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(54) Title: ORGANIC ELECTROLUMINESCENT COMPOUND AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

(57) Abstract: The present disclosure relates to an organic electroluminescent compound and an organic electroluminescent device comprising the same. An organic electroluminescent device having a low driving voltage, a high luminous efficiency and/or excellent color coordinates can be provided by comprising the organic electroluminescent compound according to the present disclosure.

Description

Title of Invention: ORGANIC ELECTROLUMINESCENT COMPOUND AND ORGANIC ELECTROLUMINESCENT DEVICE COMPRISING THE SAME

Technical Field

[1] The present disclosure relates to an organic electroluminescent compound and an organic electroluminescent device comprising the same.

Background Art

[2] An electroluminescent (EL) device is a self-light-emitting device with the advantages of providing a wider viewing angle, a greater contrast ratio, and a faster response time. The first organic EL device was developed by Eastman Kodak, by using small aromatic diamine molecules and aluminum complexes as materials for forming a light-emitting layer (*see* Appl. Phys. Lett. 51, 913, 1987).

[3] An organic EL device (OLED) changes electric energy into light by the injection of a charge into an organic light-emitting material, and commonly comprises an anode, a cathode, and an organic layer formed between the two electrodes. The organic layer of the organic EL device may be composed of a hole injection layer, a hole transport layer, an electron blocking layer, a light-emitting layer (containing host and dopant materials), an electron buffer layer, a hole blocking layer, an electron transport layer, an electron injection layer, etc.; the materials used in the organic layer can be classified into a hole injection material, a hole transport material, an electron blocking material, a light-emitting material, an electron buffer material, a hole blocking material, an electron transport material, an electron injection material, etc., depending on functions. In the organic EL device, holes from an anode and electrons from a cathode are injected into a light-emitting layer by electric voltage, and an exciton having high energy is produced by the recombination of the holes and electrons. The organic light-emitting compound moves into an excited state by the energy and emits light from energy when the organic light-emitting compound returns to the ground state from the excited state.

[4] Research is underway to improve the performance of an organic electroluminescent device by using a material suitable for each layer in the organic electroluminescent device.

[5] For example, an electron transport material actively transports electrons from a cathode to a light-emitting layer and inhibits transport of holes which are not re-combined in the light-emitting layer to increase recombination opportunity of holes and electrons in the light-emitting layer. Thus, electron-affinitive materials are used as

an electron transport material. Organic metal complexes having light-emitting function such as Alq_3 have been conventionally used as an electron transport material. However, Alq_3 also has a limitation in providing an organic electroluminescent device having sufficiently satisfactory performance, thus, there is a demand for an electron transport material having improved performance capable of replacing Alq_3. Therefore, new electron transport materials have been required, which do not have the above problems, are highly electron-affinitive, and quickly transport electrons in organic EL devices to provide organic EL devices having high luminous efficiency.

[6] Further, the electron buffer layer is a layer for solving the problem of a change in luminance caused by the change of a current characteristic of the device when exposed to a high temperature during a process of producing a panel. In order to obtain a similar current characteristic and a stability to high temperature compared to a device without an electron buffering layer, the characteristic of the compound comprised in the electron buffer layer is important.

[7] US 6,849,348 B2, US 7,285,341 B2, US 8,993,128 B2, and KR 2016-0052399 A disclose indenoquinoline derivatives as compounds for an organic electroluminescent device. However, the compounds disclosed in the above documents do not disclose the compounds of the present disclosure in view of specific compound structure including the kinds and position of the substituent.

Disclosure of Invention

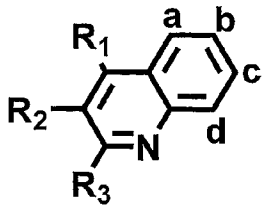
Technical Problem

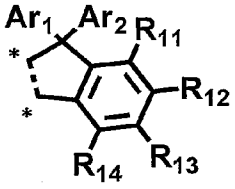
[8] The objective of the present disclosure is to provide an organic electroluminescent compound which is effective for manufacturing an organic electroluminescent device having low driving voltage, high efficiency and/or excellent color coordinates.

Solution to Problem

[9] Common compounds having a fluorene moiety can easily induce electron currents. However, the present inventors found that the compounds are stabilized against stress such as high temperature when the weak positions of quinoline, which are the second and the fourth carbon positions thereof, are protected. As a result of intensive studies, the present inventors found that the organic electroluminescent device comprising the indenoquinoline derivative which is substituted with e.g., aryl and/or heteroaryl at the second and the fourth carbon positions on the basis of quinoline has a higher luminous efficiency as well as a lower driving voltage than the indenoquinoline derivative having only one substituent in the quinoline moiety, and reached the present invention.

[10] More specifically, the present inventors found the aforementioned objective can be achieved by the organic electroluminescent compound represented by the following formula 1, and completed the present invention.

[11]  --- (1)

[12]  --- (2)

[13] In formula 1

[14] R_1 to R_3 each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl, provided that at least two of R_1 to R_3 each independently represent a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl;

[15] a and b, or b and c, or c and d of formula 1 are combined with * of formula 2 to form a ring, wherein B_1 and B_2 are bonded at the positions not bonded to * of formula 2 among a to d, regardless of the sequence;

[16] B_1 and B_2 each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, a substituted or unsubstituted (C1-C30)alkyldi(C6-C30)arylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted mono- or di- (C1-C30)alkylamino, a substituted or unsubstituted mono- or di- (C6-C30)arylamino, or a substituted or unsubstituted (C1-C30)alkyl(C6-C30)arylamino;

[17] Ar_1 and Ar_2 each independently represent halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl; or may be linked to an adjacent substituent to form a substituted or unsubstituted (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof;

[18] R_{11} to R_{14} each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsub-

stituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, a substituted or unsubstituted (C1-C30)alkyldi(C6-C30)arylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted mono- or di- (C1-C30)alkylamino, a substituted or unsubstituted mono- or di- (C6-C30)arylamino, or a substituted or unsubstituted (C1-C30)alkyl(C6-C30)arylamino; or may be linked to an adjacent substituent to form a substituted or unsubstituted (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof.

Advantageous Effects of Invention

[19] According to the present disclosure, the organic electroluminescent device having a low driving voltage, a high luminous efficiency and/or excellent color coordinates is provided.

Mode for the Invention

[20] Hereinafter, the present disclosure will be described in detail. However, the following description is intended to explain the invention, and is not meant in any way to restrict the scope of the invention.

[21] The term "organic electroluminescent compound" in the present disclosure means a compound that may be used in an organic electroluminescent device, and may be comprised in any layer constituting an organic electroluminescent device, if necessary.

[22] The term "organic electroluminescent material" in the present disclosure means a material that may be used in an organic electroluminescent device, and may comprise at least one compound. If necessary, the organic electroluminescent material may be comprised in any layer constituting an organic electroluminescent device. For example, the organic electroluminescent material may be a hole injection material, a hole transport material, a hole auxiliary material, a light-emitting auxiliary material, an electron blocking material, a light-emitting material, an electron buffer material, a hole blocking material, an electron transport material, or an electron injection material.

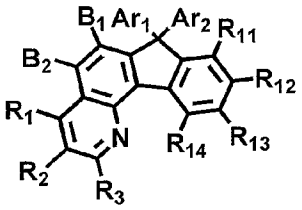
[23] An organic electroluminescent material of the present disclosure comprises at least one compound represented by formula 1 above. The compound of formula 1 may be comprised in at least one layer, which consists of the organic electroluminescent device; and may be in the electron buffer layer and/or the electron transport layer, but not limited thereto; may be included as an electron buffer material when included in the electron buffer layer and may be included as an electron transport material when included in the electron transport layer.

[24] The compound represented by formula 1 will be described in more detail as follows.

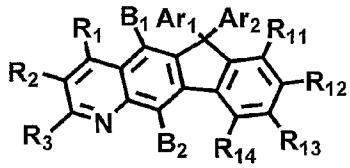
[25] The compound represented by formula 1 may be represented by any one of the

following formulae 3 to 8.

[26]

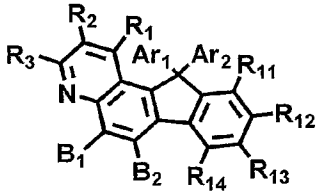


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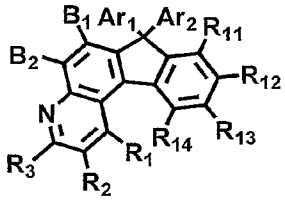


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[27]

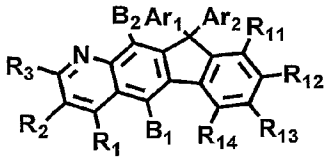


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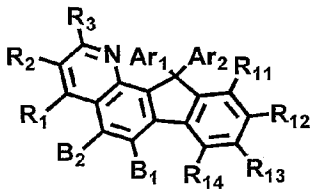


---(6)

[28]



---(7)



---(8)

[29] In formulae 3 to 8,

[30] R_1 to R_3, B_1, B_2, Ar_1, Ar_2, and R_{11} to R_{14} are as defined in formula 1.

[31] In formula1, R_1 to R_3 each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl, provided that at least two of R_1 to R_3 each independently represent a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl. In one embodiment of the present disclosure, R_1 and R_3 each independently represent a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted (5- to 20-membered)heteroaryl, and R_2 represents hydrogen. In another embodiment of the present disclosure, R_1 and R_3 each independently represent a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted (5- to 20-membered)heteroaryl, and wherein the substituents of the substituted aryl each independently represent (C6-C15)aryl-substituted or unsubstituted (5- to 25-membered)heteroaryl, wherein the substituents of the substituted heteroaryl each independently represent (C6-C15)aryl, and R_2 represents hydrogen. Specifically, R_1 and R_3 each independently may be phenyl; naphthyl; biphenyl; naphthylphenyl; carbazolyl; benzocarbazolyl; carbazolylphenyl; benzocarbazolylphenyl; dibenzocarbazolylphenyl; phenylindolocarbazolyl; triazinyl or pyrimidinyl substituted with one or more of phenyl and biphenyl; triazinyl substituted with one or more of phenyl, naphthyl, and biphenyl; or phenyl, naphthyl, biphenyl, phenylnaphthyl or naphthylphenyl substituted with pyrimidinyl.

[32] a and b, or b and c, or c and d of formula 1 are combined with * of formula 2 to form a ring, wherein B_1 and B_2 are bonded at the positions not bonded to * of formula 2 among a to d, regardless of the sequence;

[33] B_1 and B_2 each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, a substituted or unsubstituted (C1-C30)alkyldi(C6-C30)arylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted mono- or di- (C1-C30)alkylamino, a substituted or unsubstituted mono- or di- (C6-C30)arylamino, or a substituted or unsubstituted (C1-C30)alkyl(C6-C30)arylamino. In one embodiment of the present disclosure, B_1 and B_2 represent hydrogen.

[34] Ar_1 and Ar_2 each independently represent halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl; or may be linked to each other to form a substituted or unsubstituted (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof. In one embodiment of the present disclosure, Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C1-C6)alkyl, or a substituted or unsubstituted (C6-C12)aryl; or may be linked to each other to form a substituted or unsubstituted (5- to 15-membered) polycyclic, alicyclic or aromatic ring, or a combination thereof. In another embodiment of the present disclosure, Ar_1 and Ar_2 each independently represent an unsubstituted (C1-C6)alkyl or an unsubstituted (C6-C12)aryl; or may be linked to each other to form an unsubstituted (5- to 15-membered) polycyclic aromatic ring. Specifically, Ar_1 and Ar_2 may be each independently methyl or phenyl; or may be linked to each other to form a spirobifluorene ring.

[35] R_{11} to R_{14} each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, a substituted or unsubstituted (C1-C30)alkyldi(C6-C30)arylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted mono- or di- (C1-C30)alkylamino, a substituted or unsubstituted mono- or di- (C6-C30)arylamino, or a substituted or unsubstituted (C1-C30)alkyl(C6-C30)arylamino; or may be linked to each other to form a substituted

or unsubstituted (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof. In one embodiment of the present disclosure, R_{11} to R_{14} each independently represent hydrogen or a substituted or unsubstituted (C6-C12)aryl. In another embodiment of the present disclosure, R_{11} to R_{14} each independently represent hydrogen or an unsubstituted (C6-C12)aryl. According to another embodiment of the present disclosure, R_{11}, R_{13} and R_{14} are hydrogen, and R_{12} is hydrogen or an unsubstituted (C6-C12)aryl. Specifically, R_{11} to R_{14} may be each independently hydrogen or phenyl.

[36] In the formula of the present disclosure, when an adjacent substituent may be linked to form a substituted or unsubstituted (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof, the formed alicyclic, aromatic ring, or a combination thereof may contain at least one heteroatom selected from nitrogen, oxygen, and sulfur.

[37] In the formula of the present disclosure, the heteroaryl(ene) and the heterocycloalkyl each independently may contain at least one heteroatom selected from B, N, O, S, Si, and P. In addition, the heteroatom may be combined with at least one of substituents selected from hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, a substituted or unsubstituted (C1-C30)alkyldi(C6-C30)arylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted mono- or di- (C1-C30)alkylamino, a substituted or unsubstituted mono- or di- (C6-C30)arylamino, and a substituted or unsubstituted (C1-C30)alkyl(C6-C30)arylamino.

[38] According to one embodiment of the present disclosure, in the formula 1, R_1 and R_3 each independently represent a substituted or unsubstituted (C6-C20)aryl or a substituted or unsubstituted (5- to 20-membered)heteroaryl; R_2 represents hydrogen; B_1 and B_2 represent hydrogen; Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C1-C6)alkyl or a substituted or unsubstituted (C6-C12)aryl, or may be linked to each other to form a substituted or unsubstituted (5- to 15-membered) polycyclic, alicyclic or aromatic ring, or a combination thereof; R_{11} to R_{14} each independently represent hydrogen or a substituted or unsubstituted (C6-C12)aryl.

[39] According to another embodiment of the present disclosure, in formula 1, R_1 and R_3 each independently represent a substituted or unsubstituted (C6-C20)aryl or a substituted or unsubstituted (5- to 20-membered)heteroaryl, wherein the substituents of the substituted aryl each independently represent (C6-C15)aryl-substituted or unsub-

stituted (5- to 20-membered)heteroaryl, and the substituents of the substituted heteroaryl each independently represent (C6-C15)aryl; R_2 represents hydrogen; B_1 and B_2 represent hydrogen; Ar_1 and Ar_2 each independently represent an unsubstituted (C1-C6)alkyl or an unsubstituted (C6-C12)aryl; or may be linked to each other to form an unsubstituted (5- to 15-membered) polycyclic aromatic ring; R_{11} to R_{14} each independently represent hydrogen or an unsubstituted (C6-C12)aryl.

[40] Herein, "(C1-C30)alkyl" is meant to be a linear or branched alkyl having 1 to 30 carbon atoms constituting the chain, in which the number of carbon atoms is preferably 1 to 20, more preferably 1 to 10, and includes methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, and tert-butyl, etc. "(C2-C30)alkenyl" is meant to be a linear or branched alkenyl having 2 to 30 carbon atoms constituting the chain, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-methylbut-2-enyl, etc. "(C2-C30)alkynyl" is a linear or branched alkynyl having 2 to 30 carbon atoms constituting the chain, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes ethynyl, 1-propynyl, 2-propynyl, 1-butynyl, 2-butynyl, 3-butynyl, 1-methylpent-2-ynyl, etc. "(C3-C30)cycloalkyl" is a mono- or polycyclic hydrocarbon having 3 to 30 ring backbone carbon atoms, in which the number of carbon atoms is preferably 3 to 20, more preferably 3 to 7, and includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc. "(3- to 7-membered)heterocycloalkyl" is a cycloalkyl having 3 to 7 ring backbone atoms, preferably 5 to 7 ring backbone atoms and at least one heteroatom selected from the group consisting of B, N, O, S, Si, and P, preferably O, S, and N, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc. "(C6-C30)aryl(ene)" is a monocyclic or fused ring radical derived from an aromatic hydrocarbon having 6 to 30 ring backbone carbon atoms and may be partially saturated, in which the number of ring backbone carbon atoms is preferably 6 to 25, more preferably 6 to 18. The aryl includes those having a spiro structure, and includes phenyl, biphenyl, terphenyl, naphthyl, binaphthyl, phenylnaphthyl, naphthylphenyl, phenyl terphenyl, fluorenyl, phenylfluorenyl, benzofluorenyl, dibenzofluorenyl, phenanthrenyl, phenylphenanthrenyl, anthracenyl, indenyl, triphenylenyl, pyrenyl, tetracenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, spirobifluorenyl, etc. "(5- to 30-membered)heteroaryl(ene)" is an aryl group having at least one heteroatom selected from the group consisting of B, N, O, S, Si, and P, and 5 to 30 ring backbone atoms; having preferably 1 to 4 heteroatoms, and may be a monocyclic ring, or a fused ring condensed with at least one benzene ring; may be partially saturated. In addition, the heteroaryl(ene) in the present disclosure may be one formed by linking at least one heteroaryl or aryl group to a heteroaryl group via a single bond(s); may comprise those having a spiro structure; and includes a monocyclic ring-

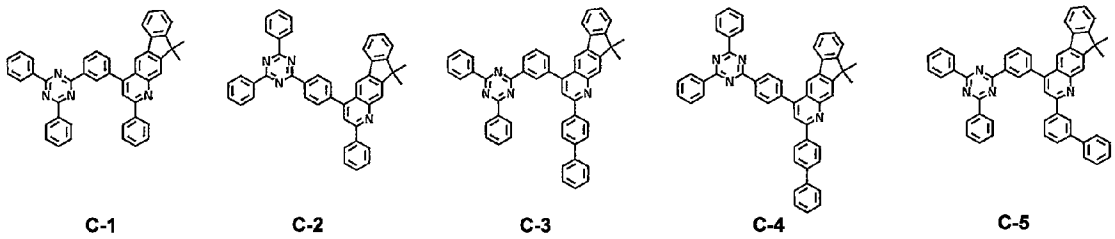
type heteroaryl including furyl, thiophenyl, pyrrolyl, imidazolyl, pyrazolyl, thiazolyl, thiadiazolyl, isothiazolyl, isoxazolyl, oxazolyl, oxadiazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, furazanyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl including benzofuranyl, benzothiophenyl, isobenzofuranyl, dibenzofuranyl, dibenzothiophenyl, benzoimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, benzoindolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, benzoquinazolinyl, quinoxalinyl, benzoquinoxalinyl, naphthyridinyl, carbazolyl, benzocarbazolyl, dibenzocarbazolyl, phenoxazinyl, phenothiazinyl, phenanthridinyl, benzodioxolyl, dihydroacridinyl, etc. "Halogen" includes F, Cl, Br, and I.

[41] In addition, "substituted" in the expression "substituted or unsubstituted" means that a hydrogen atom in a certain functional group is replaced with another atom or functional group, i.e., a substituent. The substituents of the substituted alkyl, the substituted aryl, the substituted heteroaryl, the substituted cycloalkyl, the substituted alkoxy, the substituted trialkylsilyl, the substituted dialkylarylsilyl, the substituted alkyldiarylsilyl, the substituted triarylsilyl, the substituted mono- or di- alkylamino, the substituted mono- or di- arylamino, the substituted alkylarylamino, and the substituted mono- or polycyclic, alicyclic, aromatic ring, or the combination thereof, in R_1 to R_3, B_1, B_2, Ar_1, Ar_2, and R_{11} to R_{14} are each independently at least one selected from the group consisting of deuterium; halogen; cyano; carboxyl; nitro; hydroxy; (C1-C30)alkyl; halo(C1-C30)alkyl; (C2-C30)alkenyl; (C2-C30)alkynyl; (C1-C30)alkoxy; (C1-C30)alkylthio; (C3-C30)cycloalkyl; (C3-C30)cycloalkenyl; (3- to 7-membered)heterocycloalkyl; (C6-C30)aryloxy; (C6-C30)arylthio; (C6-C30)aryl- substituted or unsubstituted (5- to 30-membered)heteroaryl; (5- to 30-membered)heteroaryl- substituted or unsubstituted (C6-C30)aryl; tri(C1-C30)alkylsilyl; tri(C6-C30)arylsilyl; di(C1-C30)alkyl(C6-C30)arylsilyl; (C1-C30)alkyldi(C6-C30)arylsilyl; amino; a mono- or di- (C1-C30)alkylamino; (C1-C30)alkyl- substituted or unsubstituted mono- or di- (C6-C30)arylamino; (C1-C30)alkyl(C6-C30)arylamino; (C1-C30)alkylcarbonyl; (C1-C30)alkoxycarbonyl; (C6-C30)arylcarbonyl; di(C6-C30)arylboronyl; di(C1-C30)alkylboronyl; (C1-C30)alkyl(C6-C30)arylboronyl; (C6-C30)ar(C1-C30)alkyl; and (C1-C30)alkyl(C6-C30)aryl. In one embodiment of the present disclosure, the substituents are each independently (C6-C15)aryl or (C6-C15)aryl-substituted or unsubstituted (5- to 25-membered)heteroaryl. Specifically, the substituents may be each independently phenyl; biphenyl; carbazolyl; benzocarbazolyl; dibenzocarbazolyl; and triazinyl or pyrimidinyl, etc., substituted with at least one of phenyl, naphthyl and biphenyl.

[42] The compound represented by formula 1 may be specifically illustrated by the

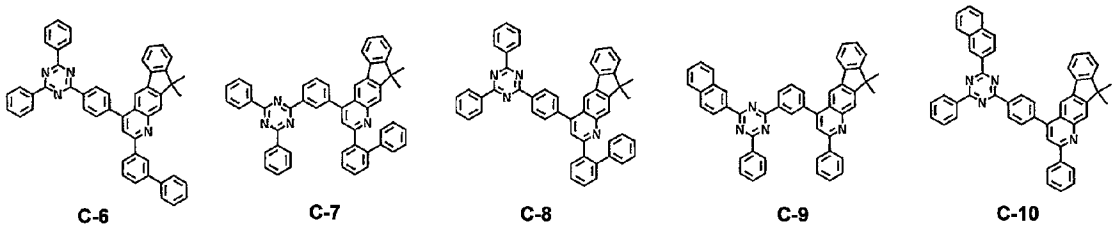
following compounds, but is not limited thereto:

[43]



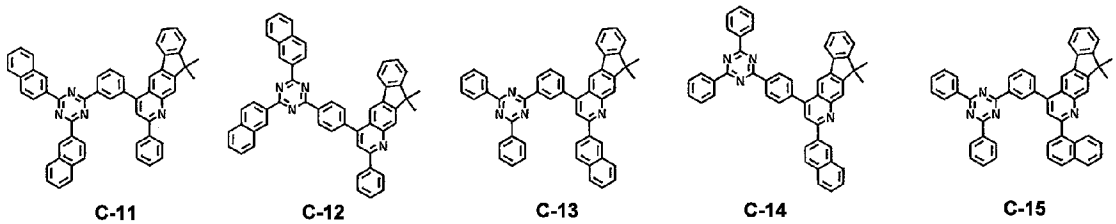
C-1 C-2 C-3 C-4 C-5

[44]



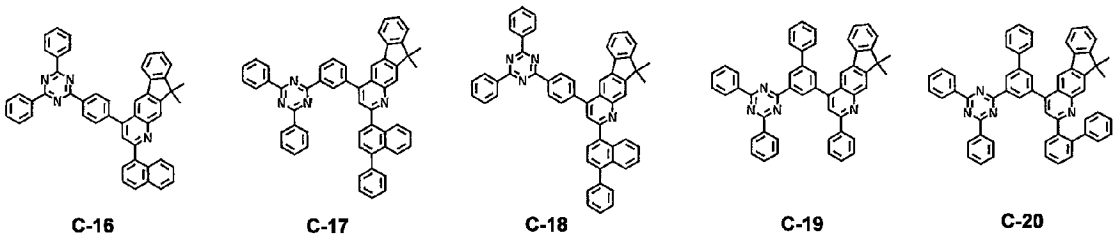
C-6 C-7 C-8 C-9 C-10

[45]



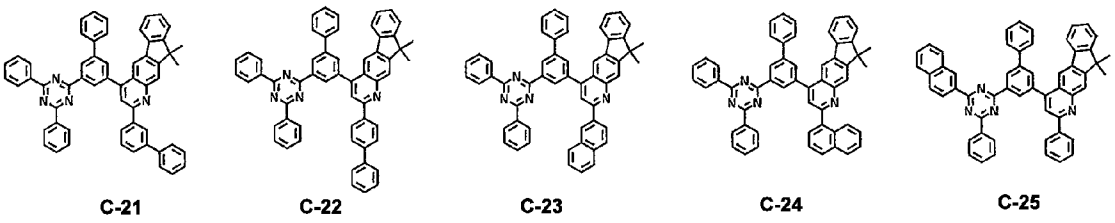
C-11 C-12 C-13 C-14 C-15

[46]



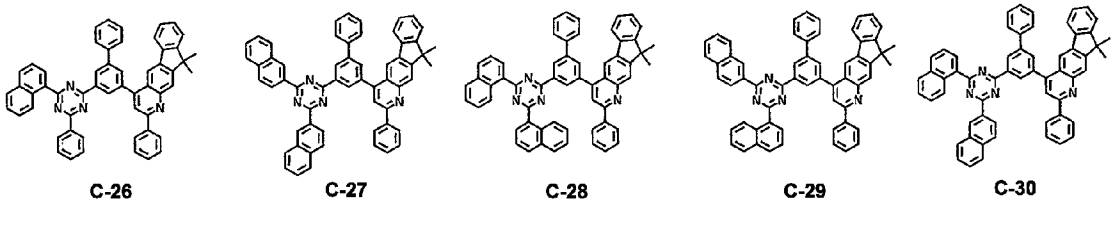
C-16 C-17 C-18 C-19 C-20

[47]



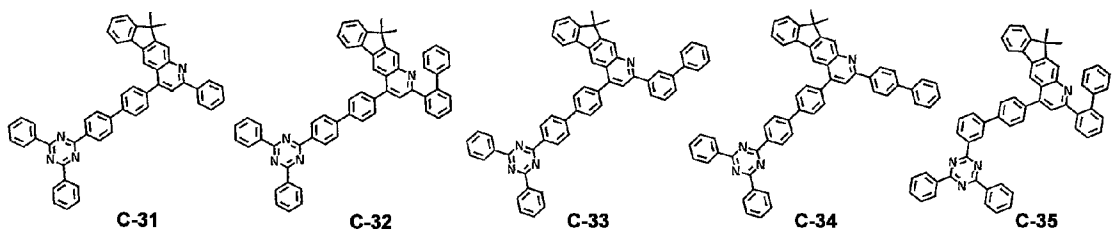
C-21 C-22 C-23 C-24 C-25

[48]



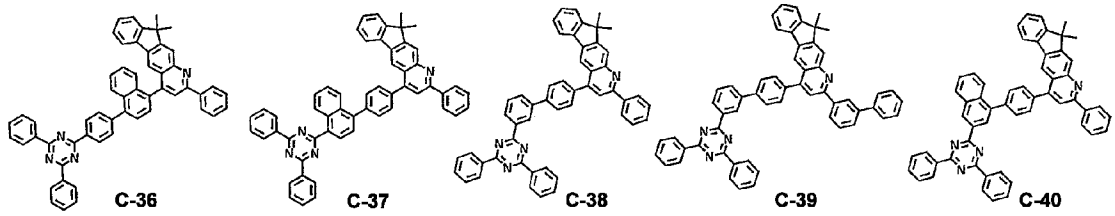
C-26 C-27 C-28 C-29 C-30

[49]

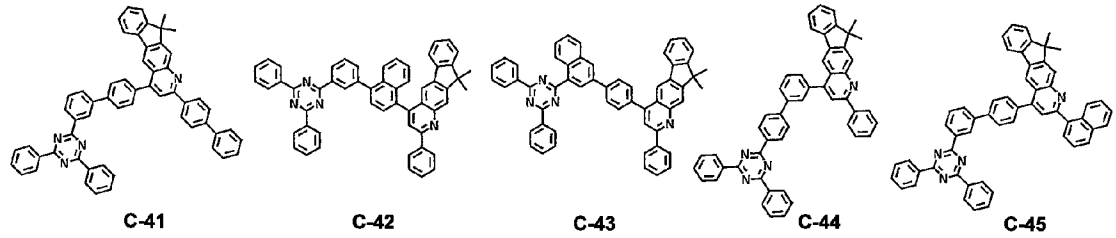


C-31 C-32 C-33 C-34 C-35

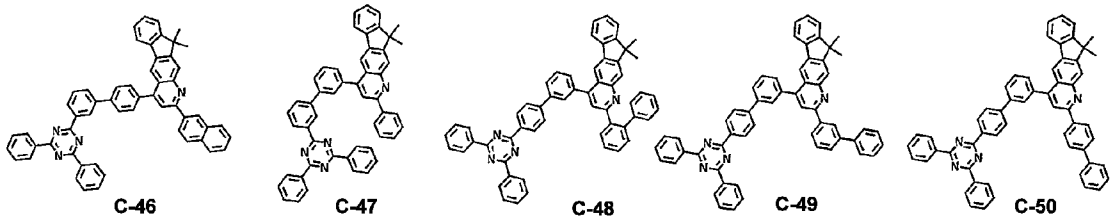
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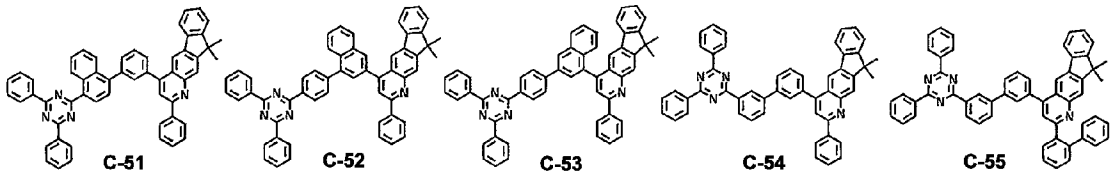
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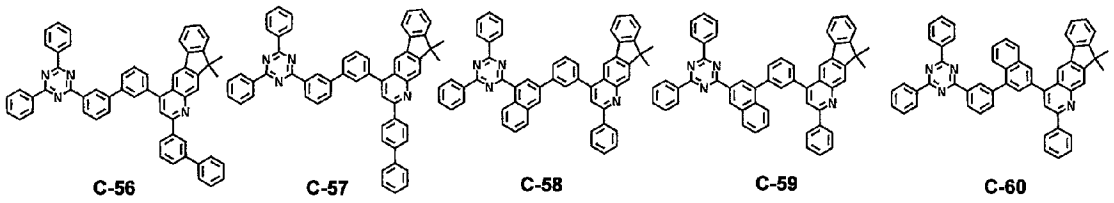
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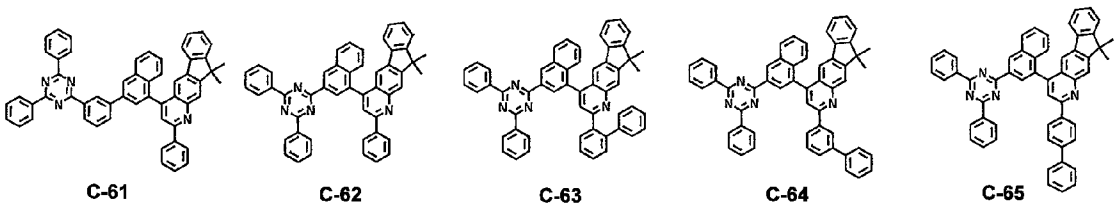
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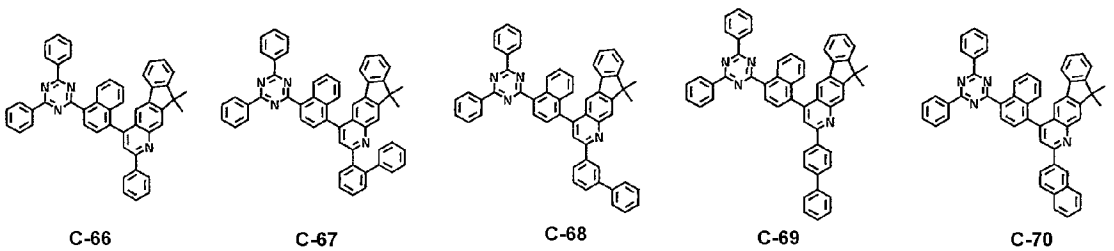
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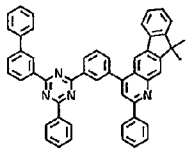
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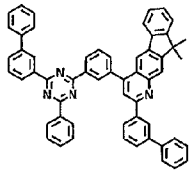


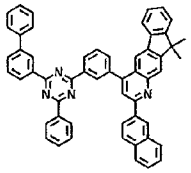
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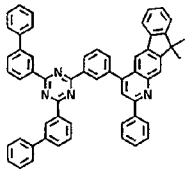


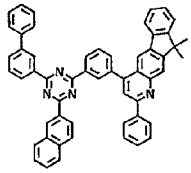
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C-71

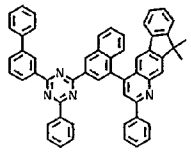

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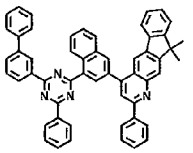

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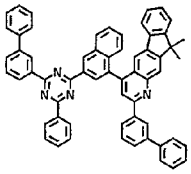

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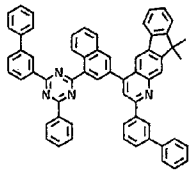

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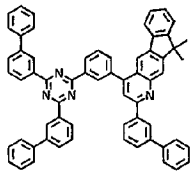
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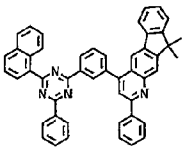

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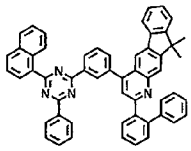

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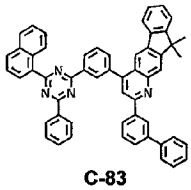

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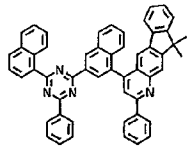

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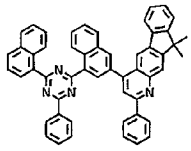
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C-81

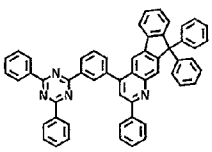

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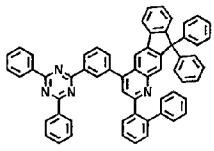

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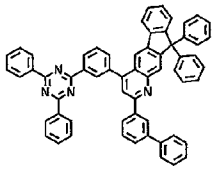

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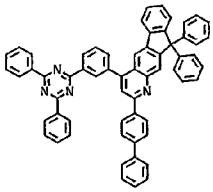

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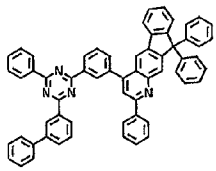
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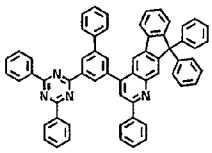

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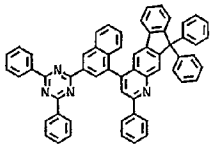

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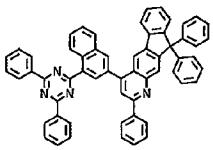

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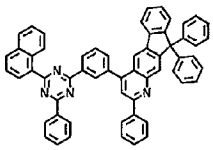

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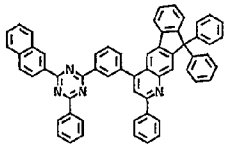
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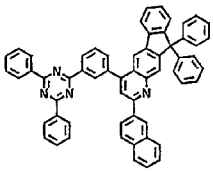

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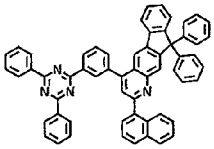

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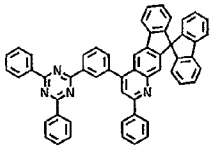

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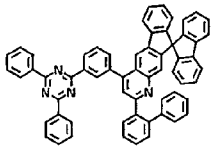

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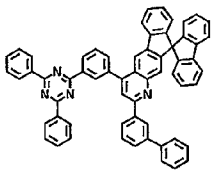
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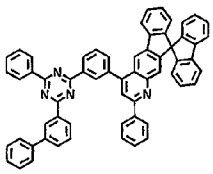

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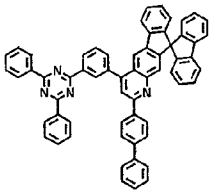

C-98

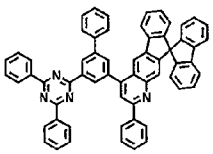

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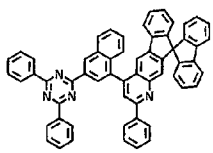

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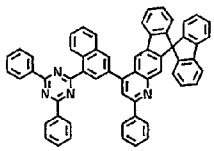
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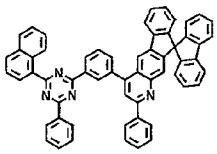

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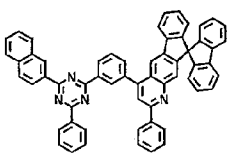

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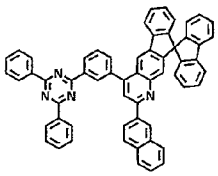

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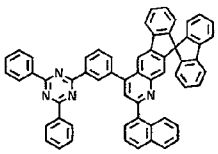

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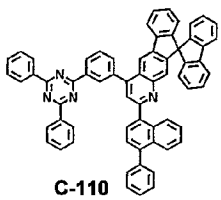
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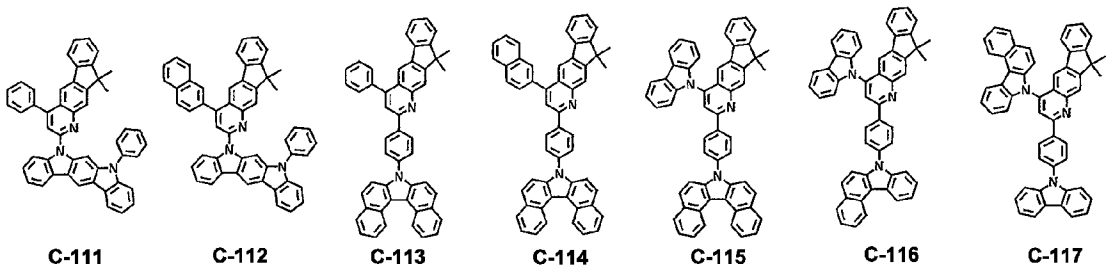

C-107


C-108


C-109

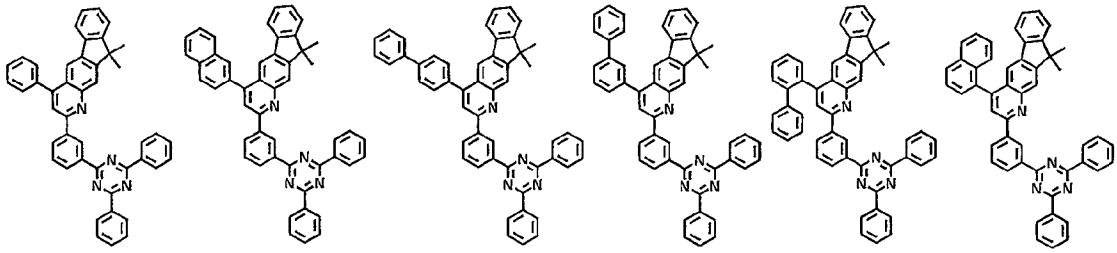

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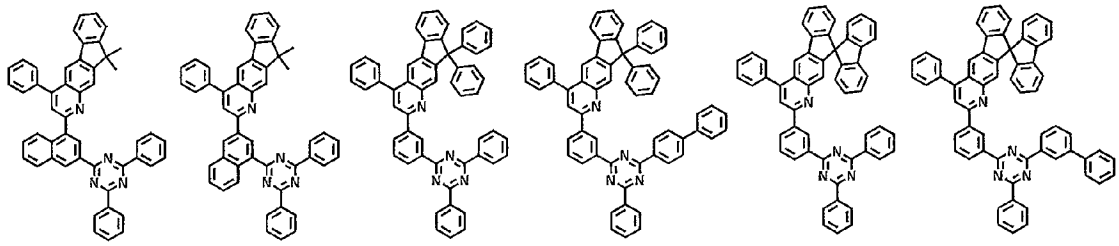
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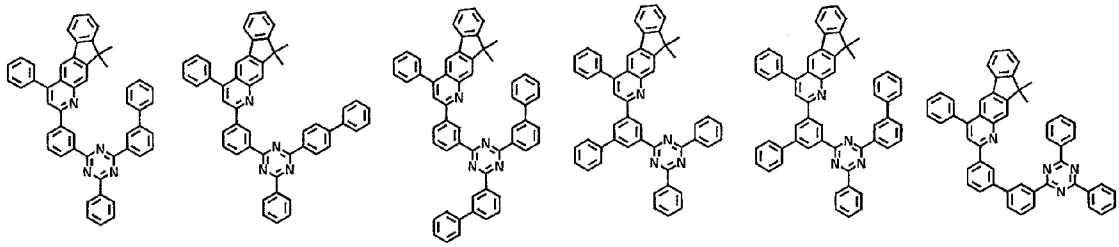
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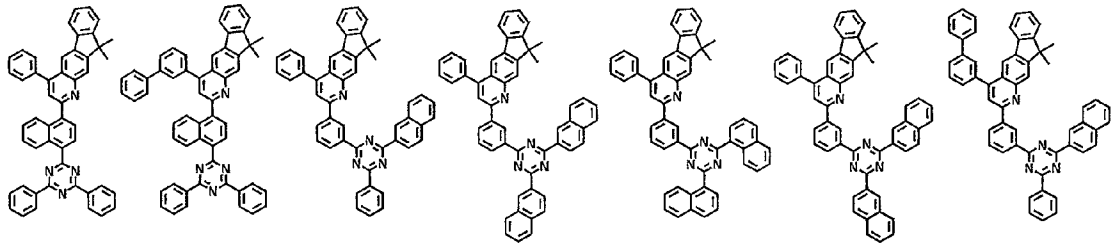
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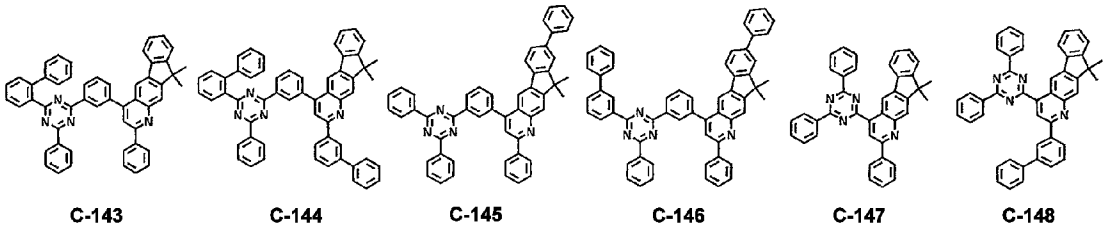
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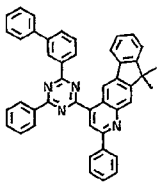
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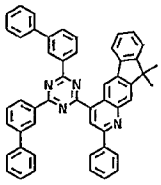
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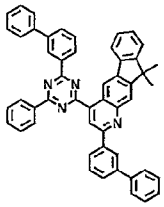


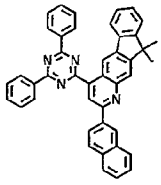
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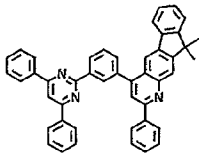
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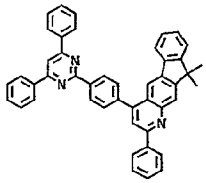

C-149


C-150

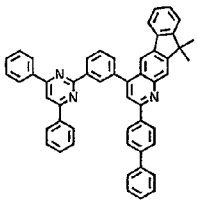

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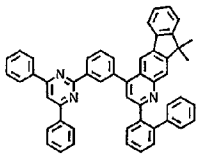

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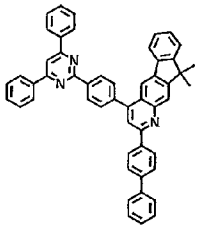

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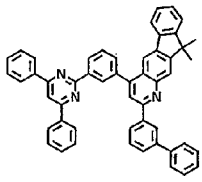

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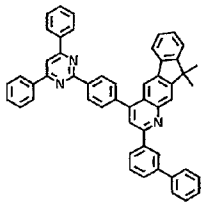
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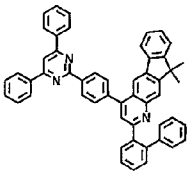

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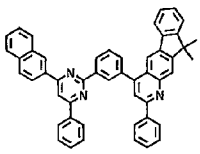

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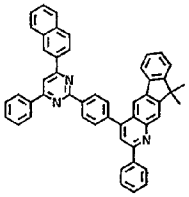

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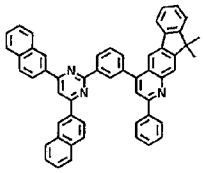

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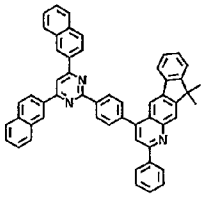
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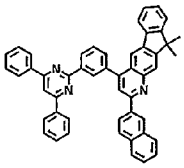

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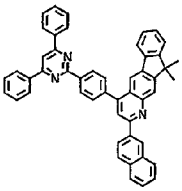

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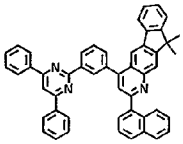

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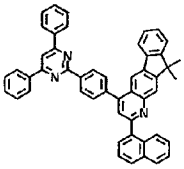

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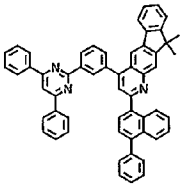
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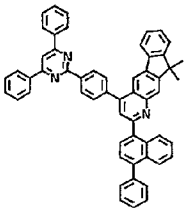

C-165


C-166

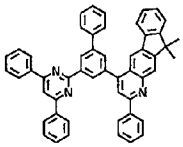

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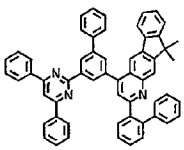

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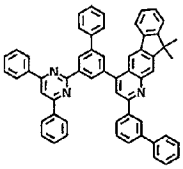

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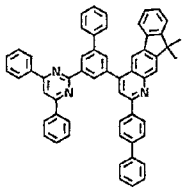

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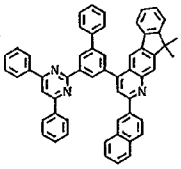
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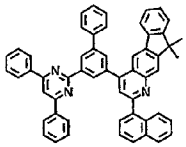

C-171


C-172

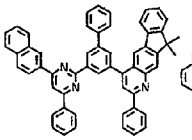

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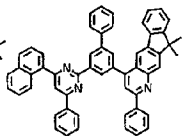

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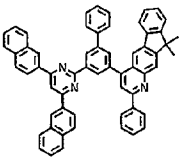

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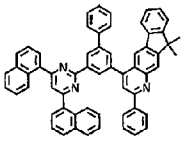

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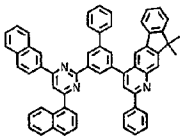
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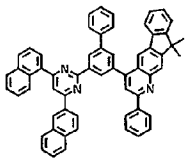

C-177


C-178

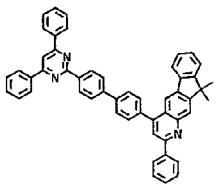

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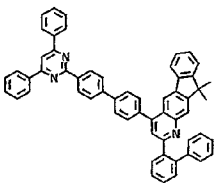

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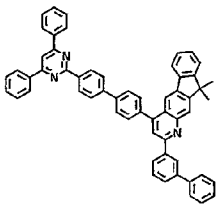

C-181

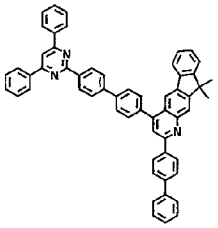

C-182

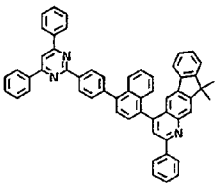
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C-183

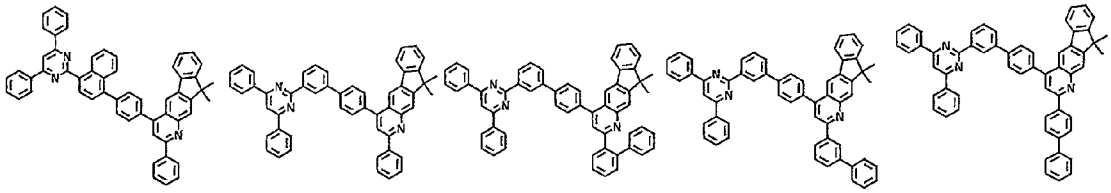

C-184


C-185


C-186

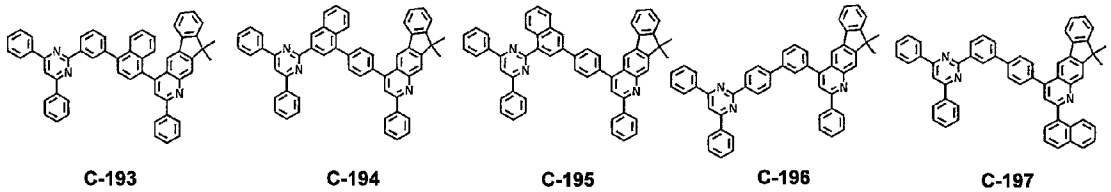

C-187

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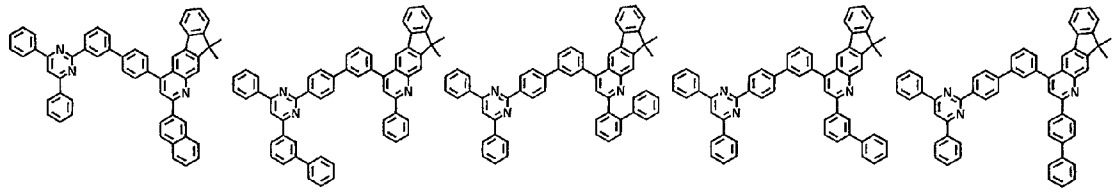
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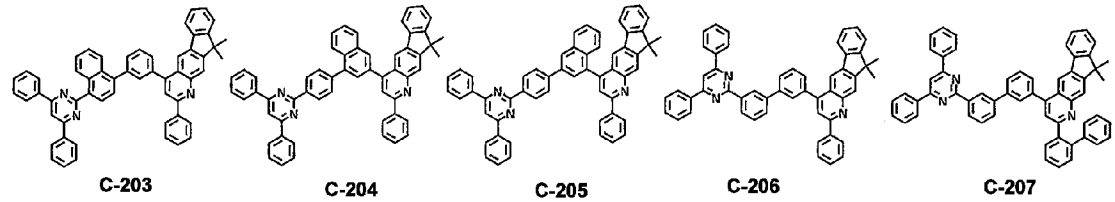
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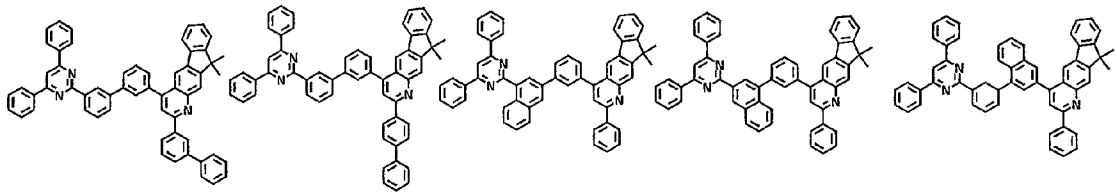
C-198 C-199 C-200 C-201 C-202

[81]



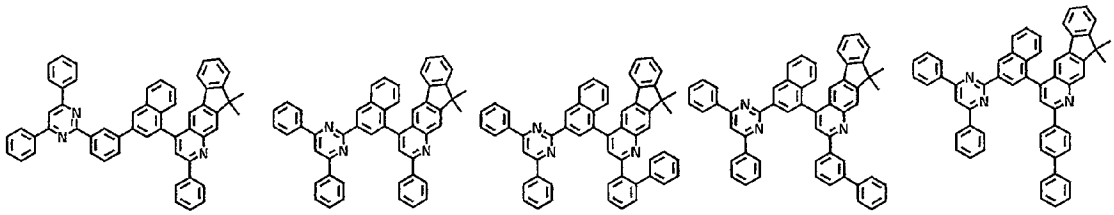
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[82]



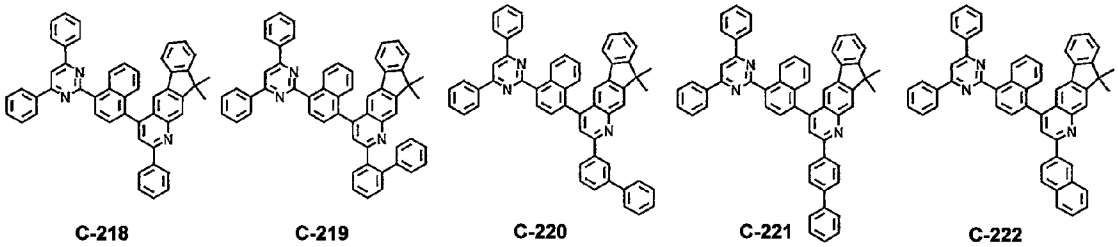
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[83]



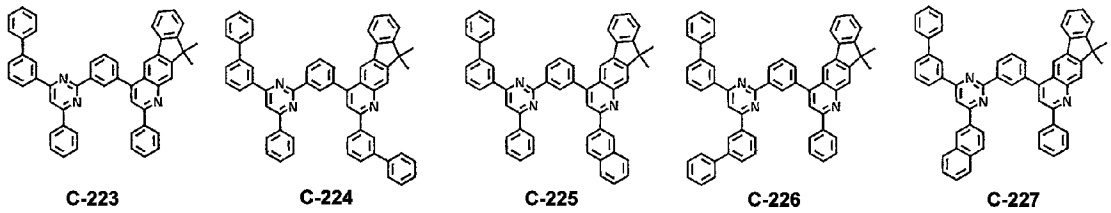
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[84]

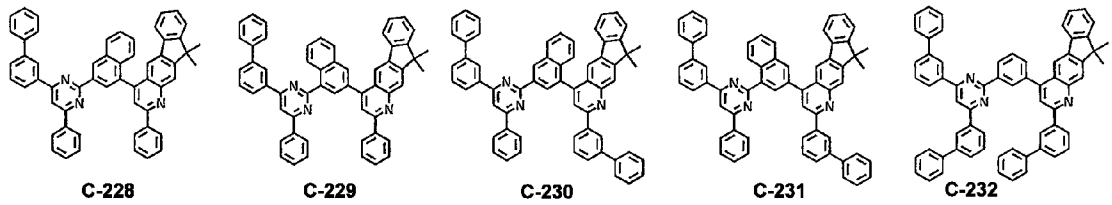


C-218 C-219 C-220 C-221 C-222

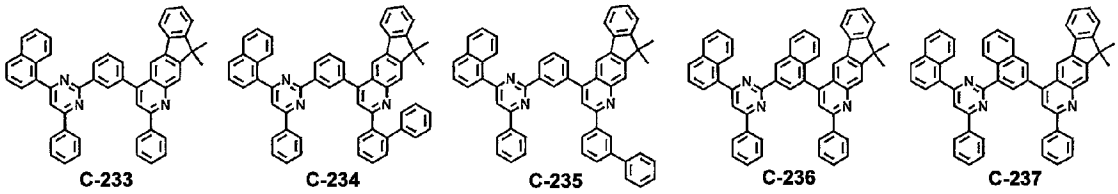
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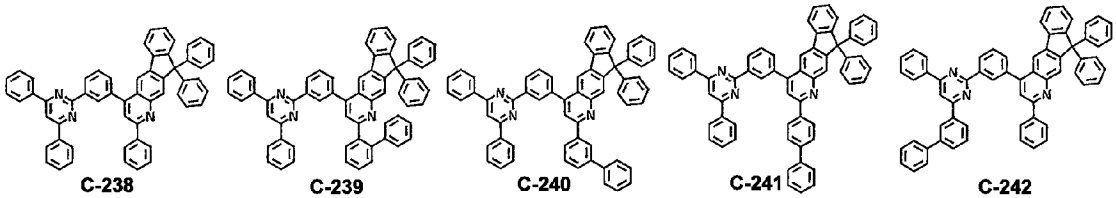
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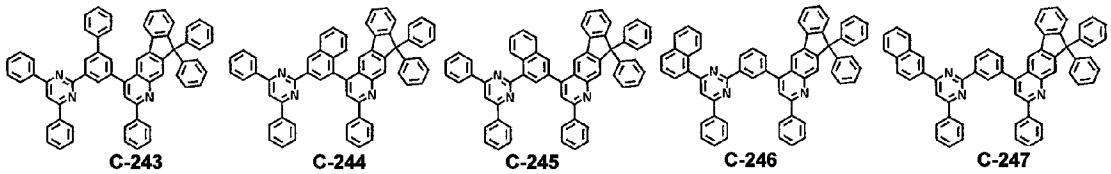
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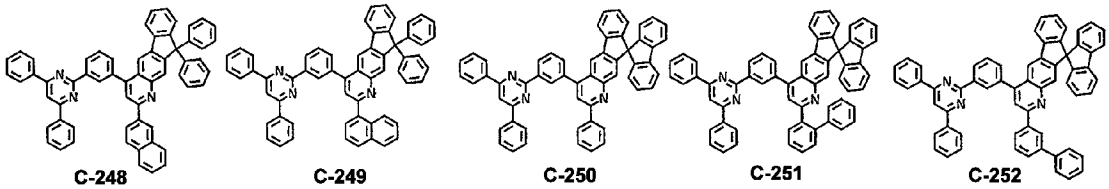
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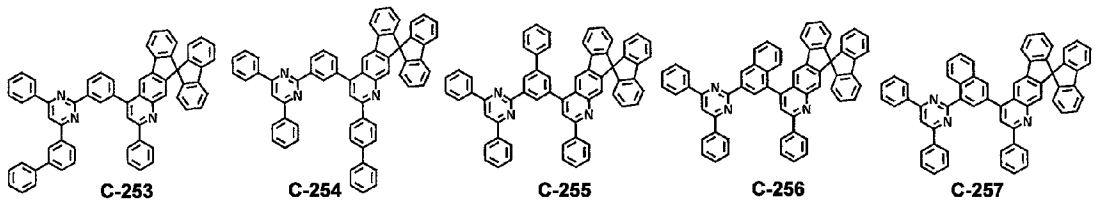
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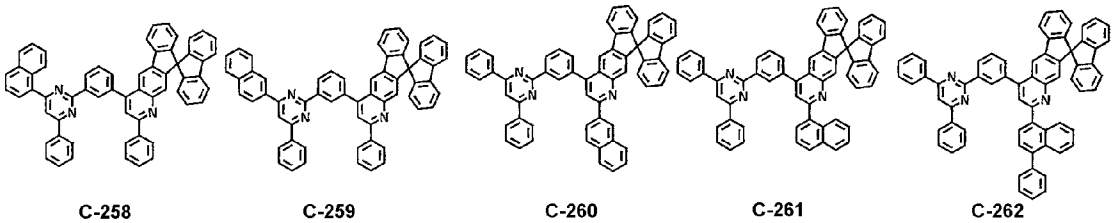
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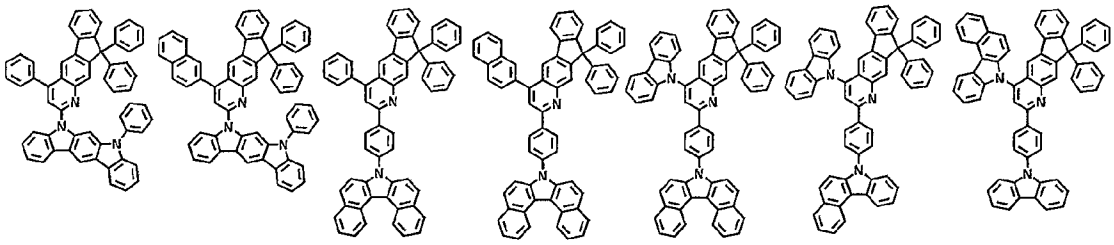
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[92]

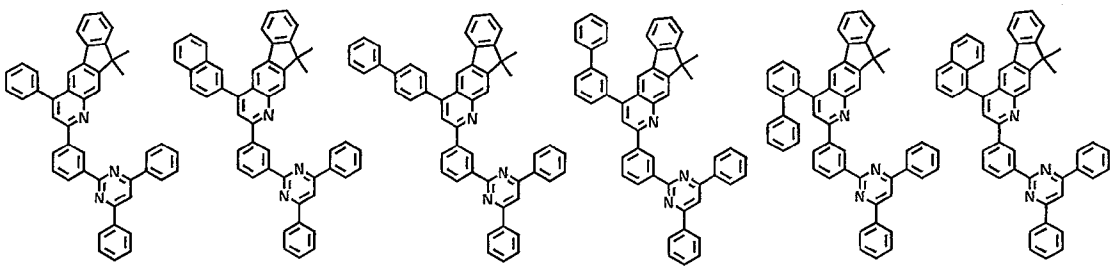


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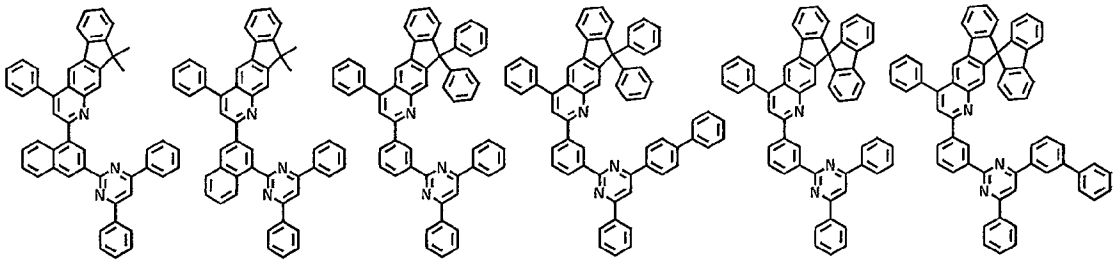
C-263 C-264 C-265 C-266 C-267 C-268 C-269

[94]



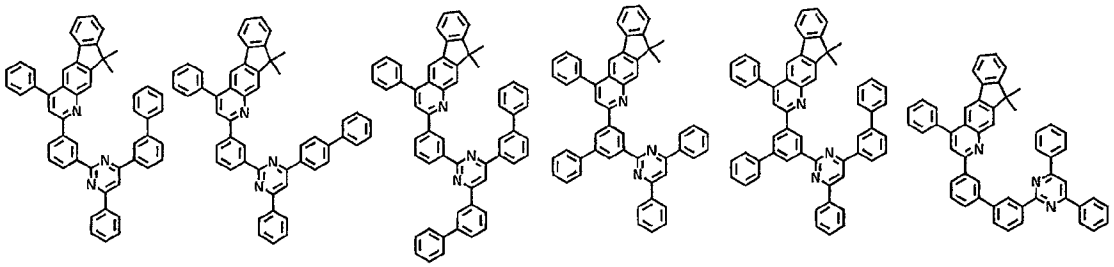
C-270 C-271 C-272 C-273 C-274 C-275

[95]



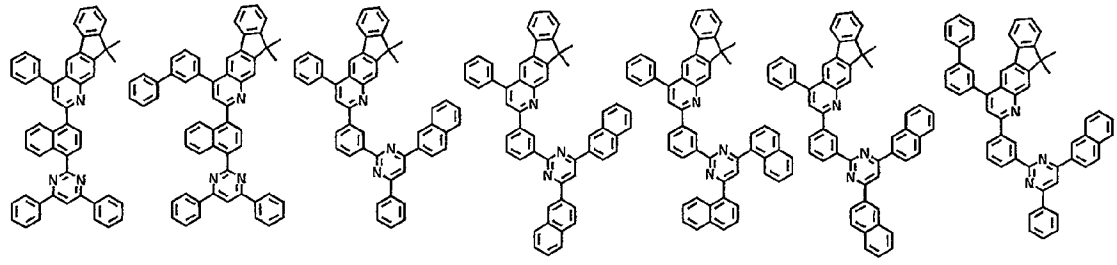
C-276 C-277 C-278 C-279 C-280 C-281

[96]



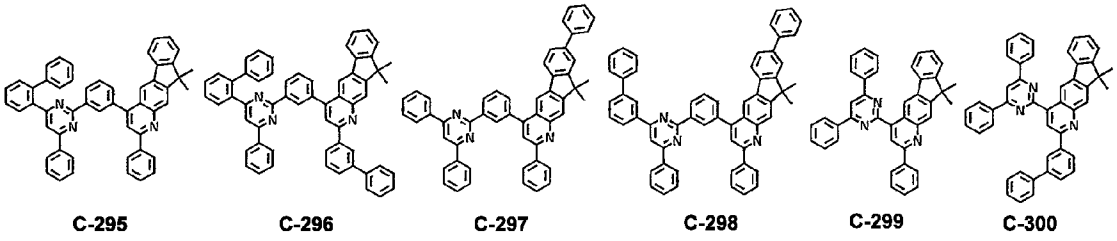
C-282 C-283 C-284 C-285 C-286 C-287

[97]



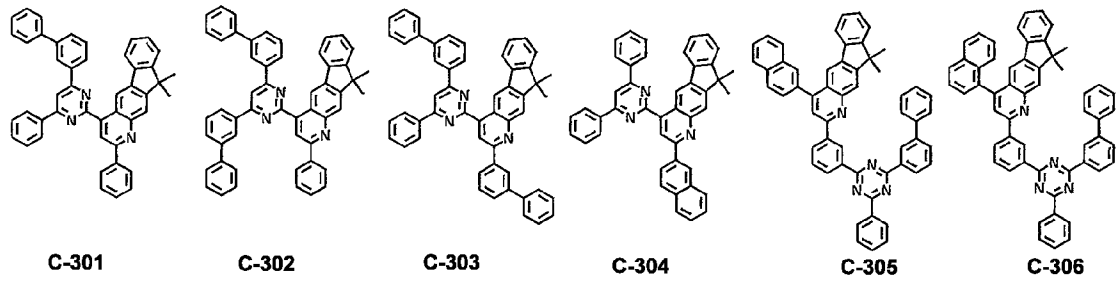
C-288 C-289 C-290 C-291 C-292 C-293 C-294

[98]



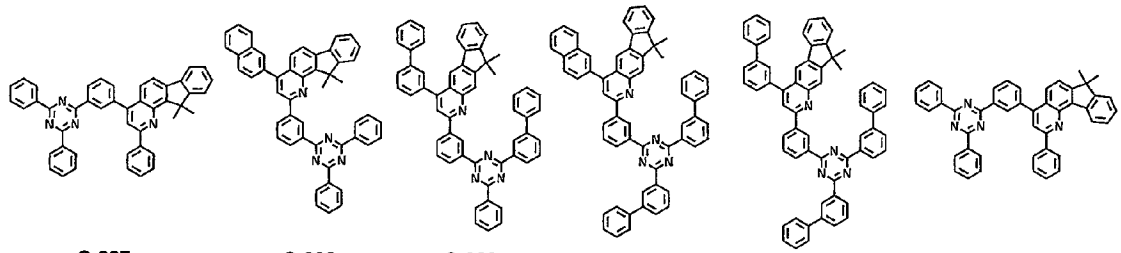
C-295 C-296 C-297 C-298 C-299 C-300

[99]



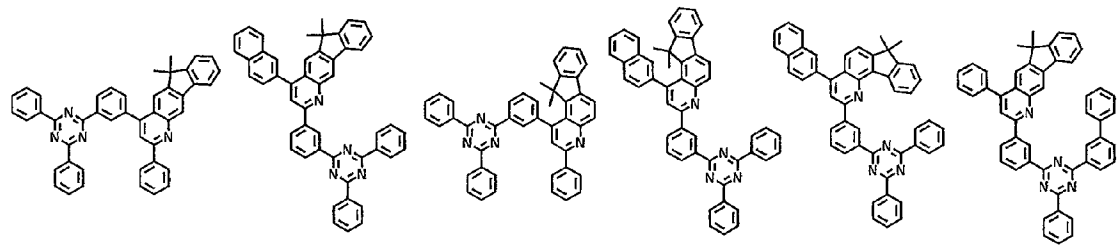
C-301 C-302 C-303 C-304 C-305 C-306

[100]



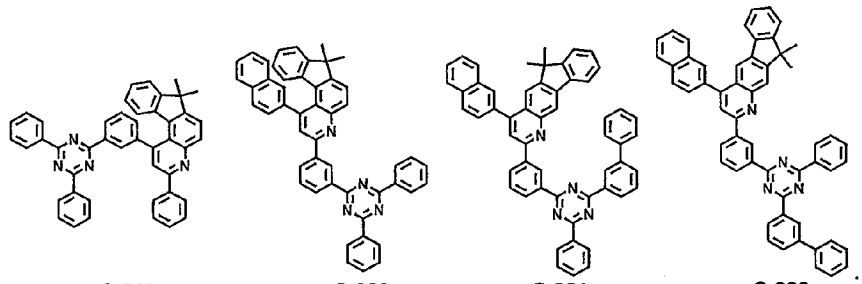
C-307 C-308 C-309 C-310 C-311 C-312

[101]



C-313 C-314 C-315 C-316 C-317 C-318

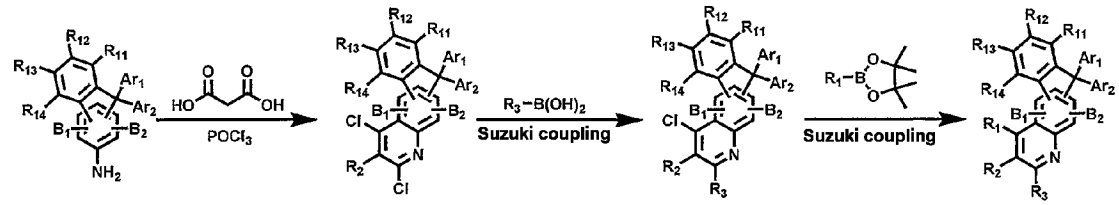
[102]



C-319 C-320 C-321 C-322

[103] The compounds of formula 1 according to the present disclosure can be prepared by a synthetic method known to one skilled in the art, e.g., the following reaction scheme 1.

[104] [Reaction Scheme 1]



[105] In the reaction scheme 1, R_1 to R_3, B_1, B_2, Ar_1, Ar_2 and R_{11} to R_{14} are as defined in formula 1.

[106] The present disclosure provides an organic electroluminescent material comprising the organic electroluminescent compound of formula 1 and an organic electrolu-

minescent device comprising the organic electroluminescent material.

[107] The organic electroluminescent material may be comprised solely of the organic electroluminescent compound of the present disclosure, or may further comprise conventional materials included in the organic electroluminescent material.

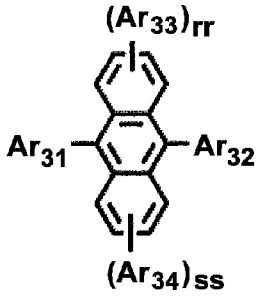
[108] The organic electroluminescent device according to the present disclosure includes a first electrode; a second electrode; and at least one organic layer interposed between the first electrode and the second electrode.

[109] One of the first electrode and the second electrode may be an anode and the other may be a cathode. The organic layer comprises a light-emitting layer, and may further comprise at least one layer selected from a hole injection layer, a hole transport layer, a hole auxiliary layer, a light-emitting auxiliary layer, an electron transport layer, an electron buffer layer, an electron injection layer, an interlayer, a hole blocking layer, and an electron blocking layer.

[110] The organic electroluminescent compound represented by formula 1 of the present disclosure may be comprised in at least one layer of the light-emitting layer, the hole injecting layer, the hole transport layer, the hole auxiliary layer, the light-emitting auxiliary layer, the electron transport layer, the electron buffer layer, the electron injection layer, the interlayer, the hole blocking layer, and the electron blocking layer. According to the case, it may be, preferably, comprised in at least one layer of the light-emitting layer, the electron buffer layer, and the electron transport layer. When used in the light-emitting layer, the organic electroluminescent compound of formula 1 of the present disclosure may be comprised as a host material. When used in the electron buffer layer, the organic electroluminescent compound of formula 1 of the present disclosure may be comprised as an electron buffer material. When used in the electron transport layer, the organic electroluminescent compound of formula 1 of the present disclosure may be comprised as an electron transport material.

[111] The light-emitting layer may include at least one host and at least one dopant. If necessary, the light-emitting layer may comprise a co-host material, i.e., a plurality of two or more host materials.

[112] The host compound to be used in the present disclosure may be a phosphorescent host compound or a fluorescent host compound, and the kinds of host compound to be used are not particularly limited. Specifically, the host compound may be a fluorescent host compound, for example, may be an anthracene compound represented by the following formula 11.

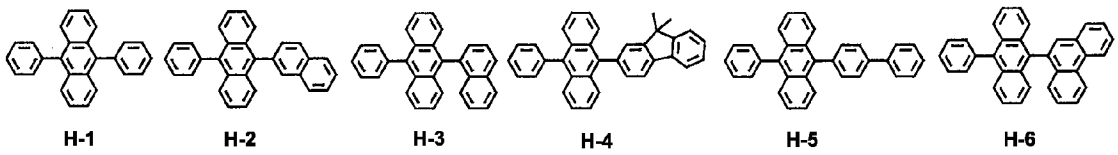
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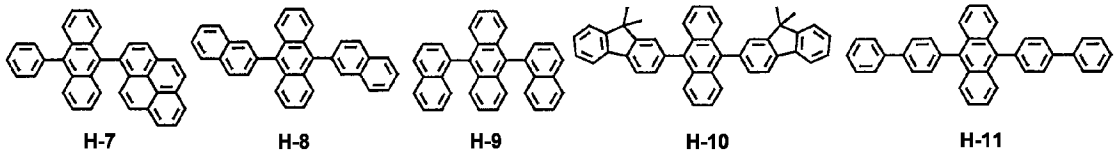
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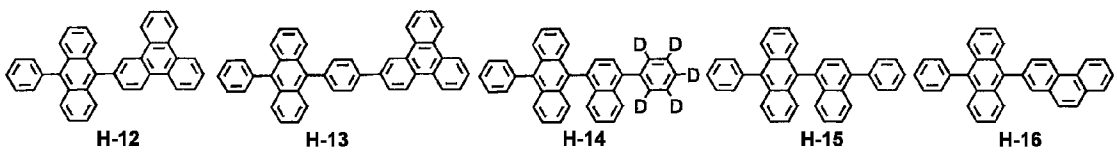
[114] In formula 11,

[115] Ar_{31} and Ar_{32} each independently represent a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl; Ar_{33} and Ar_{34} each independently represent hydrogen, deuterium, halogen, cyano, nitro, hydroxy, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted (C1-C30)alkylsilyl, a substituted or unsubstituted (C6-C30)arylsilyl, a substituted or unsubstituted (C6-C30)ar(C1-C30)alkylsilyl, or $-NR_{41}R_{42}$; R_{41} and R_{42} each independently represent hydrogen, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl, or may be bonded to each other to form a (3-to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination of alicyclic and aromatic rings whose carbon atom may be replaced with at least one heteroatom selected from nitrogen, oxygen, and sulfur; rr and ss each independently represent an integer of 1 to 4; and where rr or ss is an integer of 2 or more, each of Ar_{33} or Ar_{34} may be the same or different.

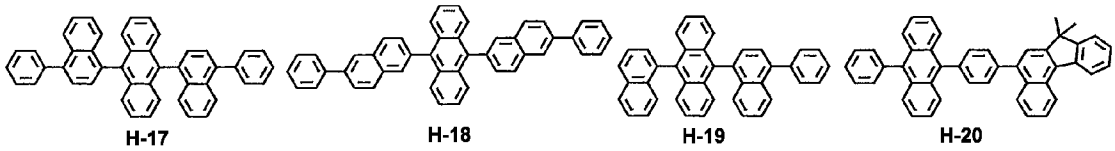
[116] The compound represented by formula 11 may be specifically illustrated by the following compounds, but is not limited thereto:

[117] 

[118] 

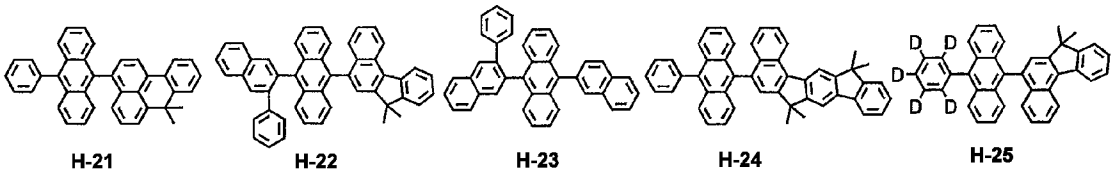
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[120]



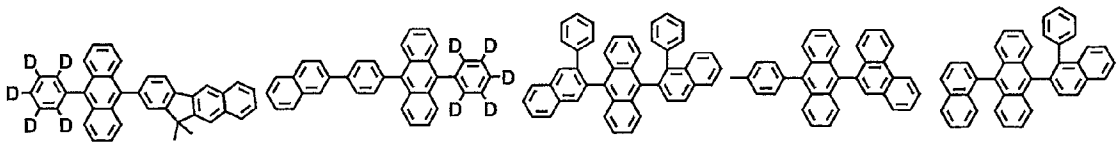
H-17 H-18 H-19 H-20

[121]



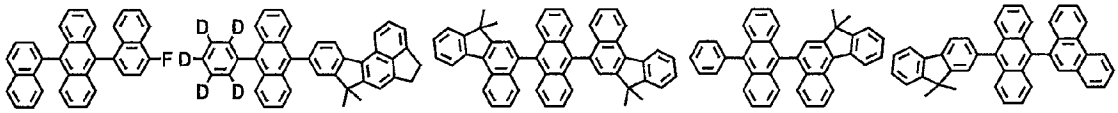
H-21 H-22 H-23 H-24 H-25

[122]



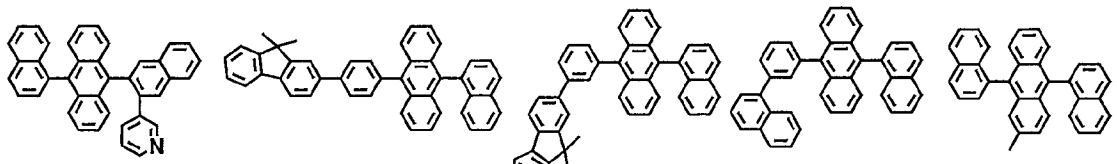
H-26 H-27 H-28 H-29 H-30

[123]



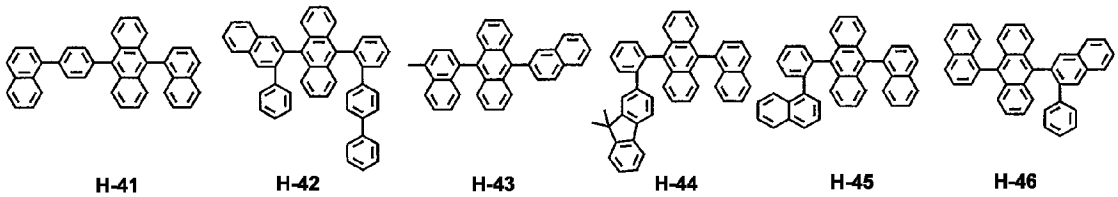
H-31 H-32 H-33 H-34 H-35

[124]



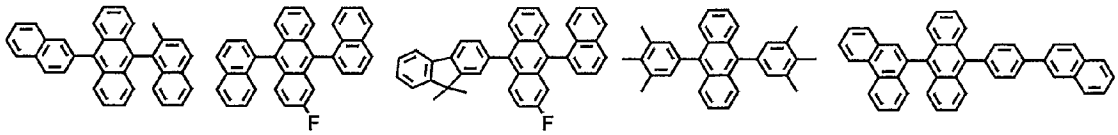
H-36 H-37 H-38 H-39 H-40

[125]



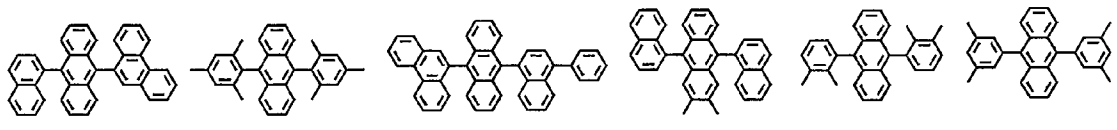
H-41 H-42 H-43 H-44 H-45 H-46

[126]



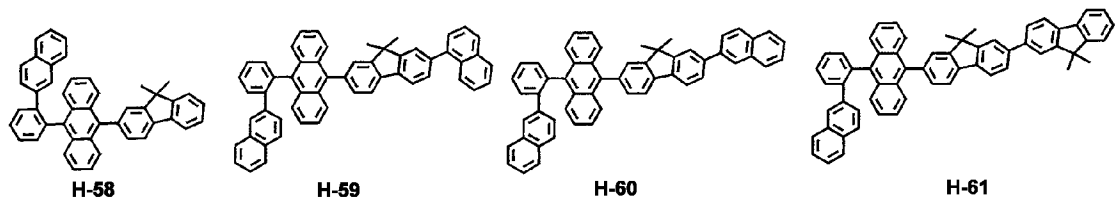
H-47 H-48 H-49 H-50 H-51

[127]



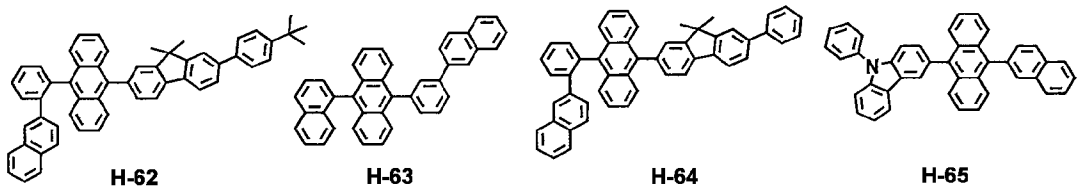
H-52 H-53 H-54 H-55 H-56 H-57

[128]

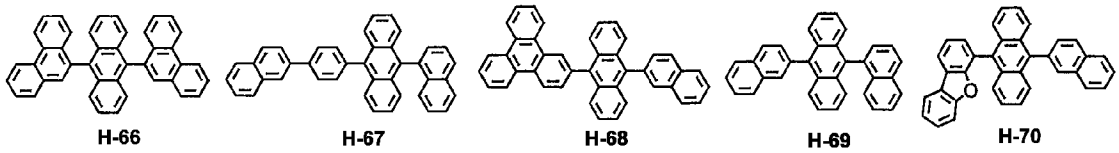


H-58 H-59 H-60 H-61

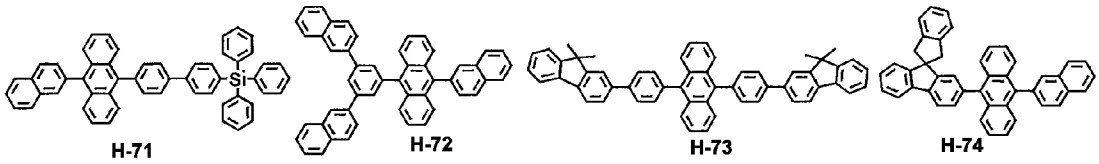
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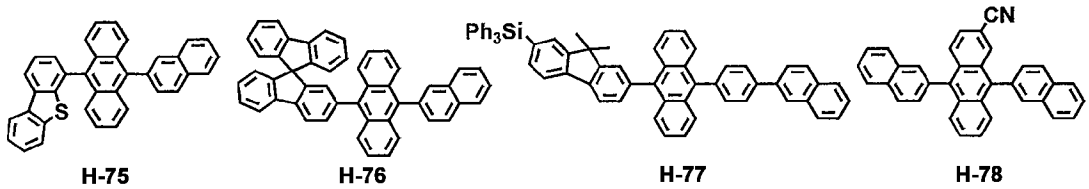
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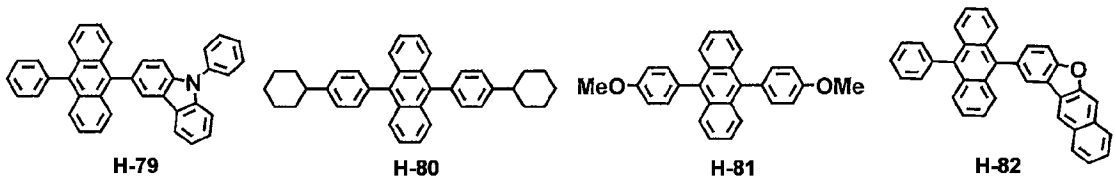
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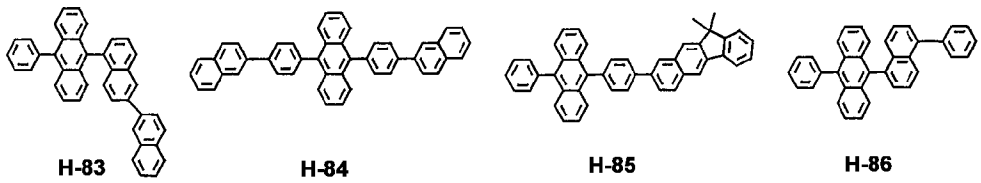
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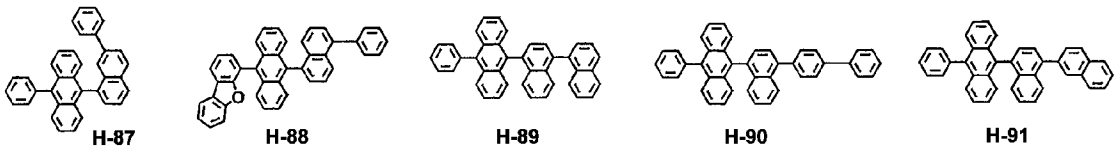
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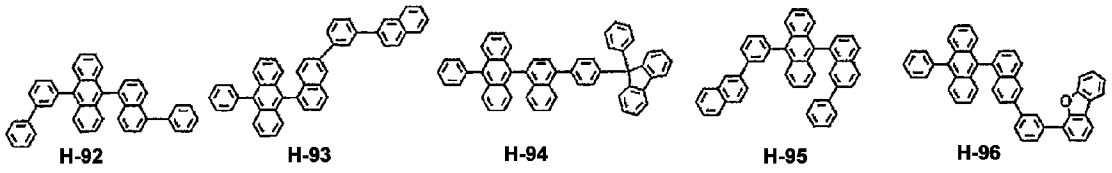
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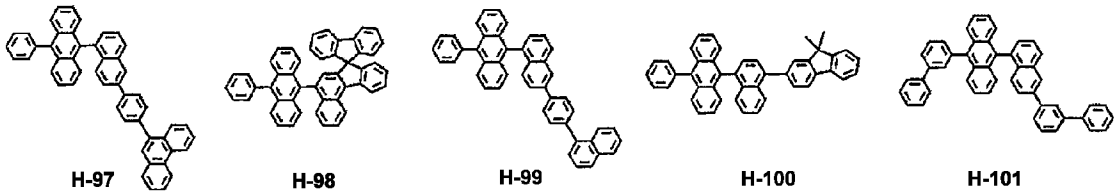
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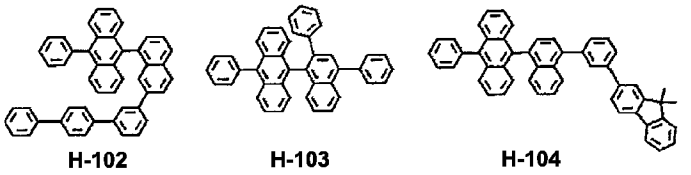


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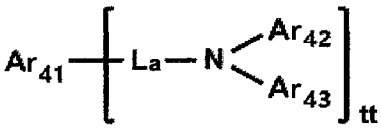


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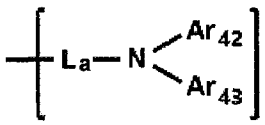


[138] 

[139] The dopant compound to be used in the present disclosure may be a phosphorescent dopant compound or a fluorescent dopant compound. Specifically, the dopant compound may be a fluorescent dopant compound, for example, may be a condensed polycyclic amine derivative represented by the following formula 21.

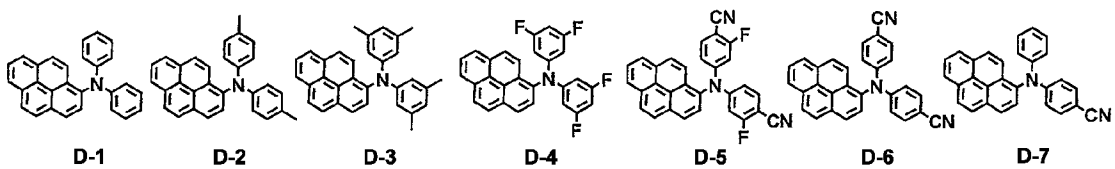
[140]  --- (21)

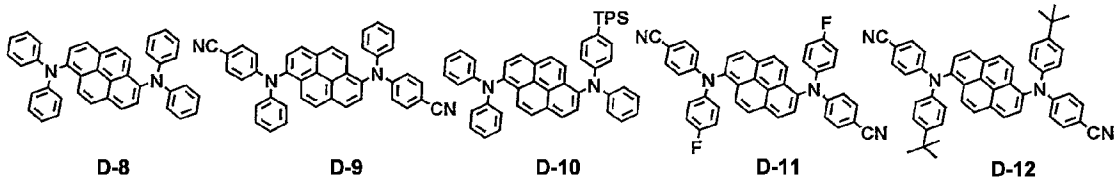
[141] In formula 21,

[142] wherein Ar_{41} represents a substituted or unsubstituted (C6-C50)aryl or styryl; L_a represents a single bond, a substituted or unsubstituted (C6-C30)arylene, or a substituted or unsubstituted (3- to 30-membered)heteroarylene; Ar_{42} and Ar_{43} each independently represent hydrogen, deuterium, halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (3- to 30-membered)heteroaryl, or may be linked to an adjacent substituent(s) to form a (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof whose carbon atom may be replaced with at least one heteroatom selected from nitrogen, oxygen, and sulfur; tt represents 1 or 2; and where tt is 2, each of  may be the same or different.

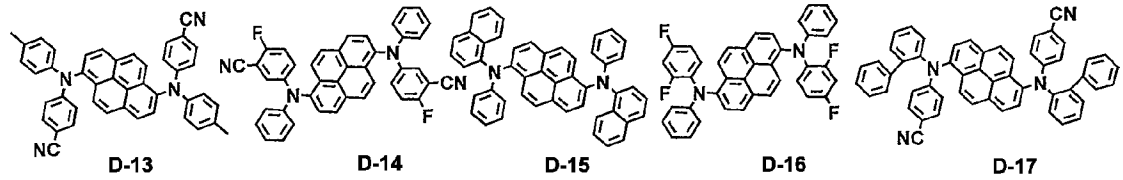
[143] A preferable aryl group for Ar_{41} includes a substituted or unsubstituted phenyl, a substituted or unsubstituted fluorenyl, a substituted or unsubstituted anthryl, a substituted or unsubstituted pyrenyl, a substituted or unsubstituted chrysenyl, a substituted or unsubstituted benzofluorenyl, and spiro[fluoren-benzofluorene], etc.

[144] The compound of formula 21 may be illustrated by the following compounds, but is not limited thereto:

[145] 

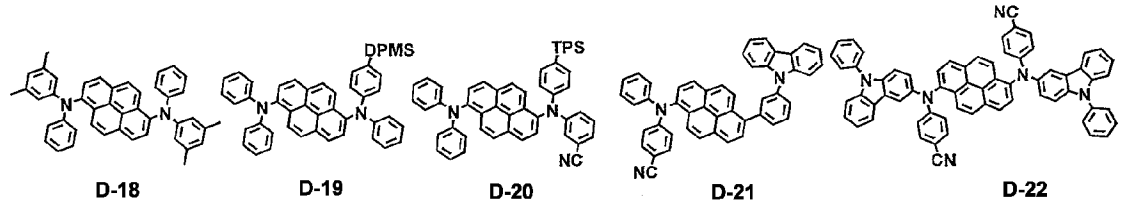
[146] 

[147]



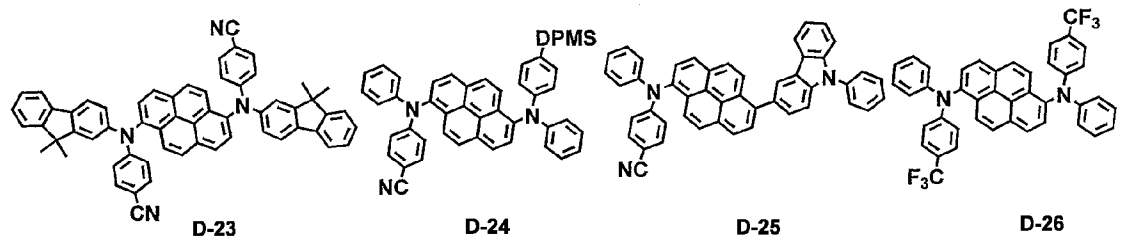
D-13 D-14 D-15 D-16 D-17

[148]



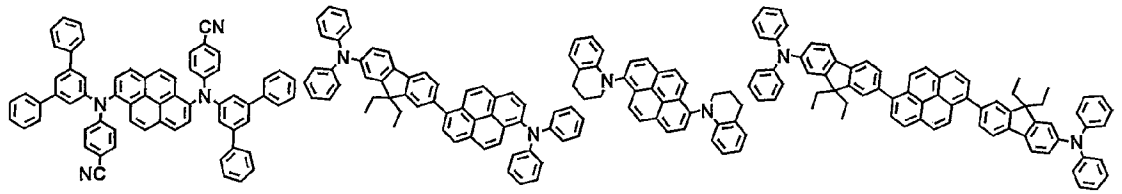
D-18 D-19 D-20 D-21 D-22

[149]



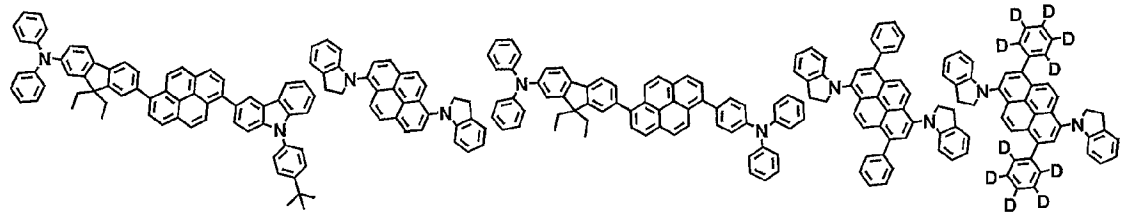
D-23 D-24 D-25 D-26

[150]



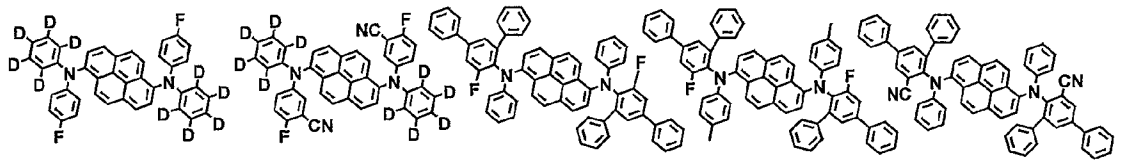
D-27 D-28 D-29 D-30

[151]



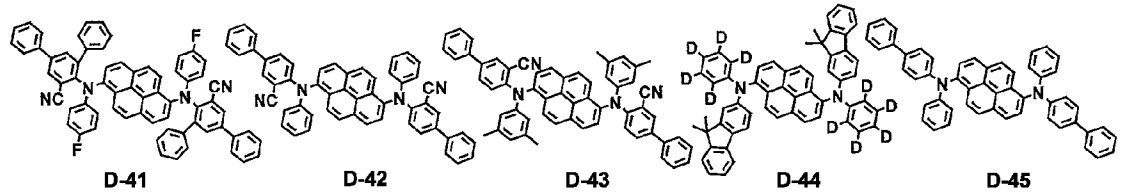
D-31 D-32 D-33 D-34 D-35

[152]



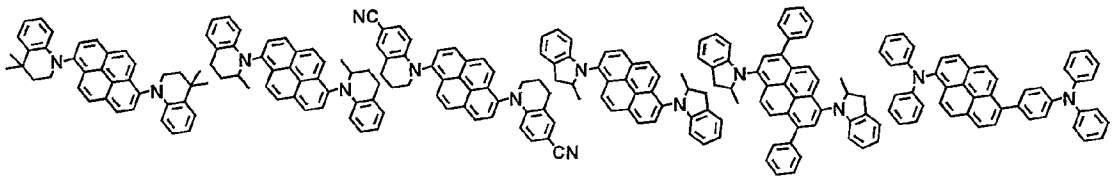
D-36 D-37 D-38 D-39 D-40

[153]



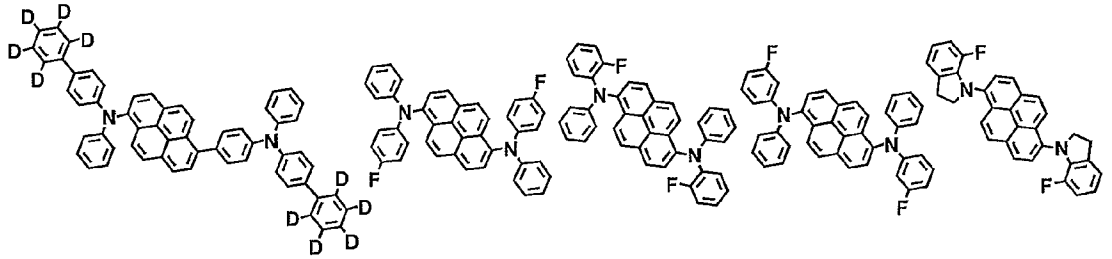
D-41 D-42 D-43 D-44 D-45

[154]



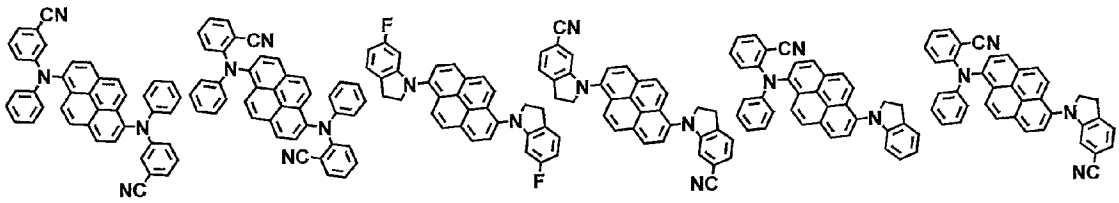
D-46 D-47 D-48 D-49 D-50 D-51

[155]



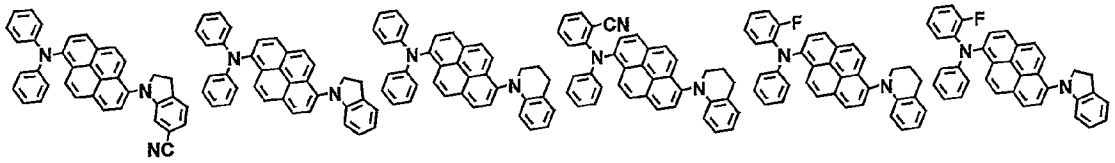
D-52 D-53 D-54 D-55 D-56

[156]



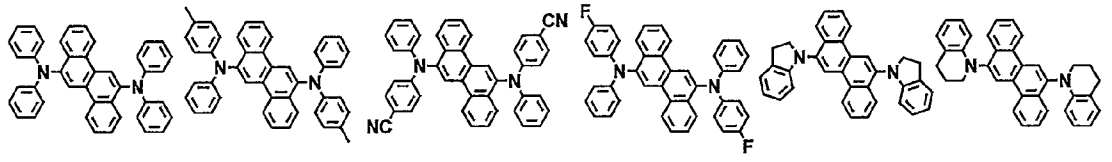
D-57 D-58 D-59 D-60 D-61 D-62

[157]



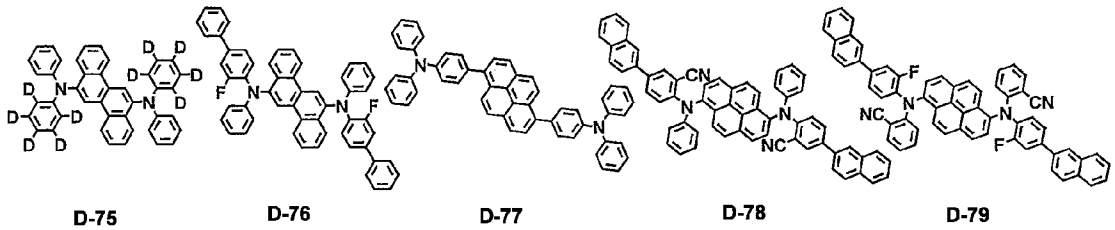
D-63 D-64 D-65 D-66 D-67 D-68

[158]



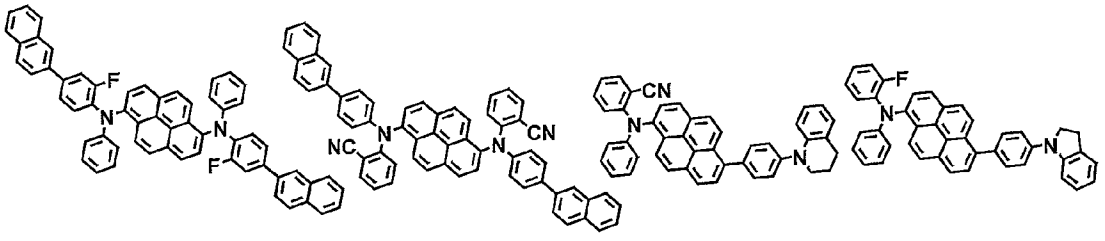
D-69 D-70 D-71 D-72 D-73 D-74

[159]



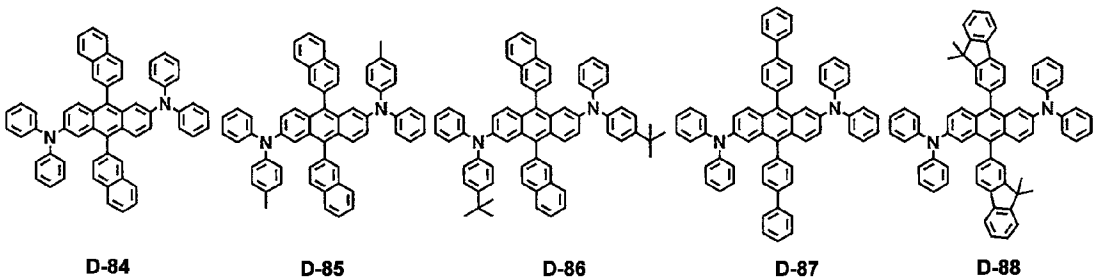
D-75 D-76 D-77 D-78 D-79

[160]



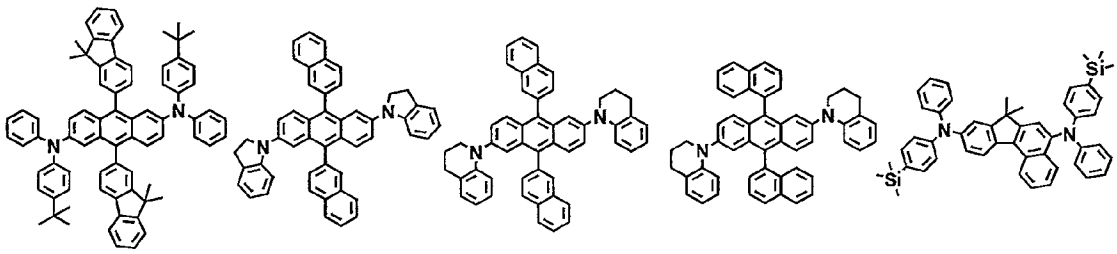
D-80 D-81 D-82 D-83

[161]



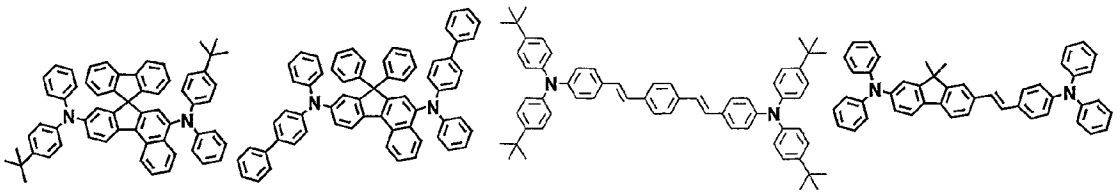
D-84 D-85 D-86 D-87 D-88

[162]



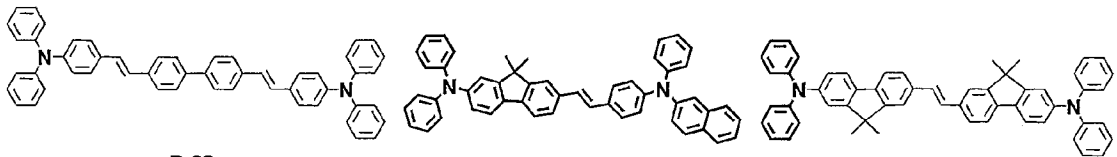
D-89 D-90 D-91 D-92 D-93

[163]



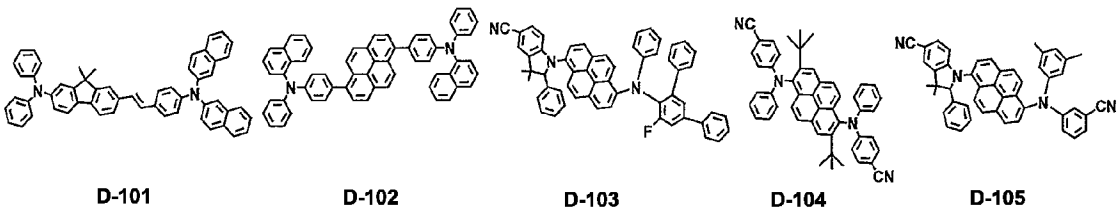
D-94 D-95 D-96 D-97

[164]



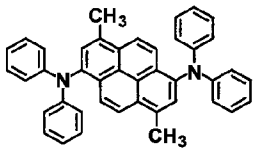
D-98 D-99 D-100

[165]



D-101 D-102 D-103 D-104 D-105

[166]



D-106

[167] The organic electroluminescent device according to the present disclosure may further comprise at least one compound selected from the group consisting of an arylamine-based compound and a styrylarylamine-based compound in the organic layer.

[168] Also, in the organic electroluminescent device of the present disclosure, the organic layer may further comprise at least one metal selected from the group consisting of

metals of Group 1, metals of Group 2, transition metals of the 4th period, transition metals of the 5th period, lanthanides, and organic metals of the d-transition elements of the Periodic Table, or at least one complex compound comprising such a metal.

[169] In addition, the organic electroluminescent device of the present disclosure further comprises at least one light-emitting layer comprising a blue, red or green light-emitting compound known in the art in addition to the compound of the present disclosure, so that it may emit white light. Further, if necessary, it may further include a yellow or orange light-emitting layer.

[170] In the organic electroluminescent device of the present disclosure, preferably, at least one layer (hereinafter, "a surface layer") selected from a chalcogenide layer, a metal halide layer, and a metal oxide layer may be placed on an inner surface(s) of one or both electrode(s). Specifically, a chalcogenide (including oxides) layer of silicon and aluminum is preferably placed on an anode surface of an electroluminescent medium layer, and a metal halide layer or a metal oxide layer is preferably placed on a cathode surface of an electroluminescent medium layer. The operation stability for the organic electroluminescent device may be obtained by the surface layer. Preferably, the chalcogenide includes $SiO_X(1\leq X\leq 2)$, $AlO_X(1\leq X\leq 1.5)$, SiON, SiAlON, etc.; the metal halide includes LiF, MgF_2, CaF_2, a rare earth metal fluoride, etc.; and the metal oxide includes Cs_2O, Li_2O, MgO, SrO, BaO, CaO, etc.

[171] A hole injection layer, a hole transport layer, an electron blocking layer, or a combination thereof can be used between the anode and the light-emitting layer. The hole injection layer may be multi-layers in order to lower the hole injection barrier (or hole injection voltage) from the anode to the hole transport layer or the electron blocking layer, wherein each of the multi-layers may use two compounds simultaneously. The hole transport layer or the electron blocking layer may also be multi-layers.

[172] An electron buffer layer, a hole blocking layer, an electron transport layer, an electron injection layer, or a combination thereof can be used between the light-emitting layer and the cathode. The electron buffer layer may be multi-layers in order to control the injection of the electron and improve the interfacial properties between the light-emitting layer and the electron injection layer, wherein each of the multi-layers may use two compounds simultaneously. The hole blocking layer or the electron transport layer may also be multi-layers, wherein each layer may use a plurality of compounds.

[173] The light-emitting auxiliary layer may be placed between the anode and the light-emitting layer, or between the cathode and the light-emitting layer. When the light-emitting auxiliary layer is placed between the anode and the light-emitting layer, it can be used for promoting the hole injection and/or the hole transport, or for preventing the overflow of electrons. When the light-emitting auxiliary layer is placed between the

cathode and the light-emitting layer, it can be used for promoting the electron injection and/or the electron transport, or for preventing the overflow of holes.

[174] In addition, the hole auxiliary layer may be placed between the hole transport layer (or hole injection layer) and the light-emitting layer, and may be effective to promote or block the hole transport rate (or the hole injection rate), thereby enabling the charge balance to be controlled. Also, the electron blocking layer may be placed between the hole transport layer (or hole injection layer) and the light-emitting layer, and can confine the excitons within the light-emitting layer by blocking the overflow of electrons from the light-emitting layer to prevent a light-emitting leakage. When an organic electroluminescent device includes two or more hole transport layers, the hole transport layer, which is further included, may be used as the hole auxiliary layer or the electron blocking layer. The hole auxiliary layer and the electron blocking layer may have an effect of improving the efficiency and/or the lifespan of the organic electroluminescent device.

[175] In addition, in the organic electroluminescent device of the present disclosure, a mixed region of an electron transport compound and a reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant may be placed on at least one surface of a pair of electrodes. In this case, the electron transport compound is reduced to an anion, and thus it becomes easier to inject and transport electrons from the mixed region to an electroluminescent medium. Furthermore, the hole transport compound is oxidized to a cation, and thus it becomes easier to inject and transport holes from the mixed region to the electroluminescent medium. Preferably, the oxidative dopant includes various Lewis acids and acceptor compounds, and the reductive dopant includes alkali metals, alkali metal compounds, alkaline earth metals, rare-earth metals, and mixtures thereof. Also, a reductive dopant layer may be employed as a charge generating layer to produce an organic electroluminescent device having two or more light-emitting layers and emitting white light.

[176] Forming each layer of the organic electroluminescent device of the present disclosure can apply one method of dry film-forming methods such as vacuum evaporation, sputtering, plasma, ion plating methods, etc., or wet film-forming methods such as spin coating, dip coating, flow coating methods, etc. The dopant compound and the host compound of the present disclosure may be film-formed by a co-evaporation process or a mixture-evaporation process.

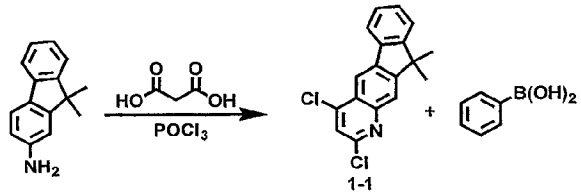
[177] When using a wet film-forming method, a thin film can be formed by dissolving or diffusing materials forming each layer into any suitable solvent such as ethanol, chloroform, tetrahydrofuran, dioxane, etc. The solvent can be any solvent where the materials forming each layer can be dissolved or diffused, and where there are no problems in film-formation capability.

[178] Also, the organic electroluminescent device of the present disclosure can be used for the manufacture of display devices such as smart phones, tablets, notebooks, PCs, TVs, or display devices for vehicles, or lighting devices such as an outdoor or indoor lighting.

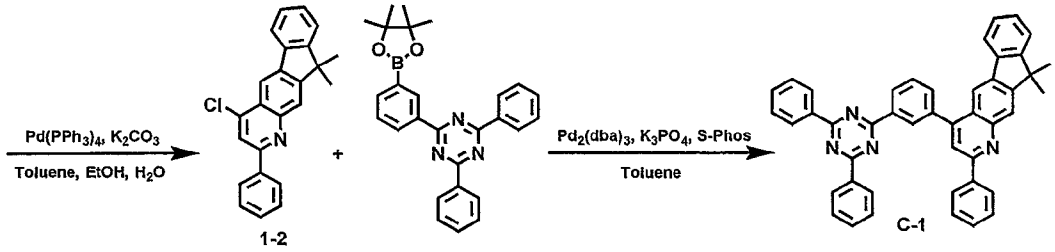
[179] Hereinafter, the preparation method of an organic electroluminescent compound according to the present disclosure, and the properties thereof will be explained in detail with reference to the representative compounds of the present disclosure in order to understand the present disclosure in detail. However, the present disclosure is not limited by the following examples.

[180] **Example 1: Preparation of compound C-1**

[181]



[182]



[183] Preparation of compound 1-1

[184] Malonic acid (75 g, 716.71 mmol) and $POCl_3$ (713 mL, 7.64 mol) were added into a round bottom flask (RBF) of 500 mL and stirred for 10 minutes. 9,9-dimethyl-9H-fluoren-2-amine (100 g, 478 mmol) was slowly added to the reaction mixture and refluxed at 150°C for 2 hours and then cooled to room temperature. The reaction mixture was slowly added to ice water and the resulting solid was filtered. The filtered solid was dissolved in $CHCl_3$ and the organic layer was separated and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound 1-1 (74 g, 49%).

[185] Preparation of compound 1-2

[186] Compound 1-1 (10 g, 32 mmol), phenylboronic acid (2.70 g, 35 mmol), $Pd(PPh_3)_4$ (2.21 g, 2.0 mmol), K_2CO_3 (13.20 g, 95 mmol), toluene (133 mL, 0.24 M), EtOH (48 mL), and water (48 mL, 2 M) were added to RBF of 500 mL and refluxed. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with dichloromethane and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound 1-2 (8.0 g, 71%).

[187] Preparation of compound C-1

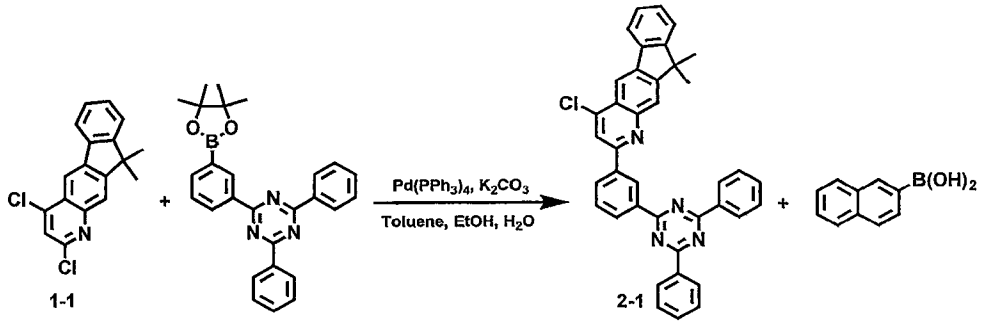
[188] Compound 1-2 (8.0 g, 22.0 mmol), 2,4-diphenyl-6-(3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)-1,3,5-triazine (19.57 g, 45.0 mmol), K_3PO_4 (23.38 g, 110 mmol), 2-dicyclohexylphosphino-2',6'-dimethoxybiphenyl (s-phos) (0.74 g, 2.0 mmol), and toluene (173 mL, 0.13 M) were added to RBF of 500 mL and stirred at 140°C for 30 minutes. $Pd_2(dba)_3$ (0.823 g, 2.0 mmol) was then added to the reaction mixture, followed by reflux for 3 hours. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with ethyl acetate and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound C-1 (5.1 g, 36%).

[189]

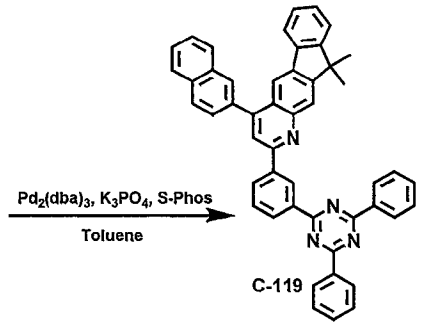
	MW	UV	PL	M.P.
C-1	628.78	280 nm	403 nm	305°C

[190] **Example 2: Preparation of compound C-119**

[191]



[192]



[193] Preparation of compound 2-1

[194] Compound 1-1 (5 g, 16 mmol), 2,4-diphenyl-6-(3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)-1,3,5-triazine (7.62 g, 18 mmol), $Pd(PPh_3)_4$ (1.10 g, 0.96 mmol), K_2CO_3 (6.60 g, 48 mmol), toluene (70 mL, 0.23 M), EtOH (24 mL), and water (24 mL, 2 M) were added to RBF of 500 mL and refluxed. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with dichloromethane and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound 2-1 (8.0 g, 85%).

[195] Preparation of compound C-119

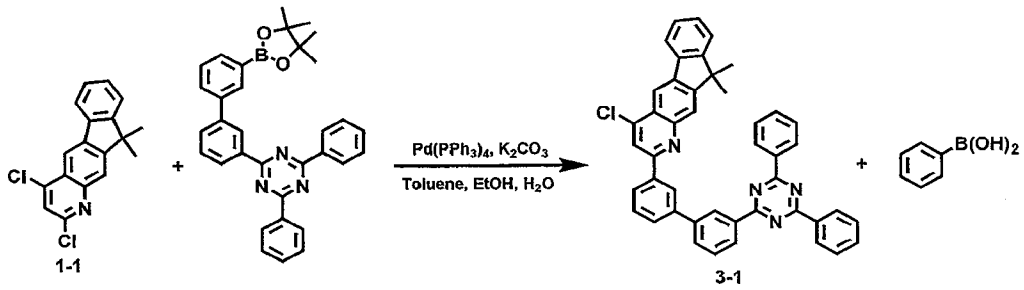
[196] Compound 2-1 (7.5 g, 13.0 mmol), 2-naphthylboronic acid (3.25 g, 26 mmol), K_3PO_4 (13.29 g, 63 mmol), s-phos (0.42 g, 1.0 mmol), and toluene (100 mL, 0.13 M) were added into RBF of 500 mL, and the reaction mixture was stirred at 140°C for 30 minutes. $Pd_2(dba)_3$ (0.468 g, 0.511 mmol) was then added thereto, followed by refluxing for 3 hours. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with ethyl acetate and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound C-119 (7.5 g, 86%).

[197]

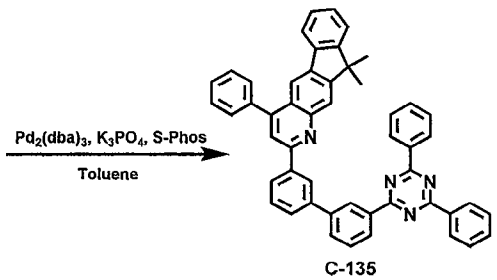
	MW	UV	PL	M.P.
C-119	678.84	282 nm	407 nm	230°C

[198] **Example 3: Preparation of compound C-135**

[199]



[200]



[201] Preparation of compound 3-1

[202] Compound 1-1 (4 g, 13 mmol), 2,4-diphenyl-6-(3'-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-[1,1'-biphenyl]-3-yl)-1,3,5-triazine (7.16 g, 14 mmol), $Pd(PPh_3)_4$ (0.883 g, 0.764 mmol), K_2CO_3 (5.28 g, 38 mmol), toluene (60 mL, 0.21 M), EtOH (20 mL), and water (19 mL, 2 M) were added to RBF of 250 mL and refluxed. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with dichloromethane and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound 3-1 (5.5 g, 64%).

[203] Preparation of compound C-135

[204] Compound 3-1 (2.5 g, 4.0 mmol), phenylboronic acid (0.919 g, 8.0 mmol), K_3PO_4 (3.921 g, 18 mmol), s-phos (0.124 g, 0.302 mmol), and toluene (30 mL, 0.126 M) were

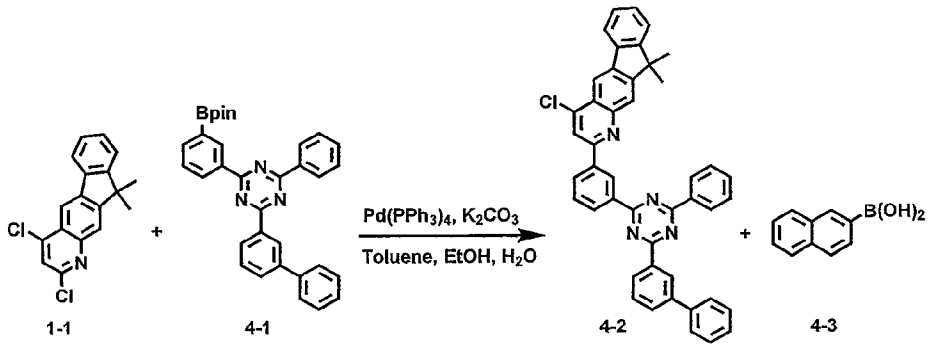
added to RBF of 100 mL, and the reaction mixture was stirred at 140°C for 30 minutes. $Pd_2(dba)_3$ (0.138 g, 0.151 mmol) was then added thereto, followed by refluxing for 3 hours. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with ethyl acetate and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound C-135 (1.5 g, 56%).

[205]

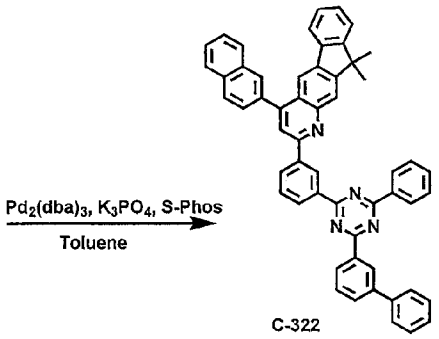
	MW	UV	PL	M.P.
C-135	704.86	282 nm	399 nm	292°C

[206] **Example 4: Preparation of compound C-322**

[207]



[208]



[209] Preparation of compound 4-2

[210] Compound 1-1 (4.6 g, 14.37 mmol), compound 4-1 (8.2 g, 16.03 mmol), $Pd(PPh_3)_4$ (1.0 g, 0.87 mmol), K_2CO_3 (6.0 g, 43.71 mmol), toluene (70 mL, 0.23 M), EtOH (22 mL), and water (22 mL, 2 M) were added to RBF of 250 mL and refluxed. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with dichloromethane and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound 4-2 (8.2 g, 86%).

[211] Preparation of compound C-322

[212] Compound 4-2 (8.0 g, 12.06 mmol), compound 4-3 (4.1 g, 24.12 mmol), K_3PO_4 (12.54 g, 59.1 mmol), s-phos (0.4 g, 0.96 mmol), and toluene (142 mL, 0.0852 M) were added to RBF of 250 mL, and the reaction mixture was stirred at 140°C for 30 minutes. $Pd_2(dba)_3$ (0.44 g, 0.48 mmol) was then added thereto, followed by refluxing

for 3 hours. After completion of the reaction, the reaction mixture was cooled to room temperature and then was extracted with ethyl acetate and treated with $MgSO_4$. Thereafter, the reaction mixture was purified by column chromatography to obtain compound C-322 (7.5 g, 82%).

[213]

	MW	M.P.
C-322	754.94 g/mol	283°C

[214] **[Comparative Example 1] Producing a blue light-emitting organic**

[215] **electroluminescent device not according to the present disclosure**

[216] An OLED device was produced not according to the present disclosure. First, a transparent electrode ITO thin film (10 Ω/sq) on a glass substrate for an OLED (GEOMATEC CO., LTD.) was subjected to an ultrasonic washing with acetone and isopropyl alcohol, sequentially, and then was stored in isopropanol. Next, the ITO substrate was mounted on a substrate holder of a vacuum vapor deposition apparatus. Compound **HI-1** was introduced into a cell of the vacuum vapor deposition apparatus, and the pressure in the chamber of the apparatus was then controlled to 10^{-7} torr. Thereafter, an electric current was applied to the cell to evaporate the introduced material, thereby forming a first hole injection layer having a thickness of 60 nm on the ITO substrate. Compound **HI-2** was then introduced into another cell of the vacuum vapor deposition apparatus, and an electric current was applied to the cell to evaporate the introduced material, thereby forming a second hole injection layer having a thickness of 5 nm on the first hole injection layer. Compound **HT-1** was introduced into another cell of the vacuum vapor deposition apparatus. Thereafter, an electric current was applied to the cell to evaporate the introduced material, thereby forming a first hole transport layer having a thickness of 20 nm on the second hole injection layer. Compound **HT-2** was then introduced into another cell of the vacuum vapor deposition apparatus, and an electric current was applied to the cell to evaporate the introduced material, thereby forming a second hole transport layer having a thickness of 5 nm on the first hole transport layer. After forming the hole injection layers and the hole transport layers, a light-emitting layer was then deposited as follows. Compound **H-15** as a host was introduced into one cell of the vacuum vapor deposition apparatus and compound **D-38** as a dopant was introduced into another cell of the apparatus. The two materials were evaporated at a different rate and the dopant was deposited in a doping amount of 2 wt%, based on the total weight of the host and dopant, to form a light-emitting layer having a thickness of 20 nm on the second hole transport layer. Next, compound **ET-1** as an electron transport material was introduced into one cell and compound **EI-1** was introduced into another cell were evaporated in a weight ratio of 1:1 and deposited to form an electron transport layer having a thickness of 35 nm.

After depositing compound **EI-1** as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 80 nm was deposited by another vacuum vapor deposition apparatus on the electron injection layer. Thus, an OLED device was produced. For each of the materials, each of the compounds was used by purifying by vacuum sublimation at 10^{-6} torr.

[217] The results of the driving voltage, the luminous efficiency, and the CIE color co-ordinates of the organic electroluminescent device produced as described above at a luminance of 1,000 nits are shown in the following Table 1.

[218] **[Comparative Example 2] Producing a blue light-emitting organic**

[219] **electroluminescent device not according to the present disclosure**

[220] In Comparative Example 2, an OLED device was produced in the same manner as in Comparative Example 1, except that the thickness of the electron transport layer was reduced to 25 nm and the compound of the following Table 1 was inserted as an electron buffer layer having a thickness of 5 nm between the light-emitting layer and the electron transport layer. The evaluation results of the organic electroluminescent devices produced in Comparative Example 2 are shown in Table 1 below.

[221] **[Device Examples 1 to 3] Producing a blue light-emitting organic**

[222] **electroluminescent device comprising the compound of the present**

[223] **disclosure as an electron buffer material**

[224] In Device Examples 1 to 3, an OLED device was produced in the same manner as in Comparative Example 1, except that the thickness of the electron transport layer was reduced to 25 nm and the compound of the following Table 1 was inserted as an electron buffer layer having a thickness of 5 nm between the light-emitting layer and the electron transport layer. The evaluation results of the organic electroluminescent devices produced in Device Examples 1 to 3 are shown in Table 1 below.

[225] **Table 1**

	Electron Buffer Material	Driving Voltage (V)	Luminous Efficiency (cd/A)	Color Coordinates	
				(x)	(y)
Comparative Example 1	-	4.4	6.5	0.139	0.096
Comparative Example 2	Compound X	5.0	5.7	0.139	0.095
Device Example 1	C-119	4.2	7.1	0.139	0.095
Device Example 2	C-1	4.2	7.2	0.139	0.093
Device Example 3	C-135	4.1	7.2	0.139	0.093

[226] It was confirmed that the organic electroluminescent device including the present compound as an electron buffer material is excellent in terms of driving voltage and/or luminous efficiency while maintaining the same level of color coordinates compared with the organic electroluminescent device not including an electron buffer material or including a conventional material as an electron buffer material.

[227] **[Comparative Examples 3 and 4] Producing a blue light-emitting organic**

[228] **electroluminescent device not according to the present disclosure**

[229] In Comparative Examples 3 and 4, an OLED device was produced in the same manner as in Comparative Example 1, except that the electron transport material was changed to the compound of the following Table 2. The evaluation results of the organic electroluminescent devices produced in Comparative Examples 3 and 4 are shown in Table 2 below.

[230] **[Device Examples 4 to 7] Producing a blue light-emitting organic**

[231] **electroluminescent device comprising the compound of the present**

[232] **disclosure as an electron transport material**

[233] In Device Examples 4 to 7, an OLED device was produced in the same manner as in Comparative Example 1, except that the electron transport material was changed to the compound of the following Table 2. The evaluation results of the organic electroluminescent devices produced in Device Examples 4 to 7 are shown in Table 2 below.

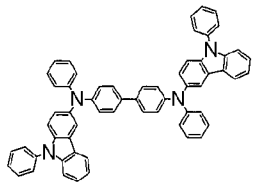
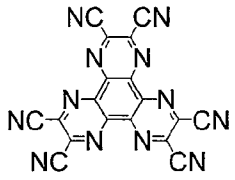
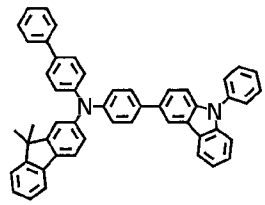
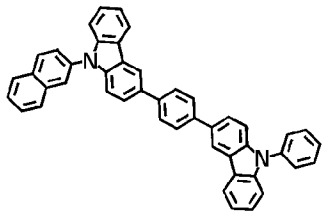
[234] **Table 2**

	Electron Transport Material	Driving Voltage (V)	Luminous Efficiency (cd/A)	Color Coordinates	
				(x)	(y)
Comparative Example 3	Compound X	4.3	4.8	0.139	0.088
Comparative Example 4	Compound Y	4.4	4.5	0.139	0.086
Device Example 4	C-119	3.8	6.2	0.139	0.088
Device Example 5	C-1	3.8	5.9	0.139	0.086
Device Example 6	C-135	4.1	6.8	0.139	0.088
Device Example 7	C-322	3.9	6.8	0.139	0.091

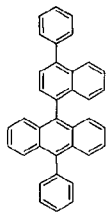
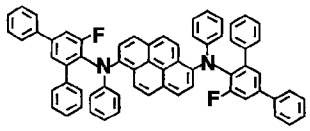
[235] It was confirmed that the organic electroluminescent device including the present compound as an electron transport material is excellent in terms of driving voltage and/or luminous efficiency while maintaining the same level of color coordinates compared with the organic electroluminescent device including a conventional

material as an electron transport material.

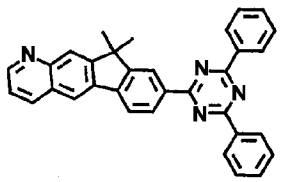
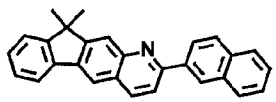
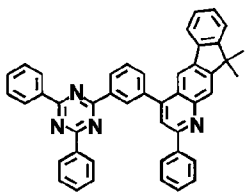
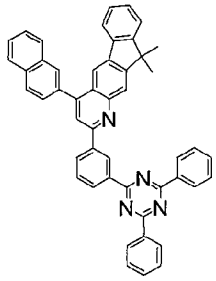
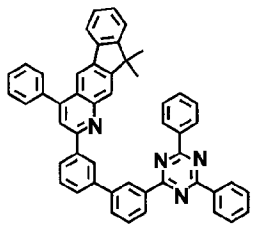
[236] **Table 3.** The compounds used in the Device Examples and Comparative Examples

Hole Injection Layer / Hole Transport Layer	 **HI-1**  **HI-2**  **HT-1**  **HT-2**

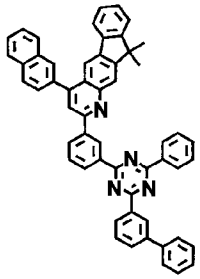
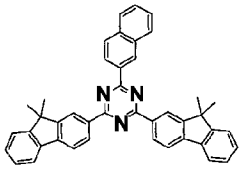
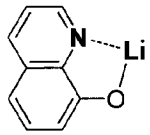
[237]

Light-Emitting Layer	 **H-15**  **D-38**

[238]

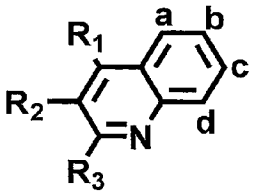
Electron Buffer Layer / Electron Transport Layer / Electron Injection Layer	 **Compound X**  **Compound Y**  **C-1**  **C-119**  **C-135**

[239]

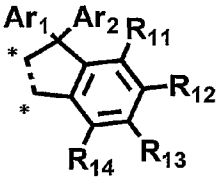
Electron Buffer Layer / Electron Transport Layer / Electron Injection Layer	 C-322  ET-1  EI-1

Claims

[Claim 1] An organic electroluminescent compound represented by the following formula 1:



--- (1)



--- (2)

wherein,

R_1 to R_3 each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl, provided that at least two of R_1 to R_3 each independently represent a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, or a substituted or unsubstituted (5- to 30-membered)heteroaryl;

a and b, or b and c, or c and d of formula 1 are combined with * of formula 2 to form a ring, wherein B_1 and B_2 are bonded at the positions not bonded to * of formula 2 among a to d, regardless of the sequence;

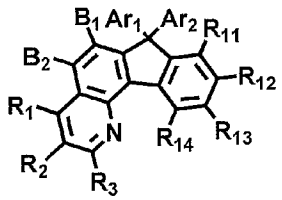
B_1 and B_2 each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, a substituted or unsubstituted (C1-C30)alkyldi(C6-C30)arylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted mono- or di-(C1-C30)alkylamino, a substituted or unsubstituted mono- or di-(C6-C30)arylamino, or a substituted or unsubstituted (C1-C30)alkyl(C6-C30)arylamino;

Ar_1 and Ar_2 each independently represent halogen, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl,

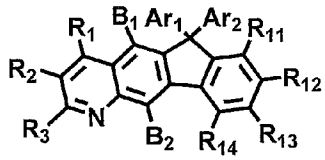
or a substituted or unsubstituted (5- to 30-membered)heteroaryl; or may be linked to an adjacent substituent to form a substituted or unsubstituted (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof; and

R_{11} to R_{14} each independently represent hydrogen, deuterium, halogen, cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C6-C30)aryl, a substituted or unsubstituted (5- to 30-membered)heteroaryl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C1-C30)alkoxy, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, a substituted or unsubstituted (C1-C30)alkyldi(C6-C30)arylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted mono- or di-(C1-C30)alkylamino, a substituted or unsubstituted mono- or di-(C6-C30)arylamino, or a substituted or unsubstituted (C1-C30)alkyl(C6-C30)arylamino; or may be linked to an adjacent substituent to form a substituted or unsubstituted (3- to 30-membered) mono- or polycyclic, alicyclic or aromatic ring, or a combination thereof.

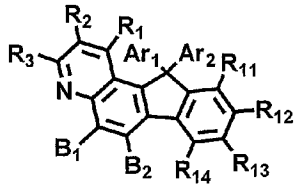
[Claim 2] The organic electroluminescent compound according to claim 1, wherein the formula 1 is represented by any one of the following formulae 3 to 8:



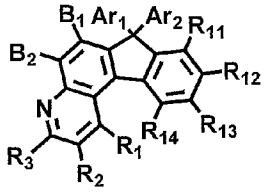
---(3)



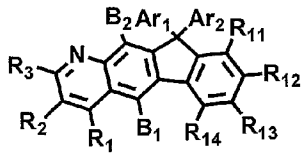
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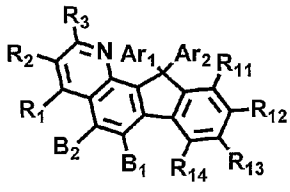
---(5)



---(6)



---(7)



---(8)

wherein,

R_1 to R_3, B_1, B_2, Ar_1, Ar_2, and R_{11} to R_{14} are as defined in claim 1.

[Claim 3] The organic electroluminescent compound according to claim 1, wherein the substituents of the substituted alkyl, the substituted aryl, the substituted heteroaryl, the substituted cycloalkyl, the substituted alkoxy, the substituted trialkylsilyl, the substituted dialkyaryllsilyl, the substituted alkyldiarylsilyl, the substituted arylsilyl, the substituted mono- or di- alkylamino, the substituted mono- or di- arylamino, the substituted alkylarylamino, and the substituted mono- or polycyclic, alicyclic, aromatic ring, or the combination thereof, in R_1 to R_3, B_1, B_2, Ar_1, Ar_2, and R_{11} to R_{14}, are each independently at least one selected from the group consisting of deuterium; halogen; cyano; carboxyl; nitro; hydroxyl; (C1-C30)alkyl; halo(C1-C30)alkyl; (C2-C30)alkenyl; (C2-C30)alkynyl; (C1-C30)alkoxy; (C1-C30)alkylthio; (C3-C30)cycloalkyl; (C3-C30)cycloalkenyl; (3- to 7-membered)heterocycloalkyl; (C6-C30)aryloxy; (C6-C30)arylthio; (C6-C30)aryl-substituted or unsubstituted (5- to 30-membered)heteroaryl; (5- to 30-membered)heteroaryl- substituted or unsubstituted (C6-C30)aryl; tri(C1-C30)alkylsilyl; tri(C6-C30)arylsilyl; di(C1-C30)alkyl(C6-C30)arylsilyl; (C1-C30)alkyldi(C6-C30)arylsilyl; amino; a mono- or di-(C1-C30)alkylamino; (C1-C30)alkyl-substituted or unsubstituted mono- or di- (C6-C30)arylamino; (C1-C30)alkyl(C6-C30)arylamino; (C1-C30)alkylcarbonyl; (C1-C30)alkoxycarbonyl; (C6-C30)arylcarbonyl; di(C6-C30)arylboronyl, di(C1-C30)alkylboronyl, (C1-C30)alkyl(C6-C30)arylboronyl; (C6-C30)ar(C1-C30)alkyl; and (C1-C30)alkyl(C6-C30)aryl.

[Claim 4] The organic electroluminescent compound according to claim 1, wherein, R_1 and R_3 each independently represent a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted (5- to 20-membered)heteroaryl;

R_2 represents hydrogen;

B_1 and B_2 represent hydrogen;

Ar_1 and Ar_2 each independently represent a substituted or unsubstituted (C1-C6)alkyl, or a substituted or unsubstituted (C6-C12)aryl, or may be linked to an adjacent substituent to form a substituted or unsubstituted (5- to 15-membered) polycyclic, alicyclic, or aromatic ring, or a combination thereof; and

R_{11} to R_{14} each independently represent hydrogen or a substituted or unsubstituted (C6-C12)aryl.

[Claim 5] The organic electroluminescent compound according to claim 1, wherein, R_1 and R_3 each independently represent a substituted or unsubstituted (C6-C20)aryl, or a substituted or unsubstituted (5- to 20-membered)heteroaryl, wherein the substituents of the substituted aryl are each independently (C6-C15)aryl-substituted or unsubstituted (5- to 25-membered)heteroaryl, and wherein the substituents of the substituted heteroaryl are each independently (C6-C15)aryl;

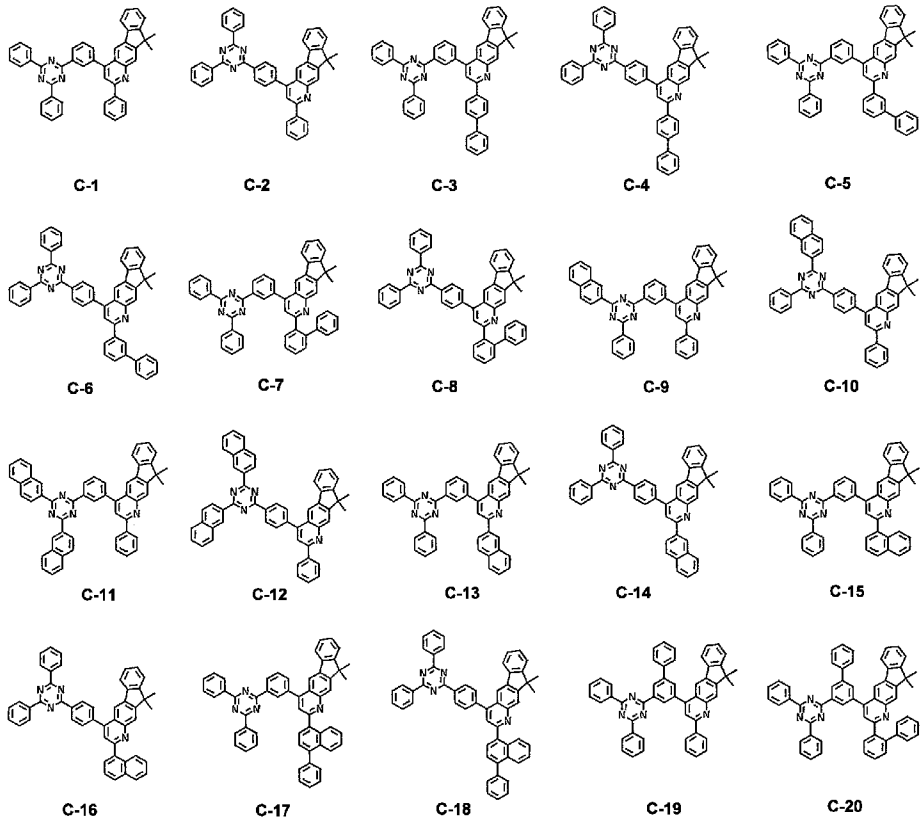
R_2 represents hydrogen;

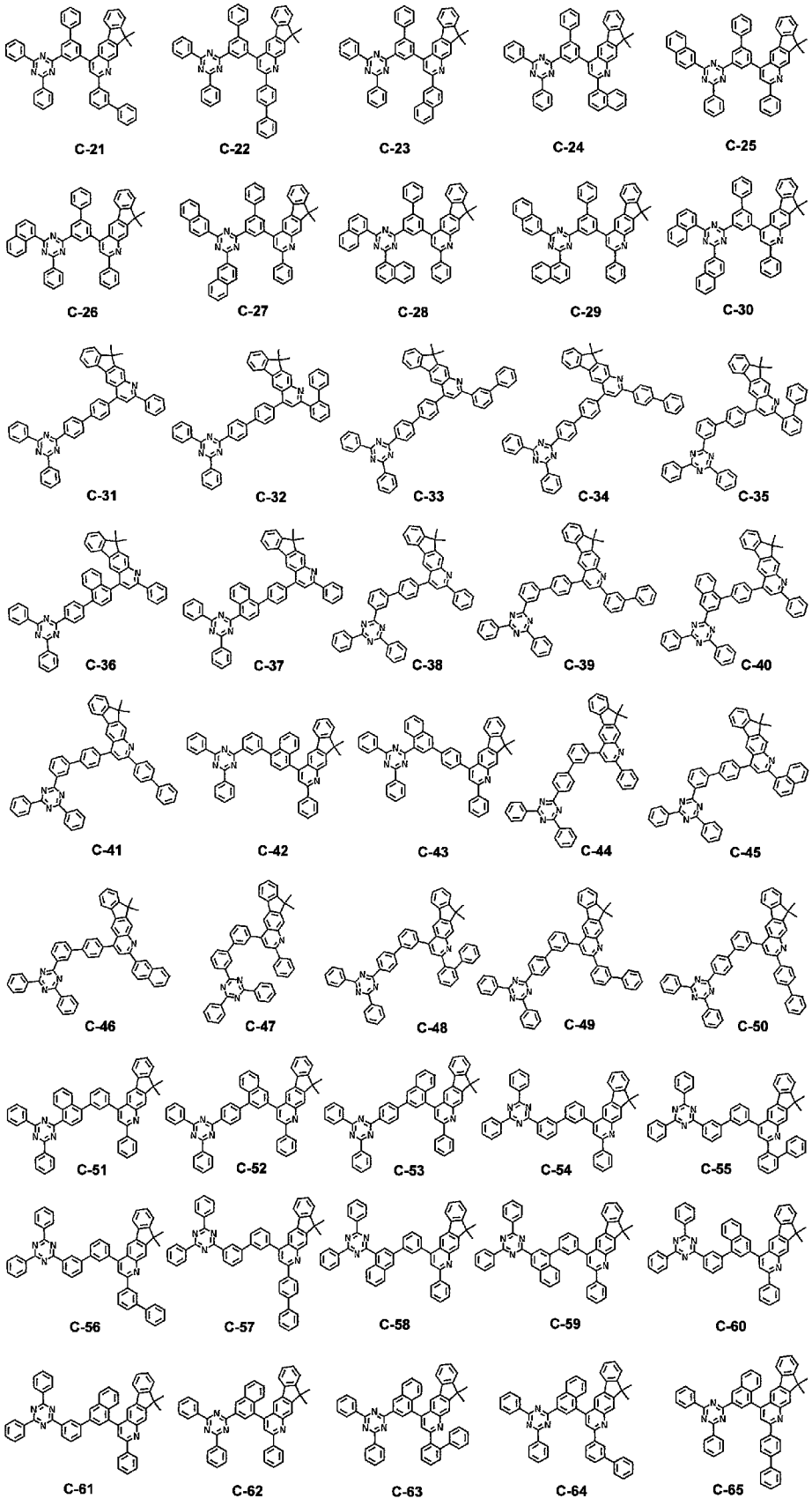
B_1 and B_2 represent hydrogen;

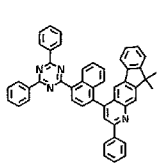
Ar_1 and Ar_2 each independently represent an unsubstituted (C1-C6)alkyl, or an unsubstituted (C6-C12)aryl; or may be linked to an adjacent substituent to form an unsubstituted (5- to 15-membered) polycyclic aromatic ring; and

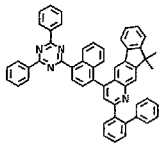
R_{11} to R_{14} each independently represent halogen or an unsubstituted (C6-C12)aryl.

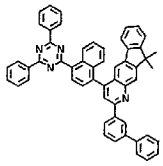
[Claim 6] The organic electroluminescent compound according to claim 1, wherein the compound represented by formula 1 is selected from the group consisting of:

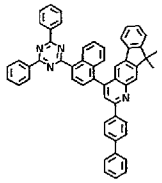


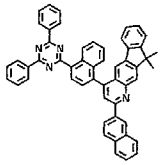

C-21
C-22
C-23
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C-34
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C-36
C-37
C-38
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C-41
C-42
C-43
C-44
C-45
C-46
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C-63
C-64
C-65

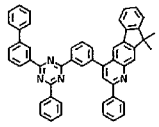

C-66

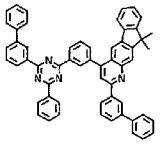

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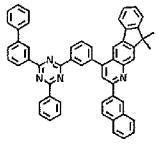

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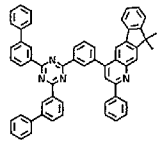

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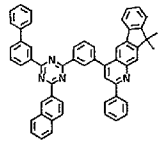

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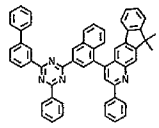

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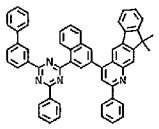

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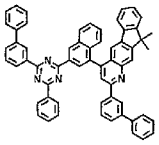

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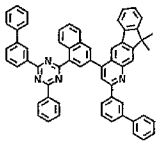

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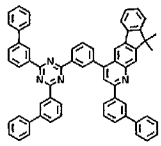

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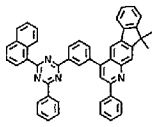

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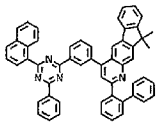

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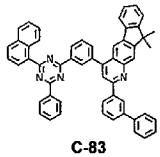

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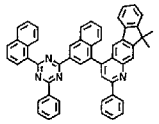

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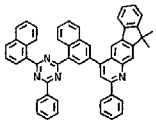

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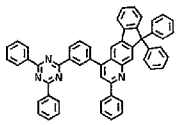

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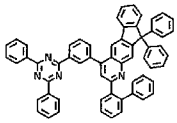

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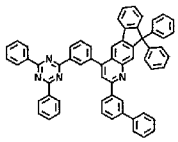

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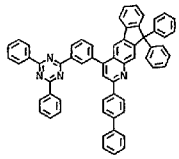

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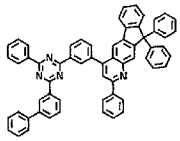

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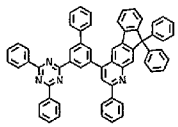

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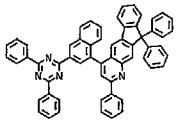

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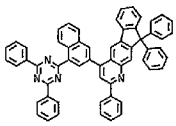

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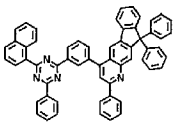

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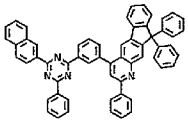

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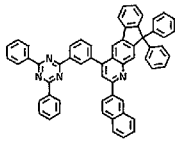

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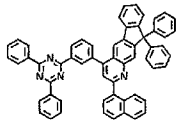

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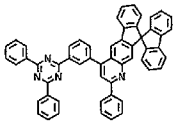

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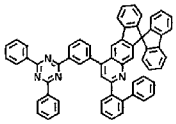

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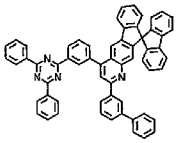

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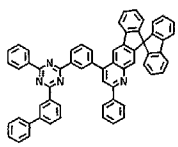

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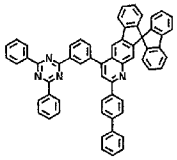

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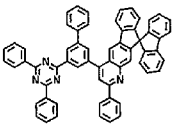

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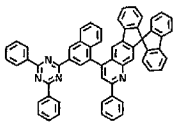

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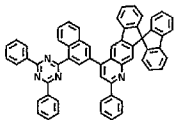

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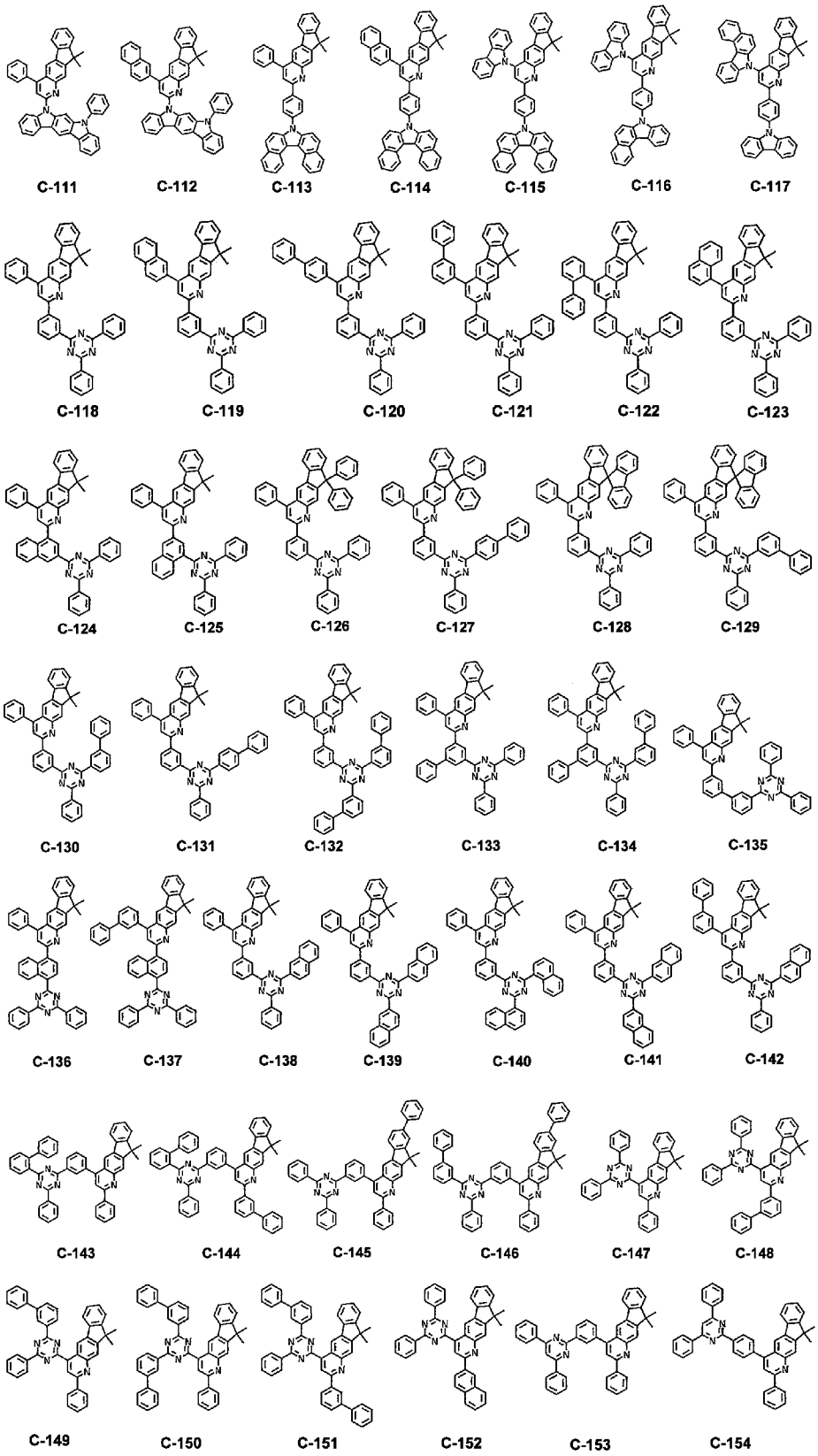
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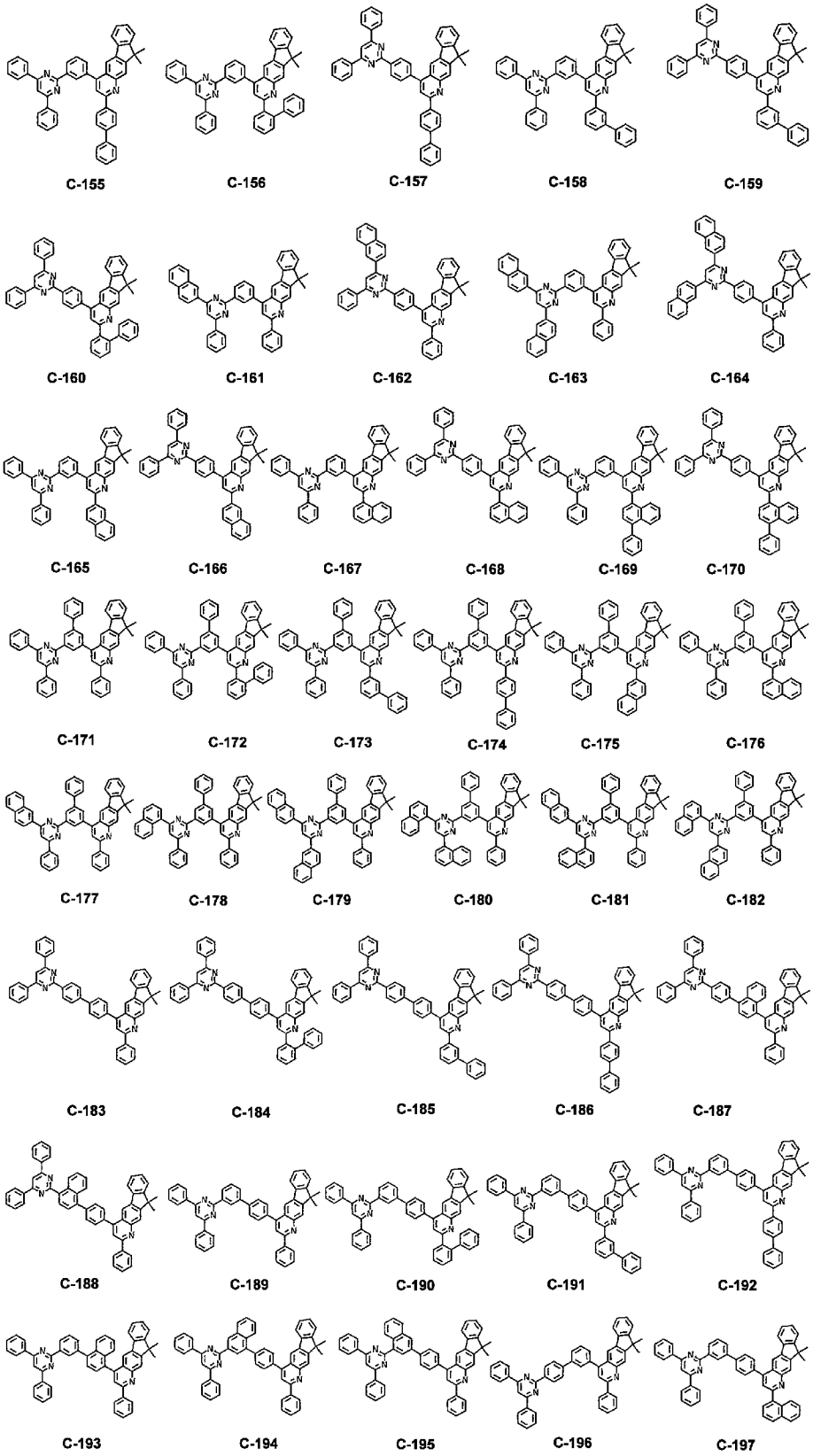
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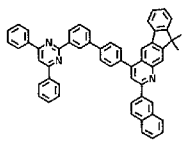
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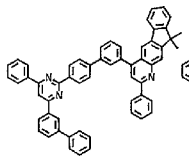
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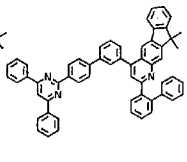
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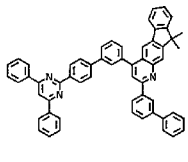

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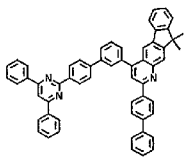

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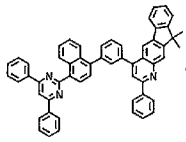

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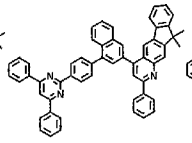

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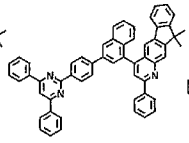

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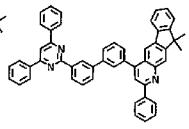

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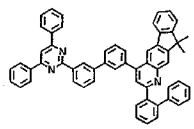

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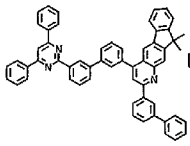

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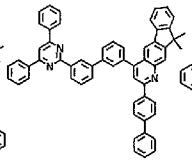

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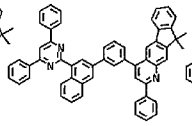

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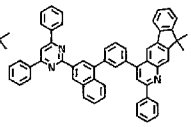

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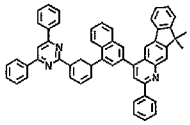

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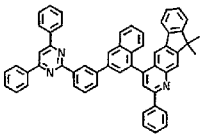

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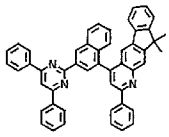

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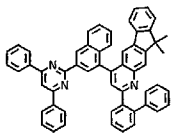

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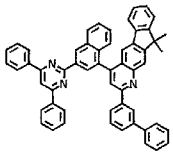

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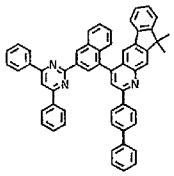

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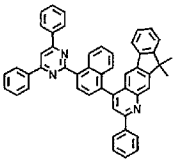

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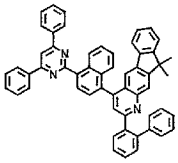

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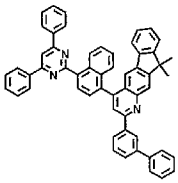

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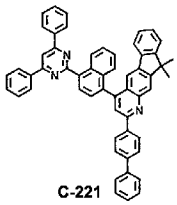

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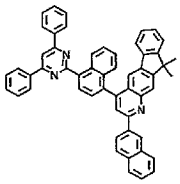

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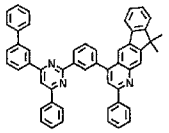

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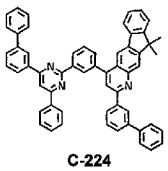

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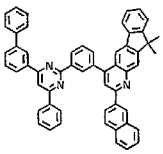

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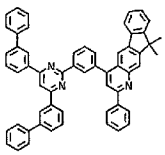

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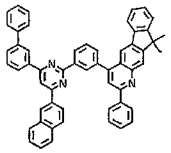

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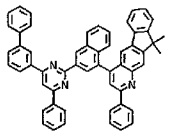

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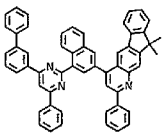

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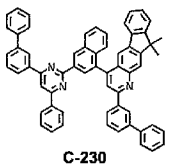

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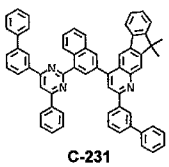

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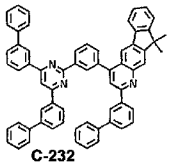

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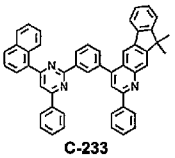

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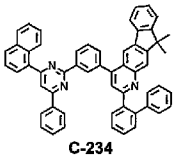

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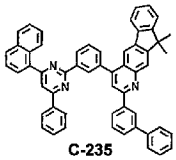

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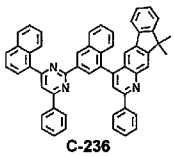

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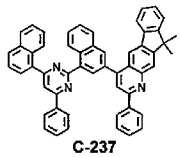

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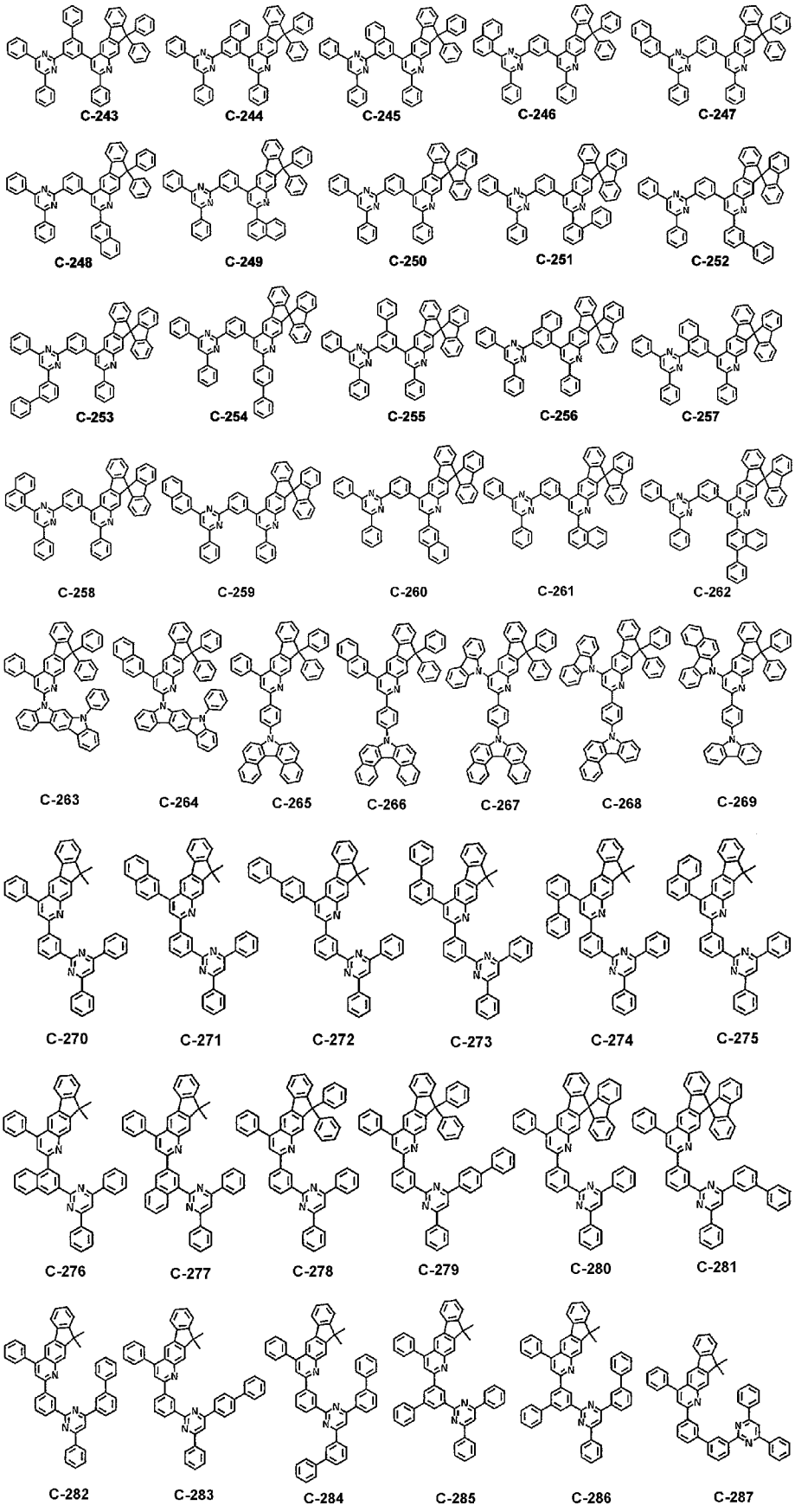
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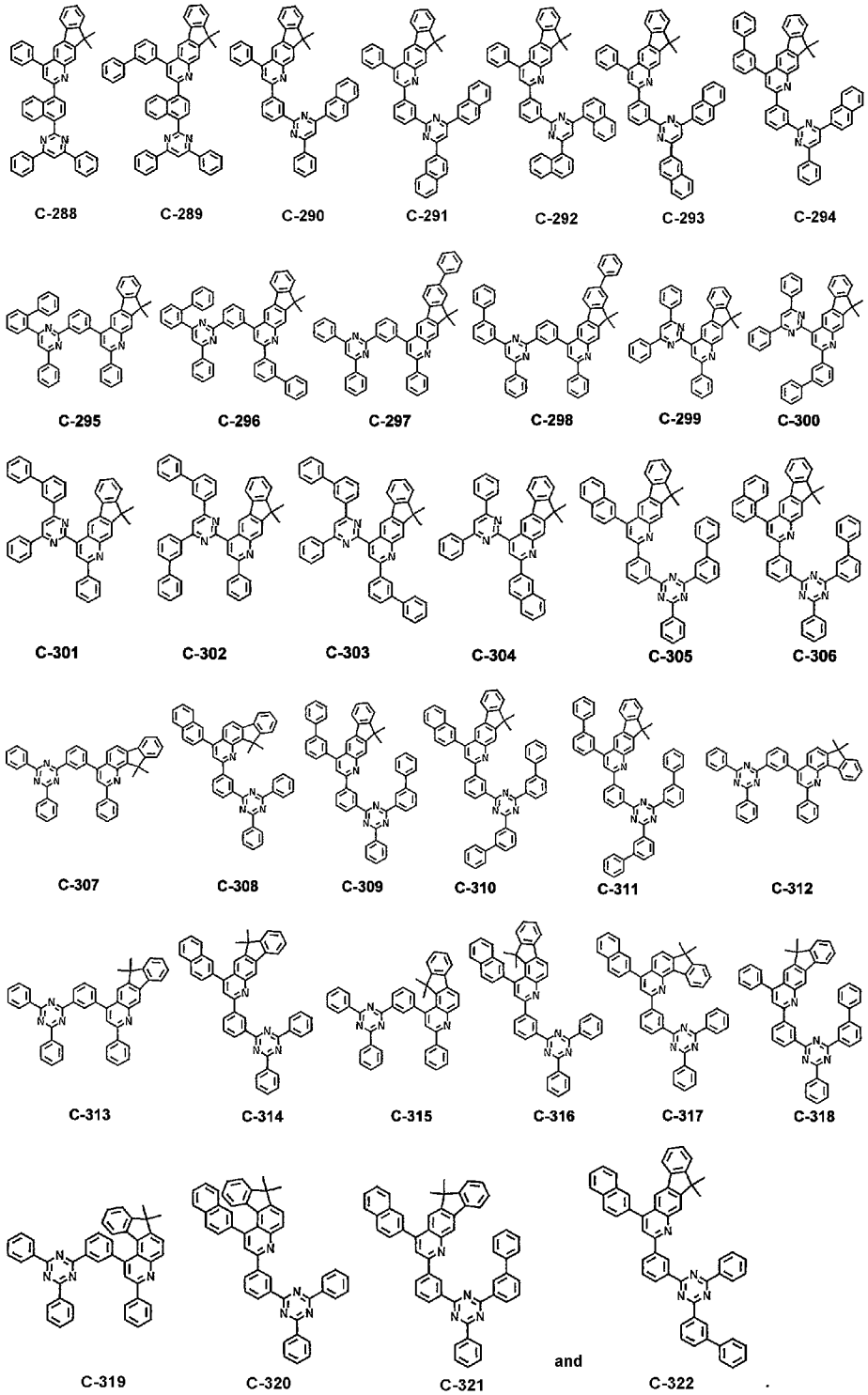
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[Claim 7] An organic electroluminescent material comprising the organic electroluminescent compound according to claim 1.

[Claim 8] An organic electroluminescent device comprising the organic electroluminescent compound according to claim 1.

[Claim 9] The organic electroluminescent device according to claim 8, wherein the organic electroluminescent compound is contained in at least one

layer of an electron buffer layer and an electron transport layer.

[Claim 10] A display device comprising the organic electroluminescent compound according to claim 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2018/008140

A. CLASSIFICATION OF SUBJECT MATTER

C09K 11/06(2006.01)i, H01L 51/00(2006.01)i, H01L 51/50(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C09K 11/06; C07D 251/12; C07D 401/04; H01L 51/50; H01L 51/54; H01L 51/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal), STN (Registry, Caplus), Google & Keywords: Indeno[1,2-g]quinoline, Indeno[2,1-h]quinoline, electroluminescent device, electron buffer layer, electron transport layer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2016-0025777 A (WS CO., LTD.) 09 March 2016 See claims 1, 5-7.	1-10
X	KR 10-2012-0139073 A (SAMSUNG DISPLAY CO., LTD.) 27 December 2012 See claims 1, 9-11	1-10
X	KR 10-2012-0031684 A (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.) 04 April 2012 See claims 1, 4-10.	1-10
A	CN 105441066 A (VALIANT CO., LTD.) 30 March 2016 See claim 1.	1-10
PX	WO 2018-062778 A1 (ROHM AND HAAS ELECTRONIC MATERIALS KOREA LTD.) 05 April 2018 See claims 1, 5(Compound B-60), 10.	1-10

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

☒ See patent family 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 application or patent 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	Date of mailing of the international search report
26 October 2018 (26.10.2018)	**26 October 2018 (26.10.2018)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2018/008140

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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KR 10-2012-0139073 A	27/12/2012	DE 102012202012 A1 US 2012-0319087 A1 US 8993128 B2	20/12/2012 20/12/2012 31/03/2015
KR 10-2012-0031684 A	04/04/2012	None	
CN 105441066 A	30/03/2016	CN 105441066 B	08/08/2017
WO 2018-062778 A1	05/04/2018	KR 10-2018-0035554 A	06/04/2018