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(54) Title: MATERIALS FOR ORGANIC ELECTROLUMINESCENT DEVICES

(57) Abstract: The present invention relates to compounds of the formula (1) which are suitable for use in electronic devices, in particular organic electroluminescent devices, and to electronic devices which comprise these compounds.

Materials for organic electroluminescent devices

The present invention relates to a compound of the formula (1), to the use of the compound in an electronic device, and to an electronic device comprising a compound of the formula (1). The present invention furthermore relates to formulation comprising one or more compounds of the formula (1).

The development of functional compounds for use in electronic devices is currently the subject of intensive research. The aim is, in particular, the development of compounds with which improved properties of electronic devices in one or more relevant points can be achieved, such as, for example, power efficiency and lifetime of the device as well as colour coordinates of the emitted light.

In accordance with the present invention, the term electronic device is taken to mean, inter alia, organic integrated circuits (OICs), organic field-effect transistors (OFETs), organic thin-film transistors (OTFTs), organic light-emitting transistors (OLETs), organic solar cells (OSCs), organic optical detectors, organic photoreceptors, organic field-quench devices (OFQDs), organic light-emitting electrochemical cells (OLECs), organic laser diodes (O-lasers) and organic electroluminescent devices (OLEDs).

Of particular interest is the provision of compounds for use in the last-mentioned electronic devices called OLEDs. The general structure and the functional principle of OLEDs are known to the person skilled in the art and are described, for example, in US 4539507.

Further improvements are still necessary with respect to the performance data of OLEDs, in particular with a view to broad commercial use, for example in display devices or as light sources. Of particular importance in this connection are the lifetime, the efficiency and the operating voltage of the OLEDs and also the colour values achieved. In particular, in case of blue-emitting OLEDs, there is potential for improvement with respect to the lifetime, the efficiency of the devices and the colour purity of the emitters.

An important starting point for achieving the said improvements is the choice of the emitter compound and of the host compound employed in the electronic device.

In the last decade, polycyclic aromatic compounds comprising Boron and Nitrogen atoms have been described (for example in US2015/0236274A1, CN107501311A, WO2018/047639A1 or WO2020/208051). These compounds can be used as fluorescent emitters.

However, there is still a need for further fluorescent emitters, especially blue-fluorescent emitters, which may be employed in OLEDs and lead to OLEDs having very good properties in terms of lifetime, colour emission and efficiency. More particularly, there is a need for blue-fluorescent emitters combining very high efficiencies, very good lifetime and suitable colour coordinates as well as high colour purity.

Furthermore, organic electroluminescent devices having, in the emitting layer, a TADF compound as a sensitizer and a fluorescent compound having high steric shielding with respect to its environment as an emitter have been described in the last few years (for example in WO2015/135624). TADF materials correspond to Thermally Activated Delayed Fluorescence materials. TADF materials are, in general, organic materials in which the energy gap between the lowest triplet state T_1 and the first excited singlet state S_1 is sufficiently small so that the S_1 state is thermally accessible from the T_1 state, as explained in e.g. H. Uoyama et al., Nature 2012, vol. 492, 234. The device construction, where the TADF compound is used as a sensitizer that transfers its energy to the fluorescent emitter, makes it possible to provide organic electroluminescent devices which emit in all emission colours, so that it is possible to use the base structures of known fluorescent emitters which nevertheless exhibit the high efficiency of electroluminescent devices with TADF. This is also known as hyperfluorescence.

As an alternative, the prior art describes organic electroluminescent devices comprising, in the emitting layer, a phosphorescent organometallic complex as a sensitizer, which shows mixing of S1 and T1 states due to the large spin-orbit coupling, and a fluorescent compound as an emitter, so that the emission decay time can significantly be shortened. This is also known as hyperphosphorescence.

Hyperfluorescence and hyperphosphorescence are also promising techniques to improve OLEDs properties, especially in terms of deep blue emission.

However, here too, further improvements are still necessary with respect to the performance data of OLEDs, in particular with a view to broad commercial use, for example in display devices or as light sources. Of particular importance in this connection are the lifetime, the efficiency, the operating voltage of the OLEDs and the colour values achieved, in particular colour purity.

An important starting point for achieving the said improvements in hyperfluorescent and hyperphosphorescent systems is the choice of the fluorescent emitter compound, preferably sterically hindered (also called shielded) fluorescent emitter compound.

In WO 2015/135624, sterically hindered fluorescent emitters based on rubrene are described. However, there is still a need for further sterically hindered fluorescent emitters, especially sterically hindered blue-fluorescent emitters, which lead to OLEDs having very good properties in terms of efficiency and colour emission. More particularly, there is a need for deep blue-fluorescent emitters combining very high efficiency, very good lifetime and suitable colour coordinates as well as high colour purity.

Furthermore, it is known that an OLED may comprise different layers, which may be applied either by vapour deposition in a vacuum chamber or by processing from a solution. The processes based on vapour deposition lead to good results, but such processes are complex and expensive. Therefore, there is also a need for OLED materials that can be easily and reliably processed from solution. In this case, the materials should have good solubility properties in the solution that comprises them. Additionally, the OLED materials that are processed from a solution should be able to orientate themselves in the deposited film to improve the overall efficiency of the OLED. The term orientation means here the horizontal molecular orientation of the compounds, as explained in Zhao et al., Horizontal molecular orientation in solution-processed organic light-emitting diodes, Appl. Phys. Lett. 106063301, 2015.

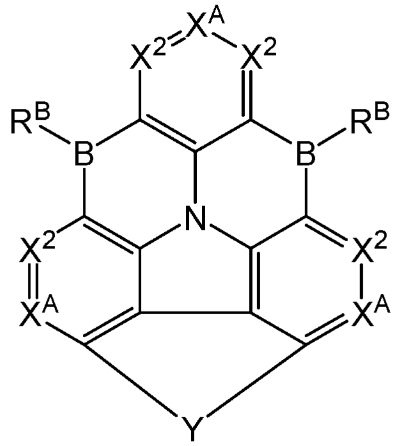
Thus, the present invention is based on the technical object of providing emitters exhibiting prompt fluorescence and/or delayed fluorescence. The present invention is also based on the technical object of providing sterically hindered fluorescent emitters, which can be used in combination with a sensitizer compound in a hyperfluorescent or hyperphosphorescent system. The present invention is also based on the technical object of providing compounds which are suitable for use in electronic devices, such as OLEDs, more particularly as emitters and, which are suitable for vacuum processing or for solution processing.

In general, there is the need for stable fluorescent emitters showing deep blue emission. The colour purity of state-of-the-art materials needs to be improved and for a potentially use in a hyperphosphorescent device the shielding factor (as disclosed in WO 2020/053314 A1) needs to be improved.

Especially the Full width at half maximum (FWHM) should be as narrow as possible.

In investigations on novel compounds for use in electronic devices, it has now been found, that compounds of formula (1) as defined below are eminently suitable for use in electronic devices. In particular, they achieve one or more, preferably all, of the above-mentioned technical objects.

The invention thus relates to compounds of formula (1),



formula (1)

where the following applies to the symbols and indices used:

X^2 stands, on each occurrence, identically or differently, for CR^2 or N;

X^A stands, on each occurrence, identically or differently, for CR^A or N;

Y is a bivalent aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R^Y;

R^B stands on each occurrence, identically or differently, for CN, $N(Ar)_2$, C(=O)Ar, $P(=O)(Ar)_2$, S(=O)Ar, $S(=O)_2Ar$, $N(R)_2$, $Si(R)_3$, OSO_2R, a straight-chain alkyl, alkoxy or thioalkoxy group having 1 to 40 carbon atoms or an alkenyl or alkynyl group having 2 to 40 carbon atoms or a branched or cyclic alkyl, alkoxy or thioalkoxy group having 3 to 40 carbon atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, or an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aryloxy group having 5 to 60 aromatic ring atoms, which may be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals;

R^2, R^A, R^Y stand on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CHO, CN, $N(Ar)_2$, C(=O)Ar, $P(=O)(Ar)_2$, S(=O)Ar, $S(=O)_2Ar$, NO_2, $Si(R)_3$, $B(OR)_2$, OSO_2R, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R, an aryloxy group having 5 to 60 aromatic ring atoms, which may be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals; where two adjacent radicals selected from R^Y, R^2, R^A may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R;

R stands on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CHO, CN, $N(Ar)_2$, C(=O)Ar, $P(=O)(Ar)_2$, S(=O)Ar, $S(=O)_2Ar$, NO_2, $Si(R')_3$,

$B(OR')_2$, OSO_2R', a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40 C atoms, each of which may be substituted by one or more radicals R´, where in each case one or more non-adjacent CH_2 groups may be replaced by R´C=CR´, C≡C, $Si(R')_2$, $Ge(R')_2$, $Sn(R')_2$, C=O, C=S, C=Se, P(=O)(R´), SO, SO_2, O, S or CONR´ and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R´, or an aryloxy group having 5 to 60 aromatic ring atoms, which may be substituted by one or more radicals R´, where two adjacent radicals R may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R´;

Ar is on each occurrence, identically or differently, an aromatic or heteroaromatic ring system having 5 to 24 aromatic ring atoms, which may in each case also be substituted by one or more radicals R´;

R´ stands on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CN, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 20 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl group having 3 to 20 C atoms, where in each case one or more non-adjacent CH_2 groups may be replaced by SO, SO_2, O, S and where one or more H atoms may be replaced by D, F, Cl, Br or I, or an aromatic or heteroaromatic ring system having 5 to 24 C atoms.

Adjacent substituents in the sense of the present invention are substituents which are bonded to atoms which are linked directly to one another or which are bonded to the same atom.

Furthermore, the following definitions of chemical groups apply for the purposes of the present application:

An aryl group in the sense of this invention contains 6 to 60 aromatic ring atoms, preferably 6 to 40 aromatic ring atoms, more preferably 6 to 20 aromatic ring atoms; a heteroaryl group in the sense of this invention contains 5 to 60 aromatic ring atoms, preferably 5 to 40 aromatic ring atoms, more preferably 5 to 20 aromatic ring atoms, at least one of which is a heteroatom. The heteroatoms are preferably selected from N, O and S. This represents the basic definition. If other preferences are indicated in the description of the present invention, for example with respect to the number of aromatic ring atoms or the heteroatoms present, these apply.

An aryl group or heteroaryl group here is taken to mean either a simple aromatic ring, i.e. benzene, or a simple heteroaromatic ring, for example pyridine, pyrimidine or thiophene, or a condensed (annellated) aromatic or heteroaromatic polycycle, for example naphthalene, phenanthrene, quinoline or carbazole. A condensed (annellated) aromatic or heteroaromatic polycycle in the sense of the present application consists of two or more simple aromatic or heteroaromatic rings condensed with one another.

An aryl or heteroaryl group, which may in each case be substituted by the above-mentioned radicals and which may be linked to the aromatic or hetero-aromatic ring system via any desired positions, is taken to mean, in particular, groups derived from benzene, naphthalene, anthracene, phenanthrene, pyrene, dihydropyrene, chrysene, perylene, fluoranthene, benzanthracene, benzophenanthrene, tetracene, pentacene, benzopyrene, furan, benzofuran, isobenzofuran, dibenzofuran, thiophene, benzothiophene, isobenzothio-phene, dibenzothiophene, pyrrole, indole, isoindole, carbazole, pyridine, quinoline, isoquinoline, acridine, phenanthridine, benzo-5,6-quinoline, benzo-6,7-quinoline, benzo-7,8-quinoline, phenothiazine, phenoxazine, pyrazole, indazole, imidazole, benzimidazole, naphthimidazole, phen-anthrimidazole, pyridimidazole, pyrazinimidazole, quinoxalinimidazole, oxazole, benzoxazole, naphthoxazole, anthroxazole, phenanthroxazole, isoxazole, 1,2-thiazole, 1,3-thiazole, benzothiazole, pyridazine, benzopyridazine, pyrimidine, benzopyrimidine, quinoxaline, pyrazine, phenazine, naphthyridine, azacarbazole, benzocarboline, phenanthroline, 1,2,3-triazole, 1,2,4-triazole, benzotriazole, 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, 1,3,5-triazine, 1,2,4-triazine, 1,2,3-triazine, tetrazole, 1,2,4,5-tetrazine, 1,2,3,4-tetrazine, 1,2,3,5-tetrazine, purine, pteridine, indolizine and benzothiadiazole.

An aryloxy group in accordance with the definition of the present invention is taken to mean an aryl group, as defined above, which is bonded via an oxygen atom. An analogous definition applies to heteroaryloxy groups.

An aralkyl group in accordance with the definition of the present invention is taken to mean an alkyl group, where at least one hydrogen atom is replaced by an aryl group. An analogous definition applies to heteroaralkyl groups.

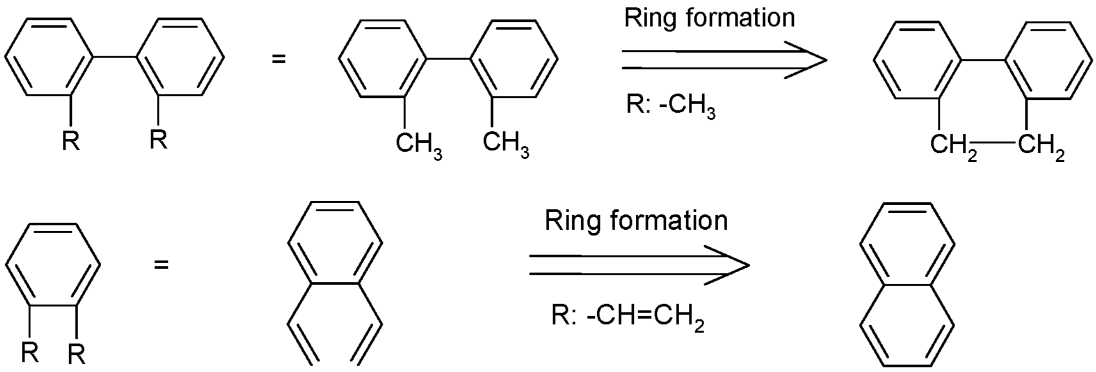
An aromatic ring system in the sense of this invention contains 6 to 60 C atoms in the ring system, preferably 6 to 40 C atoms, more preferably 6 to 20 C atoms. A heteroaromatic ring system in the sense of this invention contains 5 to 60 aromatic ring atoms, preferably 5 to 40 aromatic ring atoms, more preferably 5 to 20 aromatic ring atoms, at least one of which is a heteroatom. The heteroatoms are preferably selected from N, O and/or S. An aromatic or heteroaromatic ring system in the sense of this invention is intended to be taken to mean a system which does not necessarily contain only aryl or heteroaryl groups, but instead in which, in addition, a plurality of aryl or heteroaryl groups may be connected by a non-aromatic unit (preferably less than 10% of the atoms other than H), such as, for example, an sp^3-hybridised C, Si, N or O atom, an sp^2-hybridised C or N atom or an sp-hybridised C atom. Thus, for example, systems such as 9,9'-spirobifluorene, 9,9'-diarylfluorene, triarylamine, diaryl ether, stilbene, etc., are also intended to be taken to be aromatic ring systems in the sense of this invention, as are systems in which two or more aryl groups are connected, for example, by a linear or cyclic alkyl, alkenyl or alkynyl group or by a silyl group. Furthermore, systems in which two or more aryl or heteroaryl groups are linked to one another via single bonds are also taken to be aromatic or heteroaromatic ring systems in the sense of this invention, such as, for example, systems such as biphenyl, terphenyl or diphenyltriazine.

An aromatic or heteroaromatic ring system having 5 - 60 aromatic ring atoms, which may in each case also be substituted by radicals as defined above and which may be linked to the aromatic or heteroaromatic group via any desired positions, is taken to mean, in particular, groups derived from benzene, naphthalene, anthracene, benzanthracene, phenanthrene, benzophenanthrene, pyrene, chrysene, perylene, fluoranthene, naphthacene, pentacene, benzopyrene, biphenyl, biphenylene, terphenyl, terphenylene, quaterphenyl, fluorene, spirobifluorene, dihydrophenanthrene, dihydropyrene, tetrahydropyrene, cis- or trans-indenofluorene, truxene, isotruxene, spirotruxene, spiroisotruxene, furan, benzofuran, isobenzofuran, dibenzofuran, thiophene, benzothiophene, isobenzothiophene, dibenzothiophene, pyrrole, indole, isoindole, carbazole, indolocarbazole, indenocarbazole, pyridine, quinoline, isoquinoline, acridine, phenanthridine, benzo-5,6-quinoline, benzo-6,7-quinoline, benzo-7,8-quinoline, phenothiazine, phenoxazine, pyrazole, indazole, imidazole, benzimidazole, naphthimidazole, phenanthrimidazole, pyridimidazole, pyrazinimidazole, quinoxalinimidazole, oxazole, benzoxazole, naphthoxazole, anthroxazole, phenanthroxazole, isoxazole, 1,2-thiazole, 1,3-thiazole, benzothiazole, pyridazine, benzopyridazine, pyrimidine, benzopyrimidine, quinoxaline, 1,5-diazaanthracene, 2,7-diazapyrene, 2,3-diazapyrene, 1,6-diazapyrene, 1,8-diazapyrene, 4,5-diazapyrene, 4,5,9,10-tetraazaperylene, pyrazine, phenazine, phenoxazine, phenothiazine, fluorubin, naphthyridine, azacarbazole, benzocarboline, phenanthroline, 1,2,3-triazole, 1,2,4-triazole, benzotriazole, 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, 1,3,5-triazine, 1,2,4-

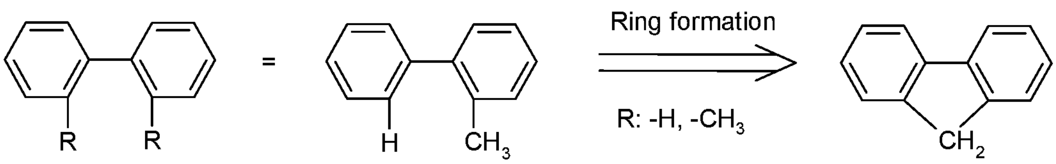
triazine, 1,2,3-triazine, tetrazole, 1,2,4,5-tetrazine, 1,2,3,4-tetrazine, 1,2,3,5-tetrazine, purine, pteridine, indolizine and benzothiadiazole, or combinations of these groups.

For the purposes of the present invention, a straight-chain alkyl group having 1 to 40 C atoms or a branched or cyclic alkyl group having 3 to 40 C atoms or an alkenyl or alkynyl group having 2 to 40 C atoms, in which, in addition, individual H atoms or CH_2 groups may be substituted by the groups mentioned above under the definition of the radicals, is preferably taken to mean the radicals methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, s-butyl, t-butyl, 2-methylbutyl, n-pentyl, s-pentyl, cyclopentyl, neopentyl, n-hexyl, cyclohexyl, neohexyl, n-heptyl, cycloheptyl, n-octyl, cyclooctyl, 2-ethylhexyl, trifluoromethyl, pentafluoroethyl, 2,2,2-trifluoroethyl, ethenyl, propenyl, butenyl, pentenyl, cyclopentenyl, hexenyl, cyclohexenyl, heptenyl, cyclo-heptenyl, octenyl, cyclooctenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl or octynyl. An alkoxy or thioalkyl group having 1 to 40 C atoms is preferably taken to mean methoxy, trifluoromethoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, i-butoxy, s-butoxy, t-butoxy, n-pentoxy, s-pentoxy, 2-methylbutoxy, n-hexoxy, cyclohexyloxy, n-heptoxy, cycloheptyloxy, n-octyloxy, cyclooctyl-oxy, 2-ethylhexyloxy, pentafluoroethoxy, 2,2,2-trifluoroethoxy, methylthio, ethylthio, n-propylthio, i-propylthio, n-butylthio, i-butylthio, s-butylthio, t-butylthio, n-pentylthio, s-pentylthio, n-hexylthio, cyclohexylthio, n-heptylthio, cycloheptylthio, n-octylthio, cyclooctylthio, 2-ethylhexylthio, trifluoro-methylthio, pentafluoroethylthio, 2,2,2-trifluoroethylthio, ethenylthio, propenylthio, butenylthio, pentenylthio, cyclopentenylthio, hexenylthio, cyclohexenylthio, heptenylthio, cycloheptenylthio, octenylthio, cyclooctenyl-thio, ethynylthio, propynylthio, butynylthio, pentynylthio, hexynylthio, heptynylthio or octynylthio.

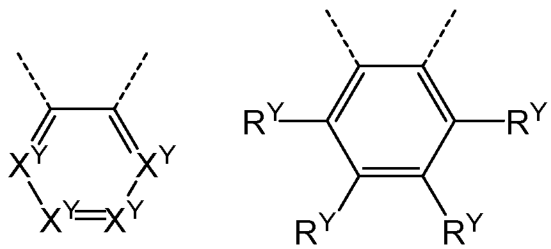
The formulation that two or more radicals may form a ring with one another is, for the purposes of the present application, intended to be taken to mean, inter alia, that the two radicals are linked to one another by a chemical bond. This is illustrated by the following schemes:



Furthermore, however, the above-mentioned formulation is also intended to be taken to mean that, in the case where one of the two radicals represents hydrogen, the second radical is bonded at the position to which the hydrogen atom was bonded, with formation of a ring. This is illustrated by the following scheme:



In a preferred embodiment Y corresponds to groups of the formulae (Y1) or (Y2):



formula (Y1) formula (Y2)

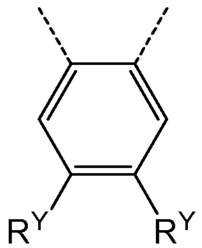
where the symbols have the same meaning as above, the dashed lines represent the bonds to Y in formula (1) and

X^Y stands, on each occurrence, identically or differently, for CR^Y or N

In a preferred embodiment only up to 2 R^Y are different to H, D or F.

In a preferred embodiment up to 2 selected from X^2, X^A or X^Y per 6-membered ring correspond to N.

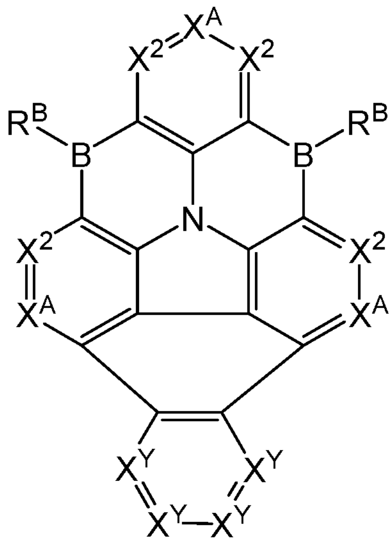
In another embodiment the group Y is selected from the group according to formula (Y2-1):



formula (Y2-1)

where the symbols have the same meaning as above.

In accordance with a preferred embodiment, the compounds of formula (1) correspond to compounds of formula (1-Y1),

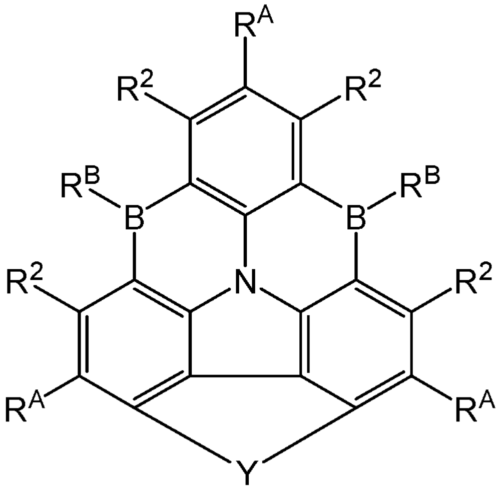


formula (1-Y1)

where the symbols have the same meaning as above and

X^Y stands, on each occurrence, identically or differently, for CR^Y or N

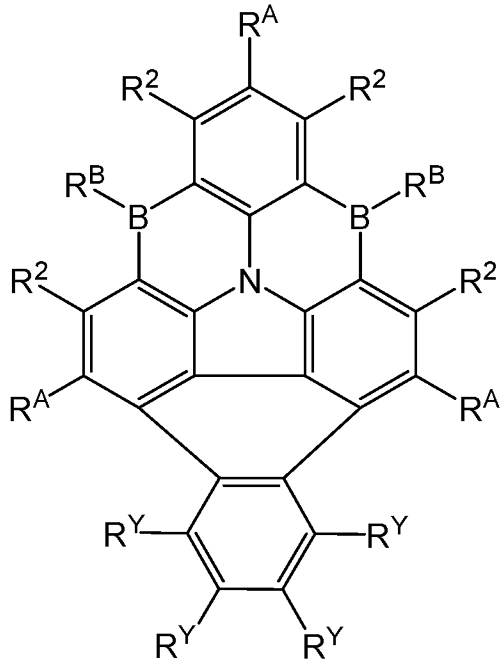
In accordance with a preferred embodiment, the compounds of formula (1) are selected from the compounds of formula (2),



formula (2)

where the symbols have the same meaning as above.

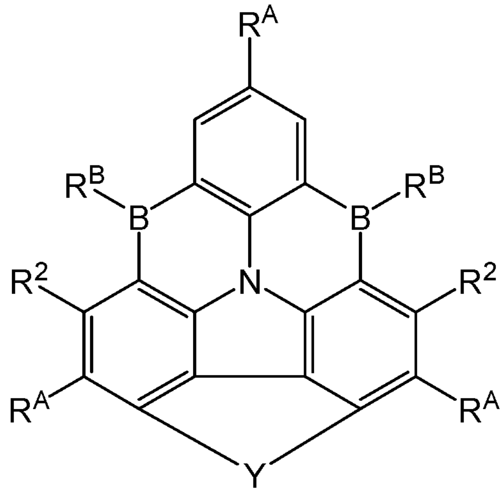
Preferably, the compounds of formula (2) correspond to compound of formula (2-Y2),



formula (2-Y2)

where the symbols have the same meaning as above.

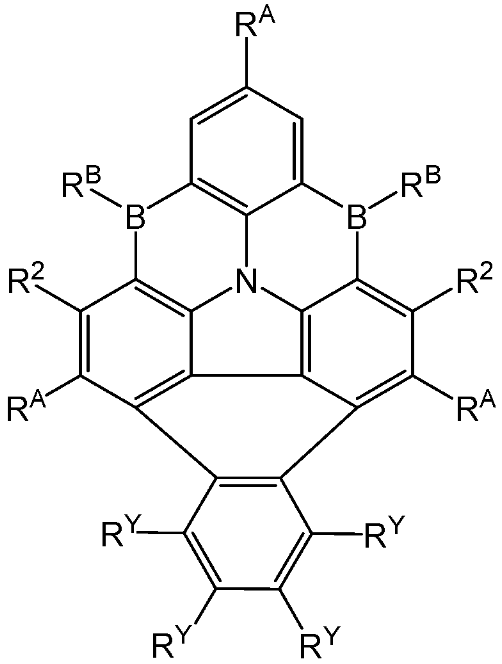
In accordance with a very preferred embodiment, the compounds of formula (1) are selected from the compounds of formula (3),



formula (3)

where the symbols have the same meaning as above.

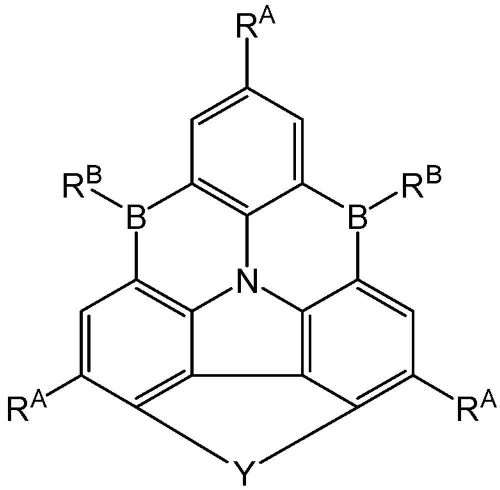
Preferably, the compounds of formula (3) correspond to compounds of formula (3-Y2),



formula (3-Y2)

where the symbols have the same meaning as above.

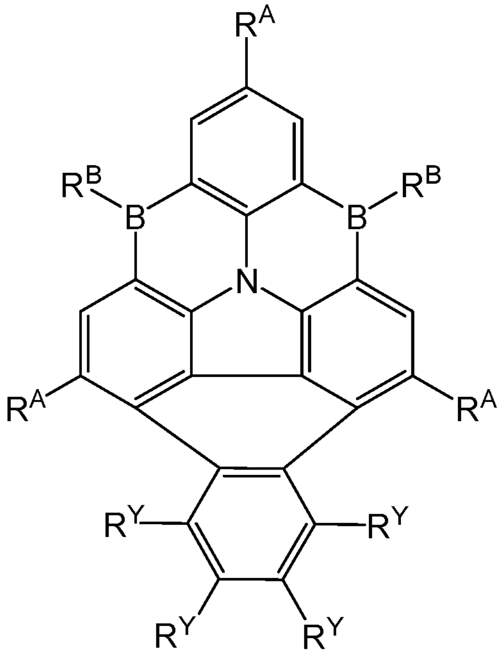
In accordance with a particularly preferred embodiment, the compounds of formula (1) are selected from the compounds of formula (4),



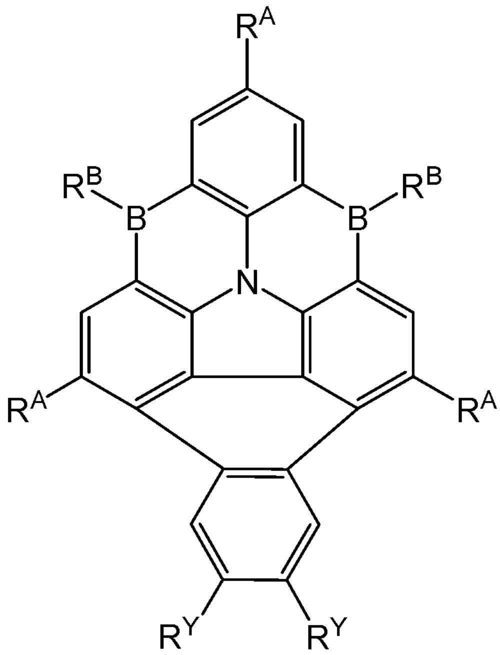
formula (4)

where the symbols and indices have the same meaning as above.

Preferably, the compounds of formula (4) correspond to compounds of formula (4-Y2) or (4-Y2-1),



formula (4-Y2)



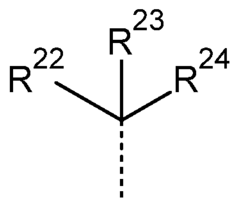
formula (4-Y2-1)

where the symbols have the same meaning as above.

Preferably, the group R^B stands on each occurrence, identically or differently, for a straight-chain alkyl, alkoxy or thioalkoxy group having 1 to 40, preferably 1 to 20, more preferably 1 to 10 carbon atoms or an alkenyl or alkynyl group having 2 to 40, preferably 2 to 20, more preferably 1 to 10 carbon atoms or a branched or cyclic alkyl, alkoxy or thioalkoxy group having 3 to 40, preferably 3 to 20, more preferably 3 to 10 carbon atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, or an aromatic or heteroaromatic ring system having 5 to 60, preferably 5 to 40, more preferably 5 to 30, very preferably 5 to 18 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60, preferably 5 to 40, more preferably 5 to 30, very preferably 5 to 18 aromatic ring atoms, which may be substituted by one or more R radicals.

More preferably, the group R^B stands on each occurrence, identically or differently, for a straight-chain alkyl or alkoxy group having 1 to 20, preferably 1 to 10 carbon atoms or an alkenyl or alkynyl group having 2 to 20, preferably 2 to 10 carbon atoms or a branched or cyclic alkyl or alkoxy group having 3 to 20, preferably 3 to 10 carbon atoms, each of which may be substituted by one or more radicals R, where one or more H atoms may be replaced by D, F, Cl or CN, or an aromatic ring system having 5 to 60, preferably 5 to 40, more preferably 5 to 30, very preferably 5 to 18 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60, preferably 5 to 40, more preferably 5 to 30, very preferably 5 to 18 aromatic ring atoms, which may be substituted by one or more R radicals.

Very preferably, the group R^B is selected on each occurrence, identically or differently,
from branched or cyclic alkyl groups represented by the general following formula (RS-a)



(RS-a)

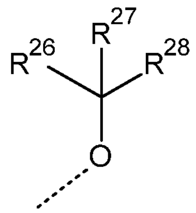
wherein

R^{22}, R^{23}, R^{24} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{25}, and where two of radicals R^{22}, R^{23}, R^{24} or all radicals R^{22}, R^{23}, R^{24} may be joined to form a (poly)cyclic alkyl group, which may be substituted by one or more radicals R^{25};

R^{25} is at each occurrence, identically or differently, selected from a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms;

with the proviso that at each occurrence at least one of radicals R^{22}, R^{23} and R^{24} is other than H, with the proviso that at each occurrence all of radicals R^{22}, R^{23} and R^{24} together have at least 4 carbon atoms and with the proviso that at each occurrence, if two of radicals R^{22}, R^{23}, R^{24} are H, the remaining radical is not a straight-chain;

or from branched or cyclic alkoxy groups represented by the general following formula (RS-b)

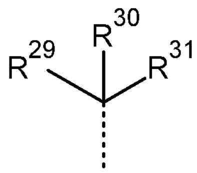


(RS-b)

wherein

R^{26}, R^{27}, R^{28} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{25} as defined above, and where two of radicals R^{26}, R^{27}, R^{28} or all radicals R^{26}, R^{27}, R^{28} may be joined to form a (poly)cyclic alkyl group, which may be substituted by one or more radicals R^{25} as defined above; with the proviso that at each occurrence only one of radicals R^{26}, R^{27} and R^{28} may be H;

or from aralkyl groups represented by the general following formula (RS-c)



(RS-c)

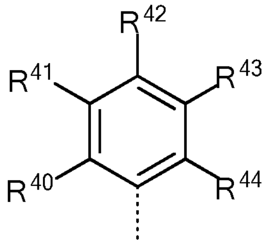
wherein

R^{29}, R^{30}, R^{31} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}, and where two or all of radicals R^{29}, R^{30}, R^{31} may be joined to form a (poly)cyclic alkyl group or an aromatic ring system, each of which may be substituted by one or more radicals R^{32};

R^{32} is at each occurrence, identically or differently, selected from a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, or an aromatic ring system having 6 to 24 aromatic ring atoms;

with the proviso that at each occurrence at least one of radicals R^{29}, R^{30} and R^{31} is other than H and that at each occurrence at least one of radicals R^{29}, R^{30} and R^{31} is or contains an aromatic ring system having at least 6 aromatic ring atoms;

or from aromatic ring systems represented by the general following formula (RS-d)

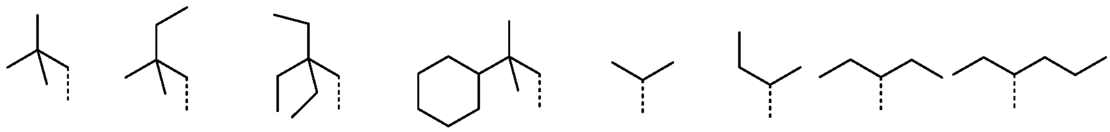


(RS-d)

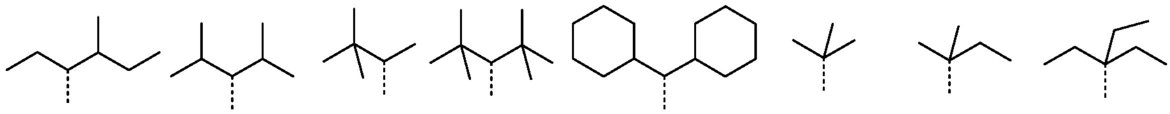
wherein

R^{40} to R^{44} is at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}, and where two or more of radicals R^{40} to R^{44} may be joined to form a (poly)cyclic alkyl group or an aromatic ring system, each of which may be substituted by one or more radicals R^{32} as defined above.

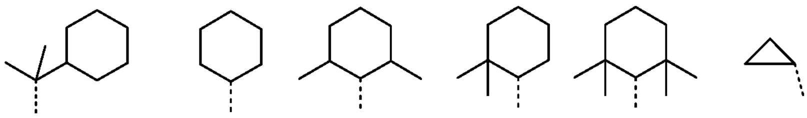
Examples of suitable groups of formulae (RS-a) to (RS-d) are the groups (RS-1) to (RS-78):



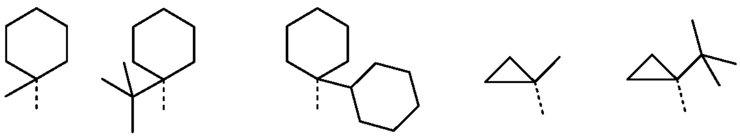
(RS-1) (RS-2) (RS-3) (RS-4) (RS-5) (RS-6) (RS-7) (RS-8)



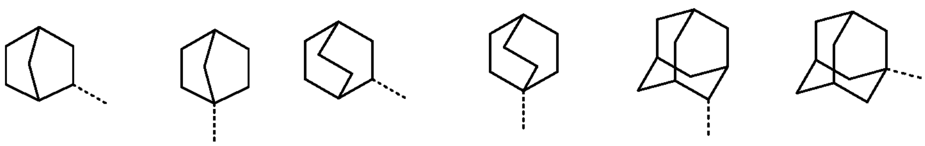
(RS-9) (RS-10) (RS-11) (RS-12) (RS-13) (RS-14) (RS-15) (RS-16)



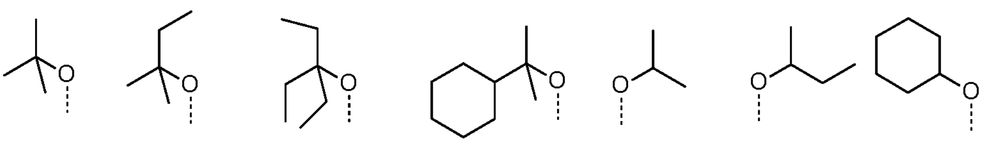
(RS-17) (RS-18) (RS-19) (RS-20) (RS-21) (RS-22)



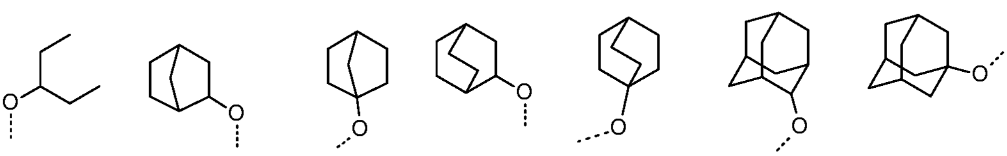
(RS-23) (RS-24) (RS-25) (RS-26) (RS-27)



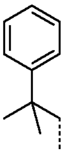
(RS-28) (RS-29) (RS-30) (RS-31) (RS-32) (RS-33)



(RS-34) (RS-35) (RS-36) (RS-37) (RS-38) (RS-39) (RS-40)



(RS-41) (RS-42) (RS-43) (RS-44) (RS-45) (RS-46) (RS-47)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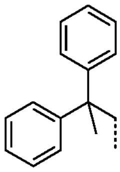
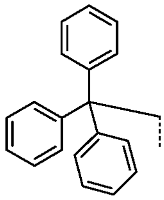

(RS-49)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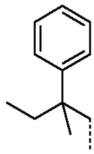
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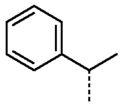
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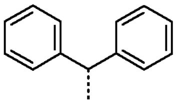
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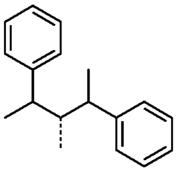
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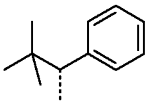
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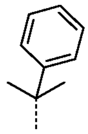
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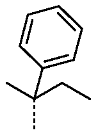
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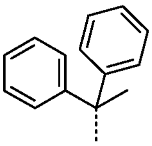
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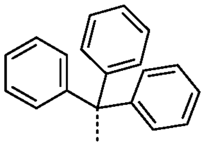
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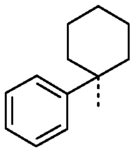
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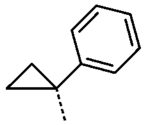
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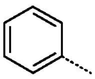
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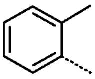
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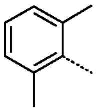
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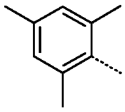
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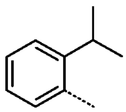
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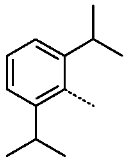
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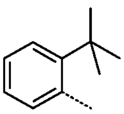
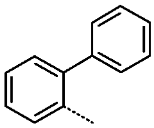

(RS-68)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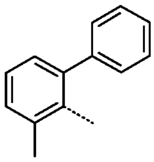
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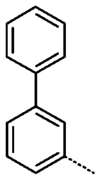
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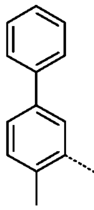
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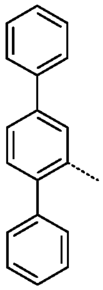
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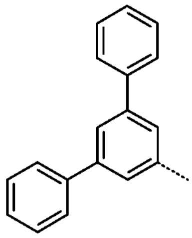
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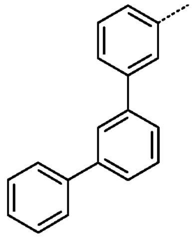
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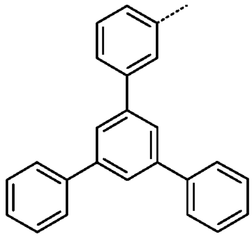
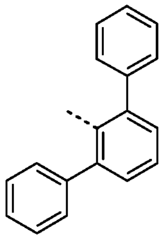
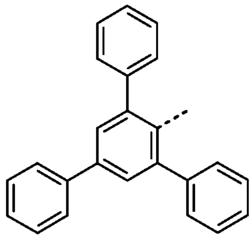

(RS-76)


(RS-77)


(RS-78)

where the dashed bond indicates the bonding of these groups to the structure of formula (1) and where the groups of formulae (RS-1) to (RS-47) may further be substituted by a least one group R^{25} as defined above and groups (RS-48) to (RS-78) may further be substituted by a least one group R^{32} as defined above.

Among the groups of formulae (RS-1) to (RS-78), the groups (RS-62), (RS-64), (RS-65), (RS-67), (RS-70), (RS-77) and (RS-78) are preferred.

Preferably, R^2, R^Y and R^A stand on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CN, $N(Ar)_2$, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40, preferably 1 to 20, more preferably 1 to 10 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40, preferably 3 to 20, more preferably 3 to 10 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60, preferably 1 to 40, more preferably 1 to 30, very preferably 1 to 18 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60, preferably 1 to 40, more preferably 1 to 30, very preferably 1 to 18 aromatic ring atoms, which may be substituted by one or more R radicals, where two adjacent radicals selected from R^Y, R^2, R^A may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R;.

More preferably, R^2, R^Y and R^A stand on each occurrence, identically or differently, for H, D, F, CN, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40, preferably 1 to 20, more preferably 1 to 10 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40 preferably 3 to 20, more preferably 3 to 10 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, O or S and where one or more H atoms may be replaced by D, F, an aromatic or heteroaromatic ring system having 5 to 60, preferably 1 to 40, more preferably 1 to 30, very preferably 1 to 18 aromatic ring atoms, which may in each case be substituted by one or more radicals R or an aralkyl or heteroaralkyl group which has 5 to 60, preferably 1 to 40, more preferably 1 to 30, very preferably 1 to 18 aromatic ring atoms, which may be substituted by one or more R radicals, where two adjacent radicals selected from R^Y, R^2, R^A may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R.

Very preferably, R^2, R^Y and R^A stand on each occurrence, identically or differently,

for H, D, F, CN; or

for a group of formula (RS-a), a group of formula (RS-b), a group of formula (RS-c) or a group of formula (RS-d), where the groups of formulae (RS-a), (RS-b), (RS-c) and (RS-d) have the same definition as above, wherein further two adjacent groups of formula (RS-a), (RS-b), (RS-c) and (RS-d) may form a mono- polycyclic- aliphatic ring system or aromatic ring system; or

for a group of formula (ArL-1),

$$\text{- - -}\left[\text{- - -}Ar^2\right]_m\!\!-Ar^3$$

formula (ArL-1)

where the dashed bond in formula (ArL-1) indicates the bonding to the structure of formula (1), where Ar^2, Ar^3 stand on each occurrence, identically or differently, for an aromatic or heteroaromatic ring systems having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R; and where m is an integer selected from 1 to 10.

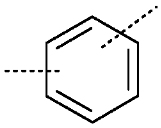
In accordance with a preferred embodiment, at least one of the group R^2, R^Y or R^A stands for a group of formula (RS-a), a group of formula (RS-b), a group of formula (RS-c) or a group of formula (RS-d), where the groups of formulae (RS-a), (RS-b), (RS-c) and (RS-d) are as defined above.

In accordance with a preferred embodiment, the groups R^B and R^A are on each occurrence, identically or differently, selected from the groups of formulae (RS-a), (RS-b), (RS-c) and (RS-d), where the groups of formulae (RS-a), (RS-b), (RS-c) and (RS-d) have the same definition as above.

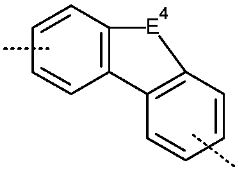
In accordance with a preferred embodiment, at least one of the group R, R^Y, R^2 or R^A stands for a group of formula (ArL-1) as defined above.

Preferably, the index m in the group of formula (ArL-1) is an integer selected from 1 to 6, very preferably from 1 to 4.

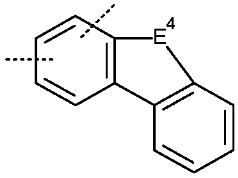
In formula (ArL-1), it is preferred that the group Ar^2 is selected from the groups of formulae (Ar2-1) to (Ar2-25),



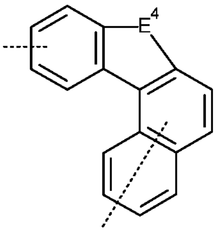
(Ar2-1)



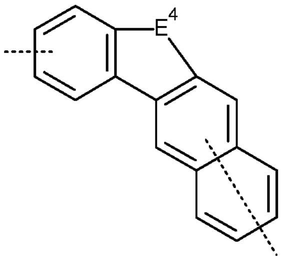
(Ar2-2)



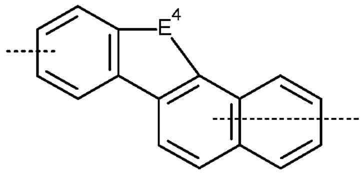
(Ar2-3)



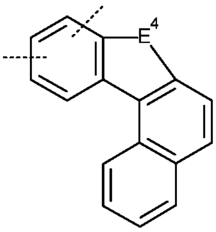
(Ar2-4)



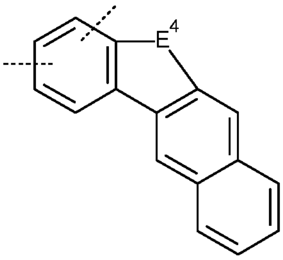
(Ar2-5)



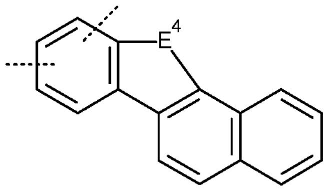
(Ar2-6)



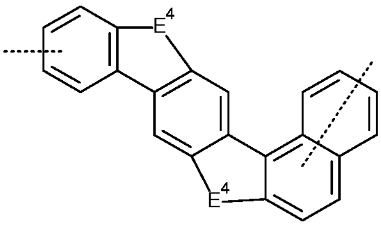
(Ar2-7)



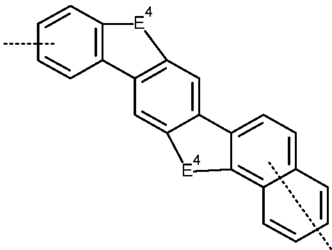
(Ar2-8)



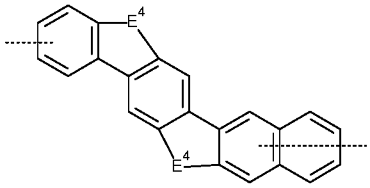
(Ar2-9)



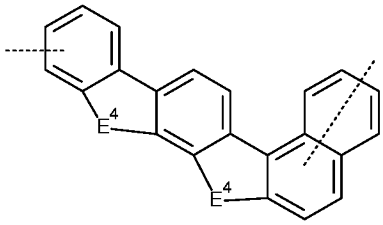
(Ar2-10)



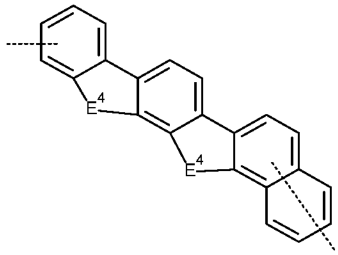
(Ar2-11)



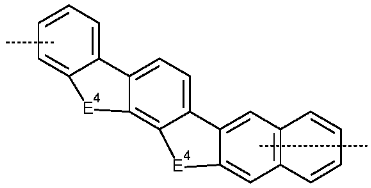
(Ar2-12)



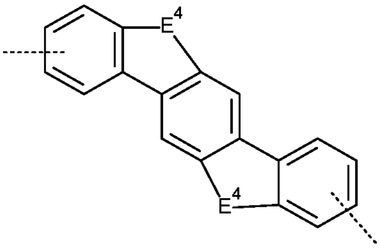
(Ar2-13)



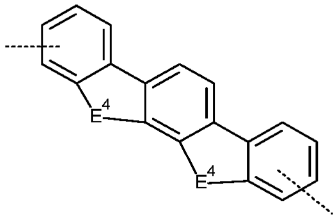
(Ar2-14)



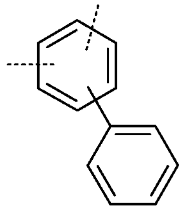
(Ar2-15)



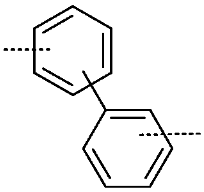
(Ar2-16)



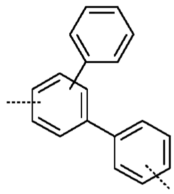
(Ar2-17)



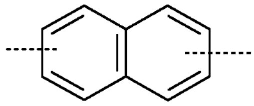
(Ar2-18)



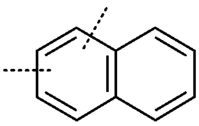
(Ar2-19)



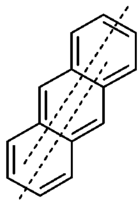
(Ar2-20)



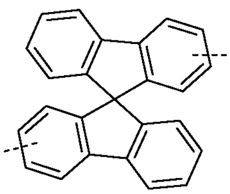
(Ar2-21)



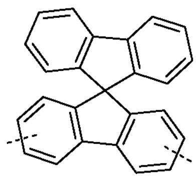
(Ar2-22)



(Ar2-23)



(Ar2-24)



(Ar2-25)

where the dashed bonds indicate the bonding to the structure of formula (1) and to a group Ar^2 or Ar^3 and the groups of formulae (Ar2-1) to (Ar2-25) may be substituted at each free position by a group R, which has the same meaning as above and where:

E^4 is selected from -B(R^{0-}), -C(R^0)$_{2}$-, -C(R^0)$_2$-C(R^0)$_2$-, -Si(R^0)$_2$-, -C(=O)-, -C(=NR^0)-, -C=(C(R^0))$_2$-, -O-, -S-, -S(=O)-, -SO_2-, -N(R^0)-, -P(R^0)- and –P((=O)R^0)-;

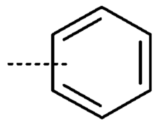
R^0 stands on each occurrence, identically or differently, for H, D, F, CN, a straight-chain alkyl group having 1 to 40 C atoms or branched or cyclic alkyl group having 3 to 40 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, C=O, C=S, SO, SO_2, O or S and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R; where two adjacent substituents R^0 may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R, which has the same meaning as above.

Preferably, E^4 is selected from -C(R^0)$_2$-, -Si(R^0)$_2$-, -O-, -S- or -N(R^0)-, where the substituent R^0 has the same meaning as above.

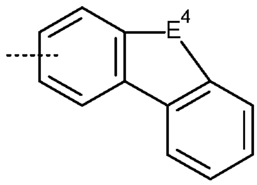
Preferably, R^0 stands on each occurrence, identically or differently, for H, D, F, CN, a straight-chain alkyl group having 1 to 40, preferably 1 to 20, more preferably 1 to 10 C atoms or branched or cyclic alkyl group having 3 to 40, preferably 3 to 20, more preferably 3 to 10 C atoms, each of which may be substituted by one or more radicals R, an aromatic or heteroaromatic ring system having 5 to 60, preferably 5 to 40, more preferably 5 to 30, very preferably 5 to 18 aromatic ring atoms, which may in each case be substituted by one or more radicals R; where two adjacent substituents R^0 may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R, which has the same meaning as above. Examples of suitable groups R^0 are H, methyl, ethyl, propyl, butyl, substituted and unsubstituted phenyl, substituted and unsubstituted biphenyl, substituted and unsubstituted naphthyl and substituted and unsubstituted fluorene.

Among formulae (Ar2-1) to (Ar2-25), following formulae are preferred: (Ar2-1), (Ar2-2), (Ar2-3), (Ar2-18), (Ar2-19), (Ar2-20), (Ar2-21), (Ar2-22) and (Ar2-25).

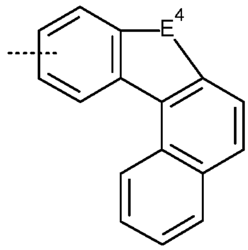
Furthermore, in formula (ArL-1), it is preferred that Ar^3 is on each occurrence, identically or differently, selected from the group consisting of the groups of formulae (Ar3-1) to (Ar3-27),



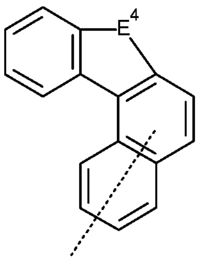
(Ar3-1)



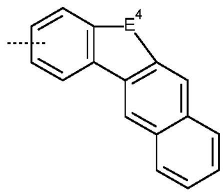
(Ar3-2)



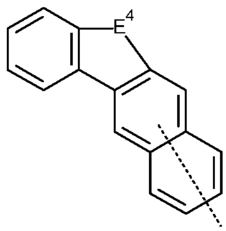
(Ar3-3)



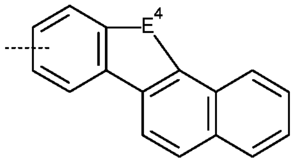
(Ar3-4)



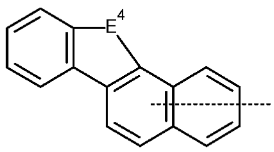
(Ar3-5)



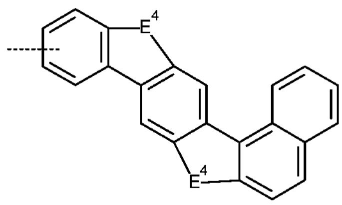
(Ar3-6)



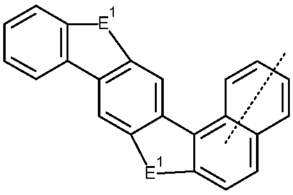
(Ar3-7)

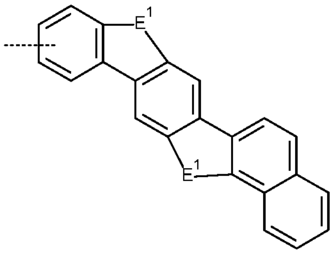


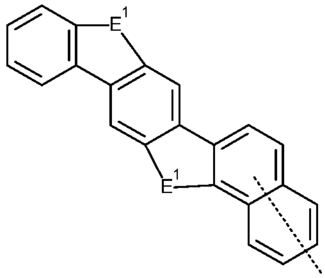
(Ar3-8)

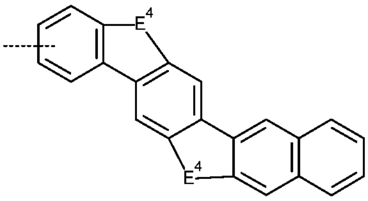


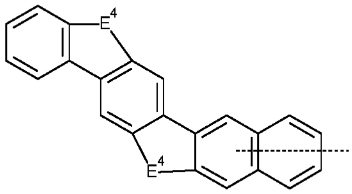
(Ar3-9)

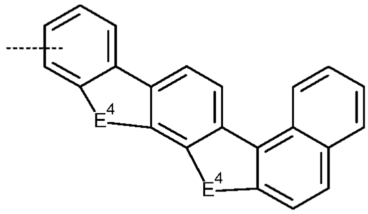

(Ar3-10)

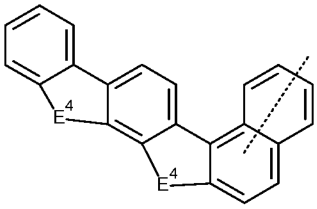

(Ar3-11)

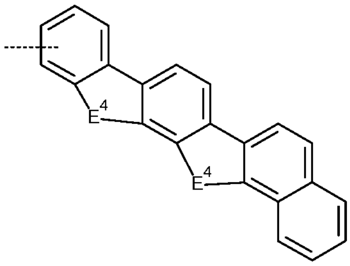

(Ar3-12)

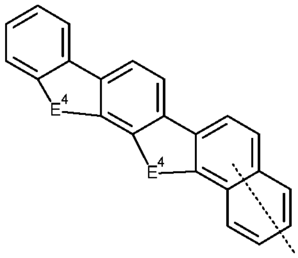

(Ar3-13)

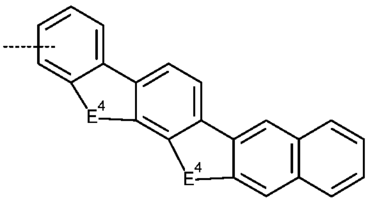

(Ar3-14)

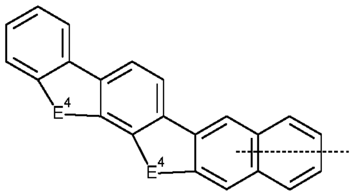

(Ar3-15)

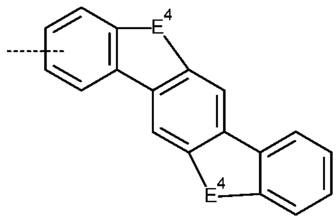

(Ar3-16)

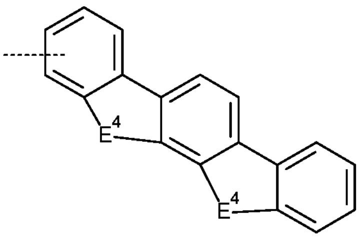

(Ar3-17)

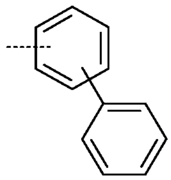

(Ar3-18)

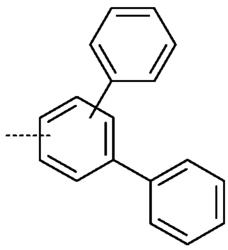

(Ar3-19)

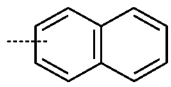
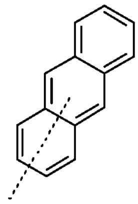
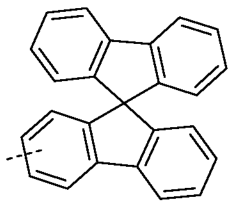

(Ar3-20)


(Ar3-21)


(Ar3-22)


(Ar3-23)


(Ar3-24)

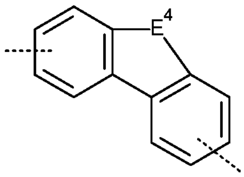
  

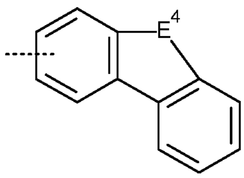
(Ar3-25) (Ar3-26) (Ar3-27)

where the dashed bond indicates the bonding to Ar^2 and where E^4 has the same meaning as above and the groups of formulae (Ar3-1) to (Ar3-27) may be substituted at each free position by a group R, which has the same meaning as above.

Among formulae (Ar3-1) to (Ar2-27), following formulae are preferred: (Ar3-1), (Ar3-2), (Ar3-23), (Ar3-24), (Ar3-25) and (Ar3-27).

In accordance with a preferred embodiment at least one group Ar^2 stands for a group of formula (Ar2-2) and/or at least one group Ar^3 stands for a group of formula (Ar3-2),



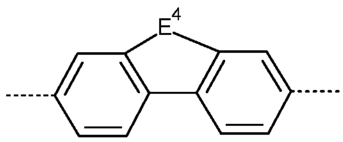


(Ar2-2) (Ar3-2)

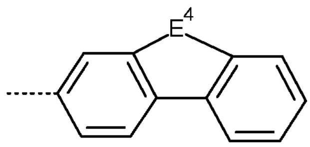
where

the dashed bonds in formula (Ar2-2) indicate the bonding to the structure of formula (1) and to a group Ar^2 or Ar^3; and the dashed bond in formula (Ar3-2) indicates the bonding to Ar^2; and E^4 has the same meaning as in above; and the groups of formulae (Ar2-2) and (Ar3-2) may be substituted at each free position by a group R, which has the same meaning as above.

In accordance with a very preferred embodiment, at least one group Ar^2 stands for a group of formula (Ar2-2-1) and/or at least one group Ar^3 stands for a group of formula (Ar3-2-1),



(Ar2-2-1)



(Ar3-2-1)

where

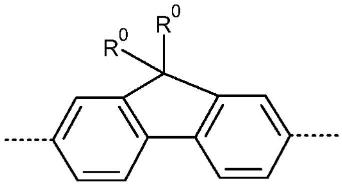
the dashed bonds in formula (Ar2-2-1) indicate the bonding to the structure of formula (1) and to a group Ar^2 or Ar^3;

the dashed bond in formula (Ar3-2-1) indicates the bonding to Ar^2;

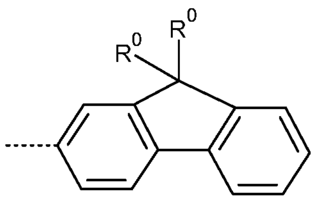
E^4 has the same meaning as above; and

the groups of formulae (Ar2-2-1) and (Ar3-2-1) may be substituted at each free position by a group R, which has the same meaning as above.

In accordance with a particularly preferred embodiment, at least one group Ar^2 stands for a group of formula (Ar2-2-1b) and/or at least one group Ar^3 stands for a group of formula (Ar3-2-1b),



(Ar2-2-1b)



(Ar3-2-1b)

where

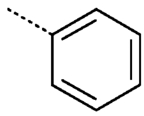
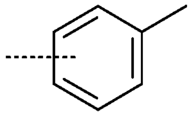
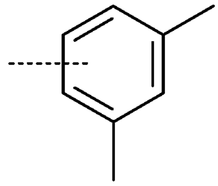
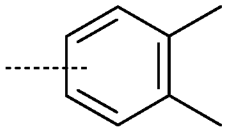
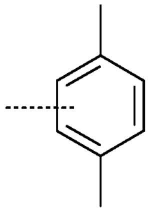
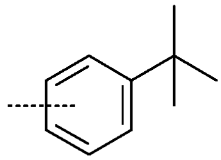
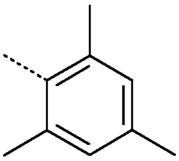
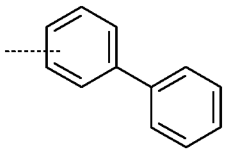
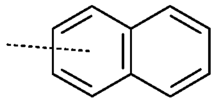
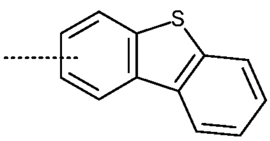
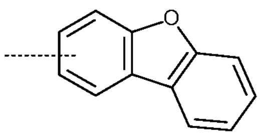
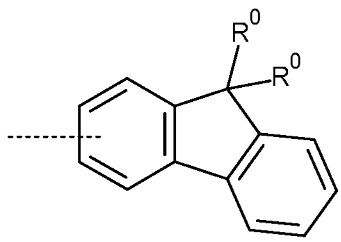
the dashed bonds in formula (Ar2-2-1b) indicate the bonding to the structure of formula (1) and to a group Ar^2 or Ar^3;

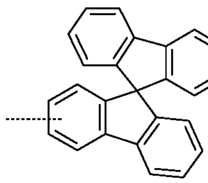
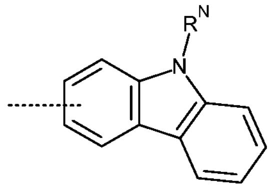
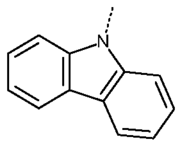
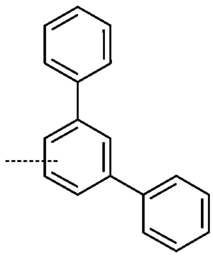
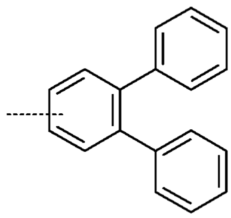
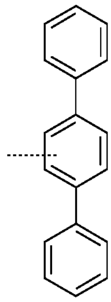
the dashed bond in formula (Ar3-2-1b) indicates the bonding to Ar^2;

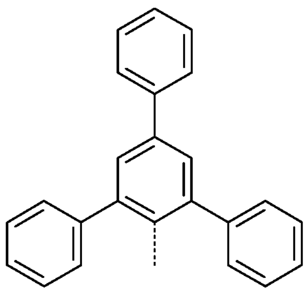
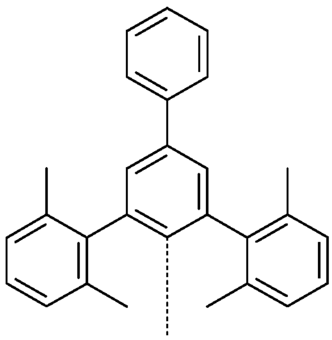
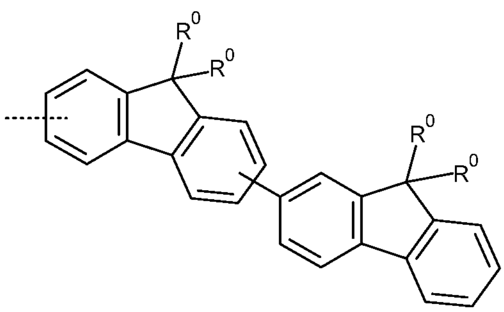
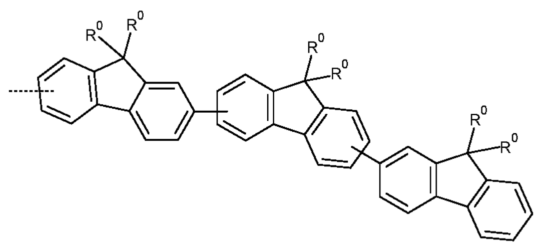
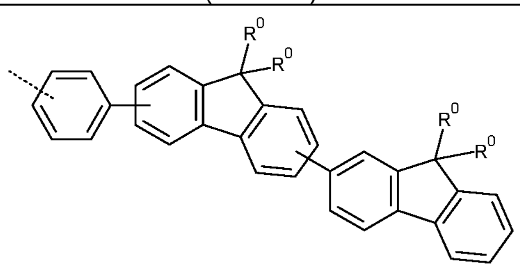
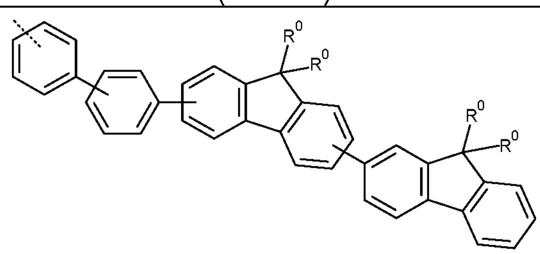
R^0 has the same meaning as above; and

the groups of formulae (Ar2-2-1b) and (Ar3-2-1b) may be substituted at each free position by a group R, which has the same meaning as above.

Examples of very suitable groups R^2, R^Y and R^A are H, D, F, CN, substituted and unsubstituted straight-chain alkyl groups having 1 to 10 C atoms, more particularly, methyl, ethyl, propyl, butyl, substituted and unsubstituted branched or cyclic alkyl group having 3 to 10 C atoms, more particularly t-butyl, and aromatic or heteroaromatic ring systems selected from the groups of formulae (Ar1-1) to (Ar1-24),

		
(Ar1-1)	(Ar1-2)	(Ar1-3)
		
(Ar1-4)	(Ar1-5)	(Ar1-6)
		
(Ar1-7)	(Ar1-8)	(Ar1-9)
		
(Ar1-10)	(Ar1-11)	(Ar1-12)

		
(Ar1-13)	(Ar1-14)	(Ar1-15)
		
(Ar1-16)	(Ar1-17)	(Ar1-18)

	
(Ar1-19)	(Ar1-20)
	
(Ar1-21)	(Ar1-22)
	

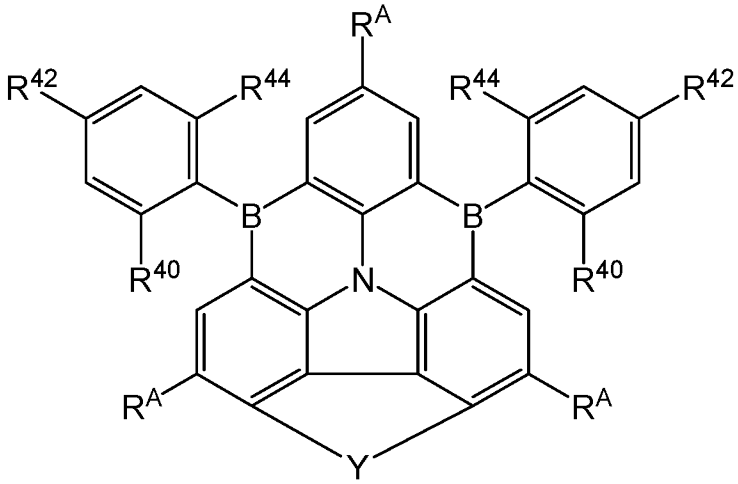
(Ar1-23)	(Ar1-24)

where in formulae (Ar1-1) to (Ar1-24):

- the dashed bond indicates the bonding to the structure of formula (1);
- R^N in formula (Ar1-14) stands on each occurrence, identically or differently, for H, D, a straight-chain alkyl group having 1 to 40, preferably 1 to 20, more preferably 1 to 10 C atoms or branched or cyclic alkyl group having 3 to 40, preferably 3 to 20, more preferably 3 to 10 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, C=O, C=S, SO, SO_2, O or S, and where one or more H atoms may be replaced by D, F or CN, an aromatic or heteroaromatic ring system having 5 to 60, preferably 5 to 40, more preferably 5 to 30, particularly preferably 5 to 18 aromatic ring atoms, which may in each case be substituted by one or more radicals R, where two adjacent substituents R^N may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R, where R has the same meaning as above;
- R^0 in formulae (Ar1-12) and (Ar1-21) to (Ar1-24) stands on each occurrence, identically or differently, for H, D, F, CN, a straight-chain alkyl group having 1 to 40 C atoms or branched or cyclic alkyl group having 3 to 40 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, C=O, C=S, SO, SO_2, O or S and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R; where two adjacent substituents R^0 may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R, which has the same meaning as above;

- the groups of formulae (Ar1-1) to (Ar1-24) may be substituted at each free position by a group R, which has the same meaning as above.

In accordance with a particularly preferred embodiment, the compounds of formula (1) are selected from the compounds of formula (5),



formula (5)

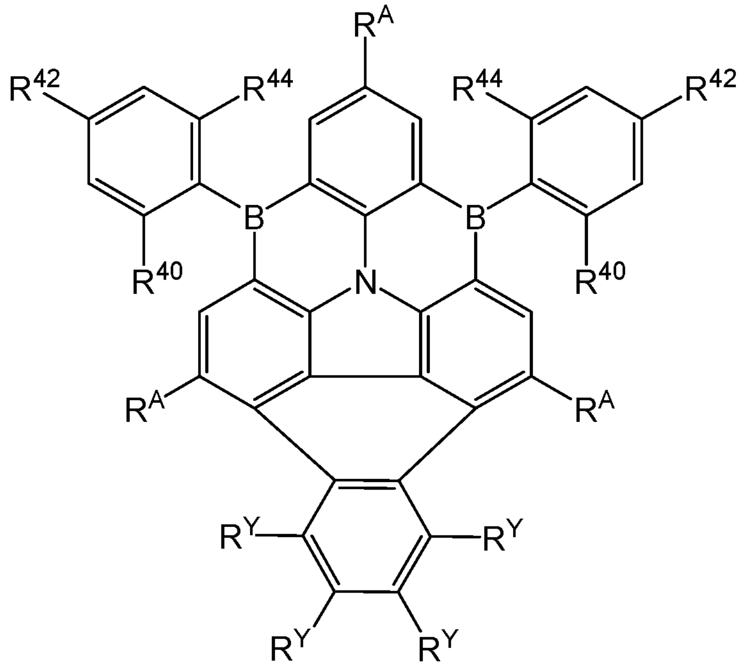
where:

R^{40}, R^{42}, R^{44} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}; where R^{32} is as defined above;

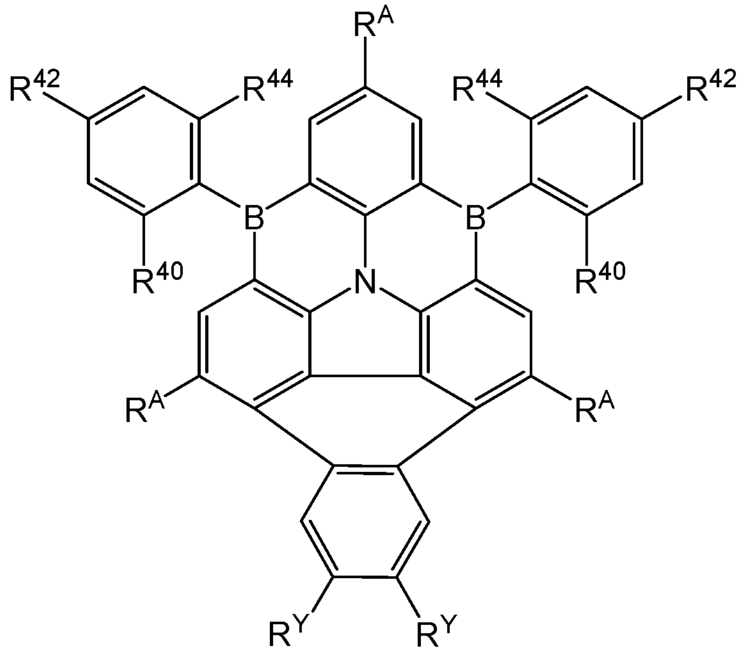
with the proviso that at least one of R^{40}, R^{42}, R^{44} is other than H;

and the other symbols have the same meaning as above.

Preferably, the compounds of formula (5) correspond to compounds of formulae (5-Y2) or (5-Y2-1),



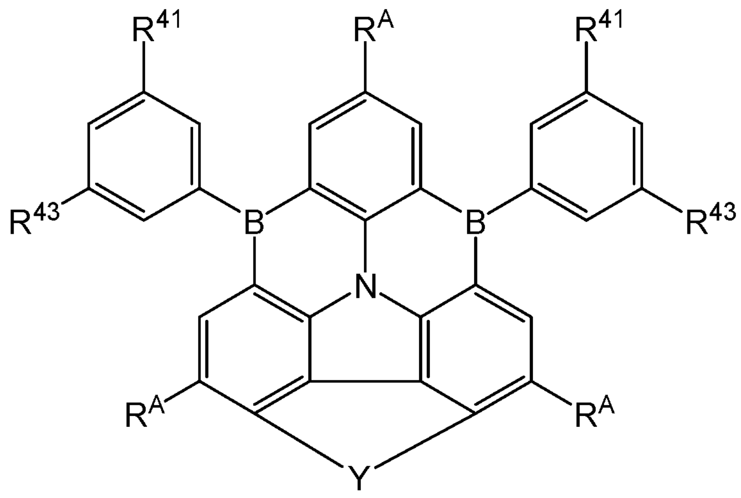
formula (5-Y2)



formula (5-Y2-1)

where the symbols have the same meaning as above.

In accordance with another particularly preferred embodiment, the compounds of formula (1) are selected from the compounds of formula (6),



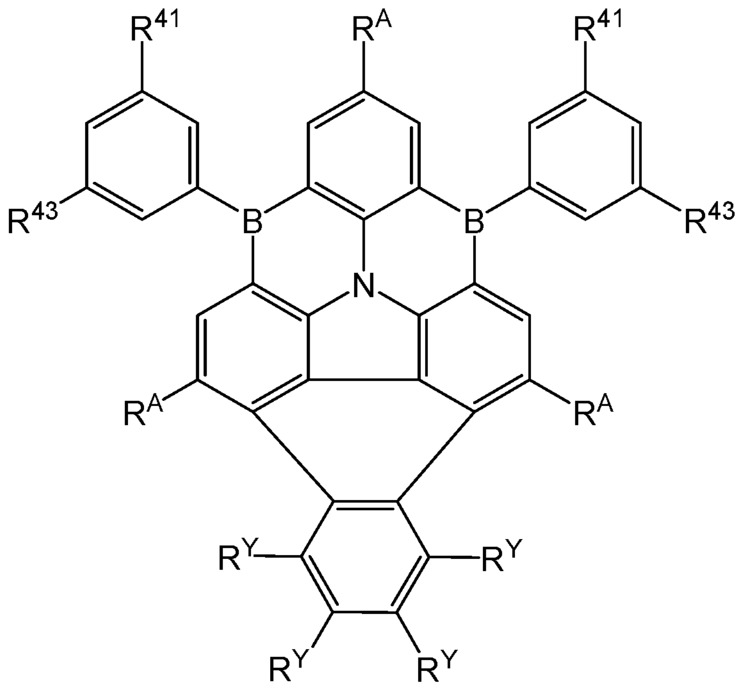
formula (6)

where:

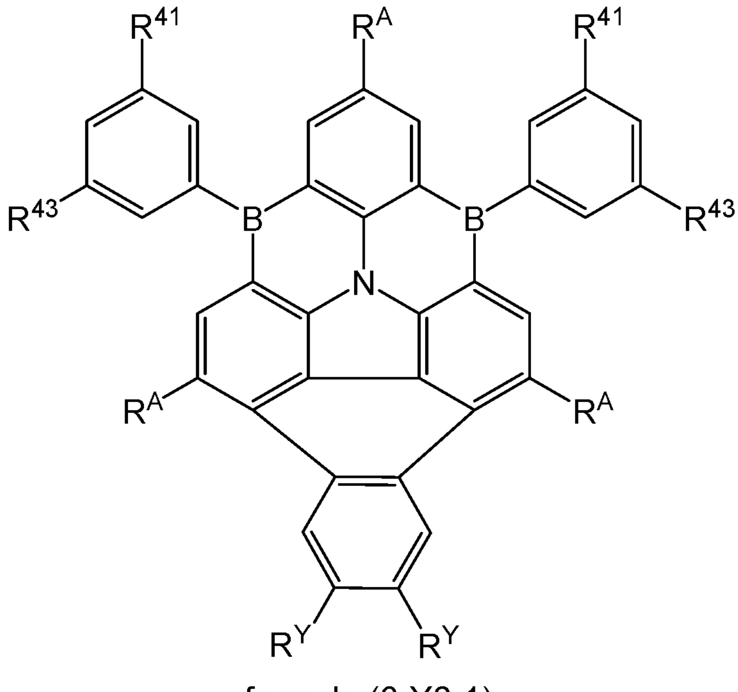
R^{41}, R^{43} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}; where R^{32} is as defined above;

with the proviso that at least one of R^{41}, R^{43} is other than H.

Preferably, the compounds of formula (6) correspond to compounds of formulae (6-Y2) or (6-Y2-1),



formula (6-Y2)



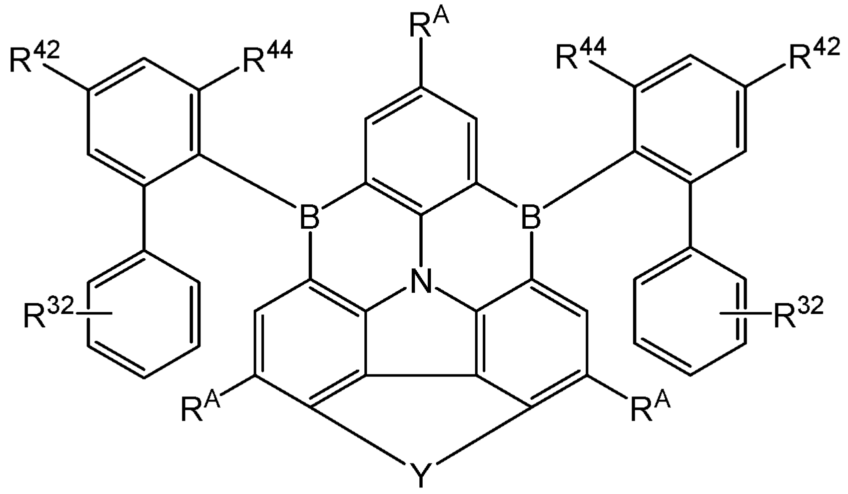
formula (6-Y2-1)

where the symbols have the same meaning as above.

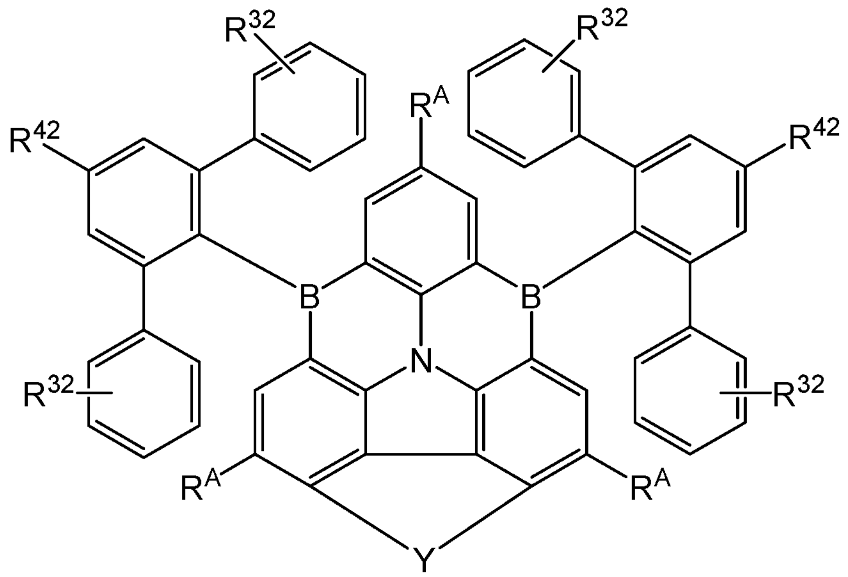
Preferably, the group R^{42} is at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}, and the groups R^{40}, R^{44} are at each occurrence, identically or differently, selected from an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}.

In accordance with a preferred embodiment, the groups R^{40}, R^{42}, R^{44} in formulae (5), (5-Y2) and (5-Y2-1) are at each occurrence, identically or differently, selected from a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}. More preferably, the groups R^{40}, R^{42}, R^{44} are at each occurrence, identically or differently, selected from a straight-chain alkyl group having 1 to 10, preferably 1 to 5 more preferably 1 to 3 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}. Example of suitable groups R^{40}, R^{42}, R^{44} in this case are methyl, ethyl and butyl.

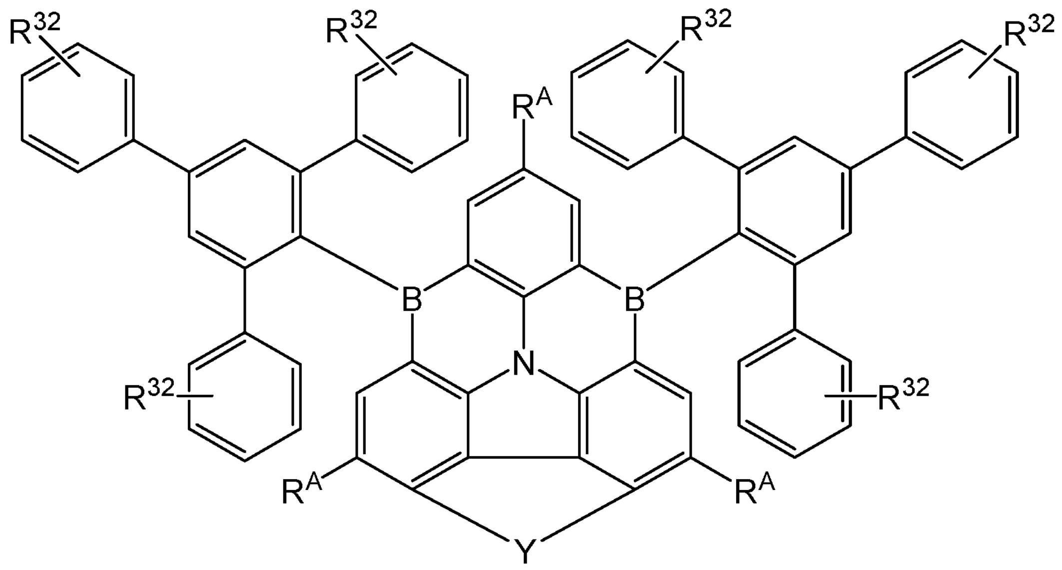
In accordance with another preferred embodiment, the groups R^{40}, R^{42}, R^{44} are at each occurrence, identically or differently, selected from an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}. Preferably, the compounds of formulae (1) are selected from the compounds of formulae (5-1), (5-2) and (5-3),



formula (5-1)



formula (5-2)



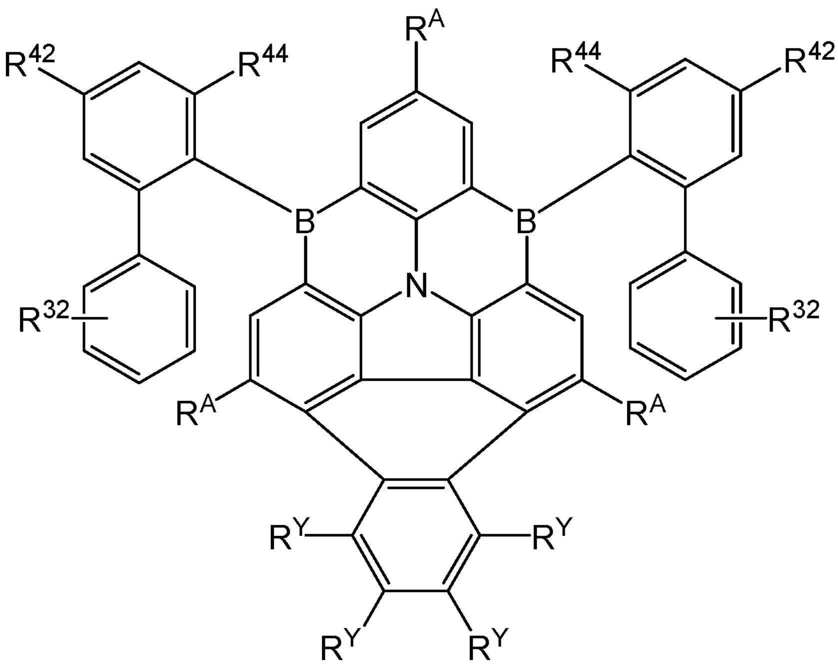
formula (5-3)

where

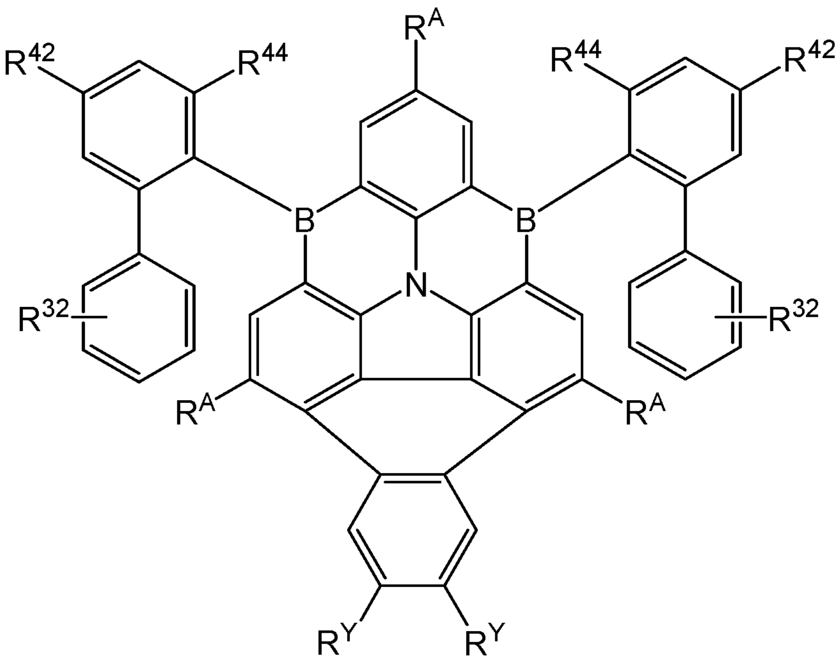
in each of formulae (5-1), (5-2) and (5-3) the phenyl groups indicated with –R^{32} are unsubstituted or substituted with one or more radicals R^{32};

R^{42} and R^{44} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}; where R^{32} is as defined above.

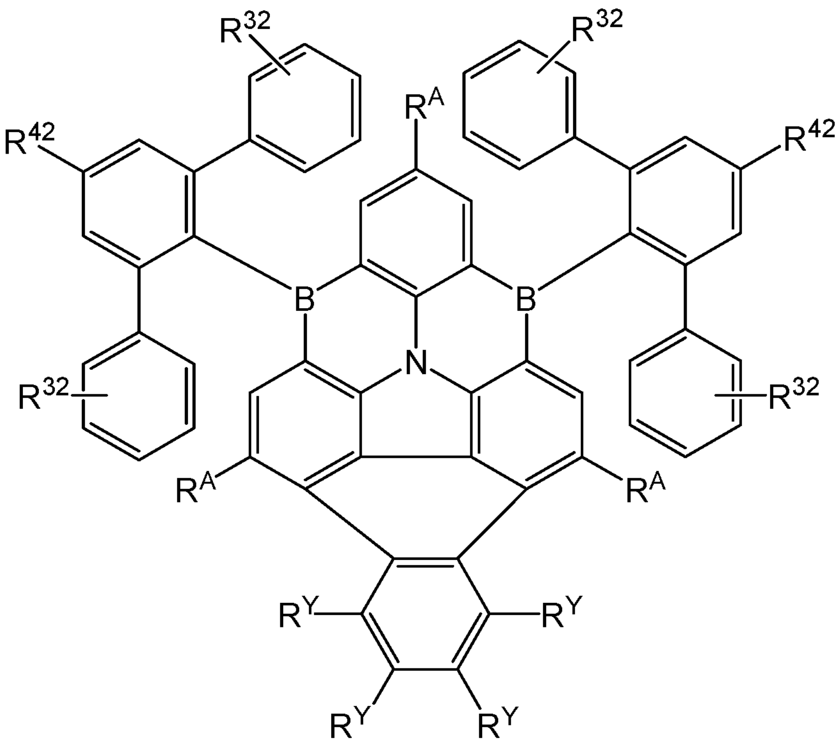
More preferably, the compounds of formulae (5-1), (5-2) and (5-3) correspond to compounds of formulae (5-1-Y2) ,(5-2-Y2), (5-3-Y2), (5-1-Y2-1) ,(5-2-Y2-1) and (5-3-Y2-1),



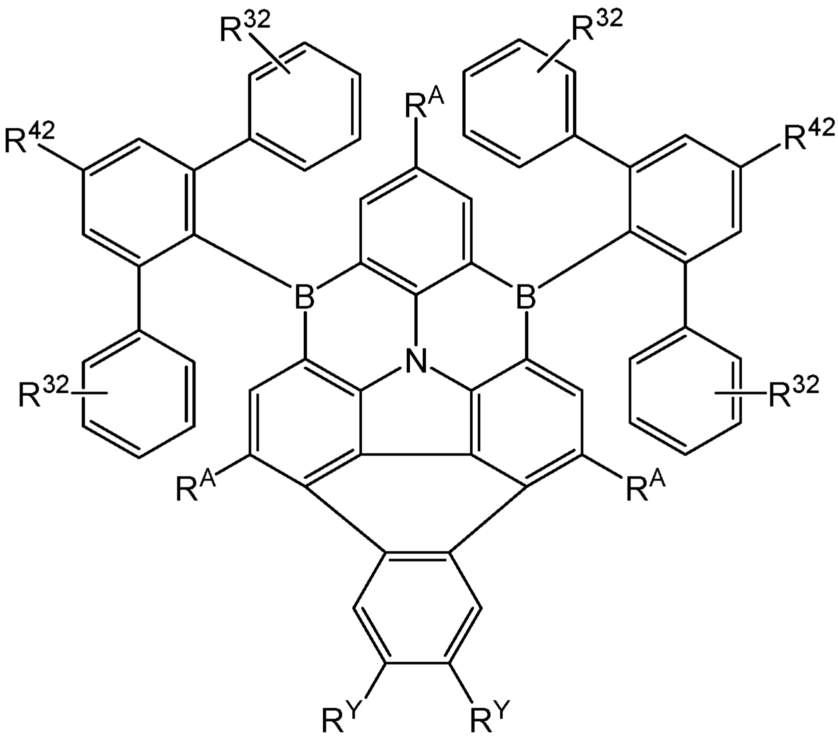
formula (5-1-Y2)



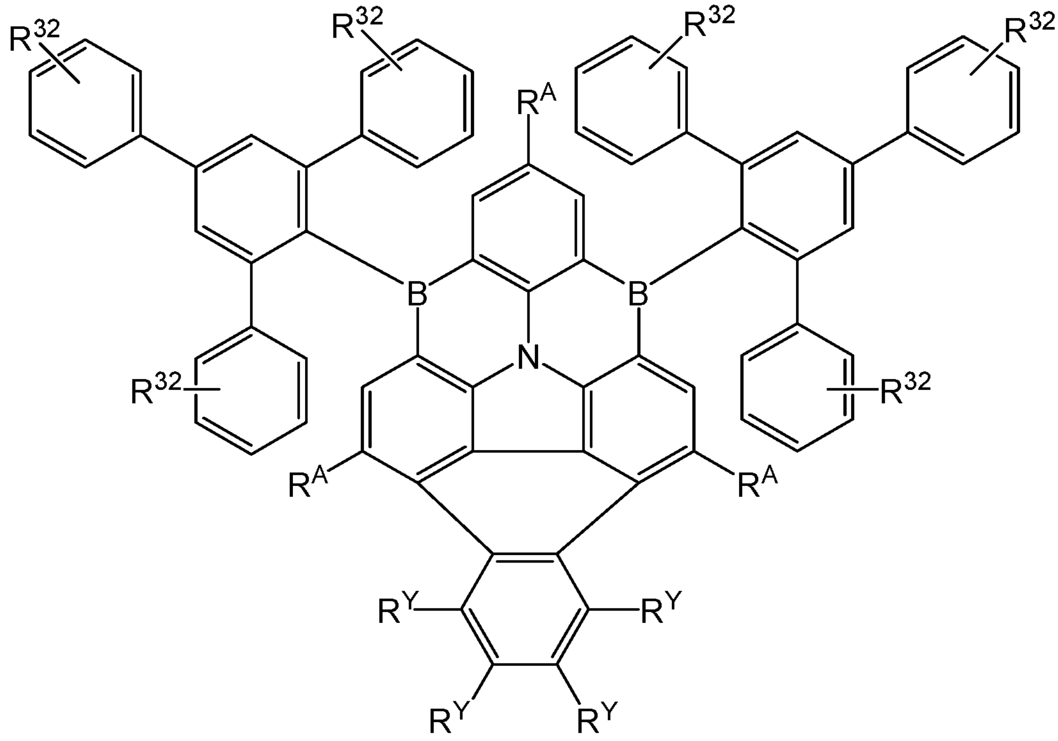
formula (5-1-Y2-1)



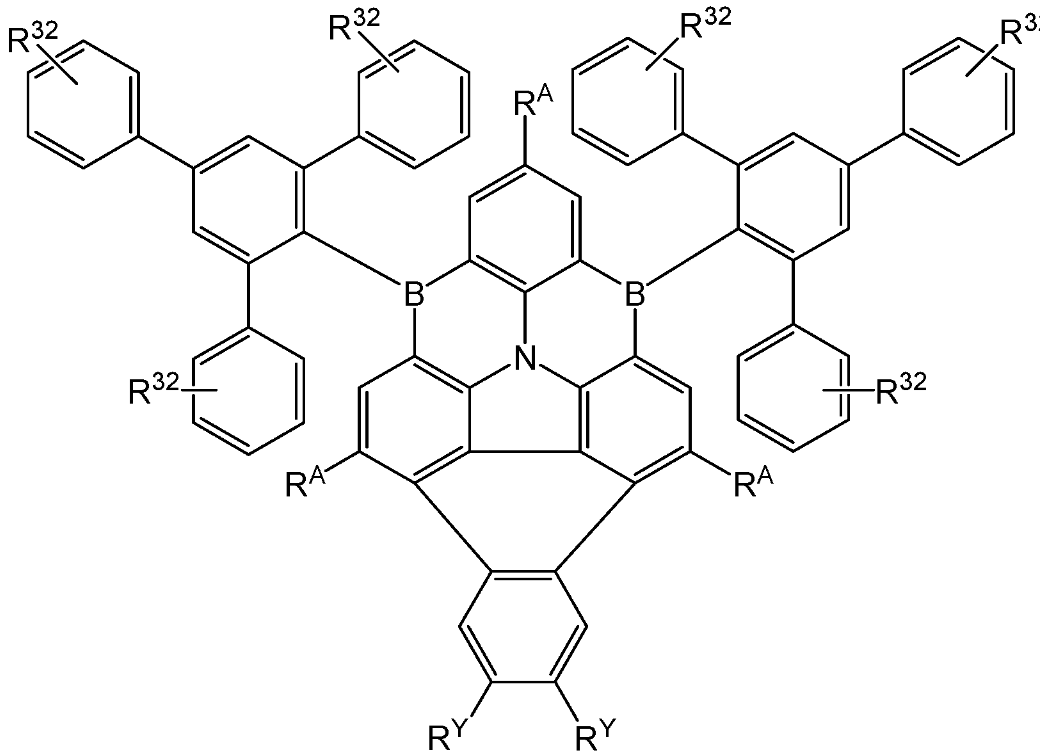
formula (5-2-Y2)



formula (5-2-Y2-1)



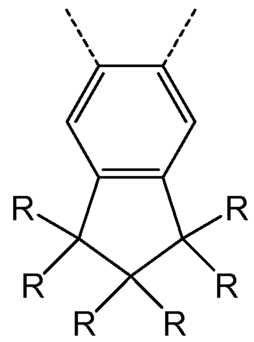
formula (5-3-Y2)



formula (5-3-Y2-1)

where the symbols have the same meaning as above.

In another preferred embodiment for formula (Y2-1) is a group according to formula (Y2-1a):



formula (Y2-1a)

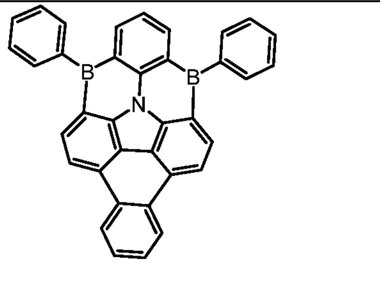
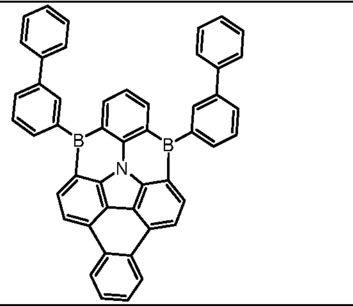
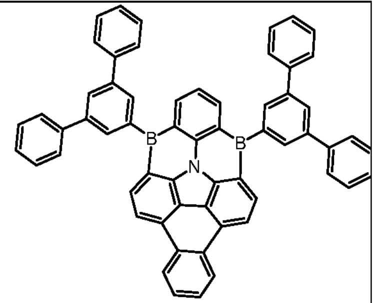
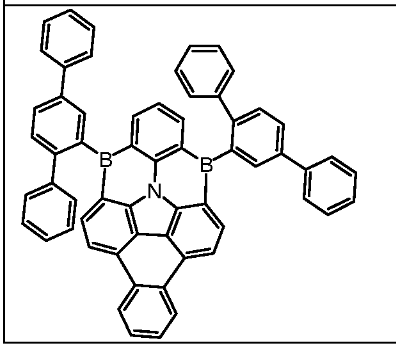
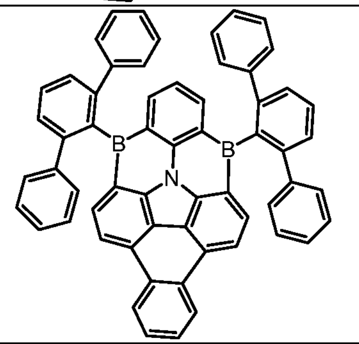
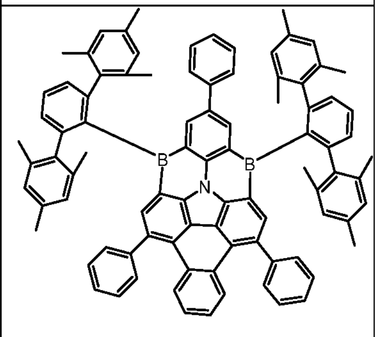
where the symbols have the same meaning as above.

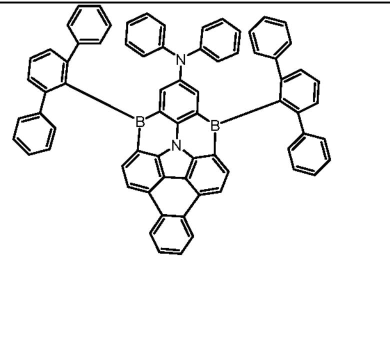
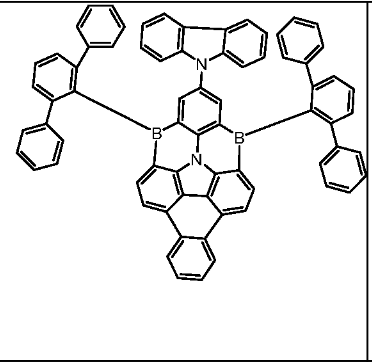
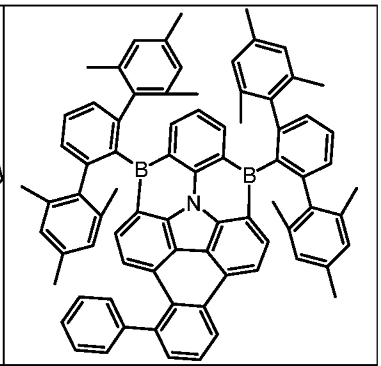
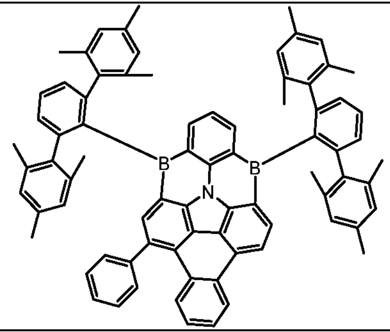
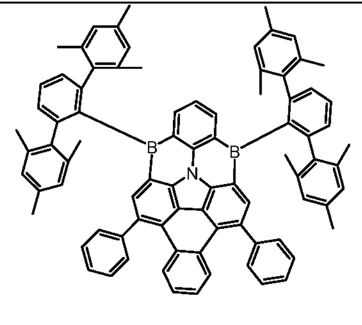
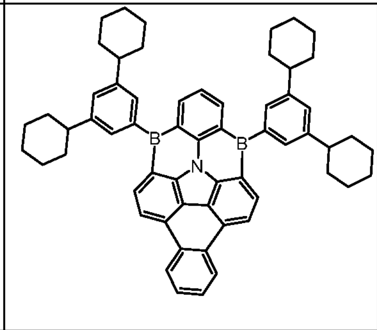
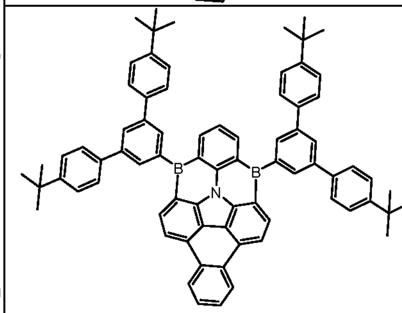
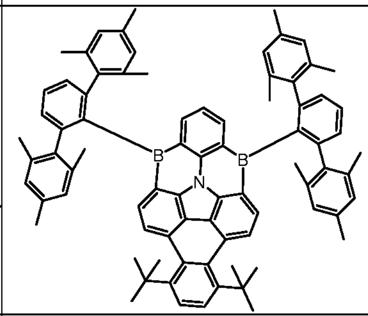
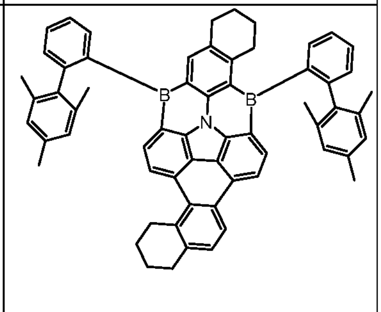
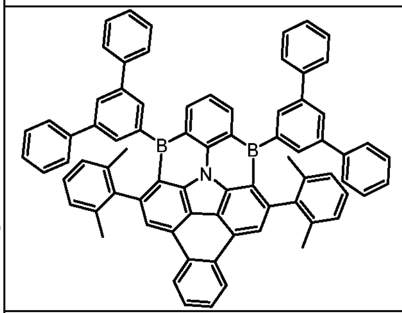
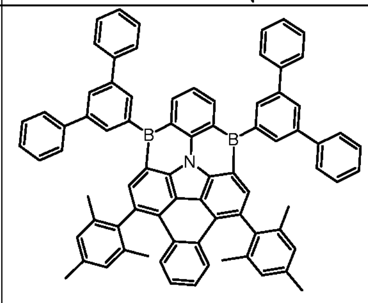
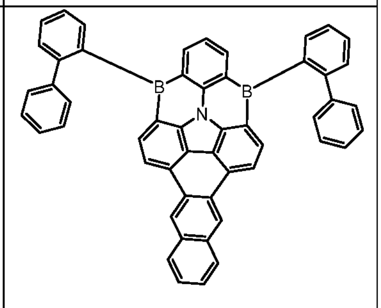
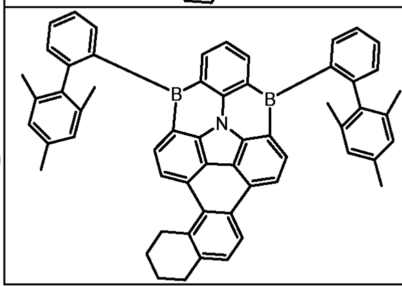
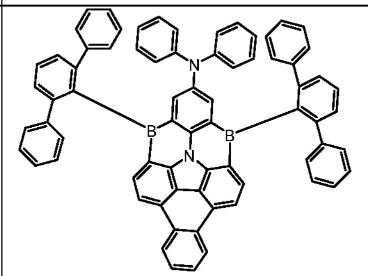
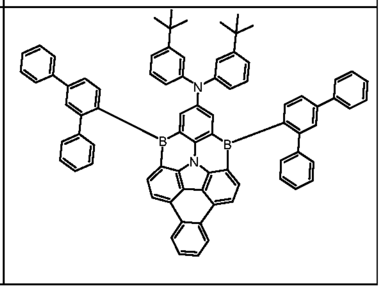
Preferably, the group R stands on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CHO, CN, $N(Ar)_2$, $Si(R')_3$, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40, preferably 1 to 20, more preferably 1 to 10 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40, preferably 3 to 20, more preferably 3 to 10 C atoms, each of which may be substituted by one or more radicals R´, where in each case one or more non-adjacent CH_2 groups may be replaced by R´C=CR´, O or S and where one or more H atoms may be replaced by D, F or CN, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R´, or an aryloxy group having 5 to 60, preferably 5 to 40, more preferably 5 to 30, very preferably 5 to 18 aromatic ring atoms, which may be substituted by one or more radicals R´, where two adjacent radicals R may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R´. When R is selected from aromatic and heteroaromatic ring systems, it is preferably selected from aromatic and heteroaromatic ring systems having 5 to 40, preferably 5 to 30, more preferably 5 to 18 aromatic ring atoms or from aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms corresponding to groups of formula (ArL-1) as defined above.

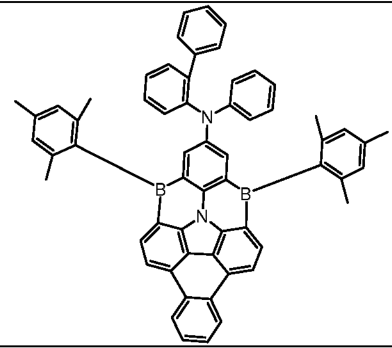
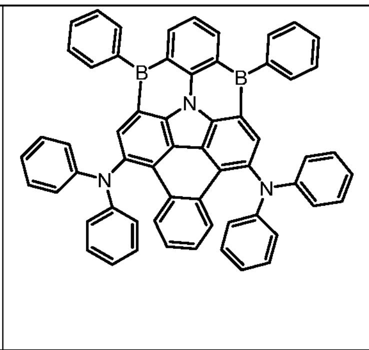
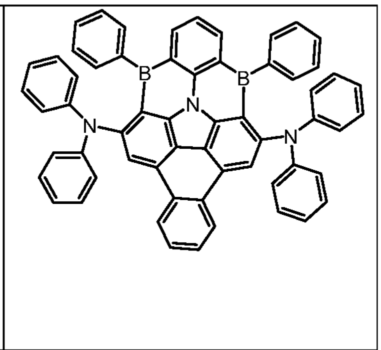
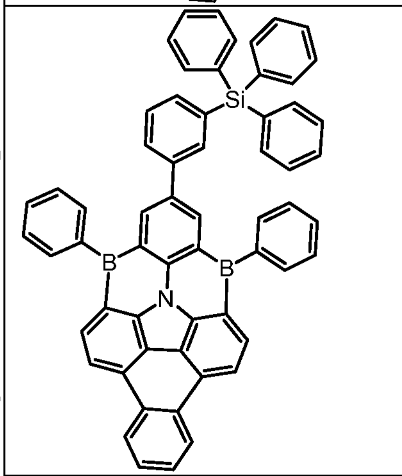
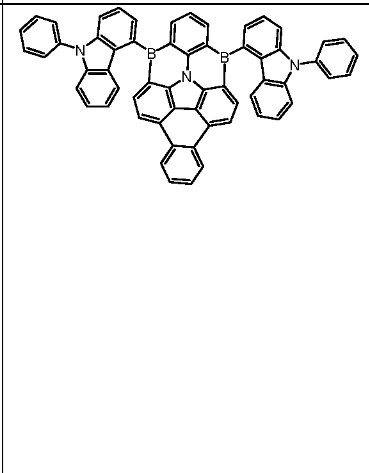
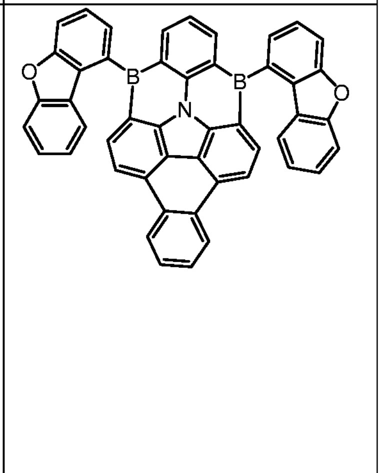
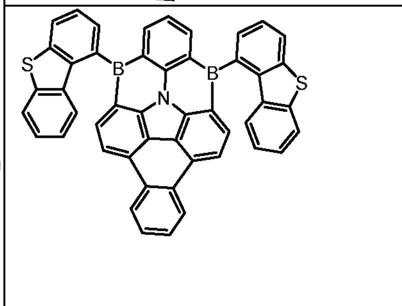
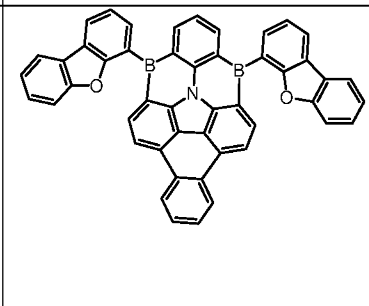
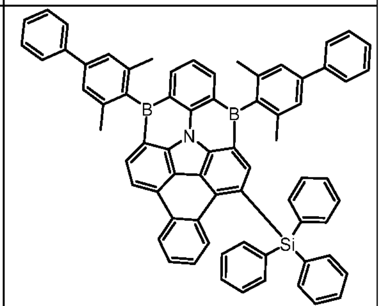
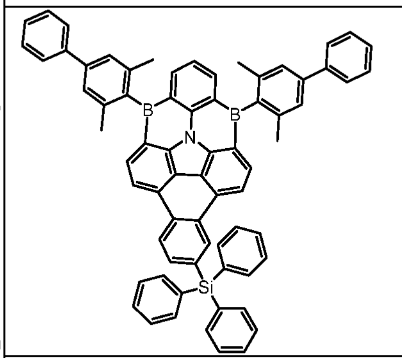
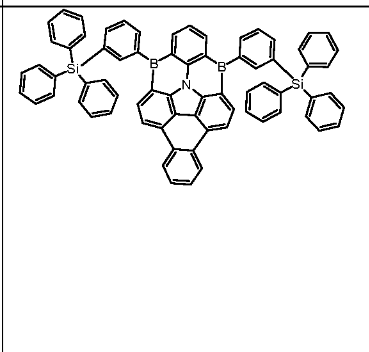
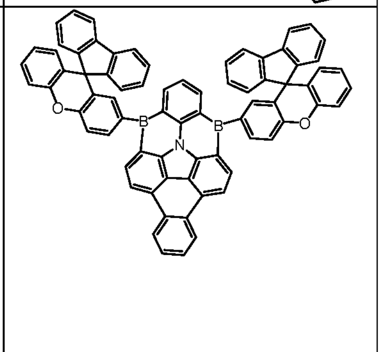
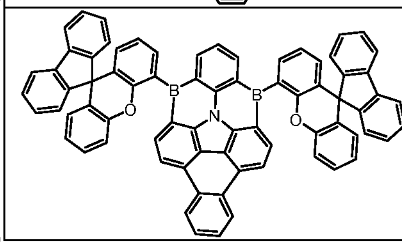
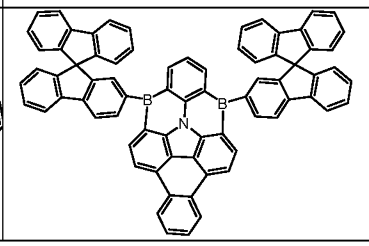
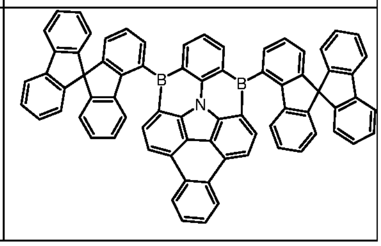
Preferably, the group Ar is on each occurrence, identically or differently, an aromatic or heteroaromatic ring system having 5 to 18, preferably 6 to 18 aromatic ring atoms, which may in each case also be substituted by one or more radicals R´.

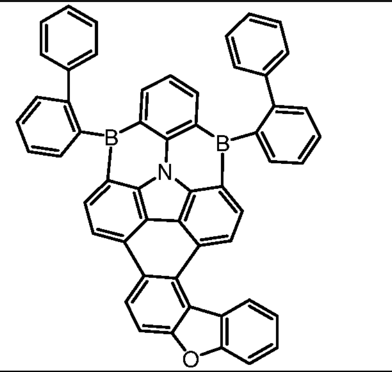
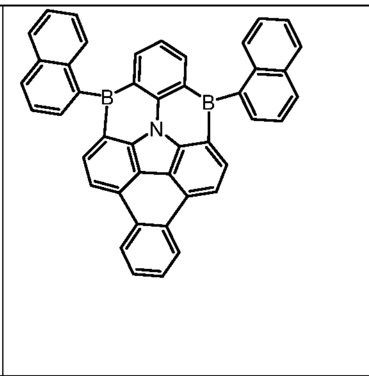
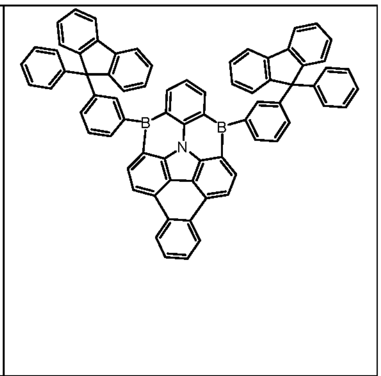
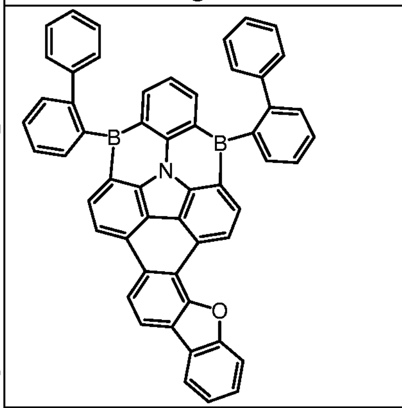
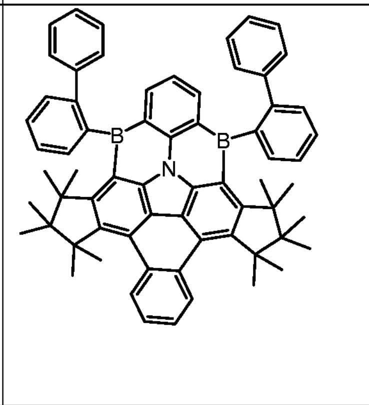
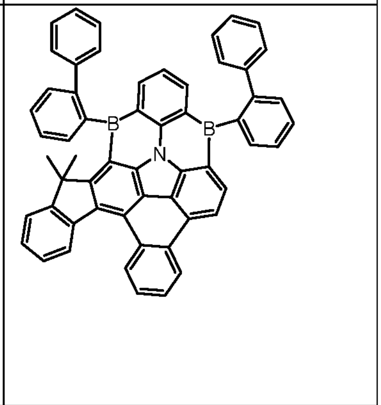
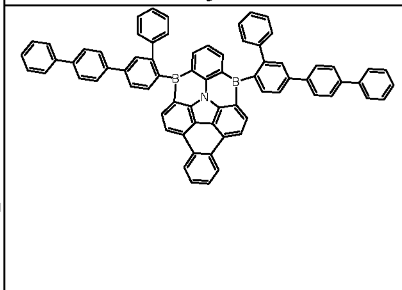
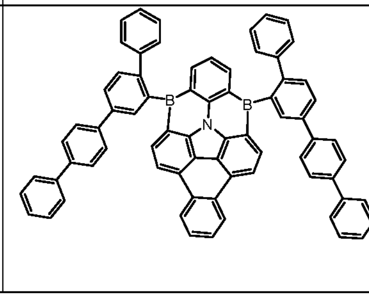
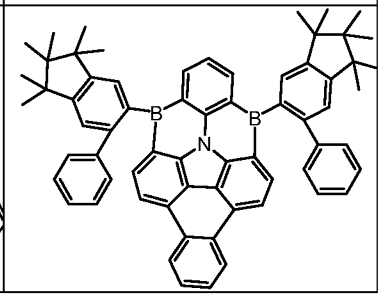
Preferably, R´ stands on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CN, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 10 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl group having 3 to 10 C atoms, where one or more H atoms may be replaced by D or F, or an aromatic or heteroaromatic ring system having 5 to 18, preferably 6 to 18 C atoms.

The following compounds are examples of compounds of formula (1):

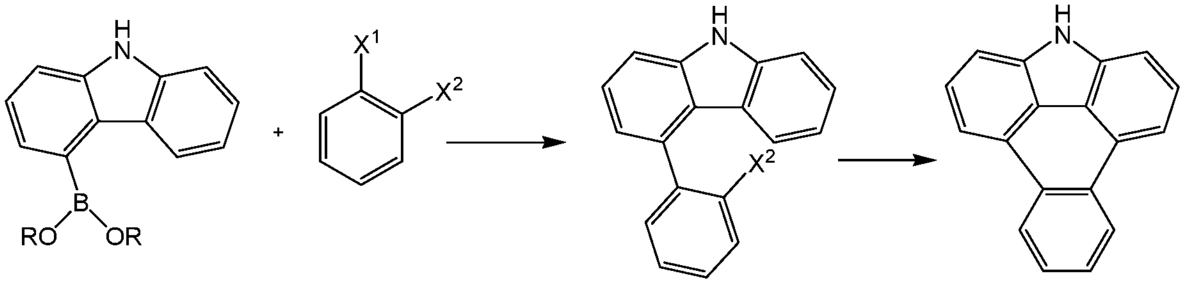
		
		
		
		
		

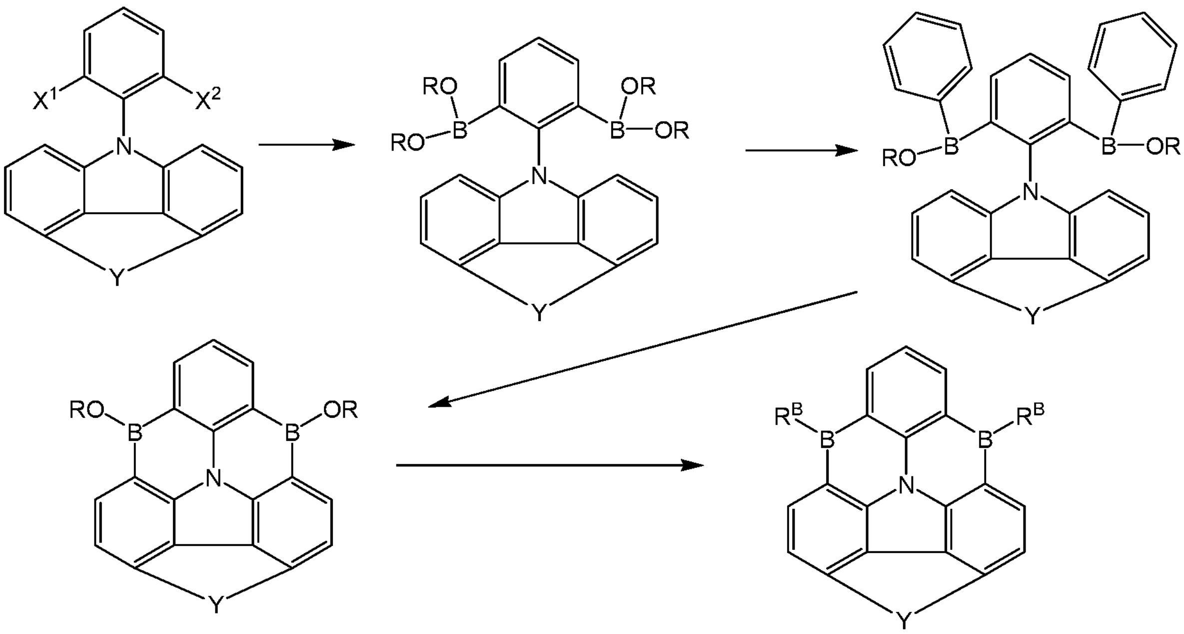
The compounds according to the invention can be prepared by synthesis steps known to the person skilled in the art, such as, for example, bromination, Suzuki coupling, Ullmann coupling, Hartwig-Buchwald coupling, etc. An example of a suitable synthesis process is depicted in general terms in schemes 1, 2 and 3 below.

Scheme 1



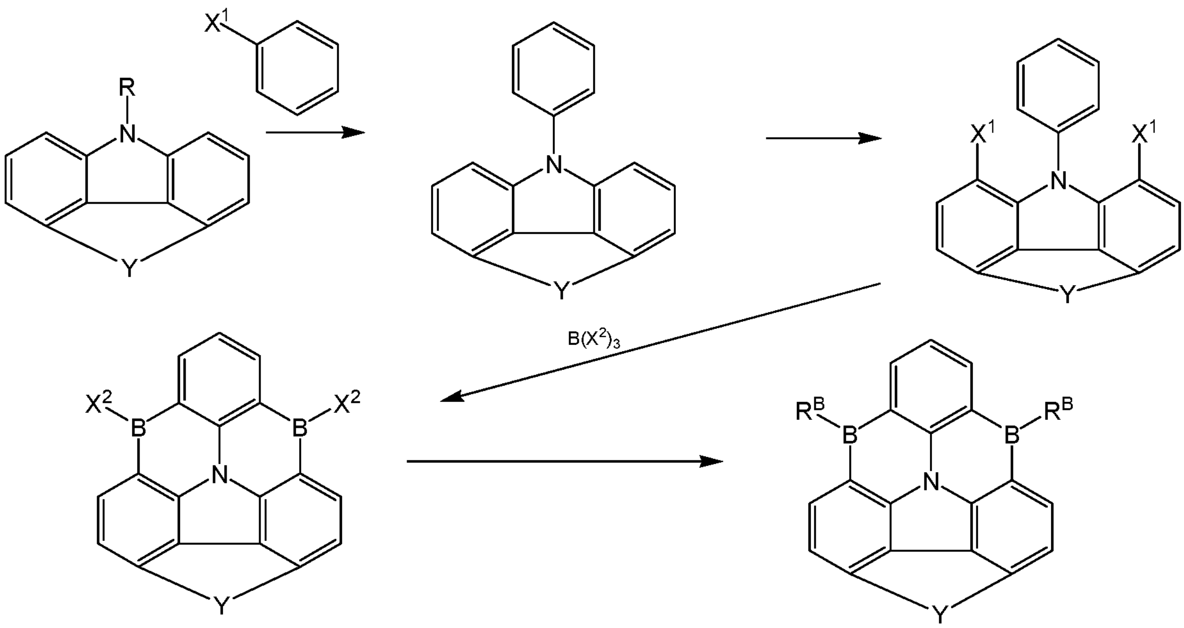
where X^1 and X^2 are leaving groups preferably selected from halogens like Br, Cl, I, preferably Br, where two radicals R present in the same boronic acid or ester group can be bonded to each other and form a ring, where the symbols Y and R^B have the same meaning as above and where the compounds depicted in Scheme 1 may be further substituted by radicals R^Y, R^2 and R^A as defined above. After coupling a suitable group to the N-group the compound of formula (1) can be synthesized according to scheme 2 or scheme 3.

Scheme 2



where X^1 and X^2 are leaving groups preferably selected from halogens like Br, Cl, I, preferably Br, where two radicals R present in the same boronic acid or ester group can be bonded to each other and form a ring, where the symbols Y and R^B have the same meaning as above and where the compounds depicted in Scheme 2 may be further substituted by radicals R^Y, R^2 and R^A as defined above.

Scheme 3



where X^1 and X^2 are a leaving groups preferably selected from halogens like Br, Cl, I, preferably Br, where the symbols Y and R^B have the same meaning as above, and where the compounds depicted in Scheme 3 may be further substituted by radicals R^Y, R^2 and R^A as defined above.

The present invention therefore relates to a process for the synthesis of the compounds according to the invention, comprising a step where a carbazole structure is substituted with at least one boronic acid or ester groups, where a cyclisation reaction with an aromatic or heteroaromatic compound occurs so that the aromatic or heteroaromatic compound bridges the two 6-membered rings of the carbazole structure forming a at least 6-membered ring. Then a triarylamine is formed with the carbazole structure.

The present invention therefore relates to a process for the synthesis of the compounds according to the invention, comprising a step where the previous formed triarylamine is substituted by at least two boronic acid or ester groups, where a cyclisation reaction occurs so that a boronic acid or ester group forms a 6-membered ring with the adjacent aromatic or heteroaromatic groups present in the triarylamine.

The present invention therefore also relates to a process for the synthesis of the compounds according to the invention, comprising a step where the previous formed triarylamine is substituted by at least two boron-halogen compounds, where a cyclisation reaction occurs so that a boron-halogen compound forms a 6-membered ring with the adjacent aromatic or heteroaromatic groups present in the triarylamine.

The present invention also relates to a polymer, oligomer or dendrimer containing one or more compounds according to formula (1), where the bond(s) to the polymer, oligomer or dendrimer may be localised at any positions in formula (1) which is substituted by R^2, R^A, R^B, R^Y or R.

For the processing of the compounds according to the invention from the liquid phase, for example by spin coating or by printing processes, formulations of the compounds according to the invention are necessary. These formulations can be, for example, solutions, dispersions or emulsions. It may be preferred to use mixtures of two or more solvents for this purpose. Suitable and preferred solvents are, for example, toluene, anisole, o-, m- or p-xylene, methyl benzoate, mesitylene, tetralin, veratrol, THF, methyl-THF, THP, chlorobenzene, dioxane, phenoxytoluene, in particular 3-phenoxytoluene, (-)-fenchone, 1,2,3,5-tetramethylbenzene, 1,2,4,5-tetramethylbenzene, 1-methylnaphthalene, 2-methylbenzothiazole, 2-phenoxyethanol, 2-pyrrolidinone, 3-methylanisole, 4-methylanisole, 3,4-dimethylanisole, 3,5-dimethylanisole, acetophenone, α-terpineol, benzothiazole, butyl benzoate, cumene, cyclohexanol, cyclohexanone, cyclohexylbenzene, decalin, dodecylbenzene, ethyl benzoate, indane, methyl benzoate, NMP, p-cymene, phenetole, 1,4-diisopropylbenzene, dibenzyl ether, diethylene glycol butyl methyl ether, triethylene glycol butyl methyl ether, diethylene glycol dibutyl ether, triethylene glycol dimethyl ether, diethylene glycol monobutyl ether, tripropylene glycol dimethyl ether, tetraethylene glycol dimethyl ether, 2-isopropylnaphthalene, pentylbenzene, hexylbenzene, heptylbenzene, octylbenzene, 1,1-bis(3,4-dimethylphenyl)ethane or mixtures of these solvents.

The present invention therefore furthermore relates to a formulation comprising a compound according to the invention and at least one further compound. The further compound may be, for example, a solvent, in particular one of the above-mentioned solvents or a mixture of these solvents. However, the further compound may also be at least one further organic or inorganic compound which is likewise employed in the electronic device, for example an emitting compound, in particular a phosphorescent dopant, and/or a further matrix material. Suitable emitting compounds and further matrix materials are indicated below in connection with the organic electroluminescent device. This further compound may also be polymeric.

The compounds and mixtures according to the invention are suitable for use in an electronic device. An electronic device here is taken to mean a device which comprises at least one layer which comprises at least one organic compound. However, the component here may also comprise inorganic materials or also layers built up entirely from inorganic materials.

The present invention therefore furthermore relates to the use of the compounds or mixtures according to the invention in an electronic device, in particular in an organic electroluminescent device.

The present invention again furthermore relates to an electronic device comprising at least one of the compounds or mixtures according to the invention mentioned above. The preferences stated above for the compound also apply to the electronic devices.

The electronic device is preferably selected from the group consisting of organic electroluminescent devices (OLEDs, PLEDs), organic integrated circuits (O-ICs), organic field-effect transistors (O-FETs), organic thin-film transistors (O-TFTs), organic light-emitting transistors (O-LETs), organic solar cells (O-SCs), organic dye-sensitised solar cells, organic optical detectors, organic photoreceptors, organic field-quench devices (O-FQDs), light-emitting electrochemical cells (LECs), organic laser diodes (O-lasers) and "organic plasmon emitting devices" (D. M. Koller *et al.*, *Nature Photonics* **2008**, 1-4), preferably organic electroluminescent devices (OLEDs, PLEDs), in particular phosphorescent OLEDs.

The organic electroluminescent device comprises a cathode, an anode and at least one emitting layer. Apart from these layers, it may also comprise further layers, for example in each case one or more hole-injection layers, hole-transport layers, hole-blocking layers, electron-transport layers, electron-injection layers, exciton-blocking layers, electron-blocking layers and/or charge-generation layers. It is likewise possible for interlayers, which have, for example, an exciton-blocking function, to be introduced between two emitting layers. However, it should be pointed out that each of these layers does not necessarily have to be present. The organic electroluminescent device here may comprise one emitting layer or a plurality of emitting layers. If a plurality of emission layers are present, these preferably have in total a plurality of emission maxima between 380 nm and 750 nm, resulting overall in white emission, i.e. various emitting compounds which are able to fluoresce or phosphoresce are used in the emitting layers. Particular preference is given to systems having three emitting layers, where the three layers exhibit blue, green and orange or red emission (for the basic structure see, for example, WO 2005/011013). These can be fluorescent or phosphorescent emission layers or hybrid systems, in which fluorescent and phosphorescent emission layers are combined with one another.

The compound according to the invention in accordance with the embodiments indicated above can be employed in various layers, depending on the precise structure and on the substitution.

Preference is given to an organic electroluminescent device comprising a compound of the formula (1) or in accordance with the preferred embodiments as fluorescent emitters or TADF (Thermally Activated Delayed Fluorescence) emitters. More particularly, the compound of the formula (1) or in accordance with the preferred embodiments is preferably employed as a blue-fluorescent emitter showing prompt fluorescence or as a blue TADF emitter.

In accordance with another preferred embodiment of the invention, the compound of formula (1) or in accordance with the preferred embodiments is employed in a hyperfluorescent system, as described for example in WO2015/135624, comprising the compound of formula (1) as a fluorescent emitter and a sensitizer compound selected from thermally activated delayed fluorescence compounds (TADF compounds), wherein the energy of the sensitizer is transferred to the fluorescent emitter via Förster resonance energy transfer.

In accordance with still another preferred embodiment of the invention, the compound of formula (1) or in accordance with the preferred embodiments is employed in a hyperphosphorescent system, as described for example in WO2001/08230A1, comprising the compound of formula (1) as a fluorescent emitter, and a sensitizer compound selected from phosphorescent compounds, wherein the energy of the sensitizer is transferred to the fluorescent emitter via Förster resonance energy transfer.

The compounds of formula (1) can also be employed in an electron-transport layer and/or in an electron-blocking or exciton-blocking layer and/or in a hole-transport layer, depending on the precise substitution. The preferred embodiments indicated above also apply to the use of the materials in organic electronic devices.

The compound of formula (1) is particularly suitable for use as a blue emitter compound. The electronic device concerned may comprise a single emitting layer comprising the compound according to the invention or it may comprise two or more emitting layers. The further emitting layers here may comprise one or more compounds according to the invention or alternatively other compounds.

If the compound according to the invention is employed as a fluorescent emitter or TADF emitter in an emitting layer, it is preferably employed in combination with one or more matrix materials. A matrix material here is taken to mean a material which is present in the emitting layer, preferably as the principal component, and which does not emit light on operation of the device.

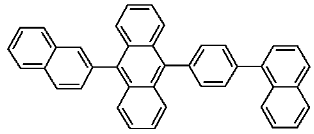
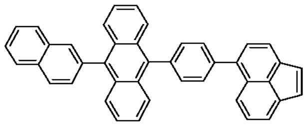
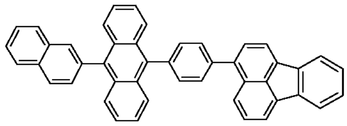
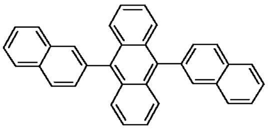
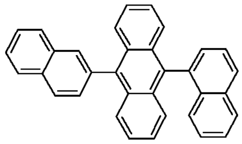
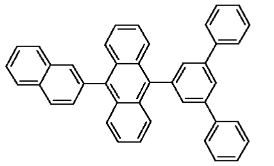
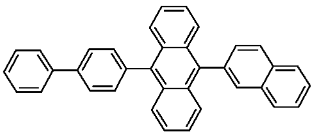
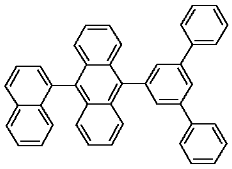
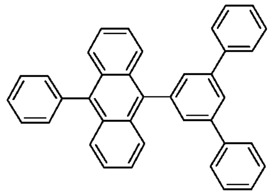
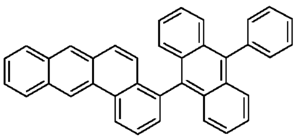
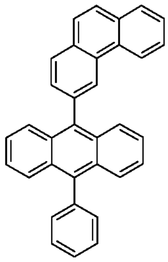
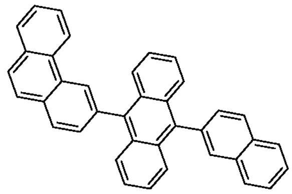
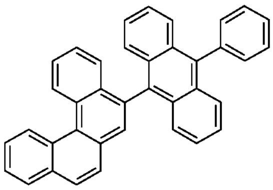
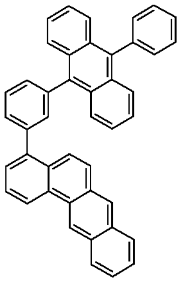
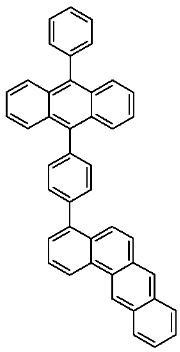
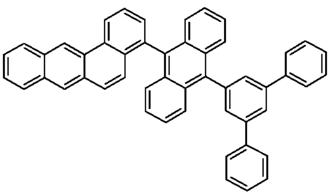
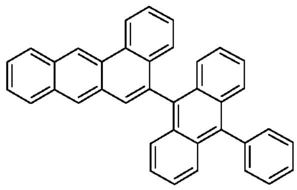
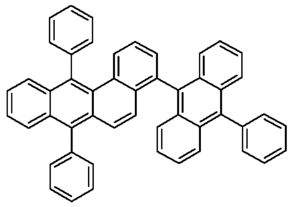
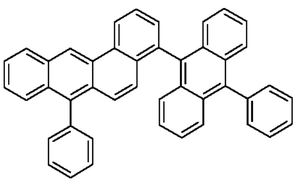
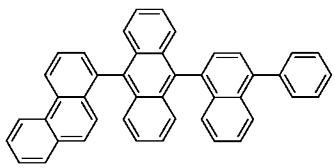
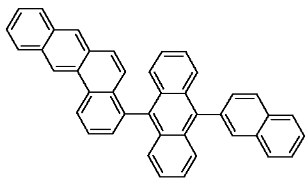
Preferably, the matrix compound has a glass transition temperature T_G of greater than 70°C, more preferably greater than 90°C, most preferably greater than 110°C.

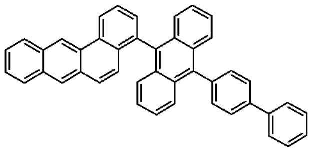
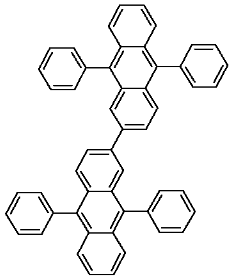
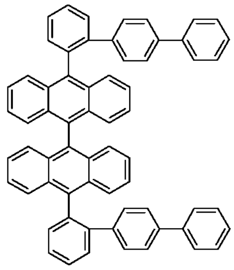
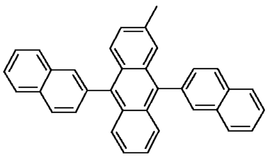
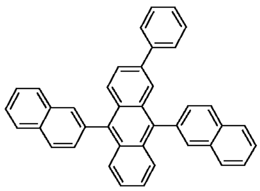
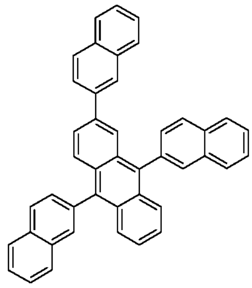
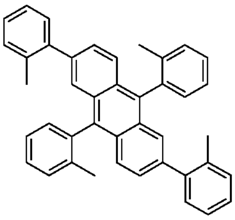
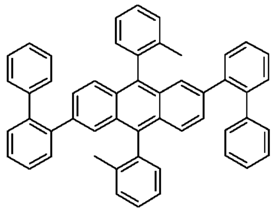
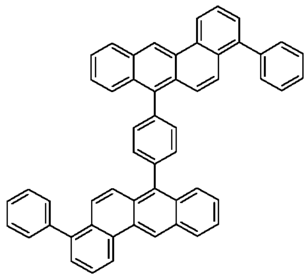
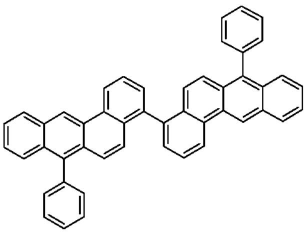
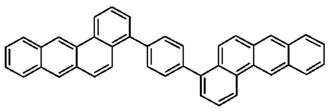
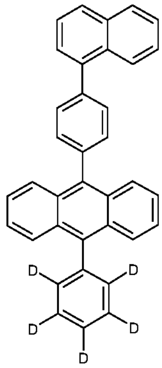
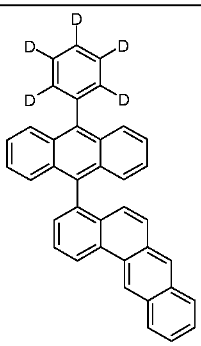
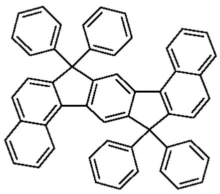
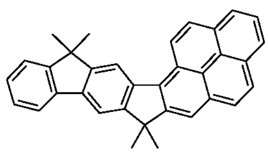
The proportion of the emitting compound in the mixture of the emitting layer is between 0.1 and 50.0%, preferably between 0.5 and 20.0%, particularly preferably between 1.0 and 10.0%. Correspondingly, the proportion of the matrix material or matrix materials is between 50.0 and 99.9%, preferably between 80.0 and 99.5%, particularly preferably between 90.0 and 99.0%.

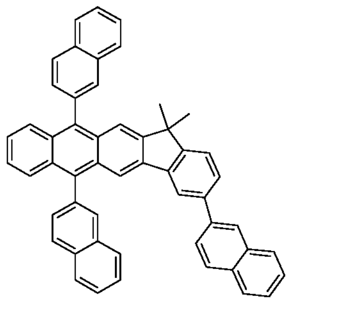
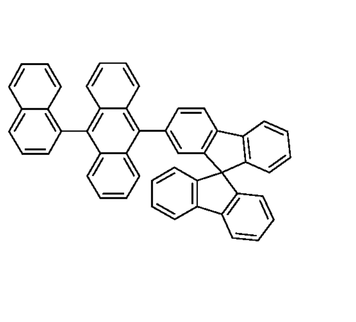
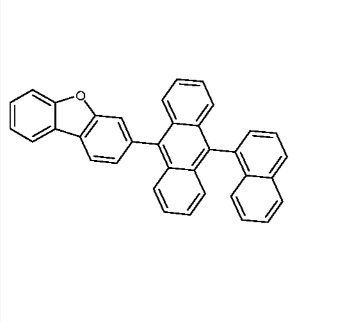
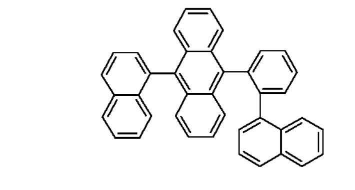
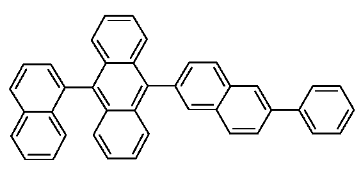
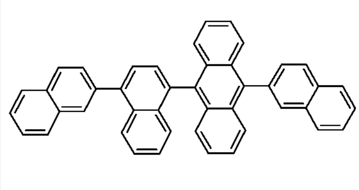
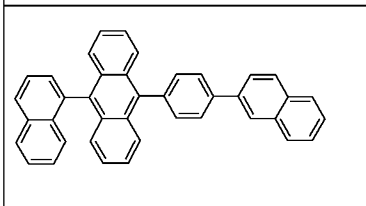
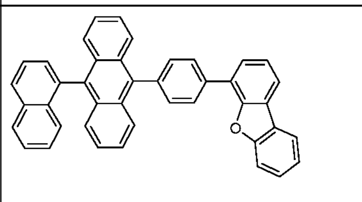
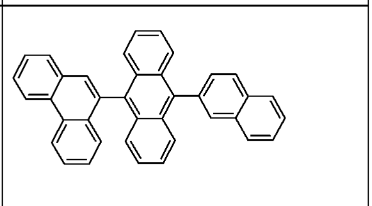
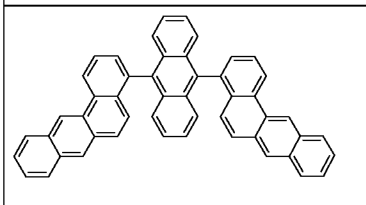
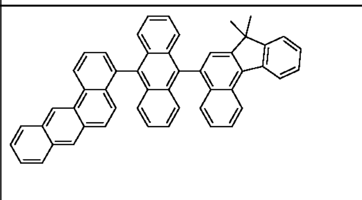
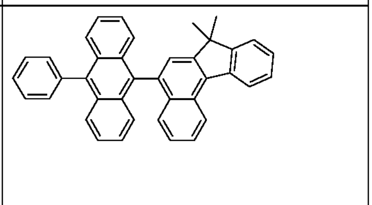
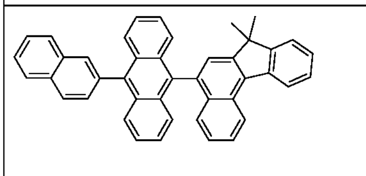
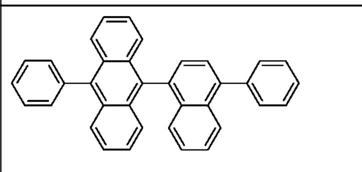
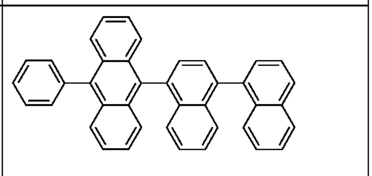
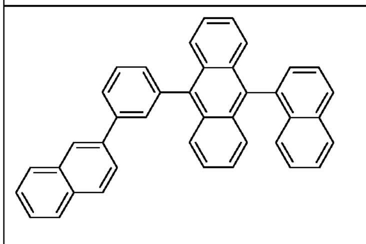
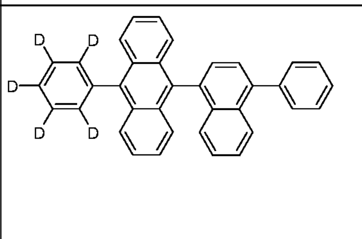
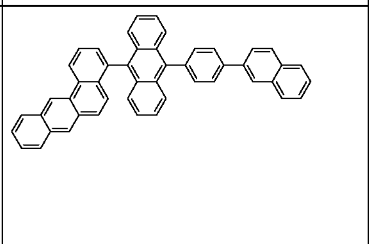
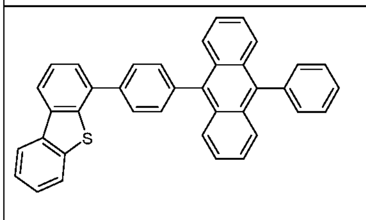
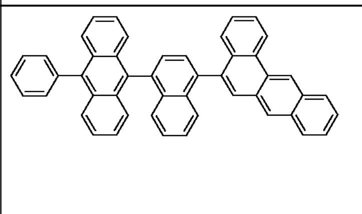
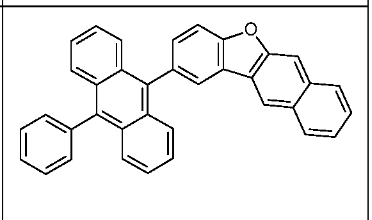
The specifications of the proportions in % are, for the purposes of the present application, taken to mean % by vol. if the compounds are applied from the gas phase and % by weight if the compounds are applied from solution.

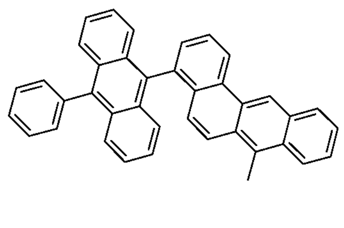
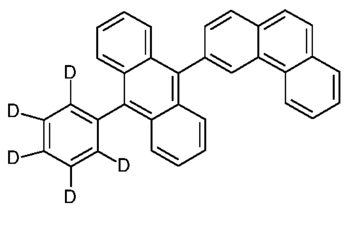
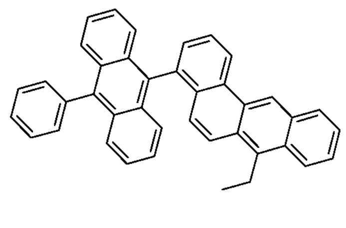
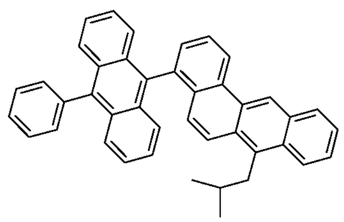
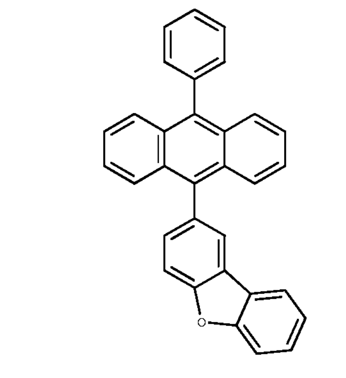
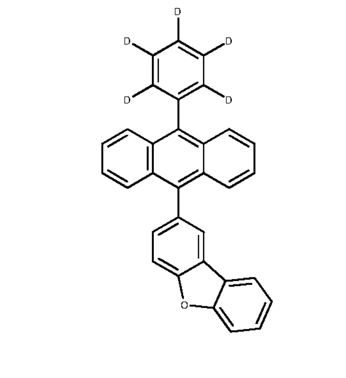
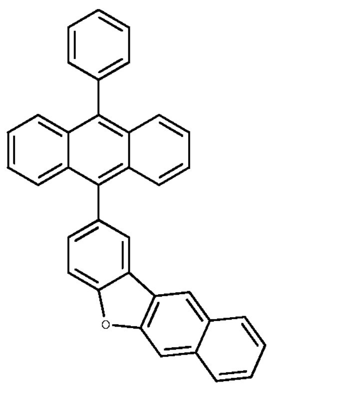
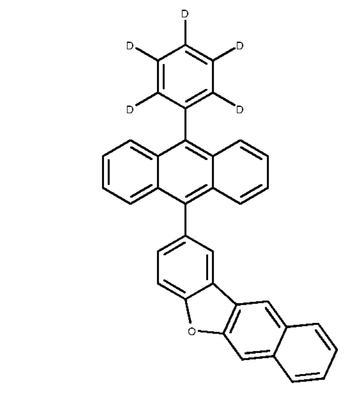
If the compound of formula (1) or in accordance with the preferred embodiments is employed in an emitting layer as a fluorescent emitter (prompt fluorescence), then the preferred matrix materials for use in combination with the fluorescent emitter are selected from the classes of the oligoarylenes (for example 2,2‘,7,7‘-tetraphenylspirobifluorene in accordance with EP 676461 or dinaphthylanthracene), in particular the oligoarylenes containing condensed aromatic groups, the oligoarylenevinylenes (for example DPVBi or spiro-DPVBi in accordance with EP 676461), the polypodal metal complexes (for example in accordance with WO 2004/081017), the hole-conducting compounds (for example in accordance with WO 2004/058911), the electron-conducting compounds, in particular ketones, phosphine oxides, sulfoxides, etc. (for example in accordance with WO 2005/084081 and WO 2005/084082), the atropisomers (for example in accordance with WO 2006/048268), the boronic acid derivatives (for example in accordance with WO 2006/117052) or the benzanthracenes (for example in accordance with WO 2008/145239). Particularly preferred matrix materials are selected from the classes of the oligoarylenes, comprising naphthalene, anthracene, benzanthracene and/or pyrene or atropisomers of these compounds, the oligoarylenevinylenes, the ketones, the phosphine oxides and the sulfoxides. Very particularly preferred matrix materials are selected from the classes of the oligoarylenes, comprising anthracene, benzanthracene, benzophenanthrene and/or pyrene or atropisomers of these compounds. An oligoarylene in the sense of this invention is intended to be taken to mean a compound in which at least three aryl or arylene groups are bonded to one another.

Particularly preferred matrix materials for use in combination with the compounds of the formula (1) employed as fluorescent emitters in the emitting layer are depicted in the following table:

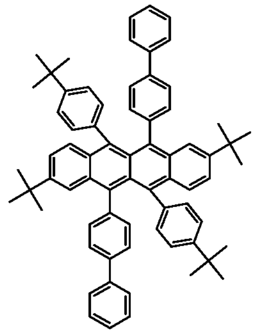
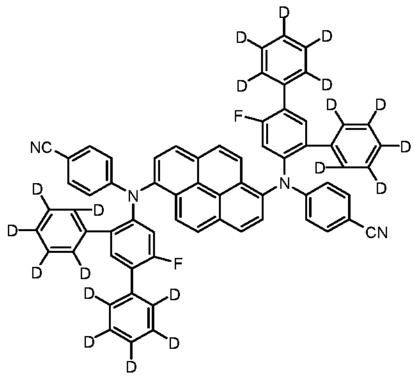
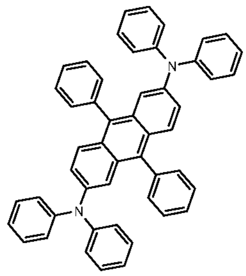
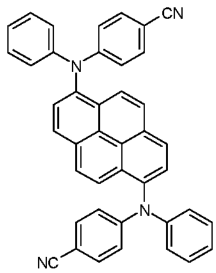
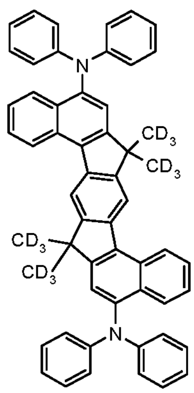
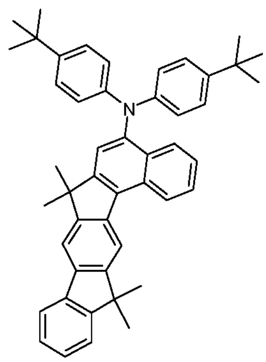
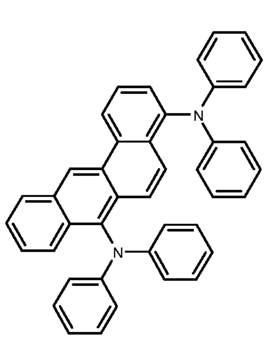
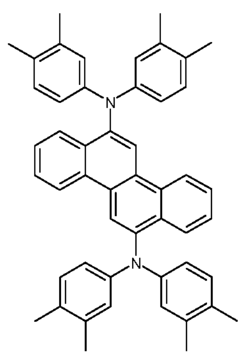
		
		
		
		
		
		
		

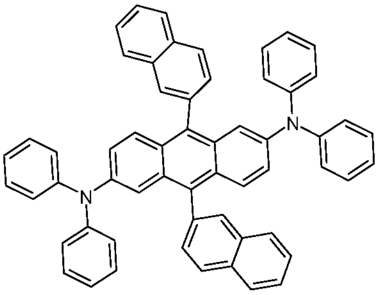
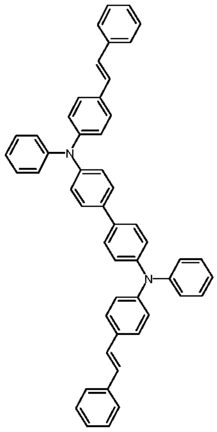
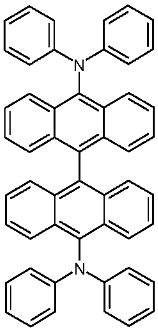
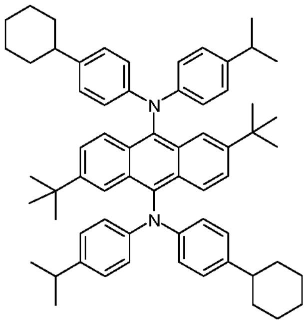
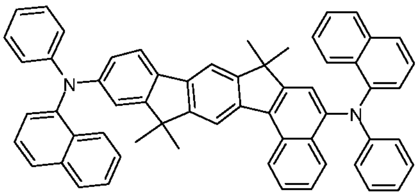
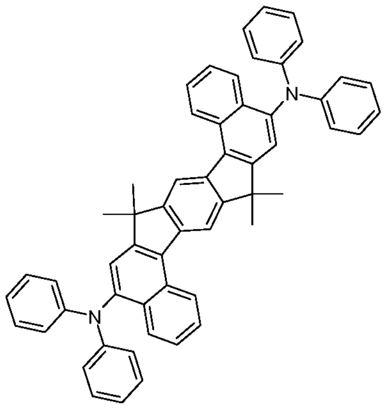
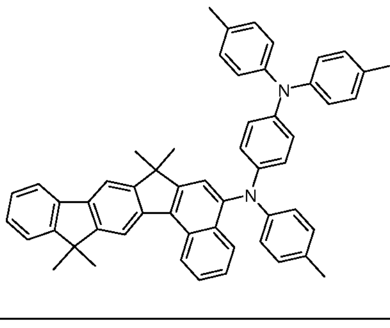
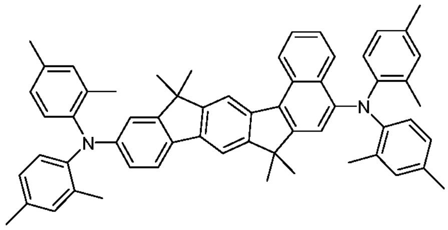
		
		
		

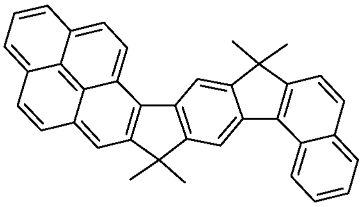
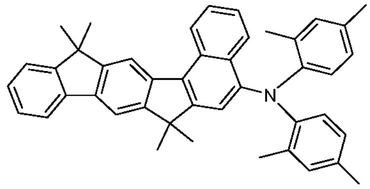
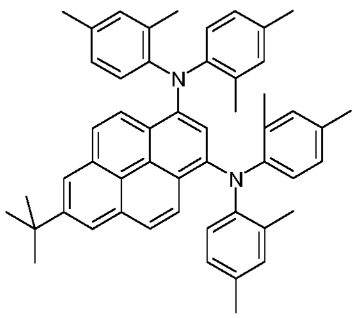
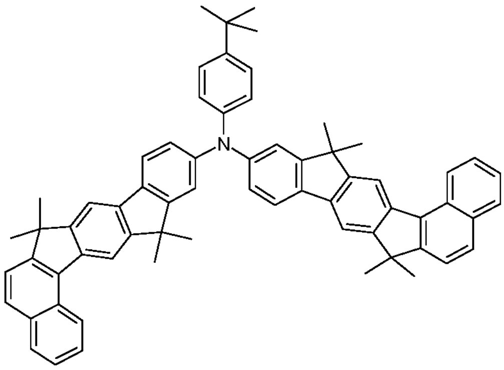
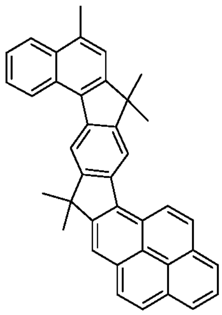
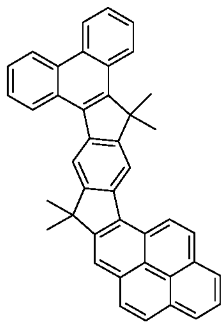
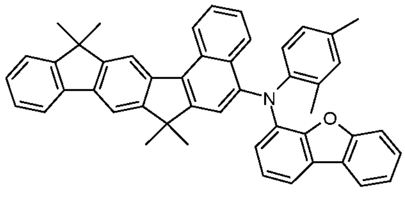
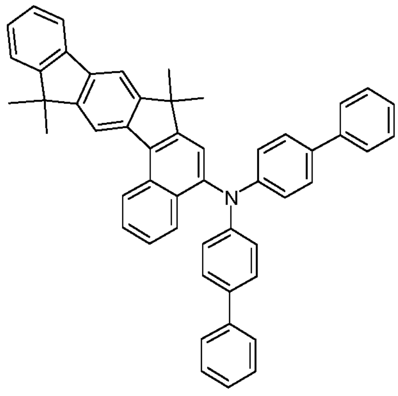
If the compound according to the invention is employed as a fluorescent emitting compound in an emitting layer, it may be employed in combination with one or more other fluorescent emitting compounds.

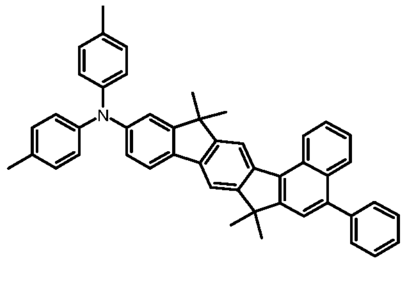
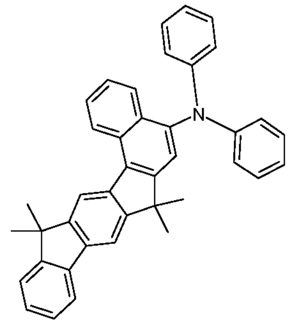
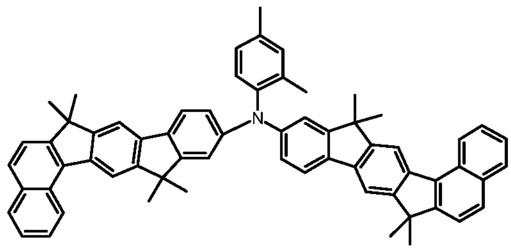
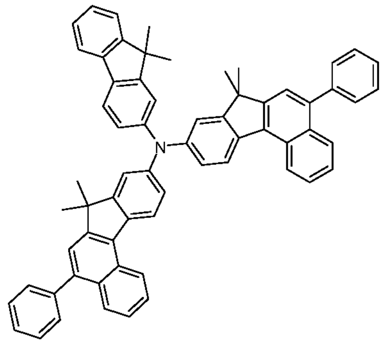
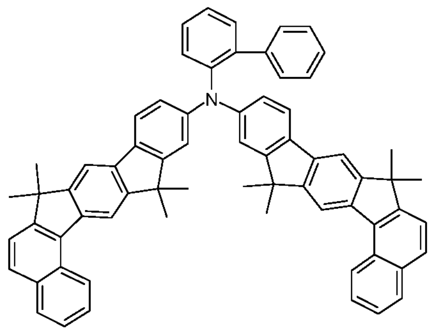
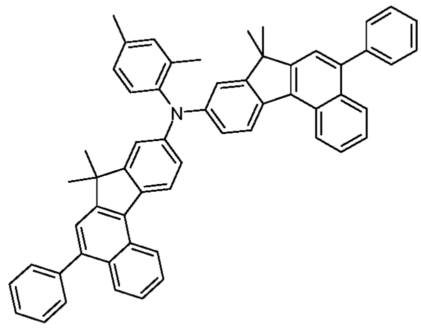
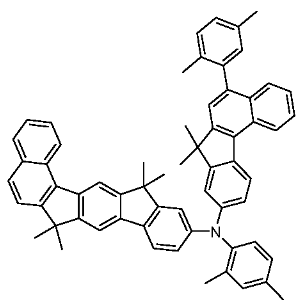
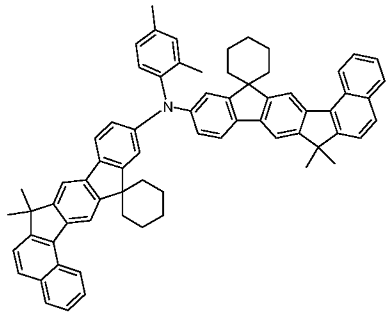
Preferred fluorescent emitters, besides the compounds according to the invention, are selected from the class of the arylamines. An arylamine in the sense of this invention is taken to mean a compound which contains three substituted or unsubstituted aromatic or heteroaromatic ring systems bonded directly to the nitrogen. At least one of these aromatic or heteroaromatic ring systems is preferably a condensed ring system, particularly preferably having at least 14 aromatic ring atoms. Preferred examples thereof are aromatic anthracenamines, aromatic anthracenediamines, aromatic pyrenamines, aromatic pyrenediamines, aromatic chrysenamines or aromatic chrysene-diamines. An aromatic anthracenamine is taken to mean a compound in which one diarylamino group is bonded directly to an anthracene group, preferably in the 9-position. An aromatic anthracenediamine is taken to mean a compound in which two diarylamino groups are bonded directly to an anthracene group, preferably in the 9,10-position. Aromatic pyrenamines, pyrene-diamines, chrysenamines and chrysenediamines are defined analogously thereto, where the diarylamino groups are preferably bonded to the pyrene in the 1-position or in the 1,6-position. Further preferred emitters are indenofluorenamines or indenofluorenediamines, for example in accordance with WO 2006/108497 or WO 2006/122630, benzoindenofluorenamines or benzoindenofluorenediamines, for example in accordance with WO 2008/006449, and dibenzoindenofluorenamines or dibenzoindenofluorene-diamines, for example in accordance with WO 2007/140847, and the indenofluorene derivatives containing condensed aryl groups which are disclosed in WO 2010/012328. Still further preferred emitters are benzanthracene derivatives as disclosed in WO 2015/158409, anthracene derivatives as disclosed in WO 2017/036573, fluorene dimers like in WO 2016/150544 or phenoxazine derivatives as disclosed in WO 2017/028940 and WO 2017/028941. Preference is likewise given to the pyrenarylamines disclosed in WO 2012/048780 and WO 2013/185871. Preference is likewise given to the benzoindenofluorenamines disclosed in WO 2014/037077, the benzofluorenamines disclosed in WO 2014/106522 and the indenofluorenes disclosed in WO 2014/111269 or WO 2017/036574.

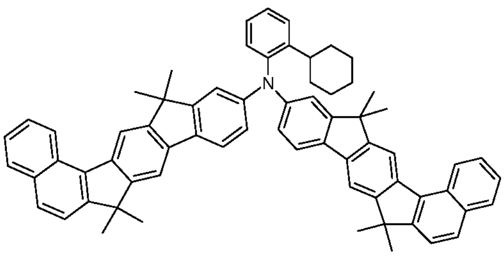
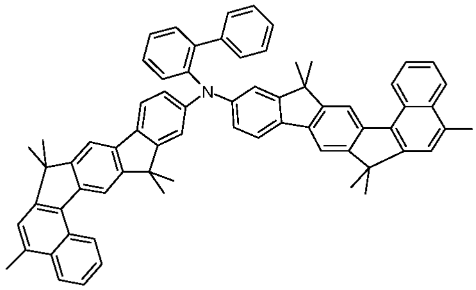
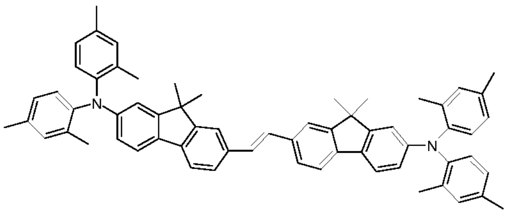
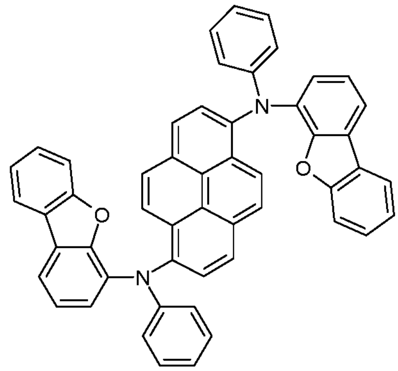
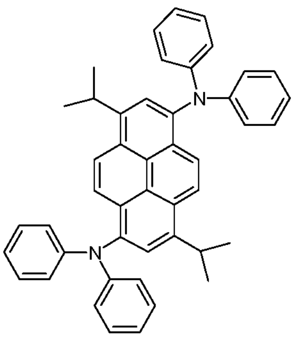
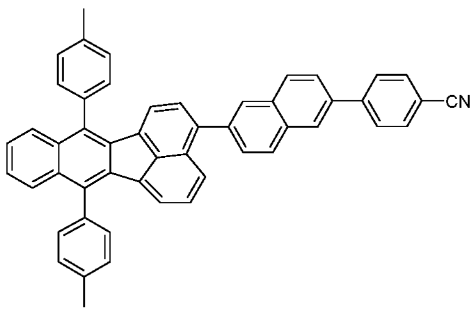
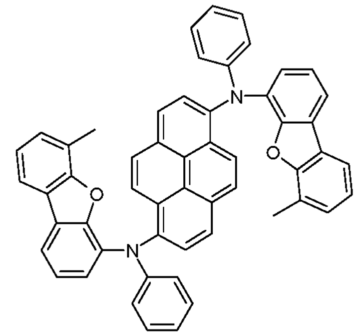
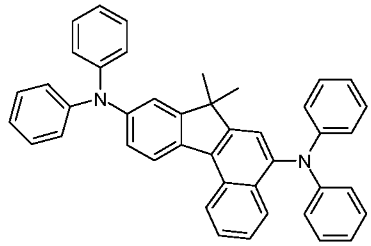
Examples of preferred fluorescent emitting compounds, besides the compounds according to the invention, which can be used in combination with the compounds of the invention in an emitting layer or which can be used in another emitting layer of the same device are depicted in the following table:

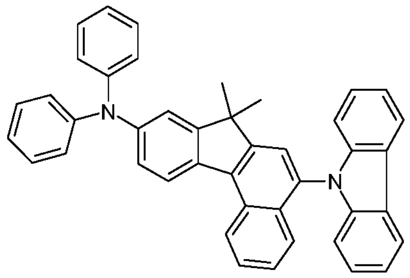
	
	
	
	

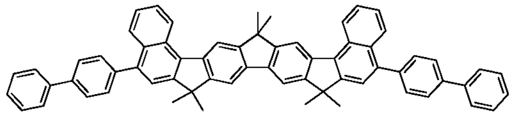
	
	
	
	

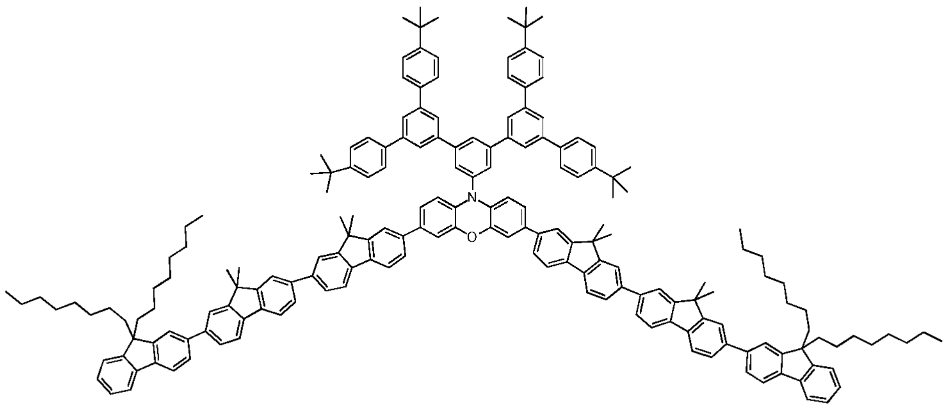
	
	
	
	

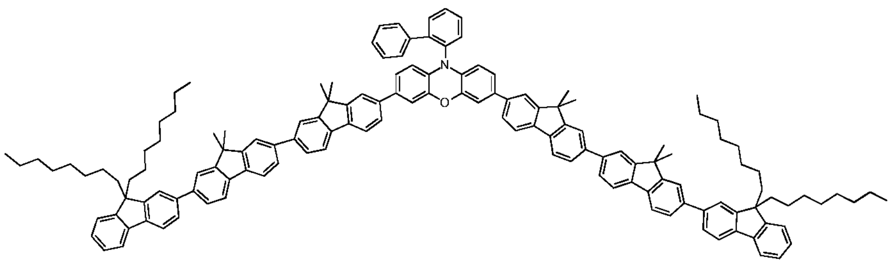
	
	
	
	

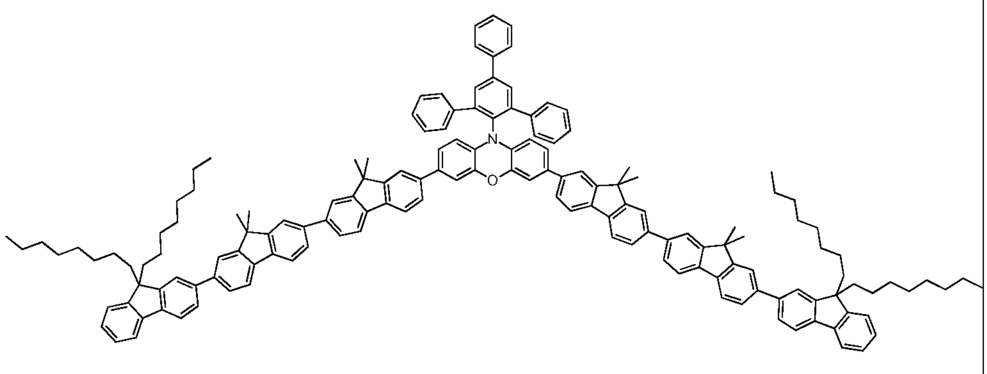
	
	
	
	

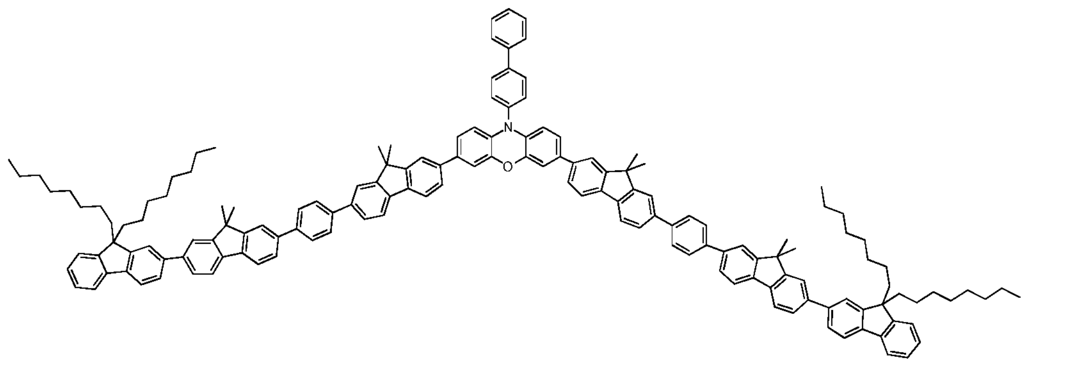


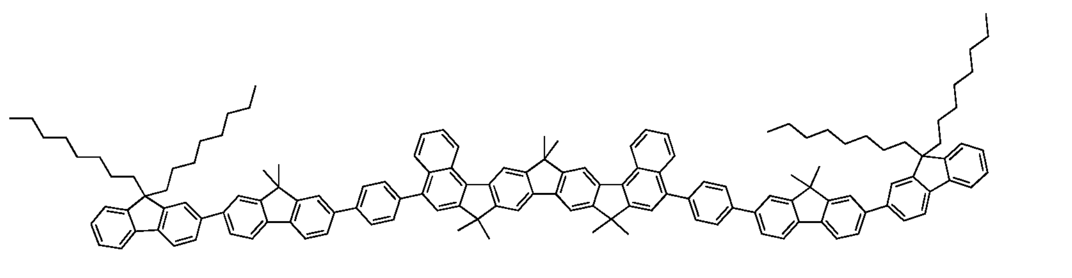


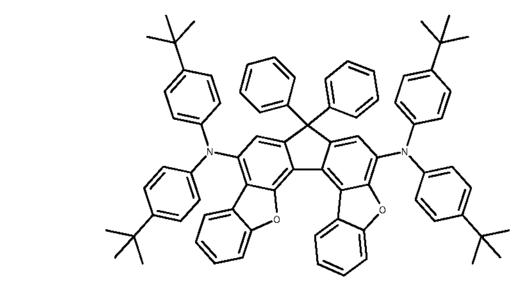


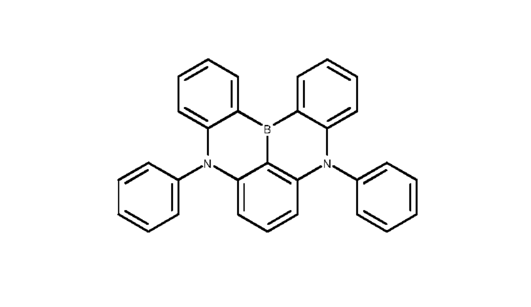












If the compound of formula (1) or in accordance with the preferred embodiments is employed in an emitting layer as a TADF emitter, then the preferred matrix materials for use in combination with the TADF emitter are selected from the classes of the ketones, phosphine oxides, sulfoxides and sulfones, for example according to WO 2004/013080, WO 2004/093207, WO 2006/005627 or WO 2010/006680, triarylamines, carbazole derivatives, e.g. CBP (N,N-biscarbazolylbiphenyl), m-CBP or the carbazole derivatives disclosed in WO 2005/039246, US 2005/0069729, JP 2004/288381, EP 1205527, WO 2008/086851 or US 2009/0134784, dibenzofuran derivatives, indolocarbazole derivatives, for example according to WO 2007/063754 or WO 2008/056746, indenocarbazole derivatives, for example according to WO 2010/136109 or WO 2011/000455, azacarbazoles, for example according to EP 1617710, EP 1617711, EP 1731584, JP 2005/347160, bipolar matrix materials, for example according to WO 2007/137725, silanes, for example according to WO 2005/111172, azaboroles or boronic esters, for example according to WO 2006/117052, diazasilole derivatives, for example according to WO 2010/054729, diazaphosphole derivatives, for example according to WO 2010/054730, triazine derivatives, for example according to WO 2010/015306, WO 2007/063754 or WO 2008/056746, pyrimidine derivatives, quinoxaline derivatives, Zn complexes, Al complexes or Be complexes, for example according to EP 652273 or WO 2009/062578, or bridged carbazole derivatives, for example according to US 2009/0136779, WO 2010/050778, WO 2011/042107 or WO 2011/088877. Suitable matrix materials are also those described in WO 2015/135624. These are incorporated into the present invention by reference. It is also possible to use mixtures of two or more of these matrix materials.

The matrix compounds for TADF emitters are preferably charge-transporting, i.e. electron-transporting or hole-transporting, or bipolar compounds. Matrix compounds used may additionally also be compounds which are neither hole- nor electron-transporting in the context of the present application. An electron-transporting compound in the context of the present invention is a compound having a LUMO ≤ -2.50 eV. Preferably, the LUMO is ≤ -2.60 eV, more preferably ≤ -2.65 eV, most preferably ≤ -2.70 eV. The LUMO is the lowest unoccupied molecular orbital. The value of the LUMO of the compound is determined by quantum-chemical calculation, as described in general terms in the examples section at the back. A hole-transporting compound in the context of the present invention is a compound having a HOMO ≥ -5.5 eV. The HOMO is preferably ≥ -5.4 eV, more preferably ≥ -5.3 eV. The HOMO is the highest occupied molecular orbital. The value of the HOMO of the compound is determined by quantum-chemical calculation, as described in general terms in the examples section at the back. A bipolar compound in the context of the present invention is a compound which is both hole- and electron-transporting.

Suitable electron-conducting matrix compounds for TADF emitters are selected from the substance classes of the triazines, the pyrimidines, the lactams, the metal complexes, especially the Be, Zn and Al complexes, the aromatic ketones, the aromatic phosphine oxides, the azaphospholes, the azaboroles substituted by at least one electron-conducting substituent, and the quinoxalines. In a preferred embodiment of the invention, the electron-conducting compound is a purely organic compound, i.e. a compound containing no metals.

Furthermore, the hyperfluorescent and hyperphosphorescent systems as mentioned above preferably comprise, additionally to the sensitizer and the fluorescent emitter, at least one matrix material. In this case, it is preferable that the lowest triplet energy of the matrix compound is not more than 0.1 eV lower than the triplet energy of the sensitizer compound.
Especially preferably, T_1(matrix) ≥ T_1(sensitizer).
More preferably: T_1(matrix) − T_1(sensitizer) ≥ 0.1 eV;
most preferably: T_1(matrix) − T_1(sensitizer) ≥ 0.2 eV.
T_1(matrix) here is the lowest triplet energy of the matrix compound and T_1(sensitizer) is the lowest triplet energy of the sensitizer compound. The triplet energy of the matrix compound T_1(matrix) is determined here from the edge of the photoluminescence spectrum measured at 4 K of the neat film. T_1(sensitizer) is determined from the edge of the photoluminescence spectrum measured at room temperature in toluene solution.

Suitable matrix materials for hyperfluorescent or hyperphosphorescent systems are the same matrix materials as mentioned above, more preferred are the matrix materials that are also preferred for TADF materials.

Suitable phosphorescent emitters are, in particular, compounds which emit light, preferably in the visible region, on suitable excitation and in addition contain at least one atom having an atomic number greater than 20, preferably greater than 38 and less than 84, particularly preferably greater than 56 and less than 80. The phosphorescent emitters used are preferably compounds which contain copper, molybdenum, tungsten, rhenium, ruthenium, osmium, rhodium, iridium, palladium, platinum, silver, gold or europium, in particular compounds which contain iridium, platinum or copper.

For the purposes of the present invention, all luminescent iridium, platinum or copper complexes are regarded as phosphorescent compounds.

Examples of the phosphorescent emitters described above are revealed by the applications WO 2000/70655, WO 2001/41512, WO 2002/02714, WO 2002/15645, EP 1191613, EP 1191612, EP 1191614, WO 2005/033244, WO 2005/019373 and US 2005/0258742. In general, all phosphorescent complexes as used in accordance with the prior art for phosphorescent OLEDs and as are known to the person skilled in the art in the area of organic electroluminescent devices are suitable for use in the devices according to the invention. The person skilled in the art will also be able to employ further phosphorescent complexes without inventive step in combination with the compounds according to the invention in OLEDs.

Preferred matrix materials for phosphorescent emitters are aromatic ketones, aromatic phosphine oxides or aromatic sulfoxides or sulfones, for example in accordance with WO 2004/013080, WO 2004/093207, WO 2006/005627 or WO 2010/006680, triarylamines, carbazole derivatives, for example CBP (N,N-biscarbazolylbiphenyl) or the carbazole derivatives disclosed in WO 2005/039246, US 2005/0069729, JP 2004/288381, EP 1205527 or WO 2008/086851, indolocarbazole derivatives, for example in accordance with WO 2007/063754 or WO 2008/056746, indenocarbazole derivatives, for example in accordance with WO 2010/136109, WO 2011/000455 or WO

2013/041176, azacarbazole derivatives, for example in accordance with EP 1617710, EP 1617711, EP 1731584, JP 2005/347160, bipolar matrix materials, for example in accordance with WO 2007/137725, silanes, for example in accordance with WO 2005/111172, azaboroles or boronic esters, for example in accordance with WO 2006/117052, triazine derivatives, for example in accordance with WO 2010/015306, WO 2007/063754 or WO 2008/056746, zinc complexes, for example in accordance with EP 652273 or WO 2009/062578, diazasilole or tetraazasilole derivatives, for example in accordance with WO 2010/054729, diazaphosphole derivatives, for example in accordance with WO 2010/054730, bridged carbazole derivatives, for example in accordance with US 2009/0136779, WO 2010/050778, WO 2011/042107, WO 2011/088877 or WO 2012/143080, triphenylene derivatives, for example in accordance with WO 2012/048781, or lactams, for example in accordance with WO 2011/116865 or WO 2011/137951.

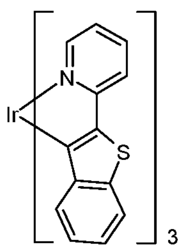
More particularly, when the phosphorescent compound is employed in a hyperphosphorescent system as described above, the phosphorescent compound is preferably selected from the phosphorescent organometallic complexes, which are described, for example, in WO2015/091716. Also particularly preferred are the phosphorescent organometallic complexes, which are described in WO2000/70655, WO2001/41512, WO2002/02714, WO2002/15645, EP1191612, WO2005/033244, WO2005/019373, US2005/0258742, WO2006/056418, WO2007/115970, WO2007/115981, WO2008/000727, WO2009/050281, WO2009/050290, WO2011/051404, WO2011/073149, WO2012/121936, US2012/0305894, WO2012/170571, WO2012/170461, WO2012/170463, WO2006/121811, WO2007/095118, WO2008/156879, WO2008/156879, WO2010/068876, WO2011/106344, WO2012/172482, EP3126371, WO2015/014835, WO2015/014944, WO2016/020516, US20160072081, WO2010/086089, WO2011/044988, WO2014/008982, WO2014/023377, WO2014/094961, WO2010/069442, WO2012/163471, WO2013/020631, US20150243912, WO2008/000726, WO2010/015307, WO2010/054731, WO2010/054728, WO2010/099852, WO2011/032626, WO2011/157339, WO2012/007086, WO2015/036074, WO2015/104045, WO2015/117718, WO2016/015815, which are preferably iridium and platinum complexes.

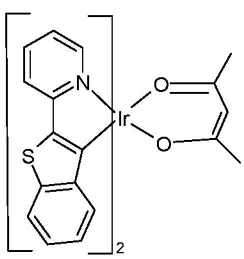
Particularly preferred are also the phosphorescent organometallic complexes having polypodal ligands as described, for example, in WO2004/081017, WO2005/042550, US2005/0170206, WO2009/146770, WO2010/102709, WO2011/066898, WO2016124304, WO2017/032439, WO2018/019688, EP3184534 and WO2018/011186.

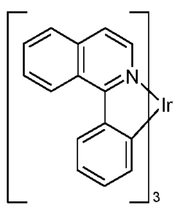
Particularly preferred are also the phosphorescent binuclear organometallic complexes as described, for example, in WO2011/045337, US20150171350, WO2016/079169, WO2018/019687, WO2018/041769, WO2018/054798, WO2018/069196, WO2018/069197, WO2018/069273.

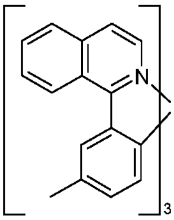
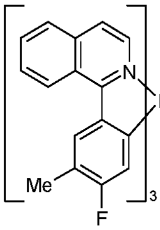
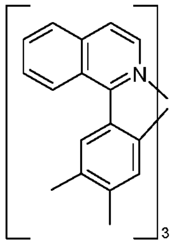
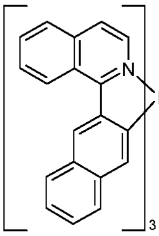
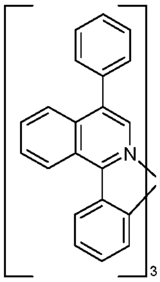
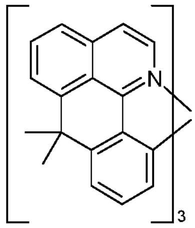
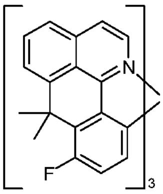
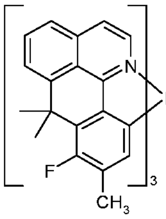
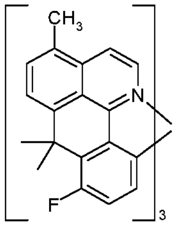
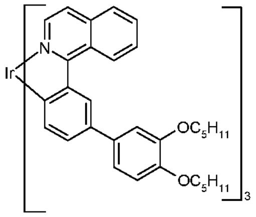
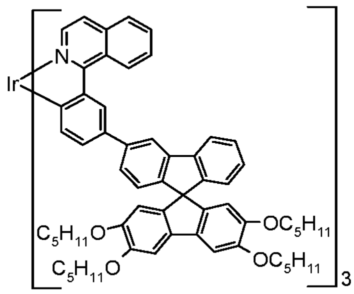
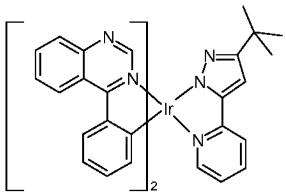
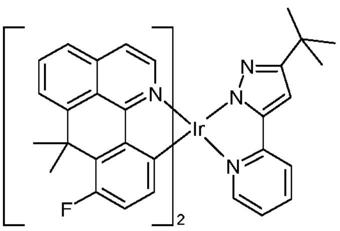
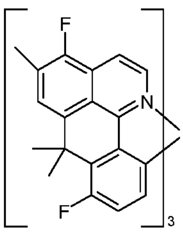
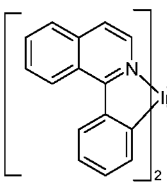
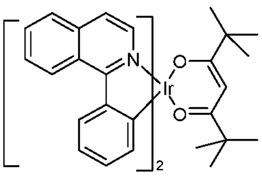
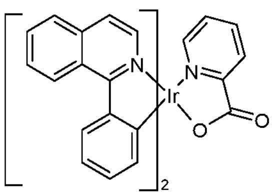
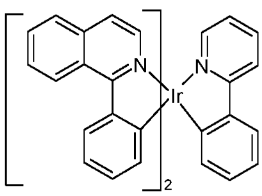
Particularly preferred are also the copper complexes as described, for example, in WO2010/031485, US2013150581, WO2013/017675, WO2013/007707, WO2013/001086, WO2012/156378, WO2013/072508, EP2543672.

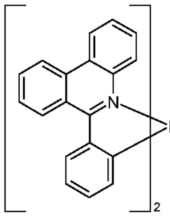
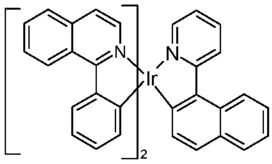
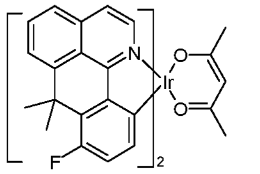
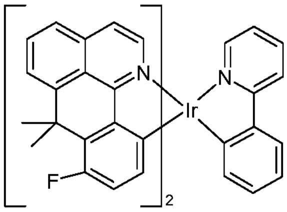
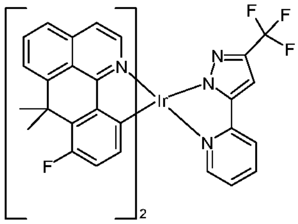
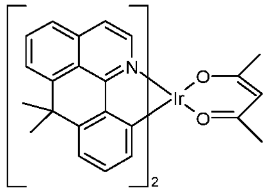
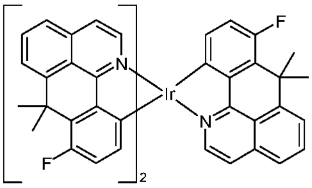
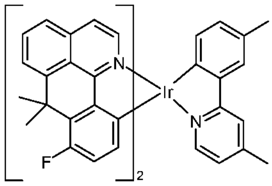
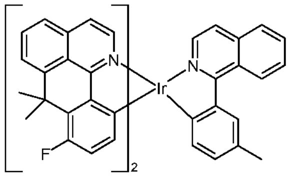
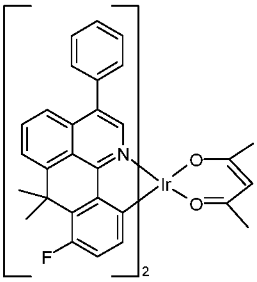
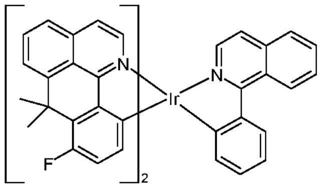
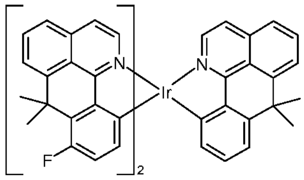
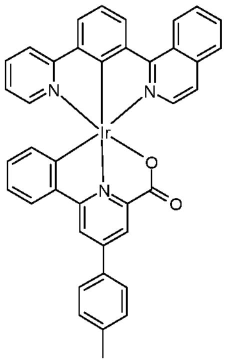
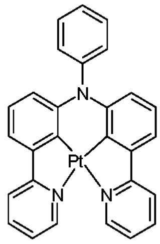
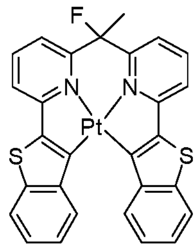
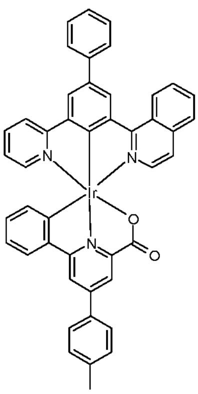
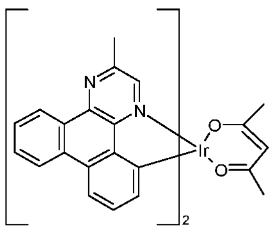
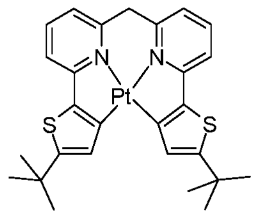
Explicit examples of phosphorescent sensitizers are $Ir(ppy)_3$ and its derivatives as well as the structures listed below:

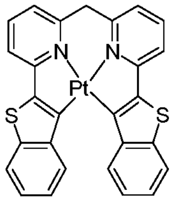
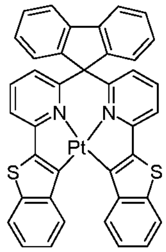
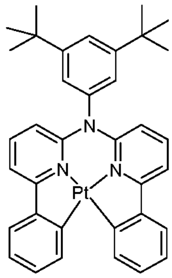
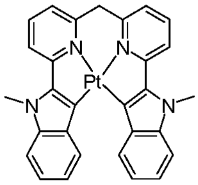
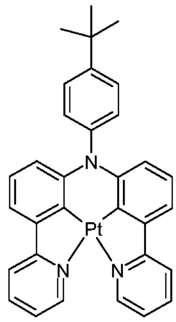
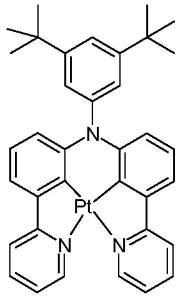
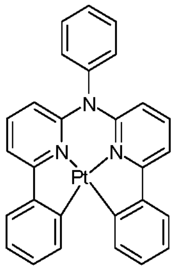
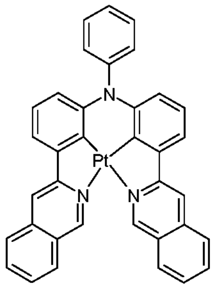
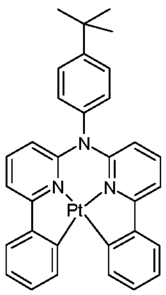
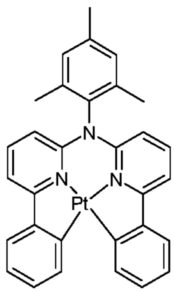
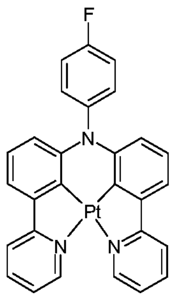
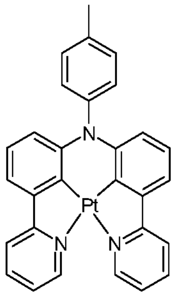
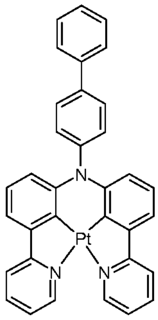
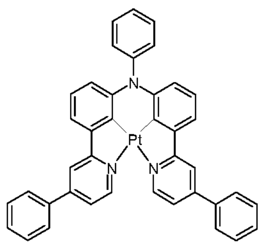


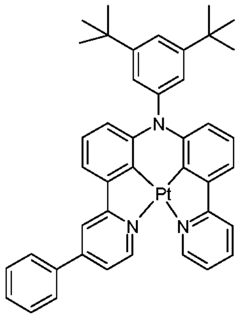


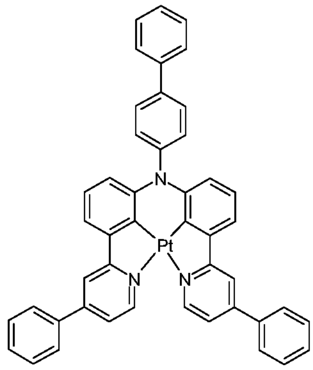


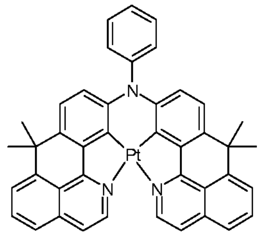



















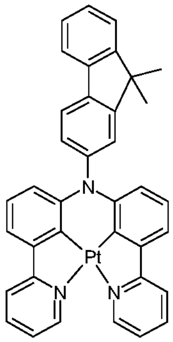



















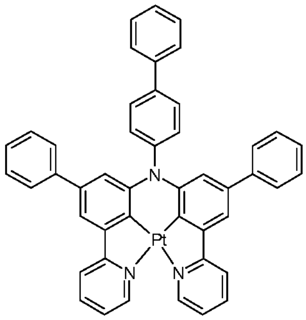















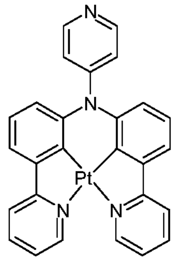


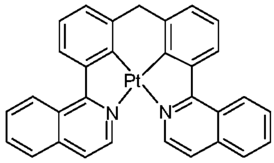


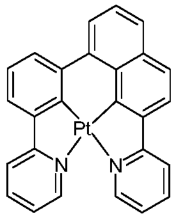


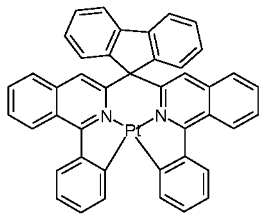


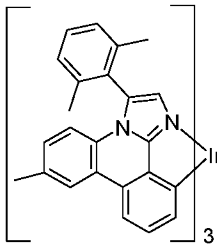


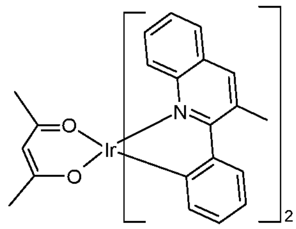


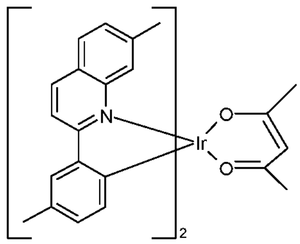


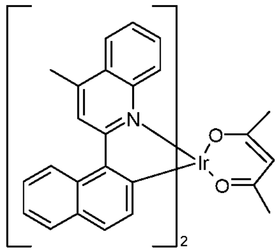


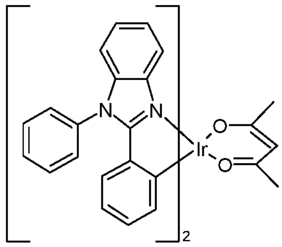


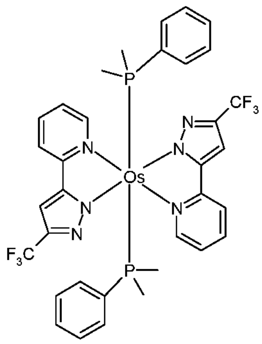


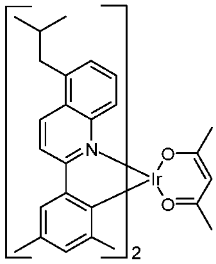


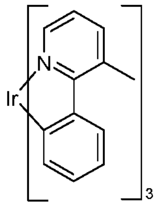


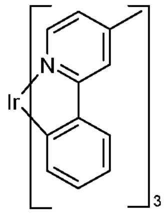


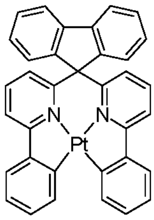


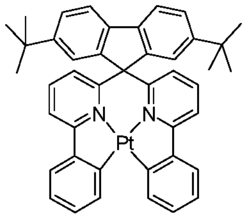


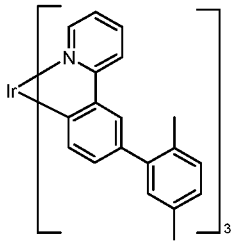


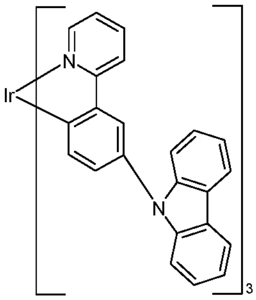


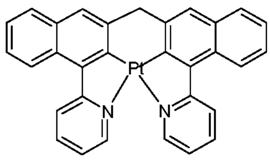


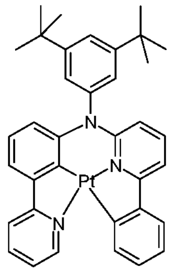


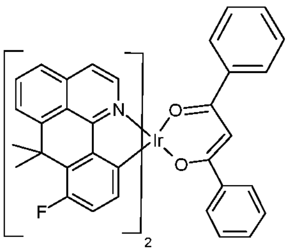


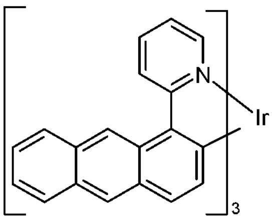


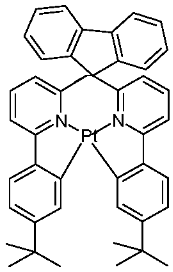


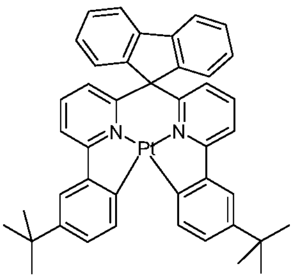


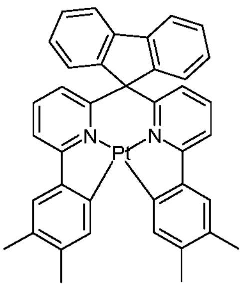


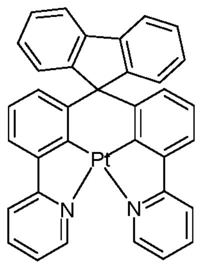


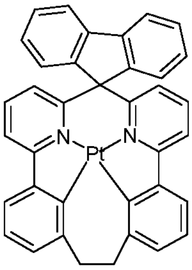


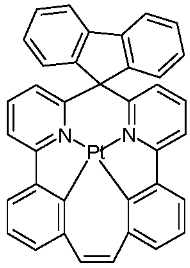


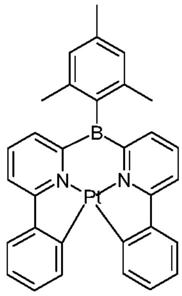


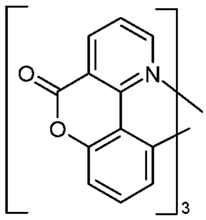


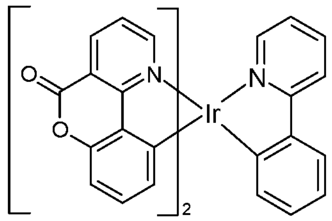


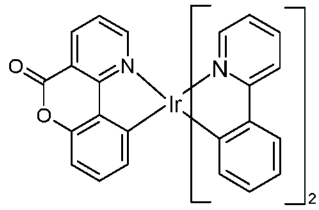


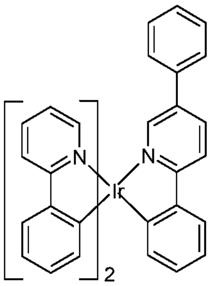


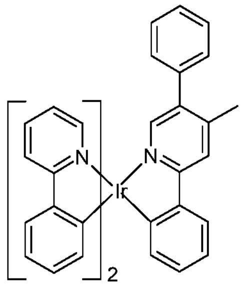


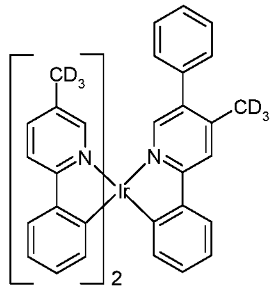


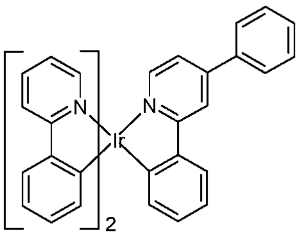


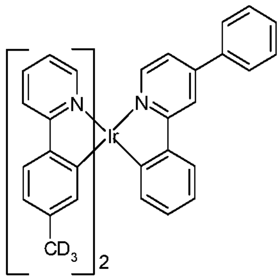


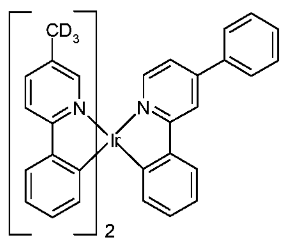


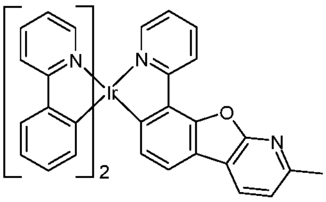


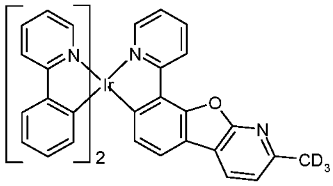


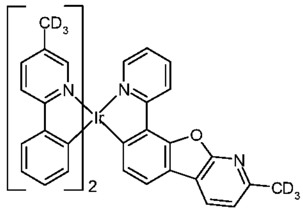


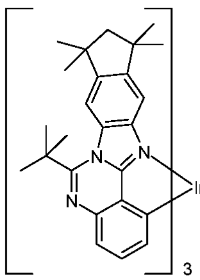


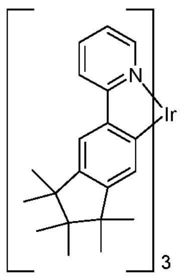


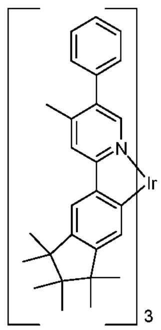


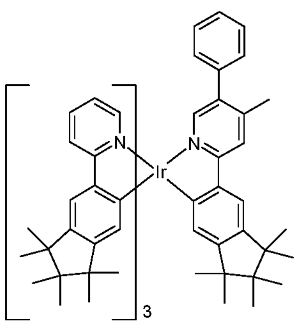


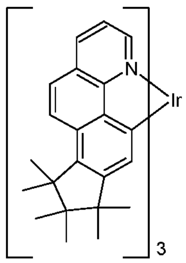


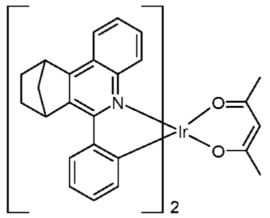


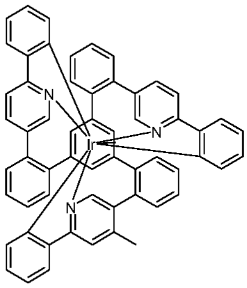


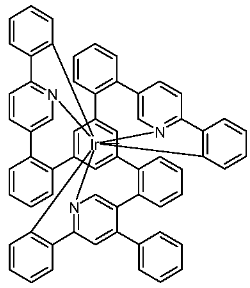


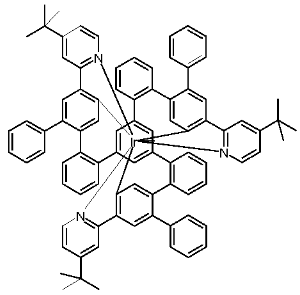


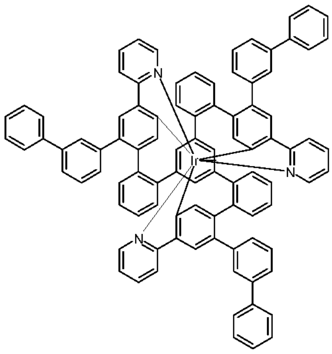


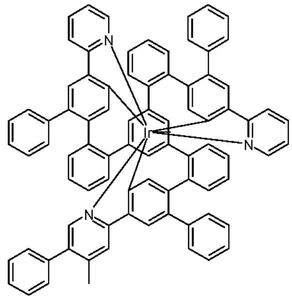


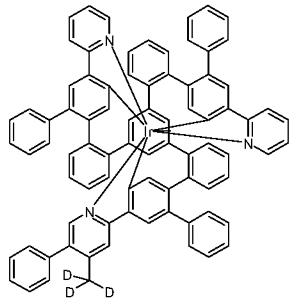




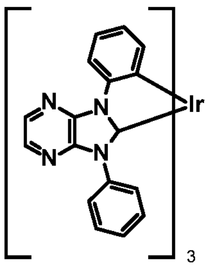


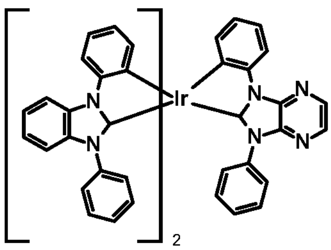


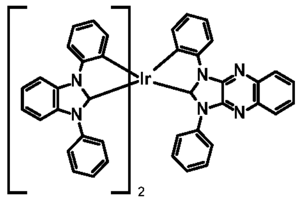


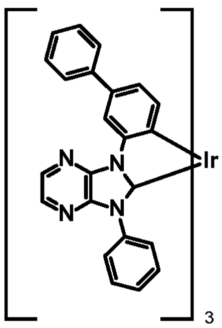


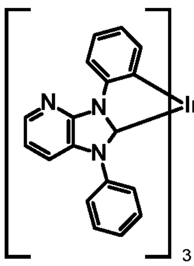
Further explicit examples of phosphorescent sensitizers are iridium and platinum complexes containing carbene ligands and the structures listed below, wherein homoleptic and heteroleptic complexes and meridonal and facial isomers may be suitable:

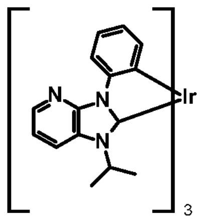


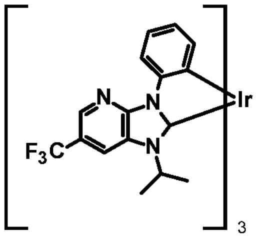


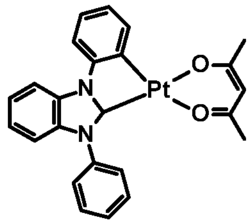


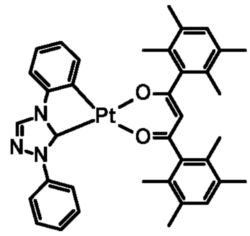




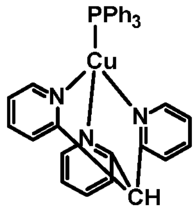


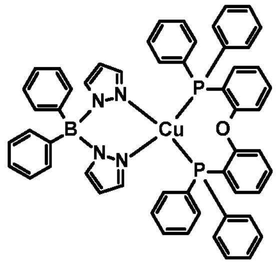


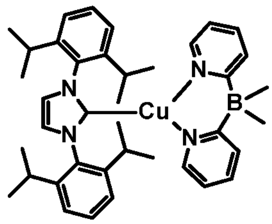




Further explicit examples of phosphorescent sensitizers are also copper complexes and the structures listed below:







Besides the compounds according to the invention, suitable TADF compounds are compounds in which the energy gap between the lowest triplet state T_1 and the first excited singlet state S_1 is sufficiently small that the S_1 state is thermally accessible from the T_1 state. Preferably, TADF compounds have a gap between the lowest triplet state T_1 and the first excited singlet state S_1 of ≤ 0.30 eV. More preferably, the gap between S_1 and T_1 is ≤ 0.20 eV, even more preferably ≤ 0.15 eV, especially more preferably ≤ 0.10 eV and even more especially preferably ≤ 0.08 eV.

The energy of the lowest excited singlet state (S_1) and the lowest triplet state (T_1) as well as the HOMO and LUMO values are determined by quantum-chemical calculations. The Gaussian09 program package (revision D or later) is used. Neutral ground state geometries of all purely organic molecules are optimized at the AM1 level of theory. Subsequently, B3PW91/6-31G(d) single point calculations including a calculation of the lowest singlet and triplet excited states with TD-B3PW91/6-31G(d). HOMO and LUMO values as well as S1 and T1 excitation energies are taken from this single-point calculation at the B3PW91/6-31G(d) level of theory.

Similarly, for metalorganic compounds, neutral ground state geometries are optimized at the HF/LANL2MB level of theory. B3PW91/6-31G(d)+LANL2DZ (LANL2DZ for all metal atoms, 6-31G(d) for all low-weight elements) is subsequently employed to calculate HOMO and LUMO values as well as TD-DFT excitation energies.

HOMO (HEh) and LUMO (LEh) values from the calculation are given in Hartree units. The HOMO and LUMO energy levels calibrated with reference to cyclic voltammetry measurements are determined therefrom in electron volts as follows:

HOMO(eV) = ((HEh*27.212)-0.9899)/1.1206
LUMO(eV) = ((LEh*27.212)-2.0041)/1.385

These values are to be regarded in the sense of the present invention as HOMO and LUMO energy levels of the materials.

The lowest triplet state T_1 is defined as the energy of the lowest TD-DFT triplet excitation energy.

The lowest excited singlet state S_1 is defined as the energy of the lowest TD-DFT singlet excitation energy.

Preferably, the TADF compound is an organic compound. Organic compounds in the context of the present invention are carbonaceous compounds that do not contain any metals. More particularly, organic compounds are formed from the elements C, H, D, B, Si, N, P, O, S, F, Cl, Br and I.

The TADF compound is more preferably an aromatic compound having both donor and acceptor substituents, with only slight spatial overlap between the LUMO and the HOMO of the compound. What is understood by donor and acceptor substituents is known in principle to those skilled in the art. Suitable donor substituents are especially diaryl- or -heteroarylamino groups and carbazole groups or carbazole derivatives, each preferably bonded to the aromatic compound via N. These groups may also have further substitution. Suitable acceptor substituents are especially cyano groups, but also, for example, electron-deficient heteroaryl groups which may also have further substitution, for example substituted or unsubstituted triazine groups.

The preferred dopant concentrations of the TADF compound in the emitting layer are described hereinafter. Because of the difference in production of the organic electroluminescent device, the dopant concentration in the case of production of the emitting layer by vapor deposition is reported in % by volume, and in the case of production of the emitting layer from solution in % by weight. The dopant concentrations in % by volume and % by weight is generally very similar.

In a preferred embodiment of the invention, in the case of production of the emitting layer by vapor deposition, the TADF compound is present in a dopant concentration of 1% to 70% by volume in the emitting layer, more preferably of 5% to 50% by volume, even more preferably of 5% to 30% by volume.

In a preferred embodiment of the invention, in the case of production of the emitting layer from solution, the TADF compound is present in a dopant concentration of 1% to 70% by weight in the emitting layer, more preferably of 5% to 50% by weight, even more preferably of 5% to 30% by weight.

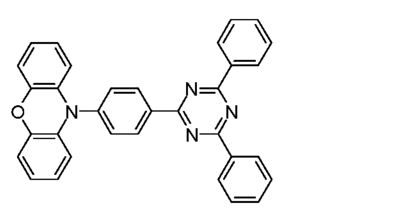
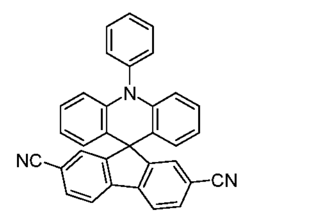
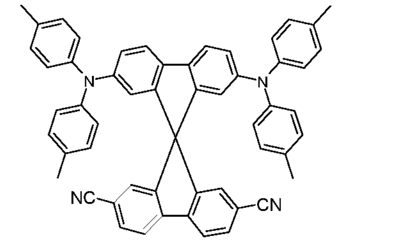
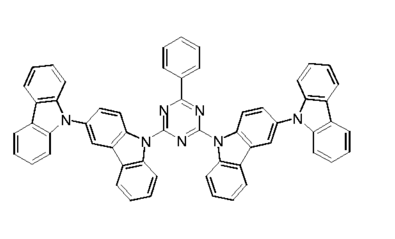
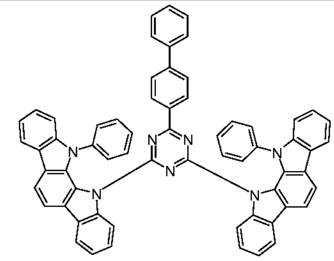
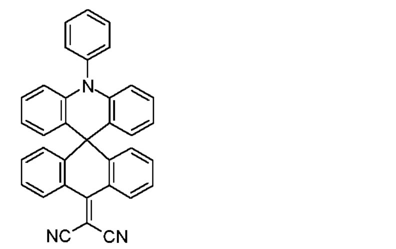
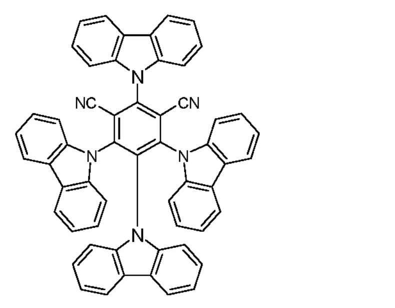
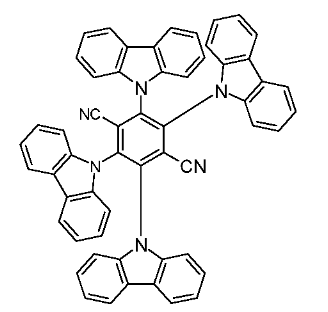
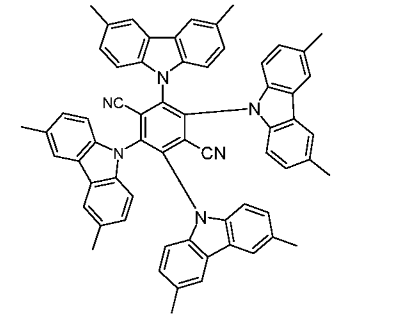
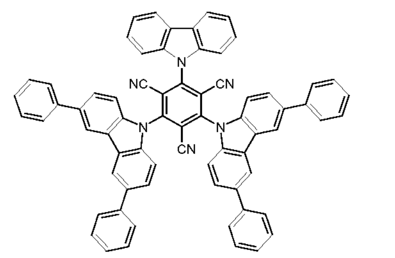
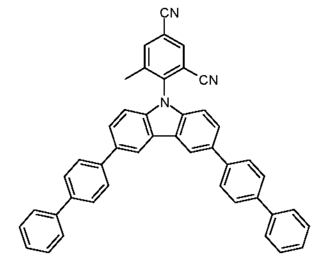
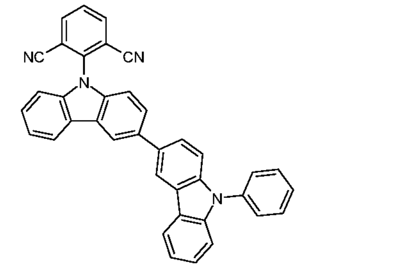
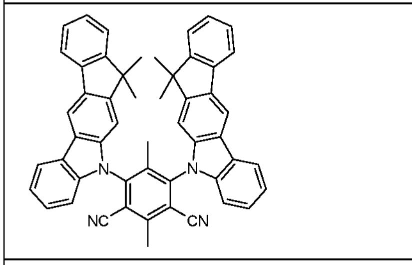
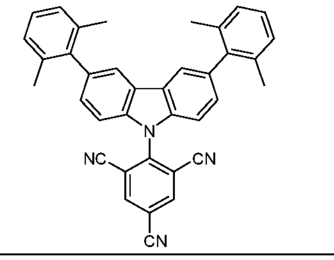
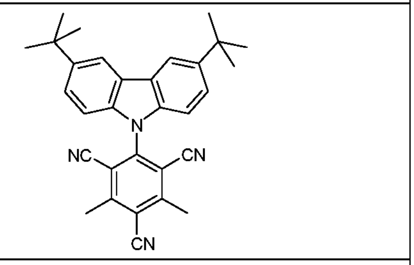
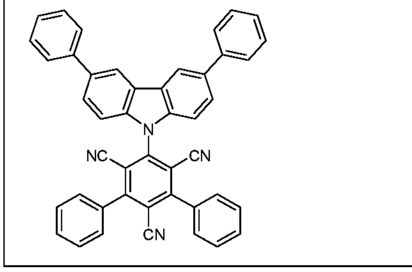
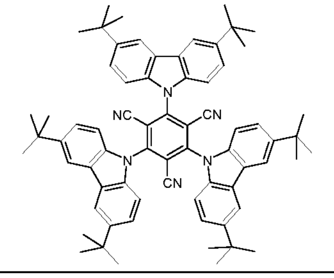
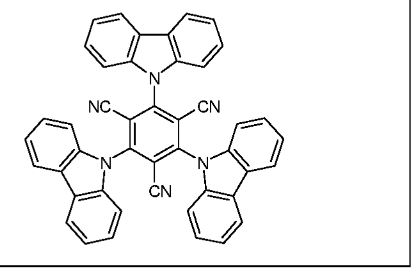
The general art knowledge of the person skilled in the art includes knowledge of which materials are generally suitable as TADF compounds. The following references disclose, by way of example, materials that are potentially suitable as TADF compounds:

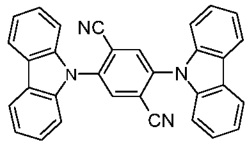
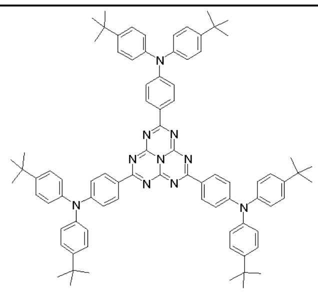
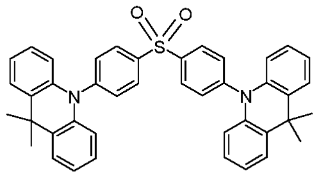
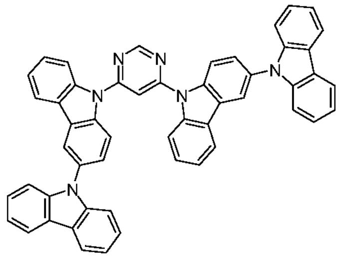
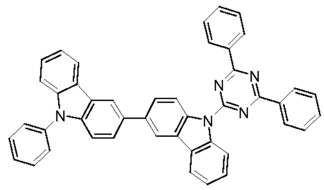
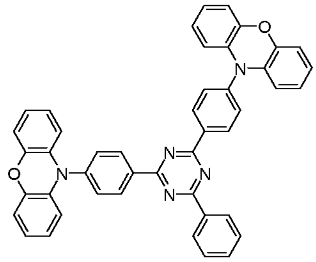
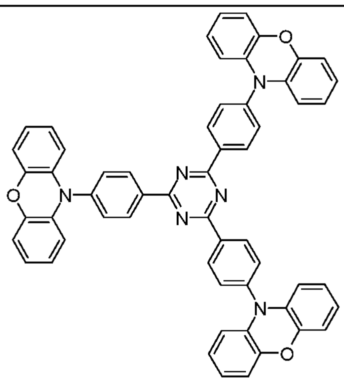
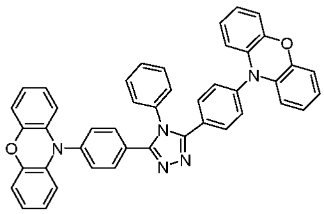
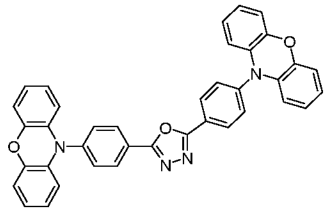
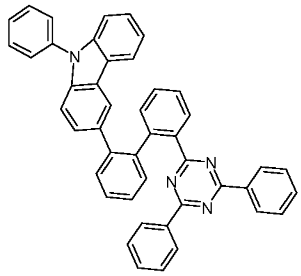
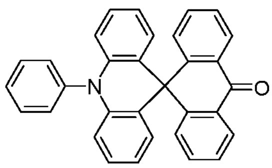
- Tanaka et al., Chemistry of Materials 25(18), 3766 (2013).
- Lee et al., Journal of Materials Chemistry C 1(30), 4599 (2013).
- Zhang et al., Nature Photonics advance online publication, 1 (2014), doi: 10.1038/nphoton.2014.12.
- Serevicius et al., Physical Chemistry Chemical Physics 15(38), 15850 (2013).
- Li et al., Advanced Materials 25(24), 3319 (2013).
- Youn Lee et al., Applied Physics Letters 101(9), 093306 (2012).
- Nishimoto et al., Materials Horizons 1, 264 (2014), doi: 10.1039/C3MH00079F.
- Valchanov et al., Organic Electronics, 14(11), 2727 (2013).
- Nasu et al., ChemComm, 49, 10385 (2013).

In addition, the following patent applications disclose potential TADF compounds: US2019058130, WO18155642, WO18117179A1, US2017047522, US2016372682A, US2015041784, US2014336379, US2014138669, WO 2013/154064, WO 2013/133359, WO 2013/161437, WO 2013/081088, WO 2013/081088, WO 2013/011954, JP 2013/116975 und US 2012/0241732.

In addition, the person skilled in the art is able to infer design principles for TADF compounds from these publications. For example, Valchanov et al. show how the colour of TADF compounds can be adjusted.

Examples of suitable molecules which exhibit TADF are the structures shown in the following table:

As mentioned above, the compounds of formula (1) or in accordance with the preferred embodiments may be used as fluorescent emitters in combination with a sensitizer in a hyperfluorescent or hyperphosphorescent system. In this case, it is preferred that the compounds of formula (1) are sterically shielded. For examples compounds of formula (1) corresponding to compounds of formulae (5) and (6), more particularly (5-1) to (5-3), are very suitable as sterically shielded fluorescent emitters in combination with a sensitizer selected from TADF compounds and phosphorescent compounds in an emitting layer. Preferably, the emitting layer further comprises at least one organic functional material selected from matrix materials.

The compounds of formula (1) or in accordance with preferred embodiments can also be employed in combination with further compounds selected from the group consisting of HTM (Hole Transport Material), HIM (Hole Injection Material), HBM (Hole Blocking Material), p-dopant, ETM (Electron Transport Material), EIM (Electron Injection Material), EBM (Electron Blocking Material), n-dopant, fluorescent emitter, phosphorescent emitter, delayed fluorescent emitter, matrix material, host material, wide band gap material and quantum material, like quantum dot and quantum rod.

The compounds of formula (1) or in accordance with preferred embodiments can also be employed in other layers, for example as hole-transport materials in a hole-injection or hole-transport layer or electron-blocking layer or as matrix materials in an emitting layer.

Generally preferred classes of material for use as corresponding functional materials in the organic electroluminescent devices according to the invention are indicated below.

Suitable charge-transport materials, as can be used in the hole-injection or hole-transport layer or electron-blocking layer or in the electron-transport layer of the electronic device according to the invention, are, for example, the compounds disclosed in Y. Shirota et al., Chem. Rev. 2007, 107(4), 953-1010, or other materials as are employed in these layers in accordance with the prior art.

Materials which can be used for the electron-transport layer are all materials as are used in accordance with the prior art as electron-transport materials in the electron-transport layer. Particularly suitable are aluminium complexes, for example Alq_3, zirconium complexes, for example Zrq_4, lithium complexes, for example LiQ, benzimidazole derivatives, triazine derivatives, pyrimidine derivatives, pyridine derivatives, pyrazine derivatives, quinoxaline derivatives, quinoline derivatives, oxadiazole derivatives, aromatic ketones, lactams, boranes, diazaphosphole derivatives and phosphine oxide derivatives. Furthermore, suitable materials are derivatives of the above-mentioned compounds, as disclosed in JP 2000/053957, WO 2003/060956, WO 2004/028217, WO 2004/080975 and WO 2010/072300.

Preferred hole-transport materials which can be used in a hole-transport, hole-injection or electron-blocking layer in the electroluminescent device according to the invention are indenofluorenamine derivatives (for example in accordance with WO 06/122630 or WO 06/100896), the amine derivatives disclosed in EP 1661888, hexaazatriphenylene derivatives (for example in accordance with WO 01/049806), amine derivatives containing condensed aromatic rings (for example in accordance with US 5,061,569), the amine derivatives disclosed in WO 95/09147, monobenzoindenofluorenamines (for example in accordance with WO 08/006449), dibenzoindenofluorenamines (for example in accordance with WO 07/140847), spirobifluorenamines (for example in accordance with WO 2012/034627 or WO 2013/120577), fluorenamines (for example in accordance with the as applications EP 2875092, EP 2875699 and EP 2875004), spirodibenzopyranamines (for example in accordance with WO 2013/083216) and dihydroacridine derivatives (for example in accordance with WO 2012/150001). The compounds according to the invention can also be used as hole-transport materials.

The cathode of the organic electroluminescent device preferably comprises metals having a low work function, metal alloys or multilayered structures comprising various metals, such as, for example, alkaline-earth metals, alkali metals, main-group metals or lanthanoids (for example Ca, Ba, Mg, Al, In, Mg, Yb, Sm, etc.). Also suitable are alloys comprising an alkali metal or alkaline-earth metal and silver, for example an alloy comprising magnesium and silver. In the case of multilayered structures, further metals which have a relatively high work function, such as, for example, Ag or Al, can also be used in addition to the said metals, in which case combinations of the metals, such as, for example, Ca/Ag, Mg/Ag or Ag/Ag, are generally used. It may also be preferred to introduce a thin interlayer of a material having a high dielectric constant between a metallic cathode and the organic semiconductor. Suitable for this purpose are, for example, alkali metal fluorides or alkaline-earth metal fluorides, but also the corresponding oxides or carbonates (for example LiF, Li_2O, BaF_2, MgO, NaF, CsF, Cs_2CO_3, etc.). Furthermore, lithium quinolinate (LiQ) can be used for this purpose. The layer thickness of this layer is preferably between 0.5 and 5 nm.

The anode preferably comprises materials having a high work function. The anode preferably has a work function of greater than 4.5 eV vs. vacuum. Suitable for this purpose are on the one hand metals having a high redox potential, such as, for example, Ag, Pt or Au. On the other hand, metal/metal oxide electrodes (for example Al/Ni/NiO_x, Al/PtO_x) may also be preferred. For some applications, at least one of the electrodes must be transparent or partially transparent in order to facilitate either irradiation of the organic material (organic solar cells) or the coupling-out of light (OLEDs, O-lasers). Preferred anode materials here are conductive mixed metal oxides. Particular preference is given to indium tin oxide (ITO) or indium zinc oxide (IZO). Preference is furthermore given to conductive, doped organic materials, in particular conductive doped polymers.

The device is appropriately (depending on the application) structured, provided with contacts and finally sealed, since the lifetime of the devices according to the invention is shortened in the presence of water and/or air.

In a preferred embodiment, the organic electroluminescent device according to the invention is characterised in that one or more layers are coated by means of a sublimation process, in which the materials are applied by vapour deposition in vacuum sublimation units at an initial pressure of less than 10^{-5} mbar, preferably less than 10^{-6} mbar. However, it is also possible here for the initial pressure to be even lower, for example less than 10^{-7} mbar.

Preference is likewise given to an organic electroluminescent device, characterised in that one or more layers are coated by means of the OVPD (organic vapour phase deposition) process or with the aid of carrier-gas sublimation, in which the materials are applied at a pressure of between 10^{-5} mbar and 1 bar. A special case of this process is the OVJP (organic vapour jet printing) process, in which the materials are applied directly through a nozzle and are thus structured (for example M. S. Arnold *et al.*, *Appl. Phys. Lett.* **2008**, *92*, 053301).

Preference is furthermore given to an organic electroluminescent device, characterised in that one or more layers are produced from solution, such as, for example, by spin coating, or by means of any desired printing process, such as, for example, screen printing, flexographic printing, nozzle printing or offset printing, but particularly preferably LITI (light induced thermal imaging, thermal transfer printing) or ink-jet printing. Soluble compounds of the formula (I) are necessary for this purpose. High solubility can be achieved through suitable substitution of the compounds.

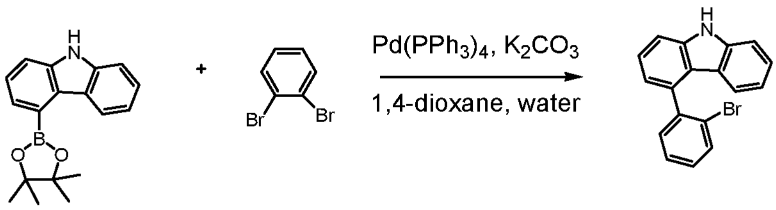
Also possible are hybrid processes, in which, for example, one or more layers are applied from solution and one or more further layers are applied by vapour deposition. Thus, it is possible, for example, to apply the emitting layer from solution and to apply the electron-transport layer by vapour deposition.
These processes are generally known to the person skilled in the art and can be applied by him without inventive step to organic electroluminescent devices comprising the compounds according to the invention.

In accordance with the invention, the electronic devices comprising one or more compounds according to the invention can be employed in displays, as light sources in lighting applications and as light sources in medical and/or cosmetic applications (for example light therapy).

The invention will now be explained in greater detail by the following examples, without wishing to restrict it thereby.

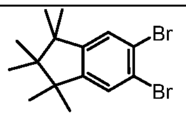
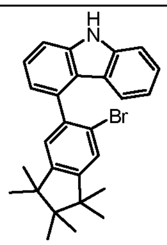
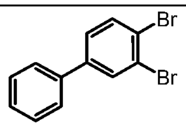
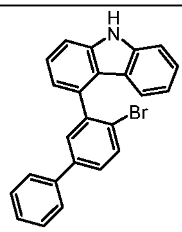
A) Syntheses Examples

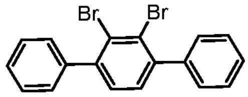
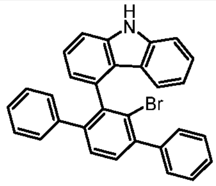
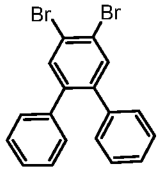
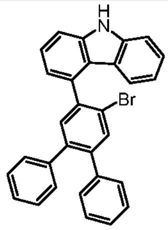
Example 1: Compound Int-1.1



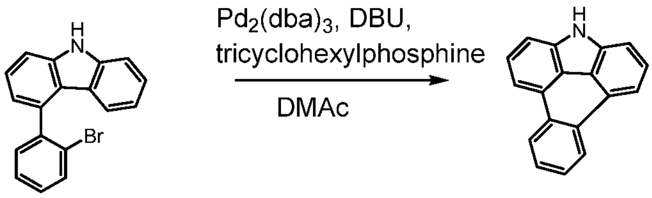
The synthesis of Int-1.1 is described in CN110330481 A [0044].

In analogous manner following compounds can be synthesized:

Intermediate	SM-A	SM-B	Product
Int-1.2	SM-A1	 CAS 1541101-19-2	
Int-1.3	SM-A1	 CAS 60108-72-7	

Int-1.4	SM-A1	 CAS1266379-41-2	
Int-1.5	SM-A1	 CAS 912922-63-5	

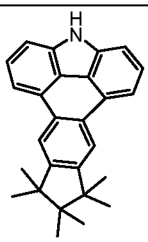
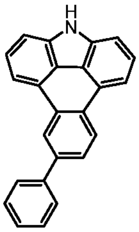
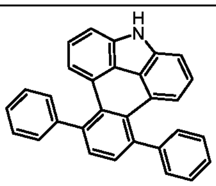
Synthesis of Int-2.1

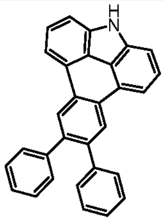


Int-1.1 Int-2.1

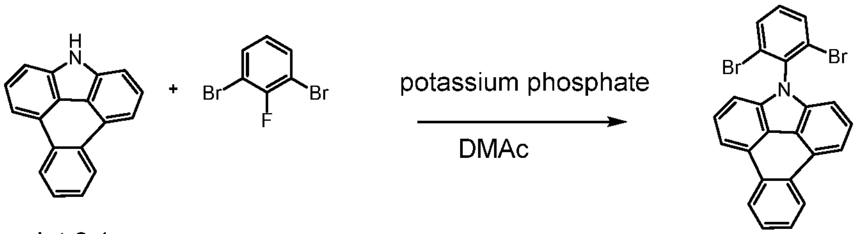
The synthesis of Int-2.1 is described in CN110330481 A [0047].

In analogous manner following compounds can be synthesized:

Intermediate	SM	Product
Int-2.2	Int-1.2	
Int-2.3	Int-1.3	
Int-2.4	Int-1.4	

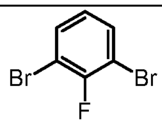
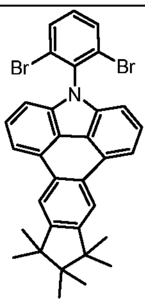
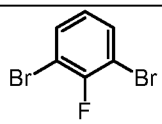
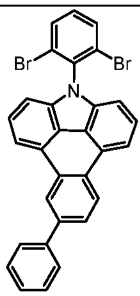
Int-2.5	Int-1.5	

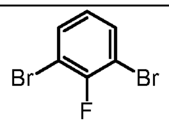
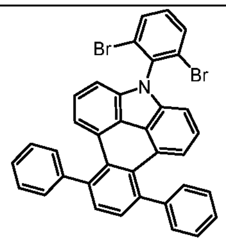
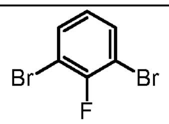
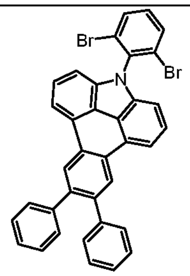
Synthesis of Int-3.1



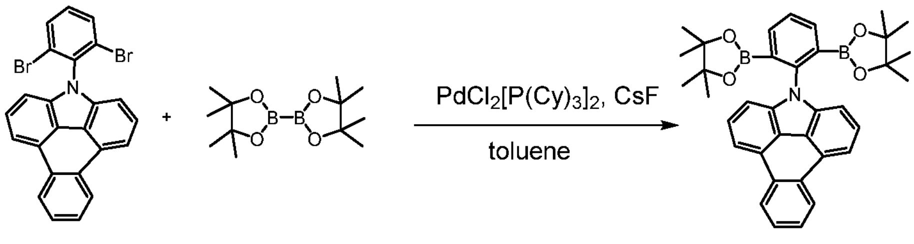
Int-3.1 is synthesized in same manner as CAS 1628715-79-6, described in WO2014146752 A1.

The following compounds can be synthesized in analogous manner:

Intermediate	SM-1	SM-2	Product
Int-3.2		Int-2.2	
Int-3.3		Int-2.3	

Int-3.4		Int-2.4	
Int-3.5		Int-2.5	

Synthesis of Int-4.1

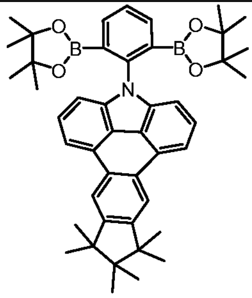
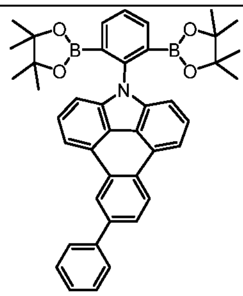
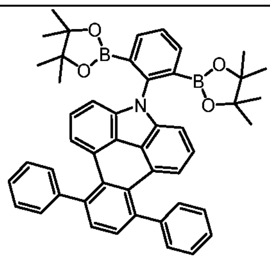
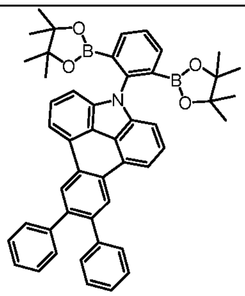


Int-3.1 Int-4.1

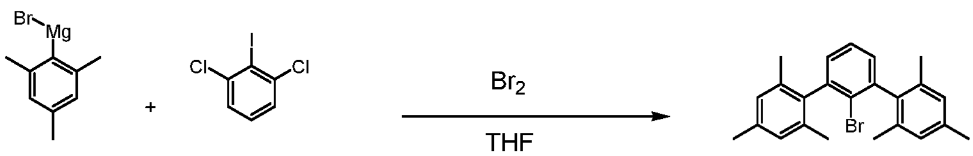
2.0 g (4.21 mmol) Int-3.1, 4.3 g (17 mmol) 4,4,5,5-tetramethyl-2-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1,3,2-dioxaborolane, 3.84 g (25.25 mmol) cesium fluoride and 623 mg (0.84 mmol) $PdCl_2[P(Cy)_3]_2$ are dissolved in 90 ml toluene and heated at reflux temperature for 48 hours. After complete conversion the reaction mixture is allowed to cool to room temperature, filtered through a fluted filter and concentrated *in vacuo*. The residue is crystallized from heptane to give the product as a solid.

The following compounds can be synthesized in analogous manner:

Intermediate	SM	Product

Int-4.2	Int-3.2	
Int-4.3	Int-3.3	
Int-4.4	Int-3.4	
Int-4.5	Int-3.5	

Synthesis of Int-5.1

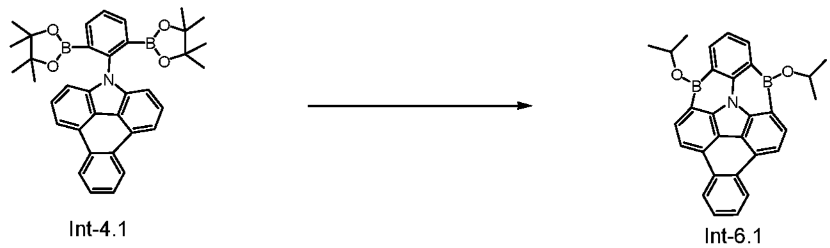


Int-5.1

540 ml (540 mmol) Bromo(2,4,6-trimethylphenyl) magnesium (1M in THF) are diluted in 600 ml THF and refluxed. A solution of 50 g (180 mmol) 1,3-dichloro-2-iodobenzene in 200 ml THF is added dropwise within one hour to the

reaction mixture and refluxed for four hours. The reaction mixture is cooled down to 0°C and 9.4 ml (184 mmol) bromide is added dropwise while keeping the temperature below 10 °C. The reaction mixture is stirred for 16 hours at room temperature. The reaction mixture is carefully quenched with 50 ml of an aqueous sodium hydrogen sulfite solution. The aqueous phase is separated and extracted with ethyl acetate, and the combined organic phases are washed with water (1x 300ml) and brine (1x 300ml) and concentrated *in vacuo*. The residue is crystallized from ethyl acetate and the product is obtained as a solid.

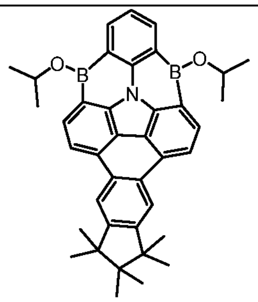
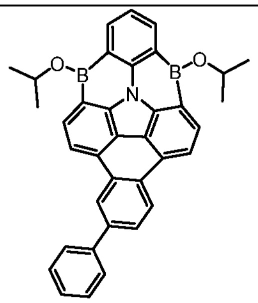
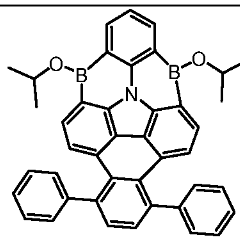
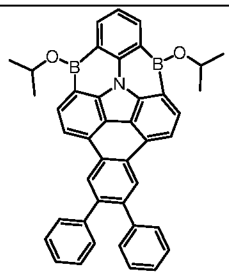
Synthesis of Int-6.1



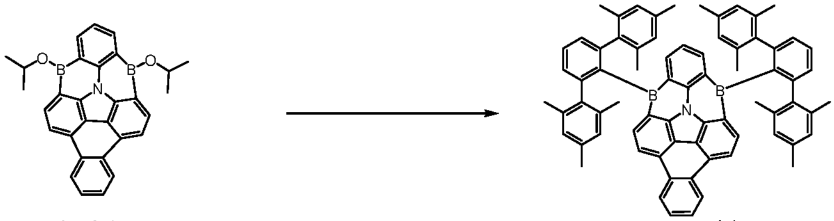
1.0 g of Int-4.1 (1.76 mmol) are suspended in 100 mL of toluene under Argon atmosphere. After addition of 1 mL NEt_3 (7.12 mmol) and stirring for 5 min 2.34 g (17.5 mmol) $AlCl_3$ are added. The resulting reaction mixture is stirred at 110 °C overnight. After cooling to room temperature 50 mL of water are added along with 100 mL of a 1:1 mixture of toluene and tetrahydrofuran, and the organic layer is washed four times with 50 mL of water. After drying the organic layer with $MgSO_4$ the solvent is removed under reduced pressure and the crude product is used without further purification.

The crude product is dissolved in 300 mL of *iso*propanol and benzene (4:1) under Argon atmosphere. Using a Soxhlet extractor with 4 Å molecular sieves the resulting reaction mixture is heated at reflux temperature for 4 d. After removal of 50% of the solvent a pale yellow solid precipitates which is separated by filtration and subsequently dried *in vacuo*.

Following compounds can be synthesized in analogous manner:

Intermediate	SM	Product
Int-6.2	Int-4.2	
Int-6.3	Int-4.3	
Int-6.4	Int-4.4	
Int-6.5	Int-4.5	

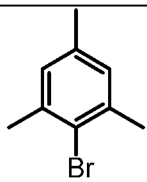
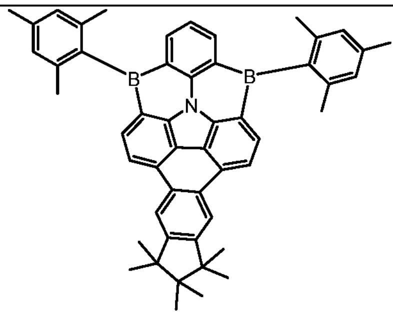
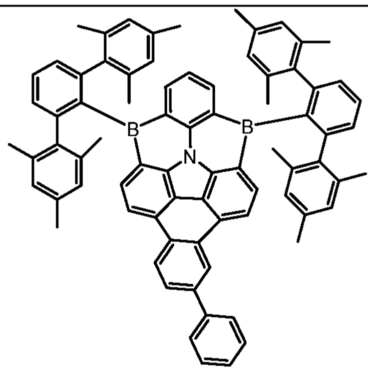
Synthesis of compound 1

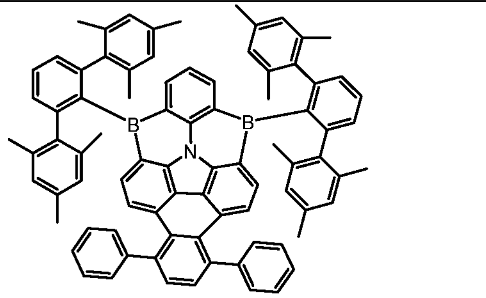
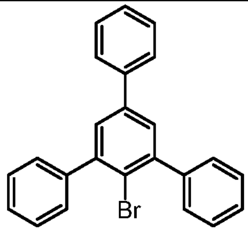
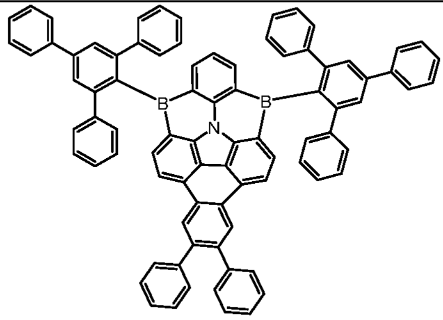
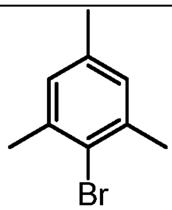
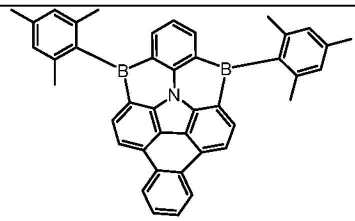
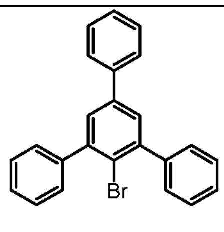
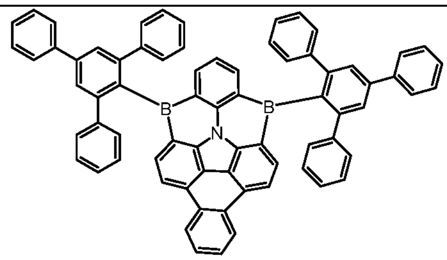


Int-6.1 compound 1

3.6 mg (9.2 mmol) of Int-5.1 are dissolved in 300 mL of diethylether under Argon atmosphere. 4.0 mL (2.5 M in hexane, 10 mmol) of *n*-BuLi are added, and the reaction mixture is stirred for 1 h at room temperature. The solvent is removed at –40 °C under reduced pressure and 1.9 g (4.2 mmol) of Int-6.1 are added afterwards. The solids are suspended in 5 mL of hexane and the resulting mixture is heated at 80 °C for 2 h. After filtration of the reaction mixture solid residue is extracted four times with 100 mL of benzene and the combined benzene layers are dried *in vacuo*. The product is further purified by crystallization from toluene to give a yellow solid.

Following compounds can be synthesized in analogous manner:

Compound	SM-1	SM-2	Product
2	Int-6.2	 CAS 576-83-0	
3	Int-6.3	Int-5.1	

4	Int-6.4	Int5.1	
5	Int-6.5	 CAS 10368-73-7	
6	Int-6.1	 CAS 576-83-0	
7	Int-6.1	 CAS 10368-73-7	

Photophysical measurements

1.) Determination of peak emission wavelength λ_{max}

To determine the peak emission wavelength of the fluorescent emitter, the fluorescent emitter is dissolved in toluene. A concentration of 1 mg/100 mL is used. The solution is excited in a fluorescence spectrometer Hitachi F-4500 with a to the material matching wavelength. The measurement is carried out at room temperature. The peak emission wavelength λ_{max} is the wavelength of the first maximum of the emission spectrum. Typically, the first maximum is also the global maximum of the spectrum.

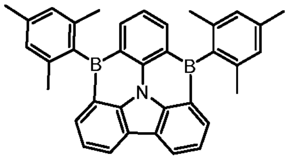
2.) Determination of the spectral broadness (full width at half maximum (FWHM))

To determine the spectral broadness of the fluorescent emitter the values for the wavelengths (X1, X2) which are at half the maximum of the peak emission wavelength (y = 0.5) are subtracted. The full width at half maximum is calculated according to formula (1):

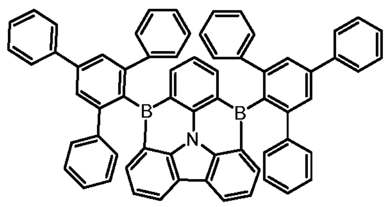
$$FWHM = X2 - X1 \qquad (1)$$

According to the described methods the following properties for the fluorescent emitters are obtained and depicted in table E-1.

Comparative examples



comparative example 1



comparative example 2

The synthesis of comparative example 1 is described in WO2020208051. Comparative example 2 can be obtain in analogous manner as described for comparative example 2 in WO2020208051.

Table E-1: Properties of fluorescent emitters

Material	λ_{max} [nm]	FWHM [meV]	CIE y
Compound 1	453	106	0.071
Compound 6	441	99	0.052

Compound 7	457	94	0.090
Comparative example 1	415	108	0.017
Comparative example 2	430	102	0.019

Compound 6 shows in comparison to comparative example 1 color shift to lighter blue by 26 nm, which leads to a more applicable color coordinate for the use in an OLED device. Additionally, the results show, that while not changing the substituent on the boron the triphenylene unit of the inventive compounds 6 and 7 show narrower spectrum and thus a higher color purity compared to the comparative examples 1 and 2. The inventive compound combine good color coordinate and small FWHM.

3.) Fabrication of OLEDs

Glass plates coated with structured ITO (50 nm, indium tin oxide) are wet-cleaned (dishwasher, Merck Extran cleaner). The substrates are then heated under nitrogen for 15 minutes at 250 °C.

All materials are thermally evaporated in a vacuum chamber. In this case, the emissive layer always consists of two materials. An indication such as H-01(99%):C-6(1%) means, that the material H-01 is present in a volume fraction of 99% and material Compound 6 (C-6) is present in a volume fraction of 1% in the emissive layer.

OLEDs consist of the following layer sequence, which is applied to the substrate after heat treatment: 20 nm HTM(95%):p-D(5%), 160 nm HTM, 20 nm emissive layer, 10 nm ETM, 20 nm ETM(50%):LiQ(50%), 1 nm LiQ, 100 nm aluminum. The composition of the emissive layer is given in Table E-2. The materials used for the OLED fabrication are listed in Table E-3.

The OLEDs are characterised by standard methods. For this purpose, the electroluminescence spectra are recorded and the current-voltage-luminous density characteristics (IUL) are measured. (The luminous density is measured perpendicular to the substrate.) The external quantum efficiency (EQE) is calculated as a function of the luminous density assuming Lambertian emission. The indication U100 means the voltage required for a luminance of 100 cd/m². EQE100 refers to the external quantum efficiency at an operating luminance of 100 cd/m².

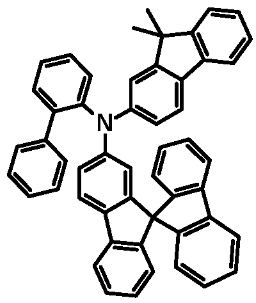
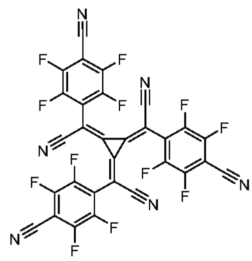
Furthermore, the CIE 1931 x and y color coordinates (CIE x und CIE y) are calculated from the electroluminescence spectra. The OLED performance data are given in table E-2.

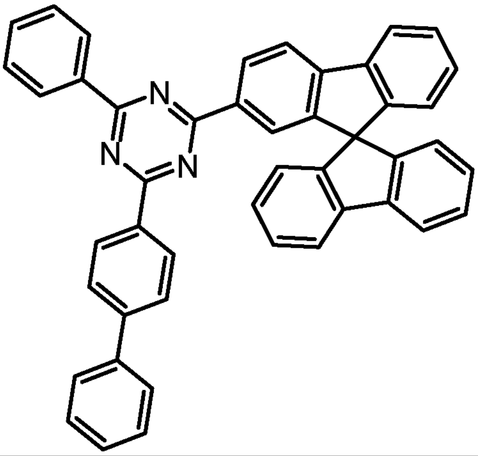
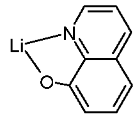
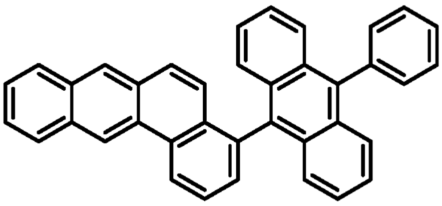
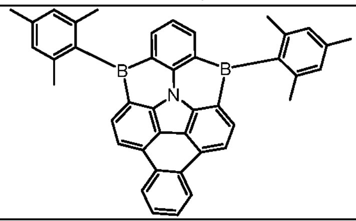
It is shown in table E-2 that by the use of the inventive Compound 3 (C-3) as emitter in the emissive layer very good EQE and low voltages are obtained. The OLED shows a deep blue color.

Table E-2: Composition of the emissive layer of the single device experiments and OLED performance results.

No.	Emissive layer	EQE100 [%]	U100 [V]	CIE y
1	H-01(99%):C-6(1%)	8.1	3.3	0.05

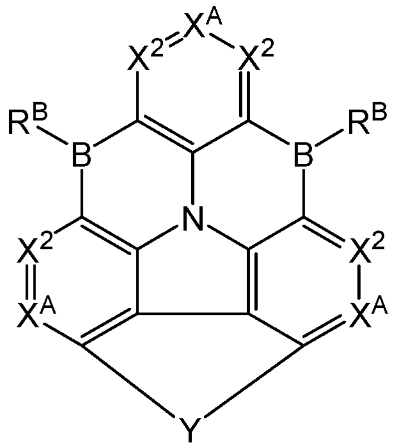
Table E-3: Structures of materials used for OLED fabrication

	
HTM	p-D [US2010102709A1; WO2015007729A1]

	
ETM	LiQ
	
H-01	Compound 6

Patent Claims

1. Compound of the formula (1),



formula (1)

where the following applies to the symbols and indices used:

X^2 stands, on each occurrence, identically or differently, for CR^2 or N;
X^A stands, on each occurrence, identically or differently, for CR^A or N;

Y is a bivalent aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R^Y;

R^B stands on each occurrence, identically or differently, for CN, $N(Ar)_2$, C(=O)Ar, $P(=O)(Ar)_2$, S(=O)Ar, $S(=O)_2Ar$, $N(R)_2$, $Si(R)_3$, OSO_2R, a straight-chain alkyl, alkoxy or thioalkoxy group having 1 to 40 carbon atoms or an alkenyl or alkynyl group having 2 to 40 carbon atoms or a branched or cyclic alkyl, alkoxy or thioalkoxy group having 3 to 40 carbon atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, or an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aryloxy group having 5 to 60 aromatic ring atoms, which may be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals;

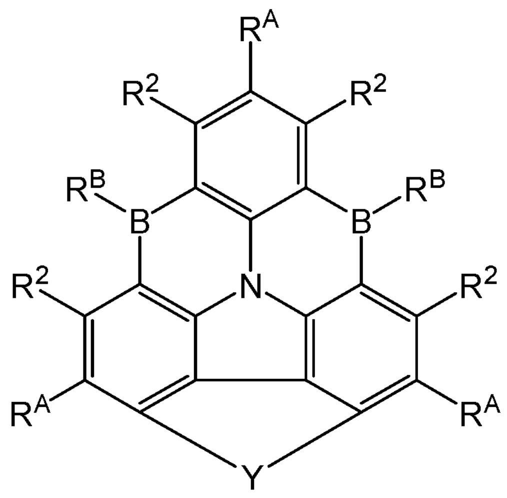
R^2, R^A, R^Y stand on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CHO, CN, $N(Ar)_2$, C(=O)Ar, $P(=O)(Ar)_2$, S(=O)Ar, $S(=O)_2Ar$, NO_2, $Si(R)_3$, $B(OR)_2$, OSO_2R, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R, an aryloxy group having 5 to 60 aromatic ring atoms, which may be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals; where two adjacent radicals selected from R^Y, R^2, R^A may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R;

R stands on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CHO, CN, $N(Ar)_2$, C(=O)Ar, $P(=O)(Ar)_2$, S(=O)Ar, $S(=O)_2Ar$, NO_2, $Si(R')_3$, $B(OR')_2$, OSO_2R', a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40 C atoms, each of which may be substituted by one or more radicals R´, where in each case one or more non-adjacent CH_2 groups may be replaced by R´C=CR´, C≡C, $Si(R´)_2$, $Ge(R´)_2$, $Sn(R´)_2$, C=O, C=S, C=Se, P(=O)(R´), SO, SO_2, O, S or CONR´ and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R´, or an aryloxy group having 5 to 60 aromatic ring atoms, which may be substituted by one or more radicals R´, where two adjacent radicals R may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R´;

Ar is on each occurrence, identically or differently, an aromatic or heteroaromatic ring system having 5 to 24 aromatic ring atoms, which may in each case also be substituted by one or more radicals R´;

R´ stands on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CN, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 20 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl group having 3 to 20 C atoms, where in each case one or more non-adjacent CH_2 groups may be replaced by SO, SO_2, O, S and where one or more H atoms may be replaced by D, F, Cl, Br or I, or an aromatic or heteroaromatic ring system having 5 to 24 C atoms.

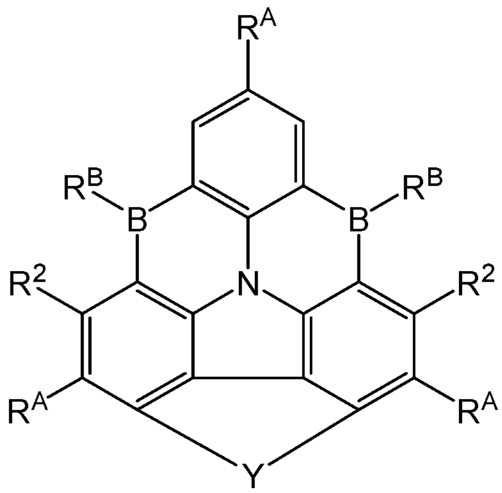
2. Compound according to claim 1, characterized in that it is selected from compounds of formula (2),



formula (2)

where the symbols have the same meaning as in claim 1.

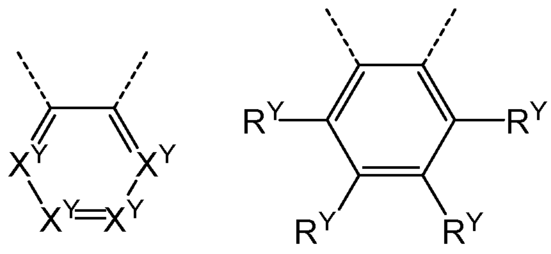
3. Compound according to claim 1 or 2, characterized in that it is selected from compounds of formula (3),



formula (3)

where the symbols have the same meaning as in claim 1.

4. Compound according to according to one or more of the preceding claims characterized in that group Y corresponds to groups of the formulae (Y1) or (Y2):



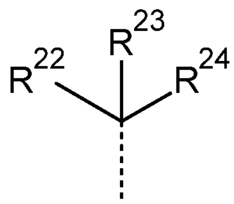
formula (Y1) formula (Y2)

5. Compound according to one or more of the preceding claims, characterized in that R^B stands on each occurrence, identically or differently, for a straight-chain alkyl, alkoxy or thioalkoxy group having 1 to 40 carbon atoms or an alkenyl or alkynyl group having 2 to 40 carbon atoms or a branched or cyclic alkyl, alkoxy or thioalkoxy group having 3 to 40 carbon atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, or an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals.

6. Compound according to one or more of the preceding claims, characterized in that R^B stands on each occurrence, identically or differently, for a straight-chain alkyl or alkoxy group having 1 to 20 carbon atoms or an alkenyl or alkynyl group having 2 to 20 carbon atoms or a branched or cyclic alkyl or alkoxy group having 3 to 20 carbon atoms, each of which may be substituted by one or more radicals R, where one or more H atoms may be replaced by D, F, Cl or CN, or an aromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals.

7. Compound according to one or more of the preceding claims, characterized in that R^B is selected on each occurrence, identically or differently,

from branched or cyclic alkyl groups represented by the general following formula (RS-a)



(RS-a)

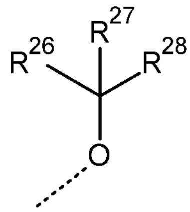
wherein

R^{22}, R^{23}, R^{24} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{25}, and where two of radicals R^{22}, R^{23}, R^{24} or all radicals R^{22}, R^{23}, R^{24} may be joined to form a (poly)cyclic alkyl group, which may be substituted by one or more radicals R^{25};

R^{25} is at each occurrence, identically or differently, selected from a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms;

with the proviso that at each occurrence at least one of radicals R^{22}, R^{23} and R^{24} is other than H, with the proviso that at each occurrence all of radicals R^{22}, R^{23} and R^{24} together have at least 4 carbon atoms and with the proviso that at each occurrence, if two of radicals R^{22}, R^{23}, R^{24} are H, the remaining radical is not a straight-chain;

or from branched or cyclic alkoxy groups represented by the general following formula (RS-b)



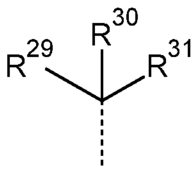
(RS-b)

wherein

R^{26}, R^{27}, R^{28} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{25} as defined above, and where two of radicals R^{26}, R^{27}, R^{28} or all radicals R^{26}, R^{27}, R^{28} may be joined to form a (poly)cyclic alkyl group, which may be substituted by one or more radicals R^{25} as defined above;

with the proviso that at each occurrence only one of radicals R^{26}, R^{27} and R^{28} may be H;

or from aralkyl groups represented by the general following formula (RS-c)



(RS-c)

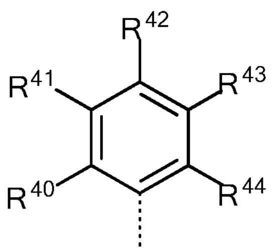
wherein

R^{29}, R^{30}, R^{31} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}, and where two or all of radicals R^{29}, R^{30}, R^{31} may be joined to form a (poly)cyclic alkyl group or an aromatic ring system, each of which may be substituted by one or more radicals R^{32};

R^{32} is at each occurrence, identically or differently, selected from a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, or an aromatic ring system having 6 to 24 aromatic ring atoms;

with the proviso that at each occurrence at least one of radicals R^{29}, R^{30} and R^{31} is other than H and that at each occurrence at least one of radicals R^{29}, R^{30} and R^{31} is or contains an aromatic ring system having at least 6 aromatic ring atoms;

or from aromatic ring systems represented by the general following formula (RS-d)



(RS-d)

wherein

R^{40} to R^{44} is at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}, and where two or more of radicals R^{40} to R^{44} may be joined to form a (poly)cyclic alkyl group or an aromatic ring system, each of which may be substituted by one or more radicals R^{32} as defined above.

8. Compound according to one or more of the preceding claims, characterized in that R^2, R^Y and R^A stand on each occurrence, identically or differently, for H, D, F, Cl, Br, I, CN, $N(Ar)_2$, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, $Si(R)_2$, $Ge(R)_2$, $Sn(R)_2$, C=O, C=S, C=Se, P(=O)(R), SO, SO_2, O, S or CONR and where one or more H atoms may be replaced by D, F, Cl, Br, I, CN or NO_2, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R, or an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals where two adjacent radicals selected from R^Y, R^2, R^A may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R;.

9. Compound according to one or more of the preceding claims characterized in that R^2, R^Y and R^A stand on each occurrence, identically or differently, for H, D, F, CN, a straight-chain alkyl, alkoxy or thioalkyl group having 1 to 40 C atoms or branched or cyclic alkyl, alkoxy or thioalkyl groups having 3 to 40 C atoms, each of which may be substituted by one or more radicals R, where in each case one or more non-adjacent CH_2 groups may be replaced by RC=CR, C≡C, O or S and where one or more H atoms may be replaced by D, F, an aromatic or heteroaromatic ring system having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R or

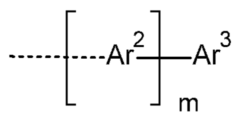
an aralkyl or heteroaralkyl group which has 5 to 60 aromatic ring atoms, which may be substituted by one or more R radicals, where two adjacent radicals selected from R^Y, R^2, R^A may form a mono- or polycyclic, aliphatic ring system or aromatic ring system, which may be substituted by one or more radicals R;.

10. Compound according to one or more of the preceding claims, characterized in that R^2, R^Y and R^A stand on each occurrence, identically or differently,

for H, D, F, CN; or

for a group of formula (RS-a), a group of formula (RS-b), a group of formula (RS-c) or a group of formula (RS-d), where the groups of formulae (RS-a), (RS-b), (RS-c) and (RS-d) have the same definition as in claim 7 wherein further two adjacent groups of formula (RS-a), (RS-b), (RS-c) and (RS-d) may form a mono- polycyclic- aliphatic ring system or aromatic ring system; or

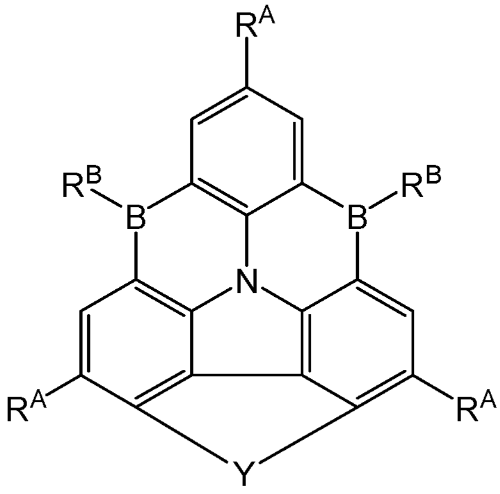
for a group of formula (ArL-1),



formula (ArL-1)

where the dashed bond in formula (ArL-1) indicates the bonding to the structure of formula (1), where Ar^2, Ar^3 stand on each occurrence, identically or differently, for an aromatic or heteroaromatic ring systems having 5 to 60 aromatic ring atoms, which may in each case be substituted by one or more radicals R; and where m is an integer selected from 1 to 10.

11. Compound according to one or more of the preceding claims, characterized in that it is selected from compounds of formula (4),

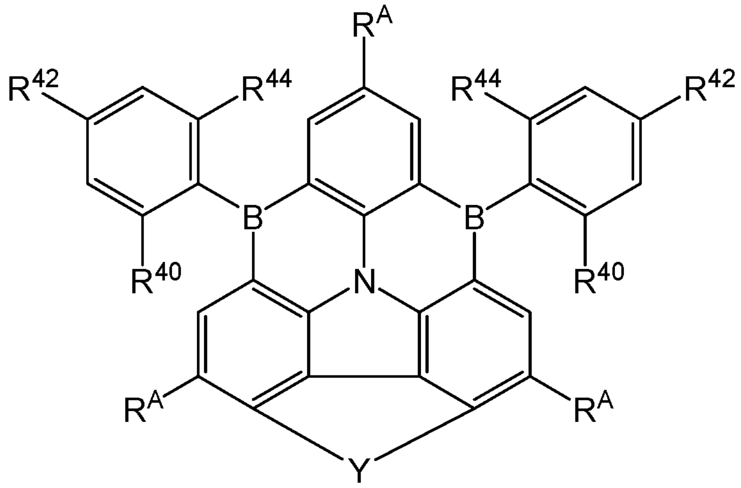


formula (4)

where the symbols have the same meaning as in claim 1.

12. Compound according to one or more of the preceding claims, characterized in that R^B and R^A are on each occurrence, identically or differently, selected from the groups of formulae (RS-a), (RS-b), (RS-c) and (RS-d), where the groups of formulae (RS-a), (RS-b), (RS-c) and (RS-d) have the same definition as in claim 7.

13. Compound according to one or more of the preceding claims, characterized in that it is selected from compounds of formula (5) or (6),



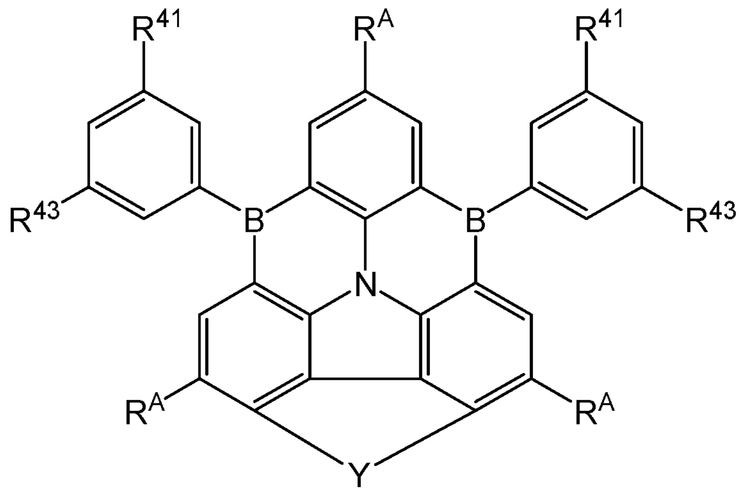
formula (5)

wherein the group R^A has the same meaning as in claim 1, and wherein, in formula (5),

R^{40}, R^{42}, R^{44} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}; where R^{32} is as defined in claim 6;

with the proviso that at least one of R^{40}, R^{42}, R^{44} is other than H;

or



formula (6)

wherein, in formula (6),

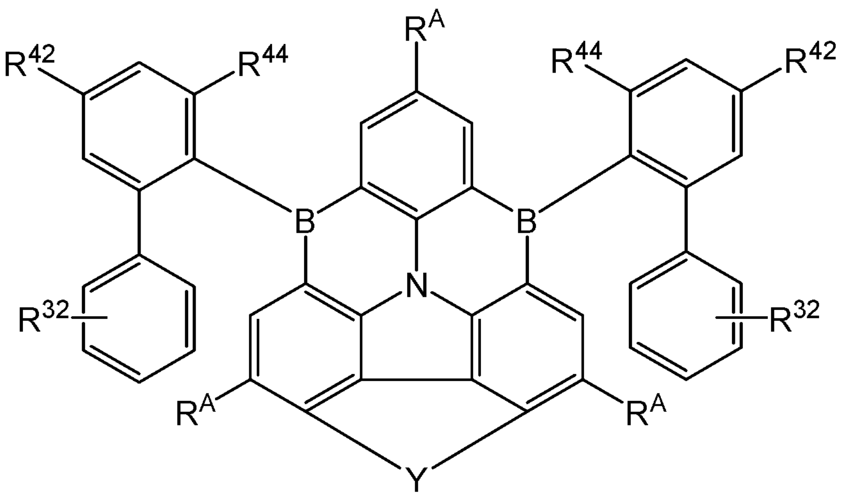
R^{41}, R^{43} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}; where R^{32} is as defined in claim 6; with the proviso that at least one of R^{41}, R^{43} is other than H.

14. Compound according to claim 13, characterized in that

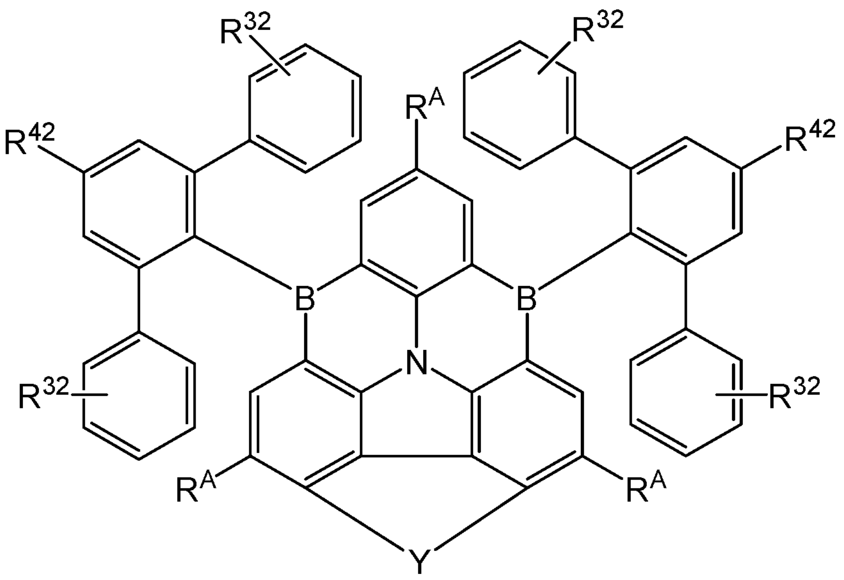
R^{42} is at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, or an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}, where R^{32} is as defined in claim 7;

R^{40}, R^{44} are at each occurrence, identically or differently, selected from an aromatic ring system having 6 to 30 aromatic ring atoms, which may in each case be substituted by one or more radicals R^{32}; where R^{32} is as defined in claim 7.

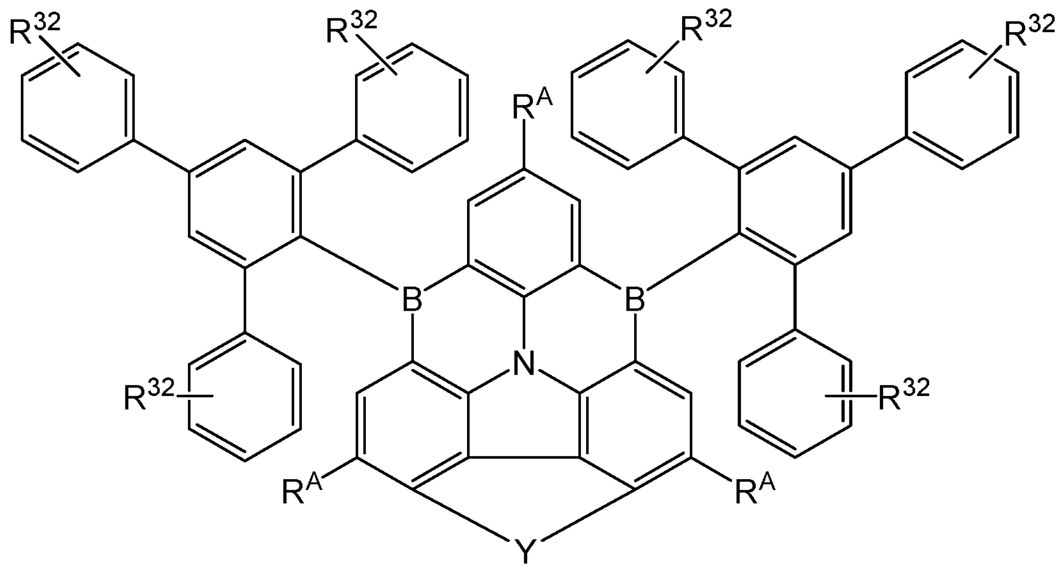
15. Compound according to one or more of the preceding claims, characterized in that it is selected from the compounds of formulae (5-1), (5-2) and (5-3),



formula (5-1)



formula (5-2)



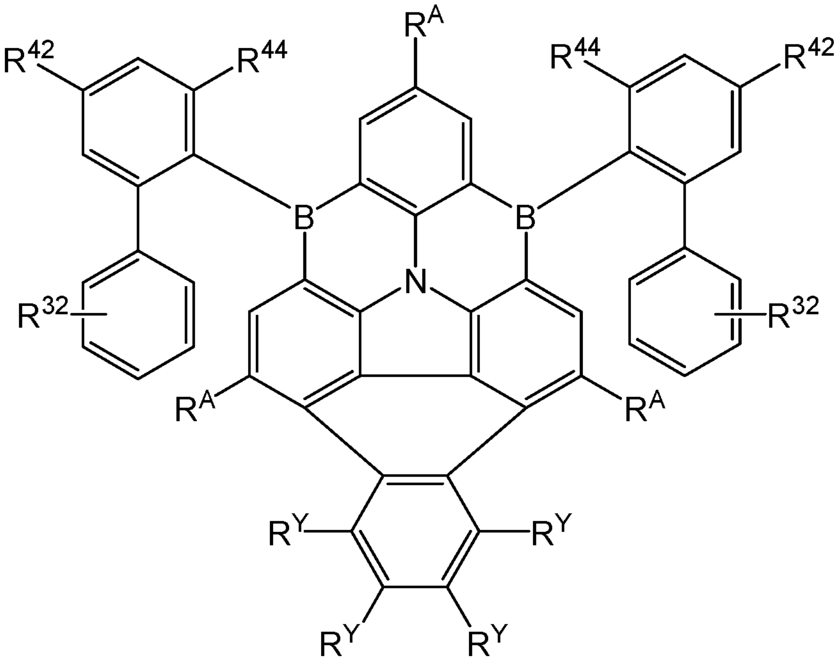
formula (5-3)

where the group R^A has the same meaning as in claim 1, and where

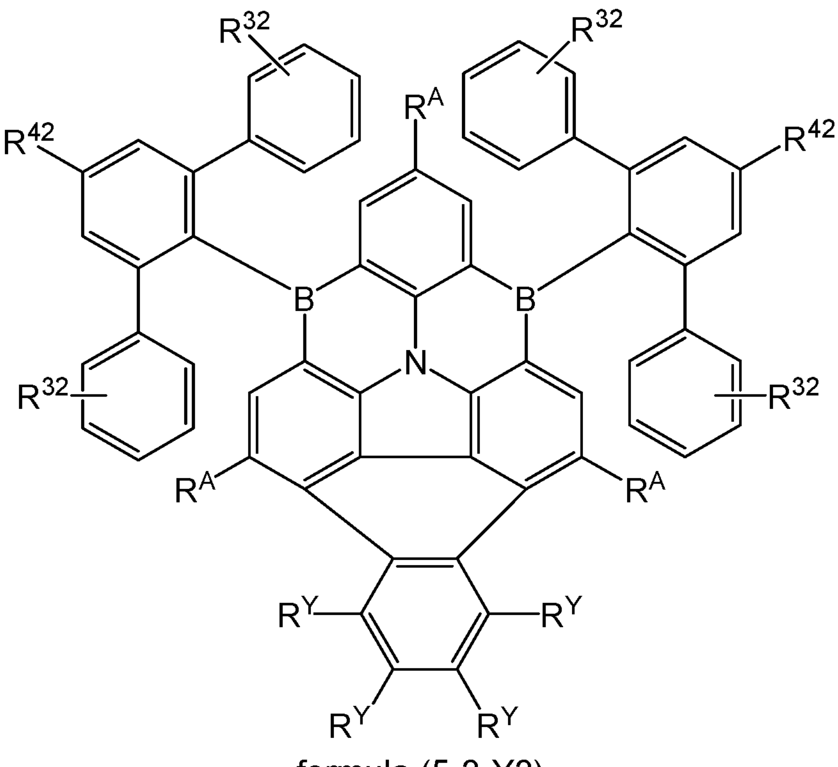
in each of formulae (5-1), (5-2) and (5-3) the phenyl groups indicated with –R^{32} are unsubstituted or substituted with one or more radicals R^{32};

R^{42} and R^{44} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}; where R^{32} is as defined in claim 7.

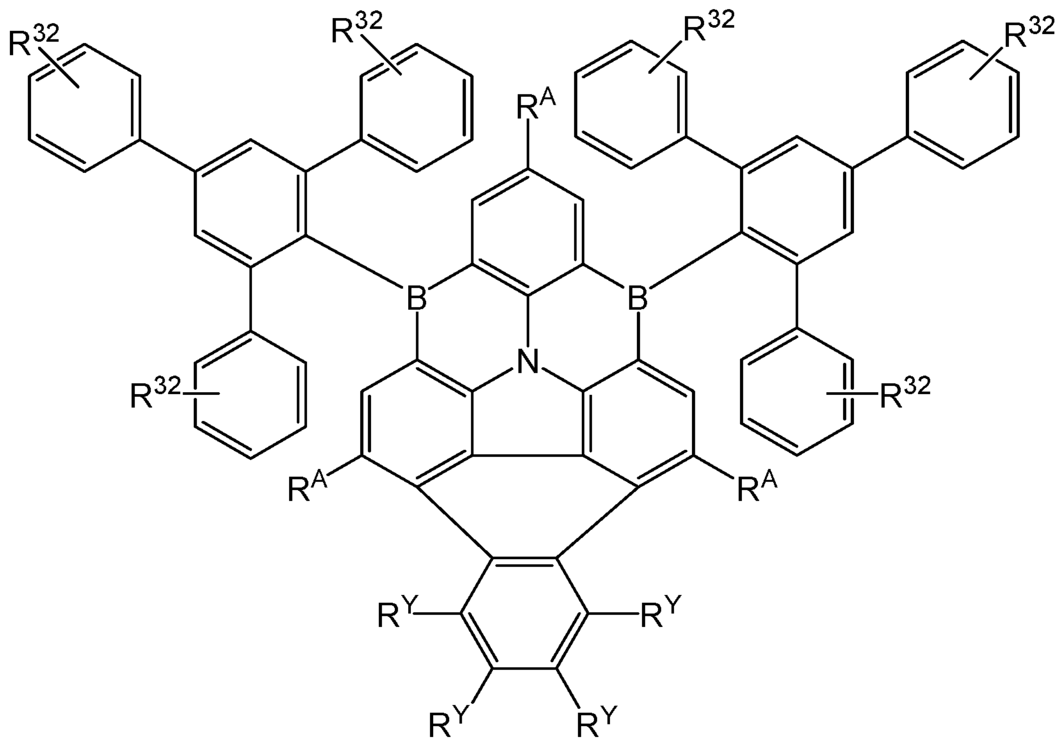
16. Compound according to one or more of the preceding claims, characterized in that it is selected from the compounds of formulae (5-1-Y2) to (5-3-Y2),



formula (5-1-Y2)



formula (5-2-Y2)



formula (5-3-Y2)

where the groups R^A, R^Y and R have the same meaning as in claim 1, and where in each of formulae (5-1-Yw) to (5-3-Yw), the phenyl groups indicated with $–R^{32}$ are unsubstituted or substituted with one or more radicals R^{32};

R^{42} and R^{44} are at each occurrence, identically or differently, selected from H, a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}; where R^{32} is as defined in claim 7.

17. Compound according to claim 13, characterized in that the groups R^{40}, R^{42}, R^{44} are at each occurrence, identically or differently, selected from a straight-chain alkyl group having 1 to 10 carbon atoms, or a branched or cyclic alkyl group having 3 to 10 carbon atoms, where the above-mentioned groups may each be substituted by one or more radicals R^{32}, where R^{32} is as defined in claim 7.

18. Polymer, oligomer or dendrimer containing one or more compounds according to claim 1, where the bond(s) to the polymer, oligomer or dendrimer may be localised at any positions in formula (1) which is substituted by R^2, R^A, R^B, R^Y or R.

19. Formulation comprising at least one compound according to one or more of the claims 1 to 17 or at least one polymer, oligomer or dendrimer according to claim 18 and at least one solvent.

20. Electronic device comprising at least one compound according to one or more of claims 1 to 17 or at least one polymer, oligomer or dendrimer according to claim 18, selected from the group consisting of organic electroluminescent devices, organic integrated circuits, organic field-effect transistors, organic thin-film transistors, organic light-emitting transistors, organic solar cells, dye-sensitised organic solar cells, organic optical detectors, organic photoreceptors, organic field-quench devices, light-emitting electrochemical cells, organic laser diodes and organic plasmon emitting devices.

21. Organic electroluminescent device comprising at least one compound according to one or more of claims 1 to 17 or at least one polymer, oligomer or dendrimer according to claim 18, characterised in that the compound according to one or more of claims 1 to 17 or the polymer, oligomer or dendrimer according to claim 18 is employed as an emitter in an emitting layer.

22. Organic electroluminescent device according to claim 21, characterized in that the compound according to one or more of claims 1 to 17 or the polymer, oligomer or dendrimer according to claim 18 is employed as a fluorescent emitter in an emitting layer, wherein the emitting layer comprises at least one further component selected from matrix materials.

23. Organic electroluminescent device according to claim 21, characterized in that the compound according to one or more of claims 1 to 17 or the polymer, oligomer or dendrimer according to claim 18 is employed as an emitter showing Thermally Activated Delayed Fluorescence in an emitting layer, wherein the emitting layer comprises at least one further component selected from matrix materials.

24. Organic electroluminescent device according to claim 21, characterized in that the compound according to one or more of claims 1 to 17 or the polymer, oligomer or dendrimer according to claim 18 is employed as a fluorescent emitter in an emitting layer, wherein the emitting layer comprises at least one sensitizer selected from phosphorescent compounds and thermally activated delayed fluorescence compounds.

25. Organic electroluminescent device according to claim 24, characterized in that the emitting layer further comprises at least one organic functional material selected from matrix materials.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/081815

A. CLASSIFICATION OF SUBJECT MATTER
INV. C09K11/06 C07F5/02 C07F7/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B C09K

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2020/208051 A1 (MERCK PATENT GMBH [DE]) 15 October 2020 (2020-10-15) claims; examples; compounds 1-53,(5-1-Y1), (5-2-Y1),(5-3-Y1) -----	1-15, 17-25 16
Y A	US 2013/200359 A1 (STOESSEL PHILIPP [DE] ET AL) 8 August 2013 (2013-08-08) claims; examples; compounds 31-42 -----	1-15, 17-25 16

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

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 February 2024	04/03/2024

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2023/081815

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