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(54) ELECTROOPICAL LIQUID CRYSTAL DISPLAY

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(57) **ABSTRACT**

The invention relates to an electrooptical liquid crystal display comprising a reorientation layer for reorientation of the liquid crystals. The field of said reorientation layer has a component parallel to the liquid crystal layer, said component being. crucial for the reorien tation. Said component comprises a liquid-crystaline medium having a positive dielectric anis otropy and contains at least one mesogenic compound of the formula (I), wherein R^1 and L are delined as in claim 1.

ELECTROOPICAL LIQUID CRYSTAL DISPLAY

[0001] The invention relates to an electro-optical liquid-crystal display having a realignment layer for realignment of the liquid crystals whose field has a component parallel to the liquid-crystal layer that is crucial for the realignment, containing a liquid-crystalline medium of positive dielectric anisotropy, where the medium comprises at least one mesogenic compound of the formula I.

[0002] In conventional liquid-crystal displays (TN, STN, OMI or AMD-TN), the electric fields for realignment are generated essentially perpendicular to the liquid-crystal layer.

[0003] International Patent Application WO 91/10936 discloses a liquid-crystal display in which the electric signals are generated in such a way that the electric fields have a significant component parallel to the liquid-crystal layer (IPS, in-plane switching). The principles of operating a display of this type are described, for example, by R. A. Soref in Journal of Applied Physics, Vol. 45, No. 12, pp. 5466-5468 (1974).

[0004] EP 0 588 568, for example, discloses various possibilities for the design of the electrodes and for addressing a display of this type. DE 198 24 137 likewise describes various embodiments of IPS displays of this type.

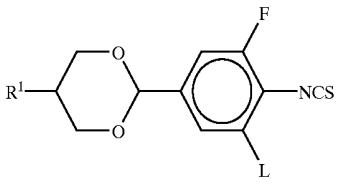
[0005] Liquid-crystalline materials for IPS displays of this type are described, for example, in DE 195 28 104.

[0006] The IPS displays containing the known liquid-crystalline media are characterised by inadequate, long response times and often excessively high operating voltages. There is thus a demand for IPS displays which do not have these disadvantages or only do so to a reduced extent. To this end, in particular liquid-crystalline materials are required which, besides an adequate phase range, low tendency towards crystallisation at low temperatures, low birefringence and adequate electrical resistance, have, in particular, low threshold voltages (V_{10}) and low rotational viscosities (γ_1), which are crucial for the response times.

[0007] This object has, surprisingly, been achieved by the use of liquid-crystalline materials in *mixtures which comprise at least one compound of the formula I.

[0008] The IPS mixtures according to the invention are distinguished by their relatively low rotational viscosity values γ_1 and their low threshold voltage and response time values.

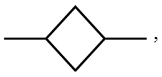
[0009] The invention thus relates to an electr-optical liquid-crystal having a realignment layer for realignment of the liquid crystals whose field has a significant component parallel to the liquid-crystal layer, containinga liquid-crystallinea medium of positive dielectric anisotropy, where the medium comprises at least one compound of the formula I



I

[0010] in which

[0011] R^1 is an alkyl or alkenyl radical having up to 15 carbon atoms which is unsubstituted, mhonosubstituted by CN or CF_3 or at least monosubstituted by halogen and in which, in addition, one or more CH_2 groups in these radicals may each, independently of one an other, be rpaed by -O-, -S-,



,

[0012] -CO-, -CO-O-, -O-CO- or -O-CO-O- in such a way that O atoms are not linked directly to one another,

[0013] and

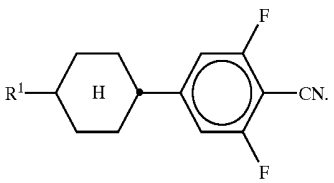
[0014] L is H or F.

[0015] Particular preference is given to compounds of the formula I in which L is F.

[0016] In the compounds of the formula I, R^1 is preferably alkyl or alkenyl having up to 7 carbon atoms. R^1 is preferably ethyl, n-propyl, n-pentyl, vinyl, 1E-alkenyl or 3E-alkenyl.

[0017] The compounds of the formula I have high dielectric anisotropy values and relatively high birefringence and clearing point values. Their use in liquid-crystal mixtures for IPS displays according to the invention facilitates high dielectric anisotropies and low rotational viscosities with retention of high clearing points and favourable birefringence values and effects low threshold voltages and short response times.

[0018] It has been found, in particular, that IPS mixtures according to the invention comprising one or more, preferably one or two, compounds of the formula I have significantly higher dielectric anisotropy values, lower rotational viscosity and threshold voltage values, as well as shorter response times than, for example, analogous mixtures which, instead of the compounds of the formula 1, comprise 3,5-difluoro-4-cyanophenylcyclohexanes of the formula

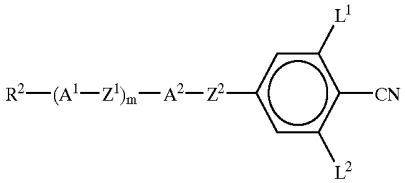


[0019] Some of the compounds of the formula I are disclosed in DE 40 27 869 Al. However, this patent application does not describe IPS displays.

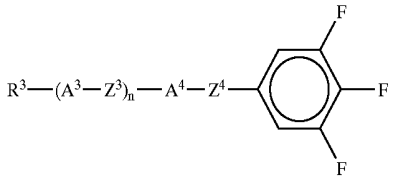
[0020] Preferred embodiments are IPS displays in which

[0021] a) the liquid-crystalline medium additionally comprises one or more compounds of the formula II containing a cyano group

II

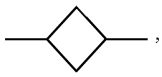


III



[0022] in which

[0023] R^2 is H, an alkyl or alkenyl radical having up to 15 carbon atoms which is unsubstituted, monosubstituted by CN or CF_3 or at least mono-substituted by halogen and. in which,,in addition, one or more CH_2 groups in these radicals may also each, independently of one another, be replaced by -O-, -S-,



[0024] -CO-, -CO-O-,

[0025] -O-CO- or -O-CO-O- in such a way that O atoms are not linked directly to one another,

[0026] A^1 and A^2 are each, independently of one another,

[0027] (a) a trans-1,4-cyclohexylene radical or 1,4-cyclohexenylene radical, in which, in addition, on rmoenn-adjacent CH-$_2$ groups may be replaced by -O- and/or -S-,

[0028] (b) a 1,4-phenylene radical, in which, in addition, one or two CH groups may be replaced by N.

[0029] (c) a radical from the group consisting of 1,4 bicydlo[2.2.2]octylene, piperidine-1,4-diyl, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl and 1,2,3,4-tetrahydronaphthalene-2,6-diyl,

[0030] where the radicals (a), (b) and (c) may be substituted by one or two fluorine atoms,

[0031] Z^1 and Z^2 are each, independently of one another, -CO-O-, -O-CO-, -CH_2O , -OCH_2-, -CH_2CH_2- -CH=CH-, -CHF-; -CHF-CHF-, -CF_2--CF_2-, -OCF_2-, -OCF_2-, -CF_2CF_2- or a single bond, and one or the radicals Z^1 and Z^2 is alternatively -$(CH_2)_4$- or -CH=CH-CH_2CH_2-,

[0032] L^1 and L^2 are each, independently of one another, H or F, and

[0033] m is 0, 1 or 2,

[0034] b) the liquid-crystalline medium comprises one or more compounds of the formula III containing a 3,4,5-trifluorophenyl group

[0035] in which

[0036] R^3 has one of the meanings indicated for R^2 in the formula II,

[0037] A^3 and A^4 each, independently of one another, have one of the meanings indicated for A^1 and A^2 in the formula II,

[0038] Z^3 and Z^4 each, independently of one another, have one of the meanings indicated for Z^1 and Z^2 in the formula II, and

[0039] n is 0, 1or 2,

[0040] c) the liquid-crystalline medium comprises one or more compounds of the formula IV

$$R^4\text{-}(A^5\text{-}Z^5)_o\text{-}A^6\text{-}R^5 \qquad \text{IV}$$

[0041] in which

[0042] R^4 and R^5 each, independently of one another, have one of the meanings indicated for R^2 in the formula II,

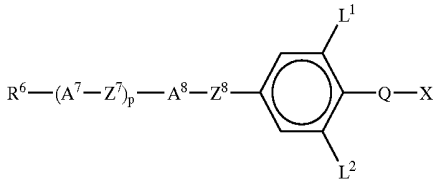
[0043] A^5 and A^6 each, independently of one another, have one of the meanings indicated for A^1 and A^2 in the formula II,

[0044] each Z^5, independently of the others, has one of the meanings indicated for Z^1 and Z^2 in the formula II, and

[0045] o is1, 2 or3

[0046] d) the liquid-crystalline medium additionally comprises one or more compounds of the formula V

V



[0047] in which

[0048] R^6 has one of the meanings indicated for R^2 in the formula II,

[0049] A^7 and A^8 each, independently of one another, have one of the meanings indicated for A^1 and A^2 in the formula II,

[0050] Z^7 and Z^8 each, independently of one another, have one of the meanings: indicated for Z^1 and Z^2 in the formula II,

[0051] L^1 and L^2 are each, independently of one another, H or F,

[0052] Q is a polyfluoroalkylene radical of the formula:

$-(O)_q-(CH_2)_r(CF_2)_s-$,$-(O)_q-(CHF)_r-(CF_2)_s-$ or

$-(O)_q-(CF_2)_r-(CHF)_s-CF_2-$, in which

[0053] q is 0or 1,

[0054] r is 0,1,2,3,4,5 or 6,

[0055] s is 1,2,3 4,5 or 6,

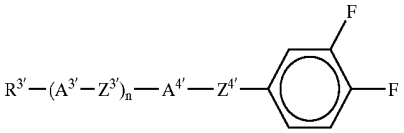
[0056] X is H, F or Cl, and

[0057] p is 0, 1or 2,

[0058] and/or

[0059] e) the liquid-crystalline medium additionally comprises one or more compounds of the formula III'

III'



[0060] in which

[0061] $R^{3'}$has one of the meanings indicated for R^2 in the formula II,

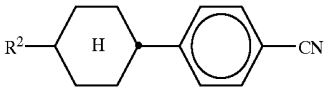
[0062] $A^{3'}$ and $A^{4'}$ each, independently of one another, have one of the meanings indicated for A^1 and A^2 in the formula II,

[0063] $Z^{3'}$ and $Z^{4'}$ each, independently of one another, have one of the meanings indicated for Z^1 and Z^2in the formula II, and

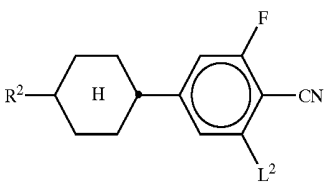
[0064] n is 0, or 2.

[0065] The compounds of the formula II are preferably selected from the group comprising the formulae IIa to IIq:

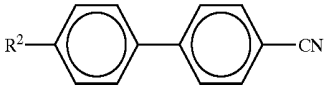
IIa



IIb



IIc



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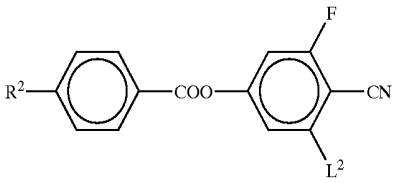
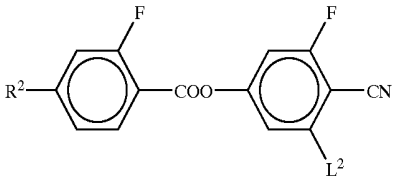
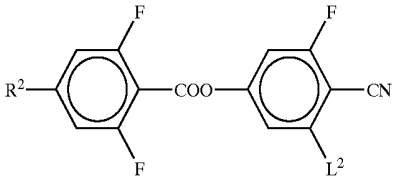
IId



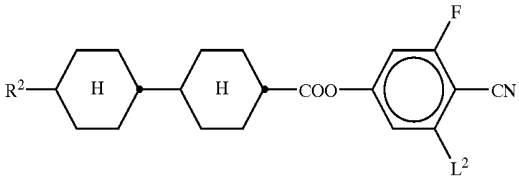
IIe



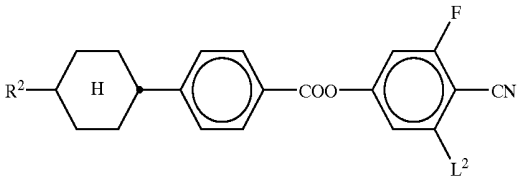
IIf



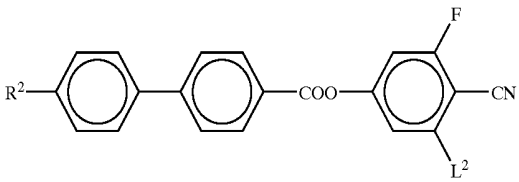
IIg



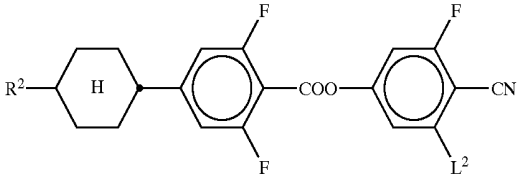
IIh



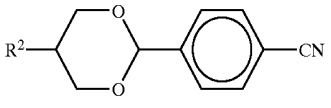
IIi



IIj



IIk



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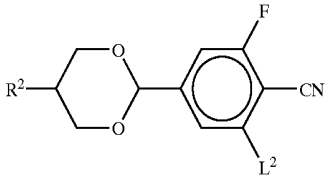
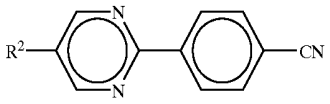
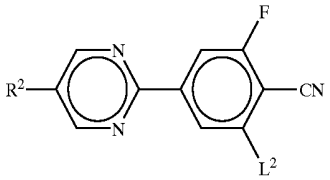
Ill



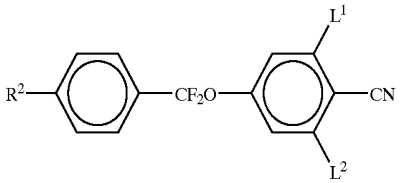
IIm



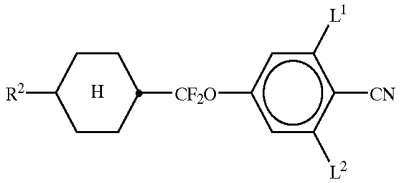
IIn



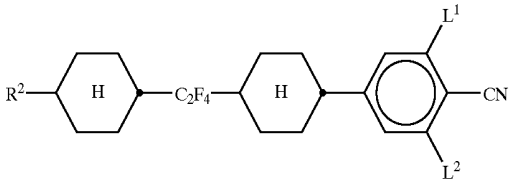
IIo



IIp



IIq



[0066] in which R^2 is as defined in the formula II, and L^1 and/or L^2 is H or F.

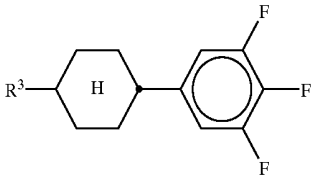
[0067] In the compounds of the formulae IIb, IIe, IIk, IIn and IIp, L^2 is particularly preferably F. In the compounds of the formulae IId, IIg, IIh and IIi, L^2 is particularly perferably H. In the compounds of the formula IIo and/or llp, L^1 and L^2 are preferably fluorine.

[0068] The liquid-crystalline medium particularly preferably comprises one or more compounds selected from the group consisting of the compounds of the formulae IIa, IIb, IIc, IId, IIh, IIk and IIp.

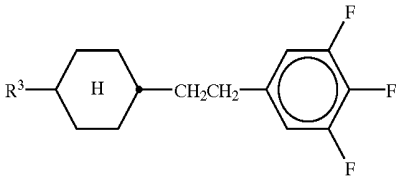
[0069] In a further preferred embodiment, the liquid-crystalline medium comprises at least one heterocyclic compound selected from the group comprising the formulae IIm, IIn, IIb and IIp.

[0070] The compounds of the formula III are preferably selected from the group comprising the formulae IIa to IIIp and III"a,

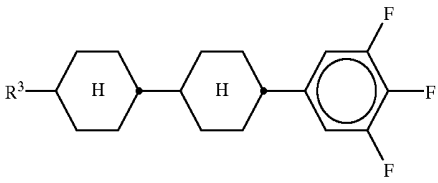
IIIa



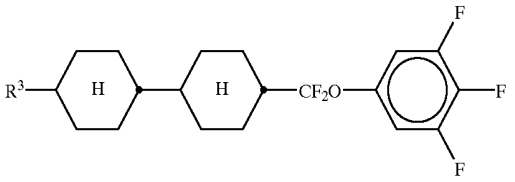
IIIb



IIIc



IIId



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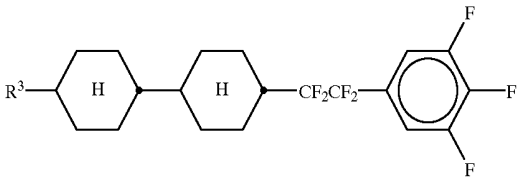
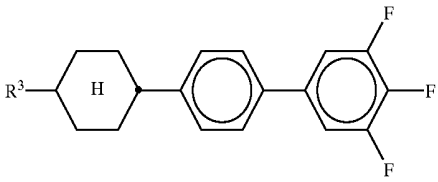
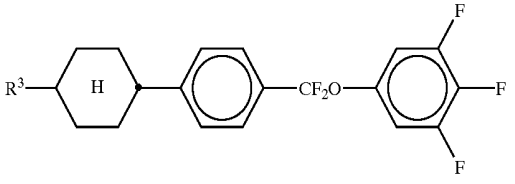


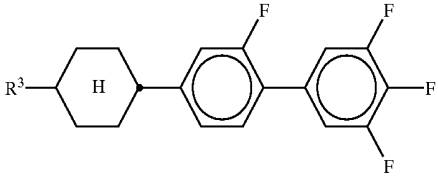
IIIf



IIIg



IIIh



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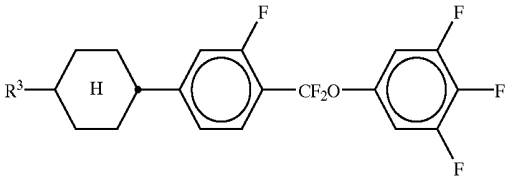
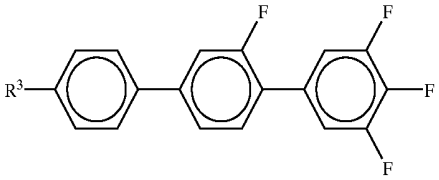
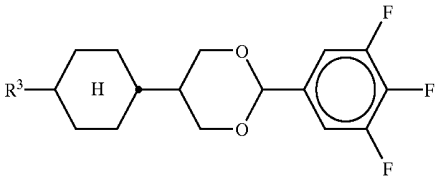
IIIi



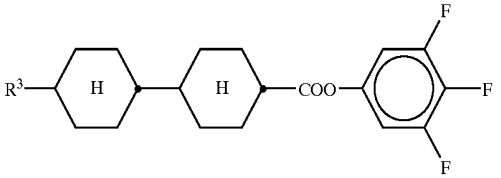
IIIj



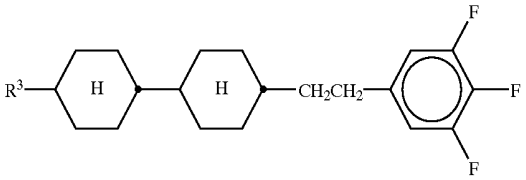
IIIk



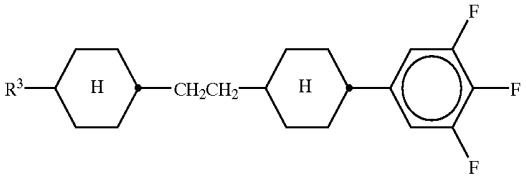
IIIl



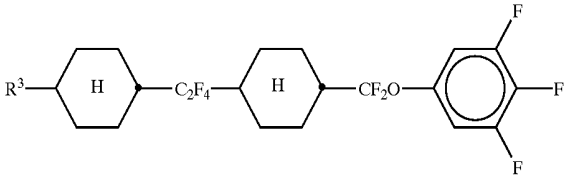
IIIm



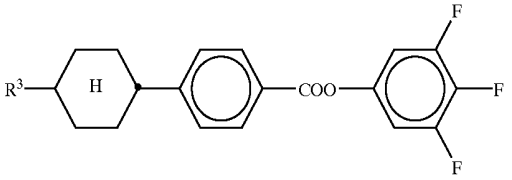
IIIn



IIIo



IIIp



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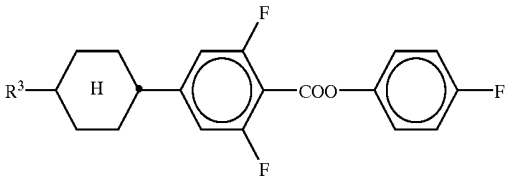
III'a

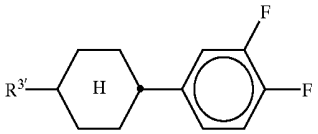


[0071] in which R^3 is as defined in the formula III.

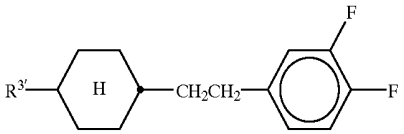
[0072] Theliquid-crystal display particularly preferably contains a liquid-crystalline medium comprising one or more compounds selected from the group comprising the formulae IIIc, IIId, IIIe, IIIf, IIIg, IIIh, IIIi, IIIk and IIIn.

[0073] The compounds of the formula III' are preferably selected from the group comprising the formulae III'a to III'l:

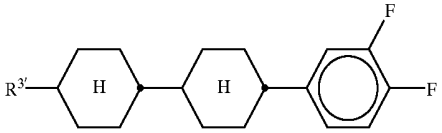
III'a



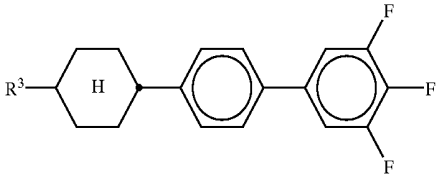
III'b



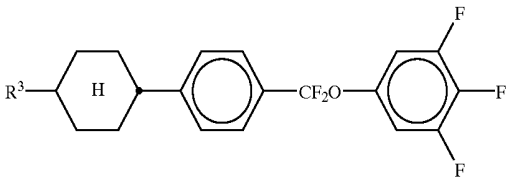
III'c



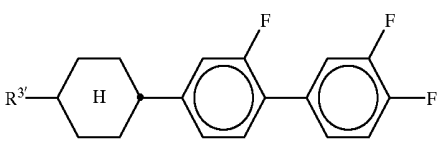
III'd



III'e



III'f



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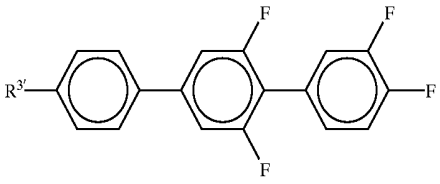
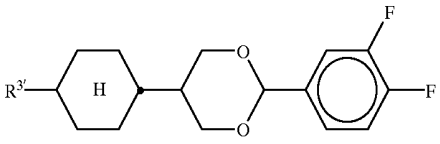
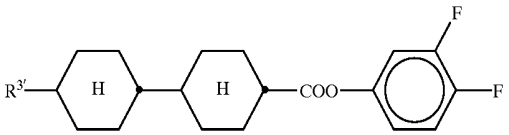
III'g



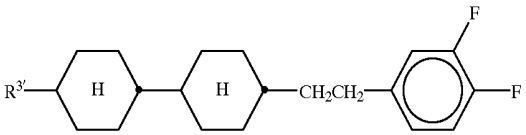
III'h



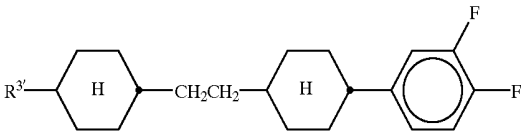
III'i



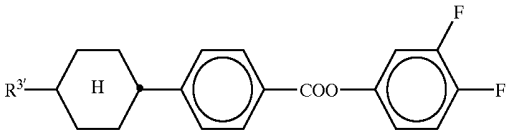
III'j



III'k



III'l

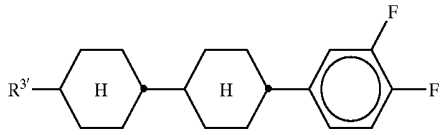


[0074] in which

[0075] $R^{3'}$ is as defined above under the formula III'.

[0076] As an alternative to or in addition to one or more compound(s) of the formula IIIc, the liquid-crystalline medium may comprise one or more compounds of the formula III'a,

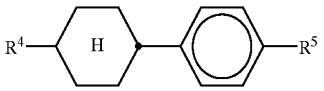
III'a



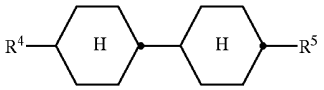
[0077] in which $R^{3'}$ is as defined above under the formula III'.

[0078] The compounds of the formula IV are preferably selected from the group comprising the formulae IVa to IVn:

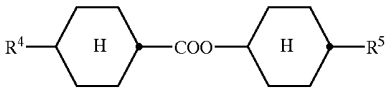
IVa



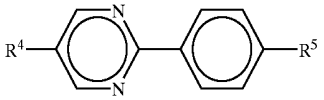
IVb



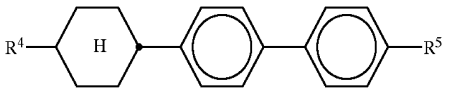
IVc



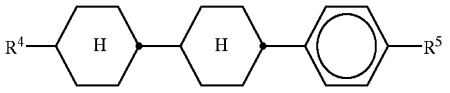
IVd



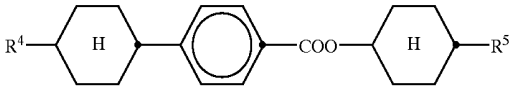
IVe



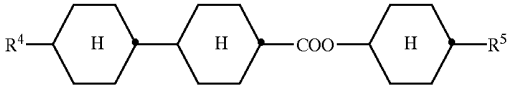
IVf



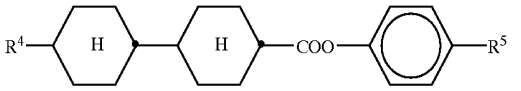
IVg



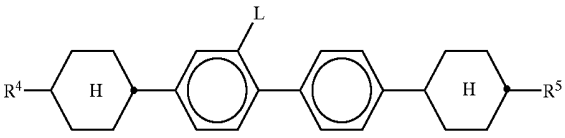
IVh



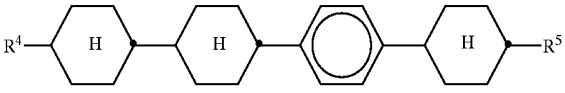
IVi



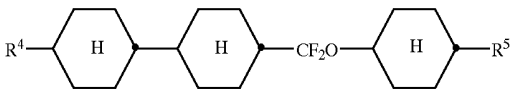
IVj



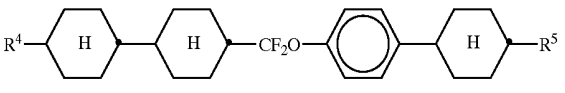
IVk



IVl



IVm



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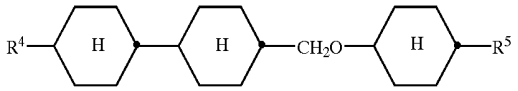
IVn



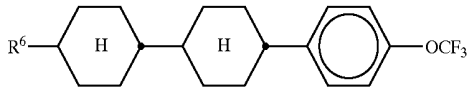
[0079] in which R^4 and R^5 are as defined in the formula IV, and L is H or F.

[0080] In the compounds of the formula IV_j, L is particularly preferably F.

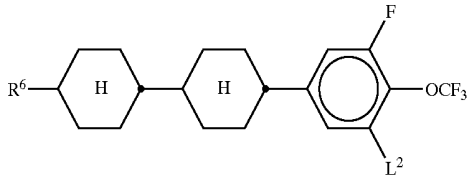
[0081] The liquid-crystal display particularly preferably contains a liquid-crystalline medium comprising one or more compounds selected from the group consisting of the compounds of the formulae IVb, IVe, IVk and IVm.

[0082] The compounds of the formula V are preferably selected from the group comprising the formulae Va to Vm:

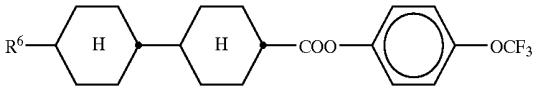
Va



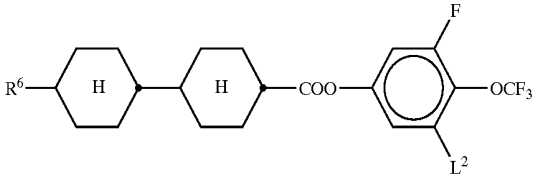
Vb



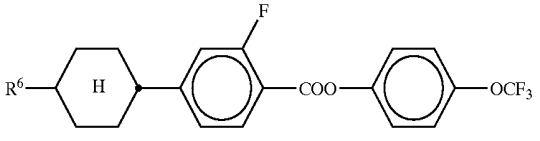
Vc



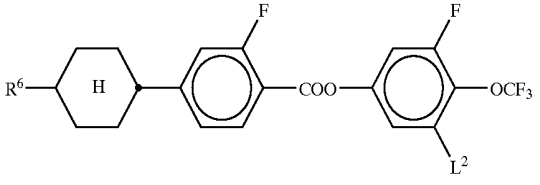
Vd



Ve



Vf



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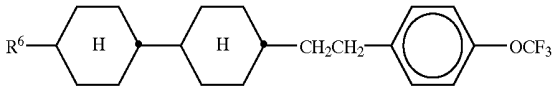
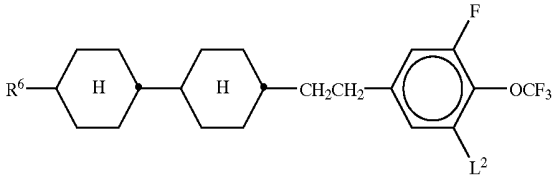
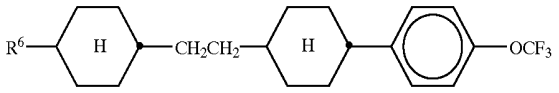
Vg



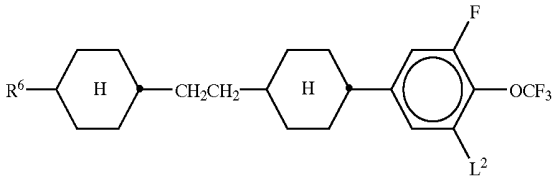
Vh



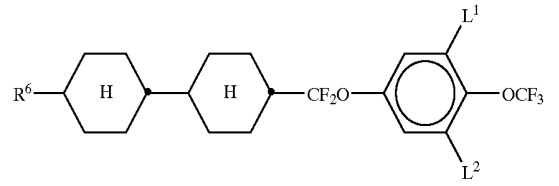
Vi



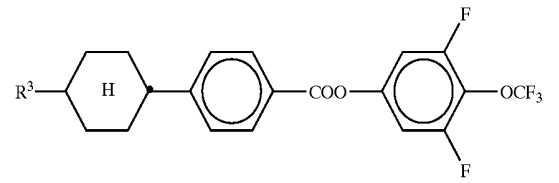
Vj



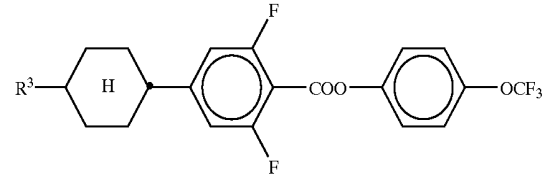
Vk



Vl



Vm



[0083] in which R^6 is as defined in the formula V, and L^2 is H or F.

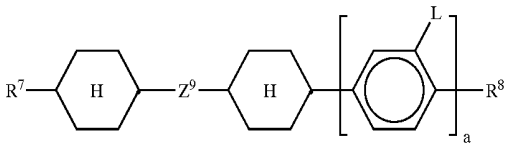
[0084] In the compounds of the formula Vd, L^2 is particularly preferably F.

[0085] The liquid-crystalline medium particularly preferably comprises one or more compounds selected from the group consisting of the compounds of the formulae Va, Vc, Vd, Ve and Vf.

[0086] In a preferred embodiment, the liquid-crystalline medium comprises one or two compounds of the formula I and one or two compounds of the formula Ve.

[0087] In a further preferred embodiment, the liquid-crystalline medium comprises one or more alkenyl compounds of the formula VI

VI



[0088] in which

[0089] R^7 is an alkenyl group having 2 to 7 carbon atoms,

[0090] Z^9 is -CH=CH-, $-CH_2CH_2-$ or a single bond,

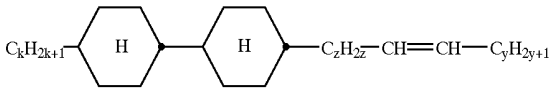
[0091] L is H or,F,

[0092] a is 0 or 1 and

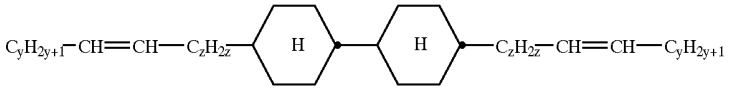
[0093] R^8 is an alkyl, alkoxy or alkenyl group having up to 12 carbon atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced by -CO-, -OCO- or -COO-, or, if a is 1, R^8 may alternatively be F.

[0094] The compounds of the formula VI are preferably selected from the group comprising the formulae VIa to VIf:

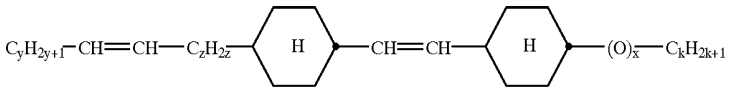
VIa



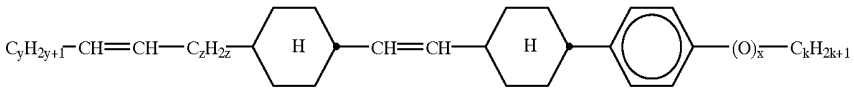
VIb



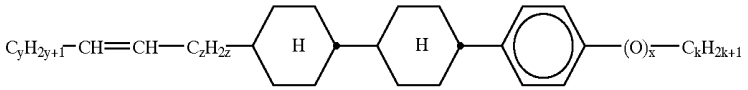
VIc



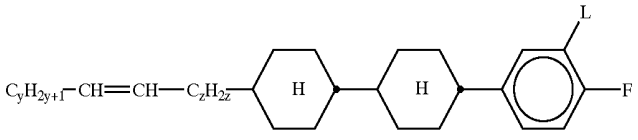
VId



VIe



VIf



[0095] in which

[0096] k is 1, 2, 3, 4or 5,

[0097] y and z are each, independently of one another, 0, 1, 2 or 3, where y+z is $<\leqq 5$, and

[0098] x is 0 or 1.

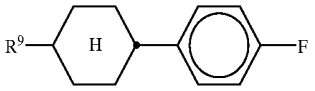
[0099] In the compounds of the formula VIf, L is preferably F.

[0100] The mixtures according to the invention preferably comprise one or two.compounds of the formula IVb and one or two compounds of the formula VIa.

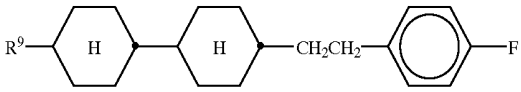
[0101] Further preferred embodiments are the following mixtures for IPS displays:

[0102] The medium additionally comprises one or more compounds containing a 4-fluoro-phenyl group, selected from the group consisting of the formulae VIIa to VIIc:

VIIa



VIIb



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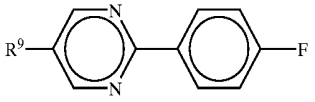
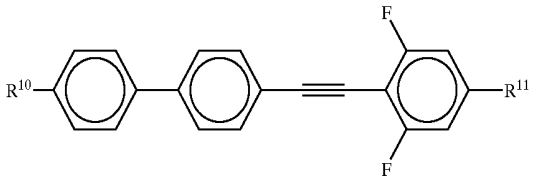
VIIc



[0103] in which R^9 has the one of the meanings indicated for R^3 in the formula III, and in particular is alkyl having 1 to 7 carbon atoms;

[0104] The medium additionally comprises one or more compounds of the formula VIII

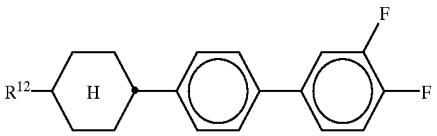
VIII



[0105] in which R^{10} and R^{11} are each, independently of one another, straight-chain alkyl or alkoxy; preferably alkyl, having 1 to 7 carbon atoms;

[0106] The medium additionally comprises one or more compounds of the formula IX

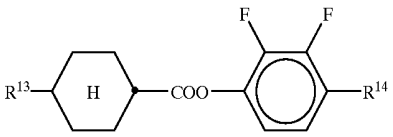
IX



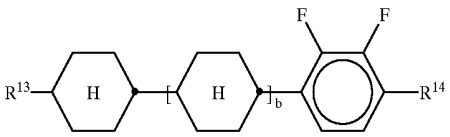
[0107] in which R^{12} has one of the meanings indicated for R^1.

[0108] The medium additionally comprises one or more compounds of negative dielectric anisotropy selected from the group consisting of the formulae X, XI and XII:

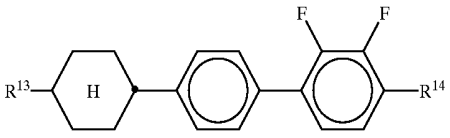
X



XI



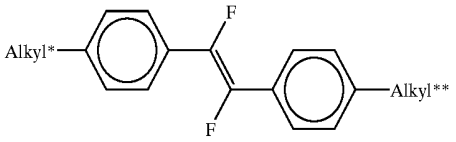
XII



[0109] in which R^{13} and R^{14} each, independently of one another, have one of the meanings indicated for R^1, and b is 0 or 1. R^{13} and R^{14} are preferably straight-chain alkyl or alkoxy having 1 to 7 carbon atoms, furthermore alkenyl or alkenyloxy having up to 7 carbon atoms. In particular, R^{13} is preferably alkyl and R^{14} is preferably alkoxy.

[0110] The medium additionally comprises one or more difluorostilbenes of the formula XIII,

XIII



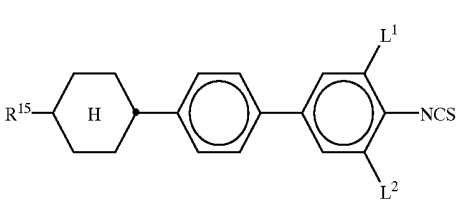
[0111] in which

[0112] Alkyl* and Alkyl** are a straight-chain alkyl radical having 1 to 6 carbon atoms, preferably 2 to 5 carbon atoms.

[0113] The% proportion of the difluorostilbenes in the mixture according to the invention is from 0 to 30% by weight, preferably from 0 to 20% by weight, in particular from 0 to 15% by weight.

[0114] The medium additionally comprises one or more compounds of the formula XIV

XIV



[0115] in which

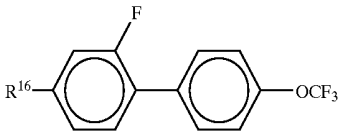
[0116] R^{15} is as defined for R^1 , and

[0117] L^1 and L^2 are each, independently of one another, H or F.

[0118] The proportion of the compounds of the formula XIV in the mixture according to the invention is from 0 to 30% by weight, preferably from 0 to 20% by weight, in particular from 0 to 15% by weight.

[0119] The medium additionally comprises one or more compounds of the formula XV

XV



[0120] in which

[0121] R^{16} is as defined for R^1, preferably is straight-chain alkyl or alkoxy having 1 to 3 carbon atoms.

[0122] The% proportion of the biphenyls in the mixture according to the invention is from 0 to 30% by weight, preferably from 0 to 20% by weight, in particular from 0 to 15% by weight.

[0123] Preference is given to displays containing liquid-crystal mixtures comprising

[0124] one or more cyano compounds selected from the group comprising the formulae IIa, IIb, IId, IIg and IIk, in particular compounds of the formulae IIb, IIg and IIk in which L^2 is F, and compounds of the formula III in which L^2 is H,

[0125] one or more dioxane compounds selected from the group comprising the formulae IIk and III, in particular of the formula III in which L^2 s F,

[0126] one or more 3,4,5-trifluorophenyl compounds selected from the group comprising the formulae IIIc, IIIf, IIIg and IIIh,

[0127] one or more compounds selected from the group comprising the formulae IVb, IVh, IVk and IVm. R^4 and R^5 are preferably straight-chain alkyl having 1 to 7 carbon atoms.

[0128] In the compounds of the formula IVb, R^5 is preferably alkoxy having 1 to 5 carbon atoms. In the compounds of the formula IVj, L is preferably F,

[0129] one or more compounds selected from the group comprising the formulae Va, Vb, Vd and Ve,

[0130] one or more alkenyl compounds selected from the group comprising the formulae VIa, VIb, VIe and VIf,

[0131] in the compounds of the formula VIa, y and z are particularly preferably 0 or 1,

[0132] in the compounds of the formula VIb, z is preferably 0,

[0133] in the compounds of the formula VIe, k is preferably 0,

[0134] in the compounds of the formula VIf, L is preferably F, and y and z are preferably 0.

[0135] Preference is furthermore given to a liquid-crystal display according to the invention in which the pixels are addressed by means of an active matrix.

[0136] The invention furthermore relates to a liquid-crystalline medium of positive dielectric an isotropy comprising at least one compound of the formula 1, at least one compound * selected from the group consisting of the compounds of the formulae IIa to IIp, IIIa to IIIo and Va to Vk, at least one compound selected from the group consisting of the com pounds of the formulae VIa to VIf, and, if desired, one or more compounds selected from the group consisting of the com pounds of the formulae IVa to Ivn.

[0137] Particular preference is given to mixtures which comprise

from 2 to 40% by weight,	preferably from 3 to 30% by weight, particularly preferably from 3 to 25% by weight, of at least one compound of the formula I,
from 15 to 85% by weight,	preferably from 20 to 65% by weight, of at least one compound selected from the group consisting of the compounds of the formulae II and III,

-continued

from 0 to 60% by weight,	preferably from 5 to 45% by weight, of at least one compound of the formula IV,
from 0 to 40% by weight,	preferably from 5 to 35% by weight, particularly preferably from 10 to 25% by weight, of at least one compound of the formula V,
from 0 to 55% by weight,	preferably from 5 to 45% by weight, of at least one compound of the formula VI.

[0138] The liquid-crystalline media used in accordance with the invention generally have a birefringence (Δn) of <0.14, preferably in the range from 0.06 to 0.13, in particular in the range from 0.09 to 0.12; with clearing points of from 60 to 95° C., in particular from 65 to 85° C.

[0139] The flow viscosity v_{20} (at 20° C.) of the mixtures used in accordance with the invention is generally less than 30 $mm^2 \cdot s^{-1}$, in particular between 15 and 25 $mm^2 \cdot s^{-1}$. The specific resistance of the materials according to the invention is generally, at 20° C., from 5×10^{10} to 5×10^{14} $\Omega \cdot cm$, the values are particularly preferably from 5×10^{11} to 5×10^{13} $\Omega \cdot cm$. The rotational viscosity γ_1 of the mixtures according to the invention is, at 20° C., preferably less than 80 mPa·s, in particular less than 65 mPa·s.

[0140] The clearing point of the media used in accordance with the invention is greater than 60° C., preferably greater than 65° C. and particularly preferably 70° C. or greater. In particular, the clearing point is in the range from 60° C. to 85° C.

[0141] The shelf life in test cells, determined as described below, is 1000 hours or more at −30° C., preferably 500 hours or more at −40° C. and very particularly preferably 1000 hours or more at −40° C.

[0142] The media used in accordance with the invention consist of from 5 to 30 compounds, preferably of from 6 to 20 compounds and particularly preferably of from 7 to 16 compounds. The mixtures according to the invention preferably comprise one or two compounds of the formula I.

[0143] It has been found that even a relatively low proportion of compounds of the formula I in a mixture with conventional liquid-crystal materials, but in particular with one or more compounds selected from the group consisting of the compounds of the formulae IIa to IIp and/or from the group consisting of the compounds of the formulae IVa to IVn, results in a significant lowering of the threshold voltage, in very low rotational viscosity values γ_1 and in fast response times, with, in particular, broad nematic phases with low smectic-nematic transition temperatures being observed. The compounds of the formulae I to VI are colourless, stable and readily miscible with one another and with other liquid-crystal materials.

[0144] The term "alkyl" covers straight-chain and branched alkyl groups having 1-7 carbon atoms, in particular the straight-chain groups methyl, ethyl, propyl, butyl, pentyl, hexyl and heptyl. Groups having 2-5 carbon atoms are preferred.

[0145] The term "alkenyl" covers straight-chain and branched alkenyl groups having 2-7 carbon atoms, in particular the straight-chain groups. Particularly preferred alkenyl groups are

[0146] C_2-C_7-1E-alkenyl, C_4-C_7-3E-alkenyl, C_5-C_7-4-alkenyl, C_6-C_7-5-alkenyl and C_7-6-alkenyl, in particular C_2-C_7-1 E-alkenyl, C_4-C_7-3E-alkenyl and C_5-C_7-4-alkenyl. Examples of very particularly preferred alkenyl groups are vinyl, 1 E-propenyl, 1 E-butenyl, 1 E-pentenyl, 1IE-hexenyl, 1 E-heptenyl, 3E-butenyl, 3E-pentenyl, 3E-hexenyl, 3E-heptenyl, 4-pentenyl, 4Z-hexenyl, 4E-hexenyl, 4Z-heptenyl, 5-hexenyl, 6-heptenyl and the like. Groups having up to 5 carbon atoms are preferred.

[0147] The, term "fluoroalkyl" preferably covers straight-chain groups having a terminal fluorine, i.e. fluoromethyl, 2-luoroethyl, 3-fluoropropyl, 4-fluorobutyl, 5-fluoropentyl, 6-fluorohexyl and 7-fluoroheptyl. However, other positions of the fluorine are not excluded.

[0148] The term "alkoxyalkyl" preferably covers straight-chain radical s of the formula C_nH_{2n+1}-O-$(CH_2)_m$, in which n and m are each, independently of one another, from 1 to 6. Preferably, m=1 and n is from 1 to 4.

[0149] Through a suitable choice of the meanings of R^1 to R^{14}, the addressing times, the threshold voltage, the steepness of the transmission characteristic lines, etc., can be modified inthe desired manner. For example, 1 E-alkenyl radicals, 3E-alkenyl radicals 2E-alkenyloxy radicals and the like generally result in shorter addressing times, improved nematic tendencies and a higher ratio of the elastic constants k_{33} (bend) and k_{11} (splay) compared with alkyl and alkoxy radicals. 4-alkenyl radicals, 3-alkenyl radicals and the like generally give lower threshold voltages and smaller values of k_{33}/k_{11} compared with alkyl and alkoxy radicals.

[0150] The optimum mixing ratio of the compounds of the formulae I-VI depends substantially on the desired properties, on the choice of the components of the formulae I, II, III, IV, V and/or VI and on the choice of any further components present. Suitable mixing ratios within the range indicated above can easily be determined from case to case.

[0151] The total amount of compounds of the formulae I to VI in the mixtures according to the invention is not crucial. The mixtures preferably chain of 50-90% a weight of compounds of the formulae I to VI. The mixtures may also comprise one or more further components in order to optimise various properties. However, the observed effect, particularly on the low-temperature stability, is generally greater the higher the total concentration of compounds of the formulae I to VI.

[0152] The liquid-crystalline media according to the invention preferably comprise from 2 to 40, in particular from 4 to 30, compounds as further constituents besides one or more compounds of the formula 1. These media very particularly preferably comprise from 7 to 25 compounds besides one or more compounds of the formula I. These further constituents are preferably selected from nematic or nematogenic (monotropic or isotropic) substances, in particular substances from the classes of the azoxybenzenes, benzylideneanilines, biphenyls, terphenyls, phenyl or cyclohexyl benzoates, phenyl or cyclohexyl esters of cyclohexane-carboxylic acid, phenyl or cyclohexyl esters of cyclohexylbenzoic acid, phenyl or cyclohexyl * * t esters of cyclohexylcyclohexanecarboxylic acid, cyclohexylphenyl esters of benzoic acid, of, cyclohexanecarboxylic acid or of cyclohexylcyclohexanecarboxylic acid, phenylcyclohexanes, * : ;cyclohexylbiphenyls, phenylcyclohexylcyclohexanes, cyclohexylcyclohexanes, cyclohexyl-cyclohexylcyclohexenes, 1,4-bis-cyclohexylbenzenes, 4,4'-bis-cyclohexylbiphenyls, phenyl- or cyclohexylpyrimidines, phenyl- or cyclohexylpyridines, phenyl- or cyclohexyldioxanes, phenyl- or cyclohexyl-1,3-dithianes, 1,2-diphenylethanes, 1,2-dicyclohexylethanes, 1-phenyl-2-cyclo-hexylethanes, 1-cyclohexyl-2-(4-phenylcyclohexyl)ethanes, 1-cyclohexyl-2-biphenylylethanes, 1-phenyl-2-cyclohexyl-lphenylethanes, optionally halogenated stilbenes, benzyl phenyl ethers, tolans and substituted cinnarnic acids. The 1,4-phenylene groups in these compounds may also be fluorinated.

[0153] The most important compounds suitable as further constituents of media according to the invention can be characterised by the formulae 1, 2, 3, 4 and 5:

R'—L—E—R"	1
R'—L—COO—E—R"	2
R'—L—OOC—E—R"	3
R'—L—CH_2CH_2—E—R"	4
R'—L—C≡C—E—R"	5

[0154] In the formulae 1, 2, 3, 4 and 5, L and E, which may be identical or different, are each, independently of one another, a bivalent radical from the group formed by -Phe-, -Cyc-, -Phe-Phe-, -Phe-Cyc-, -Cyc-Cyc-, -Pyr-, -Dio-, -G-Phe- and -G-Cyc- and their mirror images, where Phe is unsubstituted or fluorine-substituted 1,4-phenylene, Cyc is trans-1 ,4-cyclo-hexylene or 1,4-cyclohexenylene, Pyr is pyrimidine-2,5-diyl or pyridine-2,5-diyl, Dio is 1,3-dioxane-2,5-diyl, and G is 2-(trans-1,4-cyclohexyl)ethyl, pyrimidine-2,5-diyl, pyridine-2,5-diyl or 1,3-dioxane-2,5-diyl.

[0155] One of the radicals L and E is preferably Cyc, Phe or Pyr. E is preferably Cyc, Phe or Phe-Cyc. The media according to the invention preferably comprise one or more components selected from the compounds of the formulae 1, 2, 3, 4 and 5 in which L and E are selected from the group consisting of Cyc, Phe and Pyr and simultaneously one or more components selected from the compounds of the formulae 1, 2, 3, 4 and 5 in which one of the radicals L and E is selected from the group consisting of Cyc, Phe and Pyr and the other radical is selected from the group consisting of -Phe-Phe-, -Phe-Cyc-, -Cyc-Cyc-, -G-Phe- and -G-Cyc-, and optionally one or more components selected from the compounds of the formulae 1, 2, 3, 4 and 5 in which the radicals L and E are selected from the group consisting of -Phe-Cyc-, -Cyc-Cyc-, -G-Phe- and -G-Cyc-.

[0156] In a smaller sub-group of the compounds of the formulae 1, 2, 3, 4 and 5, R' and R" are each, independently of one another, alkyl, alkenyl, alkoxy, alkoxyalkyl, alkenyloxy or alkanoyloxy having up to 8 carbon atoms. This smaller sub-group is called group A below, and the compounds are referred to by the sub-formulae 1 a, 2a, 3a, 4a and 5a. In most of these compounds, R' and R" are different from one another, one of these radicals usually being alkyl, alkenyl, alkoxy or alkoxyalkyl.

[0157] In another smaller sub-group of the compounds of the formulae 1, 2, 3, 4 and 5, which is known as group B, R" is -F, -Cl, -NCS or $-(O)_iCH_{3-(k+l)}F_kCl_I$, where i is 0 or 1, and k+l is 1, 2 or 3; the compounds in which R"has this

meaning are referred to by the sub-formulae 1b, 2b, 3b, 4b and 5b. Particular preference is given to those compounds of the sub-formulae 1 b, 2b, 3b, 4b and 5b in which R" is -F, -Cl, -NCS, $-CF_3$, SF_5, $-OCHF_2$ or $-OCF_3$.

[0158] In the compounds of the sub-formulae 1b, 2b, 3b, 4b and 5b, R' is as defined for the * compounds of the sub-formulae 1a-5a and is preferably alkyl, alkenyl, alkoxy or alkoxyalkyl.

[0159] In a further smaller sub-group of the compounds of the formulae 1, 2, 3, 4 and 5, R" is -CN; this sub-group is referred to below as group C, and the compounds of this sub-group are correspondingly described by sub-formulae 1c, 2c, 3c, 4c and 5c. In the compounds of the sub-formulae 1 c, 2c, 3c, 4c and 5c, R' is as defined for the compounds of the sub-formulae 1 a-5a and is preferably alkyl, alkoxy or alkenyl.

[0160] Besides the preferred compounds of groups A, B and C, other compounds of the formulae 1, 2, 3, 4 and 5 having other variants of the proposed substituents are also customary. All these substances are obtainable by methods which are known from the literature or analogously thereto.

[0161] Besides the compounds of the formula I to VI, the media according to the invention preferably comprise one or more compounds selected from group A and/or group B and/or group C. The proportions by weight of the compounds from these groups in the media according to the invention are preferably

group A:	from 0 to 90%, preferably from 20 to 90%, in particular from 30 to 90%
group B:	from 0 to 80%, preferably from 10 to 80%, in particular from 10 to 65%
group C:	from 0 to 80%, preferably from 5 to 80%, in particular from 5 to 50%,

[0162] the sum of the proportions by weight of the group A and/or B and/or C compounds present in the respective media according to the invention preferably being from 5% to 90% and in particular from 10% to 90%.

[0163] The structure of the IPS display according to the inventio corresponds to the usual design for displays of this type, as described, for example, in WO 91/10936 or EP 0 588 568. The term usual design is broadly drawn here and also covers all dervatives and modifications of the IPS display, in particular, for example, also matrix display elements based on poly-Si TFT or MIM.

[0164] However, an essential difference of the displays according to the invention from those usual hitherto consists in the choice of the liquid-crystal parameters of the liquid-crystal layer.

[0165] The liquid-crystal mixtures which can be used in accordance with the invention are prepared in a manner conventional per se. In general, the desired amount of the components used in smaller amount is dissolved in the components making up the principal constituent, advantageously at elevated temperature. It is also possible to prepare the mixtures in other conventional manners, for example by use of pre-mixtures, for example homologue mixtures, or using so-called "multibottle" systems .

[0166] The dielectrics may also comprise further additives known to the person skilled in the art for descibed in the literature. For example, 0-15% preferably 0-10%, of pleochroic dyes and/or chiral dopants may be added. The individual compounds added are employed in concentrations of from 0.01 to 6% and preferably from 0.1 to 3%. However, the concentrations given here for the other constituents of the liquid-crystal mixtures, i.e. the liquid-crystalline or mesogenic compounds, are indicated without taking into account the concentration of these additives.

[0167] The physical properties of the liquid-crystal mixtures are determined in accordance with "Physical Properties of Liquid Crystals" Ed. W. Becker, Merck KGaA, as of Nov. 1997, unless explicitly stated otherwise.

[0168] C denotes a crystalline phase, S a smectic phase, S_C a smectic C phase, S_A a smectic A phase, N a nematic phase and I the isotropic phase.

[0169] V_0 denotes the capacitive threshold voltage. Δn denotes the optical anisotropy, and n_0 the ordinary refractive index (in each case at 589 nm). $\Delta\epsilon$ denotes the dielectric anisotropy ($\Delta\epsilon=\epsilon_{\|}-\epsilon_{\perp}$, where $\epsilon_{\|}$ denotes the dielectric constant parallel to the longitudinal molecular axes and $\epsilon_{\perp}$ denotes the dielectric constant perpendicular thereto, in each case at 1 kHz). The electro-optical data were measured in a planar cell at 20° C., unless expressly stated otherwise. All physical properties are indicated and measured at 20° C., unless expressly stated otherwise.

[0170] The cells are preferably bright in the "off" state.

[0171] The examples below are intended to illustrate the invention without representing a limitation. Above and below, percentages are per cent by weight. All temperatures are indicated in degrees Celsius. Δn denotes optical anisotropy (589 nm, 20° C), $\Delta\epsilon$ denotes the dielectric anisotropy (1 kHz, 20° C.), H.R. denotes the voltage holding ratio (at 100° C., after 5 minutes in an oven at 1 V). The capacitive threshold voltage V_0 was determined at 20° C. and 1 kHz.

[0172] The calibrated rotational viscometer gave a rotational viscosity γ_1 for ZLI-4792 (Merck KGaA) of 133 mPa·s at 20° C.

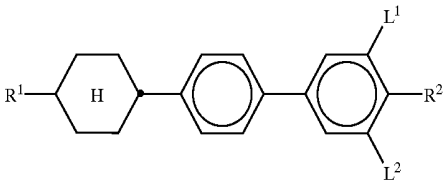
[0173] The shelf life was investigated in sealed test cells with an optical retardation of about 0.5 μm with CU-1511 from DuPont, USA, as alignment layer. To this end, in each case five test cells were bonded on both sides to crossed polarisers and stored at fixed * temperatures of 0° C., −10° C., −20° C., −30° C. and −40° C. At intervals of 24 hours in each case,. the cells were assessed visually for changes. The storage time noted at the respective. temperature t_{store} (T) was the final time at which a change was just not observed in any cell.

[0174] In the present application and in the examples below, the structures of the liquid-crystal compounds are indicated by means of acronyms, the transformation into chemical formulae taking place in accordance with Tables A and B below. All radicals C_nH_{2n+1} and C_mH_{2m+1} are straight-chain alkyl radicals having n, respectively m, carbon atoms. The coding in Table B is self-evident. In Table A, only the acronym for the parent structure is indicated, followed in individual cases, separated from the acronym for the parent structure by a dash, by a code for the substituents R^1, R^2, L^1 and L^2:

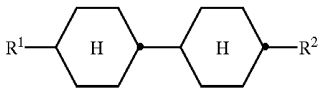
Code for R^1, R^2, L^1, L^2	R^1	R^2	L^1	L^2
nm	C_nH_{2n+1}	C_mH_{2m+1}	H	H
nOm	C_nH_{2n+1}	OC_mH_{2m+1}	H	H
nO.m	OC_nH_{2n+1}	C_mH_{2m+1}	H	H
n	C_nH_{2n+1}	CN	H	H
nN.F	C_nH_{2n+1}	CN	F	H
nN.F.F	C_nH_{2n+1}	CN	F	F
nF	C_nH_{2n+1}	F	H	H
nOF	OC_nH_{2n+1}	F	H	H
nCl	C_nH_{2n+1}	Cl	H	H
nF.F	C_nH_{2n+1}	F	F	H
nCF_3	C_nH_{2n+1}	CF_3	H	H
$nOCF_3$	C_nH_{2n+1}	OCF_3	H	H
$nOCF_2$	C_nH_{2n+1}	$OCHF_2$	H	H
nS	C_nH_{2n+1}	NCS	H	H
rVsN	C_rH_{2r+1}—CH=CH—C_sH_{2s}—	CN	H	H
rEsN	C_rH_{2r+1}—O—C_5H_{2s}—	CN	H	H
nAm	C_nH_{2n+1}	C≡C—C_mH_{2m+1}	H	H
nF.F.F	C_nH_{2n+1}	F	F	F
nCl.F.F	C_nH_{2n+1}	Cl	F	F
nCF_3.F.F	C_nH_{2n+1}	CF_3	F	F
$nOCF_3$.F.F	C_nH_{2n+1}	OCF_3	F	F
$nOCF_2$.F.F	C_nH_{2n+1}	$OCHF_2$	F	F
$nOCF_3$.F	C_nH_{2n+1}	OCF_3	F	H

[0175] Preferred displays contain media comprising one or more compounds from Tables A and B in addition to one or more compounds of the formula I.

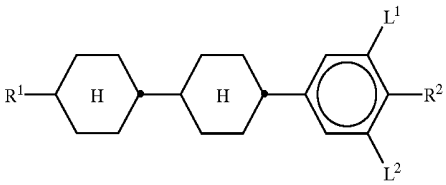
TABLE A



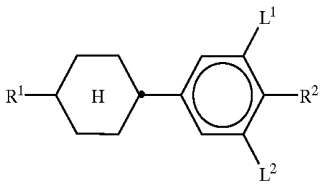
BCH



CCH

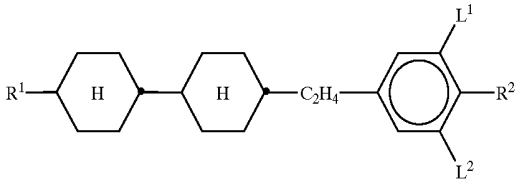


CCP

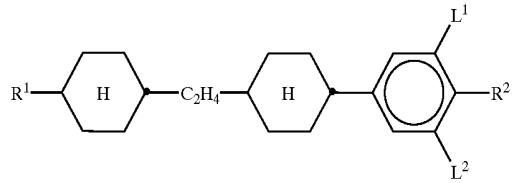


PCH

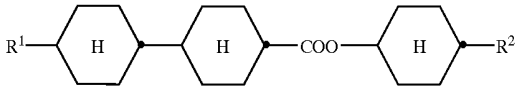
TABLE A-continued



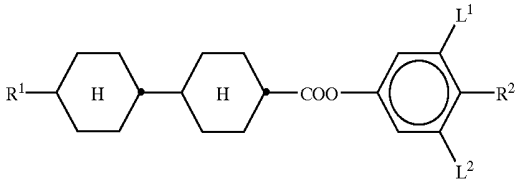
ECCP



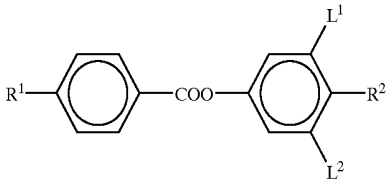
CECP



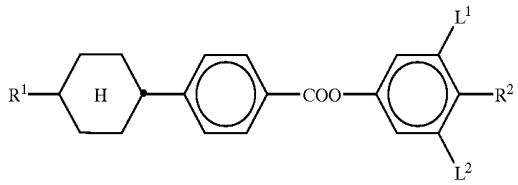
CH



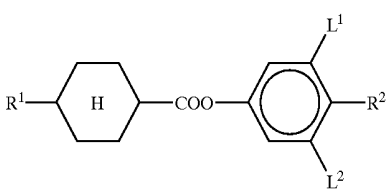
CP



ME

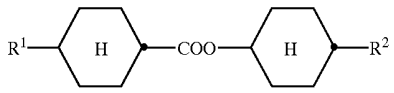


HP

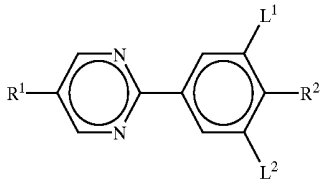


D

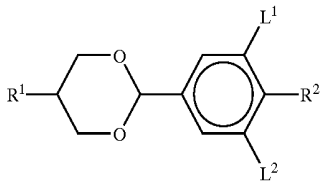
TABLE A-continued



OS

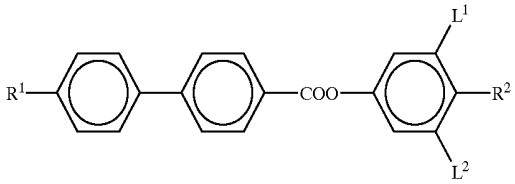


PYP

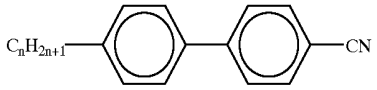


PDX

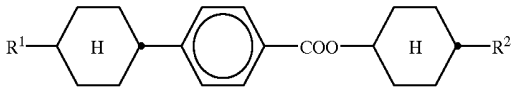
TABLE A-continued



CE



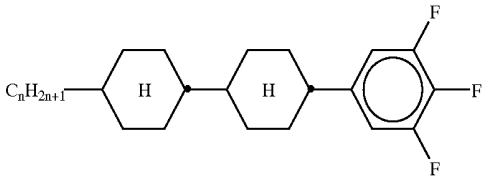
K3n



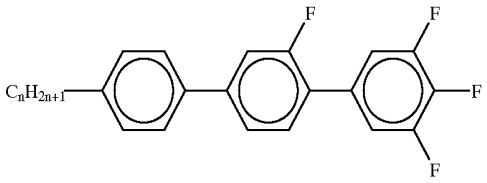
HD

[0176]

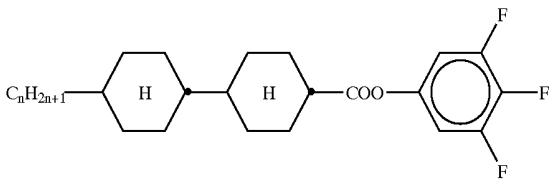
TABLE B



CCP-nF.F.F

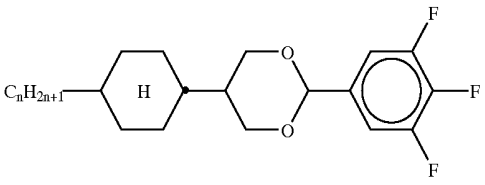


PGU-n-F

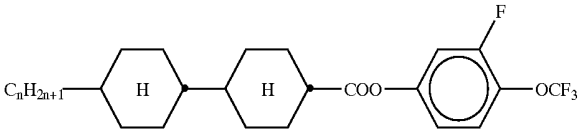


CCZU-nF-F

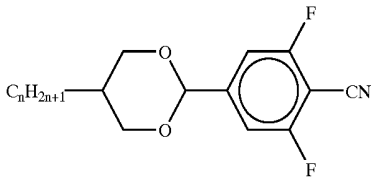
TABLE B-continued



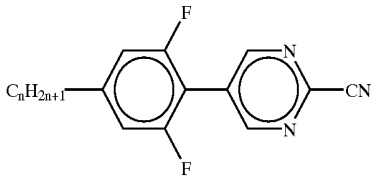
CDU-n-F



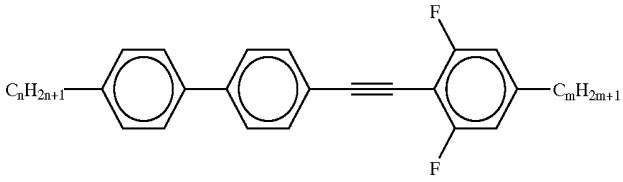
CCZG-n-OT



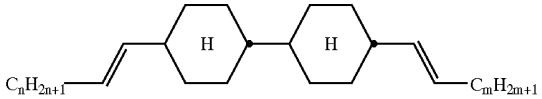
DU-n-N



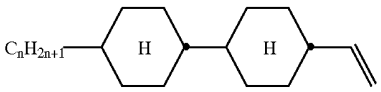
UM-n-N



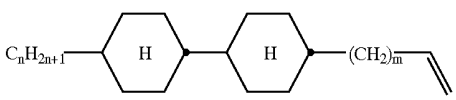
PPTUI-n-m



CC-nV-Vm

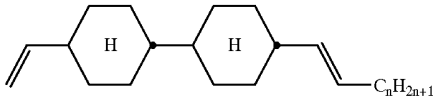


CC-n-V

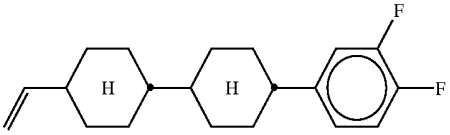


CC-n-mV

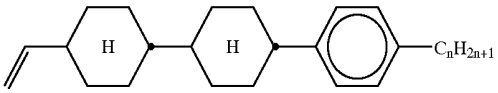
TABLE B-continued



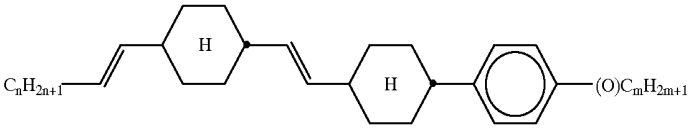
CC-V-Vn



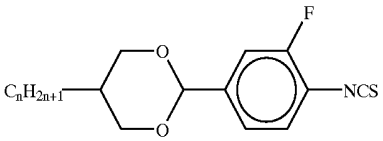
CCG-V-F



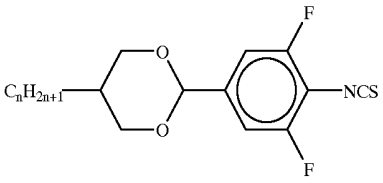
CCP-V-m



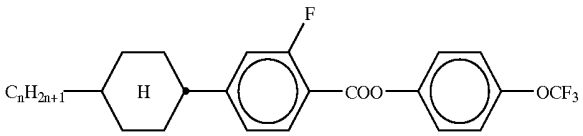
CVCP-nV-(O)m



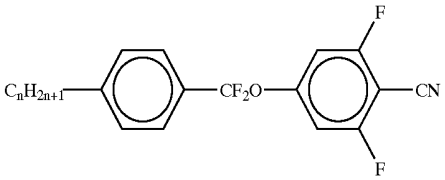
DG-n-S



DU-n-S

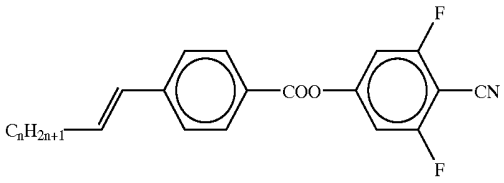


CGZP-n-OT

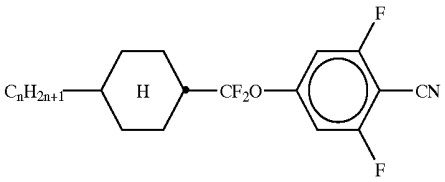


PQU-n-N

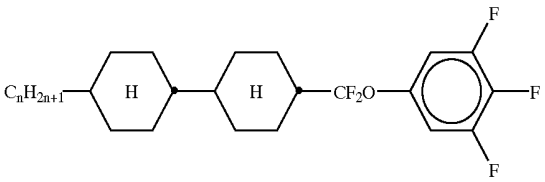
TABLE B-continued



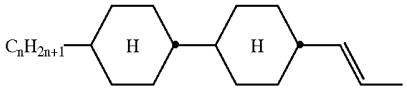
PZU-nV-N



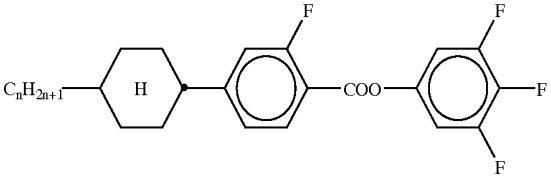
CQU-n-N



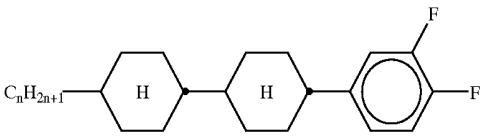
CCQU-n-F



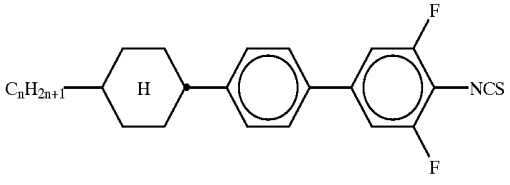
CC-n-V1



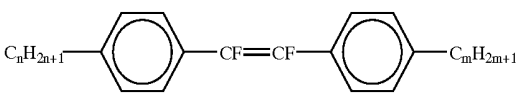
CGZU-n-F



CCP-nF.F

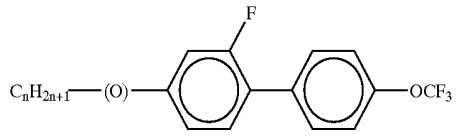


BCH-nS.F.F



P-CF=CF-P-n-m

TABLE B-continued

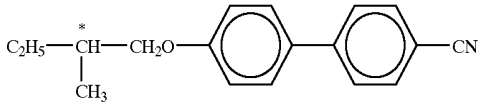


B-n(O).FOCF$_3$

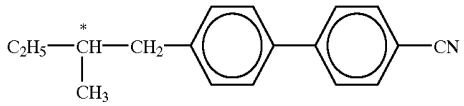
[0177]

TABLE C

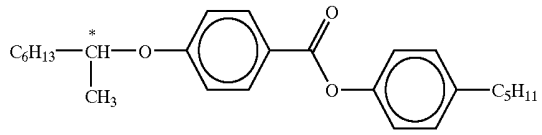
Table C shows dopants which are usually employed in the mixtures according to the invention



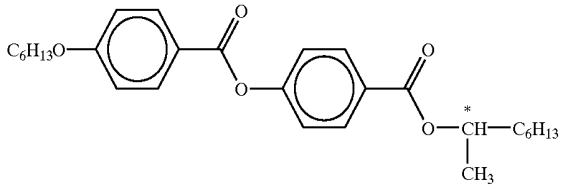
C 15



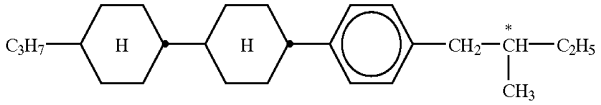
CB 15



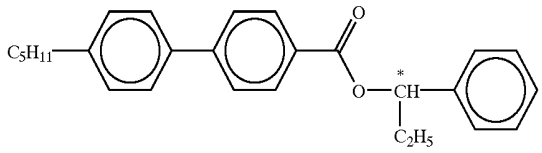
CM 21



R/S-811



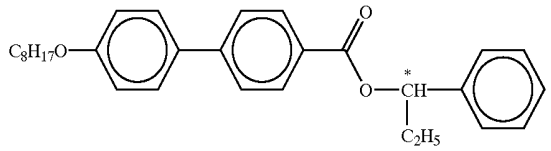
CM 44



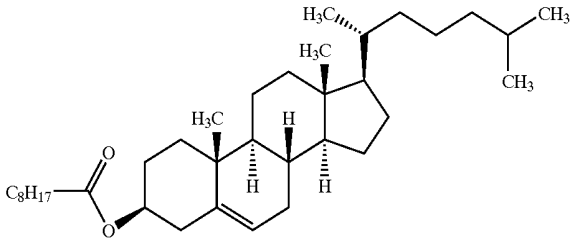
CM 45

TABLE C-continued

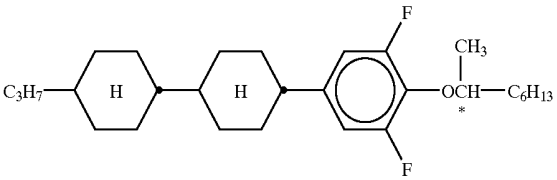
Table C shows dopants which are usually employed in the mixtures according to the invention



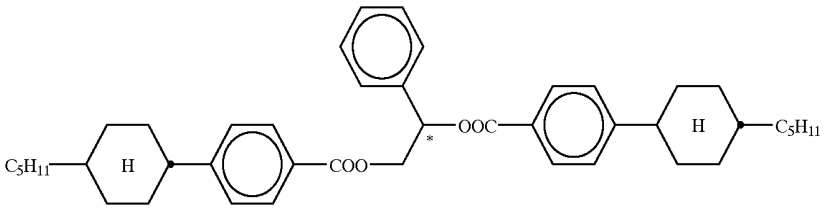
CM 47



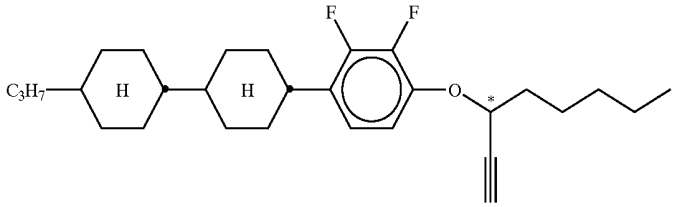
CN



R/S-2011



R/S-1011



R/S-3011

EXAMPLE 1

[0178]

An IPS display contains a nematic mixture having	
CC-3-V	19.0%
CC-3-V1	9.0%
CCH-35	5.0%

-continued

An IPS display contains a nematic mixture having	
PDX-3	5.0%
ME2N.F	4.0%
CCP-V-1	16.0%
CCP-20CF_3	7.0%
CCP-30CF_3	8.0%
DU-2-S	9.0%

-continued

An IPS display contains a nematic mixture having	
DU-3-S	10.0%
CGZP-3-OT	3.0%
BCH-32	4.0%
CBC-33	1.0%
Clearing point [° C.]:	+69.5
Δn [589 nm; 20° C.]:	+0.1006
Δε [1kHz; 20° C.]:	+9.2
γ_1 [mPa.s; 20° C.]:	62
V_0 [20° C.]:	1.18 V

EXAMPLE 2

[0179]

An IPS display contains a nematic mixture having	
CC-3-V	19.0%
CC-3-V1	8.0%
CCH-35	5.0%
PDX-3	5.0%
ME2N.F	4.0%
CCP-V-1	16.0%
CCP-20CF_3	6.0%
CCP-30CF_3	7.0%
CCG-V-F	6.0%
DU-2-S	9.0%
DU-3-S	10.0%
CGZP-3-OT	5.0%
Clearing point [° C.]:	+65.5
Δn [589 nm; 20° C.]:	+0.0965
Δε [1kHz; 20° C.]:	+9.7
γ_1 [mPa.s; 20° C.]:	59
V_0 [20° C.]:	1.18 V

EXAMPLE 3

[0180]

An IPS display contains a nematic mixture having	
CC-3-V	19.0%
CC-3-V1	9.0%
CCH-35	5.0%
PDX-3	5.0%
ME2N.F	3.5%
CCP-V-1	15.0%
CCP-20CF_3	7.5%
CCP-30CF_3	7.0%
DU-2-S	10.0%
DU-3-S	8.0%
CGZP-2-OT	5.0%
BCH-32	5.0%
CBC-33	1.0%

EXAMPLE 4

[0181]

An IPS display contains a nematic mixture having	
CC-3-V	19.0%
CC-3-V1	8.0%
CC-5-V	5.0%
PDX-3	5.0%
ME2N.F	4.0%
CCP-V-1	16.0%
CCP-20CF_3	6.0%
CCP-30CF_3	7.0%
CCG-V-F	6.0%
DU-2-S	9.0%
DU-3-S	10.0%
CGZP-3-OT	5.0%

EXAMPLE 5

[0182]

An IPS display contains a nematic mixture having	
CC-3-V	19.0%
CC-3-V1	8.0%
CCH-35	5.0%
PDX-3	5.0%
ME2N.F	4.0%
CCP-V-1	16.0%
CCP-20CF_3	6.0%
CCP-30CF_3	7.0%
DU-2-S	9.0%
DU-3-S	10.0%
CGZP-3-OT	5.0%
BCH-32	6.0%

EXAMPLE 6

[0183]

An IPS display contains a nematic mixture having	
CC-3-V1	9.0%
CC-5-V	9.0%
CC-3-V	18.0%
B-10.F0CF_3	5.0%
P-CF = CF-P-3-3	6.0%
DU-2-S	15.0%
PGU-2-F	7.0%
BCH-32	6.0%
CCP-V-1	15.0%
BCH-2S.F.F	10.0%
S → N [° C.]:	<-40
Clearing point [° C.]:	+65.0
Δn [589 nm; 20° C.]:	+0.1288
Δε [1kHz; 20° C.]:	+7.0
γ_1 [mPa.s; 20° C.]:	50

EXAMPLE 7

[0184]

An IPS display contains a nematic mixture having			
CC-3-V	19.0%	Δn [589 nm; 20° C.]:	+0.1013
CC-3-V1	9.0%	Δε [1 kHz; 20° C.]:	+8.7
CCH-35	5.0%	γ_1 [mPa • s; 20° C.]:	64
CGZP-2-OT	5.5%	V_0 [20° C.]:	1.16 V
PDX-3	7.0%		
ME2N.F	2.0%		
CCZU-2-F	6.0%		
DU-2-S	10.0%		
DU-3-S	8.0%		
CCP-30CF_3	6.0%		
CCP-V-1	15.0%		
BCH-32	6.0%		
CBC-33	1.5%		

EXAMPLE 8

[0185]

An IPS display contains a nematic mixture having			
CC-3-V	19.0%	Clearing point [° C.]:	+70.9
CC-3-V1	9.0%	Δn [589 nm; 20° C.]:	+0.0985
CC-5-V	4.0%	Δε [1 kHz; 20° C.]:	+7.2
CCH-35	4.0%	γ_1 [mPa • s; 20° C.9 :	51
PCH-301	2.0%		
PDX-3	2.0%		
K6	2.0%		
DU-2-S	10.0%		
DU-3-S	8.0%		
CCP-20CF_3	8.0%		
CCP-30CF_3	5.0%		
CGZP-2-OT	7.0%		
CCP-V-1	15.0%		
BCH-32	5.0%		

EXMAPLE 9

[0186]

An IPS display contains a nematic mixture having			
CC-3-V	19.5%	Clearing point [° C.]:	+72.3
CC-3-V1	9.0%	Δn [589 nm; 20° C.]:	+0.0997
CCH-35	5.0%	Δε [1 kHz; 20° C.]:	+9.1
PDX-3	6.5%	γ_1 [mPa • s; 20° C.]:	56
ME2N.F	3.5%		
CCP-V-1	15.0%		
CCP-20CF_3	8.0%		
CCP-30CF_3	7.0%		
DU-2-S	9.0%		
DU-3-S	8.0%		
CGZP-2-OT	3.5%		
BCH-32	5.0%		
CBC-33	1.0%		

EXAMPLE 10

[0187]

An IPS display contains a nematic mixture having			
CC-3-V1	10.0%	Clearing point [° C.]:	+69.9
CC-3-V	19.0%	Δn [589 nm; 20° C.]:	+0.1000
CC-5-V	5.0%	Δε [1 kHz; 20° C.]:	+7.3
CCH-35	5.0%	γ_1 [mPa • s; 20° C.]:	50
PCH-301	2.0%		
DU-2-S	8.0%		
DU-3-S	8.0%		
PDX-3	3.0%		
K6	4.0%		
CGZP-2-OT	8.0%		
CCP-30CF_3	8.0%		
BCH-32	5.0%		
CCP-V-1	15.0%		

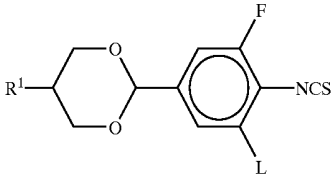
EXAMPLE 11

[0188]

An IPS display contains a nematic mixture having			
CC-3-V1	28.0%	Clearing point [° C.]:	+79.8
CCH-35	5.0%	Δn [589 nm; 20° C.]:	+0.1056
PDX-3	5.0%	Δε [1 kHz; 20 ° C.]:	+9.7
ME2N.F	4.0%	γ_1 [mPa • s; 20° C.]:	68
CCP-V-1	16.0%		
CCP-20CF_3	7.0%		
CCP-30CF_3	8.0%		
DU-2-S	19.0%		
CGZP-3-OT	3.0%		
BCH-32	4.0%		
CBC-33	1.0%		

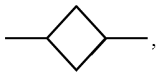
1. Electro-optical liquid-crystal display having a realignment layer for realignment of the liquid crystals whose field has a component parallel to the liquid-crystal layer that is crucial for the realignmhent, containing a liquid-crystalline medium of positive dielectric anisotropy, characterised in that the medium comprises one or more compounds of the formula I

I



in which

R^1 is an alkyl or alkenyl radical having, up to 15 carbon atoms which is unsubstituted, monosubstituted by CN or CF_3 or at least monosubstituted by halogen and in which, in addition, one or more CH_2 groups in these radicals may each, independently of one another, be replaced by -O-, -S-,



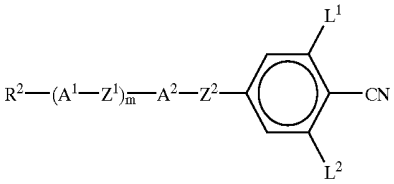
-CO-; -CO-O-, -O-CO- or -O-CO-O- in such a way that that O atoms are not linked directly to one another,

and

L is H or F.

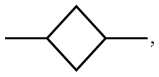
2. Liquid-crystal, display according to claim 1, characterised in that the medium additionally comprises at least one compound of the formula II:

II



in which

R^2 is H, an alkyl or alkenyl radical having up to 15 carbon atoms which is unsubstituted, monosubstituted by CN or CF_3 or at least mono-substituted by halogen and in which, in addition, one or more CH_2 groups in these radicals may also each, independently of one another, be replaced by -O-, -S-,



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

A^1 and A^2 are each, independently of one another,

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

(b) a 1,4-pheanylene radical, in which, in addition, one or two CH groups may be replaced by N, (c) a radical from the group consisting of 1,4-bicyclo[2.2.2]octylene, piperidine-1,4-diyl, naphthalene-2,6-diyl, decahydronaphthalene-2,6-diyl and 1,2,3,4-tetrahydronaphthalene-2,6-diyl, where the radicals (a), (b) and (c) may be substituted by one or two fluorine atoms,

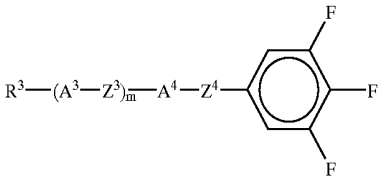
Z^1 and Z^2 are each, independently of one another, -CO-O-, -O-CO-, $-CH_2O-$, $-OCH_2-$, $-CH_2CH_2-$, -CH=CH-, -C≡C-, -CHF-CHF-, -CF=CF-, $-CF_2O-$, $-OCF_2-$, $-CF_2CF_2-$ or a single bond, and one or the radicals Z^1 and Z^2 is alternatively $-(CH_2)_4-$ or $-CH=CH-CH_2CH_2-$,

L^1 and L^2 are each, independently of one another, H or F, and

m is 0,1 or 2.

3. Liquid-crystal display according to claim 1 or **2**, characterised in that the medium additionally comprises at least one compound of the formula III

III



in which

R^3 has one of the meanings indicated for R^2 in the formula II,

A^3 and A^4 each, independently of one another, have one of the meanings indicated for A^1 and A^2 in the formula II,

Z^3 and Z^4 each, independently of one another, have one of the meanings indicated for Z^1 and Z^2 in the formula II, and

n is 0,1 or 2

4. Liquid-crystal display according to one of claims 1 to 3, characterised in that the medium additionally comprises at least one comnpound of the formula IV

IV

in which

R^4 and R^5 each, independently of one another, have one of the meanings indicated for R^2 in the formula II,

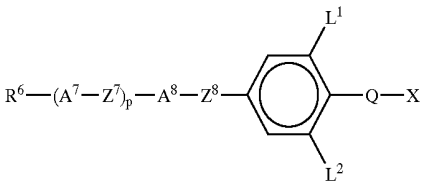
A^5 and A^6 each, independently of one another, have one of the meanings indicated for A^1 and A^2 in the formula II,

each Z^5, independently of the others, has one of the meanings indicated for Z^1 and Z^2 in the formula II, and

o is1, 2 or 3.

5. Liquid-crystal display according to one of claims 1 to 4, characterised in that the medium additionally comprises at least one compound of the formula Y

V



in which

R^6 has one of the meanings indicated for R^2 in the formula II,

A^7 and A^8 each, independently of one another, have one of the meanings indicated for A^1 and A^2 in the formula II,

Z^7 and Z^8 each, independently of one another, have one of the meanings indicated for Z^1 and Z^2 in the formula II,

L^1 and L^2 aeech, independently of one another, H or F,

Q is a polyfluoroalkylene radical of the formula

$-(O)_q-(CH_2)_r-(CF_2)_s-$, $-(O)_q-(CHF)_r-(CF_2)_s-$ or $-(O)_q-(CF_2)_r-(CHF)_s-CF_2-$, in which

q is 0or 1

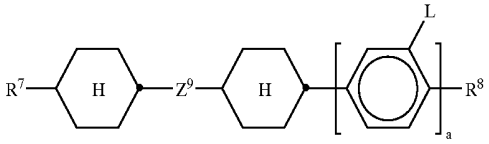
r is 0,1,2,3,4,5 or 6, S is1,2,3,4,5or 6,

X is H, F or Cl, and

p is 0,1 or 2

6. Liquid-crystal display according to one of claims 1 to 5, characterised in that the medium additionally comprises at least one compound of the formula VI

VI



in which

R^7 is an alkenyl group having 2to 7 carbon atoms,.

Z^9 is -CH=CH-, $-CH_2CH_2-$ or a single bond,

L is H or F,

a is 0 or 1, and

R^8 is an alkyl, alkoxy or alkenyl group having up to 12 carbon atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced by -CO--, -OCO- or -COO-, or, if a is 1, R^8may alternatively be F.

7. Liquid-crystal display according to one of claims 1 to 6, characterised in that the medium comprises

from 2 to 40% by wt. of at least one compound of the formula I,

from 15 to 85% by wt. of at least one compound selected from the group consisting of the compounds of the formulae II and/or III,

from 0 to 60% by wt. of at least one compound of the formula IV,

from 0 to 40% by wt. of at least one compound of the formula V, and

from 0 to 55% by wt. of at least one compound of the formula VI.

8. Liquid-crystal display according to one of claims 1 to 7, characterised in that the pixels are addressed by means of an active matrix.

9. Liquid-crystalline medium of positive dielectric anisotropy which has a composition according to at least one of claims 1 to 7.

10. Use of a liquid-crystalline medium according to claim 9 in a liquid-crystal display.

* * * * *

专利名称(译)	电光液晶显示器		
公开(公告)号	US20030207045A1	公开(公告)日	2003-11-06
申请号	US10/343768	申请日	2001-07-11
[标]申请(专利权)人(译)	HECKMEIER MICHAEL POETABCH埃克		
申请(专利权)人(译)	HECKMEIER MICHAEL POETSCH埃克		
当前申请(专利权)人(译)	MERCK PATENT GMBH		
[标]发明人	HECKMEIER MICHAEL POETSCH EIKE		
发明人	HECKMEIER, MICHAEL POETSCH, EIKE		
IPC分类号	G02F1/13 C09K19/34 C09K19/42 C09K19/44 C09K19/46 C09K19/30		
CPC分类号	C09K19/3402 Y10T428/10 C09K19/46 C09K2019/0466 C09K2019/123 C09K2019/2035 C09K2019/2042 C09K2019/301 C09K2019/3015 C09K2019/3016 C09K2019/3021 C09K2019/3077 C09K2019/3083 C09K2019/3422 C09K19/44 C09K2019/0444		
优先权	10038859 2000-08-04 DE		
其他公开文献	US6815017		
外部链接	Espacenet USPTO		

摘要(译)

本发明涉及一种电光液晶显示器，包括用于重新定向液晶的重定向层。所述重定向层的场具有平行于液晶层的分量，所述分量为。对于重新定位至关重要。所述组分包含具有正介电各向异性的液晶介质，并含有至少一种式（I）的介晶化合物，其中R 1和L如权利要求1中所定义。

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