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KIM et al.(10) **Pub. No.: US 2016/0293848 A1**(43) **Pub. Date: Oct. 6, 2016**(54) **CONDENSED-CYCLIC COMPOUND AND
ORGANIC LIGHT EMITTING DEVICE
INCLUDING THE SAME**(71) Applicants: **SAMSUNG DISPLAY CO., LTD.**,
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(2013.01); **H01L 51/5012** (2013.01)

(57)

ABSTRACTA condensed-cyclic compound and an organic light-emitting
device, the compound being represented by Formula 1:(21) Appl. No.: **14/963,274**(22) Filed: **Dec. 9, 2015**(30) **Foreign Application Priority Data**

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<Formula 1>

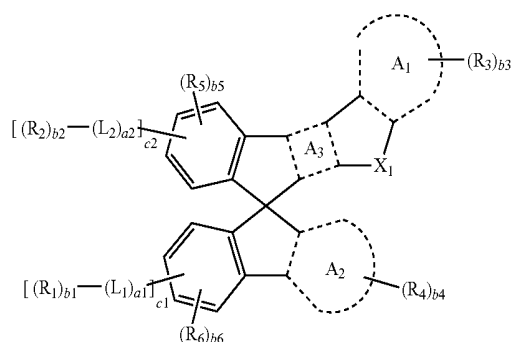
**10****190****150****110**

FIG. 1

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FIG. 2

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FIG. 3

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FIG. 4

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CONDENSED-CYCLIC COMPOUND AND ORGANIC LIGHT EMITTING DEVICE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Korean Patent Application No. 10-2015-0048326, filed on Apr. 6, 2015, in the Korean Intellectual Property Office, and entitled: "Condensed-Cyclic Compound and Organic Light Emitting Device Including the Same," is incorporated by reference herein in its entirety.

BACKGROUND

[0002] 1. Field

[0003] Embodiments relate to a condensed-cyclic compound and an organic light-emitting device including the same.

[0004] 2. Description of the Related Art

[0005] Organic light-emitting devices (OLEDs) are self-emission devices that have wide viewing angles, high contrast ratios, and short response times. In addition, the OLEDs exhibit excellent luminance, driving voltage, and response speed characteristics, and produce full-color images.

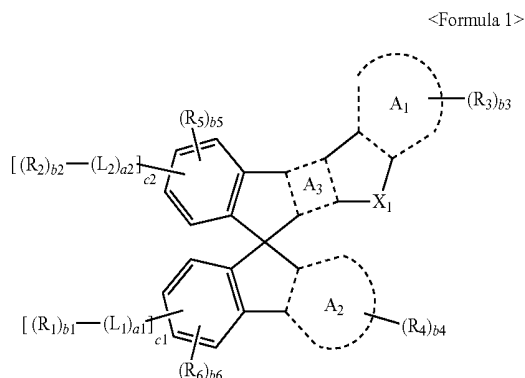
[0006] The organic light-emitting device may include a first electrode disposed on a substrate, and a hole transport region, an emission layer, an electron transport region, and a second electrode, which are sequentially disposed on the first electrode. Holes provided from the first electrode may move toward the emission layer through the hole transport region, and electrons provided from the second electrode may move toward the emission layer through the electron transport region. The holes and the electrons are recombined in the emission layer to produce excitons. These excitons change from an excited state to a ground state to thereby generate light.

SUMMARY

[0007] Embodiments are directed to a condensed-cyclic compound and an organic light-emitting device including the same.

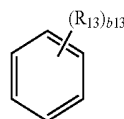
[0008] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

[0009] According to one or more exemplary embodiments, a condensed-cyclic compound represented by Formula 1 is provided:



-continued

<Formula 2A>



<Formula 2B>



[0010] wherein in Formulae 1, 2A, and 2B,

[0011] ring A₁ and ring A₂ are each independently selected from a benzene, a naphthalene, a pyridine, a pyrimidine, a pyrazine, a quinoline, an isoquinoline, a quinoxaline, a quinoxaline, and a cinnoline,

[0012] ring A₃ is selected from a group represented by Formula 2A and a group represented by Formula 2B,

[0013] X₁ is N-[(L₁₁)_{a11}-(R₁₁)_{b11}], O, or S,

[0014] X₂ is N-[(L₁₂)_{a12}-(R₁₂)_{b12}], O, or S,

[0015] L₁ and L₂ are each independently a substituted or unsubstituted condensed polycyclic group, in which at least three carbocyclic groups are condensed to one another,

[0016] a₁ and a₂ are each independently an integer selected from 1 to 5, and when a₁ is 2 or greater, a plurality of L₁s may be identical to or different from each other, and when a₂ is 2 or greater, a plurality of L₂s are identical to or different from each other,

[0017] L₁₁ to L₁₂ are each independently selected from a substituted or unsubstituted C₃-C₁₀ cycloalkylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkylene group, a substituted or unsubstituted C₃-C₁₀ cycloalkenylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenylene group, a substituted or unsubstituted C₆-C₆₀ arylene group, a substituted or unsubstituted C₁-C₆₀ heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

[0018] a₁₁ and a₁₂ are each independently an integer selected from 1 to 5, and when a₁₁ is 2 or greater, a plurality of L₁ is are identical to or different from each other, and when a₁₂ is 2 or greater, a plurality of L₁₂s are identical to or different from each other,

[0019] R₁₁ is selected from a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group;

[0020] b₁₁ is an integer selected from 1 to 4;

[0021] R₁ to R₆, R₁₂, and R₁₃ are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₂-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted

C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —N(Q₁)(Q₂), —Si(Q₃)(Q₄)(Q₅), and —B(Q₆)(Q₇);

[0022] b1, b2, b5, b6, and b12 are each independently an integer selected from 0 to 4;

[0023] b3 and b4 are each independently an integer selected from 0 to 6;

[0024] b13 is 0, 1, or 2;

[0025] c1 and c2 are each independently an integer selected from 0 to 4, and c1+c2 is 1 or greater,

[0026] at least one substituent of the substituted condensed polycyclic group, substituted C₃-C₁₀ cycloalkylene group, substituted C₁-C₁₀ heterocycloalkylene group, substituted C₃-C₁₀ cycloalkenylene group, substituted C₁-C₁₀ heterocycloalkenylene group, substituted C₆-C₆₀ arylene group, substituted C₁-C₆₀ heteroarylene group, substituted divalent non-aromatic condensed polycyclic group, substituted divalent non-aromatic condensed heteropolycyclic group, substituted C₁-C₆₀ alkyl group, substituted C₂-C₆₀ alkenyl group, substituted C₂-C₆₀ alkynyl group, substituted C₁-C₆₀ alkoxy group, substituted C₃-C₁₀ cycloalkyl group, substituted C₁-C₁₀ heterocycloalkyl group, substituted C₃-C₁₀ cycloalkenyl group, substituted C₁-C₁₀ heterocycloalkenyl group, substituted C₆-C₆₀ aryl group, substituted C₆-C₆₀ aryloxy group, substituted C₆-C₆₀ arylthio group, substituted C₁-C₆₀ heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group is selected from

[0027] a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

[0028] a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₁₁)(Q₁₂), —Si(Q₁₃)(Q₁₄)(Q₁₅), and —B(Q₁₆)(Q₁₇);

[0029] a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0030] a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅), and —B(Q₂₆)(Q₂₇); and

[0031] —N(Q₃₁)(Q₃₂), —Si(Q₃₃)(Q₃₄)(Q₃₅), and —B(Q₃₆)(Q₃₇);

[0032] wherein Q₁ to Q₇, Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₁ to Q₃₇ are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0033] According to one or more exemplary embodiments, an organic light-emitting device includes: a first electrode; a second electrode facing the first electrode; and an organic layer that is disposed between the first electrode and the second electrode and includes an emission layer; wherein the organic layer includes at least one condensed-cyclic compound described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] Features will be apparent to those of skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

[0035] FIGS. 1 to 4 illustrate schematic views of an organic light-emitting device according to an exemplary embodiment.

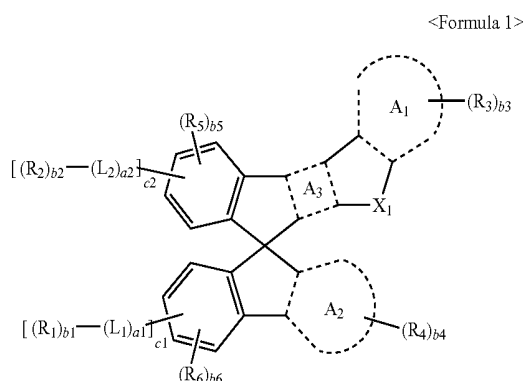
DETAILED DESCRIPTION

[0036] Example embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey exemplary implementations to those skilled in the art.

[0037] In the drawing figures, the dimensions of layers and regions may be exaggerated for clarity of illustration. It will also be understood that when a layer or element is referred to as being “on” another layer or element, it can be directly on the other layer or substrate, or intervening layers may also be present. Further, it will be understood that when a layer is referred to as being “under” another layer, it can be directly under, and one or more intervening layers may also be present. In addition, it will also be understood that when a layer is referred to as being “between” two layers, it can be the only layer between the two layers, or one or more intervening layers may also be present. Like reference numerals refer to like elements throughout.

[0038] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. Expressions such as “at least one of,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0039] A condensed-cyclic compound may be represented by Formula 1:



[0040] In Formula 1, each of rings A_1 and A_2 may be fused to a neighboring 5-membered ring by sharing carbons with the neighboring 5-membered ring. In an implementation, Formula 1, ring A_1 and ring A_2 may each independently be selected from or include, e.g., a benzene group, a naphthalene group, a pyridine group, a pyrimidine group, a pyrazine group, a quinoline group, an isoquinoline group, a quinoxaline group, a quinazoline group, and a cinnoline group.

[0041] For example, in Formula 1, ring A_1 and ring A_2 may each independently be selected from or include, e.g., a benzene, a naphthalene, a pyridine, a quinoline, and an isoquinoline.

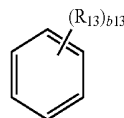
[0042] In some embodiments, in Formula 1,

[0043] ring A_1 may be a benzene or a pyridine, and ring A_2 may be selected from a benzene, a naphthalene, a pyridine, a quinoline, and an isoquinoline; or

[0044] ring A_1 may be selected from a naphthalene, a quinoline and an isoquinoline, and ring A_2 may be a benzene or a pyridine.

[0045] In Formula 1, ring A_3 may be fused to two neighboring 5-membered rings by sharing carbons thereof. In Formula 1, ring A_3 may be or include a group represented by Formula 2A or a group represented by Formula 2B.

<Formula 2A>



<Formula 2B>



[0046] R_{13} and b_{13} in Formula 2A and X_2 in Formula 2B may be the same as the descriptions provided herein.

[0047] In an implementation, in Formula 1, ring A_3 may be a group represented by Formula 2A.

[0048] In Formula 1, X_1 may be $N-[(L_{11})_{a11}-(R_{11})_{b11}]$, O, or S, and, in Formula 2B, X_2 may be $N-[(L_{12})_{a12}-(R_{12})_{b12}]$, O, or S.

[0049] For example, in Formula 1, X_1 may be $N-[(L_{11})_{a11}-(R_{11})_{b11}]$.

[0050] In Formula 1, L_1 and L_2 may each independently be or include, e.g., a substituted or unsubstituted condensed polycyclic group, in which at least three carbocyclic groups are condensed to one another. In an implementation, L_1 and L_2 may include a ring-forming atom that includes carbon and does not include a heteroatom (e.g., N, O, S, or P, and the like). In an implementation, a naphthylene group is a condensed polycyclic group including two carbocyclic groups that are condensed to each other, and a naphthylene group may not be included in L_1 and L_2 . A pyridinylene group may include N as a ring-forming atom, and a pyridinylene group may not be included in L_1 and L_2 .

[0051] According to an embodiment, in Formula 1, L_1 and L_2 may each independently be selected from:

[0052] an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthrenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, and a ovalenylene group; and

[0053] an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthrenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, and a ovalenylene group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a sulfone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an

acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, a ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinylnyl group, an isoquinolinylnyl group, a benzoquinolinylnyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinylnyl group, a quinazolinylnyl group, a cinnolinylnyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and $-\text{Si}(\text{Q}_{33})(\text{Q}_{34})(\text{Q}_{35})$,

[0054] wherein Q_{33} to Q_{35} may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group.

[0055] In some embodiments, in Formula 1, L_1 and L_2 may each independently be selected from:

[0056] a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, and a perylenylene group; and

[0057] a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, and a perylenylene group, each substituted with at least one selected from a deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, a ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinylnyl group, an isoquinolinylnyl group, a benzoquinolinylnyl group, a phthalazinyl group, a

naphthyridinyl group, a quinoxalinylnyl group, a quinazolinylnyl group, a cinnolinylnyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and $-\text{Si}(\text{Q}_{33})(\text{Q}_{34})(\text{Q}_{35})$,

[0058] wherein Q_{33} to Q_{35} may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group.

[0059] In Formula 1, a_1 and a_2 may each independently be an integer selected from 1 to 5. When a_1 is 2 or greater, a plurality of L_1 may be identical to or different from each other, and when a_2 is 2 or greater, a plurality of L_2 may be identical to or different from each other. For example, in Formula 1, " L_1 " is essentially included in a group represented by $*-(\text{L}_1)_{\text{a}_1}-(\text{R}_1)_{\text{b}_1}$, and " L_2 " is essentially included in a group represented by $*-(\text{L}_2)_{\text{a}_2}-(\text{R}_2)_{\text{b}_2}$.

[0060] In some embodiments, in Formula 1, a_1 and a_2 may each independently be 1 or 2, or a_1 and a_2 may be 1.

[0061] In the formulae above, L_{11} and L_{12} may each independently be selected from or include, e.g., a substituted or unsubstituted C_3 - C_{10} cycloalkylene group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkylene group, a substituted or unsubstituted C_3 - C_{10} cycloalkenylene group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkenylene group, a substituted or unsubstituted C_6 - C_{60} arylene group, a substituted or unsubstituted C_1 - C_{60} heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group.

[0062] In some embodiments, L_{11} and L_{12} may each independently be selected from:

[0063] a phenylene group, a pentalenylene group, an indenylene group, a naphthylene group, an azulenylene group, a heptalenylene group, an indacenylene group, an acenaphthylenylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, an ovalenylene group, a pyrrolylene group, a thiophenylene group, a furanylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a pyridinylene group, a pyrazinylene group, a pyrimidinylene group, a pyridazinylene group, an isoindolylene group, an indolylene group, an indazolylene group, a purinylene group, a quinolinylenylene group, an isoquinolinylenylene group, a benzoquinolinylenylene group, a phthalazinylene group, a naphthyridinylene group, a quinoxalinylenylene group, a quinazolinylenylene group, a cinnolinylenylene group, a carbazolylene group, a phenanthridinylene group, an acridinylene group, a phenanthrolinylene group, a phenazinylene group, a benzoimidazolylene group, a benzofuranylene group, a benzothiophenylene group, an isobenzothiazolylene group, a benzoxazolylene group, an isoben-

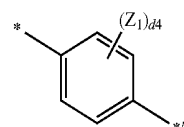
zoxazolylene group, a triazolylene group, a tetrazolylene group, an oxadiazolylene group, a triazinylene group, a dibenzofuranylene group, a dibenzothiophenylylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a thiadiazolylene group, an imidazopyridinylylene group, an imidazopyrimidinylylene group; and

[0064] a phenylene group, a pentalenylylene group, an indenylene group, a naphthylylene group, an azulenylylene group, a heptalenylene group, an indacenylene group, an acenaphthylylene group, a fluorenylylene group, a spiro-fluorenylylene group, a benzofluorenylylene group, a dibenzofluorenylylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylylene group, a hexacenylylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, a ovalenylene group, a pyrrolylene group, a thiophenylylene group, a furanylylene group, an imidazolylene group, a pyrazolylene group, a thiazolylene group, an isothiazolylene group, an oxazolylene group, an isoxazolylene group, a pyridinylylene group, a pyrazinylylene group, a pyrimidinylylene group, a pyridazinylylene group, an isoindolylylene group, an indolylylene group, an indazolylene group, a purinylylene group, a quinolylylene group, an isoquinolylylene group, a benzoquinolylylene group, a phthalazinylylene group, a naphthyridinylylene group, a quinoxalinylylene group, a quinazolylylene group, a cinnolinylylene group, a carbazolylene group, a phenanthridinylylene group, an acridinylylene group, a phenanthrolinylylene group, a phenazinylylene group, a benzoimidazolylene group, a benzofuranylylene group, a benzothiophenylylene group, an isobenzothiazolylene group, a benzoxazolylene group, a triazolylene group, a tetrazolylene group, an oxadiazolylene group, a triazinylene group, a dibenzofuranylylene group, a dibenzothiophenylylene group, a benzocarbazolylene group, a dibenzocarbazolylene group, a thiadiazolylene group, an imidazopyridinylylene group, and an imidazopyrimidinylylene group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, a ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolynyl group, an isoquinolynyl group, a benzoquinolynyl group, a phthalazinyl group, a

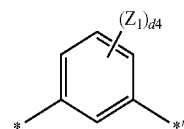
naphthyridinyl group, a quinoxalynyl group, a quinazolinyl group, a cinnolynyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and —Si(Q₃₃)(Q₃₄)(Q₃₅),

[0065] wherein Q₃₃ to Q₃₅ may each independently be selected from a C₁-C₁₀ alkyl group, a C₁-C₁₀ alkoxy group, a phenyl group, and a naphthyl group.

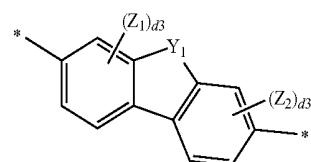
[0066] In some embodiments, L₁ and L₂ may each independently be a group represented by one of the following Formulae 3-8, 3-9, 3-25, and 3-35 to 3-41, and L₁₁ and L₁₂ may each independently be a group represented by one of the following Formulae 3-1 to 3-41:



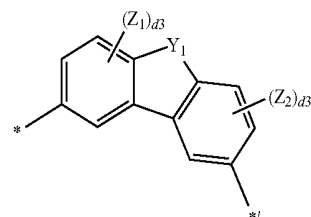
Formula 3-1



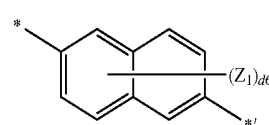
Formula 3-2



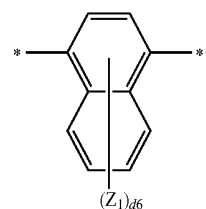
Formula 3-3



Formula 3-4

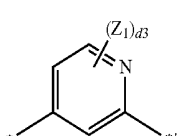
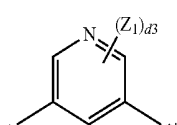
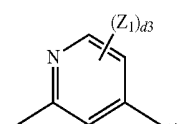
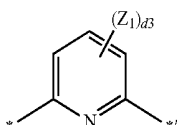
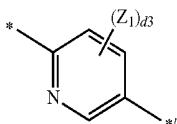
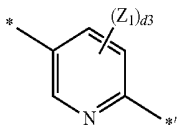
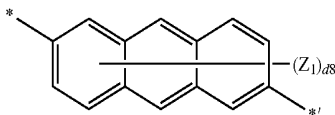
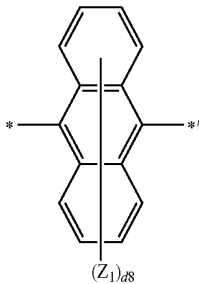
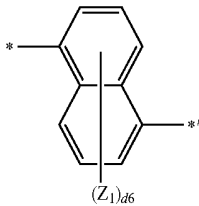


Formula 3-5



Formula 3-6

-continued



Formula 3-7

Formula 3-8

Formula 3-9

Formula 3-10

Formula 3-11

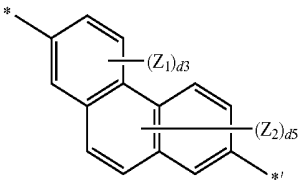
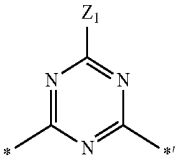
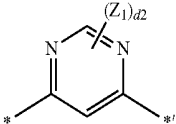
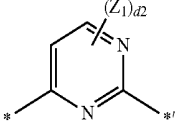
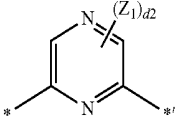
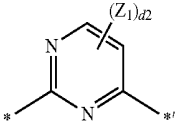
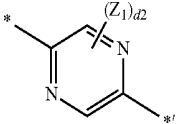
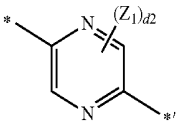
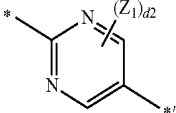
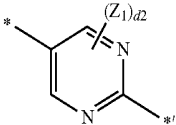
Formula 3-12

Formula 3-13

Formula 3-14

Formula 3-15

-continued



Formula 3-16

Formula 3-17

Formula 3-18

Formula 3-19

Formula 3-20

Formula 3-21

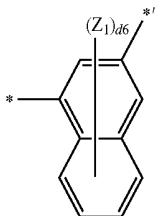
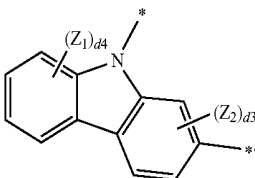
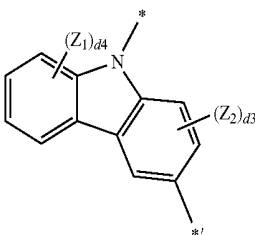
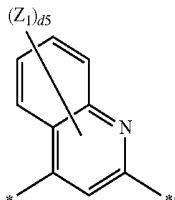
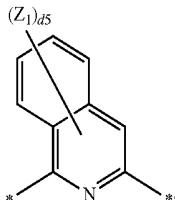
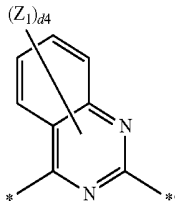
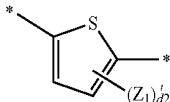
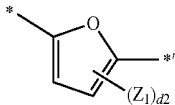
Formula 3-22

Formula 3-23

Formula 3-24

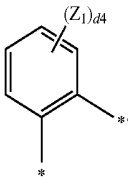
Formula 3-25

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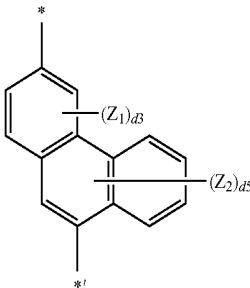
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Formula 3-26



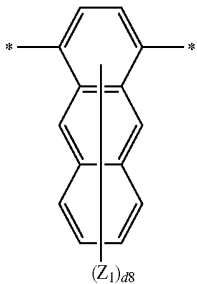
Formula 3-27

Formula 3-28

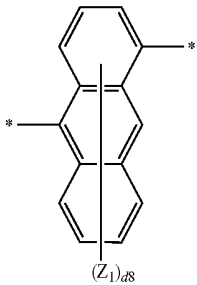


Formula 3-29

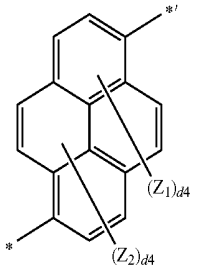
Formula 3-30



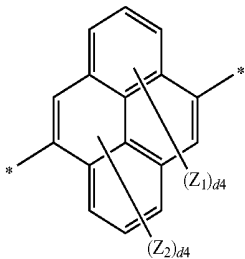
Formula 3-31



Formula 3-32



Formula 3-33



Formula 3-34

Formula 3-35

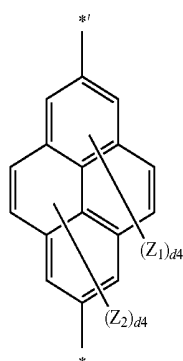
Formula 3-36

Formula 3-37

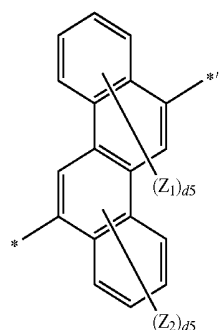
Formula 3-38

Formula 3-39

-continued



Formula 3-40



Formula 3-41

[0067] In Formulae 3-1 to 3-41,

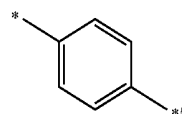
[0068] Y_1 may be O, S, $C(Z_3)(Z_4)$, $N(Z_5)$, or $Si(Z_6)(Z_7)$;

[0069] Z_1 to Z_7 may each independently be selected from a hydrogen, a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, and $-Si(Q_{33})(Q_{34})(Q_{35})$.

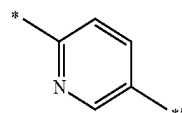
[0070] wherein Q_{33} to Q_{35} may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group;

[0071] d_2 may be 1 or 2;[0072] d_3 may be an integer selected from 1 to 3;[0073] d_4 may be an integer selected from 1 to 4;[0074] d_5 may be an integer selected from 1 to 5;[0075] d_6 may be an integer selected from 1 to 6;[0076] d_8 may be an integer selected from 1 to 8; and[0077] $*$ and $*'$ are each a binding site to a neighboring atom.

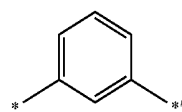
[0078] In some embodiments, L_1 and L_2 may each independently be a group represented by one of the following Formulae 4-11, 4-13, 4-27, and 4-29 to 4-35, and L_{11} and L_{12} may each independently be a group represented by one of the following Formulae 4-1 to 4-35.



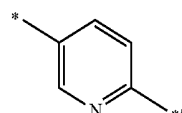
Formula 4-1



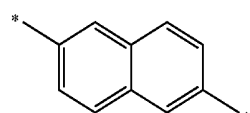
Formula 4-2



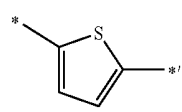
Formula 4-3



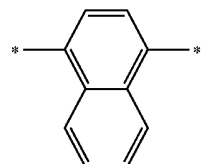
Formula 4-4



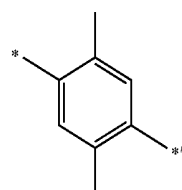
Formula 4-5



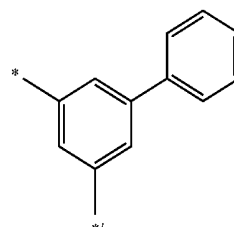
Formula 4-6



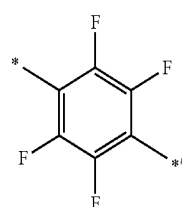
Formula 4-7



Formula 4-8

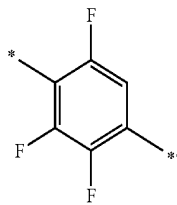
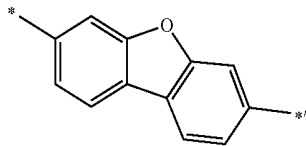
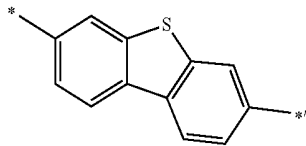
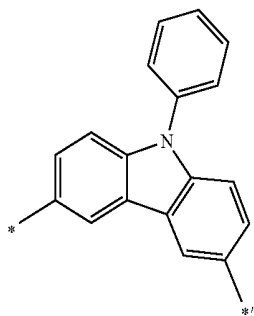
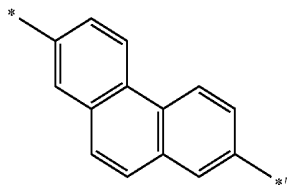
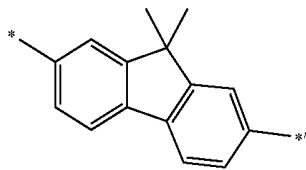
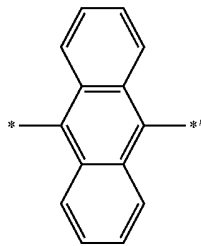


Formula 4-9



Formula 4-10

-continued



Formula 4-11

Formula 4-12

Formula 4-13

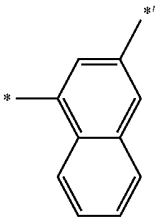
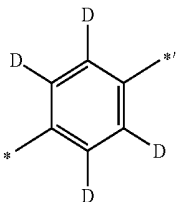
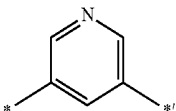
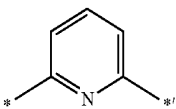
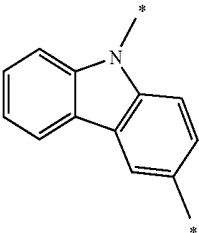
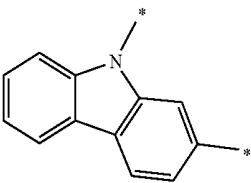
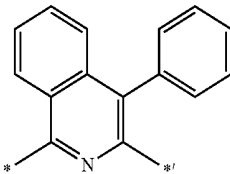
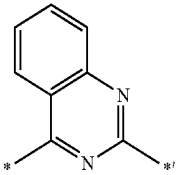
Formula 4-14

Formula 4-15

Formula 4-16

Formula 4-17

-continued



Formula 4-18

Formula 4-19

Formula 4-20

Formula 4-21

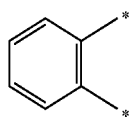
Formula 4-22

Formula 4-23

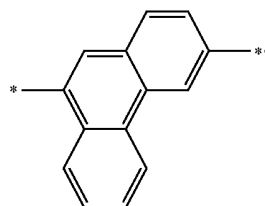
Formula 4-24

Formula 4-25

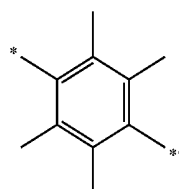
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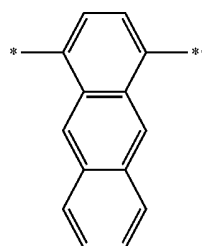
Formula 4-26



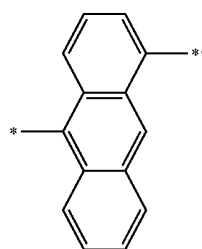
Formula 4-27



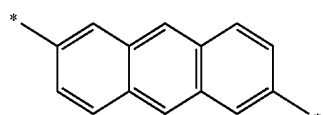
Formula 4-28



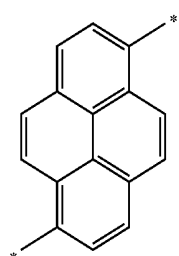
Formula 4-29



Formula 4-30

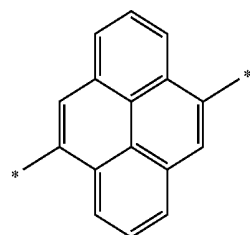


Formula 4-31

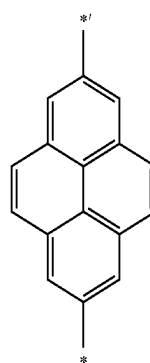


Formula 4-32

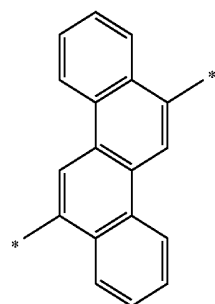
-continued



Formula 4-33



Formula 4-34



Formula 4-35

[0079] In Formulae 4-1 to 4-35, * and *' are each a binding site to a neighboring atom.

[0080] In the formulae above, a₁₁ and a₁₂ may each independently be an integer selected from 0 to 5. When a₁₁ is 2 or greater, a plurality of L₁₁ may be identical to or different from each other, and when a₁₂ is 2 or greater, a plurality of L₁₂ may be identical to or different from each other.

[0081] In some embodiments, in the formulae above, a₁₁ and a₁₂ may each independently be 0, 1, or 2, e.g., 0 or 1.

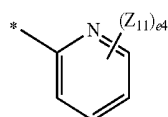
[0082] In the formulae above, R₁₁ may be selected from or include, e.g., a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

[0083] In some embodiments, R₁₁ may be selected from a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinoliny group, an isoquinoliny group, a benzoquinoliny group, a phthalazinyl group, a naphthyridinyl group, a quinoxaliny group, a quinoxaliny group, a cinnoliny group, a phenanthridinyl

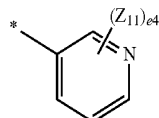
group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

[0084] a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a phenanthrenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, and a benzoxazolyl group.

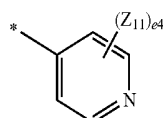
[0085] In some embodiments, R₁₁ may be a group represented by one of the following Formulae 5-1 to 5-60.



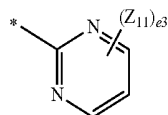
Formula 5-1



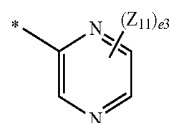
Formula 5-2



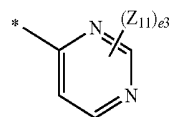
Formula 5-3



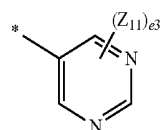
Formula 5-4



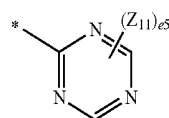
Formula 5-5



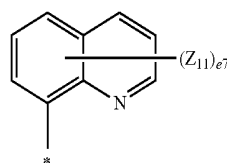
Formula 5-6



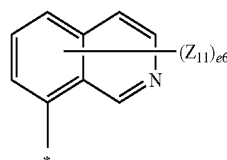
Formula 5-7



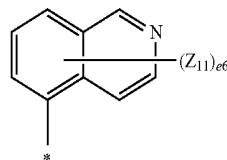
Formula 5-8



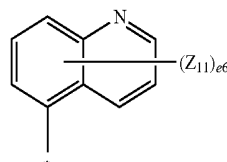
Formula 5-9



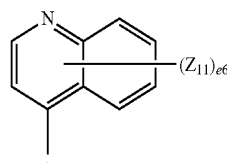
Formula 5-10



Formula 5-11



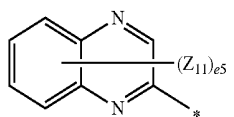
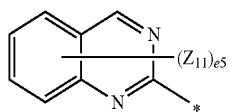
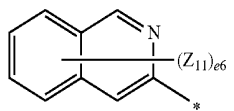
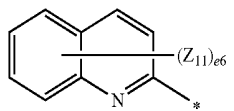
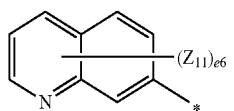
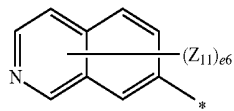
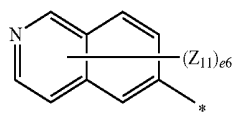
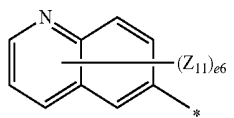
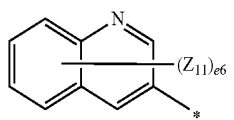
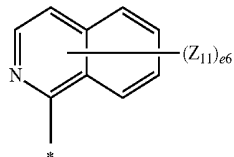
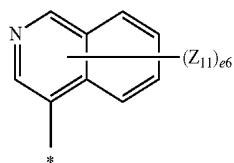
Formula 5-12



Formula 5-13

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Formula 5-14

Formula 5-15

Formula 5-16

Formula 5-17

Formula 5-18

Formula 5-19

Formula 5-20

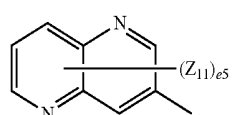
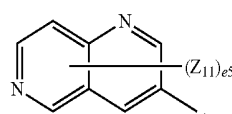
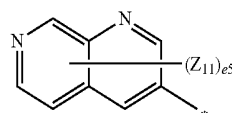
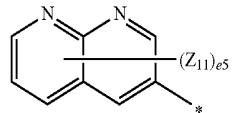
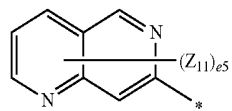
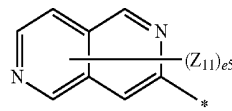
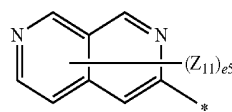
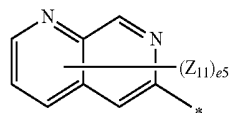
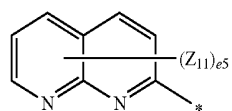
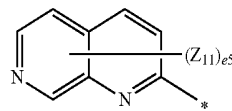
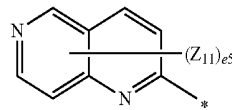
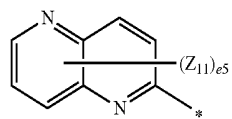
Formula 5-21

Formula 5-22

Formula 5-23

Formula 5-24

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Formula 5-25

Formula 5-26

Formula 5-27

Formula 5-28

Formula 5-29

Formula 5-30

Formula 5-31

Formula 5-32

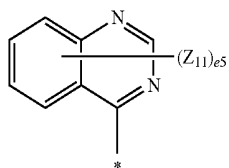
Formula 5-33

Formula 5-34

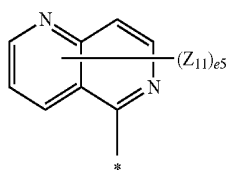
Formula 5-35

Formula 5-36

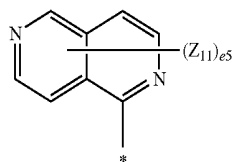
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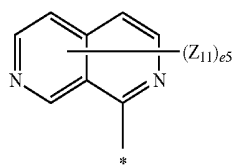
Formula 5-37



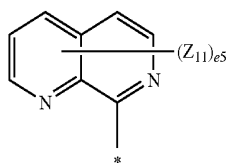
Formula 5-38



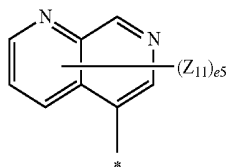
Formula 5-39



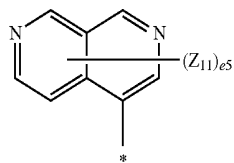
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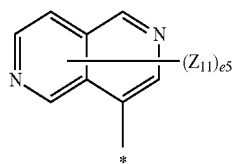
Formula 5-41



Formula 5-42

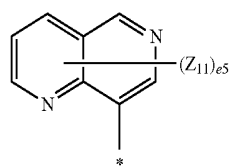


Formula 5-43

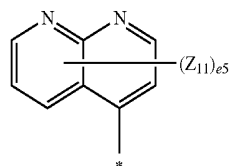


Formula 5-44

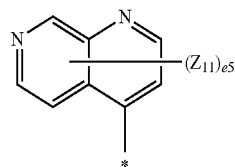
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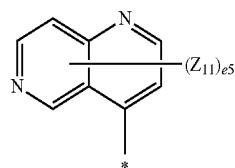
Formula 5-45



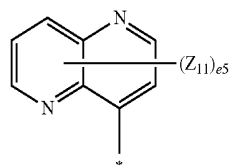
Formula 5-46



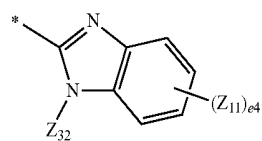
Formula 5-47



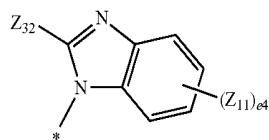
Formula 5-48



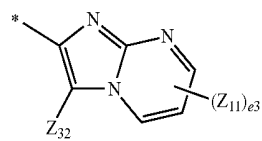
Formula 5-49



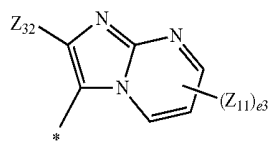
Formula 5-50



Formula 5-51

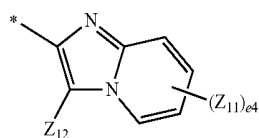


Formula 5-52

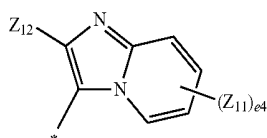


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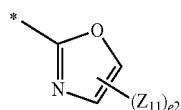
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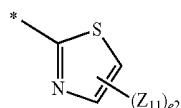
Formula 5-54



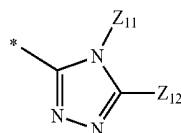
Formula 5-55



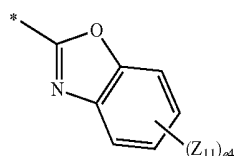
Formula 5-56



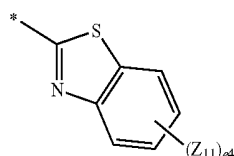
Formula 5-57



Formula 5-58



Formula 5-59



Formula 5-60

[0086] In Formulae 5-1 to 5-60,

[0087] Z_{11} and Z_{12} may each independently be selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spirofluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a biphenyl group, a terphenyl group, and —Si(Q_{13})(Q_{14})(Q_{15}),

[0088] wherein Q_{13} to Q_{15} may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group;

[0089] e_2 may be 1 or 2;

[0090] e_3 may be an integer selected from 1 to 3;

[0091] e_4 may be an integer selected from 1 to 4;

[0092] e_5 may be an integer selected from 1 to 5;

[0093] e_6 may be an integer selected from 1 to 6;

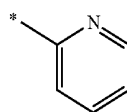
[0094] e_7 may be an integer selected from 1 to 7;

[0095] e_8 may be an integer selected from 1 to 8;

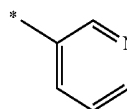
[0096] e_9 may be an integer selected from 1 to 9; and

[0097] * is a binding site to a neighboring atom.

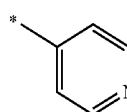
[0098] In some embodiments, R_{11} may be a group represented by one of the following Formulae 6-1 to 6-117.



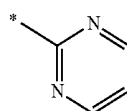
Formula 6-1



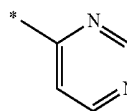
Formula 6-2



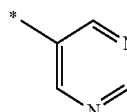
Formula 6-3



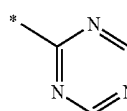
Formula 6-4



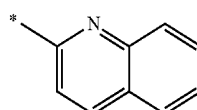
Formula 6-5



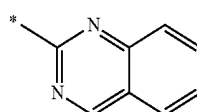
Formula 6-6



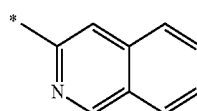
Formula 6-7



Formula 6-8

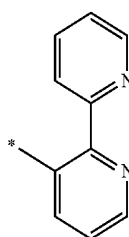
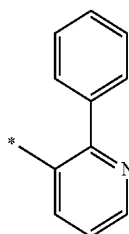
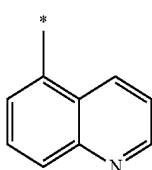
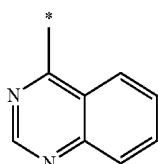
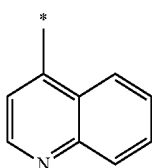
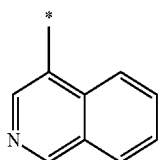
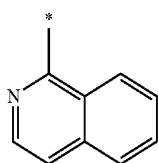
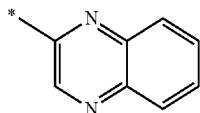
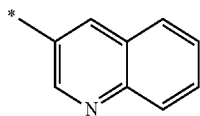


Formula 6-9



Formula 6-10

-continued



Formula 6-11

Formula 6-12

Formula 6-13

Formula 6-14

Formula 6-15

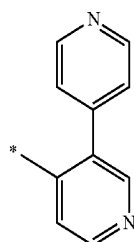
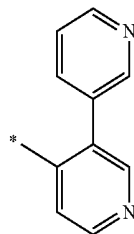
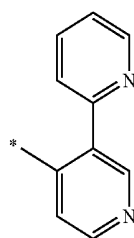
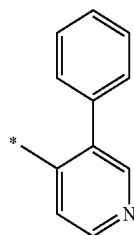
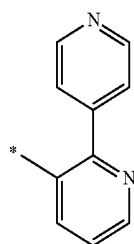
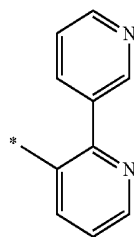
Formula 6-16

Formula 6-17

Formula 6-18

Formula 6-19

-continued



Formula 6-20

Formula 6-21

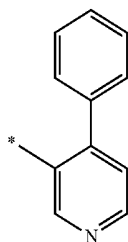
Formula 6-22

Formula 6-23

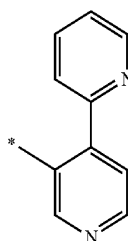
Formula 6-24

Formula 6-25

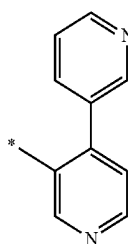
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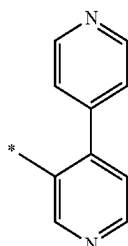
Formula 6-26



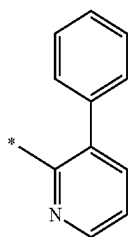
Formula 6-27



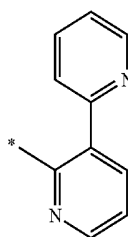
Formula 6-28



Formula 6-29

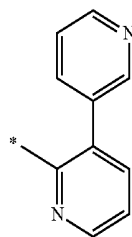


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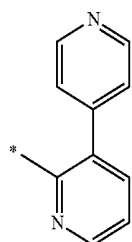


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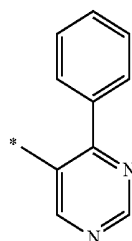
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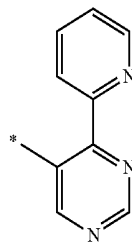
Formula 6-32



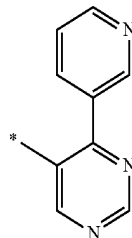
Formula 6-33



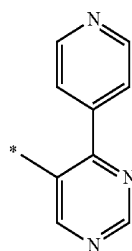
Formula 6-34



Formula 6-35

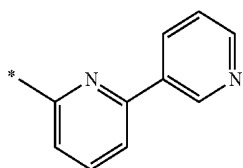
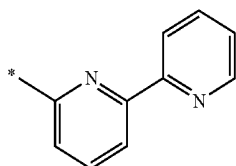
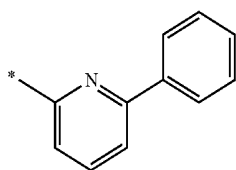
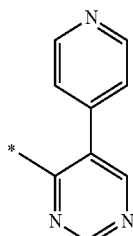
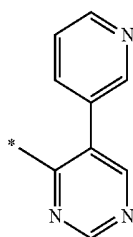
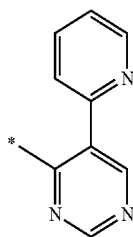
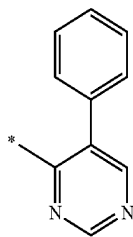


Formula 6-36



Formula 6-37

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Formula 6-38

Formula 6-39

Formula 6-40

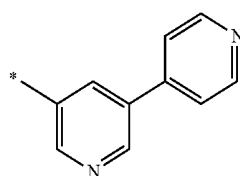
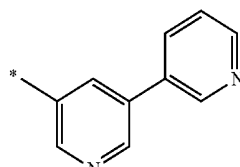
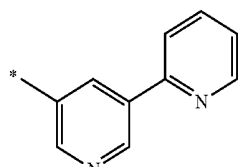
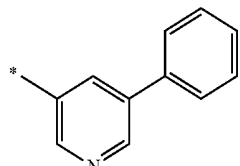
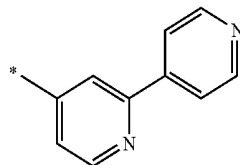
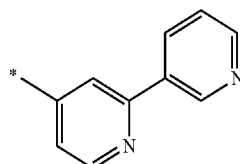
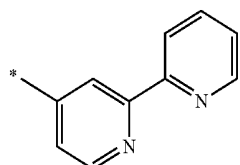
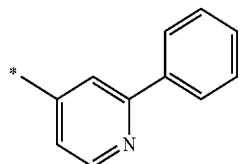
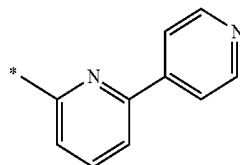
Formula 6-41

Formula 6-42

Formula 6-43

Formula 6-44

-continued



Formula 6-45

Formula 6-46

Formula 6-47

Formula 6-48

Formula 6-49

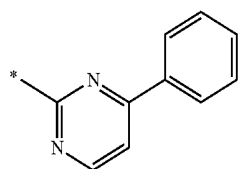
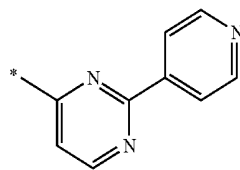
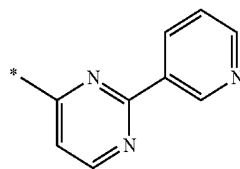
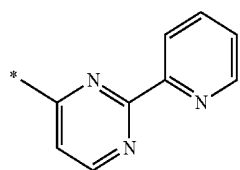
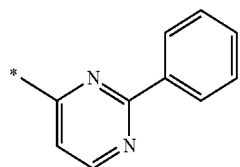
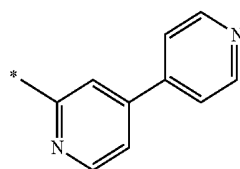
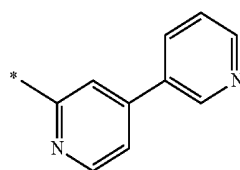
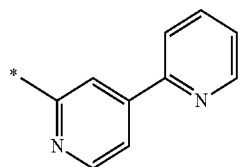
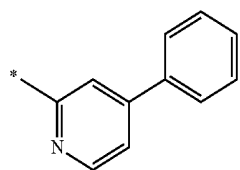
Formula 6-50

Formula 6-51

Formula 6-52

Formula 6-53

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Formula 6-54

Formula 6-55

Formula 6-56

Formula 6-57

Formula 6-58

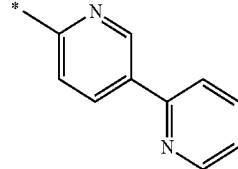
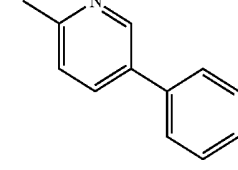
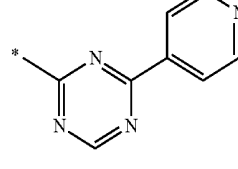
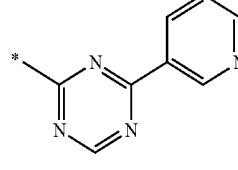
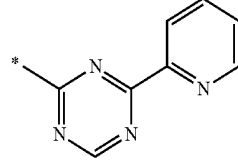
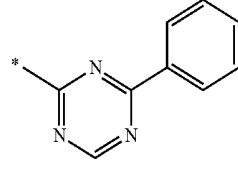
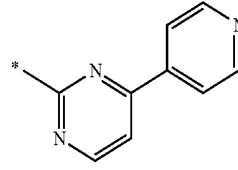
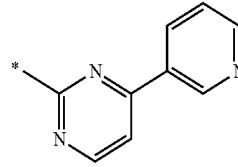
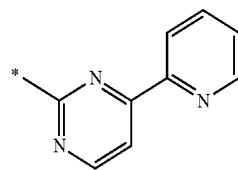
Formula 6-59

Formula 6-60

Formula 6-61

Formula 6-62

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Formula 6-63

Formula 6-64

Formula 6-65

Formula 6-66

Formula 6-67

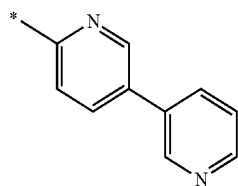
Formula 6-68

Formula 6-69

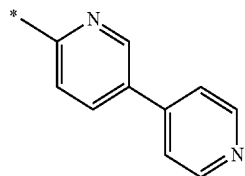
Formula 6-70

Formula 6-71

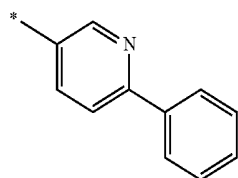
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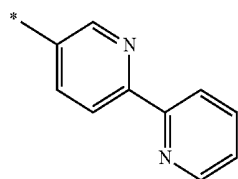
Formula 6-72



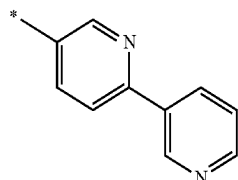
Formula 6-73



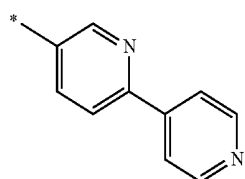
Formula 6-74



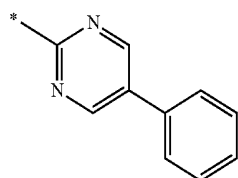
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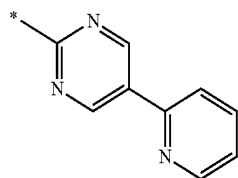
Formula 6-76



Formula 6-77

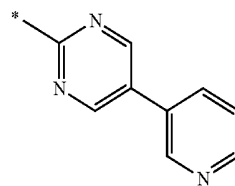


Formula 6-78

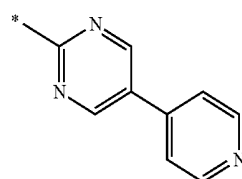


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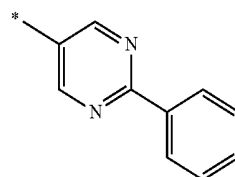
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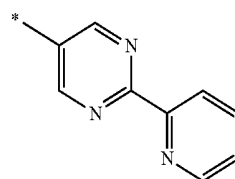
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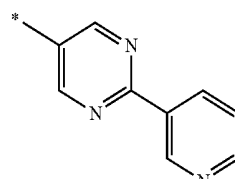
Formula 6-81



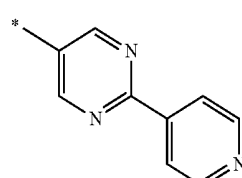
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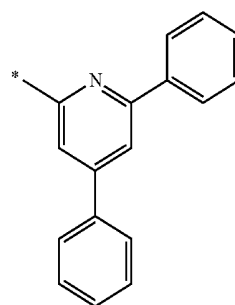
Formula 6-83



Formula 6-84

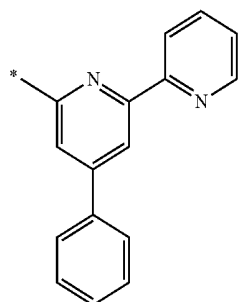


Formula 6-85



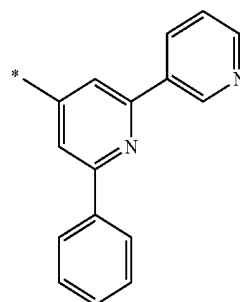
Formula 6-86

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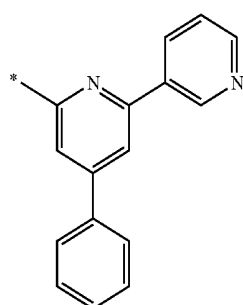


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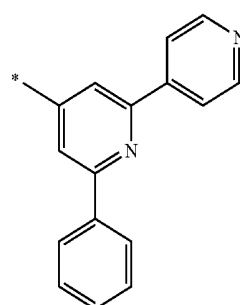
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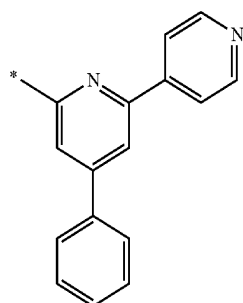
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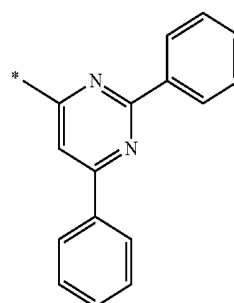
Formula 6-88



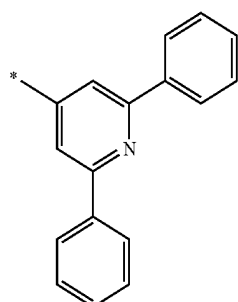
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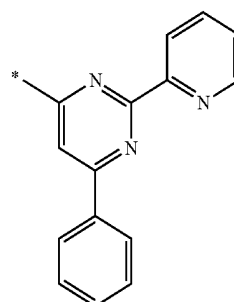
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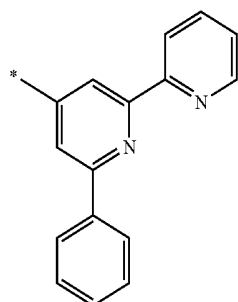
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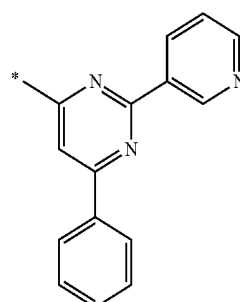
Formula 6-90



Formula 6-95

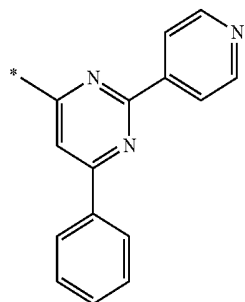


Formula 6-91



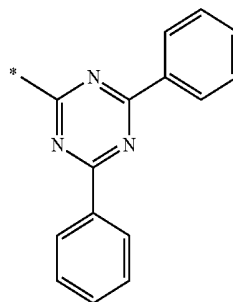
Formula 6-96

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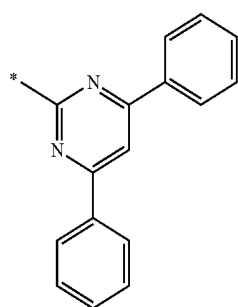


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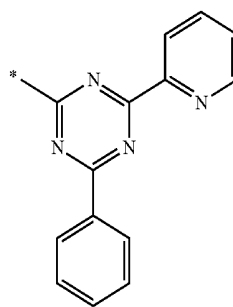
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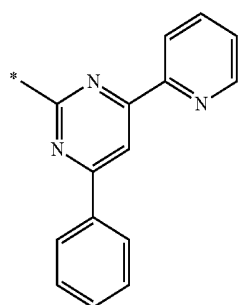
Formula 6-102



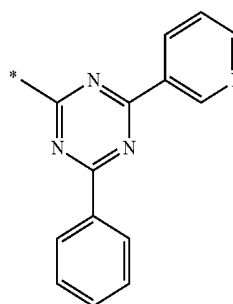
Formula 6-98



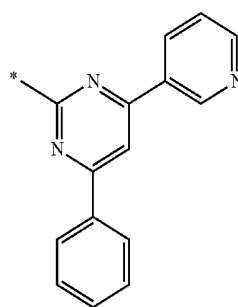
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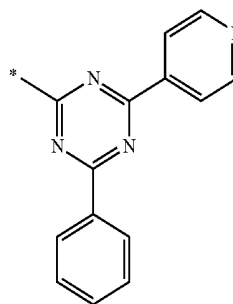
Formula 6-99



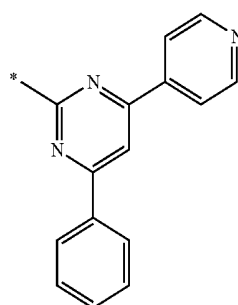
Formula 6-104



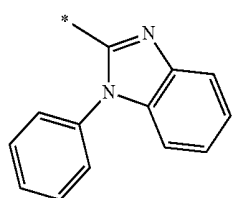
Formula 6-100



Formula 6-105

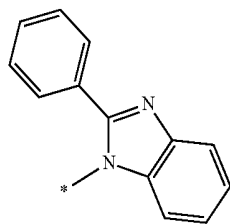


Formula 6-101

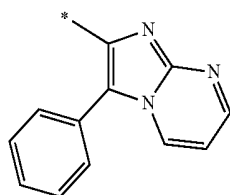


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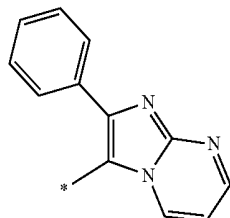
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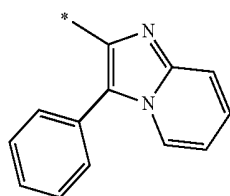
Formula 6-107



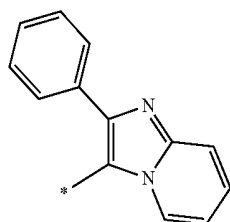
Formula 6-108



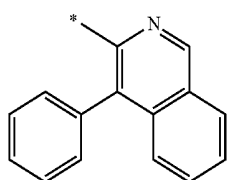
Formula 6-109



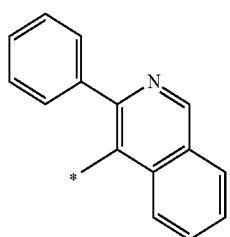
Formula 6-110



Formula 6-111

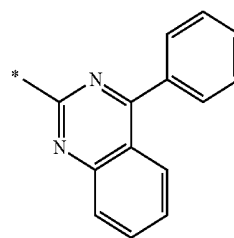


Formula 6-112

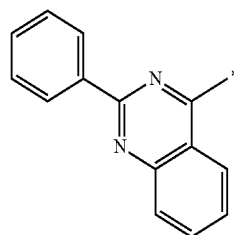


Formula 6-113

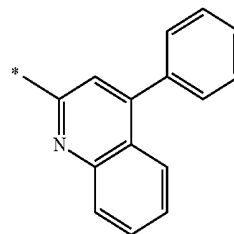
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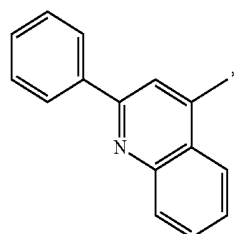
Formula 6-114



Formula 6-115



Formula 6-116



Formula 6-117

[0099] wherein, in Formulae 6-1 to 6-117, * is a binding site to a neighboring atom.

[0100] In the formulae above, b11 may be an integer selected from 1 to 4. For example, in the formulae above, b11 may be 1 or 2.

[0101] In some embodiments, in the formulae above, b11 may be 1.

[0102] In the formulae above, R_1 to R_6 , R_{12} , and R_{13} may each independently be selected from or include, e.g., a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a substituted or unsubstituted C_1 - C_{60} alkyl group, a substituted or unsubstituted C_2 - C_{60} alkenyl group, a substituted or unsubstituted C_2 - C_{60} alkynyl group, a substituted or unsubstituted C_1 - C_{60} alkoxy group, a substituted or unsubstituted C_3 - C_{10} cycloalkyl group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3 - C_{10} cycloalkenyl group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, a substituted or unsubstituted C_6 - C_{60} aryloxy group, a substituted or unsubstituted C_6 - C_{60} arylthio group, a substituted or unsubstituted C_1 - C_{60} het-

eroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, $-\text{N}(\text{Q}_1)(\text{Q}_2)$, $-\text{Si}(\text{Q}_3)(\text{Q}_4)(\text{Q}_5)$, and $-\text{B}(\text{Q}_6)(\text{Q}_7)$.

[0103] For example, in the formulae above, R_1 to R_6 , R_{12} , and R_{13} may be each independently selected from

[0104] a hydrogen, a deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, and a C_1 - C_{20} alkoxy group;

[0105] a C_1 - C_{20} alkyl group and a C_1 - C_{20} alkoxy group, each substituted with at least one selected from a deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, and a phosphoric acid group or a salt thereof;

[0106] a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthroli-nyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

[0107] a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an

isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthroli-nyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyrimidinyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from a deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a cyclopentyl group, a cyclohexenyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthroli-nyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyrimidinyl group, an imidazopyridinyl group, and $-\text{Si}(\text{Q}_{33})(\text{Q}_{34})(\text{Q}_{35})$; and

[0108] $-\text{Si}(\text{Q}_3)(\text{Q}_4)(\text{Q}_5)$.

[0109] wherein Q_3 to Q_5 and Q_{33} to Q_{35} may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group.

[0110] In some embodiments, in the formulae above, R_1 to R_6 , R_{12} , and R_{13} may each independently be selected from:

[0111] a hydrogen, a deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, and a C_1 - C_{20} alkoxy group;

[0112] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthra-

cenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

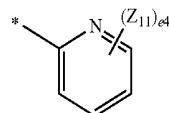
[0113] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and —Si(Q_3)(Q_4)(Q_5)(Q_{35});

[0114] —Si(Q_3)(Q_4)(Q_5),

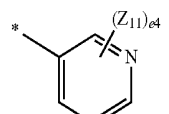
[0115] wherein Q_3 to Q_5 and Q_{33} to Q_{35} may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group.

[0116] In some embodiments, in the formulae above, R_1 to R_6 , R_{12} , and R_{13} may each independently be selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a group

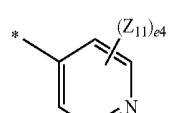
represented by one of the following Formulae 5-1 to 5-80, and —Si(Q_3)(Q_4)(Q_5), wherein Q_3 to Q_5 may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group.



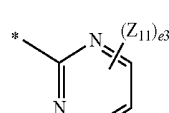
Formula 5-1



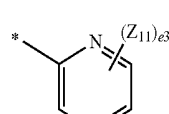
Formula 5-2



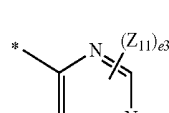
Formula 5-3



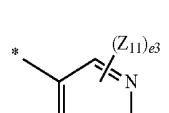
Formula 5-4



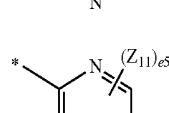
Formula 5-5



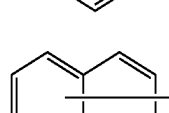
Formula 5-6



Formula 5-7



Formula 5-8

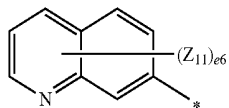
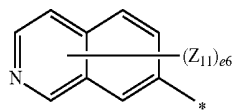
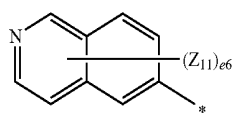
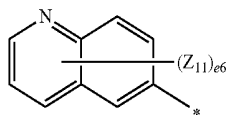
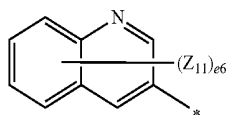
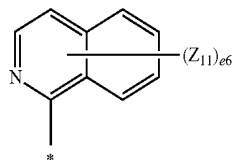
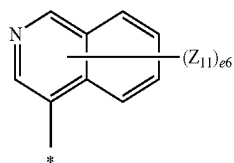
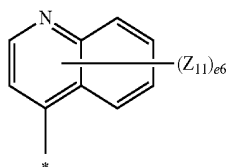
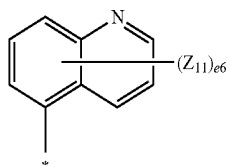
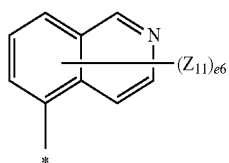


Formula 5-9



Formula 5-10

-continued



Formula 5-11

Formula 5-12

Formula 5-13

Formula 5-14

Formula 5-15

Formula 5-16

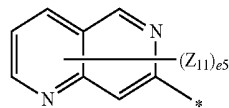
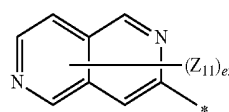
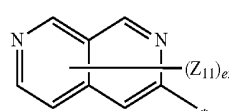
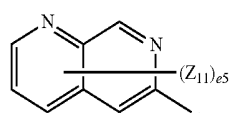
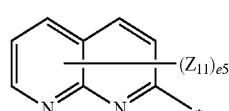
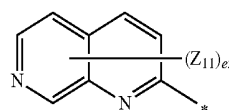
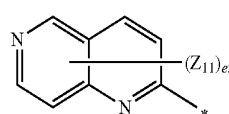
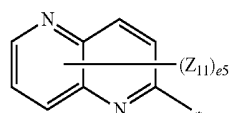
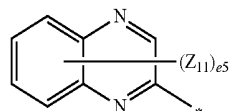
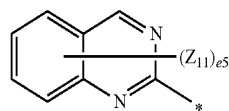
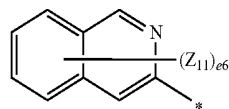
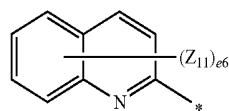
Formula 5-17

Formula 5-18

Formula 5-19

Formula 5-20

-continued



Formula 5-21

Formula 5-22

Formula 5-23

Formula 5-24

Formula 5-25

Formula 5-26

Formula 5-27

Formula 5-28

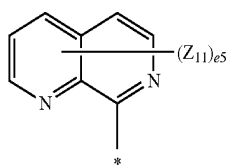
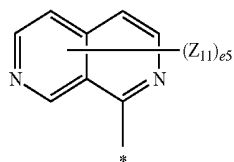
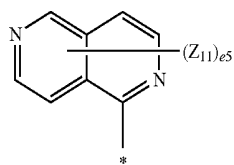
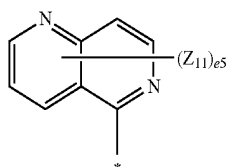
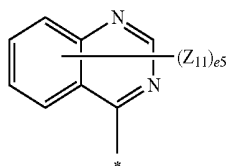
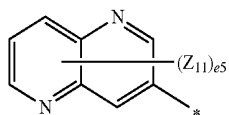
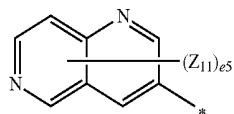
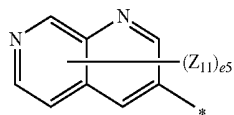
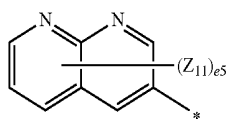
Formula 5-29

Formula 5-30

Formula 5-31

Formula 5-32

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Formula 5-33

Formula 5-34

Formula 5-35

Formula 5-36

Formula 5-37

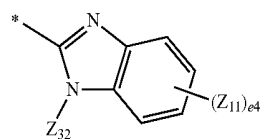
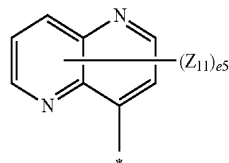
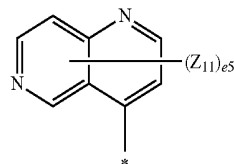
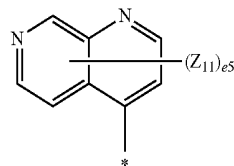
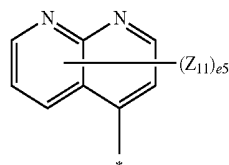
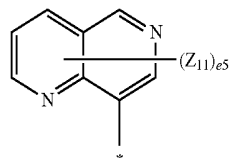
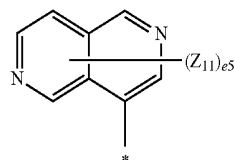
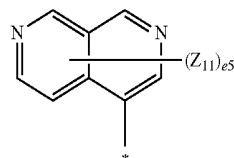
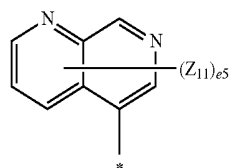
Formula 5-38

Formula 5-39

Formula 5-40

Formula 5-41

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Formula 5-42

Formula 5-43

Formula 5-44

Formula 5-45

Formula 5-46

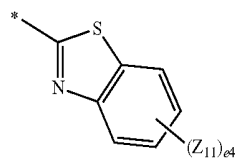
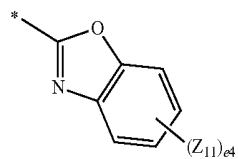
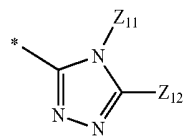
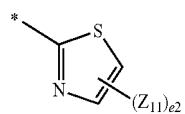
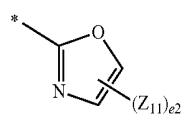
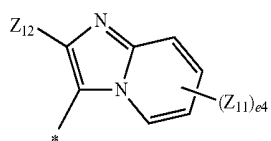
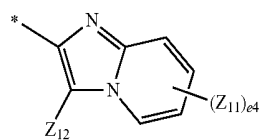
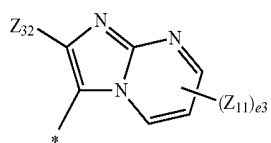
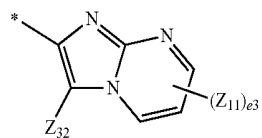
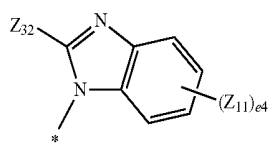
Formula 5-47

Formula 5-48

Formula 5-49

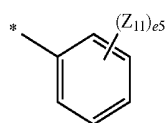
Formula 5-50

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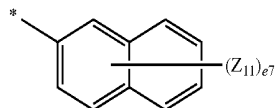


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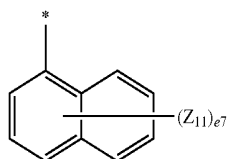
Formula 5-51



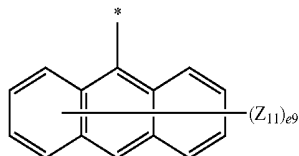
Formula 5-52



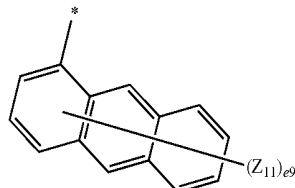
Formula 5-53



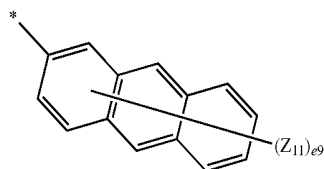
Formula 5-54



Formula 5-55

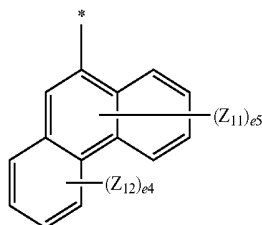


Formula 5-56



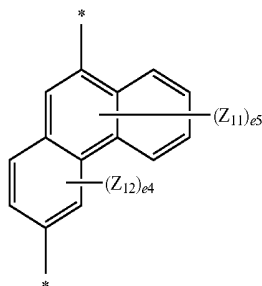
Formula 5-57

Formula 5-58



Formula 5-59

Formula 5-60



Formula 5-61

Formula 5-62

Formula 5-63

Formula 5-64

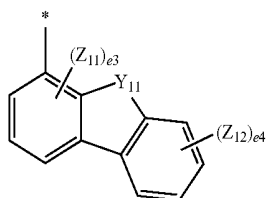
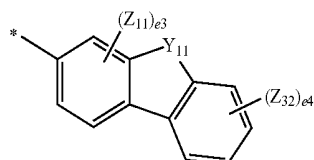
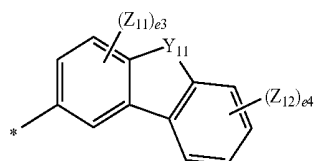
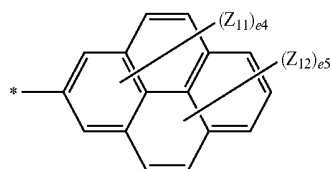
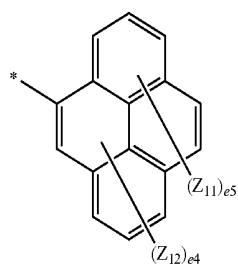
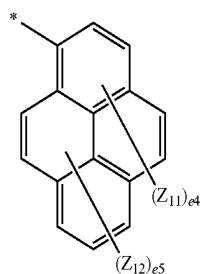
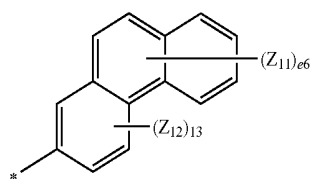
Formula 5-65

Formula 5-66

Formula 5-67

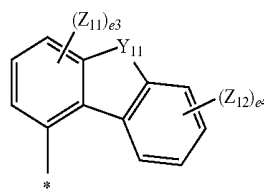
Formula 5-68

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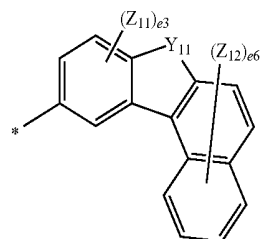
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Formula 5-69



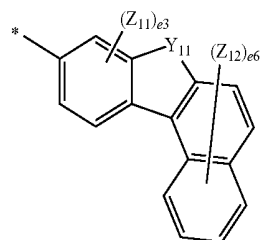
Formula 5-76

Formula 5-70



Formula 5-77

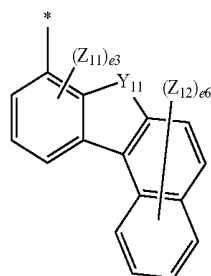
Formula 5-71



Formula 5-78

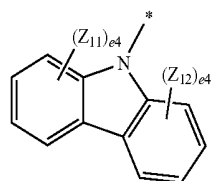
Formula 5-79

Formula 5-72



Formula 5-80

Formula 5-73



Formula 5-74

[0117] In Formulae 5-1 to 5-80,

[0118] Y_{11} may be O, S, $C(Z_{13})(Z_{14})$, $N(Z_{15})$, or $Si(Z_{16})(Z_{17})$;

Formula 5-75

[0119] Z_{11} and Z_{17} may each independently be selected from a hydrogen, a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spirofluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl

group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a biphenyl group, a terphenyl group, and $-\text{Si}(\text{Q}_{13})(\text{Q}_{14})(\text{Q}_{15})$,

[0120] wherein Q_{13} to Q_{15} may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group;

[0121] e_2 may be 1 or 2;

[0122] e_3 may be an integer selected from 1 to 3;

[0123] e_4 may be an integer selected from 1 to 4;

[0124] e_5 may be an integer selected from 1 to 5;

[0125] e_6 may be an integer selected from 1 to 6;

[0126] e_7 may be an integer selected from 1 to 7;

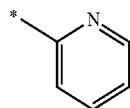
[0127] e_8 may be an integer selected from 1 to 8;

[0128] e_9 may be an integer selected from 1 to 9; and

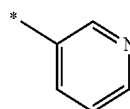
[0129] * is a binding site to a neighboring atom.

[0130] In some embodiments, in the formulae above, R_1 to R_6 , R_{12} , and R_{13} may each independently be selected from a hydrogen, a deuterium, $-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a group represented by one of the following Formulae 6-1 to 6-157, and $-\text{Si}(\text{Q}_3)(\text{Q}_4)(\text{Q}_5)$, wherein Q_3 to Q_5 may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group.

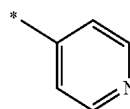
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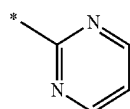
Formula 6-1



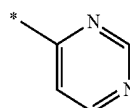
Formula 6-2



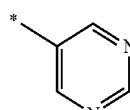
Formula 6-3



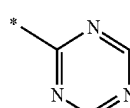
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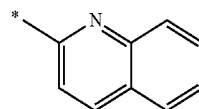
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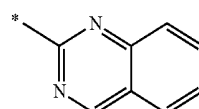
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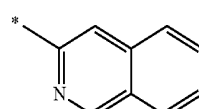
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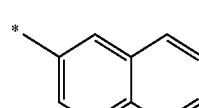
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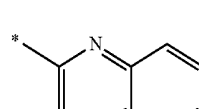
Formula 6-9



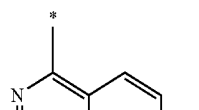
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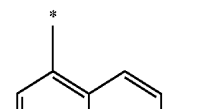
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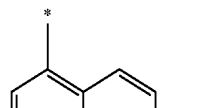
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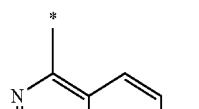
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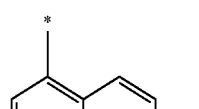
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Formula 6-15

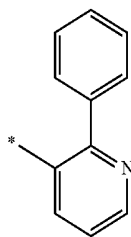


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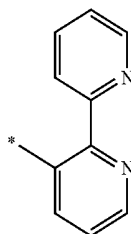


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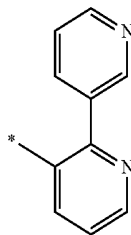
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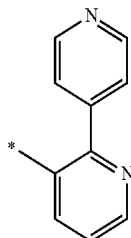
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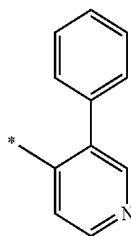
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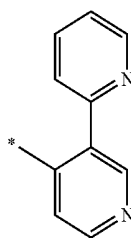
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Formula 6-21

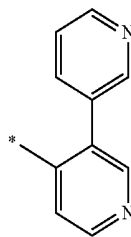


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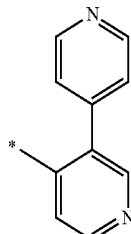


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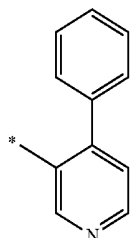
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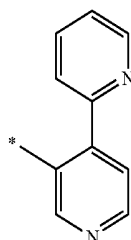
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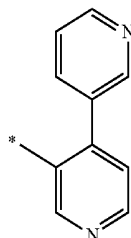
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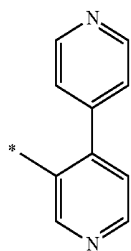
Formula 6-26



Formula 6-27

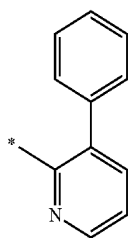


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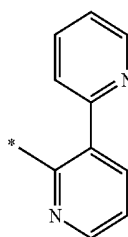


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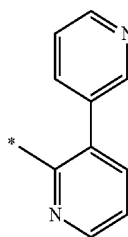
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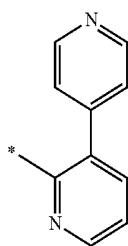
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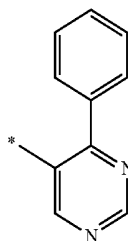
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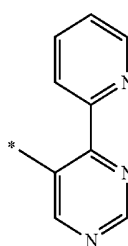
Formula 6-32



Formula 6-33

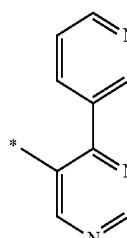


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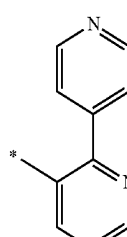


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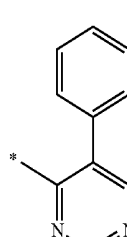
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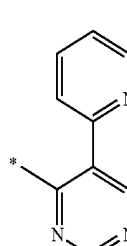
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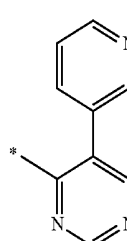
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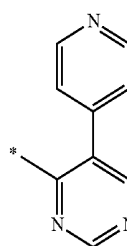
Formula 6-38



Formula 6-39

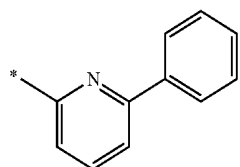


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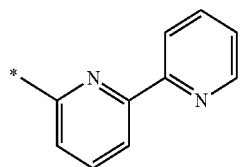


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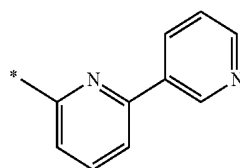
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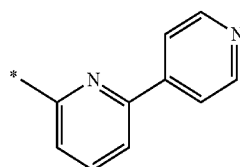
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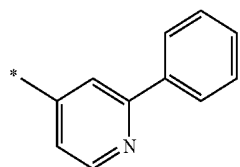
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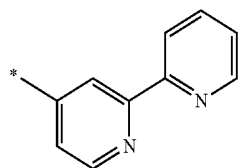
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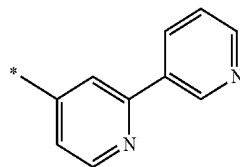
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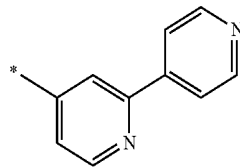
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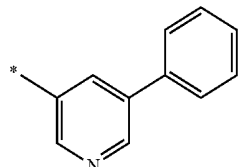
Formula 6-47



Formula 6-48

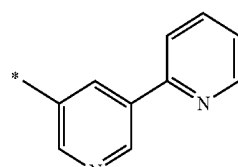


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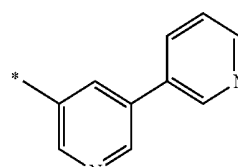


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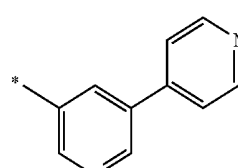
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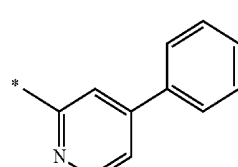
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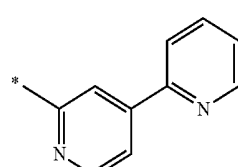
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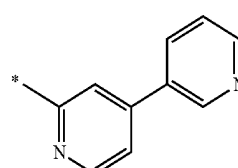
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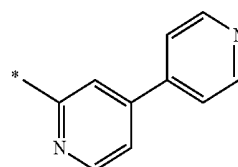
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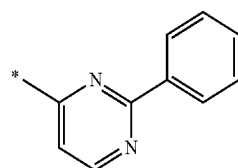
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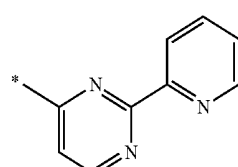
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Formula 6-57

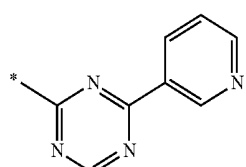
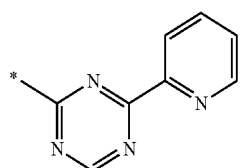
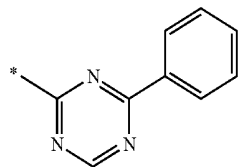
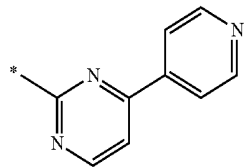
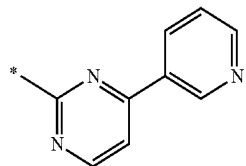
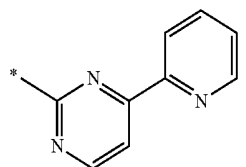
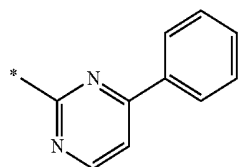
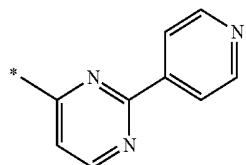
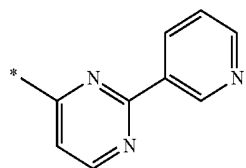


Formula 6-58



Formula 6-59

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Formula 6-60

Formula 6-61

Formula 6-62

Formula 6-63

Formula 6-64

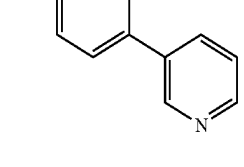
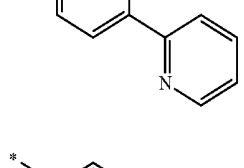
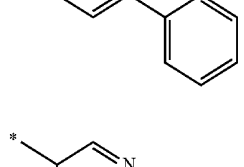
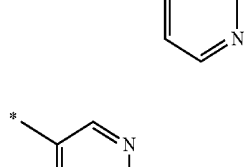
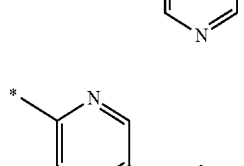
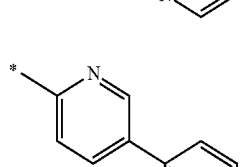
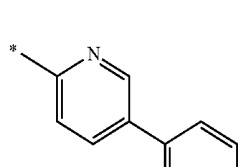
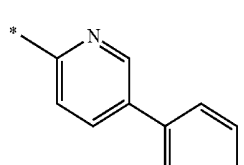
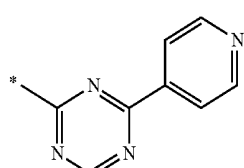
Formula 6-65

Formula 6-66

Formula 6-67

Formula 6-68

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Formula 6-69

Formula 6-70

Formula 6-71

Formula 6-72

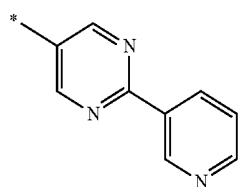
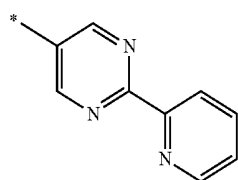
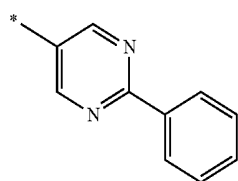
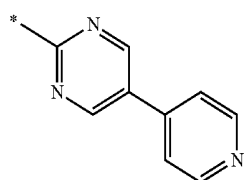
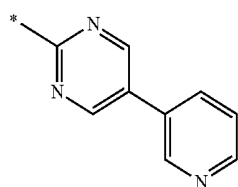
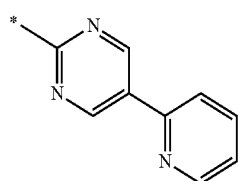
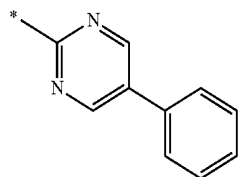
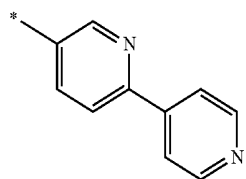
Formula 6-73

Formula 6-74

Formula 6-75

Formula 6-76

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Formula 6-77

Formula 6-78

Formula 6-79

Formula 6-80

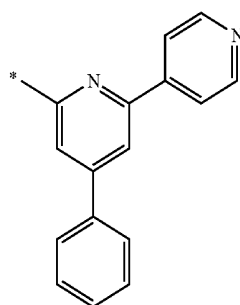
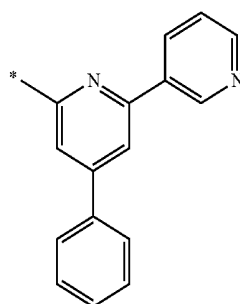
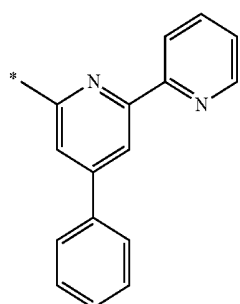
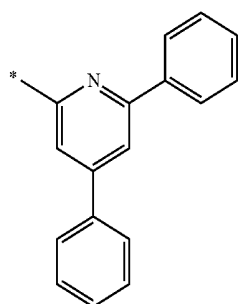
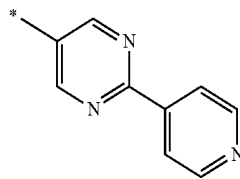
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Formula 6-82

Formula 6-83

Formula 6-84

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Formula 6-85

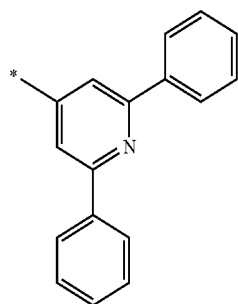
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Formula 6-87

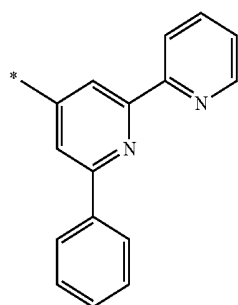
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Formula 6-89

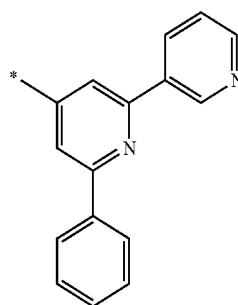
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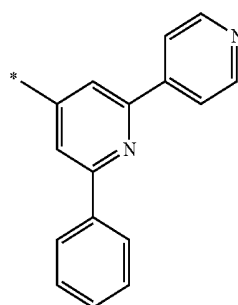
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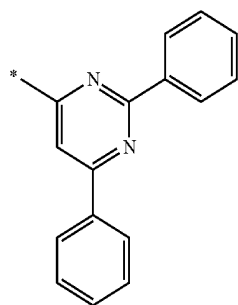
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Formula 6-92

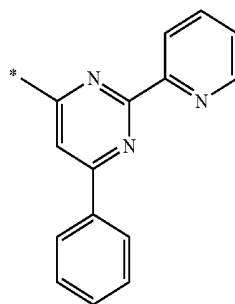


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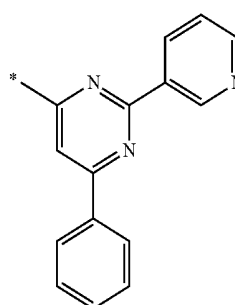


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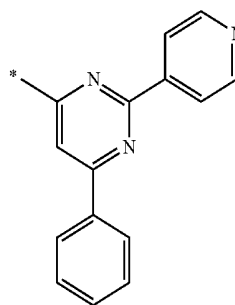
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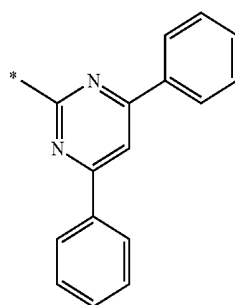
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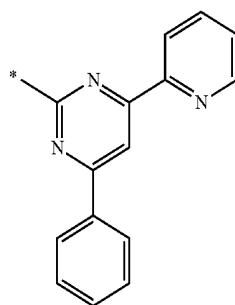
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Formula 6-97

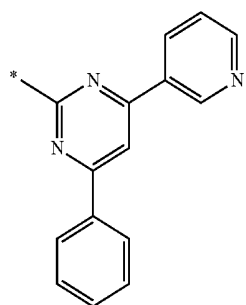


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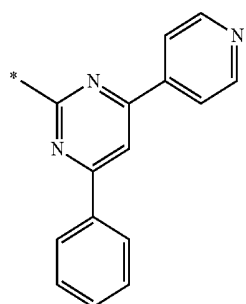


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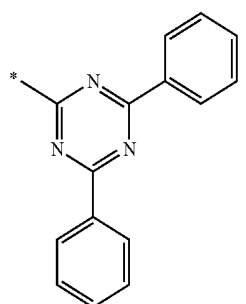
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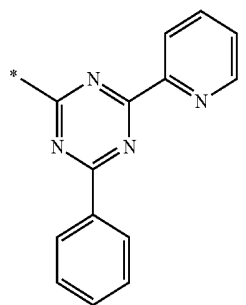
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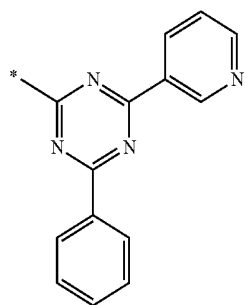
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Formula 6-102

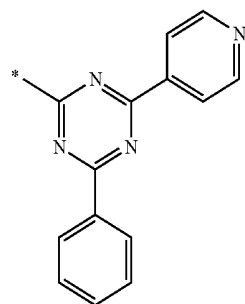


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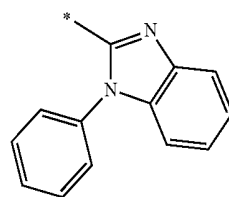


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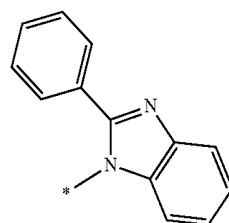
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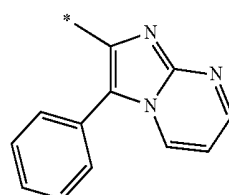
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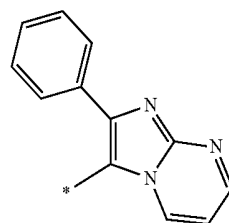
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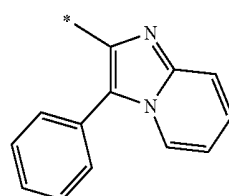
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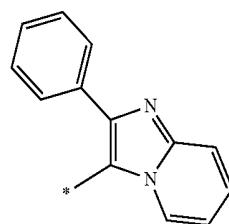
Formula 6-108



Formula 6-109

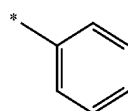
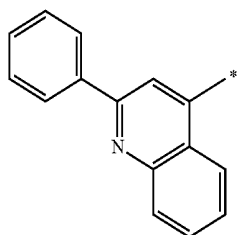
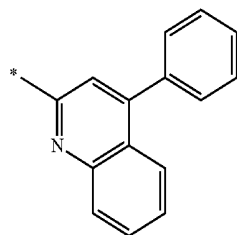
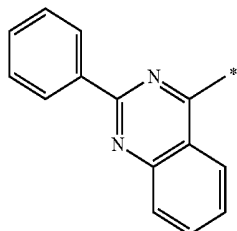
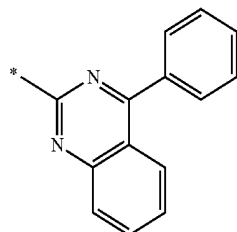
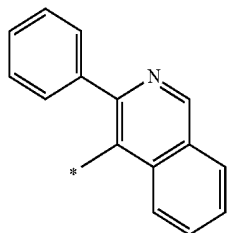
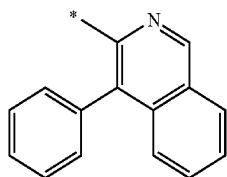


Formula 6-110



Formula 6-111

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Formula 6-112

Formula 6-113

Formula 6-114

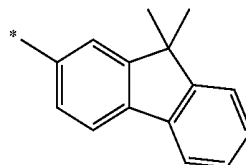
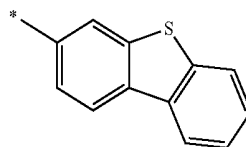
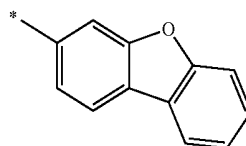
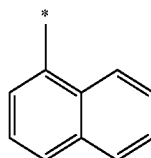
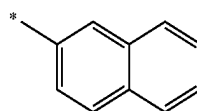
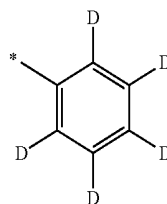
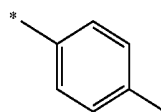
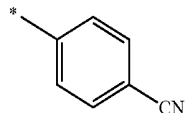
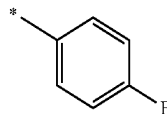
Formula 6-115

Formula 6-116

Formula 6-117

Formula 6-118

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Formula 6-119

Formula 6-120

Formula 6-121

Formula 6-122

Formula 6-123

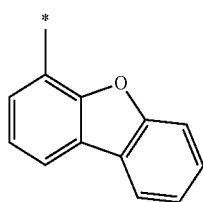
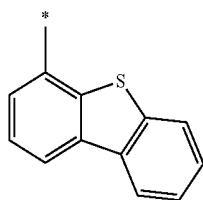
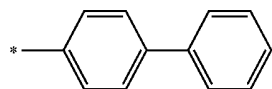
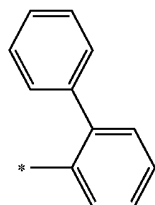
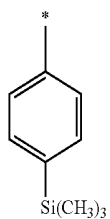
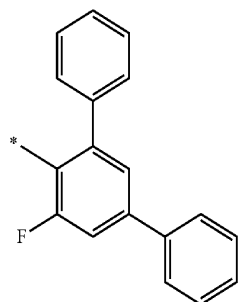
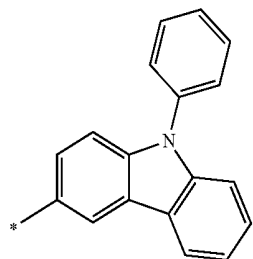
Formula 6-124

Formula 6-125

Formula 6-126

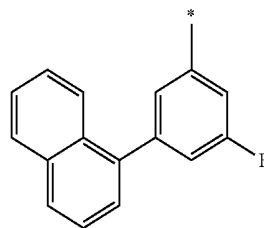
Formula 6-127

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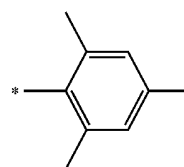
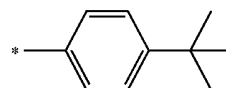


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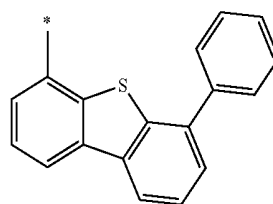
Formula 6-128



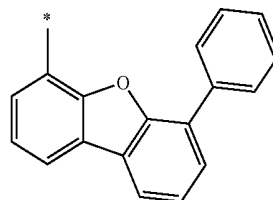
Formula 6-129



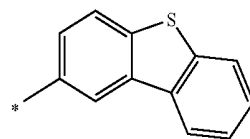
Formula 6-130



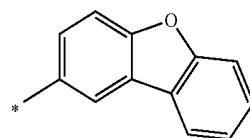
Formula 6-131



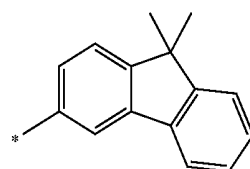
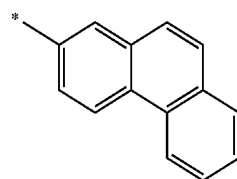
Formula 6-132



Formula 6-133



Formula 6-134



Formula 6-135

Formula 6-136

Formula 6-137

Formula 6-138

Formula 6-139

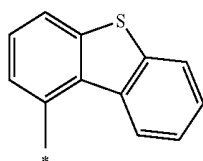
Formula 6-140

Formula 6-141

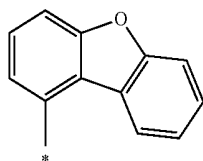
Formula 6-142

Formula 6-143

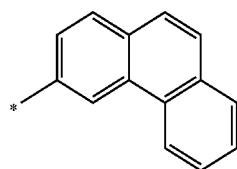
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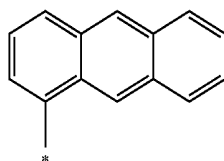
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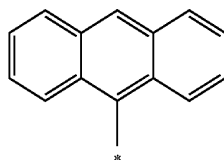
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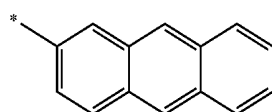
Formula 6-146



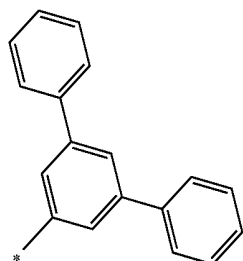
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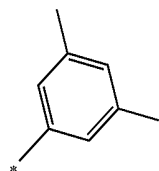
Formula 6-148



Formula 6-149

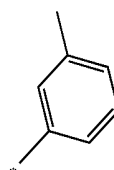


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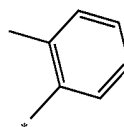


Formula 6-151

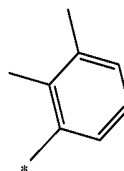
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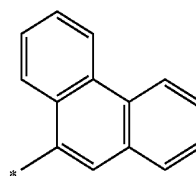
Formula 6-152



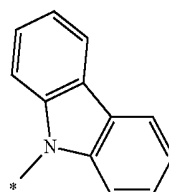
Formula 6-153



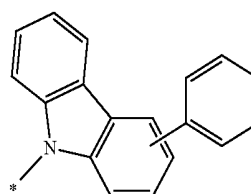
Formula 6-154



Formula 6-155



Formula 6-156



Formula 6-157

[0131] wherein, in Formulae 6-1 to 6-157, * is a binding site to a neighboring atom.

[0132] In some embodiments, in the formulae above,

[0133] R_3 to R_6 and R_{13} may each independently be selected from a hydrogen, a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, and $-Si(Q_3)(Q_4)(Q_5)$, and

[0134] R_1 , R_2 , and R_{12} may each independently be selected from or include a substituted or unsubstituted C_3 - C_{10} cycloalkyl group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkyl group, a substituted or unsubstituted

tuted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group (e.g., a group represented by one of Formulae 5-1 to 5-80, or, e.g., a group represented by one of Formulae 6-1 to 6-157).

[0135] In some embodiments, in the formulae above,

[0136] R₃ to R₆ and R₁₃ may be a hydrogen,

[0137] R₁, R₂, and R₁₂ may each independently be a group represented by one of Formulae 5-1 to 5-80 (e.g., a group represented by one of Formulae 6-1 to 6-157).

[0138] In the formulae above, b₁, b₂, b₅, b₆, and b₁₂ may each independently be an integer selected from 0 to 4, b₃ and b₄ may each independently be an integer selected from 0 to 6, and b₁₃ may be 0, 1, or 2.

[0139] For example, in the formulae above, b₁, b₂, and b₁₂ may each independently be 0, 1, or 2, e.g., 1 or 2.

[0140] In some embodiments, in the formulae above, b₁, b₂, and b₁₂ may be 1.

[0141] In some embodiments, in the formulae above, b₃ to b₆ and b₁₃ may each independently be 0, 1, or 2, e.g., 0 or 1.

[0142] In Formula 1, c₁ and c₂ may each independently be an integer selected from 0 to 4, and c₁+c₂ may be 1 or greater. For example, at least one of a group represented by *-(L₁)_{a1}-(R₁)_{b1}] and a group represented by *-(L₂)_{a2}-(R₂)_{b2}] may be essentially present in Formula 1.

[0143] In some embodiments, in Formula 1, c₁+c₂ may be 1 or 2.

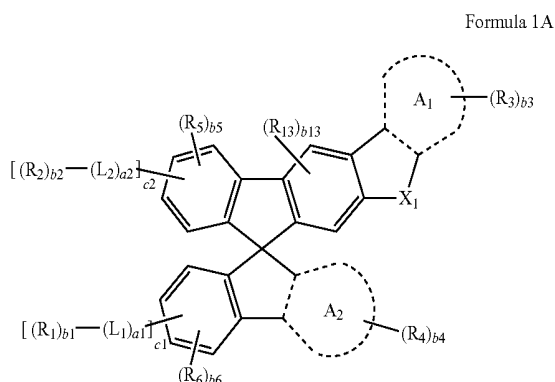
[0144] In some embodiments, in Formula 1,

[0145] c₁ may be 1, and c₂ may be 0;

[0146] c₁ may be 1, and c₂ may be 1; or

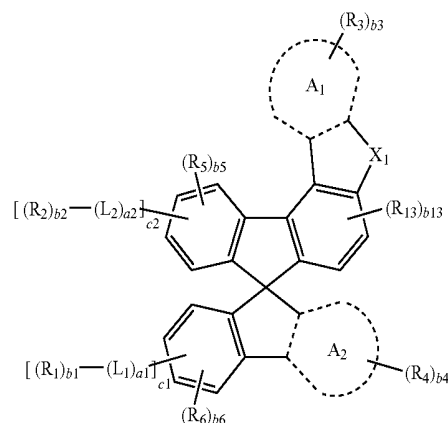
[0147] c₁ may be 0, and c₂ may be 1.

[0148] In some embodiments, the condensed-cyclic compound may be represented by one of Formulae 1A to 1E:

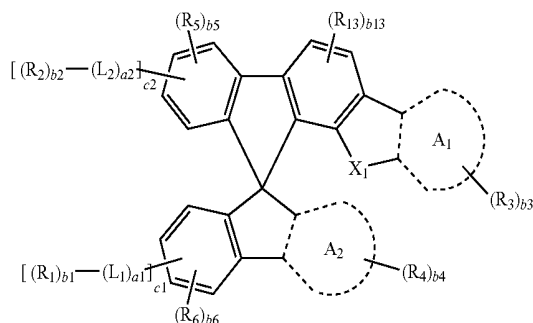


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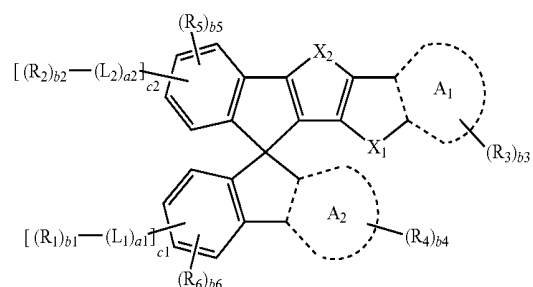
Formula 1B



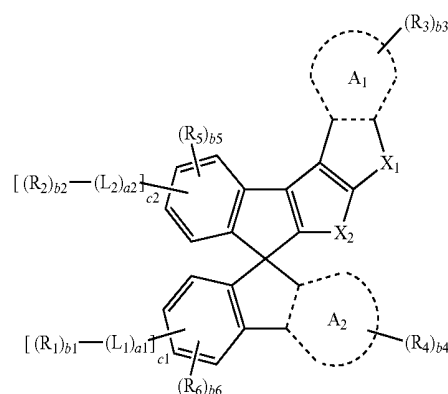
Formula 1C



Formula 1D



Formula 1E



[0149] In Formulae 1A to 1E, ring A₁, ring A₂, X₁, X₂, L₁, L₂, a₁, a₂, L₁₁, L₁₂, a₁₁, a₁₂, R₁ to R₆, R₁₁ to R₁₃, b₁ to b₆, b₁₁ to b₁₃, c₁, and c₂ are the same as the descriptions provided herein.

[0150] In some embodiments, in Formulae 1A to 1E,

[0151] ring A_1 may be a benzene or a pyridine, and ring A_2 may be selected from a benzene, a naphthalene, a pyridine, a quinoline, and an isoquinoline; or ring A_1 may be selected from a naphthalene, a quinoline, and an isoquinoline, and ring A_2 may be a benzene or a pyridine,

[0152] X_1 may be N-[(L_{11}) $_{a11}$ -(R_{11}) $_{b11}$],

[0153] X_2 may be O or S,

[0154] L_1 and L_2 may each independently be a group represented by one of Formulae 3-8, 3-9, 3-25, and 3-35 to 3-41 (e.g., a group represented by one of Formulae 4-11, 4-13, 4-27, and 4-29 to 4-35),

[0155] a_1 and a_2 may be each independently 0, 1, or 2,

[0156] L_{11} may be a group represented by one of Formulae 3-1 to 3-41 (e.g., a group represented by one of Formulae 4-1 to 4-35),

[0157] a_{11} may be 0, 1, or 2,

[0158] R_{11} may be a group represented by one of Formulae 5-1 to 5-60 (e.g., a group represented by one of Formulae 6-1 to 6-117),

[0159] b_1 may be 1 or 2,

[0160] R_1 and R_2 may each independently be a group represented by one of Formulae 5-1 to 5-80 (e.g., a group represented by one of Formulae 6-1 to 6-157),

[0161] b_1 and b_2 may each independently be 1 or 2,

[0162] R_3 to R_6 and R_{13} may each independently be selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, and —Si(Q_3)(Q_4)(Q_5),

[0163] wherein Q_3 to Q_5 may each independently be selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group;

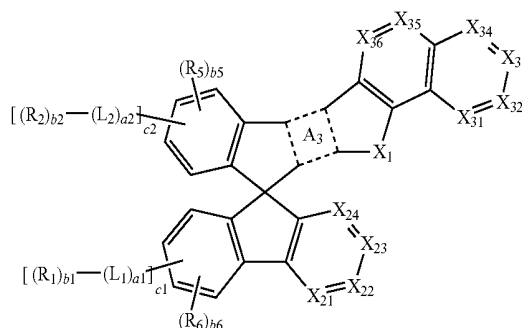
[0164] b_3 to b_6 and b_{13} may each independently be 0, 1, or 2, and

[0165] c_1 may be 1, and c_2 may be 0; c_1 may be 1, and c_2 may be 1; or c_1 may be 0, and c_2 may be 1.

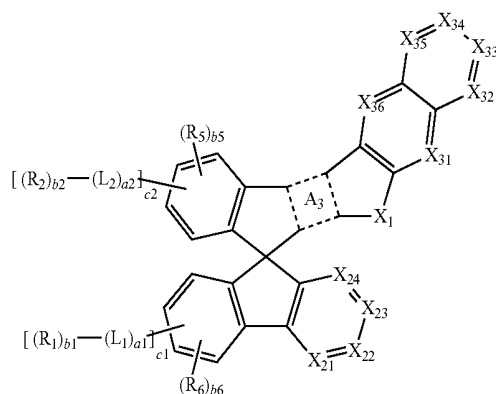
[0166] In some embodiments, the condensed-cyclic compound may be represented by one of the following Formulae 1-1 to 1-7:

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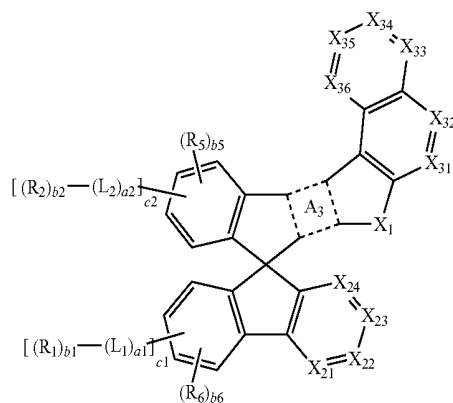
Formula 1-2



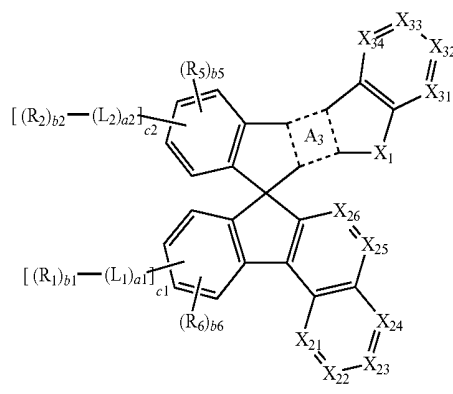
Formula 1-3



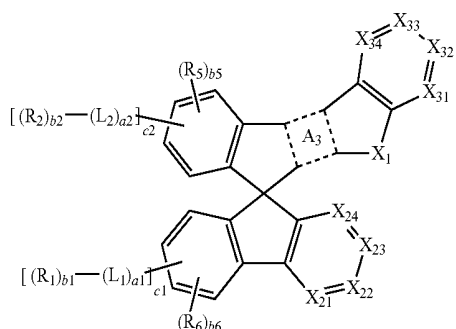
Formula 1-4



Formula 1-5

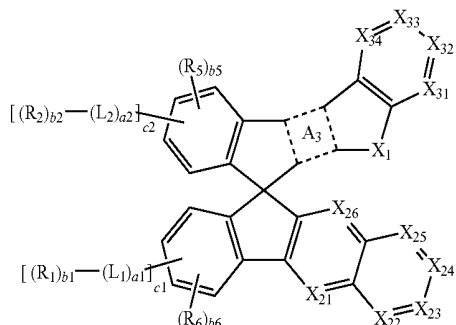


Formula 1-1

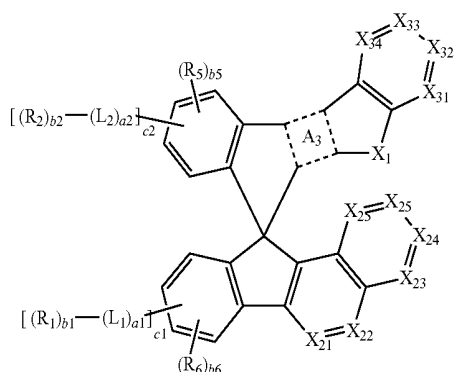


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Formula 1-6



Formula 1-7



[0167] wherein, in Formulae 1-1 to 1-7,

[0168] ring A₃, X₁, X₂, L₁, L₂, a₁, a₂, L₁₁, L₁₂, a₁₁, a₁₂, R₁, R₂, R₅, R₆, R₁₁ to R₁₃, b₁, b₂, b₅, b₆, b₁₁ to b₁₃, and c₁ and c₂ are the same as the descriptions provided herein,

[0169] X₂₁ may be N or C(R₂₁), X₂₂ may be N or C(R₂₂), X₂₃ may be N or C(R₂₃), X₂₄ may be N or C(R₂₄), X₂₅ may be N or C(R₂₅), X₂₆ may be N or C(R₂₆), X₃₁ may be N or C(R₃₁), X₃₂ may be N or C(R₃₂), X₃₃ may be N or C(R₃₃), X₃₄ may be N or C(R₃₄), X₃₅ may be N or C(R₃₅), and X₃₆ may be N or C(R₃₆),

[0170] R₂₁ to R₂₆ are the same as defined in connection with R₃, and

[0171] R₃₁ to R₃₆ are the same as defined in connection with R₄.

[0172] In some embodiments,

[0173] the number of nitrogen atoms of X₂₁ to X₂₄ and X₃₁ to X₃₄ in Formula 1-1 may be 0, 1, or 2;

[0174] the number of nitrogen atoms of X₂₁ to X₂₄ and X₃₁ to X₃₆ in Formulae 1-2 to 1-4 may be 0, 1, or 2; and

[0175] the number of nitrogen atoms of X₂₁ to X₂₆ and X₃₁ to X₃₆ in Formulae 1-5 to 1-7 may be 0, 1, or 2.

[0176] In some embodiments,

[0177] the number of nitrogen atoms of X₂₁ to X₂₄ in Formulae 1-1 to 1-4 may be 0 or 1;

[0178] the number of nitrogen atoms of X₃₁ to X₃₄ in Formulae 1-1 and 1-5 to 1-7 may be 0 or 1;

[0179] the number of nitrogen atoms of X₂₁ to X₂₆ in Formulae 1-5 to 1-7 may be 0 or 1; and

[0180] the number of nitrogen atoms of X₃₁ to X₃₆ in Formulae 1-2 to 1-4 may be 0 or 1.

[0181] For example, ring A₃ in Formulae 1-1 to 1-7 may be a group represented by Formula 2A.

[0182] In some embodiments, in Formulae 1-1 to 1-7,

[0183] X₁ may be N-[(L₁₁)_{a11}-(R₁₁)_{b11}],

[0184] X₂ may be O or S,

[0185] L₁ and L₂ may each independently be a group represented by one of Formulae 3-8, 3-9, 3-25, and 3-35 to 3-41 (e.g., a group represented by one of Formulae 4-11, 4-13, 4-27, and 4-29 to 4-35);

[0186] a₁ and a₂ may each independently be 0, 1, or 2;

[0187] L₁₁ may be a group represented by one of Formulae 3-1 to 3-41 (e.g., a group represented by one of Formulae 4-1 to 4-35);

[0188] a₁₁ may be 0, 1, or 2;

[0189] R₁₁ may be a group represented by one of Formulae 5-1 to 5-60 (e.g., a group represented by one of Formulae 6-1 to 6-117);

[0190] b₁₁ may be 1 or 2;

[0191] R₁ and R₂ may each independently be a group represented by one of Formulae 5-1 to 5-80 (e.g., a group represented by one of Formulae 6-1 to 6-157);

[0192] b₁ and b₂ may each independently be 1 or 2;

[0193] R₃ to R₆ and R₁₃ may each independently be selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, and —Si(Q₃)(Q₄)(Q₅),

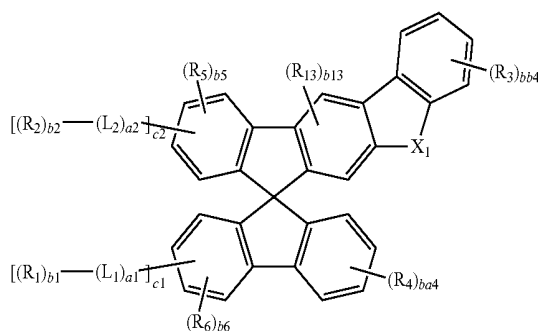
[0194] wherein Q₃ to Q₅ may each independently be selected from a C₁-C₁₀ alkyl group, a C₁-C₁₀ alkoxy group, a phenyl group, and a naphthyl group;

[0195] b₃ to b₆ and b₁₃ may each independently be 0, 1, or 2; and

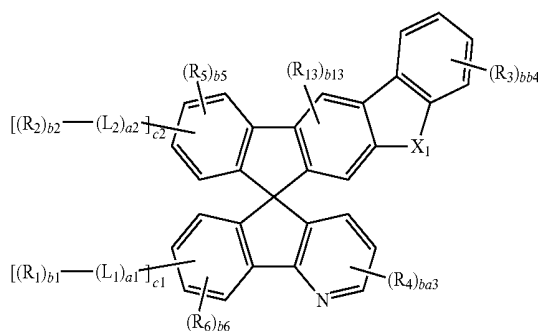
[0196] c₁ may be 1, and c₂ may be 0; c₁ may be 1, and c₂ may be 1; or c₁ may be 0, and c₂ may be 1.

[0197] In some embodiments, the condensed-cyclic compound may be represented by one of the following Formulae 1(1) to 1(42).

Formula 1(1)

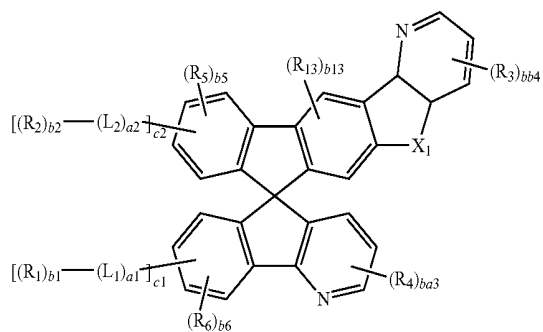


Formula 1(2)



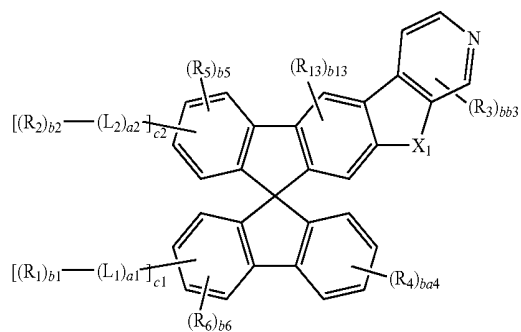
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Formula 1(3)

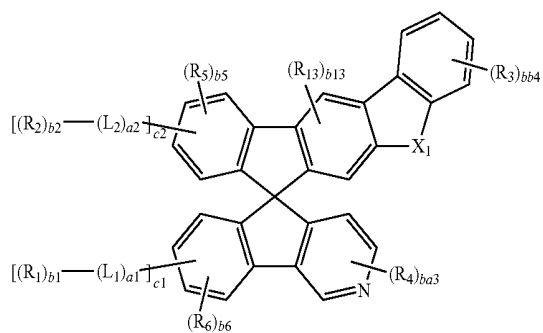


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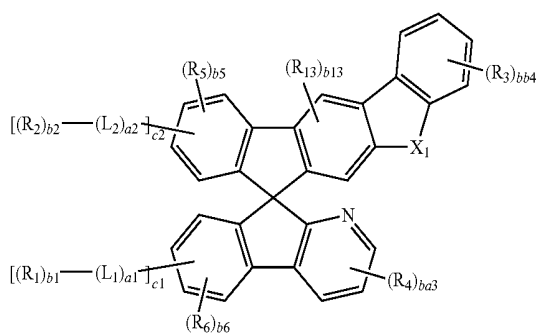
Formula 1(7)



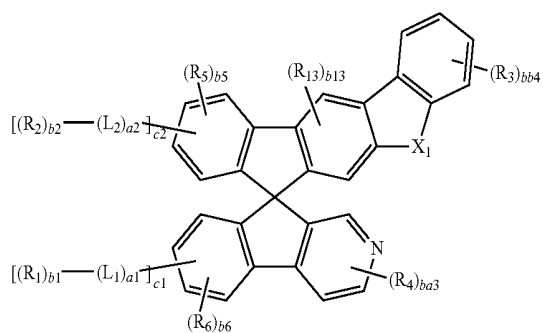
Formula 1(4)



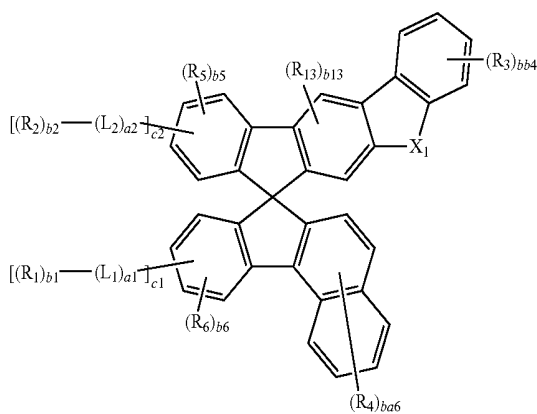
Formula 1(8)



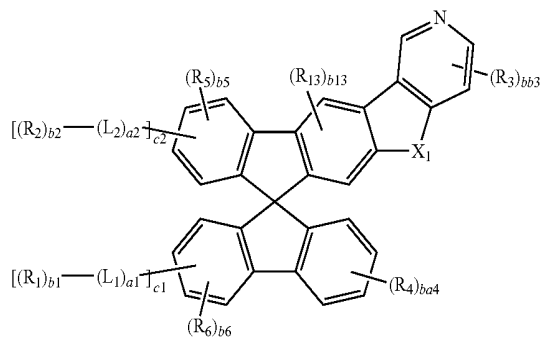
Formula 1(5)



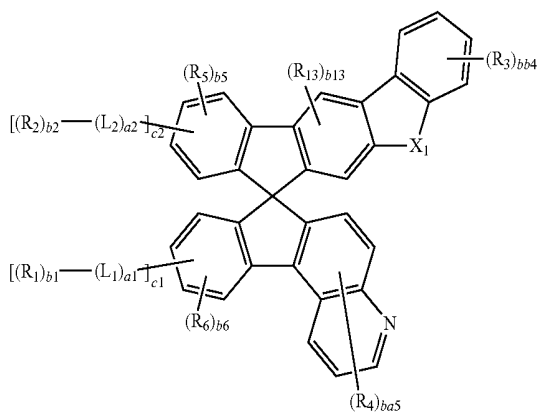
Formula 1(9)



Formula 1(6)

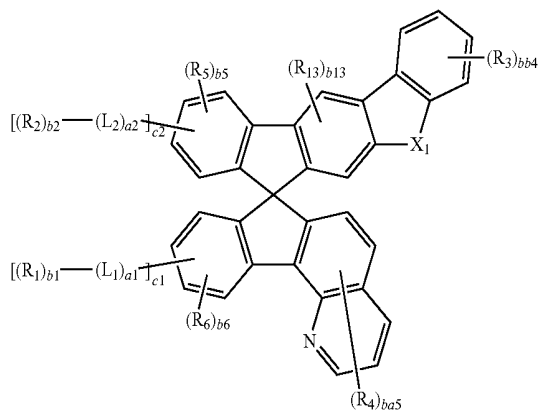


Formula 1(10)



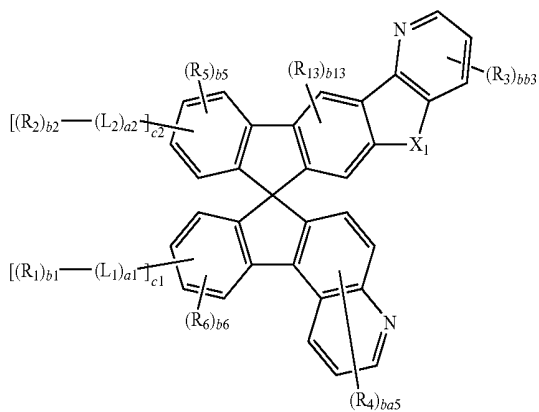
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Formula 1(11)

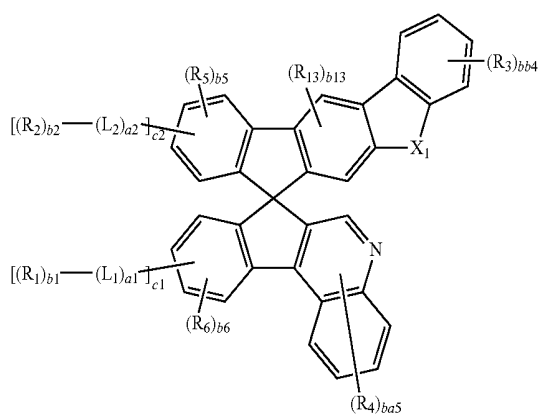


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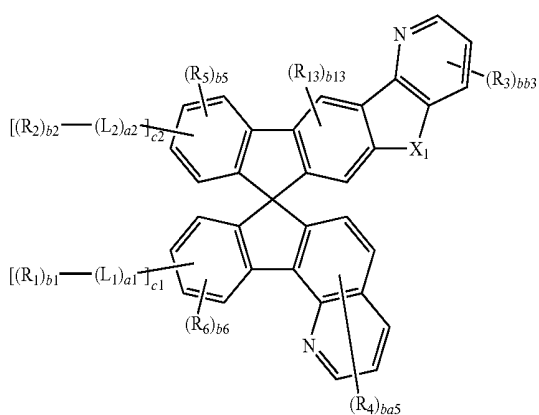
Formula 1(14)



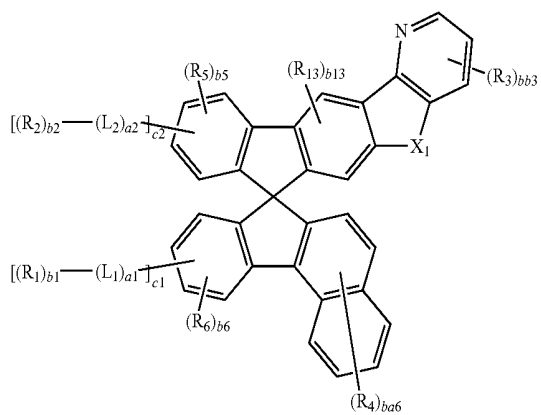
Formula 1(12)



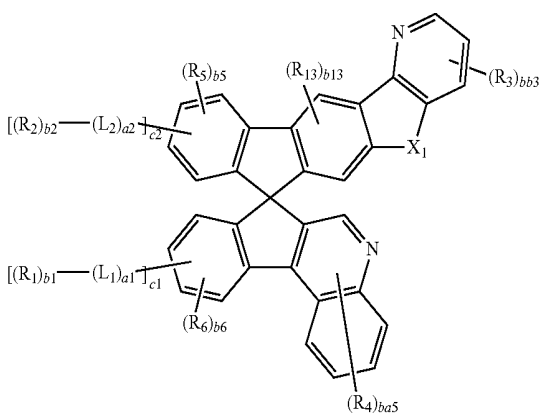
Formula 1(15)



Formula 1(13)

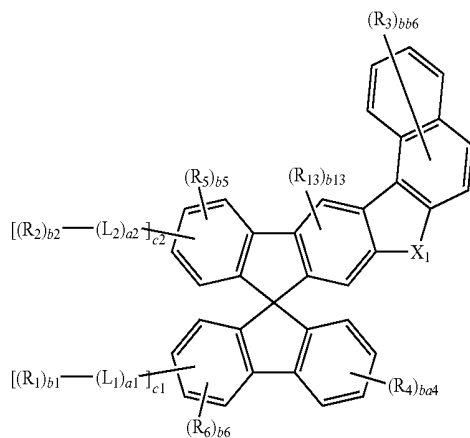


Formula 1(16)



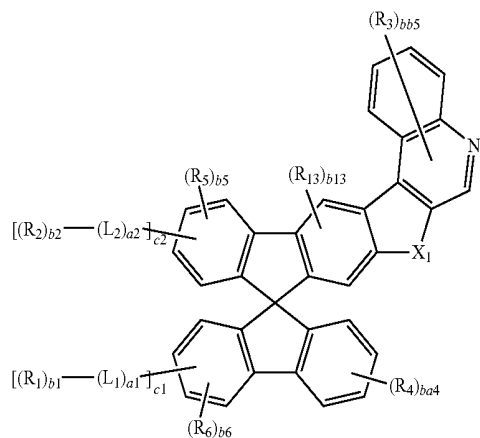
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Formula 1(17)

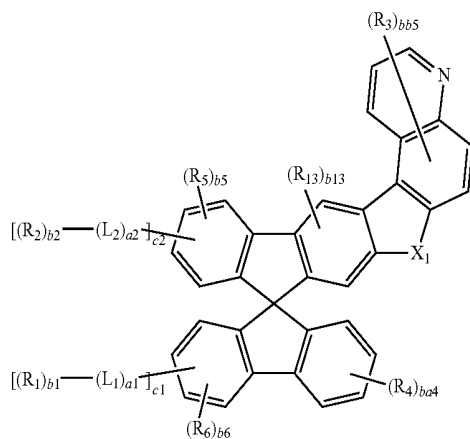


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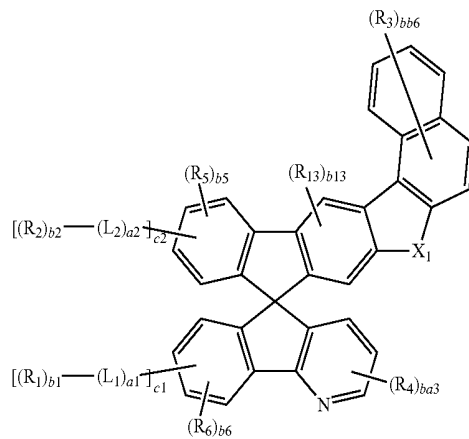
Formula 1(20)



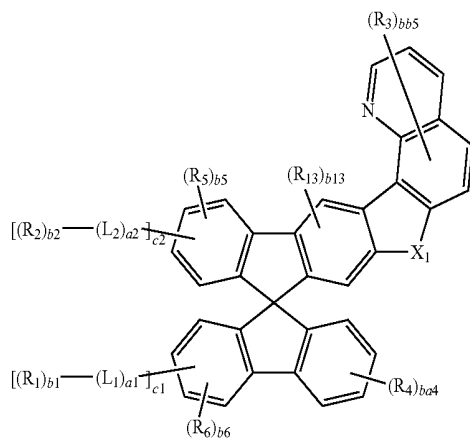
Formula 1(18)



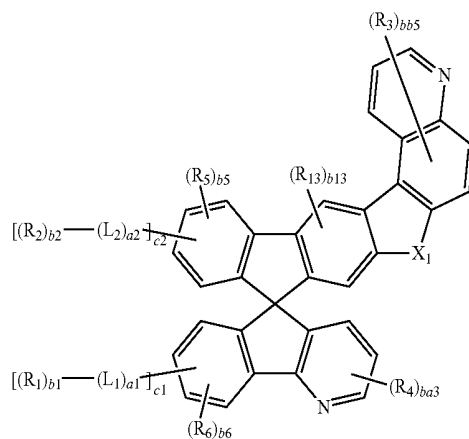
Formula 1(21)



Formula 1(19)

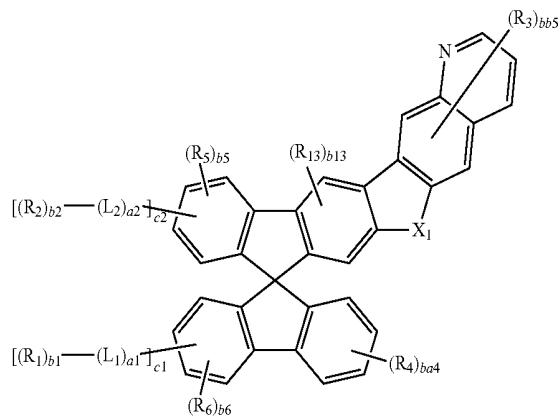


Formula 1(22)

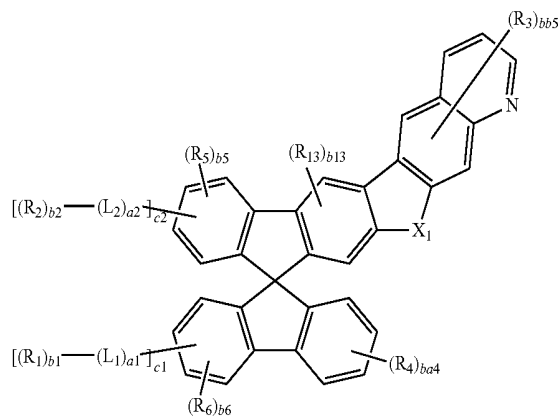


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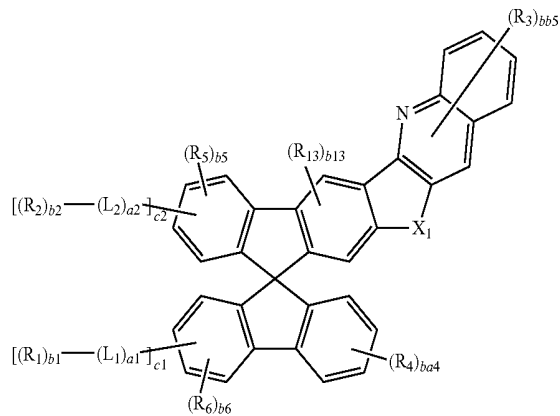
Formula 1(26)



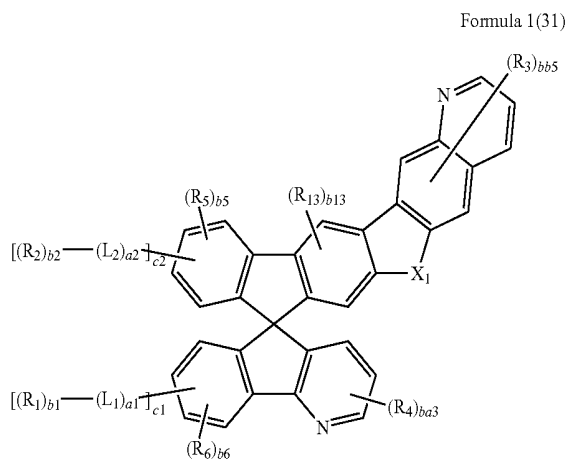
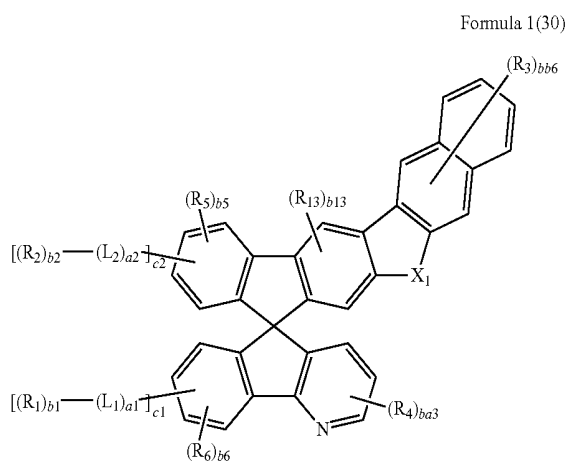
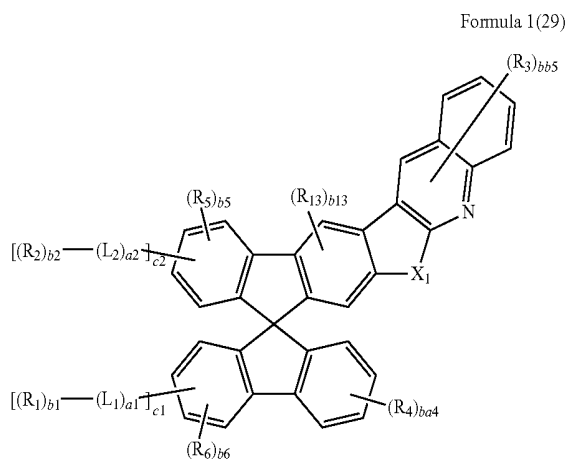
Formula 1(27)



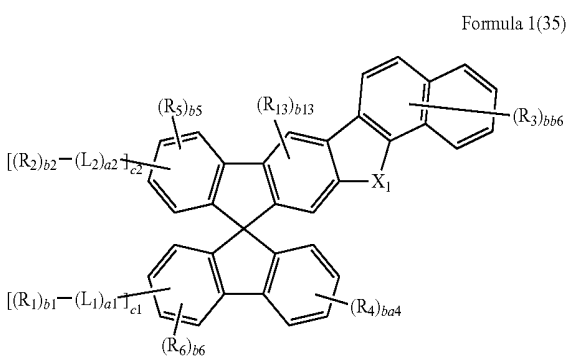
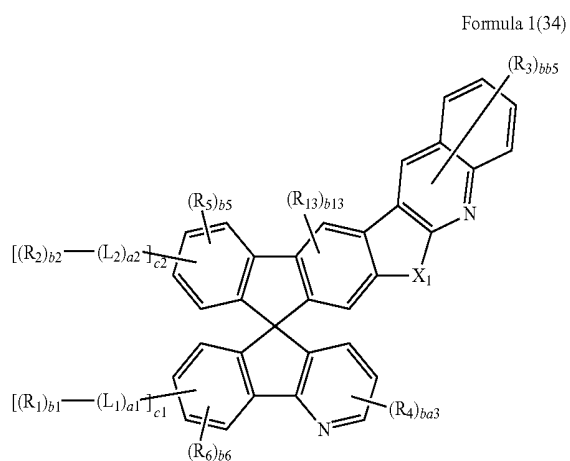
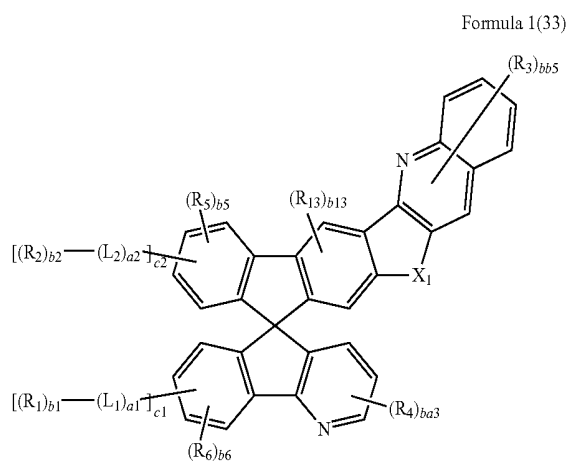
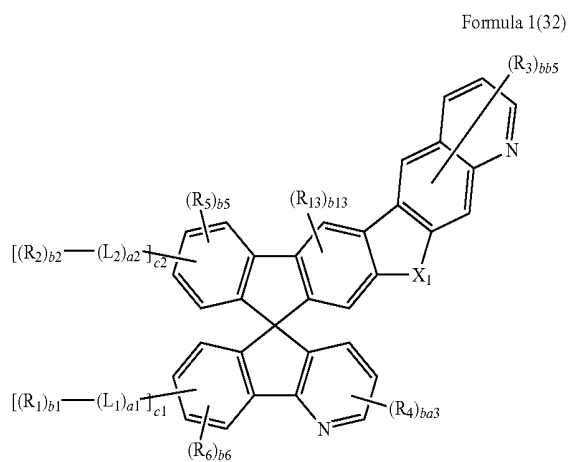
Formula 1(28)



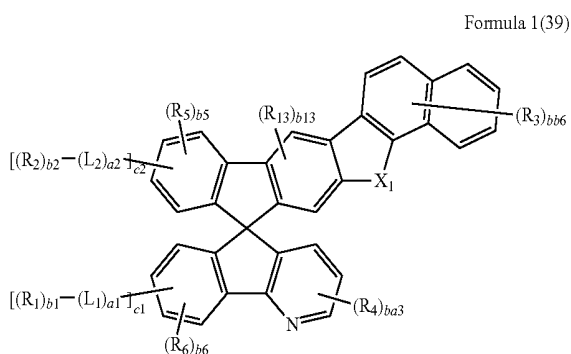
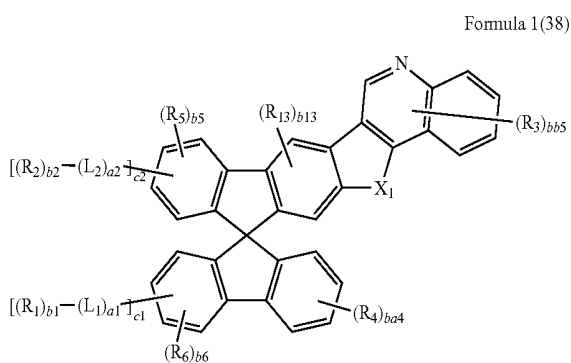
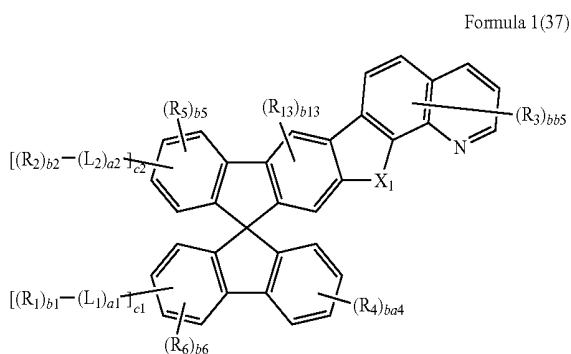
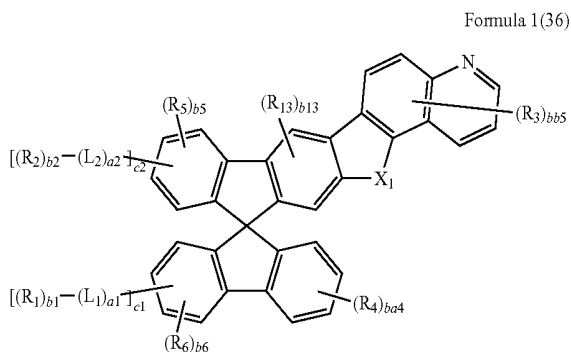
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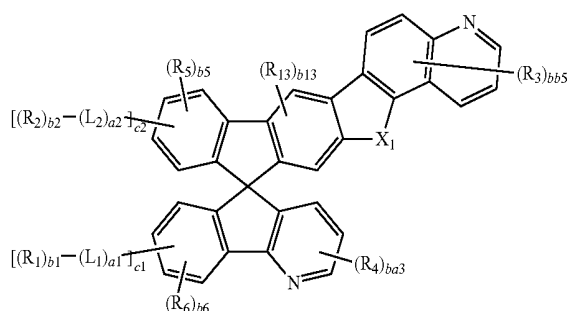


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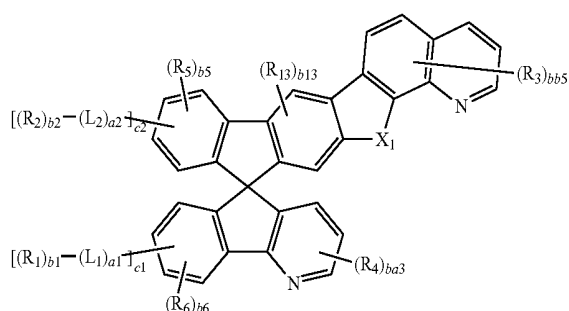


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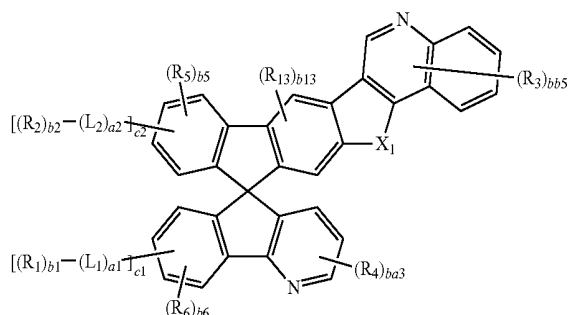
Formula 1(40)



Formula 1(41)



Formula 1(42)



[0198] wherein in Formulae 1(1) to 1(42),

[0199] X_1 , L_1 , L_2 , a_1 , a_2 , L_{11} , a_{11} , R_1 to R_6 , R_{11} , R_{13} , b_1 to b_6 , b_{11} , b_{13} , c_1 , and c_2 are the same as the descriptions provided herein,

[0200] ba_3 and bb_3 may each independently be an integer selected from 0 to 3,

[0201] ba_4 and bb_4 may each independently be an integer selected from 0 to 4,

[0202] ba_5 and bb_5 may each independently be an integer selected from 0 to 5, and

[0203] ba_6 and bb_6 may each independently be an integer selected from 0 to 6.

[0204] In some embodiments, in Formulae 1(1) to 1(40),

[0205] X_1 may be $N-[(L_{11})_{a_{11}}-(R_{11})_{b_{11}}]$,

[0206] X_2 may be O or S,

[0207] L_1 and L_2 may each independently be a group represented by one of Formulae 3-8, 3-9, 3-25, and 3-35 to 3-41 (e.g., a group represented by one of Formulae 4-11, 4-13, 4-27, and 4-29 to 4-35);

[0208] a_1 and a_2 may each independently be selected from 0, 1, and 2;

[0209] L_{11} may be a group represented by one of Formulae 3-1 to 3-41 (e.g., a group represented by one of Formulae 4-1 to 4-35),

[0210] a₁₁ may be 0, 1, or 2;

[0211] R₁₁ may be a group represented by one of Formulae 5-1 to 5-60 (e.g., a group represented by one of Formulae 6-1 to 6-117);

[0212] b₁₁ may be 1 or 2;

[0213] R₁ and R₂ may each independently be a group represented by one of Formulae 5-1 to 5-80 (e.g., a group represented by one of Formulae 6-1 to 6-157);

[0214] b₁ and b₂ may each independently be 1 or 2;

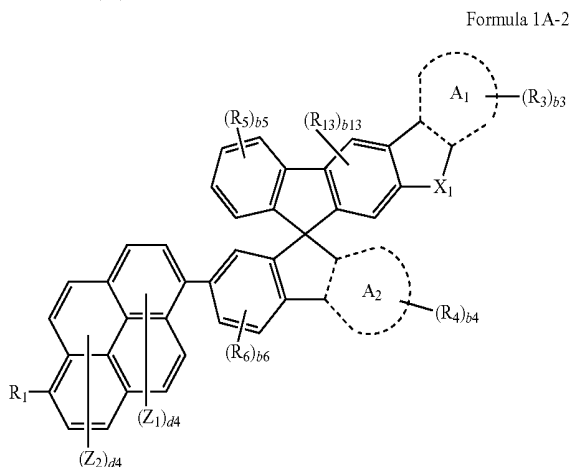
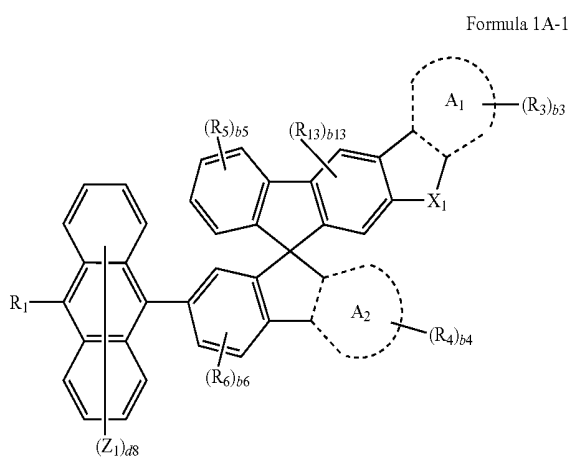
[0215] R₃ to R₆ and R₁₃ may each independently be selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, and —Si(Q₃)(Q₄)(Q₅),

[0216] wherein Q₃ to Q₅ may each independently be selected from a C₁-C₁₀ alkyl group, a C₁-C₁₀ alkoxy group, a phenyl group, and a naphthyl group;

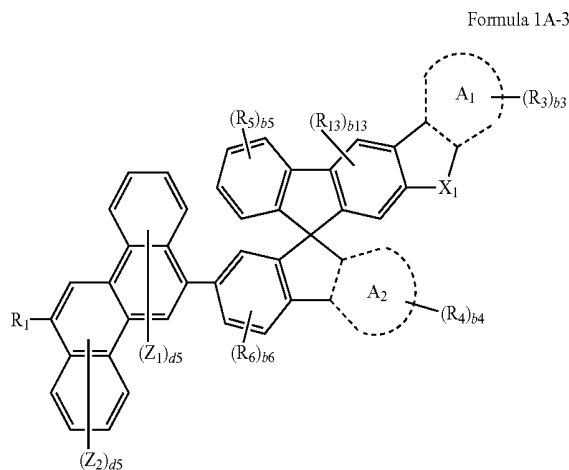
[0217] b_{a3}, b_{b3}, b_{a4}, b_{b4}, b_{a5}, b_{b5}, b_{a6}, b_{b6}, b₅, and b₆ may each independently be 0, 1, or 2, and

[0218] c₁ may be 1, and c₂ may be 0; c₁ may be 1, and c₂ may be 1; or c₁ may be 0, and c₂ may be 1.

[0219] According to some embodiments, the condensed-cyclic compound may be represented by one of the following Formulae 1A-1 to 1A-3.



-continued



[0220] In Formulae 1A-1 to 1A-3, ring A₁, ring A₂, X₁, L₁₁, L₁₂, a₁₁, a₁₂, R₁, R₃ to R₆, R₁₁ to R₁₃, b₃ to b₆, b₁₁ to b₁₃, c₁, and c₂ are the same as the descriptions provided herein.

[0221] In some embodiments, in Formulae 1A-1 to 1A-3, ring A₁ and ring A₂ may each independently be selected from a benzene, a naphthalene, a pyridine, a quinoline, and an isoquinoline,

[0222] X₁ may be N-[(L₁₁)_{a11}-(R₁₁)_{b11}],

[0223] L₁₁ may be a group represented by one of Formulae 3-1 to 3-41 (e.g., a group represented by one of Formulae 4-1 to 4-35);

[0224] a₁₁ may be 0, 1, or 2;

[0225] R₁₁ may be a group represented by one of Formulae 5-1 to 5-60 (e.g., a group represented by one of Formulae 6-1 to 6-117);

[0226] b₁₁ may be 1 or 2;

[0227] R₁ may be a group represented by one of Formulae 5-1 to 5-80 (e.g., a group represented by one of Formulae 6-1 to 6-157),

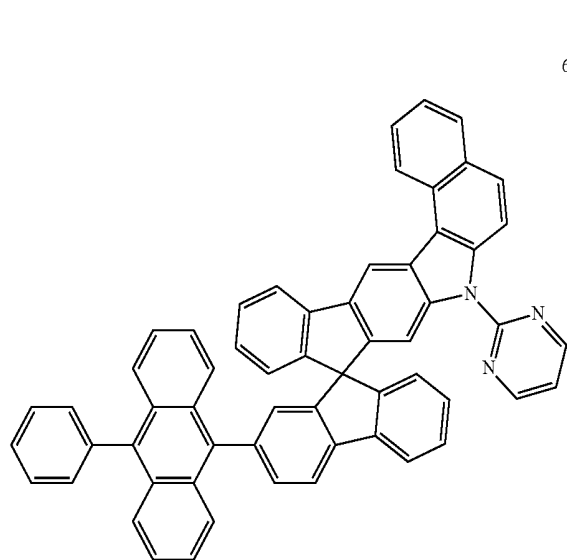
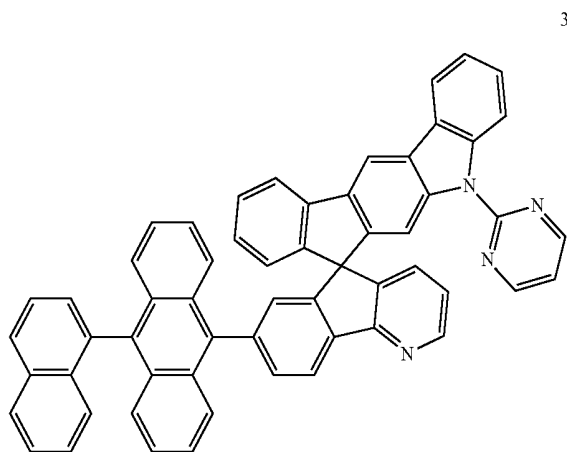
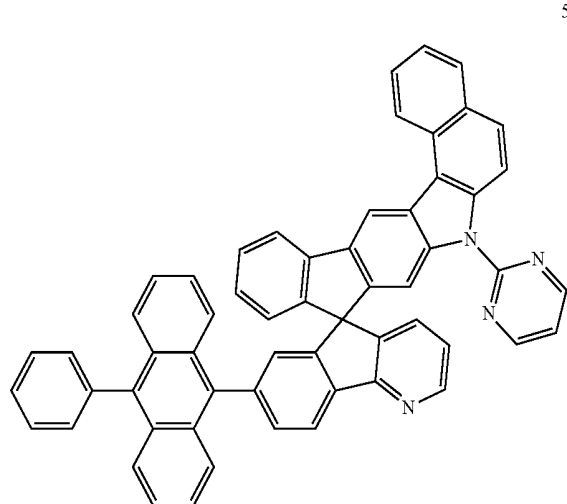
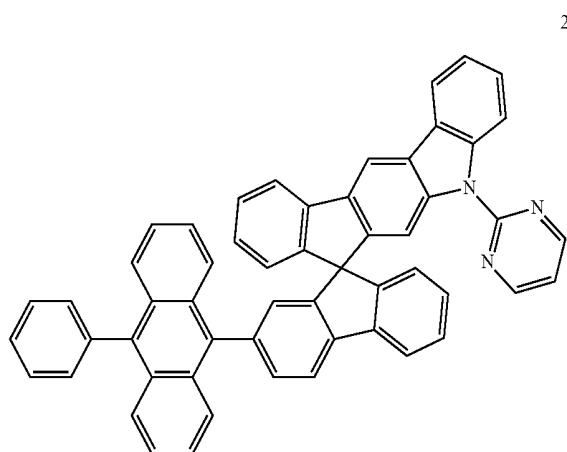
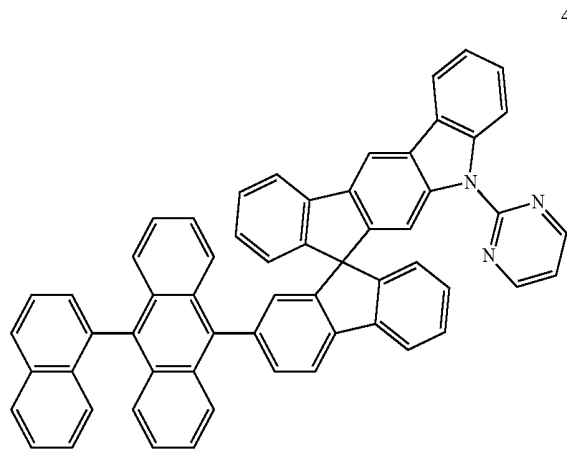
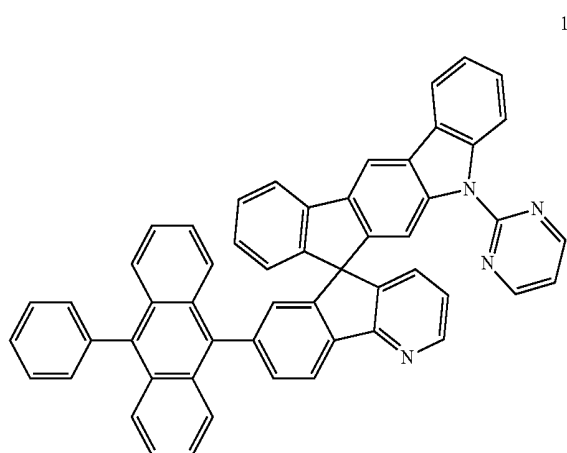
[0228] b₁ may be 1 or 2,

[0229] R₃ to R₆, R₁₃, Z₁, and Z₂ may each independently be selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, and a naphthyl group,

[0230] b₃ to b₆, b₁₃, d₄, d₅, and d₈ may each independently be 0, 1, or 2.

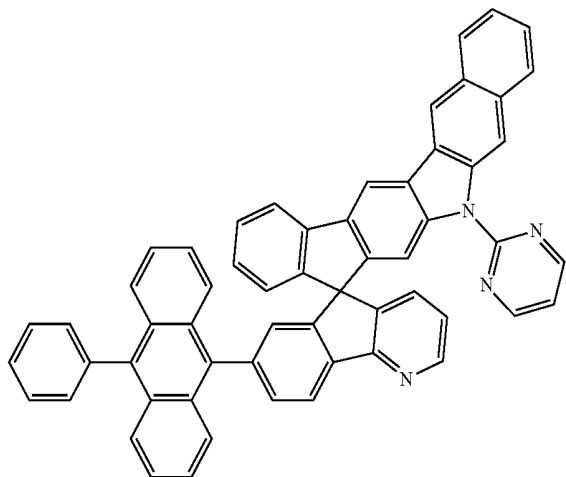
[0231] In some embodiments, the condensed-cyclic compound represented by Formula 1 may be one of the following Compounds 1 to 36.

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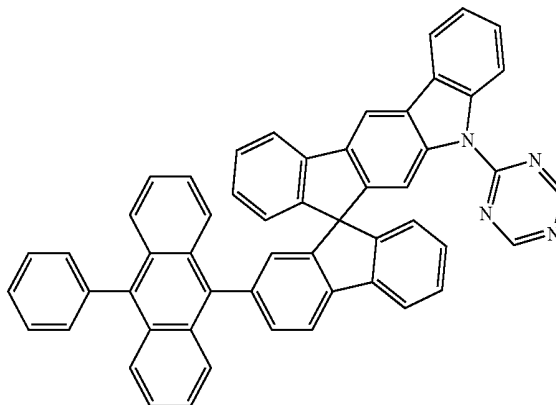
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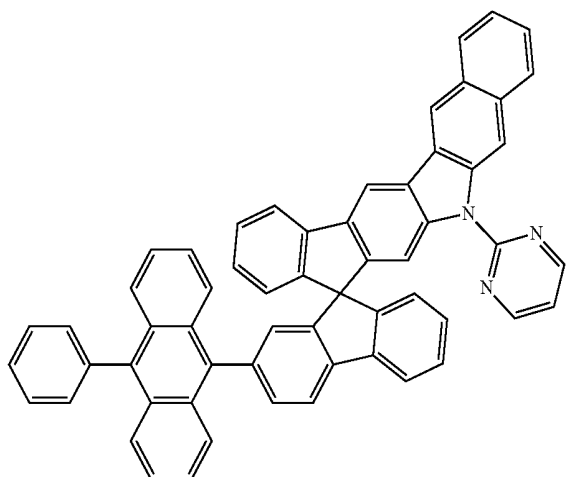


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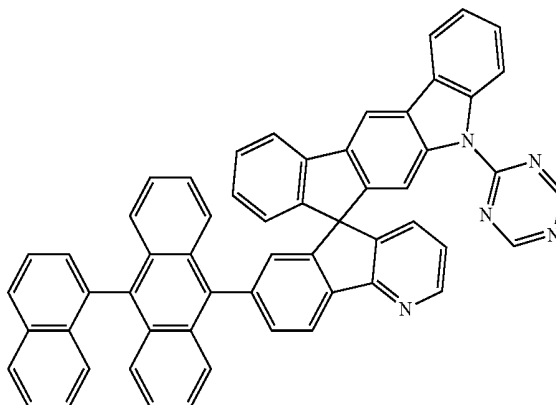
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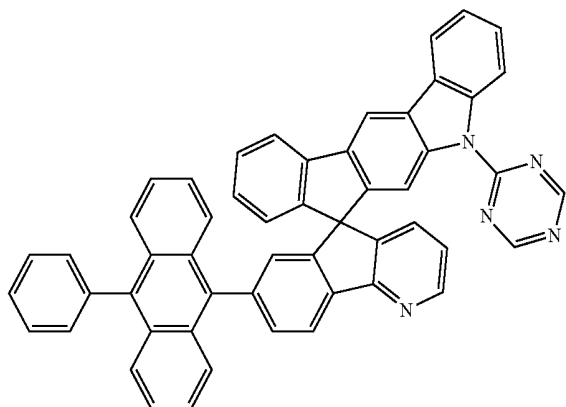
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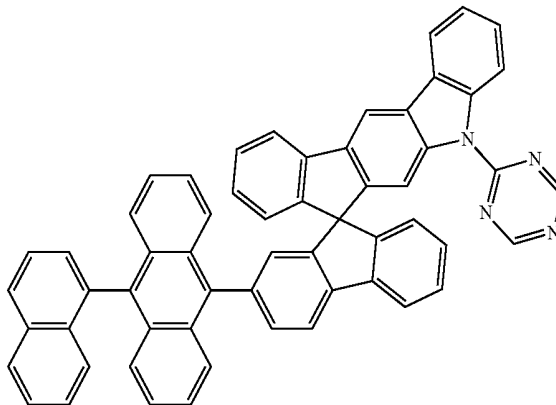
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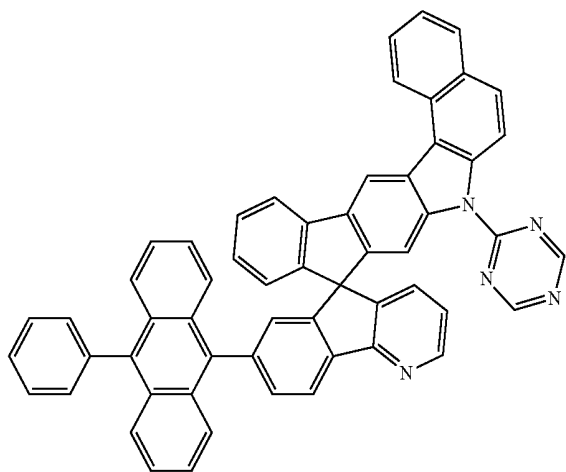


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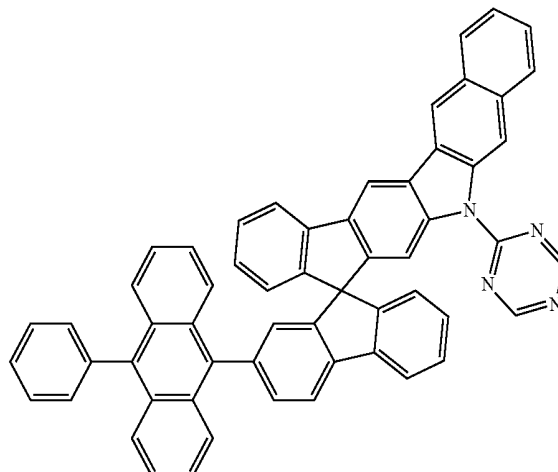
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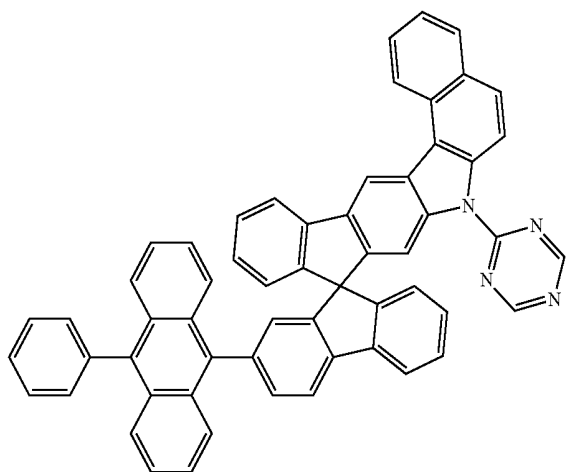


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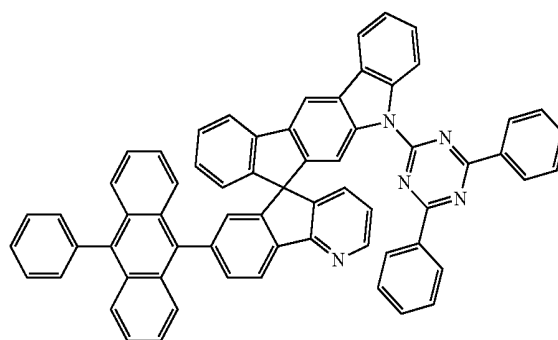
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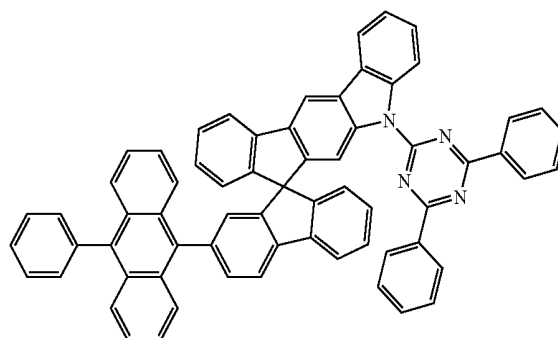
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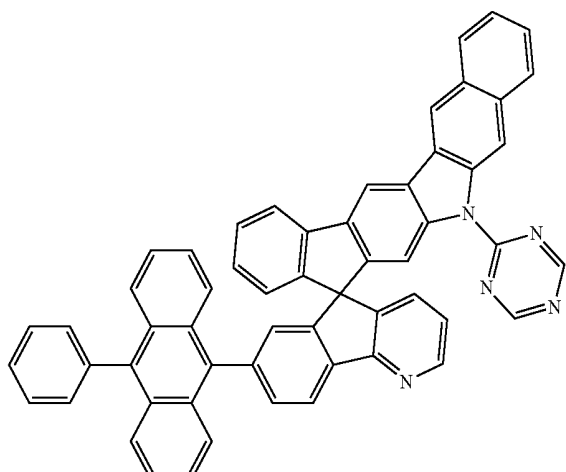
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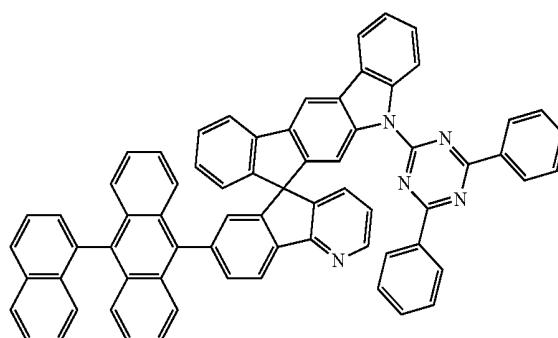
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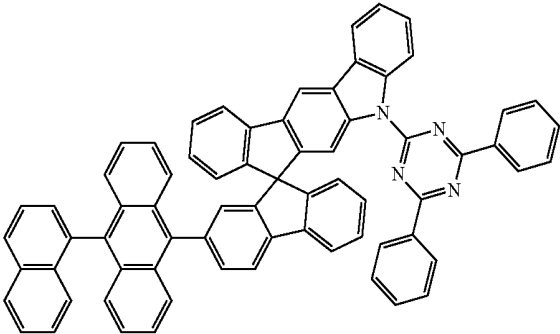


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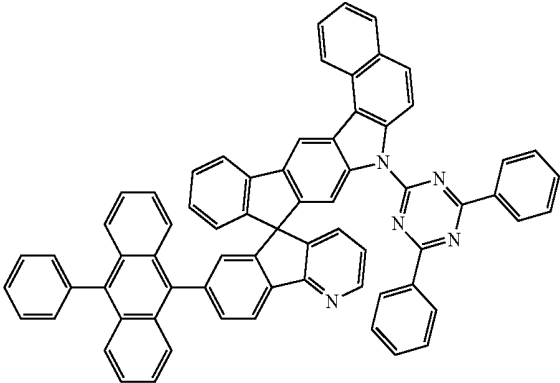


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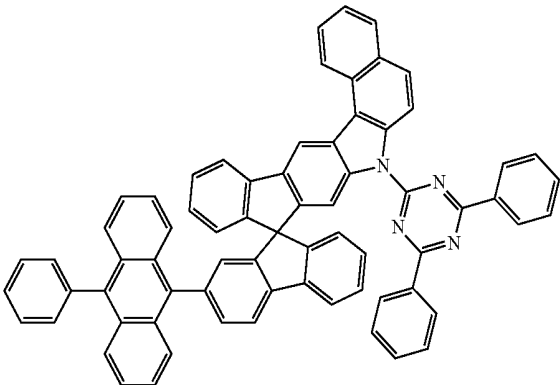
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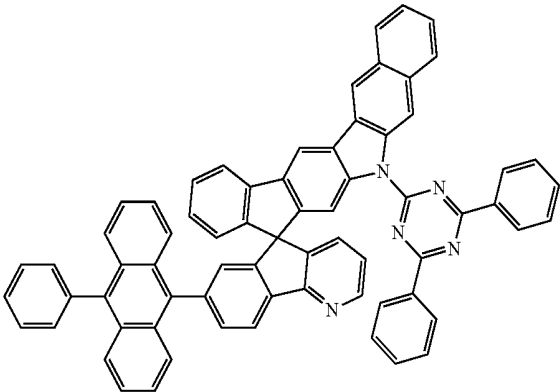
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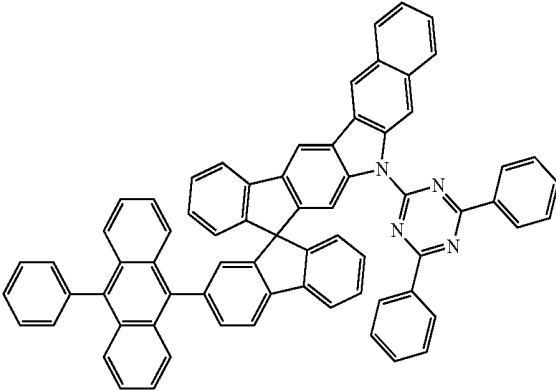


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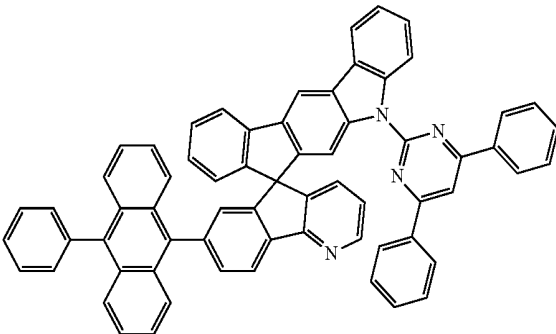


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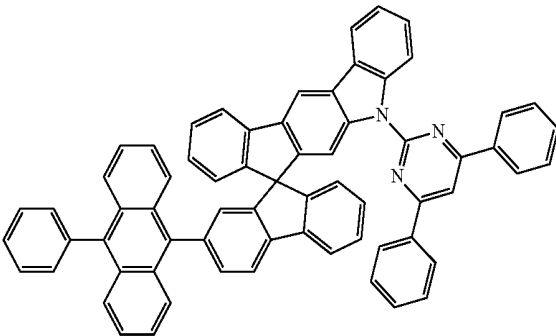
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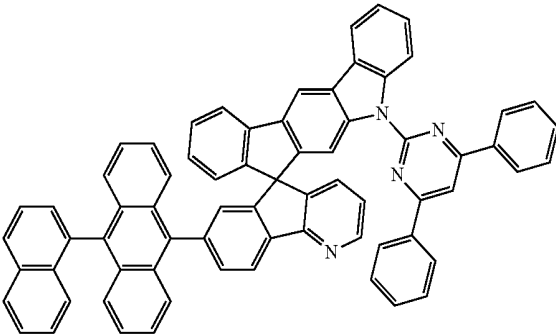
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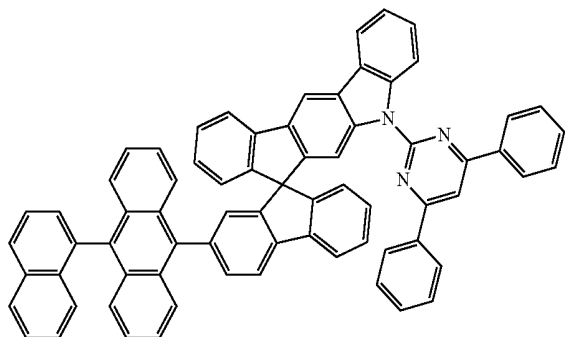


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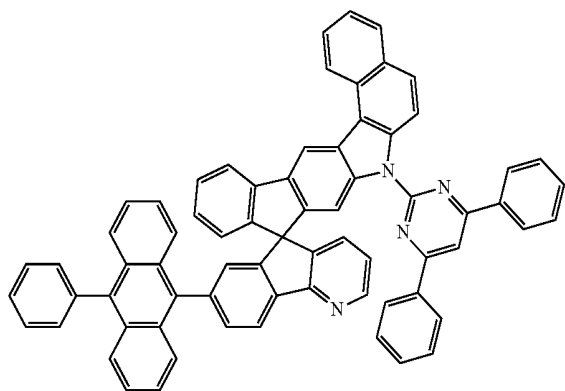


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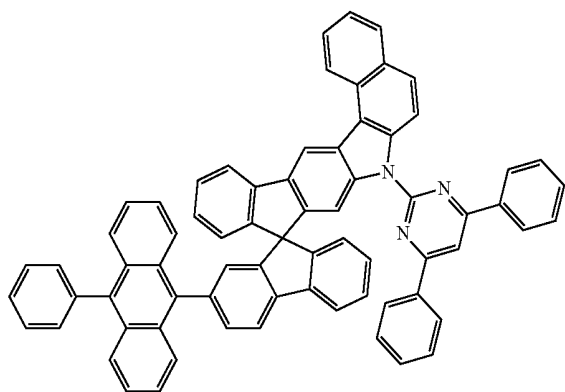
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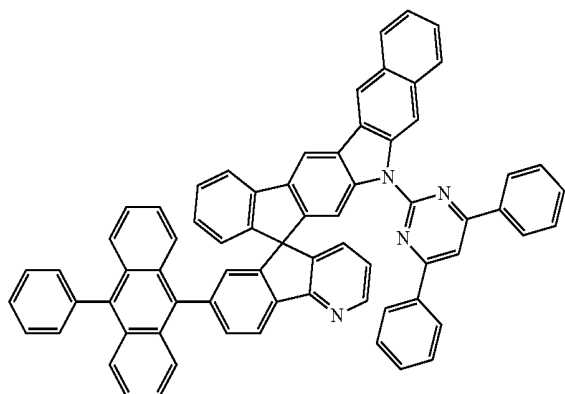
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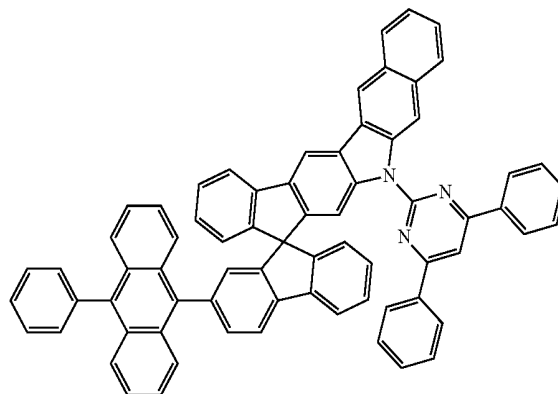


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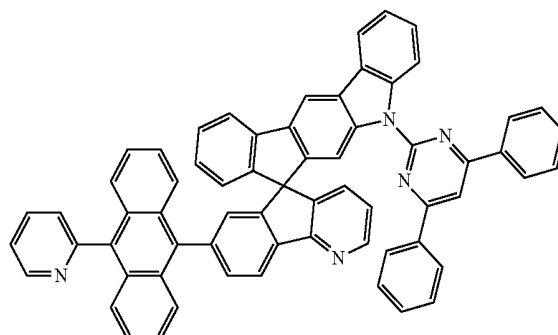


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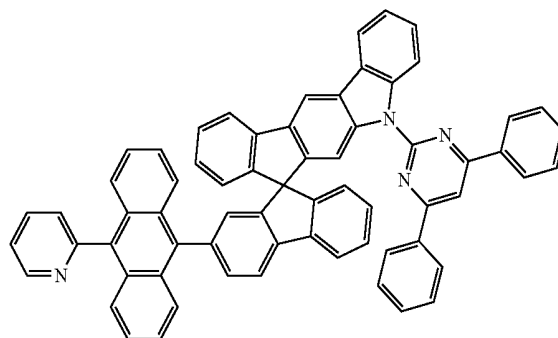
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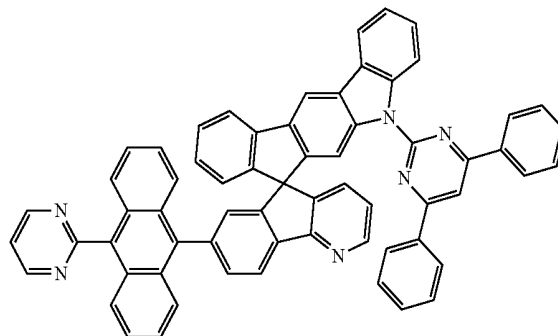
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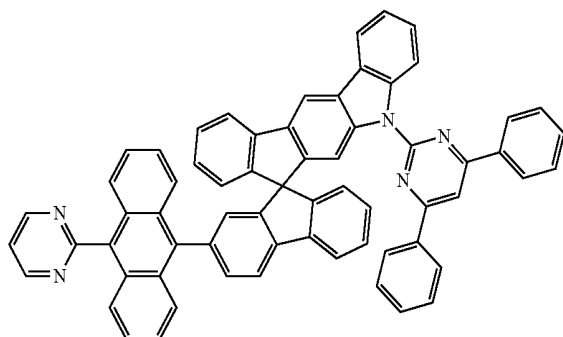


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36



[0232] The condensed-cyclic compound represented by Formula 1 may have a condensed-cyclic core, e.g., based on a spirobifluorene. Therefore, a molecular structure of the condensed-cyclic compound may be strongly tolerant with respect to electrons. Thus, deterioration of a molecular structure by electrons in a structure of the organic light-emitting device may decrease, which may result in an increase in lifespan of the organic light-emitting device. Also, the condensed-cyclic compound may have a high triplet (T1) energy level, a probability of collision between triplet excitons in the emission layer may increase, and thus an efficiency of the organic light-emitting device may improve due to a triplet-triplet annihilation (TTA) effect.

[0233] In the condensed-cyclic compound represented by Formula 1, when X_1 is $N-[(L_{11})_{a11}-(R_{11})_{b11}]$, R_{11} may be selected from a substituted or unsubstituted C_1 - C_{10} heterocycloalkyl group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_1 - C_{60} heteroaryl group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group. For example, in Formula 1, when X_1 is $N-[(L_{11})_{a11}-(R_{11})_{b11}]$, a heteroaryl group (e.g., an electron transporting moiety) may be bound to a nitrogen atom. In this regard, the condensed-cyclic compound represented by Formula 1 may exhibit improved electron injection characteristics to an emission layer, and thus exciton forming possibility in the emission layer may increase, which may help improve efficiency of the organic light-emitting device.

[0234] Also, in the condensed-cyclic compound represented by Formula 1, L_1 and L_2 may each independently be a substituted or unsubstituted condensed polycyclic group, in which at least three carbocyclic groups are condensed to one another, and a heteroatom is not included as a ring-forming atom, wherein $a1$ and $a2$ are respectively the numbers of L_1 and L_2 , but $a1$ and $a2$ are not 0. For example, in Formula 1, " L_1 " is essentially included in a group represented by $*-[(L_1)_{a1}-(R_1)_{b1}]$, and/or " L_2 " is essentially included in a group represented by $*-[(L_2)_{a2}-(R_2)_{b2}]$. Also, in Formula 1, $c1+c2$ may be 1 or greater. For example, at least one of a group represented by $*-[(L_1)_{a1}-(R_1)_{b1}]$ and a group represented by $*-[(L_2)_{a2}-(R_2)_{b2}]$ may be essentially present in Formula 1. In this regard, the condensed-cyclic compound represented by Formula 1 may help control an energy level between a host and a dopant to be appropriate, exciton energy generated from the host may be efficiently transferred, and thus efficiency of the organic light-emitting device may improve.

[0235] The condensed-cyclic compound represented by Formula 1 may be synthesized by using a suitable organic synthetic method. A method of synthesizing the condensed-cyclic compound may be understood to one of ordinary skill in the art by referring to examples used herein.

[0236] At least one of the condensed-cyclic compounds represented by Formula 1 may be used or included in between a pair of electrodes in an organic light-emitting device.

[0237] For example, the condensed-cyclic compound may be included in an emission layer. In some embodiments, the condensed-cyclic compound represented by Formula 1 may be used as a material for a capping layer, which is disposed on outer sides of a pair of electrodes in an organic light-emitting device.

[0238] Accordingly, there is provided an organic light-emitting device including a first electrode; a second electrode facing the first electrode; and an organic layer disposed between the first electrode and the second electrode, wherein the organic layer includes an emission layer and at least one condensed-cyclic compound represented by Formula 1.

[0239] As used herein, the expression the "(organic layer) includes at least one condensed-cyclic compound" may be construed as meaning the "(organic layer) may include one condensed-cyclic compound represented by Formula 1 or two different condensed-cyclic compounds represented by Formula 1".

[0240] For example, the organic layer may include only Compound 1 as the condensed-cyclic compound. In this regard, Compound 1 may be included in the emission layer of the organic light-emitting device. In some embodiments, the organic layer may include Compound 1 and Compound 2 as the condensed-cyclic compounds. In this regard, Compound 1 and Compound 2 may be situated in the same layer (for example, both Compound 1 and Compound 2 may be situated in an emission layer), or different layers (for example, Compound 1 may be situated in a hole transport layer, and Compound 2 may be situated in an emission layer).

[0241] The organic layer may include i) a hole transport region disposed between the first electrode (anode) and the emission layer and includes at least one selected from a hole injection layer, a hole transport layer, a buffer layer, and an electron blocking layer and ii) an electron transport region that is disposed between the emission layer and the second electrode (cathode) and includes at least one selected from a hole blocking layer, an electron transport layer, and an electron injection layer. At least one selected from the hole transport region and the emission layer may include at least one condensed-cyclic compound represented by Formula 1. For example, the emission layer of the organic light-emitting device may include at least one of the condensed-cyclic compounds represented by Formula 1. The condensed-cyclic compound represented by Formula 1 in the emission layer may serve as a host, and the emission layer may further include a dopant. The dopant may be a phosphorescent dopant or a fluorescent dopant. In some embodiments, the dopant may be a fluorescent dopant.

[0242] The organic light-emitting device may further include at least one selected from the first capping layer disposed in a path of light emitted from the emission layer, allowing the light to pass through to the outside after passing the first electrode and the second capping layer disposed in a path of light emitted from the emission layer, allowing the

light to pass through to the outside after passing the second electrode, wherein the at least one selected the first capping layer and the second capping layer may include at least one condensed-cyclic compound.

[0243] In some embodiments, the organic light-emitting device may have a structure of i) first electrode, organic layer, second electrode, and second capping layer, ii) first capping layer, first electrode, organic layer, and second electrode, or iii) first capping layer, first electrode, organic layer, second electrode, and second capping layer, wherein layers of each structure are sequentially stacked in the stated order. At least one selected from the first capping layer and the second capping layer may include the condensed-cyclic compound.

[0244] As used herein, the term the “organic layer” refers to a single and/or a plurality of layers disposed between the first electrode and the second electrode in an organic light-emitting device. A material included in the “organic layer” is not limited to an organic material.

[0245] FIG. 1 illustrates a schematic view of an organic light-emitting according to an embodiment. The organic light-emitting device 10 may include a first electrode 110, an organic layer 150, and a second electrode 190.

[0246] Hereinafter, a structure and a method of manufacturing the organic light-emitting device 10 according to an embodiment will be described with reference to FIG. 1.

[0247] Referring to FIG. 1, a substrate may be additionally disposed under the first electrode 110 or on the second electrode 190. The substrate may be a glass substrate or transparent plastic substrate, each with excellent mechanical strength, thermal stability, transparency, surface smoothness, ease of handling, and water resistance.

[0248] The first electrode 110 may be formed by depositing or sputtering a material for forming the first electrode on the substrate. When the first electrode 110 is an anode, the material for the first electrode may be selected from materials with a high work function to make holes be easily injected. The first electrode 110 may be a reflective electrode, a semi-transmissive electrode, or a transmissive electrode. The material for the first electrode may be a transparent and highly conductive material, and examples of the material may include indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO_2), and zinc oxide (ZnO). When the first electrode 110 is a semi-transmissive electrode or a reflective electrode, as a material for forming the first electrode, at least one selected from magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), and magnesium-silver (Mg—Ag) may be used.

[0249] The first electrode 110 may have a single-layer structure, or a multi-layer structure including a plurality of layers. For example, the first electrode 110 may have a triple-layer structure of ITO/Ag/ITO.

[0250] The organic layer 150 may be disposed on the first electrode 110. The organic layer 150 may include an emission layer.

[0251] The organic layer 150 may further include a hole transport region between the first electrode and the emission

layer, and an electron transport region disposed between the emission layer and the second electrode.

[0252] The hole transport region may include at least one selected from a hole injection layer (HIL), a hole transport layer (HTL), a buffer layer, and an electron blocking layer (EBL). The electron transport region may include at least one selected from a hole blocking layer (HBL), an electron transport layer (ETL), and an electron injection layer (EIL).

[0253] The hole transport region may have a single-layered structure formed of a single material, a single-layered structure formed of a plurality of different materials, or a multi-layered structure having a plurality of layers formed of a plurality of different materials.

[0254] For example, the hole transport region may have a single-layered structure formed of a plurality of different materials, or a structure of hole injection layer/hole transport layer, a structure of hole injection layer/hole transport layer/buffer layer, a structure of hole injection layer/buffer layer, a structure of hole transport layer/buffer layer, or a structure of hole injection layer/hole transport layer/electron blocking layer, wherein layers of each structure are sequentially stacked from the first electrode 110 in this stated order.

[0255] When the hole transport region includes a hole injection layer, the hole injection layer may be formed on the first electrode 110 by using various methods, such as vacuum-deposition, spin coating, casting, Langmuir-Blodgett (LB) method, ink-jet printing, laser-printing, or laser-induced thermal imaging (LITI).

[0256] When a hole injection layer is formed by vacuum deposition, for example, the vacuum deposition may be performed at a temperature of a deposition temperature in a range of about 100° C. to about 500° C., at a vacuum degree in a range of about 10^{-8} torr to about 10^{-3} torr, and/or at a deposition rate in a range of about 0.01 Å/sec to about 100 Å/sec in consideration of a compound for a hole injection layer to be deposited, and the structure of a hole injection layer to be formed.

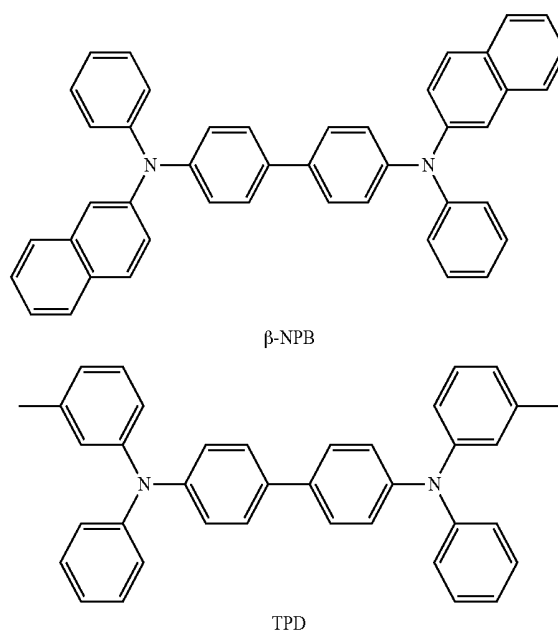
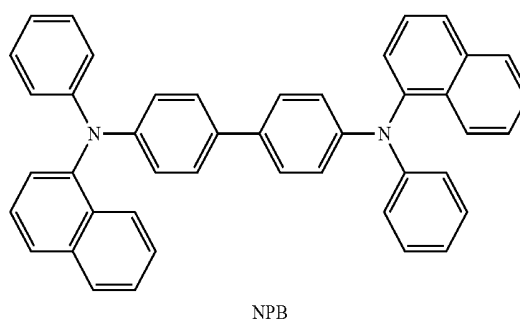
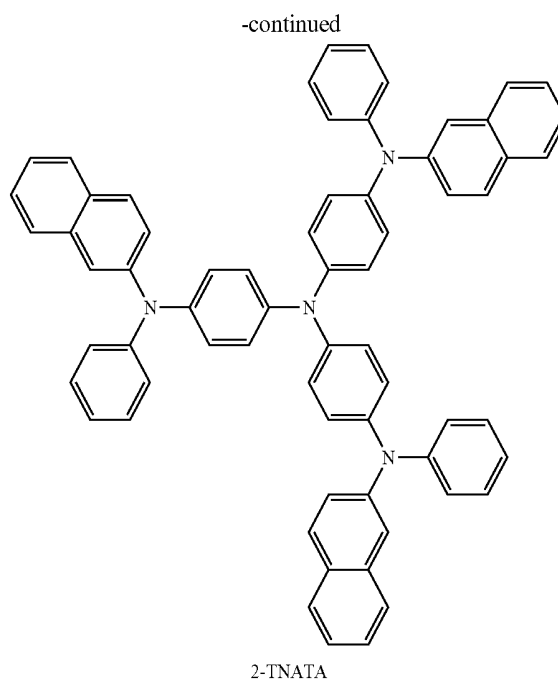
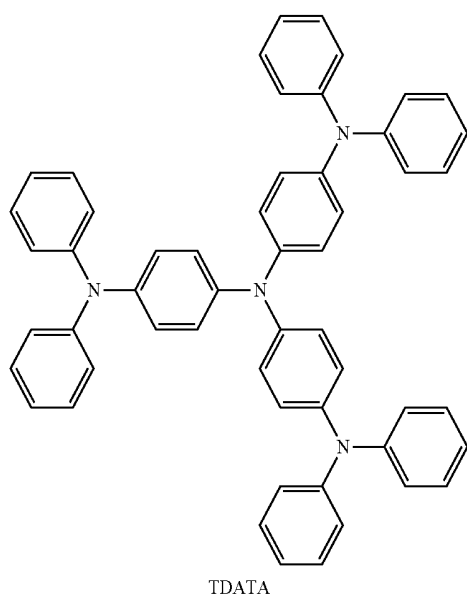
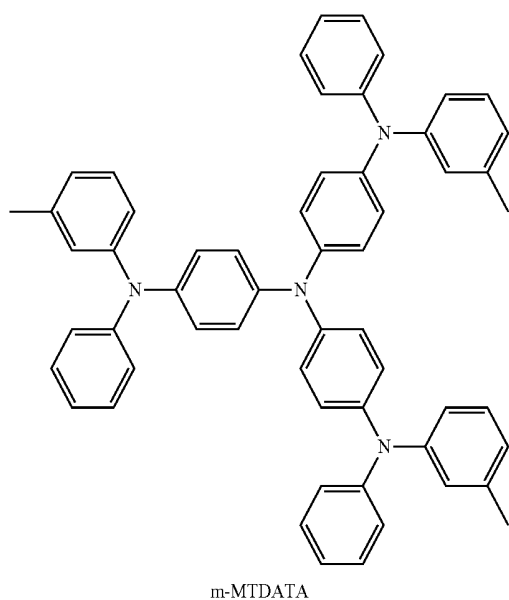
[0257] When a hole injection layer is formed by spin coating, the spin coating may be performed at a coating rate in a range of about 2000 rpm to about 5000 rpm, and at a temperature in a range of about 80° C. to 200° C. in consideration of a compound for a hole injection layer to be deposited, and the structure of a hole injection layer to be formed.

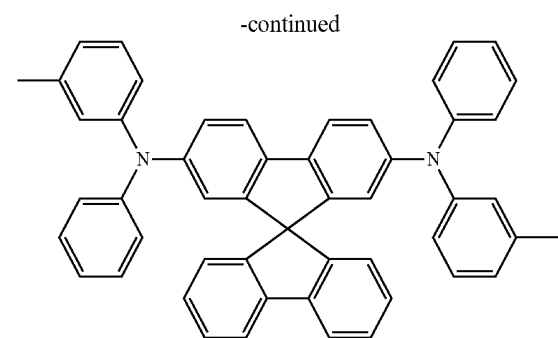
[0258] When the hole transport region includes a hole transport layer, the hole transport layer may be formed on the first electrode 110 or the hole injection layer by using various methods, such as vacuum-deposition, spin coating, casting, LB method, ink-jet printing, laser-printing, or LITI. When the hole transport layer is formed by vacuum-deposition or spin coating, conditions for vacuum-deposition and coating may be similar to the above-described vacuum-deposition and coating conditions for forming the hole injection layer.

[0259] The hole transport region may include the condensed-cyclic compound represented by Formula 1. In some embodiments, the hole transport region may include a hole

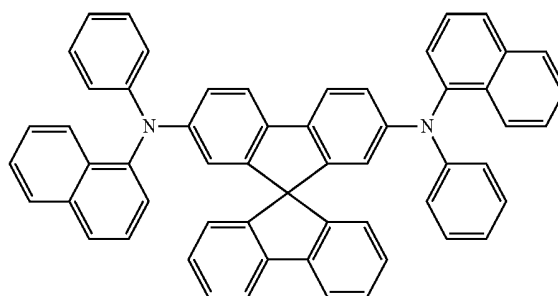
transport layer, an the hole transport layer may include the condensed-cyclic compound represented by Formula 1.

[0260] The hole transport region may include at least one selected from m-MTDATA, TDATA, 2-TNATA, NPB, P3-NPB, TPD, spiro-TPD, spiro-NPB, α -NPB, TAPC, HMTPD, 4,4',4''-tris(N-carbazolyl)triphenylamine (TCTA), polyaniline/dodecylbenzenesulfonic acid (Pani/DBSA), poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS), polyaniline/camphor sulfonic acid (Pani/CSA), (polyaniline)/poly(4-styrenesulfonate) (PANI/PSS), a compound represented by Formula 201 below, and a compound represented by Formula 202:

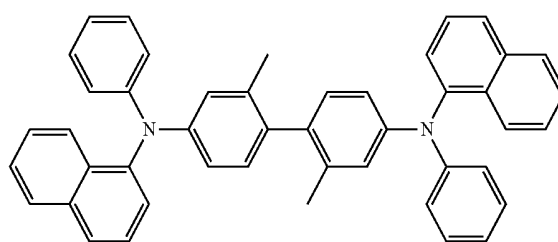




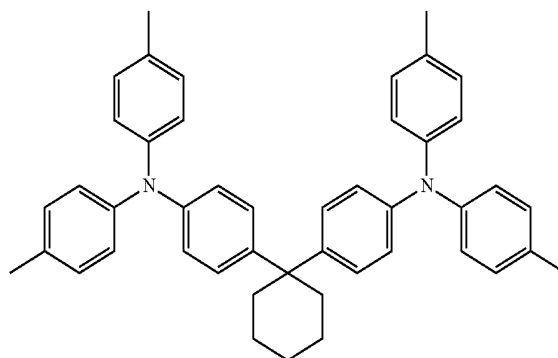
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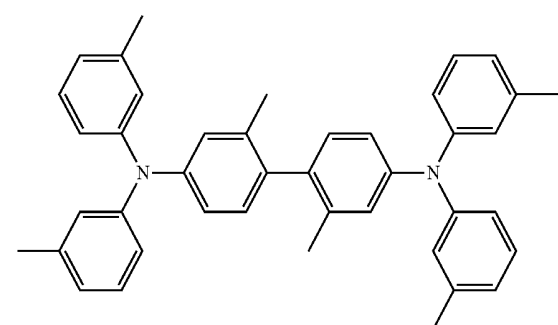
Spiro-NPB



methylated NPB

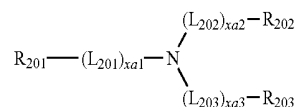


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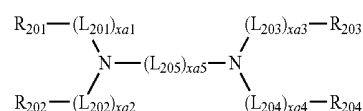


HMTPD

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<Formula 201>



<Formula 202>

[0261] wherein in Formulae 201 and 202,

[0262] L_{201} to L_{205} may be each independently the same as defined in connection with L_1 provided herein;[0263] $xa1$ to $xa4$ may be each independently selected from 0, 1, 2, and 3;[0264] $xa5$ may be selected from 1, 2, 3, 4, and 5; and

[0265] R_{201} to R_{204} may be each independently selected from a substituted or unsubstituted C_3 - C_{10} cycloalkyl group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkyl group, a substituted or unsubstituted C_3 - C_{10} cycloalkenyl group, a substituted or unsubstituted C_1 - C_{10} heterocycloalkenyl group, a substituted or unsubstituted C_6 - C_{60} aryl group, a substituted or unsubstituted C_6 - C_{60} aryloxy group, a substituted or unsubstituted C_6 - C_{60} arylthio group, a substituted or unsubstituted C_1 - C_{60} heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group.

[0266] In some embodiments, in Formulae 201 and 202,

[0267] L_{201} to L_{205} may be each independently selected from

[0268] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorene group, a dibenzofluorene group, a phenanthrenylene group, an anthracenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylenylene group, a pyrazinylenylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylenylene group, a quinazolinylene group, a carbazolylenylene group, and a triazinylene group; and

[0269] a phenylene group, a naphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzofluorenylene group, a dibenzofluorenylene group, a phenanthrenylene group, an anthracenylenylene group, a pyrenylene group, a chrysenylene group, a pyridinylenylene group, a pyrazinylenylene group, a pyrimidinylene group, a pyridazinylene group, a quinolinylene group, an isoquinolinylene group, a quinoxalinylenylene group, a quinazolinylene group, a carbazolylenylene group, and a triazinylene group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a

naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group;

[0270] xa1 to xa4 may be each independently 0, 1, or 2;

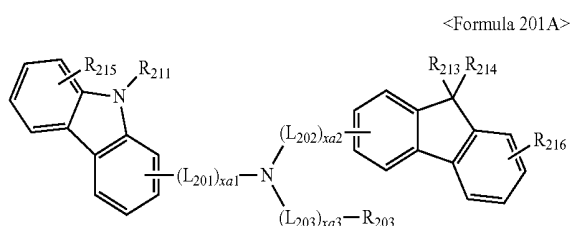
[0271] xa5 may be 1, 2, or 3;

[0272] R₂₀₁ to R₂₀₄ may be each independently selected from

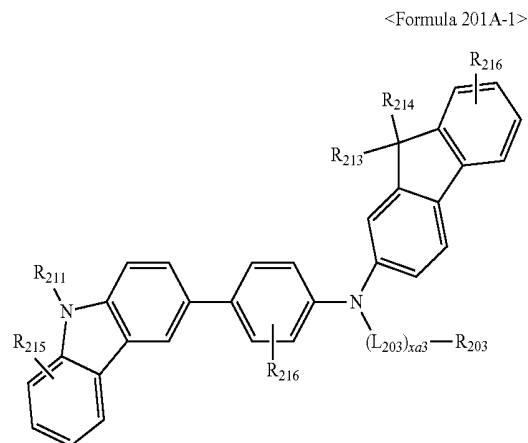
[0273] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group; and

[0274] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, an azulenyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, and a triazinyl group.

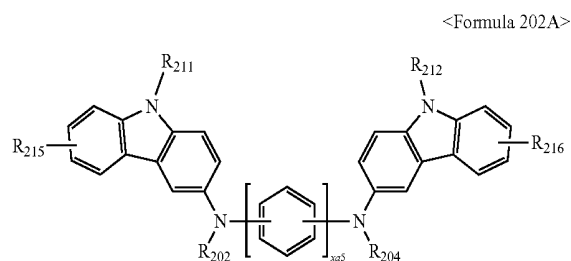
[0275] The compound represented by Formula 201 may be represented by Formula 201A:



[0276] In some embodiments, the compound represented by Formula 201 may be represented by Formula 201A-1:



[0277] In some embodiments, the compound represented by Formula 202 may be represented by Formula 202A:

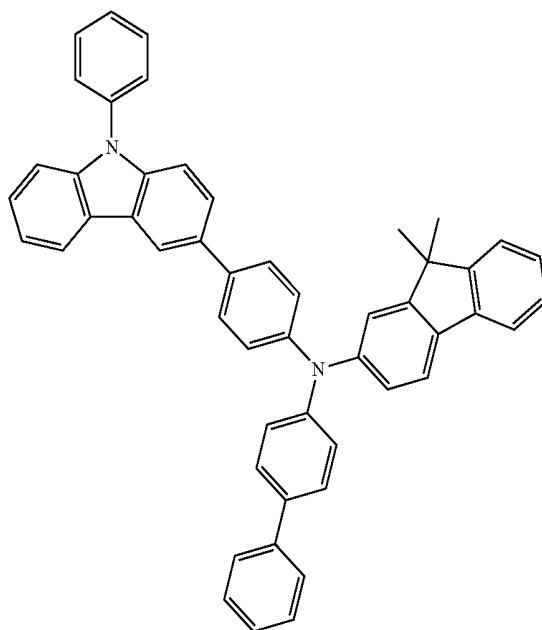
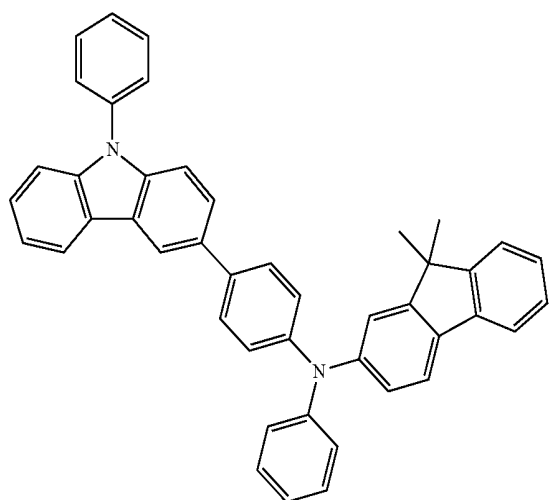


[0278] In Formulae 201A, 201A-1, and 202A, L₂₀₁ to L₂₀₃, xa1 to xa3, xa5, and R₂₀₂ to R₂₀₄ may be understood by referring to the descriptions provided herein, R₂₁₁ and R₂₁₂ may be the same as defined in connection with R₂₀₃, and R₂₁₃ to R₂₁₆ may be each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

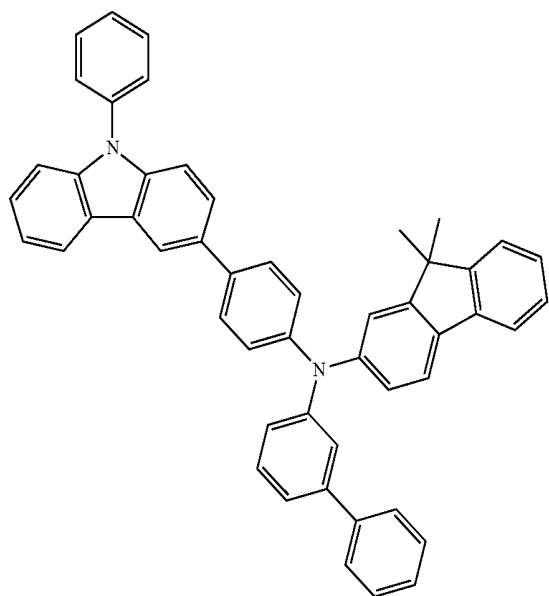
[0279] The compound represented by Formula 201 and the compound represented by Formula 202 may include Compounds HT1 to HT20:

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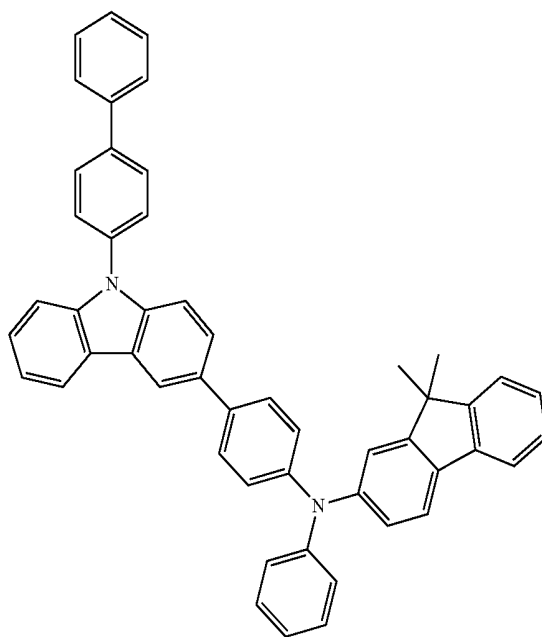
HT3



HT2



HT4

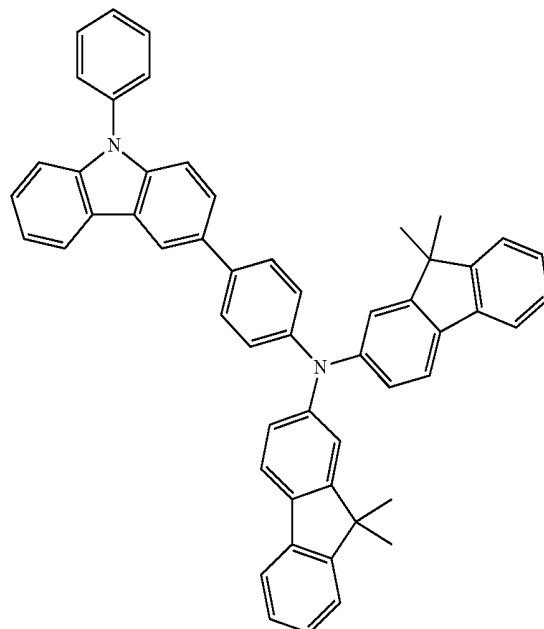
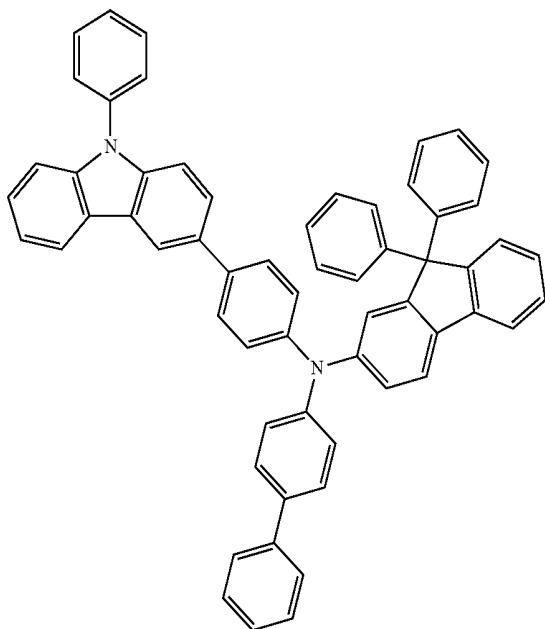


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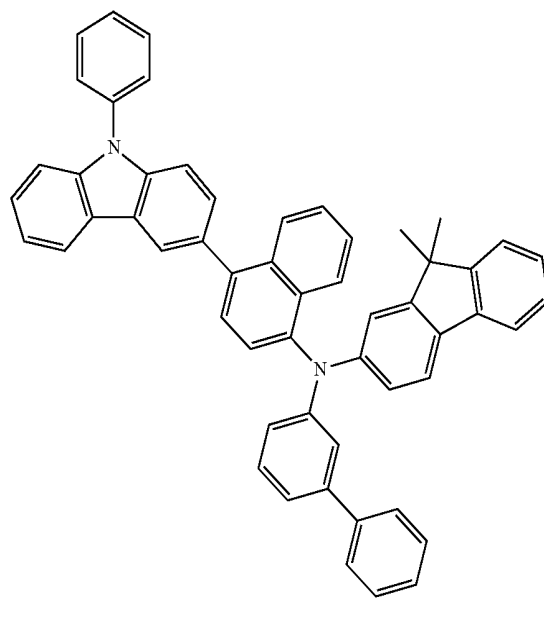
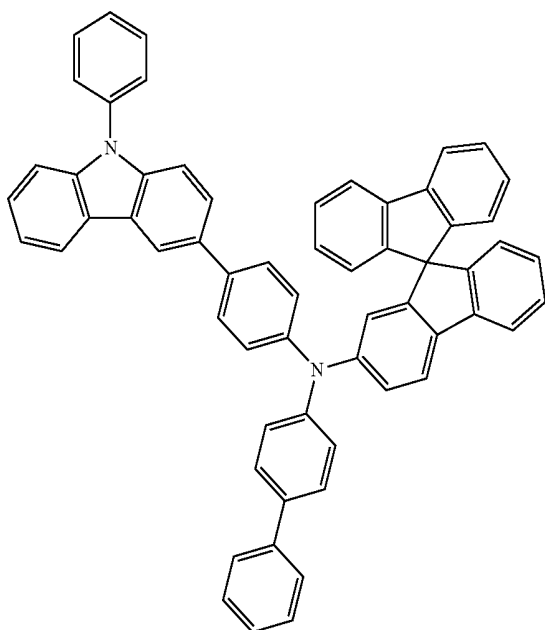
HT5

HT7



HT6

HT8

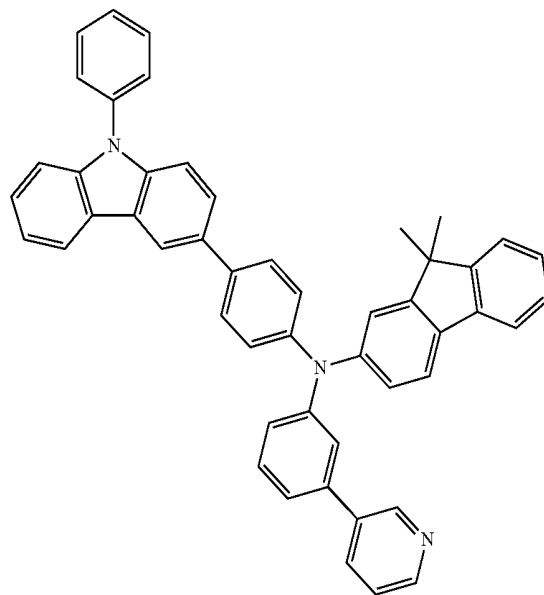
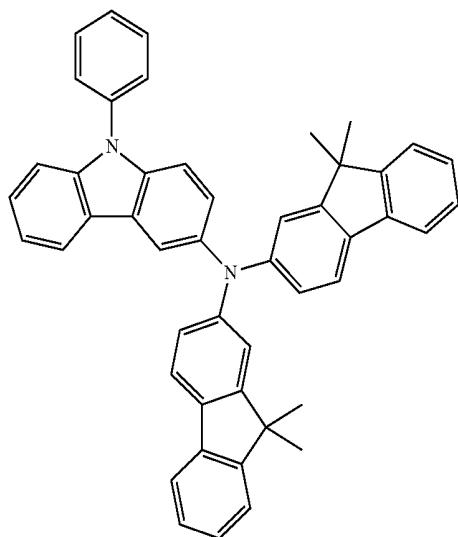


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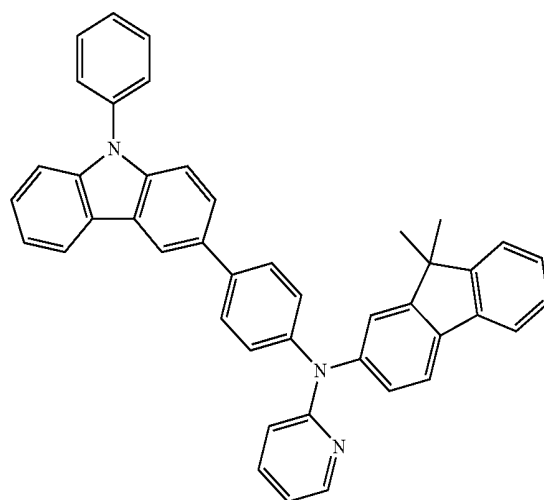
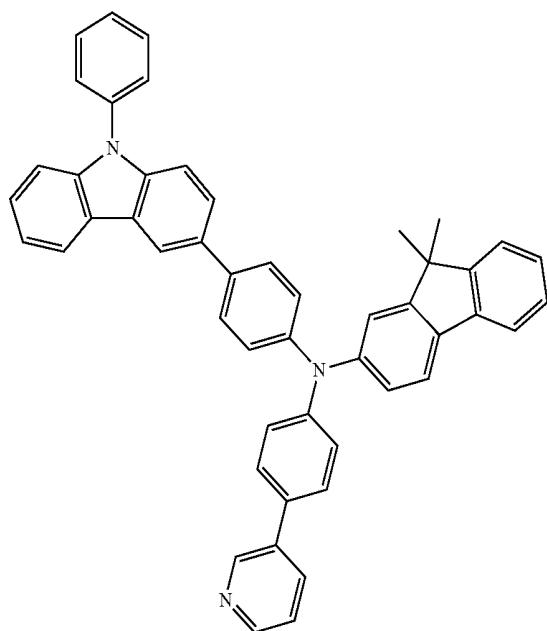
HT11

HT9

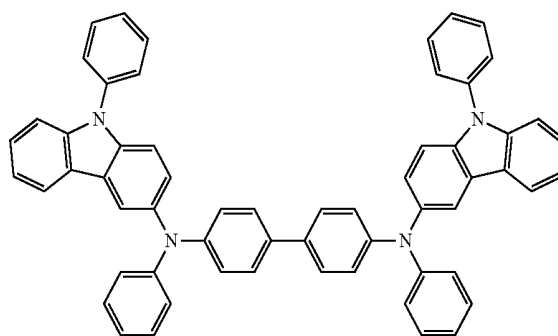


HT12

HT10

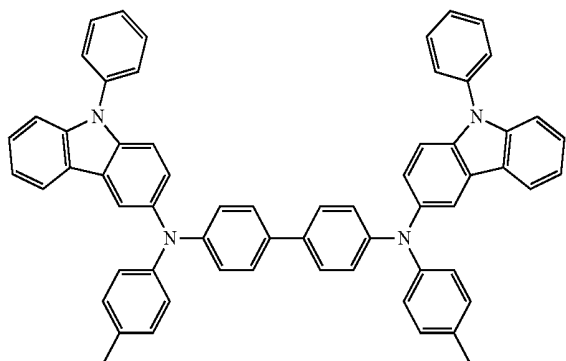


HT13



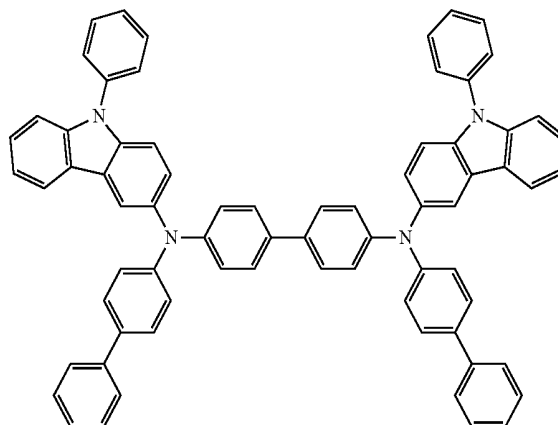
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HT14

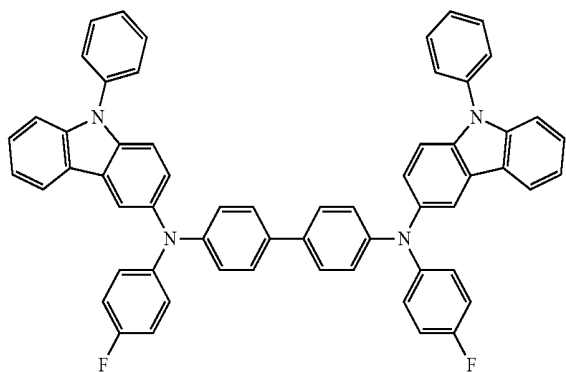


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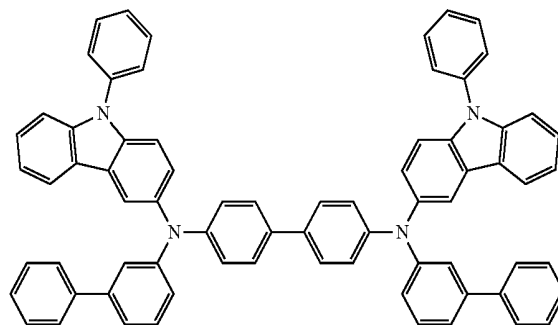
HT18



HT15

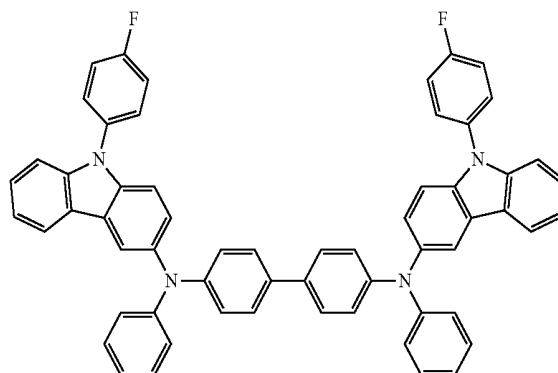
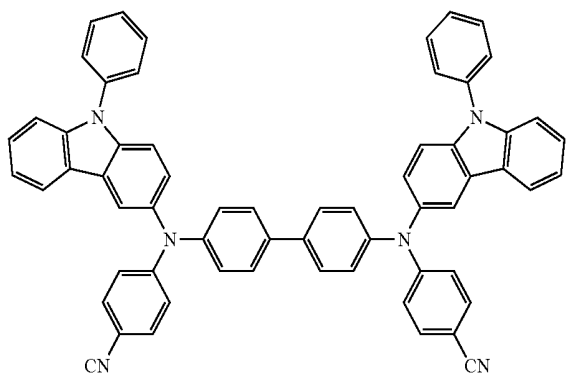


HT19

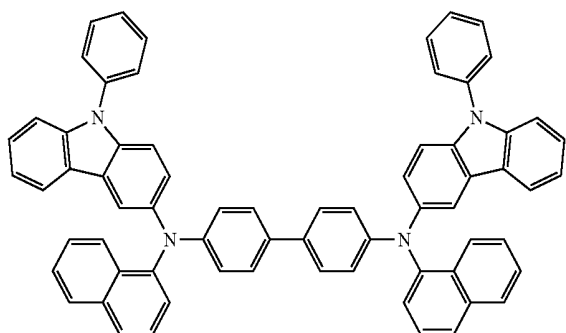


HT20

HT16



HT17

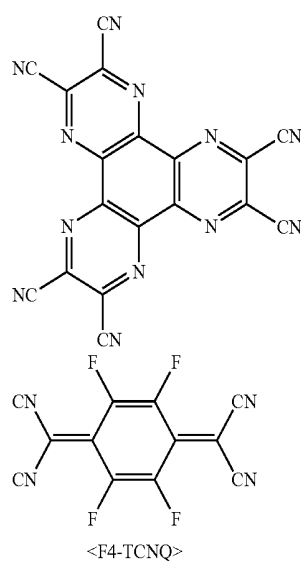


[0280] A thickness of the hole transport region may be in a range of about 100 Å to about 10,000 Å, e.g., about 100 Å to about 1,000 Å. When the hole transport region includes the a hole injection layer and a hole transport layer, a thickness of the hole injection layer may be in a range of about 100 Å to about 10,000 Å, e.g., about 100 Å to about 1,000 Å, a thickness of the hole transport layer may be in a range of about 50 Å to about 2,000 Å, e.g., about 100 Å to about 1,500 Å. When the thicknesses of the hole transport region, the hole injection layer, and the hole transport layer are within these ranges, excellent hole transport characteristics may be obtained without a substantial increase in driving voltage.

[0281] The hole transport region may further include, in addition to the mentioned materials above, a charge-generating material to improve conductive properties. The charge-

generating material may be homogeneously or non-homogeneously dispersed throughout the hole transport region.

[0282] The charge-generating material may be, for example, a p-dopant. The p-dopant may be one selected from a quinone derivative, a metal oxide, and a cyano group-containing compound. For example, non-limiting examples of the p-dopant are a quinone derivative, such as tetracyanoquinonodimethane (TCNQ) or 2,3,5,6-tetrafluoro-tetracyano-1,4-benzoquinonodimethane (F4-TCNQ); a metal oxide, such as a tungsten oxide or a molybdenum oxide, and Compound HT-D1 illustrated below.



[0283] The hole transport region may further include at least one selected from a buffer layer and an electron blocking layer in addition to the hole injection layer and the hole transport layer. Since the buffer layer may compensate for an optical resonance distance according to a wavelength of light emitted from the emission layer, light-emission efficiency of the organic light-emitting device may improve. As a material included in the buffer layer, materials that are included in the hole transport region may be used. The electron blocking layer prevents injection of electrons from the electron transport region.

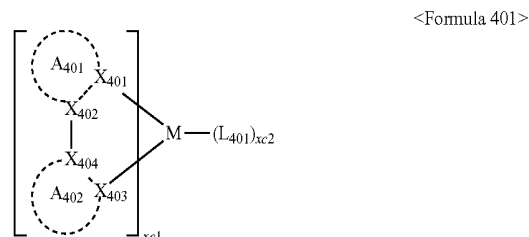
[0284] An emission layer is formed on the first electrode 110 or the hole transport region by using various methods, such as vacuum-deposition, spin coating, casting, LB method, ink-jet printing, laser-printing, or LITI. When the emission layer is formed by vacuum-deposition or spin coating, deposition and coating conditions for the emission layer may be determined by referring to the deposition and coating conditions for the hole injection layer.

[0285] When the organic light-emitting device 10 is a full color organic light-emitting device, the emission layer may be patterned into a red emission layer, a green emission layer, or a blue emission layer, according to a sub pixel. Alternatively, the emission layer may have a stacked structure of a red emission layer, a green emission layer, and a blue emission layer, or may include a red-light emission material, a green-light emission material, and a blue-light emission material, which are mixed with each other in a single layer, to emit white light.

[0286] The emission layer may include a host and a dopant. The host may include the condensed-cyclic compound represented by Formula 1.

[0287] The dopant may include a phosphorescent dopant or a fluorescent dopant.

[0288] The phosphorescent dopant may include an organometallic complex represented by Formula 401 below:



[0289] wherein, in Formula 401,

[0290] M may be selected from iridium (Ir), platinum (Pt), osmium (Os), titanium (Ti), zirconium (Zr), hafnium (Hf), europium (Eu), terbium (Tb), and thulium (Tm);

[0291] X₄₀₁ to X₄₀₄ may be each independently a nitrogen or a carbon;

[0292] ring A₄₀₁ and ring A₄₀₂ may be each independently selected from a substituted or unsubstituted benzene, a substituted or unsubstituted naphthalene, a substituted or unsubstituted fluorene, a substituted or unsubstituted spiro-fluorene, a substituted or unsubstituted indene, a substituted or unsubstituted pyrrole, a substituted or unsubstituted thiophene, a substituted or unsubstituted furan, a substituted or unsubstituted imidazole, a substituted or unsubstituted pyrazole, a substituted or unsubstituted thiazole, a substituted or unsubstituted isothiazole, a substituted or unsubstituted oxazole, a substituted or unsubstituted isoxazole, a substituted or unsubstituted pyridine, a substituted or unsubstituted pyrazine, a substituted or unsubstituted pyrimidine, a substituted or unsubstituted pyridazine, a substituted or unsubstituted quinoline, a substituted or unsubstituted isoquinoline, a substituted or unsubstituted benzoquinoline, a substituted or unsubstituted quinoxaline, a substituted or unsubstituted quinazoline, a substituted or unsubstituted carbazole, a substituted or unsubstituted benzimidazole, a substituted or unsubstituted benzofuran, a substituted or unsubstituted benzothiophene, a substituted or unsubstituted isobenzothiophene, a substituted or unsubstituted benzoxazole, a substituted or unsubstituted isobenzoxazole, a substituted or unsubstituted triazole, a substituted or unsubstituted oxadiazole, a substituted or unsubstituted triazine, a substituted or unsubstituted dibenzofuran, and a substituted or unsubstituted dibenzothiophene;

[0293] at least one of substituents of the substituted benzene, substituted naphthalene, substituted fluorene, substituted spiro-fluorene, substituted indene, substituted pyrrole, substituted thiophene, substituted furan, substituted imidazole, substituted pyrazole, substituted thiazole, substituted isothiazole, substituted oxazole, substituted isoxazole, substituted pyridine, substituted pyrazine, substituted pyrimidine, substituted pyridazine, substituted quinoline, substituted isoquinoline, substituted benzoquinoline, substituted quinoxaline, substituted quinazoline, substituted carbazole, substituted benzimidazole, substituted benzofuran, substituted benzothiophene, substituted isobenzothiophene, sub-

stituted benzoxazole, substituted isobenzoxazole, substituted triazole, substituted oxadiazole, substituted triazine, substituted dibenzofuran, and substituted dibenzothiophene may be selected from

[0294] a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group;

[0295] a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, and a C₁-C₆₀ alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₄₀₁)(Q₄₀₂), —Si(Q₄₀₃)(Q₄₀₄)(Q₄₀₅), and —B(Q₄₀₆)(Q₄₀₇);

[0296] a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0297] a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₄₁₁)(Q₄₁₂), —Si(Q₄₁₃)(Q₄₁₄)(Q₄₁₅), and —B(Q₄₁₆)(Q₄₁₇); and

[0298] —N(Q₄₂₁)(Q₄₂₂), —Si(Q₄₂₃)(Q₄₂₄)(Q₄₂₅), and —B(Q₄₂₆)(Q₄₂₇);

[0299] L₄₀₁ may be an organic ligand;

[0300] xc1 may be 1, 2, or 3; and

[0301] xc2 may be 0, 1, 2, or 3.

[0302] L₄₀₁ may be an arbitrary monovalent, divalent, or trivalent organic ligand. For example, L₄₀₁ may be selected from a halogen ligand (for example, Cl or F), a diketone ligand (for example, acetylacetonate, 1,3-diphenyl-1,3-propanedionate, 2,2,6,6-tetramethyl-3,5-heptanedionate, or

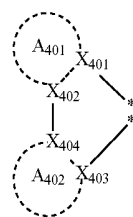
hexafluoroacetonate), a carboxylic acid ligand (for example, picolinate, dimethyl-3-pyrazolecarboxylate, or benzoate), a carbon monoxide ligand, an isonitrile ligand, a cyano ligand, and a phosphorous ligand (for example, phosphine, or phosphite).

[0303] Q₄₀₁ to Q₄₀₇, Q₄₁₁ to Q₄₁₇, and Q₄₂₁ to Q₄₂₇ may be each independently selected from a hydrogen, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₆-C₆₀ aryl group, and a C₂-C₆₀ heteroaryl group.

[0304] When A₄₀₁ in Formula 401 has a plurality of substituents, the plurality of substituents of A₄₀₁ may bind to each other to form a saturated or unsaturated ring.

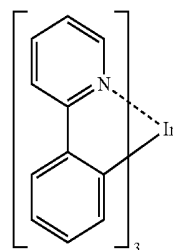
[0305] When A₄₀₁ in Formula 402 has a plurality of substituents, the plurality of substituents of A₄₀₂ may bind to each other to form a saturated or unsaturated ring.

[0306] When xc1 in Formula 401 is 2 or greater, a plurality of ligands

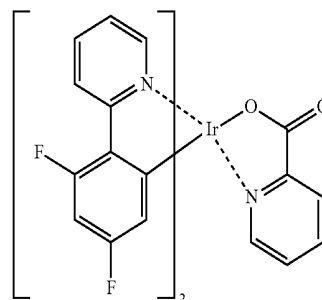


in Formula 401 may be identical or different from each other. In Formula 401, when xc1 is 2 or greater, A₄₀₁ and A₄₀₂ may be directly connected or connected via a linking group (for example, a C₁-C₅ alkylene group, —N(R')— (here, R' is a C₁-C₁₀ alkyl group or a C₆-C₂₀ aryl group), or —C(=O)—) to one other adjacent ligand of A₄₀₁ and A₄₀₂ respectively.

[0307] The phosphorescent dopant may be, for example, selected from Compounds PD1 to PD75.



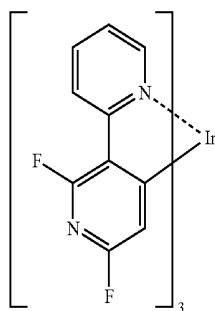
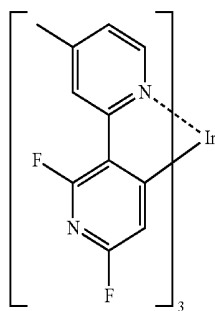
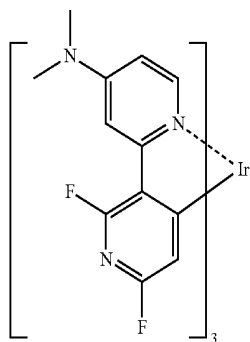
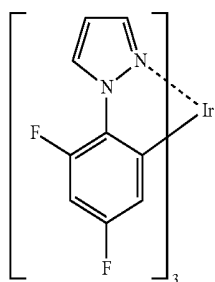
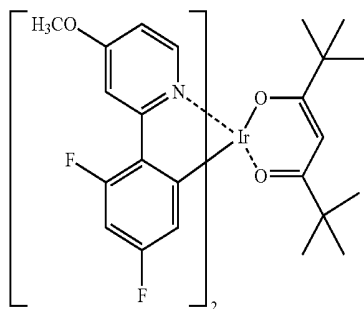
PD1



PD2

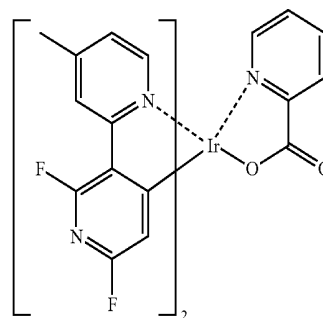
or

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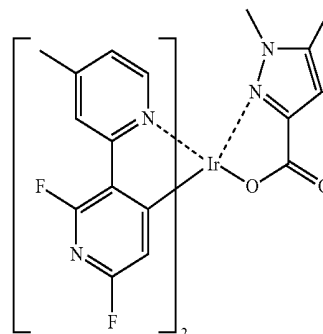
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PD3



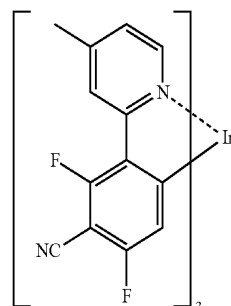
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PD4



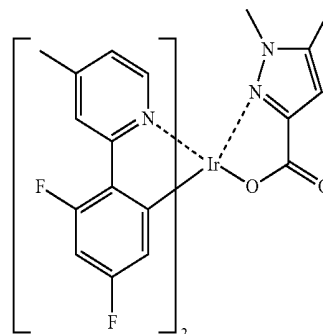
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PD5



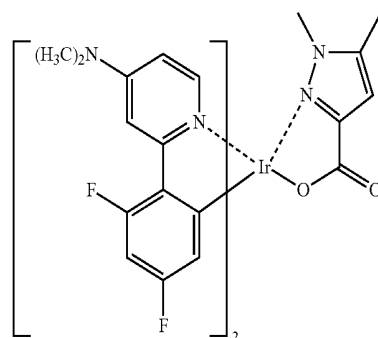
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PD6



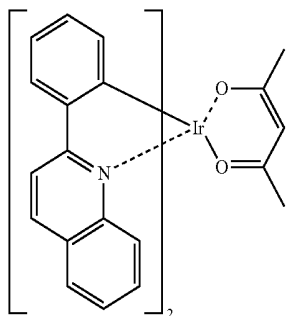
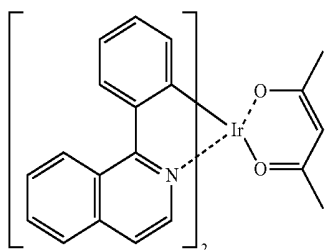
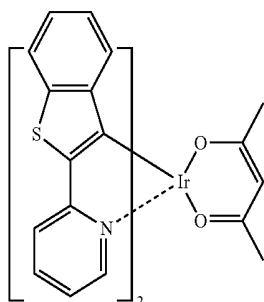
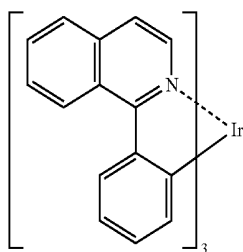
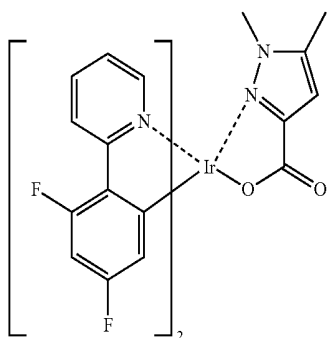
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PD7



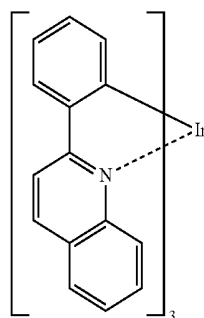
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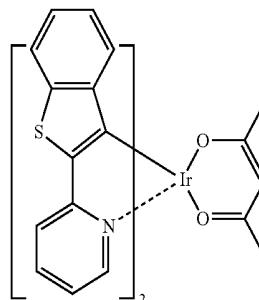
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PD13



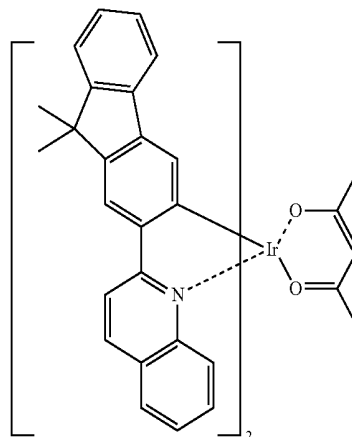
PD18

PD14



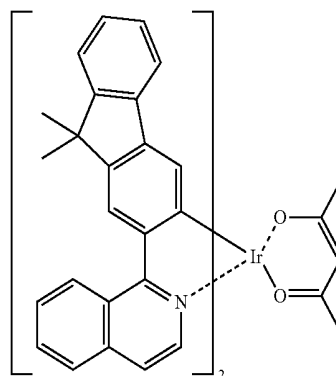
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PD15



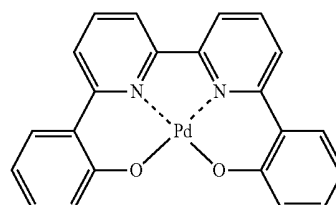
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PD16



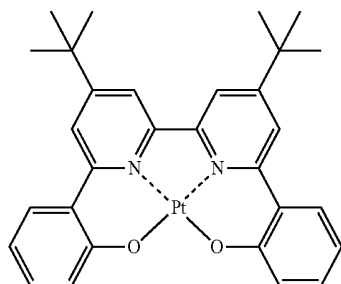
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PD17



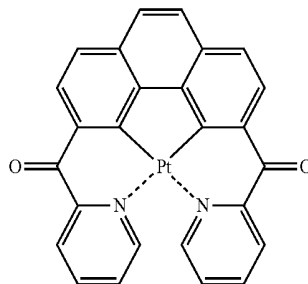
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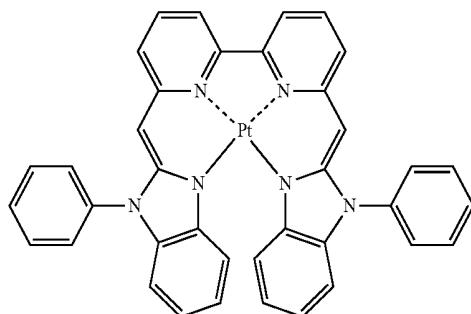
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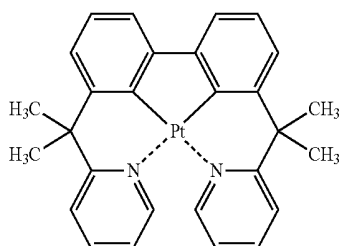


PD28

PD24

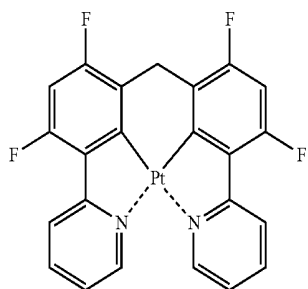
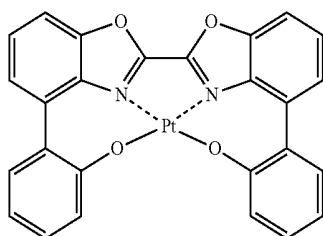


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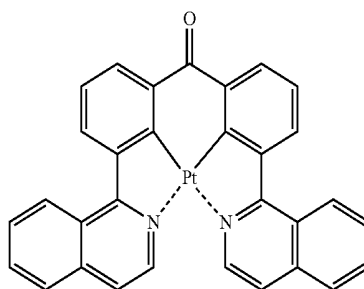
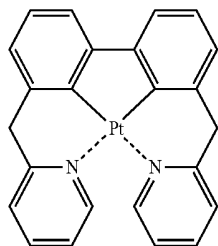
PD30

PD25

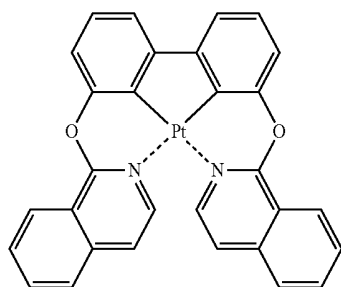


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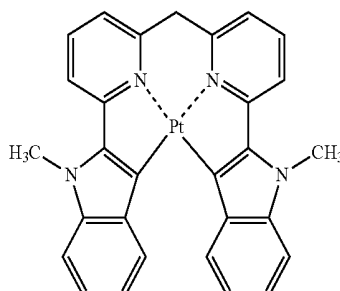
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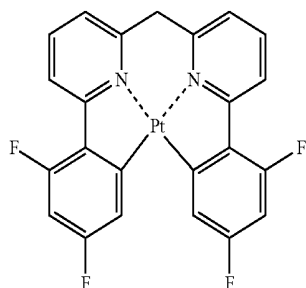
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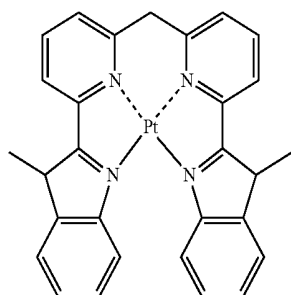
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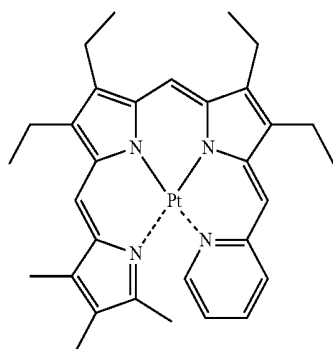
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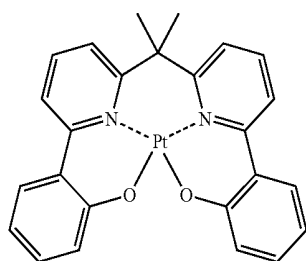
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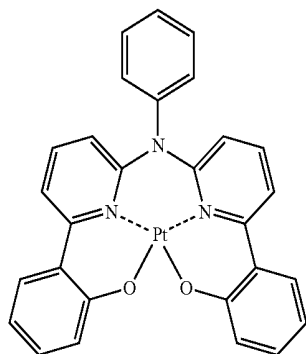
PD34



PD35

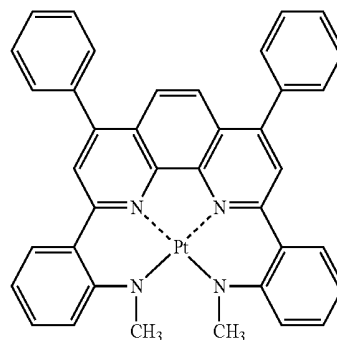


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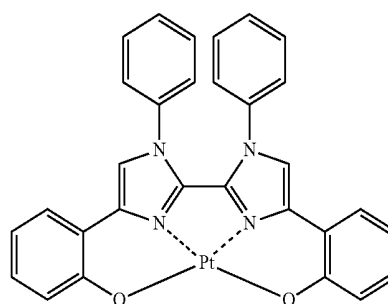


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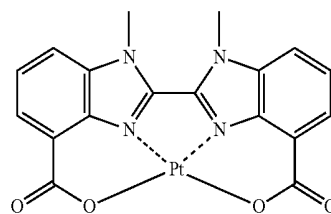
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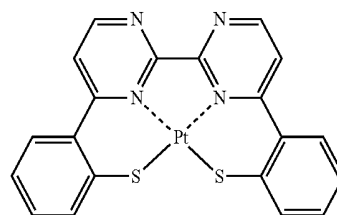
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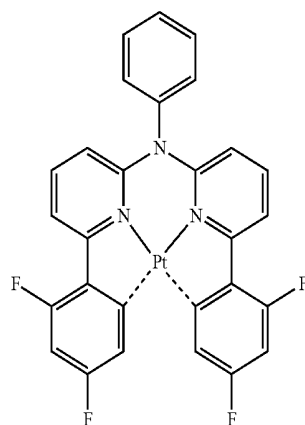
PD39



PD40

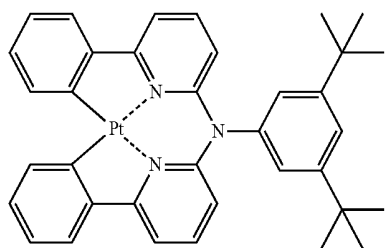
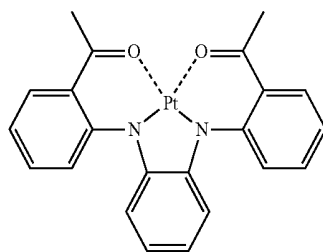
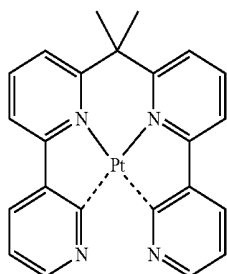
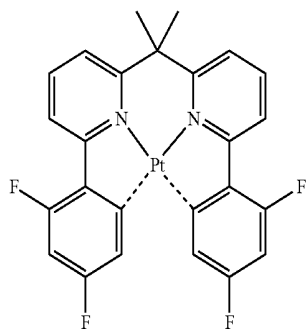
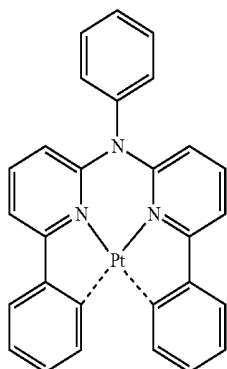


PD41



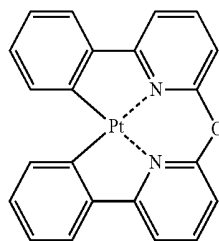
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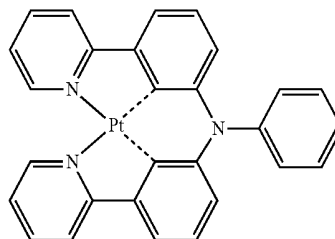
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PD43



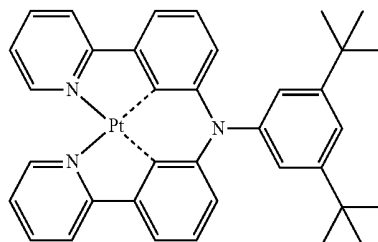
PD48

PD44



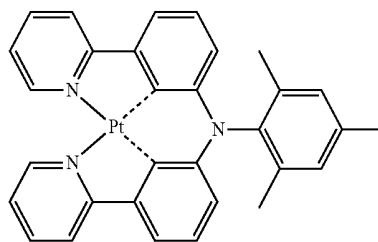
PD49

PD45



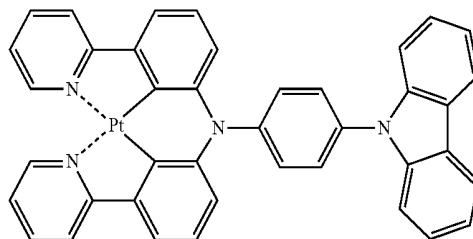
PD50

PD46

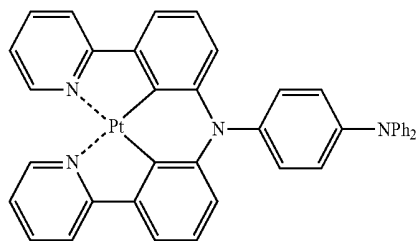


PD51

PD47

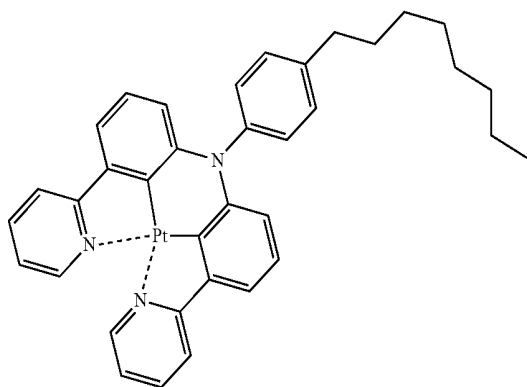
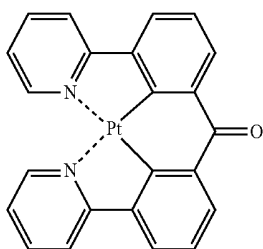
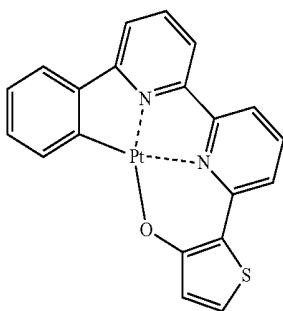
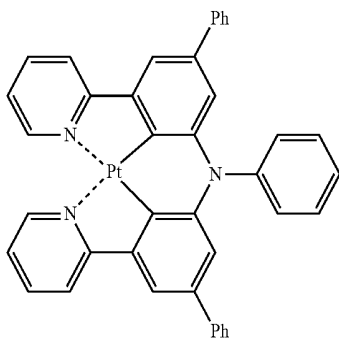
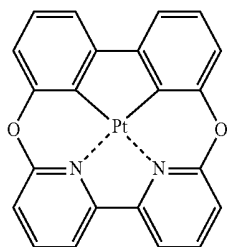


PD52



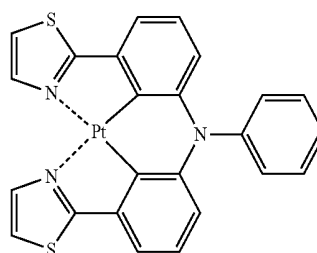
PD53

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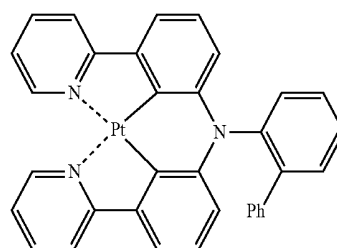
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PD54



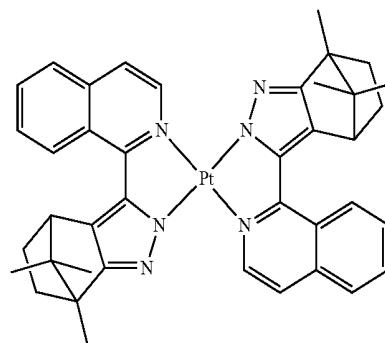
PD59

PD55



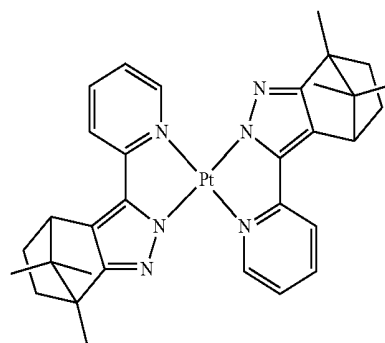
PD60

PD56



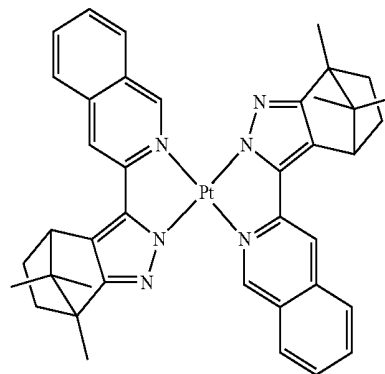
PD61

PD57



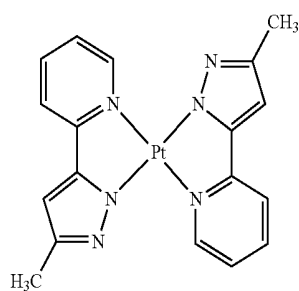
PD62

PD58



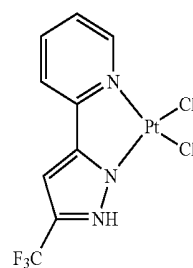
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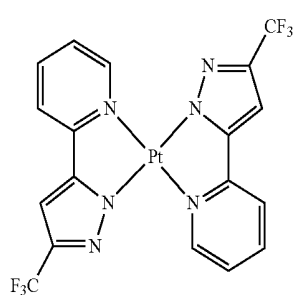


PD64

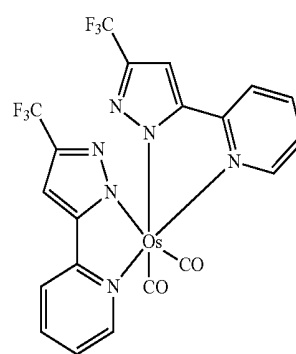
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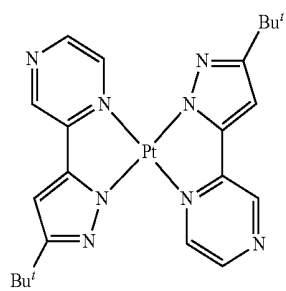
PD69



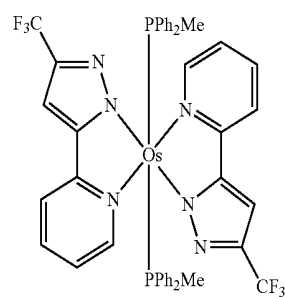
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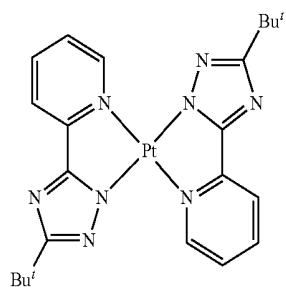
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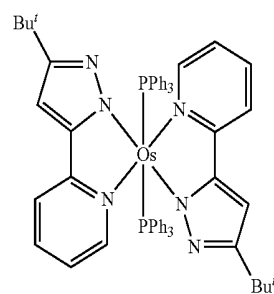
PD66



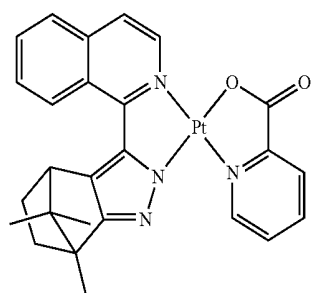
PD71



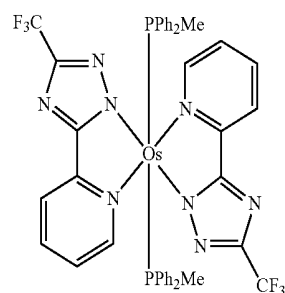
PD67



PD72

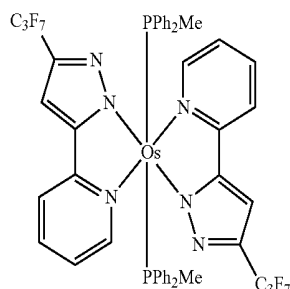


PD68

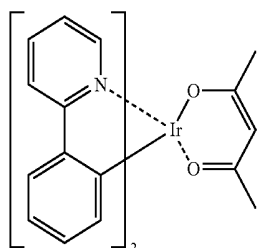


PD73

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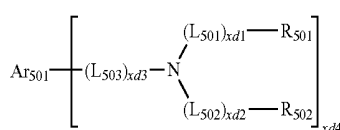


PD74



PD75

[0308] In some embodiments, the fluorescent dopant may include a compound represented by Formula 501:



<Formula 501>

[0309] wherein, in Formula 501,

[0310] Ar_{501} may be selected from

[0311] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene; and

[0312] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, naphthacene, a picene, a perylene, a pentaphene and an indenoanthracene, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_2\text{-C}_{60}$ alkynyl group, a $\text{C}_1\text{-C}_{60}$ alkoxy group, a $\text{C}_3\text{-C}_{10}$ cycloalkyl group, a $\text{C}_1\text{-C}_{10}$ heterocycloalkyl group, a $\text{C}_3\text{-C}_{10}$ cycloalkenyl group, a $\text{C}_1\text{-C}_{10}$ heterocycloalkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, a $\text{C}_6\text{-C}_{60}$ aryloxy group, a $\text{C}_6\text{-C}_{60}$ arylthio group, a $\text{C}_1\text{-C}_{60}$ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, and $-\text{Si}(\text{Q}_{501})(\text{Q}_{502})(\text{Q}_{503})$; wherein Q_{501} to Q_{503} may be each independently selected from a hydrogen, a $\text{C}_1\text{-C}_{60}$ alkyl group, a $\text{C}_2\text{-C}_{60}$ alkenyl group, a $\text{C}_6\text{-C}_{60}$ aryl group, and a $\text{C}_1\text{-C}_{60}$ heteroaryl group;

[0313] L_{501} to L_{503} may be the same as defined in connection with L_1 provided herein;

[0314] wherein R_{501} and R_{502} may be each independently selected from

[0315] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazole group, a triazinyl group, a dibenzofuranyl group, and a dibenzothio-phenyl group; and

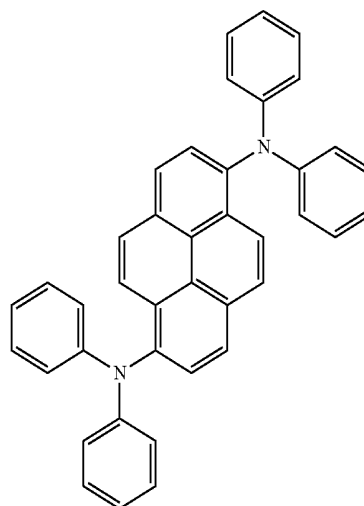
[0316] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group and a dibenzofuranyl group, and a dibenzothiophenyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a $\text{C}_1\text{-C}_{20}$ alkyl group, a $\text{C}_1\text{-C}_{20}$ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a dibenzofuranyl group, and a dibenzothiophenyl group;

[0317] xd1 to xd3 may be each independently selected from 0, 1, 2, and 3; and

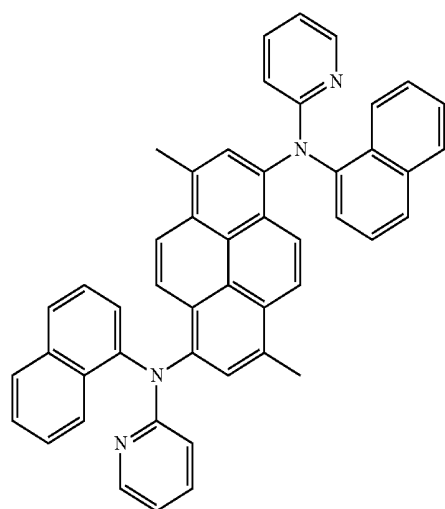
[0318] xb4 may be selected from 1, 2, 3, and 4.

[0319] The fluorescent host may include at least one selected from compounds FD1 to FD9:

FD1

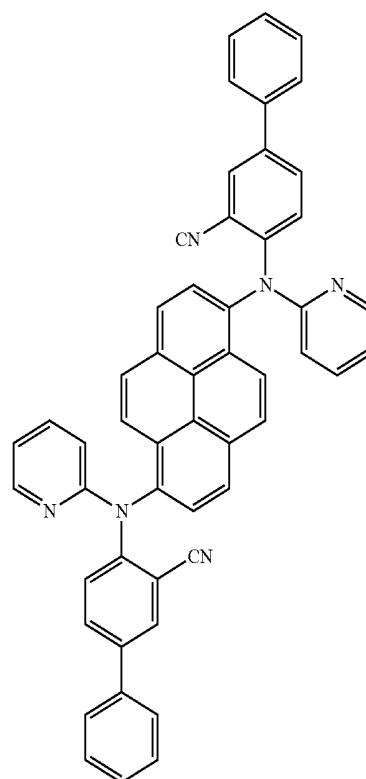


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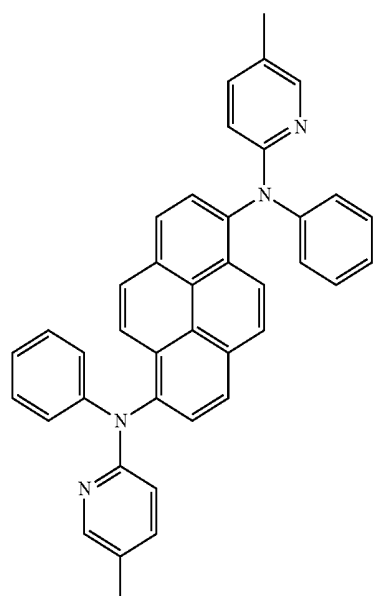
FD2

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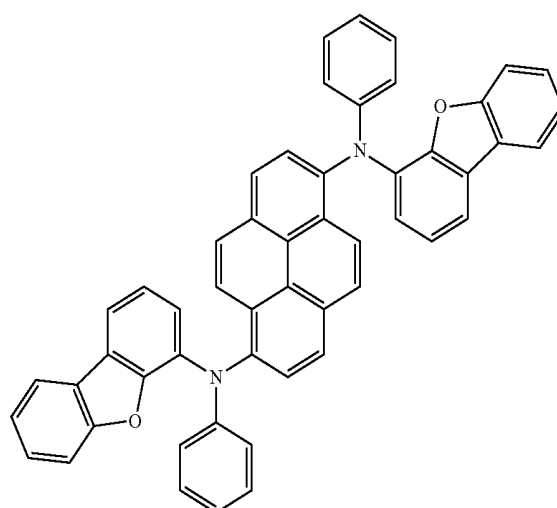


FD4

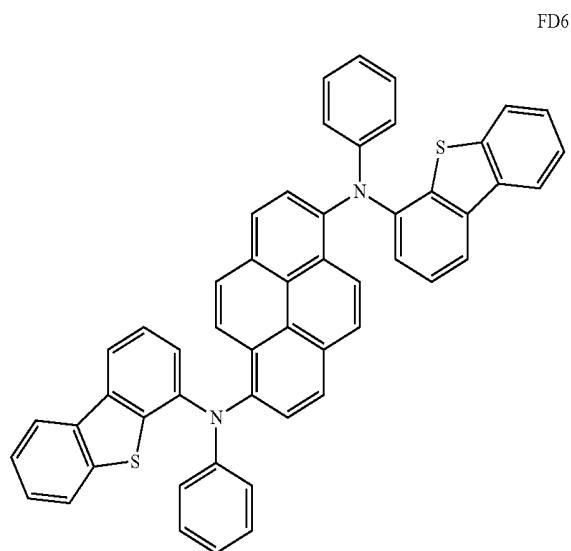
FD3



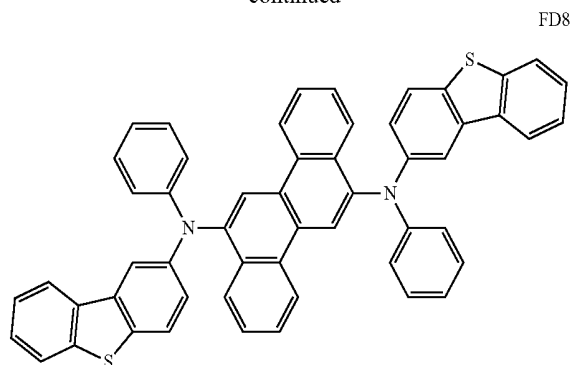
FD5



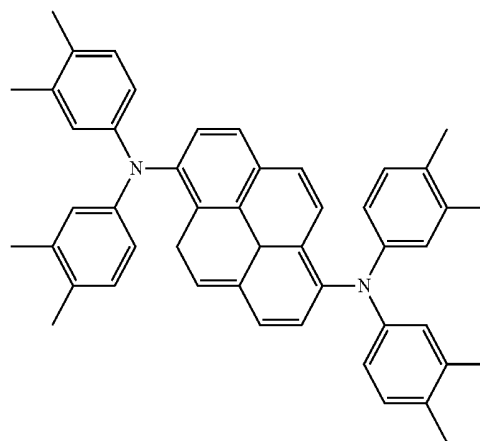
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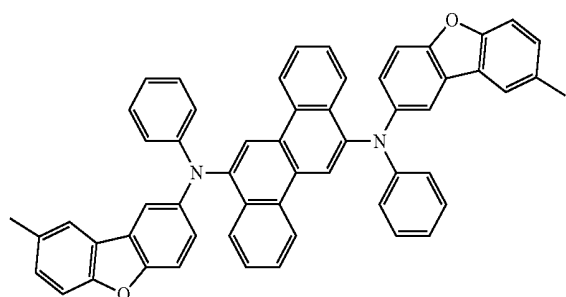
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FD9



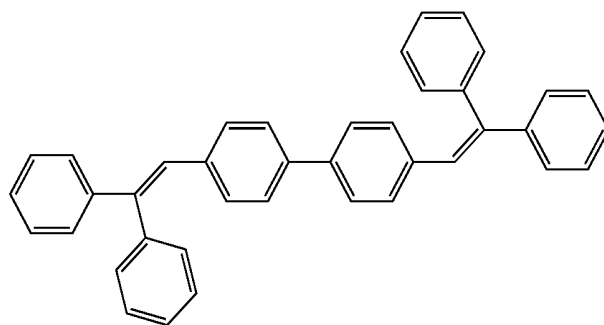
FD7



[0320] An amount of the dopant in the emission layer may be, in general, in a range of about 0.01 to about 15 parts by weight based on 100 parts by weight of the host.

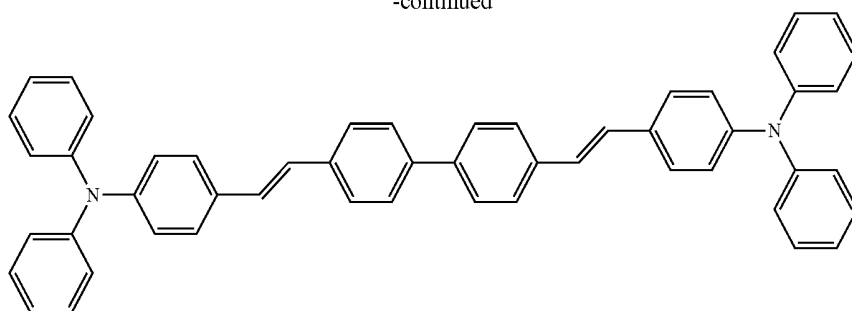
[0321] A thickness of the emission layer may be in a range of about 100 Å to about 1,000 Å, e.g., about 200 Å to about 600 Å. When the thickness of the emission layer is within this range, excellent light-emission characteristics may be obtained without a substantial increase in driving voltage.

[0322] Alternatively, the fluorescent dopant may be selected from compounds below.

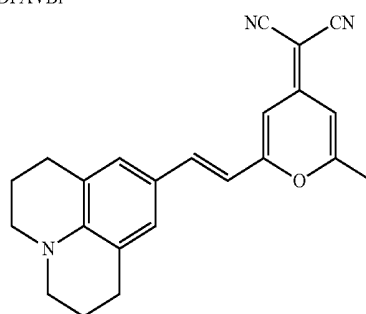
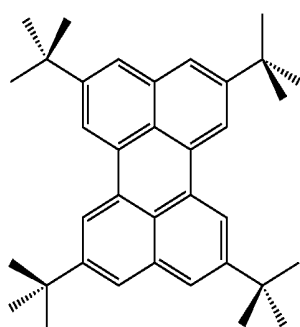


DPBVBi

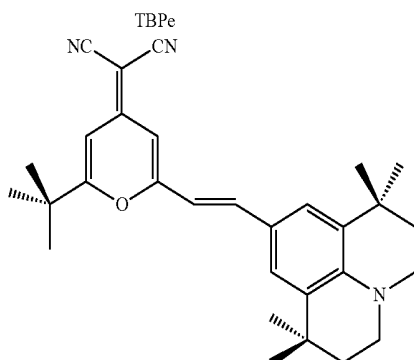
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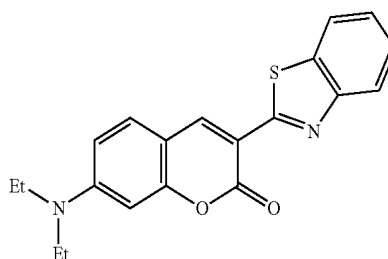
DPAVBi



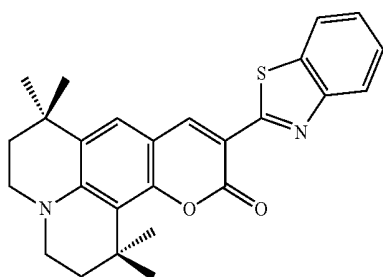
DCM



DCJTB



Coumarin 6



C545T

[0323] An amount of the dopant in the emission layer may be, in general, in a range of about 0.01 to about 15 parts by weight based on 100 parts by weight of the host.

[0324] A thickness of the emission layer may be in a range of about 100 Å to about 1,000 Å, e.g., about 200 Å to about 600 Å. When the thickness of the emission layer is within this range, excellent light-emission characteristics may be obtained without a substantial increase in driving voltage.

[0325] Then, an electron transport region may be disposed on the emission layer.

[0326] The electron transport region may include at least one selected from a hole blocking layer, an electron transport layer (ETL), and an electron injection layer.

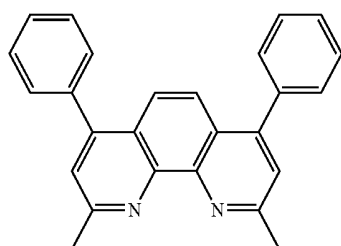
[0327] In some embodiments, the electron transport region may have a structure of electron transport layer/electron injection layer or a structure of hole blocking layer/electron

transport layer/electron injection layer, wherein layers of each structure are sequentially stacked from the emission layer in the stated order.

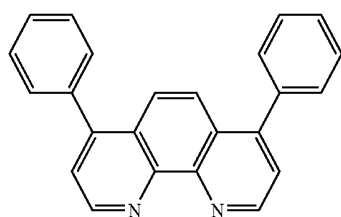
[0328] In some embodiments, the organic layer 150 of the organic light-emitting device may include an electron transport region disposed between the emission layer and the second electrode 190.

[0329] When the electron transport region includes a hole blocking layer, the hole blocking layer may be formed on the emission layer by using various methods, such as vacuum-deposition, spin coating, casting, LB method, ink-jet printing, laser-printing, or LITI. When the hole blocking layer is formed by vacuum-deposition or spin coating, deposition and coating conditions for the hole blocking layer may be determined by referring to the deposition and coating conditions for the hole injection layer.

[0330] The hole blocking layer may include, e.g., at least one selected from BCP and Bphen.



BCP

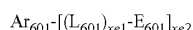


Bphen

[0331] A thickness of the hole blocking layer may be in a range of about 20 Å to about 1,000 Å, e.g., about 30 Å to about 300 Å. When the thickness of the hole blocking layer is within this range, excellent hole blocking characteristics may be obtained without a substantial increase in driving voltage.

[0332] The electron transport region may include an electron transport layer. The electron transport layer may be formed on the emission layer or the hole blocking layer by using various methods, such as vacuum deposition, spin coating, casting, LB method, ink-jet printing, laser-printing, or LITI. When the electron transport layer is formed by using vacuum deposition or spin coating, vacuum deposition and coating conditions for the electron transport layer may be determined by referring to the vacuum deposition and coating conditions for the hole injection layer.

[0333] In some embodiments, the electron transport layer may include at least one selected from a compound represented by Formula 601 and a compound represented by Formula 602:



<Formula 601>

[0334] wherein in Formula 601,

[0335] Ar_{601} may be selected from

[0336] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, a naphthacene, a picene, a perylene, a pentaphene, and an indenoanthracene; and

[0337] a naphthalene, a heptalene, a fluorene, a spiro-fluorene, a benzofluorene, a dibenzofluorene, a phenalene, a phenanthrene, an anthracene, a fluoranthene, a triphenylene, a pyrene, a chrysene, naphthacene, a picene, a perylene, a pentaphene and an indenoanthracene, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, and —Si(Q_{301})(Q_{302})(Q_{303}); wherein Q_{301} to Q_{303} may be each independently selected from a hydrogen, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_6 - C_{60} aryl group, and a C_1 - C_{60} heteroaryl group.

[0338] The descriptions for L_{601} may be the same as defined in connection with L_{201} herein.

[0339] E_{601} may be selected from

[0340] a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolyl group, an isoquinolyl group, a benzoquinolyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthroline group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolinyl group, a dibenzocarbazolinyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group; and

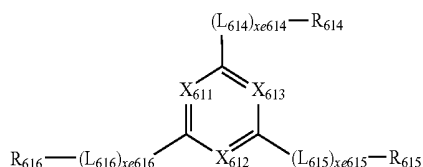
[0341] a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolyl group, an isoquinolyl group, a benzoquinolyl group, a phthalazinyl group, a naphthyridinyl group, a

quinoxaliny group, a quinazoliny group, a cinnoliny group, a carbazolyl group, a phenanthridiny group, an acridiny group, a phenanthroliny group, a phenaziny group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridiny group, and an imidazopyrimidinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, an ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinoliny group, an isoquinoliny group, a benzoquinoliny group, a phthalazinyl group, a naphthyridinyl group, a quinoxaliny group, a quinazoliny group, a cinnoliny group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenaziny group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

[0342] xe1 may be selected from 0, 1, 2, and 3; and

[0343] xe2 may be selected from 1, 2, 3, and 4.

<Formula 602>



[0344] wherein, in Formula 602,

[0345] X₆₁₁ may be N or C-(L₆₁₁)_{xe611}-R₆₁₁, X₆₁₂ may be N or C-(L₆₁₂)_{xe612}-R₆₁₂, X₆₁₃ may be N or C-(L₆₁₃)_{xe613}-R₆₁₃, and at least one selected from X₆₁₁ to X₆₁₃ may be N;

[0346] L₆₁₁ to L₆₁₆ may be the same as defined in connection with L₁ provided herein;

[0347] R₆₁₁ to R₆₁₆ may be each independently selected from

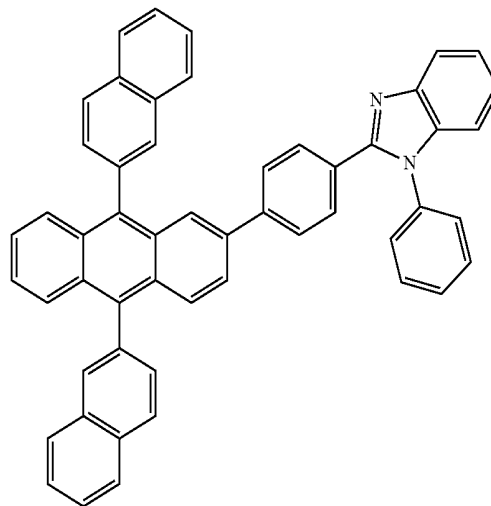
[0348] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinoliny group, an isoquinoliny group, a quinoxaliny group, a quinazoliny group, a carbazolyl group, and a triazinyl group; and

[0349] a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinoliny group, an isoquinoliny group, a quinoxaliny group, a quinazoliny group, a carbazolyl group, and a triazinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinoliny group, an isoquinoliny group, a quinoxaliny group, a quinazoliny group, a carbazolyl group, and a triazinyl group;

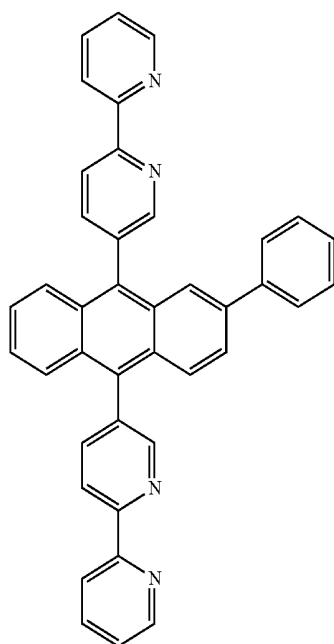
[0350] xe611 to xe616 may be each independently selected from 0, 1, 2, and 3.

[0351] The compound represented by Formula 601 and the compound represented by Formula 602 may be each independently selected from Compounds ET1 to ET15:

ET1

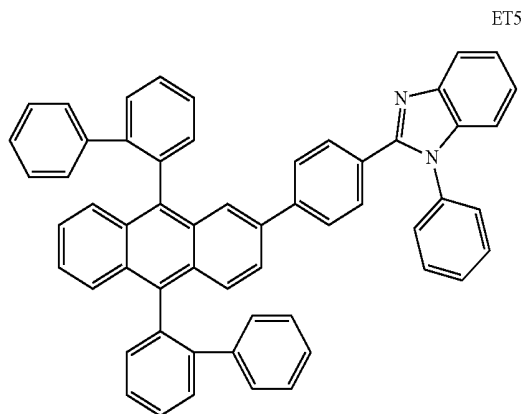


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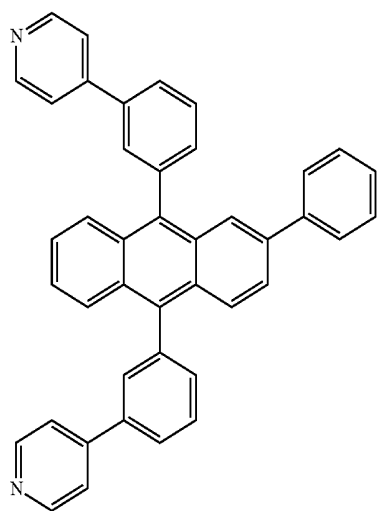


ET2

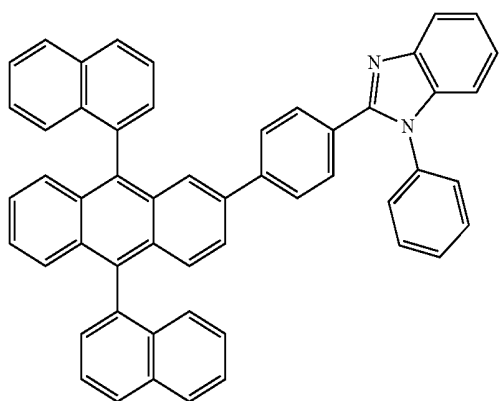
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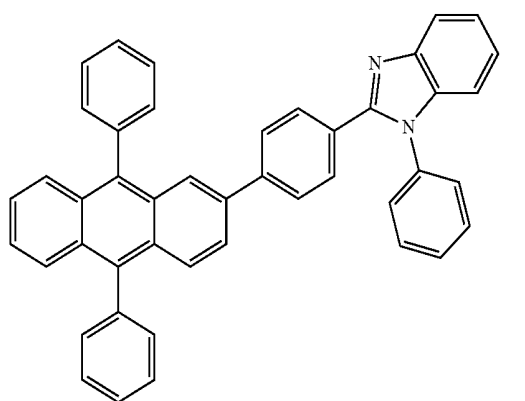
ET5



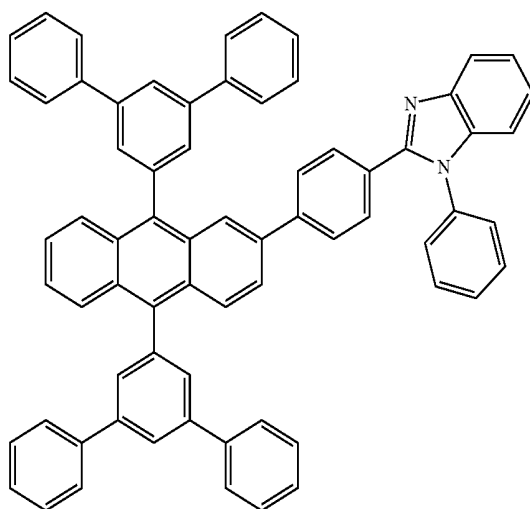
ET3



ET6



ET4



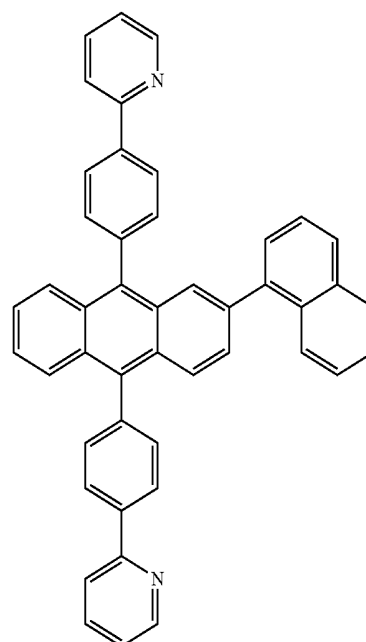
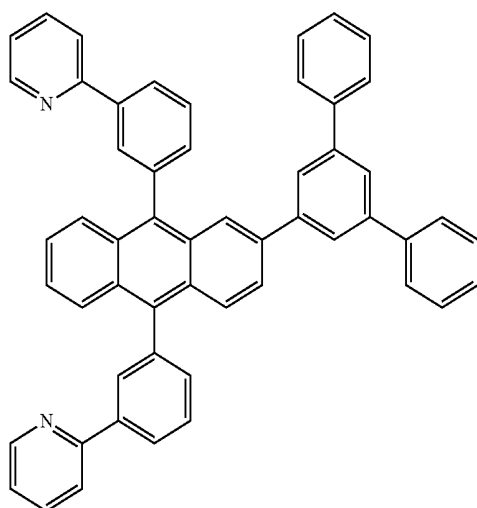
ET7

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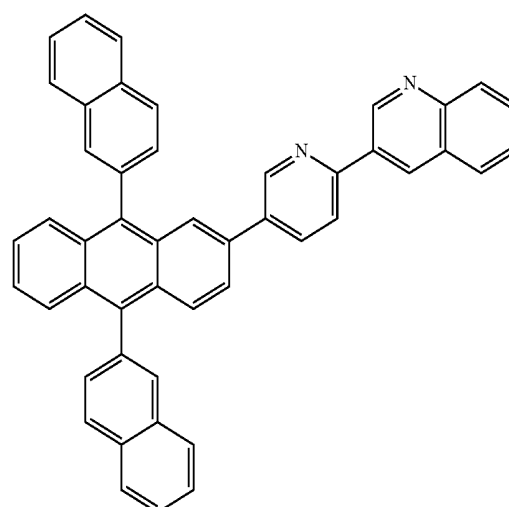
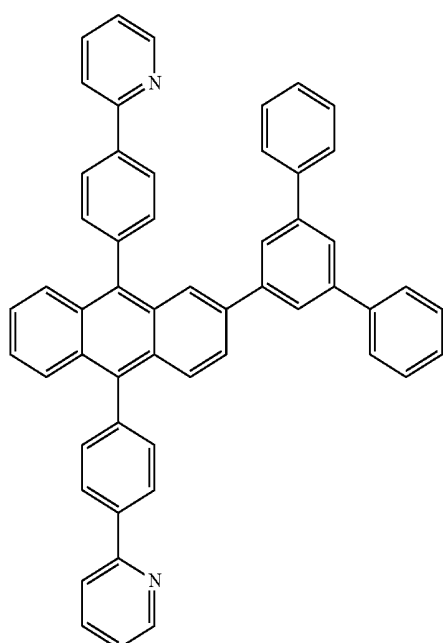
ET10

ET8

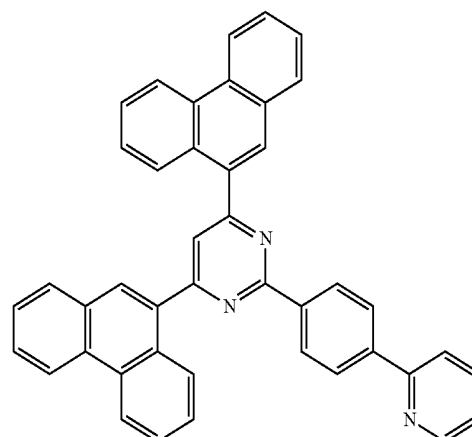


ET11

ET9

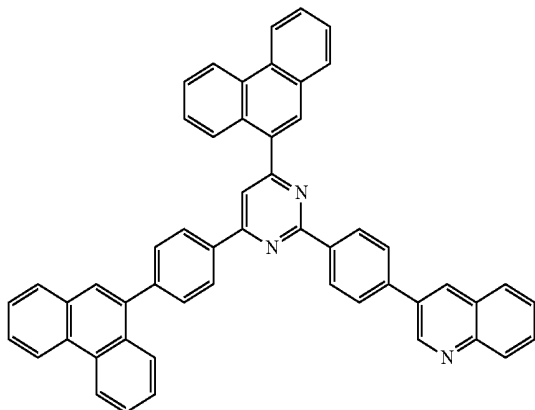


ET12



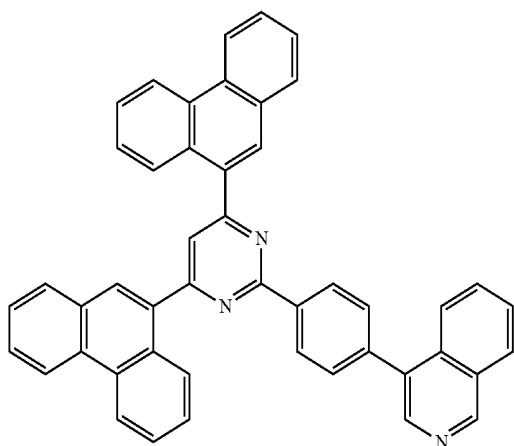
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ET13

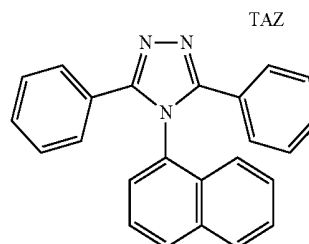
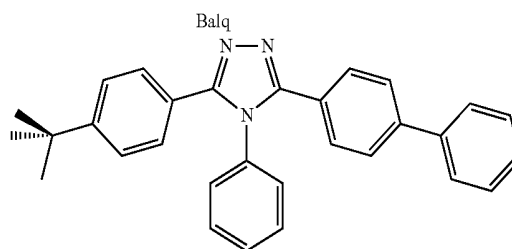
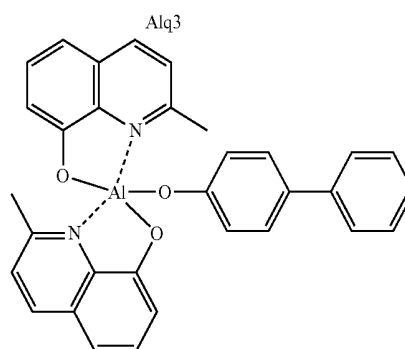
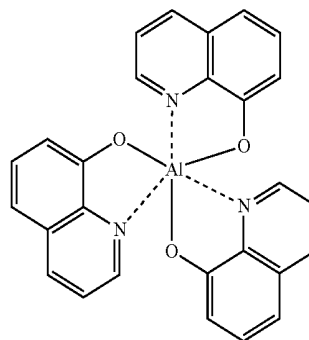
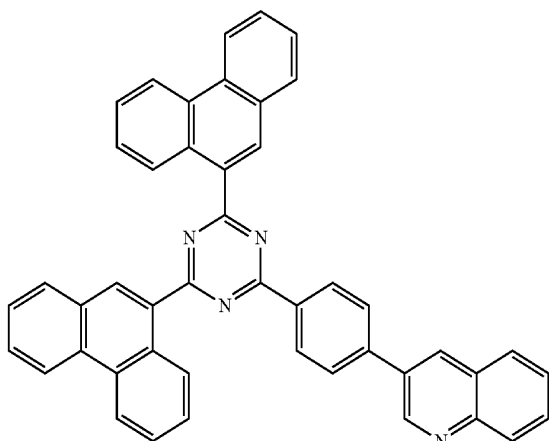


[0352] The electron transport layer may include at least one selected from BCP, Bphen, Alq₃, Balq, TAZ, and NTAZ.

ET14



ET15

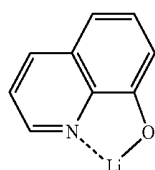


NTAZ

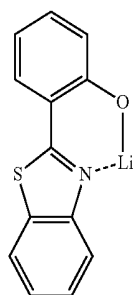
[0353] A thickness of the electron transport layer may be in a range of about 100 Å to about 1,000 Å, e.g., about 150 Å to about 500 Å. When the thickness of the electron transport layer is within this range, excellent electron transport characteristics may be obtained without a substantial increase in driving voltage.

[0354] The electron transport layer may further include a metal-containing material in addition to the materials described above.

[0355] The metal-containing material may include a Li complex. The Li complex may include, for example, Compound ET-D1 (lithium quinolate, LiQ) or ET-D2.



ET-D1



ET-D2

[0356] The electron transport region may include an electron injection layer that facilitates electron injection from the second electrode 190.

[0357] The electron injection layer may be formed on the electron transport layer by using various methods, such as vacuum-deposition, spin coating, casting, LB method, ink-jet printing, laser-printing, or LITI. When the electron injection layer is formed by vacuum-deposition or spin coating, vacuum-deposition and coating conditions for the electron injection layer may be determined by referring to the vacuum-deposition and coating conditions for the hole injection layer.

[0358] The electron injection layer may include at least one selected from LiF, NaCl, CsF, Li₂O, BaO, and LiQ.

[0359] A thickness of the electron injection layer may be in a range of about 1 Å to about 100 Å, e.g., about 3 Å to about 90 Å. When the thickness of the electron injection layer is within this range, excellent electron injection characteristics may be obtained without a substantial increase in driving voltage.

[0360] The second electrode 190 is disposed on the organic layer 150. The second electrode 190 may be a cathode that is an electron injection electrode, and in this regard, a material for forming the second electrode 190 may be a material having a low work function, and such a material may include metal, alloy, an electrically conductive compound, or a mixture thereof. Examples of a material for forming the second electrode 190 may include lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al—Li), calcium (Ca), magnesium-indium (Mg—In), and magnesium-silver (Mg—Ag). In some embodiments, the material for forming the second electrode 190 may be ITO or IZO. The second electrode 190 may be a semi-transmissive electrode or a transmissive electrode.

[0361] Referring to FIG. 2, an organic light-emitting device 20 may have a structure including a first capping layer 210, the first electrode 110, the organic layer 150, and the second electrode 190, which are sequentially stacked in the stated order. Referring to FIG. 3, an organic light-emitting device 30 may have a structure of the first electrode 110, the organic layer 150, the second electrode 190, and a second capping layer 220, wherein the layers are sequentially stacked in the stated order. Referring to FIG. 4, an organic light-emitting device 20 may have a structure of the

first capping layer 210, the first electrode 110, the organic layer 150, the second electrode 190, and the second capping layer 220, wherein the layers are stacked in the stated order.

[0362] The first electrode 110, the organic layer 150, and the second electrode 190 according to FIGS. 2 to 4 may be understood by referring to the descriptions with respect to FIG. 1.

[0363] In the organic light-emitting device 20, 40, light emitted from the emission layer in the organic layer 150 may pass through the first electrode 110, which may be a semi-transmissive electrode or transmissive electrode, and through the first capping layer 210 to the outside. In the organic light-emitting device 30, 40, light emitted from the emission layer in the organic layer 150 may pass through second electrode 190, which may be a semi-transmissive electrode or transmissive electrode, and the second capping layer 220 to the outside.

[0364] The first capping layer 210 and the second capping layer 220 may help improve external luminous efficiency based on the principle of constructive interference.

[0365] In an implementation, the first capping layer 210 shown in FIG. 2 and the second capping layer 220 shown in FIG. 3 may include the condensed-cyclic compound represented by Formula 1.

[0366] In an implementation, at least one selected from the first capping layer 210 and second capping layer 220 shown in FIG. 4 may include the condensed-cyclic compound represented by Formula 1.

[0367] In some embodiments, the organic layer 150 shown in FIGS. 2 to 4 may not include the condensed-cyclic compound represented by Formula 1.

[0368] Hereinbefore, the organic light-emitting device has been described with reference to FIGS. 1 to 4.

[0369] A C₁-C₆₀ alkyl group used herein refers to a linear or branched aliphatic hydrocarbon monovalent group having 1 to 60 carbon atoms, and examples thereof are a methyl group, an ethyl group, a propyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, a pentyl group, an iso-amyl group, and a hexyl group. A C₁-C₆₀ alkylene group used herein refers to a divalent group having the same structure as the C₁-C₆₀ alkyl group.

[0370] A C₁-C₆₀ alkoxy group used herein refers to a monovalent group represented by —OA₁₀₁ (wherein A₁₀₁ is the C₁-C₆₀ alkyl group), and detailed examples thereof are a methoxy group, an ethoxy group, and an isopropoxy group.

[0371] A C₂-C₆₀ alkenyl group used herein refers to a hydrocarbon group formed by substituting at least one carbon double bond in the middle or at the terminal of the C₂-C₆₀ alkyl group, and examples thereof are an ethenyl group, a propenyl group, and a butenyl group. A C₂-C₆₀ alkenylene group used herein refers to a divalent group having the same structure as a C₂-C₆₀ alkenyl group.

[0372] A C₂-C₆₀ alkynyl group used herein refers to a hydrocarbon group formed by substituting at least one carbon triple bond in the middle or at the terminal of the C₂-C₆₀ alkyl group, and examples thereof are an ethynyl group and a propynyl group. A C₂-C₆₀ alkynylene group used herein refers to a divalent group having the same structure as a C₂-C₆₀ alkynyl group.

[0373] A C₃-C₁₀ cycloalkyl group used herein refers to a monovalent monocyclic saturated hydrocarbon group including 3 to 10 carbon atoms, and detailed examples thereof are a cyclopropyl group, a cyclobutyl group, a

cyclopentyl group, a cyclohexyl group, and a cycloheptyl group. A C_3 - C_{10} cycloalkylene group used herein refers to a divalent group having the same structure as a C_3 - C_{10} cycloalkyl group.

[0374] A C_1 - C_{10} heterocycloalkyl group used herein refers to a monovalent monocyclic group including at least one hetero atom selected from N, O, Si, P, and S as a ring-forming atom and 1 to 10 carbon atoms, and examples thereof are a tetrahydrofuranyl group and a tetrahydrothiophenyl group. A C_1 - C_{10} heterocycloalkylene group used herein refers to a divalent group having the same structure as a C_3 - C_{10} heterocycloalkyl group.

[0375] A C_3 - C_{10} cycloalkenyl group used herein refers to a monovalent monocyclic group including 3 to 10 carbon atoms and at least one double bond in the ring thereof and does not have aromaticity, and examples thereof are a cyclopentenyl group, a cyclohexenyl group, and a cycloheptenyl group. A C_3 - C_{10} cycloalkenylene group used herein refers to a divalent group having the same structure as a C_3 - C_{10} cycloalkenyl group.

[0376] A C_1 - C_{10} heterocycloalkenyl group used herein refers to a monovalent monocyclic group including at least one hetero atom selected from N, O, Si, P, and S as a ring-forming atom, 1 to 10 carbon atoms, and at least one double bond in its ring. Examples of the C_1 - C_{10} heterocycloalkenyl group are a 2,3-dihydrofuranyl group and a 2,3-dihydrothiophenyl group. A C_1 - C_{10} heterocycloalkenylene group used herein refers to a divalent group having the same structure as a C_1 - C_{10} heterocycloalkenyl group.

[0377] A C_6 - C_{60} aryl group used herein refers to a monovalent group including a carbocyclic aromatic system having 6 to 60 carbon atoms, and a C_6 - C_{60} arylene group used herein refers to a divalent group including a carbocyclic aromatic system having 6 to 60 carbon atoms. Examples of the C_6 - C_{60} aryl group are a phenyl group, a naphthyl group, an anthracenyl group, a phenanthrenyl group, a pyrenyl group, and a chrysenyl group. When the C_6 - C_{60} aryl group and the C_6 - C_{60} arylene group each include a plurality of rings, the plurality of rings may be fused to each other.

[0378] A C_1 - C_{60} heteroaryl group used herein refers to a monovalent group having a carbocyclic aromatic system having at least one hetero atom selected from N, O, Si, P, and S as a ring-forming atom and 1 to 60 carbon atoms. A C_1 - C_{60} heteroarylene group used herein refers to a divalent group having a carbocyclic aromatic system having at least one hetero atom selected from N, O, P, and S as a ring-forming atom and 1 to 60 carbon atoms. Examples of the C_1 - C_{60} heteroaryl group are a pyridinyl group, a pyrimidinyl group, a pyrazinyl group, a pyridazinyl group, a triazinyl group, a quinolinyl group, and an isoquinolinyl group. When the C_1 - C_{60} heteroaryl group and the C_1 - C_{60} heteroarylene group each include a plurality of rings, the plurality of rings may be fused to each other.

[0379] A C_6 - C_{60} aryloxy group used herein indicates $-OA_{102}$ (wherein A_{102} is the C_6 - C_{60} aryl group), and a C_6 - C_{60} arylthio group used herein indicates $-SA_{103}$ (wherein A_{103} is the C_6 - C_{60} aryl group).

[0380] A monovalent non-aromatic condensed polycyclic group used herein refers to a monovalent group that has 2 or greater rings condensed to each other, and has only carbon atoms (for example, the number of carbon atoms may be in a range of 8 to 60) as ring forming atoms, wherein the molecular structure as a whole is non-aromatic in the entire molecular structure. An example of the monovalent non-

aromatic condensed polycyclic group is a fluorenyl group. A divalent non-aromatic condensed polycyclic group used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed polycyclic group.

[0381] A monovalent non-aromatic condensed heteropolycyclic group used herein refers to a monovalent group that has 2 or greater rings condensed to each other, has a hetero atom selected from N, O, Si, P, and S, other than carbon atoms (for example, the number of carbon atoms may be in a range of 1 to 60), as ring-forming atoms, wherein the molecular structure as a whole is non-aromatic in the entire molecular structure. The monovalent non-aromatic condensed heteropolycyclic group includes a carbazolyl group. A divalent non-aromatic condensed hetero-polycyclic group used herein refers to a divalent group having the same structure as the monovalent non-aromatic condensed heteropolycyclic group.

[0382] At least one substituent of the substituted C_3 - C_{10} cycloalkylene group, substituted C_1 - C_{10} heterocycloalkylene group, substituted C_3 - C_{10} cycloalkenylene group, substituted C_1 - C_{10} heterocycloalkenylene group, substituted C_6 - C_{60} arylene group, substituted C_1 - C_{60} heteroarylene group, substituted a divalent non-aromatic condensed polycyclic group, substituted a divalent non-aromatic condensed heteropolycyclic group, substituted C_1 - C_{60} alkyl group, substituted C_2 - C_{60} alkenyl group, substituted C_2 - C_{60} alkynyl group, substituted C_1 - C_{60} alkoxy group, substituted C_3 - C_{10} cycloalkyl group, substituted C_1 - C_{10} heterocycloalkyl group, substituted C_3 - C_{10} cycloalkenyl group, substituted C_1 - C_{10} heterocycloalkenyl group, substituted C_6 - C_{60} aryl group, substituted C_6 - C_{60} aryloxy group, substituted C_6 - C_{60} arylthio group, substituted C_1 - C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group is selected from

[0383] a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group;

[0384] a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group, each substituted with at least one selected from a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, $-N(Q_{11})(Q_{12})$, $-Si(Q_{13})(Q_{14})(Q_{15})$, and $-B(Q_{16})(Q_{17})$;

[0385] a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;

[0386] a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₆-C₆₀ aryloxy group, a C₆-C₆₀ arylthio group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q₂₁)(Q₂₂), —Si(Q₂₃)(Q₂₄)(Q₂₅), and —B(Q₂₆)(Q₂₇); and

[0387] —N(Q₃₁)(Q₃₂), —Si(Q₃₃)(Q₃₄)(Q₃₅), and —B(Q₃₆)(Q₃₇);

[0388] wherein Q₁ to Q₇, Q₁₁ to Q₁₇, Q₂₁ to Q₂₇, and Q₃₇ to Q₃₇ are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C₁-C₆₀ alkyl group, a C₂-C₆₀ alkenyl group, a C₂-C₆₀ alkynyl group, a C₁-C₆₀ alkoxy group, a C₃-C₁₀ cycloalkyl group, a C₁-C₁₀ heterocycloalkyl group, a C₃-C₁₀ cycloalkenyl group, a C₁-C₁₀ heterocycloalkenyl group, a C₆-C₆₀ aryl group, a C₁-C₆₀ heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

[0389] “Ph” used herein refers to a phenyl group, “Me” refers to a methyl group, “Et” refers to an ethyl group, and “ter-Bu” or “Bu” refers to a tert-butyl group.

[0390] Hereinafter, an organic light-emitting device of some embodiments will be described in detail with reference to Synthesis Examples and Examples. The wording “B was used instead of A” used in describing Synthesis Examples means that a molar equivalent of A was identical to a molar equivalent of B.

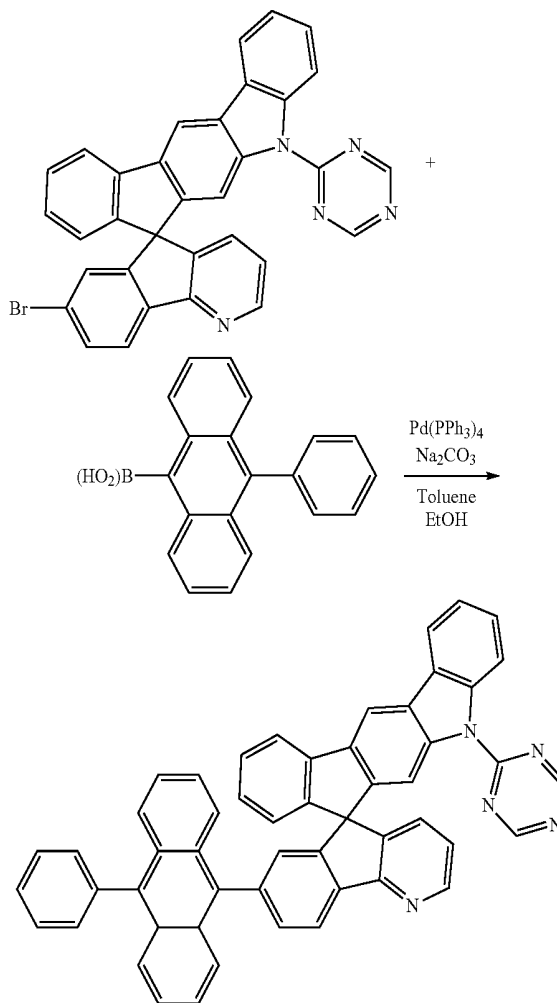
[0391] The following Examples and Comparative Examples are provided in order to highlight characteristics of one or more embodiments, but it will be understood that the Examples and Comparative Examples are not to be construed as limiting the scope of the embodiments, nor are the Comparative Examples to be construed as being outside the scope of the embodiments. Further, it will be understood that the embodiments are not limited to the particular details described in the Examples and Comparative Examples.

Example

Synthesis Example 1

Synthesis of Compound 9

[0392]



Compound 9

[0393] 0.73 g (1 eq, 1.30 mmol) of 7-bromo-5'-(1,3,5-triazin-2-yl)-5'H-spiro[indeno[1,2-b]pyridine-5,7'-indeno[2,1-b]carbazole], 0.43 g (1.1 eq, 1.43 mmol) of (10-phenylanthracen-9-yl)boronic acid, and 0.06 g (0.04 eq, 0.052 mmol) of Tetrakis(triphenylphosphine)palladium(0) were placed in a reaction container, vacuum-dried, and filled with nitrogen gas. 13 ml of toluene was added to the container to dissolve the content. Then, 6.5 ml of ethanol and 6.5 ml (10 eq, 13.0 mmol) of 2.0 M sodium carbonate aqueous solution were added, and the mixture was refluxed and stirred at a temperature of 80° C. for 3 hours. When the reaction was completed, the resultant was washed with distilled water, and an organic layer was extracted therefrom by using ethyl acetate. Then, the resultant was dried by magnesium sulfate, filtered through Celite, and purified through column chromatography to obtain 0.745 g (yield=75%) of Compound 9 (7-(10-phenylanthracen-9-yl)-5'-(1,3,5-triazin-2-yl)-5'H-

spiro[indeno[1,2-b]pyridine-5,7'-indeno[2,1-b]carbazole]). The produced compound was confirmed by using ^1H NMR and MS/FAB.

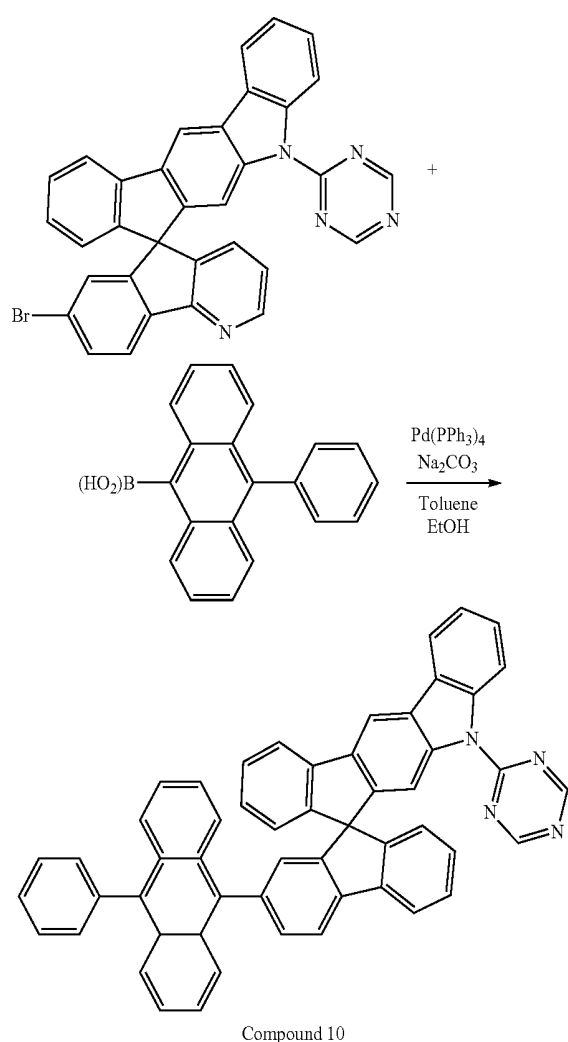
[0394] ^1H NMR: 8.87 (2H), 8.48 (1H), 8.28 (1H), 8.24 (1H), 8.09 (2H), 7.91 (5H), 7.63 (3H), 7.51 (5H), 7.40 (6H), 7.29 (3H), 7.09 (1H), 6.67 (1H).

[0395] APCI-MS (m/z): 737[M $^+$]

Synthesis Example 2

Synthesis of Compound 10

[0396]



[0397] 0.73 g (1 eq, 1.30 mmol) of 2-bromo-5'-(1,3,5-triazin-2-yl)-5'H-spiro[fluorene-9,7'-indeno[2,1-b]carbazole], 0.43 g (1.1 eq, 1.43 mmol) (10-phenylanthracen-9-yl)boronic acid, and 0.06 g (0.04 eq, 0.052 mmol) of Tetrakis(triphenylphosphine)palladium(0) were placed in a reaction container, vacuum-dried, and filled with nitrogen gas. 13 ml of toluene was added to the container to dissolve the content. Then, 6.5 ml of ethanol and 6.5 ml (10 eq, 13.0 mmol) of 2.0 M sodium carbonate aqueous solution were added, and the mixture was refluxed and stirred at a temperature of 80° C. for 3 hours. When the reaction was completed, the resultant was washed with distilled water,

and an organic layer was extracted therefrom by using ethyl acetate. The resultant was dried by using magnesium sulfate, filtered through Celite, and purified through column chromatography to obtain 0.740 g of Compound 10 (2-(10-phenylanthracen-9-yl)-5'-(1,3,5-triazin-2-yl)-5'H-spiro[fluorene-9,7'-indeno[2,1-b]carbazole]) (yield=75%). The produced compound was confirmed by using ^1H NMR and MS/FAB.

[0398] ^1H NMR: 8.87 (2H), 8.48 (1H), 8.12 (2H), 7.91 (4H), 7.81 (2H), 7.63 (2H), 7.51 (5H), 7.40 (6H), 7.24 (1H), 7.19 (2H)

[0399] APCI-MS (m/z): 736[M $^+$]

Example 1

[0400] A Corning 15 Ω/cm^2 (1,200 Å) ITO glass substrate, as an anode, was cut to a size of 50 mm×50 mm×0.7 mm, sonicated by using isopropyl alcohol and pure water for 5 minutes respectively, and cleaned by exposure to ultraviolet rays with ozone for 30 minutes. Then, the glass substrate was mounted to a vacuum-deposition apparatus.

[0401] 2-TNATA was vacuum-deposited on the ITO anode to form a hole injection layer having a thickness of 600 Å, and 4,4'-bis[N-(1-naphthyl)-N-phenyl amino group]biphenyl (NPB) was vacuum-deposited on the hole injection layer to form a hole transport layer having a thickness of 300 Å.

[0402] Compound 9 (host) and DPAVB (dopant) were co-deposited on the hole transport layer at a weight ratio of 95:5 to form an emission layer having a thickness of 20 nm.

[0403] Compound ET1 was deposited on the emission layer to form an electron transport layer having a thickness of 300 Å, LiF was deposited on the electron transport layer to form an electron injection layer having a thickness of 10 Å, and Al was vacuum-deposited on the electron injection layer to form a cathode having a thickness of 3,000 Å, thereby completing the manufacture of an organic light-emitting device.

Example 2 and Comparative Examples 1 to 5

[0404] An organic light-emitting device was manufactured in the same manner as in Example 1, except that compounds listed in Table 1 were used, respectively, instead of Compound 1, as a host, in the formation of the emission layer.

Evaluation Example 1

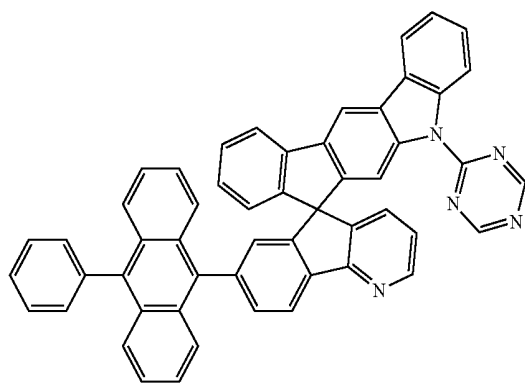
[0405] Driving voltages, current densities, luminances, and efficiencies of the organic light-emitting devices prepared in Examples 1 and 2 and Comparative Examples 1 to 5 were evaluated using Keithley SMU 236 and a luminance meter PR650. The results are shown in Table 1.

TABLE 1

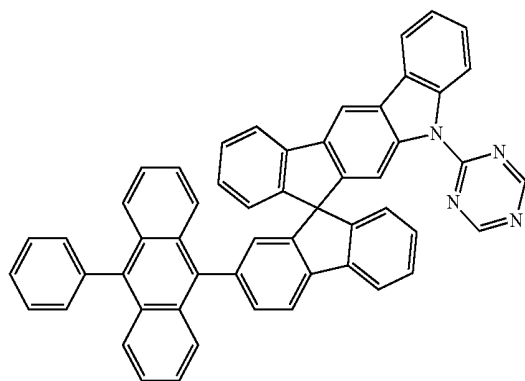
	Host	Driving voltage (V)	Current Density (mA/cm 2)	Luminance (cd/m 2)	Efficiency (cd/A)
Example 1	Compound 9	3.3	10	490	4.90
Example 2	Compound 10	3.2	10	475	4.75
Comparative Example 1	Compound A	4.5	10	311	3.11
Comparative Example 2	Compound B	4.3	10	367	3.67

TABLE 1-continued

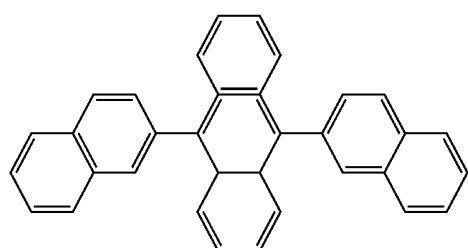
	Host	Driving voltage (V)	Current Density (mA/cm ²)	Luminance (cd/m ²)	Efficiency (cd/A)
Comparative Example 3	Compound C	4.2	10	416	4.16
Comparative Example 4	Compound D	4.4	10	378	3.78
Comparative Example 5	Compound E	4.5	10	252	2.52



9



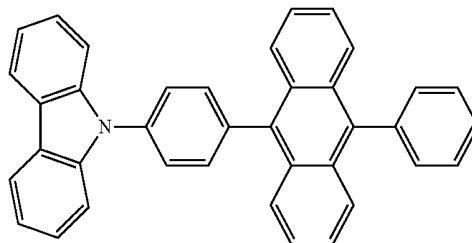
10



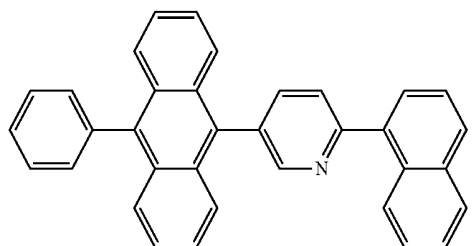
Compound A

-continued

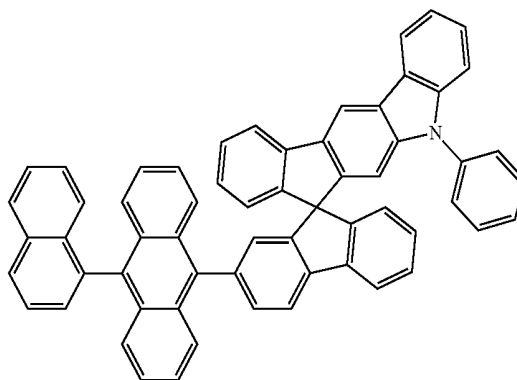
Compound B



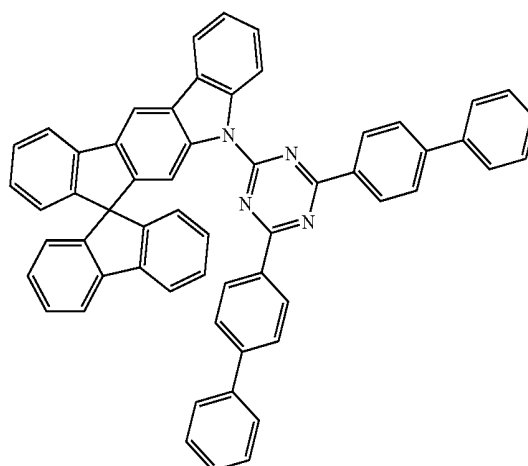
Compound C



Compound D



Compound E



[0406] Referring to Table 1, it may be seen that the organic light-emitting devices manufactured according to Examples 1 and 2 exhibited lower driving voltages, improved luminances, improved efficiencies, and improved half-lifespans, compared to the organic light-emitting devices manufactured according to Comparative Examples 1 to 5.

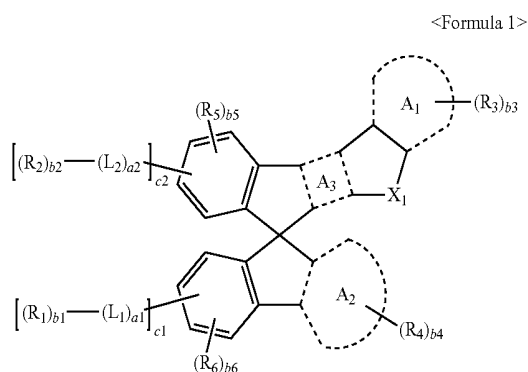
[0407] As described above, according to one or more exemplary embodiments, an organic light-emitting device

including the condensed-cyclic compound may have a low driving voltage, high efficiency, high luminance, and long lifespan.

[0408] Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

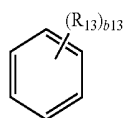
What is claimed is:

1. A condensed-cyclic compound represented by Formula 1:



wherein, in Formula 1,

ring A₁ and ring A₂ are each independently selected from a benzene group, a naphthalene group, a pyridine group, a pyrimidine group, a pyrazine group, a quinoline group, an isoquinoline group, a quinoxaline group, a quinazoline group, and a cinnoline group, ring A₃ is selected from a group represented by Formula 2A and a group represented by Formula 2B,



wherein, in Formulae 1, 2A, and 2B,

X₁ is N-[(L₁₁)_{a11}-(R₁₁)_{b11}], O, or S,

X₂ is N-[(L₁₂)_{a12}-(R₁₂)_{b12}], O, or S,

L₁ and L₂ are each independently a substituted or unsubstituted condensed polycyclic group, in which at least three carbocyclic groups are condensed to one another, a₁ and a₂ are each independently an integer selected from 1 to 5, and when a₁ is 2 or greater, a plurality of L₁ are

identical to or different from each other, and when a₂ is 2 or greater, a plurality of L₂ are identical to or different from each other,

L₁₁ to L₁₂ are each independently selected from a substituted or unsubstituted C₃-C₁₀ cycloalkylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkylene group, a substituted or unsubstituted C₃-C₁₀ cycloalkenylene group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenylene group, a substituted or unsubstituted C₆-C₆₀ arylene group, a substituted or unsubstituted C₁-C₆₀ heteroarylene group, a substituted or unsubstituted divalent non-aromatic condensed polycyclic group, and a substituted or unsubstituted divalent non-aromatic condensed heteropolycyclic group,

a₁₁ and a₁₂ are each independently an integer selected from 1 to 5, and when a₁₁ is 2 or greater, a plurality of L₁₁ are identical to or different from each other, and when a₁₂ is 2 or greater, a plurality of L₁₂ are identical to or different from each other,

R₁₁ is selected from a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, and a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group,

b₁₁ is an integer selected from 1 to 4,

R₁ to R₆, R₁₂, and R₁₃ are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a substituted or unsubstituted C₁-C₆₀ alkyl group, a substituted or unsubstituted C₂-C₆₀ alkenyl group, a substituted or unsubstituted C₂-C₆₀ alkynyl group, a substituted or unsubstituted C₁-C₆₀ alkoxy group, a substituted or unsubstituted C₃-C₁₀ cycloalkyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkyl group, a substituted or unsubstituted C₃-C₁₀ cycloalkenyl group, a substituted or unsubstituted C₁-C₁₀ heterocycloalkenyl group, a substituted or unsubstituted C₆-C₆₀ aryl group, a substituted or unsubstituted C₆-C₆₀ aryloxy group, a substituted or unsubstituted C₆-C₆₀ arylthio group, a substituted or unsubstituted C₁-C₆₀ heteroaryl group, a substituted or unsubstituted monovalent non-aromatic condensed polycyclic group, a substituted or unsubstituted monovalent non-aromatic condensed heteropolycyclic group, —N(Q₁)(Q₂), —Si(Q₃)(Q₄)(Q₅), and —B(Q₆)(Q₇),

b₁, b₂, b₅, b₆, and b₁₂ are each independently an integer selected from 0 to 4,

b₃ and b₄ are each independently an integer selected from 0 to 6,

b₁₃ is 0, 1, or 2,

c₁ and c₂ are each independently an integer selected from 0 to 4, and c₁+c₂ is 1 or greater, and

at least one substituent of the substituted condensed polycyclic group, substituted C₃-C₁₀ cycloalkylene group, substituted C₁-C₁₀ heterocycloalkylene group, substituted C₃-C₁₀ cycloalkenylene group, substituted C₁-C₁₀ heterocycloalkenylene group, substituted C₆-C₆₀ arylene group, substituted C₁-C₆₀ heteroarylene

group, substituted divalent non-aromatic condensed polycyclic group, substituted divalent non-aromatic condensed heteropolycyclic group, substituted C_1 - C_{60} alkyl group, substituted C_2 - C_{60} alkenyl group, substituted C_2 - C_{60} alkynyl group, substituted C_1 - C_{60} alkoxy group, substituted C_3 - C_{10} cycloalkyl group, substituted C_1 - C_{10} heterocycloalkyl group, substituted C_3 - C_{10} cycloalkenyl group, substituted C_1 - C_{10} heterocycloalkenyl group, substituted C_6 - C_{60} aryl group, substituted C_6 - C_{60} aryloxy group, substituted C_6 - C_{60} arylthio group, substituted C_1 - C_{60} heteroaryl group, substituted monovalent non-aromatic condensed polycyclic group, and substituted monovalent non-aromatic condensed heteropolycyclic group is selected from:

- a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group;
- a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, and a C_1 - C_{60} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic condensed heteropolycyclic group, —N(Q_{11})(Q_{12}), —Si(Q_{13})(Q_{14})(Q_{15}), and —B(Q_{16})(Q_{17});
- a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group;
- a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_6 - C_{60} aryloxy group, a C_6 - C_{60} arylthio group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, a monovalent non-aromatic con-

densed heteropolycyclic group, —N(Q_{21})(Q_{22}), —Si(Q_{23})(Q_{24})(Q_{25}), and —B(Q_{26})(Q_{27}); and —N(Q_{31})(Q_{32}), —Si(Q_{33})(Q_{34})(Q_{35}), and —B(Q_{36})(Q_{37}),

wherein Q_1 to Q_7 , Q_{11} to Q_{17} , Q_{21} to Q_{27} , and Q_{31} to Q_{37} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid or a salt thereof, a sulfonic acid or a salt thereof, a phosphoric acid or a salt thereof, a C_1 - C_{60} alkyl group, a C_2 - C_{60} alkenyl group, a C_2 - C_{60} alkynyl group, a C_1 - C_{60} alkoxy group, a C_3 - C_{10} cycloalkyl group, a C_1 - C_{10} heterocycloalkyl group, a C_3 - C_{10} cycloalkenyl group, a C_1 - C_{10} heterocycloalkenyl group, a C_6 - C_{60} aryl group, a C_1 - C_{60} heteroaryl group, a monovalent non-aromatic condensed polycyclic group, and a monovalent non-aromatic condensed heteropolycyclic group.

2. The condensed cyclic compound as claimed in claim 1, wherein ring A_1 and ring A_2 are each independently selected from a benzene group, a naphthalene group, a pyridine group, a quinoline group, and an isoquinoline group.

3. The condensed cyclic compound as claimed in claim 1, wherein X_1 is N-[(L_{11})_{a11}-(R_{11})_{b1}].

4. The condensed cyclic compound as claimed in claim 1, wherein L_1 and L_2 are each independently selected from:

an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzo-fluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthrenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, and a ovalenylene group;

an indacenylene group, an acenaphthylene group, a fluorenylene group, a spiro-fluorenylene group, a benzo-fluorenylene group, a dibenzofluorenylene group, a phenalenylene group, a phenanthrenylene group, an anthracenylene group, a fluoranthrenylene group, a triphenylenylene group, a pyrenylene group, a chrysenylene group, a naphthacenylene group, a picenylene group, a perylenylene group, a pentaphenylene group, a hexacenylene group, a pentacenylene group, a rubicenylene group, a coronenylene group, and a ovalenylene group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a

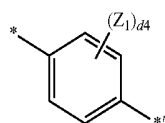
pyrenyl group, a chrysenyl group, a naphthacenyl group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexacenyl group, a pentacenyl group, a rubicenyl group, a coronenyl group, a ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and $\text{—Si}(Q_{33})(Q_{34})(Q_{35})$,

wherein Q_{33} to Q_{35} are each independently selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group.

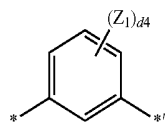
5. The condensed cyclic compound as claimed in claim 1, wherein:

L_1 and L_2 are each independently a group represented by one of the following Formulae 3-8, 3-9, 3-25, and 3-35 to 3-41, and

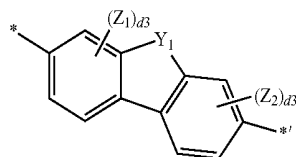
L_{11} and L_{12} are each independently a group represented by one of the following Formulae 3-1 to 3-41:



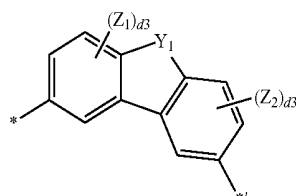
Formula 3-1



Formula 3-2

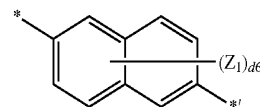


Formula 3-3

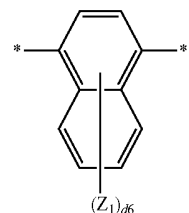


Formula 3-4

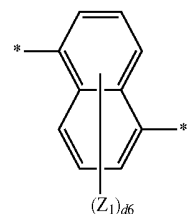
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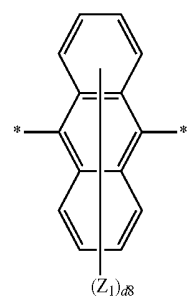
Formula 3-5



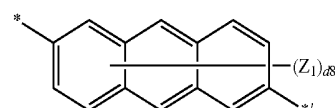
Formula 3-6



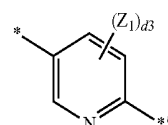
Formula 3-7



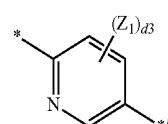
Formula 3-8



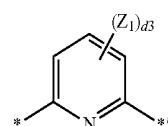
Formula 3-9



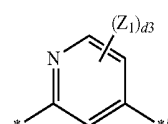
Formula 3-10



Formula 3-11

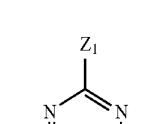
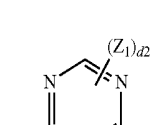
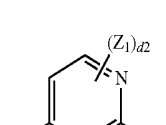
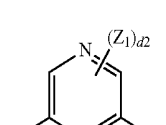
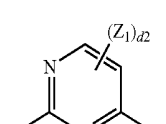
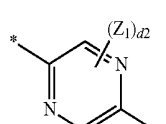
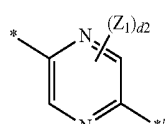
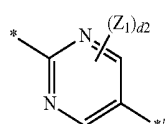
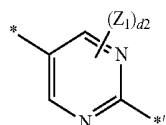
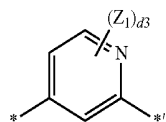
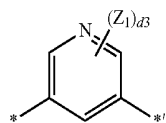


Formula 3-12



Formula 3-13

-continued



Formula 3-14

Formula 3-15

Formula 3-16

Formula 3-17

Formula 3-18

Formula 3-19

Formula 3-20

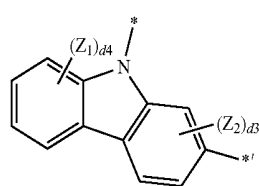
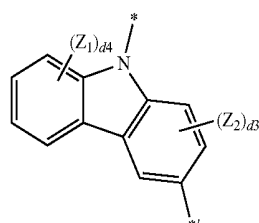
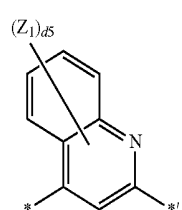
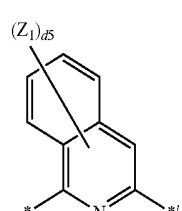
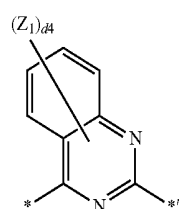
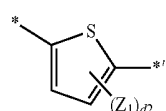
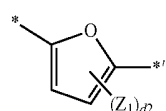
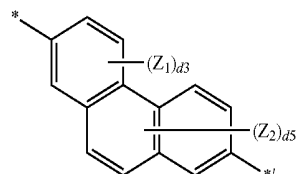
Formula 3-21

Formula 3-22

Formula 3-23

Formula 3-24

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Formula 3-25

Formula 3-26

Formula 3-27

Formula 3-28

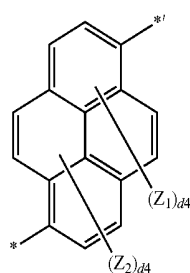
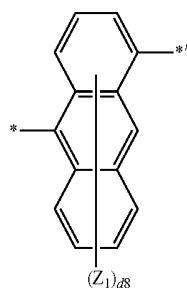
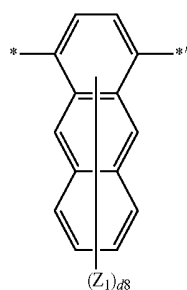
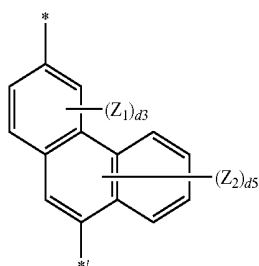
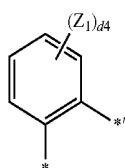
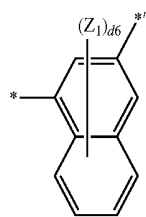
Formula 3-29

Formula 3-30

Formula 3-31

Formula 3-32

-continued



Formula 3-33

Formula 3-34

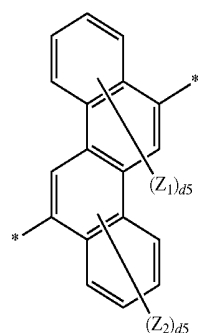
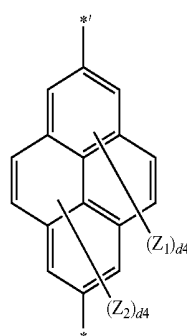
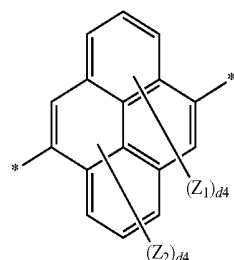
Formula 3-35

Formula 3-36

Formula 3-37

Formula 3-38

-continued



Formula 3-39

Formula 3-40

Formula 3-41

wherein, in Formulae 3-1 to 3-41,

Y_1 is O, S, $C(Z_3)(Z_4)$, $N(Z_5)$, or $Si(Z_6)(Z_7)$;

Z_1 to Z_7 are each independently selected from a hydrogen, a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, and $-Si(Q_{33})(Q_{34})(Q_{35})$,

Q_{33} to Q_{35} are each independently selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group,

d_2 is 1 or 2,

d_3 is an integer selected from 1 to 3,

d_4 is an integer selected from 1 to 4,

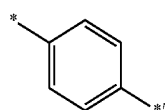
d5 is an integer selected from 1 to 5,
d6 is an integer selected from 1 to 6,
d8 is an integer selected from 1 to 8, and

* and *' are each a binding site to a neighboring atom.

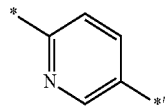
6. The condensed cyclic compound as claimed in claim 1, wherein:

L₁ and L₂ are each independently a group represented by one of the following Formulae 4-11, 4-13, 4-27, and 4-29 to 4-35, and

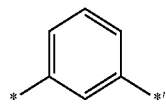
L₁₁ and L₁₂ are each independently a group represented by one of the following Formulae 4-1 to 4-35:



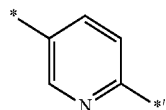
Formula 4-1



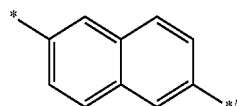
Formula 4-2



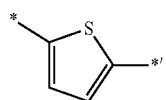
Formula 4-3



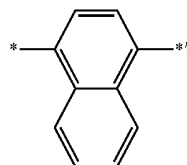
Formula 4-4



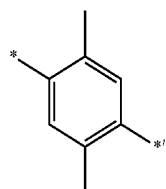
Formula 4-5



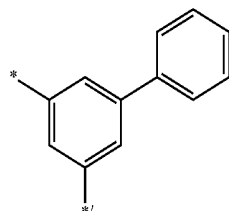
Formula 4-6



Formula 4-7

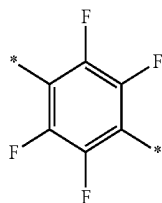


Formula 4-8

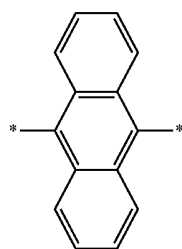


Formula 4-9

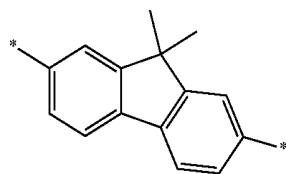
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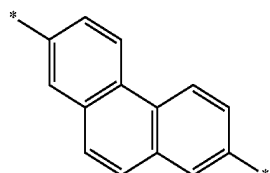
Formula 4-10



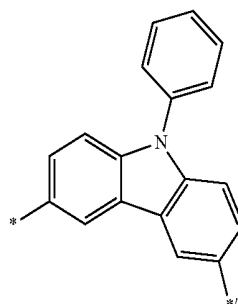
Formula 4-11



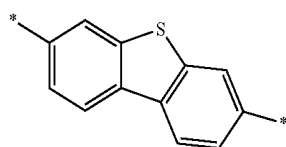
Formula 4-12



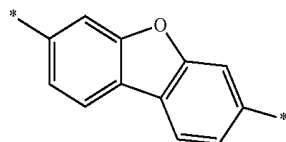
Formula 4-13



Formula 4-14

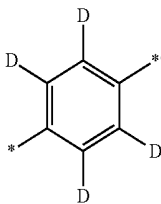
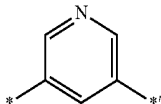
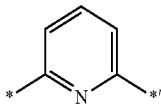
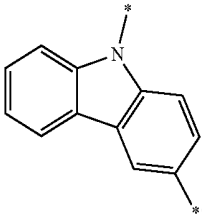
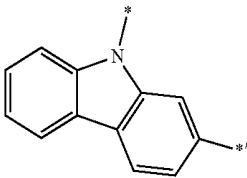
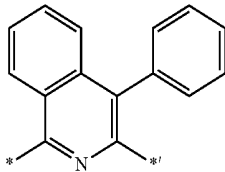
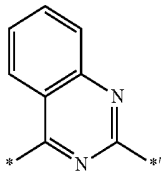
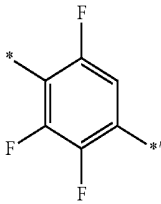


Formula 4-15



Formula 4-16

-continued



Formula 4-17

Formula 4-18

Formula 4-19

Formula 4-20

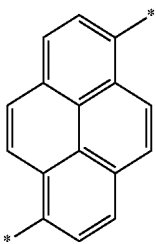
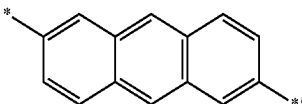
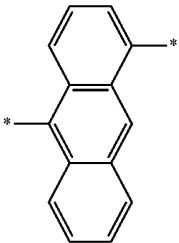
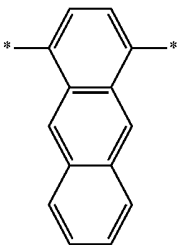
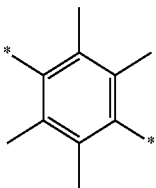
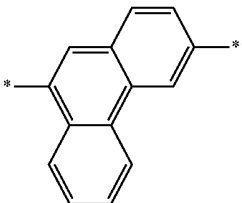
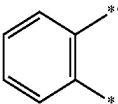
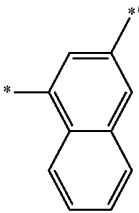
Formula 4-21

Formula 4-22

Formula 4-23

Formula 4-24

-continued



Formula 4-25

Formula 4-26

Formula 4-27

Formula 4-28

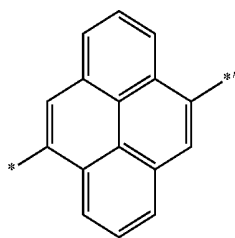
Formula 4-29

Formula 4-30

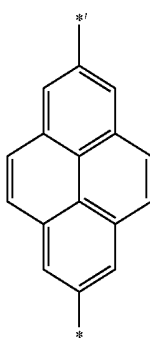
Formula 4-31

Formula 4-32

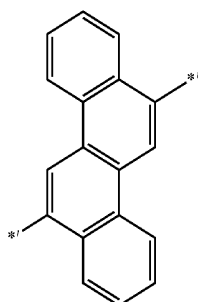
-continued



Formula 4-33



Formula 4-34



Formula 4-35

wherein, in Formulae 4-1 to 4-35, * and *¹ are each a binding site to a neighboring atom.

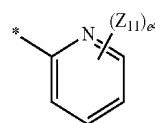
7. The condensed cyclic compound as claimed in claim 1, wherein R₁₁ is selected from:

a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyll group, an isoquinolinyll group, a benzoquinolinyll group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyll group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group;

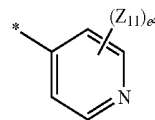
a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyll group, an isoquinolinyll group, a benzoquinolinyll group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyll group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, and a benzoxazolyl group.

indinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyll group, an isoquinolinyll group, a benzoquinolinyll group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyll group, a quinazolinyl group, a cinnolinyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a naphthyl group, a phenanthrenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyll group, an isoquinolinyll group, a benzoquinolinyll group, a quinoxalinyll group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthrolinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, and a benzoxazolyl group.

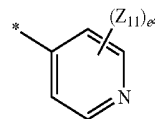
8. The condensed cyclic compound as claimed in claim 1, wherein R₁₁ is a group represented by one of the following Formulae 5-1 to 5-60:



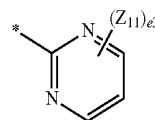
Formula 5-1



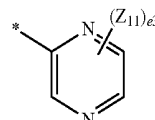
Formula 5-2



Formula 5-3

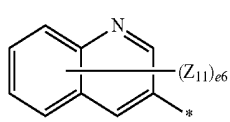
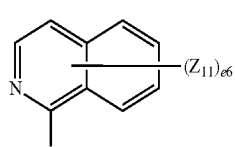
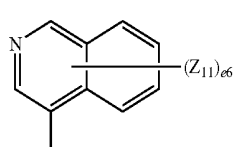
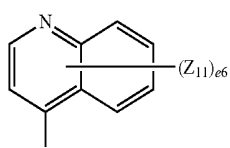
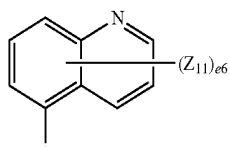
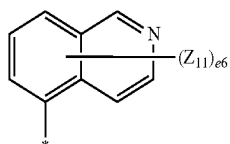
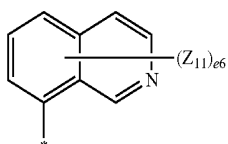
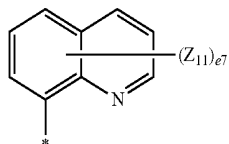
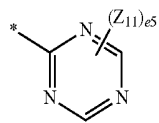
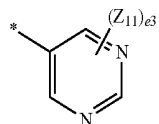
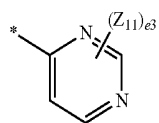


Formula 5-4



Formula 5-5

-continued



Formula 5-6

Formula 5-7

Formula 5-8

Formula 5-9

Formula 5-10

Formula 5-11

Formula 5-12

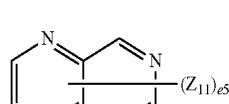
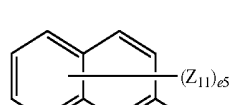
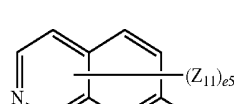
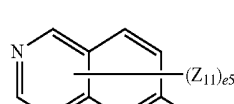
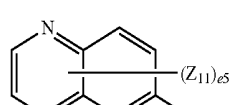
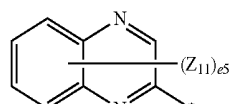
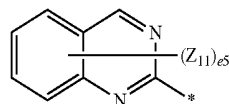
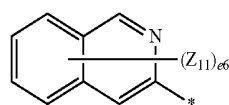
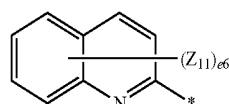
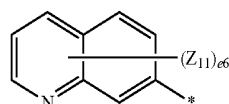
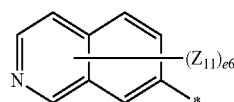
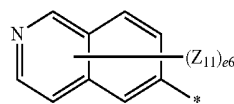
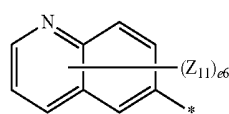
Formula 5-13

Formula 5-14

Formula 5-15

Formula 5-16

-continued



Formula 5-17

Formula 5-18

Formula 5-19

Formula 5-20

Formula 5-21

Formula 5-22

Formula 5-23

Formula 5-24

Formula 5-25

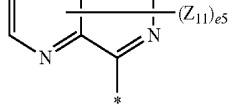
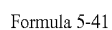
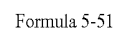
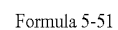
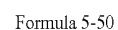
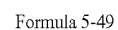
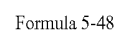
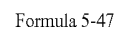
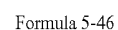
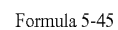
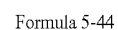
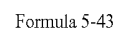
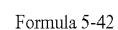
Formula 5-26

Formula 5-27

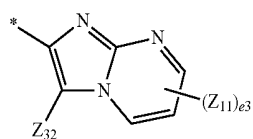
Formula 5-28

Formula 5-29

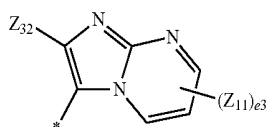
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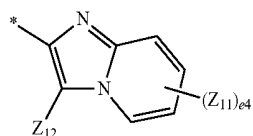
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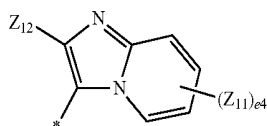
Formula 5-52



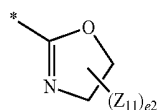
Formula 5-53



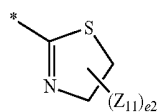
Formula 5-54



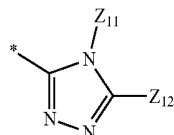
Formula 5-55



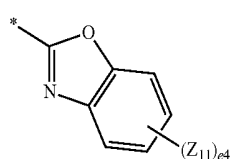
Formula 5-56



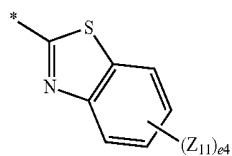
Formula 5-57



Formula 5-58



Formula 5-59



Formula 5-60

wherein, in Formulae 5-1 to 5-60,

Z_{11} and Z_{12} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzo-fluorenyl group, a dibenzo-fluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chry-

senyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a biphenyl group, a terphenyl group, and —Si(Q_{13})(Q_{14})(Q_{15}),

wherein Q_{13} to Q_{15} are each independently selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group,

e_2 is 1 or 2,

e_3 is an integer selected from 1 to 3,

e_4 is an integer selected from 1 to 4,

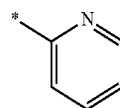
e_5 is an integer selected from 1 to 5,

e_6 is an integer selected from 1 to 6,

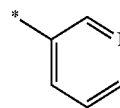
e_7 is an integer selected from 1 to 7, and

* is a binding site to a neighboring atom.

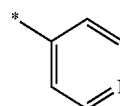
9. The condensed cyclic compound as claimed in claim 1, wherein R_{11} is a group represented by one of the following Formulae 6-1 to 6-117:



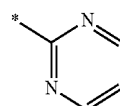
Formula 6-1



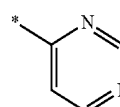
Formula 6-2



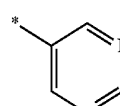
Formula 6-3



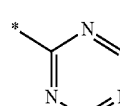
Formula 6-4



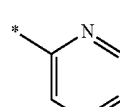
Formula 6-5



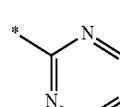
Formula 6-6



Formula 6-7

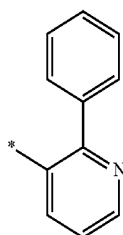
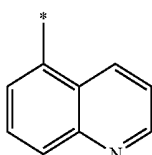
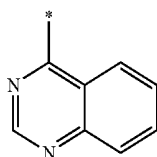
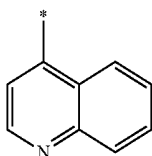
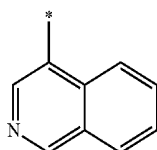
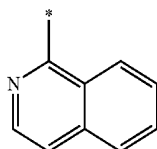
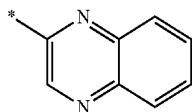
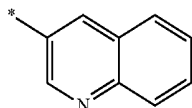
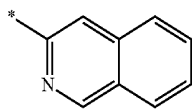


Formula 6-8



Formula 6-9

-continued



Formula 6-10

Formula 6-11

Formula 6-12

Formula 6-13

Formula 6-14

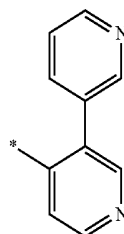
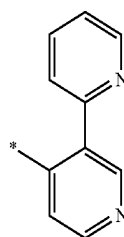
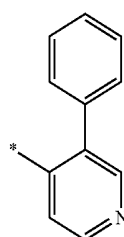
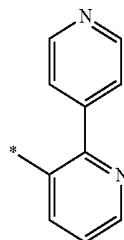
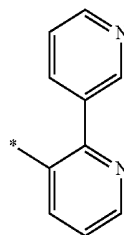
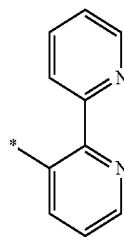
Formula 6-15

Formula 6-16

Formula 6-17

Formula 6-18

-continued



Formula 6-19

Formula 6-20

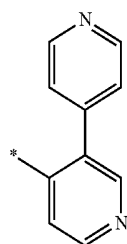
Formula 6-21

Formula 6-22

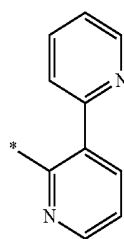
Formula 6-23

Formula 6-24

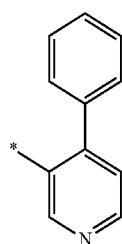
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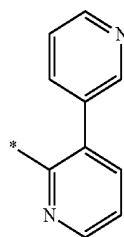
Formula 6-25



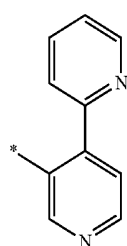
Formula 6-31



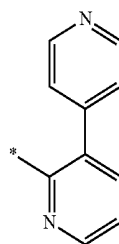
Formula 6-26



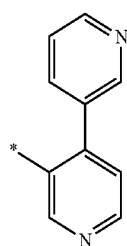
Formula 6-32



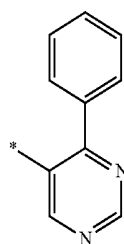
Formula 6-27



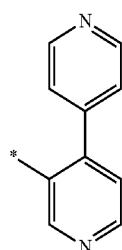
Formula 6-33



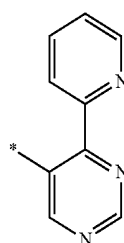
Formula 6-28



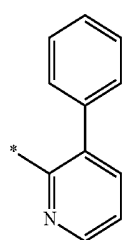
Formula 6-34



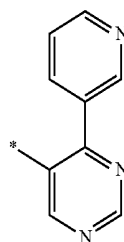
Formula 6-29



Formula 6-35

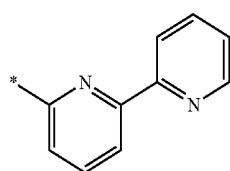
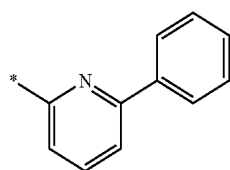
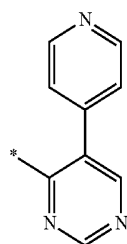
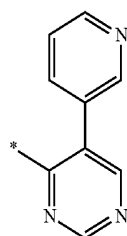
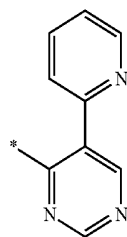
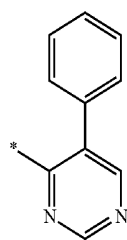
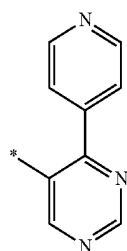


Formula 6-30



Formula 6-36

-continued



Formula 6-37

Formula 6-38

Formula 6-39

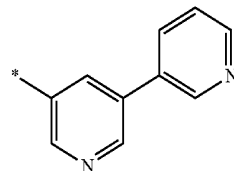
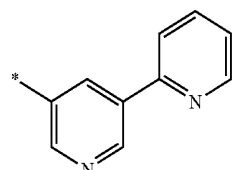
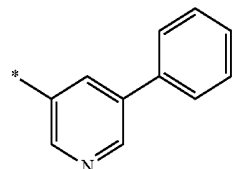
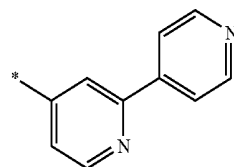
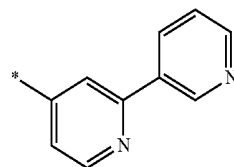
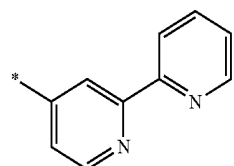
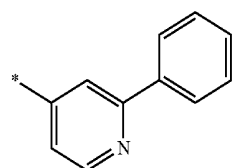
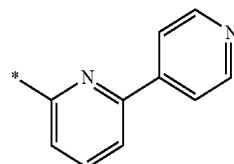
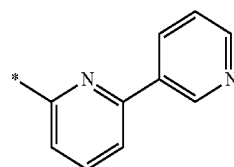
Formula 6-40

Formula 6-41

Formula 6-42

Formula 6-43

-continued



Formula 6-44

Formula 6-45

Formula 6-46

Formula 6-47

Formula 6-48

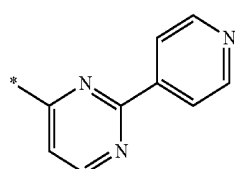
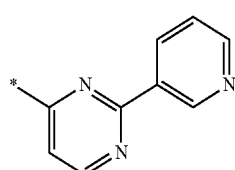
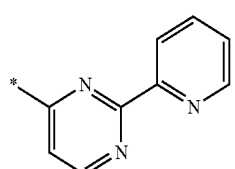
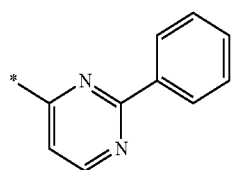
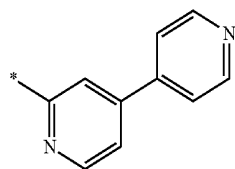
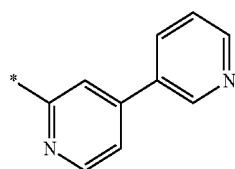
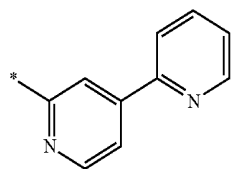
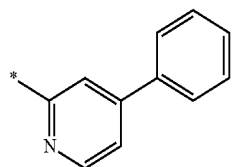
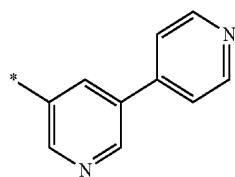
Formula 6-49

Formula 6-50

Formula 6-51

Formula 6-52

-continued



Formula 6-53

Formula 6-54

Formula 6-55

Formula 6-56

Formula 6-57

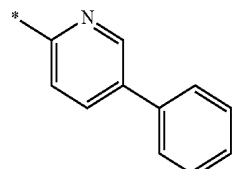
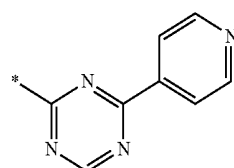
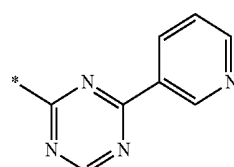
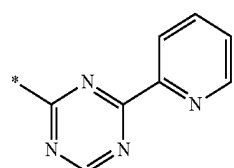
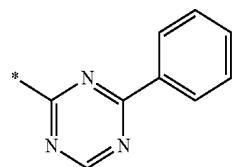
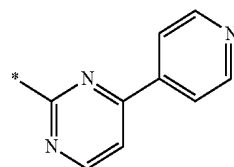
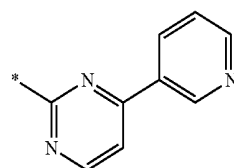
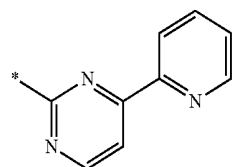
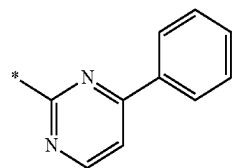
Formula 6-58

Formula 6-59

Formula 6-60

Formula 6-61

-continued



Formula 6-62

Formula 6-63

Formula 6-64

Formula 6-65

Formula 6-66

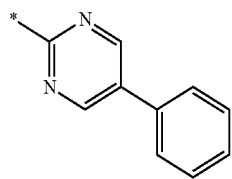
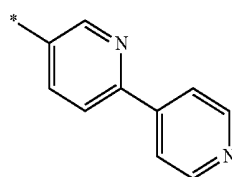
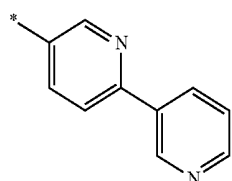
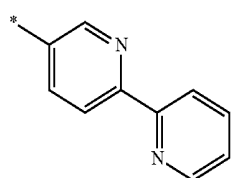
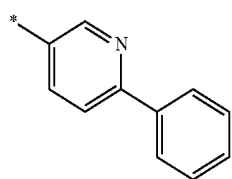
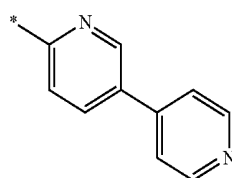
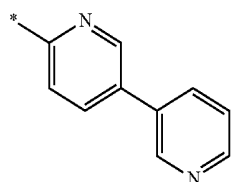
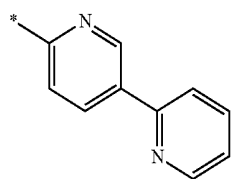
Formula 6-67

Formula 6-68

Formula 6-69

Formula 6-70

-continued



Formula 6-71

Formula 6-72

Formula 6-73

Formula 6-74

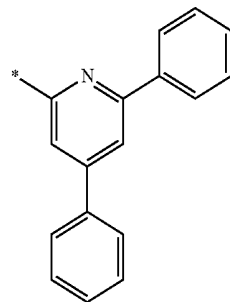
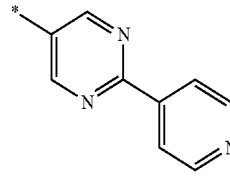
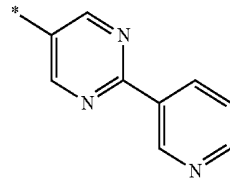
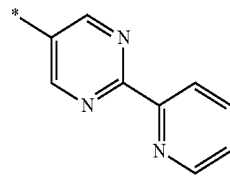
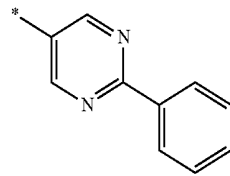
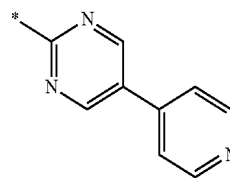
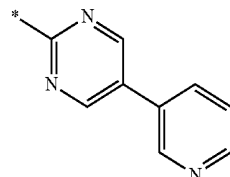
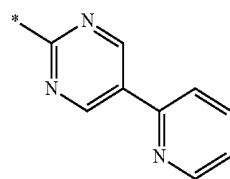
Formula 6-75

Formula 6-76

Formula 6-77

Formula 6-78

-continued



Formula 6-79

Formula 6-80

Formula 6-81

Formula 6-82

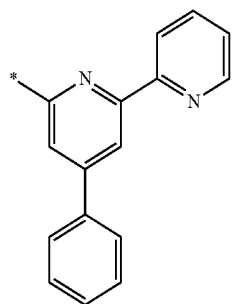
Formula 6-83

Formula 6-84

Formula 6-85

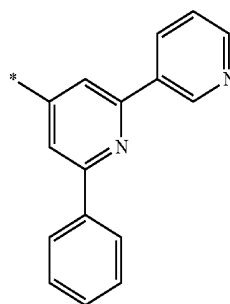
Formula 6-86

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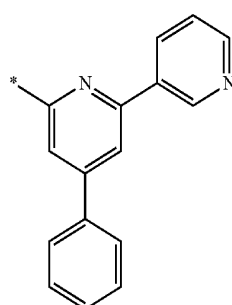


Formula 6-87

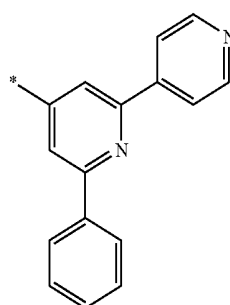
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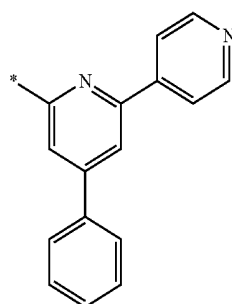
Formula 6-92



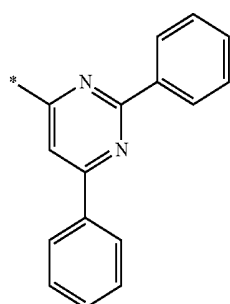
Formula 6-88



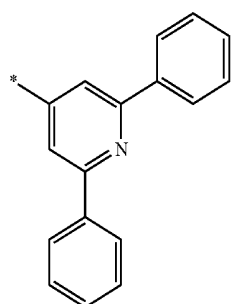
Formula 6-93



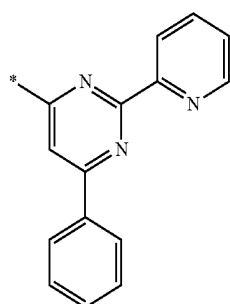
Formula 6-89



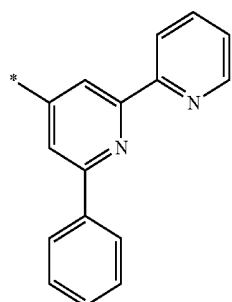
Formula 6-94



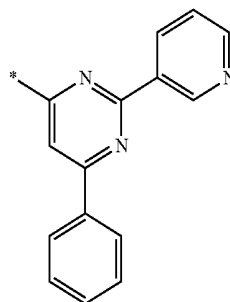
Formula 6-90



Formula 6-95

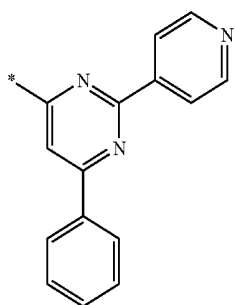


Formula 6-91



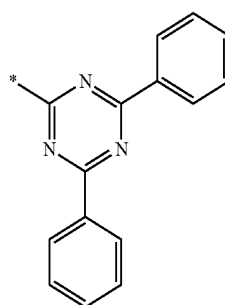
Formula 6-96

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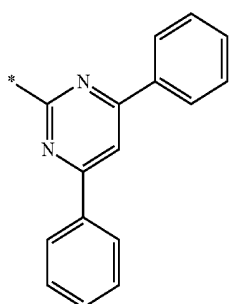
Formula 6-97

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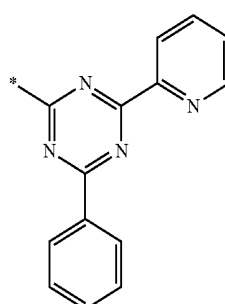


Formula 6-102

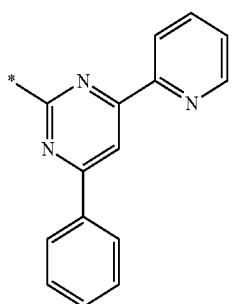
Formula 6-98



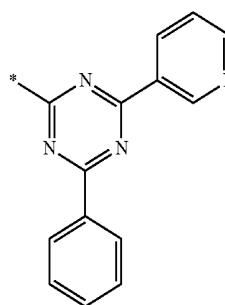
Formula 6-103



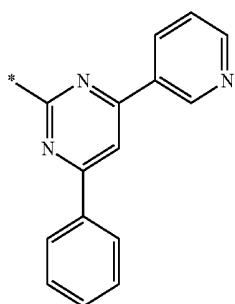
Formula 6-99



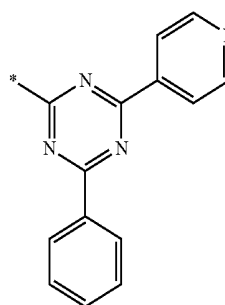
Formula 6-104



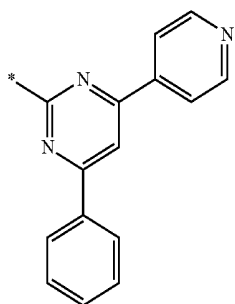
Formula 6-100



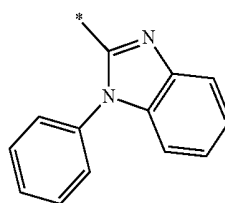
Formula 6-105



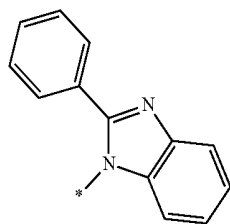
Formula 6-101



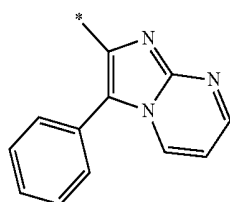
Formula 6-106



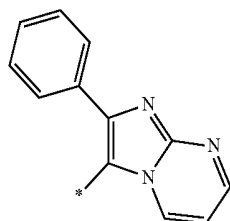
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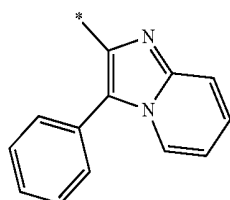
Formula 6-107



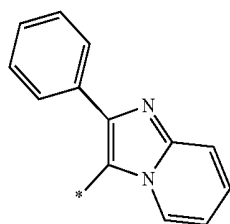
Formula 6-108



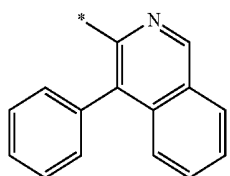
Formula 6-109



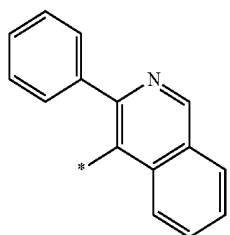
Formula 6-110



Formula 6-111

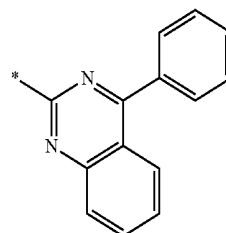


Formula 6-112

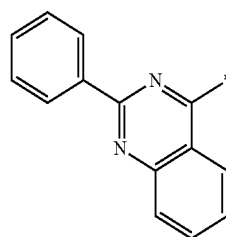


Formula 6-113

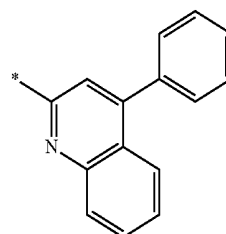
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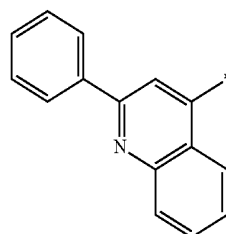
Formula 6-114



Formula 6-115



Formula 6-116



Formula 6-117

wherein, in Formulae 6-1 to 6-117, * is a binding site to a neighboring atom.

10. The condensed cyclic compound as claimed in claim 1, wherein R_1 to R_6 and R_{12} and R_{13} are each independently selected from:

a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, and a C_1 - C_{20} alkoxy group;

a C_1 - C_{20} alkyl group and a C_1 - C_{20} alkoxy group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, and a phosphoric acid group or a salt thereof;

a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluo-

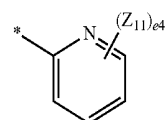
ranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthaceny group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexaceny group, a pentaceny group, a rubiceny group, a coronenyl group, a ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a dibenzosilolyl group, a thiadiazolyl group, an imidazopyridinyl group, and an imidazopyrimidinyl group, each substituted with at least one selected from a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₂₀ alkyl group, a C₁-C₂₀ alkoxy group, a cyclopentyl group, a cyclohexyl group, a cycloheptyl group, a cyclopentenyl group, a cyclohexenyl group, a phenyl group, a pentalenyl group, an indenyl group, a naphthyl group, an azulenyl group, a heptalenyl group, an indacenyl group, an acenaphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenalenyl group, a phenanthrenyl group, an anthracenyl group, a fluoranthenyl group, a triphenylenyl group, a pyrenyl group, a chrysenyl group, a naphthaceny group, a picenyl group, a perylenyl group, a pentaphenyl group, a hexaceny group, a coronenyl group, a ovalenyl group, a pyrrolyl group, a thiophenyl group, a furanyl group, an imidazolyl group, a pyrazolyl group, a thiazolyl group, an isothiazolyl group, an oxazolyl group, an isoxazolyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, an isoindolyl group, an indolyl group, an indazolyl group, a purinyl group, a quinolinyl group, an isoquinolinyl group, a benzoquinolinyl group, a phthalazinyl group, a naphthyridinyl group, a quinoxalinyl group, a quinazolinyl group, a cinnolinyl group, a carbazolyl group, a phenanthridinyl group, an acridinyl group, a phenanthrolinyl group, a phenazinyl group, a benzoimidazolyl group, a benzofuranyl group, a benzothiophenyl group, an isobenzothiazolyl group, a benzoxazolyl group, an isobenzoxazolyl group, a triazolyl group, a tetrazolyl group, an oxadiazolyl group, a triazinyl group, a dibenzofuranyl group, a dibenzothiophenyl group, a benzocarbazolyl group, a dibenzo-

carbazolyl group, a thiadiazolyl group, an imidazopyridinyl group, an imidazopyrimidinyl group, and —Si(Q₃₃)(Q₃₄)(Q₃₅); and

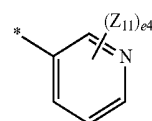
—Si(Q₃)(Q₄)(Q₅),

wherein Q₃ to Q₅ and Q₃₃ to Q₃₅ are each independently a C₁-C₁₀ alkyl group, a C₁-C₁₀ alkoxy group, a phenyl group, and a naphthyl group.

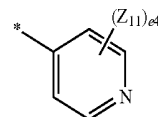
11. The condensed cyclic compound as claimed in claim 1, wherein R₁ to R₆ and R₁₂ and R₁₃ are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C₁-C₁₀ alkyl group, a C₁-C₁₀ alkoxy group, a group represented by one of the following Formulae 5-1 to 5-8, and —Si(Q₃)(Q₄)(Q₅), in which Q₃ to Q₅ are each independently selected from a C₁-C₁₀ alkyl group, a C₁-C₁₀ alkoxy group, a phenyl group, and a naphthyl group,



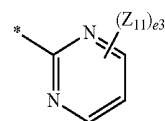
Formula 5-1



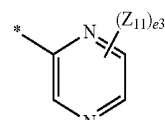
Formula 5-2



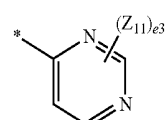
Formula 5-3



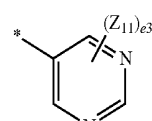
Formula 5-4



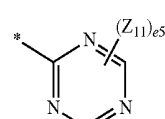
Formula 5-5



Formula 5-6

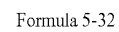
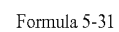
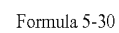
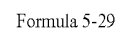
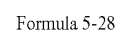
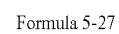
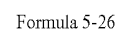
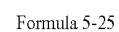
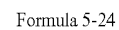
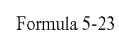
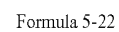
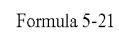
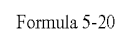


Formula 5-7

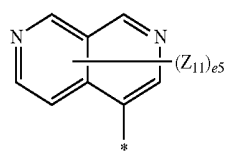
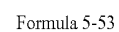
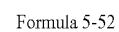
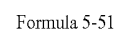
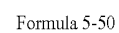
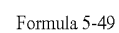
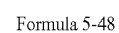
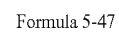
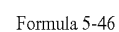
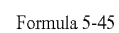
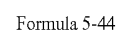


Formula 5-8

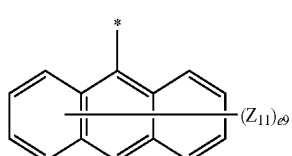
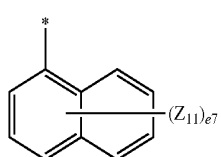
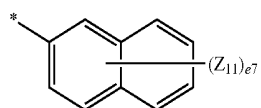
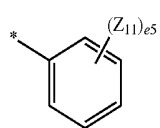
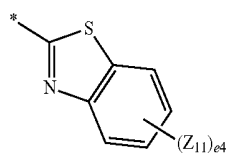
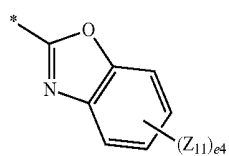
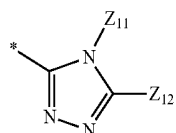
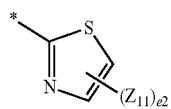
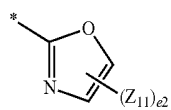
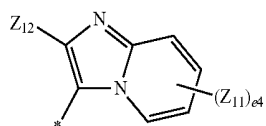
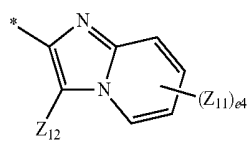
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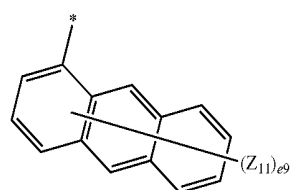


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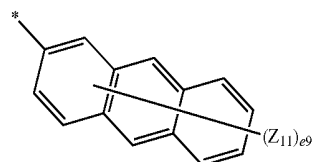


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Formula 5-54

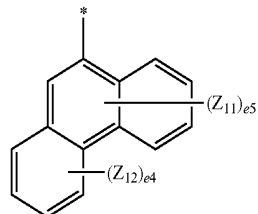


Formula 5-55



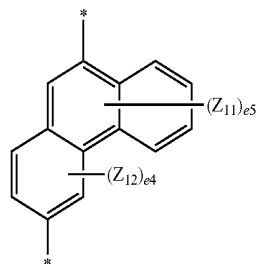
Formula 5-56

Formula 5-57



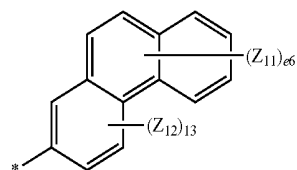
Formula 5-58

Formula 5-59

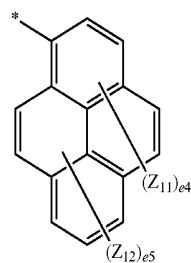


Formula 5-60

Formula 5-61

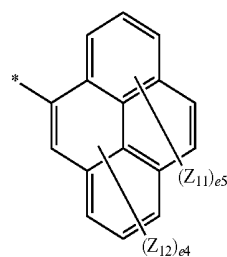


Formula 5-62



Formula 5-63

Formula 5-64



Formula 5-65

Formula 5-66

Formula 5-67

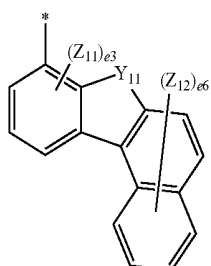
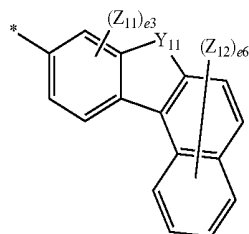
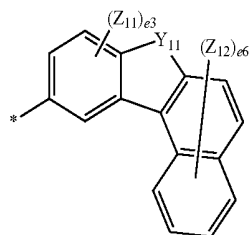
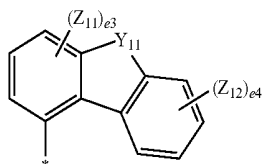
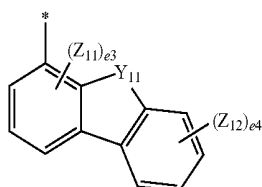
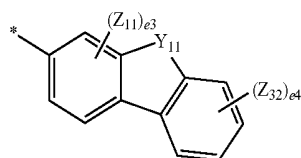
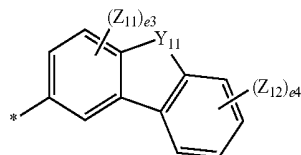
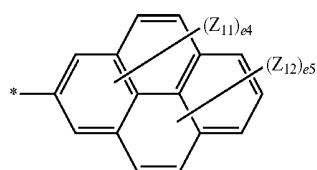
Formula 5-68

Formula 5-69

Formula 5-70

Formula 5-71

-continued



Formula 5-72

Formula 5-73

Formula 5-74

Formula 5-75

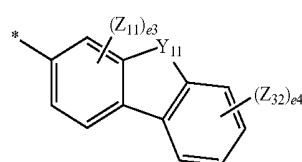
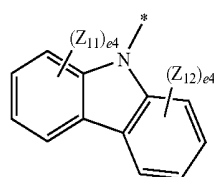
Formula 5-76

Formula 5-77

Formula 5-78

Formula 5-79

-continued



Formula 5-80

Formula 5-74

wherein, in Formulae 5-1 to 5-80,

Y_{11} is O, S, $C(Z_{13})(Z_{14})$, $N(Z_{15})$, or $Si(Z_{16})(Z_7)$;

Z_{11} to Z_{17} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, a naphthyl group, a fluorenyl group, a spiro-fluorenyl group, a benzofluorenyl group, a dibenzofluorenyl group, a phenanthrenyl group, an anthracenyl group, a pyrenyl group, a chrysenyl group, a pyridinyl group, a pyrazinyl group, a pyrimidinyl group, a pyridazinyl group, a quinolinyl group, an isoquinolinyl group, a quinoxalinyl group, a quinazolinyl group, a carbazolyl group, a triazinyl group, a biphenyl group, a terphenyl group, and — $Si(Q_{13})(Q_{14})(Q_{15})$,

wherein Q_{13} to Q_{15} are each independently selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group,

e_2 is 1 or 2,

e_3 is an integer selected from 1 to 3,

e_4 is an integer selected from 1 to 4,

e_5 is an integer selected from 1 to 5,

e_6 is an integer selected from 1 to 6,

e_7 is an integer selected from 1 to 7,

e_9 is an integer selected from 1 to 9, and

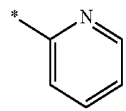
* is a binding site to a neighboring atom.

12. The condensed-cyclic compound as claimed in claim 1, wherein:

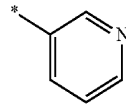
R_3 to R_6 and R_{13} are each independently selected from a hydrogen, a deuterium, —F, —Cl, —Br, —I, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, a naphthyl group, and — $Si(Q_3)(Q_4)(Q_5)$, wherein Q_3 to Q_5 are each independently selected from a C_1 - C_{10} alkyl group, a C_1 - C_{10} alkoxy group, a phenyl group, and a naphthyl group

R_1 , R_2 , and R_{12} are each independently a group represented by one of the following Formulae 6-1 to 6-157,

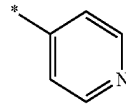
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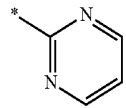
Formula 6-1



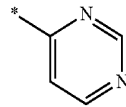
Formula 6-2



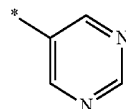
Formula 6-3



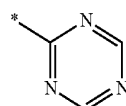
Formula 6-4



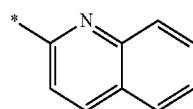
Formula 6-5



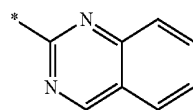
Formula 6-6



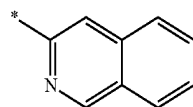
Formula 6-7



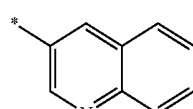
Formula 6-8



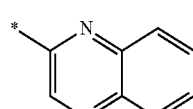
Formula 6-9



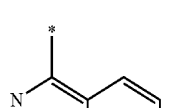
Formula 6-10



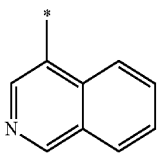
Formula 6-11



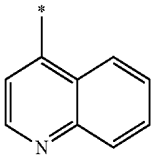
Formula 6-12



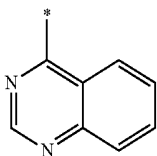
Formula 6-13



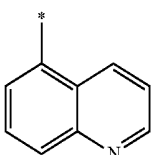
Formula 6-14



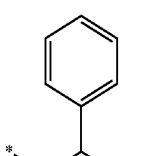
Formula 6-15



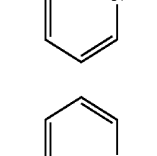
Formula 6-16



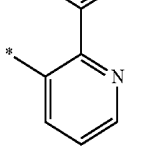
Formula 6-17



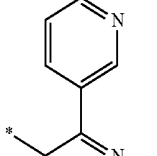
Formula 6-18



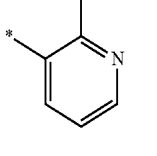
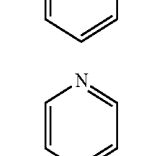
Formula 6-19



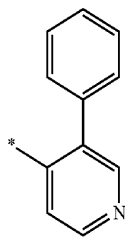
Formula 6-20



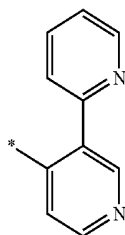
Formula 6-21



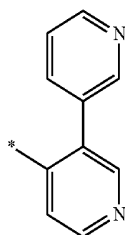
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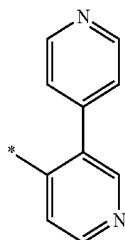
Formula 6-22



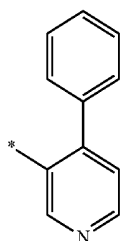
Formula 6-23



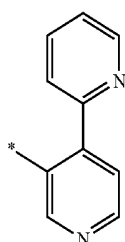
Formula 6-24



Formula 6-25

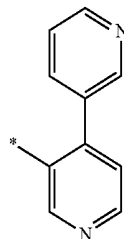


Formula 6-26

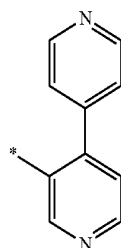


Formula 6-27

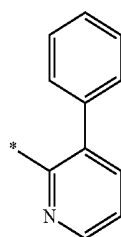
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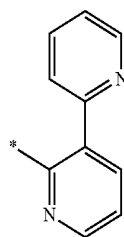
Formula 6-28



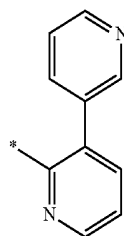
Formula 6-29



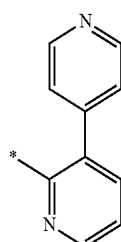
Formula 6-30



Formula 6-31

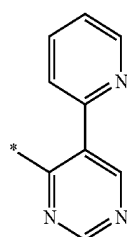
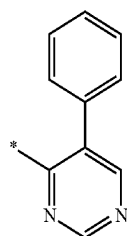
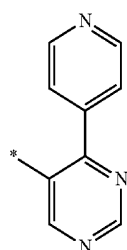
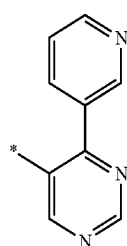
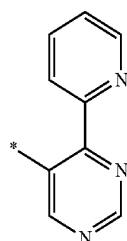
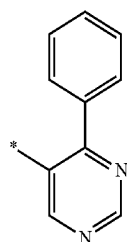


Formula 6-32



Formula 6-33

-continued



Formula 6-34

Formula 6-35

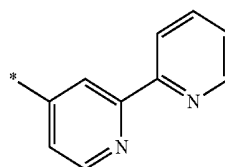
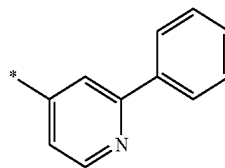
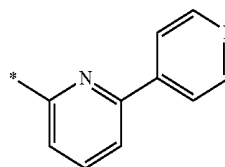
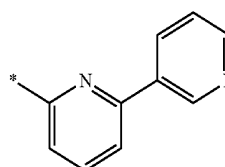
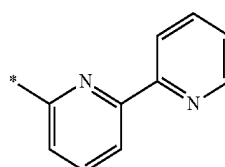
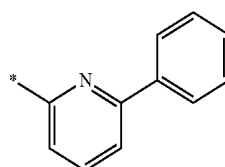
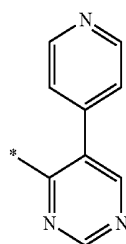
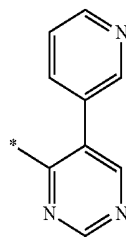
Formula 6-36

Formula 6-37

Formula 6-38

Formula 6-39

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Formula 6-40

Formula 6-41

Formula 6-42

Formula 6-43

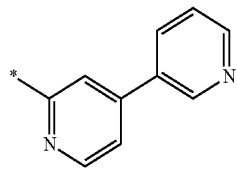
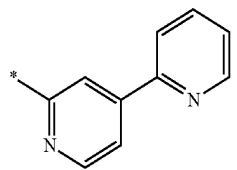
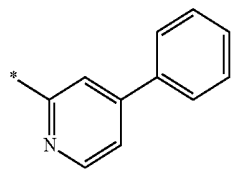
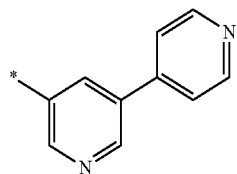
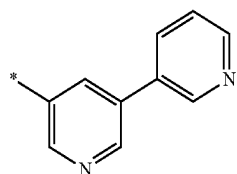
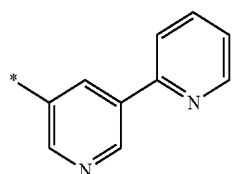
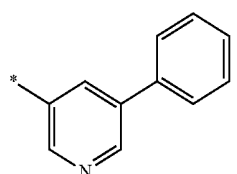
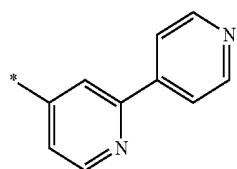
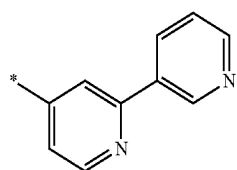
Formula 6-44

Formula 6-45

Formula 6-46

Formula 6-47

-continued



Formula 6-48

Formula 6-49

Formula 6-50

Formula 6-51

Formula 6-52

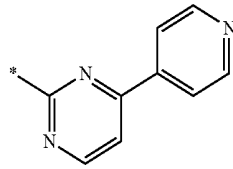
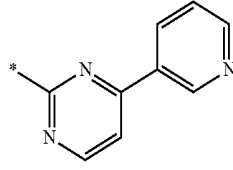
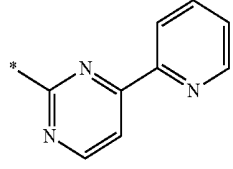
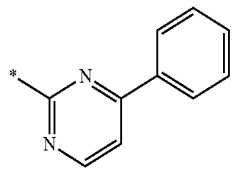
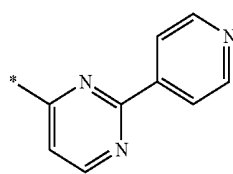
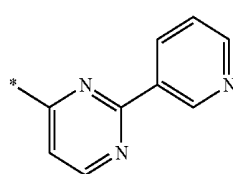
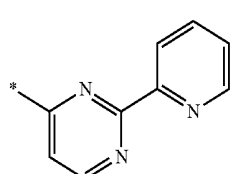
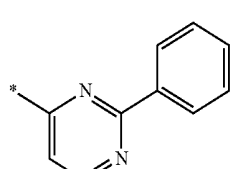
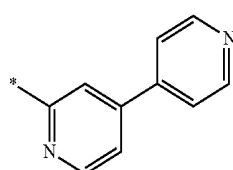
Formula 6-53

Formula 6-54

Formula 6-55

Formula 6-56

-continued



Formula 6-57

Formula 6-58

Formula 6-59

Formula 6-60

Formula 6-61

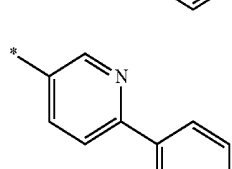
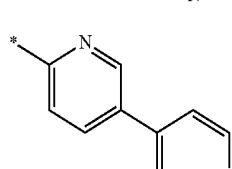
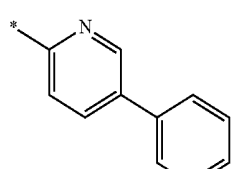
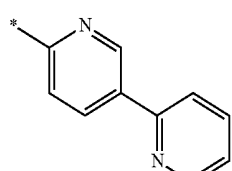
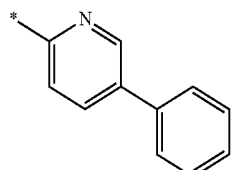
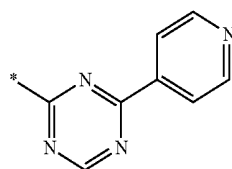
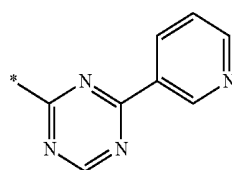
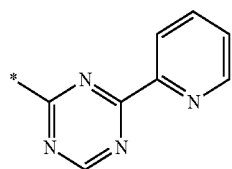
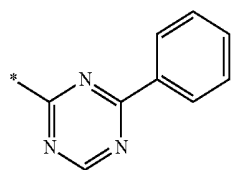
Formula 6-62

Formula 6-63

Formula 6-64

Formula 6-65

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Formula 6-66

Formula 6-67

Formula 6-68

Formula 6-69

Formula 6-70

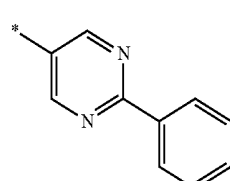
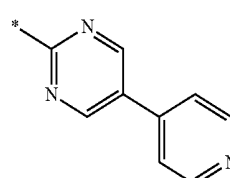
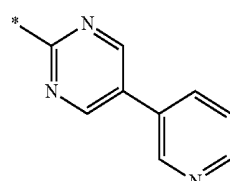
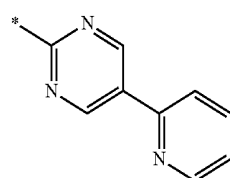
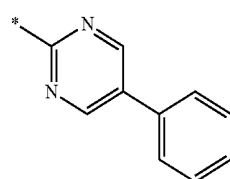
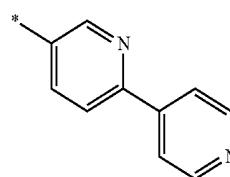
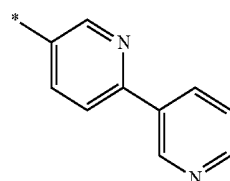
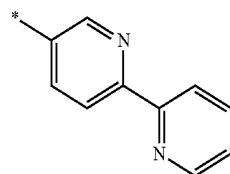
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Formula 6-72

Formula 6-73

Formula 6-74

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Formula 6-75

Formula 6-76

Formula 6-77

Formula 6-78

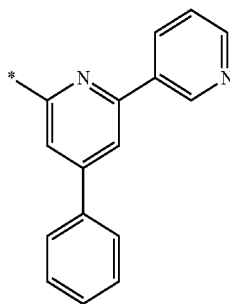
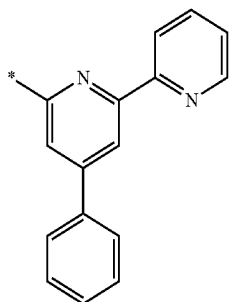
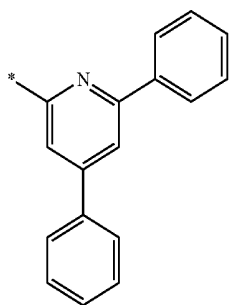
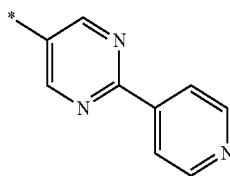
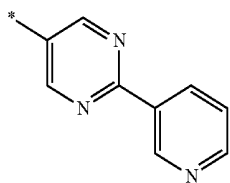
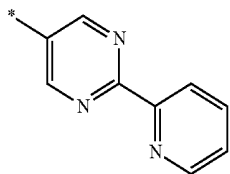
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Formula 6-80

Formula 6-81

Formula 6-82

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Formula 6-83

Formula 6-84

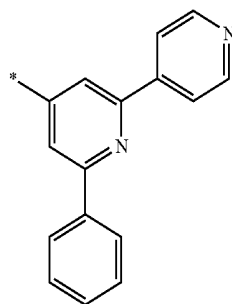
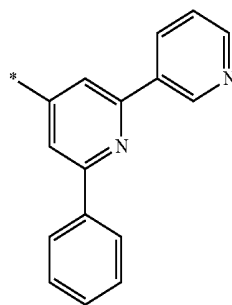
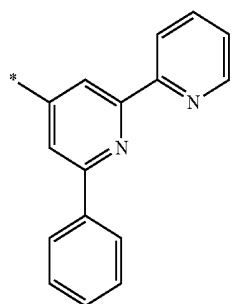
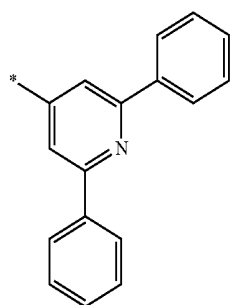
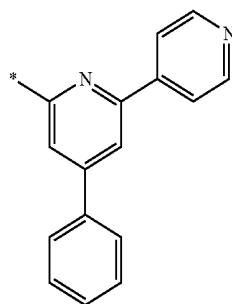
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Formula 6-86

Formula 6-87

Formula 6-88

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Formula 6-89

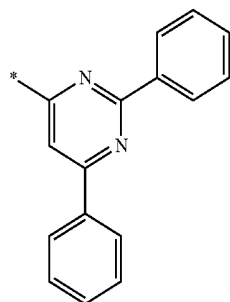
Formula 6-90

Formula 6-91

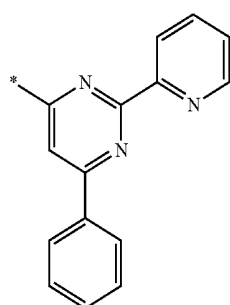
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Formula 6-93

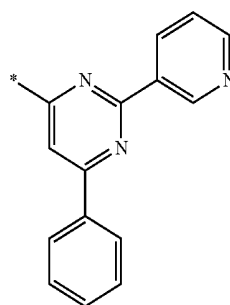
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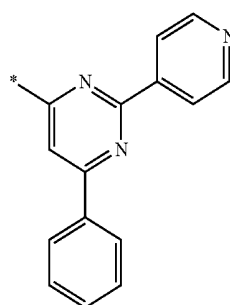
Formula 6-94



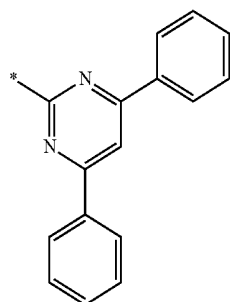
Formula 6-95



Formula 6-96

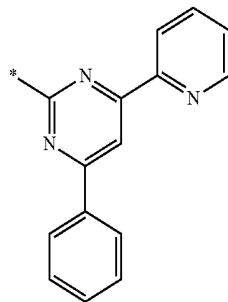


Formula 6-97

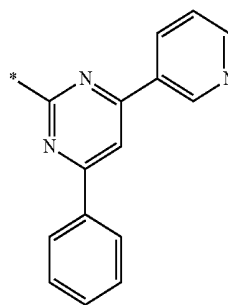


Formula 6-98

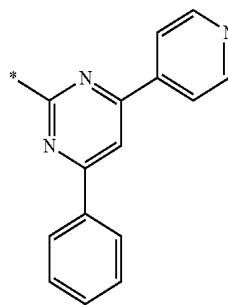
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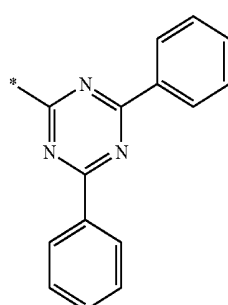
Formula 6-99



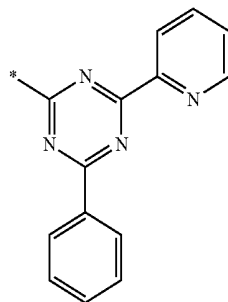
Formula 6-100



Formula 6-101

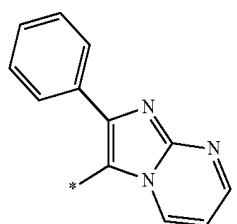
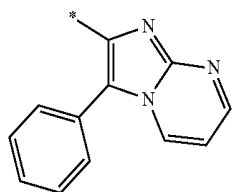
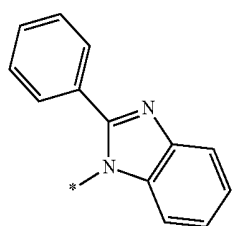
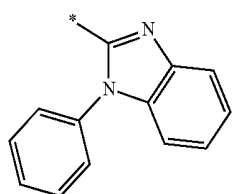
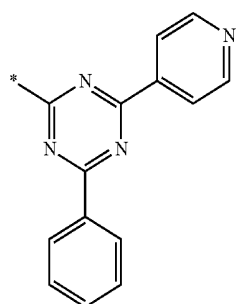
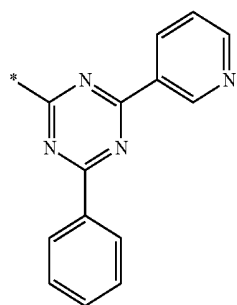


Formula 6-102



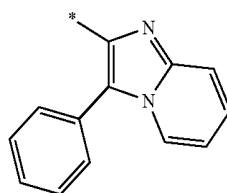
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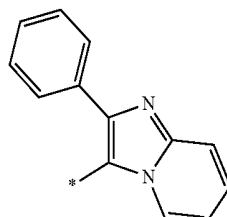
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Formula 6-104



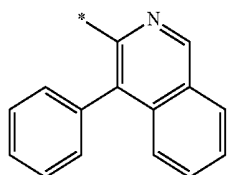
Formula 6-110

Formula 6-105



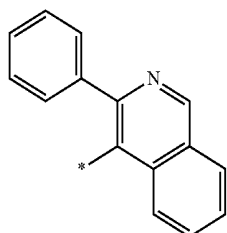
Formula 6-111

Formula 6-106



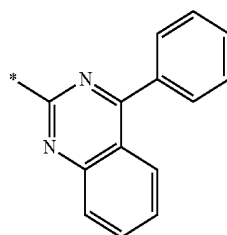
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Formula 6-107



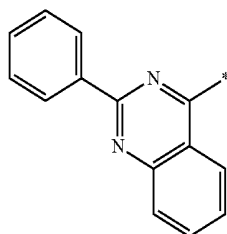
Formula 6-113

Formula 6-108

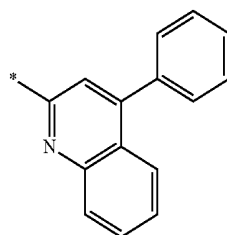


Formula 6-114

Formula 6-109

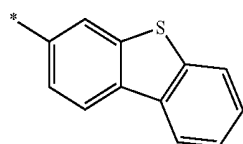
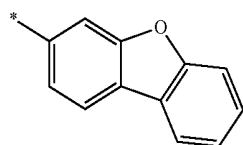
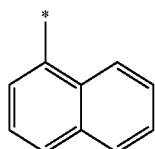
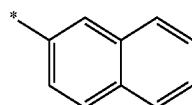
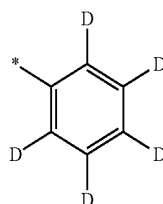
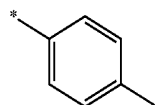
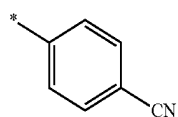
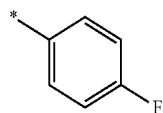
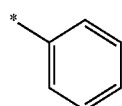
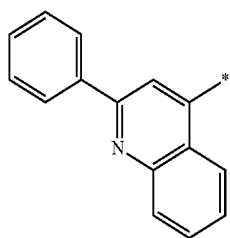


Formula 6-115



Formula 6-116

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Formula 6-117

Formula 6-118

Formula 6-119

Formula 6-120

Formula 6-121

Formula 6-122

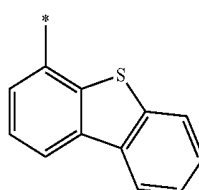
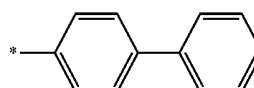
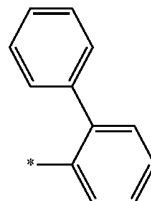
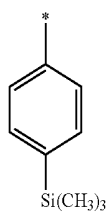
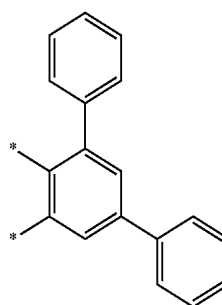
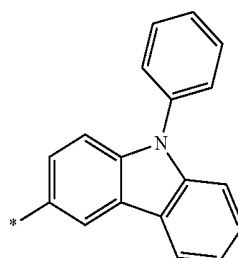
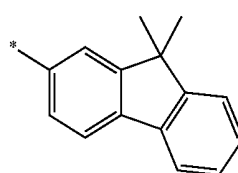
Formula 6-123

Formula 6-124

Formula 6-125

Formula 6-126

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Formula 6-127

Formula 6-128

Formula 6-129

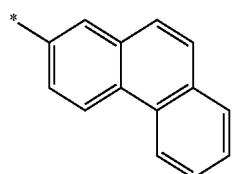
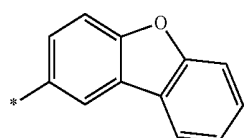
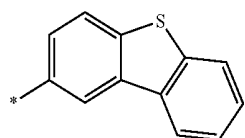
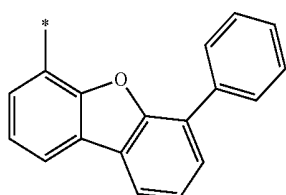
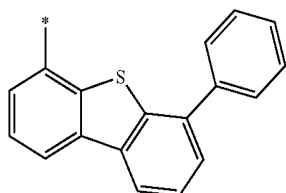
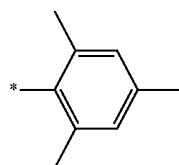
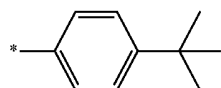
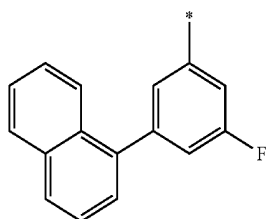
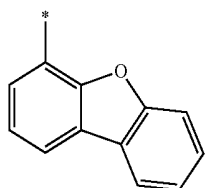
Formula 6-130

Formula 6-131

Formula 6-132

Formula 6-133

-continued



Formula 6-134

Formula 6-135

Formula 6-136

Formula 6-137

Formula 6-138

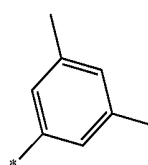
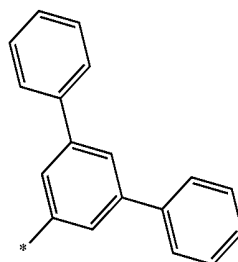
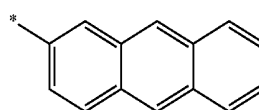
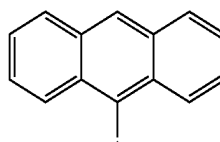
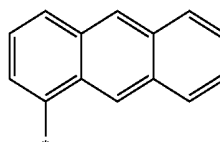
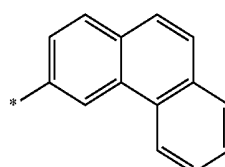
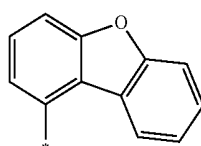
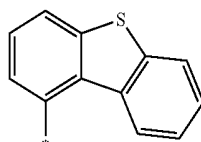
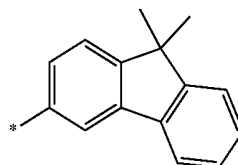
Formula 6-139

Formula 6-140

Formula 6-141

Formula 6-142

-continued



Formula 6-143

Formula 6-144

Formula 6-145

Formula 6-146

Formula 6-147

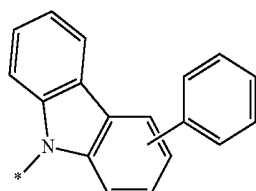
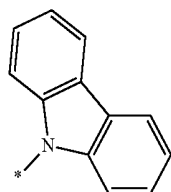
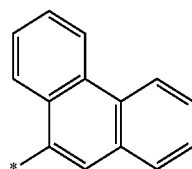
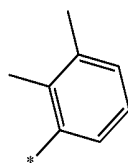
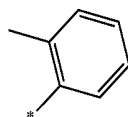
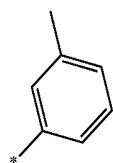
Formula 6-148

Formula 6-149

Formula 6-150

Formula 6-151

-continued



Formula 6-152

Formula 6-153

Formula 6-154

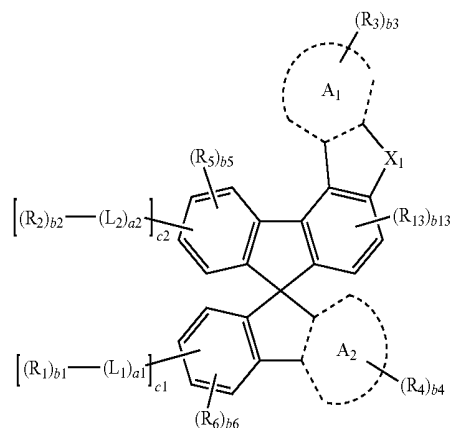
Formula 6-155

Formula 6-156

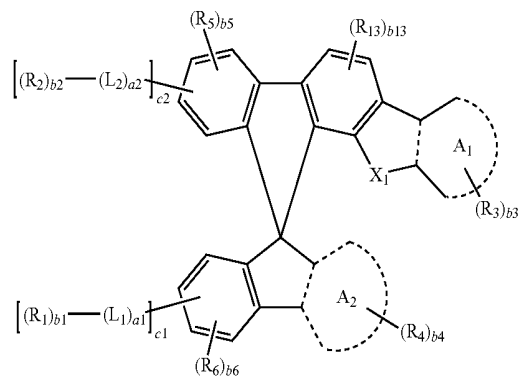
Formula 6-157

-continued

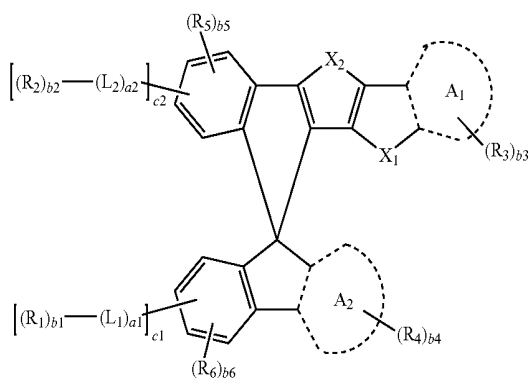
Formula 1B



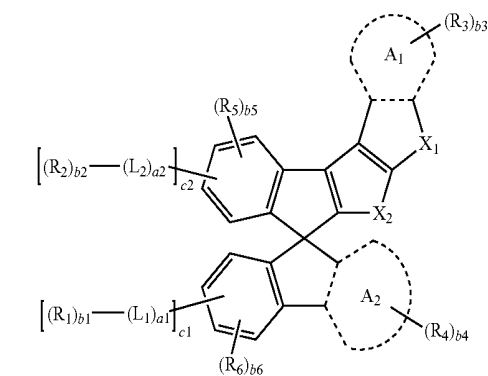
Formula 1C



Formula 1D



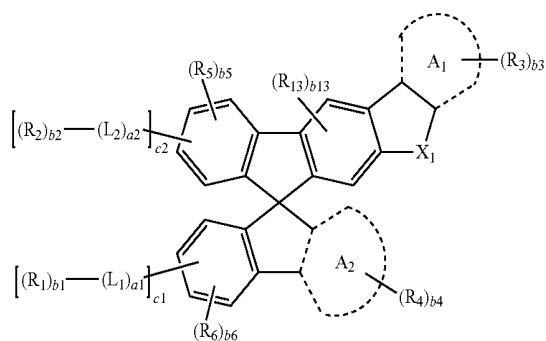
Formula 1E



wherein, in Formulae 6-1 to 6-157, * is a binding site to a neighboring atom.

13. The condensed cyclic compound as claimed in claim 1, the compound represented by Formula 1 is represented by one of the following Formulae 1A to 1E:

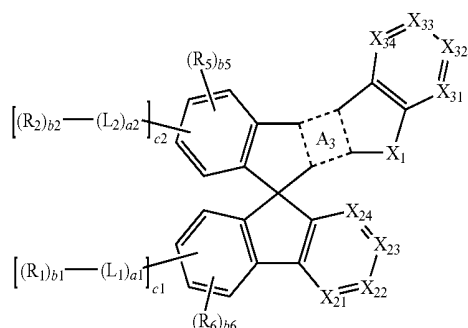
Formula 1A



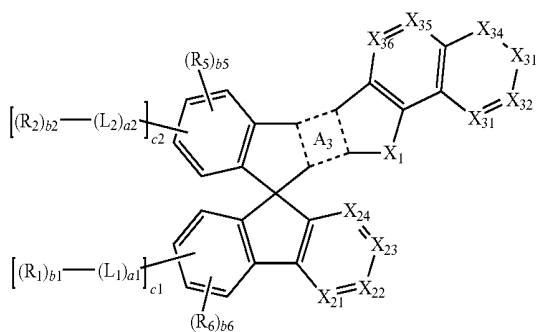
wherein, in Formulae 1A to 1E, ring A₁, ring A₂, X₁, X₂, L₁, L₂, a₁, a₂, L₁₁, L₁₂, a₁₁, a₁₂, R₁ to R₆, R₁₁ to R₁₃, b₁ to b₆, b₁₁ to b₁₃, c₁, and c₂ are defined the same as ring A₁, ring A₂, X₁, X₂, L₁, L₂, a₁, a₂, L₁₁, L₁₂, a₁₁, a₁₂, R₁ to R₆, R₁₁ to R₁₃, b₁ to b₆, b₁₁ to b₁₃, c₁, and c₂ of Formula 1.

14. The condensed cyclic compound as claimed in claim 1, the compound represented by Formula 1 is represented by one of the following Formulae 1-1 to 1-7:

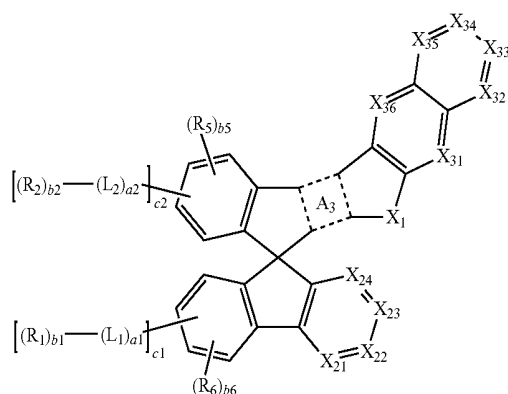
Formula 1-1



Formula 1-2

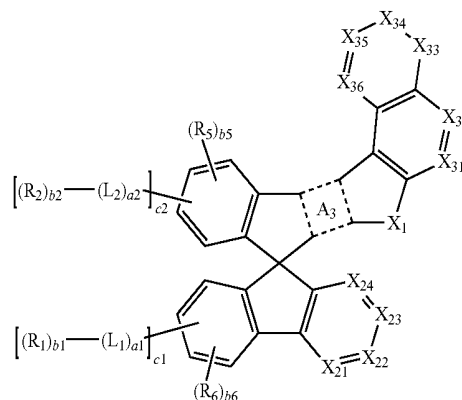


Formula 1-3

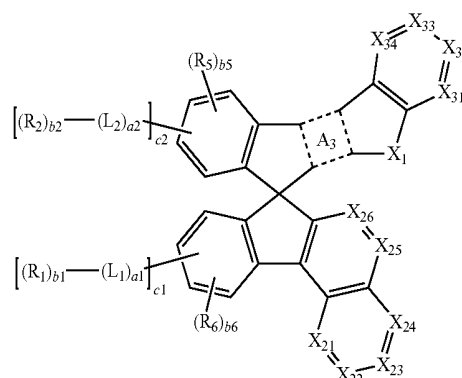


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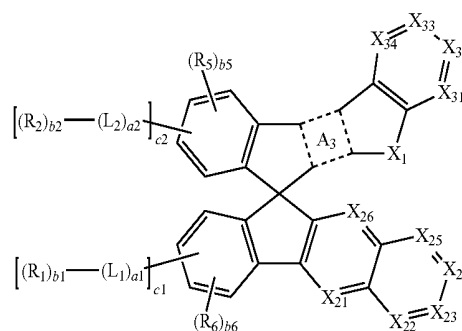
Formula 1-4



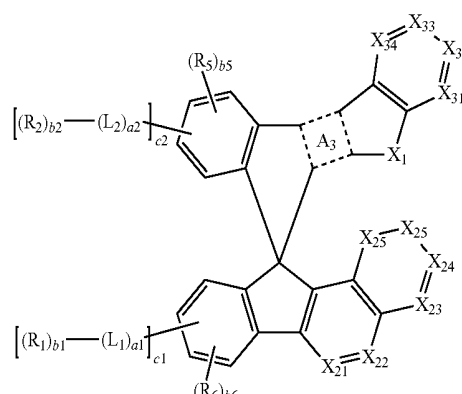
Formula 1-5



Formula 1-6



Formula 1-7



wherein, in Formulae 1-1 to 1-7,

ring A₃, X₁, X₂, L₁, L₂, a1, a2, L₁₁, L₁₂, a11, a12, R₁, R₂, R₅, R₆, R₁₁ to R₁₃, b1, b2, b5, b6, b11 to b13, c1, and c2 are defined the same as ring A₃, X₁, X₂, L₁, L₂, a1, a2, L₁₁, L₁₂, a11, a12, R₁, R₂, R₅, R₆, R₁₁ to R₁₃, b1, b2, b5, b6, b11 to b13, c1, and c2 of Formula 1,

X₂₁ is N or C(R₂₁), X₂₂ is N or C(R₂₂), X₂₃ is N or C(R₂₃), X₂₄ is N or C(R₂₄), X₂₅ is N or C(R₂₅), X₂₆ is N or C(R₂₆), X₃₁ is N or C(R₃₁), X₃₂ is N or C(R₃₂), X₃₃ is N or C(R₃₃), X₃₄ is N or C(R₃₄), X₃₅ is N or C(R₃₅), and X₃₆ is N or C(R₃₆),

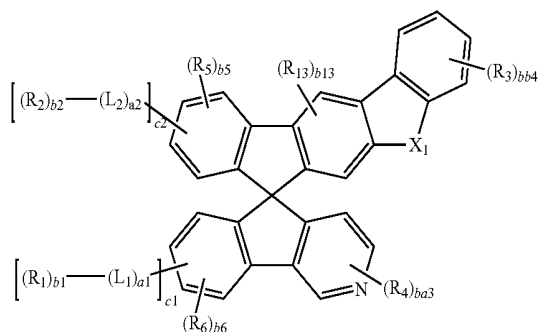
R₂₁ to R₂₆ are defined the same as R₃ of Formula 1, and

R₃₁ to R₃₆ are defined the same as R₄ of Formula 1.

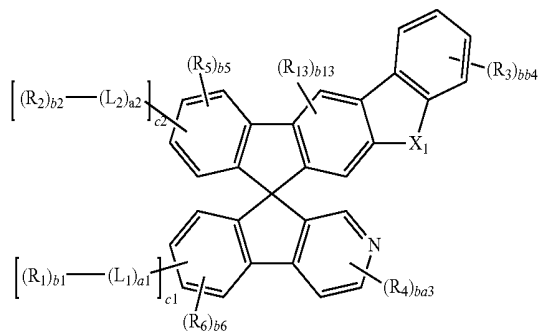
15. The condensed cyclic compound as claimed in claim 1, the compound represented by Formula 1 is represented by one of the following Formulae 1(1) to 1(42):

-continued

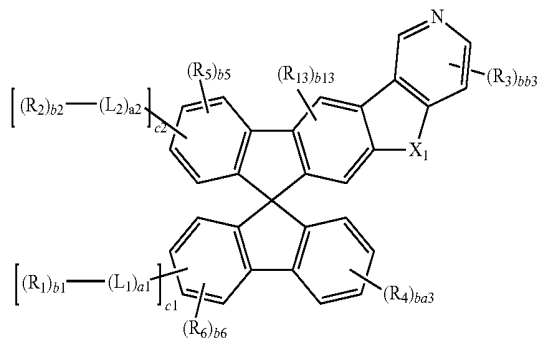
Formula 1(4)



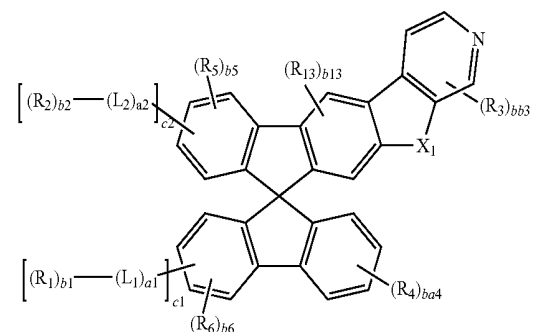
Formula 1(5)



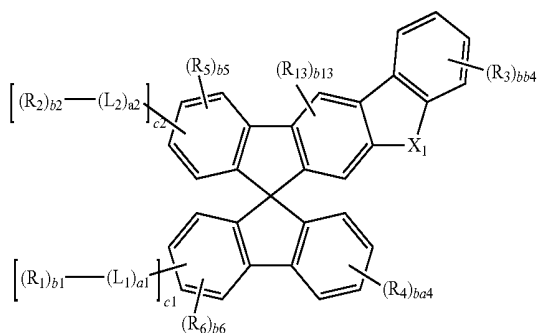
Formula 1(6)



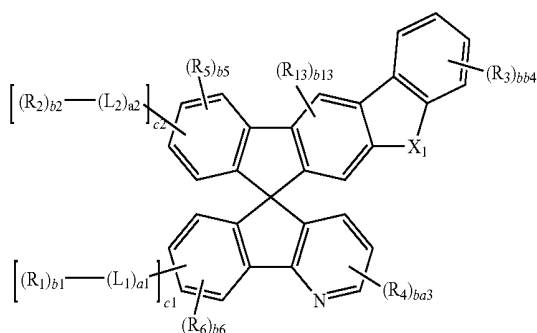
Formula 1(7)



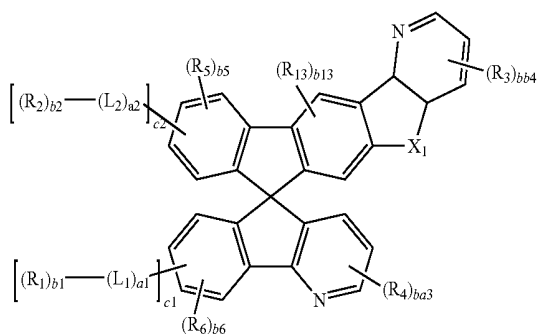
Formula 1(1)



Formula 1(2)

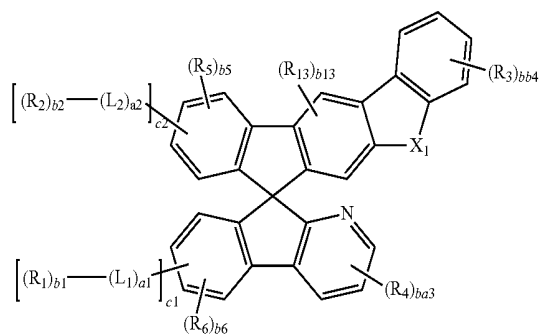


Formula 1(3)

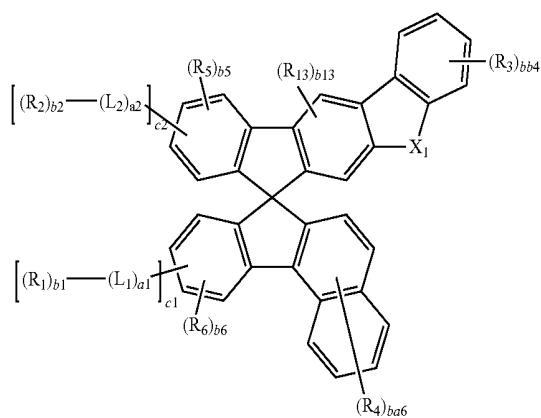


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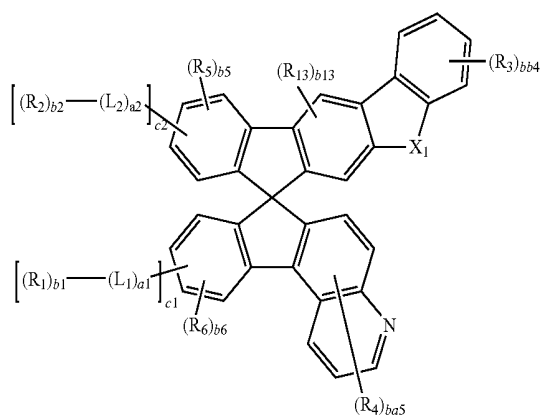
Formula 1(8)



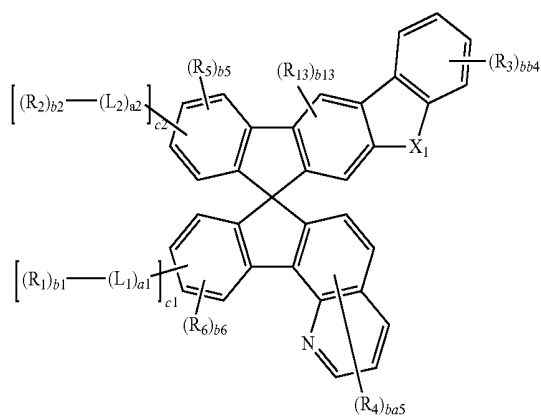
Formula 1(9)



Formula 1(10)

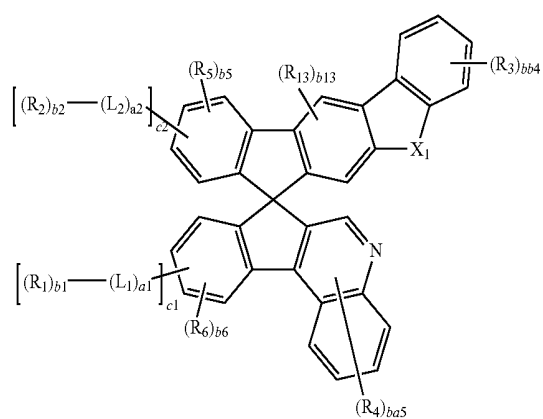


Formula 1(11)

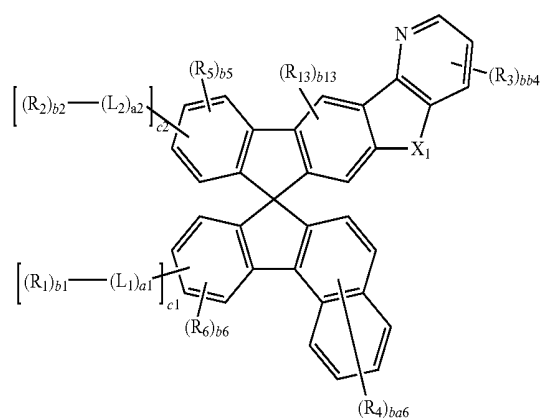


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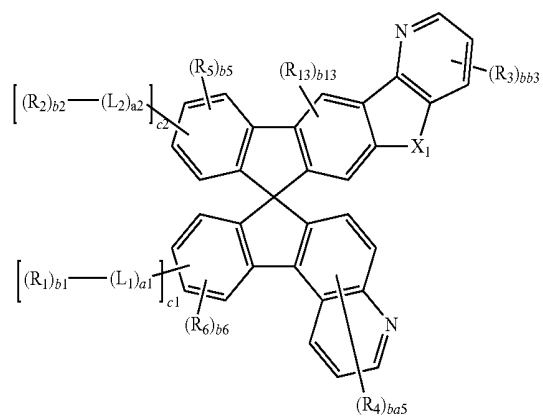
Formula 1(12)

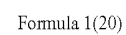


Formula 1(13)



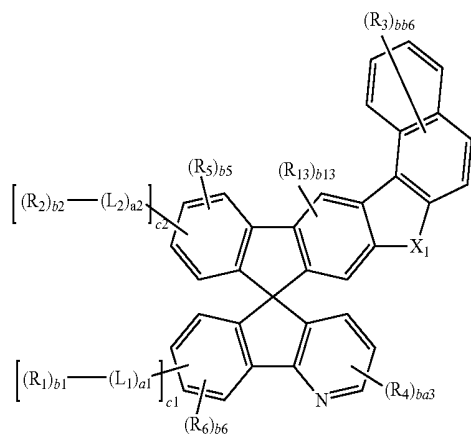
Formula 1(14)





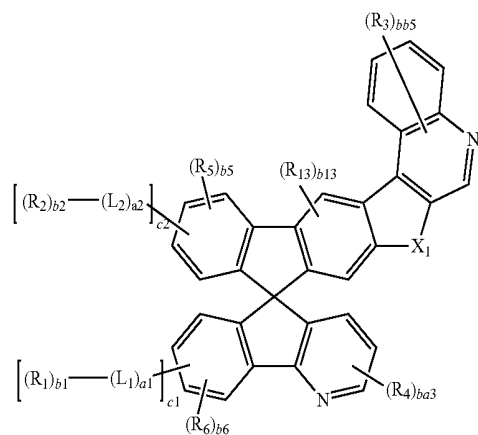
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Formula 1(21)

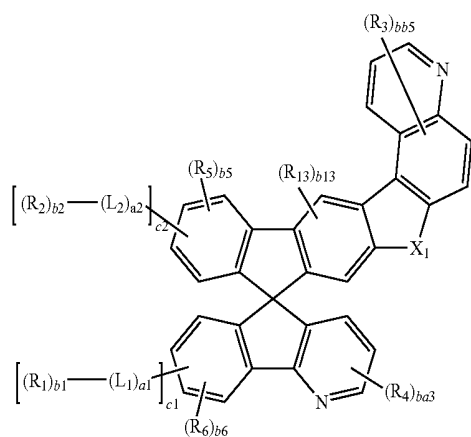


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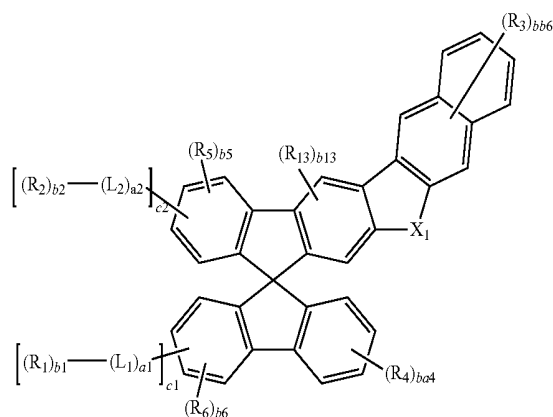
Formula 1(24)



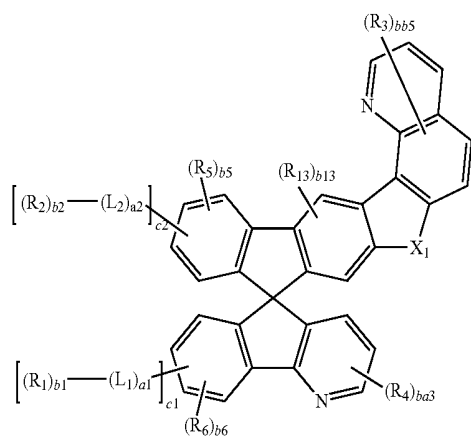
Formula 1(22)



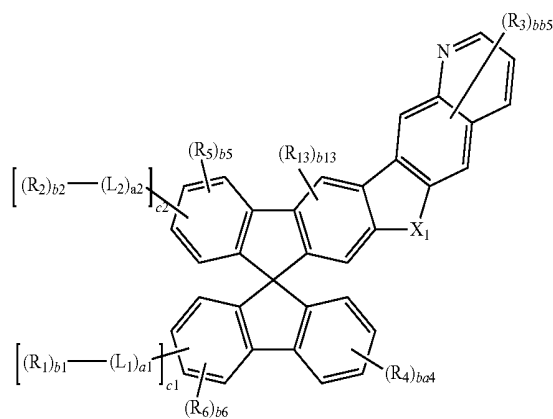
Formula 1(25)



Formula 1(23)

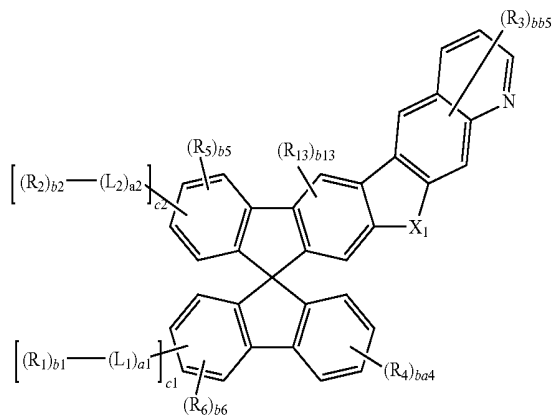


Formula 1(26)



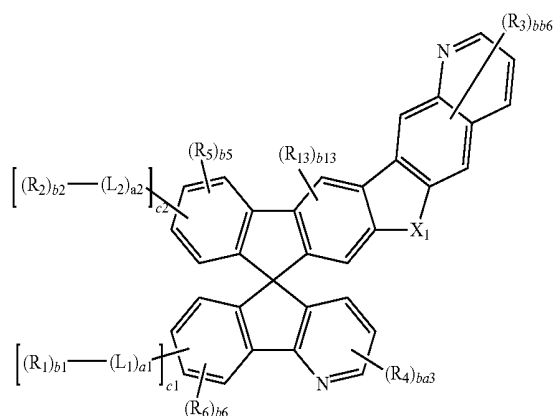
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Formula 1(27)

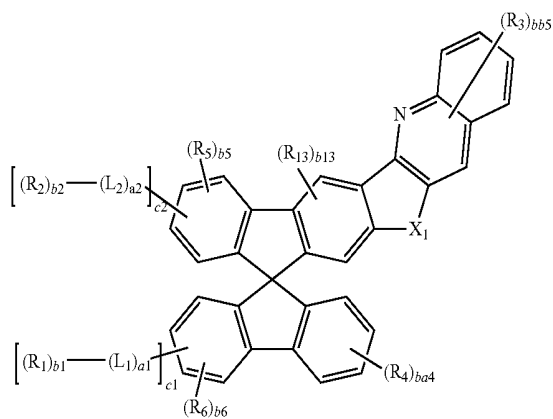


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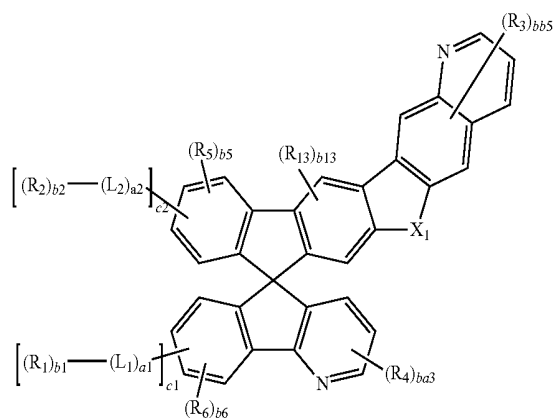
Formula 1(30)



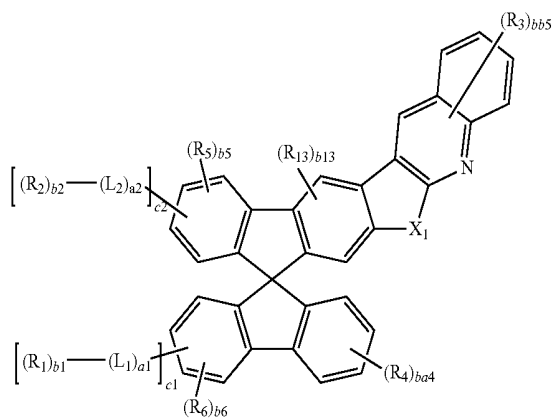
Formula 1(28)



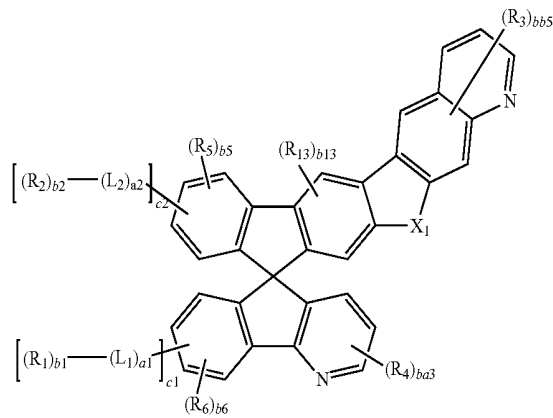
Formula 1(31)



Formula 1(29)

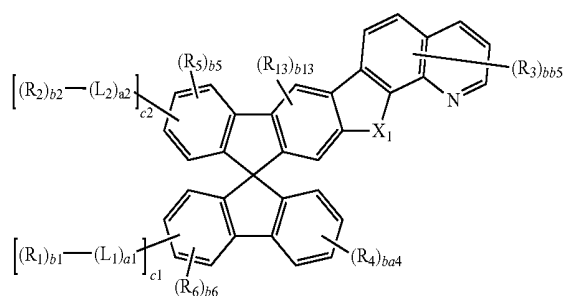


Formula 1(32)

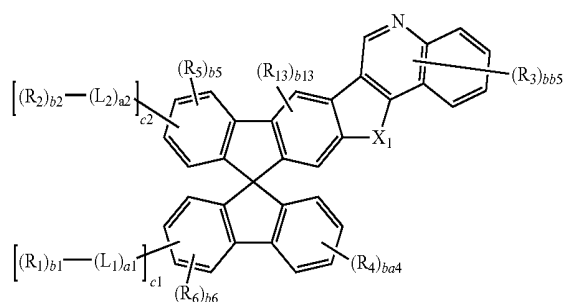


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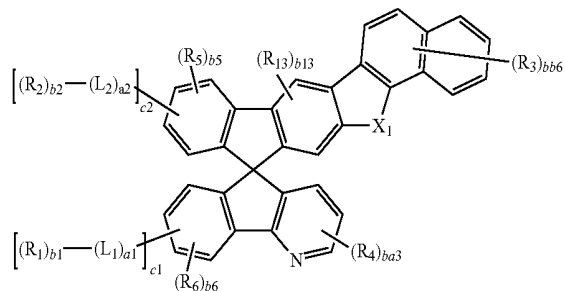
Formula 1(37)



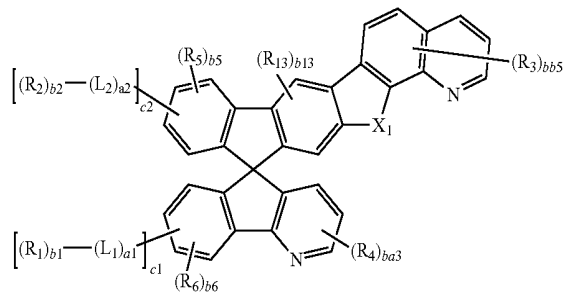
Formula 1(39)



Formula 1(40)

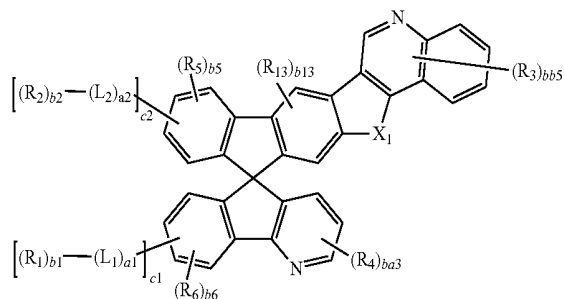


Formula 1(14)



-continued

Formula 1(42)



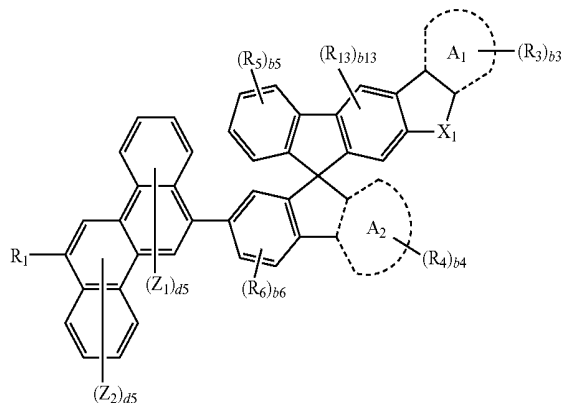
wherein, in Formulae 1(1) to 1(42),

X_1 , L_1 , L_2 , a_1 , a_2 , L_{11} , L_{12} , a_{11} , a_{12} , R_1 to R_6 , R_{11} to R_{13} , b_1 to b_6 , b_{11} to b_{13} , c_1 , and c_2 are defined the same as X_1 , L_1 , L_2 , a_1 , a_2 , L_{11} , L_{12} , a_{11} , a_{12} , R_1 to R_6 , R_{11} to R_{13} , b_1 to b_6 , b_{11} to b_{13} , c_1 , and c_2 of Formula 1, ba_3 and bb_3 are each independently an integer selected from 0 to 3, ba_4 and bb_4 are each independently an integer selected from 0 to 4, ba_5 and bb_5 are each independently an integer selected from 0 to 5, and ba_6 and bb_6 are each independently an integer selected from 0 to 6.

16. The condensed cyclic compound as claimed in claim 1, the compound represented by Formula 1 is represented by one of the following Formulae 1A-1 to 1A-3:

-continued

Formula 1A-3



wherein, in Formulae 1A-1 to 1A-3,

ring A_1 and ring A_2 are each independently selected from a benzene group, a naphthalene group, a pyridine group, a quinoline group, and an isoquinoline group,

X_1 is $N-[(L_{11})_{a11}-(R_{11})_{b11}]$,

L_{11} is a group represented by one of the following Formulae 4-1 to 4-35,

a_{11} is 0 or 1,

R_{11} is a group represented by one of the following Formulae 6-1 to 6-117,

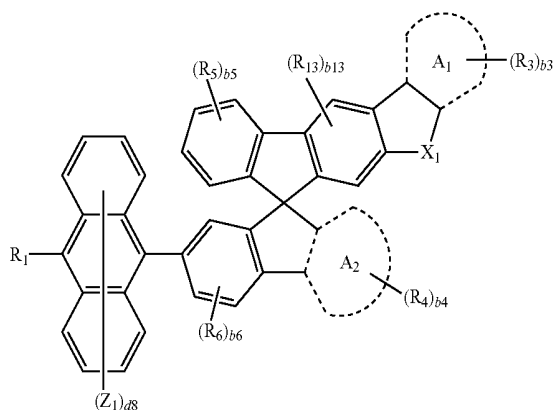
b_{11} is 1,

R_1 is a group represented by one of the following Formulae 6-1 to 6-157,

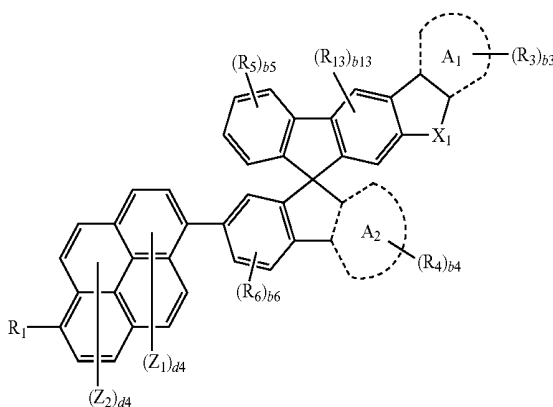
R_3 to R_6 , R_{13} , Z_1 , and Z_2 are each independently selected from a hydrogen, a deuterium, $-F$, $-Cl$, $-Br$, $-I$, a hydroxyl group, a cyano group, a nitro group, an amino group, an amidino group, a hydrazine group, a hydrazone group, a carboxylic acid group or a salt thereof, a sulfonic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a C_1 - C_{20} alkyl group, a C_1 - C_{20} alkoxy group, a phenyl group, and a naphthyl group,

b_3 to b_6 , b_{13} , d_4 , d_5 , and d_8 are each independently 0, 1, or 2:

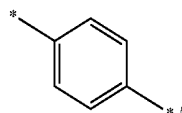
Formula 1A-1



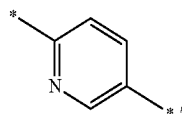
Formula 1A-2



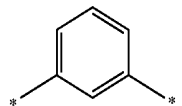
Formula 4-1



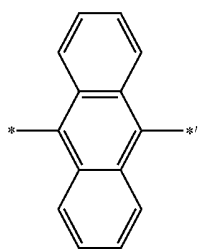
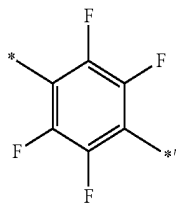
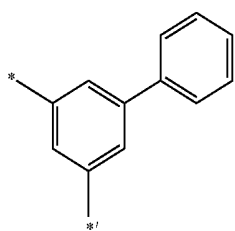
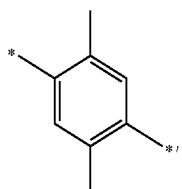
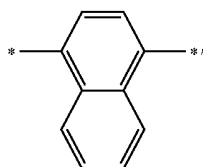
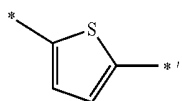
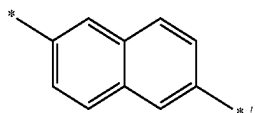
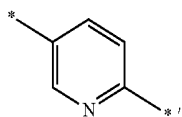
Formula 4-2



Formula 4-3



-continued



Formula 4-4

Formula 4-5

Formula 4-6

Formula 4-7

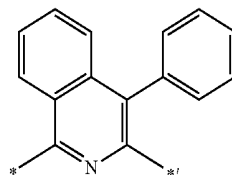
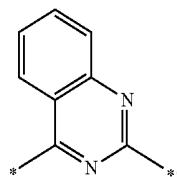
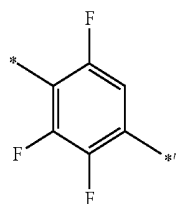
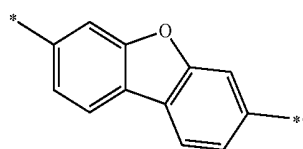
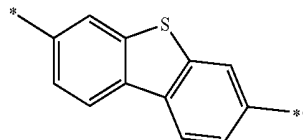
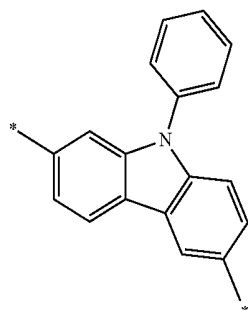
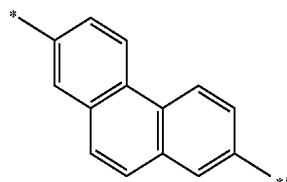
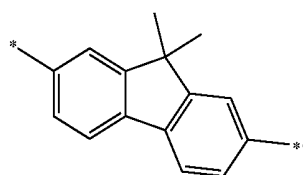
Formula 4-8

Formula 4-9

Formula 4-10

Formula 4-11

-continued



Formula 4-12

Formula 4-13

Formula 4-14

Formula 4-15

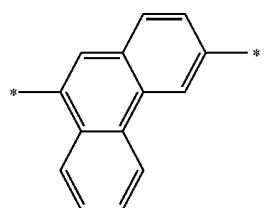
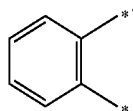
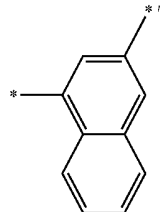
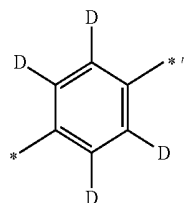
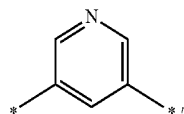
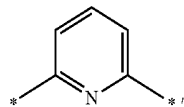
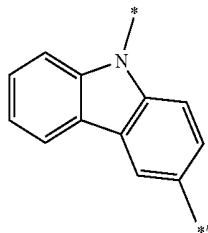
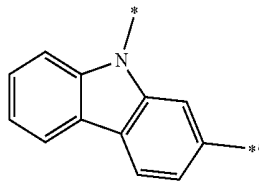
Formula 4-16

Formula 4-17

Formula 4-18

Formula 4-19

-continued



Formula 4-20

Formula 4-21

Formula 4-22

Formula 4-23

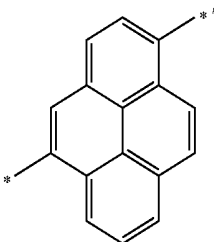
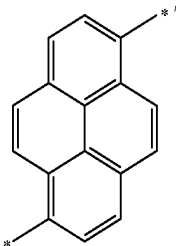
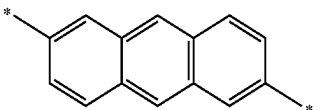
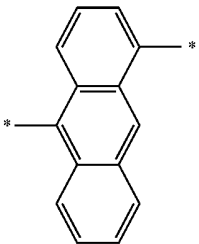
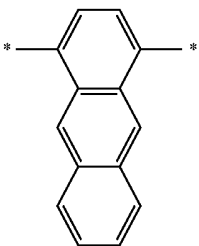
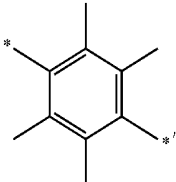
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Formula 4-25

Formula 4-26

Formula 4-27

-continued



Formula 4-28

Formula 4-29

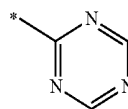
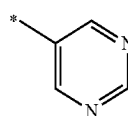
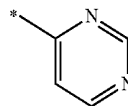
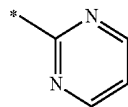
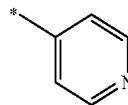
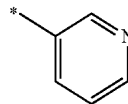
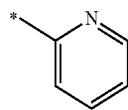
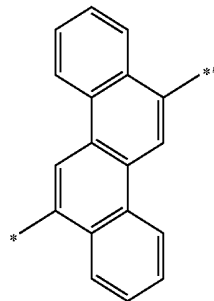
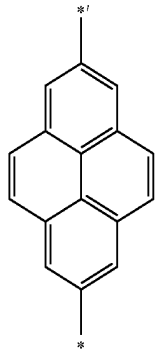
Formula 4-30

Formula 4-31

Formula 4-32

Formula 4-33

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Formula 4-34

Formula 4-35

Formula 6-1

Formula 6-2

Formula 6-3

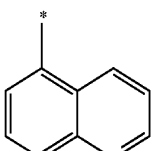
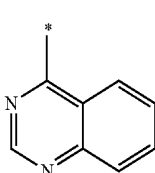
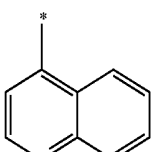
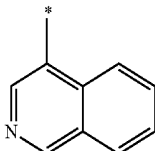
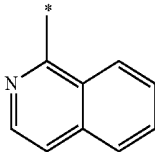
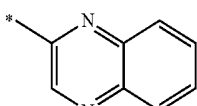
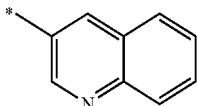
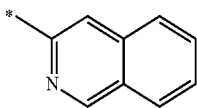
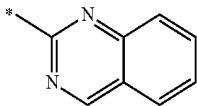
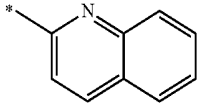
Formula 6-4

Formula 6-5

Formula 6-6

Formula 6-7

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Formula 6-8

Formula 6-9

Formula 6-10

Formula 6-11

Formula 6-12

Formula 6-13

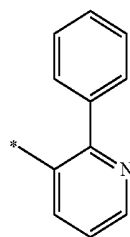
Formula 6-14

Formula 6-15

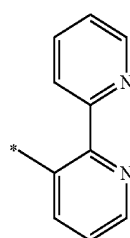
Formula 6-16

Formula 6-17

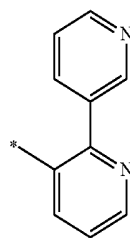
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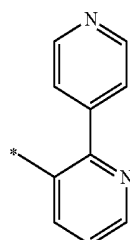
Formula 6-18



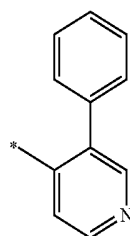
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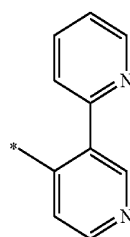
Formula 6-20



Formula 6-21

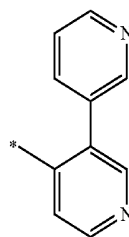


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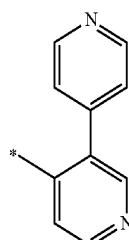


Formula 6-23

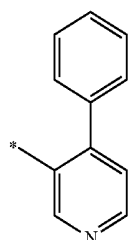
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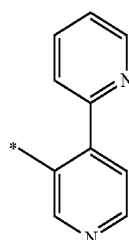
Formula 6-24



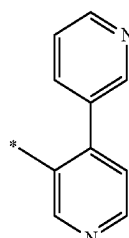
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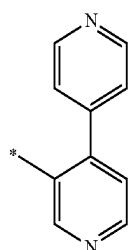
Formula 6-26



Formula 6-27

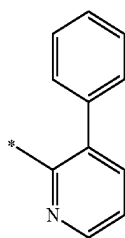


Formula 6-28

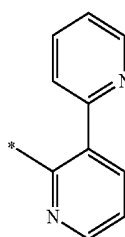


Formula 6-29

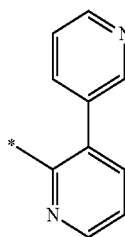
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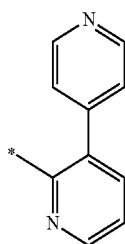
Formula 6-30



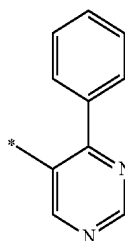
Formula 6-31



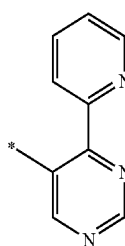
Formula 6-32



Formula 6-33

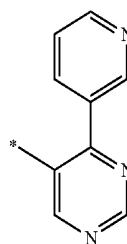


Formula 6-34

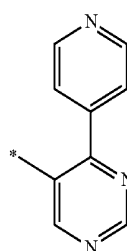


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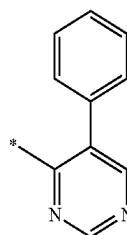
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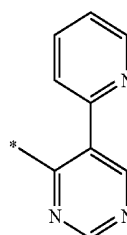
Formula 6-36



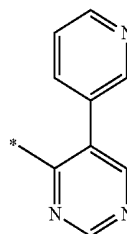
Formula 6-37



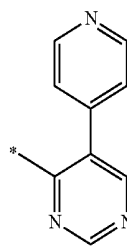
Formula 6-38



Formula 6-39

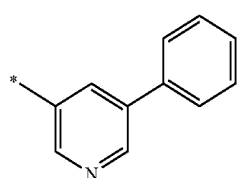
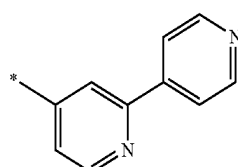
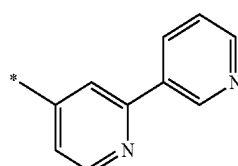
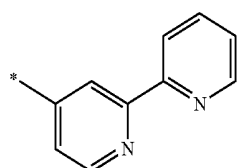
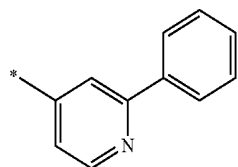
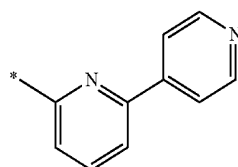
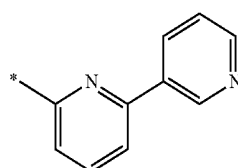
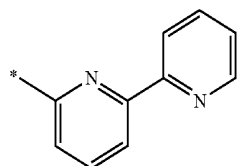
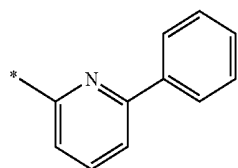


Formula 6-40



Formula 6-41

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Formula 6-42

Formula 6-43

Formula 6-44

Formula 6-45

Formula 6-46

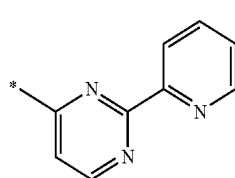
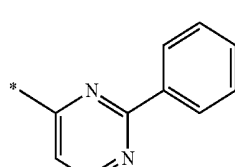
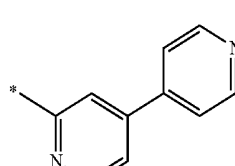
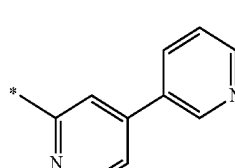
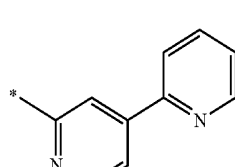
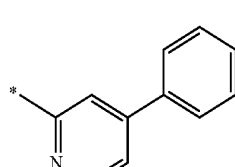
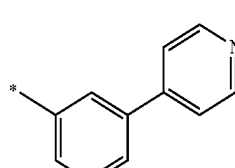
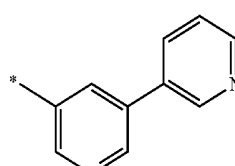
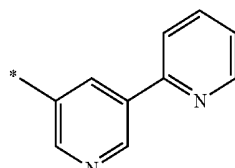
Formula 6-47

Formula 6-48

Formula 6-49

Formula 6-50

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Formula 6-51

Formula 6-52

Formula 6-53

Formula 6-54

Formula 6-55

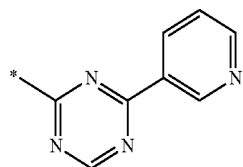
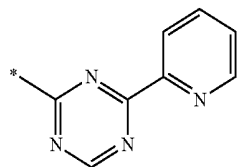
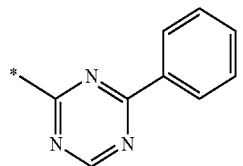
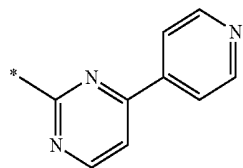
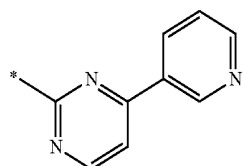
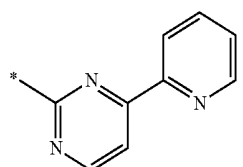
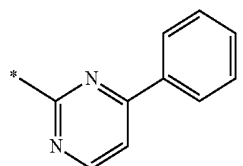
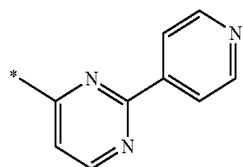
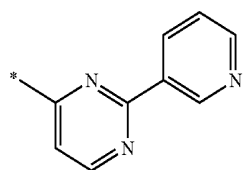
Formula 6-56

Formula 6-57

Formula 6-58

Formula 6-59

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Formula 6-60

Formula 6-61

Formula 6-62

Formula 6-63

Formula 6-64

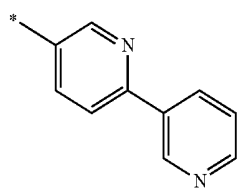
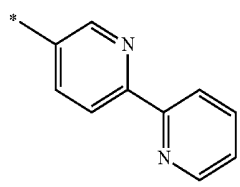
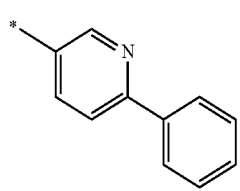
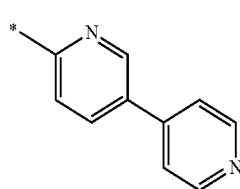
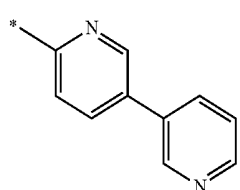
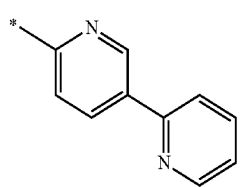
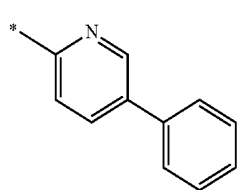
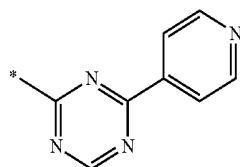
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Formula 6-66

Formula 6-67

Formula 6-68

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Formula 6-69

Formula 6-70

Formula 6-71

Formula 6-72

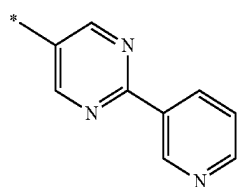
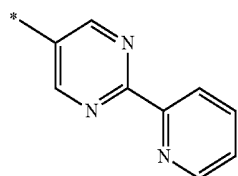
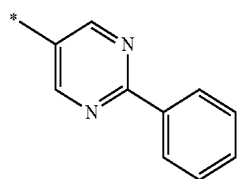
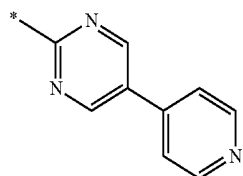
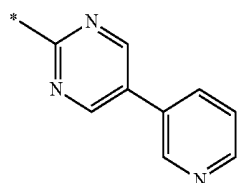
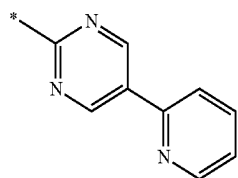
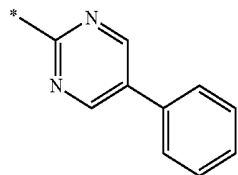
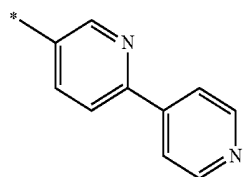
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Formula 6-74

Formula 6-75

Formula 6-76

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Formula 6-77

Formula 6-78

Formula 6-79

Formula 6-80

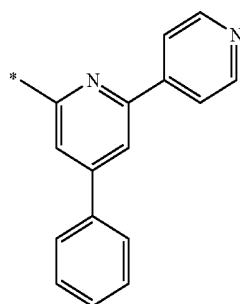
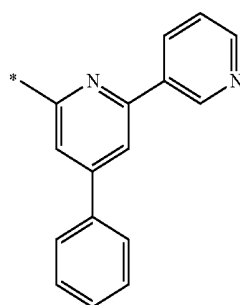
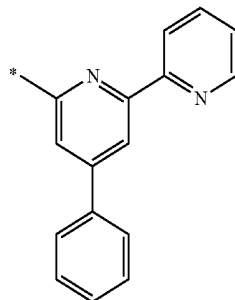
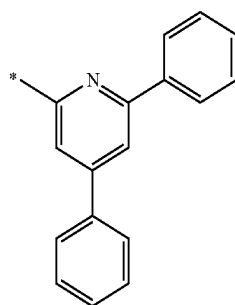
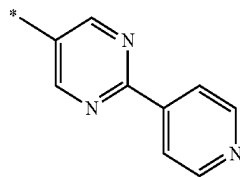
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Formula 6-82

Formula 6-83

Formula 6-84

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Formula 6-85

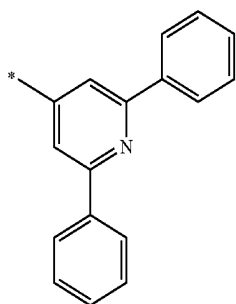
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Formula 6-87

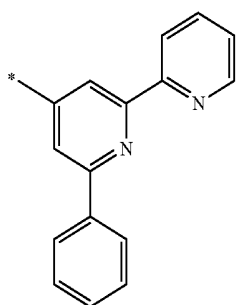
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Formula 6-89

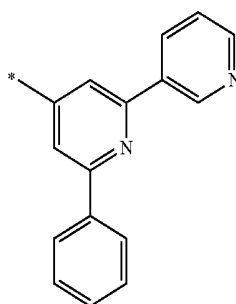
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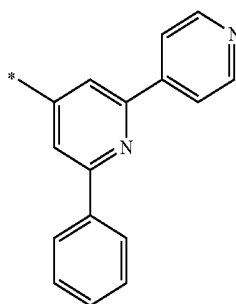
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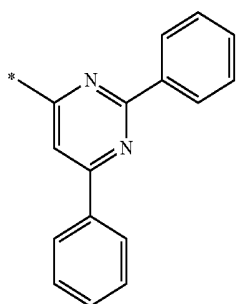
Formula 6-91



Formula 6-92

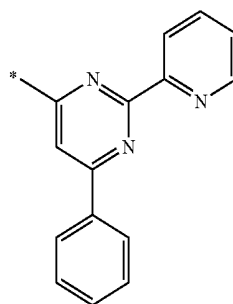


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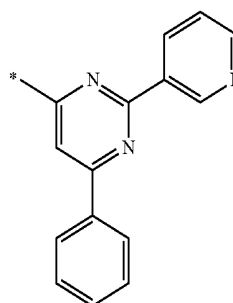


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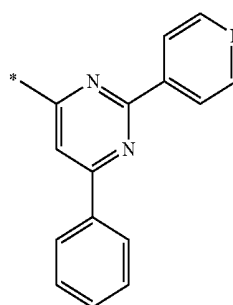
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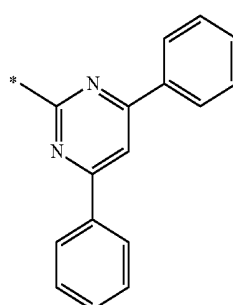
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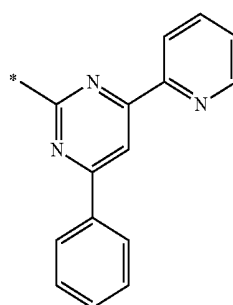
Formula 6-96



Formula 6-97

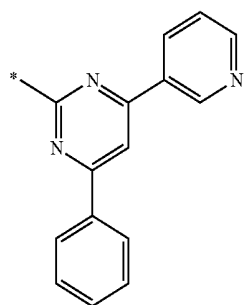


Formula 6-98



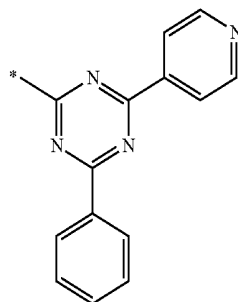
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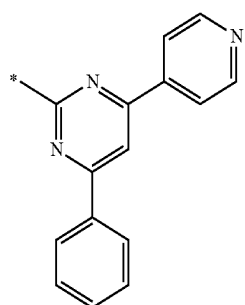


Formula 6-100

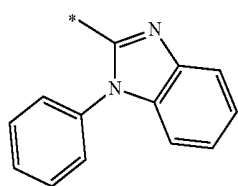
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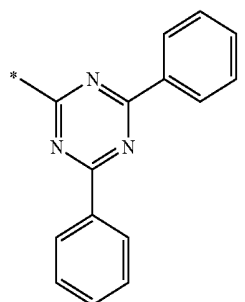
Formula 6-105



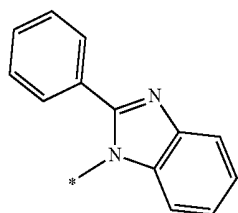
Formula 6-101



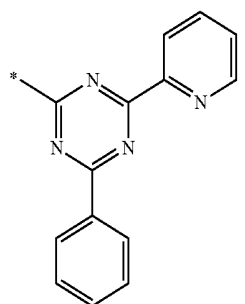
Formula 6-106



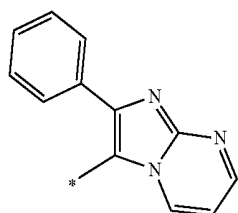
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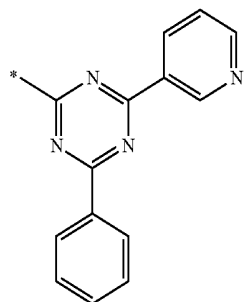
Formula 6-107



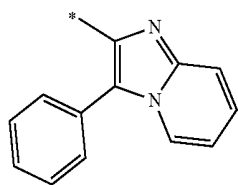
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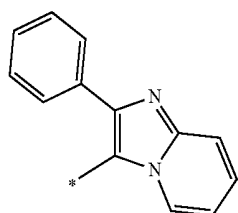
Formula 6-109



Formula 6-104

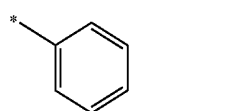
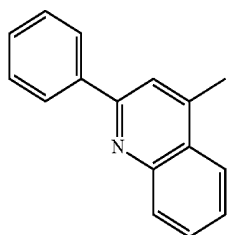
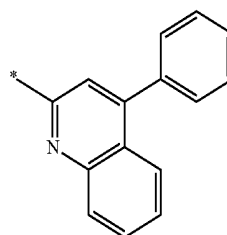
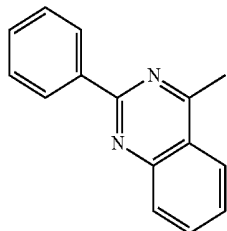
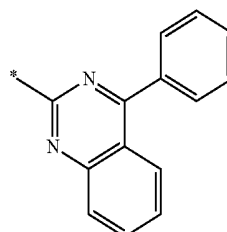
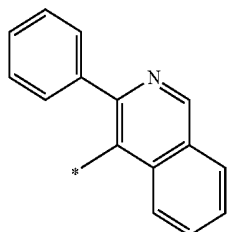
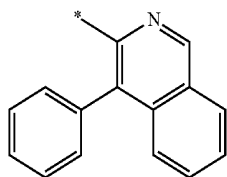


Formula 6-110



Formula 6-111

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Formula 6-112

Formula 6-113

Formula 6-114

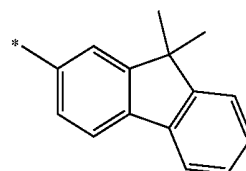
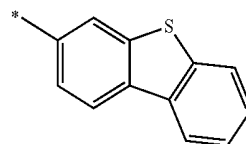
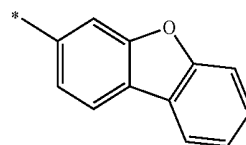
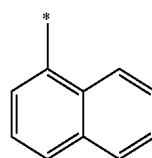
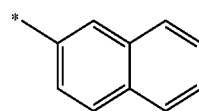
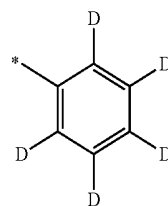
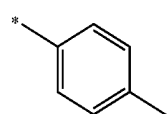
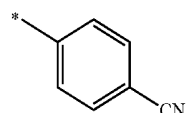
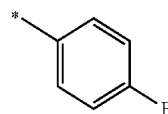
Formula 6-115

Formula 6-116

Formula 6-117

Formula 6-118

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Formula 6-119

Formula 6-120

Formula 6-121

Formula 6-122

Formula 6-123

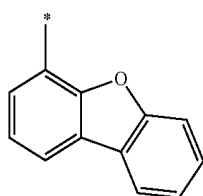
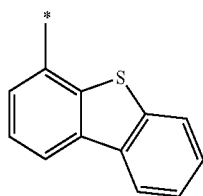
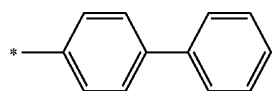
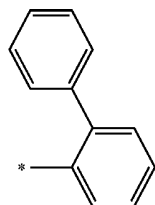
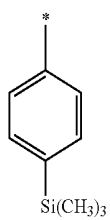
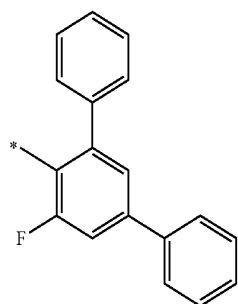
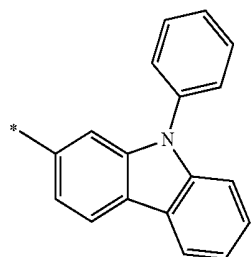
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Formula 6-125

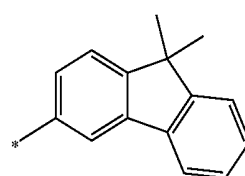
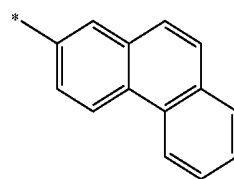
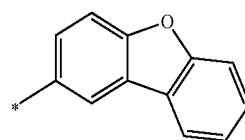
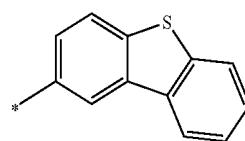
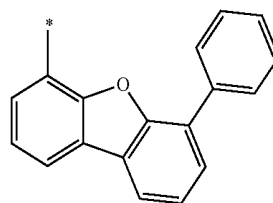
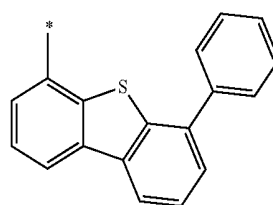
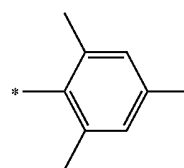
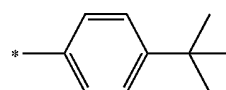
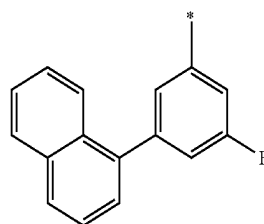
Formula 6-126

Formula 6-127

-continued



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Formula 6-128

Formula 6-129

Formula 6-130

Formula 6-131

Formula 6-136

Formula 6-137

Formula 6-138

Formula 6-139

Formula 6-140

Formula 6-141

Formula 6-142

Formula 6-143

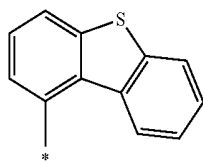
Formula 6-140

Formula 6-141

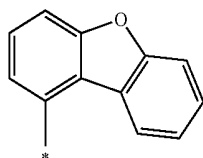
Formula 6-142

Formula 6-143

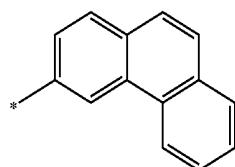
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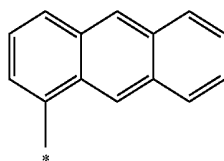
Formula 6-144



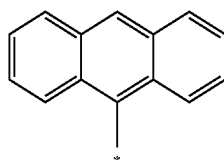
Formula 6-145



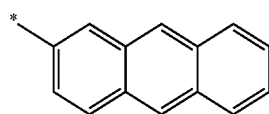
Formula 6-146



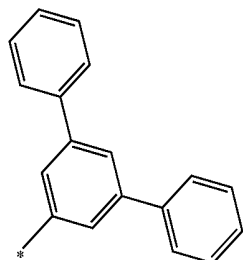
Formula 6-147



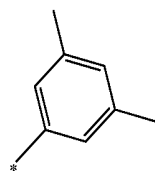
Formula 6-148



Formula 6-149

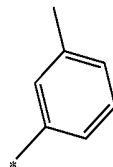


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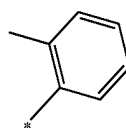


Formula 6-151

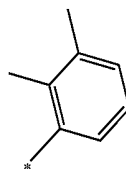
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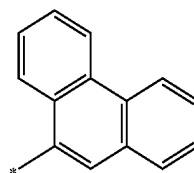
Formula 6-152



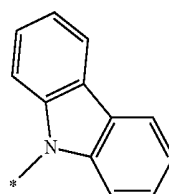
Formula 6-153



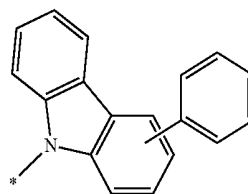
Formula 6-154



Formula 6-155



Formula 6-156

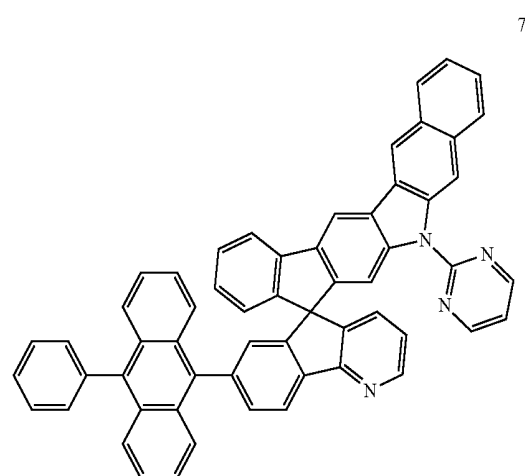
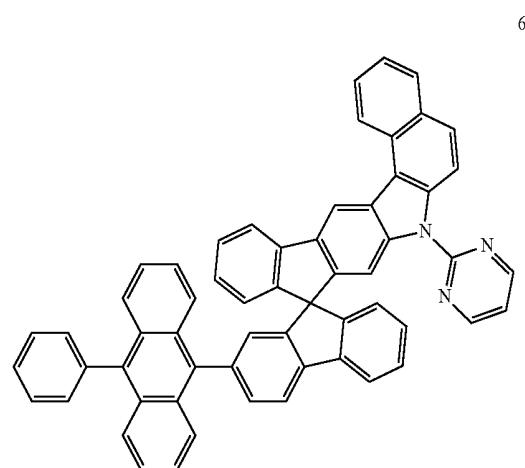
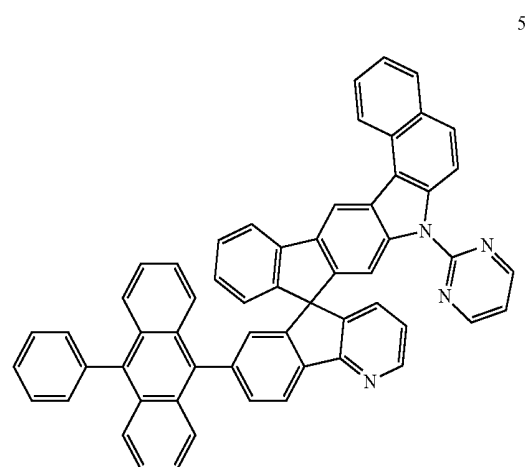
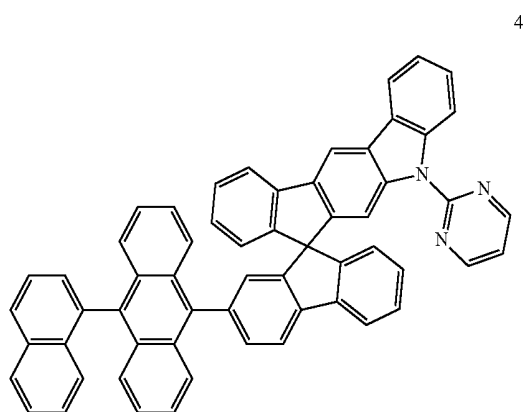
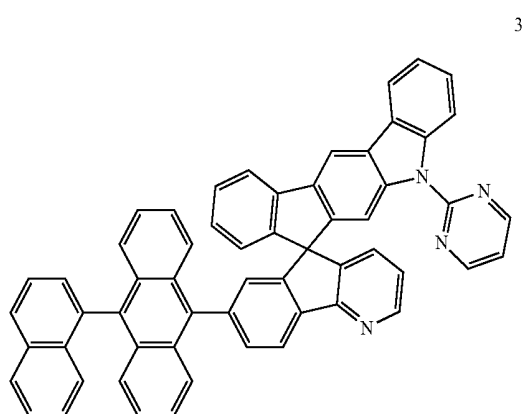
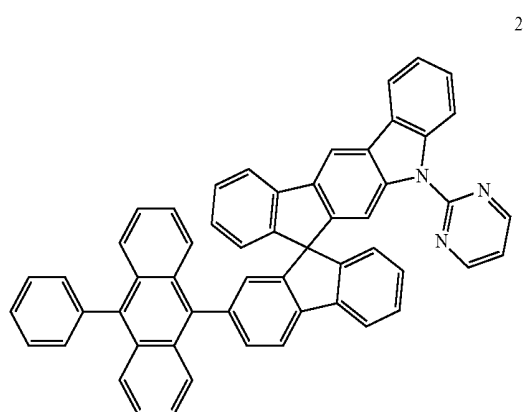
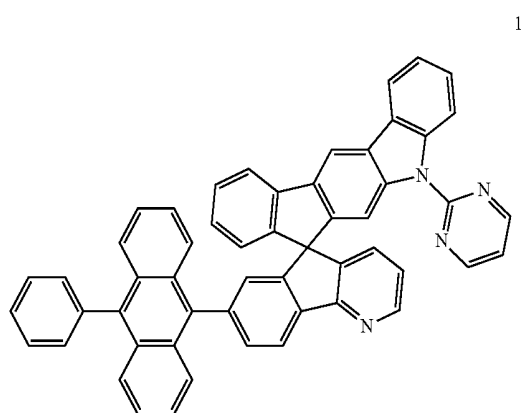


Formula 6-157

wherein, in Formulae 4-1 to 4-35 and Formulae 6-1 to 6-157, * and *' are each a binding site to a neighboring atom.

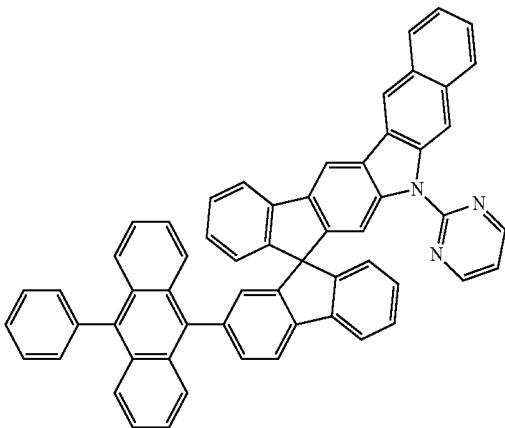
17. The condensed cyclic compound as claimed in claim 1, the compound represented by Formula 1 is one of the following Compounds 1 to 36:

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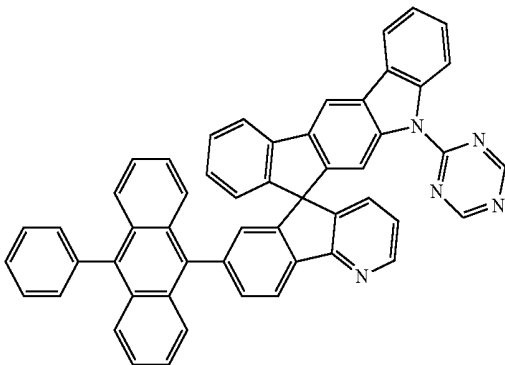


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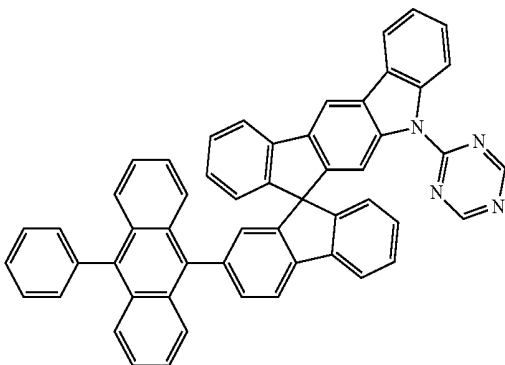
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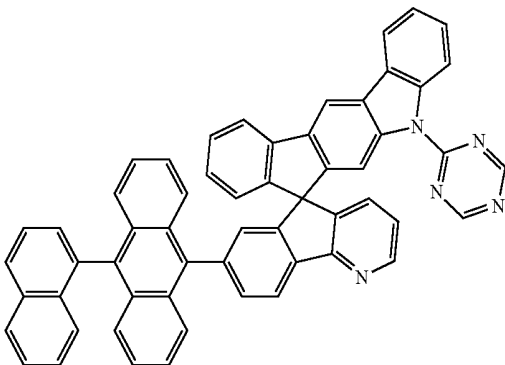
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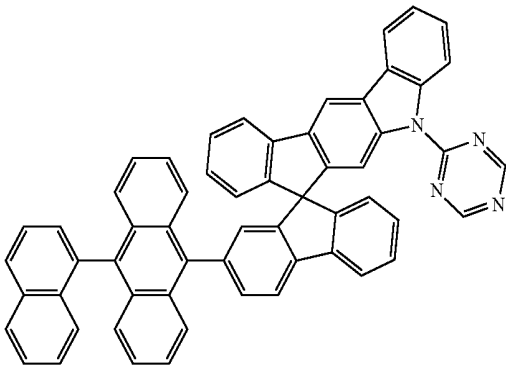


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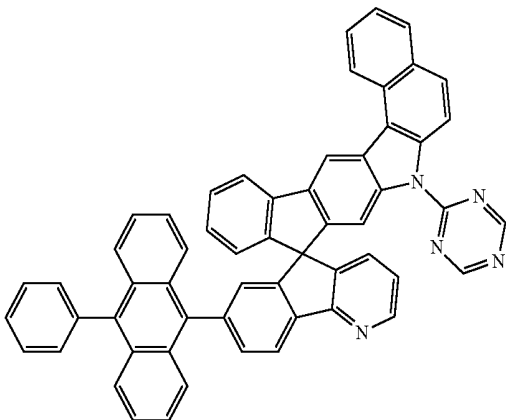


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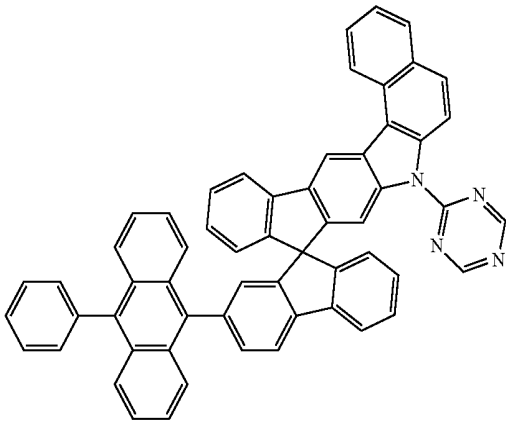
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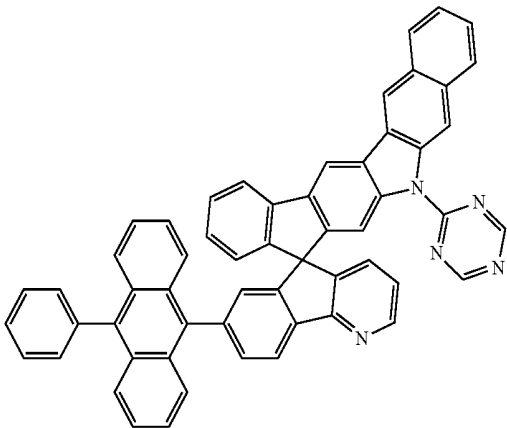


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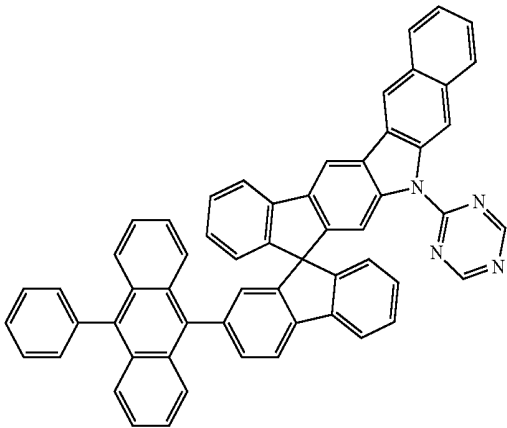


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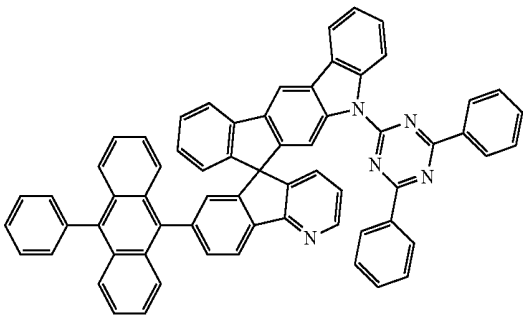
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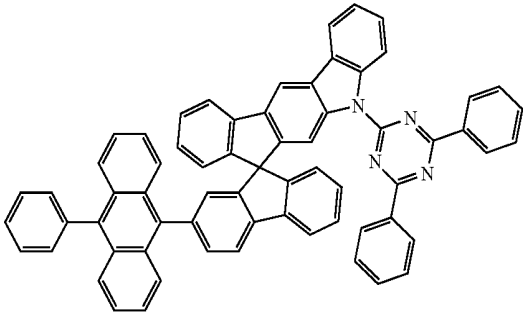
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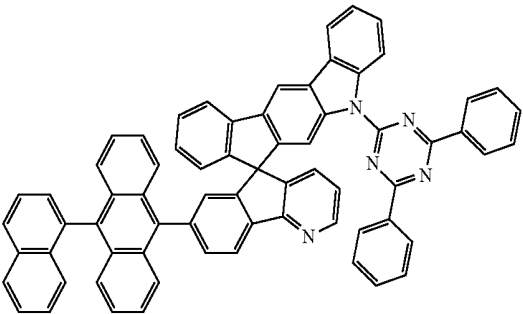


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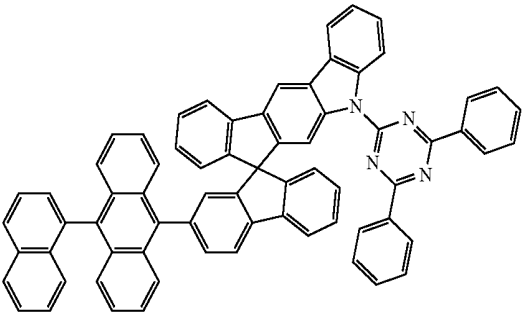


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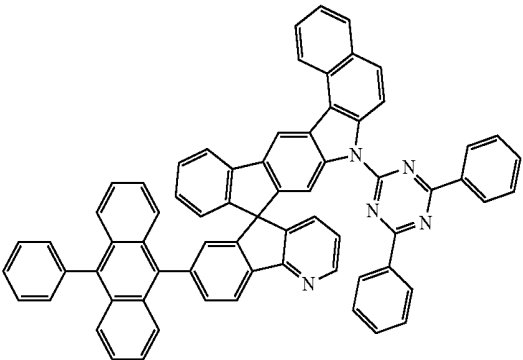
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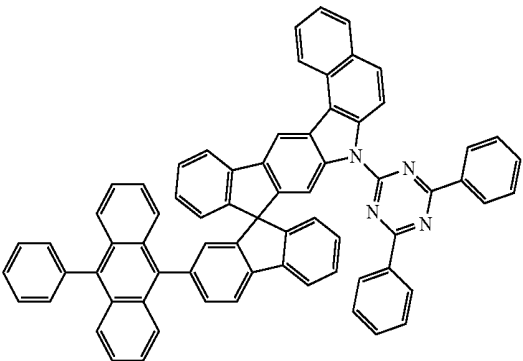
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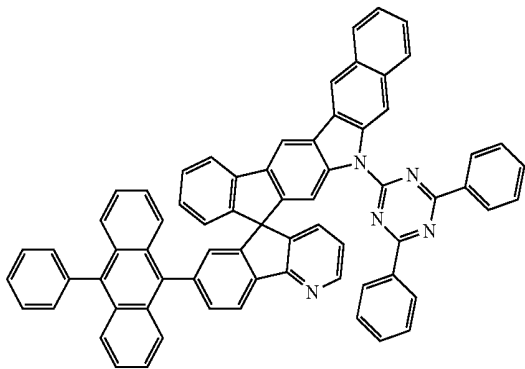


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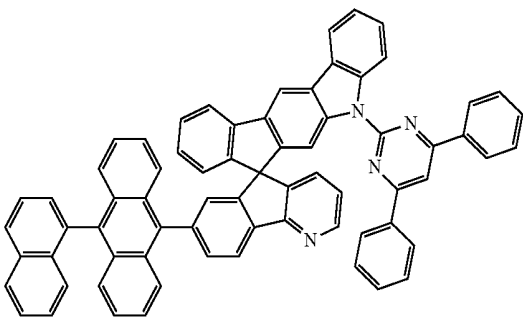
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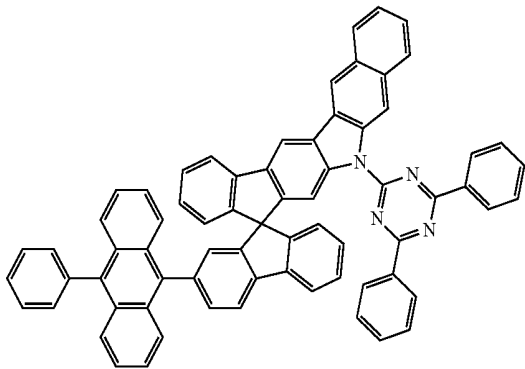


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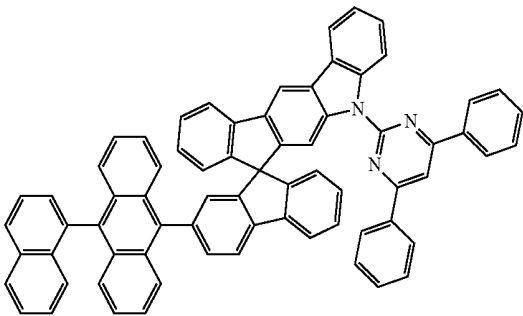
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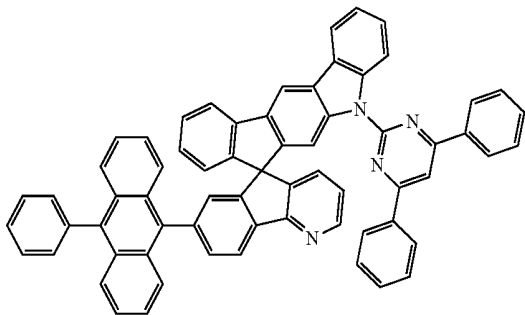
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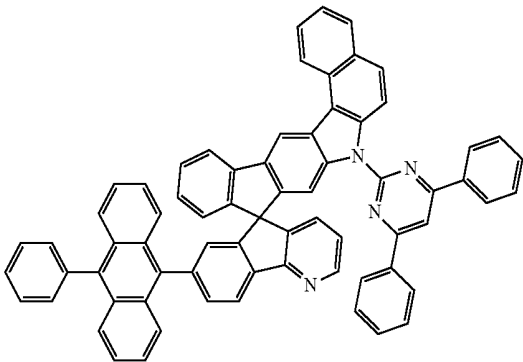
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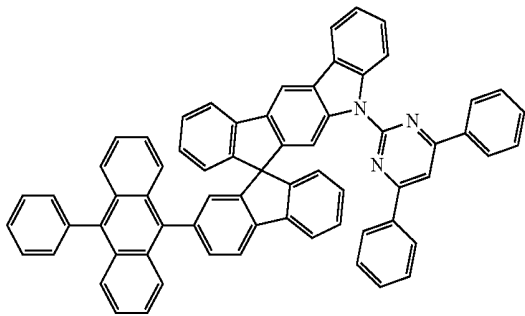
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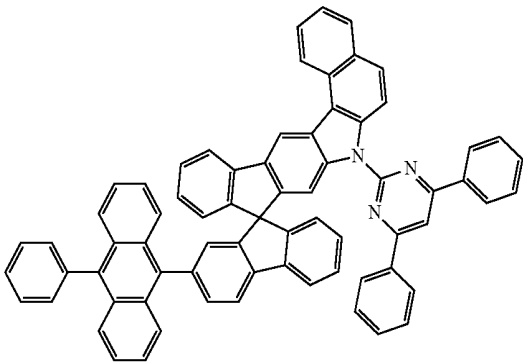
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26

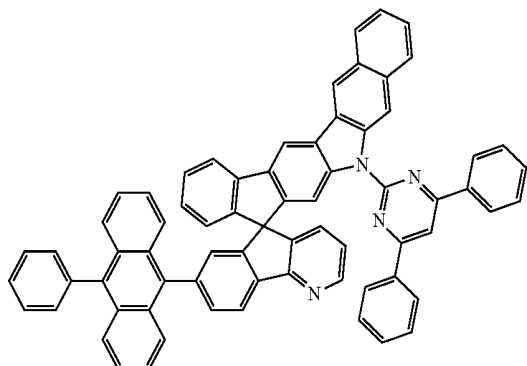


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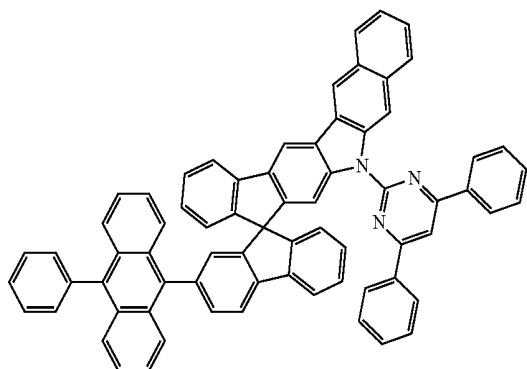


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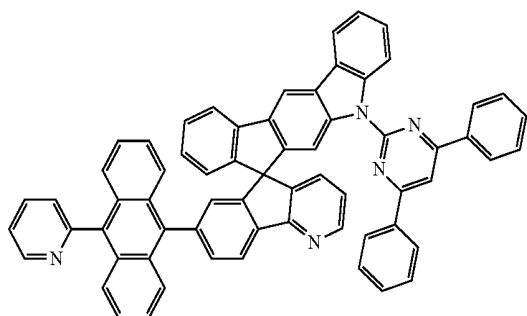
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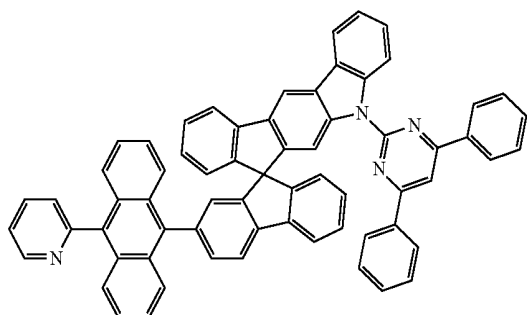
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33

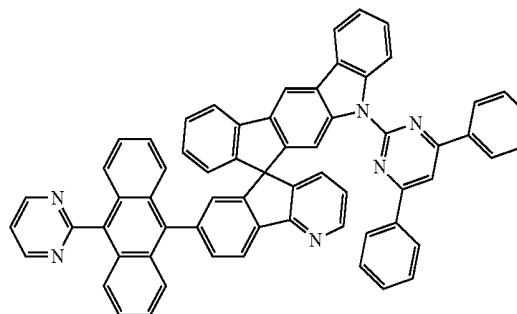


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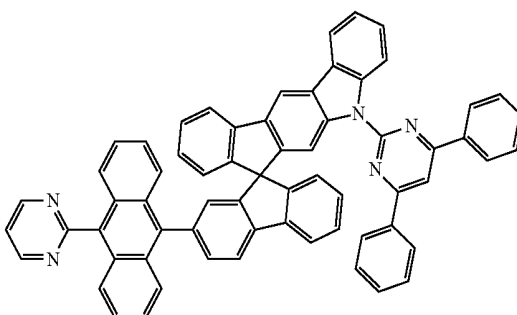


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35



36



18. An organic light-emitting device, comprising:
a first electrode
a second electrode facing the first electrode; and
an organic layer between the first electrode and the second electrode, the organic layer including an emission layer, wherein the organic layer includes the condensed-cyclic compound as claimed in claim 1.

19. The organic light-emitting device as claimed in claim 19, wherein
the first electrode is an anode,
the second electrode is a cathode,
the organic layer includes:

a hole transport region between the first electrode and the emission layer, the hole transport region including at least one selected from a hole injection layer, a hole transport layer, a buffer layer, and an electron blocking layer, and

an electron transport region between the emission layer and the second electrode, the electron transport region including at least one of a hole blocking layer, an electron transport layer, and an electron injection layer, and

at least one of the hole transport region and the emission layer includes the condensed cyclic compound.

20. The organic light-emitting device as claimed in claim 18, wherein the emission layer includes the condensed cyclic compound.

* * * * *

专利名称(译)	缩合环状化合物和包括其的有机发光器件		
公开(公告)号	US20160293848A1	公开(公告)日	2016-10-06
申请号	US14/963274	申请日	2015-12-09
[标]申请(专利权)人(译)	三星显示有限公司 成均馆大学校产学协力团		
申请(专利权)人(译)	三星DISPLAY CO. , LTD. 研究与业务基础韩国成均馆大学		
当前申请(专利权)人(译)	三星DISPLAY CO. , LTD. 研究与业务基础韩国成均馆大学		
[标]发明人	KIM SUNG WOOK KIM MYEONG SUK CHO HWAN HEE KHO SAM IL YOON SEUNG SOO		
发明人	KIM, SUNG-WOOK KIM, MYEONG-SUK CHO, HWAN-HEE KHO, SAM-IL YOON, SEUNG-SOO		
IPC分类号	H01L51/00 C09K11/02 C07D403/04 C07D471/10		
CPC分类号	H01L51/0067 H01L51/0072 H01L51/0058 H01L51/5012 C09K11/025 C07D403/04 H01L2251/558 C07D471/10 C09K11/06 C09K2211/1007 C09K2211/1011 C09K2211/1029 C09K2211/1044 C09K2211/ /1059 H01L51/0052		
优先权	1020150048326 2015-04-06 KR		
其他公开文献	US10186666		
外部链接	Espacenet USPTO		

摘要(译)

<Formula 1>

缩合环状化合物和有机发光器件，该化合物由式1表示：

