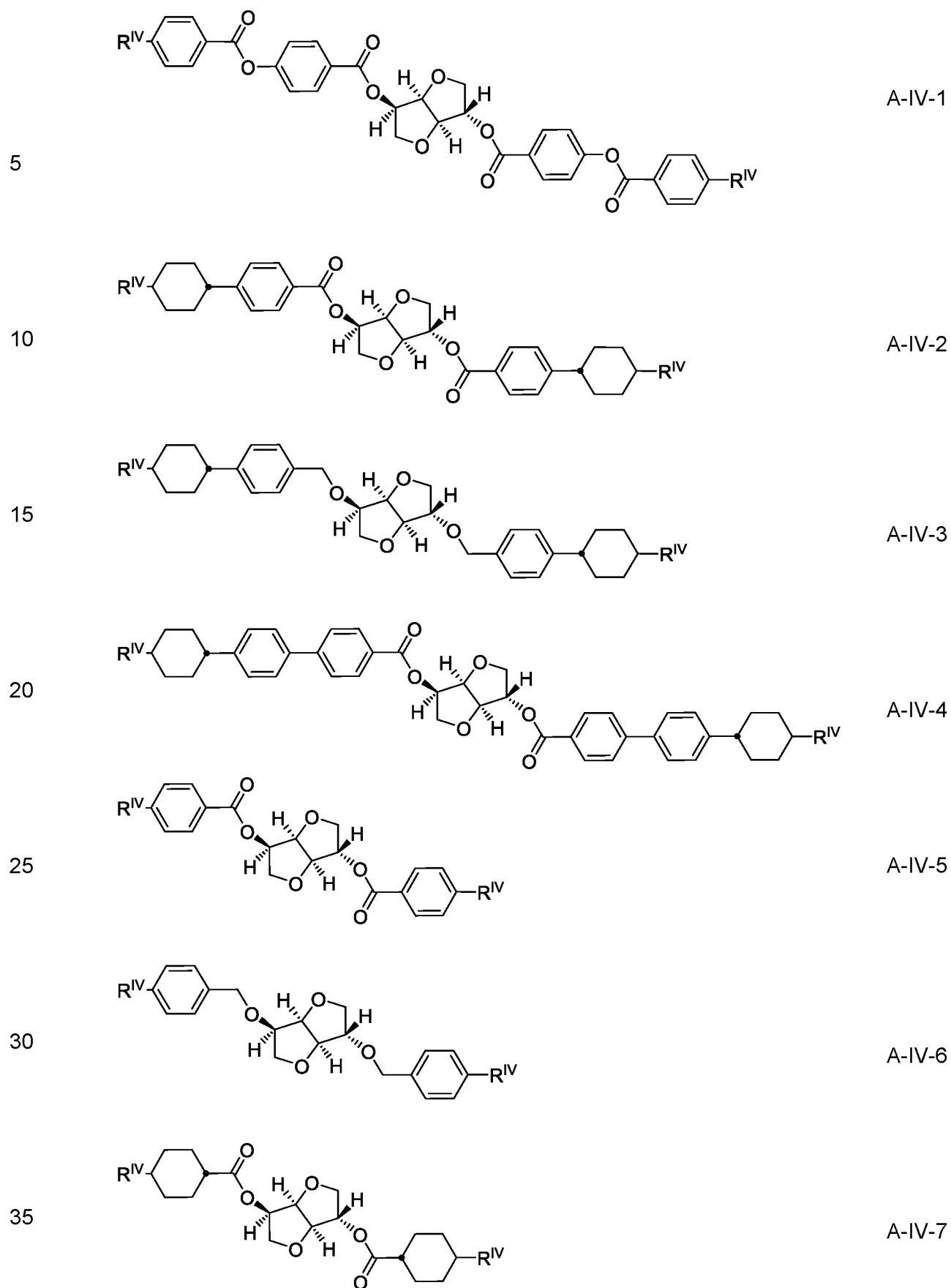
c is 0 or 1,

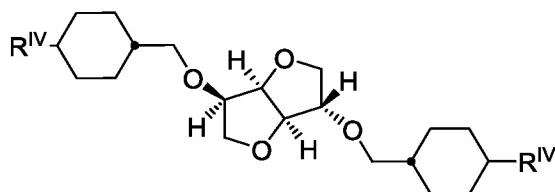
X is CH₂ or -C(O)-,

Z⁰ is -COO-, -OCO-, -CH₂CH₂- or a single bond, and

R⁰ is alkyl, alkoxy, alkylcarbonyl, alkoxy carbonyl or alkylcarbonyloxy having 1-12 carbon atoms.

Examples of compounds of formula IV are:



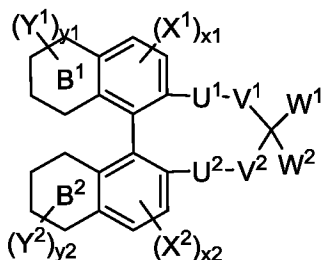


A-IV-8

The compounds of the formula A-IV are described in WO 98/00428. 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

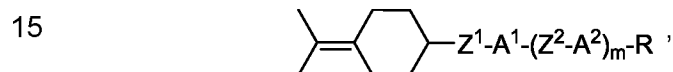
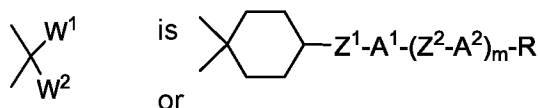
X^1 , X^2 , Y^1 and Y^2 are each, independently of one another, F, Cl, Br, I, CN, SCN, SF_5 , straight-chain or branched alkyl having from 1 to 25 carbon atoms, which is unsubstituted or monosubstituted or polysubstituted by F, Cl, Br, I or CN and in which, in addition, one or more non-adjacent CH_2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

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,

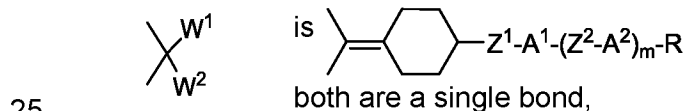
5 B^1 and B^2 are each, independently of one another, an aromatic or partially or fully saturated aliphatic six-membered ring in which one or more CH groups may each be replaced by N and one or more non-adjacent CH₂ groups may each be replaced by O or S,

10 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



U^1 and U^2 are each, independently of one another, CH₂, O, S, CO or CS,

20 V^1 and V^2 are each, independently of one another, (CH₂)_n, in which from one to four non-adjacent CH₂ groups may each be replaced by O or S, and one of V^1 and V^2 and, in the case where



n is 1, 2 or 3

30 Z^1 and Z^2 are each, independently of one another, -O-, -S-, -CO-, -COO-, -OCO-, -O-COO-, -CO-NR^x-, -NR^x-CO-, -O-CH₂-, -CH₂-O-, -S-CH₂-, -CH₂-S-, -CF₂-O-, -O-CF₂-, -CF₂-S-, -S-CF₂-, -CH₂-CH₂-, -CF₂-CH₂-, -CH₂-CF₂-, -CF₂-CF₂-, -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-,
 35 or -COO-CH=CH-, or a single bond,

R^x denotes alkyl having 1 to 6 C atoms,

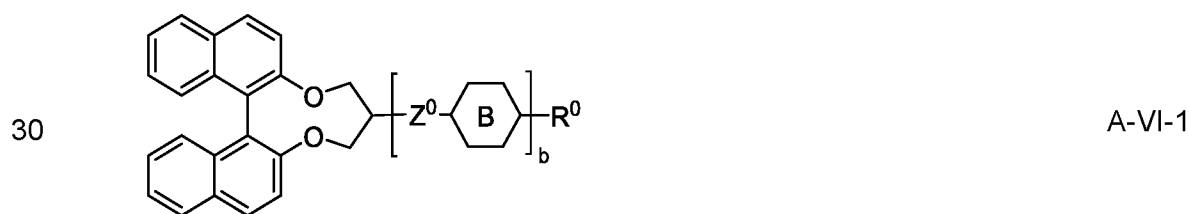
A^1 , A^2 and A^3 are each, independently of one another, 1,4-phenylene, in which one or two non-adjacent CH groups may each be replaced by N, 1,4-cyclohexylene, in which one or two non-adjacent CH_2 groups may each be replaced by O or S, 1,3-dioxolane-4,5-diyl, 1,4-cyclohexenylenes, 1,4-bicyclo[2.2.2]octylene, piperidine-1,4-diyl, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl or 1,2,3,4-tetrahydronaphthalene-2,6-diyl, where each of these groups may be 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, alkoxy carbonyl or alkoxy carbonyloxy 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 monosubstituted 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 $\equiv$ C-, where no two O and/or S atoms are bonded directly to one another, or a polymerisable group.

Particular preference is given to chiral binaphthyl derivatives of the formula 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:



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

20 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,

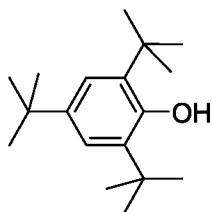
25 and Z^0 is, in particular, $-\text{OC}(\text{O})-$ or a single bond.

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.

35 The pitch p of the LC media or host mixtures according to the invention is preferably in the range of from 5 to 50 μm , more preferably from 8 to 30 μm and particularly preferably from 10 to 20 μm .

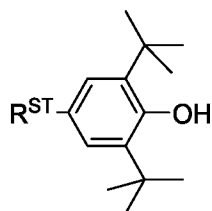
Preferably, the media according to the invention, comprise a stabiliser selected from the group of compounds of the formulae ST-1 to ST-18.

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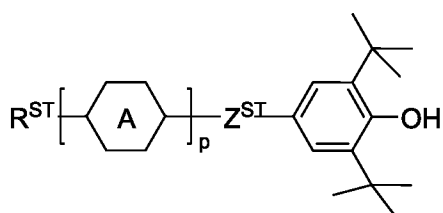
ST-1

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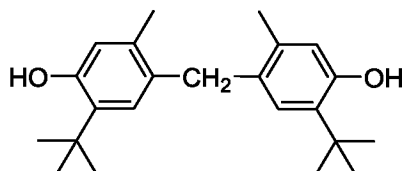
ST-2

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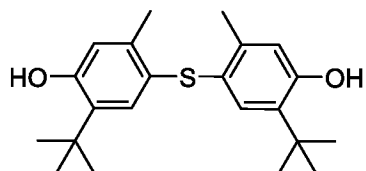
ST-3

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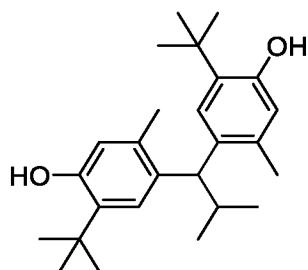
ST-4

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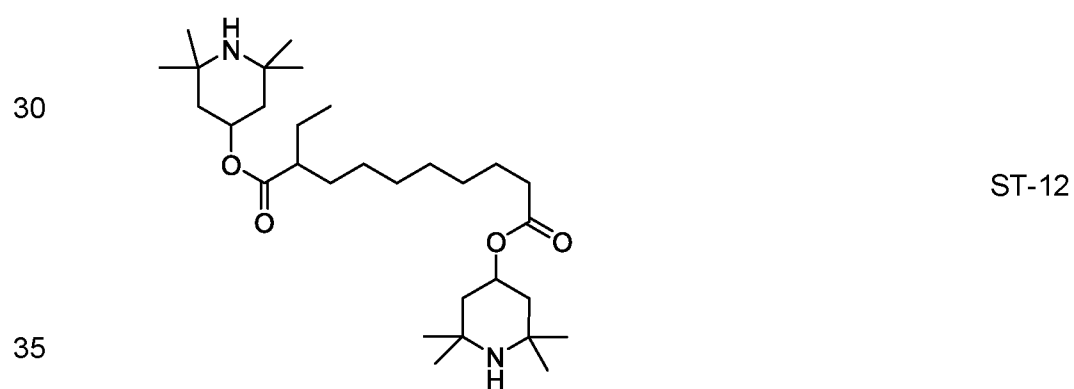
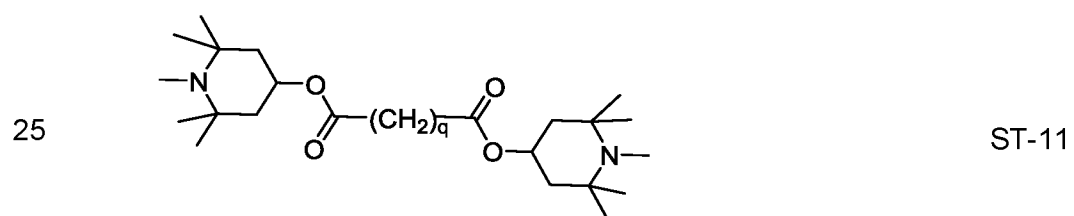
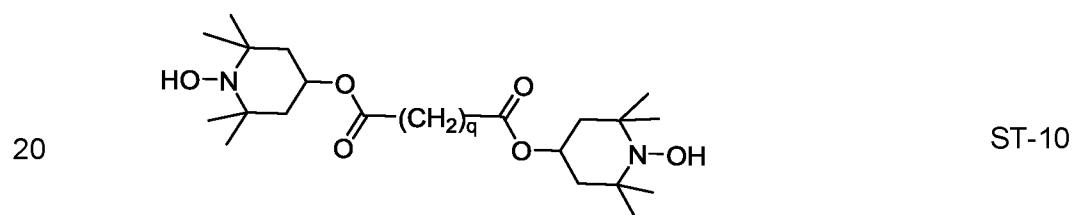
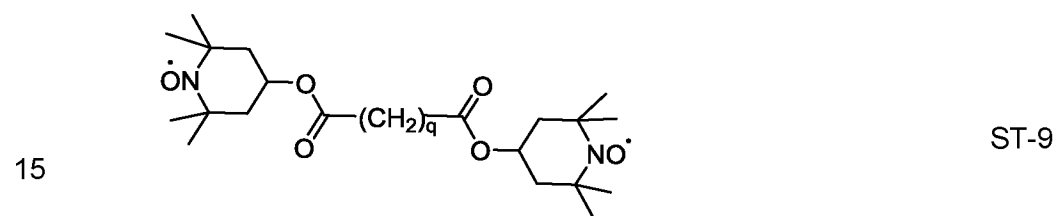
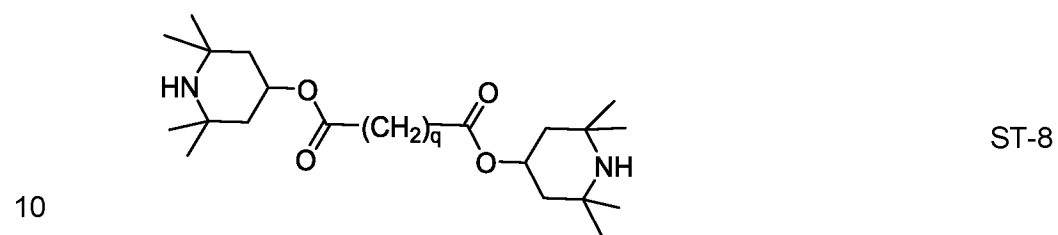
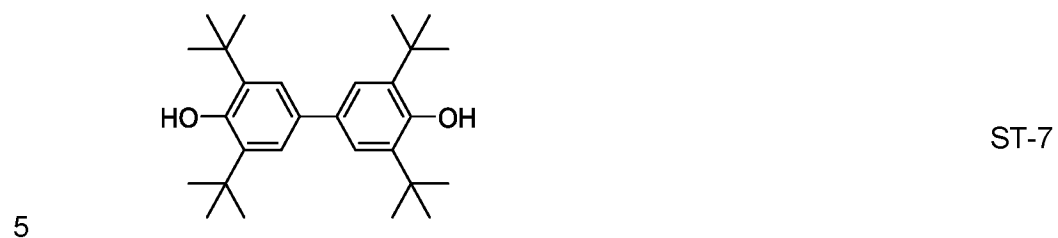
ST-5

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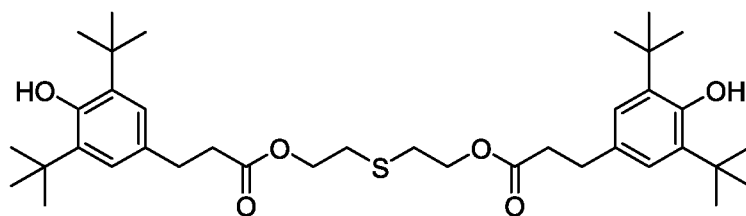


ST-6

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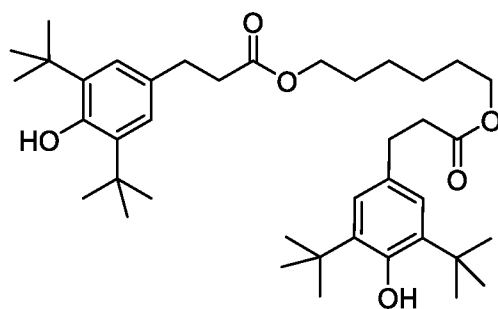


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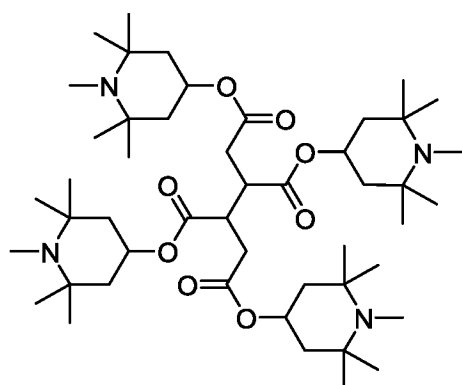
ST-13

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ST-14

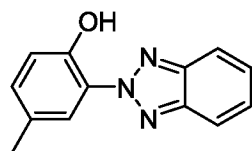
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ST-15

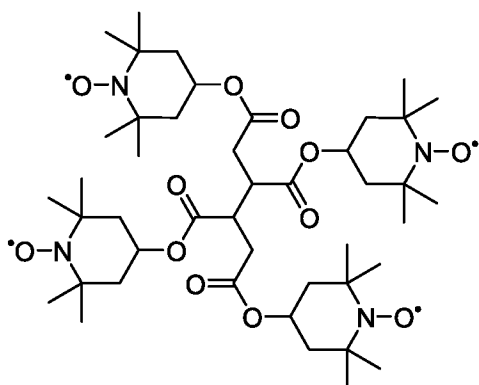
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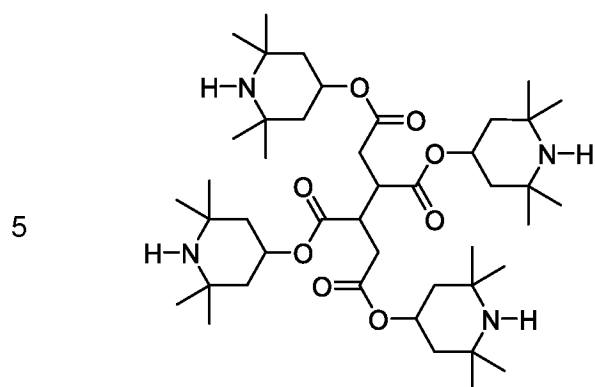
ST-16

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ST-17

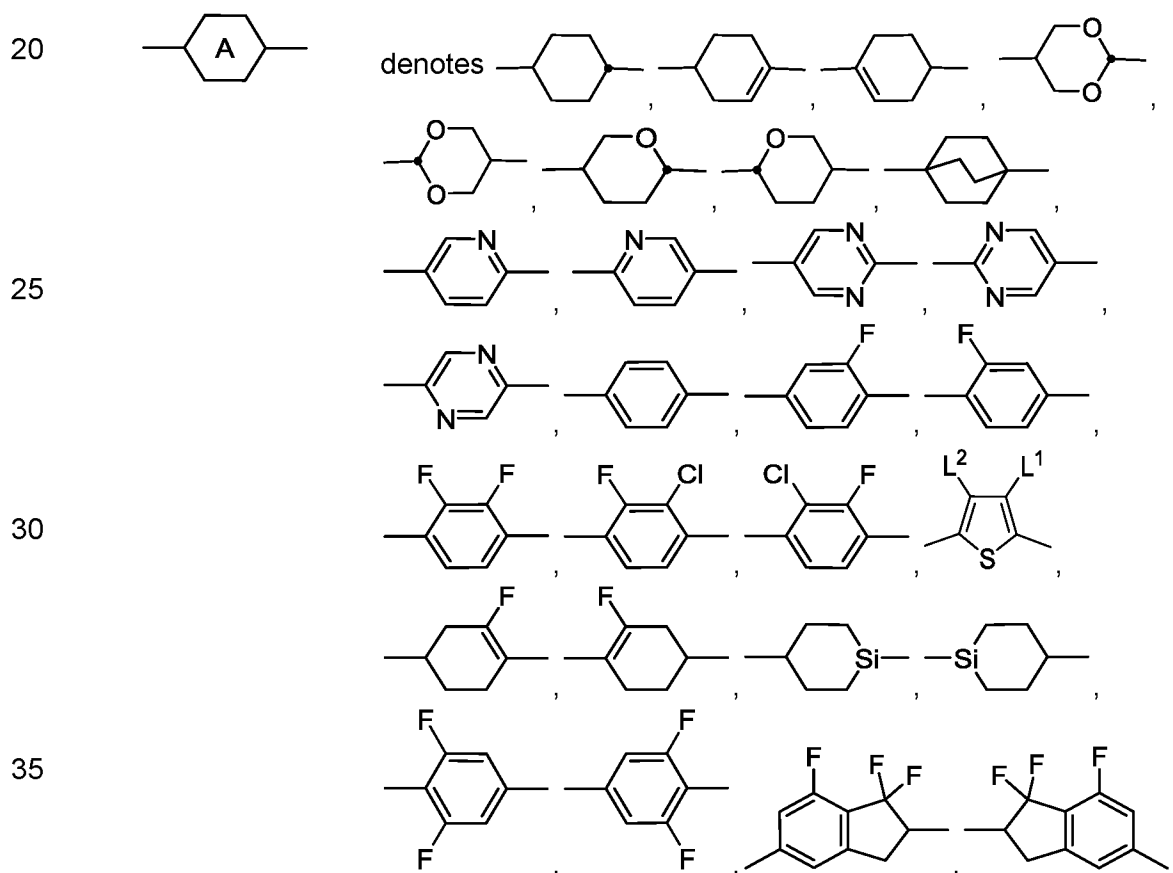
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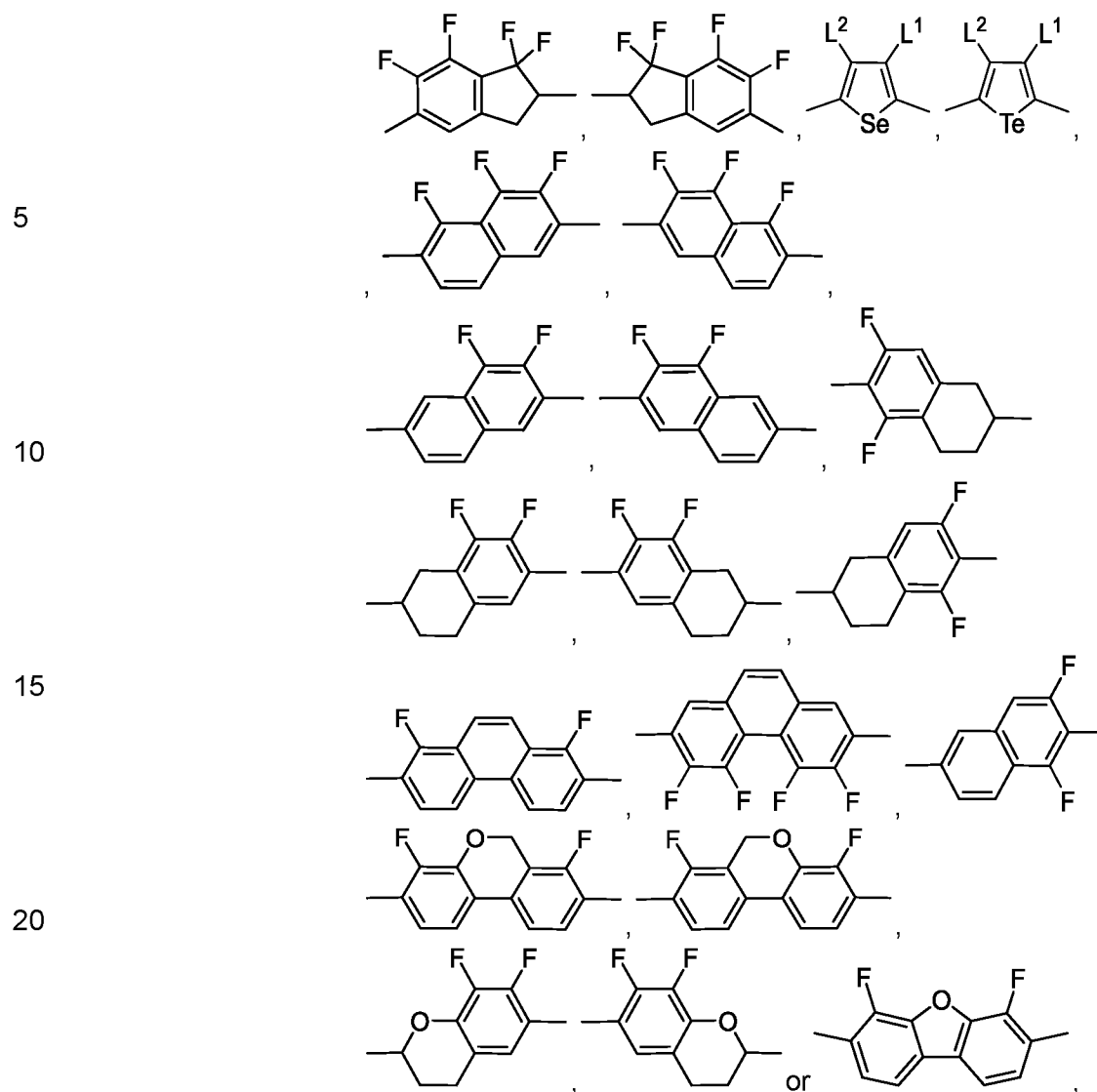


ST-18

10 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 $-C\equiv C-$, $-CF_2O-$, $-OCF_2-$, $-CH=CH-$, , , $-O-$, $-CO-O-$, $-O-CO-$ 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 be replaced by halogen,





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

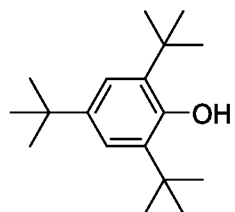
L^1 and L^2 each, independently of one another, denote F, Cl, CF_3 or CHF_2 ,

30 p is 1 or 2,

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

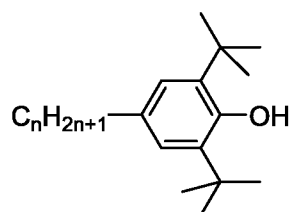
Of the compounds of the formula ST, special preference is given to the compounds of the following formulae

35



ST-1

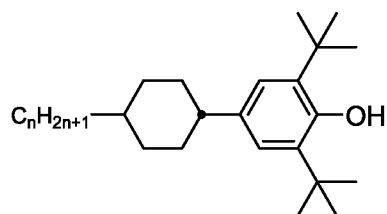
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ST-2a

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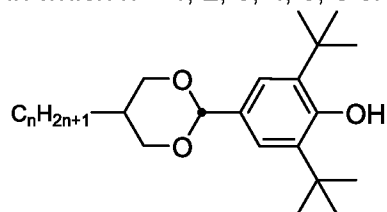
in which $n = 1, 2, 3, 4, 5, 6$ or 7 , preferably $n = 1$ or 7



ST-3a

15

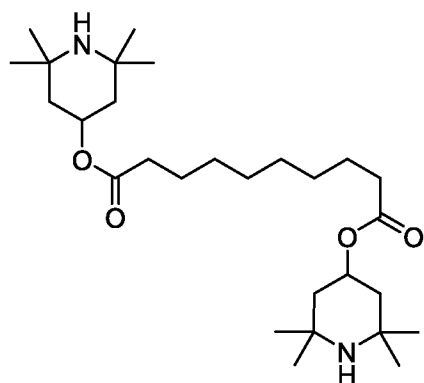
in which $n = 1, 2, 3, 4, 5, 6$ or 7 , preferably $n = 3$



ST-3b

20

in which $n = 1, 2, 3, 4, 5, 6$ or 7 , preferably $n = 3$



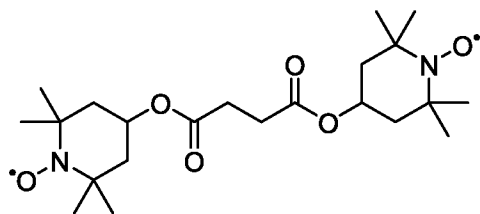
ST-8-1

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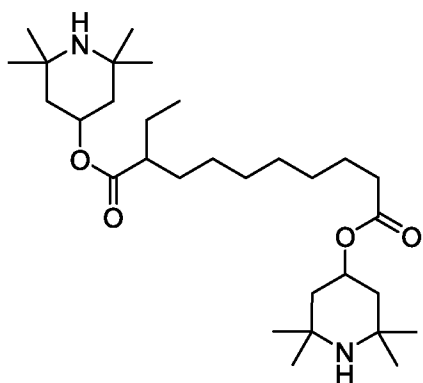
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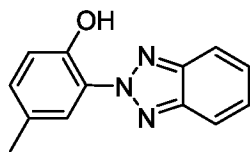
ST-9-1

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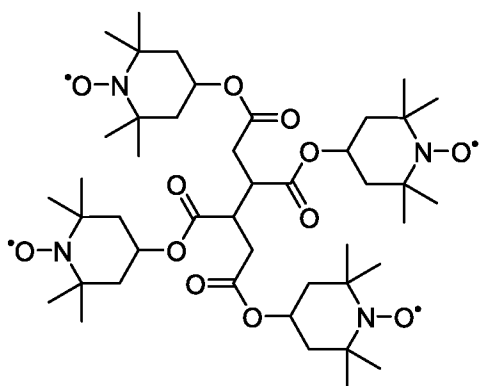
ST-12

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ST-16

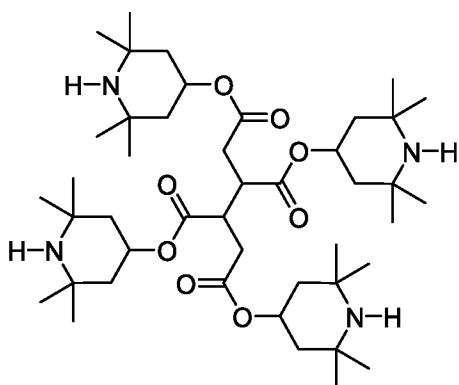
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ST-17

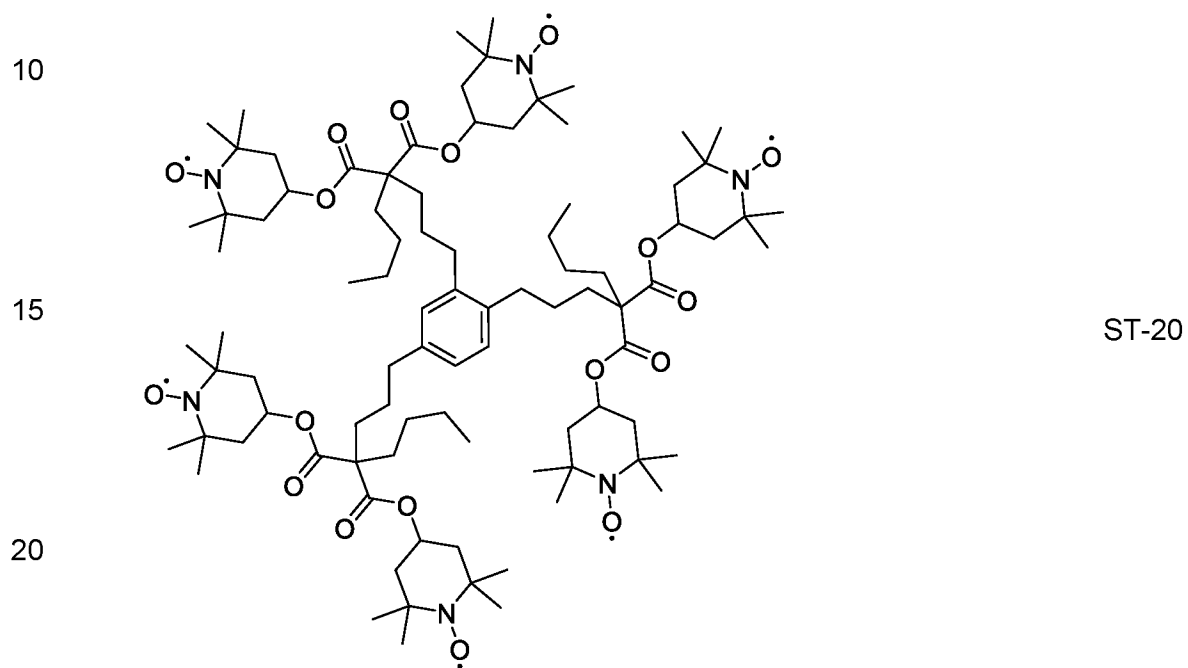
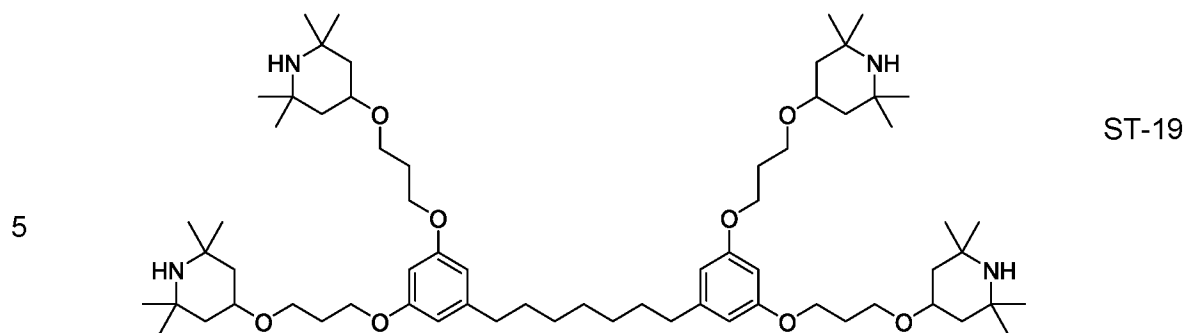
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ST-18

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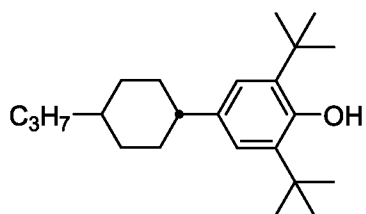


25 In the compounds of the formulae ST-3a and ST-3b, n preferably denotes 3. In the compounds of the formula ST-2a, n preferably denotes 7.

30 Very particularly preferred mixtures according to the invention comprise one or more stabilisers 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:

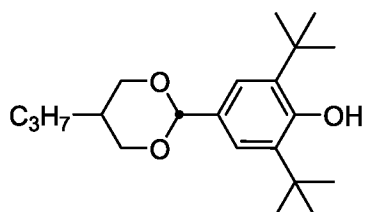


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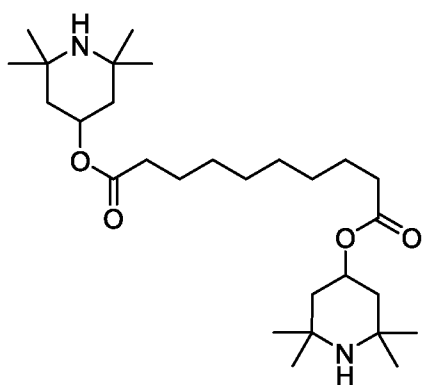
ST-3a-1

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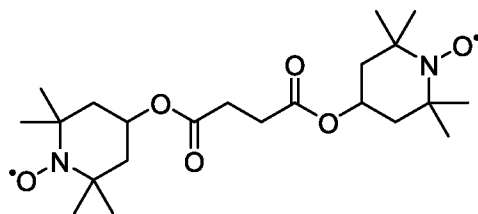
ST-3b-1

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ST-8-1

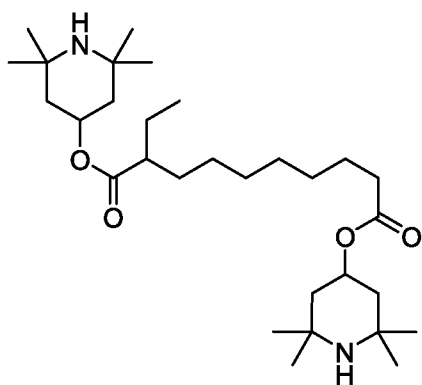
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ST-9-1

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30



ST-12

35

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.

5 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-18, the concentration correspondingly increases to 0.01 – 1% in the case of two compounds, based on the mixtures.

10 However, the total proportion of the compounds of the formulae ST-1 to ST-18, based on the mixture according to the invention, should not exceed 2%.

Other mesogenic compounds which are not explicitly mentioned above can optionally and advantageously also be used in the media in accordance with the present
15 invention. Such compounds are known to the person skilled in the art.

In a preferred embodiment of the present invention, the total concentration of compounds of formula C in the liquid-crystalline medium is 5 % or more, preferably 8 % or more, very preferably 10% or more and particularly preferably 12 % or more.

20

In a preferred embodiment of the present invention, the liquid-crystalline media preferably comprise in total 2 % to 40 %, preferably 5 % to 30 % and particularly preferably 8 % to 25 % of compounds of formula C.

25 In a preferred embodiment of the present invention, the liquid-crystalline media comprise in total 5 % to 45 %, preferably 10 % to 40 % and particularly preferably 15 % to 35 % of one or more compounds of formula T, preferably selected from the formulae T-1a and T-2a, very preferably from T-1a-5 and T-2a-4.

In a preferred embodiment of the present invention, the liquid-crystalline media
30 comprise in total 5 % to 35 %, preferably 10 % to 30 % and particularly preferably 15 % to 25 % of one or more compounds of the formula T-1a.

In a preferred embodiment of the present invention, the liquid-crystalline media comprise in total 5 % to 35 %, preferably 10 % to 30 % and particularly preferably 15 % to 25 % of one or more compounds of the formula T-1a, and in addition 5 to 15%
35 of one or more compounds of the formula T-2a-4.

In a preferred embodiment, the medium comprises one or more compounds of formula I, preferably of formula I-2 or I-3, in a total concentration in the range of from 1 % to 25 %, more preferably from 2 % to 20 %, and particularly preferably from 5 % to 15 %.

5 In a preferred embodiment of the present invention the medium comprises one or more compounds of formula II, preferably of formula II-1, in a total concentration of 5 % to 35 %, more preferably 10 % to 30 %, particularly preferably 15 % to 25 %.

10 In a preferred embodiment of the present invention the medium comprises one or more compounds of formula IIA-1 in a total concentration of 5 % to 25 %, more preferably 8 % to 20 %, particularly preferably 12 % to 17 %.

15 In a preferred embodiment of the present invention the medium comprises one or more compounds of formula II-1 in an total concentration of 30% or less, more preferably 25% or less, particularly preferably 20% or less.

20 In a preferred embodiment of the present invention the medium comprises one or more compounds of formula III, preferably III-1 and/or III-2, more preferably III-1h and/or III-1b, in a total concentration of 15 % to 70 %, more preferably 25 % to 60 %, particularly preferably 35 % to 50 %.

25 In a preferred embodiment, the medium comprises one or more compounds of the formulae C and I and II and/or IIA, and III and T, preferably in a total concentration of 90% or more, more preferably 95%, 96% or 97% or more, very preferably 98% or more and in particular 99% or more.

30 In a preferred embodiment, the medium comprises one or more compounds of the formulae C and II and III and T, preferably in a total concentration of 90% or more, more preferably 95%, 96% or 97% or more, very preferably 98% or more and in particular 99% or more.

35 In a preferred embodiment, the medium comprises one or more compounds of the formulae C and I and III and T, preferably in a total concentration of 90% or more, more preferably 95%, 96% or 97% or more, very preferably 98% or more and in particular 99% or more.

Further preferred embodiments of the present invention, taken alone or in combination with one another, are as follows, wherein some compounds are abbreviated using the acronyms as described in Tables A and B and given in Table C below:

- 5 - The medium comprises one, two, three, four or more compounds of formula III-1, preferably selected from the compounds of the formulae III-1b, III-1f and III-1h; more preferably of III-1b and III-1h;
- The medium comprises a compound of formula III-1b, preferably in a total concentration in the range of from 5% to 35%, more preferably 10% to 30%, in particular 15% to 25%;
- 10 - The medium comprises a compound of formula III-1h, preferably in a total concentration in the range of from 10% to 40%, more preferably 15% to 35%, in particular 18% to 30%;
- The medium comprises the compound PPU-TO-S and/or PPTU-TO-S and/or PTPU-TO-S and/or PP(1)TO-n-S;
- 15 - The medium comprises one or more compounds of formula I-2d, preferably the compounds PGU-2-S and/or PGU-3-S and/or PGU-4-S, and/or CPU-2-S and/or CPU-3-S and/or CPU-4-S;
- The medium comprises one or more compounds of formula I-2d and formula II-1b, preferably the compounds PGU-3-S and/or PGU-4-S and PTU-3-S and/or PTU-4-S and/or PTU-5-S;
- 20 - The medium comprises one or more compounds of formula PPTU-n-S and/or PTPU-n-S in an total concentration in the range of from 15 to 25 %;
- The medium comprises one or more compounds of formula PPTU-n-S and/or PTPU-n-S and/or PGTU-n-S in a total concentration in the range of from 15 to 30 %, in which n is 1, 2, 3, 4, 5, or 6;
- 25 - The medium comprises one or more compounds of formula ST-3, preferably ST-3a and/or ST-3b, particularly preferably ST-3b-1, in a total concentration in the range of from 0.01 to 1%, preferably from 0.05 to 0.5%, particularly from 0.10 to 0.15%.
- 30 The liquid-crystal media in accordance with the present invention preferably have a clearing point of 90°C or more, more preferably 100°C or more, more preferably 110°C or more, more preferably 120°C or more, more preferably 130°C or more, particularly preferably 140°C or more and very particularly preferably 150°C or more.

The liquid-crystal media in accordance with the present invention preferably have a clearing point of 160°C or less, more preferably 140°C or less, particularly preferably 120°C or less, and very particularly preferably 100°C or less.

- 5 The nematic phase of the media according to the invention preferably extends at least from 0°C or less to 90°C or more. It is advantageous for the media according to the invention to exhibit even broader nematic phase ranges, preferably at least from -10°C or less to 120°C or more, very preferably at least from -20°C or less to 140°C or more and in particular at least from -30°C or less to 150°C or more, very particularly
- 10 preferably at least from -40°C or less to 170°C or more.

The $\Delta\epsilon$ of the liquid-crystal medium according to the present invention, at 1 kHz and 20°C, is preferably 5 or more, more preferably 7 or more and very preferably 10 or more.

- 15 The birefringence (Δn) of the liquid-crystal media according to the present invention, at 589 nm (Na^D) and 20°C, is preferably 0.280 or more, more preferably 0.300 or more, even more preferably 0.320 or more, very preferably 0.330 or more and in particular 0.350 or more.

- 20 The Δn of the liquid-crystal media according to the present invention, at 589 nm (Na^D) and 20°C, is preferably in the range from 0.200 to 0.900, more preferably in the range from 0.250 to 0.800, even more preferably in the range from 0.300 to 0.700 and very particularly preferably in the range from 0.350 to 0.600.

- 25 In a preferred embodiment of the present application, the Δn of the liquid-crystal media in accordance with the present invention is preferably 0.50 or more, more preferably 0.55 or more.

- 30 The compounds of the formulae I to III in each case include dielectrically positive compounds having a dielectric anisotropy of greater than 3, dielectrically neutral compounds having a dielectric anisotropy of less than 3 and greater than -1.5 and dielectrically negative compounds having a dielectric anisotropy of -1.5 or less.

- 35 The compounds of the formulae C, I, II and III are preferably dielectrically positive.

In the present application, the expression dielectrically positive describes compounds or components where $\Delta\epsilon > 3.0$, dielectrically neutral describes those where $-1.5 \leq \Delta\epsilon \leq 3.0$ and dielectrically negative describes those where $\Delta\epsilon < -1.5$. $\Delta\epsilon$ is determined at a frequency of 1 kHz and at 20°C. The dielectric anisotropy of the respective compound is determined from the results of a solution of 10 % of the respective individual compound in a nematic host mixture. If the solubility of the respective compound in the host mixture is less than 10 %, the concentration is reduced to 5 %. The capacitances of the test mixtures are determined both in a cell having homeotropic alignment and in a cell having homogeneous alignment. The cell thickness of both types of cells is approximately 20 μm . The voltage applied is a rectangular wave having a frequency of 1 kHz and an effective value of typically 0.5 V to 1.0 V, but it is always selected to be below the capacitive threshold of the respective test mixture.

$\Delta\epsilon$ is defined as $(\epsilon_{||} - \epsilon_{\perp})$, while $\epsilon_{\text{ave.}}$ is $(\epsilon_{||} + 2 \epsilon_{\perp}) / 3$.

The host mixture used for the determination of physical constants of pure compounds by extrapolation is ZLI-4792 from Merck KGaA, Germany. The absolute values of the dielectric constants, the birefringence (Δn) and the rotational viscosity (γ_1) of the compounds are determined from the change in the respective values of the host mixture on addition of the compounds. The concentration in the host is 10 % or in case of insufficient solubility 5 %. The values are extrapolated to a concentration of 100 % of the added compounds.

In the examples, the phase sequences of pure compounds are given using the following abbreviations:

K: crystalline, N: nematic, SmA: smectic A, SmB: smectic B, I: isotropic.

Components having a nematic phase at the measurement temperature of 20°C are measured as such, all others are treated like compounds.

The expression threshold voltage in the present application refers to the optical threshold and is quoted for 10 % relative contrast (V_{10}), and the expression saturation voltage refers to the optical saturation and is quoted for 90 % relative contrast (V_{90}), in both cases unless expressly stated otherwise. The capacitive threshold voltage (V_0), also called the Freedericks threshold (V_{Fr}), is only used if expressly mentioned.

The parameter ranges indicated in this application all include the limit values, unless expressly stated otherwise.

5 The different upper and lower limit values indicated for various ranges of properties in combination with one another give rise to additional preferred ranges.

10 Throughout this application, the following conditions and definitions apply, unless expressly stated otherwise. All concentrations are quoted in per cent by weight and relate to the respective mixture as a whole, all temperatures are quoted in degrees Celsius and all temperature differences are quoted in differential degrees. All physical properties are determined in accordance with "Merck Liquid Crystals, Physical
15 Properties of Liquid Crystals", Status Nov. 1997, Merck KGaA, Germany, and are quoted for a temperature of 20°C, unless expressly stated otherwise. The optical anisotropy (Δn) is determined at a wavelength of 589.3 nm. The dielectric anisotropy ($\Delta\epsilon$) is determined at a frequency of 1 kHz. The threshold voltages, as well as all other electro-optical properties, are determined using test cells produced at Merck KGaA, Germany. The test cells for the determination of $\Delta\epsilon$ have a cell thickness of approximately 20 μm . The electrode is a circular ITO electrode having an area of 1.13 cm^2 and a guard ring. The orientation layers are SE-1211 from Nissan Chemicals, Japan, for homeotropic
20 orientation ($\epsilon_{||}$) and polyimide AL-1054 from Japan Synthetic Rubber, Japan, for homogeneous orientation ($\epsilon_{\perp}$). The capacitances are determined using a Solatron 1260 frequency response analyser using a sine wave with a voltage of 0.3 V_{rms} . The light used in the electro-optical measurements is white light. A set-up using a commercially available DMS instrument from Autronic-Melchers, Germany, is used here. The characteristic voltages have been determined under perpendicular observation. The threshold
25 (V_{10}), mid-grey (V_{50}) and saturation (V_{90}) voltages have been determined for 10 %, 50 % and 90 % relative contrast, respectively.

30 The liquid-crystalline media are investigated with respect to their properties in the microwave frequency range as described in A. Penirschke et al. "Cavity Perturbation Method for Characterization of Liquid Crystals up to 35 GHz", 34th European Microwave Conference – Amsterdam, pp. 545-548. Compare in this respect also A. Gaebler et al. "Direct Simulation of Material Permittivities ...", 12MTC 2009 – International Instrumentation and Measurement Technology Conference, Singapore,
35 2009 (IEEE), pp. 463-467, and DE 10 2004 029 429 A, in which a measurement method is likewise described in detail.

The liquid crystal is introduced into a polytetrafluoroethylene (PTFE) or quartz capillary. The capillary has an inner diameter of 0.5mm and an outer diameter of 0.78mm. The effective length is 2.0 cm. The filled capillary is introduced into the centre of the cylindrical cavity with a resonance frequency of 19 GHz. This cavity has a length of 11.5 mm and a radius of 6 mm. The input signal (source) is then applied, and the frequency depending response of the cavity is recorded using a commercial vector network analyser (N5227A PNA Microwave Network Analyzer, Keysight Technologies Inc. USA. For other frequencies, the dimensions of the cavity are adapted correspondingly.

The change in the resonance frequency and the Q factor between the measurement with the capillary filled with the liquid crystal and the measurement without the capillary filled with the liquid crystal is used to determine the dielectric constant and the loss angle at the corresponding target frequency by means of equations 10 and 11 in the above-mentioned publication A. Penirschke et al., 34th European Microwave Conference – Amsterdam, pp. 545-548, as described therein.

The values for the components of the properties perpendicular and parallel to the director of the liquid crystal are obtained by alignment of the liquid crystal in a magnetic field. To this end, the magnetic field of a permanent magnet is used. The strength of the magnetic field is 0.35 tesla.

Preferred components are phase shifters, varactors, wireless and radio wave antenna arrays, matching circuit adaptive filters and others.

In the present application, the term compounds is taken to mean both one compound and a plurality of compounds, unless expressly stated otherwise.

All mixtures according to the invention are nematic. The liquid-crystal media according to the invention preferably have nematic phases in preferred ranges given above. The expression 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 no clearing occurs on heating from the nematic phase. At high temperatures, the clearing point is measured in capillaries by conventional methods. The investigation at low temperatures is carried out in a flow

viscometer at the corresponding temperature and checked by storage of bulk samples:
 The storage stability in the bulk (LTS) of the media according to the invention at a given
 temperature T is determined by visual inspection. 2 g of the media of interest are filled
 into a closed glass vessel (bottle) of appropriate size placed in a refrigerator at a
 5 predetermined temperature. The bottles are checked at defined time intervals for the
 occurrence of smectic phases or crystallisation. For every material and at each
 temperature two bottles are stored. If crystallisation or the appearance of a smectic
 phase is observed in at least one of the two correspondent bottles the test is
 terminated and the time of the last inspection before the one at which the occurrence of
 10 a higher ordered phase is observed is recorded as the respective storage stability. The
 test is finally terminated after 1000 h, *i.e.* an LTS value of 1000 h means that the
 mixture is stable at the given temperature for at least 1000 h.

The liquid crystals employed preferably have a positive dielectric anisotropy. This is
 15 preferably 2 or more, preferably 4 or more, particularly preferably 6 or more and very
 particularly preferably 10 or more.

Furthermore, the liquid-crystal media according to the invention are characterised by
 high anisotropy values in the microwave range. The birefringence at about 19 GHz is,
 20 for example, preferably 0.14 or more, particularly preferably 0.15 or more, particularly
 preferably 0.20 or more, particularly preferably 0.25 or more and very particularly
 preferably 0.30 or more. In addition, the birefringence is preferably 0.80 or less.

The dielectric anisotropy in the microwave range is defined as
 25

$$\Delta\epsilon_r \equiv (\epsilon_{r,||} - \epsilon_{r,\perp}) .$$

The tunability (τ) is defined as

30
$$\tau \equiv (\Delta\epsilon_r / \epsilon_{r,||}) .$$

The material quality (η) is defined as

$$\eta \equiv (\tau / \tan \delta_{\epsilon_{r,\max}}), \text{ where}$$

35 the maximum dielectric loss is

$$\tan \delta_{\varepsilon r, \max.} \equiv \max. \{ \tan \delta_{\varepsilon r, \perp}, \tan \delta_{\varepsilon r, ||} \}.$$

5 The tunability τ of the medium according to the invention, measured at 20°C and 19 GHz is 0.250 or more, preferably 0.300 or more, 0.310 or more, 0.320 or more, 0.330 or more, or 0.340 or more, very preferably 0.345 or more and in particular 0.350 or more.

10 The material quality (η) of the preferred liquid-crystal materials is 6 or more, preferably 8 or more, preferably 10 or more, preferably 15 or more, preferably 17 or more, preferably 20 or more, particularly preferably 25 or more and very particularly preferably 30 or more.

15 In the corresponding components, the preferred liquid-crystal materials have phase shifter qualities of 15°/dB or more, preferably 20°/dB or more, preferably 30°/dB or more, preferably 40°/dB or more, preferably 50°/dB or more, particularly preferably 80°/dB or more and very particularly preferably 100°/dB or more.

20 In some embodiments, however, liquid crystals having a negative value of the dielectric anisotropy can also advantageously be used.

The liquid crystals employed are either individual substances or mixtures. They preferably have a nematic phase.

25 The liquid-crystal media in accordance with the present invention may comprise further additives and chiral dopants in the usual concentrations. The total concentration of these further constituents is in the range from 0 % to 10 %, preferably 0.1 % to 6 %, based on the mixture as a whole. The concentrations of the individual compounds used are each preferably in the range from 0.1 % to 3 %. The concentration of these and similar additives is not taken into consideration when quoting the values and concentration ranges of the liquid-crystal components and liquid-crystal compounds of the liquid-crystal media in this application.

30

35 Preferably the media according to the present invention comprise one or more chiral compounds as chiral dopants in order to adjust their cholesteric pitch. Their total concentration in the media according to the instant invention is preferably in the range

0.05 % to 15 %, more preferably from 1 % to 10 % and most preferably from 2 % to 6 %.

5 Optionally the media according to the present invention may comprise further liquid crystal compounds in order to adjust the physical properties. Such compounds are known to the skilled person. Their concentration in the media according to the instant invention is preferably 0 % to 30 %, more preferably 0.1 % to 20 % and most preferably 1 % to 15 %.

10 The response times are given as rise time (τ_{on}) for the time for the change of the relative tuning, respectively of the relative contrast for the electro-optical response, from 0 % to 90 % ($t_{90} - t_0$), i.e. including the delay time ($t_{10} - t_0$), as decay time (τ_{off}) for the time for the change of the relative tuning, respectively of the relative contrast for the electro-optical response, from 100 % back to 10 % ($t_{100} - t_{10}$) and as the total response
15 time ($\tau_{total} = \tau_{on} + \tau_{off}$), respectively.

The liquid-crystal media according to the invention consist of a plurality of compounds, preferably 3 to 30, more preferably 4 to 20 and very preferably 4 to 16 compounds. These compounds are mixed in a conventional manner. In general, the desired amount
20 of the compound used in the smaller amount is dissolved in the compound used in the larger amount. If the temperature is above the clearing point of the compound used in the higher concentration, it is particularly easy to observe completion of the dissolution process. It is, however, also possible to prepare the media in other conventional ways, for example using so-called pre-mixes, which can be, for example, homologous or
25 eutectic mixtures of compounds, or using so-called "multibottle" systems, the constituents of which are themselves ready-to-use mixtures.

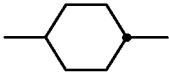
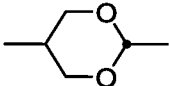
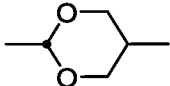
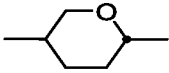
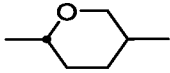
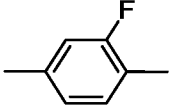
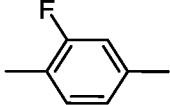
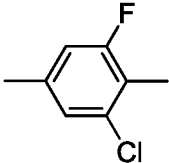
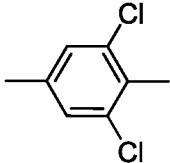
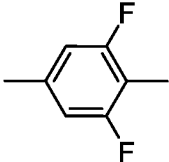
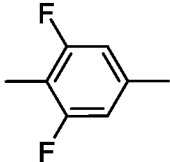
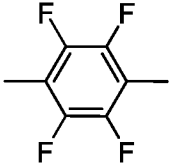
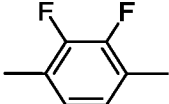
All temperatures, such as, for example, the melting point $T(C,N)$ or $T(C,S)$, the transition from the smectic (S) to the nematic (N) phase $T(S,N)$ and the clearing point
30 $T(N,I)$ of the liquid crystals, are quoted in degrees Celsius. All temperature differences are quoted in differential degrees.

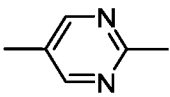
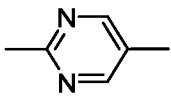
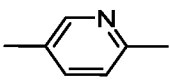
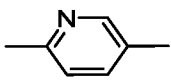
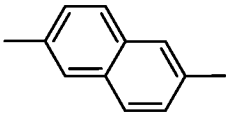
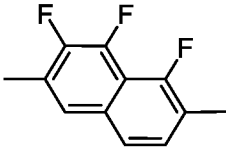
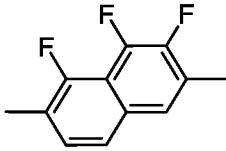
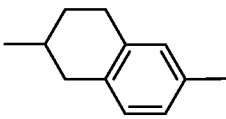
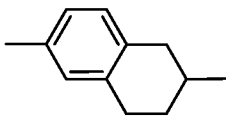
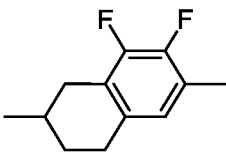
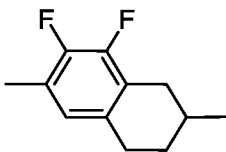
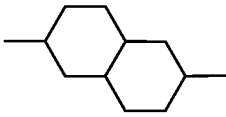
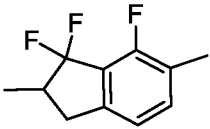
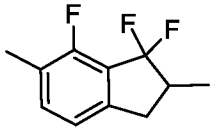
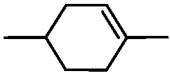
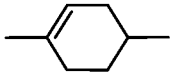
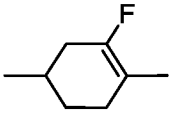
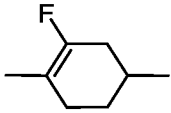
In the present invention and especially in the following examples, the structures of the mesogenic compounds are indicated by means of abbreviations, also referred to as
35 acronyms. In these acronyms, the chemical formulae are abbreviated as follows using Tables A to C below. All groups C_nH_{2n+1} , C_mH_{2m+1} and C_lH_{2l+1} , and C_nH_{2n-1} , C_mH_{2m-1} and

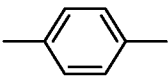
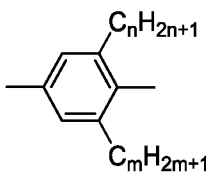
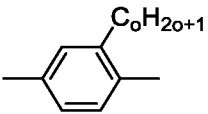
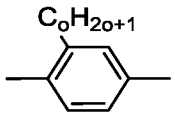
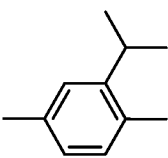
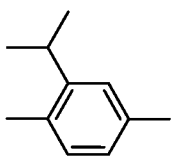
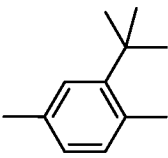
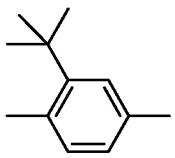
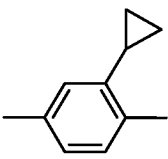
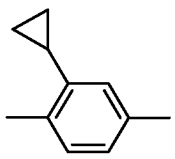
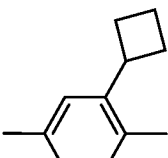
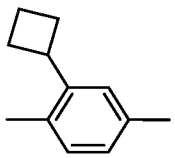
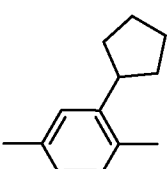
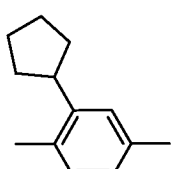
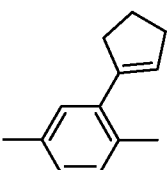
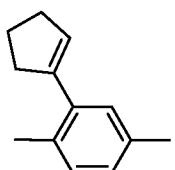
C_nH_{2n-1} denote straight-chain alkyl or alylene, respectively, in each case having n, m or l C atoms, wherein n and m, independently are 1, 2, 3, 4, 5, 6 or 7 and l is 1, 2 or 3.

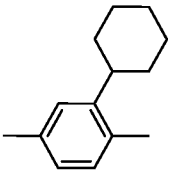
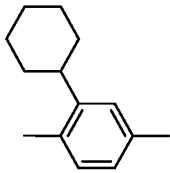
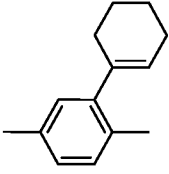
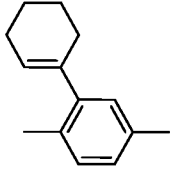
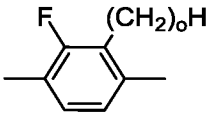
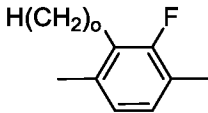
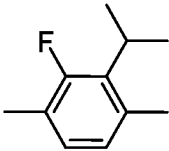
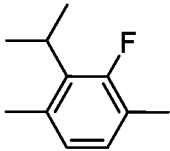
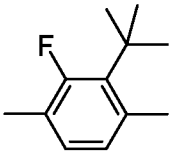
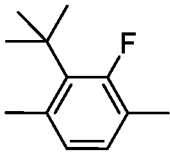
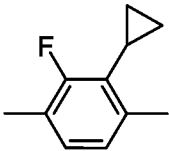
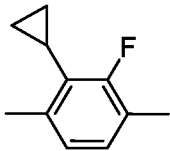
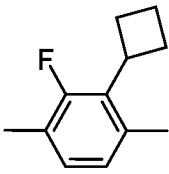
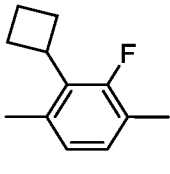
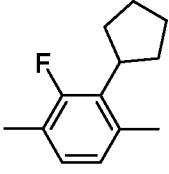
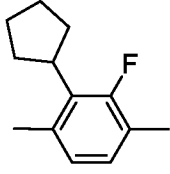
Table A lists the codes used for the ring elements of the core structures of the compounds, while Table B shows the linking groups and end groups. Table C shows illustrative structures of compounds with their respective abbreviations.

Table A: Ring elements

10	C			
	D		DI	
15	A		AI	
20	G		GI	
	G(Cl)		P(Cl,Cl)	
25	U		UI	
30	U(F,F)			
35	Y			

	M		MI	
5	N		NI	
10	Np			
15	N3f		N3fl	
	tH		tHI	
20	tH2f		tH2fl	
25	dH			
	K		KI	
30	L		LI	
35	F		FI	

	P		P(n,m)	
5	P(o)		PI(o)	
10	P(i3)		PI(ic3)	
	P(t4)		PI(t4)	
15	P(c3)		PI(c3)	
20	P(c4)		PI(c4)	
25	P(c5)		PI(c5)	
30	P(e5)		PI(e5)	
35				

5	P(c6)		PI(c6)	
	P(e6)		PI(e6)	
10	GI(o)	 in which o = 1,2,3,4,5 or 6	G(o)	 in which o = 1,2,3,4,5 or 6
15	GI(i3)		G(i3)	
20	GI(t4)		G(t4)	
25	GI(c3)		G(c3)	
30	GI(c4)		G(c4)	
35	GI(c5)		G(c5)	

5	GI(e5)		G(e5)	
	GI(c6)		G(c6)	
10	GI(e6)		G(e6)	
15	Np(1,4)		Th	

Table B: Linking groups

20	E	-CH ₂ CH ₂ -	Z	-CO-O-
	V	-CH=CH-	ZI	-O-CO-
	X	-CF=CH-	O	-CH ₂ -O-
	XI	-CH=CF-	OI	-O-CH ₂ -
25	B	-CF=CF-	Q	-CF ₂ -O-
	T	-C≡C-	QI	-O-CF ₂ -
	W	-CF ₂ CF ₂ -		

Table B: End groups

30	Left-hand side		Right-hand side	
			Used alone	
	-n-	C _n H _{2n+1} -	-n	-C _n H _{2n+1}
	-nO-	C _n H _{2n+1} -O-	-On	-O-C _n H _{2n+1}
35	-V-	CH ₂ =CH-	-V	-CH=CH ₂
	-nV-	C _n H _{2n+1} -CH=CH-	-nV	-C _n H _{2n} -CH=CH ₂

	-Vn-	$\text{CH}_2=\text{CH}-\text{C}_n\text{H}_{2n+1}-$	-Vn	$-\text{CH}=\text{CH}-\text{C}_n\text{H}_{2n+1}$
	-nVm-	$\text{C}_n\text{H}_{2n+1}-\text{CH}=\text{CH}-\text{C}_m\text{H}_{2m}-$	-nVm	$-\text{C}_n\text{H}_{2n}-\text{CH}=\text{CH}-\text{C}_m\text{H}_{2m+1}$
	-N-	$\text{N}\equiv\text{C}-$	-N	$-\text{C}\equiv\text{N}$
	-S-	$\text{S}=\text{C}=\text{N}-$	-S	$-\text{N}=\text{C}=\text{S}$
5	-F-	F-	-F	-F
	-CL-	Cl-	-CL	-Cl
	-M-	CFH_2-	-M	$-\text{CFH}_2$
	-D-	$\text{CF}_2\text{H}-$	-D	$-\text{CF}_2\text{H}$
	-T-	CF_3-	-T	$-\text{CF}_3$
10	-MO-	$\text{CFH}_2\text{O}-$	-OM	$-\text{OCFH}_2$
	-DO-	$\text{CF}_2\text{HO}-$	-OD	$-\text{OCF}_2\text{H}$
	-TO-	$\text{CF}_3\text{O}-$	-OT	$-\text{OCF}_3$
	-FXO-	$\text{CF}_2=\text{CH}-\text{O}-$	-OXF	$-\text{O}-\text{CH}=\text{CF}_2$
	-A-	$\text{H}-\text{C}\equiv\text{C}-$	-A	$-\text{C}\equiv\text{C}-\text{H}$
15	-nA-	$\text{C}_n\text{H}_{2n+1}-\text{C}\equiv\text{C}-$	-An	$-\text{C}\equiv\text{C}-\text{C}_n\text{H}_{2n+1}$
	-NA-	$\text{N}\equiv\text{C}-\text{C}\equiv\text{C}-$	-AN	$-\text{C}\equiv\text{C}-\text{C}\equiv\text{N}$

Used in combination with others

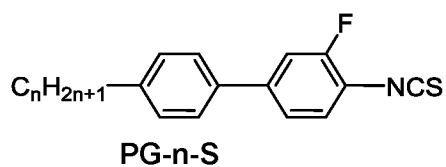
	-...A...-	$-\text{C}\equiv\text{C}-$	-...A...	$-\text{C}\equiv\text{C}-$
20	-...V...-	$-\text{CH}=\text{CH}-$	-...V...	$-\text{CH}=\text{CH}-$
	-...Z...-	$-\text{CO}-\text{O}-$	-...Z...	$-\text{CO}-\text{O}-$
	-...ZI...-	$-\text{O}-\text{CO}-$	-...ZI...	$-\text{O}-\text{CO}-$
	-...K...-	$-\text{CO}-$	-...K...	$-\text{CO}-$
25	-...W...-	$-\text{CF}=\text{CF}-$	-...W...	$-\text{CF}=\text{CF}-$

in which n and m each denote integers, and the three dots “...” are placeholders for other abbreviations from this table.

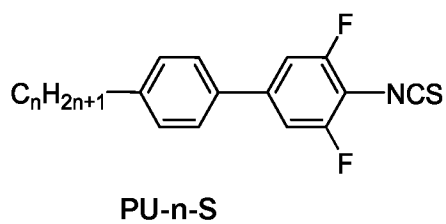
The following table shows illustrative structures together with their respective abbreviations. These are shown in order to illustrate the meaning of the rules for the abbreviations. They furthermore represent compounds which are preferably used.

Table C: Illustrative structures

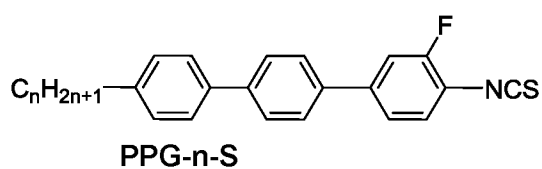
The following illustrative structures are compounds, which are preferably additionally used in the media:



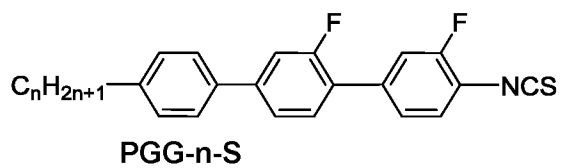
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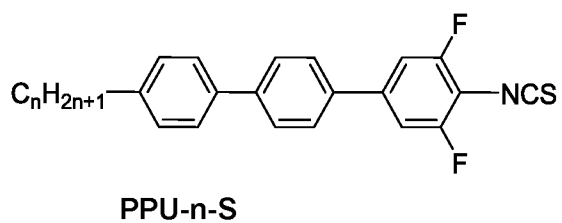
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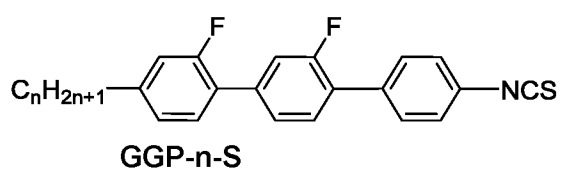
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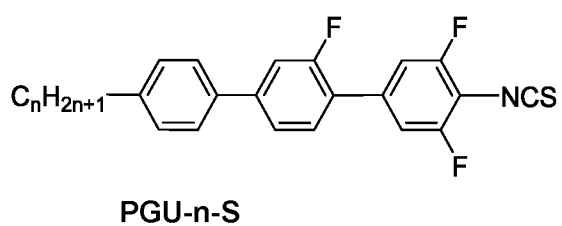
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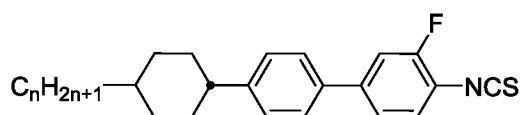
25



30

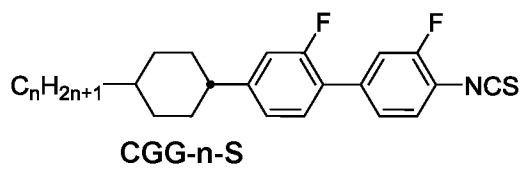


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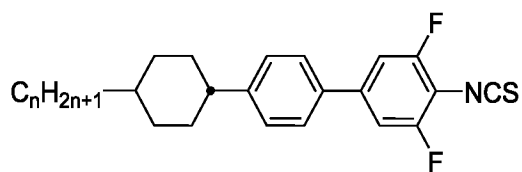
CPG-n-S

5



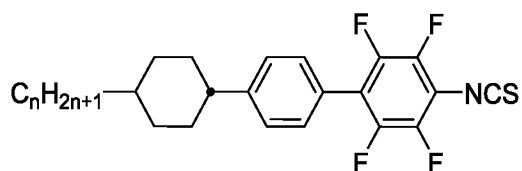
CGG-n-S

10



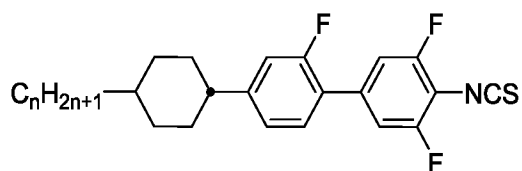
CPU-n-S

15



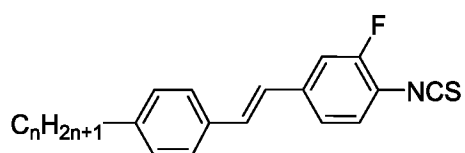
CPU(F,F)-n-S

20



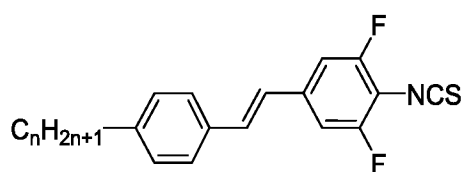
CGU-n-S

25



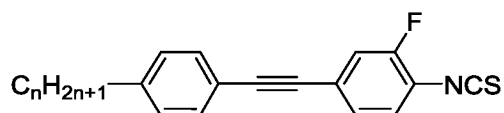
PVG-n-S

30

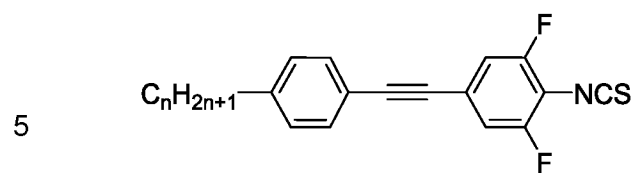


PVU-n-S

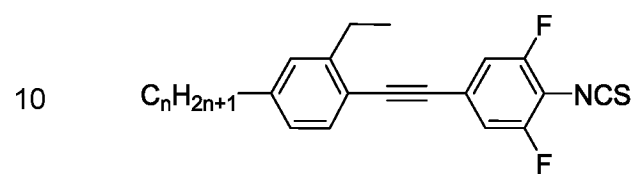
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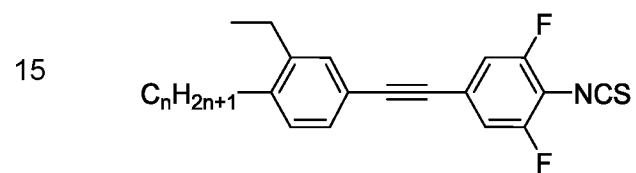
PTG-n-S



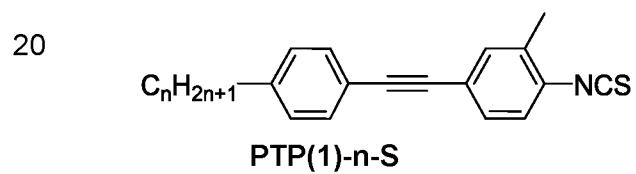
PTU-n-S



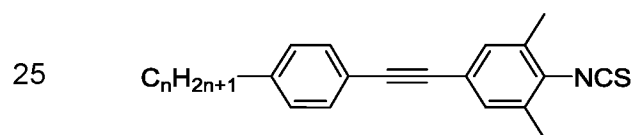
P(2)TU-n-S



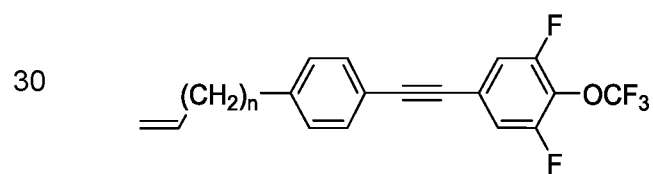
PI(2)TU-n-S



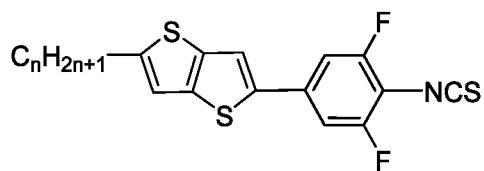
PTP(1)-n-S



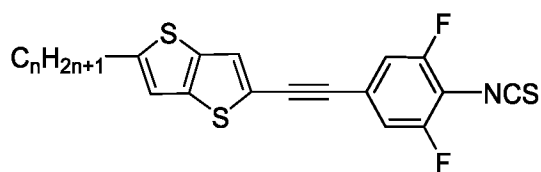
PTP(1,1)-n-S



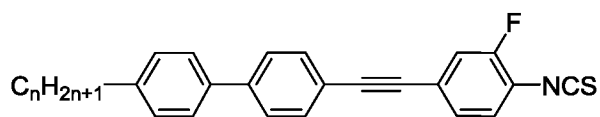
PTU-Vn-OT



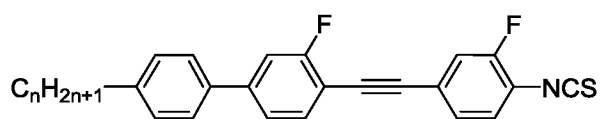
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ThU-n-S

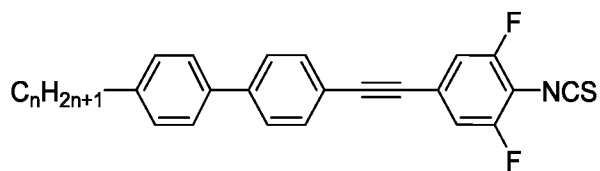
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ThTU-n-S

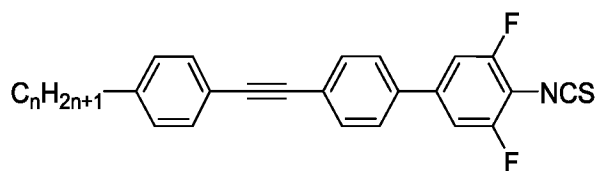
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PPTG-n-S

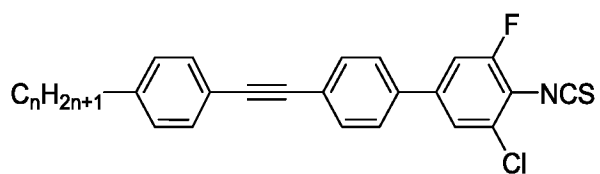
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PGTG-n-S

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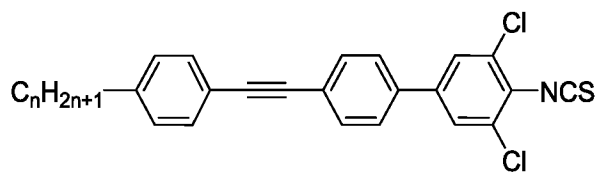
PPTU-n-S

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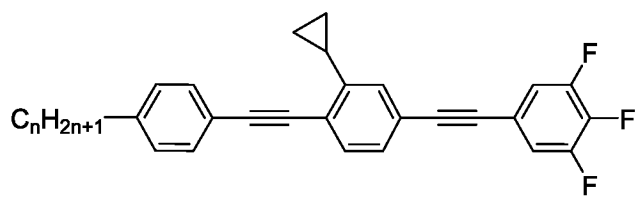
PTPU-n-S

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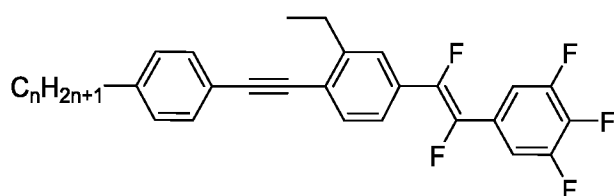
PTPG(Cl)-n-S



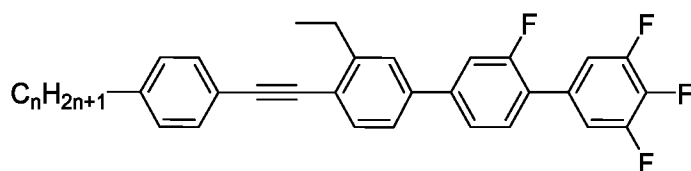
5 PTPP(Cl,Cl)-n-S



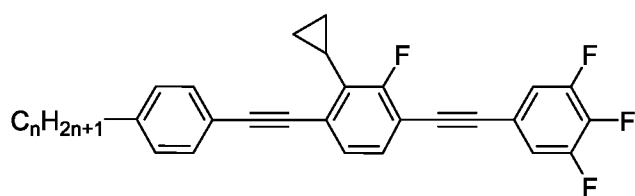
10 PTPI(c3)TU-n-F



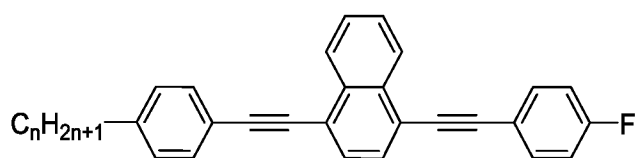
15 PTPI(2)WU-n-F



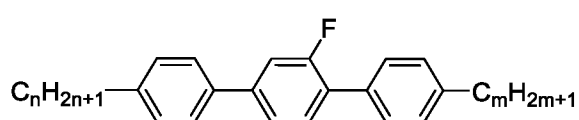
20 PTPI(2)GU-n-F



25 PTG(c3)TU-n-F

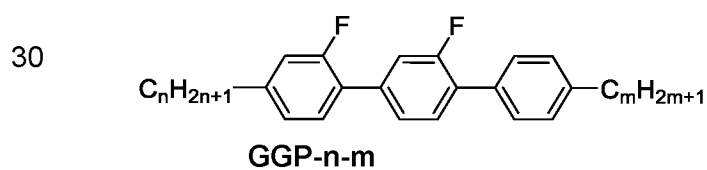
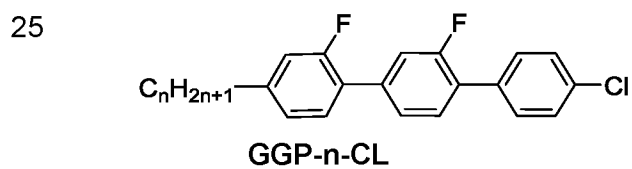
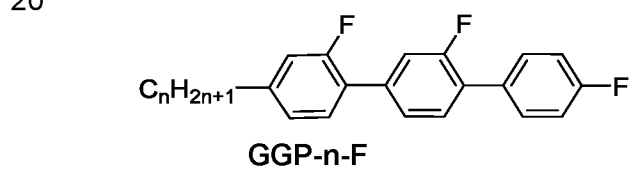
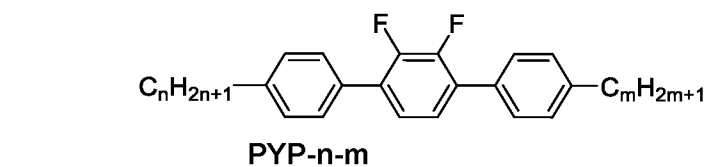
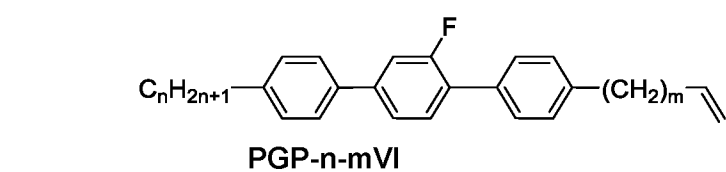
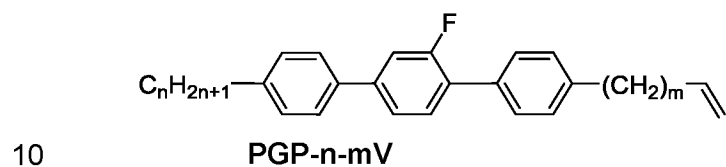
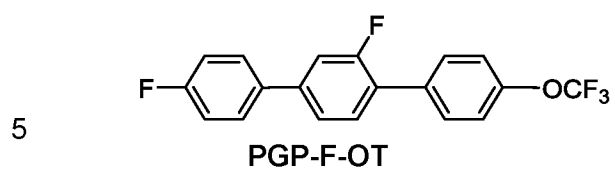


30 PTN(1,4)TP-n-F

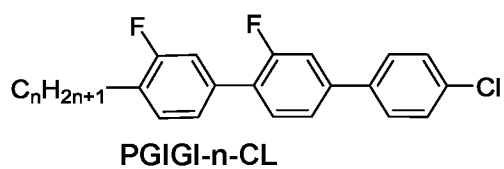


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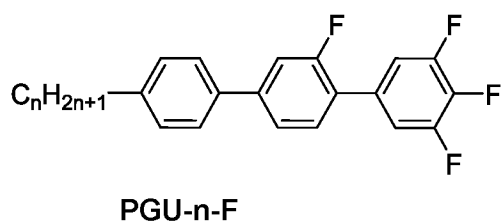
PGP-n-m



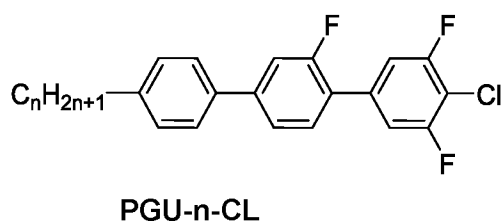
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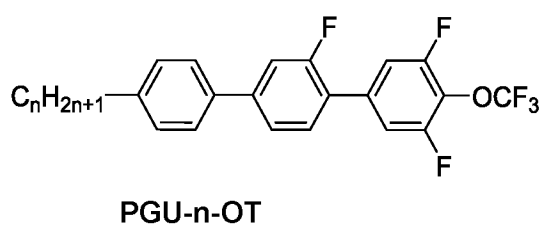
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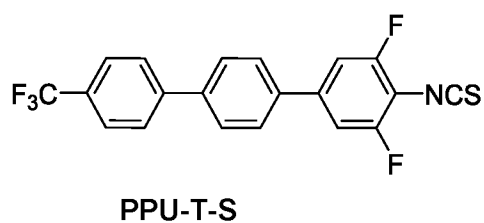
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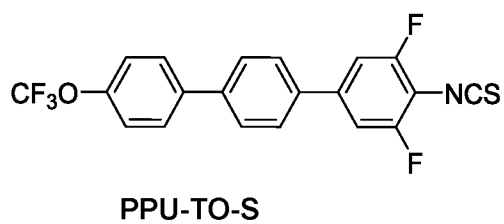
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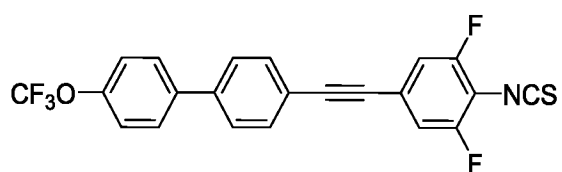
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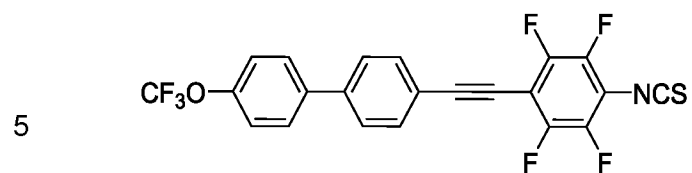
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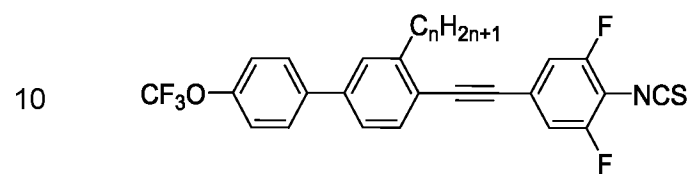
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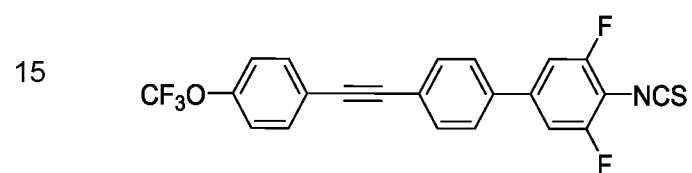
PPTU-TO-S



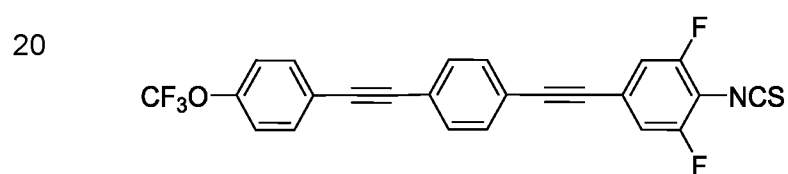
PPTU(F,F)-TO-S



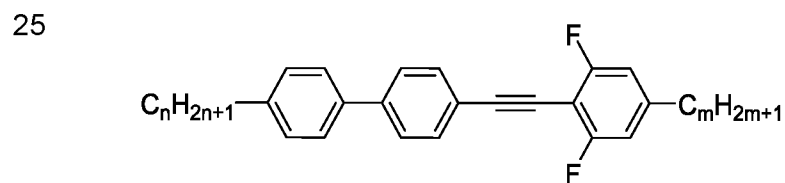
PP(n)TU-TO-S



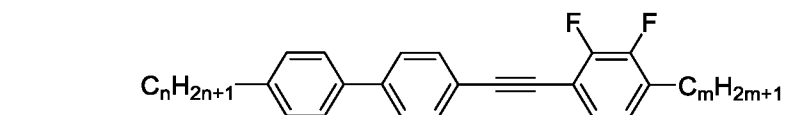
PTPU-TO-S



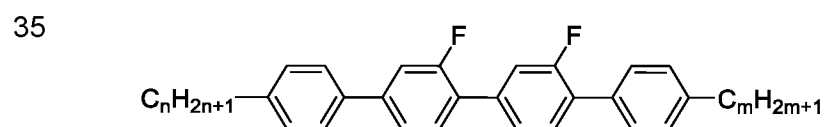
PTPTU-TO-S



PPTUI-n-m

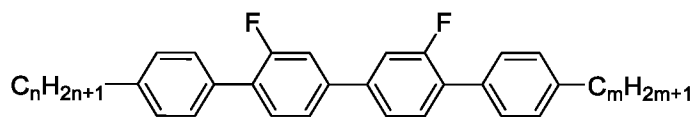


PPTY-n-m



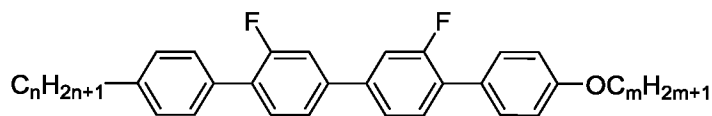
PGGP-n-m

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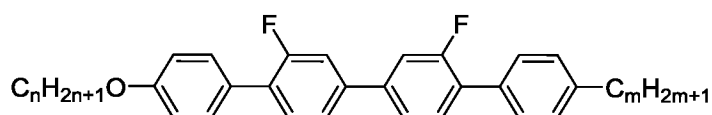
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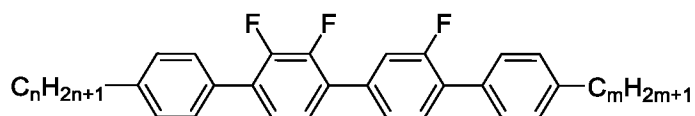
PGIGP-n-Om

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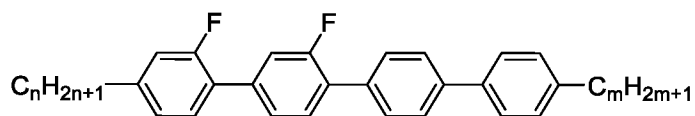
PGIGP-nO-m

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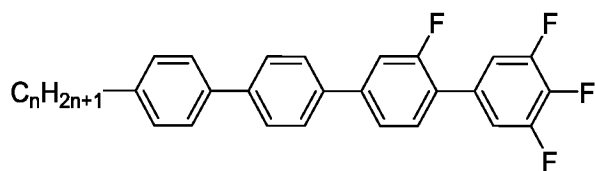
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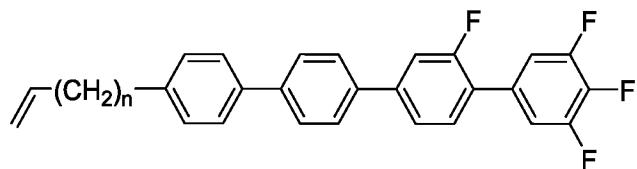
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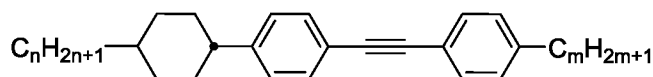


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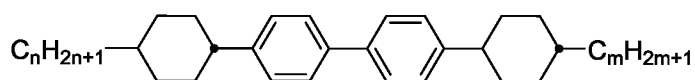
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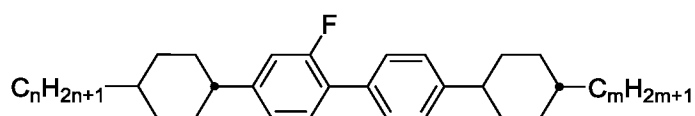
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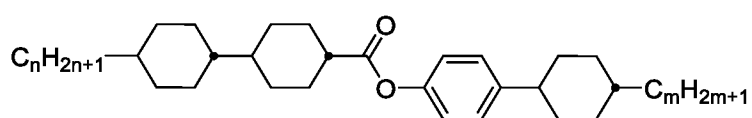
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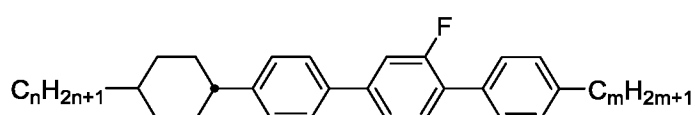
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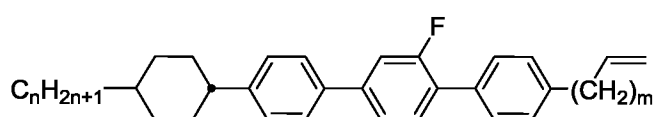
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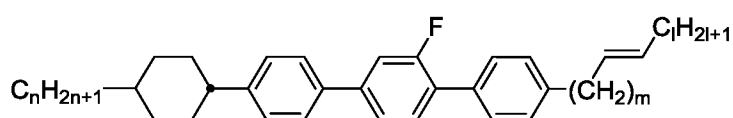
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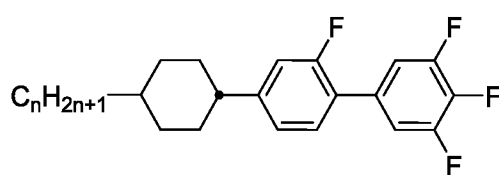
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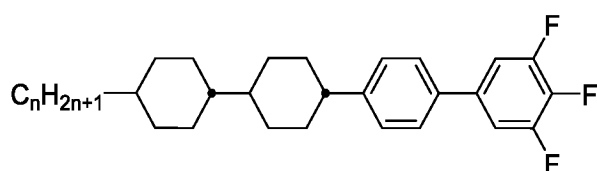
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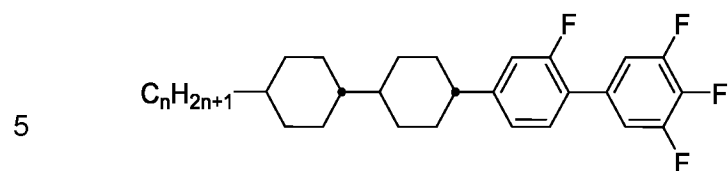
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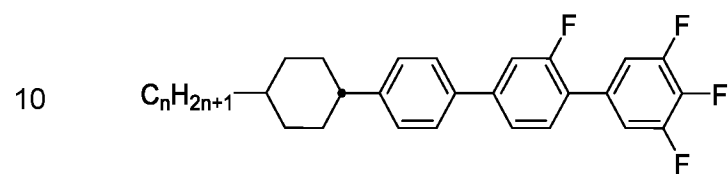
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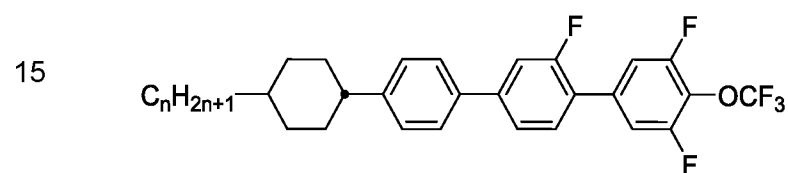
CCPU-n-F



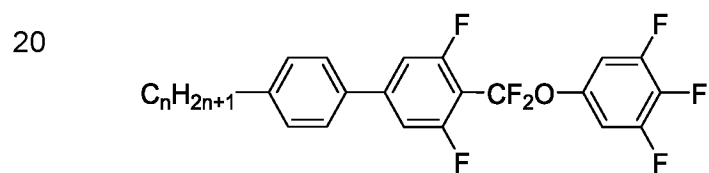
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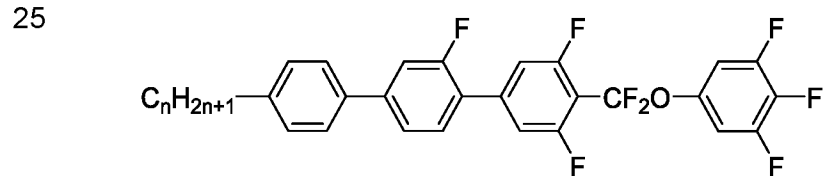
CPGU-n-F



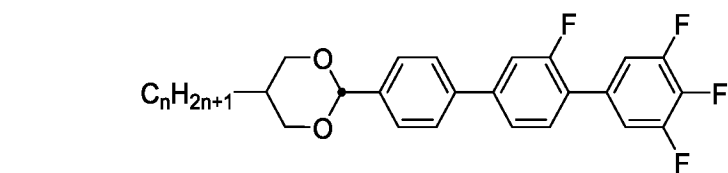
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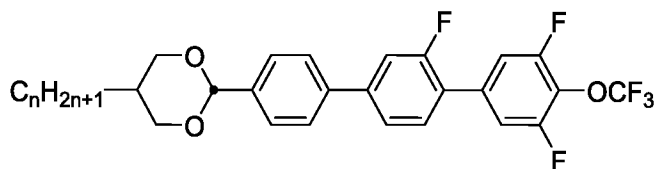


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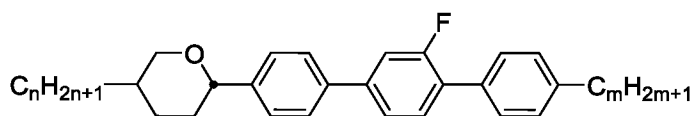


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DPGU-n-F

**DPGU-n-OT**

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**APGP-n-m**

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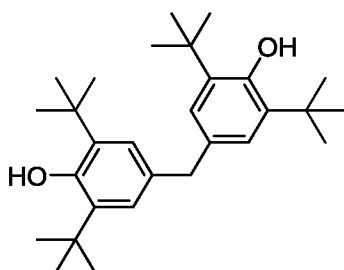
in which m and n, identically or differently, are 1,2,3,4,5,6 or 7.

Preferably, the medium according to the invention comprises one or more compounds selected from the compounds of Table C.

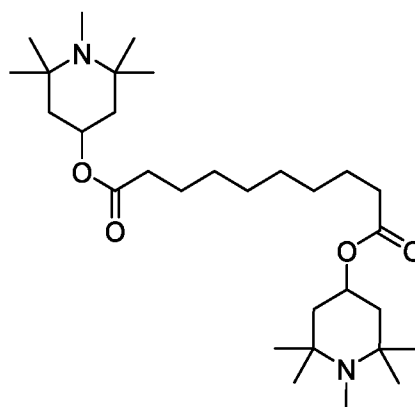
15

The following table, Table D, shows illustrative compounds which can be used as alternative stabilisers in the mesogenic media in accordance with the present invention. The total concentration of these and similar compounds in the media is preferably 5 % or less.

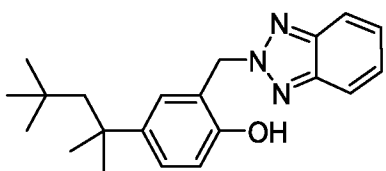
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Table D

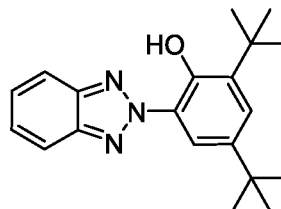
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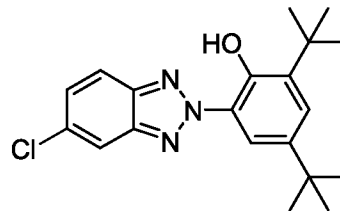
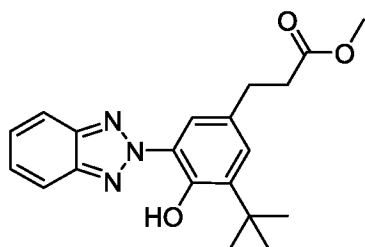
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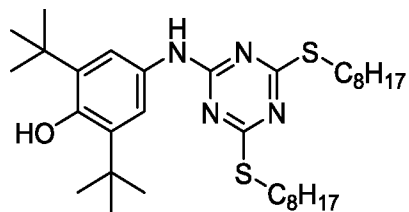
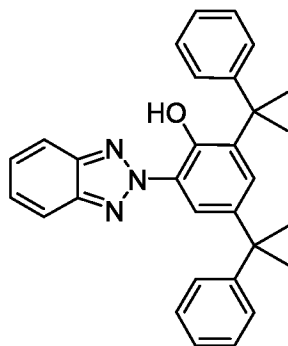
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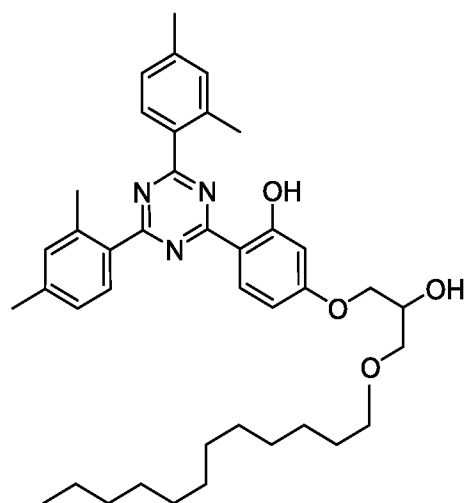
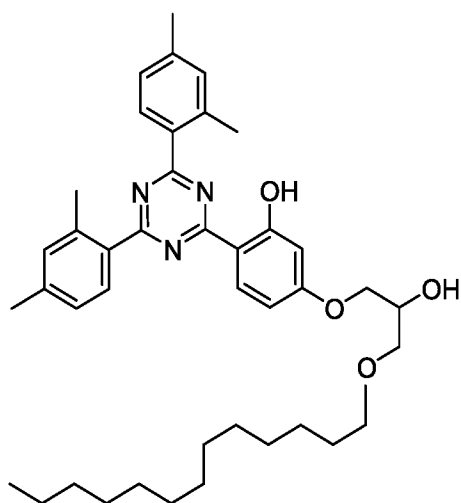
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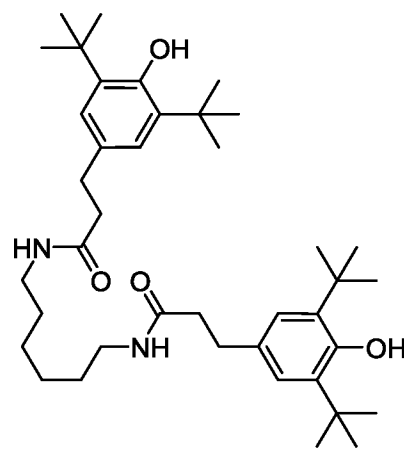
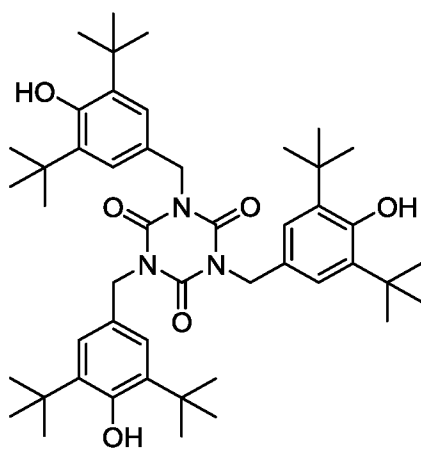
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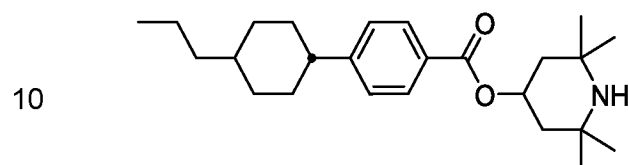
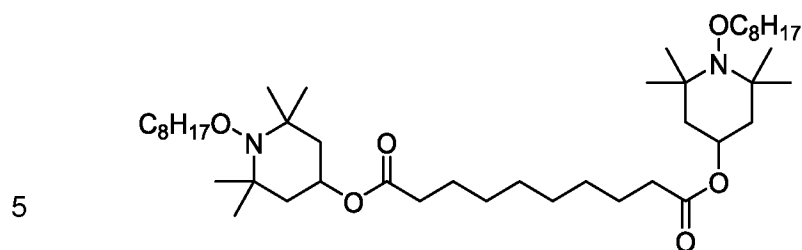


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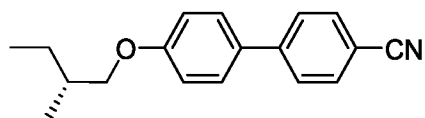
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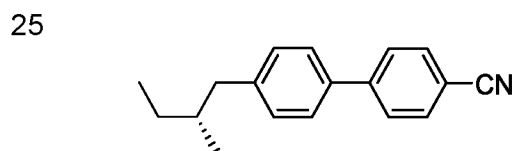


15 In a preferred embodiment of the present invention, the mesogenic media comprise one or more compounds selected from the group of the compounds from Table D. The following table, Table E, shows illustrative compounds which can preferably be used as chiral dopants in the mesogenic media in accordance with the present invention.

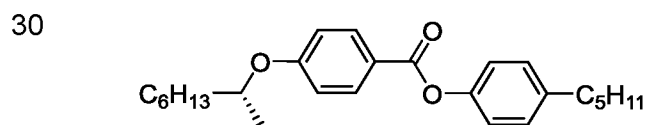
20 **Table E**



C 15

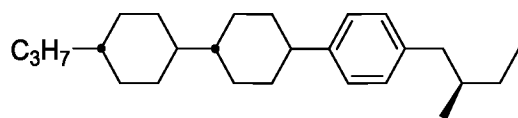


CB 15



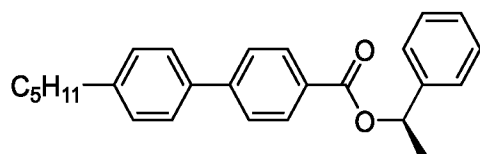
CM 21

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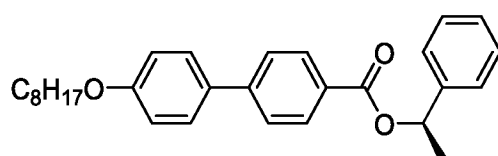
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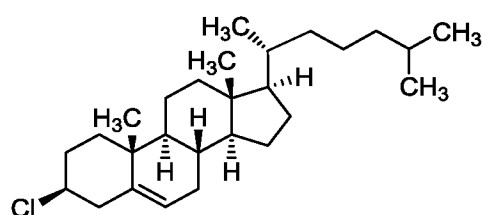
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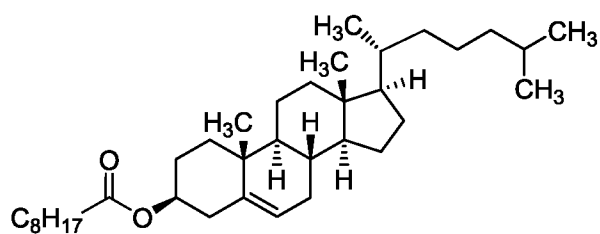
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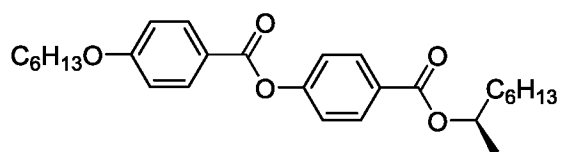
CC

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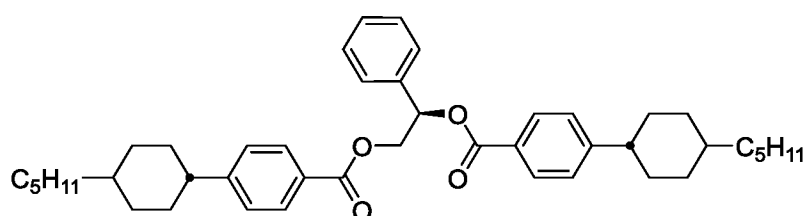
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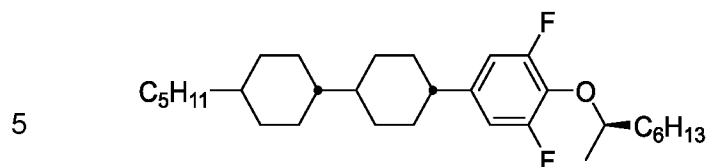
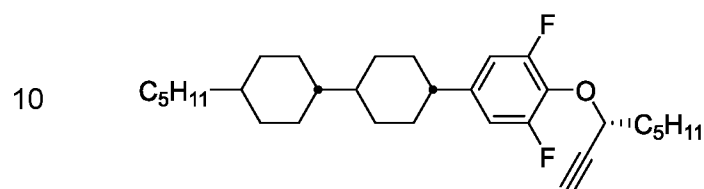
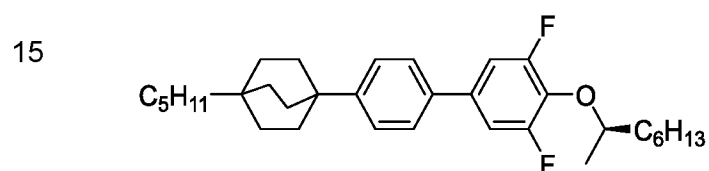
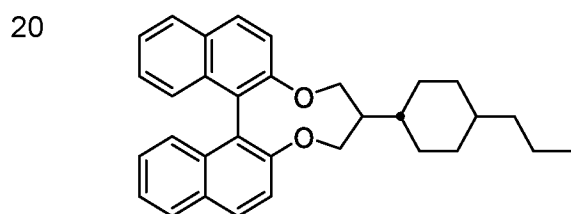


R/S-811

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R/S-1011**R/S-2011****R/S-3011****R/S-4011****R/S-5011**

25

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

The mesogenic media in accordance with the present application preferably comprise

30 two or more, preferably four or more, compounds selected from the group consisting of the compounds from the above tables.

Unless indicated otherwise, parts or per cent data denote parts by weight or per cent by weight.

35 Above and below:

	V_0	denotes threshold voltage, capacitive [V] at 20°C,
	n_e	denotes extraordinary refractive index at 20°C and 589 nm,
	n_o	denotes ordinary refractive index at 20°C and 589 nm,
	Δn	denotes optical anisotropy at 20°C and 589 nm,
5	$\varepsilon_{\perp}$	denotes dielectric permittivity perpendicular to the director at 20°C and 1 kHz,
	$\varepsilon_{ }$	denotes dielectric permittivity parallel to the director at 20°C and 1 kHz,
	$\Delta\varepsilon$	denotes dielectric anisotropy at 20°C and 1 kHz,
10	cl.p., T(N,I)	denotes clearing point [°C],
	γ_1	denotes rotational viscosity measured at 20°C [mPa·s],
	K_1	denotes elastic constant, "splay" deformation at 20°C [pN],
	K_2	denotes elastic constant, "twist" deformation at 20°C [pN],
	K_3	denotes elastic constant, "bend" deformation at 20°C [pN],
15	$K_{avg.}$	denotes average elastic constant defined as $K_{avg.} = \frac{1}{3}(1.5 \cdot K_1 + K_3)$
	LTS	denotes low-temperature stability (nematic phase), determined in test cells or in the bulk, as specified.

20 Unless explicitly noted otherwise, all values indicated in the present application for temperatures, such as, for example, the melting point T(C,N), the transition from the smectic (S) to the nematic (N) phase T(S,N) and the clearing point T(N,I) or cl.p., are indicated in degrees Celsius (°C). M.p. denotes melting point. Furthermore, Tg = glass state, C = crystalline state, N = nematic phase, S = smectic phase and I = isotropic phase. The numbers between these symbols represent the transition temperatures.

25

The term "threshold voltage" for the present invention relates to the capacitive threshold (V_0), also called the Freedericksz threshold, unless explicitly indicated otherwise. In the examples, as is generally usual, the optical threshold can also be indicated for 10 % relative contrast (V_{10}).

30

The display used for measurement of the capacitive threshold voltage consists of two plane-parallel glass outer plates at a separation of 20 μm , which each have on the insides an electrode layer and an unrubbed polyimide alignment layer on top, which cause a homeotropic edge alignment of the liquid-crystal molecules.

35

The so-called "HTP" denotes the helical twisting power of an optically active or chiral substance in an LC medium (in μm). Unless indicated otherwise, the HTP is measured in the commercially available nematic LC host mixture MLD-6260 (Merck KGaA) at a temperature of 20°C.

5

The Clearing point is measured using the Mettler Thermosystem FP900. The optical anisotropy (Δn) is measured using an Abbe Refractometer H005 (Natrium-spectral lamp Na10 at 589nm, 20 °C). The dielectric anisotropy ($\Delta\epsilon$) is measured using an LCR-Meter E4980A/Agilent (G005) at 20°C (ϵ -parallel-cells with JALS 2096-R1). The turn on voltage (V_0) is measured using an LCR-Meter E4980A/Agilent (G005) at 20°C (ϵ -parallel-cells with JALS 2096-R1). The rotational viscosity (γ_1) is measured using a TOYO LCM-2 (0002) at 20°C (gamma 1 negative cells with JALS-2096-R 1). The elastic constant (K_1 , splay) is measured using an LCR-Meter E4980A/Agilent (G005) at 20°C (ϵ parallel-cells with JALS 2096-R1). K_3 : The elastic constant (K_3 , bend) is measured using an LCR-Meter E4980A/Agilent (G005) at 20°C (ϵ -parallel-cells with JALS 2096-R1).

10

15

20

Unless explicitly noted otherwise, all concentrations in the present application are indicated in per cent by weight and relate to the corresponding mixture as a whole, comprising all solid or liquid-crystalline components, without solvents. All physical properties are determined in accordance with "Merck Liquid Crystals, Physical Properties of Liquid Crystals", Status November 1997, Merck KGaA, Germany, and apply for a temperature of 20°C, unless explicitly indicated otherwise.

25

Examples

The following examples illustrate the present invention without limiting it in any way. It is clear to the person skilled in the art from the physical properties what properties can be achieved and in what ranges they can be modified. In particular, the combination of the various properties which can preferably be achieved is thus well defined for the person skilled in the art.

30

Synthesis Examples

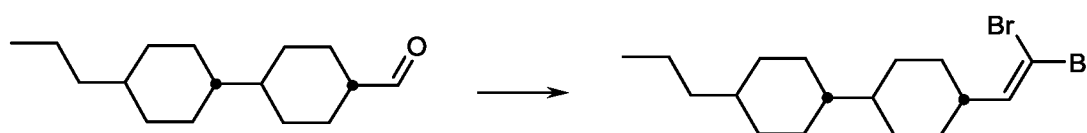
35

Abbreviations:

RT room temperature (typically 20°C $\pm$ 1°C)

	THF	Tetrahydrofuran
	MTB ether	Methyl- <i>tert</i> -butyl ether
	DCM	Dichloromethane
	dist.	distilled
5	XPhos	2-Dicyclohexylphosphino-2',4',6'-triisopropylbiphenyl
	XPhos Pd G2	Chloro(2-dicyclohexylphosphino-2',4',6'-triisopropyl-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)palladium (II)]

10 Step 1: 1-(2,2-Dibromovinyl)-4-(4-propylcyclohexyl)cyclohexane

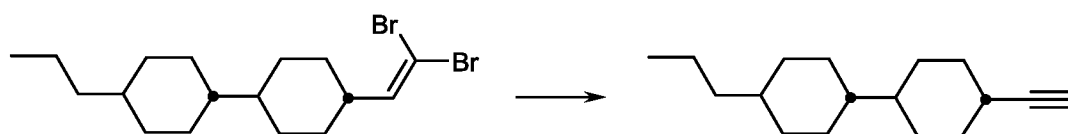


15 A solution of carbon tetrabromide (14.0 g, 42 mmol) in dichloromethane (40 ml) is treated with zinc dust (2.8 g, 42 mmol) and triphenylphosphine (11.1 g, 42 mmol), and the reaction mixture is stirred at room temp. overnight. Then a suspension of 4-(4-propylcyclohexyl)cyclohexane carbaldehyde (5.0 g, 21 mmol) in dichloromethane (60 ml) is added dropwise, and the reaction mixture is stirred at room temperature for 2 h. It is filtered and concentrated *in vacuo*, and the residue is dissolved in a mixture of

20 heptane, methanol and dist. water. The phases are separated, and the aqueous phase is extracted with heptane. The combined organic phases are washed with methanol/water, dried (sodium sulfate) and concentrated *in vacuo*. The crude product is purified by flash chromatography (heptane) to give 1-(2,2-dibromovinyl)-4-(4-propylcyclohexyl)cyclohexane as a colorless oil.

25

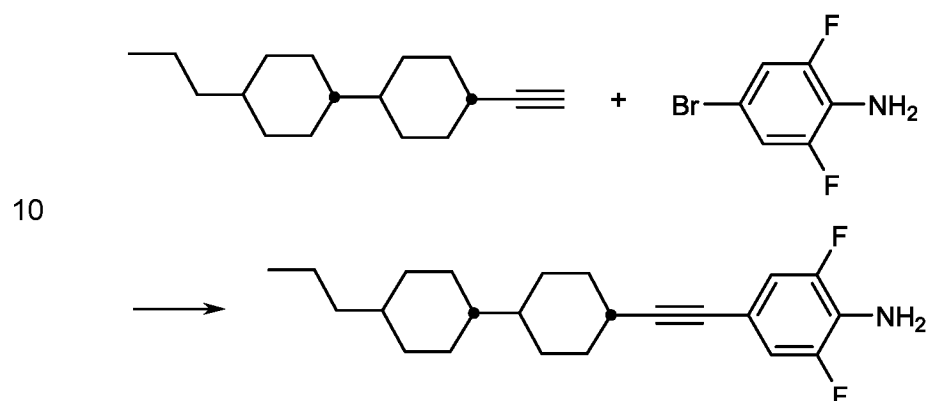
30 Step 2: 1-Ethynyl-4-(4-propylcyclohexyl)cyclohexane



35 A solution of *n*-butyllithium in hexane (9.8 ml, 15.5 mmol) is added slowly to a solution of 1-(2,2-dibromovinyl)-4-(4-propylcyclohexyl)cyclohexane (2.9 g, 7.4 mmol) in tetrahydrofuran (15 ml) at -70°C. The reaction mixture is stirred for 1 h at -70°C and then allowed to warm up to room temp. and stirred for an additional hour. It is hydrolyzed with water at 0°C, and the phases are separated. The aqueous phase is extracted with methyl *tert*-butyl ether. The combined organic phases are washed with

brine, dried (sodium sulfate) and concentrated *in vacuo*. The residue is purified by flash chromatography (heptane) to give 1-ethynyl-4-(4-propylcyclohexyl)cyclohexane as a light yellow oil.

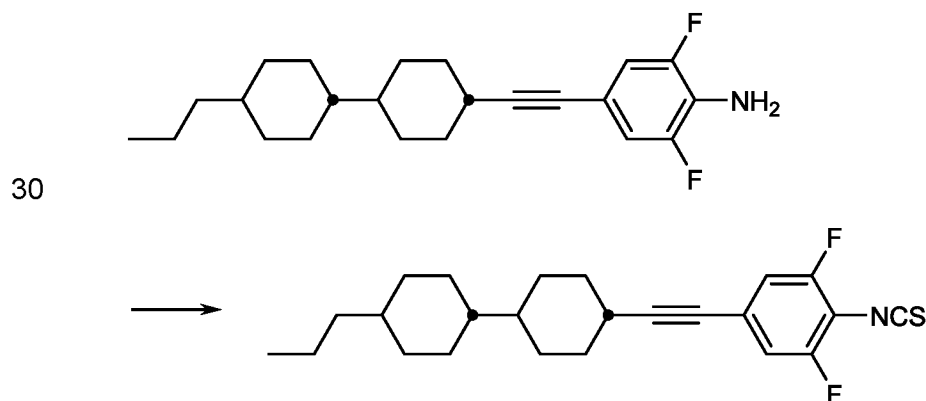
5 Step 3: 2,6-Difluoro-4-[2-[4-(4-propylcyclohexyl)cyclohexyl]ethynyl]aniline



15 A solution of 1-ethynyl-4-(4-propylcyclohexyl)cyclohexane (1.5 g, 6.5 mmol) and 4-bromo-2,6-difluoro-aniline (1.3 g, 6.1 mmol) in diisopropylamine (15 ml) and tetrahydrofuran (15 ml) is heated to 70°C under nitrogen. Then XPhos Pd G2 (10 mg, 0.01 mmol), XPhos (6 mg, 0.01 mmol) and copper(I)-iodide (1 mg, 0.01 mmol) are added, and the reaction mixture is stirred at 70°C overnight. Then it is filtered and concentrated *in vacuo*. The residue is purified by flash chromatography (heptane/methyl *tert*-butyl ether) to give 2,6-difluoro-4-[2-[4-(4-propylcyclohexyl)cyclohexyl]ethynyl]aniline as a light brown solid.

20

25 Step 4:
1,3-Difluoro-2-isothiocyanato-5-[2-[4-(4-propylcyclohexyl)cyclohexyl]ethynyl]benzene



Thiophosgene (0.4 mL, 5.2 mmol) is added dropwise to a mixture of 2,6-difluoro-4-[2-[4-(4-propylcyclohexyl)cyclohexyl]ethynyl]aniline (1.7 g, 4.7 mmol) and

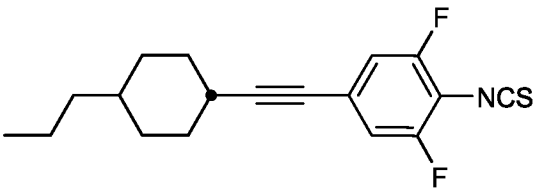
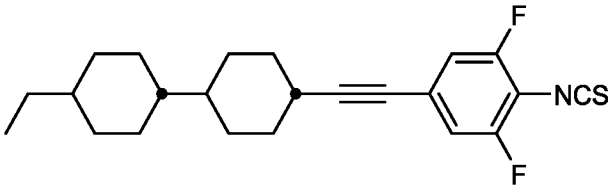
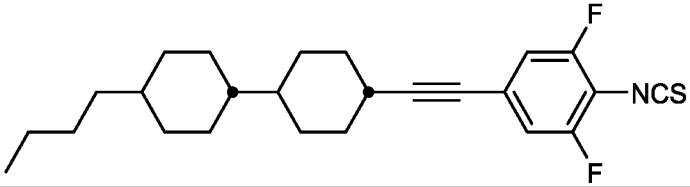
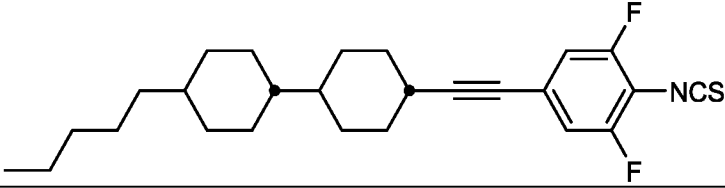
1,4-diazabicyclo[2.2.2]octane (1.3 g, 11.8 mmol) in dichloromethane (20 ml) at 0°C, and the reaction mixture is stirred for 1 h at room temperature. It is hydrolyzed with brine, and the phases are separated. The aqueous phase is washed with dichloromethane, and the combined organic phases are dried (sodium sulfate) and concentrated *in vacuo*. The residue is purified by flash chromatography (heptane) and crystallization with heptane to give 1,3-difluoro-2-isothiocyanato-5-[2-[4-(4-propylcyclohexyl)cyclohexyl]ethynyl]benzene as pale yellow crystals.

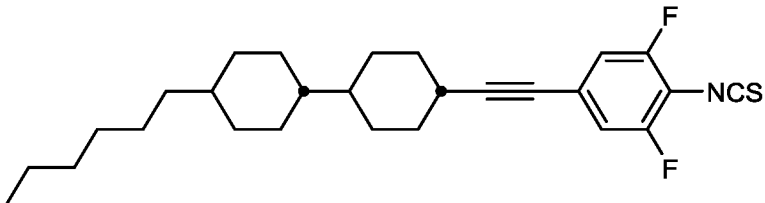
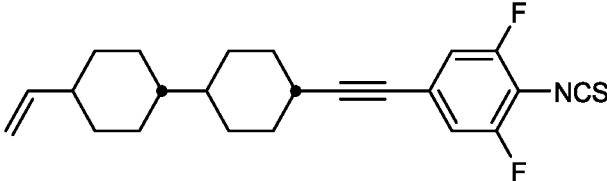
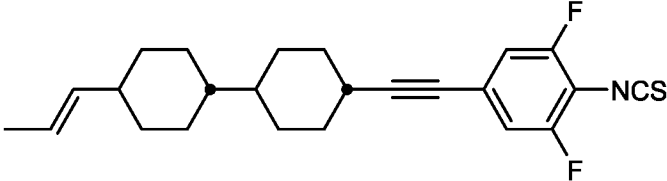
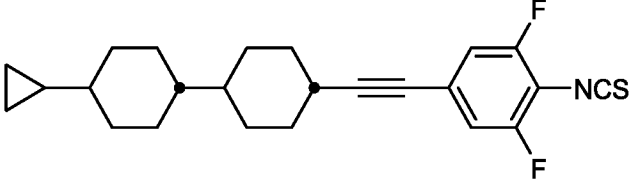
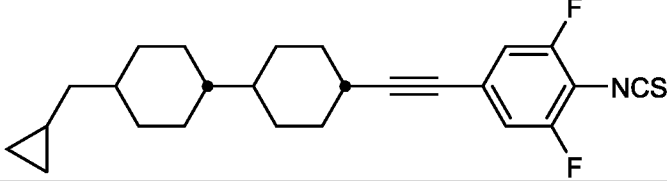
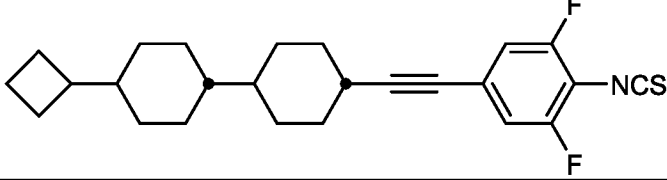
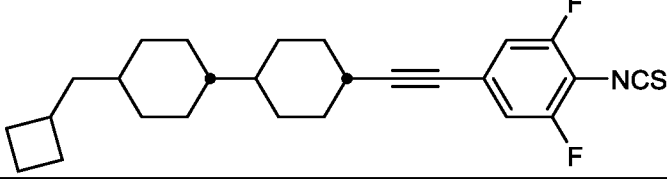
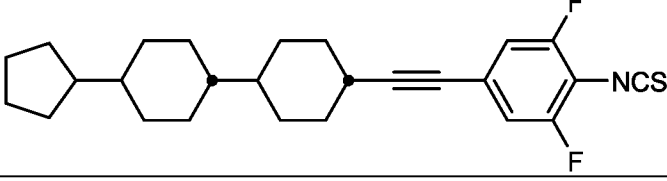
Phase sequence: K 69 N 224 I.

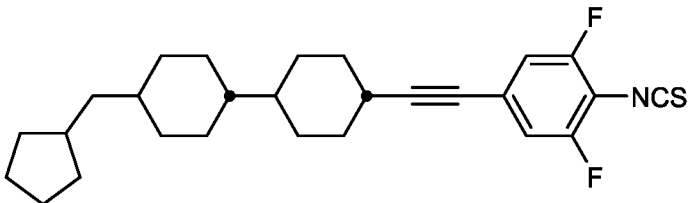
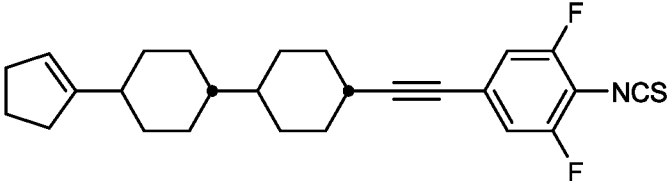
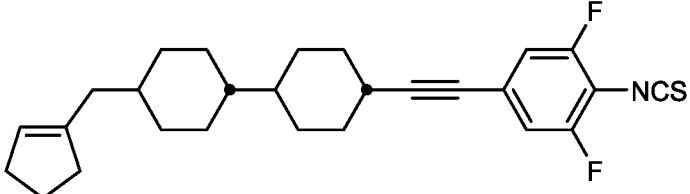
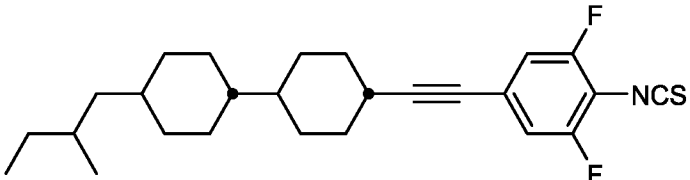
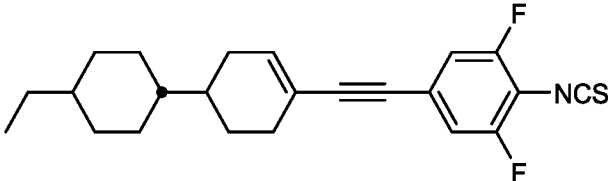
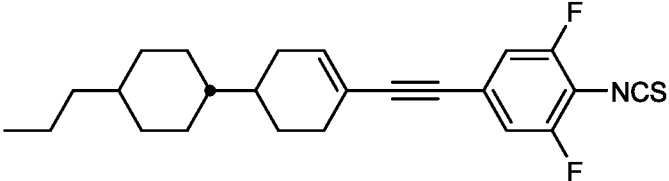
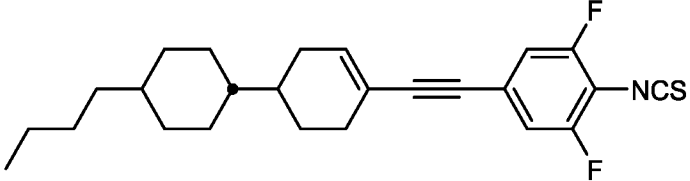
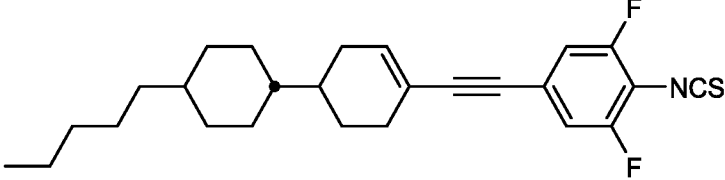
$$\Delta\varepsilon = 14.8$$

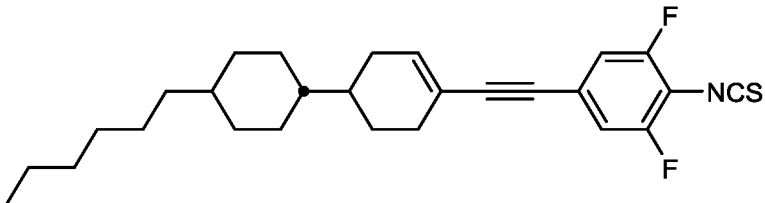
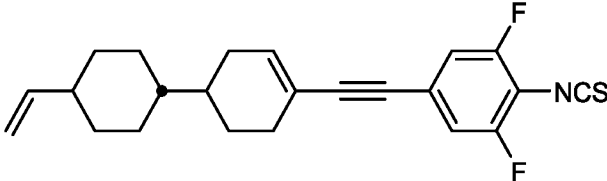
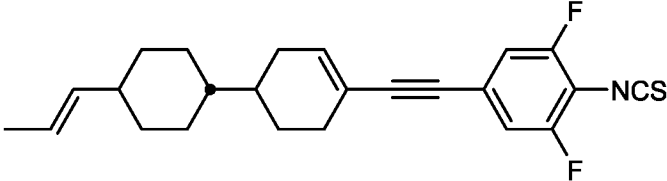
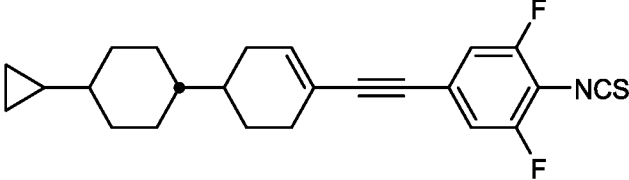
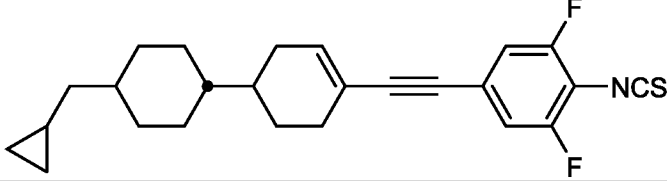
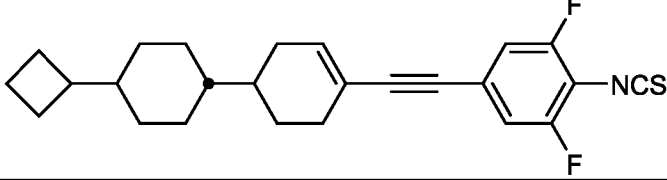
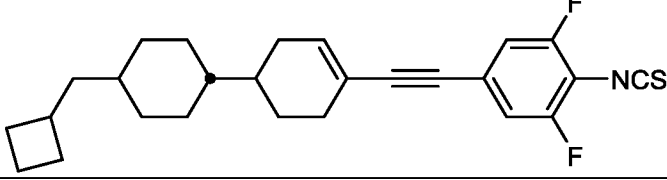
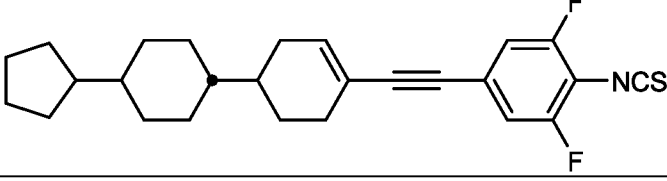
$$\Delta n = 0.2617$$

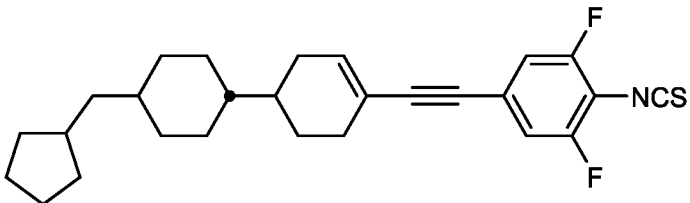
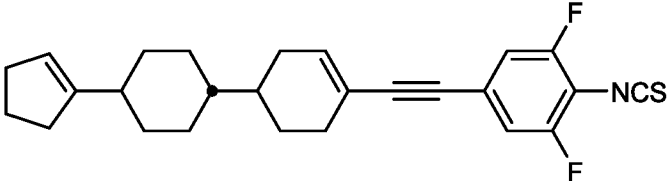
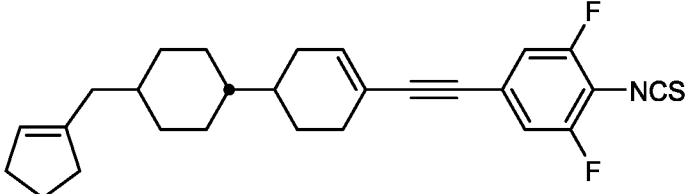
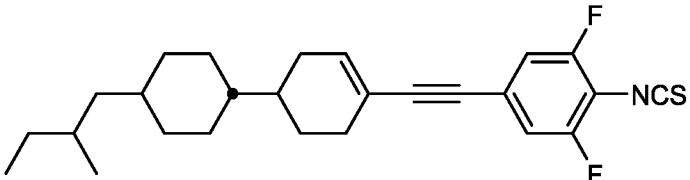
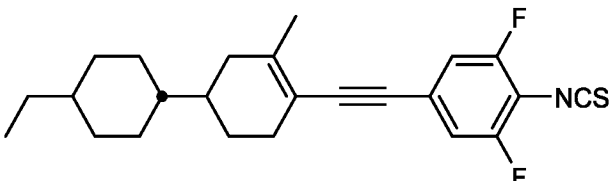
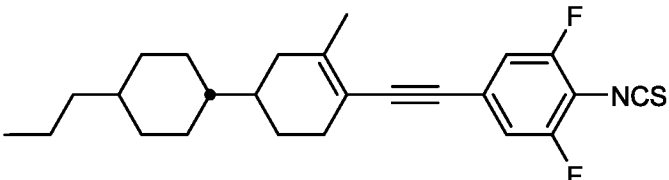
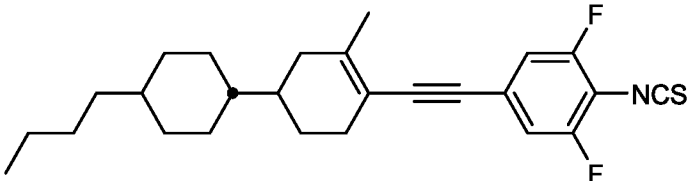
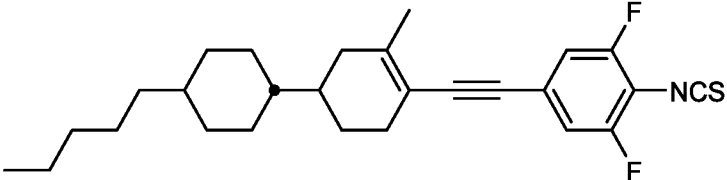
In analogy to Synthesis Examples 1 to 4 the following compounds are obtained:

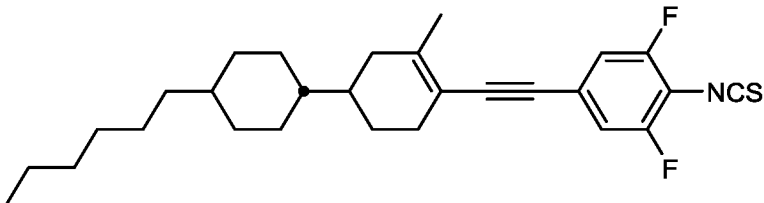
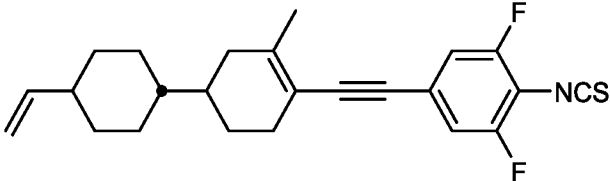
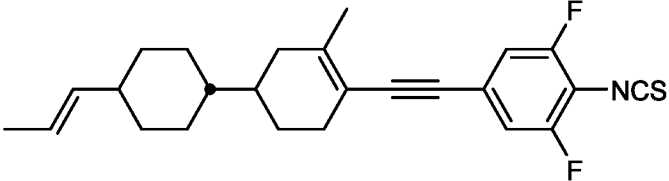
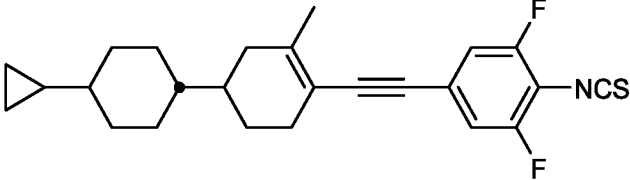
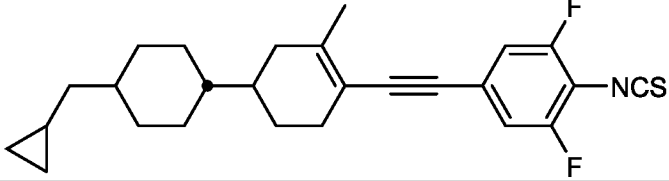
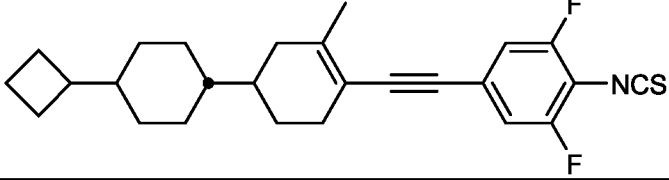
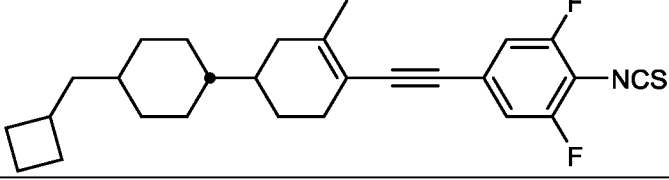
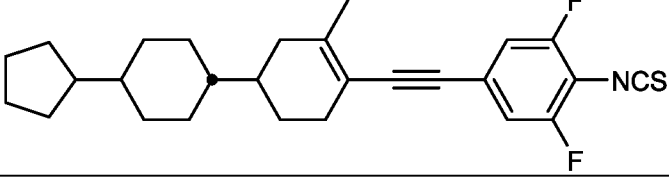
No.	Compound	physical parameters
1		K 47 N (9.6) I
2		
3		
4		

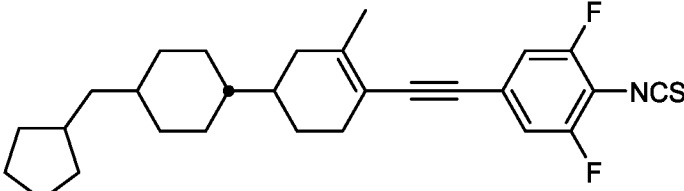
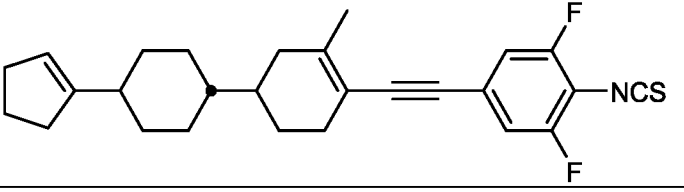
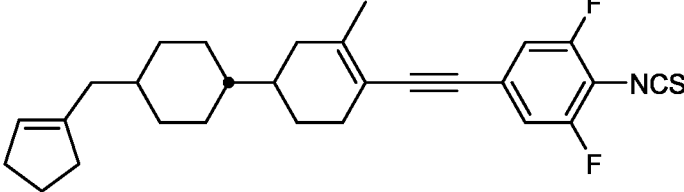
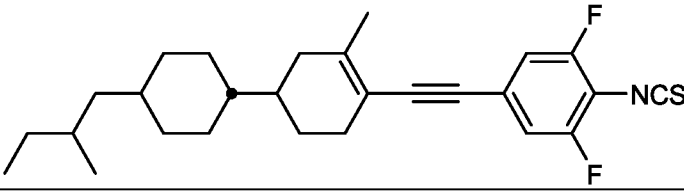
5		
6		
7		
8		
9		
10		
11		
12		

5	13		
	14		
10	15		
15	16		
20	17		
25	18		$\Delta\epsilon = 17.4$ $\Delta n = 0.327$
	19		
30	20		

21		
22		
23		
24		
25		
26		
27		
28		

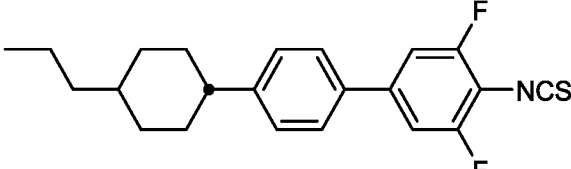
5	29		
	30		
10	31		
15	32		
20	33		
25	34		$\Delta\epsilon = 17.7$ $\Delta n = 0.317$
30	35		
35	36		

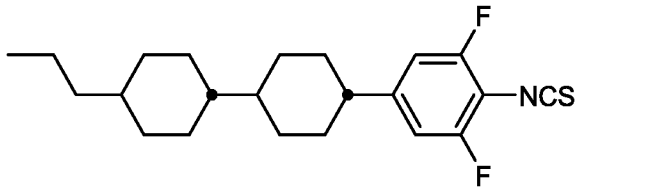
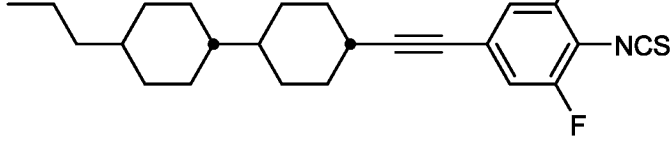
5	37		
	38		
10	39		
15	40		
20	41		
	42		
25	43		
30	44		

45		
46		
47		
48		

The compound according to the invention combines a high clearing temperature with high birefringence which is why it is particularly suitable for microwave applications. The compound of formula CPU-3-F (Table 1) is known for its use in liquid crystalline media for microwave applications from prior art. Due to the aromatic ring P, the clearing temperature is relatively low (198°C), whereas the corresponding cyclohexane-diyl derivative CCU-3-S has a significantly higher clearing temperature of 225 °C. However, the birefringence of the compound CCP-3-S is far too low for the applications according to the invention, where values well above 0.200 are required. Surprisingly, the birefringence of the compound CCU-3-S can be significantly increased to almost the level of CPU-3-S by the introduction of the triple bond while keeping the same high clearing temperature.

Table 1

	phase sequence	Δn
	K 52 N 198 I	0.2950

5	CPU-3-F 	K 65 N 225 I	0.1990
	CCU-3-F  CCTU-3-F	K 69 N 224 I	0.2617

Mixture Examples

Liquid-crystal mixtures C1 and N1 having the compositions and properties as indicated in the following tables are prepared and characterized with respect to their general physical properties and their applicability in microwave components at 19 GHz and 20°C.

Comparative Example C1

	CPG-3-F	12.0 %	T(N,I) [°C]:	92.5
	CPG-5-F	10.0 %	Δn [589 nm, 20°C]:	0.0969
	CCEP-3-OT	5.0 %	n_e [589 nm, 20°C]:	1.5764
25	CCEP-5-OT	5.0 %	n_o [589 nm, 20°C]:	1.4795
	CGPC-3-3	2.0 %	$\Delta \varepsilon$ [1 kHz, 20°C]:	5.3
	CGPC-5-3	2.0 %	$\varepsilon_{ }$ [1 kHz, 20°C]:	8.4
	CGPC-5-5	2.0 %	$\varepsilon_{\perp}$ [1 kHz, 20°C]:	3.1
30	CP-6-F	8.0 %	γ_1 [mPa s, 20°C]:	128
	CP-7-F	6.0 %	K_1 [pN, 20°C]:	13.2
	CCP-2-OT	8.0 %	K_3 [pN, 20°C]:	19.6
	CCP-3-OT	12.0 %	K_3/K_1 [pN, 20°C]:	1.48
35	CCP-4-OT	7.0 %	V_0 [V, 20°C]:	1.66
	CCP-5-OT	11.0 %	τ [20°C, 19 GHz]:	0.100

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	CP-5-F	10.0 %	$\epsilon_{r,\parallel}$ [20°C, 19 GHz]:	2.49
	Σ	100.0 %	$\epsilon_{r,\perp}$ [20°C, 19 GHz]:	2.24
			$\tan \delta_{\epsilon, r,\parallel}$ [20°C, 19 GHz]:	0.0049
5			$\tan \delta_{\epsilon, r,\perp}$ [20°C, 19 GHz]:	0.0125
			η [20°C, 19 GHz]:	8.0
10	<u>Example N1</u>			
	C1	90.0 %	$T(N,I)$ [°C]:	103
	CCTU-3-S	10.0 %	Δn [589 nm, 20°C]:	0.1134
	Σ	100.0	n_e [589 nm, 20°C]:	1.5764
15			n_o [589 nm, 20°C]:	1.4795
			$\Delta \epsilon$ [1 kHz, 20°C]:	6.3
			$\epsilon_{\parallel}$ [1 kHz, 20°C]:	9.4
			$\epsilon_{\perp}$ [1 kHz, 20°C]:	3.1
20			τ [20°C, 19 GHz]:	0.108
			$\epsilon_{r,\parallel}$ [20°C, 19 GHz]:	2.58
			$\epsilon_{r,\perp}$ [20°C, 19 GHz]:	2.30
			$\tan \delta_{\epsilon, r,\parallel}$ [20°C, 19 GHz]:	0.0045
25			$\tan \delta_{\epsilon, r,\perp}$ [20°C, 19 GHz]:	0.0123
			η [20°C, 19 GHz]:	8.8

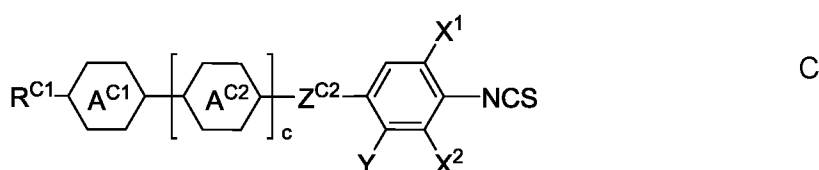
The addition of the compound of formula C to the medium C1 results in a surprisingly higher figure-of-merit η which is improved from 8.0 to 8.8 due to higher tunability τ and reduced dielectric loss $\tan \delta$. Due to its excellent phase properties, the clearing temperature of the medium is also significantly improved from 92.5 to 103 °C.

35

Patent Claims

1. A liquid crystal medium comprising
a) a compound of formula C

5



10

in which

R^{C1} denotes H, straight-chain or branched alkyl having 1 to 12 C atoms or alkenyl having 2 to 12 C atoms, in which one or more CH₂-groups may be

replaced by , , ,  or , where one or more non-adjacent CH₂-groups may be

15

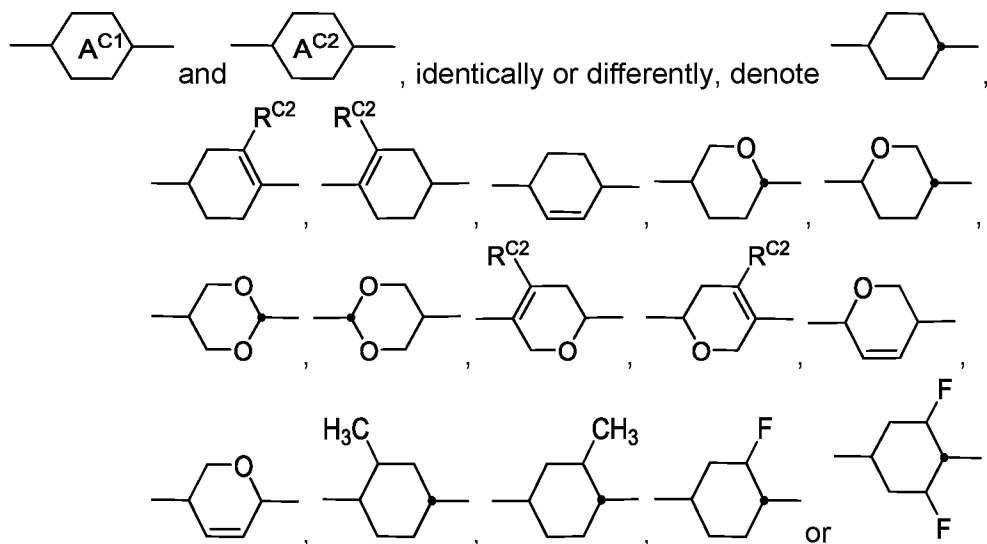
, where one or more non-adjacent CH₂-groups may be replaced by O and where one or more H atoms may be replaced by F,

Z^{C2} denotes -CH=CH-, -CF=CF-, -CH=CF-, -CF=CH- or -C≡C-,

X^1, X^2 identically or differently, denote H, Cl, F or methyl,

Y denotes H, Cl, F, or alkyl or alkoxy each having 1 to 6 C atoms,

20



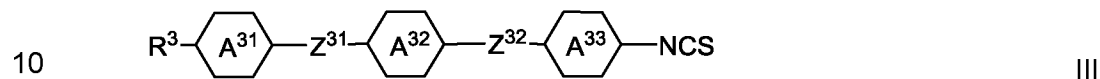
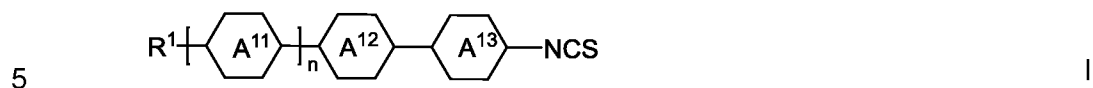
R^{C2} denotes H, CH_3 or F, and

c is 0 or 1,

35 and

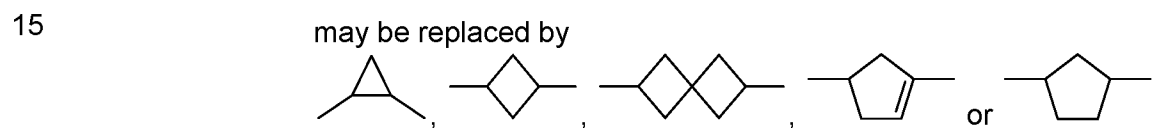
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b) one or more compounds selected from the group of compounds of the formulae I, II and III:

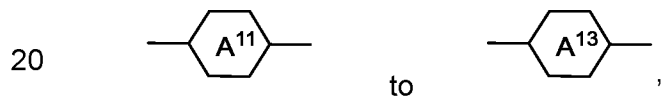


in which

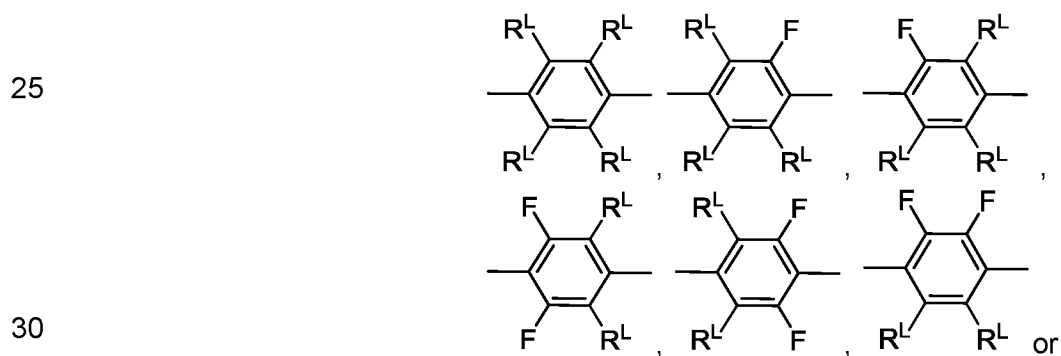
R^1 denotes H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17 C atoms, or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15 C atoms, in which one or more CH_2 -groups may be replaced by



n is 0, 1 or 2,

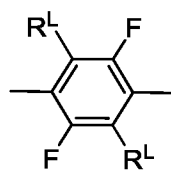


on each occurrence, independently of one another, denote

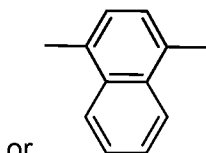


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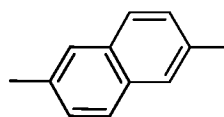
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5 in which R^L , on each occurrence, identically or differently, denotes H or alkyl having 1 to 6 C atoms,

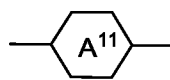


or



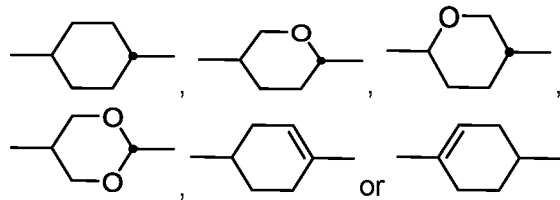
or

10 in which one or more H atoms may be replaced by a group R^L or F,



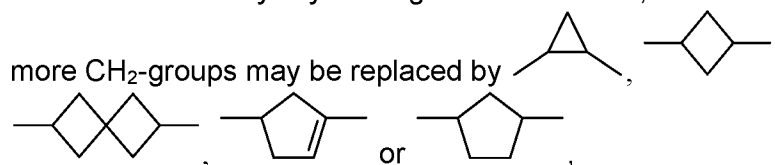
15 and wherein

alternatively denotes



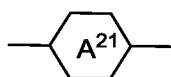
20 R^2

denotes H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17 C atoms, or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15 C atoms, in which one or

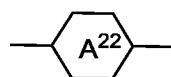


30 Z^{21}

denotes *trans*- $\text{CH}=\text{CH}$ -, *trans*- $\text{CF}=\text{CF}$ - or $-\text{C}\equiv\text{C}-$, and

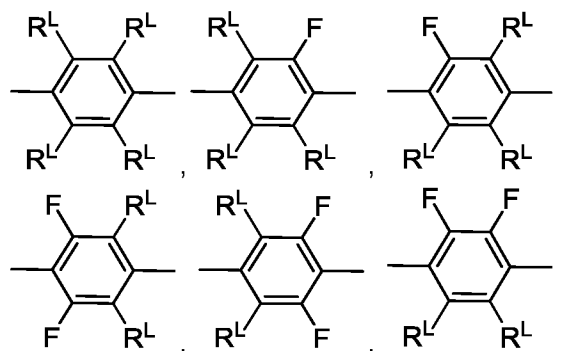


35 and

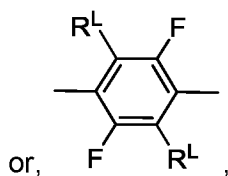


independently of one another, denote

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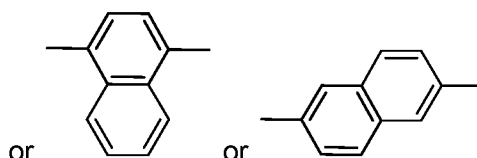


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or, in which R^L , on each occurrence, identically or differently, denotes H or alkyl having 1 to 6 C atoms,

15



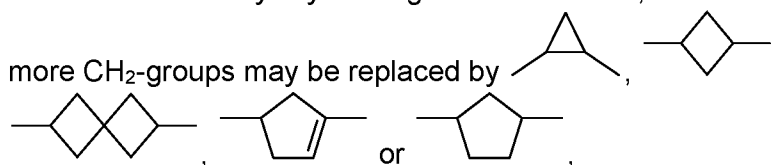
in which one or more H atoms may be replaced by a group R^L or F,

20

 R^3

denotes H, unfluorinated alkyl or unfluorinated alkoxy having 1 to 17 C atoms, or unfluorinated alkenyl, unfluorinated alkenyloxy or unfluorinated alkoxyalkyl having 2 to 15 C atoms, in which one or

25

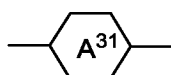


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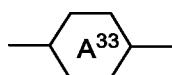
one of Z^{31} and Z^{32}

denotes *trans*-CH=CH-, *trans*-CF=CF- or -C≡C- and the other one, independently thereof, denotes -C≡C-, *trans*-CH=CH-, *trans*-CF=CF- or a single bond, and

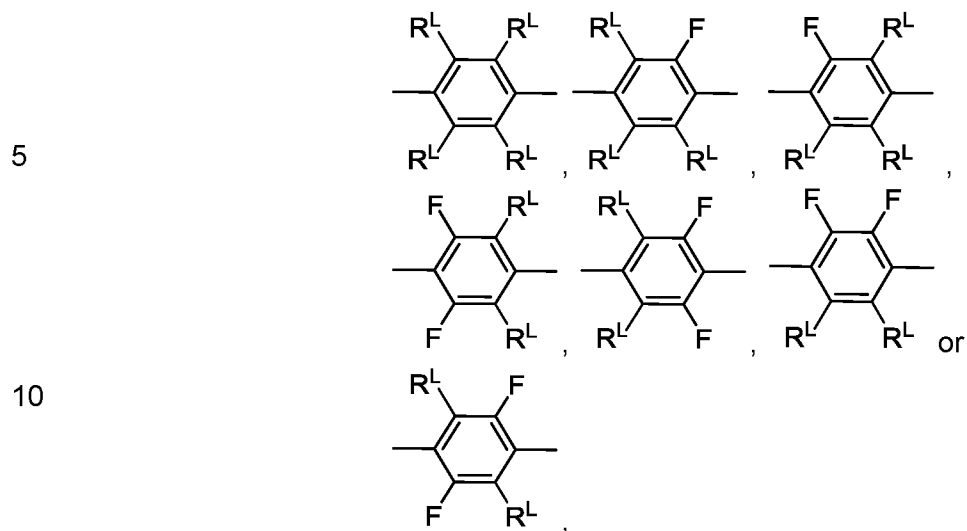
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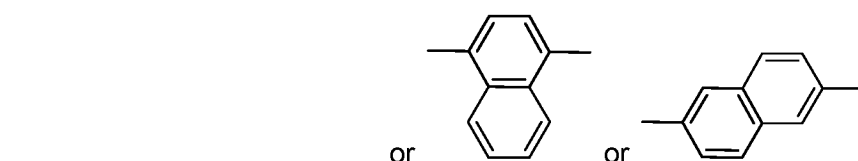
to



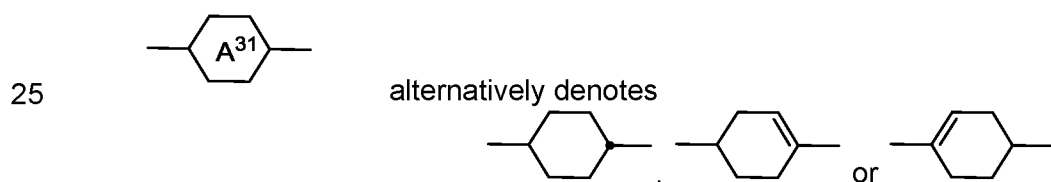
independently of one another, denote



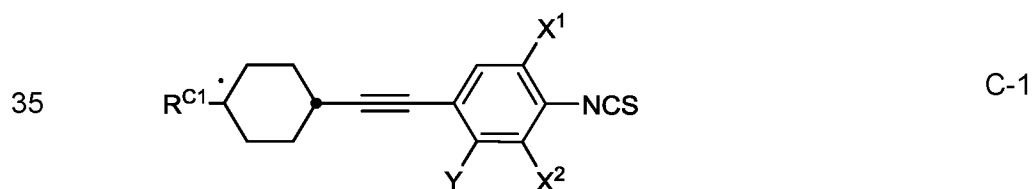
in which R^L , on each occurrence, identically or differently, denotes H or alkyl having 1 to 6 C atoms,

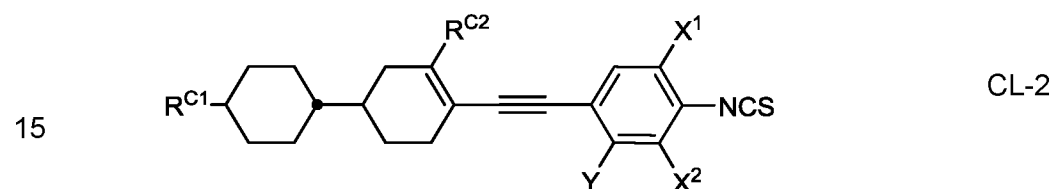
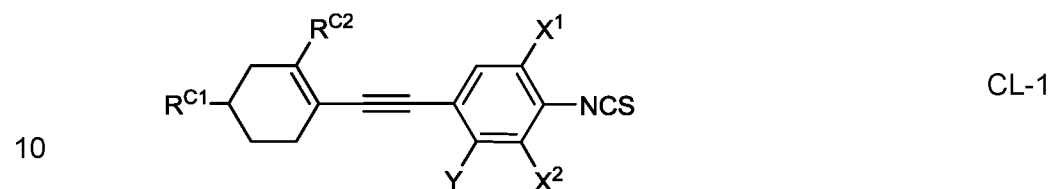
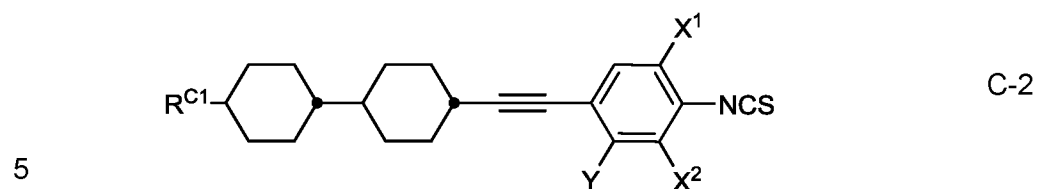


in which one or more H atoms may be replaced by a group R^L or F, and wherein



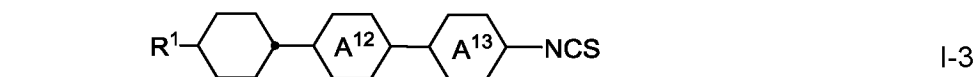
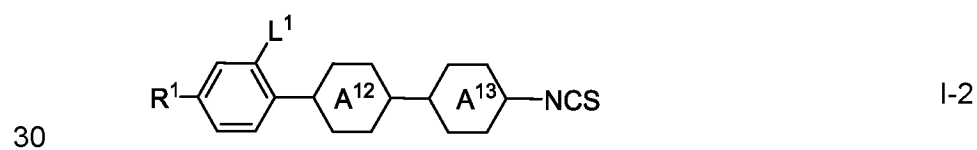
2. The medium according to claim 1, wherein the medium comprises one or more compounds of formula C selected from the group consisting of the compounds of the formulae C-1, C-2 and CL-1 and CL-2

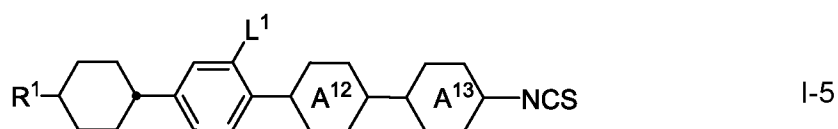
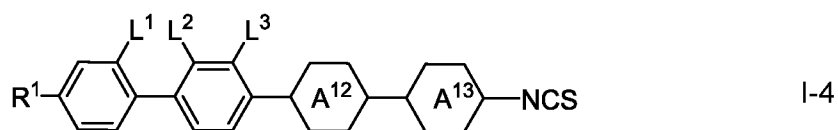




in which the occurring groups have the meanings given in claim 1 for formula C.

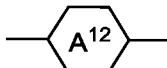
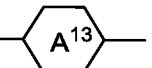
- 20
3. The liquid crystal medium according to claim 1 or 2, wherein the medium comprises one or more compounds selected from the group of compounds of the formulae I-1 to I-5





in which

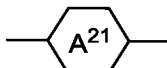
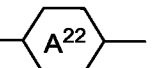
L¹, L² and L³ on each occurrence, identically or differently, denote H or F, and

R¹,  and  have the meanings given for formula I in claim 1.

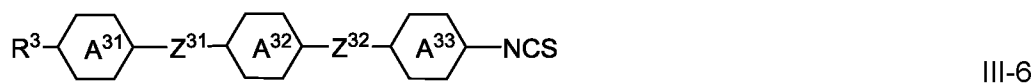
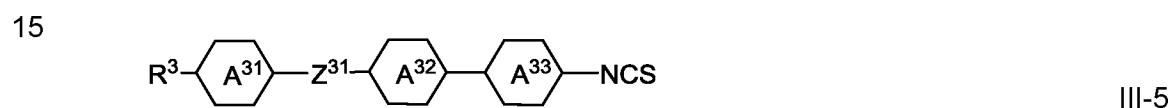
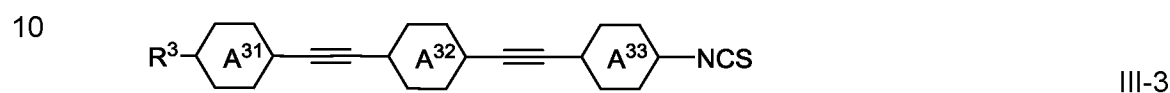
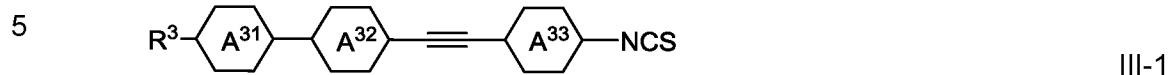
4. The liquid crystal medium according to one or more of claims 1 to 3, wherein the medium comprises one or more compounds selected from the group of compounds of the formulae II-1 to II-3



in which

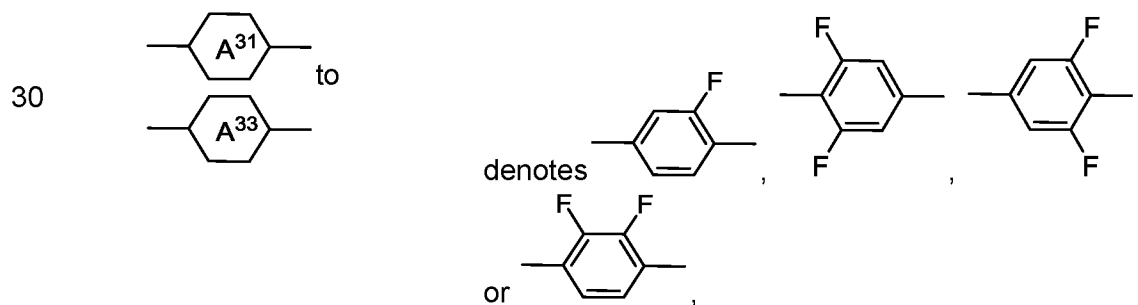
R²,  and  have the meanings given in claim 1 for formula II.

5. The medium according to one or more of claims 1 to 4, wherein the medium comprises one or more compounds of formula III selected from the group consisting of the compounds of the formulae III-1 to III-6



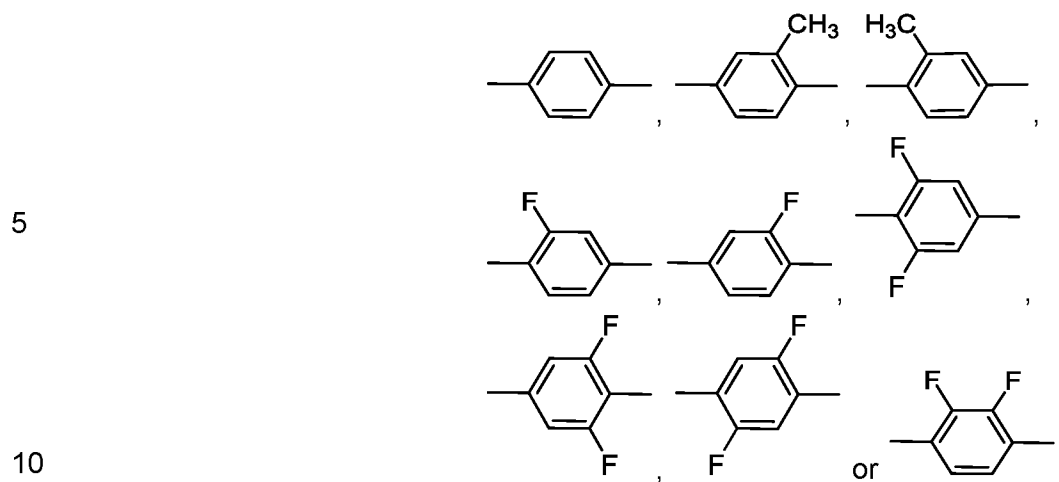
20 in which
 Z^{31} and Z^{32} independently of one another denote *trans*-CH=CH- or *trans*-CF=CF-, preferably *trans*-CH=CH-, and in formula III-6 alternatively one of Z^{31} and Z^{32} may denote -C≡C- and the other groups have the meaning given in claim 1 under formula III,
 25 R^3 denotes unfluorinated alkyl or alkoxy having 1 to 7 C atoms or unfluorinated alkenyl having 2 to 7 C atoms,

and one of

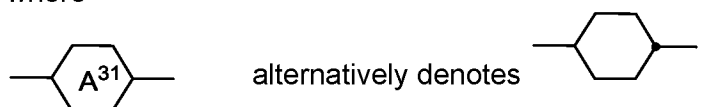


and the others, independently of one another, denote

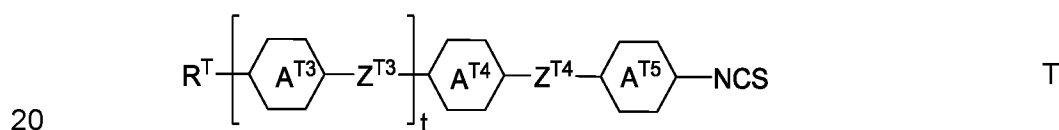
- 167 -



where

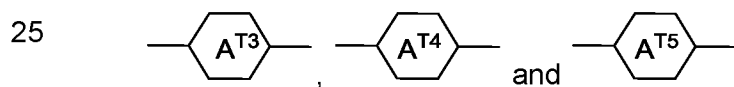


15 6. The medium according to one or more of claims 1 to 5, wherein the medium comprises one or more compounds of formula T

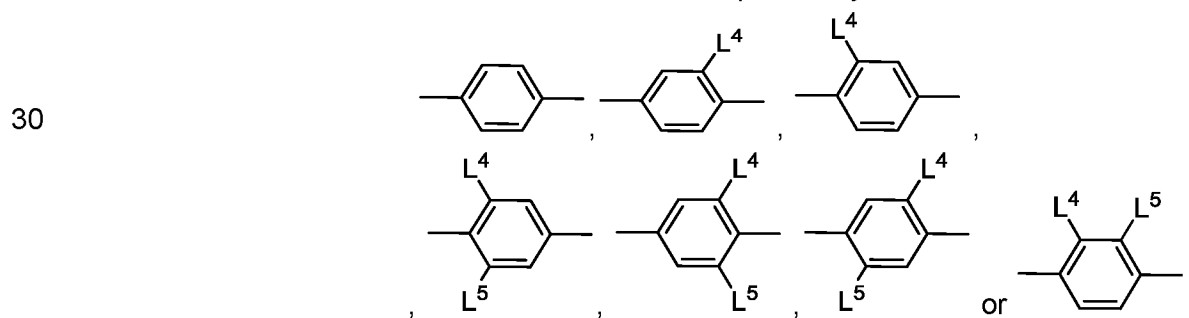


in which

R^T denotes halogen, CN, NCS, R^F , $R^F\text{-O-}$ or $R^F\text{-S-}$, wherein R^F denotes fluorinated alkyl or fluorinated alkenyl having up to 12 C atoms,



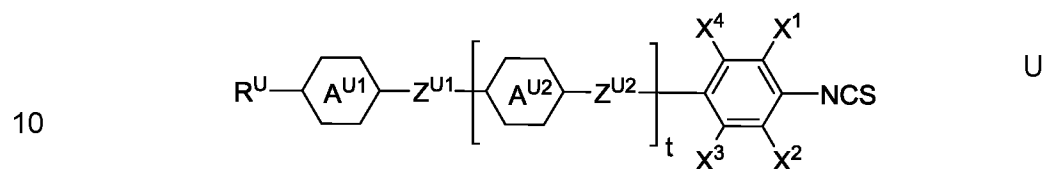
on each occurrence, independently of one another, denote



L^4 and L^5 identically or differently, denote F, Cl or straight-chain or branched or cyclic alkyl or alkenyl each having up to 12 C atoms;

Z^{T3}, Z^{T4} identically or differently, denote $-\text{CH}=\text{CH}-$, $-\text{CF}=\text{CF}-$,
 $-\text{CH}=\text{CF}-$, $-\text{CF}=\text{CH}-$, $-\text{C}\equiv\text{C}-$ or a single bond, and
 t is 0 or 1.

5 7. The medium according to one or more of claims 1 to 6, wherein the medium comprises one or more compounds of formula U



in which

R^U denotes H, alkyl or alkoxy having 1 to 12 C atoms, or alkenyl, alkenyloxy or alkoxyalkyl having 2 to 12 C atoms, in which one or more CH_2 -groups may

15 be replaced by or , or denotes a group R^P ,

R^P denotes halogen, CN, NCS, R^F , $R^F\text{-O-}$ or $R^F\text{-S-}$, wherein

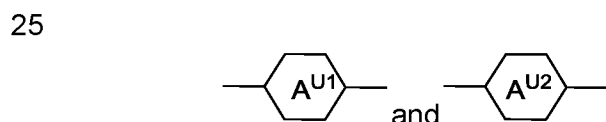
R^F denotes fluorinated alkyl or fluorinated alkenyl having up to 9 C atoms,

20 Z^{U1}, Z^{U2} identically or differently, denote $-\text{CH}=\text{CH}-$, $-\text{CF}=\text{CF}-$, $-\text{CH}=\text{CF}-$,
 $-\text{CF}=\text{CH}-$, $-\text{C}\equiv\text{C}-$ or a single bond,

X^1, X^2 ,

X^3 and X^4 identically or differently, denote Cl or F,

t is 0 or 1, and



denote a radical selected from the following groups:

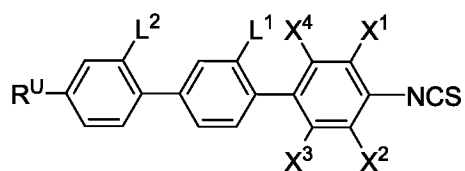
- 30 a) the group consisting of 1,4-phenylene, 1,4-naphthylene, and 2,6-naphthylene, in which one or two CH groups may be replaced by N and in which one or more H atoms may be replaced by L, wherein tetrafluoro-1,4-phenylene is excluded,
- b) the group consisting of trans-1,4-cyclohexylene, 1,4-cyclohexenylenyl, bicyclo[1.1.1]pentane-1,3-diyl, 4,4'-bicyclohexylene, bicyclo[2.2.2]octane-1,4-diyl and spiro[3.3]heptane-2,6-diyl, in which one or more non-adjacent CH_2 groups may be replaced by $-\text{O-}$ and/or $-\text{S-}$ and in which one or more H atoms may be replaced by F, and
- 35

- c) the group consisting of thiophene-2,5-diyl, thieno[3,2-b]thiophene-2,5-diyl, selenophene-2,5-diyl, each of which may also be mono- or polysubstituted by L, wherein

L on each occurrence, identically or differently, denotes F, Cl, CN, SCN, SF₅ or straight-chain or branched, in each case optionally fluorinated, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 12 C atoms.

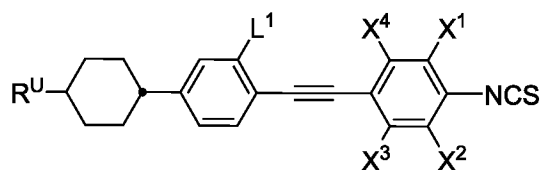
8. The medium according to one or more of claims 1 to 7, wherein the medium comprises one or more compounds selected from the group consisting of the compounds of the formulae U-1 to U-11





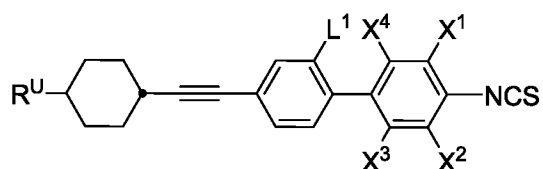
U-6

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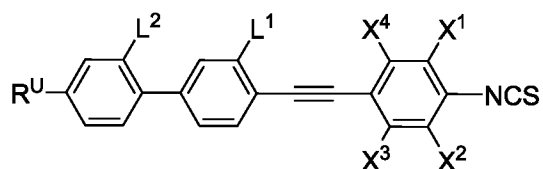
U-7

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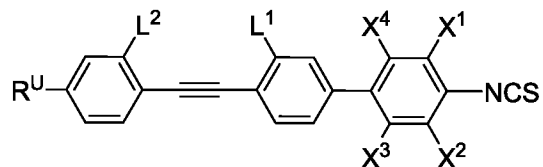
U-8

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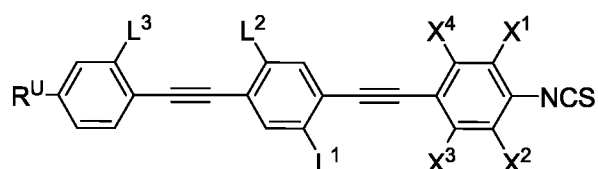
U-9

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U-10

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U-11

in which

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L^1 , L^2 and L^3 identically or differently, denote H, F, Cl, methyl, ethyl, n-propyl, isopropyl, cyclopropyl, cyclobutyl, cyclopentyl or cyclopentenyl, and

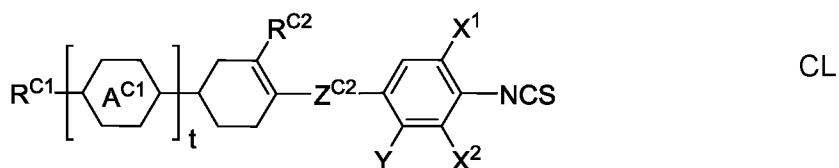
R^U , X^1 , X^2 , X^3 and X^4 have the meanings given in claim 7.

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9. A compound of formula C as defined in claim 1, in which at least one of X^1 and X^2 is different from H.

10. A compound of formula CL

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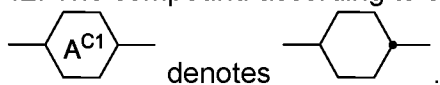
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in which the occurring groups have the meanings defined for formula C in claim 1, and
t is 0 or 1.

15

11. The compound according to claim 10, wherein the group Z^{C2} denotes $-C\equiv C-$.

12. The compound according to claim 10 or 11, wherein t is 1 and the group



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13. The compound according to one or more of claims 10 to 12, wherein the group R^{C2} denotes CH_3 .

14. A component for high-frequency technology, characterised in that it comprises the liquid crystal medium according to one or more of claims 1 to 8.

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15. The component according to claim 14, wherein the component is a liquid-crystal based antenna element, a phase shifter, a tunable filter, a tunable metamaterial structure, a matching network or a varactor.

16. A microwave antenna array, characterised in that it comprises one or more components according to claim 14 or 15.

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2021/073507

A. CLASSIFICATION OF SUBJECT MATTER

INV. C09K19/04 C09K19/30
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, CHEM ABS Data, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	examples 1-5, 7; comparative examples 1-3; claims 1, 3; compounds (2-1), (2-3), (2-4)	4-6, 14-16
A		7,8, 10-13
Y	----- EP 2 982 730 A1 (MERCK PATENT GMBH [DE]) 10 February 2016 (2016-02-10)	4,5, 14-16
A	claims; examples; compounds PTG-n-S, PVG-n-S, PPTU-n-S	7,8, 10-13
Y	----- EP 3 543 313 A1 (MERCK PATENT GMBH [DE]) 25 September 2019 (2019-09-25)	6,14-16
A	claims; examples; compounds PPU-T0-S, LPTU-n-S	7,8, 10-13
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

6 December 2021

Date of mailing of the international search report

10/12/2021

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Authorized officer

Schoenhentz, Jérôme

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/073507

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	WO 2021/037962 A1 (MERCK PATENT GMBH [DE]) 4 March 2021 (2021-03-04) claims; examples; compounds CPU(F,F)-n-S -----	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2021/073507

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			WO 2021037962 A1	04-03-2021
