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USHAKOV et al.(10) **Pub. No.: US 2021/0009901 A1**(43) **Pub. Date: Jan. 14, 2021**(54) **LIQUID-CRYSTAL DISPLAY DEVICES
CONTAINING POLYMERISABLE
COMPOUNDS**(71) Applicant: **Merck Patent GmbH**, Darmstadt (DE)(72) Inventors: **Dmitry USHAKOV**, Muenster (DE);
Kaja Christina DEING, Darmstadt
(DE)(73) Assignee: **Merck Patent GmbH**, Darmstadt (DE)(21) Appl. No.: **16/934,466**(22) Filed: **Jul. 21, 2020****Related U.S. Application Data**(62) Division of application No. 15/834,518, filed on Dec.
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ABSTRACT

Liquid-crystal (LC) display devices comprising polymerisable compounds, processes and intermediates for the preparation of the devices and compounds, LC media comprising the compounds, and the use of the polymerisable compounds and LC media for optical, electro-optical and electronic purposes, in particular in LC displays, especially in LC displays of the polymer sustained alignment type.

LIQUID-CRYSTAL DISPLAY DEVICES CONTAINING POLYMERISABLE COMPOUNDS

[0001] The present invention relates to liquid-crystal (LC) display devices containing polymerisable compounds, to processes and intermediates for the preparation of the devices and compounds, to LC media comprising the compounds, and to the use of the polymerisable compounds and LC media for optical, electro-optical and electronic purposes, in particular in LC displays, especially in LC displays of the polymer sustained alignment type.

BACKGROUND OF THE INVENTION

[0002] One of the liquid-crystal display (LCD) modes used at present is the TN (“twisted nematic”) mode. However, TN LCDs have the disadvantage of a strong viewing-angle dependence of the contrast.

[0003] In addition, so-called VA (“vertically aligned”) displays are known which have a broader viewing angle. The LC cell of a VA display contains a layer of an LC medium between two transparent electrodes, where the LC medium usually has a negative dielectric anisotropy. In the switched-off state, the molecules of the LC layer are aligned perpendicular to the electrode surfaces (homeotropically) or have a tilted homeotropic alignment. On application of an electrical voltage to the two electrodes, a realignment of the LC molecules parallel to the electrode surfaces takes place.

[0004] Furthermore, OCB (“optically compensated bend”) displays are known which are based on a birefringence effect and have an LC layer with a so-called “bend” alignment and usually positive dielectric anisotropy. On application of an electrical voltage, a realignment of the LC molecules perpendicular to the electrode surfaces takes place. In addition, OCB displays normally contain one or more birefringent optical retardation films in order to prevent undesired transparency to light of the bend cell in the dark state. OCB displays have a broader viewing angle and shorter response times compared with TN displays.

[0005] Also known are so-called IPS (“in-plane switching”) displays, which contain an LC layer between two substrates, where the two electrodes are arranged on only one of the two substrates and preferably have intermeshed, comb-shaped structures. On application of a voltage to the electrodes, an electric field which has a significant component parallel to the LC layer is thereby generated between them. This causes realignment of the LC molecules in the layer plane.

[0006] Furthermore, so-called FFS (“fringe-field switching”) displays have been reported (see, inter alia, S. H. Jung et al., Jpn. J. Appl. Phys., Volume 43, No. 3, 2004, 1028), which contain two electrodes on the same substrate, one of which structured in a comb-shaped manner and the other is unstructured. A strong, so-called “fringe field” is thereby generated, i.e. a strong electric field close to the edge of the electrodes, and, throughout the cell, an electric field which has both a strong vertical component and also a strong horizontal component. FFS displays have a low viewing-angle dependence of the contrast. FFS displays usually contain an LC medium with positive dielectric anisotropy, and an alignment layer, usually of polyimide, which provides planar alignment to the molecules of the LC medium.

[0007] FFS displays can be operated as active-matrix or passive-matrix displays. In the case of active-matrix dis-

plays, individual pixels are usually addressed by integrated, non-linear active elements, such as, for example, transistors (for example thin-film transistors (“TFTs”)), while in the case of passive-matrix displays, individual pixels are usually addressed by the multiplex method, as known from the prior art.

[0008] Furthermore, FFS displays have been disclosed (see S. H. Lee et al., Appl. Phys. Lett. 73(20), 1998, 2882-2883 and S. H. Lee et al., Liquid Crystals 39(9), 2012, 1141-1148), which have similar electrode design and layer thickness as FFS displays, but comprise a layer of an LC medium with negative dielectric anisotropy instead of an LC medium with positive dielectric anisotropy. The LC medium with negative dielectric anisotropy shows a more favourable director orientation that has less tilt and more twist orientation compared to the LC medium with positive dielectric anisotropy, as a result of which these displays have a higher transmission. The displays further comprise an alignment layer, preferably of polyimide provided on at least one of the substrates that is in contact with the LC medium and induces planar alignment of the LC molecules of the LC medium. These displays are also known as “Ultra Brightness FFS (UB-FFS)” mode displays. These displays require an LC medium with high reliability.

[0009] The term “reliability” as used hereinafter means the quality of the performance of the display during time and with different stress loads, such as light load, temperature, humidity, voltage, and comprises display effects such as image sticking (area and line image sticking), mura, yogore etc. which are known to the skilled person in the field of LC displays. As a standard parameter for categorising the reliability usually the voltage holding ratio (VHR) value is used, which is a measure for maintaining a constant electrical voltage in a test display. The higher the VHR value, the better the reliability of the LC medium.

[0010] In VA displays of the more recent type, uniform alignment of the LC molecules is restricted to a plurality of relatively small domains within the LC cell. Disclinations may exist between these domains, also known as tilt domains. VA displays having tilt domains have, compared with conventional VA displays, a greater viewing-angle independence of the contrast and the grey shades. In addition, displays of this type are simpler to produce since additional treatment of the electrode surface for uniform alignment of the molecules in the switched-on state, such as, for example, by rubbing, is no longer necessary. Instead, the preferential direction of the tilt or pretilt angle is controlled by a special design of the electrodes.

[0011] In so-called MVA (“multidomain vertical alignment”) displays, this is usually achieved by the electrodes having protrusions which cause a local pretilt. As a consequence, the LC molecules are aligned parallel to the electrode surfaces in different directions in different, defined regions of the cell on application of a voltage. “Controlled” switching is thereby achieved, and the formation of interfering disclination lines is prevented. Although this arrangement improves the viewing angle of the display, it results, however, in a reduction in its transparency to light. A further development of MVA uses protrusions on only one electrode side, while the opposite electrode has slits, which improves the transparency to light. The slitted electrodes generate an inhomogeneous electric field in the LC cell on application of a voltage, meaning that controlled switching is still achieved. For further improvement of the transparency to

light, the separations between the slits and protrusions can be increased, but this in turn results in a lengthening of the response times. In so-called PVA (“patterned VA”) displays, protrusions are rendered completely superfluous in that both electrodes are structured by means of slits on the opposite sides, which results in increased contrast and improved transparency to light, but is technologically difficult and makes the display more sensitive to mechanical influences (“tapping”, etc.). For many applications, such as, for example, monitors and especially TV screens, however, a shortening of the response times and an improvement in the contrast and luminance (transmission) of the display are demanded.

[0012] A further development are displays of the so-called PS (“polymer sustained”) or PSA (“polymer sustained alignment”) type, for which the term “polymer stabilised” is also occasionally used. In these, a small amount (for example 0.3% by weight, typically <1% by weight) of one or more polymerisable, compound(s), preferably polymerisable monomeric compound(s), is added to the LC medium and, after filling the LC medium into the display, is polymerised or crosslinked in situ, usually by UV photopolymerisation, optionally while a voltage is applied to the electrodes of the display. The polymerisation is carried out at a temperature where the LC medium exhibits a liquid crystal phase, usually at room temperature. The addition of polymerisable mesogenic or liquid-crystalline compounds, also known as reactive mesogens or “RMs”, to the LC mixture has proven particularly suitable.

[0013] Unless indicated otherwise, the term “PSA” is used hereinafter when referring to displays of the polymer sustained alignment type in general, and the term “PS” is used when referring to specific display modes, like PS-VA, PS-TN and the like.

[0014] Also, unless indicated otherwise, the term “RM” is used hereinafter when referring to a polymerisable mesogenic or liquid-crystalline compound.

[0015] In the meantime, the PS(A) principle is being used in various conventional LC display modes. Thus, for example, PS-VA, PS-OCB, PS-IPS, PS-FFS, PS-UB-FFS and PS-TN displays are known. The polymerisation of the RMs preferably takes place with an applied voltage in the case of PS-VA and PS-OCB displays, and with or without, preferably without, an applied voltage in the case of PS-IPS displays. As can be demonstrated in test cells, the PS(A) method results in a pretilt in the cell. In the case of PS-OCB displays, for example, it is possible for the bend structure to be stabilised so that an offset voltage is unnecessary or can be reduced. In the case of PS-VA displays, the pretilt has a positive effect on response times. For PS-VA displays, a standard MVA or PVA pixel and electrode layout can be used. In addition, however, it is also possible, for example, to manage with only one structured electrode side and no protrusions, which significantly simplifies production and at the same time results in very good contrast at the same time as very good transparency to light.

[0016] Furthermore, the so-called posi-VA displays (“positive VA”) have proven to be a particularly suitable mode. Like in classical VA displays, the initial orientation of the LC molecules in posi-VA displays is homeotropic, i.e. substantially perpendicular to the substrates, in the initial state when no voltage is applied. However, in contrast to classical VA displays, in posi-VA displays LC media with positive dielectric anisotropy are used. Like in the usually

used IPS displays, the two electrodes in posi-VA displays are arranged on only one of the two substrates, and preferably exhibit intermeshed and comb-shaped (interdigital) structures. By application of a voltage to the interdigital electrodes, which create an electrical field that is substantially parallel to the layer of the LC medium, the LC molecules are transferred into an orientation that is substantially parallel to the substrates. In posi-VA displays polymer stabilisation, by addition of RMs to the LC medium which are polymerised in the display, has also proven to be advantageous, as a significant reduction of the switching times could thereby be realised.

[0017] PS-VA displays are described, for example, in EP 1 170 626 A2, U.S. Pat. Nos. 6,861,107, 7,169,449, US 2004/0191428 A1, US 2006/0066793 A1 and US 2006/0103804 A1. PS-OCB displays are described, for example, in T.-J.-Chen et al., Jpn. J. Appl. Phys. 45, 2006, 2702-2704 and S. H. Kim, L.-C.-Chien, Jpn. J. Appl. Phys. 43, 2004, 7643-7647. PS-IPS displays are described, for example, in U.S. Pat. No. 6,177,972 and Appl. Phys. Lett. 1999, 75(21), 3264. PS-TN displays are described, for example, in Optics Express 2004, 12(7), 1221.

[0018] Like the conventional LC displays described above, PSA displays can be operated as active-matrix or passive-matrix displays. In the case of active-matrix displays, individual pixels are usually addressed by integrated, non-linear active elements, such as, for example, transistors (for example thin-film transistors (“TFTs”)), while in the case of passive-matrix displays, individual pixels are usually addressed by the multiplex method, as known from the prior art.

[0019] The PSA display may also comprise an alignment layer on one or both of the substrates forming the display cell. The alignment layer is usually applied on the electrodes (where such electrodes are present) such that it is in contact with the LC medium and induces initial alignment of the LC molecules. The alignment layer may comprise or consist of, for example, a polyimide, which may also be rubbed, or may be prepared by a photoalignment method.

[0020] In particular for monitor and especially TV applications, optimisation of the response times, but also of the contrast and luminance (thus also transmission) of the LC display continues to be demanded. The PSA method can provide significant advantages here. In particular in the case of PS-VA, PS-IPS, PS-FFS and PS-posi-VA displays, a shortening of the response times, which correlate with a measurable pretilt in test cells, can be achieved without significant adverse effects on other parameters.

[0021] Prior art has suggested biphenyl diacrylates or dimethacrylates, which are optionally fluorinated as RMs for use in PSA displays

[0022] However, the problem arises that not all combinations consisting of an LC mixture and one or more RMs are suitable for use in PSA displays because, for example, an inadequate tilt or none at all becomes established or since, for example, the so-called “voltage holding ratio” (VHR or HR) is inadequate for TFT display applications. In addition, it has been found that, on use in PSA displays, the LC mixtures and RMs known from the prior art do still have some disadvantages. Thus, not every known RM which is soluble in LC mixtures is suitable for use in PSA displays. In addition, it is often difficult to find a suitable selection criterion for the RM besides direct measurement of the pretilt in the PSA display. The choice of suitable RMs

becomes even smaller if polymerisation by means of UV light without the addition of photoinitiators is desired, which may be advantageous for certain applications.

[0023] In addition, the selected combination of LC host mixture/RM should have the lowest possible rotational viscosity and the best possible electrical properties. In particular, it should have the highest possible VHR. In PSA displays, a high VHR after irradiation with UV light is particularly necessary since UV exposure is a requisite part of the display production process, but also occurs as normal exposure during operation of the finished display.

[0024] In particular, it would be desirable to have available novel materials for PSA displays which produce a particularly small pretilt angle. Preferred materials here are those which produce a lower pretilt angle during polymerisation for the same exposure time than the materials known to date, and/or through the use of which the (higher) pretilt angle that can be achieved with known materials can already be achieved after a shorter exposure time. The production time ("tact time") of the display could thus be shortened and the costs of the production process reduced.

[0025] A further problem in the production of PSA displays is the presence or removal of residual amounts of unpolymerised RMs, in particular after the polymerisation step for production of the pretilt angle in the display. For example, unreacted RMs of this type may adversely affect the properties of the display by, for example, polymerising in an uncontrolled manner during operation after finishing of the display.

[0026] Thus, the PSA displays known from the prior art often exhibit the undesired effect of so-called "image sticking" or "image burn", i.e. the image produced in the LC display by temporary addressing of individual pixels still remains visible even after the electric field in these pixels has been switched off or after other pixels have been addressed.

[0027] This "image sticking" can occur on the one hand if LC host mixtures having a low VHR are used. The UV component of daylight or the backlighting can cause undesired decomposition reactions of the LC molecules therein and thus initiate the production of ionic or free-radical impurities. These may accumulate, in particular, at the electrodes or the alignment layers, where they may reduce the effective applied voltage. This effect can also be observed in conventional LC displays without a polymer component.

[0028] In addition, an additional "image sticking" effect caused by the presence of unpolymerised RMs is often observed in PSA displays. Uncontrolled polymerisation of the residual RMs is initiated here by UV light from the environment or by the backlighting. In the switched display areas, this changes the tilt angle after a number of addressing cycles. As a result, a change in transmission in the switched areas may occur, while it remains unchanged in the unswitched areas.

[0029] It is therefore desirable for the polymerisation of the RMs to proceed as completely as possible during production of the PSA display and for the presence of unpolymerised RMs in the display to be excluded as far as possible or reduced to a minimum. Thus, RMs and LC mixtures are required which enable or support highly effective and complete polymerisation of the RMs. In addition, controlled reaction of the residual RM amounts would be

desirable. This would be simpler if the RM polymerised more rapidly and effectively than the compounds known to date.

[0030] A further problem that has been observed in the operation of PSA displays is the stability of the pretilt angle. Thus, it was observed that the pretilt angle, which was generated during display manufacture by polymerising the RM as described above, does not remain constant but can deteriorate after the display was subjected to voltage stress during its operation. This can negatively affect the display performance, e.g. by increasing the black state transmission and hence lowering the contrast.

[0031] Another problem to be solved is that the RMs of prior art do often have high melting points, and do only show limited solubility in many currently common LC mixtures, and therefore frequently tend to spontaneously crystallise out of the mixture. In addition, the risk of spontaneous polymerisation prevents the LC host mixture being warmed in order to dissolve the polymerisable component, meaning that the best possible solubility even at room temperature is necessary. In addition, there is a risk of separation, for example on introduction of the LC medium into the LC display (chromatography effect), which may greatly impair the homogeneity of the display. This is further increased by the fact that the LC media are usually introduced at low temperatures in order to reduce the risk of spontaneous polymerisation (see above), which in turn has an adverse effect on the solubility.

[0032] Another problem observed in prior art is that the use of conventional LC media in LC displays, including but not limited to displays of the PSA type, often leads to the occurrence of mura in the display, especially when the LC medium is filled in the display cell manufactured using the one drop filling (ODF) method. This phenomenon is also known as "ODF mura". It is therefore desirable to provide LC media which lead to reduced ODF mura.

[0033] Another problem observed in prior art is that LC media for use in PSA displays, including but not limited to displays of the PSA type, do often exhibit high viscosities and, as a consequence, high switching times. In order to reduce the viscosity and switching time of the LC medium, it has been suggested in prior art to add LC compounds with an alkenyl group. However, it was observed that LC media containing alkenyl compounds often show a decrease of the reliability and stability, and a decrease of the VHR especially after exposure to UV radiation. Especially for use in PSA displays this is a considerable disadvantage, because the photo-polymerisation of the RMs in the PSA display is usually carried out by exposure to UV radiation, which may cause a VHR drop in the LC medium.

[0034] There is thus still a great demand for PSA displays and LC media and polymerisable compounds for use in such displays, which do not show the drawbacks as described above, or only do so to a small extent, and have improved properties.

[0035] In particular, there is a great demand for PSA displays, and LC media and polymerisable compounds for use in such PSA displays, which enable a high specific resistance at the same time as a large working-temperature range, short response times, even at low temperatures, and a low threshold voltage, a low pretilt angle, a multiplicity of grey shades, high contrast and a broad viewing angle, have high reliability and high values for the "voltage holding ratio" (VHR) after UV exposure, and, in case of the

polymerisable compounds, have low melting points and a high solubility in the LC host mixtures. In PSA displays for mobile applications, it is especially desired to have available LC media that show low threshold voltage and high birefringence.

[0036] The invention is based on the object of providing novel suitable materials, in particular RMs and LC media comprising the same, for use in PSA displays, which do not have the disadvantages indicated above or do so to a reduced extent.

[0037] In particular, the invention is based on the object of providing RMs, and LC media comprising them, for use in PSA displays, which enable very high specific resistance values, high VHR values, high reliability, low threshold voltages, short response times, high birefringence, show good UV absorption especially at longer wavelengths, enable quick and complete polymerisation of the RMs, allow the generation of a low pretilt angle as quickly as possible, enable a high stability of the pretilt even after longer time and/or after UV exposure, reduce or prevent the occurrence of “image sticking” and “ODF mura” in the display, and in case of the RMs polymerise as rapidly and completely as possible and show a high solubility in the LC media which are typically used as host mixtures in PSA displays.

[0038] A further object of the invention is the provision of novel RMs, in particular for optical, electro-optical and electronic applications, and of suitable processes and intermediates for the preparation thereof.

[0039] These and other objects have been achieved in accordance with the present invention by materials and processes as described in the present application. In particular, it has been found, surprisingly, that the use of RMs of formula I as described hereinafter allows achieving the advantageous effects as mentioned above. These compounds are characterized in that they contain a mesogenic biphenyl core with two or more polymerisable reactive groups, one or more alkoxy substituents and one or more F or Cl atoms attached thereto, and wherein all polymerisable reactive groups have the same meaning.

[0040] It was surprisingly found that the use of these RMs, and of LC media comprising them, in PSA displays facilitates a quick and complete UV-photopolymerisation reaction in particular at longer UV wavelengths in the range from 300-380 nm and especially above 320 nm, even without the addition of photoinitiator, leads to a fast generation of a large and stable pretilt angle, reduces image sticking and ODF mura in the display, leads to a high reliability and a high VHR value after UV photopolymerisation, especially in case of LC host mixtures containing LC compounds with an alkenyl group, and enables to achieve fast response times, a low threshold voltage and a high birefringence.

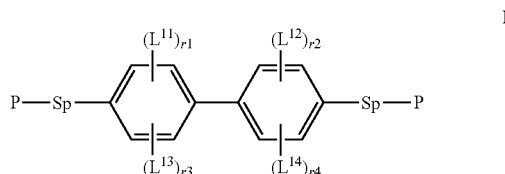
[0041] In addition, the RMs according to the invention have low melting points, good solubility in a wide range of LC media, especially in commercially available LC host mixtures for PSA use, and a low tendency to crystallisation. Besides, they show good absorption at longer UV wavelengths, in particular in the range from 300-380 nm, and enable a quick and complete polymerisation with small amounts of residual, unreacted RMs in the cell.

[0042] JP 2012-018215 A and WO 2014/174929 A1 disclose hybrid type RMs which contain at least two different polymerisable reactive groups and wherein the mesogenic

core may also be substituted by an alkoxy group, but do neither disclose nor suggest RMs as disclosed and claimed hereinafter.

SUMMARY OF THE INVENTION

[0043] The invention relates to polymerisable compounds of formula I



wherein the individual radicals, independently of each other, and on each occurrence identically or differently, have the following meanings

[0044] P a methacrylate group or an acrylate group, wherein both groups P have the same meaning,

[0045] Sp a single bond, $-(CH_2)_{p1}-$, $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$, or $-CO-O-(CH_2)_{p1}-$, wherein $p1$ is 2, 3, 4, 5 or 6, and, if Sp is $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$ or $-CO-O-(CH_2)_{p1}-$ the O-atom or CO-group, respectively, is linked to the benzene ring,

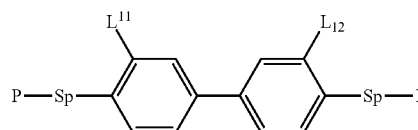
[0046] L^{11} , L^{12} F, Cl or OR,

[0047] R straight-chain or branched alkyl with 1 to 4 C atoms that is optionally fluorinated,

[0048] L^{13} , L^{14} the options for L^{11} , L^{12} , or $-CN$ or straight chain, branched or cyclic alkyl having 1 to 12, preferably 1 to 6, C atoms, wherein one or more non-adjacent CH_2 -groups are optionally replaced by $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$, $-O-CO-O-$ in such a manner that O- and/or S-atoms are not directly connected with each other, and wherein one or more H atoms are each optionally replaced by F or Cl,

[0049] $r1$, $r2$ 0, 1, 2, 3 or 4, wherein $r1+r2 \geq 2$,

[0050] $r3$, $r4$ 0, 1, 2, 3 or 4, wherein $r1+r3 \leq 4$ and $r2+r4 \leq 4$, wherein the compounds contain at least group L^{11} or L^{12} that is F or Cl, and at least one group L^{11} or L^{12} that is OR, and with the proviso that the following compounds are excluded



wherein P, Sp, L^{11} and L^{12} are as defined above.

[0051] The invention further relates to the use of compounds of formula I as polymerisable compounds in LC media and LC displays, especially in the LC medium, active layer or alignment layer of an LC display, wherein the LC displays are preferably PSA displays.

[0052] The invention further relates to methods for preparing compounds of formula I, and to novel intermediates used or obtained in these methods.

[0053] The invention furthermore relates to an LC medium comprising one or more compounds of formula I.

[0054] The invention furthermore relates to an LC medium comprising one or more polymerisable compounds, at least one of which is a compound of formula I.

[0055] The invention furthermore relates to an LC medium comprising

[0056] a polymerisable component A) comprising, preferably consisting of, one or more polymerisable compounds, at least one of which is a compound of formula I, and

[0057] a liquid-crystalline component B), hereinafter also referred to as “LC host mixture”, comprising, preferably consisting of, one or more mesogenic or liquid-crystalline compounds.

[0058] The liquid-crystalline component B) of an LC medium according to the present invention is hereinafter also referred to as “LC host mixture”, and preferably comprises one or more, preferably at least two mesogenic or LC compounds selected from low-molecular-weight compounds which are unpolymerisable.

[0059] The invention furthermore relates to an LC medium as described above and below, wherein the LC host mixture or component B) comprises at least one mesogenic or LC compound comprising an alkenyl group.

[0060] The invention furthermore relates to an LC medium or LC display as described above, wherein the compounds of formula I, or the polymerisable compounds of component A), are polymerised.

[0061] The invention furthermore relates to a process for preparing an LC medium as described above and below, comprising the steps of mixing one or more mesogenic or LC compounds, or an LC host mixture or LC component B) as described above and below, with one or more compounds of formula I, and optionally with further LC compounds and/or additives.

[0062] The invention furthermore relates to the use of compounds of formula I and LC media according to the invention in PSA displays, in particular the use in PSA displays containing an LC medium, for the production of a tilt angle in the LC medium by in-situ polymerisation of the compound(s) of the formula I in the PSA display, preferably in an electric or magnetic field.

[0063] The invention furthermore relates to an LC display comprising one or more compounds of formula I or an LC medium according to the invention, in particular a PSA display, particularly preferably a PS-VA, PS-OCB, PS-IPS, PS-FFS, PS-UB-FFS, PS-posi-VA or PS-TN display.

[0064] The invention furthermore relates to the use of compounds of formula I and LC media according to the invention in polymer stabilised SA-VA displays, and to a polymer stabilised SA-VA display comprising one or more compounds of formula I or an LC medium according to the invention.

[0065] The invention furthermore relates to an LC display comprising a polymer obtainable by polymerisation of one or more compounds of formula I or of a polymerisable component A) as described above, or comprising an LC medium according to the invention, which is preferably a PSA display, very preferably a PS-VA, PS-OCB, PS-IPS, PS-FFS, PS-UB-FFS, PS-posi-VA or PS-TN display.

[0066] The invention furthermore relates to an LC display of the PSA type comprising two substrates, at least one of which is transparent to light, an electrode provided on each

substrate or two electrodes provided on only one of the substrates, and located between the substrates, a layer of an LC medium that comprises one or more polymerisable compounds and an LC component as described above and below, wherein the polymerisable compounds are polymerised between the substrates of the display.

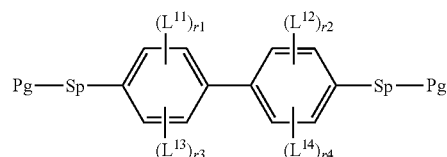
[0067] The invention furthermore relates to a process for manufacturing an LC display as described above and below, comprising the steps of filling or otherwise providing an LC medium, which comprises one or more polymerisable compounds as described above and below, between the substrates of the display, and polymerising the polymerisable compounds.

[0068] The PSA displays according to the invention have two electrodes, preferably in the form of transparent layers, which are applied to one or both of the substrates. In some displays, for example in PS-VA, PS-OCB or PS-TN displays, one electrode is applied to each of the two substrates. In other displays, for example in PS-posi-VA, PS-IPS or PS-FFS or PS-UB-FFS displays, both electrodes are applied to only one of the two substrates.

[0069] In a preferred embodiment the polymerisable component is polymerised in the LC display while a voltage is applied to the electrodes of the display.

[0070] The polymerisable compounds of the polymerisable component are preferably polymerised by photo-polymerisation, very preferably by UV photo-polymerisation.

[0071] The invention furthermore relates to compounds of formula II



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wherein Sp, L^{11} , L^{12} , L^{13} , L^{14} , $r1$ - $r4$ have the meanings given in formula I or one of the preferred meanings given above and below, and Pg denotes OH, a protected hydroxyl group or a masked hydroxyl group.

[0072] The invention furthermore relates to the use of compounds of formula II as intermediates in the synthesis of polymerisable compounds, especially those of formula I.

[0073] The invention furthermore relates to a process for synthesizing compounds of formula I by esterification or etherification of the compounds of formula II, wherein Pg denotes OH, using corresponding acids, acid derivatives, or halogenated compounds containing a polymerisable group P.

DETAILED DESCRIPTION OF THE INVENTION

[0074] Unless stated otherwise, the compounds of formula I are preferably selected from achiral compounds.

[0075] As used herein, the terms “active layer” and “switchable layer” mean a layer in an electrooptical display, for example an LC display, that comprises one or more molecules having structural and optical anisotropy, like for example LC molecules, which change their orientation upon an external stimulus like an electric or magnetic field, resulting in a change of the transmission of the layer for polarized or unpolarized light.

[0076] As used herein, the terms “tilt” and “tilt angle” will be understood to mean a tilted alignment of the LC molecules of an LC medium relative to the surfaces of the cell in an LC display (here preferably a PSA display). The tilt angle here denotes the average angle ($<90^\circ$) between the

longitudinal molecular axes of the LC molecules (LC director) and the surface of the plane-parallel outer plates which form the LC cell. A low value for the tilt angle (i.e. a large deviation from the 90° angle) corresponds to a large tilt here. A suitable method for measurement of the tilt angle is given in the examples. Unless indicated otherwise, tilt angle values disclosed above and below relate to this measurement method.

[0077] As used herein, the terms “reactive mesogen” and “RM” will be understood to mean a compound containing a mesogenic or liquid crystalline skeleton, and one or more functional groups attached thereto which are suitable for polymerisation and are also referred to as “polymerisable group” or “P”.

[0078] Unless stated otherwise, the term “polymerisable compound” as used herein will be understood to mean a polymerisable monomeric compound.

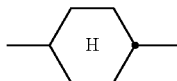
[0079] As used herein, the term “low-molecular-weight compound” will be understood to mean to a compound that is monomeric and/or is not prepared by a polymerisation reaction, as opposed to a “polymeric compound” or a “polymer”.

[0080] As used herein, the term “unpolymerisable compound” will be understood to mean a compound that does not contain a functional group that is suitable for polymerisation under the conditions usually applied for the polymerisation of the RMs.

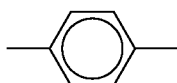
[0081] The term “mesogenic group” as used herein is known to the person skilled in the art and described in the literature, and means a group which, due to the anisotropy of its attracting and repelling interactions, essentially contributes to causing a liquid-crystal (LC) phase in low-molecular-weight or polymeric substances. Compounds containing mesogenic groups (mesogenic compounds) do not necessarily have to have an LC phase themselves. It is also possible for mesogenic compounds to exhibit LC phase behaviour only after mixing with other compounds and/or after polymerisation. Typical mesogenic groups are, for example, rigid rod- or disc-shaped units. An overview of the terms and definitions used in connection with mesogenic or LC compounds is given in *Pure Appl. Chem.* 2001, 73(5), 888 and C. Tschierske, G. Pelzl, S. Diele, *Angew. Chem.* 2004, 116, 6340-6368.

[0082] The term “spacer group”, hereinafter also referred to as “Sp”, as used herein is known to the person skilled in the art and is described in the literature, see, for example, *Pure Appl. Chem.* 2001, 73(5), 888 and C. Tschierske, G. Pelzl, S. Diele, *Angew. Chem.* 2004, 116, 6340-6368. As used herein, the terms “spacer group” or “spacer” mean a flexible group, for example an alkylene group, which connects the mesogenic group and the polymerisable group(s) in a polymerisable mesogenic compound.

[0083] Above and below,

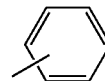


denotes a trans-1,4-cyclohexylene ring, and



denotes a 1,4-phenylene ring.

[0084] In a group



the single bond shown between the two ring atoms can be attached to any free position of the benzene ring.

[0085] Above and below “organic group” denotes a carbon or hydrocarbon group.

[0086] “Carbon group” denotes a mono- or polyvalent organic group containing at least one carbon atom, where this either contains no further atoms (such as, for example, $\text{—C}\equiv\text{C—}$) or optionally contains one or more further atoms, such as, for example, N, O, S, B, P, Si, Se, As, Te or Ge (for example carbonyl, etc.). The term “hydrocarbon group” denotes a carbon group which additionally contains one or more H atoms and optionally one or more heteroatoms, such as, for example, N, O, S, B, P, Si, Se, As, Te or Ge.

[0087] “Halogen” denotes F, Cl, Br or I, preferably F or Cl.

[0088] —CO— , —C(=O)— and —C(O)— denote a carbonyl group, i.e.



[0089] A carbon or hydrocarbon group can be a saturated or unsaturated group. Unsaturated groups are, for example, aryl, alkenyl or alkynyl groups. A carbon or hydrocarbon radical having more than 3 C atoms can be straight-chain, branched and/or cyclic and may also contain spiro links or condensed rings.

[0090] The terms “alkyl”, “aryl”, “heteroaryl”, etc., also encompass polyvalent groups, for example alkylene, arylene, heteroarylene, etc.

[0091] The term “aryl” denotes an aromatic carbon group or a group derived therefrom. The term “heteroaryl” denotes “aryl” as defined above, containing one or more heteroatoms, preferably selected from N, O, S, Se, Te, Si and Ge.

[0092] Preferred carbon and hydrocarbon groups are optionally substituted, straight-chain, branched or cyclic, alkyl, alkenyl, alkynyl, alkoxy, alkylcarbonyl, alkoxy-carbonyl, alkylcarbonyloxy and alkoxy-carbonyloxy having 1 to 40, preferably 1 to 20, very preferably 1 to 12, C atoms, optionally substituted aryl or aryloxy having 5 to 30, preferably 6 to 25, C atoms, or optionally substituted alkylaryl, arylalkyl, alkylaryloxy, arylalkyloxy, arylcarbonyl, aryloxy-carbonyl, arylcarbonyloxy and aryloxy-carbonyloxy having 5 to 30, preferably 6 to 25, C atoms, wherein one or more C atoms may also be replaced by hetero atoms, preferably selected from N, O, S, Se, Te, Si and Ge.

[0093] Further preferred carbon and hydrocarbon groups are C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, C₃-C₂₀ allyl, C₄-C₂₀ alkyldienyl, C₄-C₂₀ polyenyl, C₆-C₂₀ cycloalkyl, C₄-C₁₅ cycloalkenyl, C₆-C₃₀ aryl, C₆-C₃₀ alkylaryl, C₆-C₃₀ arylalkyl, C₆-C₃₀ alkylaryloxy, C₆-C₃₀ arylalkyloxy, C₂-C₃₀ heteroaryl, C₂-C₃₀ heteroaryloxy.

[0094] Particular preference for carbon and hydrocarbon groups is given to C₁-C₁₂ alkyl, C₂-C₁₂ alkenyl, C₂-C₁₂ alkynyl, C₆-C₂₅ aryl and C₂-C₂₅ heteroaryl.

[0095] Further preferred carbon and hydrocarbon groups are straight-chain, branched or cyclic alkyl having 1 to 20, preferably 1 to 12, C atoms, which are unsubstituted or mono- or polysubstituted by F, Cl, Br, I or CN and in which one or more non-adjacent CH₂ groups may each be replaced, independently of one another, by —C(R^x)=C(R^x)—, —C≡C—, —N(R^x)—, —O—, —S—, —CO—, —CO—O—, —O—CO—, —O—CO—O— in such a way that O and/or S atoms are not linked directly to one another.

[0096] R^x preferably denotes H, F, Cl, CN, a straight-chain, branched or cyclic alkyl chain having 1 to 25 C atoms, in which, in addition, one or more non-adjacent C atoms may be replaced by —O—, —S—, —CO—, —CO—O—, —O—CO—, —O—CO—O— and in which one or more H atoms may be replaced by F or Cl, or denotes an optionally substituted aryl or aryloxy group with 6 to 30 C atoms, or an optionally substituted heteroaryl or heteroaryloxy group with 2 to 30 C atoms.

[0097] Preferred alkyl groups are, for example, methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, s-butyl, t-butyl, 2-methylbutyl, n-pentyl, s-pentyl, cyclopentyl, n-hexyl, cyclohexyl, 2-ethylhexyl, n-heptyl, cycloheptyl, n-octyl, cyclooctyl, n-nonyl, n-decyl, n-undecyl, n-dodecyl, dodecanyl, trifluoromethyl, perfluoro-n-butyl, 2,2,2-trifluoroethyl, perfluorooctyl, perfluorohexyl, etc.

[0098] Preferred alkenyl groups are, for example, ethenyl, propenyl, butenyl, pentenyl, cyclopentenyl, hexenyl, cyclohexenyl, heptenyl, cycloheptenyl, octenyl, cyclooctenyl, etc.

[0099] Preferred alkynyl groups are, for example, ethynyl, propynyl, butynyl, pentynyl, hexynyl, octynyl, etc.

[0100] Preferred alkoxy groups are, for example, methoxy, ethoxy, 2-methoxy-ethoxy, n-propoxy, i-propoxy, n-butoxy, i-butoxy, s-butoxy, t-butoxy, 2-methylbutoxy, n-pentoxy, n-hexoxy, n-heptoxy, n-octoxy, n-nonoxo, n-decoxy, n-undecoxo, n-dodecoxy, etc.

[0101] Preferred amino groups are, for example, dimethylamino, methylamino, methylphenylamino, phenylamino, etc.

[0102] Aryl and heteroaryl groups can be monocyclic or polycyclic, i.e. they can contain one ring (such as, for example, phenyl) or two or more rings, which may also be fused (such as, for example, naphthyl) or covalently bonded (such as, for example, biphenyl), or contain a combination of fused and linked rings. Heteroaryl groups contain one or more heteroatoms, preferably selected from O, N, S and Se.

[0103] Particular preference is given to mono-, bi- or tricyclic aryl groups having 6 to 25 C atoms and mono-, bi- or tricyclic heteroaryl groups having 5 to 25 ring atoms, which optionally contain fused rings and are optionally substituted. Preference is furthermore given to 5-, 6- or 7-membered aryl and heteroaryl groups, in which, in addition, one or more CH groups may be replaced by N, S or O in such a way that O atoms and/or S atoms are not linked directly to one another.

[0104] Preferred aryl groups are, for example, phenyl, biphenyl, terphenyl, [1,1':3',1'']terphenyl-2'-yl, naphthyl, anthracene, binaphthyl, phenanthrene, 9,10-dihydro-phenanthrene, pyrene, dihydropyrene, chrysene, perylene, tetracene, pentacene, benzopyrene, fluorene, indene, indenofluorene, spirobifluorene, etc.

[0105] Preferred heteroaryl groups are, for example, 5-membered rings, such as pyrrole, pyrazole, imidazole, 1,2,3-triazole, 1,2,4-triazole, tetrazole, furan, thiophene, selenophene, oxazole, isoxazole, 1,2-thiazole, 1,3-thiazole, 1,2,3-oxadiazole, 1,2,4-oxadiazole, 1,2,5-oxadiazole, 1,3,4-oxadiazole, 1,2,3-thiadiazole, 1,2,4-thiadiazole, 1,2,5-thiadiazole, 1,3,4-thiadiazole, 6-membered rings, such as pyridine, pyridazine, pyrimidine, pyrazine, 1,3,5-triazine, 1,2,4-triazine, 1,2,3-triazine, 1,2,4,5-tetrazine, 1,2,3,4-tetrazine, 1,2,3,5-tetrazine, or condensed groups, such as indole, isindole, indolizine, indazole, benzimidazole, benzotriazole, purine, naphthimidazole, phenanthrimidazole, pyridimidazole, pyrazinimidazole, quinoxalinimidazole, benzoxazole, naphthoxazole, anthroxazole, phenanthroxazole, isoxazole, benzothiazole, benzofuran, isobenzofuran, dibenzofuran, quinoline, isoquinoline, pteridine, benzo-5,6-quinoline, benzo-6,7-quinoline, benzo-7,8-quinoline, benzoisoquinoline, acridine, phenothiazine, phenoxazine, benzopyridazine, benzopyrimidine, quinoxaline, phenazine, naphthyridine, azacarbazole, benzocarboline, phenanthridine, phenanthroline, thieno[2,3b]thiophene, thieno[3,2b]thiophene, dithienothiophene, isobenzothiophene, dibenzothiophene, benzothiadiazothiophene, or combinations of these groups.

[0106] The aryl and heteroaryl groups mentioned above and below may also be substituted by alkyl, alkoxy, thioalkyl, fluorine, fluoroalkyl or further aryl or heteroaryl groups.

[0107] The (non-aromatic) alicyclic and heterocyclic groups encompass both saturated rings, i.e. those containing exclusively single bonds, and also partially unsaturated rings, i.e. those which may also contain multiple bonds. Heterocyclic rings contain one or more heteroatoms, preferably selected from Si, O, N, S and Se.

[0108] The (non-aromatic) alicyclic and heterocyclic groups can be monocyclic, i.e. contain only one ring (such as, for example, cyclohexane), or polycyclic, i.e. contain a plurality of rings (such as, for example, decahydronaphthalene or bicyclooctane). Particular preference is given to saturated groups. Preference is furthermore given to mono-, bi- or tricyclic groups having 5 to 25 ring atoms, which optionally contain fused rings and are optionally substituted. Preference is furthermore given to 5-, 6-, 7- or 8-membered carbocyclic groups, in which, in addition, one or more C atoms may be replaced by Si and/or one or more CH groups may be replaced by N and/or one or more non-adjacent CH₂ groups may be replaced by —O— and/or —S—.

[0109] Preferred alicyclic and heterocyclic groups are, for example, 5-membered groups, such as cyclopentane, tetrahydrofuran, tetrahydrothiofuran, pyrrolidine, 6-membered groups, such as cyclohexane, silinane, cyclohexene, tetrahydropyran, tetrahydrothiopyran, 1,3-dioxane, 1,3-dithiane, piperidine, 7-membered groups, such as cycloheptane, and fused groups, such as tetrahydronaphthalene, decahydronaphthalene, indane, bicyclo[1.1.1]pentane-1,3-diyl, bicyclo[2.2.2]octane-1,4-diyl, spiro[3.3]heptane-2,6-diyl, octahydro-4,7-methanoindane-2,5-diyl.

[0110] Preferred substituents are, for example, solubility-promoting groups, such as alkyl or alkoxy, electron-with-

drawing groups, such as fluorine, nitro or nitrile, or substituents for increasing the glass transition temperature (T_g) in the polymer, in particular bulky groups, such as, for example, t-butyl or optionally substituted aryl groups.

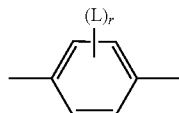
[0111] Preferred substituents, hereinafter also referred to as “L^S”, are, for example, F, Cl, Br, I, —CN, —NO₂, —NCO, —NCS, —OCN, —SCN, —C(=O)N(R^x)₂, —C(=O)Y¹, —C(=O)R^x, —N(R^x)₂, straight-chain or branched alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy each having 1 to 25 C atoms, in which one or more H atoms may optionally be replaced by F or Cl, optionally substituted silyl having 1 to 20 Si atoms, or optionally substituted aryl having 6 to 25, preferably 6 to 15, C atoms,

[0112] wherein R^x denotes H, F, Cl, CN, or straight chain, branched or cyclic alkyl having 1 to 25 C atoms, wherein one or more non-adjacent CH₂-groups are optionally replaced by —O—, —S—, —CO—, —CO—O—, —O—CO—, —O—CO—O— in such a manner that O- and/or S-atoms are not directly connected with each other, and wherein one or more H atoms are each optionally replaced by F, Cl, P— or P-Sp—, and

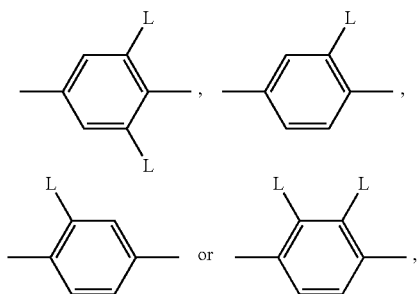
[0113] Y¹ denotes halogen.

[0114] “Substituted silyl or aryl” preferably means substituted by halogen, —CN, R⁰, —OR⁰, —CO—R⁰, —CO—O—R⁰, —O—CO—R⁰ or —O—CO—O—R⁰, wherein R⁰ denotes H or alkyl with 1 to 20 C atoms.

[0115] Particularly preferred substituents L^S are, for example, F, Cl, CN, NO₂, CH₃, C₂H₅, OCH₃, OC₂H₅, COCH₃, COC₂H₅, COOCH₃, COOC₂H₅, CF₃, OCF₃, OCHF₂, OC₂F₅, furthermore phenyl.



is preferably



in which each L, independently, has one of the meanings given for L^S above.

[0116] The compounds of formula I show the following advantageous properties when used in PSA displays:

[0117] a tilt suitable for tilt generation which is inside a certain process window,

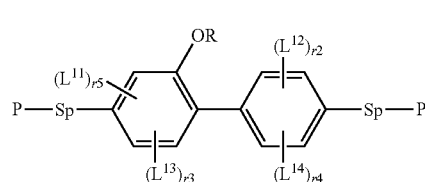
[0118] fast polymerization leading to minimal residues of RM after the UV-process,

[0119] a high voltage-holding-ratio after the UV-process,

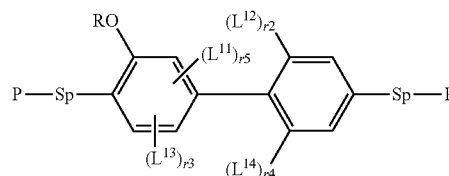
[0120] sufficient stability against heat,

[0121] sufficient solubility in organic solvents typically used in display manufacture.

[0122] Preferred compounds of formula I are selected from the following subformulae:



I1



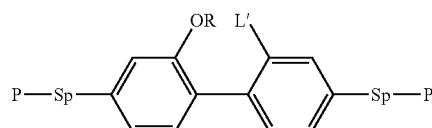
I2

wherein P, Sp, R, L¹¹, L¹², L¹³, L¹⁴, r₂, r₃, r₄ have the meanings given in formula I, r₅ is 0, 1, 2 or 3, r₃+r₅ ≤ 3, and r₂+r₅ is ≥ 1, preferably 1, 2 or 3, very preferably 1 or 2, most preferably 1.

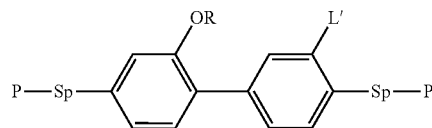
[0123] Especially preferred are compounds of formula I1.

[0124] Preferred compounds of formula I1 are those wherein r₃ is 0 and r₄ is 0.

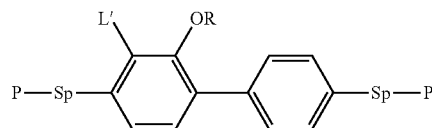
[0125] Very preferred compounds of formula I, I1 and I2 are selected from the following subformulae:



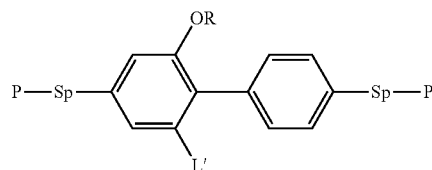
I1-1



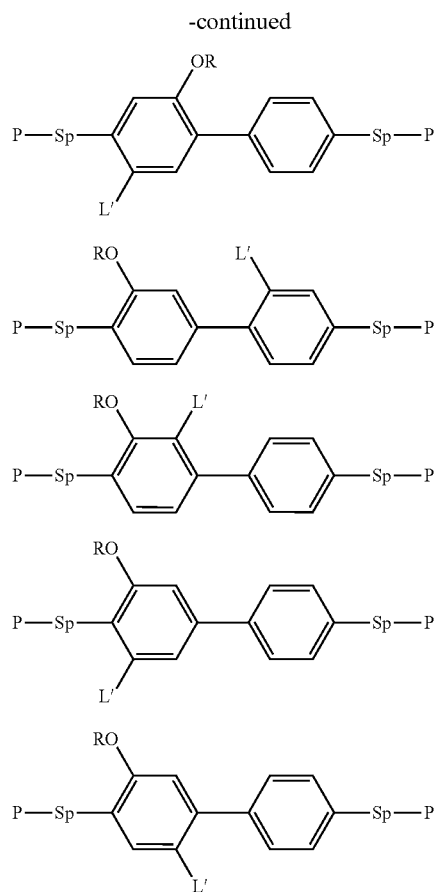
I1-2



I1-3



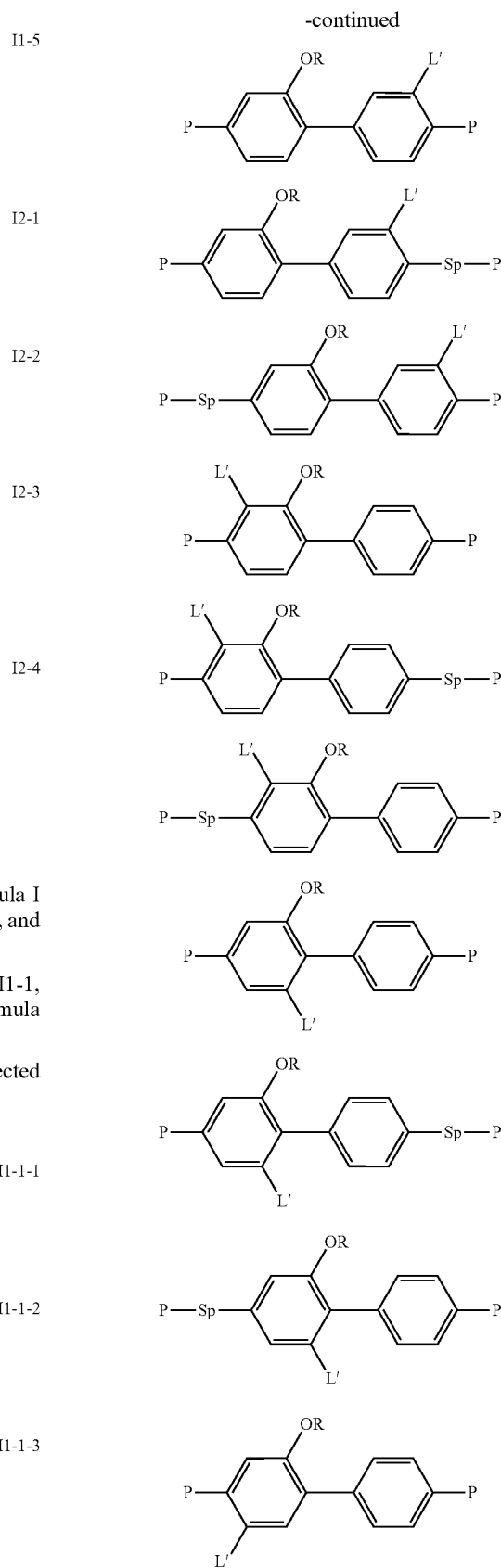
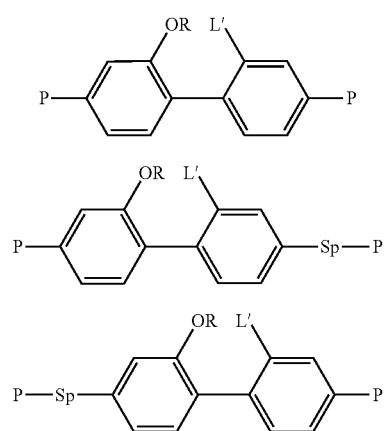
I1-4



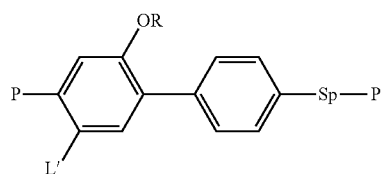
wherein P, Sp and R have the meanings given in formula I or one of the preferred meanings given above and below, and L' is F or Cl, preferably F.

[0126] Preferred compounds are those of formula I1-1, I1-2, I1-4, I2-1 and I2-2, very preferred those of formula I1-1.

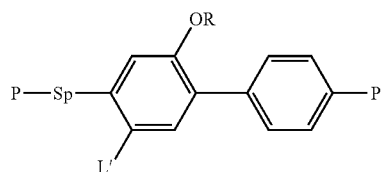
[0127] Very preferred compounds of formula I are selected from the following subformulae:



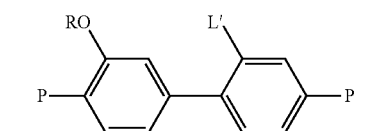
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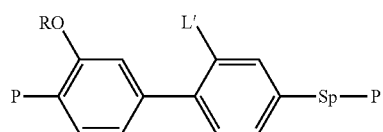
I1-5-2



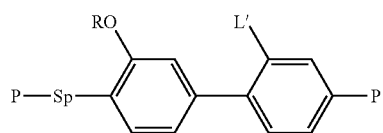
I1-5-3



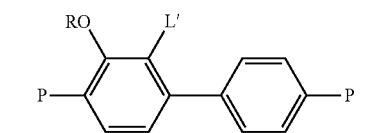
I2-1-1



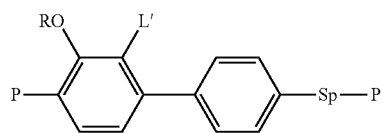
I2-1-2



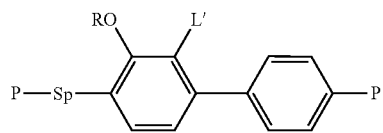
I2-1-3



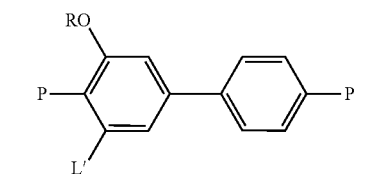
I2-2-1



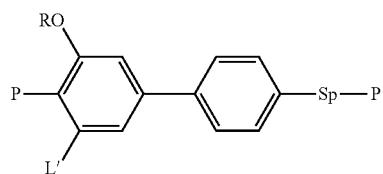
I2-2-2



I2-2-3

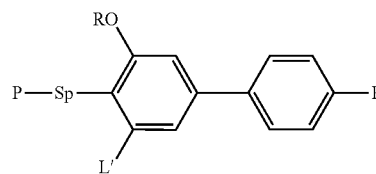


I2-3-1

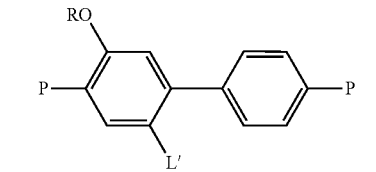


I2-3-2

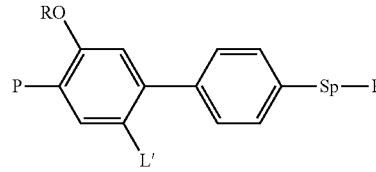
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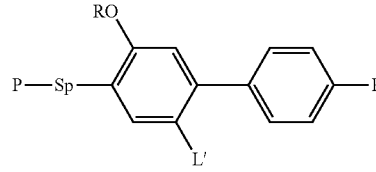
I2-3-3



I2-4-1



I2-4-2



I2-4-3

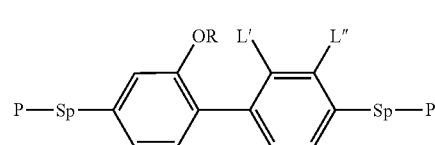
wherein P, R and L' have the meanings given in formula I1-1, and Sp has one of the meanings given in formula I which is different from a single bond.

[0128] Preferred compounds are those of formula I1-1-1, I1-1-2, I1-1-3, I1-2-1, I1-2-1, I1-2-3, I1-4-1, I1-4-2, I1-4-3, I2-1-1, I2-1-2, I2-1-3, I2-2-1, I2-2-2 and I2-2-3, very preferred those of formula I1-1-1, I1-1-2 and I1-1-3.

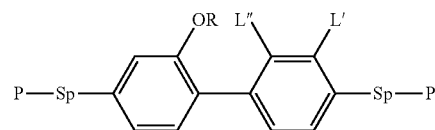
[0129] Another preferred embodiment relates to compounds of formula I1 and I2 wherein $r3+r4>0$, preferably $r3+r4$ is 1 or 2.

[0130] Preferred compounds of this preferred embodiment are those wherein $r3+r4>0$, preferably $r3+r4$ is 1 or 2, and L^{13} and L^{14} denote F, Cl, CN, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy each having 1 to 6 C atoms, in which one or more H atoms may optionally be replaced by F or Cl, and very preferably L^{13} and L^{14} denote F, Cl or OR wherein R is as defined above.

[0131] Very preferred compounds of this preferred embodiment are selected from the following subformulae:

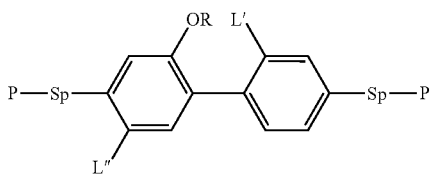
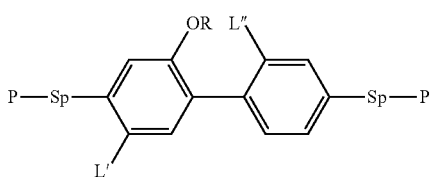
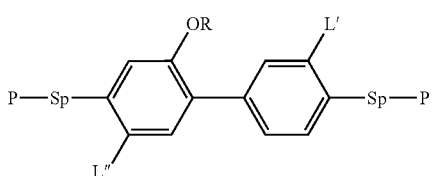
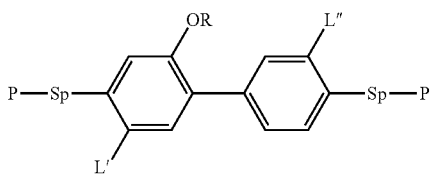
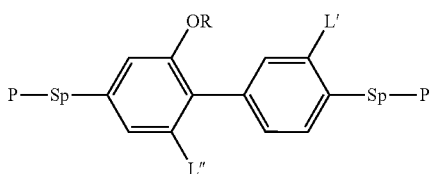
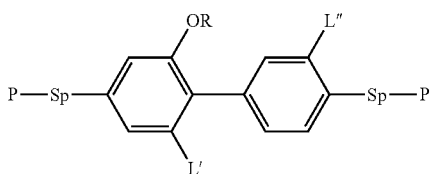
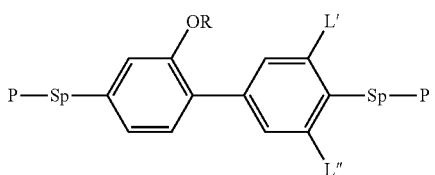
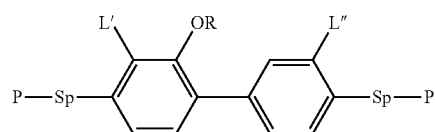
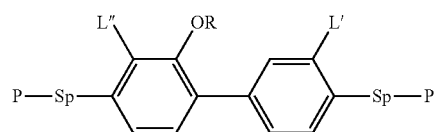


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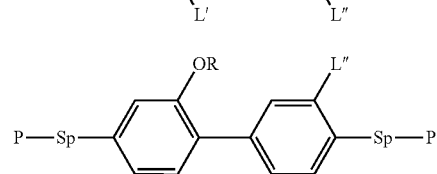
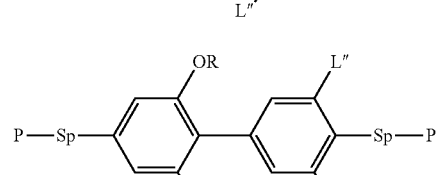
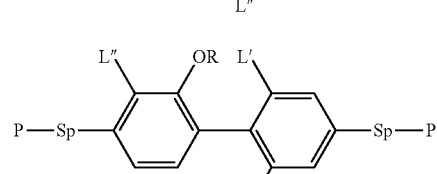
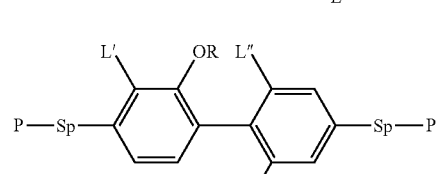
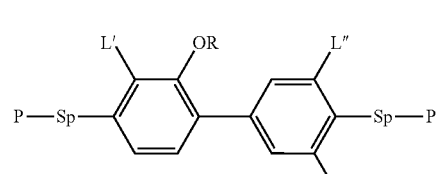
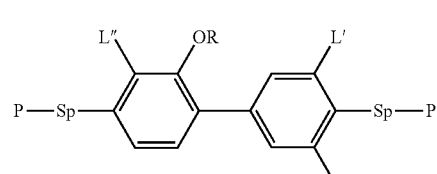
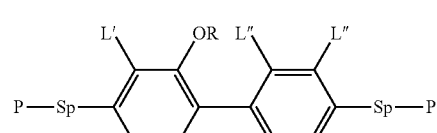
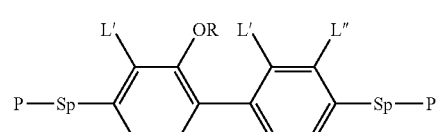
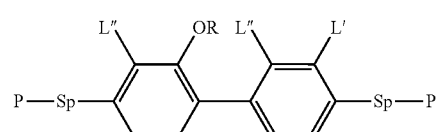


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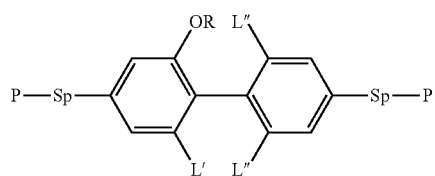
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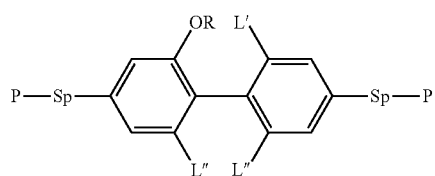
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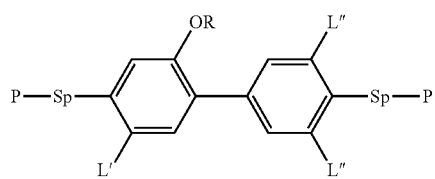
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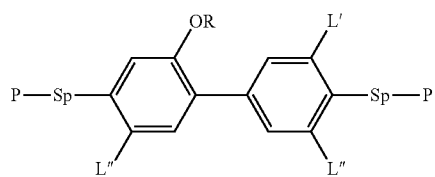
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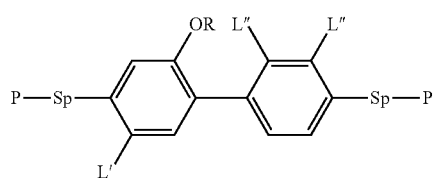
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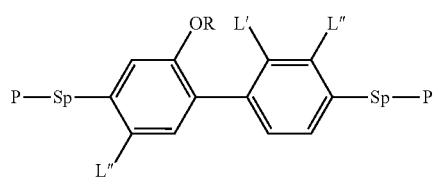
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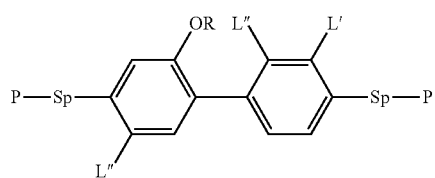
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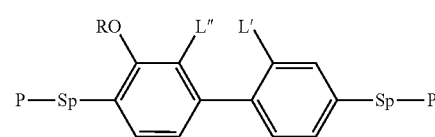
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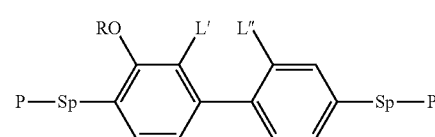
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II-32

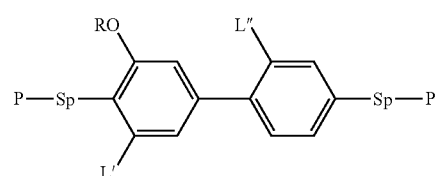


I2-5

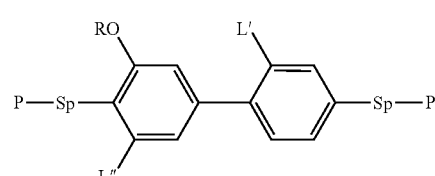


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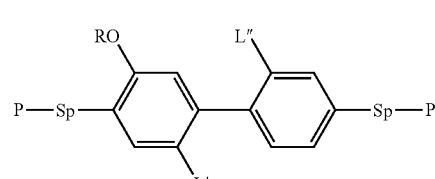
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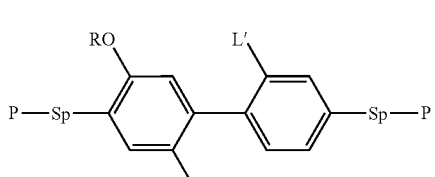
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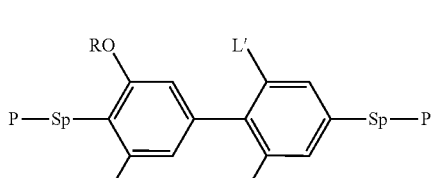
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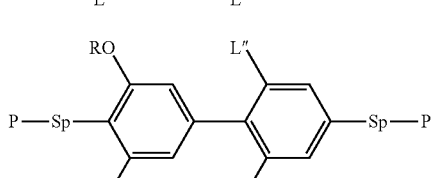
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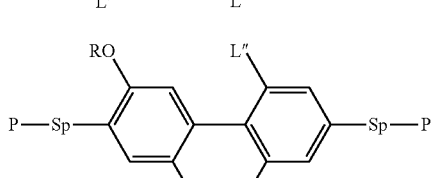
I2-10



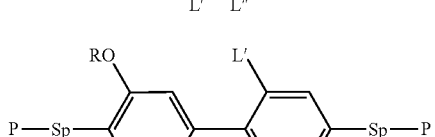
I2-11



I2-12



I2-13



I2-14

wherein P, Sp and R have the meanings given in formula I or one of the preferred meanings given above and below, L'

is F or Cl, preferably F, and V has one of the meanings given for L¹³ in formula I or one of its preferred meanings given above and below.

[0132] Preferred compounds of formula I1-6 to I2-14 are those wherein both groups Sp denote a single bond.

[0133] Further preferred compounds of formula I1-6 to I2-14 are those wherein one of the two groups Sp is a single bond and the other is different from a single bond.

[0134] Preferred compounds of formula I and II and their subformulae are selected from the following preferred embodiments, including any combination thereof:

[0135] P is methacrylate,

[0136] both groups Sp are a single bond,

[0137] one of the two groups Sp is a single bond and the other is $-(CH_2)_{p1}-$, $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$, or $-CO-O-(CH_2)_{p1}-$, wherein p1 is 2, 3, 4, 5 or 6,

[0138] if Sp is different from a single bond, it is selected from $-(CH_2)_{p1}-$, $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$, or $-CO-O-(CH_2)_{p1}-$, wherein p1 is 2, 3, 4, 5 or 6,

[0139] r1+r2 is 2,

[0140] r1 is 1 and r2 is 1,

[0141] r1 is 2 and r2 is 0, or r1 is 0 and r2 is 2,

[0142] r1+r2 is 3,

[0143] r1 is 1 and r2 is 2, or r1 is 2 and r2 is 1,

[0144] r3 is 0,

[0145] r4 is 0,

[0146] r3+r4 is 0,

[0147] r3+r4 is 1 or 2,

[0148] r2+r5 is 1 or 2, preferably 1,

[0149] L¹¹ and L¹² are selected from F or OR,

[0150] R is OCH₃ or OC₂H₅, preferably OCH₃,

[0151] L¹¹ and L¹² are selected from F, OCH₃ or OC₂H₅,

[0152] the compound contains two groups L¹¹ and L¹², one of which is F or Cl, and the other of which is OR,

[0153] the compound contains two groups L¹¹ and L¹², one of which is F, and the other of which is OCH₃,

[0154] L' is F,

[0155] L¹³ and L¹⁴ denote F, Cl, CN, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy each having 1 to 6 C atoms, in which one or more H atoms may optionally be replaced by F or Cl,

[0156] L¹³ and L¹⁴ are F, Cl or OR wherein R is as defined above.

[0157] L" is F, Cl, CN, alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy each having 1 to 6 C atoms, in which one or more H atoms may optionally be replaced by F or Cl,

[0158] L" is F, Cl or OR wherein R is as defined above.

[0159] Preferred compounds of formula II are those selected from the above preferred subformulae I1-1 to I2-4, I1-1-1 to I2-4-3, and I1-6 to I2-14 wherein P is replaced by Pg as defined in formula II.

[0160] Suitable protected hydroxyl groups Pg for use in compounds of formula II and its subformulae are known to the person skilled in the art. Preferred protecting groups for hydroxyl groups are alkyl, alkoxyalkyl, acyl, alkylsilyl, arylsilyl and arylmethyl groups, especially 2-tetrahydropyrany, methoxymethyl, methoxyethoxymethyl, acetyl, triisopropylsilyl, tert-butyl-dimethylsilyl or benzyl.

[0161] The term "masked hydroxyl group" is understood to mean any functional group that can be chemically converted into a hydroxyl group. Suitable masked hydroxyl groups Pg are known to the person skilled in the art.

[0162] The compounds of formula II are suitable as intermediates for the preparation of compounds of the formula I and its subformulae.

[0163] The invention further relates to the use of the compounds of formula II as intermediates for the preparation of compounds of the formula I and its subformulae.

[0164] The compounds and intermediates of the formulae I and II and sub-formulae thereof can be prepared analogously to processes known to the person skilled in the art and described in standard works of organic chemistry, such as, for example, in Houben-Weyl, Methoden der organischen Chemie [Methods of Organic Chemistry], Thieme-Verlag, Stuttgart.

[0165] For example, compounds of formula I can be synthesised by esterification or etherification of the intermediates of formula II, wherein Pg denotes OH, using corresponding acids, acid derivatives, or halogenated compounds containing a polymerisable group P.

[0166] For example, acrylic or methacrylic esters can be prepared by esterification of the corresponding alcohols with acid derivatives like, for example, (meth)acryloyl chloride or (meth)acrylic anhydride in the presence of a base like pyridine or triethyl amine, and 4-(N,N-dimethylamino)pyridine (DMAP). Alternatively the esters can be prepared by esterification of the alcohols with (meth)acrylic acid in the presence of a dehydrating reagent, for example according to Steglich with dicyclohexylcarbodiimide (DCC), N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide (EDC) or N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride and DMAP.

[0167] Further suitable methods are shown in the examples.

[0168] For the production of PSA displays, the polymerisable compounds contained in the LC medium are polymerised or crosslinked (if one compound contains two or more polymerisable groups) by in-situ polymerisation in the LC medium between the substrates of the LC display, optionally while a voltage is applied to the electrodes.

[0169] The structure of the PSA displays according to the invention corresponds to the usual geometry for PSA displays, as described in the prior art cited at the outset. Geometries without protrusions are preferred, in particular those in which, in addition, the electrode on the colour filter side is unstructured and only the electrode on the TFT side has slots. Particularly suitable and preferred electrode structures for PS-VA displays are described, for example, in US 2006/0066793 A1.

[0170] A preferred PSA type LC display of the present invention comprises:

[0171] a first substrate including a pixel electrode defining pixel areas, the pixel electrode being connected to a switching element disposed in each pixel area and optionally including a micro-slit pattern, and optionally a first alignment layer disposed on the pixel electrode,

[0172] a second substrate including a common electrode layer, which may be disposed on the entire portion of the second substrate facing the first substrate, and optionally a second alignment layer,

[0173] an LC layer disposed between the first and second substrates and including an LC medium com-

prising a polymerisable component A and a liquid crystal component B as described above and below, wherein the polymerisable component A may also be polymerised.

[0174] The first and/or second alignment layer controls the alignment direction of the LC molecules of the LC layer. For example, in PS-VA displays the alignment layer is selected such that it imparts to the LC molecules homeotropic (or vertical) alignment (i.e. perpendicular to the surface) or tilted alignment. Such an alignment layer may for example comprise a polyimide, which may also be rubbed, or may be prepared by a photoalignment method.

[0175] The LC layer with the LC medium can be deposited between the substrates of the display by methods that are conventionally used by display manufacturers, for example the so-called one-drop-filling (ODF) method. The polymerisable component of the LC medium is then polymerised for example by UV photopolymerisation. The polymerisation can be carried out in one step or in two or more steps.

[0176] The PSA display may comprise further elements, like a colour filter, a black matrix, a passivation layer, optical retardation layers, transistor elements for addressing the individual pixels, etc., all of which are well known to the person skilled in the art and can be employed without inventive skill.

[0177] The electrode structure can be designed by the skilled person depending on the individual display type. For example for PS-VA displays a multi-domain orientation of the LC molecules can be induced by providing electrodes having slits and/or bumps or protrusions in order to create two, four or more different tilt alignment directions.

[0178] Upon polymerisation the polymerisable compounds form a crosslinked polymer, which causes a certain pretilt of the LC molecules in the LC medium. Without wishing to be bound to a specific theory, it is believed that at least a part of the crosslinked polymer, which is formed by the polymerisable compounds, will phase-separate or precipitate from the LC medium and form a polymer layer on the substrates or electrodes, or the alignment layer provided thereon. Microscopic measurement data (like SEM and AFM) have confirmed that at least a part of the formed polymer accumulates at the LC/substrate interface.

[0179] The polymerisation can be carried out in one step. It is also possible firstly to carry out the polymerisation, optionally while applying a voltage, in a first step in order to produce a pretilt angle, and subsequently, in a second polymerisation step without an applied voltage, to polymerise or crosslink the compounds which have not reacted in the first step ("end curing").

[0180] Suitable and preferred polymerisation methods are, for example, thermal or photopolymerisation, preferably photopolymerisation, in particular UV induced photopolymerisation, which can be achieved by exposure of the polymerisable compounds to UV radiation.

[0181] Optionally one or more polymerisation initiators are added to the LC medium. Suitable conditions for the polymerisation and suitable types and amounts of initiators are known to the person skilled in the art and are described in the literature. Suitable for free-radical polymerisation are, for example, the commercially available photoinitiators Irgacure651®, Irgacure184e, Irgacure907®, Irgacure369® or Darocure1173® (Ciba AG). If a polymerisation initiator

is employed, its proportion is preferably 0.001 to 5% by weight, particularly preferably 0.001 to 1% by weight.

[0182] The polymerisable compounds according to the invention are also suitable for polymerisation without an initiator, which is accompanied by considerable advantages, such, for example, lower material costs and in particular less contamination of the LC medium by possible residual amounts of the initiator or degradation products thereof. The polymerisation can thus also be carried out without the addition of an initiator. In a preferred embodiment, the LC medium thus does not contain a polymerisation initiator.

[0183] The LC medium may also comprise one or more stabilisers in order to prevent undesired spontaneous polymerisation of the RMs, for example during storage or transport. Suitable types and amounts of stabilisers are known to the person skilled in the art and are described in the literature. Particularly suitable are, for example, the commercially available stabilisers from the Irganox® series (Ciba AG), such as, for example, Irganox® 1076. If stabilisers are employed, their proportion, based on the total amount of RMs or the polymerisable component (component A), is preferably 10-500,000 ppm, particularly preferably 50-50,000 ppm.

[0184] The polymerisable compounds of formula I do in particular show good UV absorption in, and are therefore especially suitable for, a process of preparing a PSA display including one or more of the following features:

[0185] the polymerisable medium is exposed to UV light in the display in a 2-step process, including a first UV exposure step ("UV-1 step") to generate the tilt angle, and a second UV exposure step ("UV-2 step") to finish polymerization,

[0186] the polymerisable medium is exposed to UV light in the display generated by an energy-saving UV lamp (also known as "green UV lamps"). These lamps are characterized by a relative low intensity ($1/100-1/10$ of a conventional UV1 lamp) in their absorption spectra from 300-380 nm, and are preferably used in the UV2 step, but are optionally also used in the UV1 step when avoiding high intensity is necessary for the process.

[0187] the polymerisable medium is exposed to UV light in the display generated by a UV lamp with a radiation spectrum that is shifted to longer wavelengths, preferably 340 nm or more, to avoid short UV light exposure in the PS-VA process.

[0188] Both using lower intensity and a UV shift to longer wavelengths protect the organic layer against damage that may be caused by the UV light.

[0189] A preferred embodiment of the present invention relates to a process for preparing a PSA display as described above and below, comprising one or more of the following features:

[0190] the polymerisable LC medium is exposed to UV light in a 2-step process, including a first UV exposure step ("UV-1 step") to generate the tilt angle, and a second UV exposure step ("UV-2 step") to finish polymerization,

[0191] the polymerisable LC medium is exposed to UV light generated by a UV lamp having an intensity of from 0.5 mW/cm² to 10 mW/cm² in the wavelength range from 300-380 nm, preferably used in the UV2 step, and optionally also in the UV1 step,

[0192] the polymerisable LC medium is exposed to UV light having a wavelength of 340 nm or more, and preferably 400 nm or less.

[0193] This preferred process can be carried out for example by using the desired UV lamps or by using a band pass filter and/or a cut-off filter, which are substantially transmissive for UV light with the respective desired wavelength(s) and are substantially blocking light with the respective undesired wavelengths. For example, when irradiation with UV light of wavelengths λ of 300-400 nm is desired, UV exposure can be carried out using a wide band pass filter being substantially transmissive for wavelengths 300 nm $< \lambda < 400$ nm. When irradiation with UV light of wavelength λ of more than 340 nm is desired, UV exposure can be carried out using a cut-off filter being substantially transmissive for wavelengths $\lambda > 340$ nm.

[0194] "Substantially transmissive" means that the filter transmits a substantial part, preferably at least 50% of the intensity, of incident light of the desired wavelength(s). "Substantially blocking" means that the filter does not transmit a substantial part, preferably at least 50% of the intensity, of incident light of the undesired wavelengths. "Desired (undesired) wavelength" e.g. in case of a band pass filter means the wavelengths inside (outside) the given range of λ , and in case of a cut-off filter means the wavelengths above (below) the given value of λ .

[0195] This preferred process enables the manufacture of displays by using longer UV wavelengths, thereby reducing or even avoiding the hazardous and damaging effects of short UV light components.

[0196] UV radiation energy is in general from 6 to 100 J, depending on the production process conditions.

[0197] Preferably the LC medium according to the present invention does essentially consist of a polymerisable component A), or one or more polymerisable compounds of formula I, and an LC component B), or LC host mixture, as described above and below. However, the LC medium may additionally comprise one or more further components or additives, preferably selected from the list including but not limited to co-monomers, chiral dopants, polymerisation initiators, inhibitors, stabilizers, surfactants, wetting agents, lubricating agents, dispersing agents, hydrophobing agents, adhesive agents, flow improvers, defoaming agents, deaerators, diluents, reactive diluents, auxiliaries, colourants, dyes, pigments and nanoparticles.

[0198] Particular preference is given to LC media comprising one, two or three polymerisable compounds of formula I.

[0199] Preference is furthermore given to LC media in which the polymerisable component A) comprises exclusively polymerisable compounds of formula I.

[0200] Preference is furthermore given to LC media in which the liquid-crystalline component B) or the LC host mixture has a nematic LC phase, and preferably has no chiral liquid crystal phase.

[0201] The LC component B), or LC host mixture, is preferably a nematic LC mixture.

[0202] Preference is furthermore given to achiral compounds of formula I, and to LC media in which the compounds of component A) and/or B) are selected exclusively from the group consisting of achiral compounds.

[0203] Preferably the proportion of the polymerisable component A) in the LC medium is from >0 to $<5\%$, very preferably from >0 to $<1\%$, most preferably from 0.01 to 0.5%.

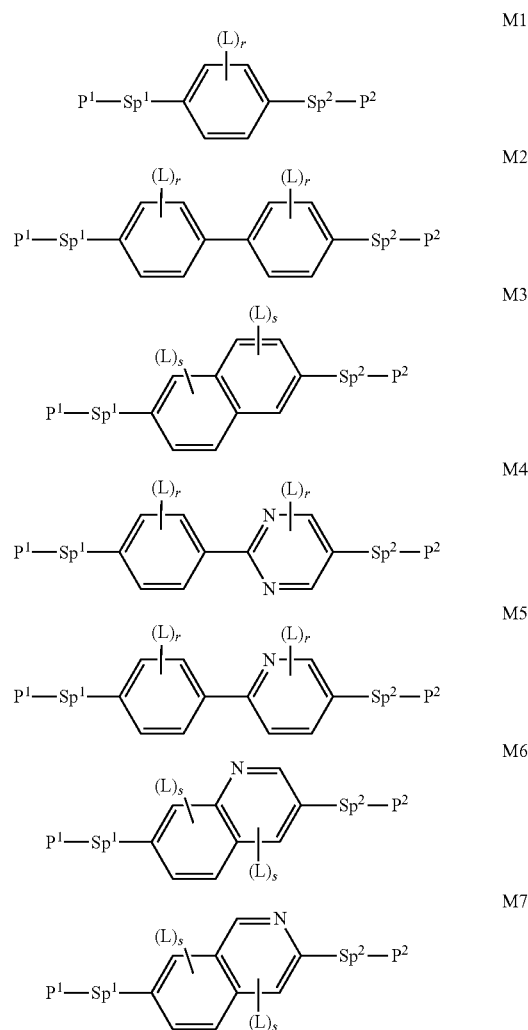
[0204] Preferably the proportion of compounds of formula I in the LC medium is from >0 to $<5\%$, very preferably from >0 to $<1\%$, most preferably from 0.01 to 0.5%.

[0205] Preferably the proportion of the LC component B) in the LC medium is from 95 to $<100\%$, very preferably from 99 to $<100\%$.

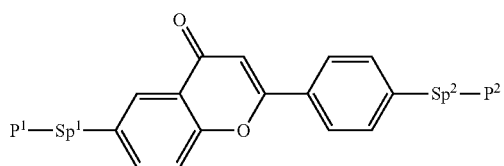
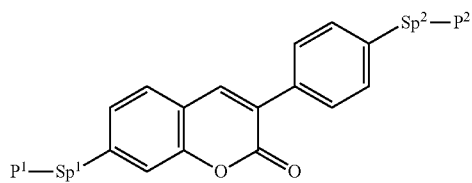
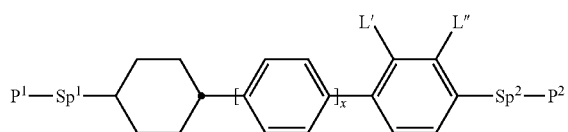
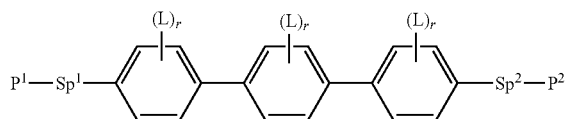
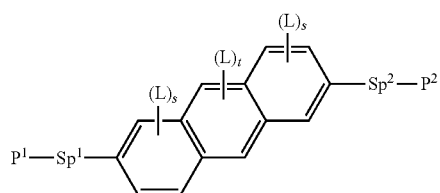
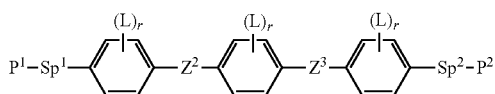
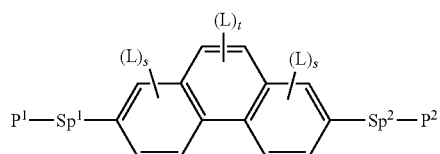
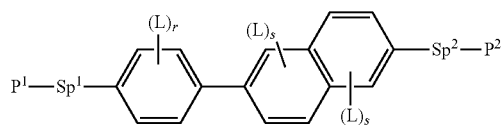
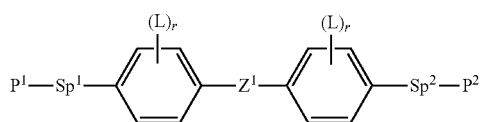
[0206] In a preferred embodiment the polymerisable compounds of the polymerisable component B) are exclusively selected from formula I.

[0207] In another preferred embodiment the polymerisable component B) comprises, in addition to the compounds of formula I, one or more further mesogenic polymerisable compounds ("co-monomers"), preferably selected from RMs.

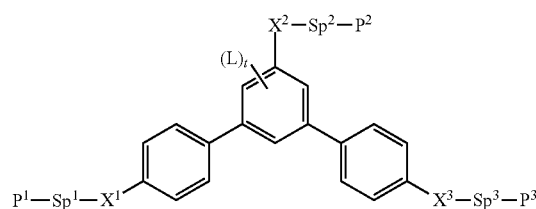
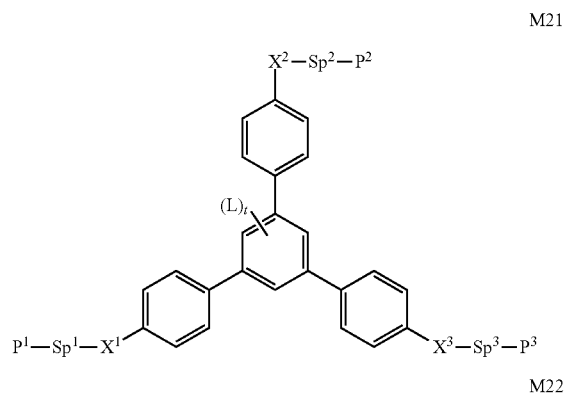
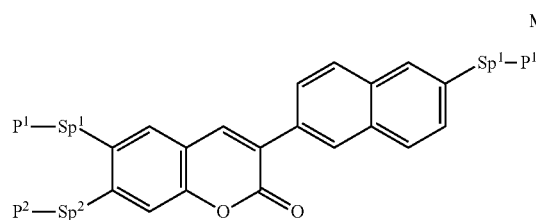
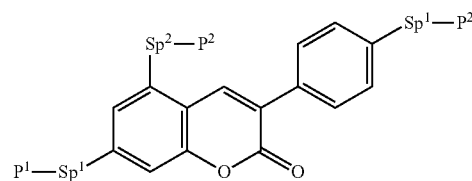
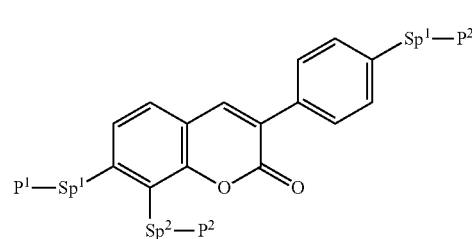
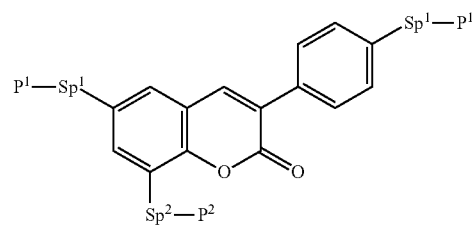
[0208] Suitable and preferred mesogenic polymerisable comonomers are selected from the following formulae:



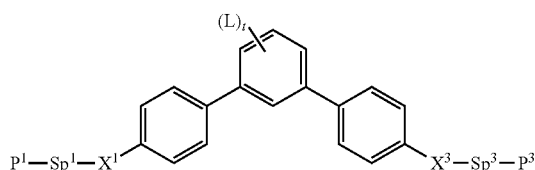
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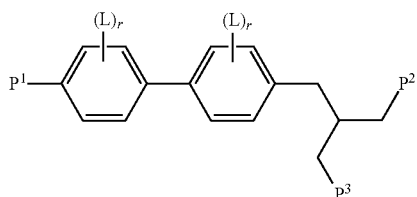
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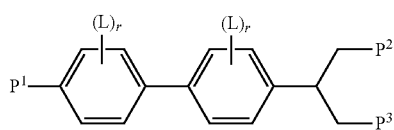
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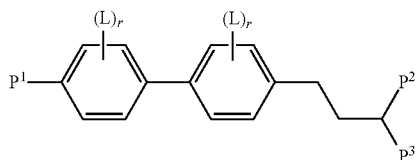
M23



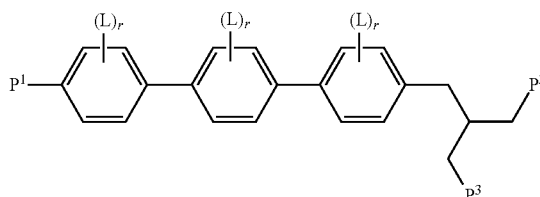
M24



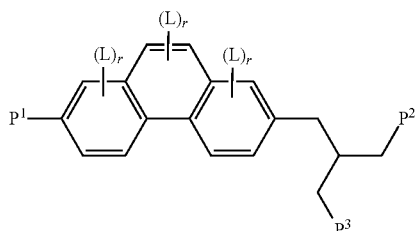
M25



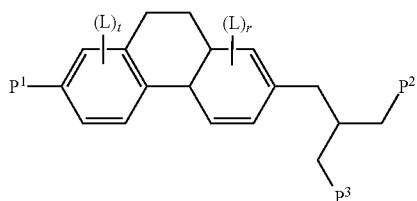
M26



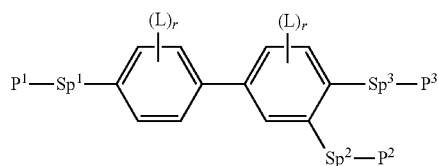
M27



M28

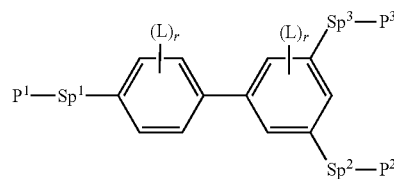


M29



M30

-continued



M31

in which the individual radicals have the following meanings:

[0209] P^1 , P^2 and P^3 each, independently of one another, denote an acrylate or methacrylate group,

[0210] Sp^1 , Sp^2 and Sp^3 each, independently of one another, denote a single bond or a spacer group having one of the meanings indicated above and below for Sp , and particularly preferably denote $-(CH_2)_{p1}-$, $-(CH_2)_{p1}-O-$, $-(CH_2)_{p1}-CO-O-$, $-(CH_2)_{p1}-O-CO-$ or $-(CH_2)_{p1}-O-CO-O-$, in which $p1$ is an integer from 1 to 12, where, in addition, one or more of the radicals P^1-Sp^1- , P^1-Sp^2- and P^3-Sp^3- may denote R^{aa} , with the proviso that at least one of the radicals P^1-Sp^1- , P^2-Sp^2 and P^3-Sp^3- present is different from R^{aa} ,

[0211] R^{aa} denotes H, F, Cl, CN or straight-chain or branched alkyl having 1 to 25 C atoms, in which, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by $C(R^0)=C(R^{00})-$, $-C\equiv C-$, $-N(R^0)-$, $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$, $-O-CO-O-$ in such a way that O and/or S atoms are not linked directly to one another, and in which, in addition, one or more H atoms may be replaced by F, Cl, CN or P^1-Sp^1- , particularly preferably straight-chain or branched, optionally mono- or polyfluorinated alkyl, alkoxy, alkenyl, alkynyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 12 C atoms (where the alkenyl and alkynyl radicals have at least two C atoms and the branched radicals have at least three C atoms),

[0212] R^0 , R^{00} each, independently of one another and identically or differently on each occurrence, denote H or alkyl having 1 to 12 C atoms,

[0213] R^v and R^z each, independently of one another, denote H, F, CH_3 or CF_3 ,

[0214] X^1 , X^2 and X^3 each, independently of one another, denote $-CO-O-$, $-O-CO-$ or a single bond,

[0215] Z^1 denotes $-O-$, $-CO-$, $-C(R^vR^z)-$ or $-CF_2CF_2-$,

[0216] Z^2 and Z^3 each, independently of one another, denote $-CO-O-$, $-O-CO-$, $-CH_2O-$, $-OCH_2-$, $-CF_2O-$, $-OCF_2-$ or $-(CH_2)_n-$, where n is 2, 3 or 4,

[0217] L on each occurrence, identically or differently, denotes F, Cl, CN or straight-chain or branched, optionally mono- or polyfluorinated alkyl, alkoxy, alkenyl, alkynyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 12 C atoms, preferably F,

[0218] L' and L'' each, independently of one another, denote H, F or Cl,

[0219] r denotes 0, 1, 2, 3 or 4,

[0220] s denotes 0, 1, 2 or 3,

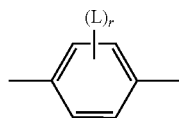
[0221] t denotes 0, 1 or 2,

[0222] x denotes 0 or 1.

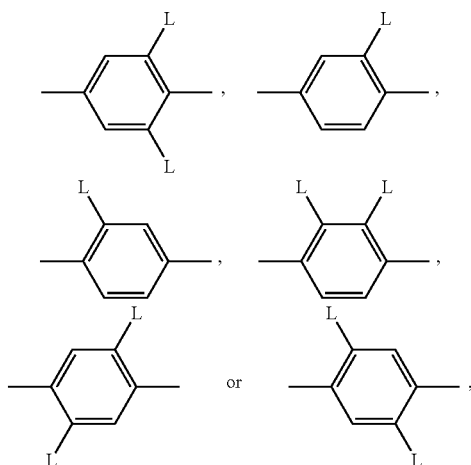
[0223] Especially preferred are compounds of formulae M2, M13, M17, M22, M23, M24 and M30.

[0224] Further preferred are trireactive compounds M15 to M30, in particular M17, M18, M19, M22, M23, M24, M25, M26, M30 and M31.

[0225] In the compounds of formulae M1 to M31 the group



is preferably



wherein L on each occurrence, identically or differently, has one of the meanings given above or below, and is preferably F, Cl, CN, NO₂, CH₃, C₂H₅, C(CH₃)₃, CH(CH₃)₂, CH₂CH(CH₃)C₂H₅, OCH₃, OC₂H₅, COCH₃, COC₂H₅, COOCH₃, COOC₂H₅, CF₃, OCF₃, OCHF₂, OC₂F₅ or P-Sp-, very preferably F, Cl, CN, CH₃, C₂H₅, OCH₃, COCH₃, OCF₃ or P-Sp-, more preferably F, Cl, CH₃, OCH₃, COCH₃ oder OCF₃, especially F or CH₃.

[0226] Besides the polymerisable compounds described above, the LC media for use in the LC displays according to the invention comprise an LC mixture ("host mixture") comprising one or more, preferably two or more LC compounds which are selected from low-molecular-weight compounds that are unpolymersable. These LC compounds are selected such that they stable and/or unreactive to a polymerisation reaction under the conditions applied to the polymerisation of the polymerisable compounds.

[0227] In principle, any LC mixture which is suitable for use in conventional displays is suitable as host mixture. Suitable LC mixtures are known to the person skilled in the art and are described in the literature, for example mixtures in VA displays in EP 1 378 557 A1 and mixtures for OCB displays in EP 1 306 418 A1 and DE 102 24 046 A1.

[0228] The polymerisable compounds of formula I are especially suitable for use in an LC host mixture that comprises one or more mesogenic or LC compounds comprising an alkenyl group (hereinafter also referred to as "alkenyl compounds"), wherein said alkenyl group is stable

to a polymerisation reaction under the conditions used for polymerisation of the compounds of formula I and of the other polymerisable compounds contained in the LC medium. Compared to RMs known from prior art, the compounds of formula I in such an LC host mixture exhibit improved properties, like solubility, reactivity or capability of generating a tilt angle.

[0229] Thus, in addition to the polymerisable compounds of formula I, the LC medium according to the present invention comprises one or more mesogenic or liquid crystalline compounds comprising an alkenyl group, ("alkenyl compound"), where this alkenyl group is preferably stable to a polymerisation reaction under the conditions used for the polymerisation of the polymerisable compounds of formula I or of the other polymerisable compounds contained in the LC medium.

[0230] The alkenyl groups in the alkenyl compounds are preferably selected from straight-chain, branched or cyclic alkenyl, in particular having 2 to 25 C atoms, particularly preferably having 2 to 12 C atoms, in which, in addition, one or more non-adjacent CH₂ groups may be replaced by —O—, —S—, —CO—, —CO—O—, —O—CO—, —O—CO—O— in such a way that O and/or S atoms are not linked directly to one another, and in which, in addition, one or more H atoms may be replaced by F and/or Cl.

[0231] Preferred alkenyl groups are straight-chain alkenyl having 2 to 7 C atoms and cyclohexenyl, in particular ethenyl, propenyl, butenyl, hexenyl, heptenyl, 1,4-cyclohexen-1-yl and 1,4-cyclohexen-3-yl.

[0232] The concentration of compounds containing an alkenyl group in the LC host mixture (i.e. without any polymerisable compounds) is preferably from 5% to 100%, very preferably from 20% to 60%.

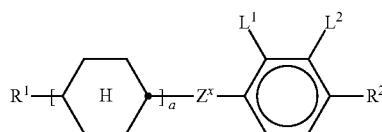
[0233] Especially preferred are LC mixtures containing 1 to 5, preferably 1, 2 or 3 compounds having an alkenyl group.

[0234] The mesogenic and LC compounds containing an alkenyl group are preferably selected from formulae AN and AY as defined below.

[0235] Besides the polymerisable component A) as described above, the LC media according to the present invention comprise an LC component B), or LC host mixture, comprising one or more, preferably two or more LC compounds which are selected from low-molecular-weight compounds that are unpolymersable. These LC compounds are selected such that they stable and/or unreactive to a polymerisation reaction under the conditions applied to the polymerisation of the polymerisable compounds.

[0236] In a first preferred embodiment the LC medium contains an LC component B), or LC host mixture, based on compounds with negative dielectric anisotropy. Such LC media are especially suitable for use in PS-VA and PS-UB-FFS displays. Particularly preferred embodiments of such an LC medium are those of sections a)-z3) below:

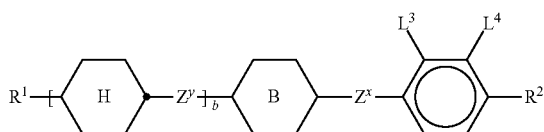
[0237] a) LC medium wherein the component B) or LC host mixture comprises one or more compounds selected from formulae CY and PY:



CY

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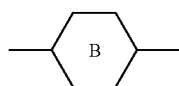
PY



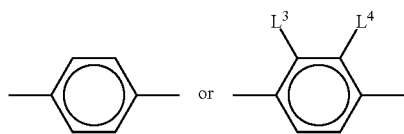
[0238] wherein

[0239] a denotes 1 or 2,

[0240] b denotes 0 or 1,



denotes



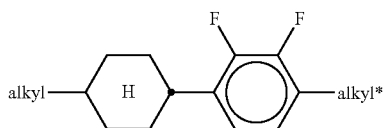
[0241] R^1 and R^2 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by $-O-$, $-CH=CH-$, $-CO-$, $-OCO-$ or $-COO-$ in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,

[0242] Z^x and Z^y each, independently of one another, denote $-CH_2CH_2-$, $-CH=CH-$, $-CF_2O-$, $-OCF_2-$, $-CH_2O-$, $-OCH_2-$, $-COO-$, $-O-CO-$, $-C_2F_4-$, $-CF=CF-$, $-CH=CH-CH_2O-$ or a single bond, preferably a single bond,

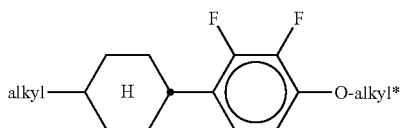
[0243] L^{1-4} each, independently of one another, denote F, Cl, OCF_3 , CF_3 , CH_3 , CH_2F , CHF_2 .

[0244] Preferably, both L^1 and L^2 denote F or one of L^1 and L^2 denotes F and the other denotes Cl, or both L^3 and L^4 denote F or one of L^3 and L^4 denotes F and the other denotes Cl.

[0245] The compounds of the formula CY are preferably selected from the group consisting of the following sub-formulae:



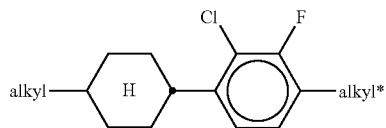
CY1



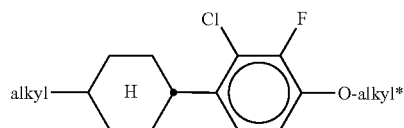
CY2

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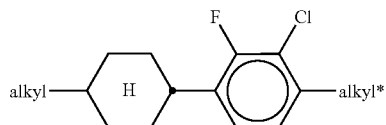
CY3



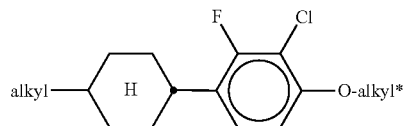
CY4



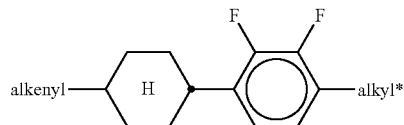
CY5



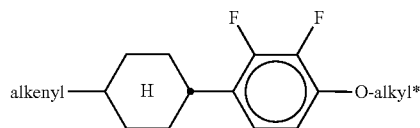
CY6



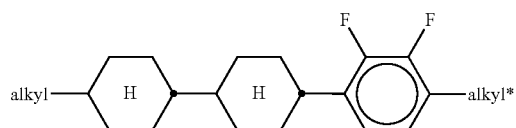
CY7



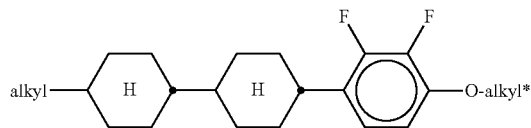
CY8



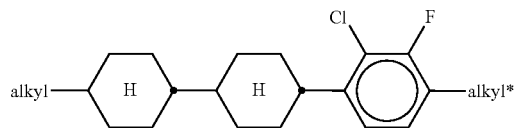
CY9



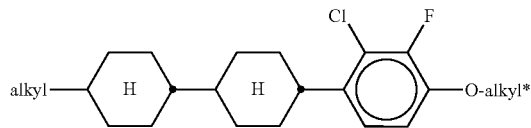
CY10



CY11

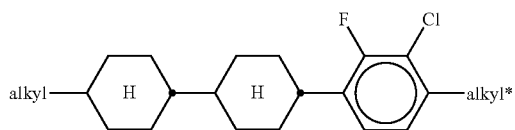


CY12

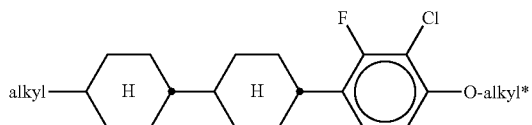


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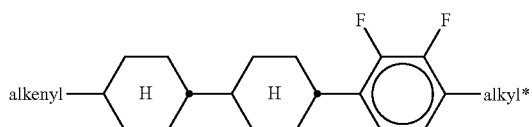
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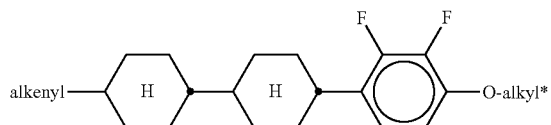
CY14



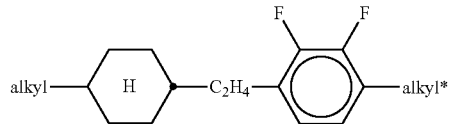
CY15



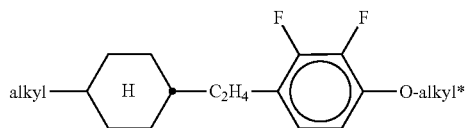
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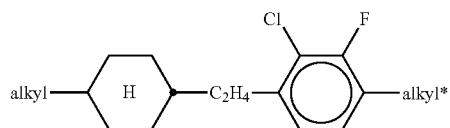
CY17



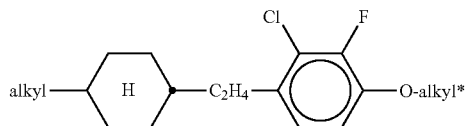
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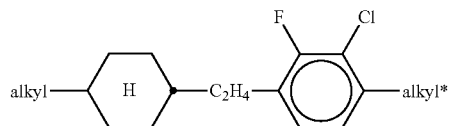
CY19



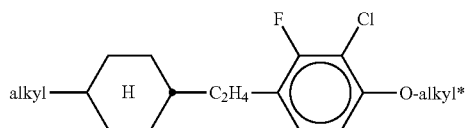
CY20



CY21

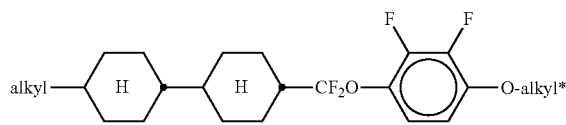


CY22

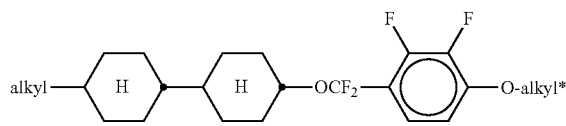


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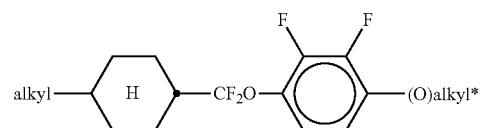
CY23



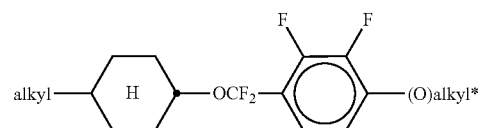
CY24



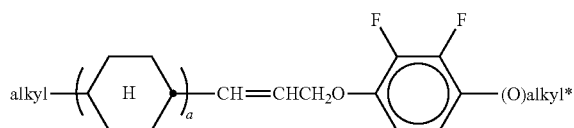
CY25



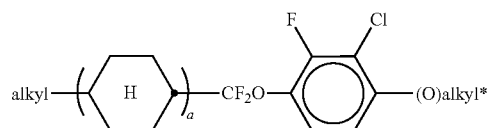
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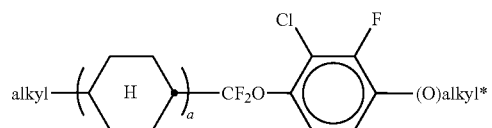
CY27



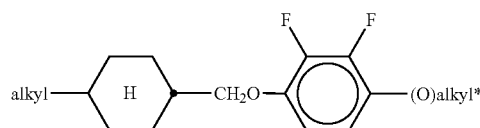
CY28



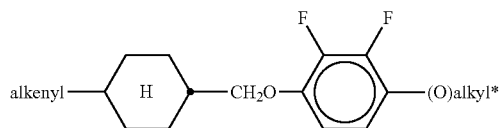
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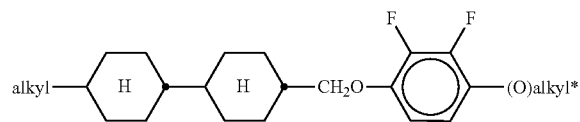
CY30



CY31

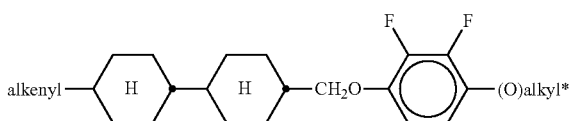


CY32



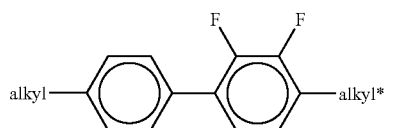
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CY33

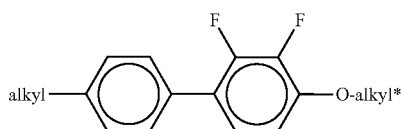


[0246] in which a denotes 1 or 2, alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms, and (O) denotes an oxygen atom or a single bond. Alkenyl preferably denotes $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

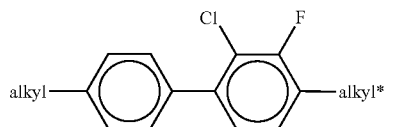
[0247] The compounds of the formula PY are preferably selected from the group consisting of the following sub-formulae:



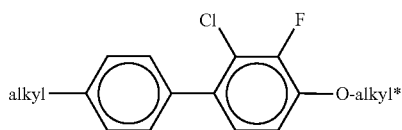
PY1



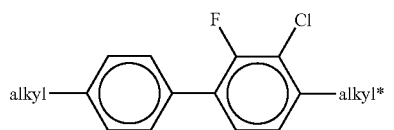
PY2



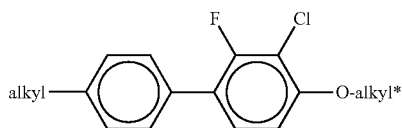
PY3



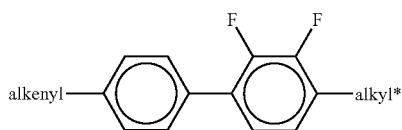
PY4



PY5



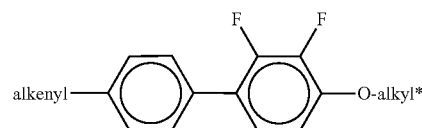
PY6



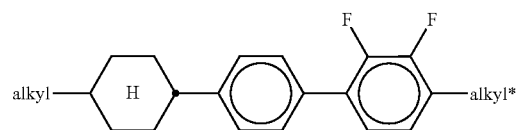
PY7

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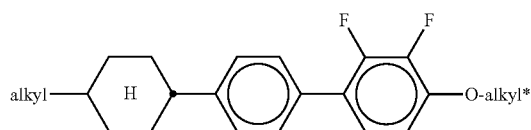
PY8



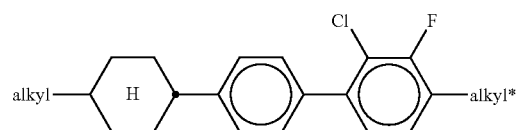
PY9



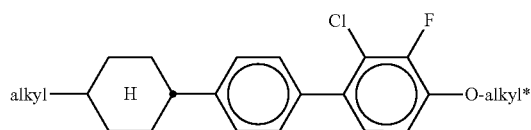
PY10



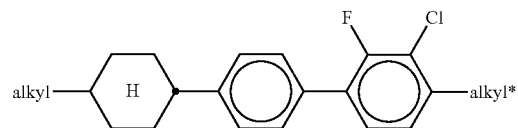
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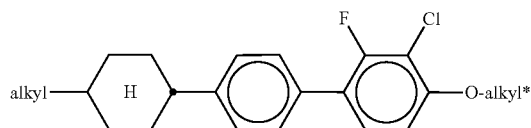
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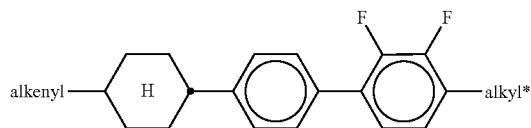
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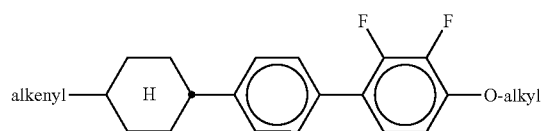
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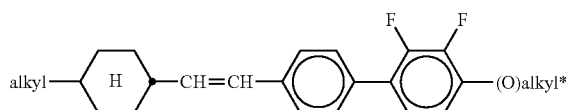
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PY16

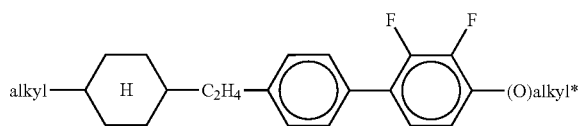


PY17

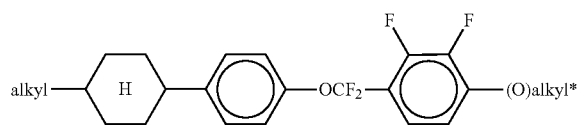


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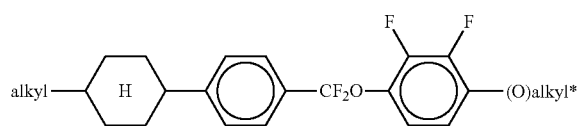
PY18



PY19



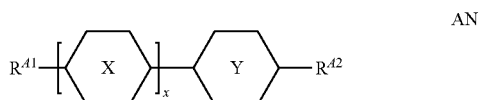
PY20



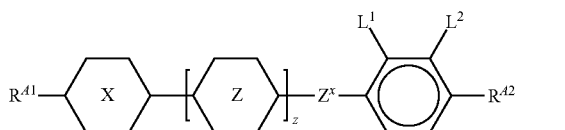
[0248] in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms, and (O) denotes an oxygen atom or a single bond. Alkenyl preferably denotes $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

[0249] b) LC medium wherein the component B) or LC host mixture comprises one or more mesogenic or LC compounds comprising an alkenyl group (hereinafter also referred to as "alkenyl compounds"), wherein said alkenyl group is stable to a polymerisation reaction under the conditions used for polymerisation of the polymerisable compounds contained in the LC medium.

[0250] Preferably the component B) or LC host mixture comprises one or more alkenyl compounds selected from formulae AN and AY

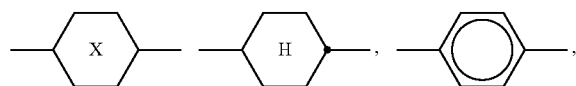


AN

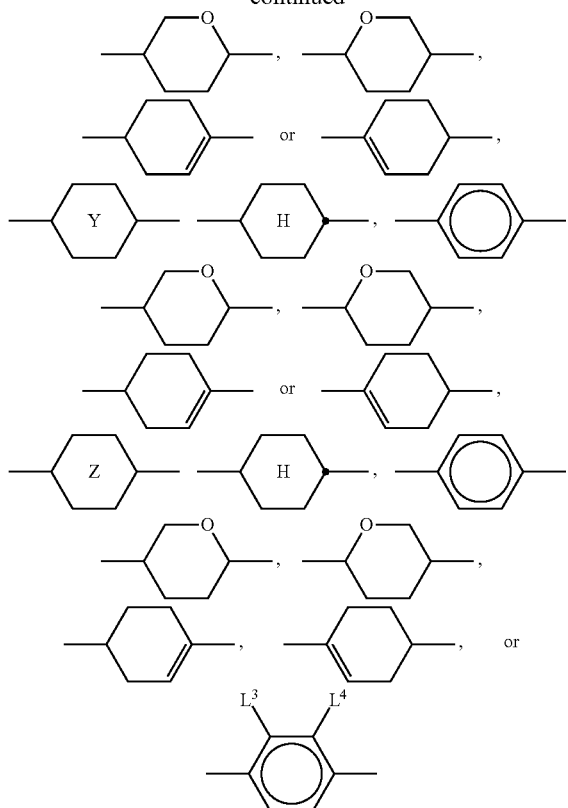


AY

[0251] in which the individual radicals, on each occurrence identically or differently, and each, independently of one another, have the following meaning:



-continued



[0252] R^{41} alkenyl having 2 to 9 C atoms or, if at least one of the rings X, Y and Z denotes cyclohexenyl, also one of the meanings of R^{42} ,

[0253] R^{42} alkyl having 1 to 12 C atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced by $-\text{O}-$, $-\text{CH}=\text{CH}-$, $-\text{CO}-$, $-\text{OCO}-$ or $-\text{COO}-$ in such a way that O atoms are not linked directly to one another,

[0254] Z^x $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CO}-\text{O}-$, $-\text{O}-\text{CO}-$, $-\text{C}_2\text{F}_4-$, $-\text{CF}=\text{CF}-$, $-\text{CH}=\text{CH}-\text{CH}_2\text{O}-$, or a single bond, preferably a single bond,

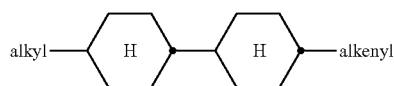
[0255] $\text{L}^{1,2}$ H, F, Cl, OCF_3 , CF_3 , CH_3 , CH_2F or CHF_2H , preferably H, F or Cl,

[0256] x 1 or 2,

[0257] z 0 or 1.

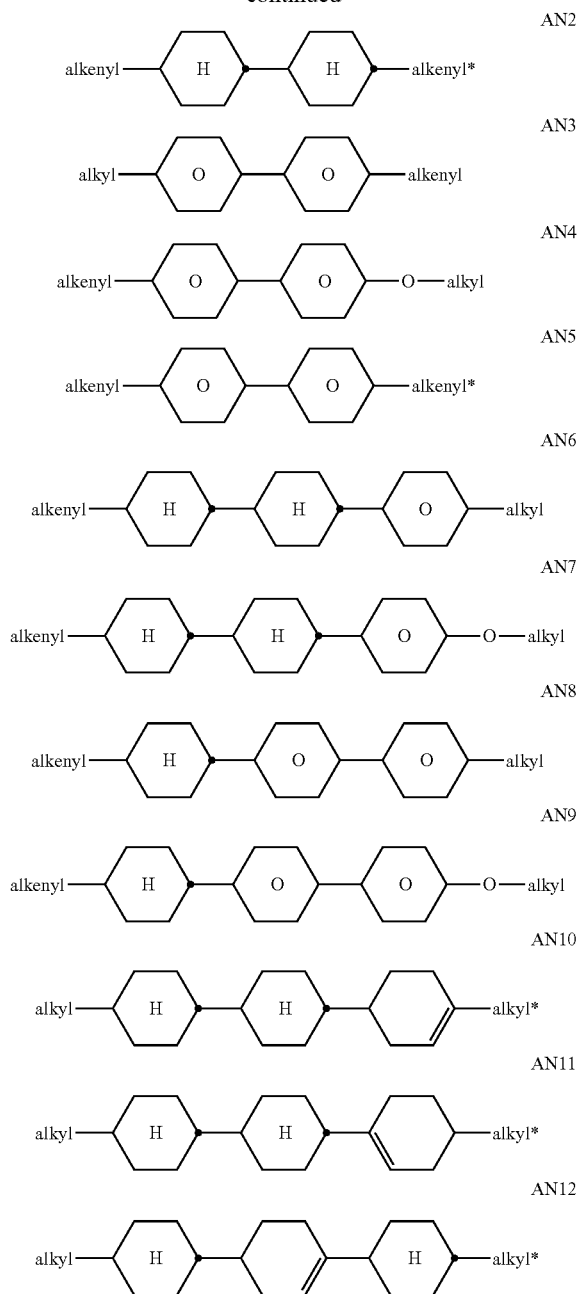
[0258] Preferred compounds of formula AN and AY are those wherein R^{42} is selected from ethenyl, propenyl, butenyl, pentenyl, hexenyl and heptenyl.

[0259] In a preferred embodiment the component B) or LC host mixture comprises one or more compounds of formula AN selected from the following sub-formulae:



AN1

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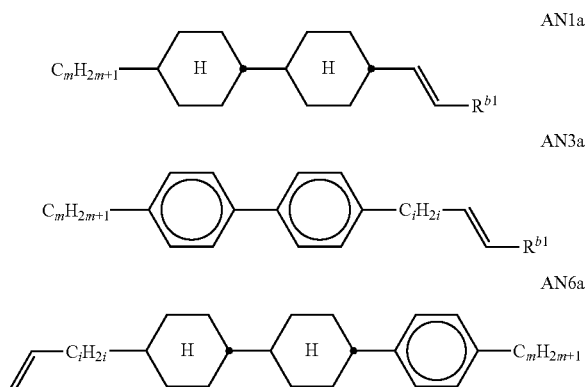


[0260] in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-7 C atoms. Alkenyl and alkenyl* preferably denote $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

[0261] Preferably the component B) or LC host mixture comprises one or more compounds selected from for-

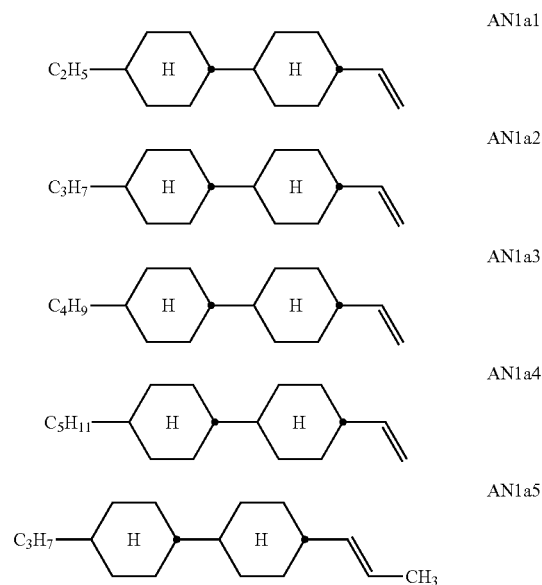
mulae AN1, AN2, AN3 and AN6, very preferably one or more compounds of formula AN1.

[0262] In another preferred embodiment the component B) or LC host mixture comprises one or more compounds of formula AN selected from the following sub-formulae:



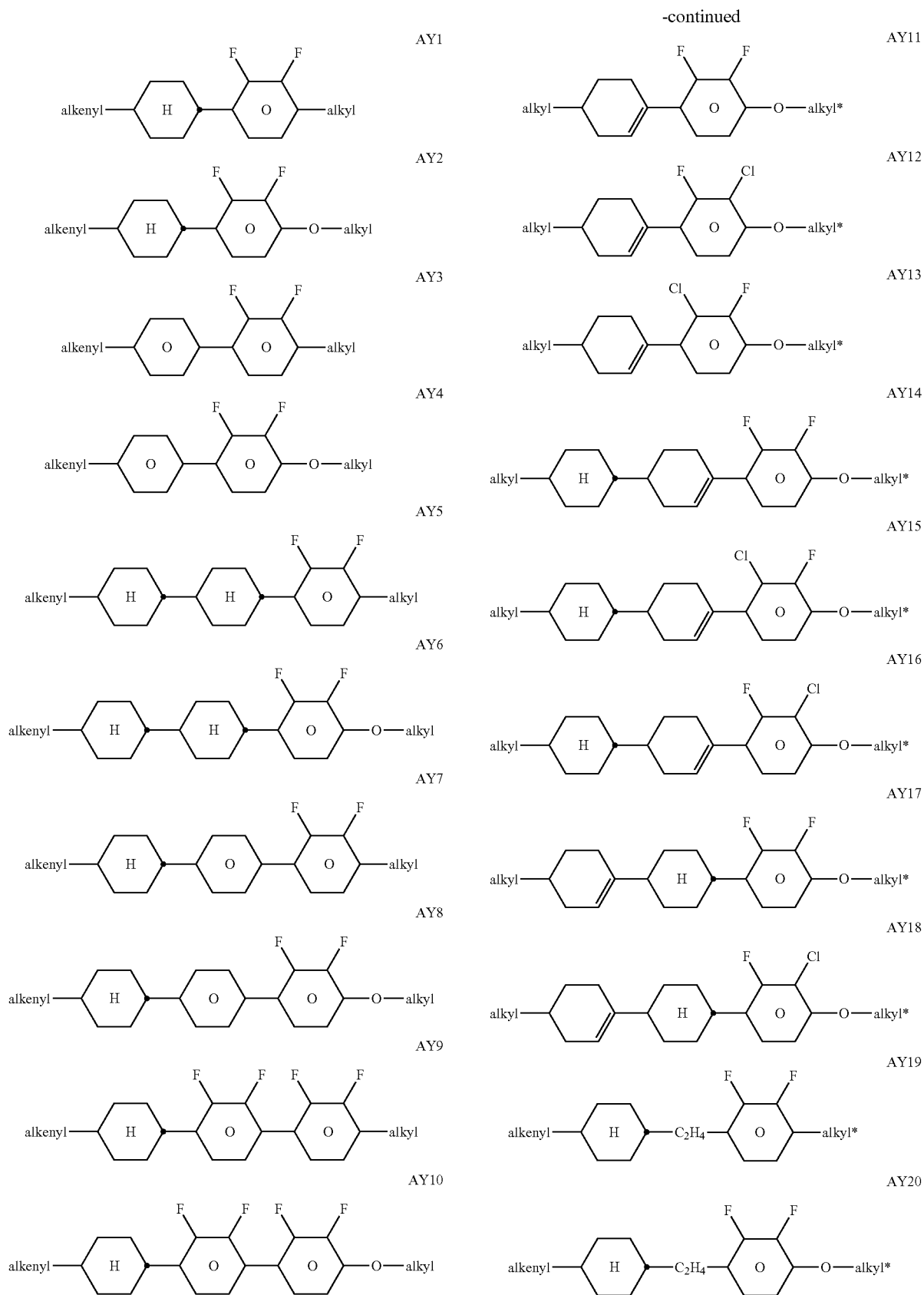
[0263] in which m denotes 1, 2, 3, 4, 5 or 6, i denotes 0, 1, 2 or 3, and R^{b1} denotes H, CH_3 or C_2H_5 .

[0264] In another preferred embodiment the component B) or LC host mixture comprises one or more compounds selected from the following sub-formulae:

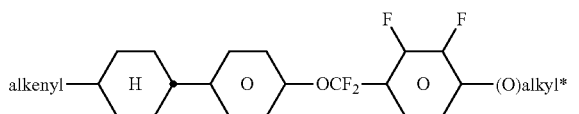
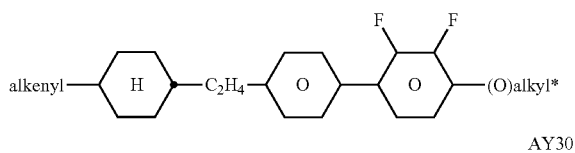
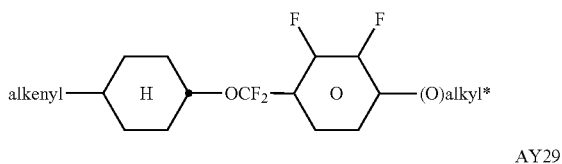
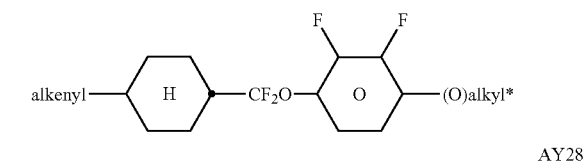
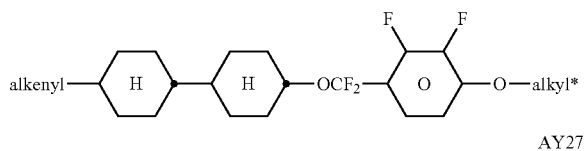
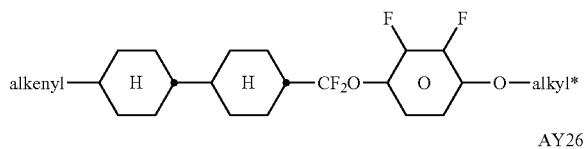
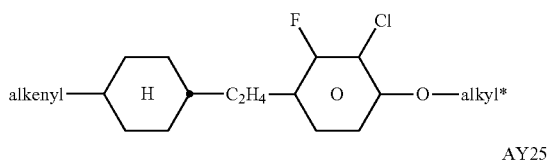
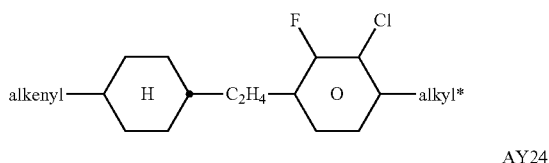
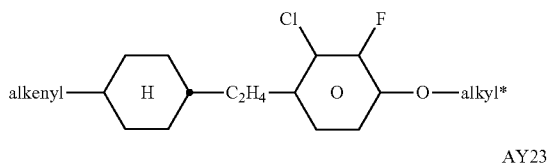
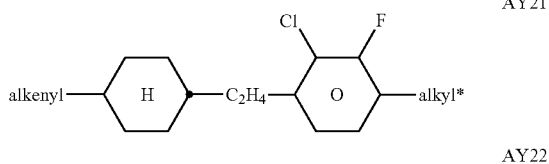


[0265] Most preferred are compounds of formula AN1a2 and AN1a5.

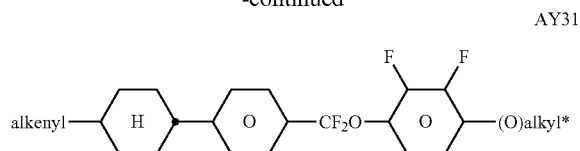
[0266] In another preferred embodiment the component B) or LC host mixture comprises one or more compounds of formula AY selected from the following sub-formulae:



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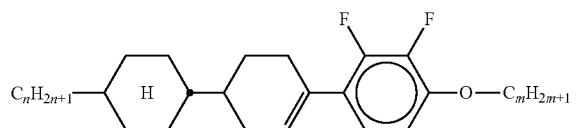
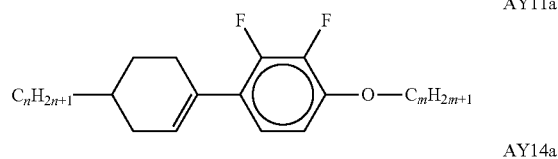
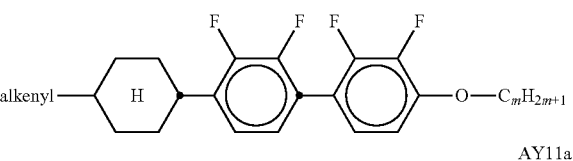
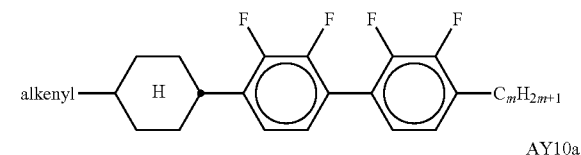
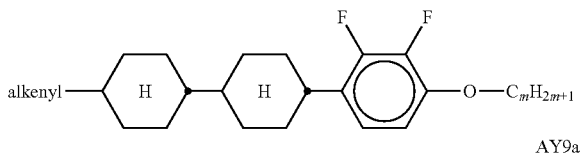
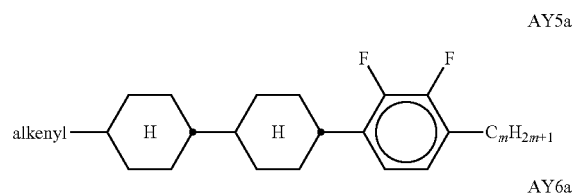


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[0267] in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, “(O)” denotes an O-atom or a single bond, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-7 C atoms. Alkenyl and alkenyl* preferably denote $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

[0268] In another preferred embodiment the component B) or LC host mixture comprises one or more compounds of formula AY selected from the following sub-formulae:



[0269] in which m and n each, independently of one another, denote 1, 2, 3, 4, 5 or 6, and alkenyl denotes $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

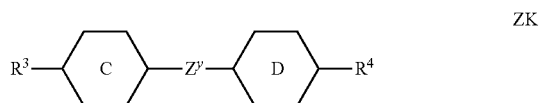
[0270] Preferably the proportion of compounds of formula AN and AY in the LC medium is from 2 to 70% by weight, very preferably from 5 to 60% by weight, most preferably from 10 to 50% by weight.

[0271] Preferably the LC medium or LC host mixture contains 1 to 5, preferably 1, 2 or 3 compounds selected from formulae AN and AY.

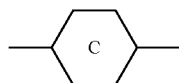
[0272] In another preferred embodiment of the present invention the LC medium comprises one or more compounds of formula AY14, very preferably of AY14a. The proportion of compounds of formula AY14 or AY14a in the LC medium is preferably 3 to 20% by weight.

[0273] The addition of alkenyl compounds of formula AN and/or AY enables a reduction of the viscosity and response time of the LC medium.

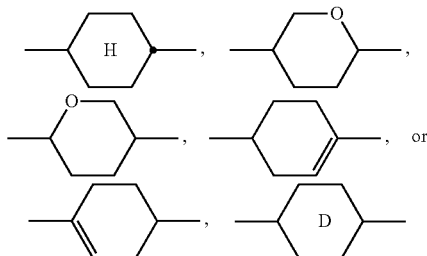
[0274] c) LC medium wherein the component B) or LC host mixture comprises one or more compounds of the following formula:



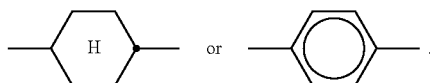
[0275] in which the individual radicals have the following meanings:



denotes



denotes

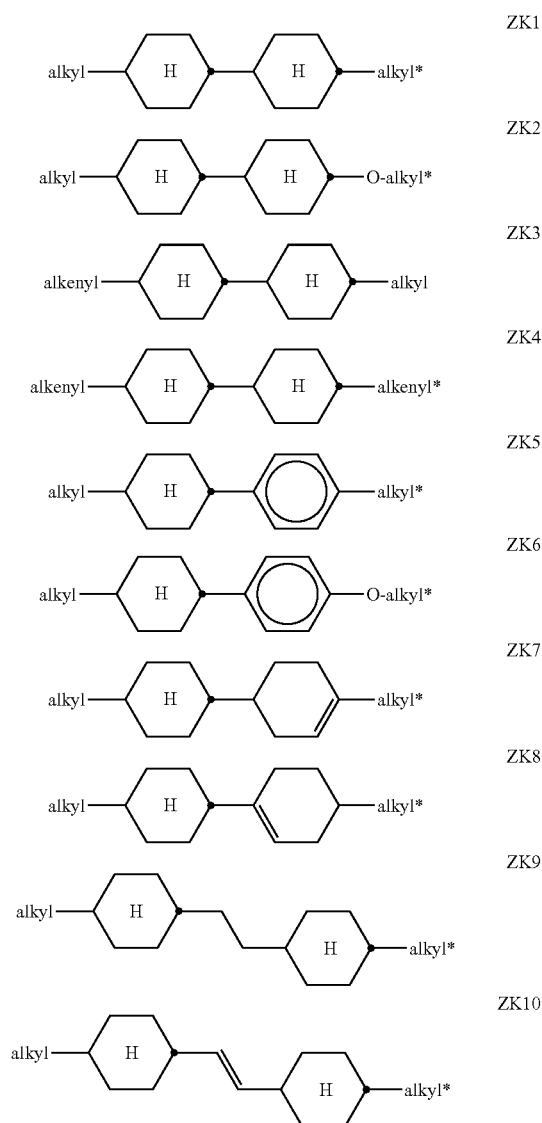


[0276] R^3 and R^4 each, independently of one another, denote alkyl having 1 to 12 C atoms, in which, in

addition, one or two non-adjacent CH_2 groups may be replaced by $-\text{O}-$, $-\text{CH}=\text{CH}-$, $-\text{CO}-$, $-\text{O}-\text{CO}-$ or $-\text{CO}-\text{O}-$ in such a way that O atoms are not linked directly to one another,

[0277] Z' denotes $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CO}-\text{O}-$, $-\text{O}-\text{CO}-$, $-\text{C}_2\text{F}_4-$, $-\text{CF}=\text{CF}-$, $-\text{CH}=\text{CH}-\text{CH}_2\text{O}-$ or a single bond, preferably a single bond.

[0278] The compounds of the formula ZK are preferably selected from the group consisting of the following sub-formulae:

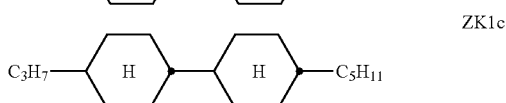
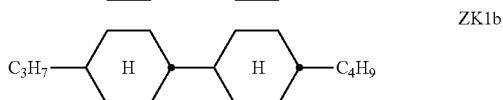
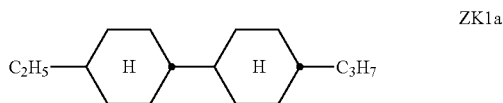


[0279] in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl preferably denotes $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

${}_2\text{—CH=CH—}$, $\text{CH}_3\text{—(CH}_2\text{)}_3\text{—CH=CH—}$ or $\text{CH}_3\text{—CH=CH—(CH}_2\text{)}_2\text{—}$.

[0280] Especially preferred are compounds of formula ZK1.

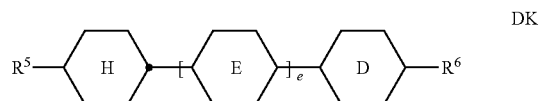
[0281] Particularly preferred compounds of formula ZK are selected from the following sub-formulae:



[0282] wherein the propyl, butyl and pentyl groups are straight-chain groups.

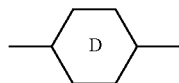
[0283] Most preferred are compounds of formula ZK1a.

[0284] d) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds of the following formula:

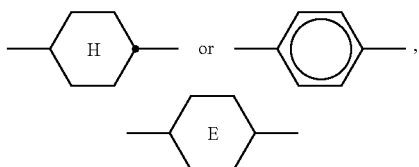


[0285] in which the individual radicals on each occurrence, identically or differently, have the following meanings:

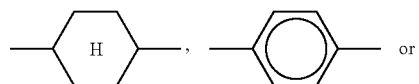
[0286] R^5 and R^6 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by —O— , —CH=CH— , —CO— , —OCO— or —COO— in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,



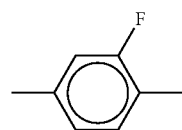
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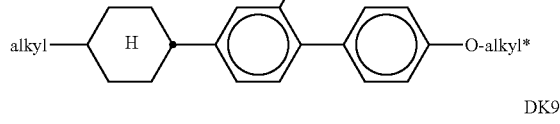
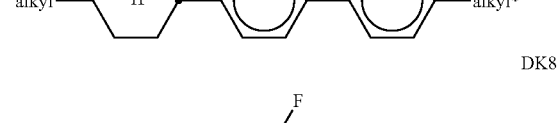
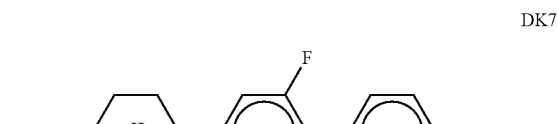
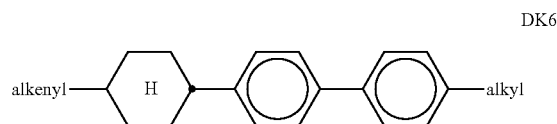
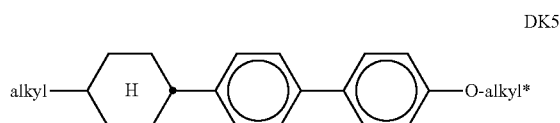
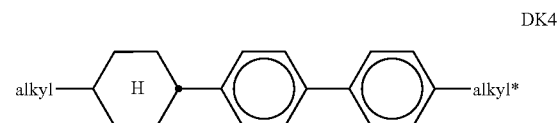
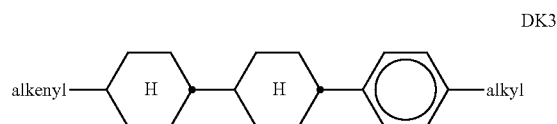
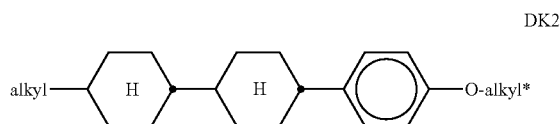
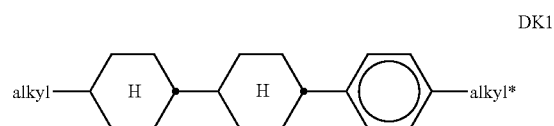


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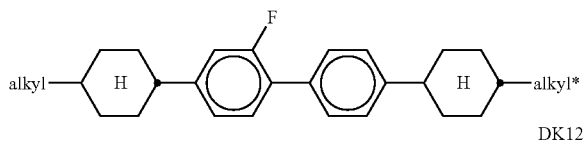
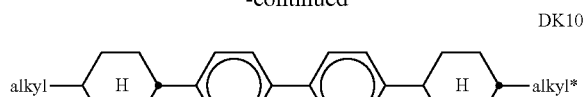


[0287] e denotes 1 or 2.

[0288] The compounds of the formula DK are preferably selected from the group consisting of the following sub-formulae:

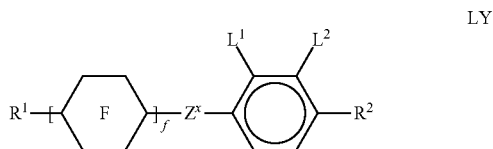


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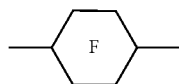


[0289] in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl denotes a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl preferably denotes $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

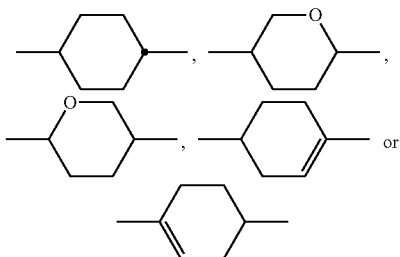
[0290] e) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds of the following formula:



[0291] in which the individual radicals have the following meanings:



denotes



[0292] with at least one ring F being different from cyclohexylene,

[0293] f denotes 1 or 2,

[0294] R^1 and R^2 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced

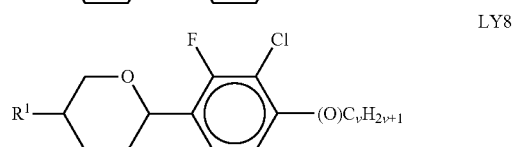
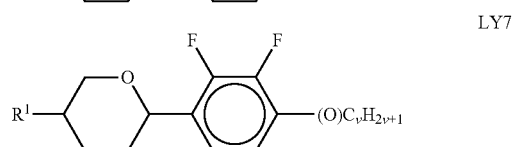
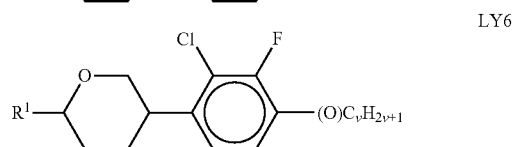
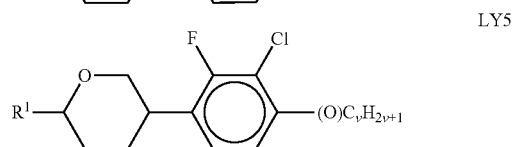
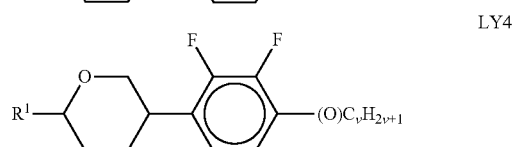
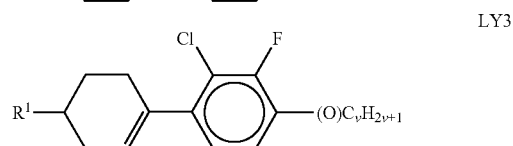
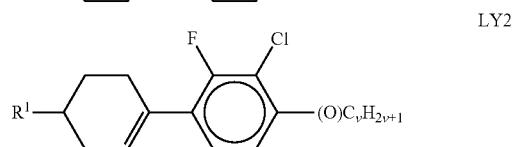
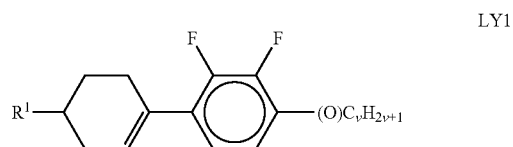
by $-\text{O}-$, $-\text{CH}=\text{CH}-$, $-\text{CO}-$, $-\text{OCO}-$ or $-\text{COO}-$ in such a way that O atoms are not linked directly to one another,

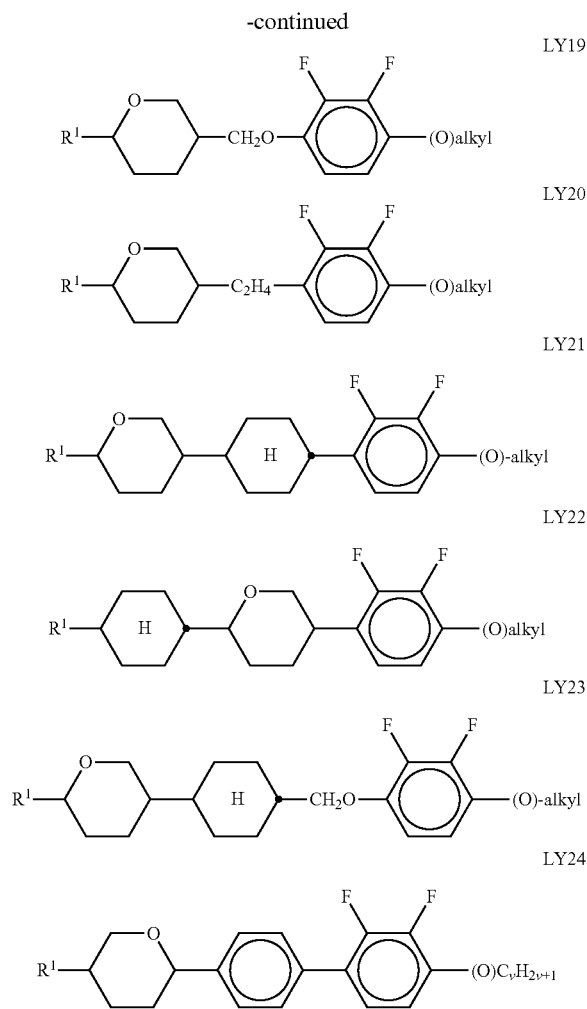
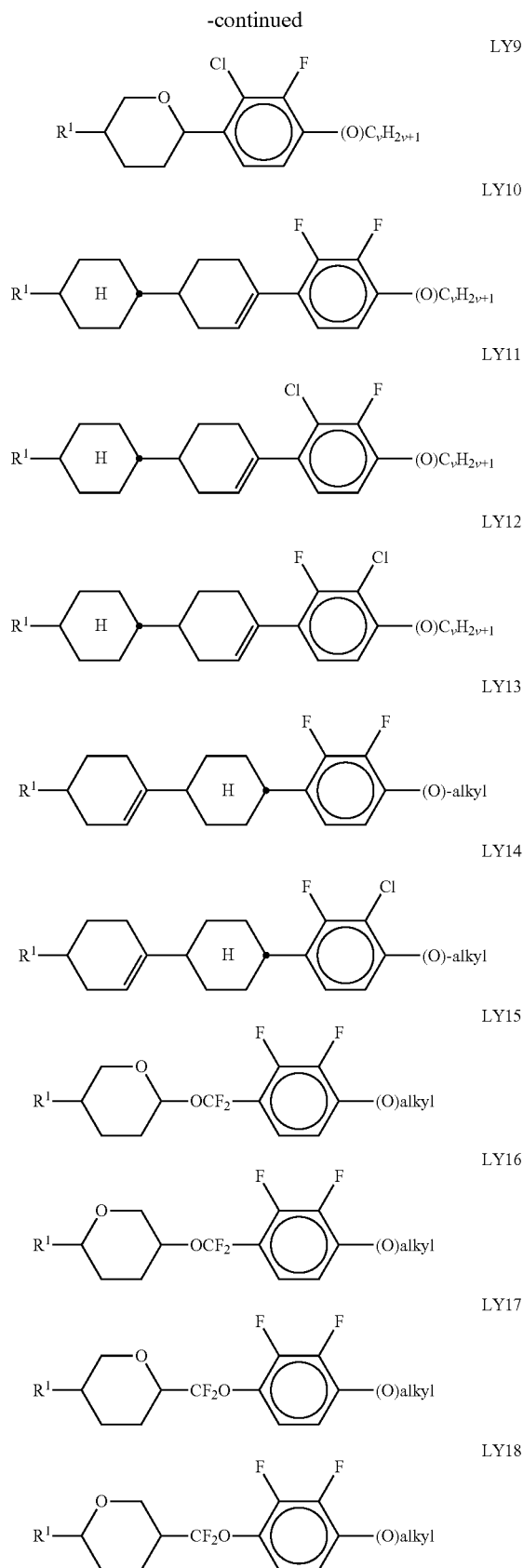
[0295] Z^x denotes $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CO}-\text{O}-$, $-\text{O}-\text{CO}-$, $-\text{C}_2\text{F}_4-$, $-\text{CF}=\text{CF}-$, $-\text{CH}=\text{CH}-\text{CH}_2\text{O}-$ or a single bond, preferably a single bond,

[0296] L^1 and L^2 each, independently of one another, denote F, Cl, OCF_3 , CF_3 , CH_3 , CH_2F , CHF_2 .

[0297] Preferably, both radicals L^1 and L^2 denote F or one of the radicals L^1 and L^2 denotes F and the other denotes Cl.

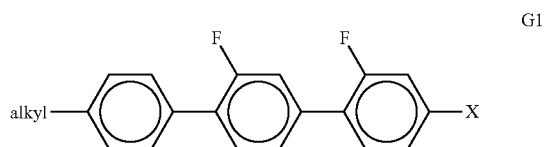
[0298] The compounds of the formula LY are preferably selected from the group consisting of the following sub-formulae:



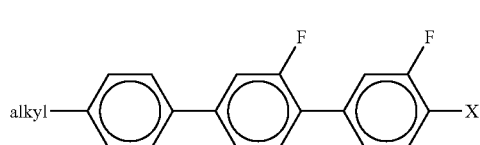
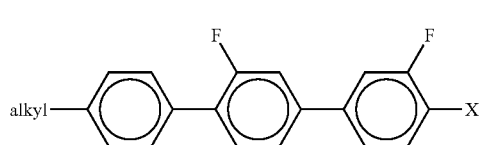
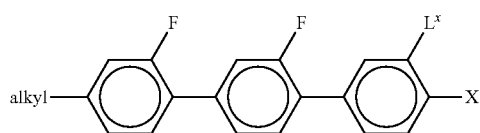


[0299] in which R¹ has the meaning indicated above, alkyl denotes a straight-chain alkyl radical having 1-6 C atoms, (O) denotes an oxygen atom or a single bond, and v denotes an integer from 1 to 6. R¹ preferably denotes straight-chain alkyl having 1 to 6 C atoms or straight-chain alkenyl having 2 to 6 C atoms, in particular CH₃, C₂H₅, n-C₃H₇, n-C₄H₉, n-C₅H₁₁, CH₂=CH—, CH₂=CHCH₂CH₂—, CH₃—CH=CH—, CH₃—CH₂—CH=CH—, CH₃—(CH₂)₂—CH=CH—, CH₃—(CH₂)₃—CH=CH— or CH₃—CH=CH—(CH₂)₂—.

[0300] f) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds selected from the group consisting of the following formulae:

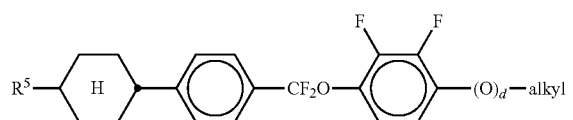
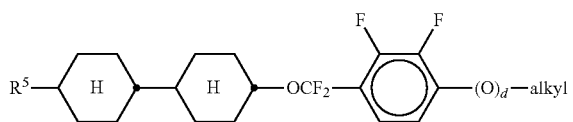
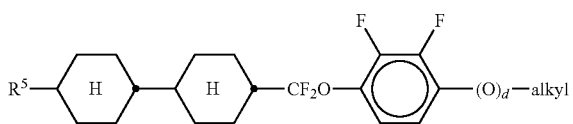
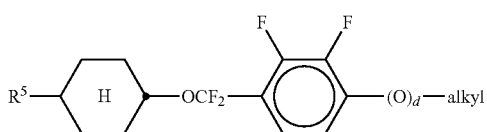
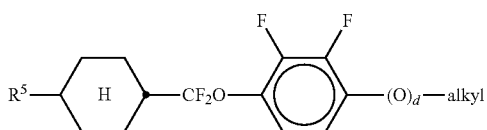


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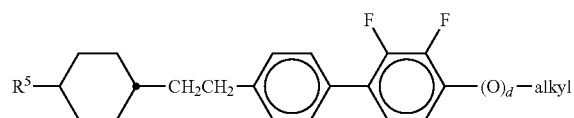
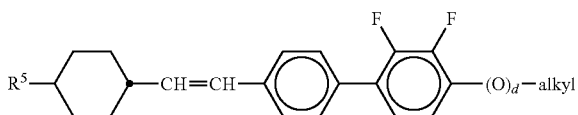
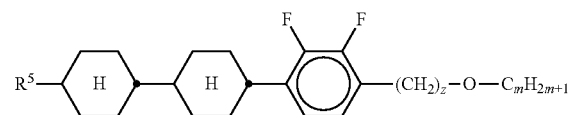
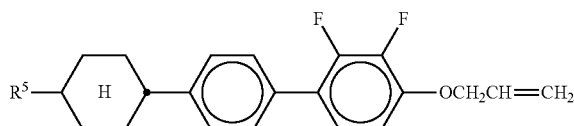
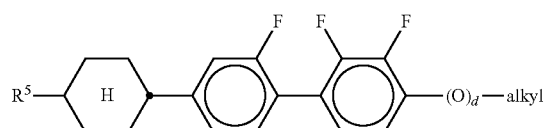
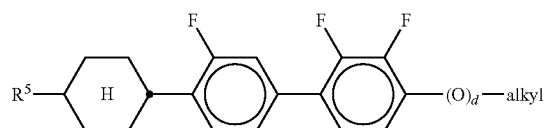
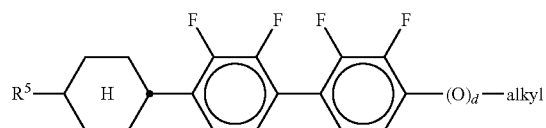
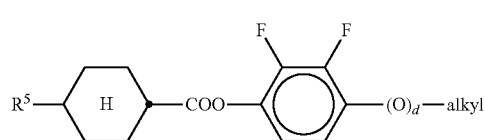
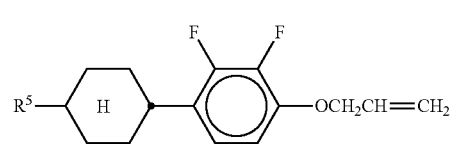
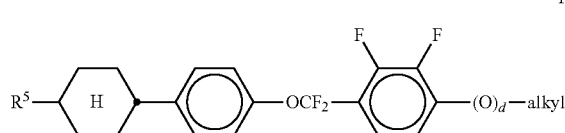


[0301] in which alkyl denotes C₁₋₆-alkyl, L_x denotes H or F, and X denotes F, Cl, OCF₃, OCHF₂ or OCH=CF₂. Particular preference is given to compounds of the formula G1 in which X denotes F.

[0302] g) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds selected from the group consisting of the following formulae:

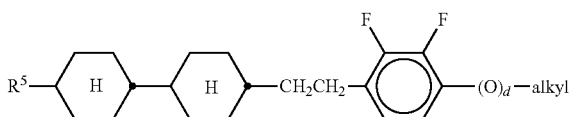


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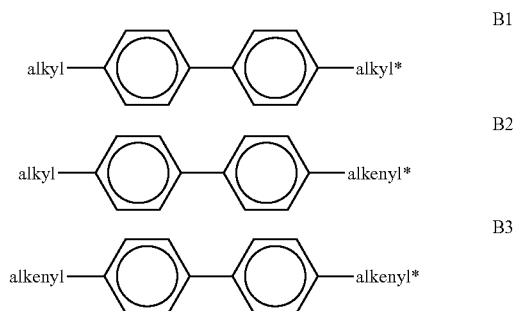
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Y16



[0303] in which R^5 has one of the meanings indicated above for R^1 , alkyl denotes C_{1-6} -alkyl, d denotes 0 or 1, and z and m each, independently of one another, denote an integer from 1 to 6. R^5 in these compounds is particularly preferably C_{1-6} -alkyl or -alkoxy or C_{2-6} -alkenyl, d is preferably 1. The LC medium according to the invention preferably comprises one or more compounds of the above-mentioned formulae in amounts of 5% by weight.

[0304] h) LC medium wherein component B) or the LC host mixture additionally comprises one or more biphenyl compounds selected from the group consisting of the following formulae:

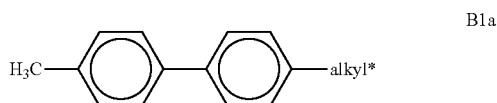


[0305] in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl and alkenyl* preferably denote $CH_2=CH-$, $CH_2=CHCH_2CH_2-$, $CH_3-CH=CH-$, $CH_3-CH_2-CH=CH-$, $CH_3-(CH_2)_2-CH=CH-$, $CH_3-(CH_2)_3-CH=CH-$ or $CH_3-CH=CH-(CH_2)_2-$.

[0306] The proportion of the biphenyls of the formulae B1 to B3 in the LC host mixture is preferably at least 3% by weight, in particular $\geq 5\%$ by weight.

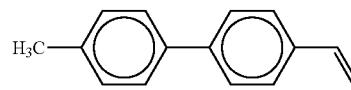
[0307] The compounds of the formula B2 are particularly preferred.

[0308] The compounds of the formulae B1 to B3 are preferably selected from the group consisting of the following sub-formulae:

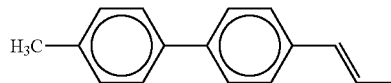


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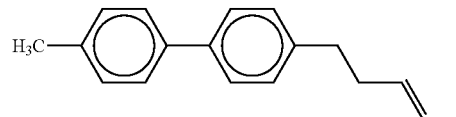
B2a



B2b

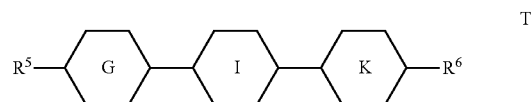


B2c

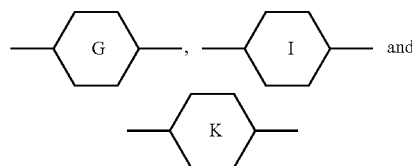


[0309] in which alkyl* denotes an alkyl radical having 1-6 C atoms. The medium according to the invention particularly preferably comprises one or more compounds of the formulae B1a and/or B2c.

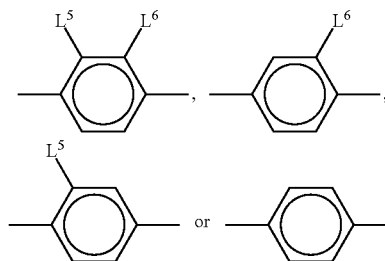
[0310] i) LC medium wherein component B) or the LC host mixture additionally comprises one or more terphenyl compounds of the following formula:



[0311] in which R^5 and R^6 each, independently of one another, have one of the meanings indicated above, and



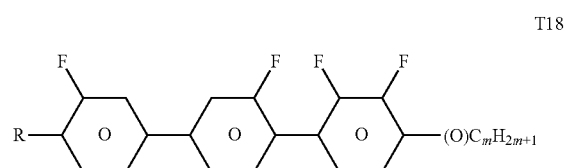
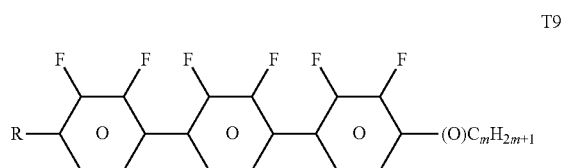
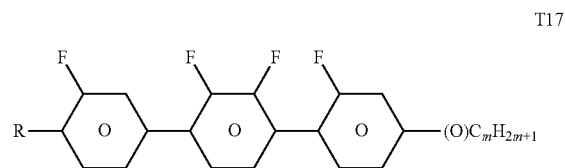
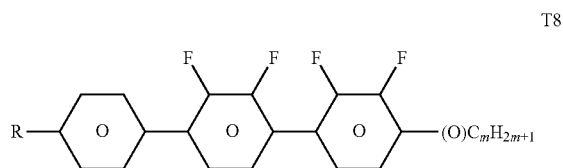
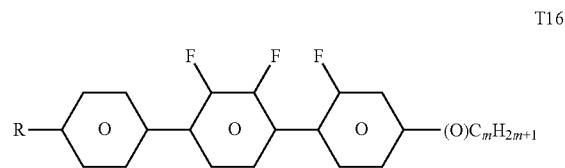
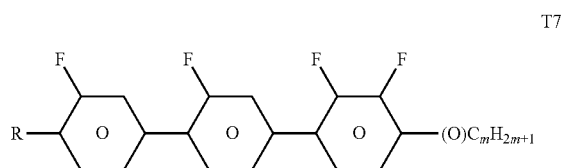
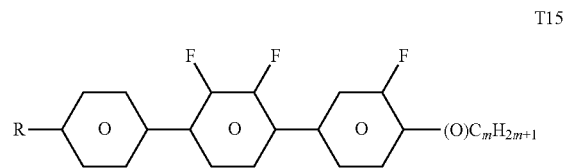
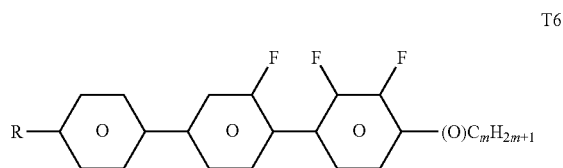
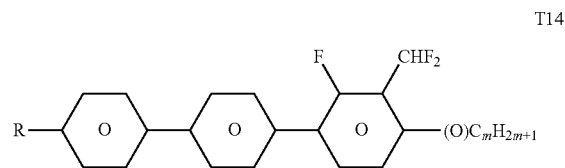
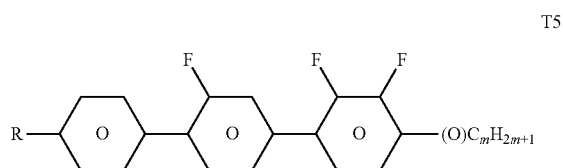
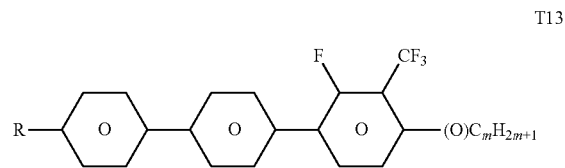
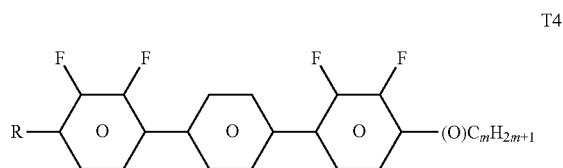
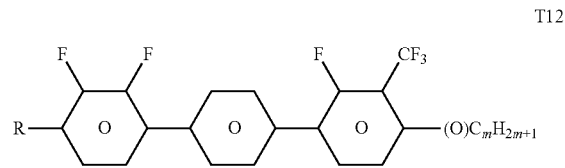
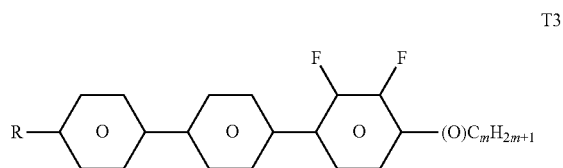
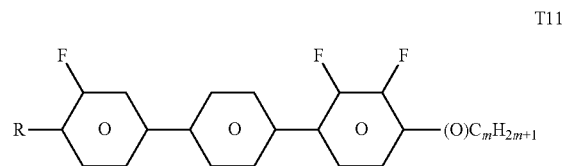
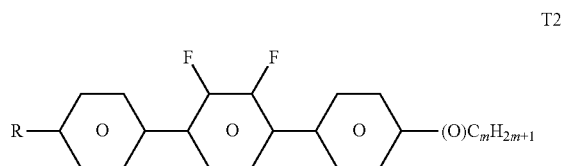
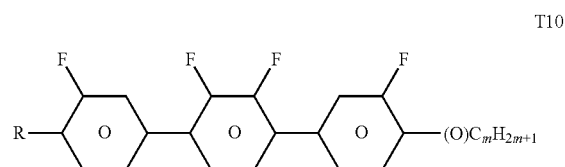
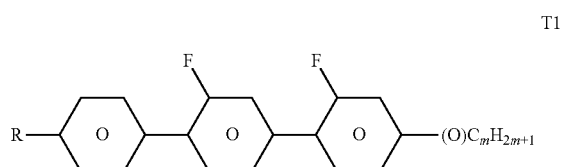
[0312] each, independently of one another, denote



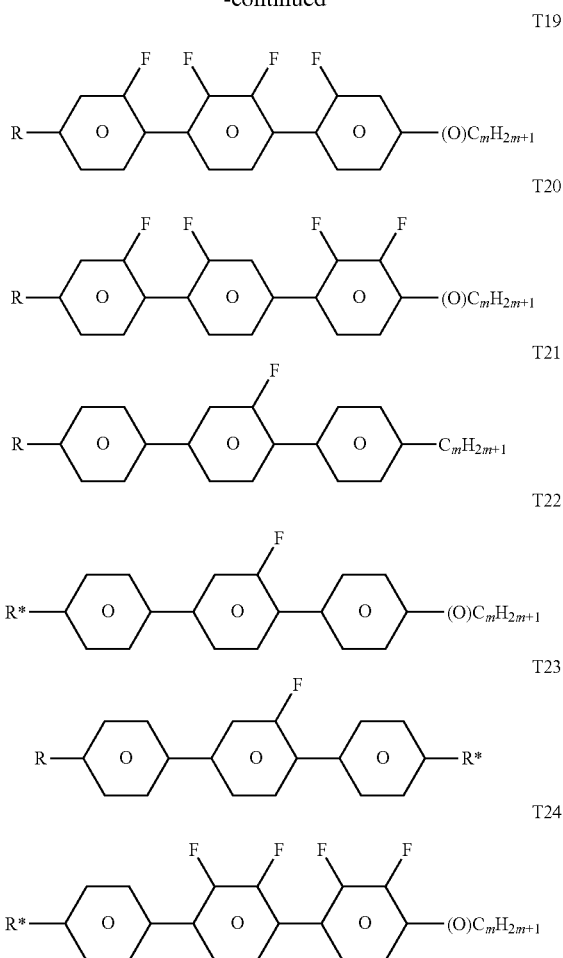
[0313] in which L^5 denotes F or Cl, preferably F, and L^6 denotes F, Cl, OCF_3 , CF_3 , CH_3 , CH_2F or CHF_2 , preferably F.

[0314] The compounds of the formula T are preferably selected from the group consisting of the following sub-formulae:

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[0315] in which R denotes a straight-chain alkyl or alkoxy radical having 1-7 C atoms, R* denotes a straight-chain alkenyl radical having 2-7 C atoms, (O) denotes an oxygen atom or a single bond, and m denotes an integer from 1 to 6. R* preferably denotes $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

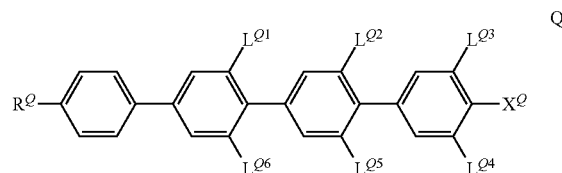
[0316] R preferably denotes methyl, ethyl, propyl, butyl, pentyl, hexyl, methoxy, ethoxy, propoxy, butoxy or pentoxy.

[0317] The LC host mixture according to the invention preferably comprises the terphenyls of the formula T and the preferred sub-formulae thereof in an amount of 0.5-30% by weight, in particular 1-20% by weight.

[0318] Particular preference is given to compounds of the formulae T1, T2, T3 and T21. In these compounds, R preferably denotes alkyl, furthermore alkoxy, each having 1-5 C atoms.

[0319] The terphenyls are preferably employed in LC media according to the invention if the Δn value of the mixture is to be 0.1. Preferred LC media comprise 2-20% by weight of one or more terphenyl compounds of the formula T, preferably selected from the group of compounds T1 to T22.

[0320] k) LC medium wherein component B) or the LC host mixture additionally comprises one or more quaterphenyl compounds selected from the group consisting of the following formulae:



[0321] wherein

[0322] R^Q is alkyl, alkoxy, oxaalkyl or alkoxyalkyl having 1 to 9 C atoms or alkenyl or alkenyloxy having 2 to 9 C atoms, all of which are optionally fluorinated,

[0323] X^Q is F, Cl, halogenated alkyl or alkoxy having 1 to 6 C atoms or halogenated alkenyl or alkenyloxy having 2 to 6 C atoms,

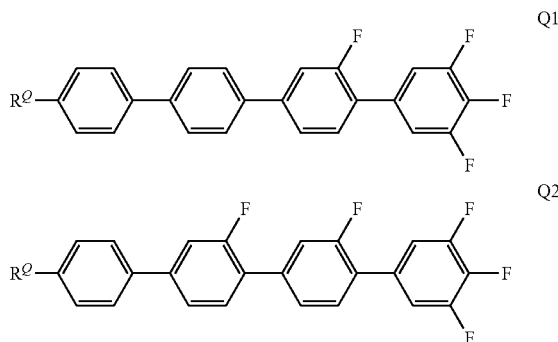
[0324] L^Q1 to L^Q6 independently of each other are H or F, with at least one of L^Q1 to L^Q6 being F.

[0325] Preferred compounds of formula Q are those wherein R^Q denotes straight-chain alkyl with 2 to 6 C-atoms, very preferably ethyl, n-propyl or n-butyl.

[0326] Preferred compounds of formula Q are those wherein L^Q3 and L^Q4 are F. Further preferred compounds of formula Q are those wherein L^Q3 , L^Q4 and one or two of L^Q1 and L^Q2 are F.

[0327] Preferred compounds of formula Q are those wherein X^Q denotes F or OCF_3 , very preferably F.

[0328] The compounds of formula Q are preferably selected from the following subformulae



[0329] wherein R^Q has one of the meanings of formula Q or one of its preferred meanings given above and below, and is preferably ethyl, n-propyl or n-butyl.

[0330] Especially preferred are compounds of formula Q1, in particular those wherein R^Q is n-propyl.

[0331] Preferably the proportion of compounds of formula Q in the LC host mixture is from >0 to 5% by weight, very preferably from 0.1 to 2% by weight, most preferably from 0.2 to 1.5% by weight.

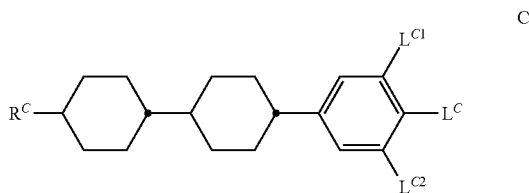
[0332] Preferably the LC host mixture contains 1 to 5, preferably 1 or 2 compounds of formula Q.

[0333] The addition of quaterphenyl compounds of formula Q to the LC host mixture enables to reduce ODF mura, whilst maintaining high UV absorption, enabling

quick and complete polymerisation, enabling strong and quick tilt angle generation, and increasing the UV stability of the LC medium.

[0334] Besides, the addition of compounds of formula Q, which have positive dielectric anisotropy, to the LC medium with negative dielectric anisotropy allows a better control of the values of the dielectric constants ϵ_{\parallel} and ϵ_{\perp} , and in particular enables to achieve a high value of the dielectric constant ϵ_{\parallel} while keeping the dielectric anisotropy $\Delta\epsilon$ constant, thereby reducing the kick-back voltage and reducing image sticking.

[0335] 1) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds of formula C:



[0336] wherein

[0337] R^C denotes alkyl, alkoxy, oxaalkyl or alkoxyalkyl having 1 to 9 C atoms or alkenyl or alkenyloxy having 2 to 9 C atoms, all of which are optionally fluorinated,

[0338] X^C denotes F, Cl, halogenated alkyl or alkoxy having 1 to 6 C atoms or halogenated alkenyl or alkenyloxy having 2 to 6 C atoms,

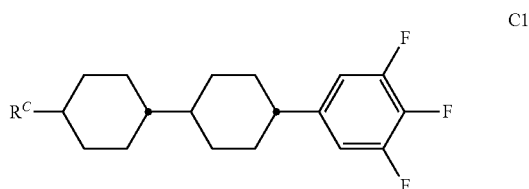
[0339] L^{C1} , L^{C2} independently of each other denote H or F, with at least one of L^{C1} and L^{C2} being F.

[0340] Preferred compounds of formula C are those wherein R^C denotes straight-chain alkyl with 2 to 6 C-atoms, very preferably ethyl, n-propyl or n-butyl.

[0341] Preferred compounds of formula C are those wherein L^{C1} and L^{C2} are F.

[0342] Preferred compounds of formula C are those wherein X^C denotes F or OCF_3 , very preferably F.

[0343] Preferred compounds of formula C are selected from the following formula



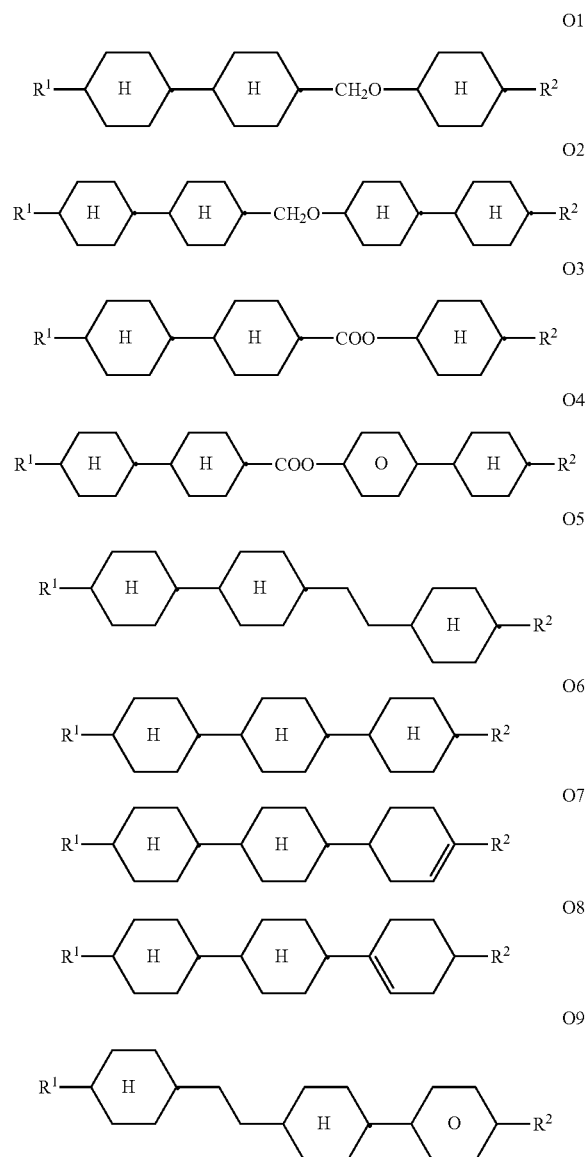
[0344] wherein R^C has one of the meanings of formula C or one of its preferred meanings given above and below, and is preferably ethyl, n-propyl or n-butyl, very preferably n-propyl.

[0345] Preferably the proportion of compounds of formula C in the LC host mixture is from >0 to $\leq 10\%$ by weight, very preferably from 0.1 to 8% by weight, most preferably from 0.2 to 5% by weight.

[0346] Preferably the LC host mixture contains 1 to 5, preferably 1, 2 or 3 compounds of formula C.

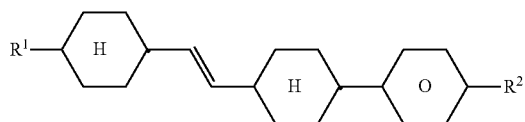
[0347] The addition of compounds of formula C, which have positive dielectric anisotropy, to the LC medium with negative dielectric anisotropy allows a better control of the values of the dielectric constants ϵ_{\parallel} and ϵ_{\perp} , and in particular enables to achieve a high value of the dielectric constant ϵ_{\parallel} while keeping the dielectric anisotropy $\Delta\epsilon$ constant, thereby reducing the kick-back voltage and reducing image sticking. Besides, the addition of compounds of formula C enables to reduce the viscosity and the response time of the LC medium.

[0348] m) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds selected from the group consisting of the following formulae:

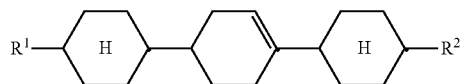


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O10



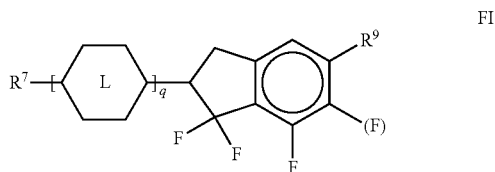
O11



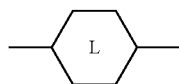
[0349] in which R^1 and R^2 have the meanings indicated above and preferably each, independently of one another, denote straight-chain alkyl having 1 to 6 C atoms or straight-chain alkenyl having 2 to 6 C atoms.

[0350] Preferred media comprise one or more compounds selected from the formulae O1, O3 and O4.

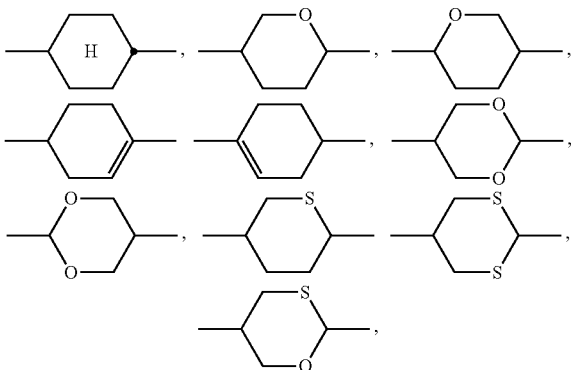
[0351] n) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds of the following formula:



[0352] in which



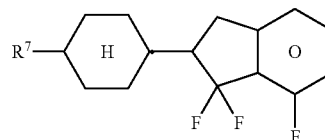
denotes



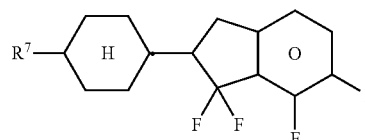
[0353] R^9 denotes H, CH_3 , C_2H_5 or $n-C_3H_7$, (F) denotes an optional fluorine substituent, and q denotes 1, 2 or 3, and R^7 has one of the meanings indicated for R^1 , preferably in amounts of >3% by weight, in particular 5% by weight and very particularly preferably 5-30% by weight.

[0354] Particularly preferred compounds of the formula FI are selected from the group consisting of the following sub-formulae:

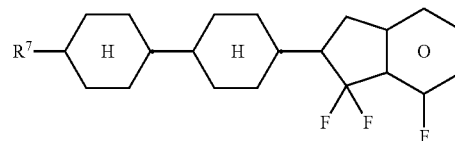
FI1



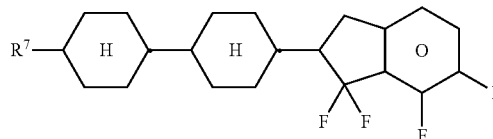
FI2



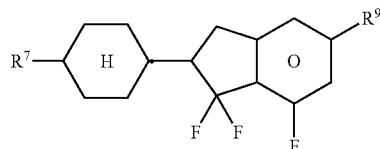
FI3



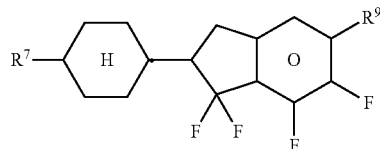
FI4



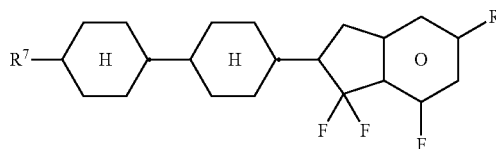
FI5



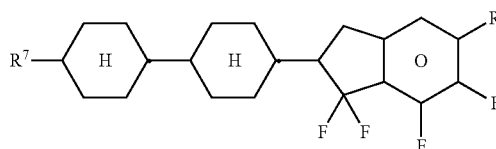
FI6



FI7

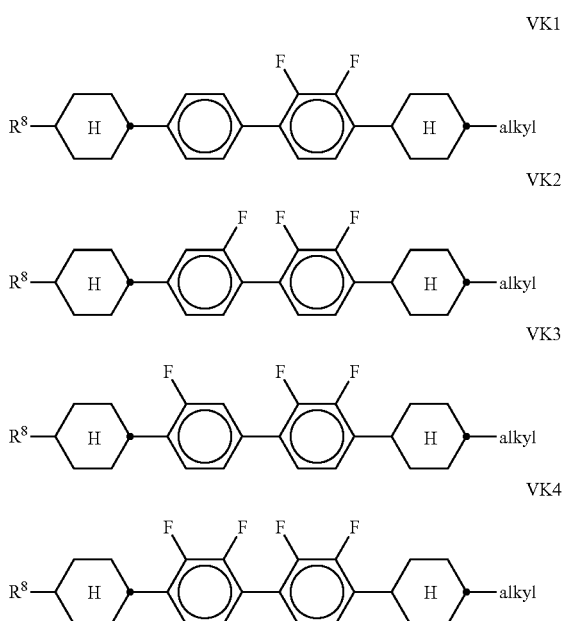


FI8



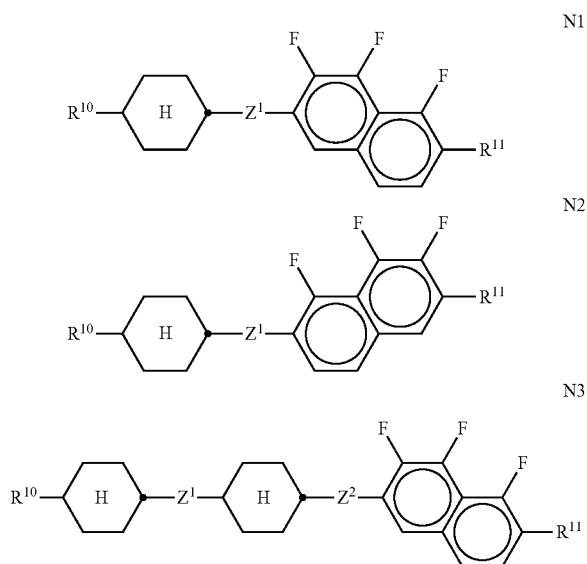
[0355] in which R^7 preferably denotes straight-chain alkyl, and R^9 denotes CH_3 , C_2H_5 or $n-C_3H_7$. Particular preference is given to the compounds of the formulae FI1, FI2 and FI3.

[0356] o) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds selected from the group consisting of the following formulae:

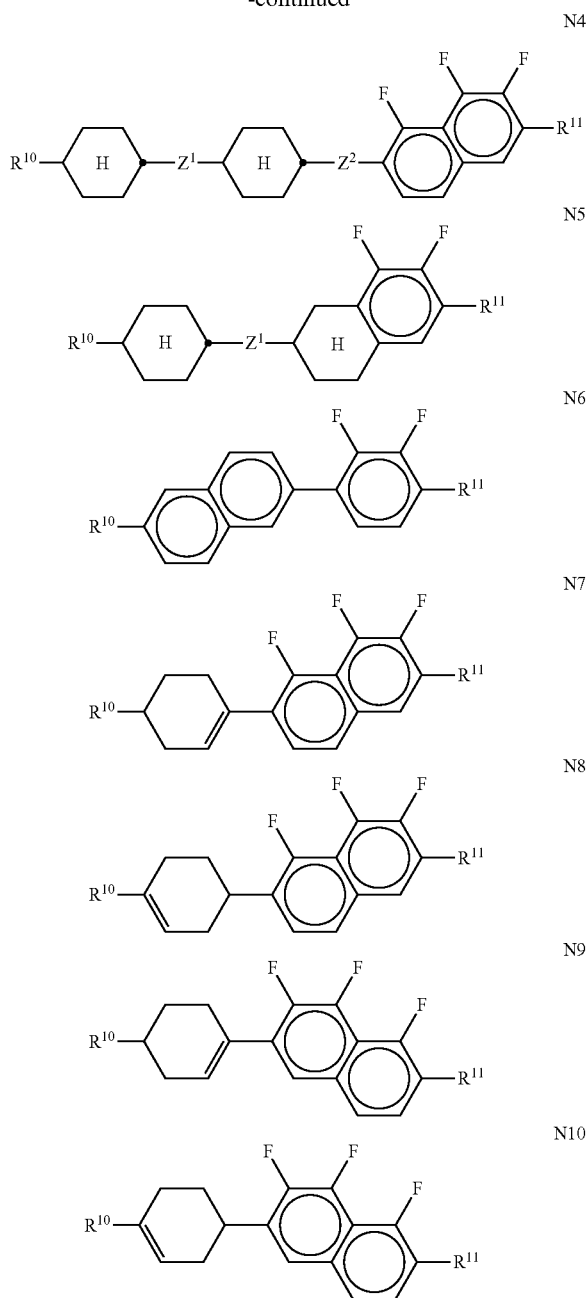


[0357] in which R^8 has the meaning indicated for R^1 , and alkyl denotes a straight-chain alkyl radical having 1-6 C atoms.

[0358] p) LC medium wherein component B) or the LC host mixture additionally comprises one or more compounds which contain a tetrahydronaphthyl or naphthyl unit, such as, for example, the compounds selected from the group consisting of the following formulae:



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[0359] in which

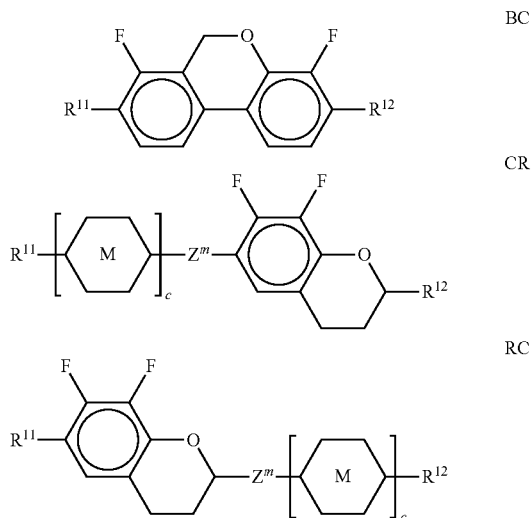
[0360] R^{10} and R^{11} each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by $-O-$, $-CH=CH-$, $-CO-$, $-OCO-$ or $-COO-$ in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,

[0361] and R^{10} and R^{11} preferably denote straight-chain alkyl or alkoxy having 1 to 6 C atoms or straight-chain alkenyl having 2 to 6 C atoms, and

[0362] Z^1 and Z^2 each, independently of one another, denote $-C_2H_4-$, $-CH=CH-$, $-(CH_2)_4-$,

$-(CH_2)_3O-$, $-O(CH_2)_3-$, $-CH=CH-$
 CH_2CH_2- , $-CH_2CH_2CH=CH-$, $-CH_2O-$,
 $-OCH_2-$, $-CO-O-$, $-O-CO-$, $-C_2F_4-$,
 $-CF=CF-$, $-CF=CH-$, $-CH=CF-$, $-CH_2-$
 or a single bond.

[0363] q) LC medium wherein component B) or the LC host mixture additionally comprises one or more difluorodibenzochromans and/or chromans of the following formulae:



[0364] in which

[0365] R^{11} and R^{12} each, independently of one another, have one of the meanings indicated above for R^{11} ,

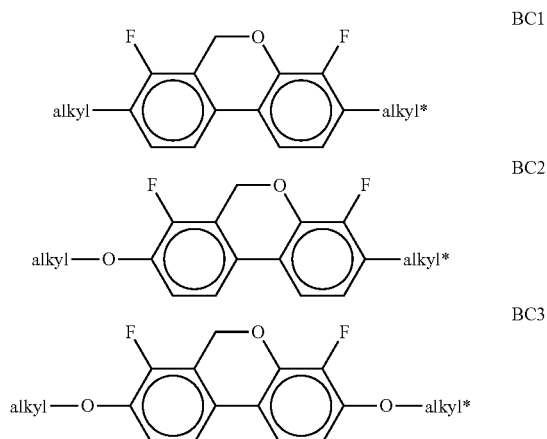
[0366] ring M is trans-1,4-cyclohexylene or 1,4-phenylene,

[0367] Z^m $-C_2H_4-$, $-CH_2O-$, $-OCH_2-$, $-CO-O-$ or $-O-CO-$,

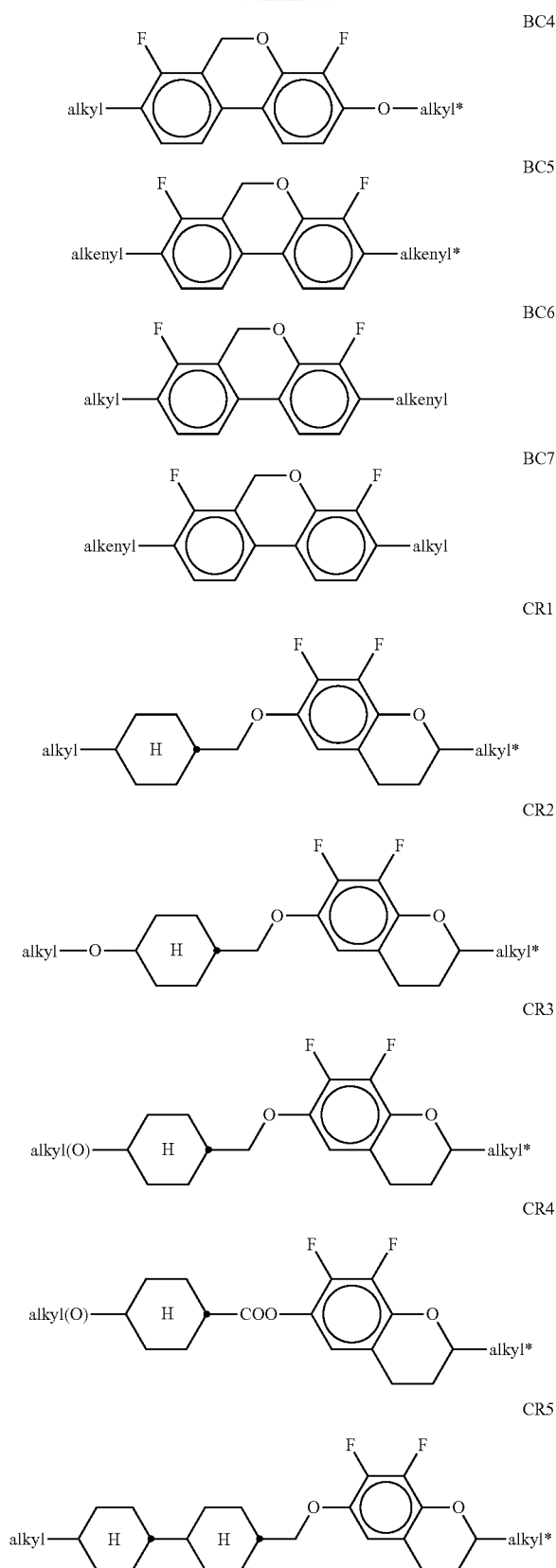
[0368] c is 0, 1 or 2,

[0369] preferably in amounts of 3 to 20% by weight, in particular in amounts of 3 to 15% by weight.

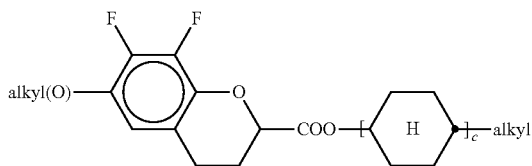
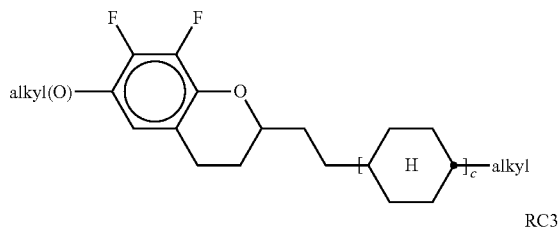
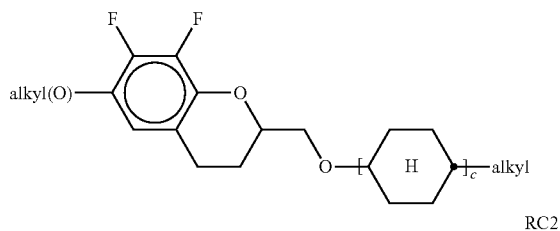
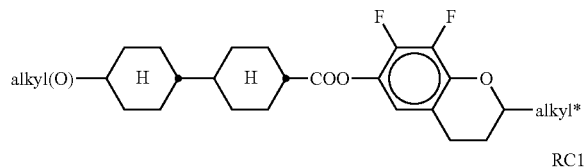
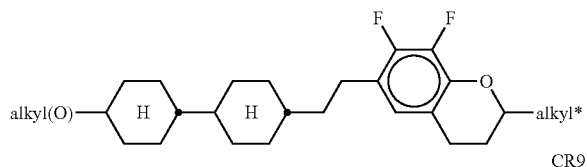
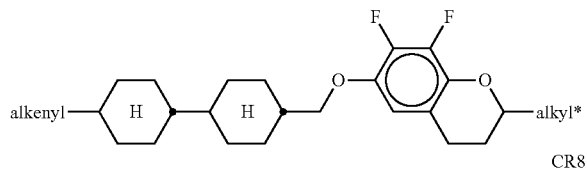
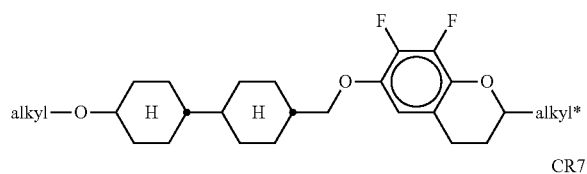
[0370] Particularly preferred compounds of the formulae BC, CR and RC are selected from the group consisting of the following sub-formulae:



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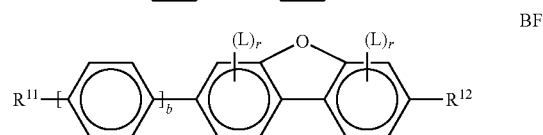
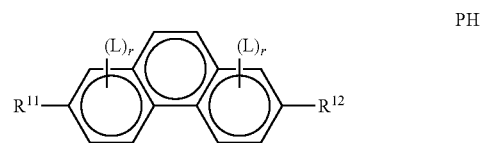


[0371] in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, (O) denotes an oxygen atom or a single bond, c is 1 or 2, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-6 C atoms. Alkenyl and alkenyl* preferably denote $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{CHCH}_2\text{CH}_2-$, $\text{CH}_3-\text{CH}=\text{CH}-$, $\text{CH}_3-\text{OCH}_2-$

$\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_2-\text{CH}=\text{CH}-$, $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-$ or $\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}_2)_2-$.

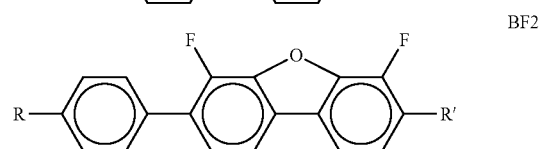
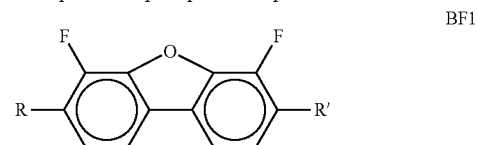
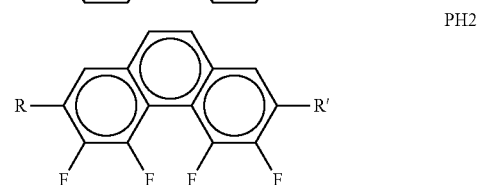
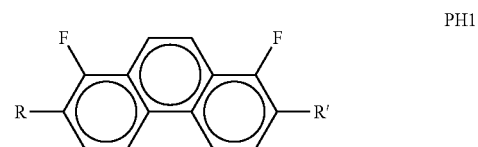
[0372] Very particular preference is given to LC host mixtures comprising one, two or three compounds of the formula BC-2.

[0373] r) LC medium wherein component B) or the LC host mixture additionally comprises one or more fluorinated phenanthrenes and/or dibenzofurans of the following formulae:



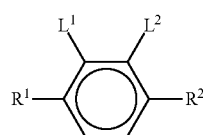
[0374] in which R^{11} and R^{12} each, independently of one another, have one of the meanings indicated above for R^{11} , b denotes 0 or 1, L denotes F, and r denotes 1, 2 or 3.

[0375] Particularly preferred compounds of the formulae PH and BF are selected from the group consisting of the following sub-formulae:



[0376] in which R and R' each, independently of one another, denote a straight-chain alkyl or alkoxy radical having 1-7 C atoms.

[0377] s) LC medium wherein component B) or the LC host mixture additionally comprises one or more monocyclic compounds of the following formula



Y

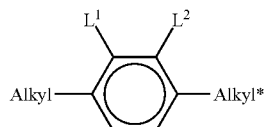
[0378] wherein

[0379] R^1 and R^2 each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH_2 groups may be replaced by $-O-$, $-CH=CH-$, $-CO-$, $-OCO-$ or $-COO-$ in such a way that O atoms are not linked directly to one another, preferably alkyl or alkoxy having 1 to 6 C atoms,

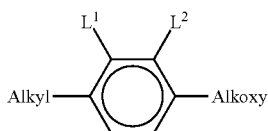
[0380] L^1 and L^2 each, independently of one another, denote F, Cl, OCF_3 , CF_3 , CH_3 , CH_2F , CHF_2 .

[0381] Preferably, both L^1 and L^2 denote F or one of L^1 and L^2 denotes F and the other denotes Cl,

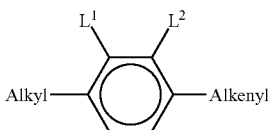
[0382] The compounds of the formula Y are preferably selected from the group consisting of the following sub-formulae:



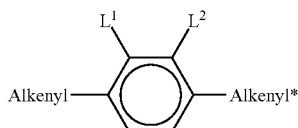
Y1



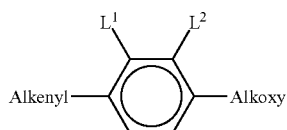
Y2



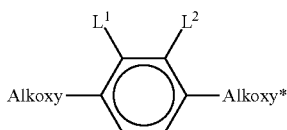
Y3



Y4

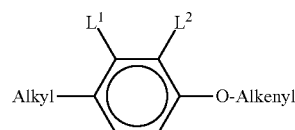


Y5

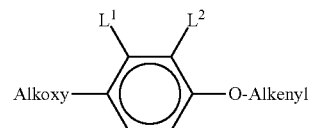


Y6

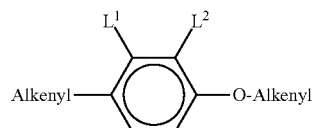
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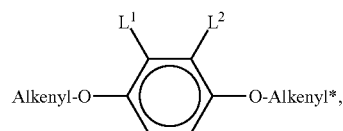
Y7



Y8



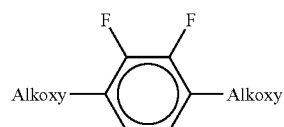
Y9



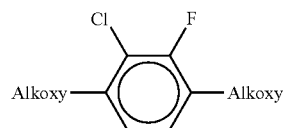
Y10

[0383] in which, Alkyl and Alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, Alkoxy denotes a straight-chain alkoxy radical having 1-6 C atoms, Alkenyl and Alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-6 C atoms, and O denotes an oxygen atom or a single bond. Alkenyl and Alkenyl* preferably denote $CH_2=CH-$, $CH_2=CHCH_2CH_2-$, $CH_3-CH=CH-$, $CH_3-CH_2-CH=CH-$, $CH_3-(CH_2)_2-CH=CH-$, $CH_3-(CH_2)_3-CH=CH-$ or $CH_3-CH=CH-(CH_2)_2-$.

[0384] Particularly preferred compounds of the formula Y are selected from the group consisting of the following sub-formulae:



Y6A



Y6B

[0385] wherein Alkoxy preferably denotes straight-chain alkoxy with 3, 4, or C atoms.

[0386] t) LC medium which, apart from the polymerisable compounds as described above and below, does not contain a compound which contains a terminal vinyloxy group ($-O-CH=CH_2$).

[0387] u) LC medium wherein component B) or the LC host mixture comprises 1 to 8, preferably 1 to 5, compounds of the formulae CY1, CY2, PY1 and/or PY2. The

proportion of these compounds in the LC host mixture as a whole is preferably 5 to 60%, particularly preferably 10 to 35%. The content of these individual compounds is preferably in each case 2 to 20%.

[0388] v) LC medium wherein component B) or the LC host mixture comprises 1 to 8, preferably 1 to 5, compounds of the formulae CY9, CY10, PY9 and/or PY10. The proportion of these compounds in the LC host mixture as a whole is preferably 5 to 60%, particularly preferably 10 to 35%. The content of these individual compounds is preferably in each case 2 to 20%.

[0389] w) LC medium wherein component B) or the LC host mixture comprises 1 to 10, preferably 1 to 8, compounds of the formula ZK, in particular compounds of the formulae ZK1, ZK2 and/or ZK6. The proportion of these compounds in the LC host mixture as a whole is preferably 3 to 25%, particularly preferably 5 to 45%. The content of these individual compounds is preferably in each case 2 to 20%.

[0390] x) LC medium in which the proportion of compounds of the formulae CY, PY and ZK in the LC host mixture as a whole is greater than 70%, preferably greater than 80%.

[0391] y) LC medium in which the LC host mixture contains one or more compounds containing an alkenyl group, preferably selected from formulae AN and AY, very preferably selected from formulae AN1, AN3, AN6 and AY14, most preferably from formulae AN1a, AN3a, AN6a and AY14. The concentration of these compounds in the LC host mixture is preferably from 2 to 70%, very preferably from 3 to 55%.

[0392] z) LC medium wherein component B) or the LC host mixture contains one or more, preferably 1 to 5, compounds selected of formula PY1-PY8, very preferably of formula PY2. The proportion of these compounds in the LC host mixture as a whole is preferably 1 to 30%, particularly preferably 2 to 20%. The content of these individual compounds is preferably in each case 1 to 20%.

[0393] z1) LC medium wherein component B) or the LC host mixture contains one or more, preferably 1, 2 or 3, compounds selected from formulae T1, T2 and T5, very preferably from formula T2. The content of these compounds in the LC host mixture as a whole is preferably 1 to 20%.

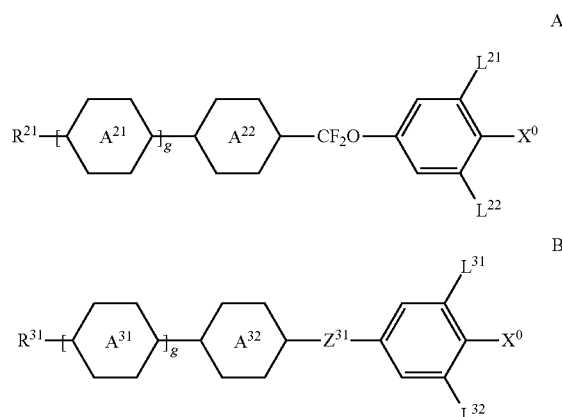
[0394] z2) LC medium in which the LC host mixture contains one or more compounds selected from formulae CY and PY, one or more compounds selected from formulae AN and AY, and one or more compounds selected from formulae T and Q.

[0395] z3) LC medium in which the LC host mixture contains one or more, preferably 1, 2 or 3, compounds of formula BF1, and one or more, preferably 1, 2 or 3, compounds selected from formulae AY14, AY15 and AY16, very preferably of formula AY14. The proportion of the compounds of formula AY14-AY16 in the LC host mixture is preferably from 2 to 35%, very preferably from 3 to 30%. The proportion of the compounds of formula BF1 in the LC host mixture is preferably from 0.5 to 20%, very preferably from 1 to 15%. Further preferably the LC host mixture according to this preferred embodiment contains one or more, preferably 1, 2 or 3 compounds of formula T, preferably selected from formula T1, T2 and T5, very preferably from formula T2 or T5. The propor-

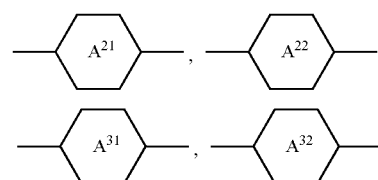
tion of the compounds of formula T in the LC host mixture medium is preferably from 0.5 to 15%, very preferably from 1 to 10%.

[0396] In a second preferred embodiment the LC medium contains an LC host mixture based on compounds with positive dielectric anisotropy. Such LC media are especially suitable for use in PS-OCB-, PS-TN-, PS-Posi-VA-, PS-IPS- or PS-FFS-displays.

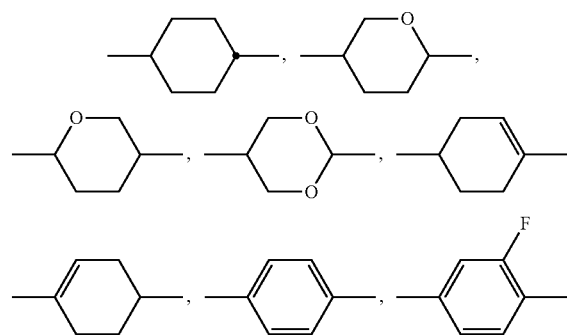
[0397] Preferred LC medium for this embodiment comprise an LC host mixture comprising one or more compounds of the formula A or B below:

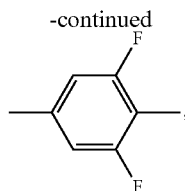


in which the individual radicals have, independently of each other and on each occurrence identically or differently, the following meanings:



each, independently of one another, and on each occurrence, identically or differently





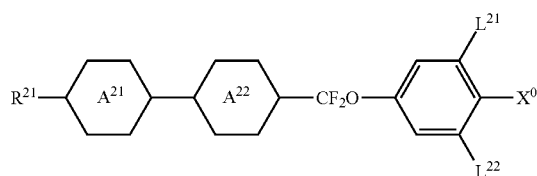
[0398] R^{21} , R^{31} each, independently of one another, alkyl, alkoxy, oxaalkyl or alkoxyalkyl having 1 to 9 C atoms or alkenyl or alkenyloxy having 2 to 9 C atoms, all of which are optionally fluorinated,

[0404] In the compounds of formula A and B, R^{21} and R^{31} are preferably selected from straight-chain alkyl or alkoxy with 1, 2, 3, 4, 5 or 6 C atoms, and straight-chain alkenyl with 2, 3, 4, 5, 6 or 7 C atoms.

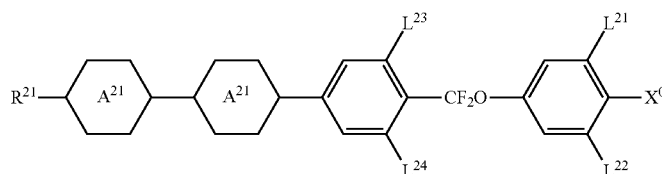
[0405] In the compounds of formula A and B, g is preferably 1 or 2.

[0406] In the compounds of formula B, Z^{31} is preferably COO, trans-CH=CH or a single bond, very preferably COO or a single bond.

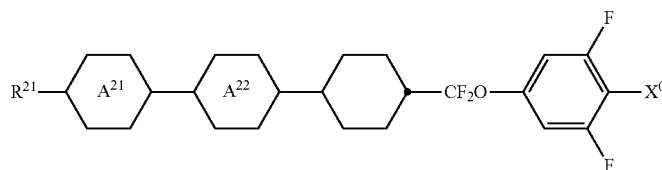
[0407] Preferably component B) of the LC medium of this embodiment comprises one or more compounds of formula A selected from the group consisting of the following formulae:



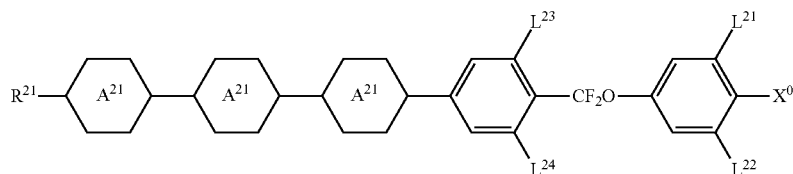
A1



A2



A3



A4

[0399] X^0 F, Cl, halogenated alkyl or alkoxy having 1 to 6 C atoms or halogenated alkenyl or alkenyloxy having 2 to 6 C atoms,

[0400] Z^{31} —CH₂CH₂—, —CF₂CF₂—, —COO—, trans-CH=CH—, trans-CF=CF—, —CH₂O— or a single bond, preferably —CH₂CH₂—, —COO—, trans-CH=CH— or a single bond, particularly preferably —COO—, trans-CH=CH— or a single bond,

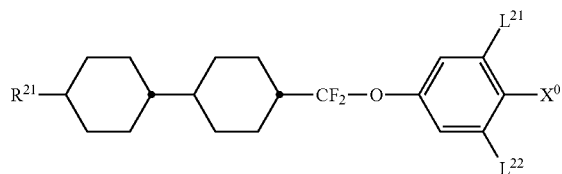
[0401] L^{21} , L^{22} , L^{31} , L^{32} each, independently of one another, H or F,

[0402] g 0, 1, 2 or 3.

[0403] In the compounds of formula A and B, X^0 is preferably F, Cl, CF₃, CHF₂, OCF₃, OCHF₂, OCFHCF₃, OCFHCHF₂, OCFHCHF₂, OCF₂CH₃, OCF₂CHF₂, OCF₂CHF₂, OCF₂CF₂CHF₂, OCF₂CF₂CHF₂, OCFHCF₂CF₃, OCFHCF₂CHF₂, OCF₂CF₂CF₃, OCF₂CF₂CCIF₂, OCCIFCF₂CF₃ or CH=CF₂, very preferably F or OCF₃, most preferably F.

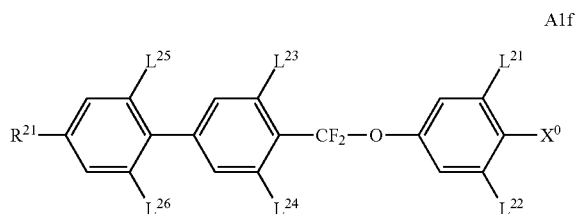
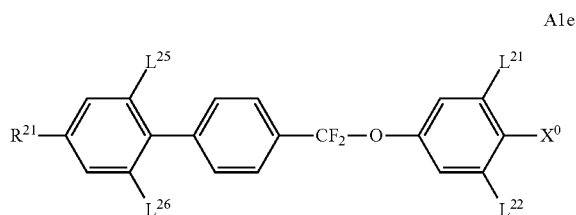
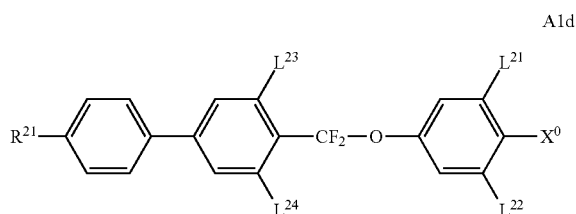
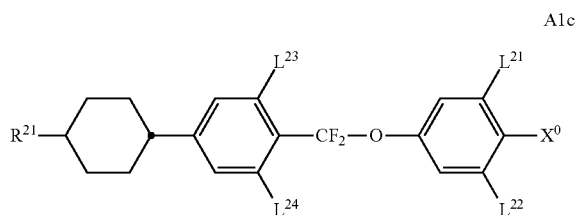
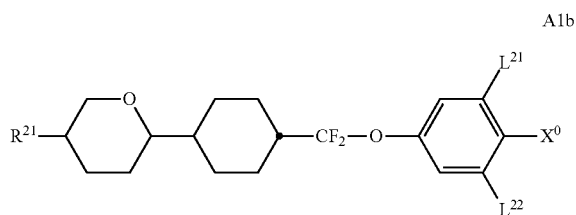
in which A^{21} , R^{21} , X^0 , L^{21} and L^{22} have the meanings given in formula A, L^{23} and L^{24} each, independently of one another, are H or F, and X^0 is preferably F. Particularly preferred are compounds of formulae A1 and A2.

[0408] Particularly preferred compounds of formula A1 are selected from the group consisting of the following subformulae:



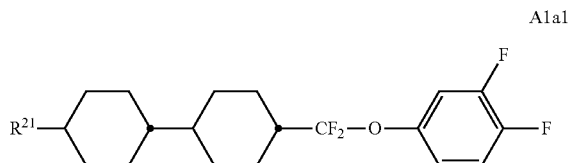
A1a

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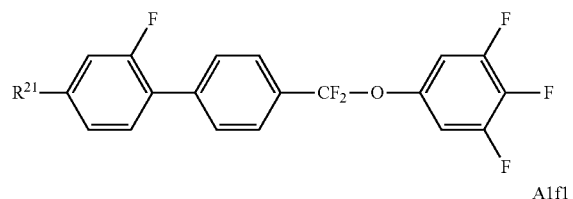
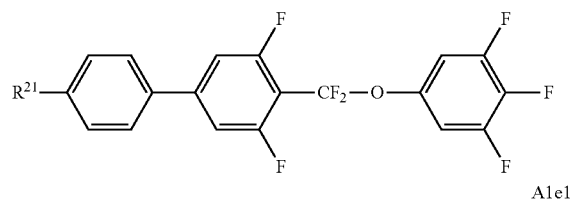
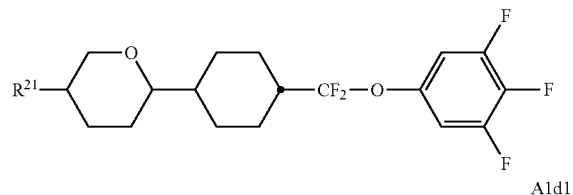
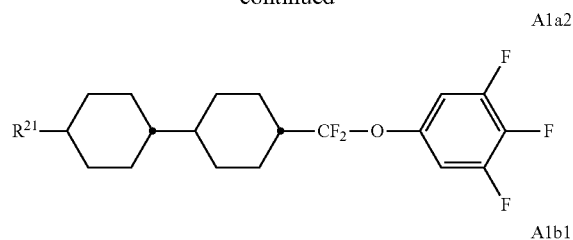


in which R^{21} , X^0 , L^{21} and L^{22} have the meaning given in formula A1, L^{23} , L^{24} , L^{25} and L^{26} are each, independently of one another, H or F, and X^0 is preferably F.

[0409] Very particularly preferred compounds of formula A1 are selected from the group consisting of the following subformulae:

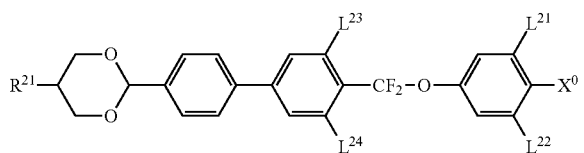
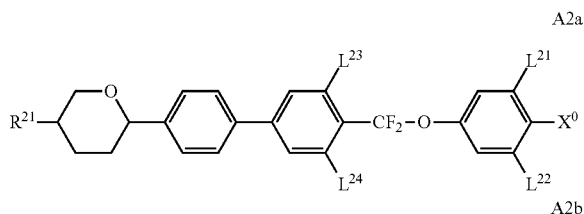


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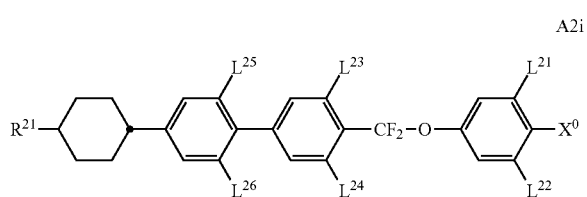
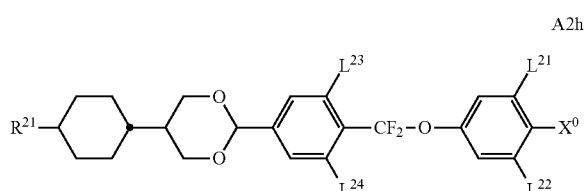
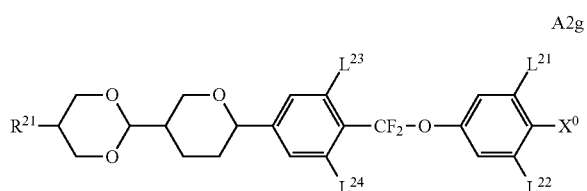
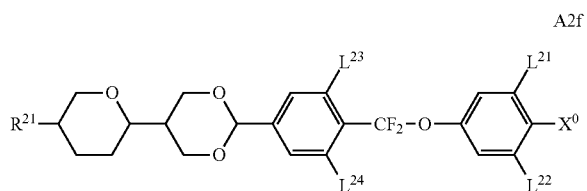
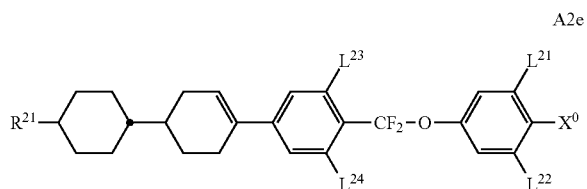
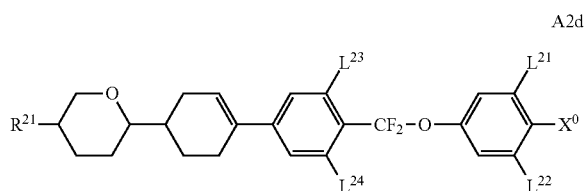
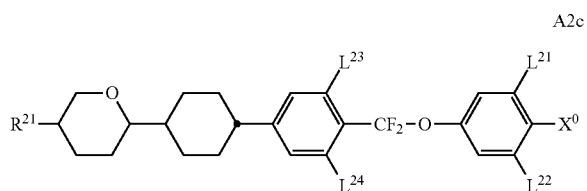


[0410] In which R^{21} is as defined in formula A1.

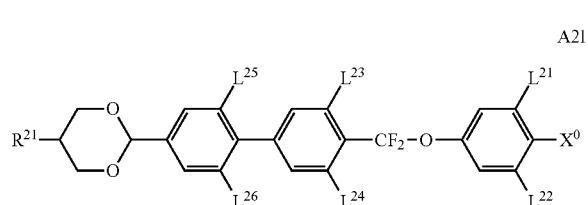
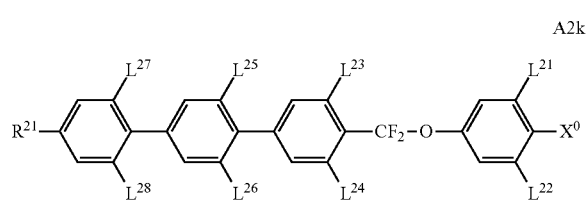
[0411] Particularly preferred compounds of formula A2 are selected from the group consisting of the following subformulae:



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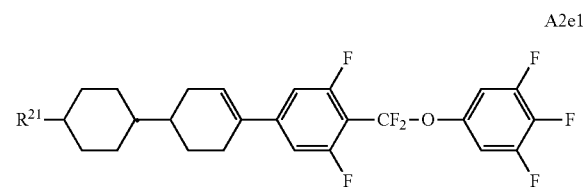
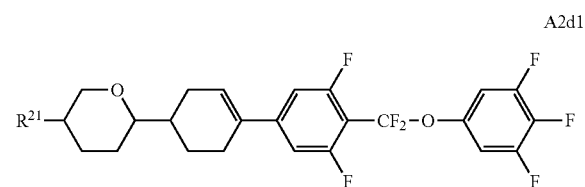
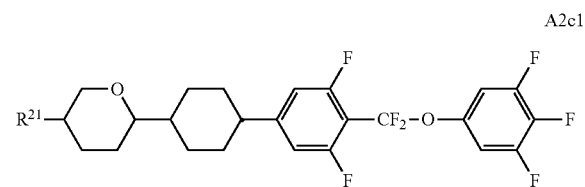
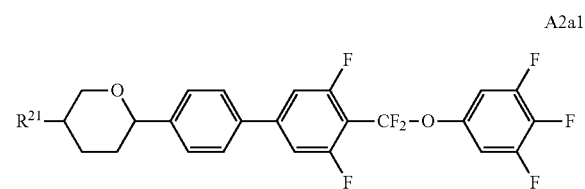


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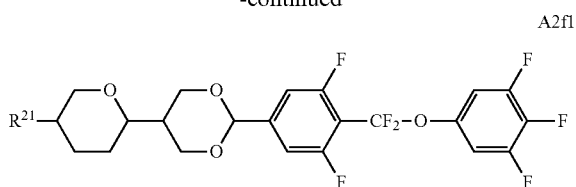


in which R^{21} , X^0 , L^{21} and L^{22} have the meaning given in formula A2, L^{23} , L^{24} , L^{25} and L^{26} each, independently of one another, are H or F, and X^0 is preferably F.

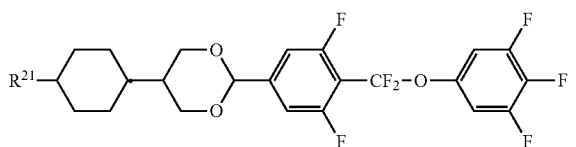
[0412] Very particularly preferred compounds of formula A2 are selected from the group consisting of the following subformulae:



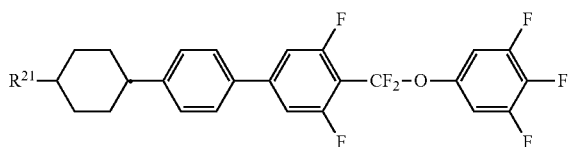
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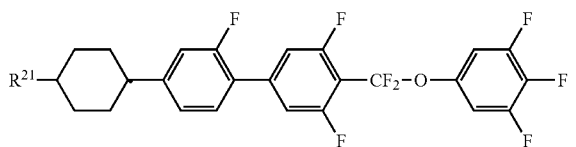
A2h1



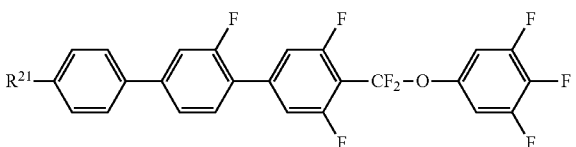
A2i1



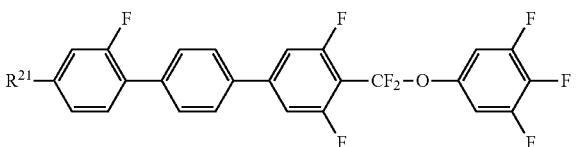
A2i2



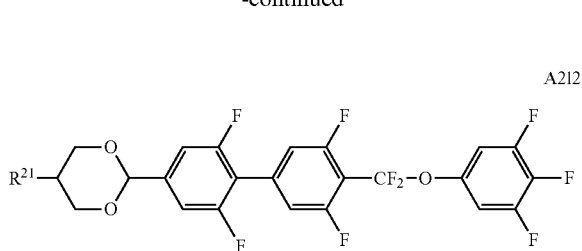
A2k1



A2k2



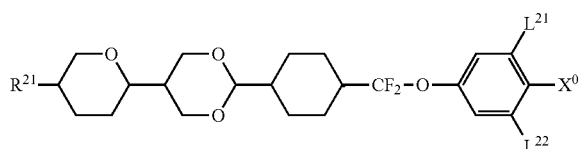
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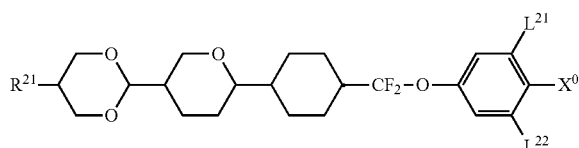
in which R^{21} and X^0 are as defined in formula A2.

[0413] Particularly preferred compounds of formula A3 are selected from the group consisting of the following subformulae:

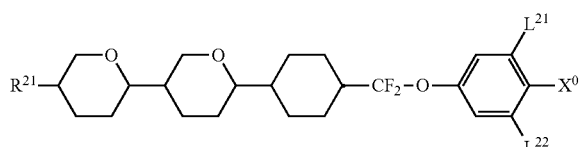
A3a



A3b



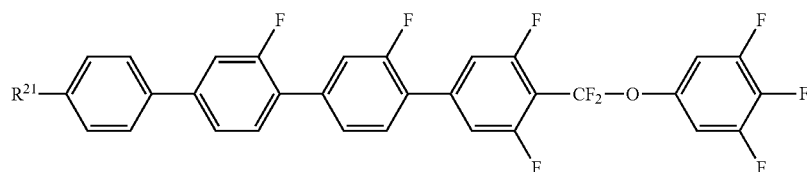
A3c



in which R^{21} , X^0 , L^{21} and L^{22} have the meaning given in formula A3, and X^0 is preferably F.

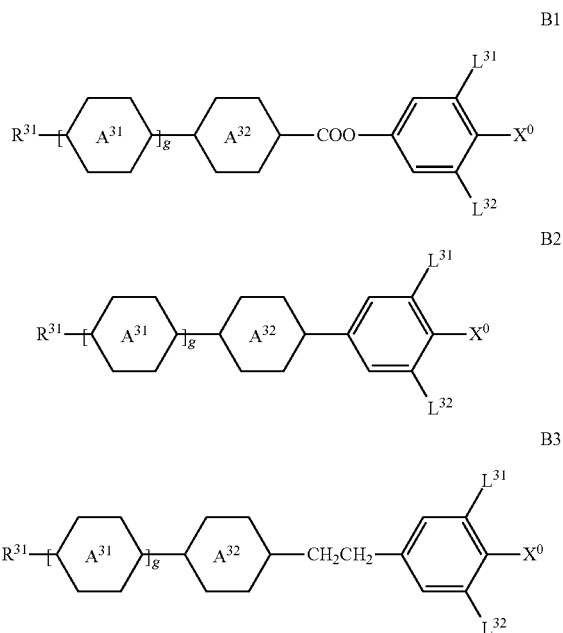
[0414] Particularly preferred compounds of formula A4 are selected from the group consisting of the following subformulae:

A4a



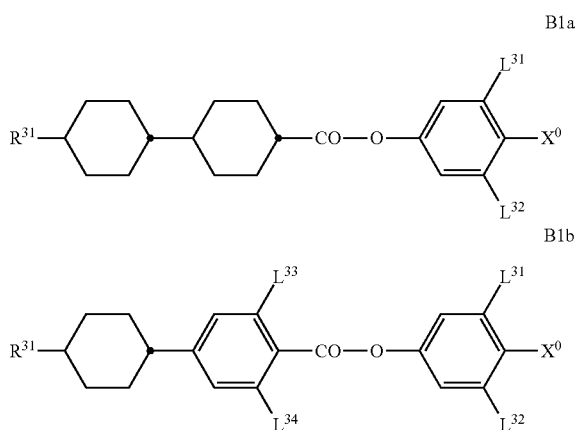
in which R^{21} is as defined in formula A4.

[0415] Preferably component B) of the LC medium of this embodiment comprises one or more compounds of formula B selected from the group consisting of the following formulae:



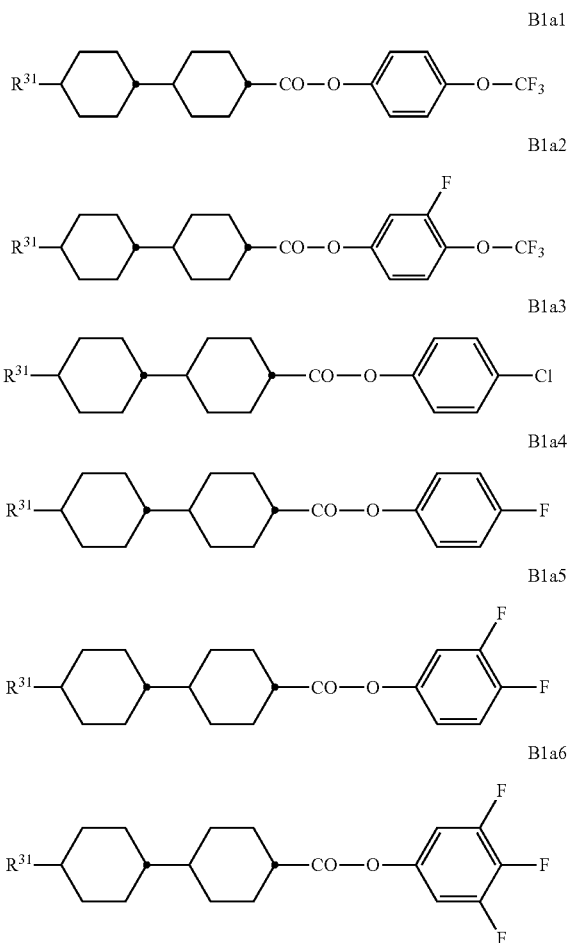
in which g, A³¹, A³², R³¹, X⁰, L³¹ and L³² have the meanings given in formula B, and X⁰ is preferably F. Particularly preferred are compounds of formulae B1 and B2.

[0416] Particularly preferred compounds of formula B1 are selected from the group consisting of the following subformulae:



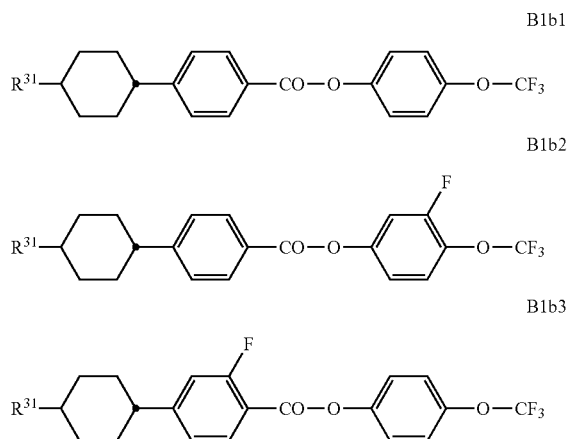
in which R³¹, X⁰, L³¹ and L³² have the meaning given in formula B1, and X⁰ is preferably F.

[0417] Very particularly preferred compounds of formula B1a are selected from the group consisting of the following subformulae:

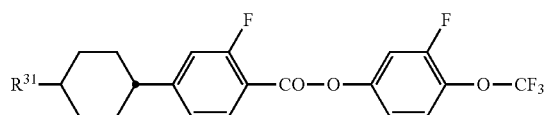


in which R³¹ is as defined in formula B1.

[0418] Very particularly preferred compounds of formula B1b are selected from the group consisting of the following subformulae:



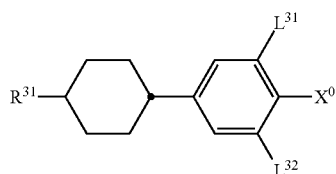
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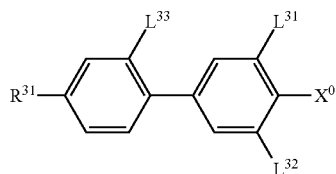
B1b4

in which R^{31} is as defined in formula B1.

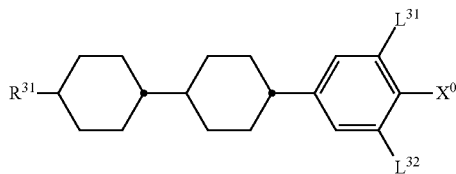
[0419] Particularly preferred compounds of formula B2 are selected from the group consisting of the following subformulae:



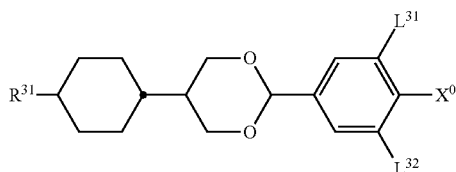
B2a



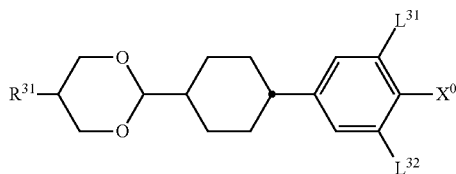
B2b



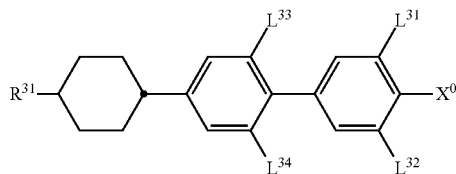
B2c



B2d

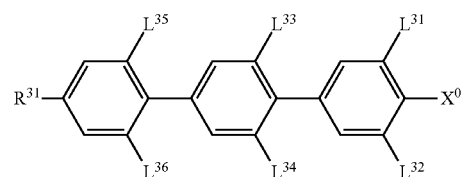


B2e

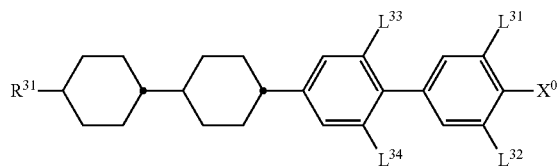


B2f

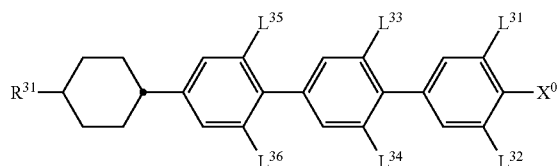
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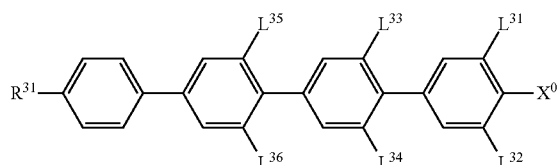
B2g



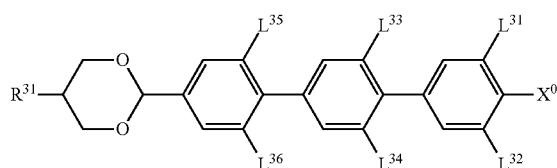
B2h



B2i



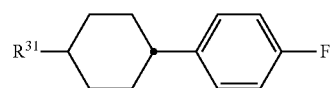
B2j



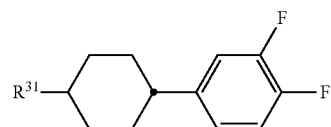
B2k

in which R^{31} , X^0 , L^{31} and L^{32} have the meaning given in formula B2, L^{33} , L^{34} , L^{35} and L^{36} are each, independently of one another, H or F, and X^0 is preferably F.

[0420] Very particularly preferred compounds of formula B2 are selected from the group consisting of the following subformulae:

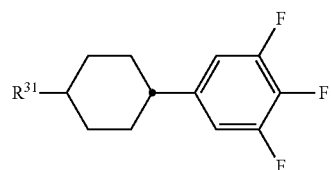


B2a1

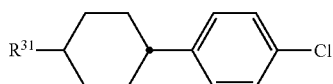


B2a2

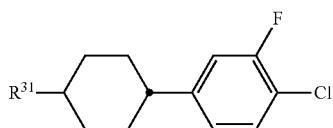
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B2a3



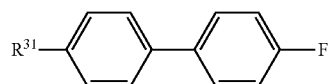
B2a4



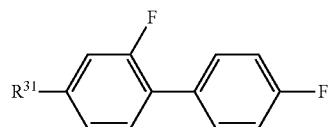
B2a5

in which R³¹ is as defined in formula B2.

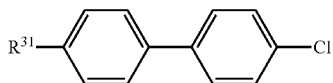
[0421] Very particularly preferred compounds of formula B2b are selected from the group consisting of the following subformulae



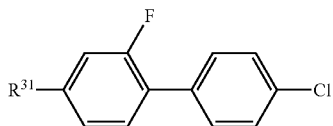
B2b1



B2b2



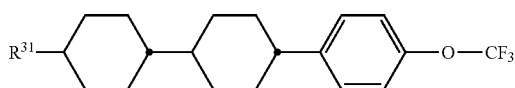
B2b3



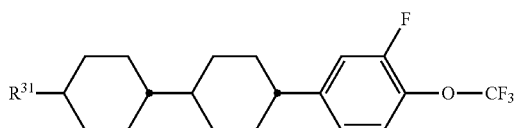
B2b4

in which R³¹ is as defined in formula B2.

[0422] Very particularly preferred compounds of formula B2c are selected from the group consisting of the following subformulae:

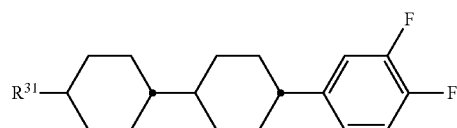


B2c1

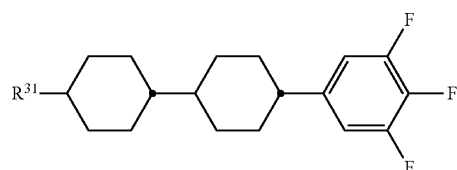


B2c2

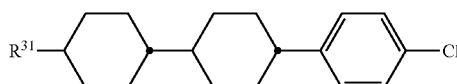
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B2c3



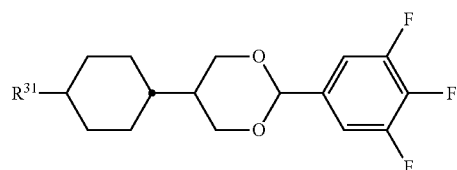
B2c4



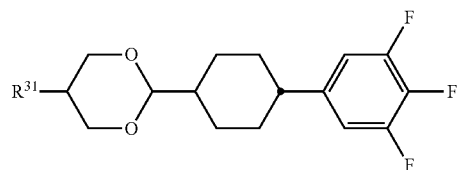
B2c5

in which R³¹ is as defined in formula B2.

[0423] Very particularly preferred compounds of formula B2d and B2e are selected from the group consisting of the following subformulae:



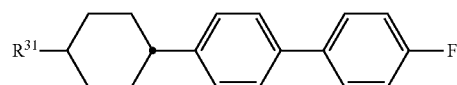
B2d1



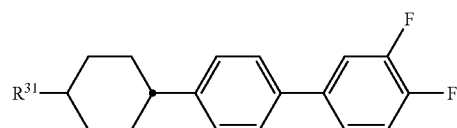
B2e1

in which R³¹ is as defined in formula B2.

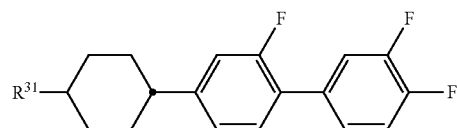
[0424] Very particularly preferred compounds of formula B2f are selected from the group consisting of the following subformulae:



B2f1

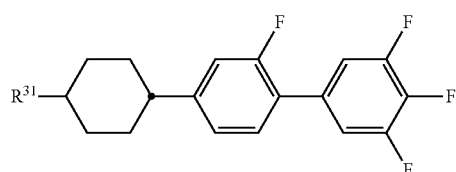
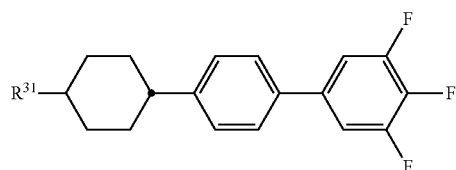


B2f2



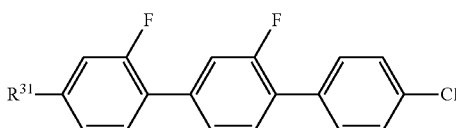
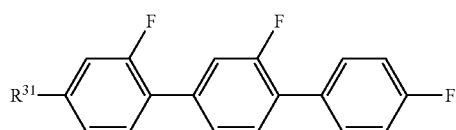
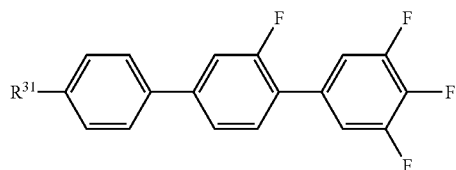
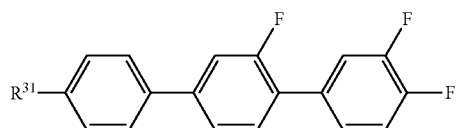
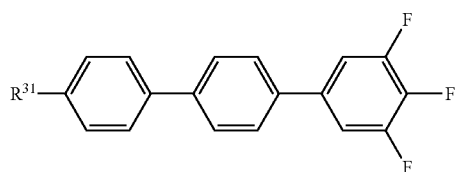
B2f3

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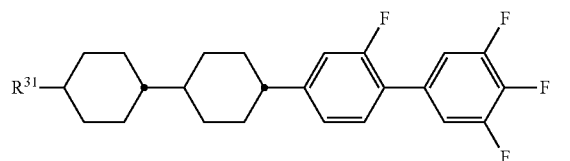
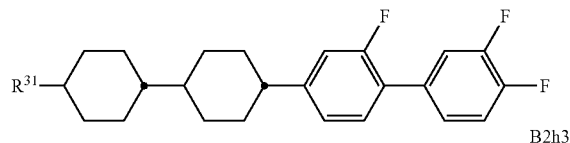
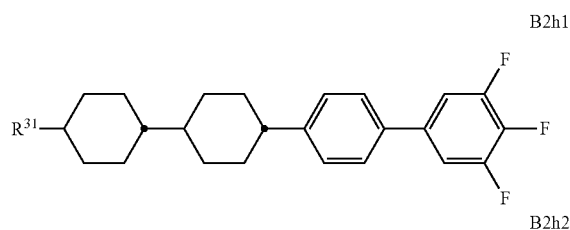
in which R^{31} is as defined in formula B2.

[0425] Very particularly preferred compounds of formula B2g are selected from the group consisting of the following subformulae:



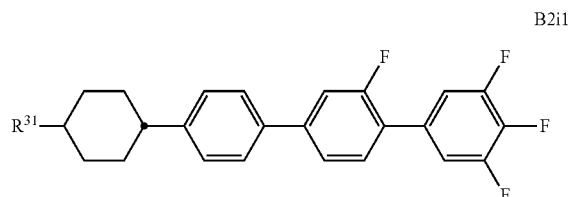
in which R^{31} is as defined in formula B2.

[0426] Very particularly preferred compounds of formula B2h are selected from the group consisting of the following subformulae:



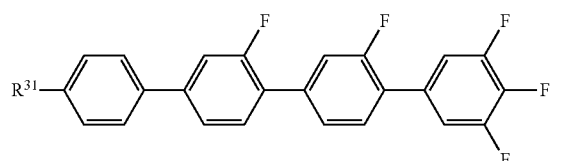
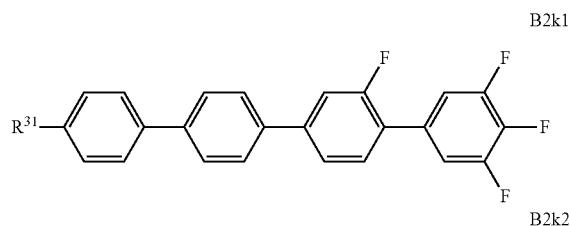
in which R^{31} is as defined in formula B2.

[0427] Very particularly preferred compounds of formula B2i are selected from the group consisting of the following subformulae:



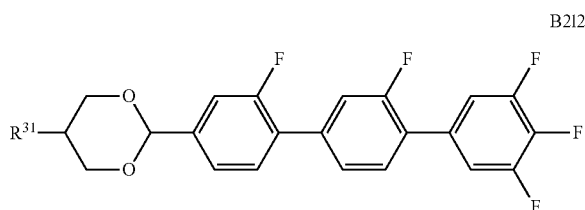
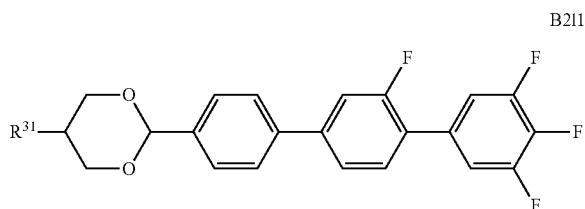
in which R^{31} is as defined in formula B2.

[0428] Very particularly preferred compounds of formula B2k are selected from the group consisting of the following subformulae:



in which R^{31} is as defined in formula B2.

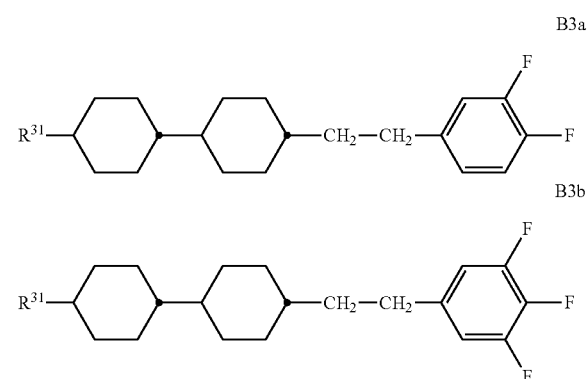
[0429] Very particularly preferred compounds of formula B21 are selected from the group consisting of the following subformulae:



in which R³¹ is as defined in formula B2.

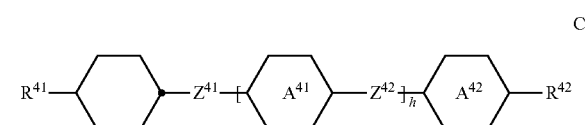
[0430] Alternatively to, or in addition to, the compounds of formula B1 and/or B2 component B) of the LC medium may also comprise one or more compounds of formula B3 as defined above.

[0431] Particularly preferred compounds of formula B3 are selected from the group consisting of the following subformulae:

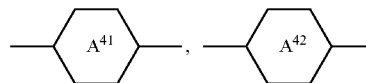


in which R³¹ is as defined in formula B3.

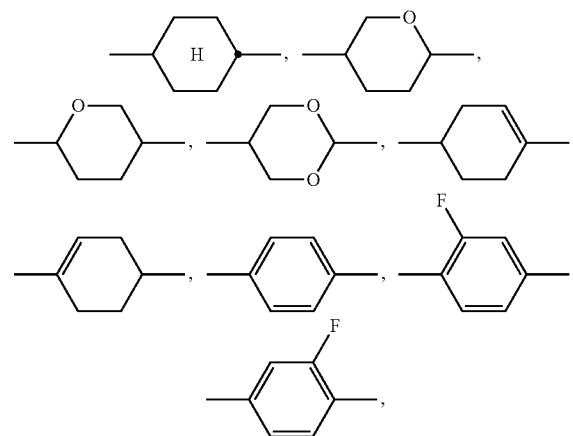
[0432] Preferably component B) of the LC medium in this embodiment comprises, in addition to the compounds of formula A and/or B, one or more compounds of formula C



in which the individual radicals have the following meanings:



each, independently of one another, and on each occurrence, identically or differently



[0433] R⁴¹, R⁴² each, independently of one another, alkyl, alkoxy, oxaalkyl or alkoxyalkyl having 1 to 9 C atoms or alkenyl or alkenyloxy having 2 to 9 C atoms, all of which are optionally fluorinated,

[0434] Z⁴¹, Z⁴² each, independently of one another, —CH₂CH₂—, —COO—, trans-CH=CH—, trans-CF=CF—, —CH₂O—, —CF₂O—, —C=C— or a single bond, preferably a single bond,

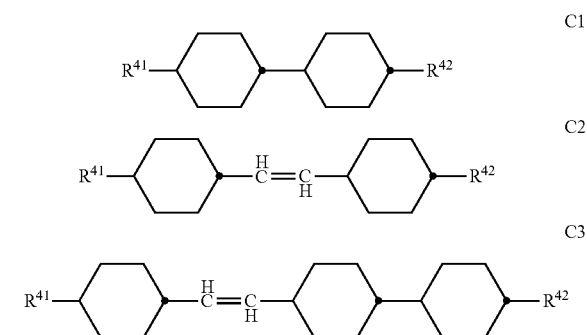
[0435] h 0, 1, 2 or 3.

[0436] In the compounds of formula C, R⁴¹ and R⁴² are preferably selected from straight-chain alkyl or alkoxy with 1, 2, 3, 4, 5 or 6 C atoms, and straight-chain alkenyl with 2, 3, 4, 5, 6 or 7 C atoms.

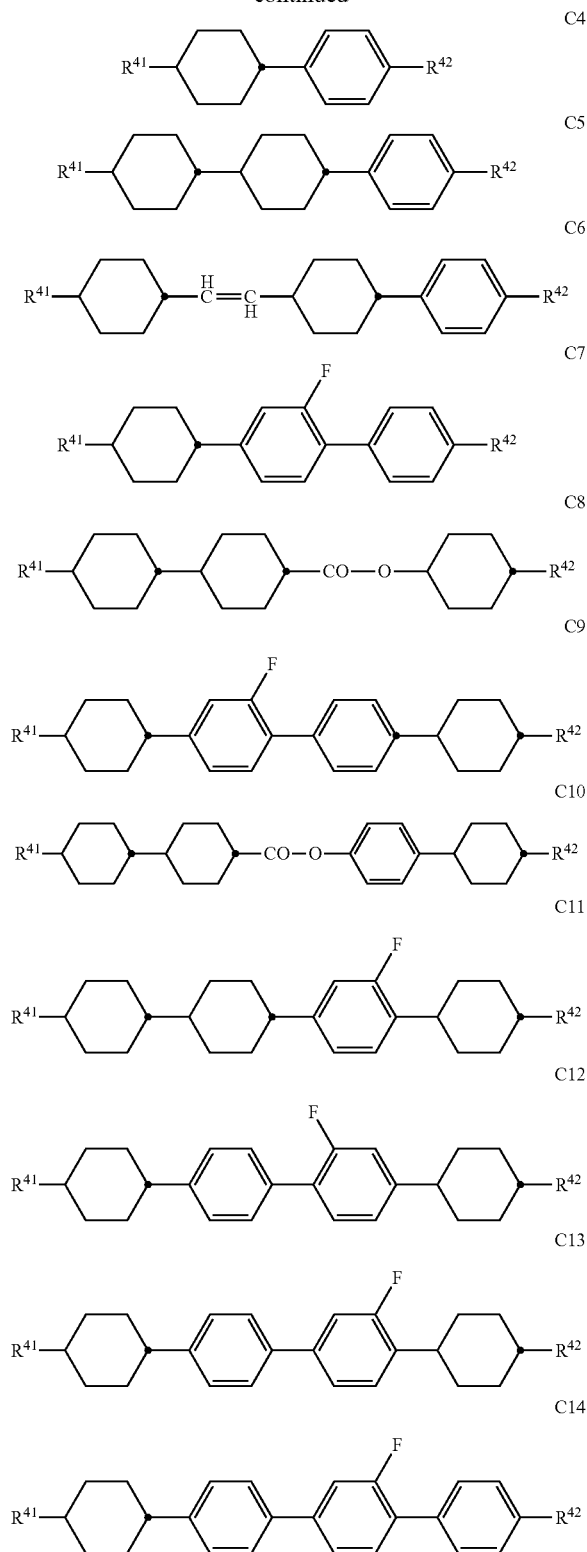
[0437] In the compounds of formula C, h is preferably 0, 1 or 2.

[0438] In the compounds of formula C, Z⁴¹ and Z⁴² are preferably selected from COO, trans-CH=CH and a single bond, very preferably from COO and a single bond.

[0439] Preferred compounds of formula C are selected from the group consisting of the following subformulae:



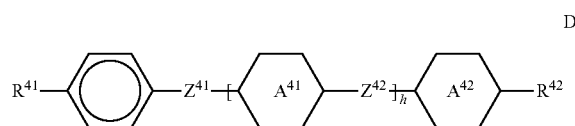
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wherein R^{41} and R^{42} have the meanings given in formula U, and preferably denote each, independently of one another, alkyl, alkoxy, fluorinated alkyl or fluorinated alkoxy with 1

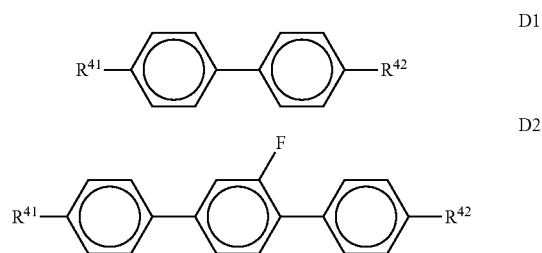
to 7 C atoms, or alkenyl, alkenyloxy, alkoxyalkyl or fluorinated alkenyl with 2 to 7 C atoms.

[0440] Further preferably component B) of the LC medium in this embodiment comprises, in addition to the compounds of formula A and/or B, and optionally compound of the formula C, one or more compounds of formula D



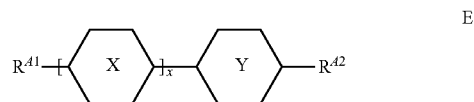
in which A^{41} , A^{42} , Z^{41} , Z^{42} , R^{41} , R^{42} and h have the meanings given in formula C above or one of the preferred meanings given above.

[0441] Preferred compounds of formula D are selected from the group consisting of the following subformulae:

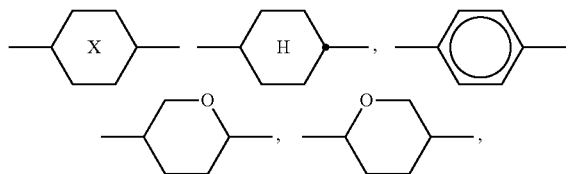


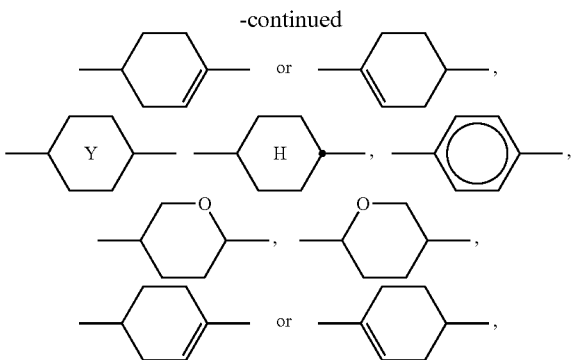
in which R^{41} and R^{42} have the meanings given in formula D and R^{41} preferably denotes alkyl, and in formula D1 R^{42} preferably denotes alkenyl, particularly preferably $-(CH_2)_2-CH=CH-CH_3$, and in formula D2 R^{42} preferably denotes alkyl, $-(CH_2)_2-CH=CH_2$ or $-(CH_2)_2-CH=CH-CH_3$.

[0442] Further preferably component B) of the LC medium in this embodiment comprises, in addition to the compounds of formula A and/or B, and optionally C and/or D, one or more compounds of formula E containing an alkenyl group



in which the individual radicals, on each occurrence identically or differently, each, independently of one another, have the following meaning:





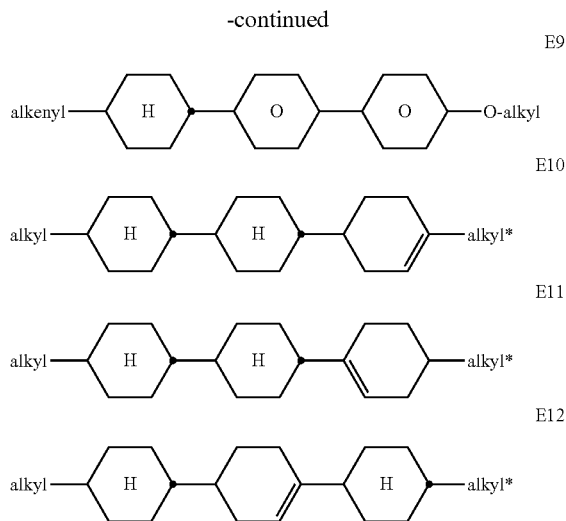
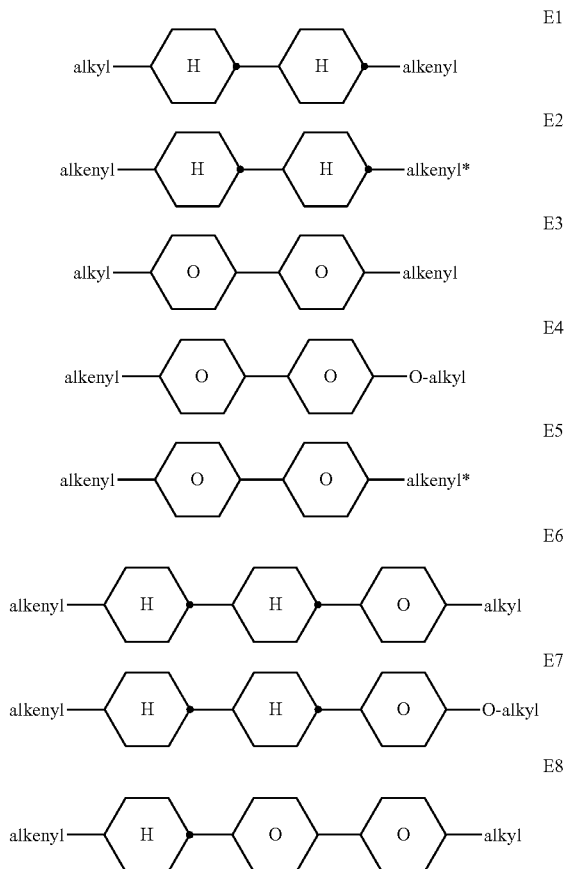
[0443] RA^1 alkenyl having 2 to 9 C atoms or, if at least one of the rings X, Y and Z denotes cyclohexenyl, also one of the meanings of R^{42} ,

[0444] R^{42} alkyl having 1 to 12 C atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced by $-O-$, $-CH=CH-$, $-CO-$, $-OCO-$ or $-COO-$ in such a way that O atoms are not linked directly to one another,

[0445] x 1 or 2.

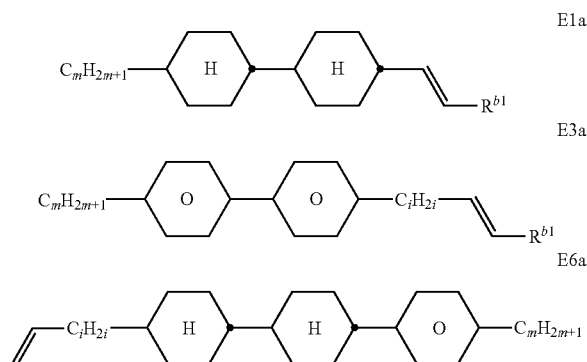
[0446] R^{42} is preferably straight-chain alkyl or alkoxy having 1 to 8 C atoms or straight-chain alkenyl having 2 to 7 C atoms.

[0447] Preferred compounds of formula E are selected from the following sub-formulae:



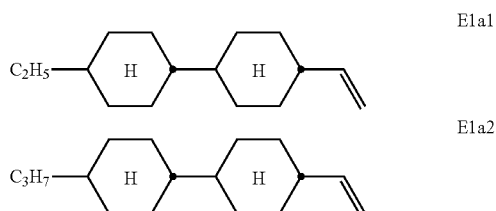
in which alkyl and alkyl* each, independently of one another, denote a straight-chain alkyl radical having 1-6 C atoms, and alkenyl and alkenyl* each, independently of one another, denote a straight-chain alkenyl radical having 2-7 C atoms. Alkenyl and alkenyl* preferably denote $CH_2=CH-$, $CH_2=CHCH_2CH_2-$, $CH_3-CH=CH-$, $CH_3-CH_2-CH=CH-$, $CH_3-(CH_2)_2-CH=CH-$, $CH_3-(CH_2)_3-CH=CH-$ or $CH_3-CH=CH-(CH_2)_2-$.

[0448] Very preferred compounds of the formula E are selected from the following sub-formulae:

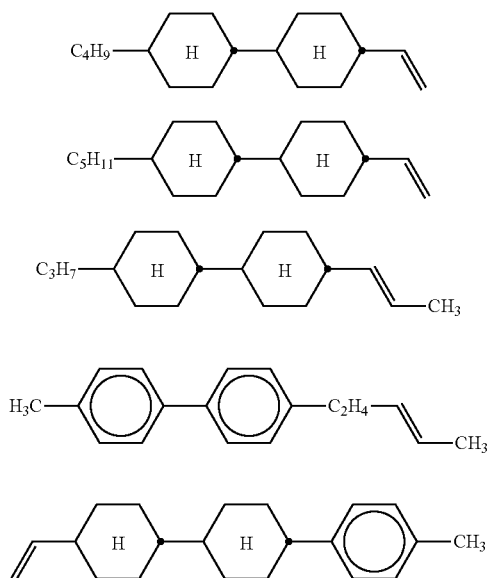


in which m denotes 1, 2, 3, 4, 5 or 6, i denotes 0, 1, 2 or 3, and R^{b1} denotes H, CH_3 or C_2H_5 .

[0449] Very particularly preferred compounds of the formula E are selected from the following sub-formulae:



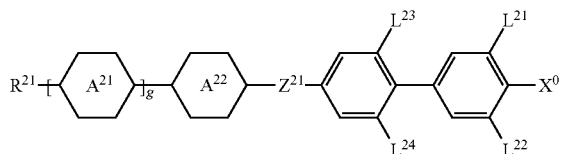
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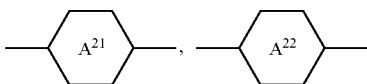
[0450] Most preferred are compounds of formula E1a2, E1a5, E3a1 and E6a1.

[0451] Further preferably component B) of the LC medium in this embodiment comprises, in addition to the compounds of formula A and/or B, and optionally C, D and/or E, one or more compounds of formula F

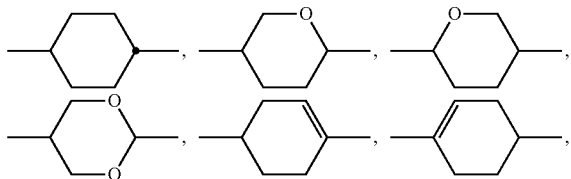
F



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



denote



-continued

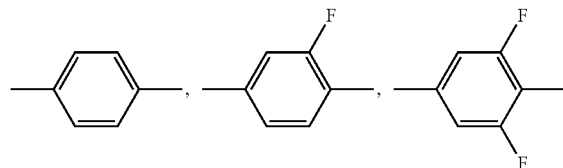
E1a3

E1a4

E1a5

E3a1

E6a1



[0452] R^{21} , R^{31} each, independently of one another, alkyl, alkoxy, oxaalkyl or alkoxyalkyl having 1 to 9 C atoms or alkenyl or alkenyloxy having 2 to 9 C atoms, all of which are optionally fluorinated,

[0453] X^0 F, Cl, halogenated alkyl or alkoxy having 1 to 6 C atoms or halogenated alkenyl or alkenyloxy having 2 to 6 C atoms,

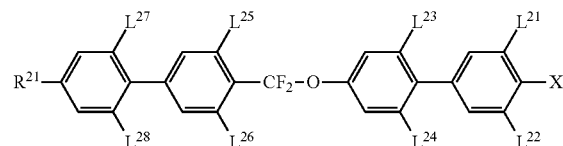
[0454] Z^{21} $-\text{CH}_2\text{CH}_2-$, $-\text{CF}_2\text{CF}_2-$, $-\text{COO}-$, trans-CH=CH- , trans-CF=CF- , $-\text{CH}_2\text{O-}$ or a single bond, preferably $-\text{CH}_2\text{CH}_2-$, $-\text{COO}-$, trans-CH=CH- or a single bond, particularly preferably $-\text{COO}-$, trans-CH=CH- or a single bond,

[0455] L^{21} , L^{22} , L^{23} , L^{24} each, independently of one another, H or F,

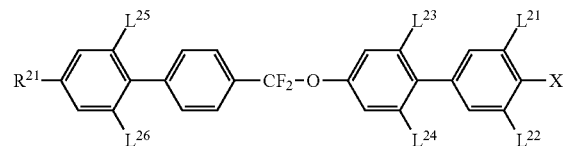
[0456] g 0, 1, 2 or 3.

[0457] Particularly preferred compounds of formula F are selected from the group consisting of the following formulae:

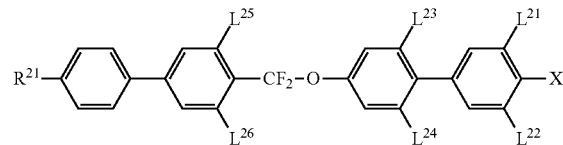
F1



F2

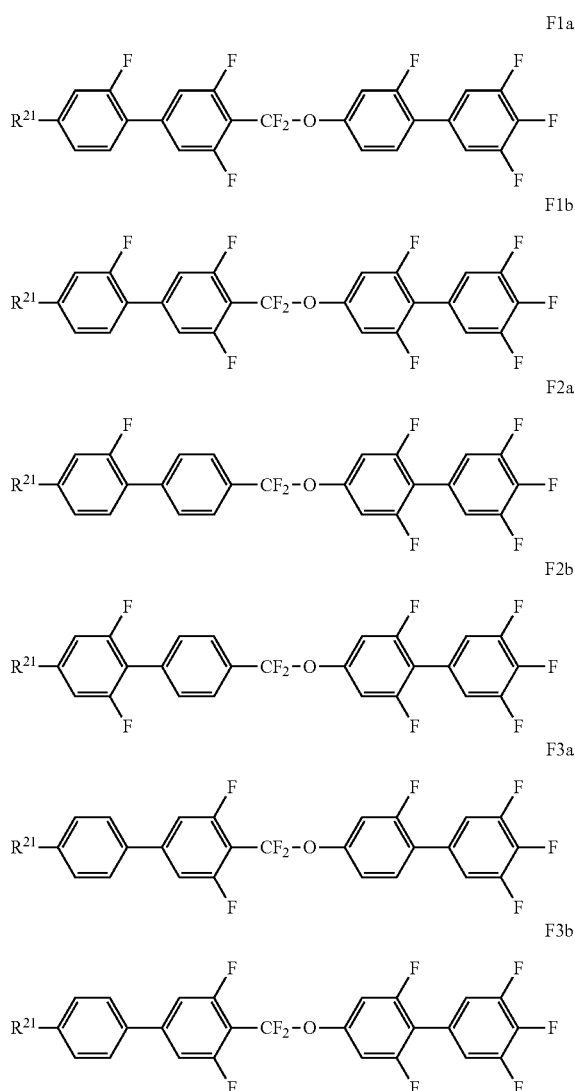


F3



in which R^{21} , X^0 , L^{21} and L^{22} have the meaning given in formula F, L^{25} and L^{26} are each, independently of one another, H or F, and X^0 is preferably F.

[0458] Very particularly preferred compounds of formula F1-F3 are selected from the group consisting of the following subformulae:



[0459] In which R^{21} is as defined in formula F1.

[0460] The concentration of the compounds of formula A and B in the LC host mixture is preferably from 2 to 60%, very preferably from 3 to 45%, most preferably from 4 to 35%.

[0461] The concentration of the compounds of formula C and D in the LC host mixture is preferably from 2 to 70%, very preferably from 5 to 65%, most preferably from 10 to 60%.

[0462] The concentration of the compounds of formula E in the LC host mixture is preferably from 5 to 50%, very preferably from 5 to 35%.

[0463] The concentration of the compounds of formula F in the LC host mixture is preferably from 2 to 30%, very preferably from 5 to 20%.

[0464] Further preferred embodiments of this second preferred embodiment of the present invention are listed below, including any combination thereof.

[0465] 2a) The LC host mixture comprises one or more compounds of formula A and/or B with high positive dielectric anisotropy, preferably with $\Delta\epsilon > 15$.

[0466] 2b) The LC host mixture comprises one or more compounds selected from the group consisting of formulae A1a2, A1b1, A1d1, A1f1, A2a1, A2h1, A212, A2k1, B2h3, B211, F1a. The proportion of these compounds in the LC host mixture is preferably from 4 to 40%, very preferably from 5 to 35%.

[0467] 2c) The LC host mixture comprises one or more compounds selected from the group consisting of formulae B2c1, B2c4, B2f4, C14. The proportion of these compounds in the LC host mixture is preferably from 4 to 40%, very preferably from 5 to 35%.

[0468] 2d) The LC host mixture comprises one or more compounds selected from the group consisting of formulae C₃, C₄, C₅, C₉ and D2. The proportion of these compounds in the LC host mixture is preferably from 8 to 70%, very preferably from 10 to 60%.

[0469] 2e) The LC host mixture comprises one or more compounds selected from the group consisting of formulae G1, G2 and G5, preferably G1a, G2a and G5a. The proportion of these compounds in the LC host mixture is preferably from 4 to 40%, very preferably from 5 to 35%.

[0470] 2f) The LC host mixture comprises one or more compounds selected from the group consisting of formulae E1, E3 and E6, preferably E1a, E3a and E6a, very preferably E1a2, E1a5, E3a1 and E6a1. The proportion of these compounds in the LC host mixture is preferably from 5 to 60%, very preferably from 10 to 50%.

[0471] The combination of compounds of the preferred embodiments mentioned above with the polymerised compounds described above causes low threshold voltages, low rotational viscosities and very good low-temperature stabilities in the LC media according to the invention at the same time as constantly high clearing points and high HR values, and allows the rapid establishment of a particularly low pretilt angle in PSA displays. In particular, the LC media exhibit significantly shortened response times, in particular also the grey-shade response times, in PSA displays compared with the media from the prior art.

[0472] The LC media and LC host mixtures of the present invention preferably have a nematic phase range of at least 80 K, particularly preferably at least 100 K, and a rotational viscosity ≤ 250 mPa·s, preferably ≤ 200 mPa·s, at 20° C.

[0473] In the VA-type displays according to the invention, the molecules in the layer of the LC medium in the switched-off state are aligned perpendicular to the electrode surfaces (homeotropically) or have a tilted homeotropic alignment. On application of an electrical voltage to the electrodes, a realignment of the LC molecules takes place with the longitudinal molecular axes parallel to the electrode surfaces.

[0474] LC media according to the invention based on compounds with negative dielectric anisotropy according to the first preferred embodiment, in particular for use in displays of the PS-VA and PS-UB-FFS type, have a negative dielectric anisotropy 4E, preferably from -0.5 to -10, in particular from -2.5 to -7.5, at 20° C. and 1 kHz.

[0475] The birefringence Δn in LC media according to the invention for use in displays of the PS-VA and PS-UB-FFS type is preferably below 0.16, particularly preferably from 0.06 to 0.14, very particularly preferably from 0.07 to 0.12.

[0476] In the OCB-type displays according to the invention, the molecules in the layer of the LC medium have a "bend" alignment. On application of an electrical voltage, a

realignment of the LC molecules takes place with the longitudinal molecular axes perpendicular to the electrode surfaces.

[0477] LC media according to the invention for use in displays of the PS-OCB, PS-TN, PS-IPS, PS-posi-VA and PS-FFS type are preferably those based on compounds with positive dielectric anisotropy according to the second preferred embodiment, and preferably have a positive dielectric anisotropy $\Delta\epsilon$ from +4 to +17 at 20° C. and 1 kHz.

[0478] The birefringence Δn in LC media according to the invention for use in displays of the PS-OCB type is preferably from 0.14 to 0.22, particularly preferably from 0.16 to 0.22.

[0479] The birefringence Δn in LC media according to the invention for use in displays of the PS-TN-, PS-posi-VA-, PS-IPS- oder PS-FFS-type is preferably from 0.07 to 0.15, particularly preferably from 0.08 to 0.13.

[0480] LC media according to the invention, based on compounds with positive dielectric anisotropy according to the second preferred embodiment, for use in displays of the PS-TN-, PS-posi-VA-, PS-IPS- oder PS-FFS-type, preferably have a positive dielectric anisotropy $\Delta\epsilon$ from +2 to +30, particularly preferably from +3 to +20, at 20° C. and 1 kHz.

[0481] The LC media according to the invention may also comprise further additives which are known to the person skilled in the art and are described in the literature, such as, for example, polymerisation initiators, inhibitors, stabilisers, surface-active substances or chiral dopants. These may be polymerisable or non-polymerisable. Polymerisable additives are accordingly ascribed to the polymerisable component or component A). Non-polymerisable additives are accordingly ascribed to the non-polymerisable component or component B).

[0482] In a preferred embodiment the LC media contain one or more chiral dopants, preferably in a concentration from 0.01 to 1%, very preferably from 0.05 to 0.5%. The chiral dopants are preferably selected from the group consisting of compounds from Table B below, very preferably from the group consisting of R- or S-1011, R- or S-2011, R- or S-3011, R- or S-4011, and R- or S-5011.

[0483] In another preferred embodiment the LC media contain a racemate of one or more chiral dopants, which are preferably selected from the chiral dopants mentioned in the previous paragraph.

[0484] Furthermore, it is possible to add to the LC media, for example, 0 to 15% by weight of pleochroic dyes, furthermore nanoparticles, conductive salts, preferably ethyldimethyldodecylammonium 4-hexoxybenzoate, tetrabutyl-ammonium tetraphenylborate or complex salts of crown ethers (cf., for example, Haller et al., Mol. Cryst. Liq. Cryst. 24, 249-258 (1973)), for improving the conductivity,

or substances for modifying the dielectric anisotropy, the viscosity and/or the alignment of the nematic phases. Substances of this type are described, for example, in DE-A 22 09 127, 22 40 864, 23 21 632, 23 38 281, 24 50 088, 26 37 430 and 28 53 728.

[0485] The individual components of the preferred embodiments above, including a)-z3), of the LC media according to the invention are either known or methods for the preparation thereof can readily be derived from the prior art by the person skilled in the relevant art, since they are based on standard methods described in the literature. Corresponding compounds of the formula CY are described, for example, in EP-A-0 364 538. Corresponding compounds of the formula ZK are described, for example, in DE-A-26 36 684 and DE-A-33 21 373.

[0486] The LC media which can be used in accordance with the invention are prepared in a manner conventional per se, for example by mixing one or more of the above-mentioned compounds with one or more polymerisable compounds as defined above, and optionally with further liquid-crystalline compounds and/or additives. In general, the desired amount of the components used in lesser amount is dissolved in the components making up the principal constituent, advantageously at elevated temperature. It is also possible to mix solutions of the components in an organic solvent, for example in acetone, chloroform or methanol, and to remove the solvent again, for example by distillation, after thorough mixing. The invention furthermore relates to the process for the preparation of the LC media according to the invention.

[0487] It goes without saying to the person skilled in the art that the LC media according to the invention may also comprise compounds in which, for example, H, N, O, Cl, F have been replaced by the corresponding isotopes like deuterium etc.

[0488] The following examples explain the present invention without restricting it. However, they show the person skilled in the art preferred mixture concepts with compounds preferably to be employed and the respective concentrations thereof and combinations thereof with one another. In addition, the examples illustrate which properties and property combinations are accessible.

[0489] Preferred mixture components are shown in Tables A1 and A2 below. The compounds shown in Table A1 are especially suitable for use in LC mixtures with positive dielectric anisotropy. The compounds shown in Table A2 are especially suitable for use in LC mixtures with negative dielectric anisotropy.

[0490] In Table A1, m and n are independently of each other an integer from 1 to 12, preferably 1, 2, 3, 4, 5 or 6, k is 0, 1, 2, 3, 4, 5 or 6, and $(O)C_mH_{2m+1}$ means C_mH_{2m+1} or OC_mH_{2m+1} .

TABLE A1

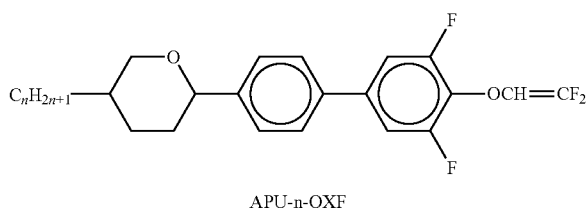
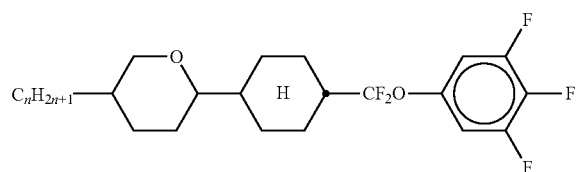
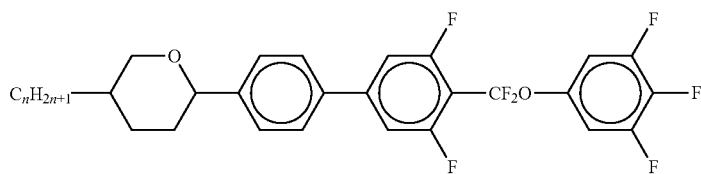


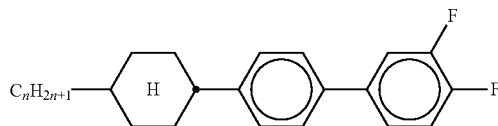
TABLE A1-continued



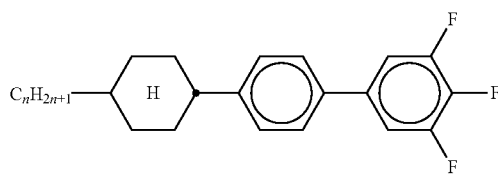
ACQU-n-F



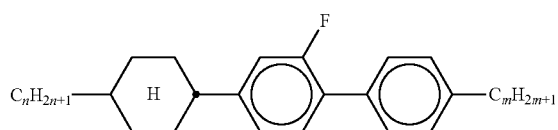
APUQU-n-F



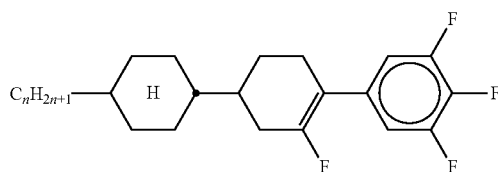
BCH-nF•F



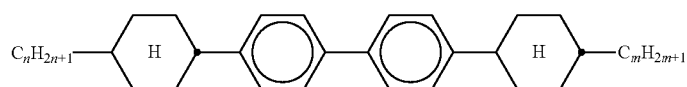
BCH-nF•F•F



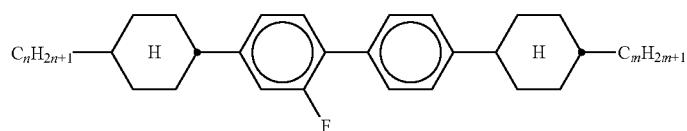
BCH-n•Fm



CFU-n-F



CBC-nm



CBC-nmF

TABLE A1-continued

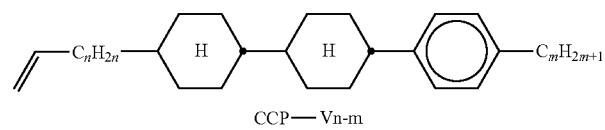
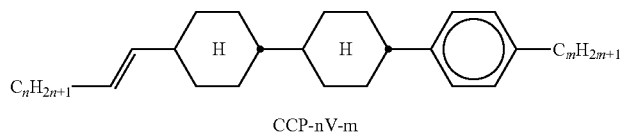
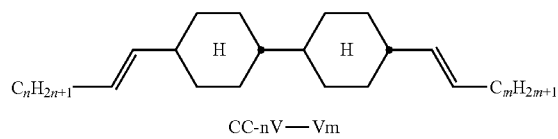
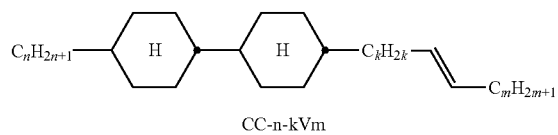
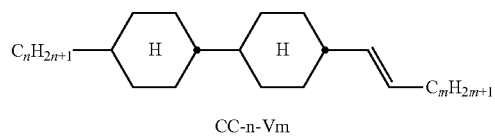
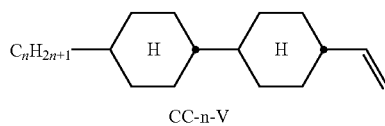
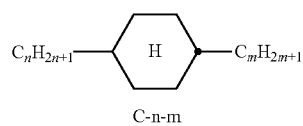
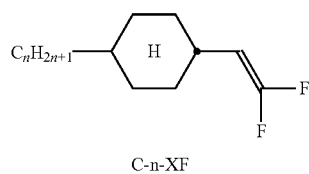
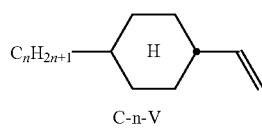
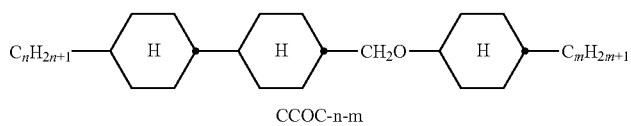


TABLE A1-continued

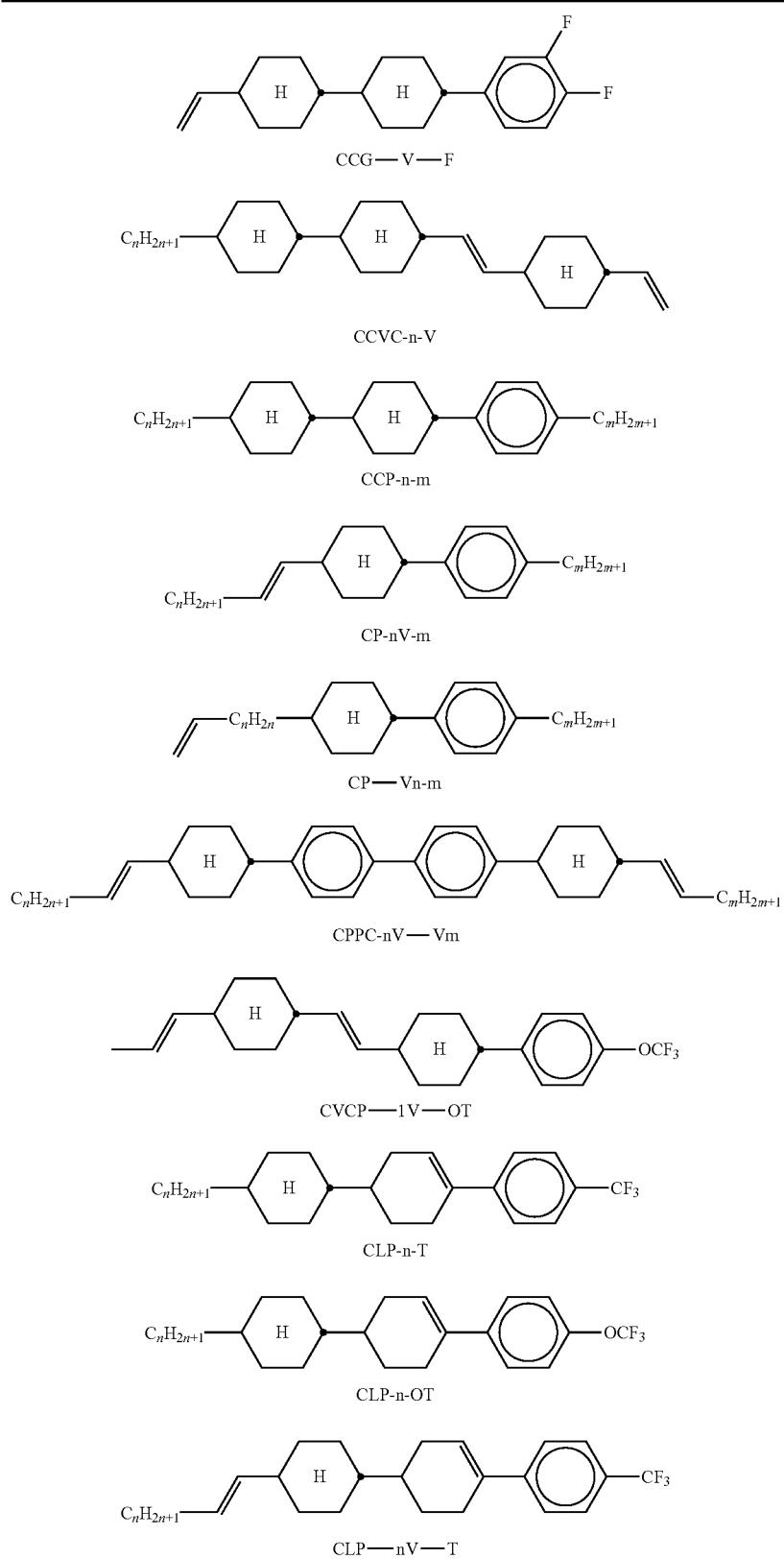


TABLE A1-continued

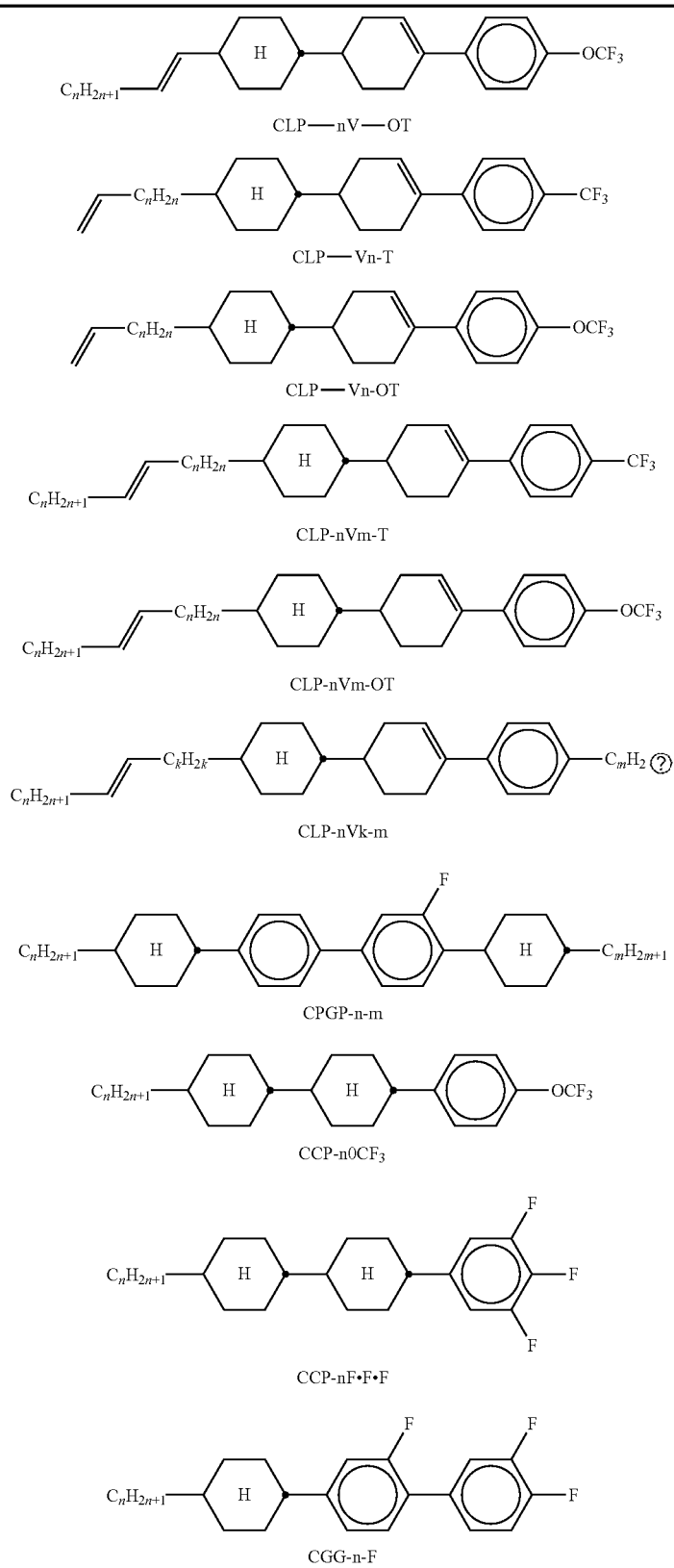


TABLE A1-continued

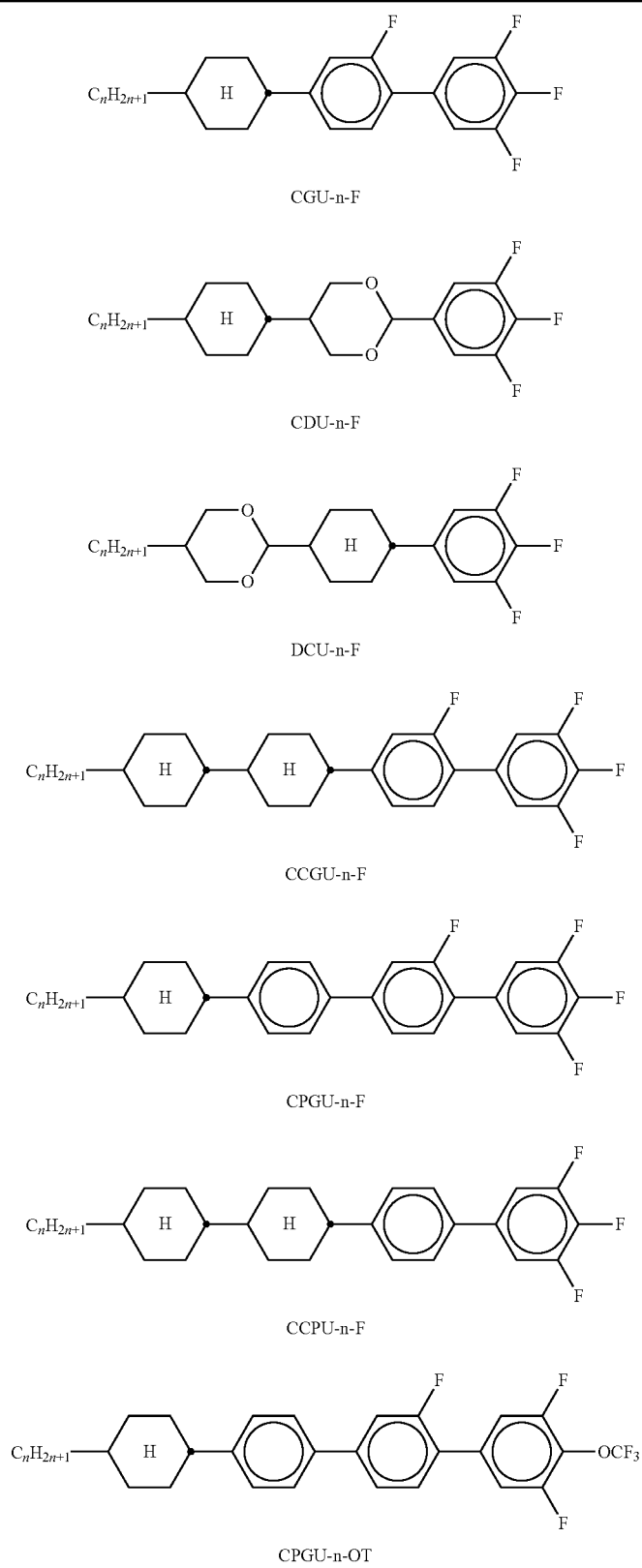
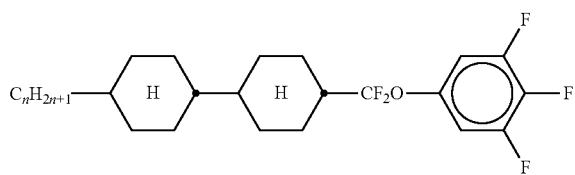
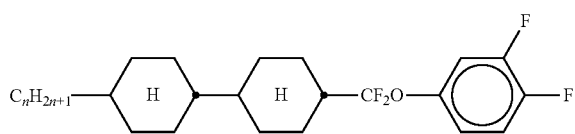


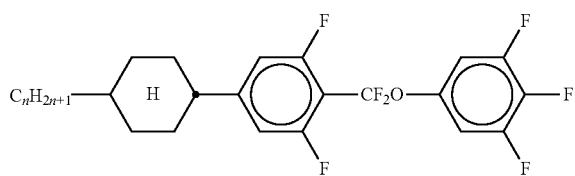
TABLE A1-continued



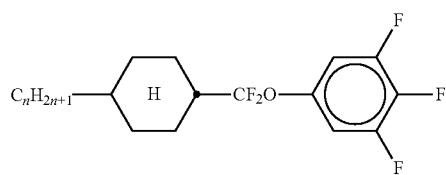
CCQU-n-F



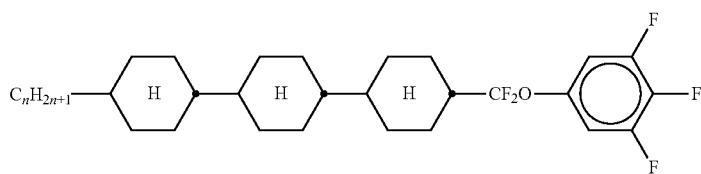
CCQG-n-F



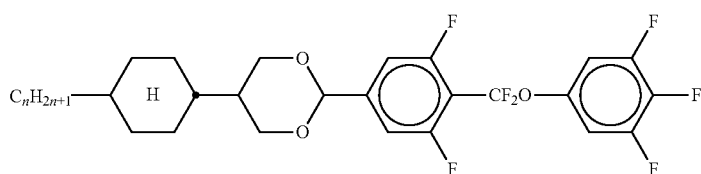
CUQU-n-F



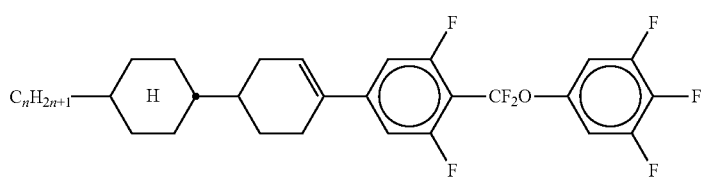
CQU-n-F



CCCQU-n-F

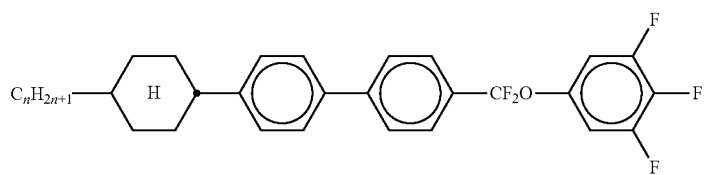


CDUQU-n-F

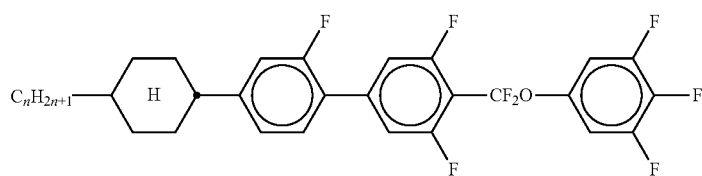


CLUQU-n-F

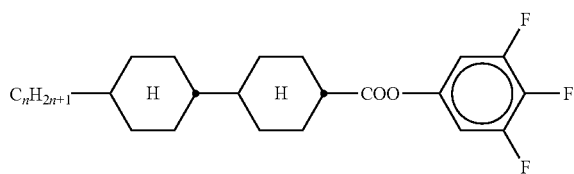
TABLE A1-continued



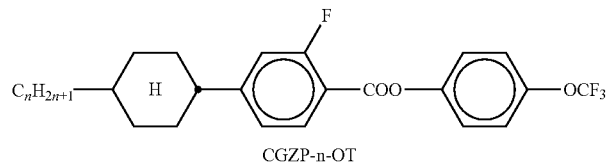
CPPQU-n-F



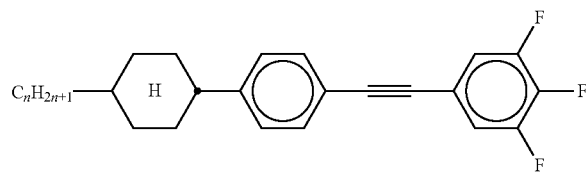
CGUQU-n-F



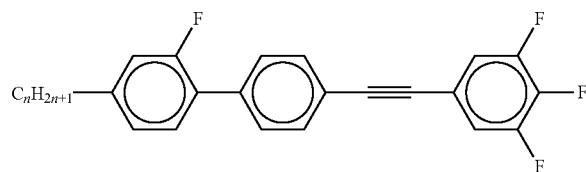
CCZU-n-F



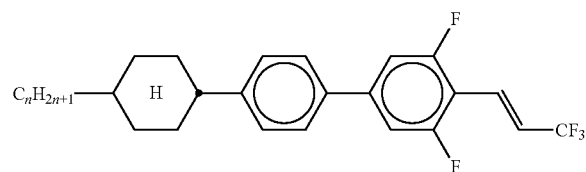
CGZP-n-OT



CPTU-n-F

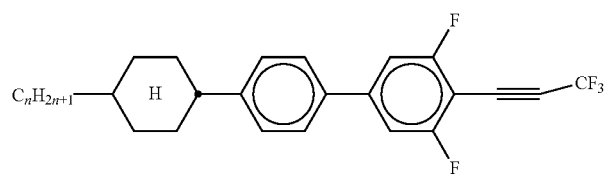


GPTU-n-F

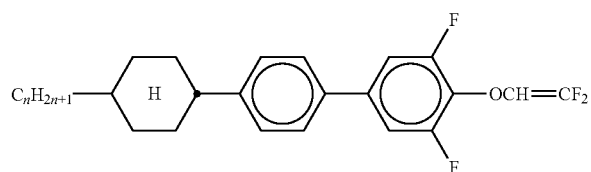


CPU-n-VT

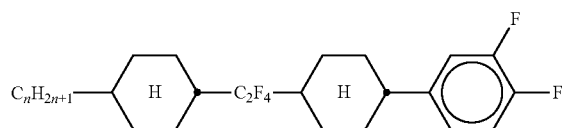
TABLE A1-continued



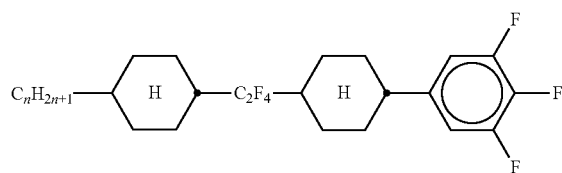
CPU-n-AT



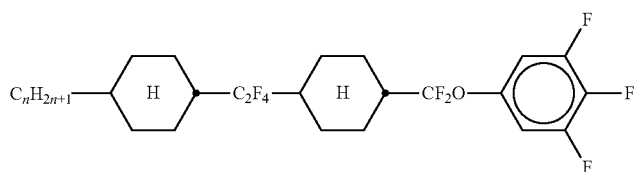
CPU-n-OXF



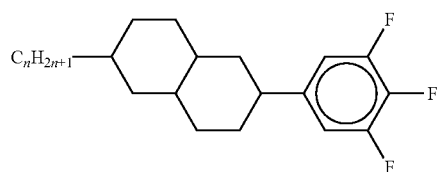
CWCg-n-F



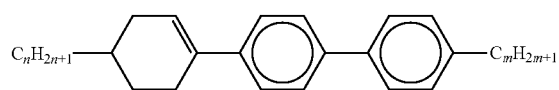
CWCu-n-F



CWCQU-n-F

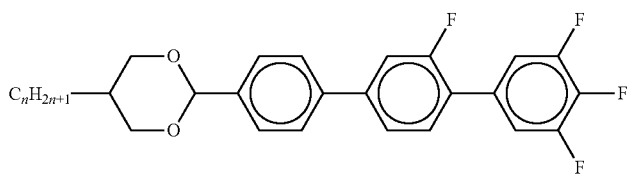


Dec-U-n-F

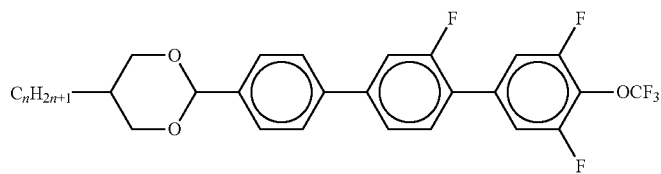


LPP-n-m

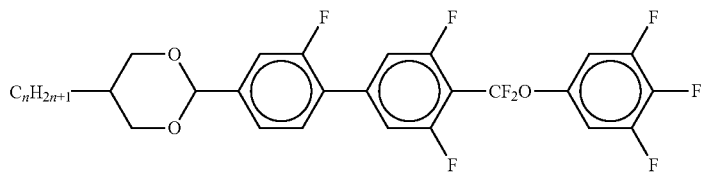
TABLE A1-continued



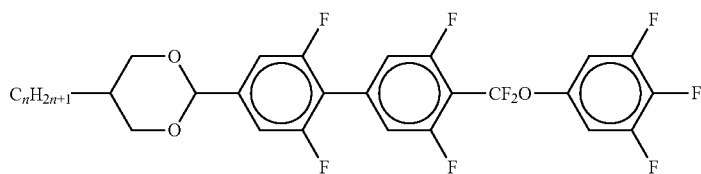
DPGU-n-F



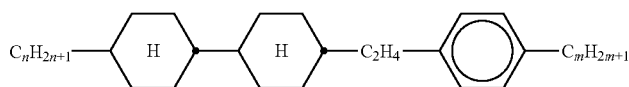
DPGU-n-OT



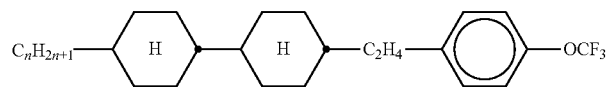
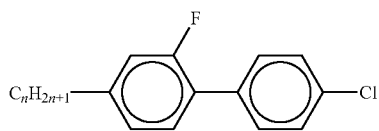
DGUQU-n-F



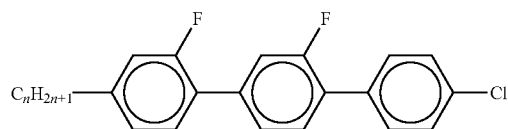
DUUQU-n-F



ECCP-nm

ECCP-nOCF₃

GP-n-Cl



GGP-n-Cl

TABLE A1-continued

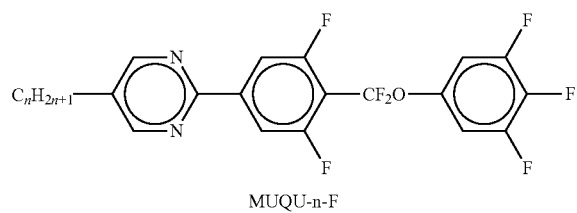
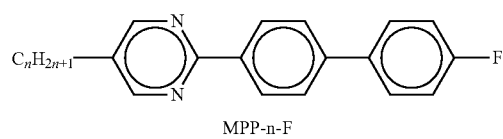
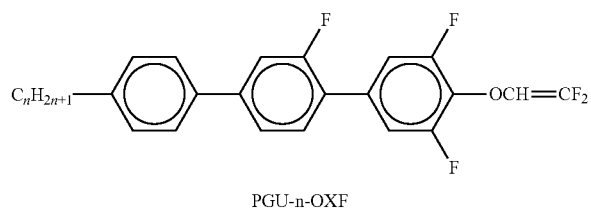
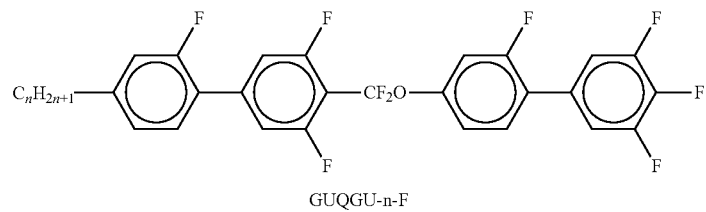
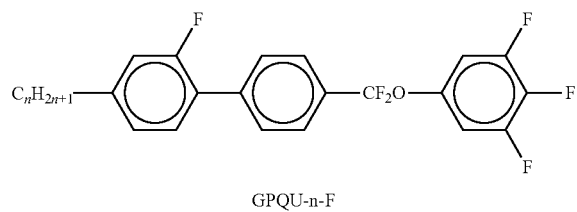
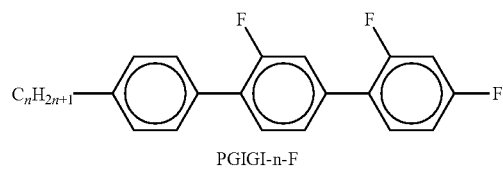
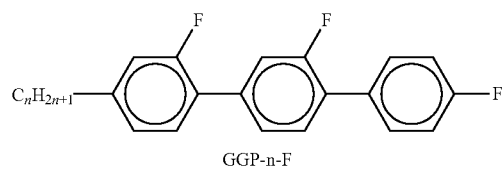


TABLE A1-continued

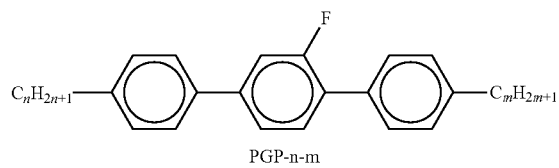
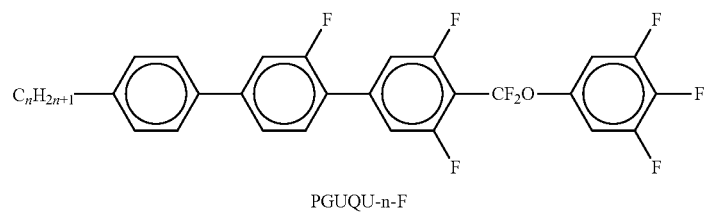
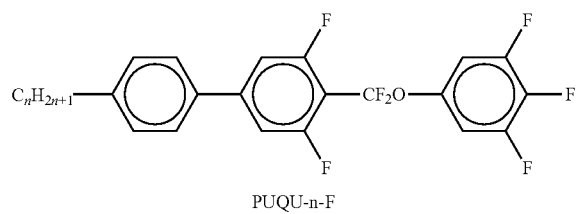
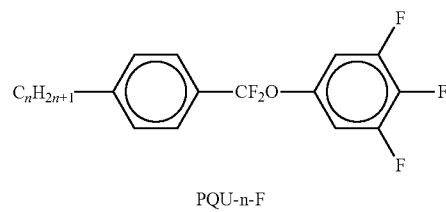
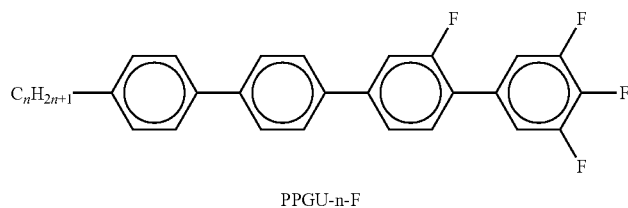
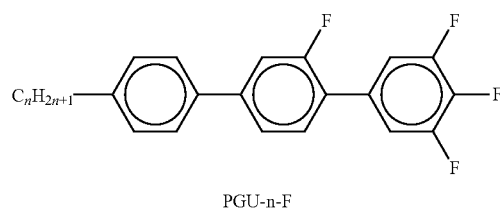
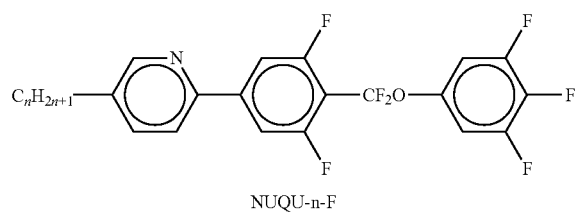
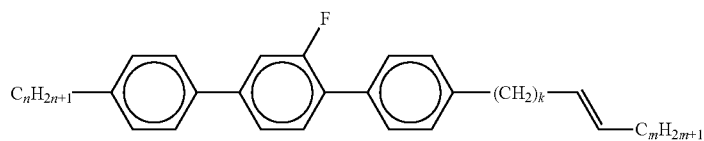
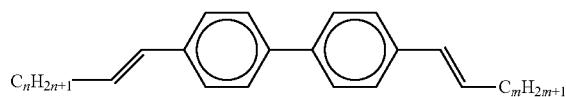


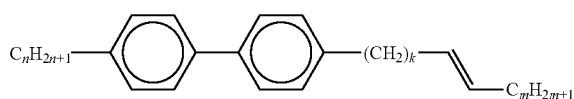
TABLE A1-continued



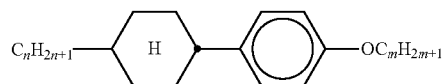
PGP-n-kVm



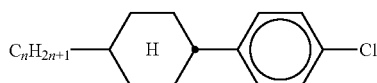
PP-nV—Vm



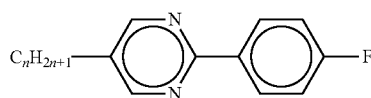
PP-n-kVm



PCH-nOm



PCH-nCl

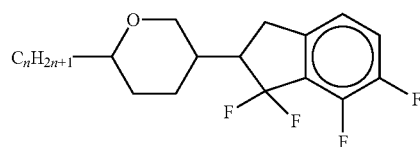


PYP-nF

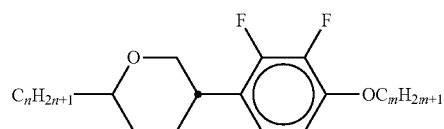
Ⓢ indicates text missing or illegible when filed

[0491] In Table A2, m and n are independently of each other an integer from 1 to 12, preferably 1, 2, 3, 4, 5 or 6, k is 0, 1, 2, 3, 4, 5 or 6, and (O) C_mH_{2m+1} means C_mH_{2m+1} or OC_mH_{2m+1} .

TABLE A2

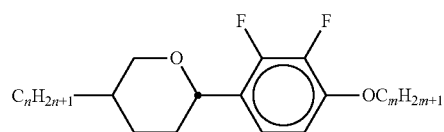


AIK-n-F

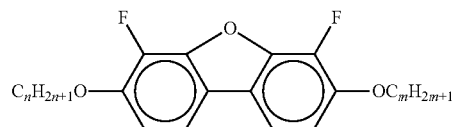


AIY-n-Om

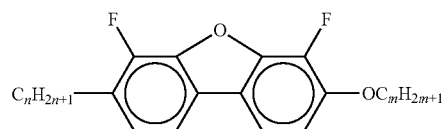
TABLE A2-continued



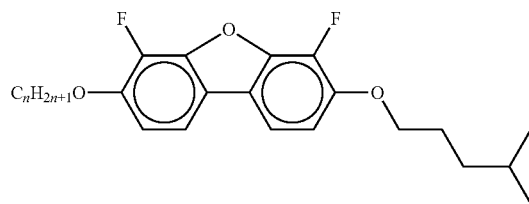
AIY-n-Om



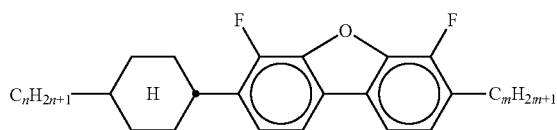
B-nO-Om



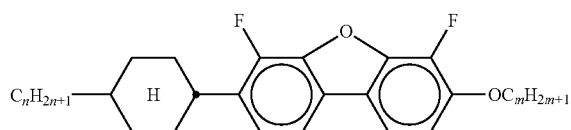
B-n-Om



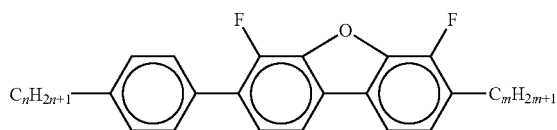
B-nO-O5i



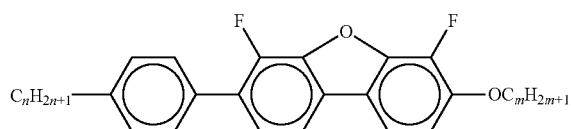
CB-n-m



CB-n-Om



PB-n-m



PB-n-Om

TABLE A2-continued

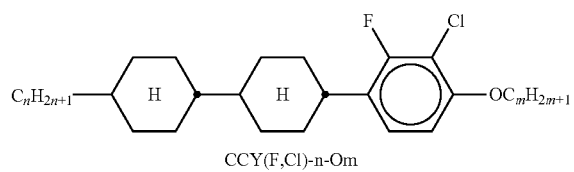
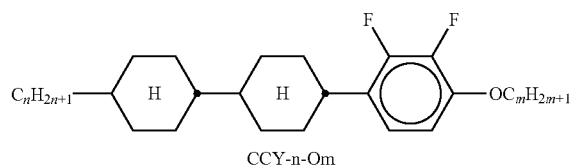
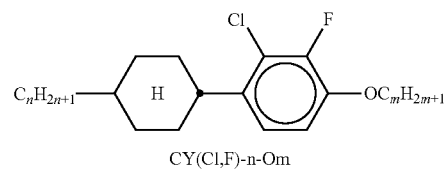
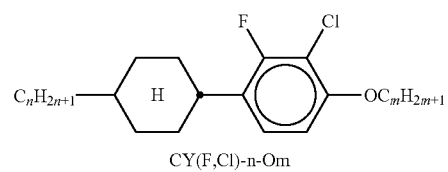
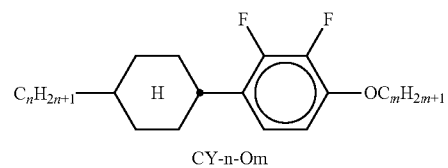
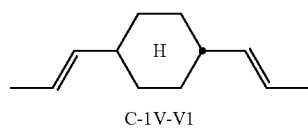
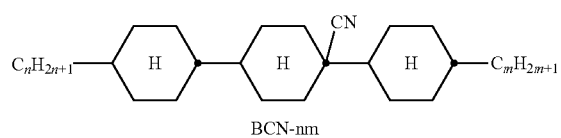
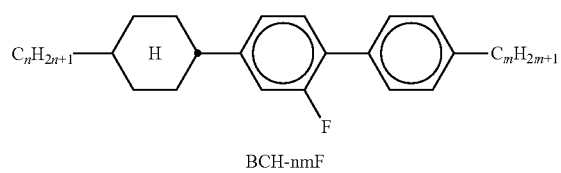


TABLE A2-continued

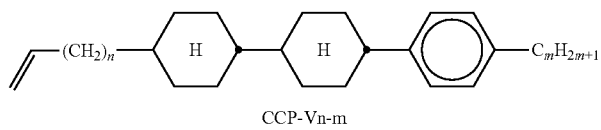
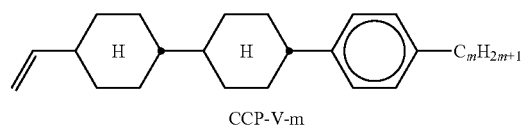
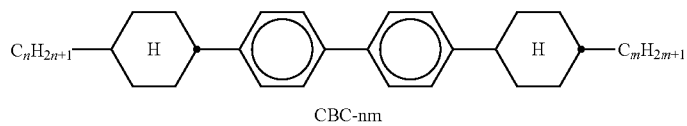
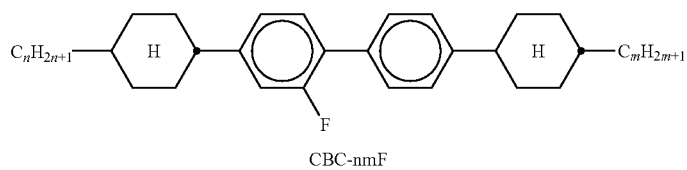
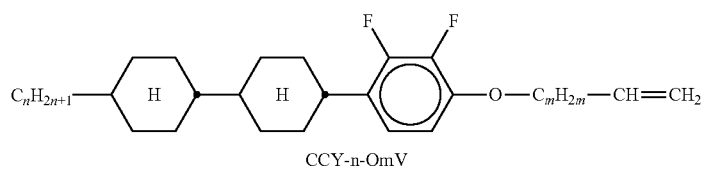
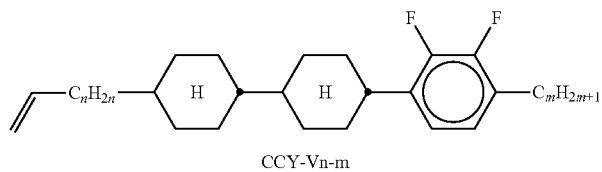
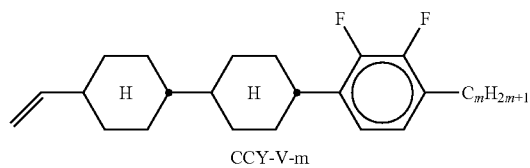
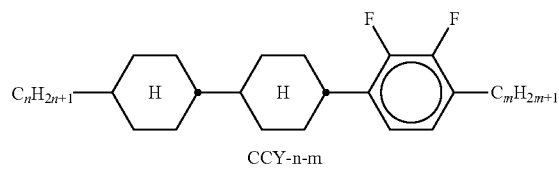
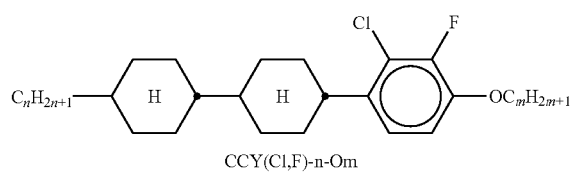


TABLE A2-continued

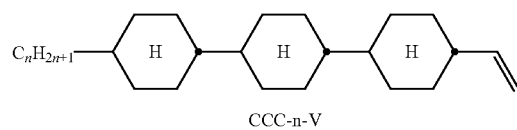
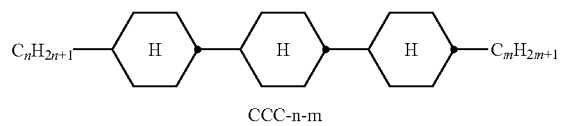
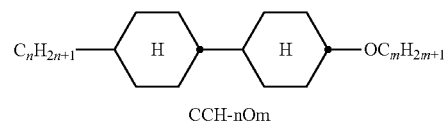
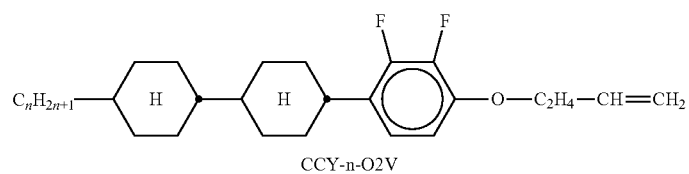
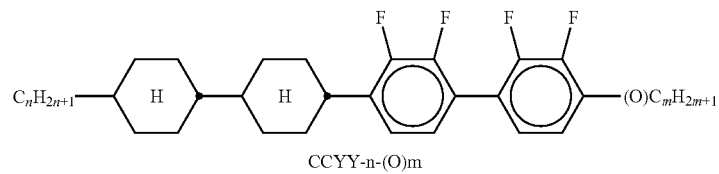
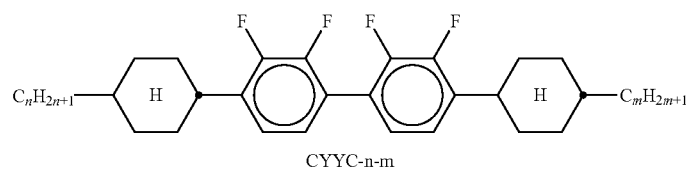
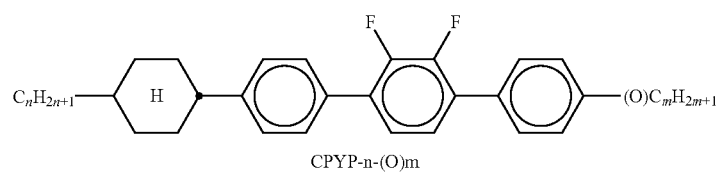
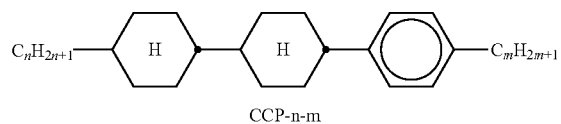
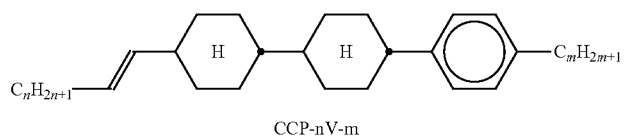


TABLE A2-continued

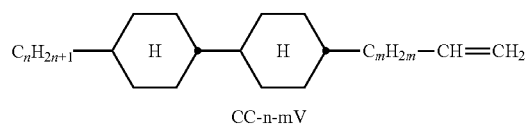
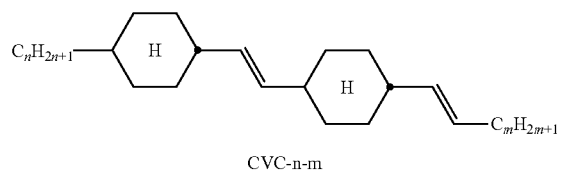
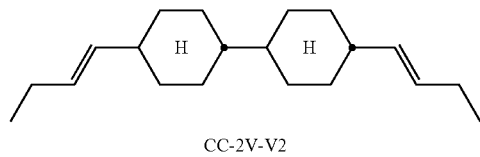
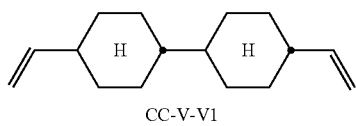
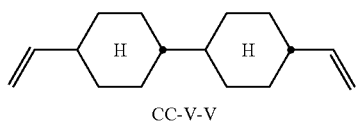
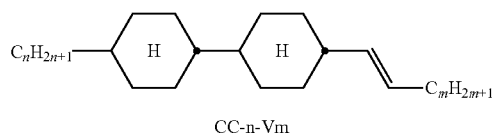
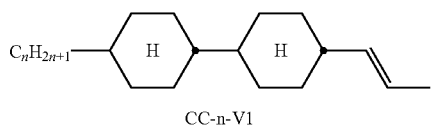
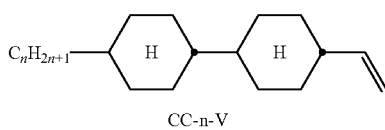
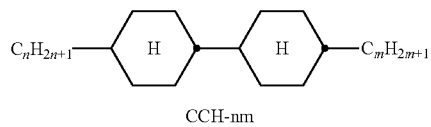
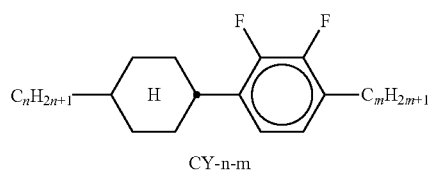


TABLE A2-continued

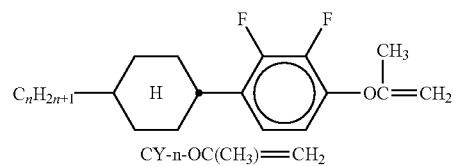
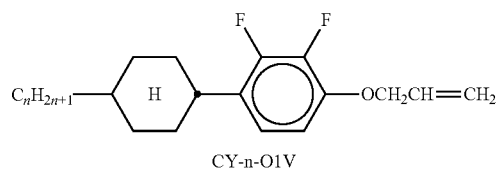
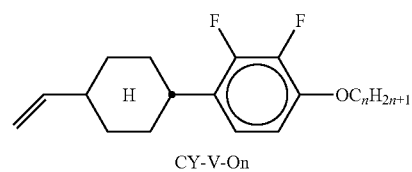
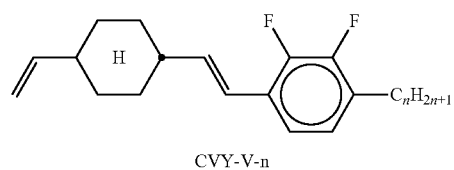
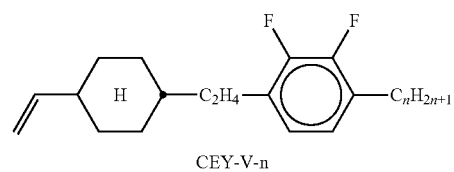
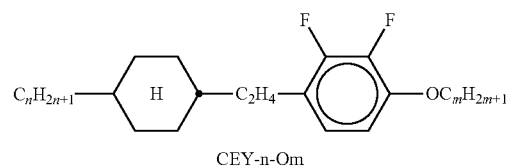
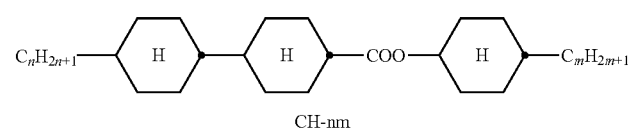
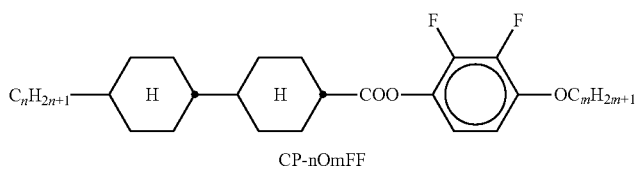
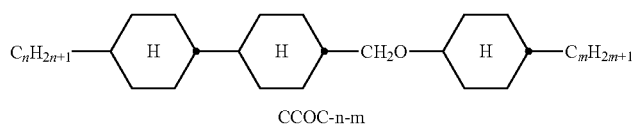


TABLE A2-continued

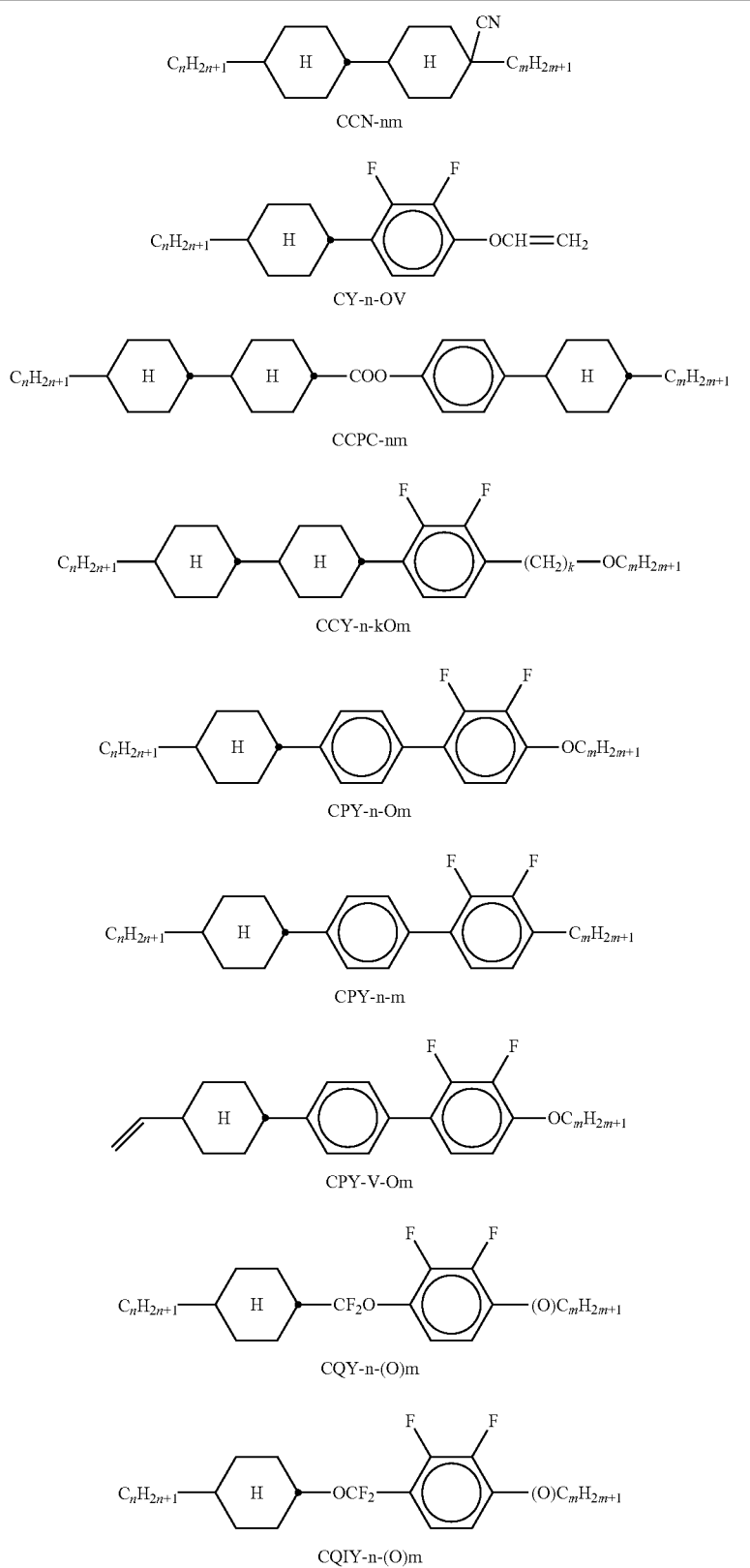


TABLE A2-continued

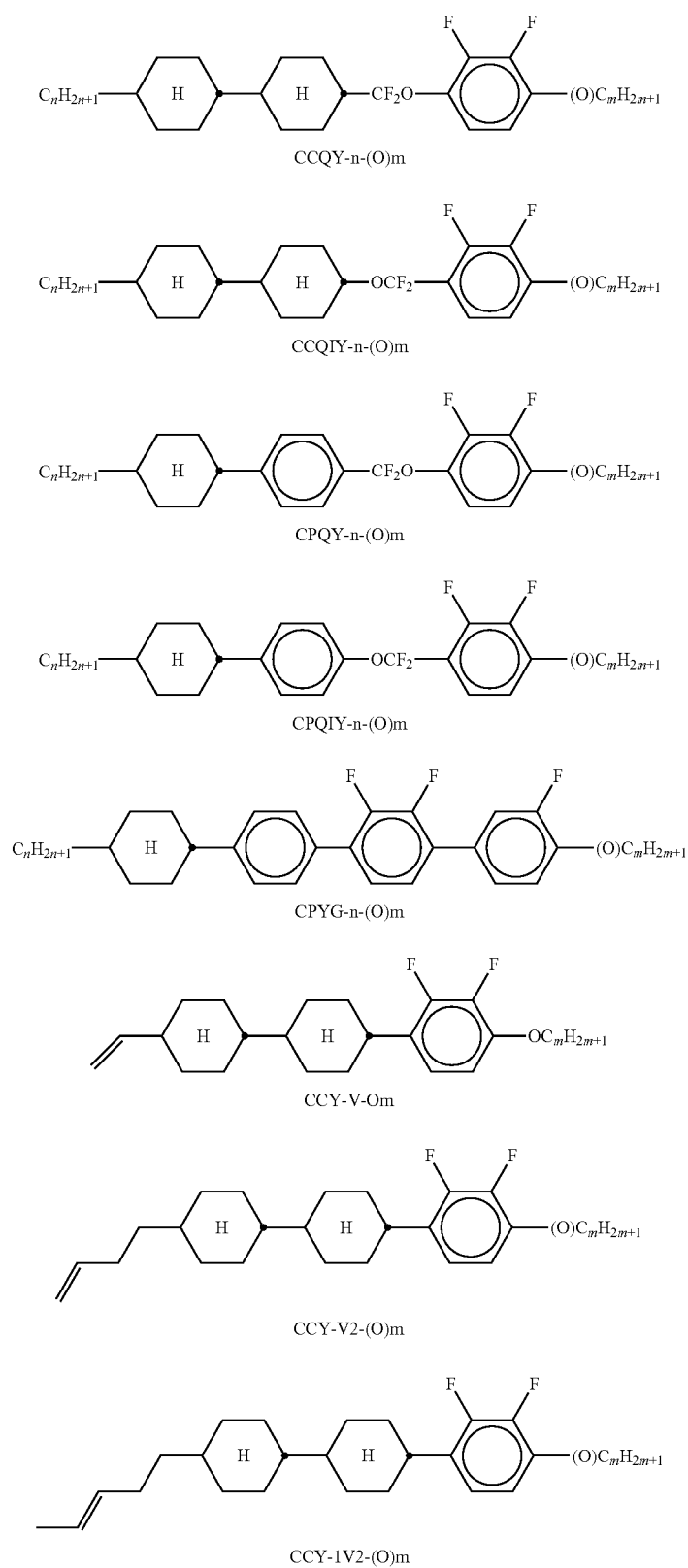
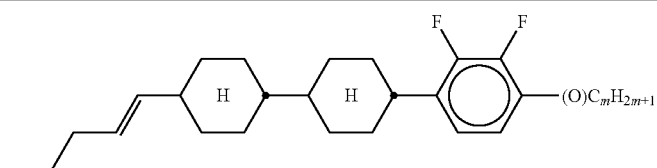
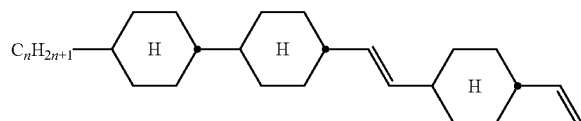


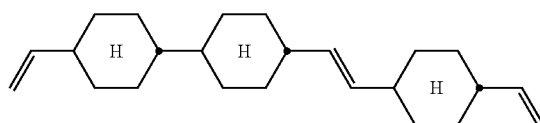
TABLE A2-continued



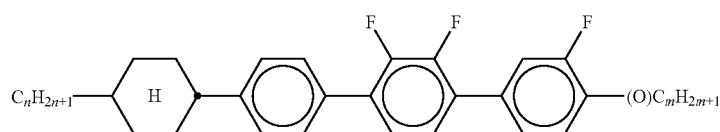
CCY-3V-(O)m



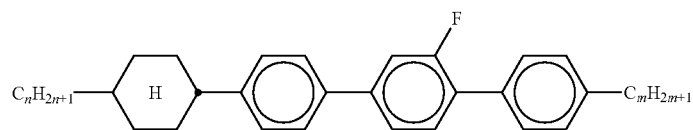
CCVC-n-V



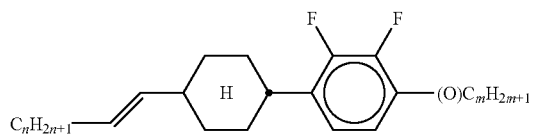
CCVC-V-V



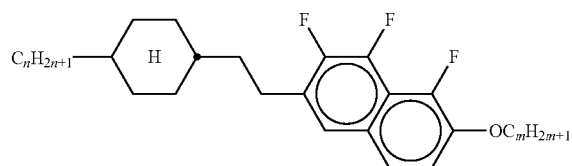
CPYG-n-(O)m



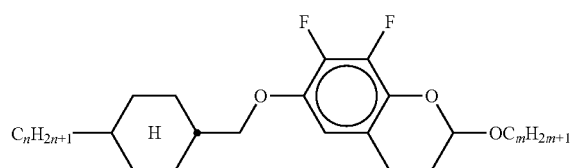
CPGP-n-m



CY-nV-(O)m



CENaph-n-Om



COChrom-n-Om

TABLE A2-continued

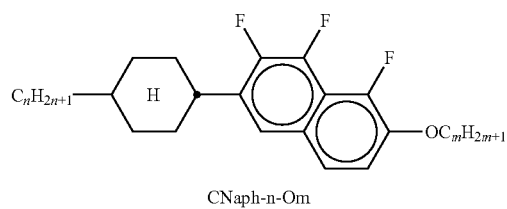
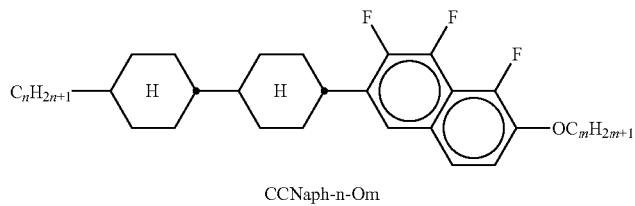
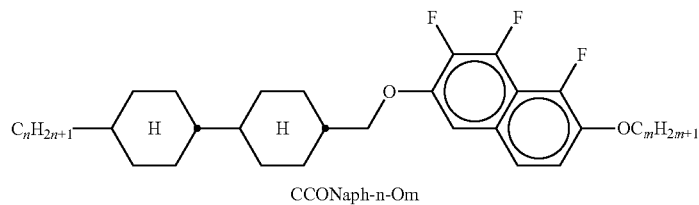
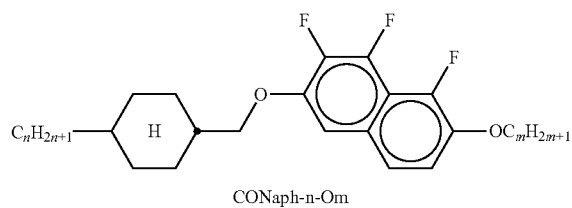
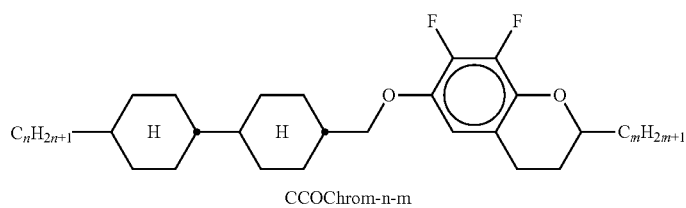
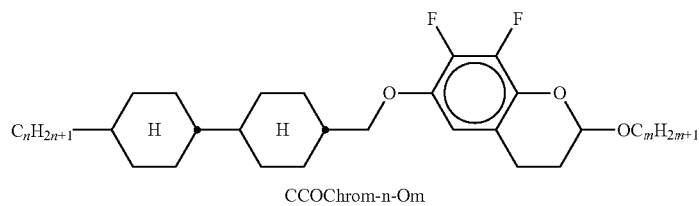
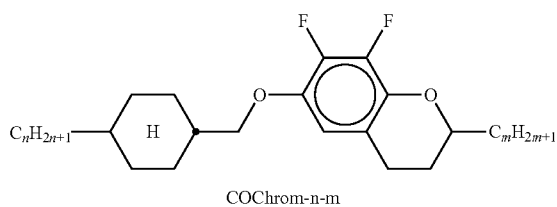


TABLE A2-continued

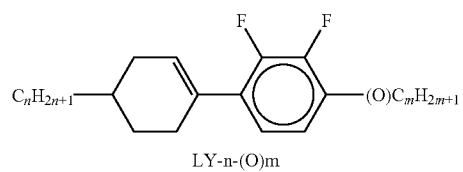
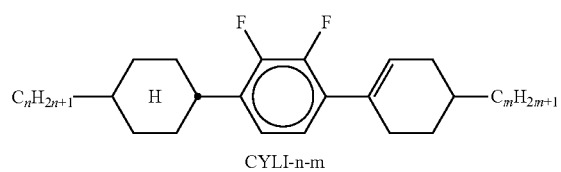
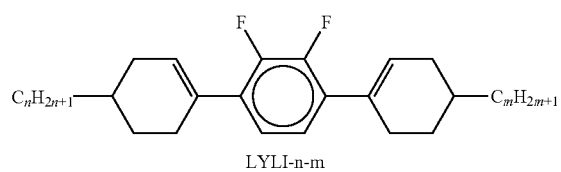
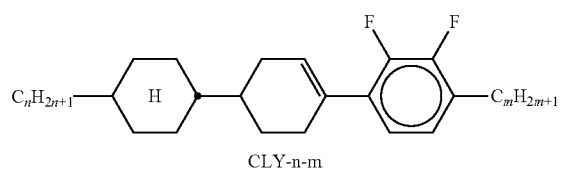
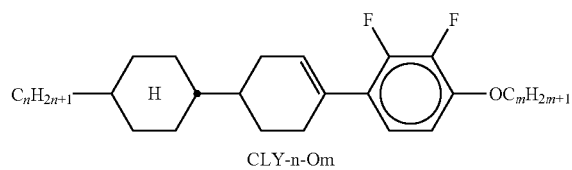
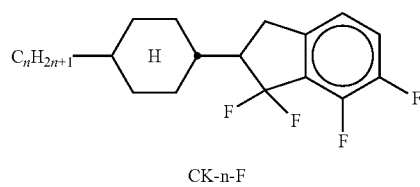
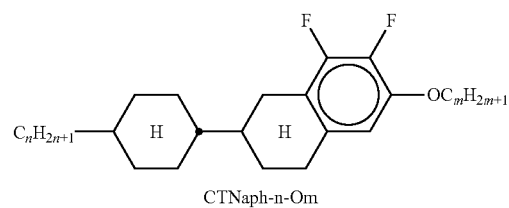
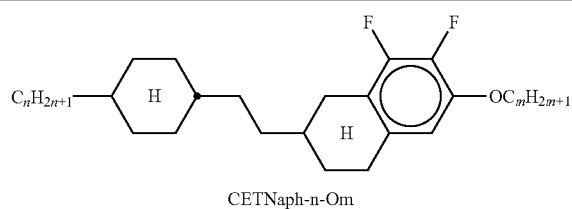
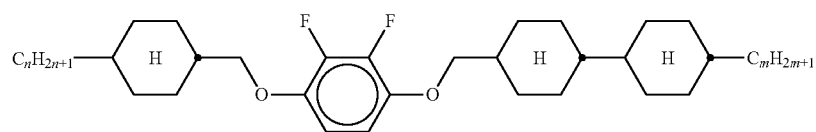
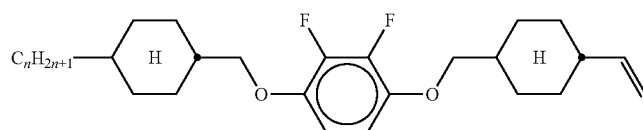


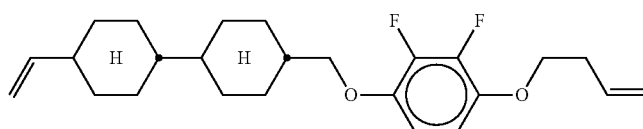
TABLE A2-continued



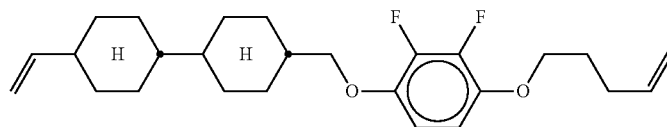
COYOICC-n-m



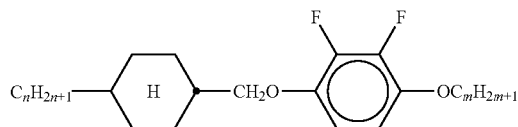
COYOIC-n-V



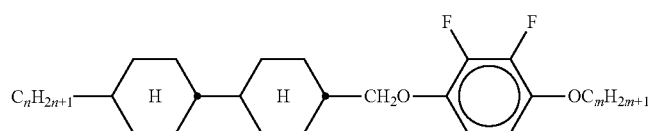
CCOY-V-O2V



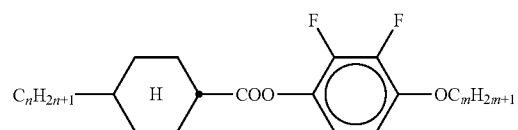
CCOY-V-O3V



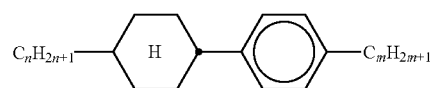
COY-n-Om



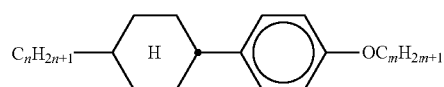
CCOY-n-Om



D-nOmFF



PCH-nm



PCH-nOm

TABLE A2-continued

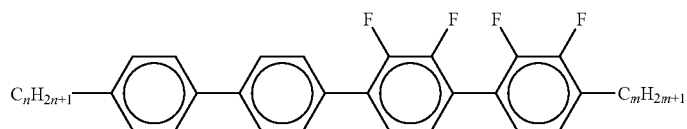
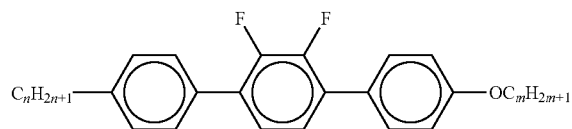
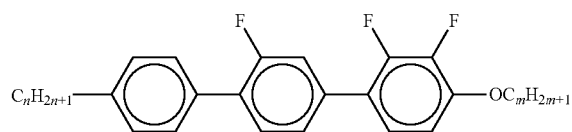
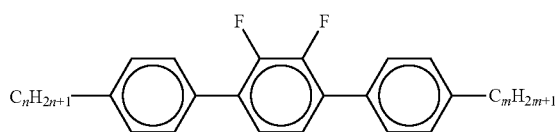
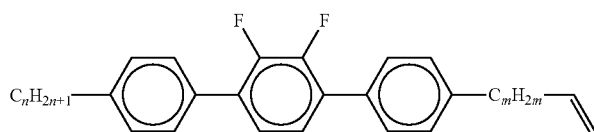
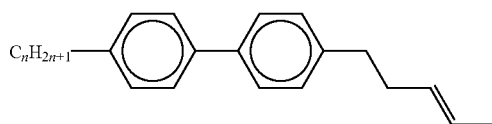
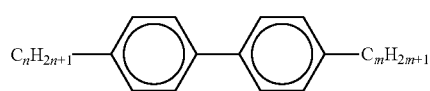
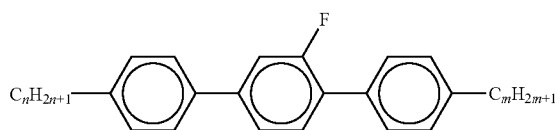
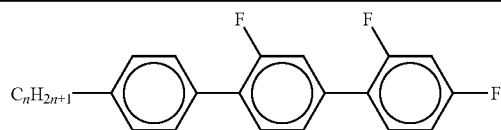
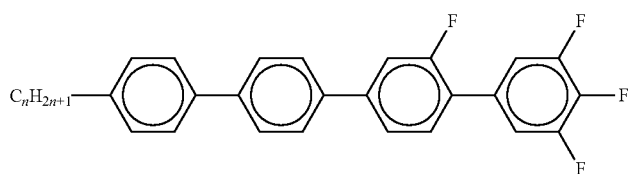
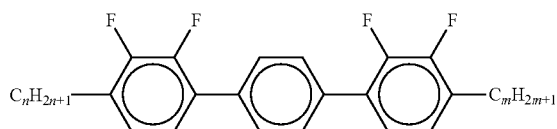


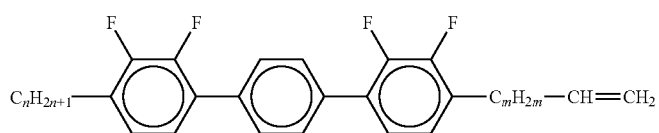
TABLE A2-continued



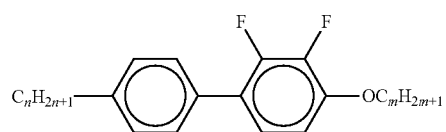
PPGU-n-F



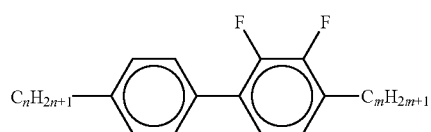
YPY-n-m



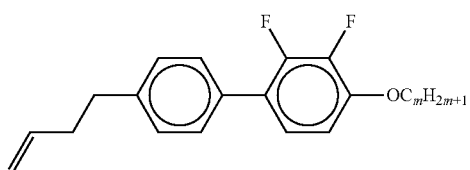
YPY-n-mV



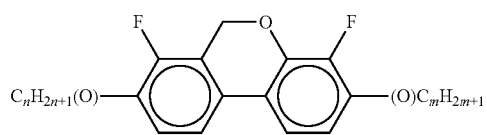
PY-n-Om



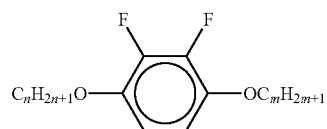
PY-n-m



PY-V2-Om

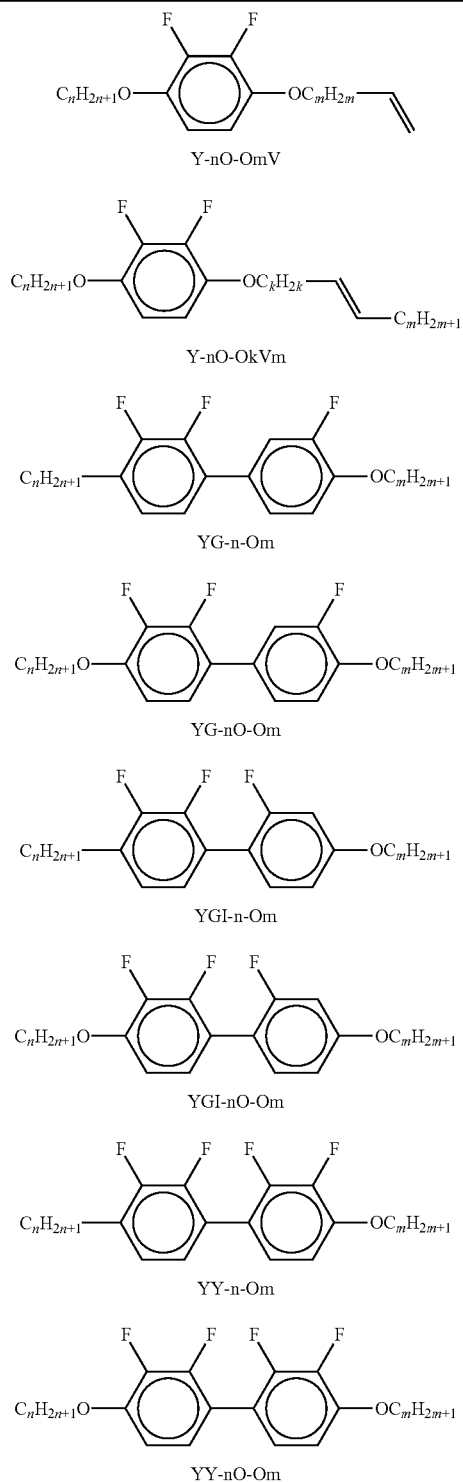


DFDBC-n(O)-(O)m



Y-nO-Om

TABLE A2-continued



[0492] In a first preferred embodiment of the present invention, the LC media according to the invention, especially those with positive dielectric anisotropy, comprise one or more compounds selected from the group consisting of compounds from Table A1.

[0493] In a second preferred embodiment of the present invention, the LC media according to the invention, especially those with negative dielectric anisotropy, comprise one or more compounds selected from the group consisting of compounds from Table A2.

[0494] Table B shows possible chiral dopants which can be added to the LC media according to the invention.

TABLE B

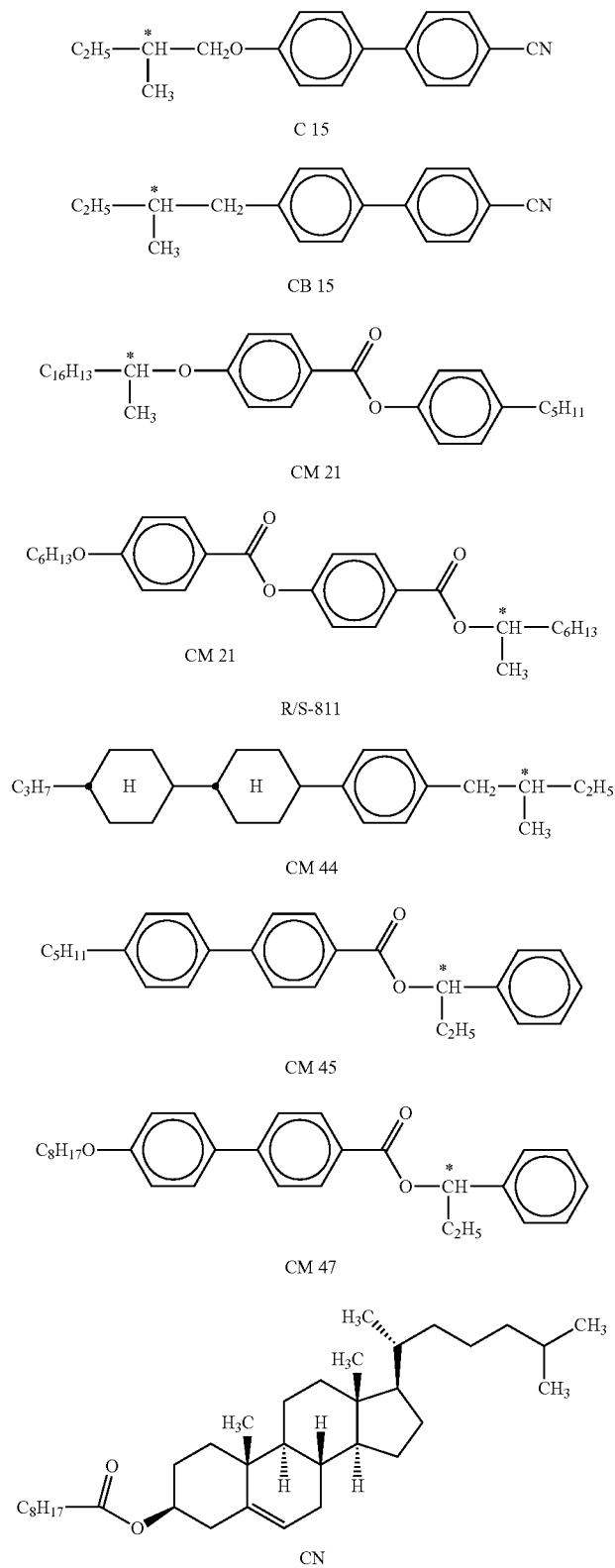
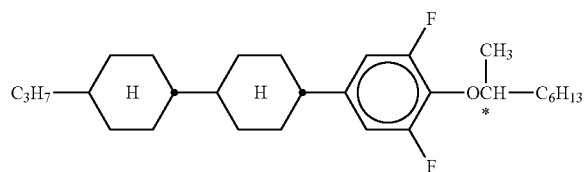
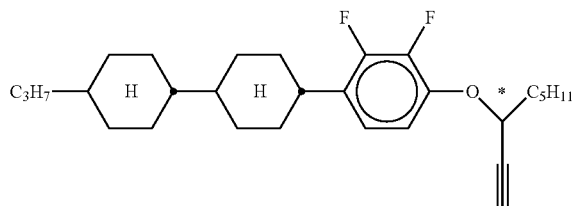


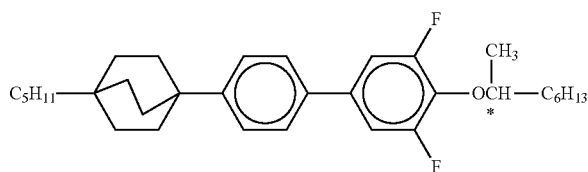
TABLE B-continued



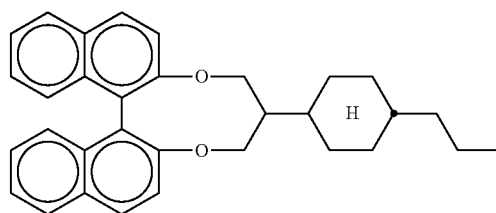
R/S-2011



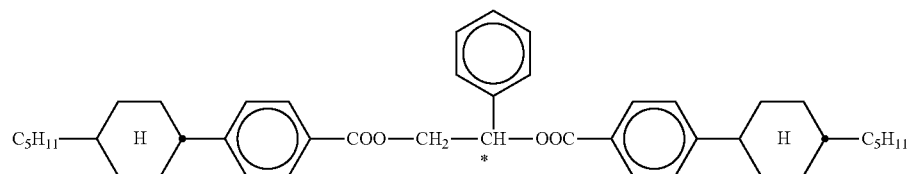
R/S-3011



R/S-4011



R/S-5011



R/S-1011

[0495] The LC media preferably comprise 0 to 10% by weight, in particular 0.01 to 5% by weight, particularly preferably 0.1 to 3% by weight, of dopants. The LC media preferably comprise one or more dopants selected from the group consisting of compounds from Table B.

[0496] Table C shows possible stabilisers which can be added to the LC media according to the invention. Therein n denotes an integer from 1 to 12, preferably 1, 2, 3, 4, 5, 6, 7 or 8, and terminal methyl groups are not shown.

TABLE C

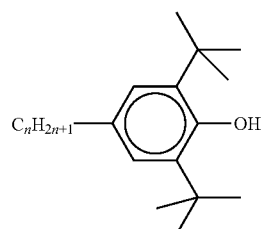
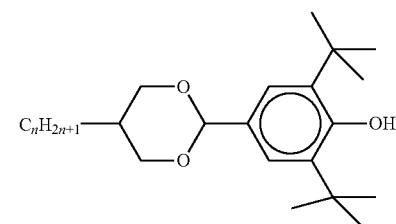
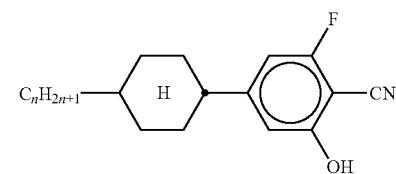
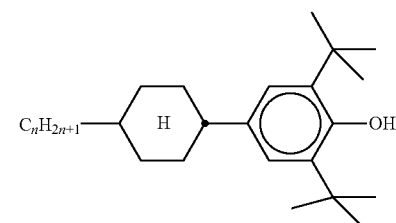
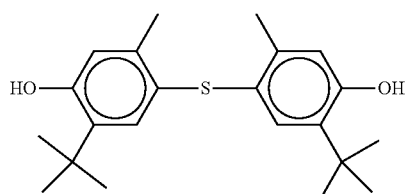
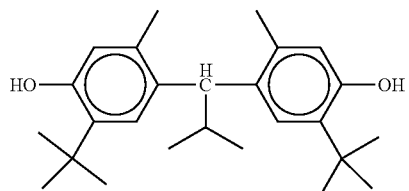
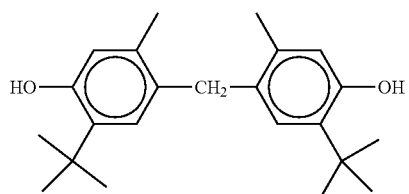


TABLE C-continued

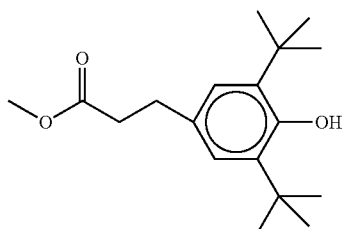
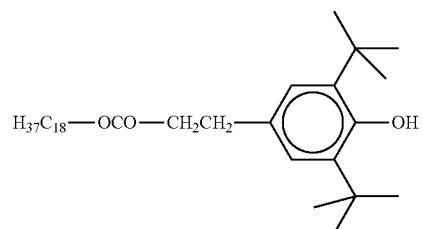
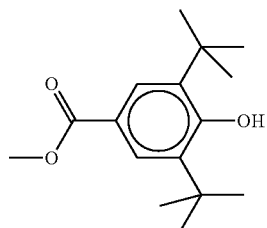
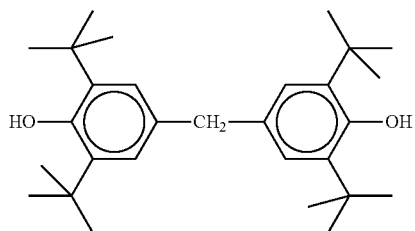
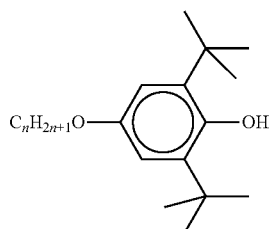
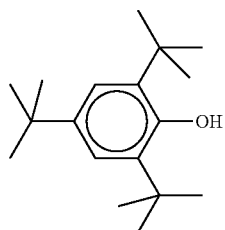


TABLE C-continued

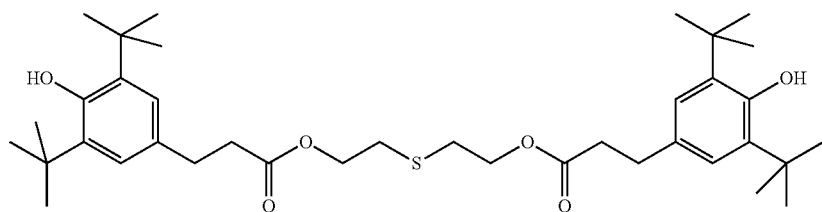
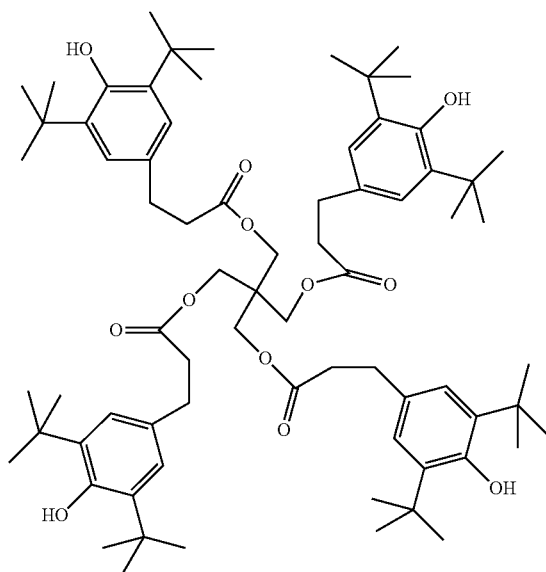
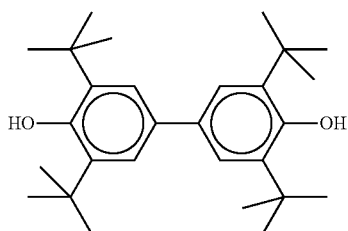
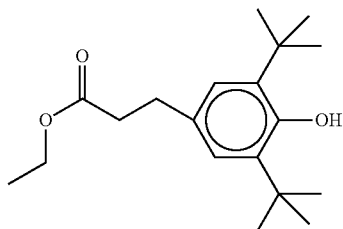


TABLE C-continued

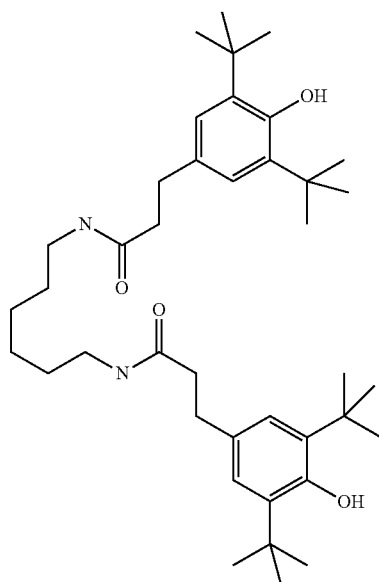
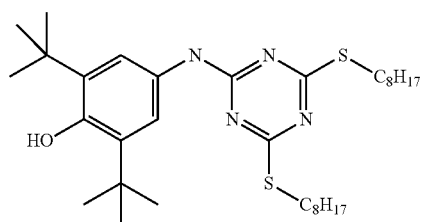
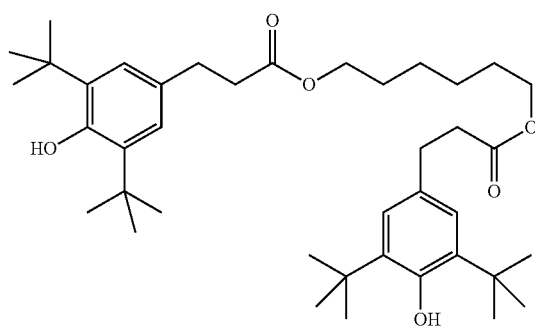
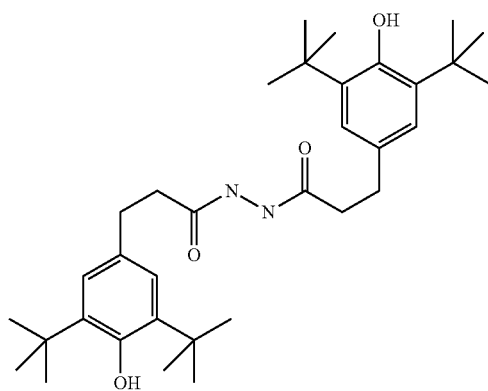


TABLE C-continued

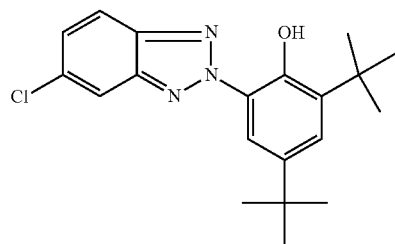
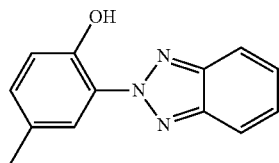
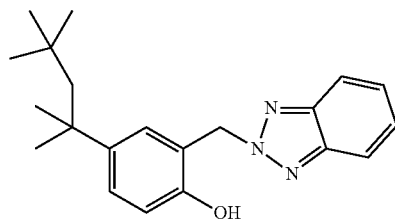
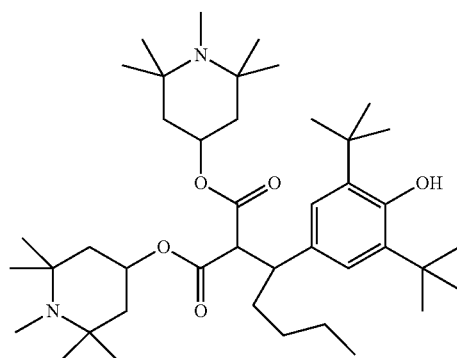
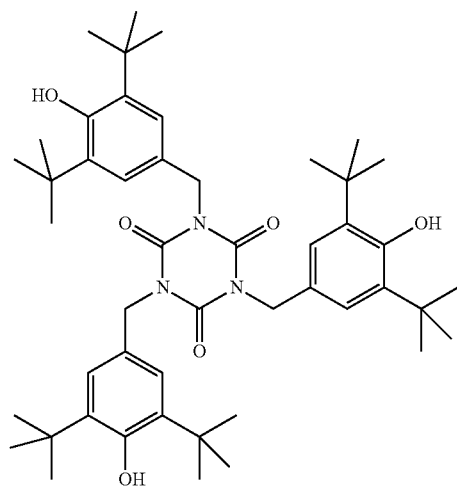


TABLE C-continued

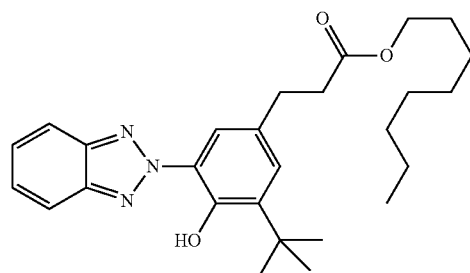
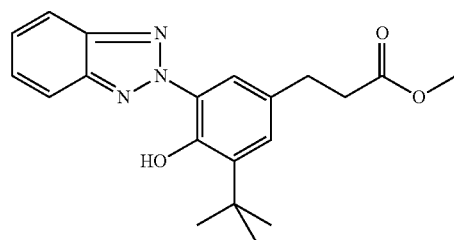
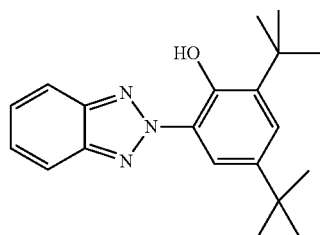
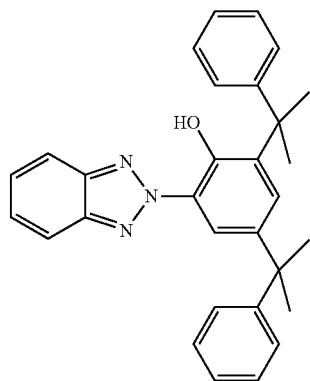
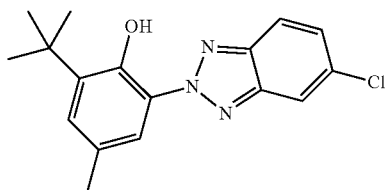


TABLE C-continued

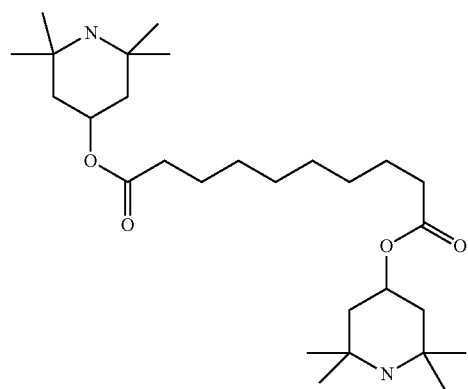
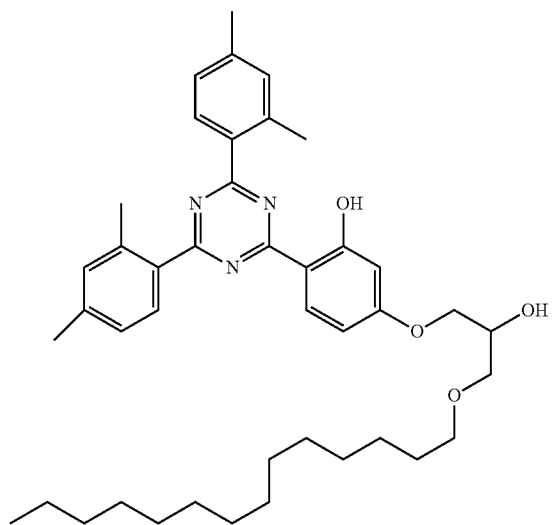
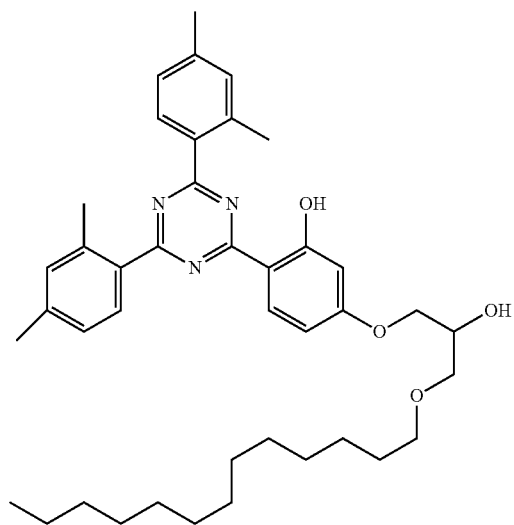


TABLE C-continued

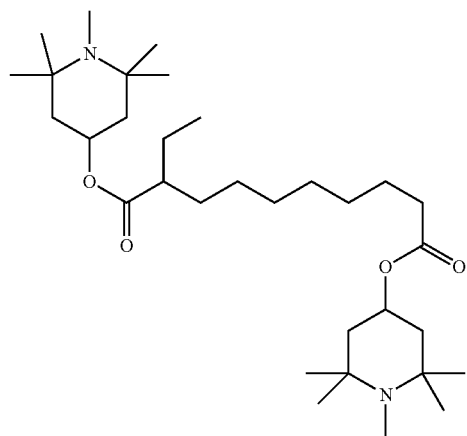
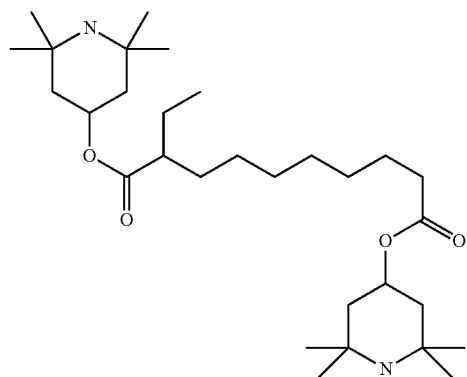
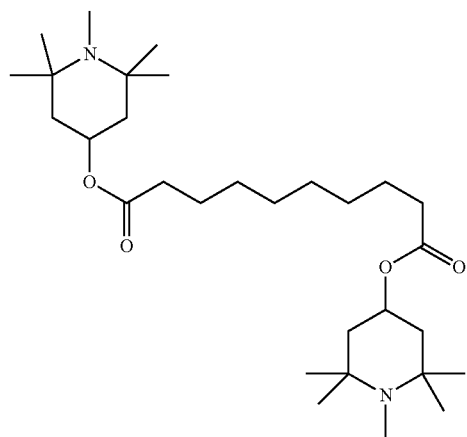


TABLE C-continued

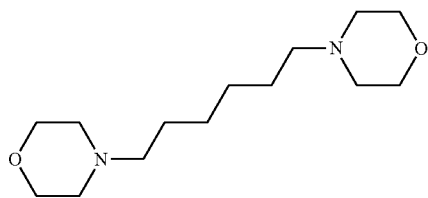
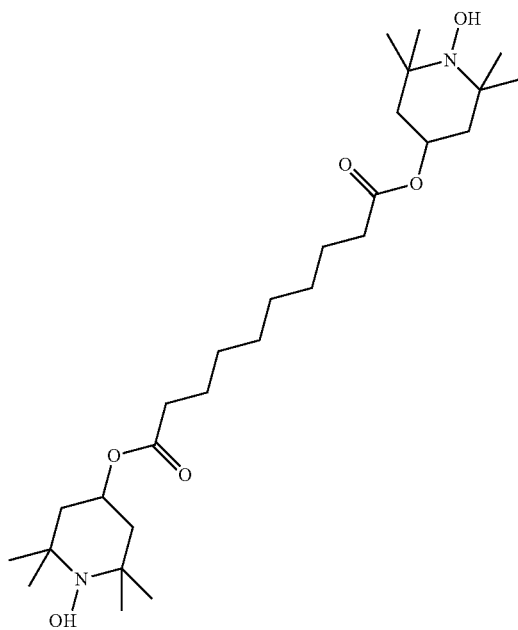
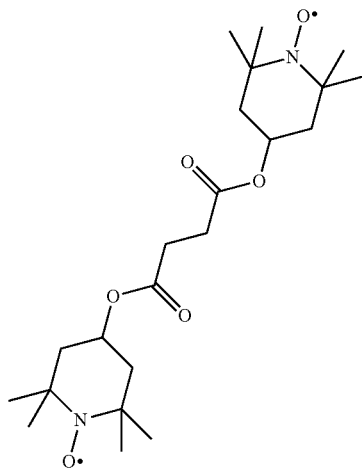


TABLE C-continued

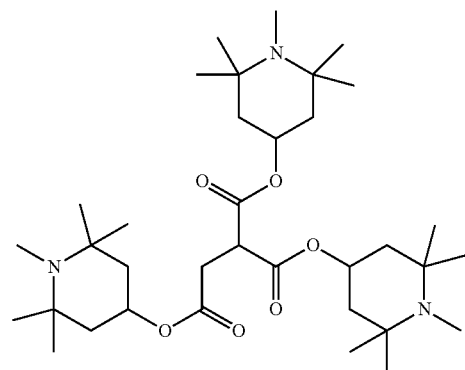
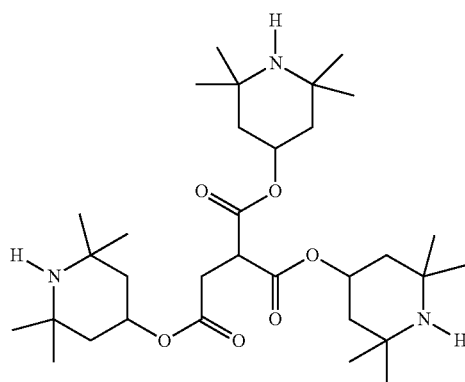
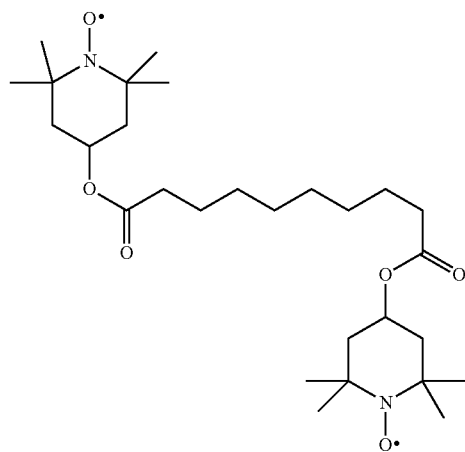


TABLE C-continued

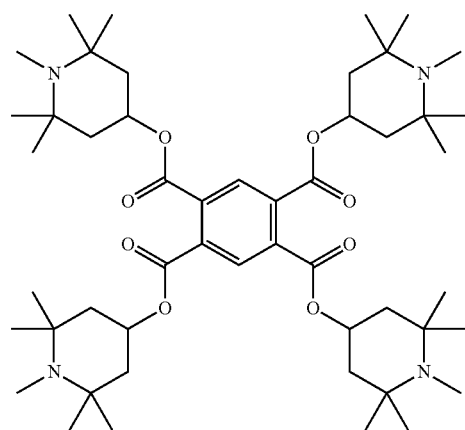
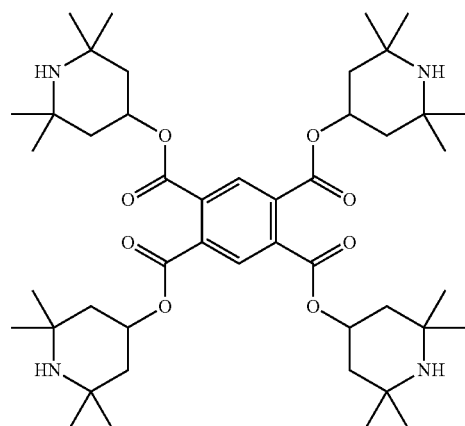
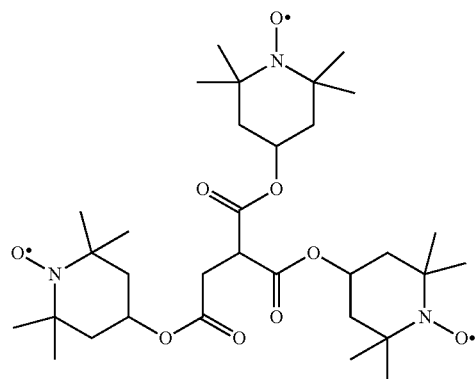
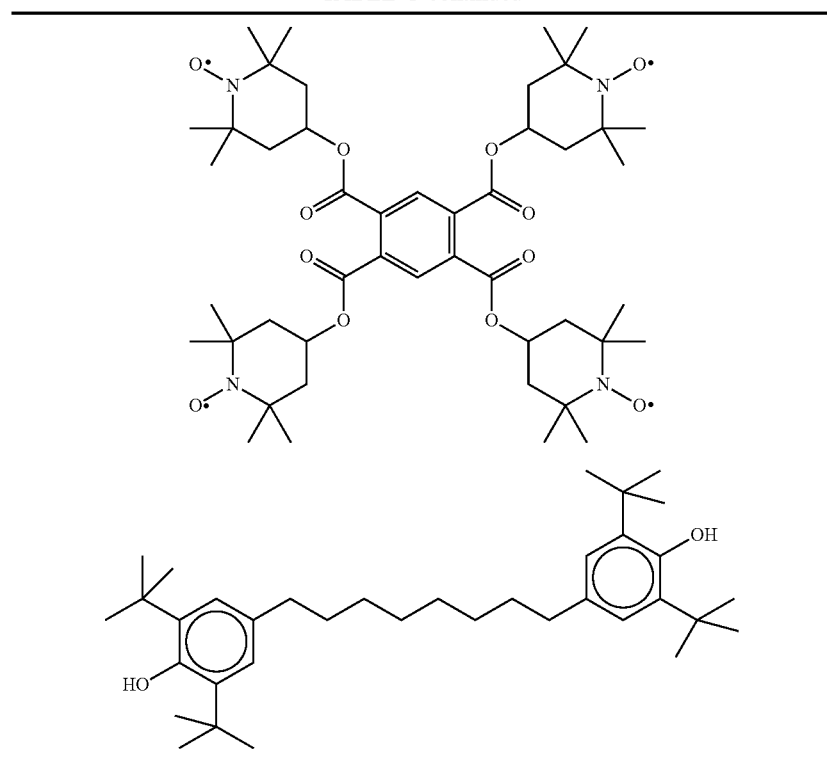


TABLE C-continued



[0497] The LC media preferably comprise 0 to 10% by weight, in particular 1 ppm to 5% by weight, particularly preferably 1 ppm to 1% by weight, of stabilisers. The LC media preferably comprise one or more stabilisers selected from the group consisting of compounds from Table C.

[0498] Table D shows illustrative reactive mesogenic compounds which can be used in the LC media in accordance with the present invention.

TABLE D

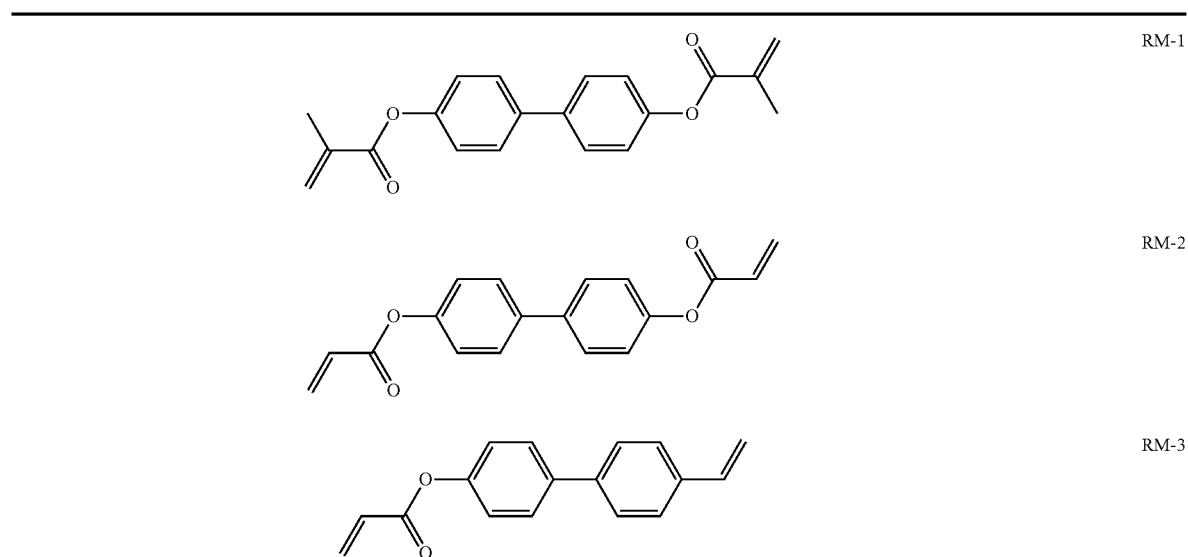


TABLE D-continued

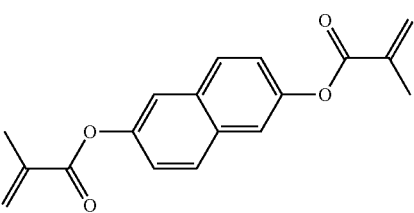
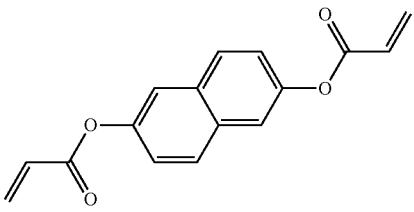
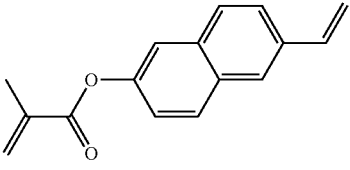
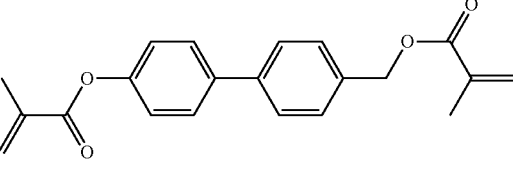
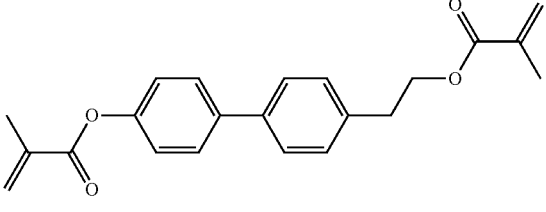
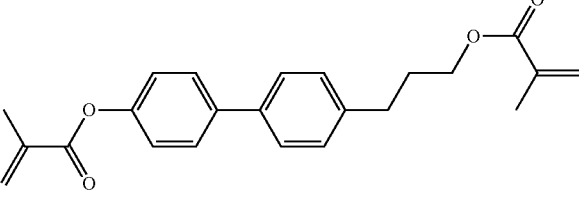
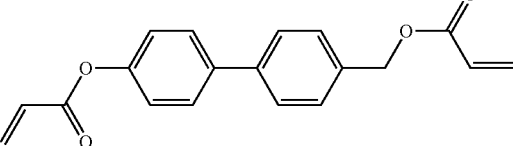
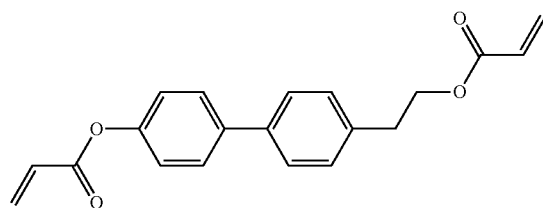
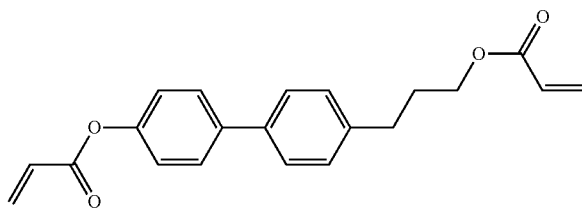
	RM-4
	RM-5
	RM-6
	RM-7
	RM-8
	RM-9
	RM-10

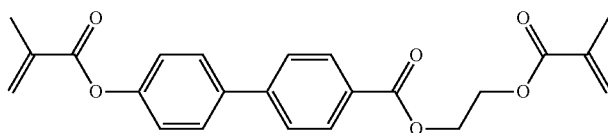
TABLE D-continued



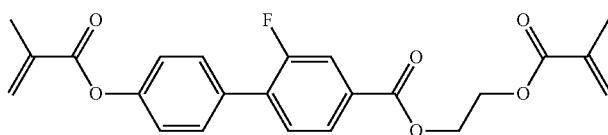
RM-11



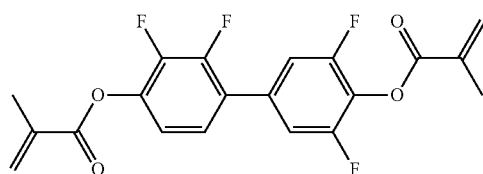
RM-12



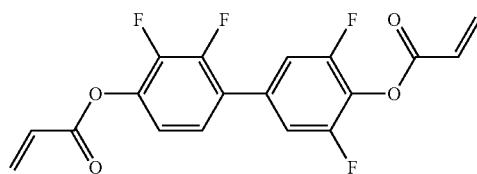
RM-13



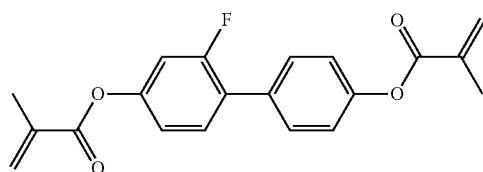
RM-14



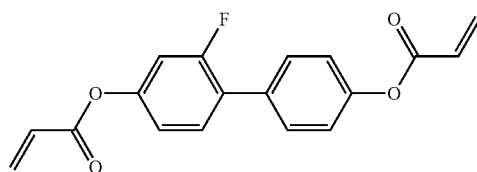
RM-15



RM-16



RM-17



RM-18

TABLE D-continued

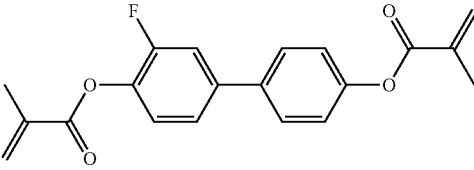
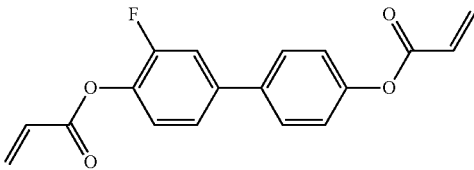
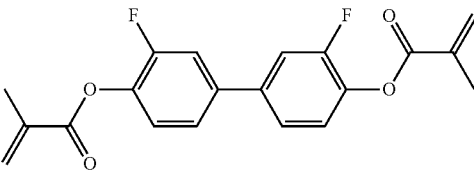
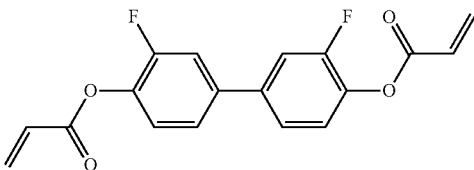
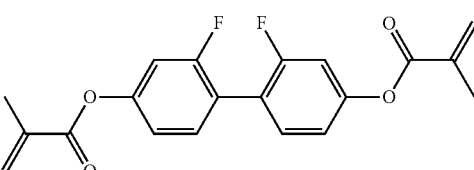
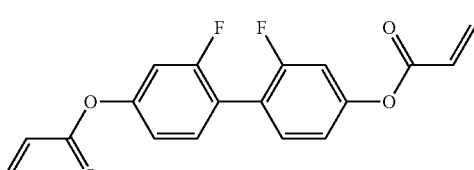
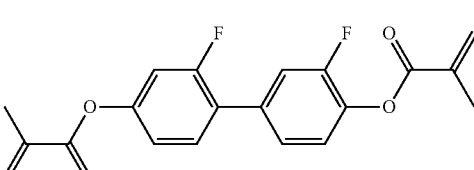
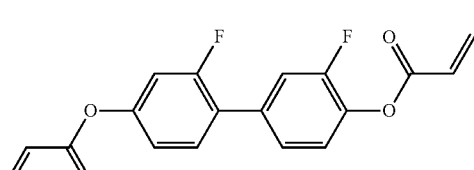
	RM-19
	RM-20
	RM-21
	RM-22
	RM-23
	RM-24
	RM-25
	RM-26

TABLE D-continued

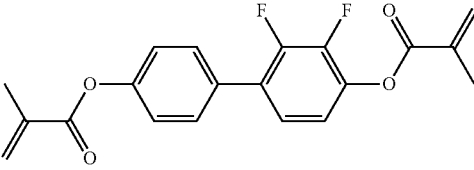
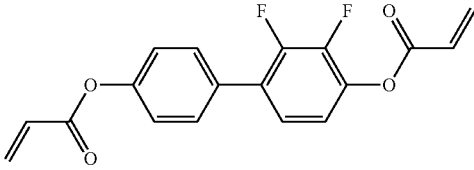
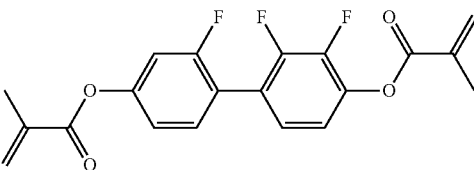
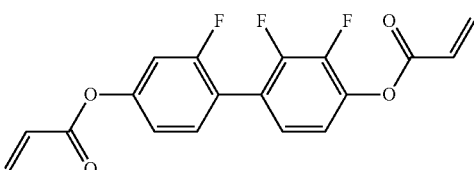
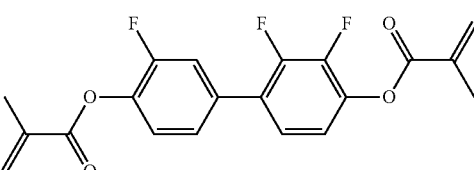
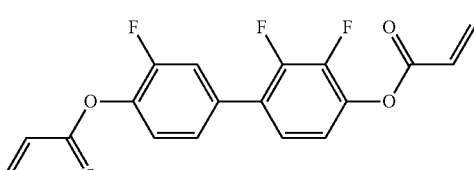
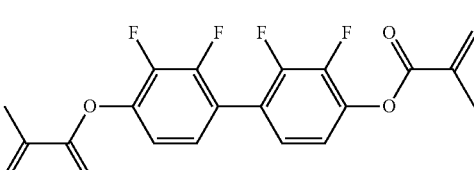
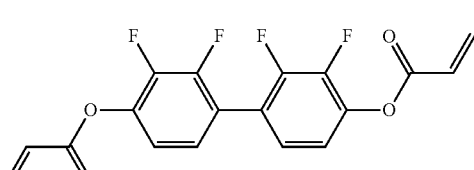
	RM-27
	RM-28
	RM-29
	RM-30
	RM-31
	RM-32
	RM-33
	RM-34

TABLE D-continued

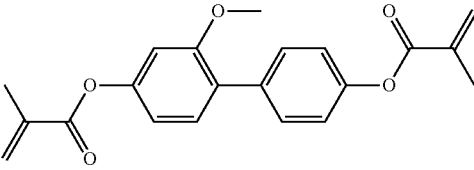
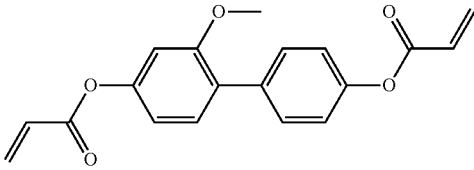
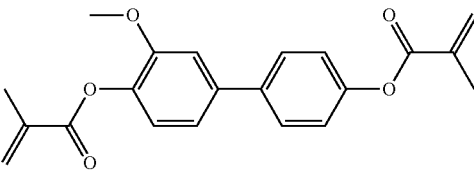
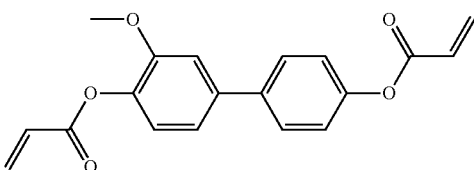
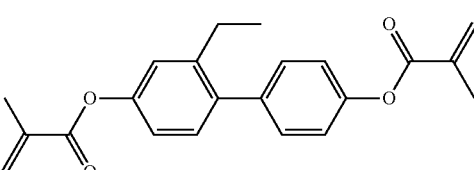
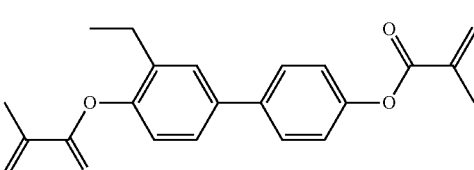
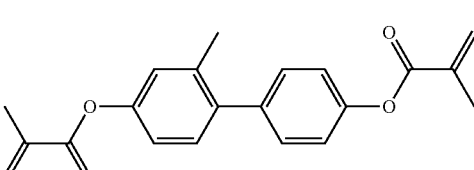
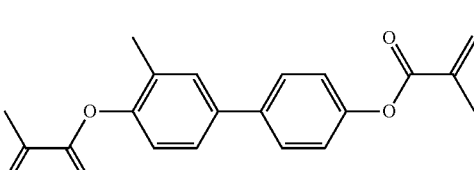
	RM-35
	RM-36
	RM-37
	RM-38
	RM-39
	RM-40
	RM-41
	RM-42

TABLE D-continued

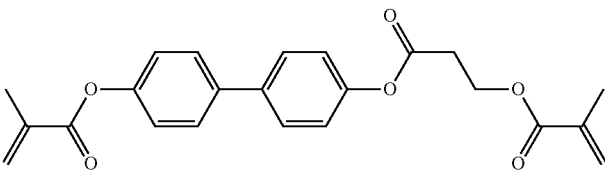
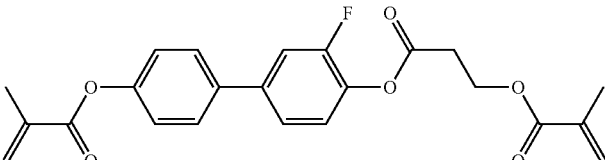
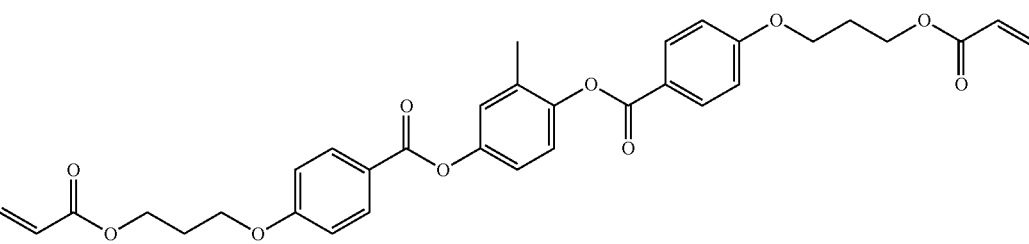
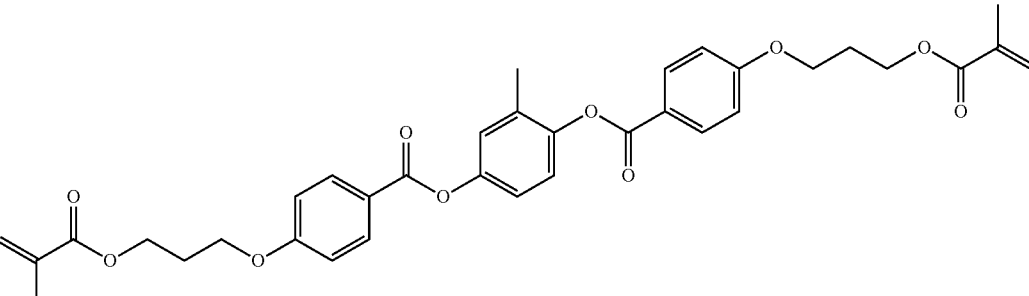
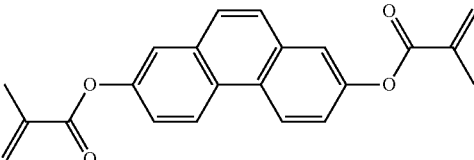
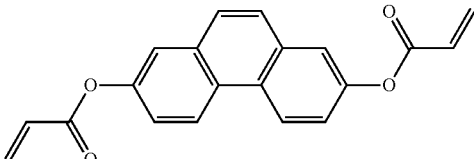
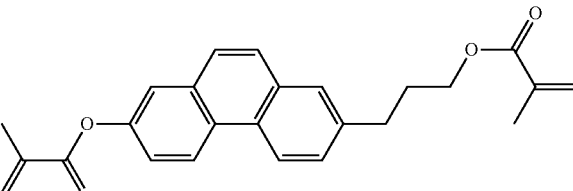
	RM-43
	RM-44
	RM-45
	RM-46
	RM-47
	RM-48
	RM-49

TABLE D-continued

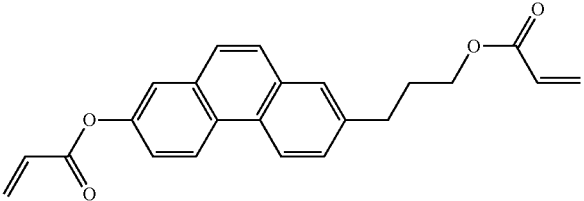
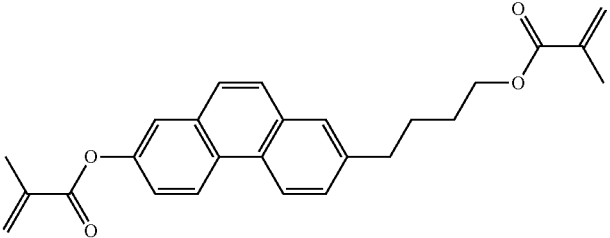
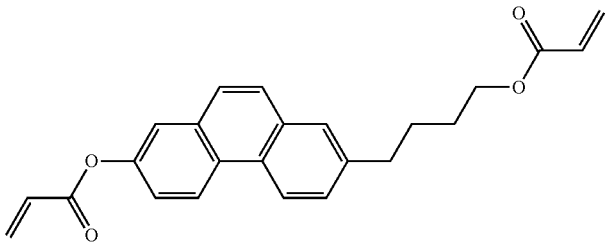
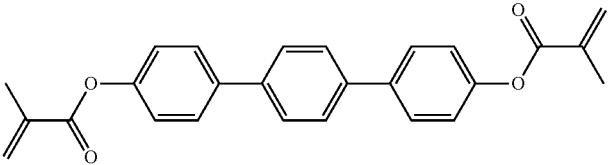
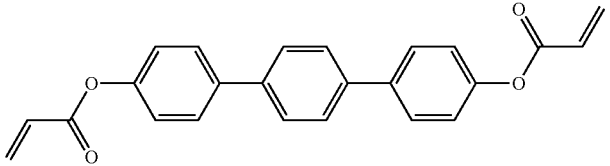
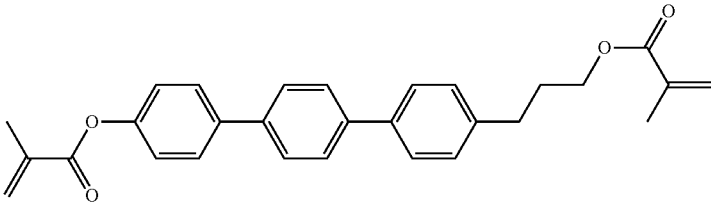
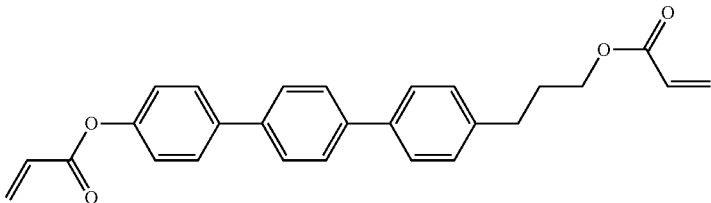
	RM-50
	RM-51
	RM-52
	RM-53
	RM-54
	RM-55
	RM-56

TABLE D-continued

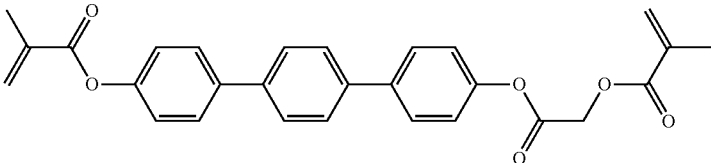
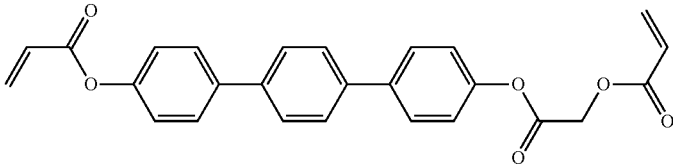
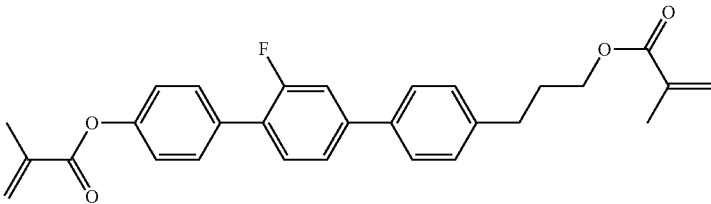
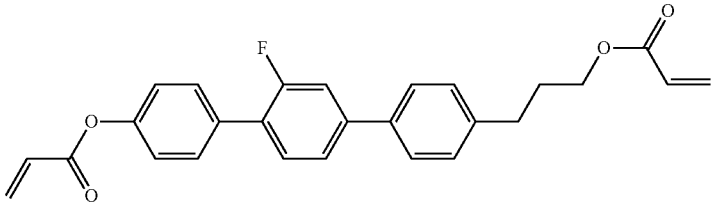
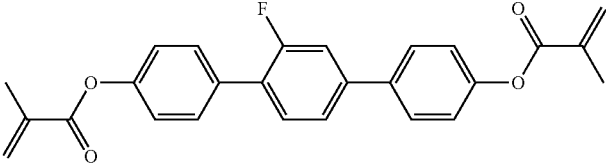
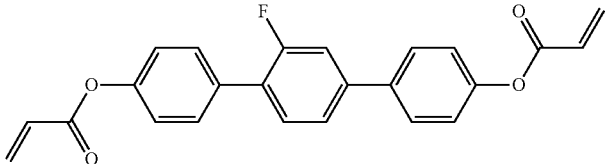
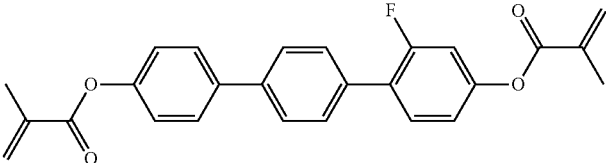
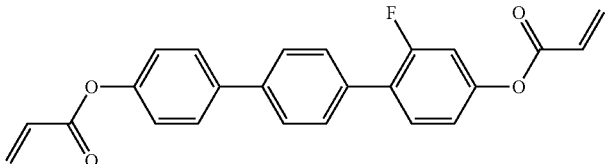
	RM-57
	RM-58
	RM-59
	RM-60
	RM-61
	RM-62
	RM-63
	RM-64

TABLE D-continued

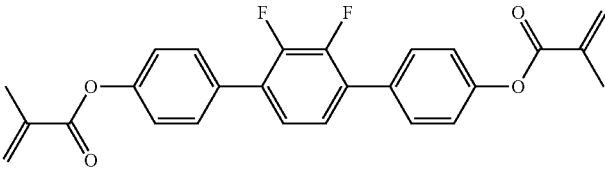
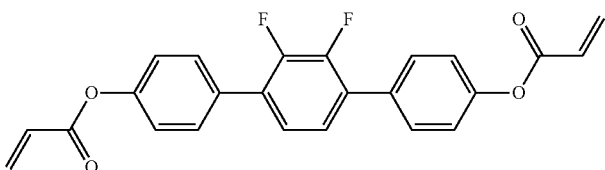
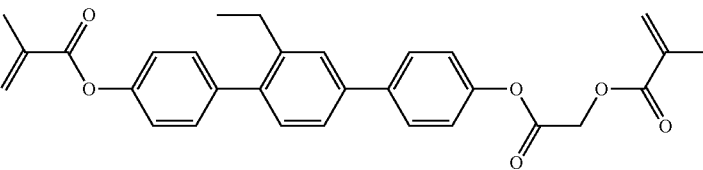
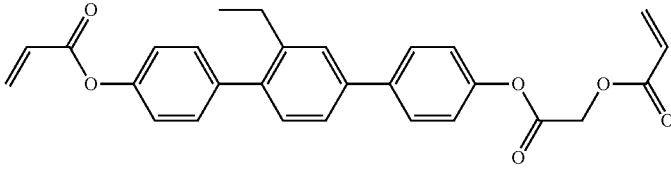
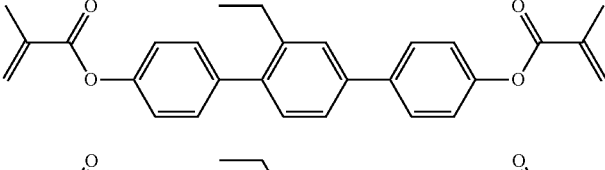
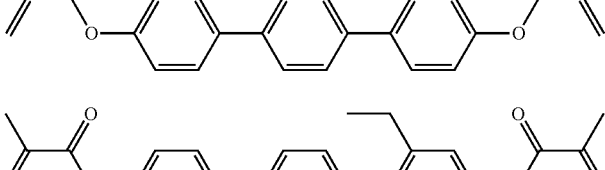
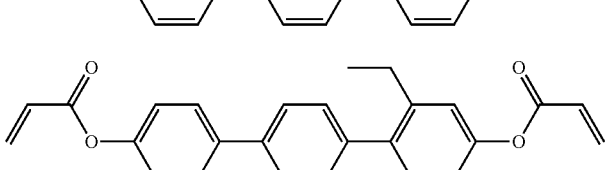
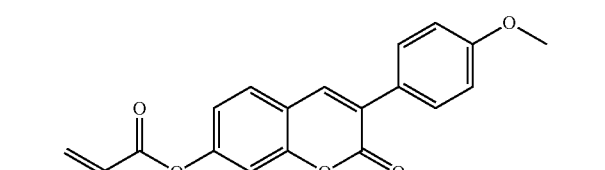
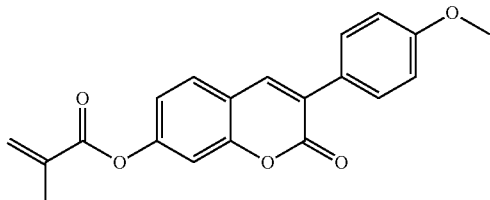
	RM-65
	RM-66
	RM-67
	RM-68
	RM-69
	RM-70
	RM-71
	RM-72
	RM-73

TABLE D-continued

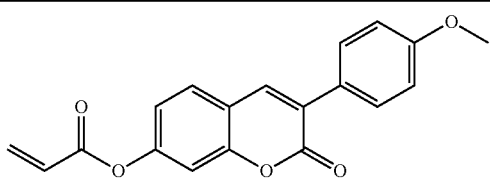
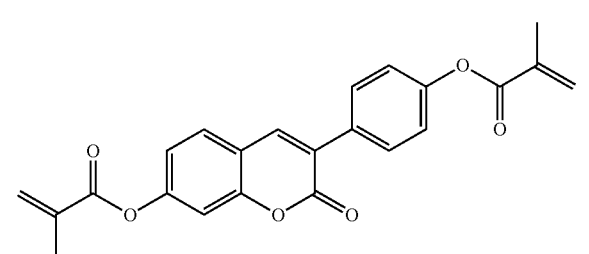
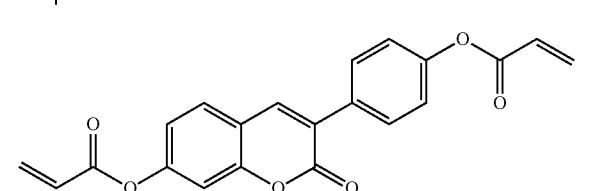
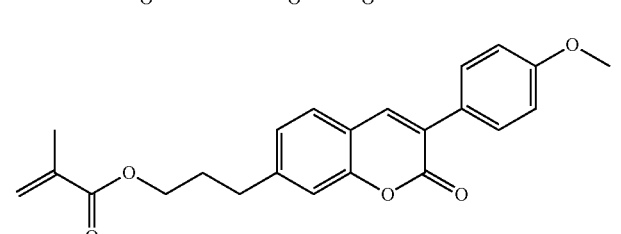
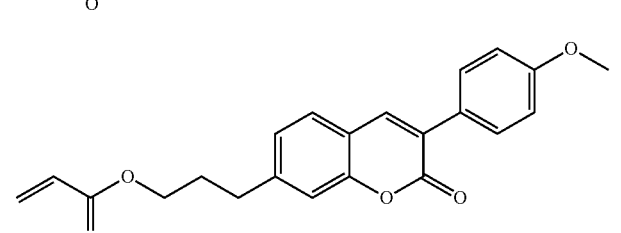
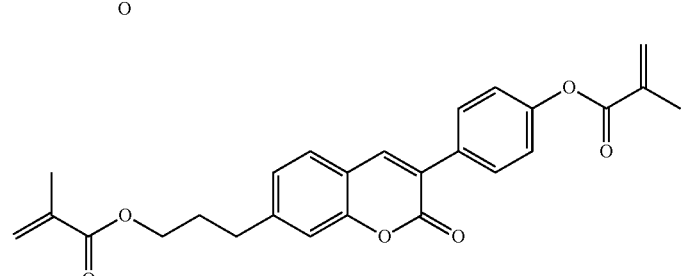
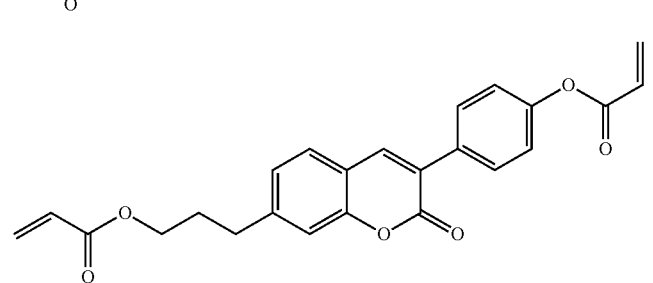
	RM-74
	RM-75
	RM-76
	RM-77
	RM-78
	RM-79
	RM-80

TABLE D-continued

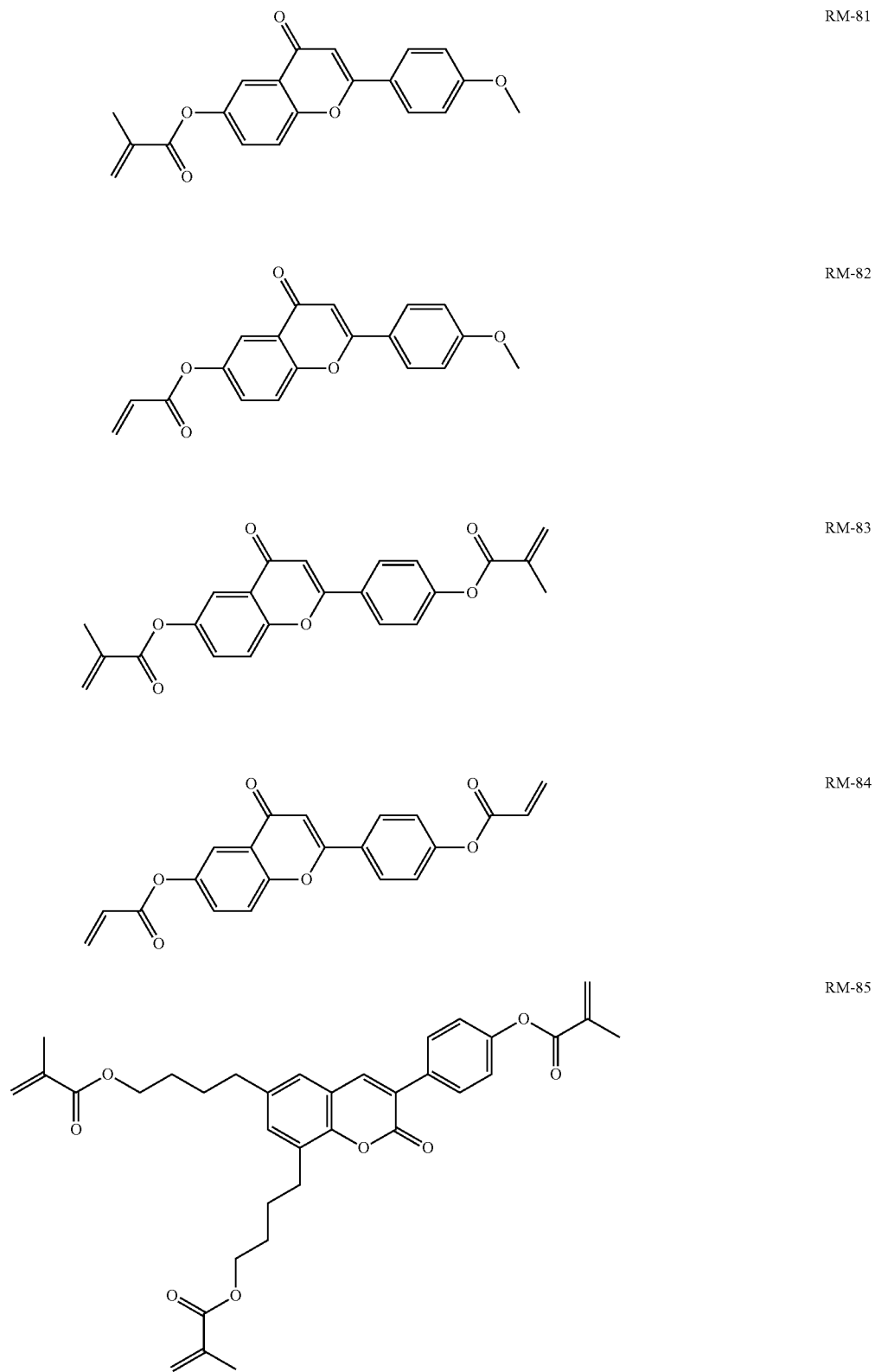
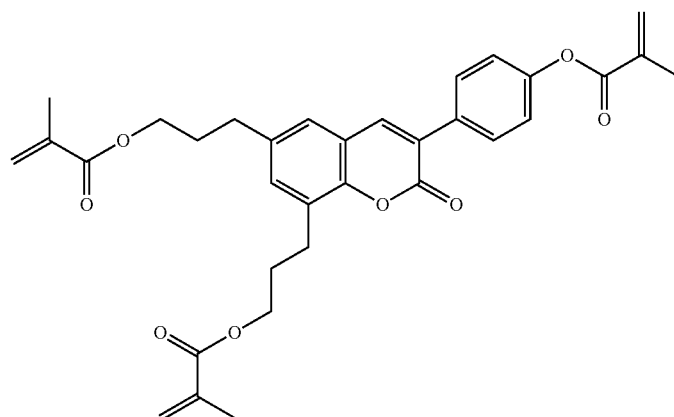
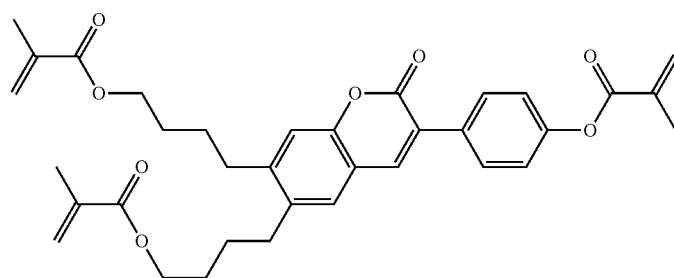


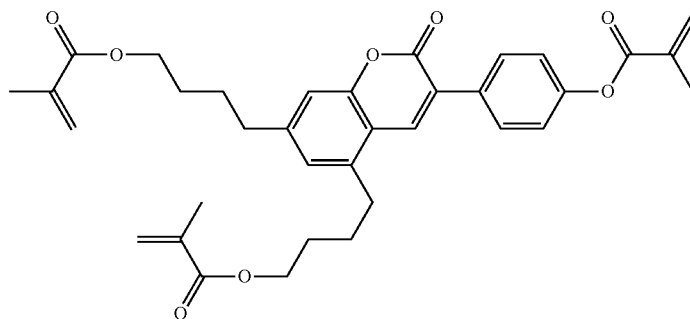
TABLE D-continued



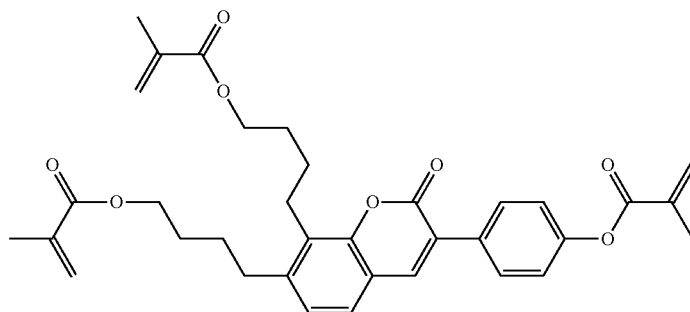
RM-86



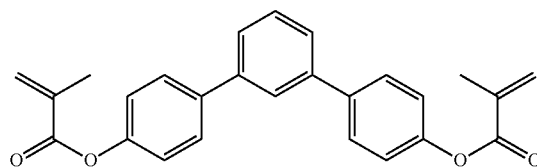
RM-87



RM-88



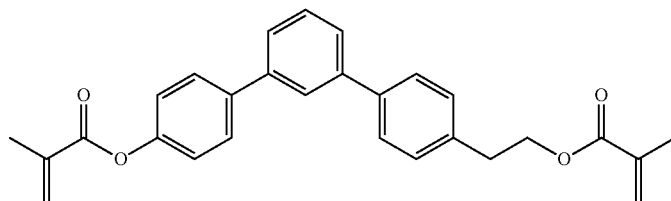
RM-89



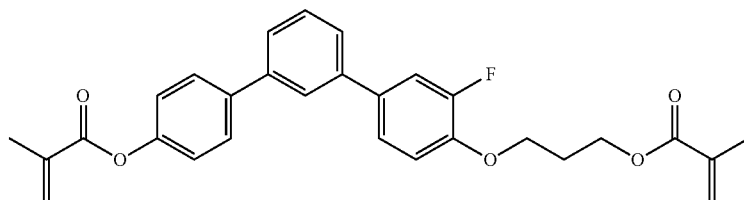
RM-90

TABLE D-continued

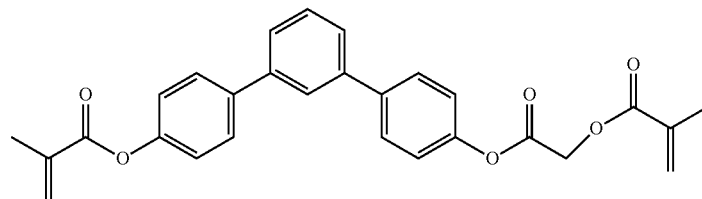
RM-91



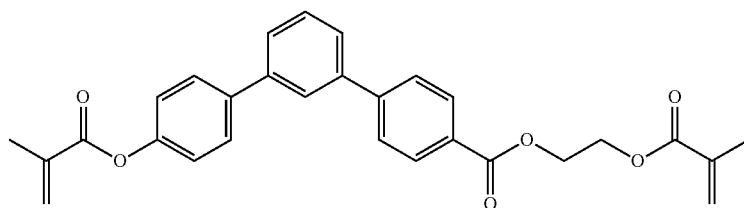
RM-92



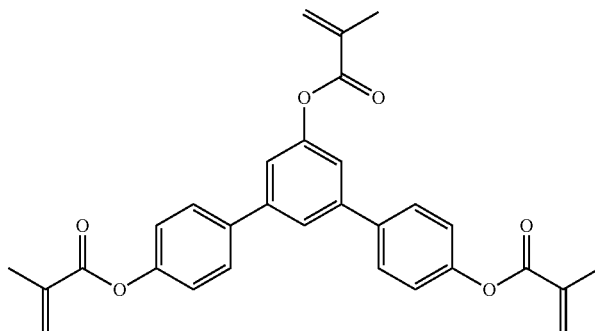
RM-93



RM-94



RM-95



RM-96

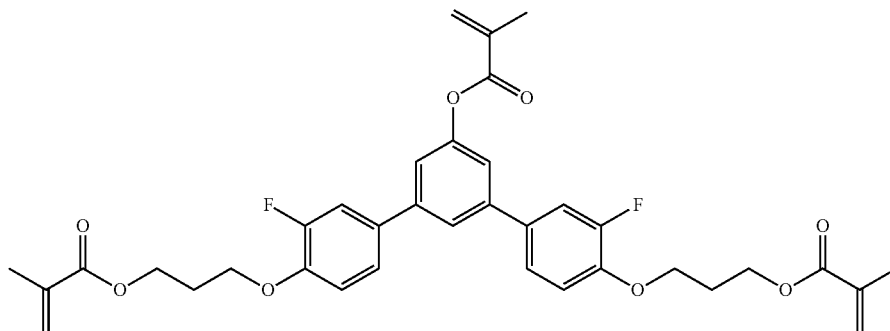


TABLE D-continued

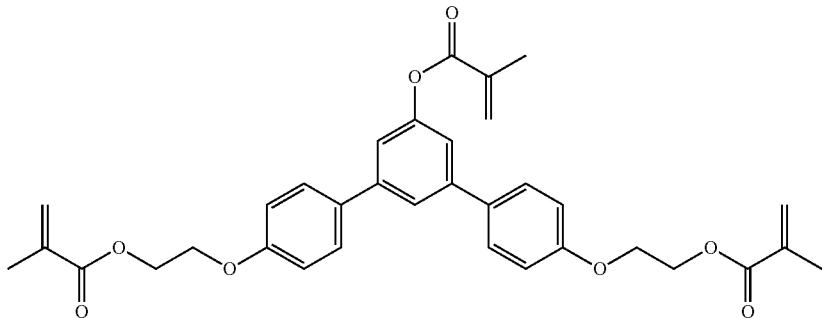
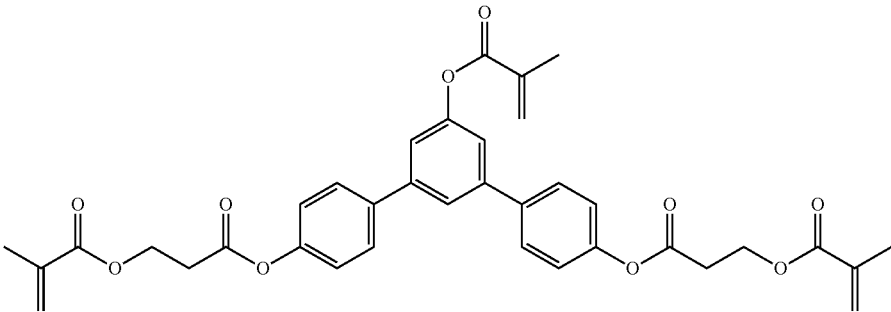
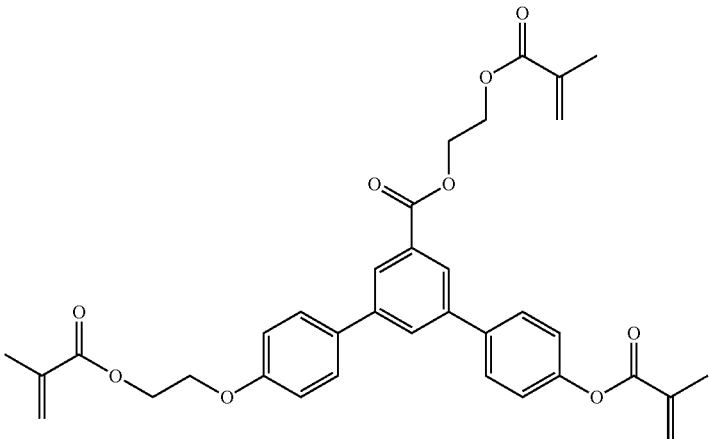
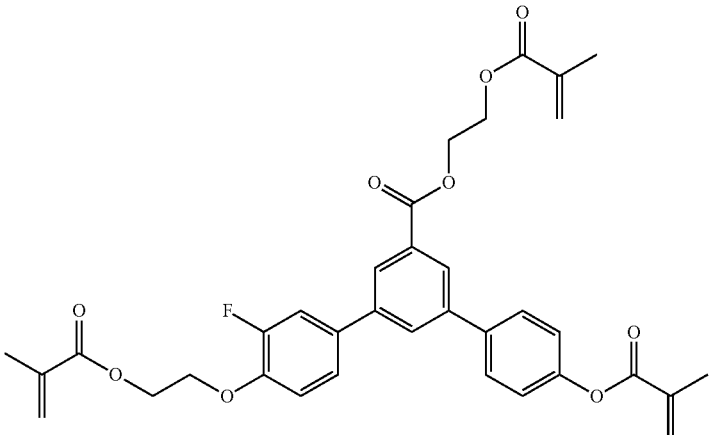
	RM-97
	RM-98
	RM-99
	RM-100

TABLE D-continued

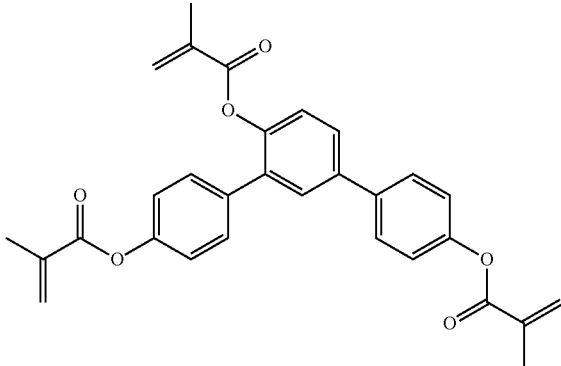
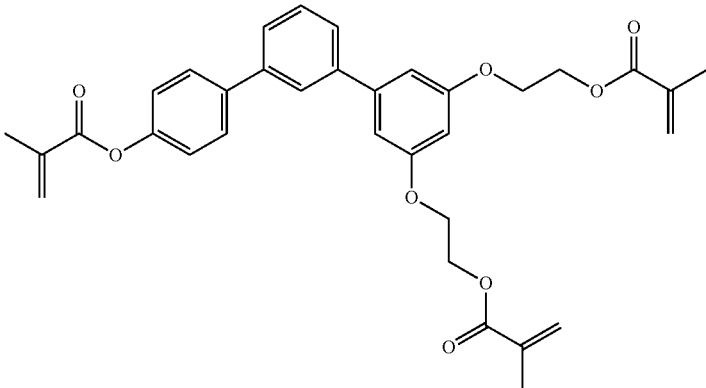
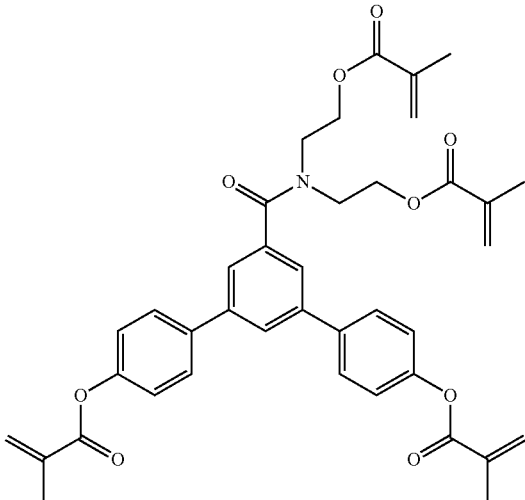
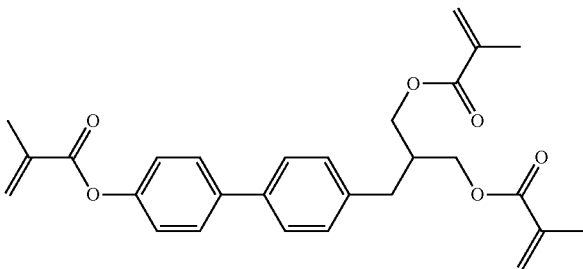
	RM-101
	RM-102
	RM-103
	RM-104

TABLE D-continued

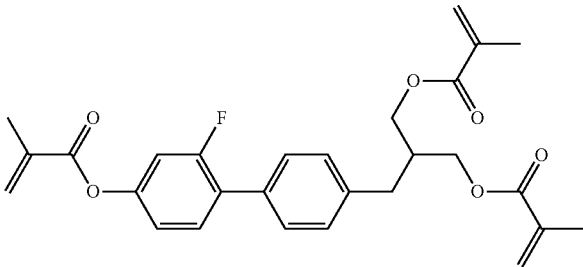
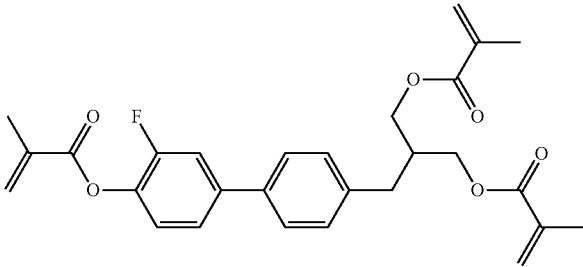
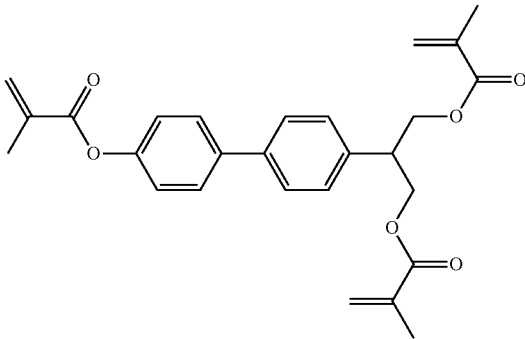
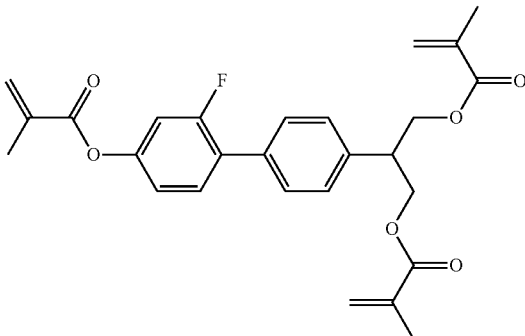
	RM-105
	RM-106
	RM-107
	RM-108

TABLE D-continued

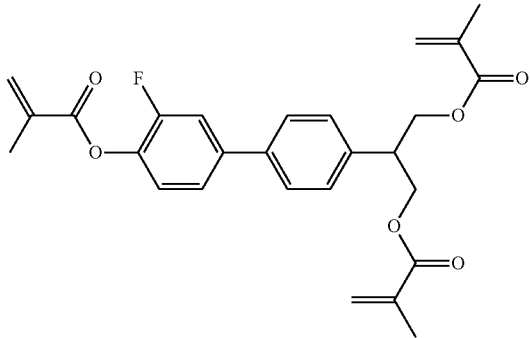
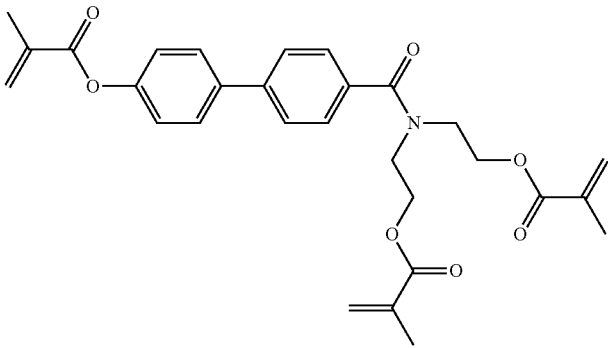
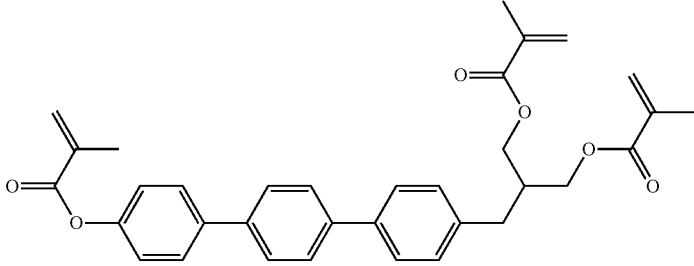
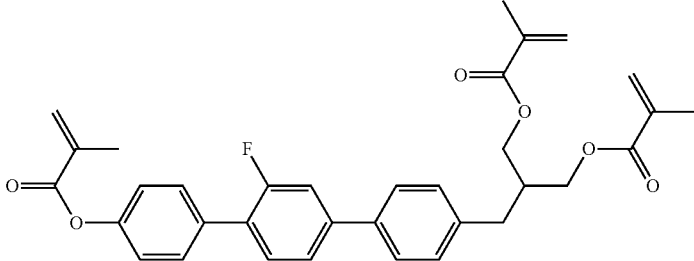
 <chem>CC(=C)C(=O)OC1=CC=C(C=C1)C(F)=C(OC)C2=CC=CC=C2C(C)(C)COC(=O)C=C</chem>	RM-109
 <chem>CC(=C)C(=O)OC1=CC=C(C=C1)C(=O)N(CCCOC(=O)C=C)CCOC(=O)C=C</chem>	RM-110
 <chem>CC(=C)C(=O)OC1=CC=C(C=C1)C2=CC=CC=C2C(C)(C)COC(=O)C=C</chem>	RM-111
 <chem>CC(=C)C(=O)OC1=CC=C(C=C1)C(F)=C(OC)C2=CC=CC=C2C(C)(C)COC(=O)C=C</chem>	RM-112

TABLE D-continued

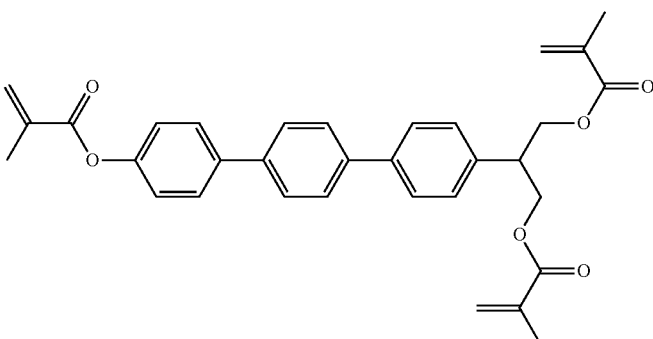
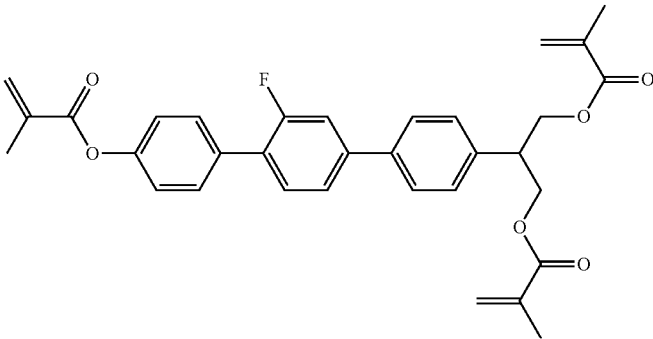
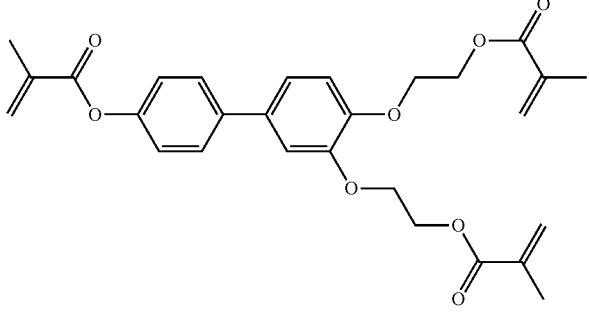
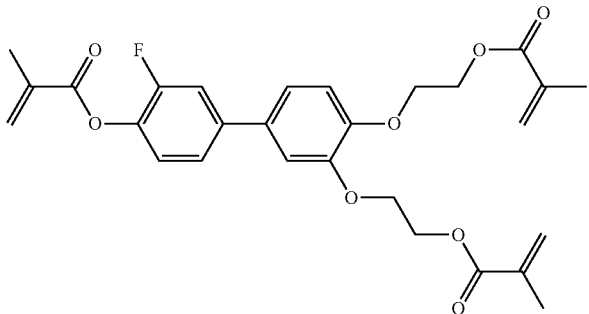
	RM-113
	RM-114
	RM-115
	RM-116

TABLE D-continued

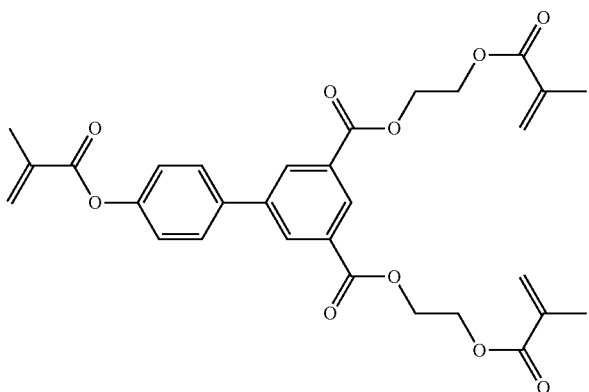
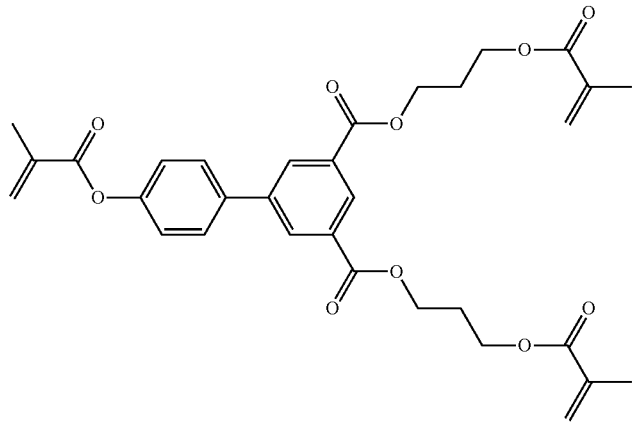
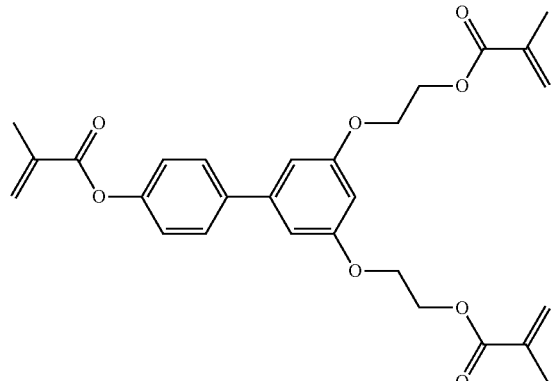
 <chem>CC(=C)C(=O)Oc1ccc(cc1)-c2cc(ccc2C(=O)OCCOC(=C)C)C(=O)OCCOC(=C)C</chem>	RM-117
 <chem>CC(=C)C(=O)Oc1ccc(cc1)-c2cc(ccc2C(=O)OCCOC(=O)C)C(=O)OCCOC(=O)C</chem>	RM-118
 <chem>CC(=C)C(=O)Oc1ccc(cc1)-c2cc(ccc2OC(=O)C)OC(=O)C</chem>	RM-119

TABLE D-continued

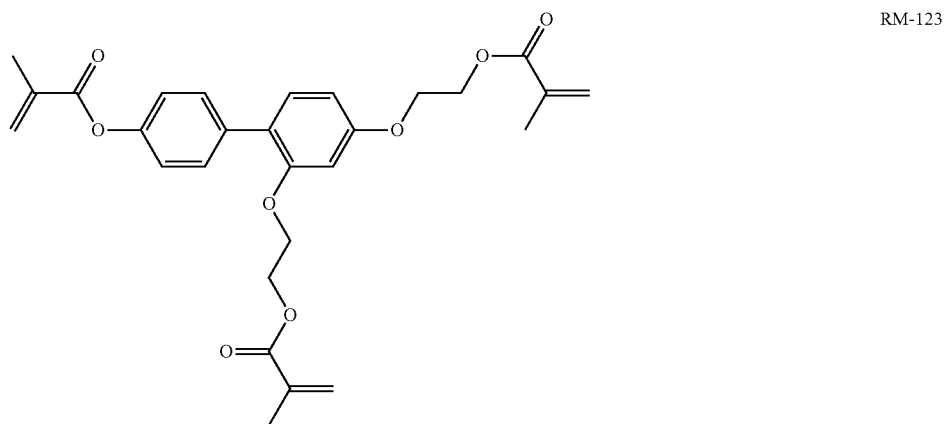
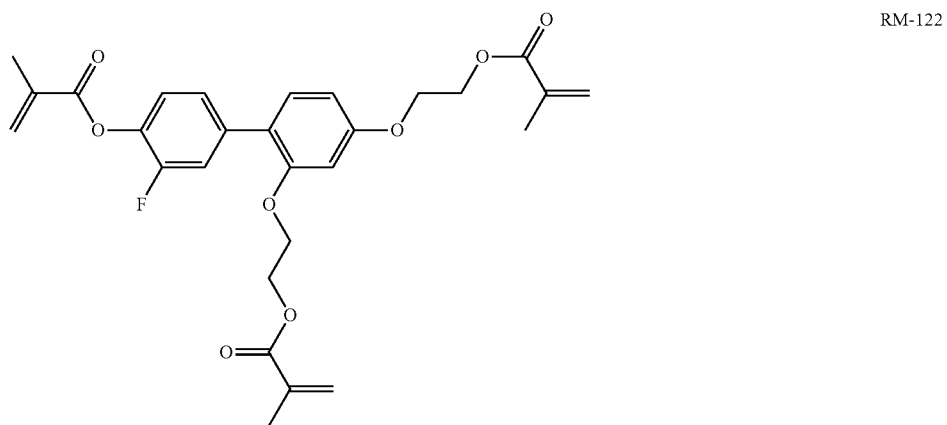
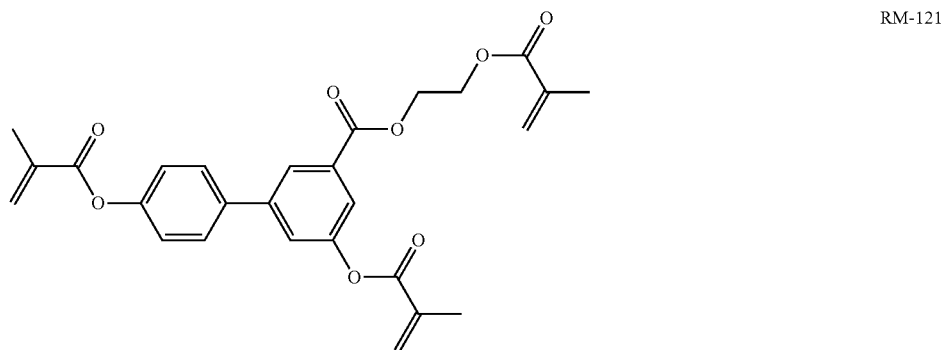
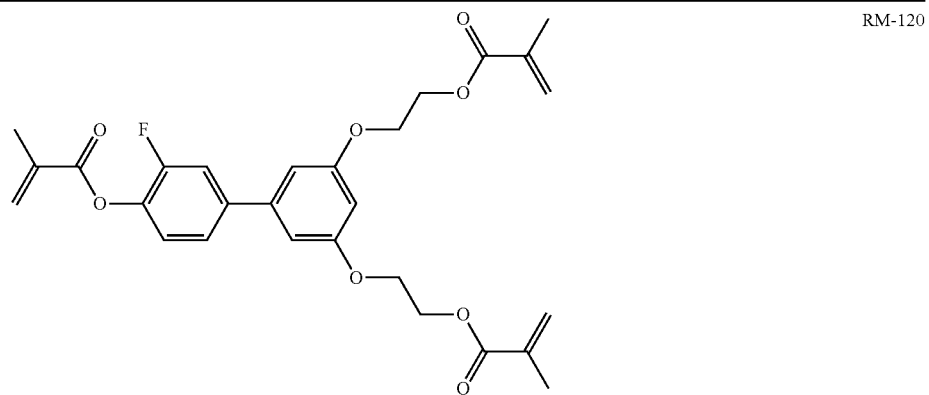
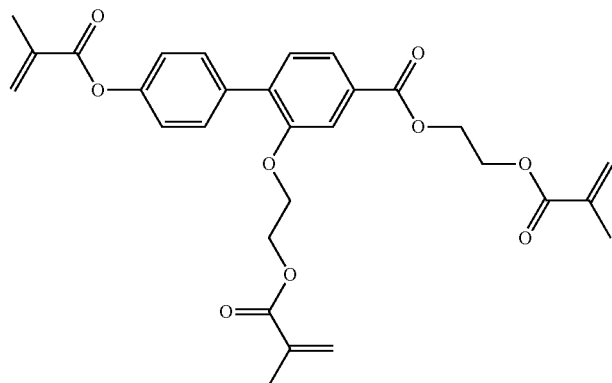
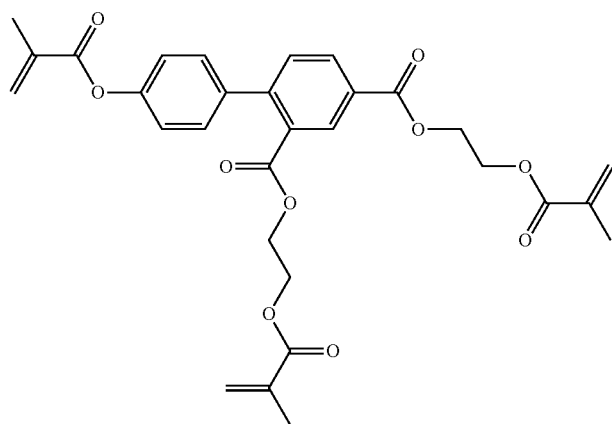


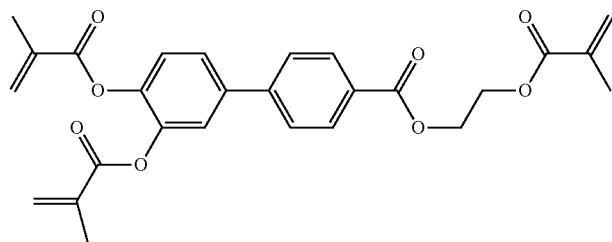
TABLE D-continued



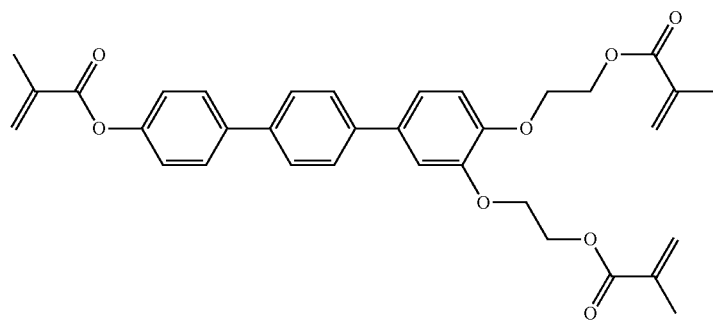
RM-124



RM-125

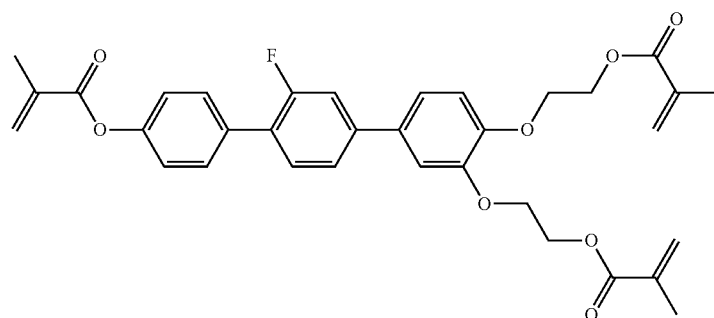


RM-126

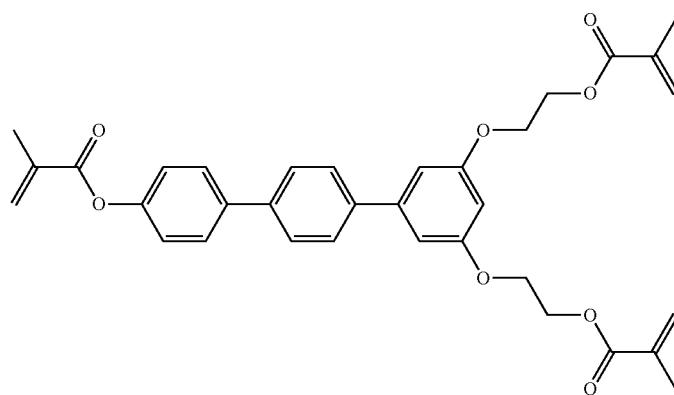


RM-127

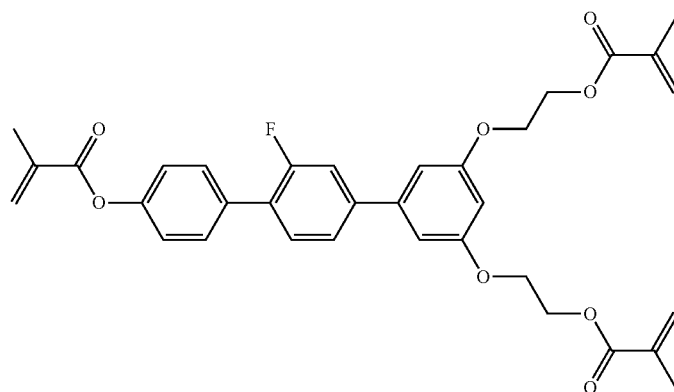
TABLE D-continued



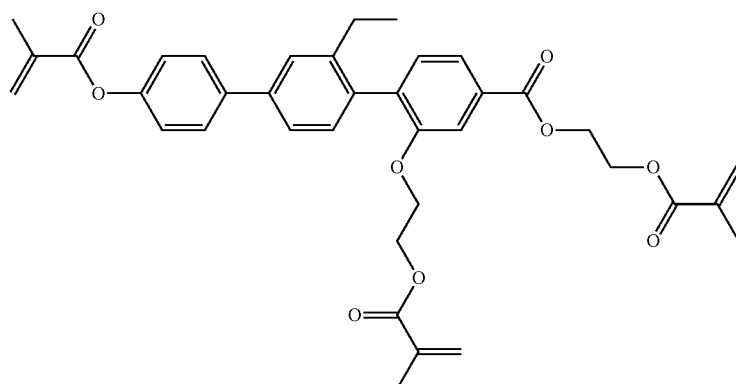
RM-128



RM-129



RM-130



RM-131

[0499] In a preferred embodiment, the mixtures according to the invention comprise one or more polymerisable compounds, preferably selected from the polymerisable compounds of the formulae RM-1 to RM-131. Of these, compounds RM-1, RM-4, RM-8, RM-17, RM-19, RM-35, RM-37, RM-43, RM-47, RM-49, RM-51, RM-59, RM-69, RM-71, RM-83, RM-97, RM-98, RM-104, RM-112, RM-115 and RM-116 are particularly preferred.

[0500] Without further elaboration, it is believed that one skilled in the art can, using the preceding description, utilize the present invention to its fullest extent. The preceding preferred specific embodiments are, therefore, to be construed as merely illustrative, and not limitative of the remainder of the disclosure in any way whatsoever.

EXAMPLES

[0501] The following examples explain the present invention without restricting it. However, they show the person skilled in the art preferred mixture concepts with compounds preferably to be employed and the respective concentrations thereof and combinations thereof with one another. In addition, the examples illustrate which properties and property combinations are accessible.

[0502] In addition, the following abbreviations and symbols are used:

[0503] V_0 threshold voltage, capacitive [V] at 20° C.,

[0504] n_e extraordinary refractive index at 20° C. and 589 nm,

[0505] n_o ordinary refractive index at 20° C. and 589 nm,

[0506] Δn optical anisotropy at 20° C. and 589 nm,

[0507] ϵ_{\perp} dielectric permittivity perpendicular to the director at 20° C. and 1 kHz,

[0508] ϵ_{\parallel} dielectric permittivity parallel to the director at 20° C. and 1 kHz,

[0509] $\Delta\epsilon$ dielectric anisotropy at 20° C. and 1 kHz,

[0510] cl.p., T(N,I) clearing point [° C.],

[0511] γ_1 rotational viscosity at 20° C. [mPa·s],

[0512] K_1 elastic constant, “splay” deformation at 20° C. [pN],

[0513] K_2 elastic constant, “twist” deformation at 20° C. [pN],

[0514] K_3 elastic constant, “bend” deformation at 20° C. [pN].

[0515] Unless explicitly noted otherwise, all concentrations in the present application are quoted in percent by weight and relate to the corresponding mixture as a whole, comprising all solid or liquid-crystalline components, without solvents.

[0516] Unless explicitly noted otherwise, all temperature values indicated in the present application, such as, for example, for 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), are quoted in degrees Celsius (° C.). M.p. denotes melting point, cl.p.=clearing point. Furthermore, C=crystalline state, N=nematic phase, S=smectic phase and I=isotropic phase. The data between these symbols represent the transition temperatures.

[0517] All physical properties are and have been 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., and Δn is determined at 589 nm and $\Delta\epsilon$ at 1 kHz, unless explicitly indicated otherwise in each case.

[0518] The term “threshold voltage” for the present invention relates to the capacitive threshold (V_0), also known as the Freedericks threshold, unless explicitly indicated otherwise. In the examples, the optical threshold may also, as generally usual, be quoted for 10% relative contrast (V_{10}).

[0519] Unless stated otherwise, the process of polymerising the polymerisable compounds in the PSA displays as described above and below is carried out at a temperature where the LC medium exhibits a liquid crystal phase, preferably a nematic phase, and most preferably is carried out at room temperature.

[0520] Unless stated otherwise, methods of preparing test cells and measuring their electrooptical and other properties are carried out by the methods as described hereinafter or in analogy thereto.

[0521] The display used for measurement of the capacitive threshold voltage consists of two plane-parallel glass outer plates at a separation of 25 μm , each of which has on the inside an electrode layer and an unrubbed polyimide alignment layer on top, which effect a homeotropic edge alignment of the liquid-crystal molecules.

[0522] The display or test cell used for measurement of the tilt angles consists of two plane-parallel glass outer plates at a separation of 4 μm , each of which has on the inside an electrode layer and a polyimide alignment layer on top, where the two polyimide layers are rubbed antiparallel to one another and effect a homeotropic edge alignment of the liquid-crystal molecules.

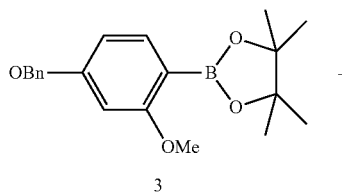
[0523] The polymerisable compounds are polymerised in the display or test cell by irradiation with UV light of defined intensity for a prespecified time, with a voltage simultaneously being applied to the display (usually 10 V to 30 V alternating current, 1 kHz). In the examples, unless indicated otherwise, a metal halide lamp and an intensity of 100 mW/cm^2 is used for polymerisation. The intensity is measured using a standard meter (Hoenle UV-meter high end with UV sensor).

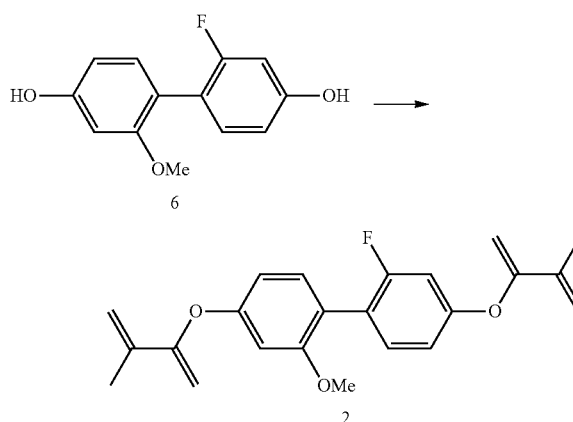
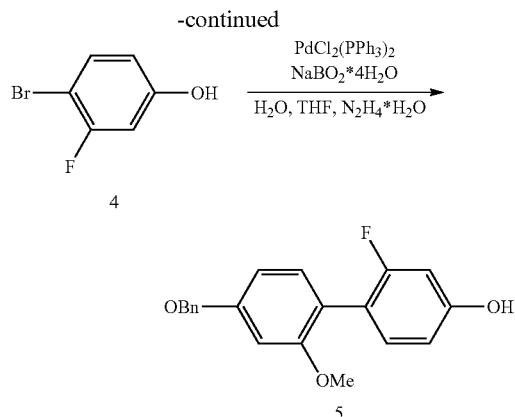
[0524] The tilt angle is determined using the Mueller Matrix Polarimeter “AxoScan” from Axometrics. A low value (i.e. a large deviation from the 90° angle) corresponds to a large tilt here.

[0525] Unless stated otherwise, the term “tilt angle” means the angle between the LC director and the substrate, and “LC director” means in a layer of LC molecules with uniform orientation the preferred orientation direction of the optical main axis of the LC molecules, which corresponds, in case of calamitic, uniaxially positive birefringent LC molecules, to their molecular long axis.

Example 1

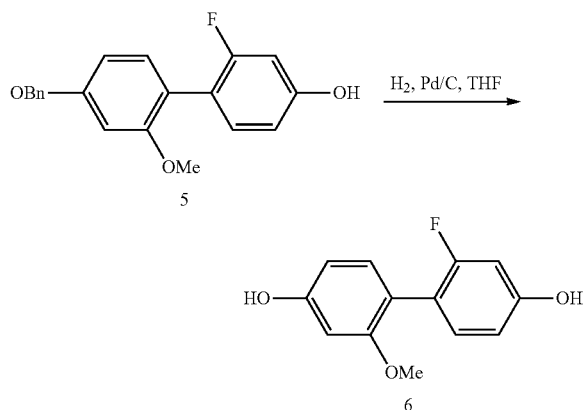
[0526] Polymerisable compound (or “RM”) 1 is prepared as follows.





[0527] 3: The preparation of boronic ester 3 is described in WO 2014/133361 A1.

[0528] 5: A solution of boronic ester 3 (3.0 g, 95%, 36.3 mmol) and phenol 4 (7.0 g, 36.4 mmol) in tetrahydrofuran (120 mL) was added to a stirred solution of sodium metaborate (tetrahydrate, 8.9 g, 64.5 mmol) in water (30 mL) at room temperature. The resulting mixture was treated with bis(triphenylphosphine)-palladium(II) chloride (1.5 g, 2.0 mmol), followed by addition of hydrazine hydrate (0.07 mL, 1.5 mmol). The reaction mixture was stirred overnight at 70° C., before it was treated with 2M HCl and ethyl acetate. Aqueous phase was separated and extracted with ethyl acetate (2 times). The combined organic phase was washed with sat. NaCl solution, dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was purified with flash chromatography (heptane/ethyl acetate) to give 5 as a yellowish oil. (9.0 g, 65%; GC: 86.0%)



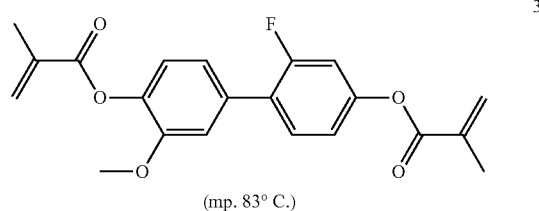
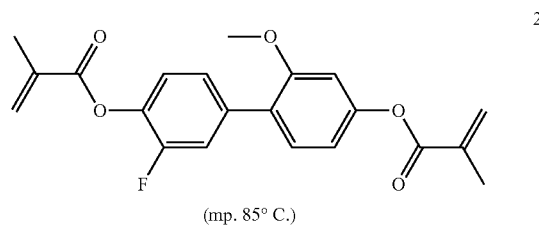
[0529] 6: A solution of 5 (9.0 g, 27.7 mmol) in tetrahydrofuran (90 mL) was hydrogenated over Pd/C (5%, 3.0 g) at room temperature for 15h, before it was treated with additional 3.0 g of Pd/C. The resulted mixture was hydrogenated for additional 15 h, filtered and concentrated in vacuo. The residue was used in the next step without further purification (oil, 6.3 g, 97%).

[0530] 16: Methacrylic acid (7.0 g, 80.7 mmol) and 4-dimethylaminopyridine (DMAP, 0.33 g, 2.7 mmol) were added to a stirred solution of biphenol 6 (6.3 g, 26.9 mmol) in dichloromethane (100 mL) at room temperature. The resulting mixture was cooled to 3° C. followed by dropwise addition 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide (12.5 g, 155 mmol). The reaction mixture was allowed to warm to room temperature and stirred over two days, before it was concentrated in vacuo. The residue was purified by flash chromatography (heptane/ethyl acetate) and recrystallized from heptane/ethanol (5:1) to give 2 as white crystals (6.5 g, 65%; GC: 99.7%; HPLC: 99.7%). ¹H NMR: 2.04-2.06 (m, 6H), 3.81 (s, 3H), 5.85-5.87 (m, 2H), 6.34 (br.s., 2H), 6.87 (dd, J=8.2, 2.1 Hz, 1H), 6.97 (d, J=2.2 Hz, 1H), 7.07-7.14 (m, 2H), 7.33 (d, J=8.2 Hz, 1H), 7.44 (dd, J=8.3, 8.3 Hz, 1H); EI-MS: 370.1.

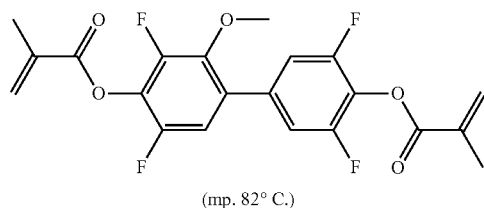
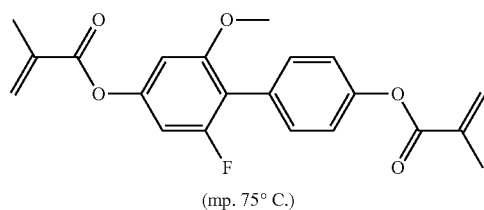
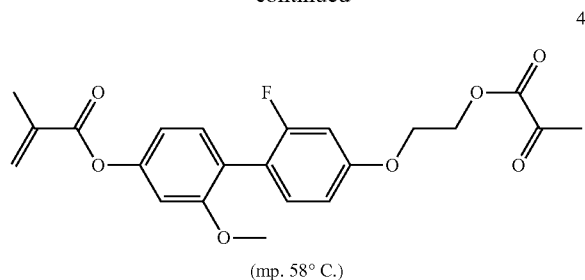
[0531] DSC: Tg -5 K 83 I.

Examples 2-5

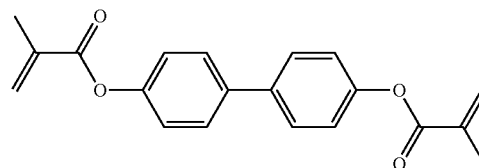
[0532] The following polymerisable monomeric compounds are prepared in analogy to the methods described in Example 1.



-continued



and which is typically used in PSA mixtures of prior art, to nematic LC host mixtures N1 and N2, at a concentration of 0.300% by weight.



C1

[0537] Polymerisable mixtures P11-P22 according to the invention are prepared by adding RM 1 or 2 of Example 1 or 2, respectively, to nematic LC host mixtures N1 and N2 at a concentration of 0.345% by weight, to have an equimolar amount of 0.093 mmol RM per 10 g mixture compared to mixtures C11 and C21.

[0538] The compositions of the individual polymerisable mixtures are shown in Table 1.

TABLE 1

Mix. No.	Polymerisable mixture composition					
	P11	P12	C11	P21	P22	C21
LC Host	N1	N1	N1	N2	N2	N2
RM	1	2	C1	1	2	C1

Polymerisable Mixture Examples

[0533] The nematic LC host mixture N1 is formulated as follows:

CCH-501	9.00%	cl.p.	70.0° C.
CCH-35	14.00%	Δn	0.0825
PCH-53	8.00%	$\Delta \epsilon$	-3.5
CY-3-O4	14.00%	$\epsilon_{ }$	3.5
CY-5-O4	13.00%	K_3/K_1	1.00
CCY-2-1	9.00%	γ_1	141 mPa s
CCY-3-1	9.00%	V_0	2.10 V
CCY-3-O2	8.00%		
CCY-5-O2	8.00%		
CPY-2-O2	8.00%		

[0534] The nematic LC host mixture N2 is formulated as follows:

CY-3-O2	18.00%	cl.p.	+74.5° C.
CPY-2-O2	10.00%	Δn	0.1021
CPY-3-O2	10.00%	$\Delta \epsilon$	-3.1
CCY-3-O2	9.00%	$\epsilon_{ }$	3.5
CCY-4-O2	4.00%	K_3/K_1	1.16
PYP-2-3	9.00%	γ_1	86 mPa s
CC-3-V	40.00%	V_0	2.29 V

[0535] Polymerisable mixtures are prepared by adding various individual polymerisable monomeric compounds (hereinafter referred to as reactive mesogen or “RM”) to nematic LC host mixtures N1 and N2.

[0536] As reference, polymerisable mixtures C11 and C21 are prepared by adding RM C1 which has no substituents,

Use Examples

[0539] The individual polymerisable mixtures are filled into PSA test cells, the RM is polymerised under application of a voltage, and several properties like tilt angle generation, VHR under UV stress and residual RM content are measured.

Residual RM Measurement

[0540] The polymerisation speed is measured by determining the residual content of residual, unpolymerised RM (in % by weight) in the mixture after UV exposure with a given intensity and lamp spectrum after a given UV exposure time. The smaller the residual RM content after a given time interval, the faster the polymerization,

[0541] For this purpose the polymerisable mixtures are inserted into electrooptic test cells from Varitronics made of two soda-lime glass substrates coated with an ITO electrode layer and a rubbed VA-polyimide alignment layer. The LC layer thickness is approx. 7 μ m.

[0542] The test cells are illuminated by a MH-lamp (UV-Cube 2000) using a 320 nm long pass filter (N-WG320) and a light intensity of 100 mW/cm², causing polymerisation of the RM. Illumination times are given in the respective tables below.

[0543] After polymerization the test cells are opened, and the mixture is dissolved and rinsed out of the test cell with 2 ml ethyl methyl ketone and analyzed by High Performance Liquid Chromatography (HPLC). For better comparison, the results are given by % rel. At 0 min illumination time, a 100% of RM are present and after x min illumination time y % of the RM are still present. The results are shown in Table 3.

TABLE 3

Residual RM content					
Mixture	UV Time/min	0	2	4	6
C11	residual RM/	100	80	63	53
P11	% rel	100	72	51	40
P12		100	59	32	19

Mixture	UV Time/min	0	2	6
C21	residual RM/	100	49	19
P21	% rel	100	47	17
P22		100	30	7

[0544] It can be seen that, compared to mixtures C₁₁ and C₂₁, for polymerisable mixtures P11, P12, P21 and P22 the amount of residual RM is lower, and thus polymerisation speed is faster.

Tilt Angle Generation

[0545] For measuring the tilt angle generation the polymerisable mixtures are inserted into electrooptic test cells made of two soda-lime glass substrates coated with an ITO electrode layer of approx. 200 nm thickness and a VA-polyimide alignment layer (JALS-2096-R1) of approx. 30 nm thickness which is rubbed antiparallel. The LC-layer thickness d is approx. 4 μm.

[0546] The test cells are illuminated by a MH-lamp (UV-Cube 2000) using a 320 nm long pass filter (N-WG320) and a light intensity of 100 mW/cm² at 20° C. with an applied square voltage of 24 VRMS (alternating current, 1 khz), causing polymerisation of the RM and a generation of a tilt angle. Illumination times are given in the respective tables. The generated tilt was measured after a period of time of 12 hours using the Mueller Matrix Polarimeter “AxoScan” from Axometrics. The results are shown in Table 4.

TABLE 4

Tilt angles				
Mixture	UV Time/min	0	2	6
C11	Tilt/°	90	85	78
P11		89	82	74
P12		89	81	72
C21		89	77	70
P21		88	80	76
P22		89	77	74

[0547] It can be seen that, compared to mixtures C₁₁ and C₂₁, polymerisable mixtures P11, P12, P21 and P22 show a comparable or even faster and stronger tilt angle generation.

[0548] In conclusion, the use examples demonstrate that, compared to RMs of prior art, the RMs and polymerisable mixtures according to the present invention show an improved polymerization speed and more complete polymerization, while maintaining a sufficient pretilt generation or even enhancing pretilt angle generation for display applications.

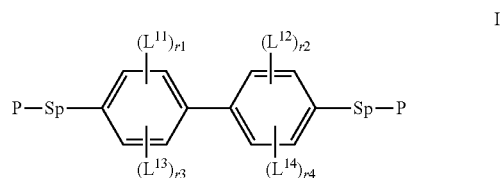
[0549] The entire disclosure[s] of all applications, patents and publications, cited herein and of corresponding European application No. 16202818.7 filed Dec. 8, 2016 is incorporated by reference herein.

[0550] The preceding examples can be repeated with similar success by substituting the generically or specifically

described reactants and/or operating conditions of this invention for those used in the preceding examples.

[0551] From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions.

1. A liquid crystal (LC) display device, which is a PSA display or a polymer stabilised SA-VA display, and which comprises two substrates, at least one which is transparent to light, an electrode provided on each substrate or two electrodes provided on only one of the substrates, and located between the substrates a layer of an LC medium, wherein the LC medium comprises one or more polymerisable compounds of the following formula I and the polymerisable compounds are polymerised between the substrates of the display:



wherein the individual radicals, independently of each other, and on each occurrence identically or differently, have the following meanings

P are a methacrylate group or an acrylate group, wherein both groups P have the same meaning,

Sp are a single bond or $-(CH_2)_{p1}-$, $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$, or $-CO-O-(CH_2)_{p1}-$, wherein p1 is 2, 3, 4, 5 or 6, and, if Sp is $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$ or $-CO-O-(CH_2)_{p1}-$ the O-atom or CO-group, respectively, is linked to the benzene ring,

L¹¹, L¹² are F, Cl or OR,

R is straight-chain or branched alkyl with 1 to 4 C atoms that is optionally fluorinated,

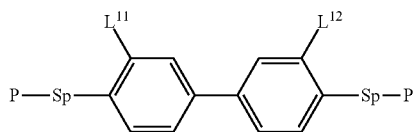
L¹³, L¹⁴ are F, Cl, $-CN$ or straight chain, branched or cyclic alkyl having 1 to 25 C atoms, wherein one or more non-adjacent CH₂-groups are optionally replaced by $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$, $-O-CO-O-$ in such a manner that O- and/or S-atoms are not directly connected with each other, and wherein one or more H atoms are each optionally replaced by F or Cl,

r1, r2 are 0, 1, 2, 3 or 4, wherein r1+r2≥2,

r3, r4 are 0, 1, 2, 3 or 4, wherein r1+r3≤4 and r2+r4≤4,

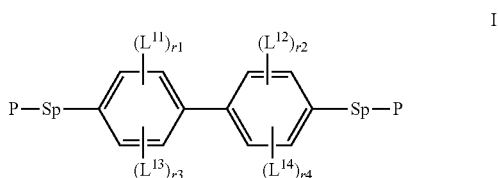
wherein the compounds contain at least group L¹¹ or L¹² that is F or Cl, and at least one group L¹¹ or L¹² that is OR, and

with the proviso that the following compounds are excluded



wherein P, Sp, L^{11} and L^{12} are as defined above.

2. A liquid crystal (LC) display device, which comprises and an LC medium, wherein the LC medium comprises one or more polymerisable compounds of the following formula I:



wherein the individual radicals, independently of each other, and on each occurrence identically or differently, have the following meanings

P are a methacrylate group or an acrylate group, wherein both groups P have the same meaning,

Sp are a single bond or $-(CH_2)_{p1}-$, $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$, or $-CO-O-(CH_2)_{p1}-$, wherein $p1$ is 2, 3, 4, 5 or 6, and, if Sp is $-O-(CH_2)_{p1}-$, $-O-CO-(CH_2)_{p1}-$ or $-CO-O-(CH_2)_{p1}-$ the O-atom or CO-group, respectively, is linked to the benzene ring,

L^{11} , L^{12} are F, Cl or OR,

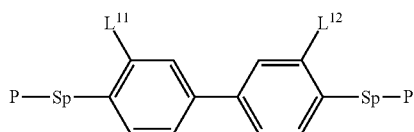
R is straight-chain or branched alkyl with 1 to 4 C atoms that is optionally fluorinated,

L^{13} , L^{14} are F, Cl, $-CN$ or straight chain, branched or cyclic alkyl having 1 to 25 C atoms, wherein one or more non-adjacent CH_2 -groups are optionally replaced by $-O-$, $-S-$, $-CO-$, $-CO-O-$, $-O-CO-$, $-O-CO-O-$ in such a manner that O- and/or S-atoms are not directly connected with each other, and wherein one or more H atoms are each optionally replaced by F or Cl,

$r1$, $r2$ are 0, 1, 2, 3 or 4, wherein $r1+r2 \geq 2$,

$r3$, $r4$ are 0, 1, 2, 3 or 4, wherein $r1+r3 \leq 4$ and $r2+r4 \leq 4$, wherein the compounds contain at least group L^{11} or L^{12} that is F or Cl, and at least one group L^{11} or L^{12} that is OR, and

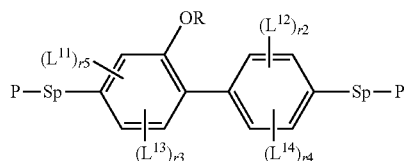
with the proviso that the following compounds are excluded



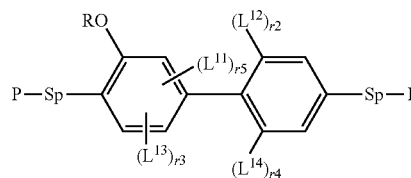
wherein P, Sp, L^{11} and L^{12} are as defined above.

3. The LC display device of claim 2, which is a PS-VA, PS-OCB, PS-IPS, PS-FFS, PS-UB-FFS, PS-posi-VA, PS-TN or polymerized SA-VA display.

4. The LC display device of claim 1, wherein the compound of formula I is selected from the following subformulae:



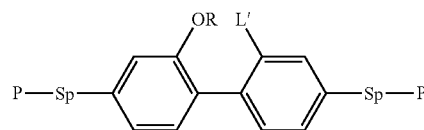
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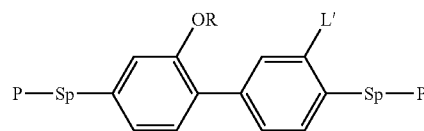
12

wherein P, Sp, R, L^{11} , L^{12} , L^{13} , L^{14} , $r2$, $r3$, $r4$ have the meanings given in claim 1, $r5$ is 0, 1, 2 or 3, $r3+r5 \leq 3$, and $r2+r5 \geq 1$.

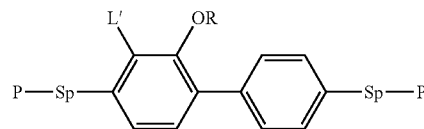
5. The LC display device of claim 1, wherein the compound of formula I is selected from the following subformulae:



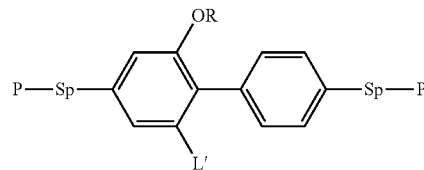
11-1



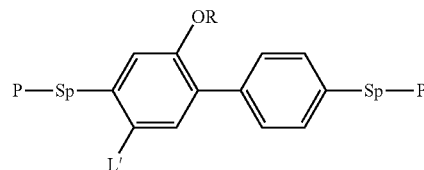
11-2



11-3

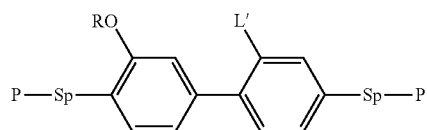


11-4

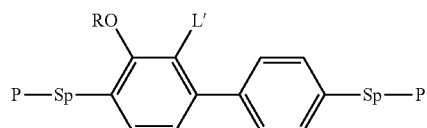


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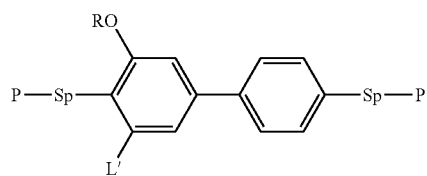
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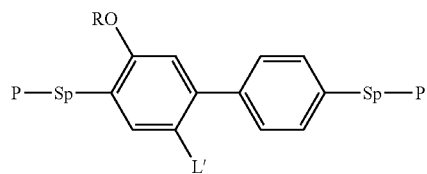
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I2-2



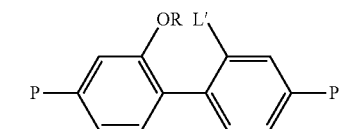
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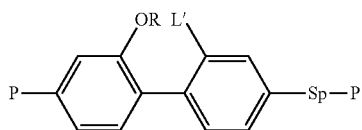
I2-4

wherein P, Sp and R have the meanings given in claim 1 and L' is F or Cl.

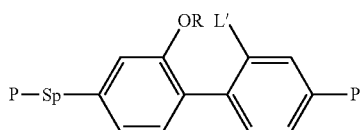
6. The LC display device of claim 1, wherein the compound of formula I is selected from the following subformulae:



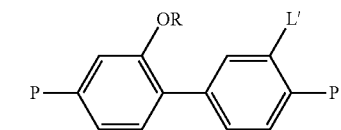
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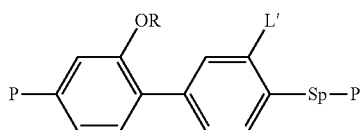
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I1-1-3

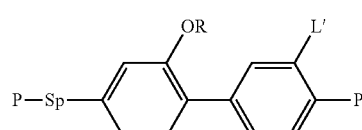


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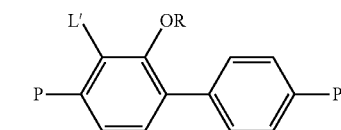


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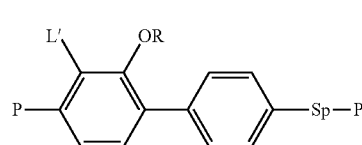
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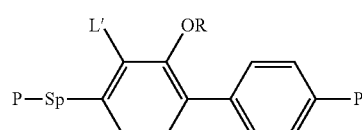
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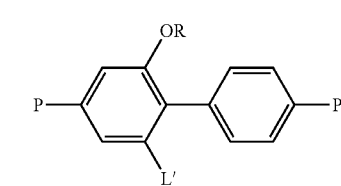
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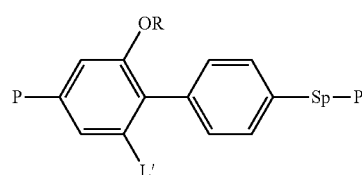
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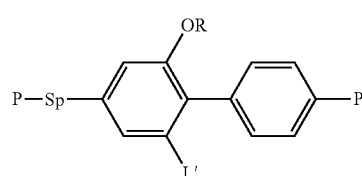
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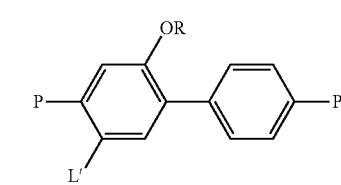
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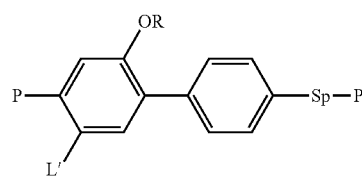
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I1-4-3

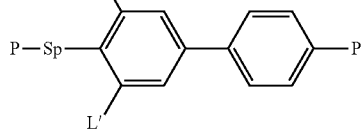
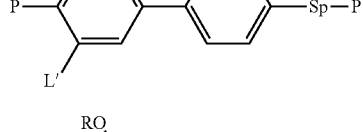
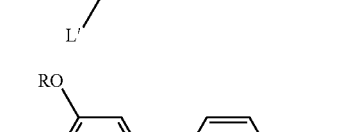
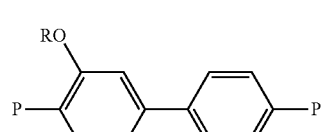
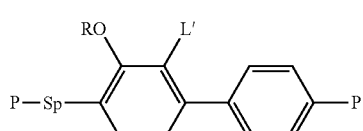
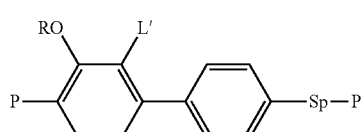
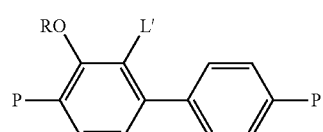
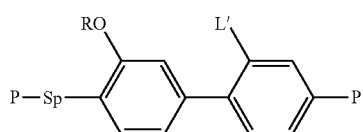
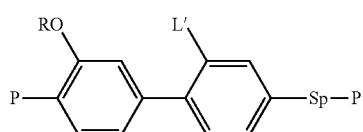
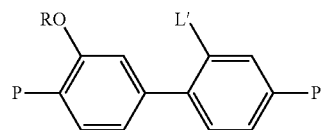
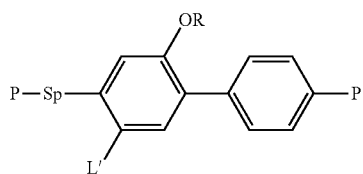


I1-5-1



I1-5-2

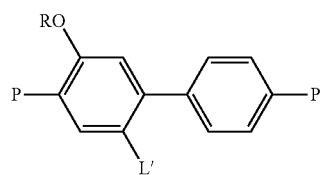
-continued



-continued

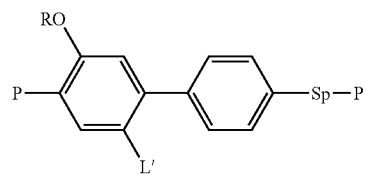
I1-5-3

I2-4-1



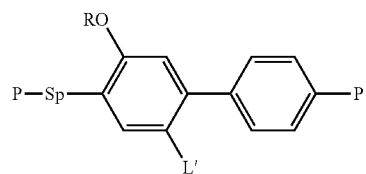
I2-1-1

I2-4-2



I2-1-2

I2-4-3



I2-1-3

I2-2-1

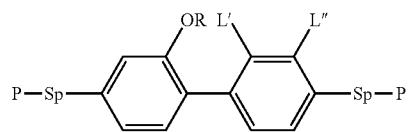
wherein P and R have the meanings given in claim 1, L' is F or Cl and Sp has one of the meanings given in claim 1 which is different from a single bond.

I2-2-2

7. The LC display device of claim 1, wherein the compound of formula I is selected from the following subformulae:

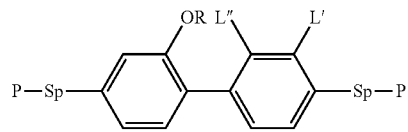
I2-2-3

I1-6



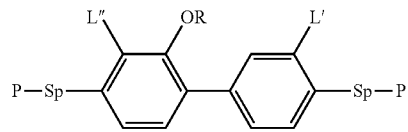
I2-2-3

I1-7



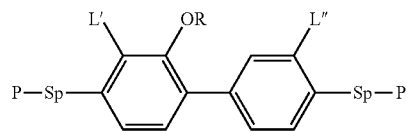
I2-3-1

I1-8



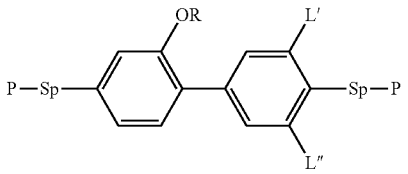
I2-3-2

I1-9



I2-3-3

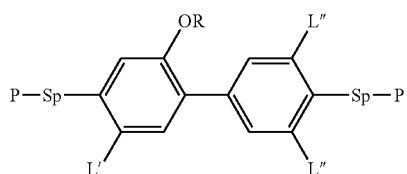
I1-10



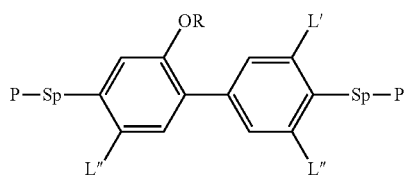
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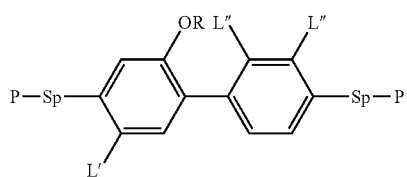
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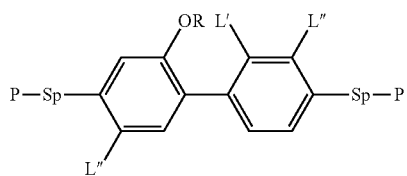
II-28



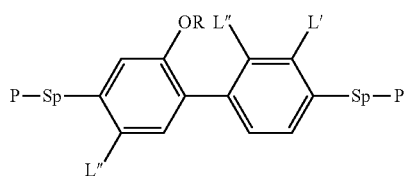
II-29



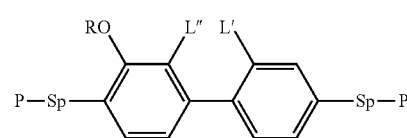
II-30



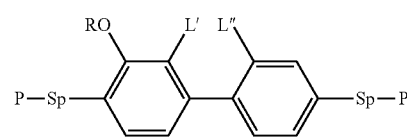
II-31



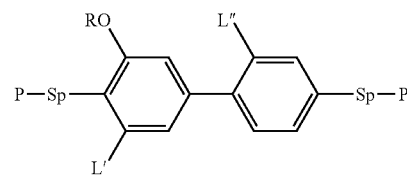
II-32



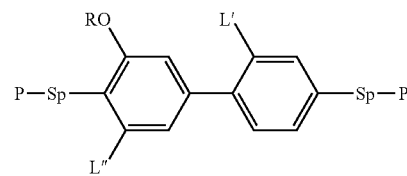
I2-5



I2-6

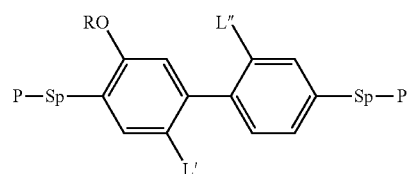


I2-7

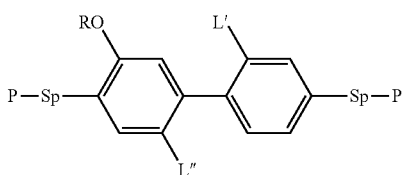


I2-8

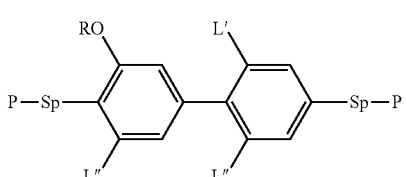
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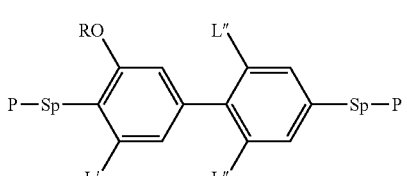
I2-9



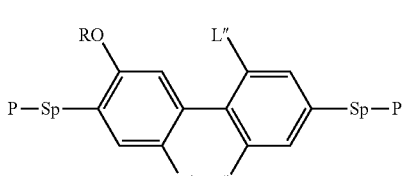
I2-10



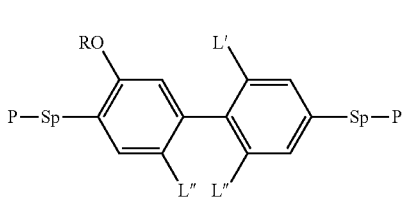
I2-11



I2-12



I2-13



I2-14

wherein P, Sp and R have the meanings given in claim 1, L' is F or Cl and L'' has one of the meanings of L'¹³ given in claim 1.

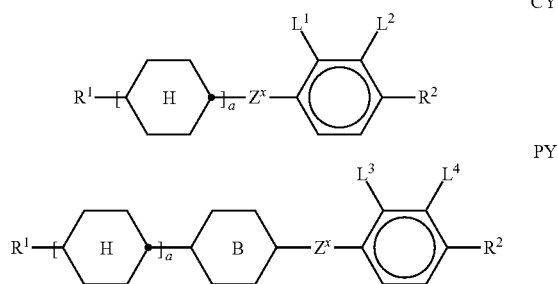
8. The LC display device of claim 5, wherein, in the compound of formula I, R is CH₃ and L' is F.

9. The LC display device of claim 1, wherein the LC medium comprises:

a polymerisable component A) comprising one or more polymerisable compounds of formula I, and

a liquid-crystalline LC component B) comprising one or more mesogenic or liquid-crystalline compounds.

10. The LC display device of claim 1, wherein the LC medium further comprises one or more compounds of the formulae CY and/or PY:

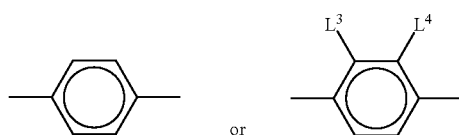


in which the individual radicals have the following meanings:

a denotes 1 or 2,

b denotes 0 or 1,

denotes

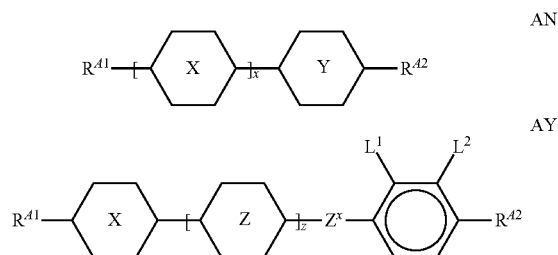


R¹ and R² each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH₂ groups may be replaced by —O—, —CH=CH—, —CO—, —O—CO— or —CO—O— in such a way that O atoms are not linked directly to one another,

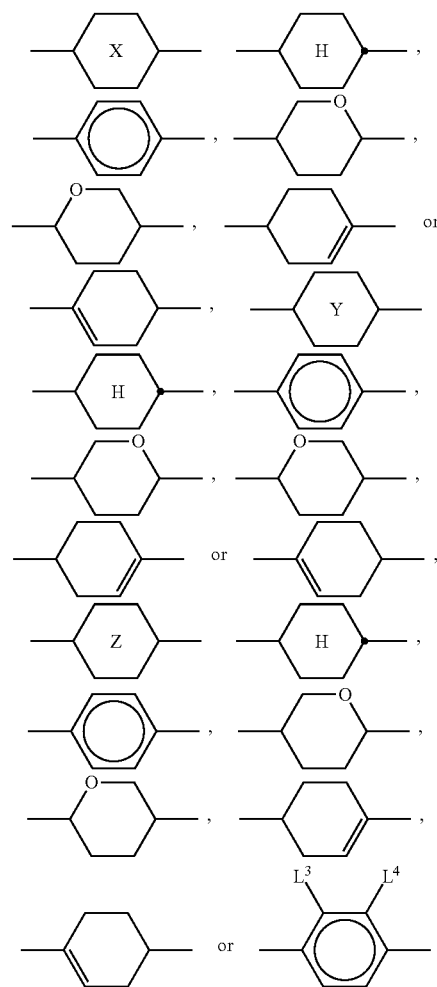
Zˣ denotes —CH=CH—, —CH₂O—, —OCH₂—, —CF₂O—, —OCF₂—, —O—, —CH₂—, —CH₂CH₂— or a single bond, preferably a single bond,

L¹-⁴ each, independently of one another, denote F, Cl, OCF₃, CF₃, CH₃, CH₂F, CHF₂.

11. The LC display device of claim 1, wherein the LC medium further comprises one or more compounds selected from the following formulae:



in which the individual radicals, on each occurrence identically or differently, each, independently of one another, have the following meaning:



R⁴¹ alkenyl having 2 to 9 C atoms or, if at least one of the rings X, Y and Z denotes cyclohexenyl, also one of the meanings of R⁴²,

R⁴² alkyl having 1 to 12 C atoms, in which, in addition, one or two non-adjacent CH₂ groups may be replaced by —O—, —CH=CH—, —CO—, —OCO— or —COO— in such a way that O atoms are not linked directly to one another,

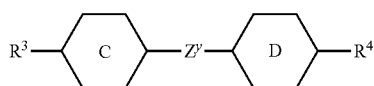
Zˣ —CH₂CH₂—, —CH=CH—, —CF₂O—, —OCF₂—, —CH₂O—, —OCH₂—, —CO—O—, —O—CO—, —C₂F₄—, —CF=CF—, —CH=CH—CH₂O—, or a single bond

L¹-⁴ each, independently of one another, H, F, Cl, OCF₃, CF₃, CH₃, CH₂F or CHF₂H,

x 1 or,

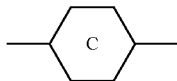
z 0 or 1.

12. The LC display device of claim 1, wherein the LC medium further comprises one or more compounds of the following formula:

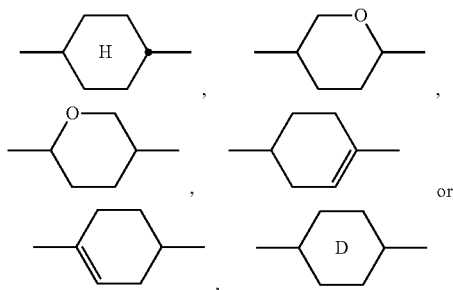


ZK

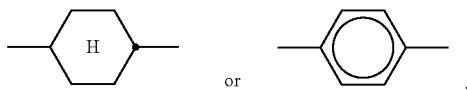
in which the individual radicals have the following meanings:



denotes



denotes

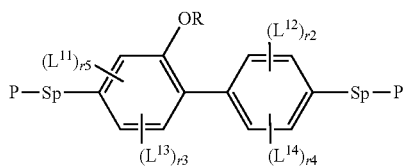


R^3 and R^4 each, independently of one another, denote alkyl having 1 to 12 C atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced by $-O-$, $-CH=CH-$, $-CO-$, $-O-CO-$ or $-CO-O-$ in such a way that O atoms are not linked directly to one another,

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

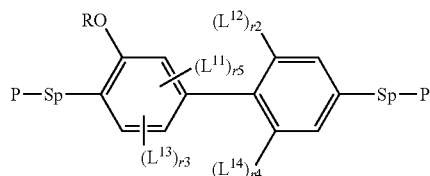
13. A process for the production of an LC display device according to claim 1, comprising the steps of providing the LC medium comprising one or more polymerisable compounds of formula I between the substrates of the display and polymerising the polymerisable compounds.

14. The LC display device of claim 2, wherein the compound of formula I is selected from the following subformulae:



II

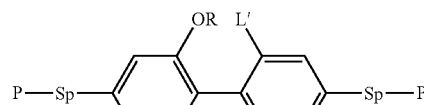
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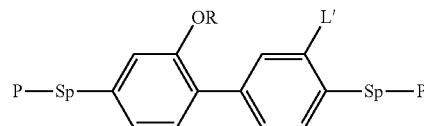
I2

wherein P, Sp, R, L^{11} , L^{12} , L^{13} , L^{14} , r_2 , r_3 , r_4 have the meanings given in claim 1, r_5 is 0, 1, 2 or 3, $r_3+r_5 \leq 3$, and $r_2+r_5 \geq 1$.

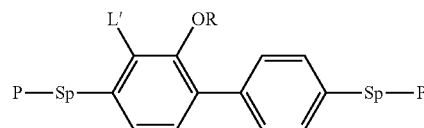
15. The LC display device of claim 2, wherein the compound of formula I is selected from the following subformulae:



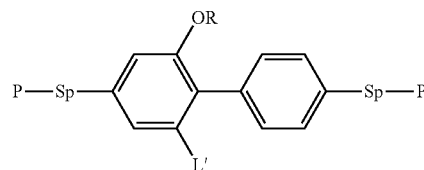
I1-1



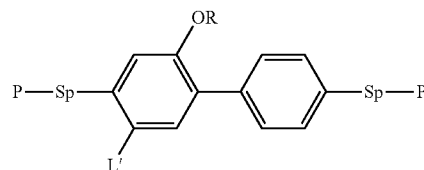
I1-2



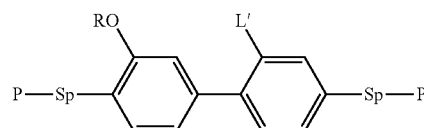
I1-3



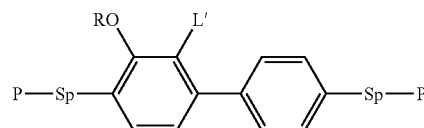
I1-4



I1-5

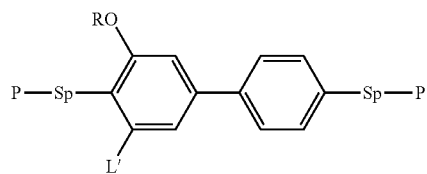


I2-1

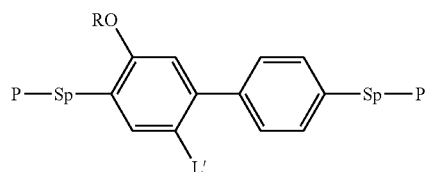


I2-2

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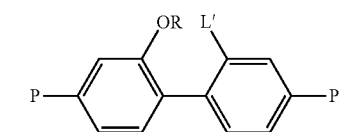
I2-3



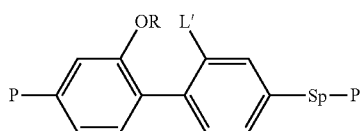
I2-4

wherein P, Sp and R have the meanings given in claim 1 and L' is F or Cl.

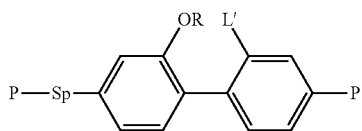
16. The LC display device of claim 2, wherein the compound of formula I is selected from the following subformulae:



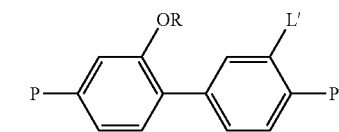
I1-1-1



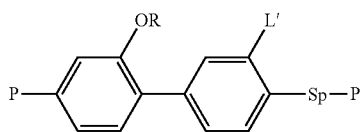
I1-1-2



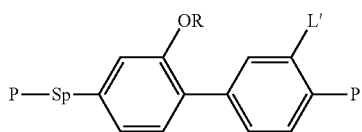
I1-1-3



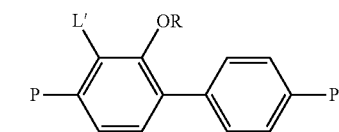
I1-2-1



I1-2-2

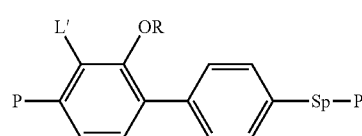


I1-2-3

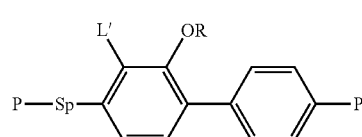


I1-3-1

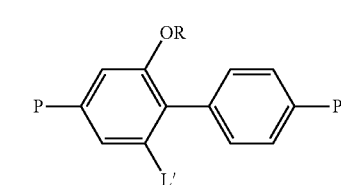
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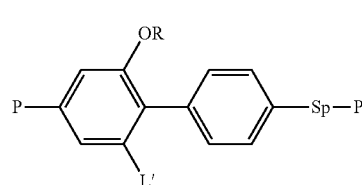
I1-3-2



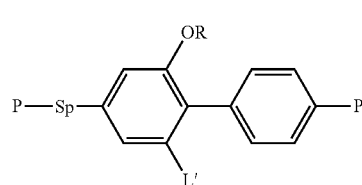
I1-3-3



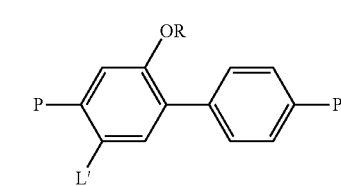
I1-4-1



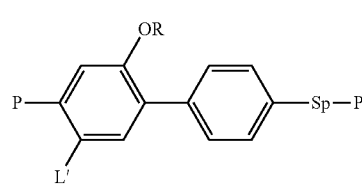
I1-4-2



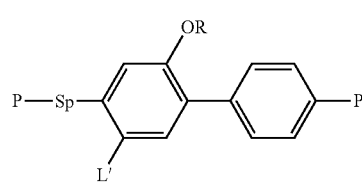
I1-4-3



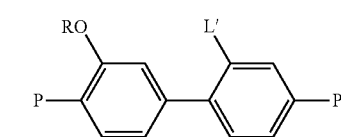
I1-5-1



I1-5-2

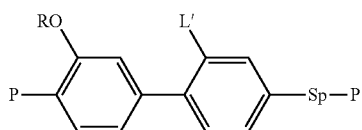


I1-5-3

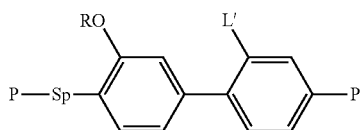


I2-1-1

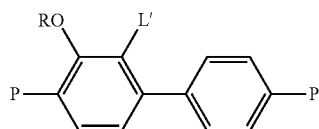
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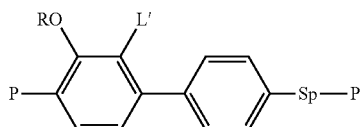
I2-1-2



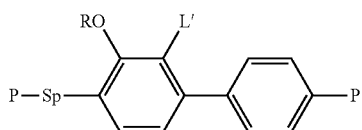
I2-1-3



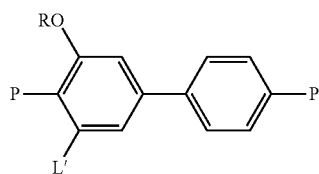
I2-2-1



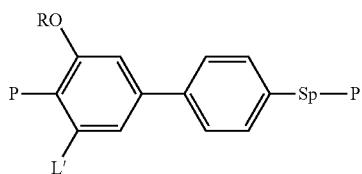
I2-2-2



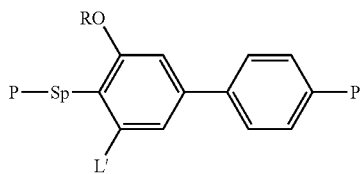
I2-2-3



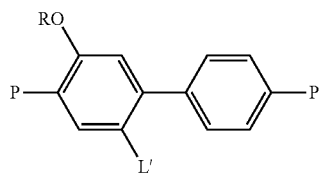
I2-3-1



I2-3-2

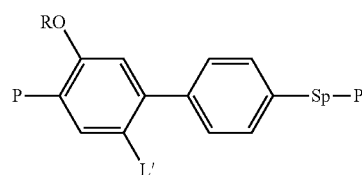


I2-3-3

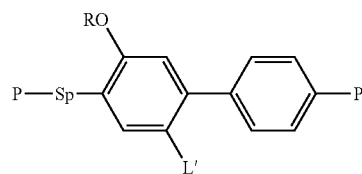


I2-4-1

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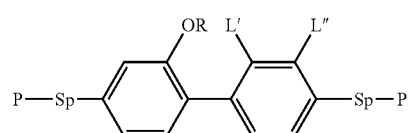
I2-4-2



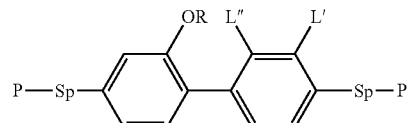
I2-4-3

wherein P and R have the meanings given in claim 1, L' is F or Cl and Sp has one of the meanings given in claim 1 which is different from a single bond.

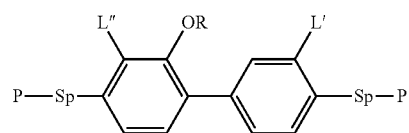
17. The LC display device of claim 2, wherein the compound of formula I is selected from the following subformulae:



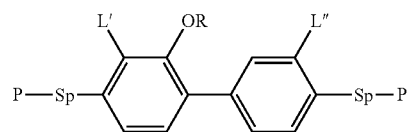
I1-6



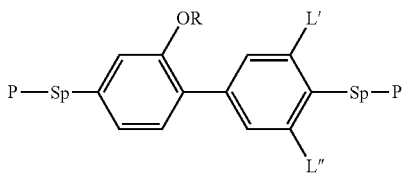
I1-7



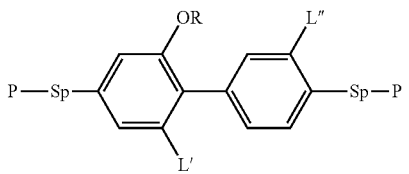
I1-8



I1-9

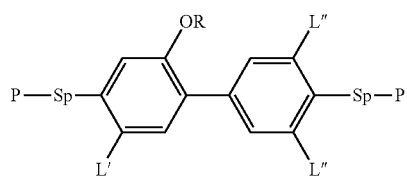


I1-10

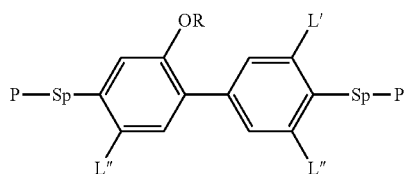


I1-11

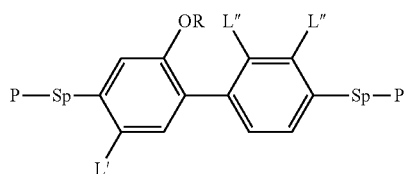
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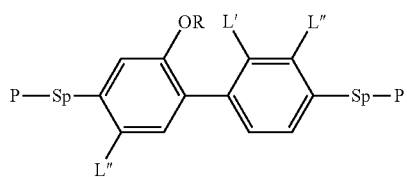
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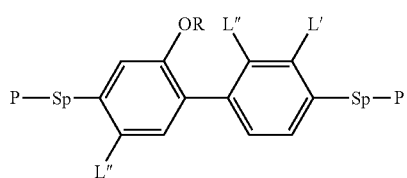
II-29



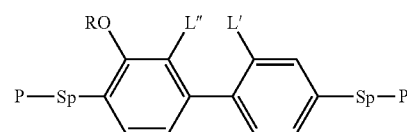
II-30



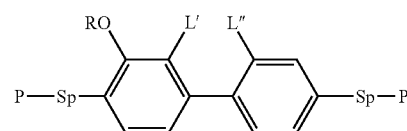
II-31



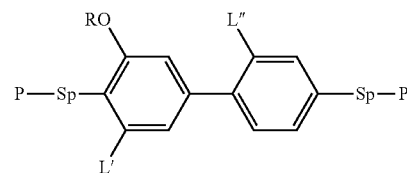
II-32



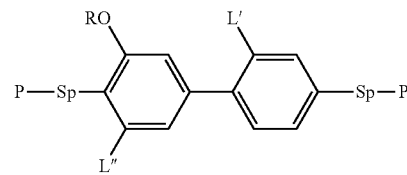
I2-5



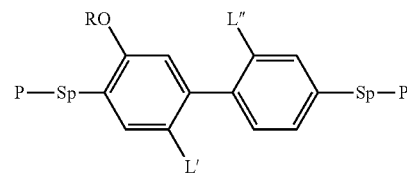
I2-6



I2-7

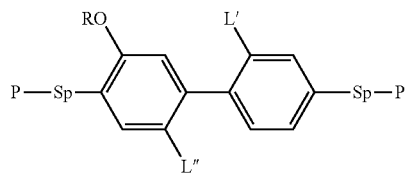


I2-8

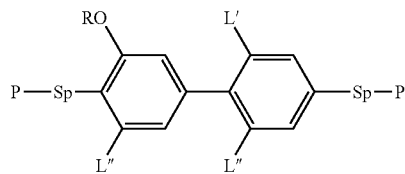


I2-9

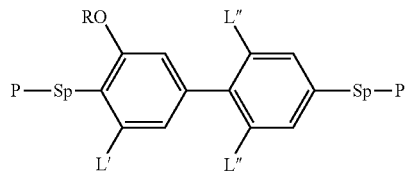
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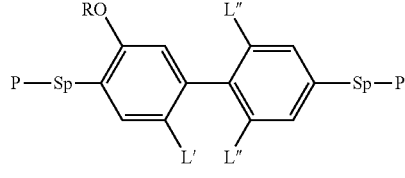
I2-10



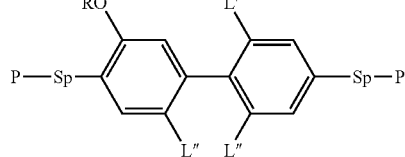
I2-11



I2-12



I2-13



I2-14

wherein P, Sp and R have the meanings given in claim 1, L' is F or Cl and V has one of the meanings of L¹³ given in claim 1.

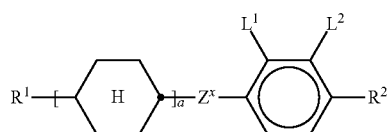
18. The LC display device of claim 15, wherein, in the compound of formula I, R is CH₃ and L' is F.

19. The LC display device of claim 2, wherein the LC medium comprises:

a polymerisable component A) comprising one or more polymerisable compounds of formula I, and

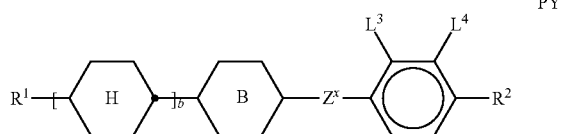
a liquid-crystalline LC component B) comprising one or more mesogenic or liquid-crystalline compounds.

20. The LC display device of claim 2, wherein the LC medium further comprises one or more compounds of the formulae CY and/or PY:



CY

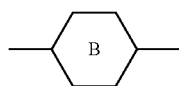
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in which the individual radicals have the following meanings:

a denotes 1 or 2,

b denotes 0 or 1,



denotes

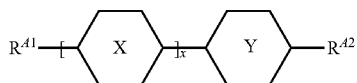


R¹ and R² each, independently of one another, denote alkyl having 1 to 12 C atoms, where, in addition, one or two non-adjacent CH₂ groups may be replaced by —O—, —CH=CH—, —CO—, —O—CO— or —CO—O— in such a way that O atoms are not linked directly to one another,

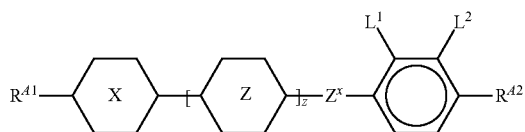
Z^x denotes —CH=CH—, —CH₂O—, —OCH₂—, —CF₂O—, —OCF₂—, —O—, —CH₂—, —CH₂CH₂— or a single bond, preferably a single bond,

L¹⁻⁴ each, independently of one another, denote F, Cl, OCF₃, CF₃, CH₃, CH₂F, CHF₂.

21. The LC display device of claim 2, wherein the LC medium further comprises one or more compounds selected from the following formulae:

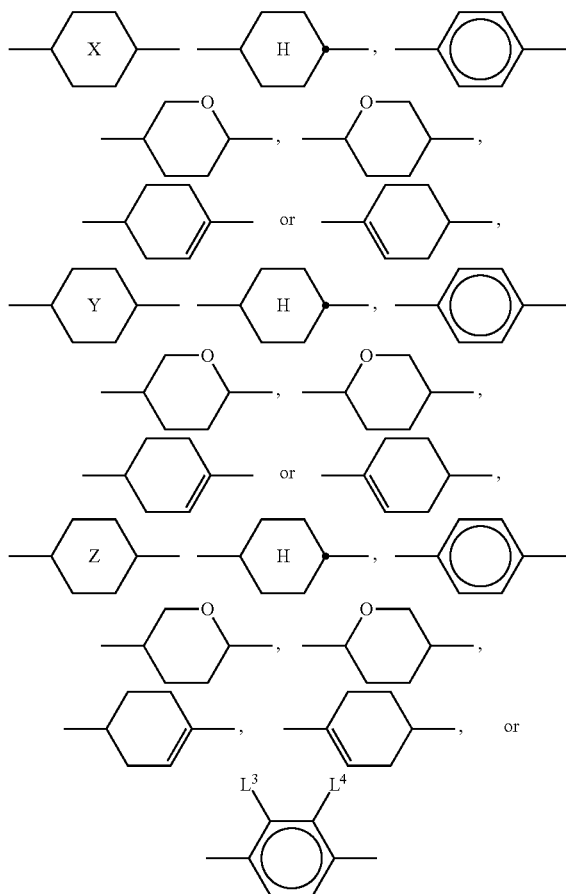


AN



AY

in which the individual radicals, on each occurrence identically or differently, each, independently of one another, have the following meaning:



R⁴¹ alkenyl having 2 to 9 C atoms or, if at least one of the rings X, Y and Z denotes cyclohexenyl, also one of the meanings of R⁴²,

R⁴² alkyl having 1 to 12 C atoms, in which, in addition, one or two non-adjacent CH₂ groups may be replaced by —O—, —CH=CH—, —CO—, —OCO— or —COO— in such a way that O atoms are not linked directly to one another,

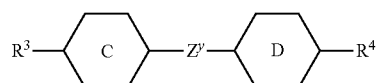
Z^x —CH₂CH₂—, —CH=CH—, —CF₂O—, —OCF₂—, —CH₂O—, —OCH₂—, —CO—O—, —O—CO—, —C₂F₄—, —CF=CF—, —CH=CH—CH₂O—, or a single bond

L¹⁻⁴ each, independently of one another, H, F, Cl, OCF₃, CF₃, CH₃, CH₂F or CHF₂H,

x 1 or,

z 0 or 1.

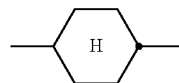
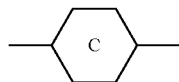
22. The LC display device of claim 2, wherein the LC medium further comprises one or more compounds of the following formula:



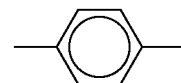
ZK

in which the individual radicals have the following meanings:

denotes

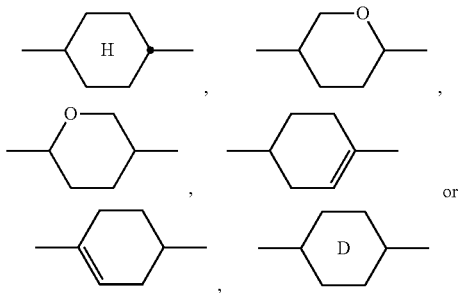


or



,

denotes



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

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

* * * * *