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(54) Title: ELECTROLUMINESCENT DEVICE

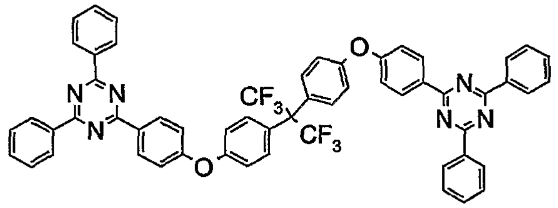
(57) Abstract: Disclosed are electroluminescent devices that comprise organic layers that contain triazine, or pyrimidine compounds. The compounds are suitable components of, for example, blueemitting, durable, organo-electroluminescent layers. The electroluminescent devices may be employed for full color display panels in, for example, mobile phones, televisions and personal computer screens.

ELECTROLUMINESCENT DEVICE

The present invention relates to organo-electroluminescent (EL) devices, in particular EL devices that comprise durable, especially blue-emitting organo-electroluminescent layers. The organo-electroluminescent layers comprise certain triazine, or pyrimidine compounds.

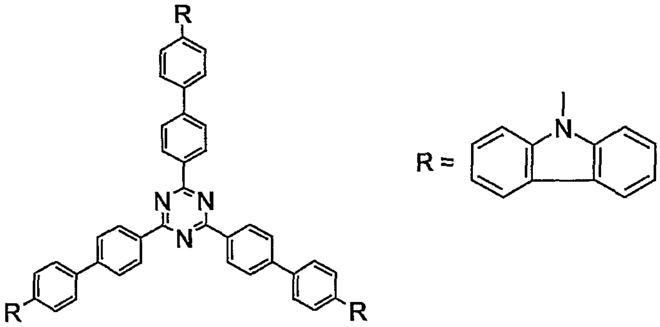
The present invention is aimed at an electroluminescent device comprising an organic light-emitting layer that contains at least one blue-emitting triazine, or pyrimidine compound.

US-B-6,352,791 relates to an electroluminescent arrangement, comprising at least two electrodes, and a light emitting layer system including at least one emitter layer and at least one electron-conducting layer, wherein the at least one electron-conducting layer does not emit light and includes one triazine compound, such as, for example,

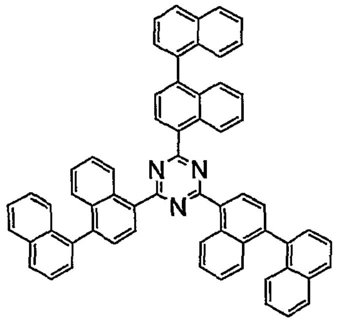


US-B-6225467 is directed to organic electroluminescent (EL) devices, which contain an electron transport component comprised of triazine compounds, such as, for example, 4,6-tris(4-biphenylyl)-1,3,5-triazine, 2,4,6-tris[4-(4'-methylbiphenylyl)]-1,3,5-triazine, 2,4,6-tris[4-(4'-tert-butylbiphenylyl)-1,3,5-triazine, 2,4,6-tris[4-(3',4'-dimethylbiphenylyl)]-1, 3,5-triazine, 2,4,6-tris[4-(4'-methoxybiphenylyl)]-1,3,5-triazine, 2,4,6-tris[4-(3'-methoxybiphenylyl)]-1,3,5-triazine, 2,4-bis(4-biphenylyl)-6-phenyl-1,3,5-triazine and 2,4-bis(4-biphenylyl)-6-m-tolyl-1,3,5-triazine.

EP-A-1,202,608 relates to an electroluminescent arrangement, wherein a host material constituting the hole transporting layer is a compound of formula



EP-A-1,013,740 relates to an electroluminescent element, wherein among others the following compound can be used as EL material:



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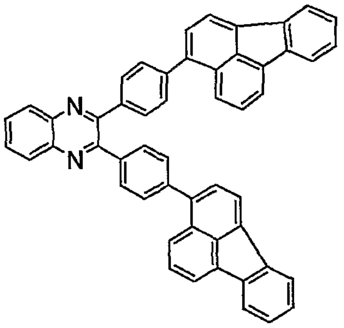
JP2003040873 relates to novel quinoxaline compounds, such as



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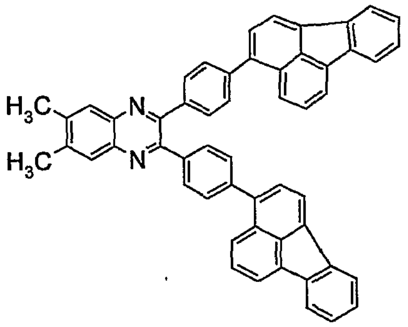

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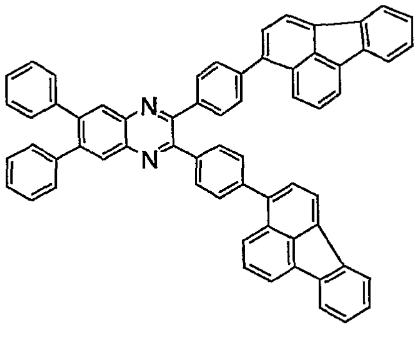


, and their use in organic EL elements.

U.S. Pat. No. 5,104,740 teaches an electroluminescent element that comprises a fluorescent layer containing a coumarinic or azacoumarinic derivative and a hole transport layer, both made of organic compounds and laminated on top of the other.

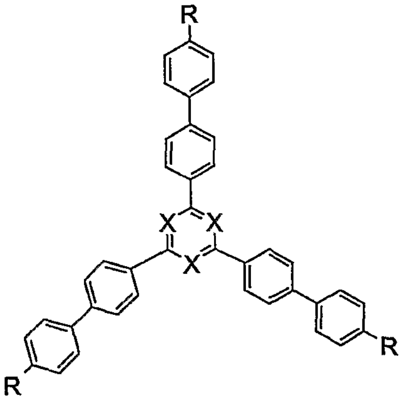
U.S. Pat. No. 6,280,859 discloses certain polyaromatic organic compounds for use as a light-emitting material in organo-electroluminescent devices.

U.S. Pat. No. 5,116,708 is aimed at a hole transport material for EL devices.

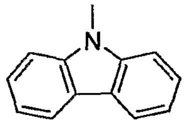
WO98/04007 and EP-A-1013740 relate to an electroluminescent arrangement with the electron-conducting layer containing one or more compounds comprising triazine as basic substance.

EP-A-1013740 discloses the use of triazine compounds in EL devices.

EP-A-1,202,608 discloses EL devices comprising a carbazole compound of formula

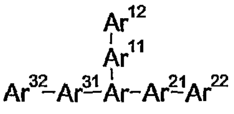


, wherein R is



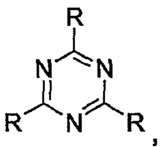
and X is C or N, which constitutes the hole transporting layer.

JP2002324678 relates to light emitting elements comprising at least one kind of compound of formula

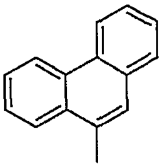


$$Ar^{32}-Ar^{31}-Ar(-Ar^{11}-Ar^{12})-Ar^{21}-Ar^{22}$$

, wherein Ar^{11}, Ar^{21} and Ar^{31} denote arylene groups, Ar^{12}, Ar^{22} and Ar^{32} denote substituents or hydrogen atoms, wherein at least one of Ar^{11}, Ar^{21}, Ar^{31}, Ar^{12}, Ar^{22} and Ar^{32} is either a condensed ring aryl structure or a condensed ring heteroaryl structure; Ar denotes an arylene group or a heteroarylene group; and at least one amine derivative having a condensed ring group with two or more rings are contained in a luminous layer. As examples of compounds of the above formula, wherein Ar denotes a heteroarylene group the following two compounds are explicitly mentioned:



, R is a group of formula



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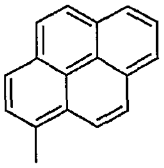

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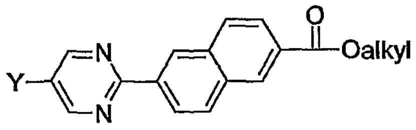
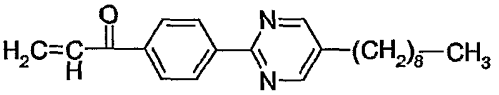
WO02/02714 relates to electroluminescent iridium compounds with fluorinated phenylpyridines, phenylpyrimidines, and phenylquinolines and devices made with such compounds.

US-A-5,770,108 describes liquid crystal compositions comprising pyrimidine compounds of the following formula , wherein Y is alkyl or -O-alkyl and liquid crystal element comprising said composition.



WO01/05863 relates to EL devices comprising arylamine-substituted poly(arylene vinylenes).

JP2000347432 describes the use of



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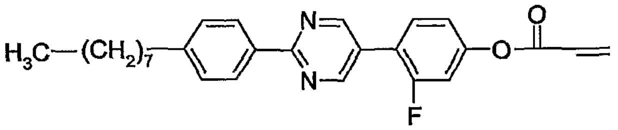
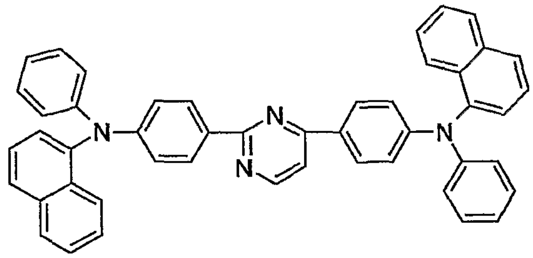


in EL devices.

EP-A-926216 relates to EL devices using triaryl amine compounds, such as



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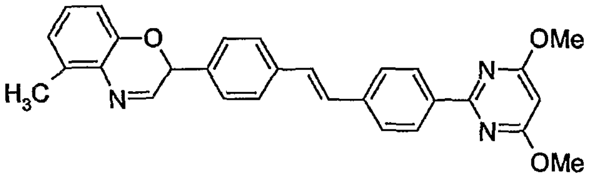
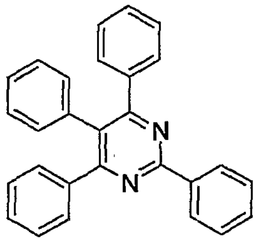
EP-A-690 053 relates to the use of conjugated compounds containing two or more pyrimidine rings, which are part of the conjugated system, as electroluminescent materials. The conjugated compounds described in EP-A-690 053 comprise pyrimidin-2,5-diyl groups which do not carry substituents at positions 4 and 6.

EP-A-563009 relates to EL devices comprising

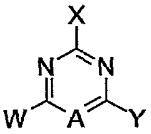


as light emitting material.

US-A-5,077,142 relates to EL devices comprising a number of organic compounds as light emitting material. A pyrimidine moiety, , is listed among a long list of possible organic compounds.

It is the object of the present invention to provide a light emitting element with excellent light emitting characteristics and durability.

Accordingly, the present invention relates to an electroluminescent device comprising an anode, a cathode and one or a plurality of organic compound layers sandwiched therebetween, in which said organic compound layers comprise a compound of formula


(I).

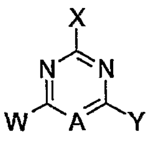
Preferably, the compound or compounds of the present invention emit light below about 520 nm, in particular between about 380 nm and about 520 nm.

The compound or compounds of the present invention have especially a NTSC coordinate of between about (0.12, 0.05) and about (0.16, 0.10), very especially a NTSC coordinate of about (0.14, 0.08).

The compound or compounds of the present invention have a melting point above about 150°C, preferably above about 200°C and most preferred above about 250°C.

To obtain organic layers of this invention with the proper T_g, or glass transition temperature, it is advantageous that the present organic compounds have a glass transition temperature greater than about 100°C, for example greater than about 110°C, for example greater than about 120°C, for instance greater than about 130°C.

Accordingly, the present invention is directed to compounds of formula



(I), wherein

A is CH, or N,

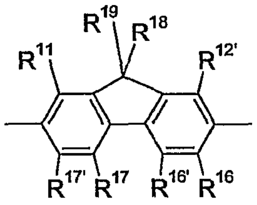
X is a group of the formula $-(X^1)_m-(X^2)_n-X^3$

W is a group of the formula $-(W^1)_a-(W^2)_b-W^3$, and

Y is a group of the formula $-(Y^1)_c-(Y^2)_d-Y^3$, wherein

a, b, c, d, m and n are independently of each other 0, or 1,

W^1, W^2, X^1, X^2, Y^1 and Y^2 are independently of each other a group of formula



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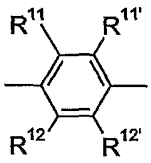

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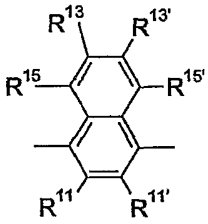

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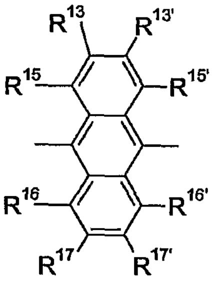

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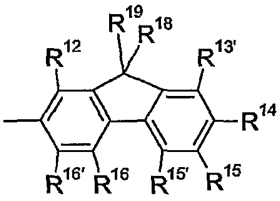
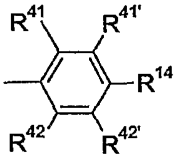


,

W^3, X^3 and Y^3 are independently of each other a group of formula



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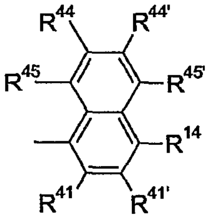

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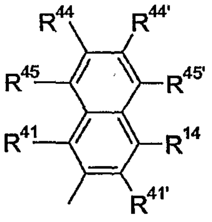

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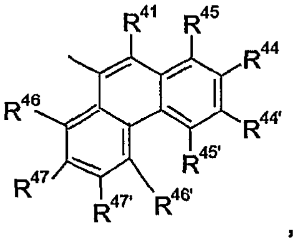

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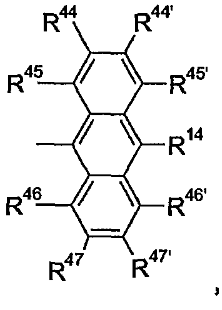
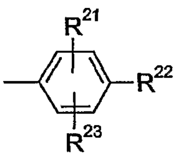


, or a C_{16}-C_{30}aryl group, such as fluoranthenyl, triphenlenyl, chrysenyl, naphthacenyl, picenyl, perylenyl, pentaphenyl, hexacenyl, or pyrenyl, which can be substituted by G;

R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17}, $R^{17'}$, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, R^{44}, $R^{44'}$, R^{45}, $R^{45'}$, R^{46}, $R^{46'}$, R^{47} and $R^{47'}$ are independently of each other H, E, C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by G; C_1-C_{18}alkyl; C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_1-C_{18}alkoxy; or C_1-C_{18}alkoxy which is substituted by E and/or interrupted by D; C_7-C_{18}aralkyl; or C_7-C_{18}aralkyl which is substituted by G;

R^{14} is H, C_1-C_{18}alkyl; or C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_1-C_{18}alkoxy; or C_1-C_{18}alkoxy which is substituted by E and/or interrupted by D;



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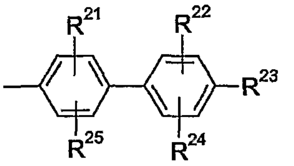

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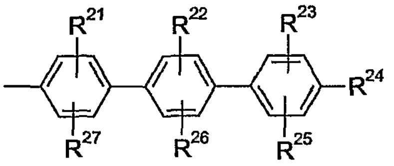

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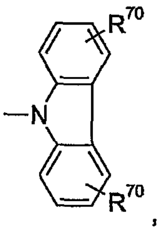
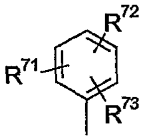


, or

-NAr^{1}Ar^2, wherein Ar^1 and Ar^2 are independently of each other



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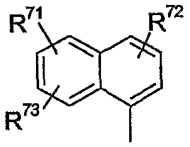


, R^{21}, R^{22}, R^{23}, R^{24}, R^{25}, R^{26} and R^{27} are independently of each other H, E, C_1-C_{18}alkyl; C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_7-C_{18}aralkyl; C_7-C_{18}aralkyl which is substituted by G;

R^{70}, R^{71}, R^{72} and R^{73} are independently of each other C_1-C_{18}alkyl, C_1-C_{18}alkyl which is interrupted by –O– , C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, -OR^5, or -SR^5,

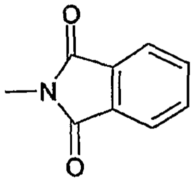
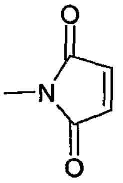
R^{18} and R^{19} are independently of each other C_1-C_{18}alkyl; C_1-C_{18}alkoxy, C_6-C_{18}aryl; C_7-C_{18}aralkyl; or R^{18} and R^{19} together form a ring especially a five- or six-membered ring, which can optionally be substituted by C_1-C_8alkyl,

D is -CO-; -COO-; -OCOO-; -S-; -SO-; -SO$_2$-; -O-; -NR^5-; SiR^{61}R^{62}-; -POR^5-; -CR^{63}=CR^{64}-; or -C≡C-;

E is -OR^5; -SR^5; -NR^{5}R^6; -COR^8; -COOR^7; -OCOOR^7, -CONR^{5}R^6; -CN; or halogen;

G is E, or C_1-C_{18}alkyl,

wherein R^5 and R^6 are independently of each other C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, or C_1-C_{18}alkoxy; C_1-C_{18}alkyl or C_1-C_{18}alkyl which is interrupted by –O–; or

R^5 and R^6 together form a five or six membered ring, in particular  or  ,

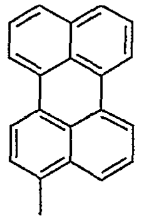
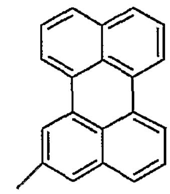
R^7 is C_7-C_{12}alkylaryl; C_1-C_{18}alkyl; or C_1-C_{18}alkyl which is interrupted by –O-;

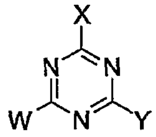
R^8 is C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, or C_1-C_{18}alkoxy; C_1-C_{18}alkyl; C_7-C_{12}alkylaryl, or C_1-C_{18}alkyl which is interrupted by –O-;

R^{61} and R^{62} are independently of each other C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, C_1-C_{18}alkoxy; or C_1-C_{18}alkyl which is interrupted by –O-, and

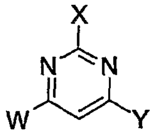
R^{63} and R^{64} are independently of each other H, C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, C_1-C_{18}alkoxy; or C_1-C_{18}alkyl which is interrupted by –O-.

If W^3 and/or Y^3 are different from a C_{16}-C_{30}aryl group, X is preferably a group of the formula –X^1-X^3, especially phenyl, or biphenyl.

If W^3 and/or Y^3 are a C_{16}-C_{30}aryl group, they are especially a fluoranthenyl, triphenlenyl, chrysenyl, naphthacen, picenyl, perylenyl, such as  or  , pentaphenyl, hexacenyl, or pyrenyl group, which can be substituted by G; very especially a fluoranthenyl group, which can be substituted by G.

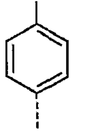
In a preferred embodiment the present invention is directed to triazine compounds of formula  .

In a preferred embodiment the present invention is directed to pyrimidine compounds of formula



.

If W^3, Y^3 and/or X^3 are different from a C_{16}-C_{30}aryl group, they are in one embodiment of the present application especially a C_6-C_{10}-aryl group, such as phenyl, 1-naphthyl, 2-naphthyl, 3- or 4-biphenyl, 9-phenanthryl, 2- or 9-fluorenyl, which is optionally substituted by C_1-C_6-alkyl, or C_1-C_4-alkoxy, especially



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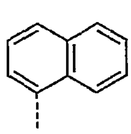

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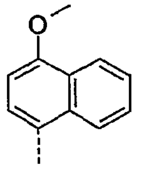

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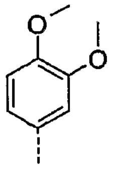

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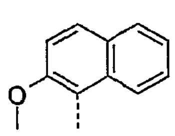

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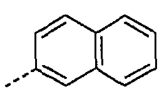

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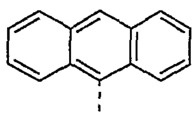

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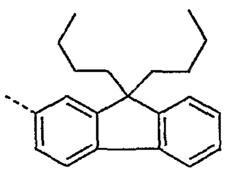

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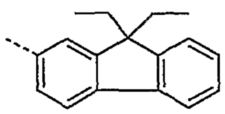

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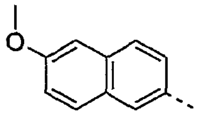

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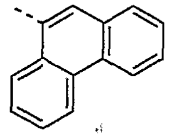

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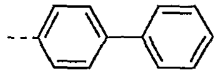

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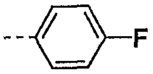
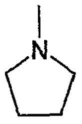
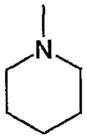
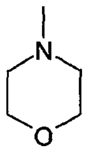
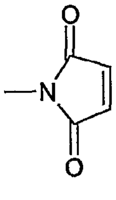
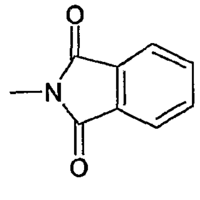
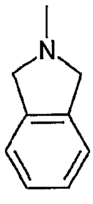
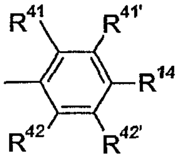
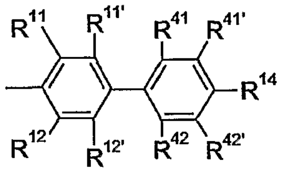


.

Preferably, R^{18} and R^{19} are independently of each other H, C_1-C_{18}alkyl, such as n-butyl, sec-butyl, hexyl, octyl, or 2-ethyl-hexyl, C_1-C_{18}alkyl which is substituted by E and/or interrupted by D, such as $-CH_2(OCH_2CH_2)_wOCH_3$, w = 1, 2, 3, or 4, C_6-C_{24}aryl, such as phenyl, naphthyl, or biphenyl, C_6-C_{24}aryl which is substituted by G, such as $-C_6H_4OCH_3$, $-C_6H_4OCH_2CH_3$, $-C_6H_3(OCH_3)_2$, $-C_6H_3(OCH_2CH_3)_2$, $-C_6H_4CH_3$, $-C_6H_3(CH_3)_2$, $-C_6H_2(CH_3)_3$, or $-C_6H_4tBu$, or R^{18} and R^{19} together form a 5 or 6 membered ring, such as cyclohexyl, or cyclopentyl, which can optionally be substituted by C_1-C_8alkyl.

D is preferably -CO-, -COO-, -S-, -SO-, $-SO_2-$, -O-, $-NR^5-$, wherein R^5 is C_1-C_{18}alkyl, such as methyl, ethyl, n-propyl, iso-propyl, n-butyl, isobutyl, or sec-butyl, or C_6-C_{24}aryl, such as phenyl, naphthyl, or biphenyl.

E is preferably $-OR^5$; $-SR^5$; $-NR^5R^6$; $-COR^8$; $-COOR^7$; $-CONR^5R^6$; or -CN; wherein R^5, R^5, R^7 and R^8 are independently of each other C_1-C_{18} alkyl, such as methyl, ethyl, n-propyl, iso-propyl, n-butyl, isobutyl, sec-butyl, hexyl, octyl, or 2-ethyl-hexyl, or C_6-C_{24}aryl, such as phenyl, naphthyl, or biphenyl, or R^5 and R^6 together form a ring , , , , , or .

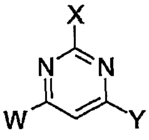
In a preferred embodiment of the present invention X is , or . In another preferred embodiment of the present invention W and Y are a group of the formula $-W^1$-W^2-W^3. In another preferred embodiment of the present invention at least one of a and b and c and d is 1, or both a and b and c and d are 1.

R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17} and $R^{17'}$, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, R^{44}, $R^{44'}$, R^{45}, $R^{45'}$, R^{46}, $R^{46'}$, R^{47}, and $R^{47'}$ as well as R^{14} are preferably independently of each other H, E; or C_1-C_{18}alkyl; , such as methyl, ethyl, n-propyl, iso-propyl, n-butyl, isobutyl, sec-butyl, t-butyl, 2-methylbutyl, n-pentyl, isopentyl, n-hexyl, 2-ethylhexyl, or n-heptyl, C_1-C_{18}alkyl which is substituted by E and/or interrupted by D, such as $-CH_2OCH_3$, $-CH_2OCH_2CH_3$, $-CH_2OCH_2CH_2OCH_3$, or $-CH_2OCH_2CH_2OCH_2CH_3$, C_6-C_{24}aryl, such as phenyl, naphthyl, or biphenyl, C_6-C_{24}aryl which is substituted by G, such as $-C_6H_4OCH_3$, $-C_6H_4OCH_2CH_3$; wherein D is –O-, E is $-OR^5$; $-SR^5$; $-NR^5R^6$; $-COR^8$; $-COOR^7$; $-CONR^5R^6$; -CN; $-OCOOR^7$; or halogen; G is E, or C_1-C_8alkyl; wherein R^5 and R^6 are independently of each other C_6-C_{12}aryl, or C_1-C_8alkyl;

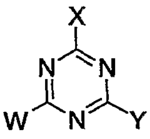
R^7 is C_7-C_{12}alkylaryl, or C_1-C_8alkyl; and

R^8 is C_6-C_{12}aryl; or C_1-C_8alkyl.

In a preferred embodiment the present invention is directed to compounds of formula

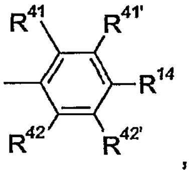


(II), or

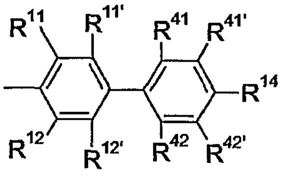


(III), wherein

X is



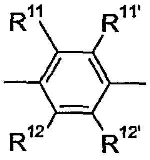
, or



, and

W and Y are a group of the formula $-W^1-W^2-W^3$, wherein

W^1 is a group of formula



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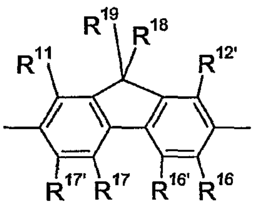
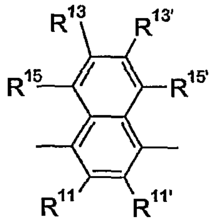
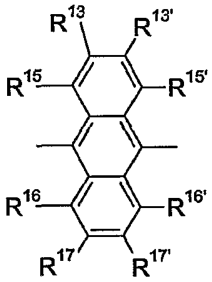


,

W^2 is a group of formula

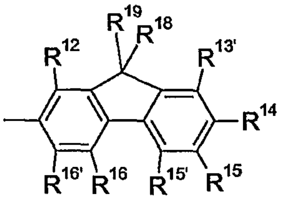


, or



,

W^3 is a group of formula



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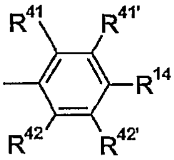

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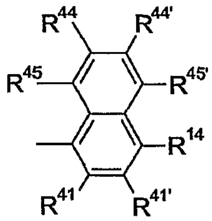

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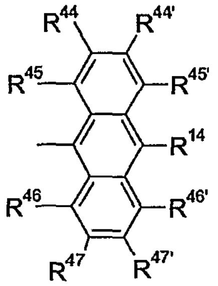
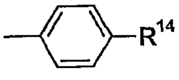


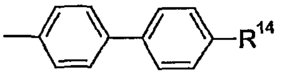
, wherein

R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{14}, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17}, $R^{17'}$, R^{18}, R^{19}, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, R^{44}, $R^{44'}$, R^{45}, $R^{45'}$, R^{46}, $R^{46'}$, R^{47} and $R^{47'}$ are as defined above, or $R^{15'}$ and R^{41} or $R^{15'}$ and R^{45}

represents a single carbon carbon bond, or X, W and Y are a group of the formula $-W^1-W^2-W^3$, wherein W^1, W^2 and W^3 are as defined above.

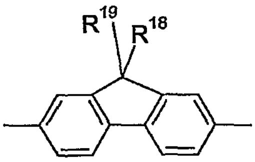
In said embodiment compounds of formula II, or III are especially preferred, wherein

X is 

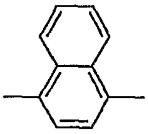
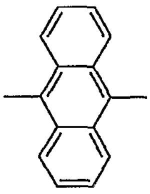
, or 

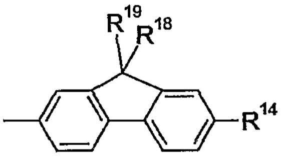
, and

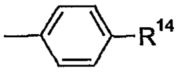
W and Y are a group of the formula $-W^1-W^2-W^3$, wherein

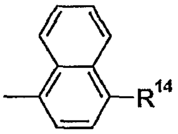
W^1 is a group of formula , 

,

W^2 is a group of formula , or ,

W^3 is a group of formula 

, 

, 

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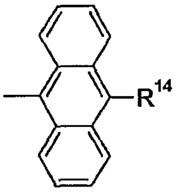
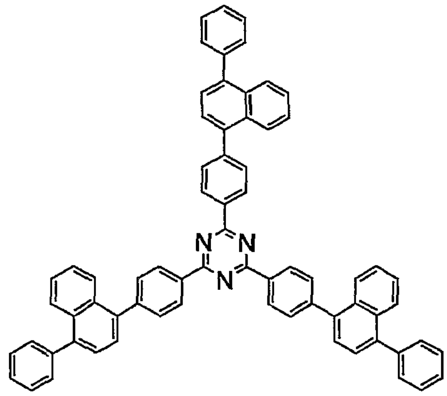
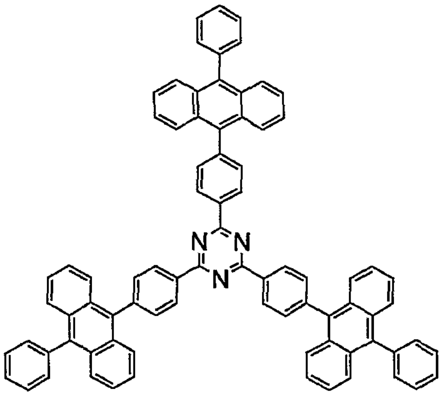


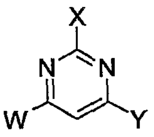
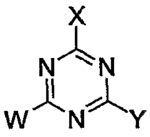
, wherein

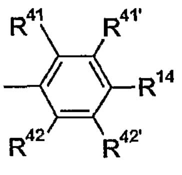
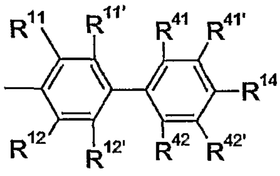
R^{14} is H, C_1-C_8alkyl, or C_1-C_8alkoxy, and

wherein R^{18} and R^{19} are independently of each other C_1-C_8alkyl, or cyclohexyl, wherein the following compounds are excluded:

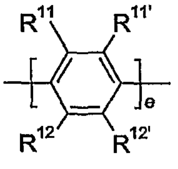

and

.

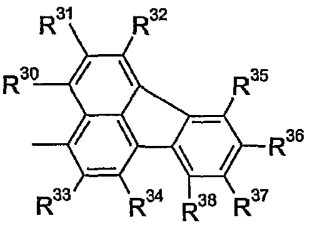
In a further preferred embodiment the present invention is directed to compounds of formula


(II), or

(III), wherein

X is

, or

, and

W and Y are a group Ar^1-Ar^2, wherein

Ar^1 is a group of formula

,

Ar^2 is a group of formula

, wherein

R^{30}, R^{31}, R^{32}, R^{33}, R^{34}, R^{35}, R^{36}, R^{37} and R^{38} are independently of each other H, E, C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by G; C_1-C_{18}alkyl; C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_7-C_{18}aralkyl; or C_7-C_{18}aralkyl which is substituted by G;

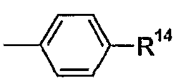
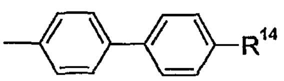
e is an integer 1, or 2, or

X, W and Y are independently of each other a group Ar^1-Ar^2, wherein Ar^1 and Ar^2 are as defined above, and

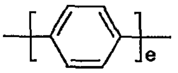
D, E, G, R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, and R^{14} are defined above.

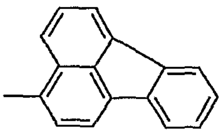
If X, W and Y are independently of each other a group Ar^1-Ar^2, they can be different, but they have preferably the same meaning.

In said embodiment compounds of formula II, or III are especially preferred, wherein

X is , or , and

W and Y are a group Ar^1-Ar^2, wherein

Ar^1 is a group of formula ,

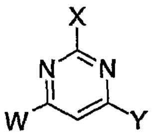
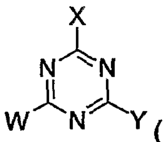
Ar^2 is a group of formula 

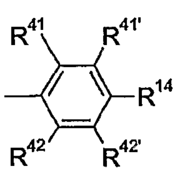
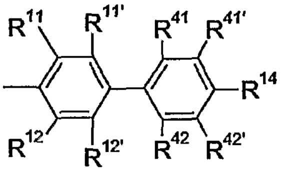
e is an integer 1, or 2,

R^{14} is H, C_1-C_8alkyl, or C_1-C_8alkoxy, or

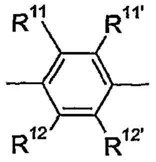
X, W and Y are a group Ar^1-Ar^2, wherein Ar^1 and Ar^2 are as defined above.

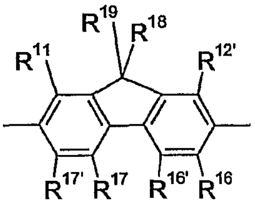
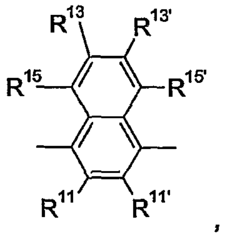
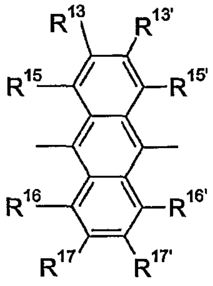
In a further preferred embodiment the present invention is directed to compounds of formula

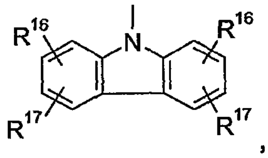
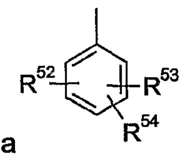
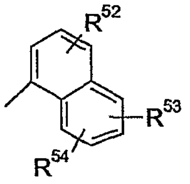
 (II), or  (III), wherein

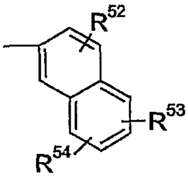
X is , or , and

W and Y are a group of the formula $-W^1$-$(W^2)_b$-W^3, wherein b is 1, or 2,

W^1 and W^2 are independently of each other a group of formula ,

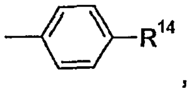
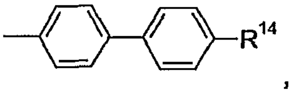
, , or ,

W^3 is a group of formula , or $-NR^{50}R^{51}$, wherein R^{50} and R^{51} are independently of each other a group of formula ,  or

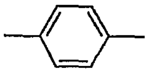
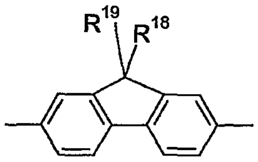
, wherein R^{52}, R^{53} and R^{54} are independently of each other hydrogen, C_1-C_8alkyl, a hydroxyl group, a mercapto group, C_1-C_8alkoxy, C_1-C_8alkylthio, halogen, halo-C_1-C_8alkyl, a cyano group, an aldehyde group, a ketone group, a carboxyl group, an ester group, a carbamoyl group, an amino group, a nitro group, a silyl group or a siloxanyl group, wherein R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{14}, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17}, $R^{17'}$, R^{18}, R^{19}, R^{41}, $R^{41'}$, R^{42} and $R^{42'}$ are as defined above, or X, W and Y are independently of each other a group of the formula $-W^1-(W^2)_b-W^3$, wherein b, W^1, W^2 and W^3 are as defined above.

If X, W and Y are independently of each other a group $-W^1-(W^2)_b-W^3$, they can be different, but they have preferably the same meaning.

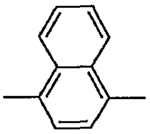
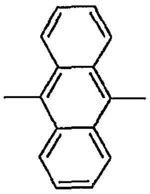
In said embodiment compounds of formula II, or III are especially preferred, wherein

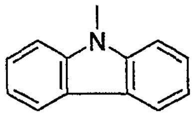
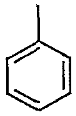
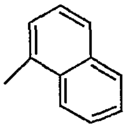
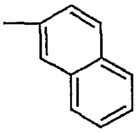
X is , or , and

W and Y are a group of the formula $-W^1-(W^2)_b-W^3$, wherein b is 1, or 2,

W^1 is a group of formula , ,

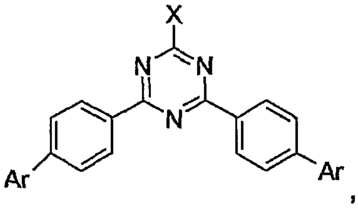
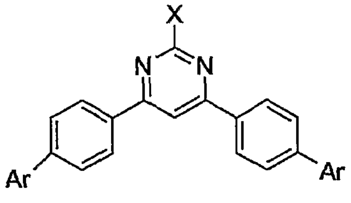
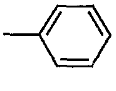
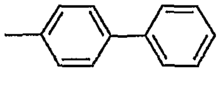
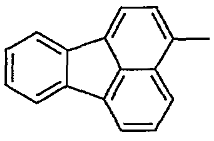
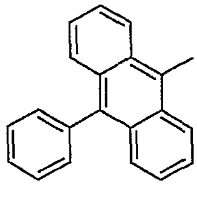
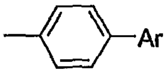
W^2 is a group of formula

, or ,

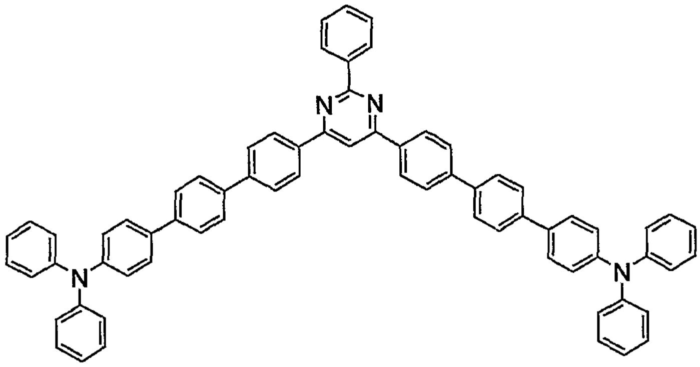
W^3 is a group of formula , or $-NR^{50}R^{51}$, wherein R^{50} and R^{51} are independently of each other a group of formula ,  or ,

R^{14} is H, C_1-C_8alkyl, or C_1-C_8alkoxy, and

R^{18} and R^{19} are independently of each other C_1-C_8alkyl.

In an especially preferred embodiment the present invention is directed to compounds of formula , , wherein X is a group of formula , or , which can optionally be substituted by G, Ar is a group of formula , or , which can optionally be substituted by G, or X is a group of formula .

Specific examples of preferred triazine and pyrimidine compounds are:



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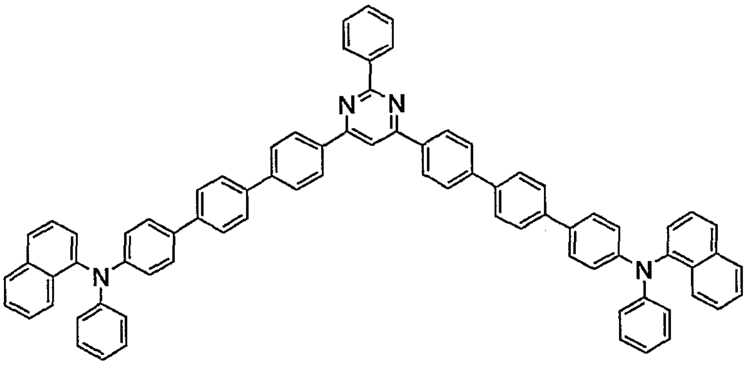

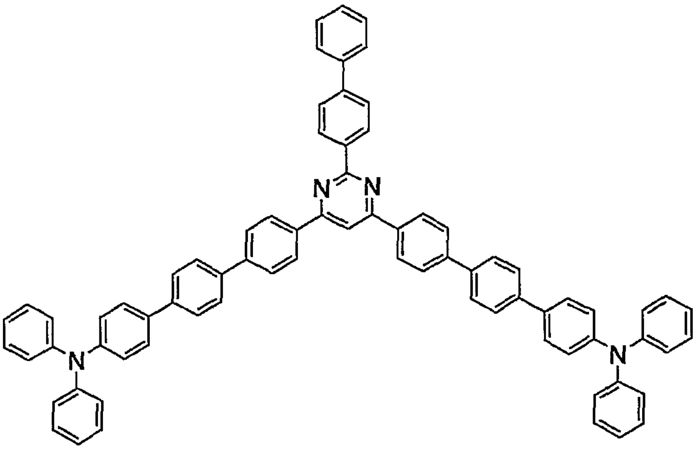

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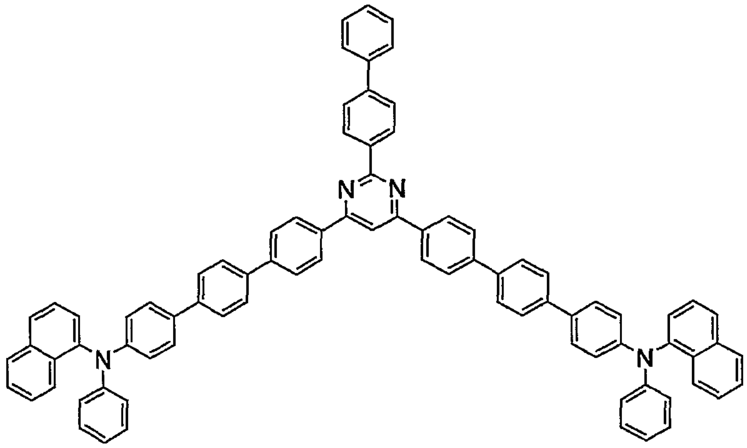

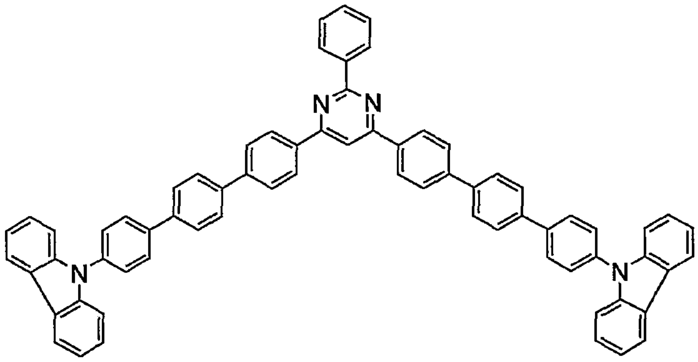

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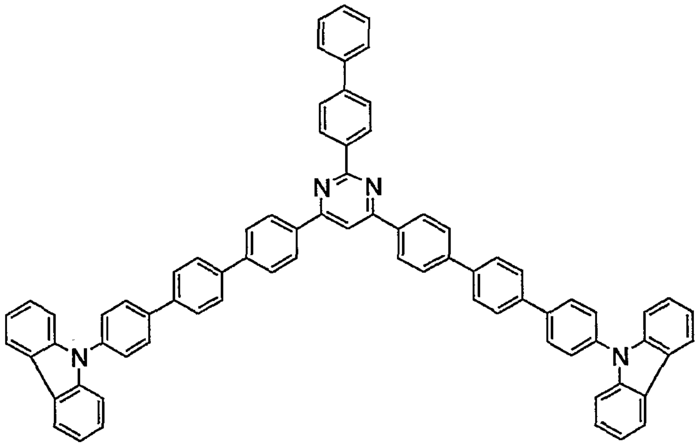

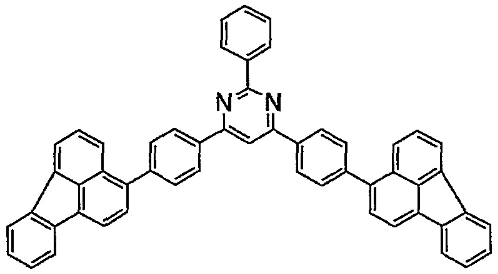
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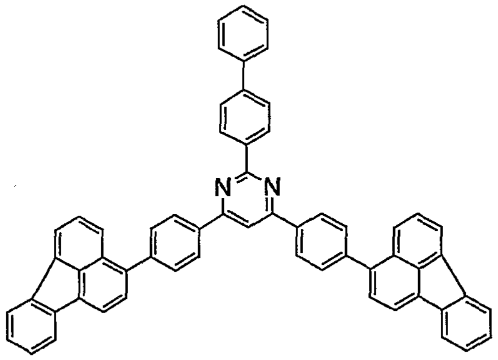
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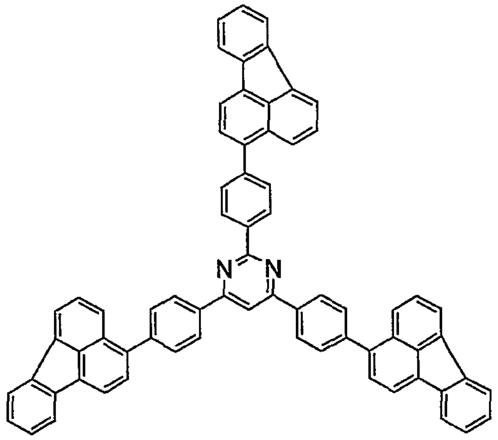
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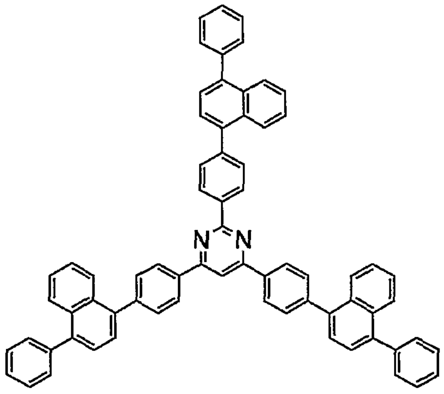
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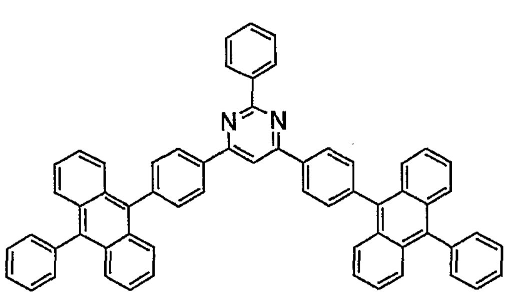
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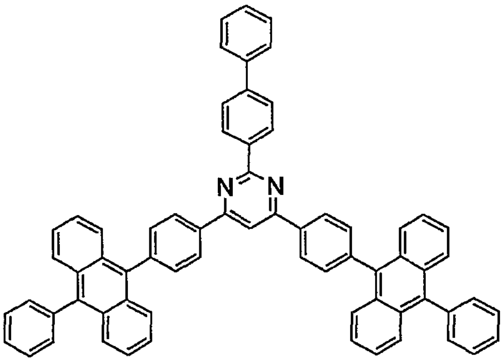
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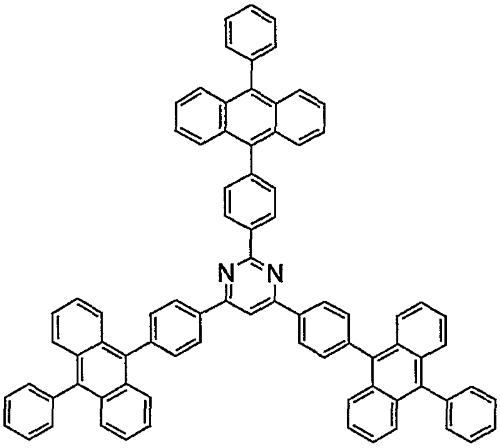
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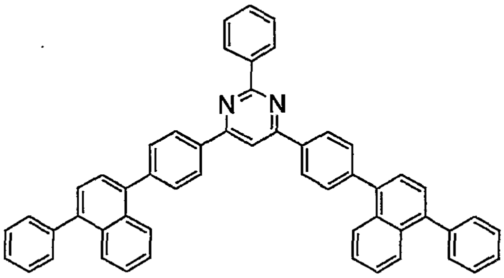
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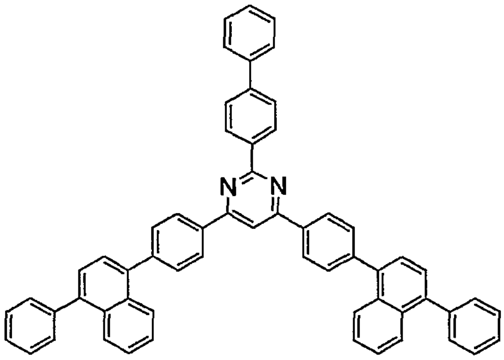
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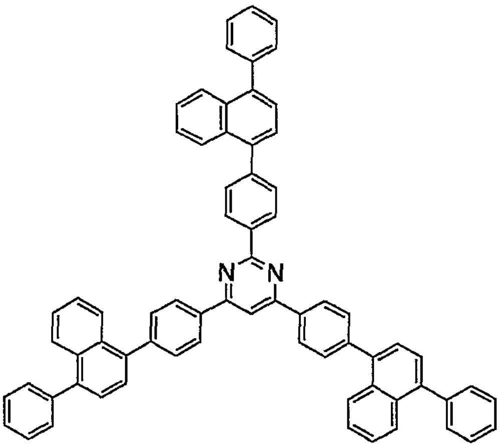
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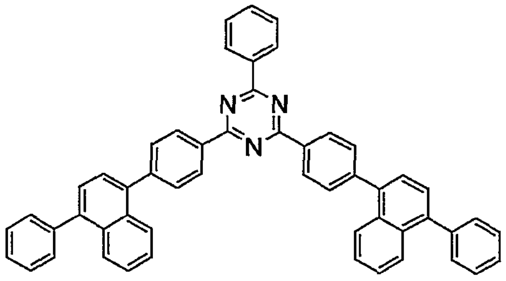
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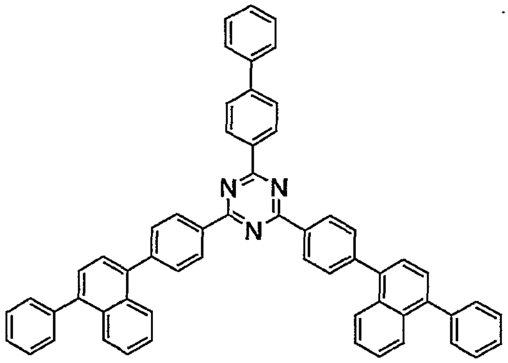
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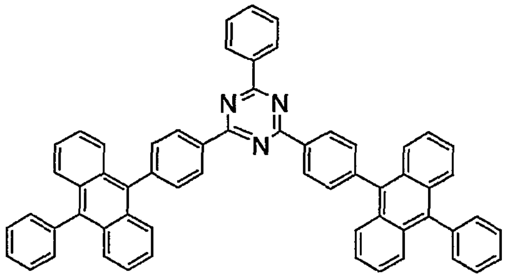
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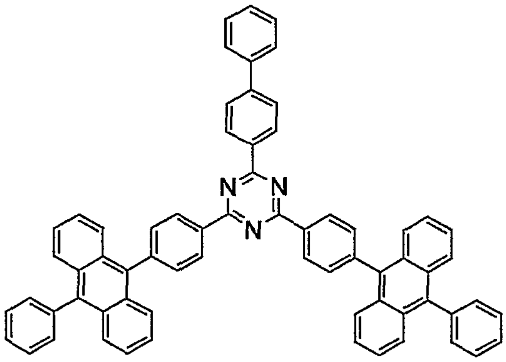
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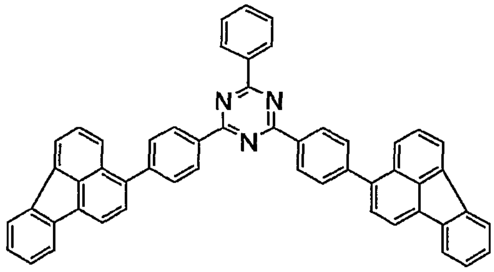
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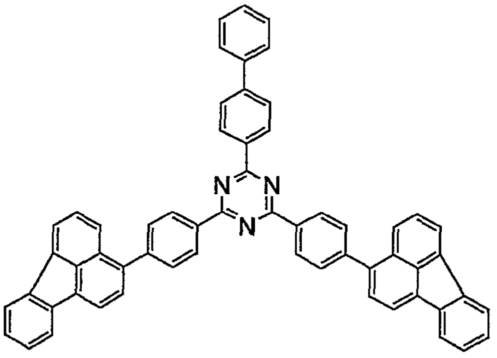
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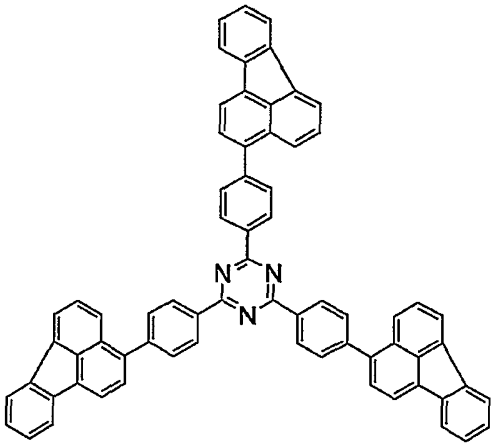
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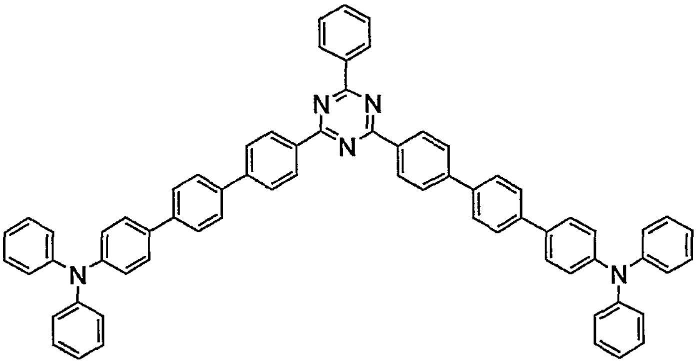
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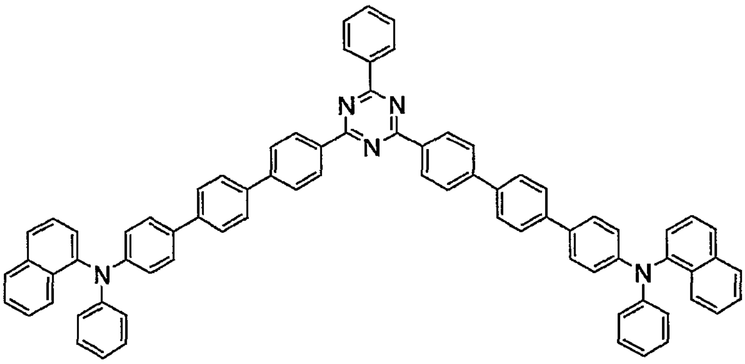
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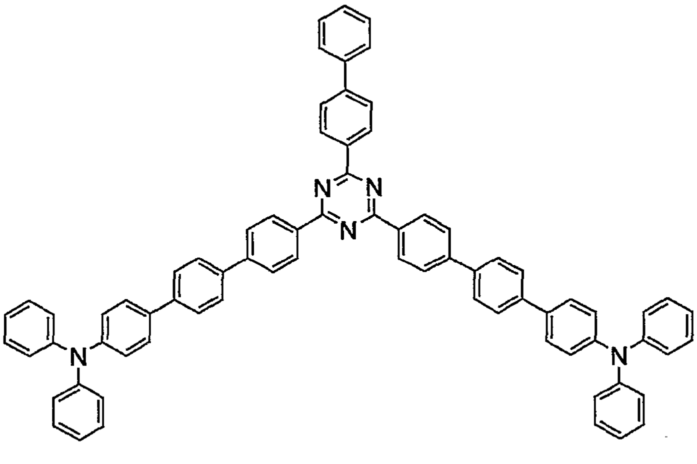
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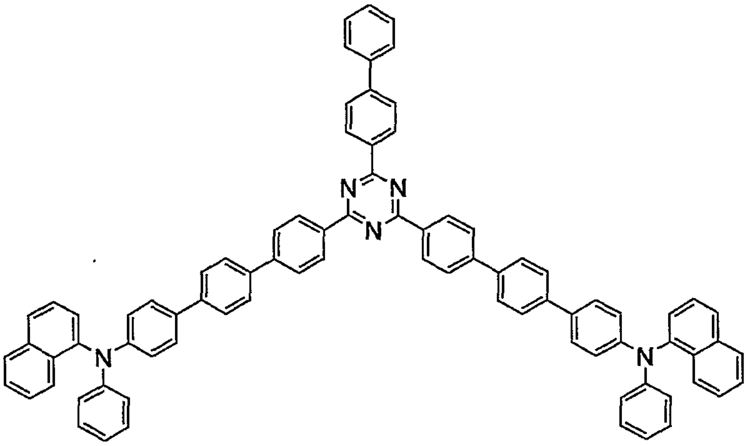

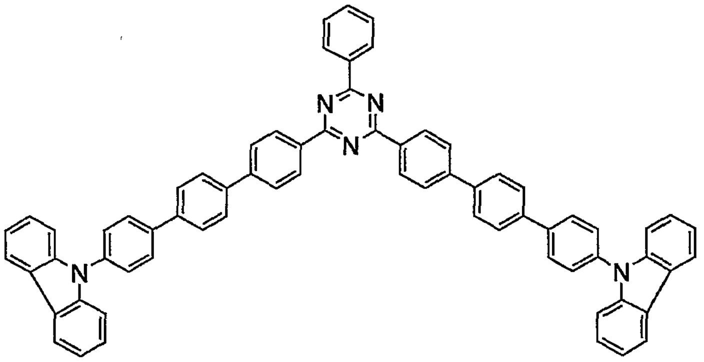

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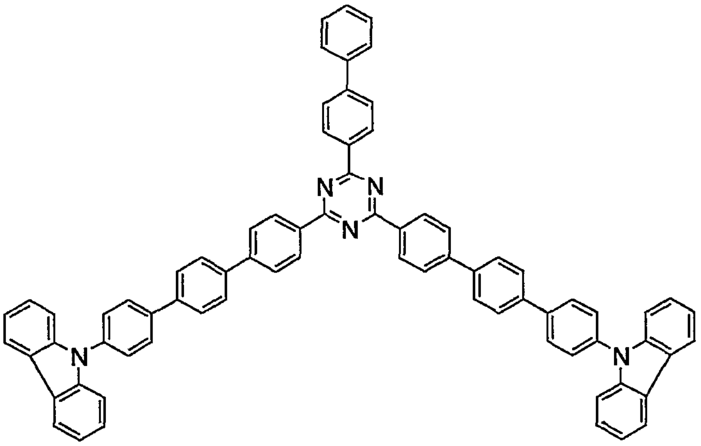
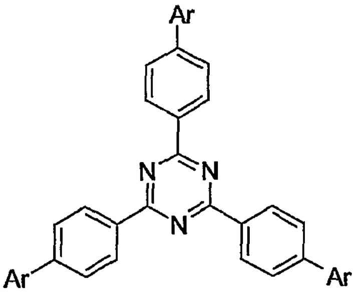


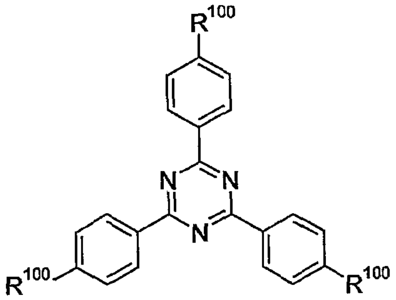
The present triazine and pyrimidine compounds show a high solid state fluorescence in the desired wavelength range and can be prepared according to or analogous to known procedures (se, for example, PCT/EP03/11637 and PCT/EP2004/050146).

The triazine compounds of the present invention of the formula:

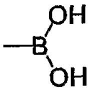


, wherein Ar is W^2-W^3,

can, for example, be prepared according to a process, which comprises reacting a derivative of formula



wherein R^{100} stands for halogen such as chloro or bromo, preferably bromo, or E having the meaning of



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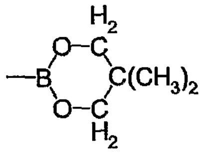

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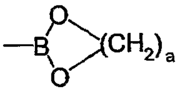


wherein a is 2 or 3,

with boronic acid derivative

E-Ar,

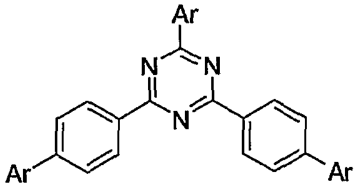
or - in case R^{100} is not halogen –

Hal-Ar,

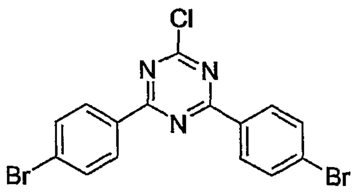
wherein Hal stands for halogen, preferably for bromo,

in the presence of an allylpalladium catalyst of the μ-halo(triisopropylphosphine)(η^3-allyl)palladium(II) type (see for example WO99/47474).

Accordingly, unsymmetrical substituted triazine compounds of the present invention of the formula:

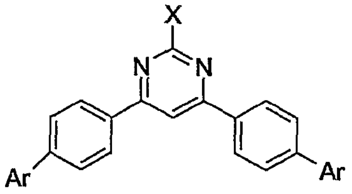


can, for example, be prepared according to a process, which comprises reacting a derivative of formula

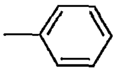


with a boronic acid derivative E-Ar, wherein E is as defined above.

The pyrimidine compounds of the present invention, comprising the following units:



, wherein X is



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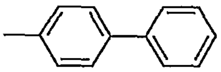
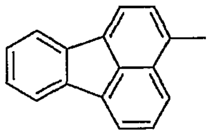


, Ar is defined as above and is especially



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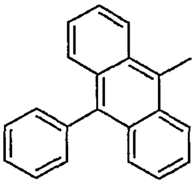
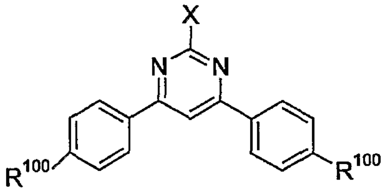
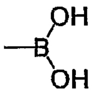


,

can be prepared according to a process, which comprises reacting a derivative of formula

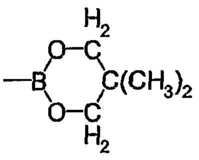


R^{100} stands for halogen such as chloro or bromo, preferably bromo,
with boronic acid derivative
E-Ar, E having the meaning of



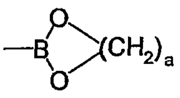
$-B(OH)_2$

or



$-B(OCH_2)_2C(CH_3)_2$

or



$-B(O)_2(CH_2)_a$

wherein a is 2 or 3,

in the presence of an allylpalladium catalyst of the μ-halo(triisopropylphosphine)(η^3-allyl)palladium(II) type (see for example WO99/47474).

Preferably, the reaction is carried out in the presence of an organic solvent, such as an aromatic hydrocarbon or a usual polar organic solvent, such as benzene, toluene, xylene, tetrahydrofurane, or dioxane, or mixtures thereof, most preferred toluene. Usually, the amount of the solvent is chosen in the range of from 1 to 10 l per mol of boronic acid derivative. Also preferred, the reaction is carried out under an inert atmosphere such as nitrogen, or argon.

Further, it is preferred to carry out the reaction in the presence of an aqueous base, such as an alkali metal hydroxide or carbonate such as NaOH, KOH, Na_2CO_3, K_2CO_3, Cs_2CO_3 and the like, preferably an aqueous K_2CO_3 solution is chosen. Usually, the molar ratio of the base to compound III is chosen in the range of from 0.5:1 to 50:1.

Generally, the reaction temperature is chosen in the range of from 40 to 180°C, preferably under reflux conditions.

Preferred, the reaction time is chosen in the range of from 1 to 80 hours, more preferably from 20 to 72 hours.

In a preferred embodiment a usual catalyst for coupling reactions or for polycondensation reactions is used, preferably Pd-based catalyst such as known tetrakis(triarylphosphonium)-palladium, preferably $(Ph_3P)_4Pd$ and derivatives thereof. Usually, the catalyst is added in a molar ratio from inventive DPP polymer to the catalyst in the range of from 100:1 to 10:1, preferably from 50:1 to 30:1.

Also preferred, the catalyst is added as in solution or suspension. Preferably, an appropriate organic solvent such as the ones described above, preferably benzene, toluene, xylene, THF, dioxane, more preferably toluene, or mixtures thereof, is used. The amount of solvent usually is chosen in the range of from 1 to 10 l per mol of boronic acid derivative.

The obtained inventive polymer can be isolated by well-known methods. Preferably, after cooling down the reaction mixture to room temperature, it is poured into acetone and the obtained precipitation is filtered off, washed and dried.

C_1-C_{18}Alkyl is a branched or unbranched radical such as for example methyl, ethyl, propyl, isopropyl, n-butyl, sec-butyl, isobutyl, tert-butyl, 2-ethylbutyl, n-pentyl, isopentyl, 1-methylpentyl, 1,3-dimethylbutyl, n-hexyl, 1-methylhexyl, n-heptyl, isoheptyl, 1,1,3,3-tetramethylbutyl, 1-methylheptyl, 3-methylheptyl, n-octyl, 2-ethylhexyl, 1,1,3-trimethylhexyl, 1,1,3,3-tetramethylpentyl, nonyl, decyl, undecyl, 1-methylundecyl, dodecyl, 1,1,3,3,5,5-hexamethylhexyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, or octadecyl.

C_1-C_{18}Alkoxy radicals are straight-chain or branched alkoxy radicals, e.g. methoxy, ethoxy, n-propoxy, isopropoxy, n-butoxy, sec-butoxy, tert-butoxy, amyloxy, isoamyloxy or tert-amyloxy, heptyloxy, octyloxy, isooctyloxy, nonyloxy, decyloxy, undecyloxy, dodecyloxy, tetradecyloxy, pentadecyloxy, hexadecyloxy, heptadecyloxy and octadecyloxy.

C_2-C_{18}Alkenyl radicals are straight-chain or branched alkenyl radicals, such as e.g. vinyl, allyl, methallyl, isopropenyl, 2-butenyl, 3-butenyl, isobutenyl, n-penta-2,4-dienyl, 3-methyl-but-2-enyl, n-oct-2-enyl, n-dodec-2-enyl, isododecenyl, n-dodec-2-enyl or n-octadec-4-enyl.

C_{2-24}Alkynyl is straight-chain or branched and preferably C_{2-8}alkynyl, which may be unsubstituted or substituted, such as, for example, ethynyl, 1-propyn-3-yl, 1-butyn-4-yl, 1-pentyn-5-yl, 2-methyl-3-butyn-2-yl, 1,4-pentadiyn-3-yl, 1,3-pentadiyn-5-yl, 1-hexyn-6-yl, cis-3-methyl-2-penten-4-yn-1-yl, trans-3-methyl-2-penten-4-yn-1-yl, 1,3-hexadiyn-5-yl, 1-octyn-8-yl, 1-nonyn-9-yl, 1-decyn-10-yl or 1-tetracosyn-24-yl,
C_4-C_{18}cycloalkyl is preferably C_5-C_{12}cycloalkyl, such as, for example, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl. Cyclohexyl and cyclododecyl are most preferred.

The term “aryl group" is typically C_6-C_{30}aryl, such as phenyl, indenyl, azulenyl, naphthyl, biphenyl, terphenylyl or quadphenylyl, as-indacenyl, s-indacenyl, acenaphthylenyl, phenanthryl, fluoranthenyl, triphenlenyl, chrysenyl, naphthacen, picenyl, perylenyl, pentaphenyl, hexacenyl, pyrenyl, or anthracenyl, preferably phenyl, 1-naphthyl, 2-naphthyl, 9-phenanthryl, 2- or 9-fluorenyl, 3- or 4-biphenyl, which may be unsubstituted or substituted. Examples of C_6-C_{18}aryl are phenyl, 1-naphthyl, 2-naphthyl, 3- or 4-biphenyl, 9-phenanthryl, 2- or 9-fluorenyl, which may be unsubstituted or substituted.

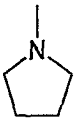
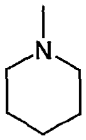
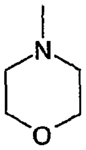
C_7-C_{24}aralkyl radicals are preferably C_7-C_{18}aralkyl radicals, which may be substituted, such as, for example, benzyl, 2-benzyl-2-propyl, β-phenyl-ethyl, α,α-dimethylbenzyl, ω-phenyl-butyl, ω,ω-dimethyl-ω-phenyl-butyl, ω-phenyl-dodecyl, ω-phenyl-octadecyl, ω-phenyl-eicosyl or ω-phenyl-docosyl, preferably C_7-C_{18}aralkyl such as benzyl, 2-benzyl-2-propyl, β-phenyl-ethyl, α,α-dimethylbenzyl, ω-phenyl-butyl, ω,ω-dimethyl-ω-phenyl-butyl, ω-phenyl-dodecyl or ω-phenyl-octadecyl, and particularly preferred C_7-C_{12}aralkyl such as benzyl, 2-benzyl-2-propyl, β-phenyl-ethyl, α,α-dimethylbenzyl, ω-phenyl-butyl, or ω,ω-dimethyl-ω-phenyl-butyl, in which both the aliphatic hydrocarbon group and aromatic hydrocarbon group may be unsubstituted or substituted.

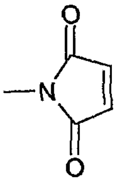
C_7-C_{12}alkylaryl is, for example, a phenyl group substituted with one, two or three C_1-C_6alkyl groups, such as, for example, 2-, 3-, or 4-methylphenyl, 2-, 3-, or 4-ethylphenyl, 3-, or 4-isopropylphenyl, 3,4-dimethylphenyl, 3,5-dimethylphenyl, or 3,4,5-trimethylphenyl.

The term "heteroaryl group", especially C_2-C_{30}heteroaryl, is a ring, wherein nitrogen, oxygen or sulfur are the possible hetero atoms, and is typically an unsaturated heterocyclic radical with five to 18 atoms having at least six conjugated π-electrons such as thienyl, benzo[b]thienyl, dibenzo[b,d]thienyl, thianthrenyl, furyl, furfuryl, 2H-pyranyl, benzofuranyl, isobenzofuranyl, 2H-chromenyl, xanthenyl, dibenzofuranyl, phenoxythienyl, pyrrolyl, imidazolyl, pyrazolyl, pyridyl, bipyridyl, triazinyl, pyrimidinyl, pyrazinyl, 1H-pyrrolizinyl, isoindolyl, pyridazinyl, indolizinyl, isoindolyl, indolyl, 3H- indolyl, phthalazinyl, naphthyridinyl, quinoxalinyl, quinazolinyl, cinnolinyl, indazolyl, purinyl, quinolizinyl, chinolyl, isochinolyl, phthalazinyl, naphthyridinyl, chinoxalinyl, chinazolinyl, cinnolinyl, pteridinyl, carbazolyl, 4aH-carbazolyl, carbolinyl, benzotriazolyl, benzoxazolyl, phenanthridinyl, acridinyl, perimidinyl, phenanthrolinyl, phenazinyl, isothiazolyl, phenothiazinyl, isoxazolyl, furazanyl or phenoxazinyl, preferably the above-mentioned mono- or bicyclic heterocyclic radicals, which may be unsubstituted or substituted.

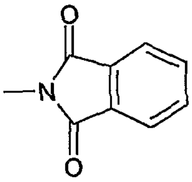
Halogen is fluorine, chlorine, bromine and iodine.

The terms "haloalkyl" mean groups given by partially or wholly substituting the above-mentioned alkyl group, with halogen, such as trifluoromethyl etc. The "aldehyde group, ketone group, ester group, carbamoyl group and amino group" include those substituted by an alkyl group, a cycloalkyl group, an aryl group, an aralkyl group or a heterocyclic group, wherein the alkyl group, the cycloalkyl group, the aryl group, the aralkyl group and the heterocyclic group may be unsubstituted or substituted. The term "silyl group" means a group of formula $-SiR^{62}R^{63}R^{64}$, wherein R^{62}, R^{63} and R^{64} are independently of each other a C_1-C_8alkyl group, in particular a C_1-C_4 alkyl group, a C_6-C_{24}aryl group or a C_7-C_{12}aralkylgroup, such as a trimethylsilyl group. The term "siloxanyl group" means a group of formula $-O-SiR^{62}R^{63}R^{64}$, wherein R^{62}, R^{63} and R^{64} are as defined above, such as a trimethylsiloxanyl group.

Examples of a five or six membered ring formed by R^5 and R^6 are heterocycloalkanes or heterocycloalkenes having from 3 to 5 carbon atoms which can have one additional hetero atom selected from nitrogen, oxygen and sulfur, for example  ,  ,  , or



, which can be part of a bicyclic system, for example



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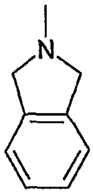


.

Possible substituents of the above-mentioned groups are C_1-C_8alkyl, a hydroxyl group, a mercapto group, C_1-C_8alkoxy, C_1-C_8alkylthio, halogen, halo-C_1-C_8alkyl, a cyano group, an aldehyde group, a ketone group, a carboxyl group, an ester group, a carbamoyl group, an amino group, a nitro group or a silyl group.

As described above, the aforementioned radicals may be substituted by E and/or, if desired, interrupted by D. Interruptions are of course possible only in the case of radicals containing at least 2 carbon atoms connected to one another by single bonds; C_6-C_{18}aryl is not interrupted; interrupted arylalkyl or alkylaryl contains the unit D in the alkyl moiety. C_1-C_{18}alkyl substituted by one or more E and/or interrupted by one or more units D is, for example, $(CH_2CH_2O)_n$-R^x, where n is a number from the range 1-9 and R^x is H or C_1-C_{10}alkyl or C_2-C_{10}alkanoyl (e.g. CO-CH(C_2H_5)C_4H_9), CH_2-CH($OR^{y'}$)-CH_2-O-R^y, where R^y is C_1-C_{18}alkyl, C_5-C_{12}cycloalkyl, phenyl, C_7-C_{15}phenylalkyl, and $R^{y'}$ embraces the same definitions as R^y or is H; C_1-C_8alkylene-COO-R^z, e.g. CH_2COOR^z, $CH(CH_3)COOR^z$, $C(CH_3)_2COOR^z$, where R^z is H, C_1-C_{18}alkyl, $(CH_2CH_2O)_{1-9}$-R^x, and R^xembraces the definitions indicated above; CH_2CH_2-O-CO-CH=CH_2; $CH_2CH(OH)CH_2$-O-CO-C(CH_3)=CH_2.

The electroluminescent devices may be employed for full color display panels in, for example, mobile phones, televisions and personal computer screens.

The electroluminescent devices of the present invention are otherwise designed as is known in the art, for example as described in U.S. Pat. Nos. 5,518,824, 6,225,467, 6,280,859, 5,629,389, 5,486,406, 5,104,740, 5,116,708 and 6,057,048, the relevant disclosures of which are hereby incorporated by reference.

For example, organic EL devices contain one or more layers such as:

substrate; base electrode; hole-injecting layer; hole transporting layer; emitter layer; electron-transporting layer; electron-injecting layer; top electrode; contacts and encapsulation.
This structure is a general case and may have additional layers or may be simplified by omitting layers so that one layer performs a plurality of tasks. For instance, the simplest organic EL device consists of two electrodes which sandwich an organic layer that performs all functions, including the function of light emission.

A preferred EL device comprises in this order:
(a) an anode,
(b) a hole injecting layer and/or a hole transporting layer,
(c) a light-emitting layer,
(d) optionally an electron transporting layer and
(e) a cathode.
In particular, the present organic compounds function as light emitters and are contained in the light emission layer or form the light-emitting layer.
The light emitting compounds of this invention exhibit intense fluorescence in the solid state and have excellent electric-field-applied light emission characteristics. Further, the light emitting compounds of this invention are excellent in the injection of holes from a metal electrode and the transportation of holes; as well as being excellent in the injection of electrons from a metal electrode and the transportation of electrons. They are effectively used as light emitting materials and may be used in combination with other hole transporting materials, other electron transporting materials or other dopants.
The organic compounds of the present invention form uniform thin films. The light emitting layers may therefore be formed of the present organic compounds alone.
Alternatively, the light-emitting layer may contain a known light-emitting material, a known dopant, a known hole transporting material or a known electron transporting material as required. In the organic EL device, a decrease in the brightness and life caused by quenching can be prevented by forming it as a multi-layered structure. The light-emitting material, a dopant, a hole-injecting material and an electron-injecting material may be used in combination as required. Further, a dopant can improve the light emission brightness and the light emission efficiency, and can attain the red or blue light emission. Further, each of the hole transporting zone, the light-emitting layer and the electron transporting zone may have the layer structure of at least two layers. In the hole transporting zone in this case, a layer to which holes are injected from an electrode is called "hole-injecting layer", and a layer which receives holes from the hole-injecting layer and transport the holes to a light-emitting layer is called "hole transporting layer". In the electron transporting zone, a layer to which electrons

are injected from an electrode is called "electron-injecting layer", and a layer which receives electrons from the electron-injecting layer and transports the electrons to a light-emitting layer is called "electron transporting layer". These layers are selected and used depending upon factors such as the energy level and heat resistance of materials and adhesion to an organic layer or metal electrode.

The light-emitting material or the dopant which may be used in the light-emitting layer together with the organic compounds of the present invention includes for example anthracene, naphthalene, phenanthrene, pyrene, tetracene, coronene, chrysene, fluorescein, perylene, phthaloperylene, naphthaloperylene, perinone, phthaloperinone, naphthaloperinone, diphenylbutadiene, tetraphenylbutadiene, coumarine, oxadiazole, aldazine, bisbenzoxazoline, bisstyryl, pyrazine, cyclopentadiene, quinoline metal complex, aminoquinoline metal complex, benzoquinoline metal complex, imine, diphenylethylene, vinyl anthracene, diaminocarbazole, pyran, thiopyran, polymethine, merocyanine, an imidazole-chelated oxynoid compound, quinacridone, rubrene, and fluorescent dyestuffs for a dyestuff laser or for brightening.

The compounds of the present invention and the above compound or compounds that can be used in a light-emitting layer may be used in any mixing ratio for forming a light-emitting layer. That is, the organic compounds of the present invention may provide a main component for forming a light-emitting layer, or they may be a doping material in another main material, depending upon a combination of the above compounds with the organic compounds of the present invention.

The hole-injecting material is selected from compounds which are capable of transporting holes, are capable of receiving holes from the anode, have an excellent effect of injecting holes to a light-emitting layer or a light-emitting material, prevent the movement of excitons generated in a light-emitting layer to an electron-injecting zone or an electron-injecting material and have the excellent capability of forming a thin film. Suitable hole-injecting materials include for example a phthalocyanine derivative, a naphthalocyanine derivative, a porphyrin derivative, oxazole, oxadiazole, triazole, imidazole, imidazolone, imidazolthione, pyrazoline, pyrazolone, tetrahydroimidazole, oxazole, oxadiazole, hydrazone, acylhydrazone, polyarylalkane, stilbene, butadiene, benzidine type triphenylamine, styrylamine type triphenylamine, diamine type triphenylamine, derivatives of these, and polymer materials such as polyvinylcarbazole, polysilane and an electroconducting polymer.

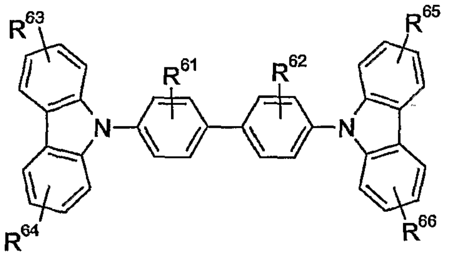
In the organic EL device of the present invention, the hole-injecting material which is more effective is an aromatic tertiary amine derivative or a phthalocyanine derivative. Although not specially limited, specific examples of the tertiary amine derivative include triphenylamine, tritolylamine, tolyldiphenylamine, N,N'-diphenyl-N,N'-(3-methylphenyl)-1,1-biphenyl-4,4'-

diamine, N,N,N',N'-tetra(4-methylphenyl)-1,1'-phenyl-4,4'-diamine, N,N,N',N'-tetra(4-methylphenyl)-1,1'-biphenyl-4,4'-diamine, N,N'-diphenyl-N,N'-di(1-naphthyl)-1,1'-biphenyl-4,4'-diamine, N,N'-di(methylphenyl)-N,N'-di(4-n-butylphenyl)-phenanthrene-9,10- diamine, 4,4', 4''-tris(3-methylphenyl)-N-phenylamino)triphenylamine, 1,1-bis(4-di-p-tolylaminophenyl)cyclohexane, and oligomers or polymers having aromatic tertiary amine structures of these.

Although not specially limited, specific examples of the phthalocyanine (Pc) derivative include phthalocyanine derivatives or naphthalocyanine derivatives such as H_2Pc, CuPc, CoPc, NiPc, ZnPc, PdPc, FePc, MnPc, ClAlPc, ClGaPc, ClInPc, ClSnPc, Cl_2SiPc, (HO)AlPc, (HO)GaPc, VOPc, TiOPc, MoOPc, and GaPc-O-GaPc.

The hole transporting layer can reduce the driving voltage of the device and improve the confinement of the injected charge recombination within the light emitting layer, comprising the compounds of the present invention. Any conventional suitable aromatic amine hole transporting material described for the hole-injecting layer may be selected for forming this layer.

A preferred class of hole transporting materials is comprised of 4,4'-bis(9-carbazolyl)-1,1'-biphenyl compounds of the formula



wherein R^{61} and R^{62} is a hydrogen atom or an C_1-C_3alkyl group; R^{63} through R^{66} are substituents independently selected from the group consisting of hydrogen, a C_1-C_6alkyl group, a C_1-C_6alkoxy group, a halogen atom, a dialkylamino group, a C_6-C_{30}aryl group, and the like. Illustrative examples of 4,4'-bis(9-carbazolyl)-1,1'-biphenyl compounds include 4,4'-bis(9-carbazolyl)-1,1'-biphenyl and 4,4'-bis(3-methyl-9-carbazolyl)-1,1'-biphenyl, and the like.

The electron transporting layer is not necessarily required for the present device, but is optionally and preferably used for the primary purpose of improving the electron injection characteristics of the EL devices and the emission uniformity. Illustrative examples of electron transporting compounds, which can be utilized in this layer, include the metal chelates of 8-hydroxyquinoline as disclosed in U.S. Pat. Nos. 4,539,507, 5,151,629, and 5,150,006, the disclosures of which are totally incorporated herein by reference.

Although not specially limited, specific examples of the metal complex compound include lithium 8-hydroxyquinolinate, zinc bis(8-hydroxyquinolinate), copper bis(8-

hydroxyquinolinate), manganese bis(8-hydroxyquinolinate), aluminum tris(8-hydroxyquinolinate), aluminum tris(2-methyl-8-hydroxyquinolinate), gallium tris(8-hydroxyquinolinate), beryllium bis(10-hydroxybenzo[h]quinolinate), zinc bis(10-hydroxybenzo[h]quinolinate), chlorogallium bis(2-methyl-8-quinolinate), gallium bis(2-methyl-8-quinolinate)(o-cresolate), aluminum bis(2-methyl-8-quinolinate)(1-naphtholate), gallium bis(2-methyl-8-quinolinate)(2-naphtholate), gallium bis(2-methyl-8-quinolinate)phenolate, zinc bis(o-(2-benzooxazolyl)phenolate), zinc bis(o-(2-benzothiazolyl)phenolate) and zinc bis(o-(2-benzotrizolyl)phenolate). The nitrogen-containing five-membered derivative is preferably an oxazole, thiazole, thiadiazole, or triazole derivative. Although not specially limited, specific examples of the above nitrogen-containing five-membered derivative include 2,5-bis(1-phenyl)-1,3,4-oxazole, 1,4-bis(2-(4-methyl-5-phenyloxazolyl)benzene, 2,5-bis(1-phenyl)-1,3,4-thiazole, 2,5-bis(1-phenyl)-1,3,4-oxadiazole, 2-(4'-tert-butylphenyl)-5-(4"-biphenyl)1,3,4-oxadiazole, 2,5-bis(1-naphthyl)-1,3,4-oxadiazole, 1,4-bis[2-(5-phenyloxadiazolyl)]benzene, 1,4-bis[2-(5-phenyloxadiazolyl)-4-tert-butylbenzene], 2-(4'-tert-butylphenyl)-5-(4"-biphenyl)-1,3,4-thiadiazole, 2,5-bis(1-naphthyl)-1,3,4-thiadiazole, 1,4-bis[2-(5-phenylthiazolyl)]benzene, 2-(4'-tert-butylphenyl)-5-(4"-biphenyl)-1,3,4-triazole, 2,5-bis(1-naphthyl)-1,3,4-triazole and 1,4-bis[2-(5-phenyltriazolyl)]benzene. Another class of electron transport materials are oxadiazole metal chelates, such as bis[2-(2-hydroxyphenyl)-5-phenyl-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-phenyl-1,3,4-oxadiazolato]beryllium; bis[2-(2-hydroxyphenyl)-5-(1-naphthyl)-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-(1-naphthyl)-1,3,4-oxadiazolato]beryllium; bis[5-biphenyl-2-(2-hydroxyphenyl)-1,3,4-oxadiazolato]zinc; bis[5-biphenyl-2-(2-hydroxyphenyl)-1,3,4-oxadiazolato]beryllium; bis(2-hydroxyphenyl)-5-phenyl-1,3,4-oxadiazolato]lithium; bis[2-(2-hydroxyphenyl)-5-p-tolyl-1,3,4-oxadiazolato]zinc; bis 2-(2-hydroxyphenyl)-5-p-tolyl-1,3,4-oxadiazolato]beryllium; bis[5-(p-tert-butylphenyl)-2-(2-hydroxyphenyl)-1,3,4-oxadiazolato]zinc; bis[5-(p-tert-butylphenyl)-2-(2-hydroxyphenyl)-1,3,4-oxadiazolato]berylliu m; bis[2-(2-hydroxyphenyl)-5-(3-fluorophenyl)-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-(4-fluorophenyl)-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-(4-fluorophenyl)-1,3,4-oxadiazolato]beryllium; bis[5-(4-chlorophenyl)-2-(2-hydroxyphenyl)-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxy phenyl)-5-(4-methoxyphenyl)-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxy-4-methylphenyl)-5-phenyl-1,3,4-oxadiazolato]zinc; bis[2-.alpha.-(2-hydroxynaphthyl)-5-phenyl-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-p-pyridyl-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-p-pyridyl-1,3,4-oxadiazolato]beryllium; bis[2-(2-hydroxyphenyl)-5-(2-thiophenyl)-1,3,4-oxadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-phenyl-1,3,4-thiadiazolato]zinc; bis[2-(2-hydroxyphenyl)-5-phenyl-1,3,4-thiadiazolato]beryllium; bis[2-(2-hydroxyphenyl)-5-(1-

naphthyl)-1,3,4-thiadiazolato]zinc; and bis[2-(2-hydroxyphenyl)-5-(1-naphthyl)-1,3,4-thiadiazolato]beryllium, and the like.

In the organic EL device of the present invention, the light-emitting layer may contain, in addition to the light-emitting organic material of the present invention, at least one of other light-emitting material, other dopant, other hole-injecting material and other electron-injecting material. For improving the organic EL device of the present invention in the stability against temperature, humidity and ambient atmosphere, a protective layer may be formed on the surface of the device, or the device as a whole may be sealed with a silicone oil, or the like.

The electrically conductive material used for the anode of the organic EL device is suitably selected from those materials having a work function of greater than 4 eV. The electrically conductive material includes carbon, aluminum, vanadium, iron, cobalt, nickel, tungsten, silver, gold, platinum, palladium, alloys of these, metal oxides such as tin oxide and indium oxide used for ITO substrates or NESA substrates, and organic electroconducting polymers, such as polythiophene and polypyrrole.

The electrically conductive material used for the cathode is suitably selected from those having a work function of smaller than 4 eV. The electrically conductive material includes magnesium, calcium, tin, lead, titanium, yttrium, lithium, ruthenium, manganese, aluminum and alloys of these, while the electrically conductive material shall not be limited to these. Examples of the alloys include magnesium/silver, magnesium/indium and lithium/aluminum, while the alloys shall not be limited to these. Each of the anode and the cathode may have a layer structure formed of two layers or more as required.

For the effective light emission of the organic EL device, at least one of the electrodes is desirably sufficiently transparent in the light emission wavelength region of the device. Further, the substrate is desirably transparent as well. The transparent electrode is produced from the above electrically conductive material by a deposition method or a sputtering method such that a predetermined light transmittance is secured. The electrode on the light emission surface side has for instance a light transmittance of at least 10%. The substrate is not specially limited so long as it has adequate mechanical and thermal strength and has transparency. For example, it is selected from glass substrates and substrates of transparent resins such as a polyethylene substrate, a polyethylene terephthalate substrate, a polyether sulfone substrate and a polypropylene substrate.

In the organic EL device of the present invention, each layer can be formed by any one of dry film forming methods such as a vacuum deposition method, a sputtering method, a plasma method and an ion plating method and wet film forming methods such as a spin coating method, a dipping method and a flow coating method. The thickness of each layer is not specially limited, while each layer is required to have a proper thickness. When the layer thickness is too large, inefficiently, a high voltage is required to achieve predetermined emission of light. When the layer thickness is too small, the layer is liable to have a pinhole, etc., so that sufficient light emission brightness is hard to obtain when an electric field is applied. The thickness of each layer is for example in the range of from about 5 nm to about 10 µm, for instance about 10 nm to about 0.2 µm.

In the wet film forming method, a material for forming an intended layer is dissolved or dispersed in a proper solvent such as ethanol, chloroform, tetrahydrofuran and dioxane, and a thin film is formed from the solution or dispersion. The solvent shall not be limited to the above solvents. For improving the film formability and preventing the occurrence of pinholes in any layer, the above solution or dispersion for forming the layer may contain a proper resin and a proper additive. The resin that can be used includes. insulating resins such as polystyrene, polycarbonate, polyarylate, polyester, polyamide, polyurethane, polysulfone, polymethyl methacrylate, polymethyl acrylate and cellulose, copolymers of these, photoconductive resins such as poly-N-vinylcarbozole and polysilane, and electroconducting polymers such as polythiophene and polypyrrole. The above additive includes an antioxidant, an ultraviolet absorbent and a plasticizer.

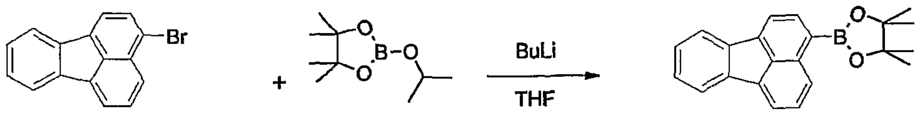
When the light-emitting organic material of the present invention is used in a light-emitting layer of an organic EL device, an organic EL device can be improved in organic EL device characteristics such as light emission efficiency and maximum light emission brightness. Further, the organic EL device of the present invention is remarkably stable against heat and electric current and gives a usable light emission brightness at a low actuation voltage. The problematic deterioration of conventional devices can be remarkably decreased.

The organic EL device of the present invention has significant industrial values since it can be adapted for a flat panel display of an on-wall television set, a flat light-emitting device, a light source for a copying machine or a printer, a light source for a liquid crystal display or counter, a display signboard and a signal light.

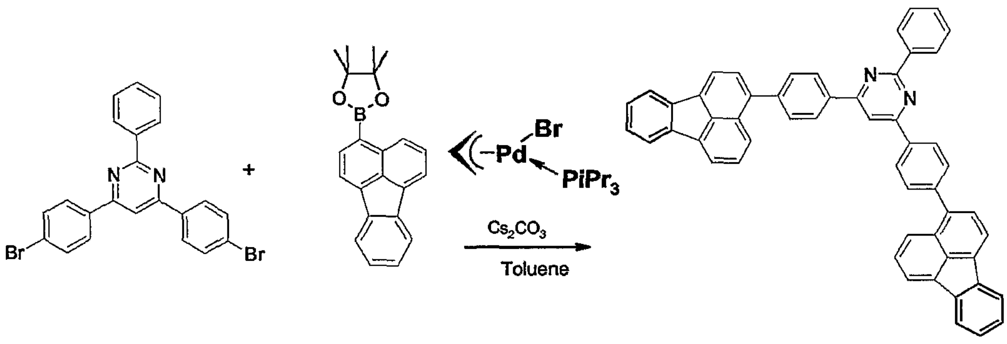
The material of the present invention can be used in the fields of an organic EL device, an electrophotographic photoreceptor, a photoelectric converter, a solar cell, an image sensor, dye lasers and the like.

The following Examples illustrate the invention. In the Examples and throughout this application, the term light emitting material means the present triazine, or pyrimidine compounds.

Example 1



a) 3-bromo-fluoranthene is prepared as described in example 1 of DE 35 36 259. 2.00 g (7.11 mmol) 3-bromo-fluoranthene is dissolved in 40 ml anhydrous tetrahydrofuran (THF) under argon. To this solution 3.4 ml (8.54 mmol) n-butyl lithium are added at –78 °C. After 1 h 2.65 g (14.2 mmol) 2-isopropoxy-4,4,5,5-tetramethy-1,3,2-dioxaborolane are added at –78 °C. The reaction mixture is stirred at –78 °C for 1 h. The reaction mixture is warmed up to 20 °C, poured into water and extracted with 95 % dichloromethane and 5 % ether. The organic phase is dried with magnesium sulphate and the solvent is removed in vacuum. The product is used without further purification for the next reaction.

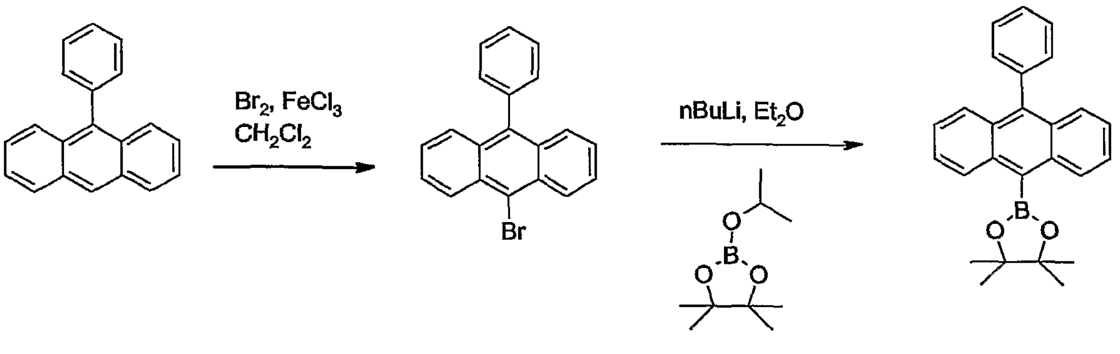


(Cpd. A1)

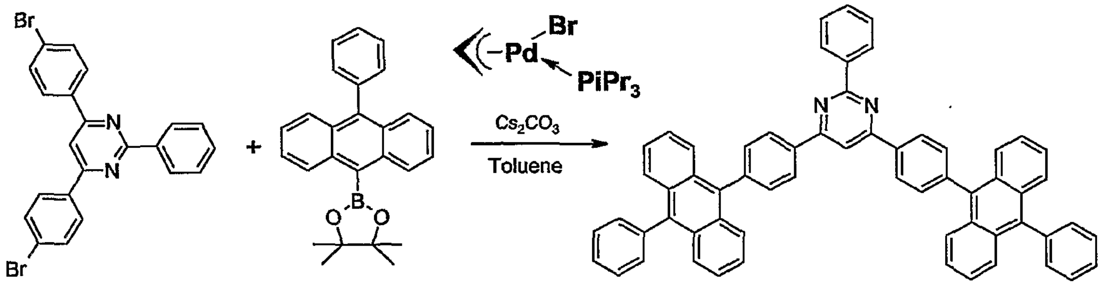
b) To 1.00 g (2.15 mmol) of 4,6-bis-(4-bromo-phenyl)-2-phenyl-pyrimidine in 50 ml toluene and 10 ml water, 3.29 g (10.1 mmol) Cs_2CO_3 are added under an argon atmosphere. The palladium catalyst is added. Then 2.11 g (6.44 mmol) 4,4,5,5-tetramethy-1,3,2-dioxaborolan-3-fluoranthene is added and the reaction mixture is refluxed for 21 h under argon. The reaction mixture is filtered on HYFLO® Super Gel (Fluka). The organic phase is washed with water and dried with magnesium sulphate and the HYFLO® is washed with dichloromethane. The solvent is removed in vacuum. A column chromatography on silica gel with toluene / hexane 1 / 1 gives the desired product.

Melting point 310-312 °C

Example 2



a) 9-(10-phenylanthryl)-4,4,5,5-tertramethyl-1,3,2-dioxaborolane is prepared according to example 5 of US-A-20020132134.



The desired pyrimidine compound is prepared in analogy to example 1b).

Application Example 1

Present compound A1, as light emitting material, 2,5-bis(1-naphthyl)-1,3,4-oxadiazole and a polycarbonate resin in a weight ratio of 5:3:2 are dissolved in tetrahydrofuran, and the solution is spin-coated on a cleaned glass substrate with an ITO electrode to form a light-emitting layer having a thickness of 100 nm. An electrode having a thickness of 150 nm is formed thereon from a magnesium/indium alloy having a magnesium/indium mixing ratio of 10/1, to obtain an organic EL device. The device exhibits light emission with excellent brightness and efficiency at a direct current voltage of 5 V.

Application Example 2

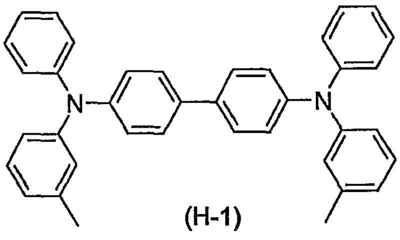
Present compound A1 is vacuum-deposited on a cleaned glass substrate with an ITO electrode to form a light-emitting layer having a thickness of 100 nm. An electrode having a thickness of 100 nm is formed thereon from a magnesium/silver alloy having a magnesium/silver mixing ratio of 10/1, to obtain an organic EL device. The light-emitting layer is formed by deposition under a vacuum of 10^{-6} Torr at a substrate temperature of room temperature. The device shows emission having an excellent brightness and efficiency at a direct current voltage of 5 V.

Application Example 3

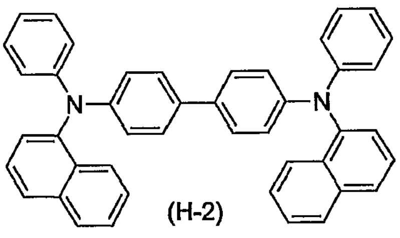
Present compound A1 is dissolved in methylene chloride tetrahydrofuran, and the solution is spin-coated on a cleaned glass substrate with an ITO electrode to form a light-emitting layer having a thickness of 50 nm. Then, aluminum bis(2-methyl-8-quinolinate)(2-naphtolate) is vacuum-deposited to form an electron transporting layer having a thickness of 10 nm, and an electrode having a thickness of 100 nm is formed thereon from a magnesium/aluminum alloy having a magnesium/aluminum mixing ratio of 10/1, to obtain an organic EL device. The light-emitting layer and the electron-injecting layer are formed by deposition under a vacuum of 10^{-6} Torr at a substrate temperature of room temperature. The device shows an emission having an excellent brightness and efficiency at a direct current voltage of 5 V.

Application Example 4

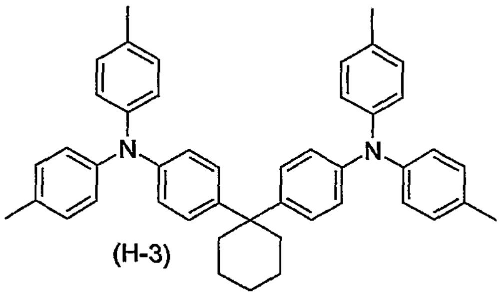
One of hole transporting materials (H-1) to (H-6) is vacuum-deposited on a cleaned glass substrate with an ITO electrode, to form a hole transporting layer having a thickness of 30 nm. Then, present compound A1 is vacuum-deposited to form a light-emitting layer having a thickness of 30 nm. Further, one of electron transporting materials (E-1) to (E-6) is vacuum-deposited to form an electron transporting layer having a thickness of 30 nm. An electrode having a thickness of 150 nm is formed thereon from a magnesium/silver alloy having a magnesium/silver mixing ratio of 10/1, to obtain an organic EL device. Each layer is formed under a vacuum of 10^{6} Torr at a substrate temperature of room temperature. All the organic EL devices obtained in these Examples shows high brightness and efficiency.



(H-1) ,



(H-2) ,



(H-3)

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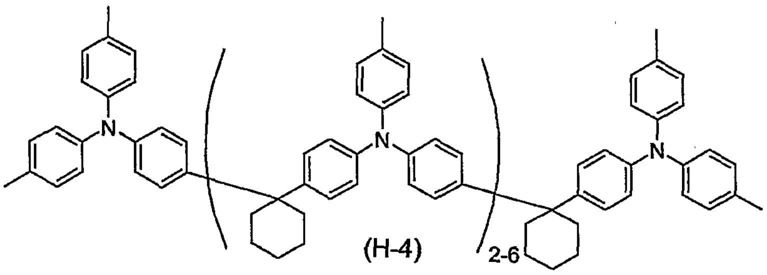

(H-4)

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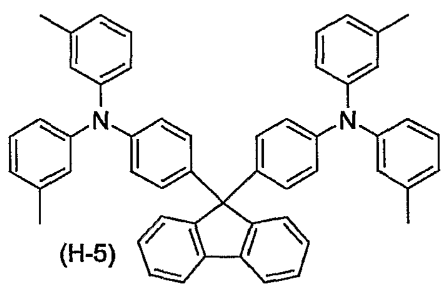

(H-5)

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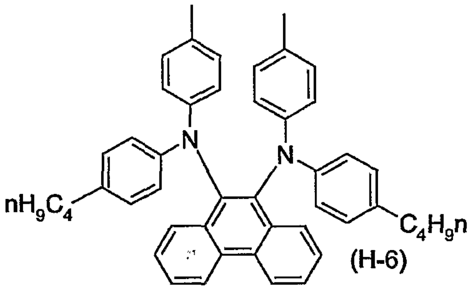
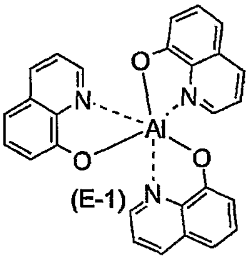


(H-6)



(E-1)

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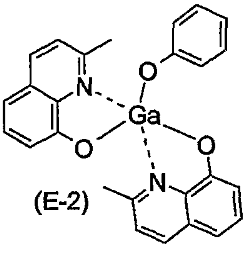

(E-2)

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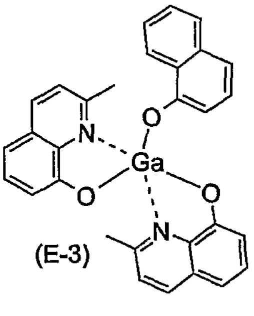

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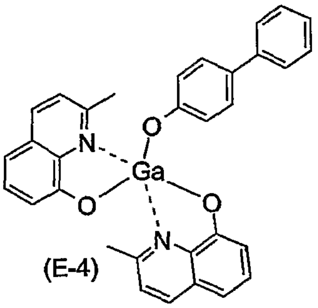
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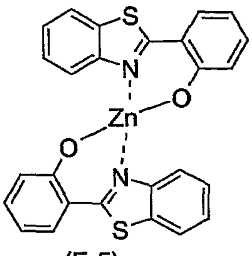
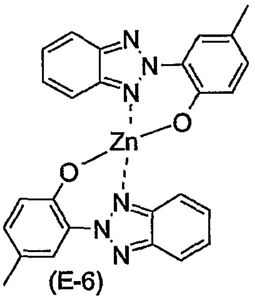

(E-5),


(E-6)

Application Example 5

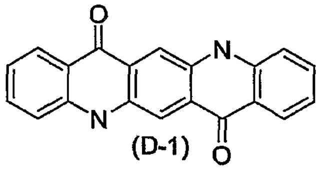
On a cleaned glass substrate with an ITO electrode, 4,4',4"-tris(N-(3-methylphenyl)-N-phenylamino)triphenylamine is vacuum-deposited to form a hole-injecting layer having a thickness of 25 nm. Further, a hole transporting material (H-1) is vacuum-deposited to form a hole transporting layer having a thickness of 5 nm. Then, compound A1 as light-emitting material is vacuum-deposited to form a light-emitting layer having a thickness of 20 nm. Further, an electron transporting material (E-1) is vacuum-deposited to form an electron transporting layer having a thickness of 30 nm. Then, an electrode having a thickness of 150 nm is formed thereon from a magnesium/silver alloy having an magnesium/silver mixing ratio of 10/1, to obtain an organic EL device. The device shows emission having an outstanding brightness and efficiency at a direct current voltage of 5 V.

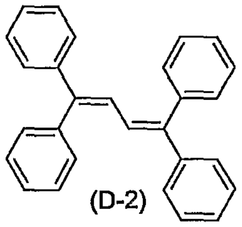
Application Example 6

A hole transporting material (H-5) is vacuum-deposited on a cleaned glass substrate with an ITO electrode to form a hole transporting layer having a thickness of 20 nm. Then, compound A1 as light-emitting material is vacuum-deposited to form a light-emitting layer having a thickness of 20 nm. Further, an electron transporting material (E-2) is vacuum-deposited to form a first electron transporting layer having a thickness of 20 nm. Then, an electron transporting material (E-5) is vacuum-deposited to form a second electron transporting layer having a thickness of 10 nm, and an electrode having a thickness of 150 nm is formed thereon from a magnesium/silver alloy having an magnesium/silver mixing ratio of 10/1, to obtain an organic EL device. The device shows light emission having an excellent brightness and efficiency at a direct current voltage of 5 V.

Application Example 7

An organic EL device is prepared in the same manner as in Application Example 4 except that the light-emitting layer is replaced with a 30 nm thick light-emitting layer formed by vacuum-depositing compound A1 and one of the dopant compounds (D-1) to (D-7) in a weight ratio of 100:1. All the organic EL devices obtained in these Examples shows high brightness characteristics and gives intended light emission colors.


(D-1) ,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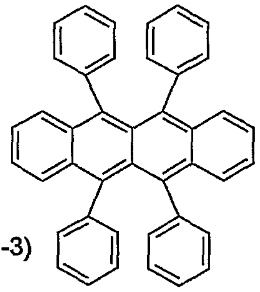
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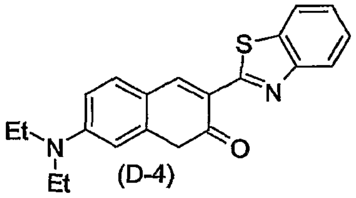
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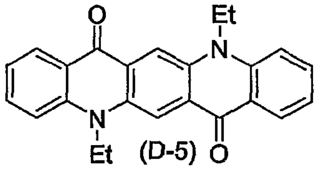
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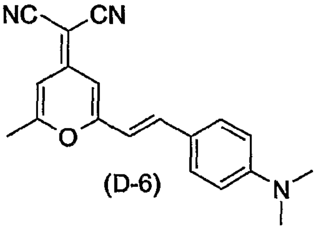
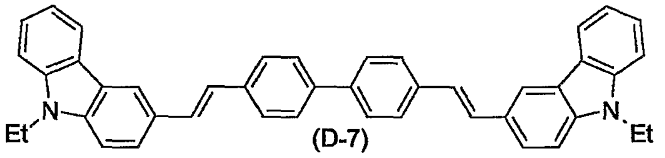

(D-6) ,


(D-7) .

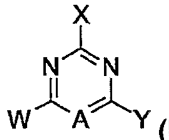
Application Example 8

On a cleaned glass substrate with an ITO electrode, N,N'-1-naphthyl-N,N'-diphenyl-1,1'-biphenyl-4,4'-diamine and 5,10-diphenylanthracene are vacuum-deposited to form a hole-injecting layer. Further, 4,4'-bis(9-carbazolyl)-1,1'-biphenyl is vacuum-deposited to form a hole transporting layer. Then, compound A1 as light-emitting material is vacuum-deposited to form a light-emitting layer. Then, an electrode is formed thereon from a magnesium/silver alloy having an magnesium/silver mixing ratio of 9/1, to obtain an organic EL device. The device shows emission having an outstanding brightness and efficiency at a direct current voltage of 5 V.

The organic EL devices obtained in the Application Examples of the present invention show an excellent light emission brightness and achieved a high light emission efficiency. When the organic EL devices obtained in the above Examples are allowed to continuously emit light at 3 (mA/cm^2), all the organic EL devices remain stable. Since the light-emitting materials of the present invention have a very high fluorescence quantum efficiency, the organic EL devices using the light-emitting materials achieved light emission with a high brightness in a low electric current applied region, and when the light-emitting layer additionally uses a doping material, the organic EL devices are improved in maximum light emission brightness and maximum light emission efficiency. Further, by adding a doping material having a different fluorescent color to the light-emitting material of the present invention, there are obtained light-emitting devices having a different light emission color. The organic EL devices of the present invention accomplish improvements in light emission efficiency and light emission brightness and a longer device life, and does not impose any limitations on a light-emitting material, a dopant, a hole transporting material, an electron transporting material, a sensitizer, a resin and an electrode material used in combination and the method of producing the device. The organic EL device using the material of the present invention as a light-emitting material can achieve light emission having a high brightness with a high light emission efficiency and a longer life as compared with conventional devices. According to the light-emitting material of the present invention and the organic EL device of the present invention, there can be achieved an organic EL device having a high brightness, a high light emission efficiency and a long life.

Claims

1. A compound of formula



(I), wherein

A is CH, or N,

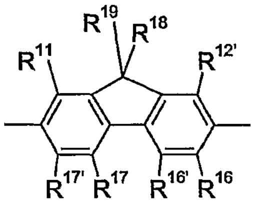
X is a group of the formula $-(X^1)_m-(X^2)_n-X^3$

W is a group of the formula $-(W^1)_a-(W^2)_b-W^3$, and

Y is a group of the formula $-(Y^1)_c-(Y^2)_d-Y^3$, wherein

a, b, c, d, m and n are independently of each other 0, or 1,

W^1, W^2, X^1, X^2, Y^1 and Y^2 are independently of each other a group of formula



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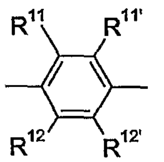

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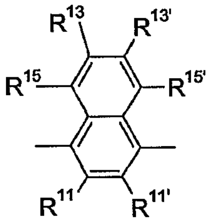

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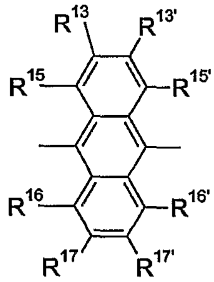
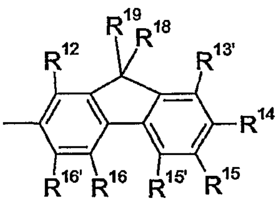


, and

W^3, X^3 and Y^3 are independently of each other a group of formula



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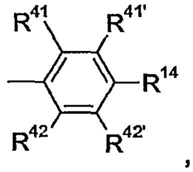

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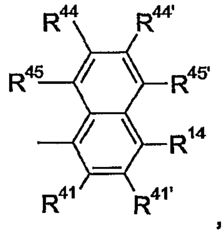

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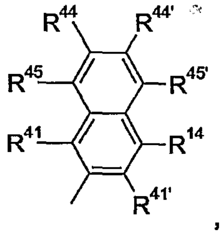

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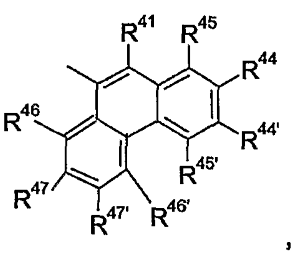
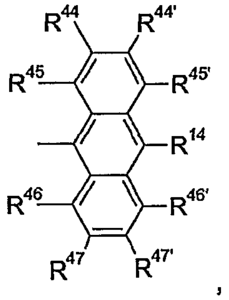


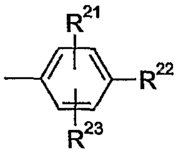
, or



, or a C_{16}-C_{30}aryl group, such as fluoranthenyl, triphenlenyl, chrysenyl, naphthacenyl, picenyl, perylenyl, pentaphenyl, hexacenyl, or pyrenyl, which can be substituted by G;

R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17}, $R^{17'}$, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, R^{44}, $R^{44'}$, R^{45}, $R^{45'}$, R^{46}, $R^{46'}$, R^{47} and $R^{47'}$ are independently of each other H, E, C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by G; C_1-C_{18}alkyl; C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_1-C_{18}alkoxy; or C_1-C_{18}alkoxy which is substituted by E and/or interrupted by D; C_7-C_{18}aralkyl; or C_7-C_{18}aralkyl which is substituted by G;

R^{14} is H, C_1-C_{18}alkyl; or C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_1-C_{18}alkoxy; or C_1-C_{18}alkoxy which is substituted by E and/or interrupted by D;



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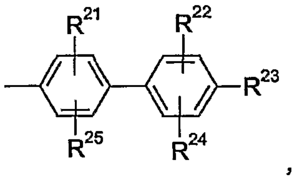

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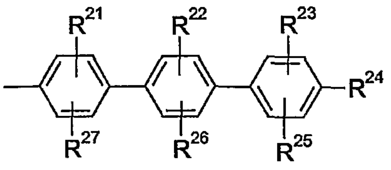

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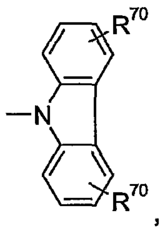
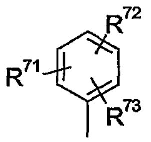
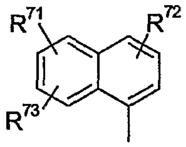


, or –NAr^1Ar^2, wherein Ar^1 and Ar^2 are independently of each other



, or



, R^{21}, R^{22}, R^{23}, R^{24}, R^{25}, R^{26} and R^{27} are independently of each other H, E, C_1-C_{18}alkyl; C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_7-C_{18}aralkyl; C_7-C_{18}aralkyl which is substituted by G;

R^{70}, R^{71}, R^{72} and R^{73} are independently of each other C_1-C_{18}alkyl, C_1-C_{18}alkyl which is interrupted by –O-, C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, -OR^5, or -SR^5,

R^{18} and R^{19} are independently of each other C_1-C_{18}alkyl; C_1-C_{18}alkoxy, C_6-C_{18}aryl; C_7-C_{18}aralkyl; or R^{18} and R^{19} together form a ring especially a five- or six-membered ring, which can optionally be substituted by C_1-C_8alkyl,

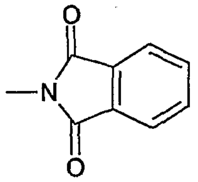
D is -CO-; -COO-; -OCOO-; -S-; -SO-; -SO_2-; -O-; -NR^5-; $SiR^{61}R^{62}$-; -POR^5-; -CR^{63}=CR^{64}-; or -C≡C-;

E is -OR^5; -SR^5; -NR^5R^6; -COR^8; -$COOR^7$; -$OCOOR^7$, -$CONR^5R^6$; -CN; or halogen;

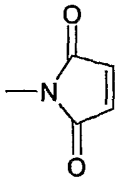
G is E, or C_1-C_{18}alkyl,

wherein R^5 and R^6 are independently of each other C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, or C_1-C_{18}alkoxy; C_1-C_{18}alkyl or C_1-C_{18}alkyl which is interrupted by –O-; or

R^5 and R^6 together form a five or six membered ring, in particular



or



,

R^7 is C_7-C_{12}alkylaryl; C_1-C_{18}alkyl; or C_1-C_{18}alkyl which is interrupted by –O-;

R^8 is C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, or C_1-C_{18}alkoxy; C_1-C_{18}alkyl, C_7-C_{12}alkylaryl, or C_1-C_{18}alkyl which is interrupted by –O-;

R^{61} and R^{62} are independently of each other C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, C_1-C_{18}alkoxy; or C_1-C_{18}alkyl which is interrupted by –O-, and

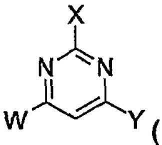
R^{63} and R^{64} are independently of each other H, C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by C_1-C_{18}alkyl, C_1-C_{18}alkoxy; or C_1-C_{18}alkyl which is interrupted by –O-.

2. The compound according to claim 1, wherein R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17} and $R^{17'}$, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, R^{44}, $R^{44'}$, R^{45}, $R^{45'}$, R^{46}, $R^{46'}$, R^{47}, and $R^{47'}$ as well as R^{14} are preferably independently of each other H, E; or C_1-C_{18}alkyl; C_1-C_{18}alkyl which is substituted by E and/or interrupted by D, C_6-C_{24}aryl, C_6-C_{24}aryl which is substituted by G; wherein D is –O-, E is -OR^5; -SR^5; -NR^5R^6; -COR^8; -$COOR^7$; -$CONR^5R^6$; -CN; -$OCOOR^7$; or halogen; G is E, or C_1-C_8alkyl; wherein R^5 and R^6 are independently of each other C_6-C_{12}aryl, or C_1-C_8alkyl;

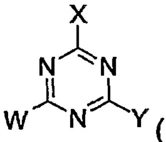
R^7 is C_7-C_{12}alkylaryl, or C_1-C_8alkyl; and

R^8 is C_6-C_{12}aryl; or C_1-C_8alkyl.

3. The compound according to claim 1 of formula

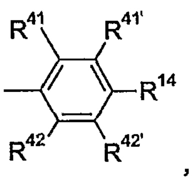


(II), or

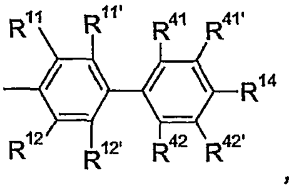


(III), wherein

X is

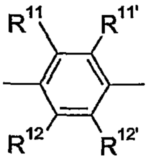
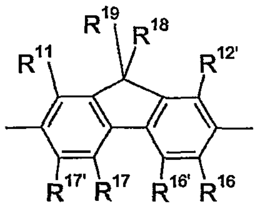


, or

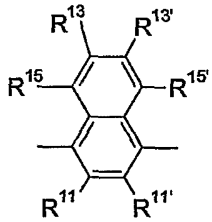
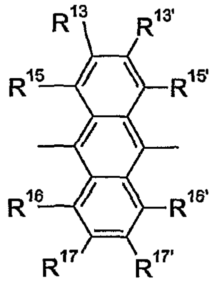


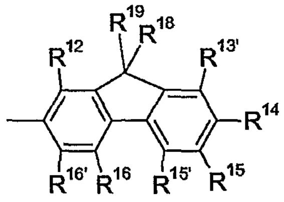
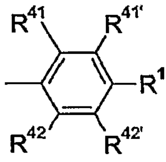
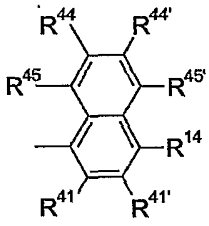
, and

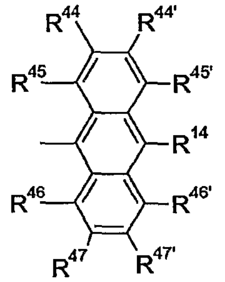
W and Y are a group of the formula -W^1-W^2-W^3, wherein

W¹ is a group of formula  ,  ,

W² is a group of formula

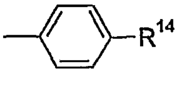
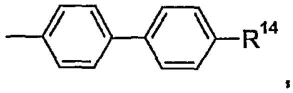
 , or  ,

W³ is a group of formula  ,  ,  ,

 , wherein

R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{14}, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17}, $R^{17'}$, R^{18}, R^{19}, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, R^{44}, $R^{44'}$, R^{45}, $R^{45'}$, R^{46}, $R^{46'}$, R^{47} and $R^{47'}$ are as defined in claim 1, or X, W and Y are a group of the formula $-W^1-W^2-W^3$, wherein W^1, W^2 and W^3 are as defined above.

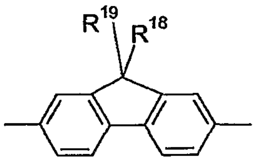
4. The compound according to claim 3 of formula II, or III, wherein

X is  , or  , and

W and Y are a group of the formula $-W^1-W^2-W^3$, wherein

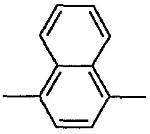
W^1 is a group of formula

,

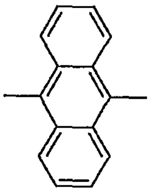


,

W^2 is a group of formula

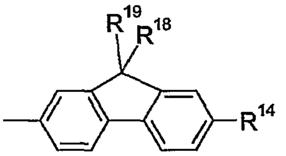


, or



,

W^3 is a group of formula



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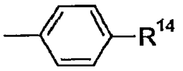

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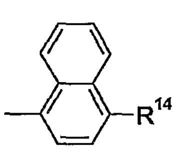

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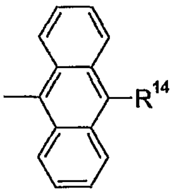
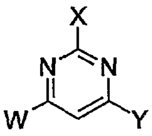


, wherein

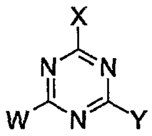
R^{14} is H, C$_1$-C$_8$alkyl, or C$_1$-C$_8$alkoxy, and

wherein R^{18} and R^{19} are independently of each other C$_1$-C$_8$alkyl, or cyclohexyl.

5. The compound according to claim 1 of formula

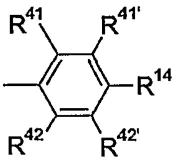


(II), or



(III), wherein

X is



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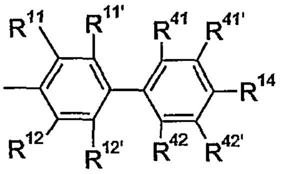
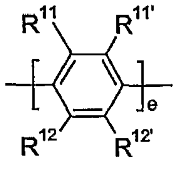


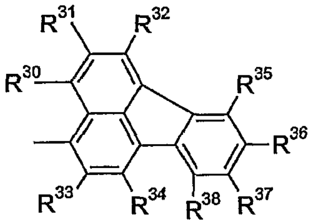
, and

W and Y are a group Ar^1-Ar^2, wherein

Ar^1 is a group of formula



,

Ar^2 is a group of formula 

, wherein

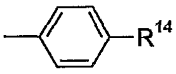
R^{30}, R^{31}, R^{32}, R^{33}, R^{34}, R^{35}, R^{36}, R^{37} and R^{38} are independently of each other H, E, C_6-C_{18}aryl; C_6-C_{18}aryl which is substituted by G; C_1-C_{18}alkyl; C_1-C_{18}alkyl which is substituted by E and/or interrupted by D; C_7-C_{18}aralkyl; or C_7-C_{18}aralkyl which is substituted by G;

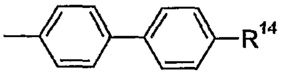
e is an integer 1, or 2, or

X, W and Y are independently of each other a group Ar^1-Ar^2, wherein Ar^1 and Ar^2 are as defined above, and

D, E, G, R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{41}, $R^{41'}$, R^{42}, $R^{42'}$, and R^{14} are defined as in claim 1.

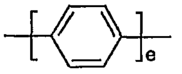
6. The compound of formula II or III according to claim 5, wherein

X is 

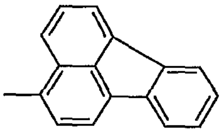
, or 

, and

W and Y are a group Ar^1-Ar^2, wherein

Ar^1 is a group of formula 

,

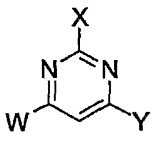
Ar^2 is a group of formula 

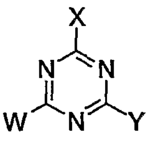
e is an integer 1, or 2,

R^{14} is H, C_1-C_8alkyl, or C_1-C_8alkoxy, or

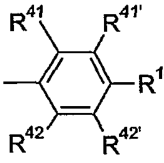
X, W and Y are independently of each other a group Ar^1-Ar^2, wherein Ar^1 and Ar^2 are as defined above.

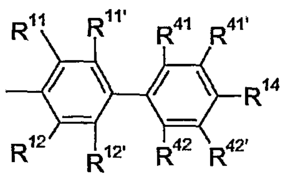
7. The compound according to claim 1 of formula



(II), or


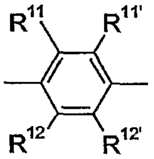
(III), wherein

X is 

, or 

, and

W and Y are a group of the formula $-W^1-(W^2)_b-W^3$, wherein b is 1, or 2,

W^1 and W^2 are independently of each other a group of formula 

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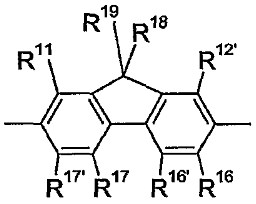
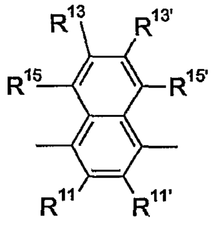
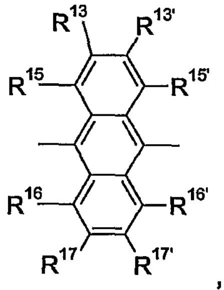
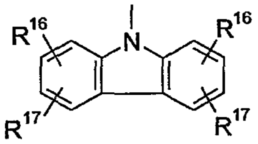
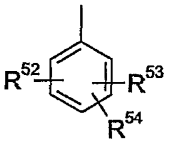


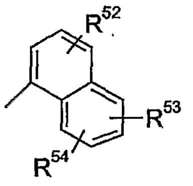
, 

, or 

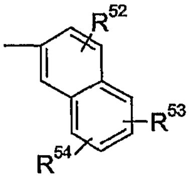
,

W^3 is a group of formula 

, or $-NR^{50}R^{51}$, wherein R^{50} and R^{51} are independently of each other a group of formula 

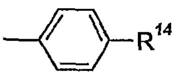
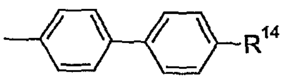
, 

or

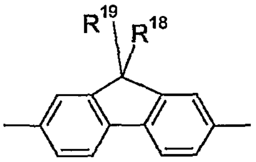


, wherein R^{52}, R^{53} and R^{54} are independently of each other hydrogen, C_1-C_8alkyl, a hydroxyl group, a mercapto group, C_1-C_8alkoxy, C_1-C_8alkylthio, halogen, halo-C_1-C_8alkyl, a cyano group, an aldehyde group, a ketone group, a carboxyl group, an ester group, a carbamoyl group, an amino group, a nitro group, a silyl group or a siloxanyl group, wherein R^{11}, $R^{11'}$, R^{12}, $R^{12'}$, R^{13}, $R^{13'}$, R^{14}, R^{15}, $R^{15'}$, R^{16}, $R^{16'}$, R^{17}, $R^{17'}$, R^{18}, R^{19}, R^{41}, $R^{41'}$, R^{42} and $R^{42'}$ are as defined in claim 1, or X, W and Y are independently of each other a group of the formula $-W^1-(W^2)_b-W^3$, wherein b, W^1, W^2 and W^3 are as defined above.

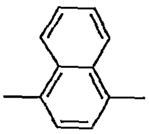
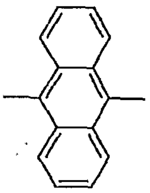
8. The compound according to claim 7 of formula II, or III, wherein

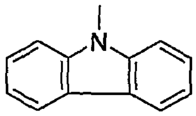
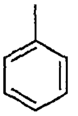
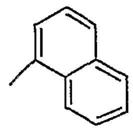
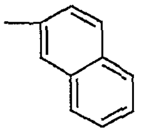
X is  , or  , and

W and Y are a group of the formula $-W^1$ $-(W^2)_b-W^3$, wherein b is 1, or 2,

W^1 is a group of formula  ,  ,

W^2 is a group of formula

 , or  ,

W^3 is a group of formula  , or -NR^{50}R^{51}, wherein R^{50} and R^{51} are independently of each other a group of formula  ,  or  ,

R^{14} is H, C_1-C_8alkyl, or C_1-C_8alkoxy, and

R^{18} and R^{19} are independently of each other C_1-C_8alkyl.

9. An electroluminescent device, comprising a compound of formula I according to any of claims 1 to 8.

10. Electroluminescent device according to claim 9, wherein the electroluminescent device comprises in this order

(a) an anode

(b) a hole injecting layer and/or a hole transporting layer

(c) a light-emitting layer

(d) optionally an electron transporting layer and

(e) a cathode.

11. Electroluminescent device according to claim 10, wherein the compound of formula I forms the light-emitting layer.

12. Use of the compounds of formula I according to any of claims 1 to 8 for electrophotographic photoreceptors, photoelectric converters, solar cells, image sensors, dye lasers and electroluminescent devices.

INTERNATIONAL SEARCH REPORT

Inte[illegible]ional Application No
PCT/EP2005/051731

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C09K11/06 H05B33/14 C07D239/26

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)
IPC 7 C09K H05B C07D

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 practical, search terms used)

EPO-Internal, PAJ, 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.
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 12, 5 December 2003 (2003-12-05) -& JP 2004 031004 A (KONICA MINOLTA HOLDINGS INC), 29 January 2004 (2004-01-29) abstract & JP 2004 031004 A (KONICA MINOLTA HOLDINGS INC) 29 January 2004 (2004-01-29) compounds 2-1, 2-2, 2-12 -----	1-12
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 12, 5 December 2003 (2003-12-05) & JP 2004 095262 A (FUJI PHOTO FILM CO LTD), 25 March 2004 (2004-03-25) abstract -/--	1-12

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search 18 July 2005	Date of mailing of the international search report 26/07/2005
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Lehnert, A

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	& JP 2004 095262 A (FUJI PHOTO FILM CO LTD) 25 March 2004 (2004-03-25) paragraphs ‘0039! - ‘0041! -----	
X	US 6 352 791 B1 (FINK RALPH ET AL) 5 March 2002 (2002-03-05) cited in the application claim 2 -----	1-12
X	US 6 225 467 B1 (ESTEGHAMATIAN MOHAMMAD ET AL) 1 May 2001 (2001-05-01) cited in the application the whole document -----	1-12
P,X	WO 2004/039786 A (CIBA SPECIALTY CHEMICALS HOLDING INC; SCHAEFER, THOMAS; BUJARD, PATRIC) 13 May 2004 (2004-05-13) the whole document -----	1-12
P,X	WO 2004/077885 A (CIBA SPECIALTY CHEMICALS HOLDING INC; HAYOZ, PASCAL; SCHAEFER, THOMAS;) 10 September 2004 (2004-09-10) the whole document -----	1-12
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 08, 6 August 2003 (2003-08-06) -& JP 2003 109763 A (CANON INC), 11 April 2003 (2003-04-11) abstract & JP 2003 109763 A (CANON INC) 11 April 2003 (2003-04-11) paragraphs ‘0112!, ‘0114! -----	1-12
X	US 5 716 722 A (HAMADA ET AL) 10 February 1998 (1998-02-10) claim 7 -----	1-12
X	EP 1 202 608 A (KABUSHIKI KAISHA TOYOTA CHUO KENKYUSHO) 2 May 2002 (2002-05-02) cited in the application claims 10,11 -----	1-12
X	US 6 057 048 A (HU ET AL) 2 May 2000 (2000-05-02) claim 34 -----	1-12
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 06, 3 June 2003 (2003-06-03) & JP 2003 045662 A (KONICA CORP), 14 February 2003 (2003-02-14) abstract -----	1-12

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 1 (part) - 12 (part)

Present claims 1-12 relate to an extremely large number of possible compounds, devices comprising these compounds and uses of these compounds. In fact, the claims contain so many options, variables, possible permutations and provisos, that a lack of clarity (and conciseness) within the meaning of Article 6 PCT arises to such an extent as to render a meaningful search of the claims impossible. Consequently, the search has been carried out for those parts of the application which do appear to be clear (and concise), namely. those compounds recited in the examples and closely related homologous compounds.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1 (part) - 12 (part)
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP2005/051731

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 6057048 A	02-05-2000	US 6229012 B1	08-05-2001
JP 2003045662 A	14-02-2003	NONE	