US 20180366652A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2018/0366652 A1**

MO et al. (43) **Pub. Date: Dec. 20, 2018**

(54) **HETEROCYCLIC COMPOUND AND ORGANIC LIGHT EMITTING DEVICE USING SAME**

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(21) Appl. No.: **15/780,402**

(22) PCT Filed: **Dec. 1, 2016**

(86) PCT No.: **PCT/KR2016/014019**

§ 371 (c)(1),
(2) Date: **May 31, 2018**

(30) **Foreign Application Priority Data**

Dec. 1, 2015 (KR) 10-2015-0170140

Publication Classification

(51) **Int. Cl.**

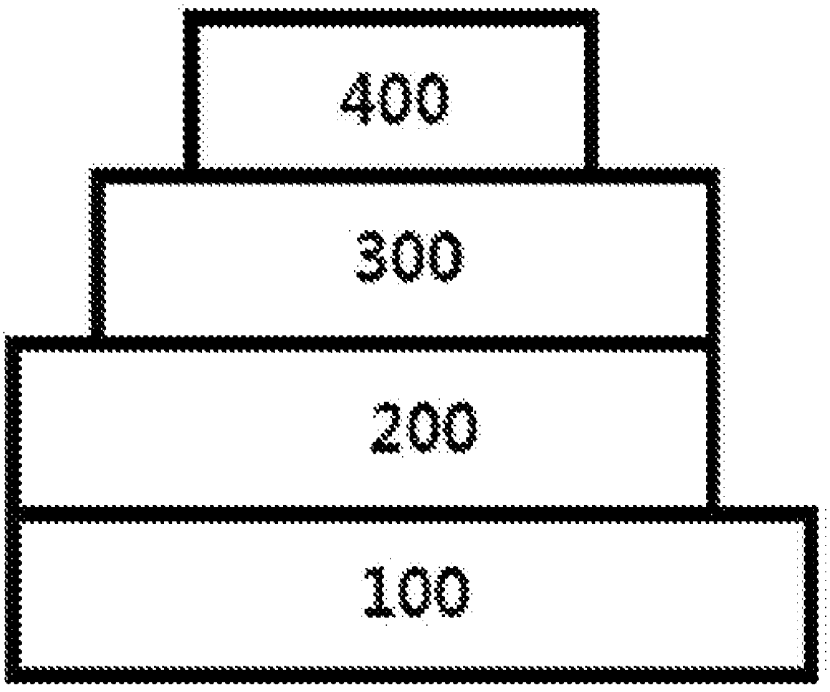
H01L 51/00	(2006.01)
C07D 401/14	(2006.01)
C07D 471/04	(2006.01)

(52) **U.S. Cl.**

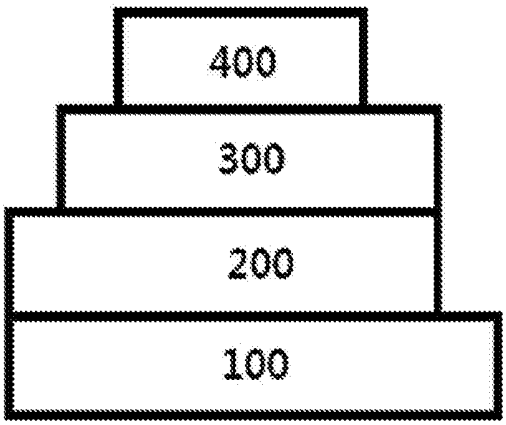
CPC ***H01L 51/0067*** (2013.01); ***C07D 401/14*** (2013.01); *H01L 51/5096* (2013.01); ***C07D 471/04*** (2013.01); ***H01L 51/0072*** (2013.01)

(57) **ABSTRACT**

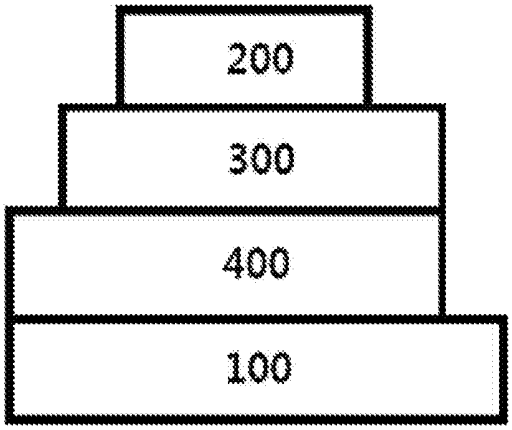
The present application provides a hetero-cyclic compound which may significantly improve the service life, efficiency, electrochemical stability, and thermal stability of an organic light emitting device, and an organic light emitting device in which the hetero-cyclic compound is contained in an organic compound layer.



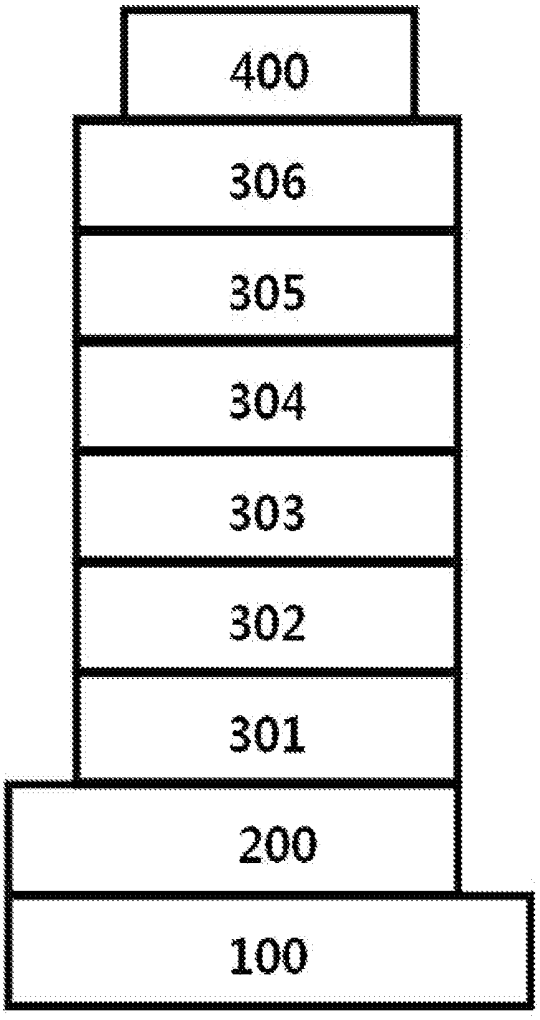
[Figure 1]



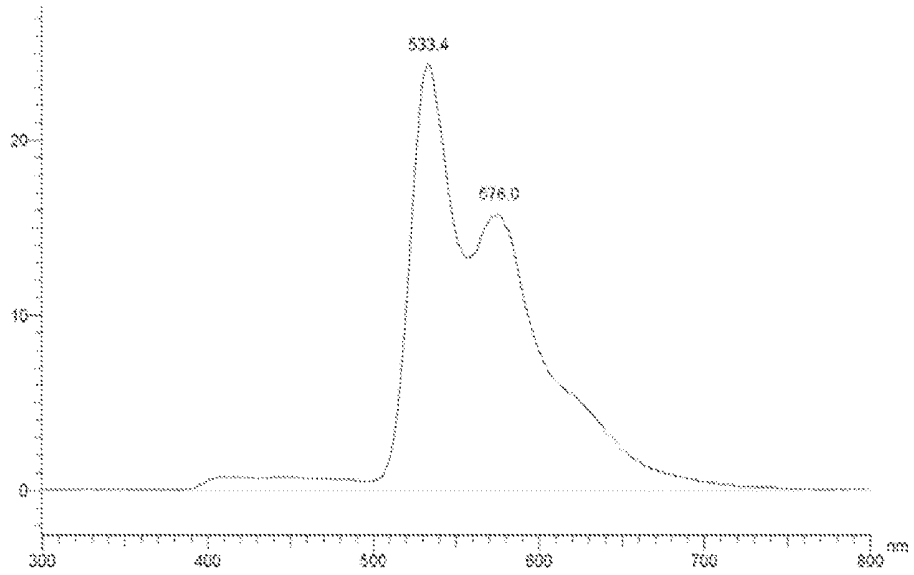
[Figure 2]



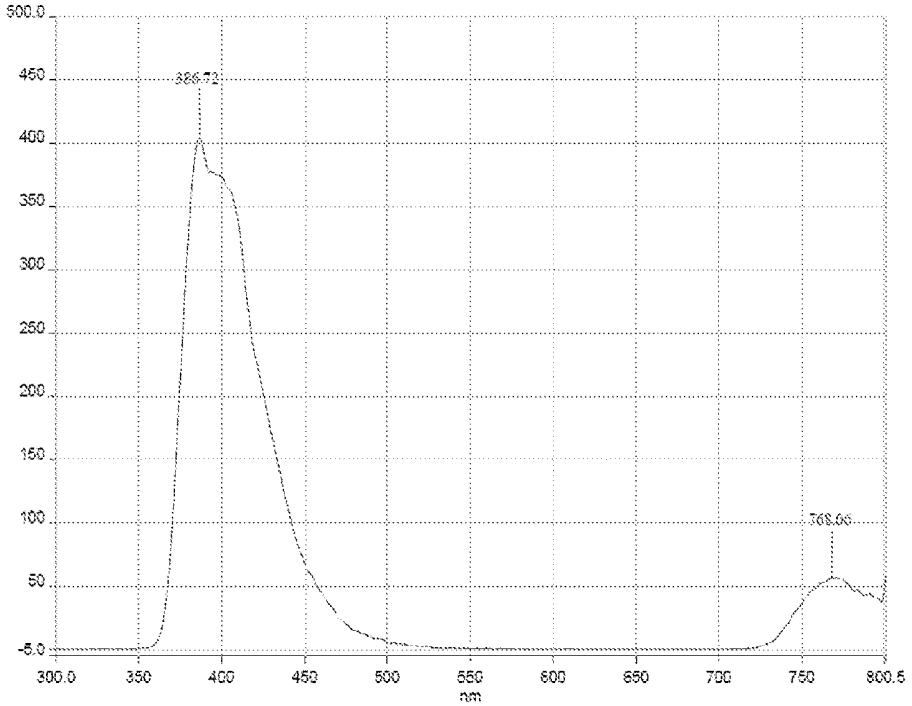
[Figure 3]



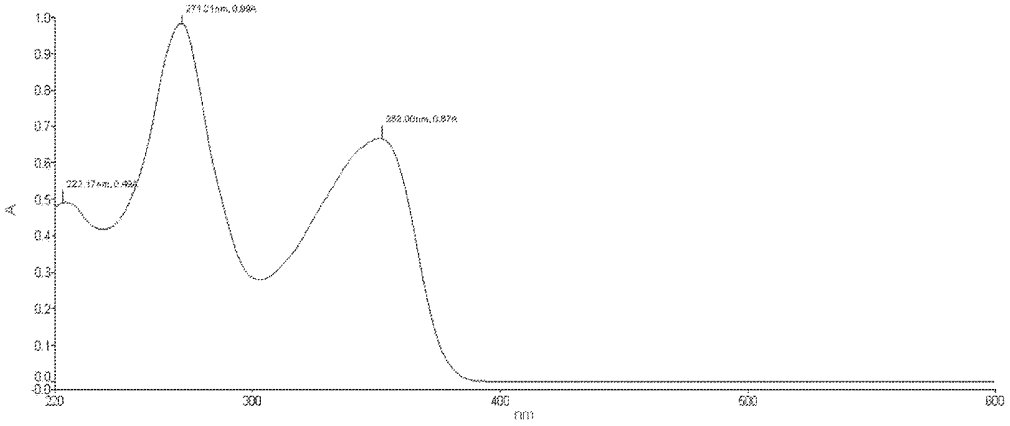
[Figure 4]



[Figure 5]



[Figure 6]



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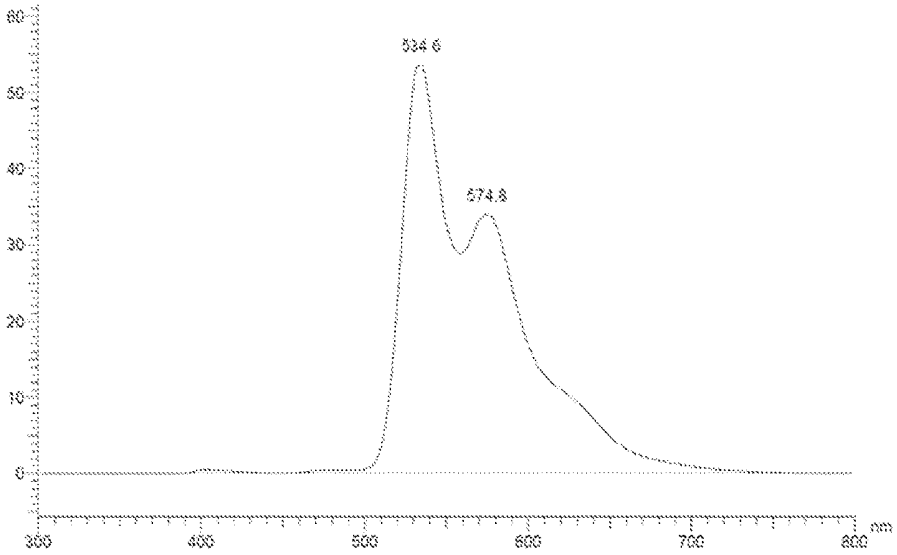
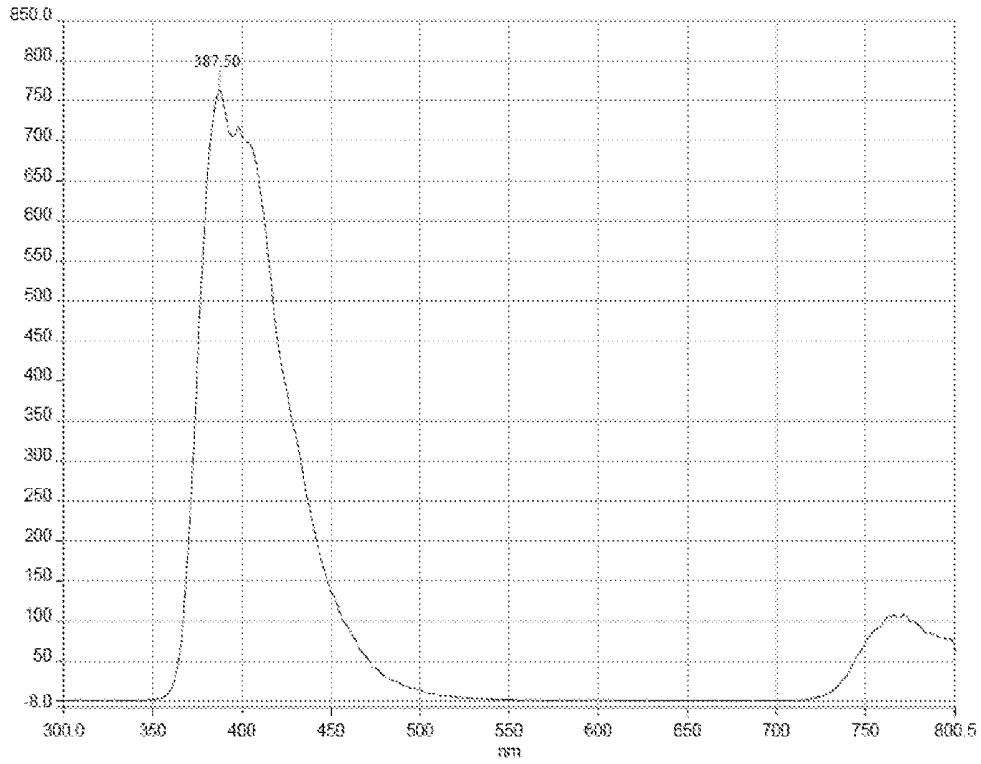


[Figure 8]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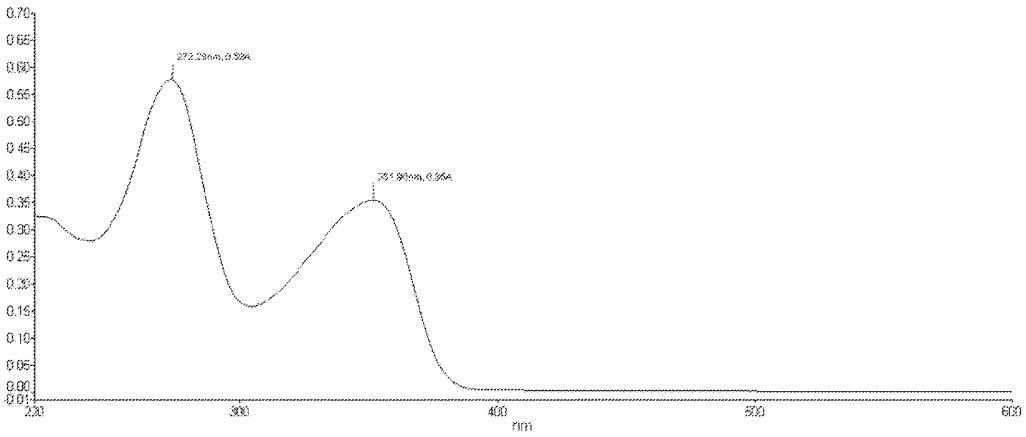
[Figure 9]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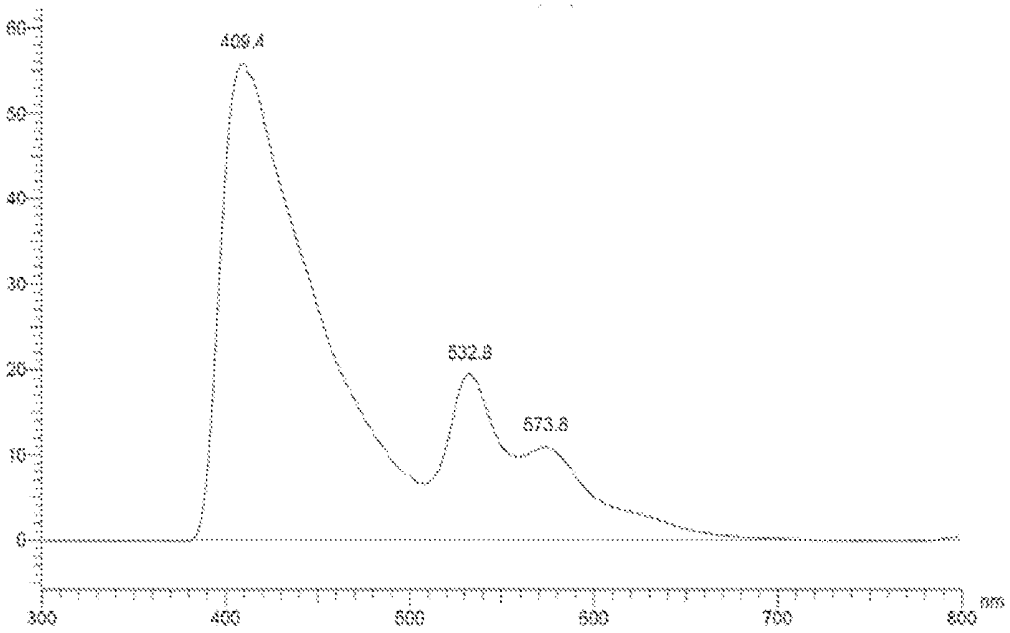
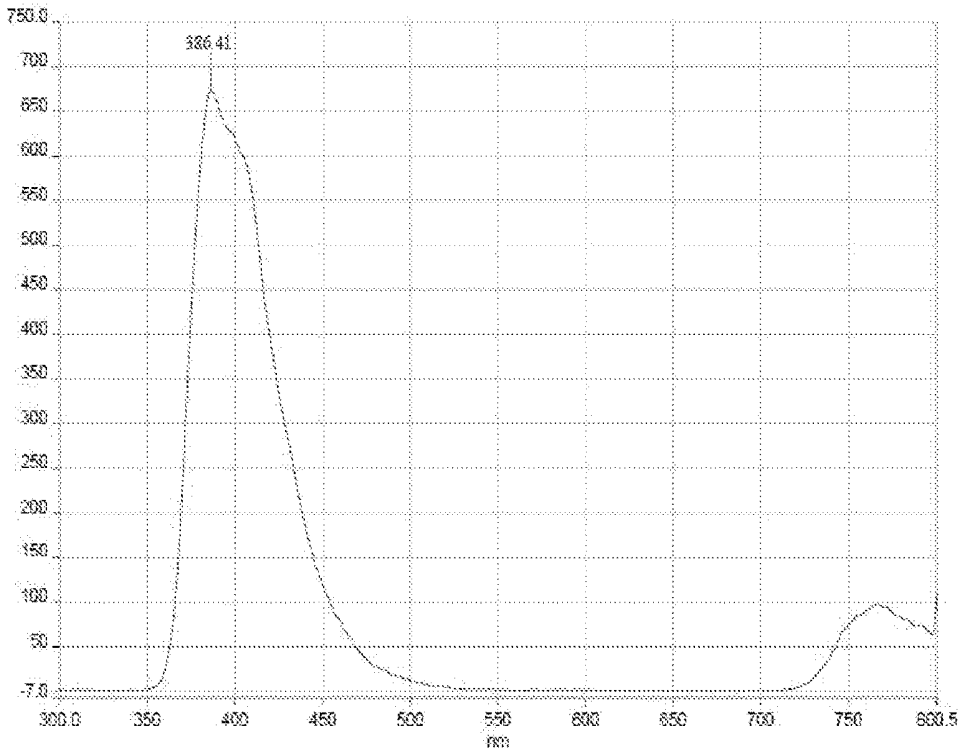
[Figure 10]



[Figure 11]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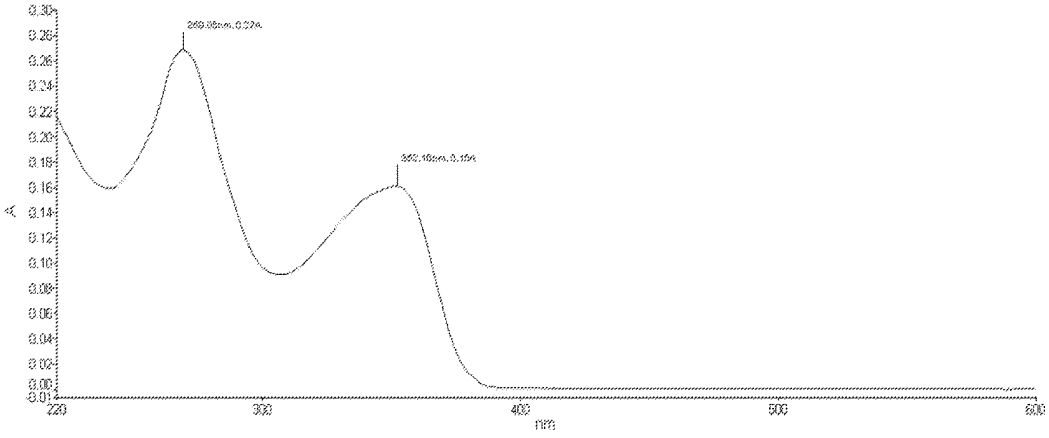
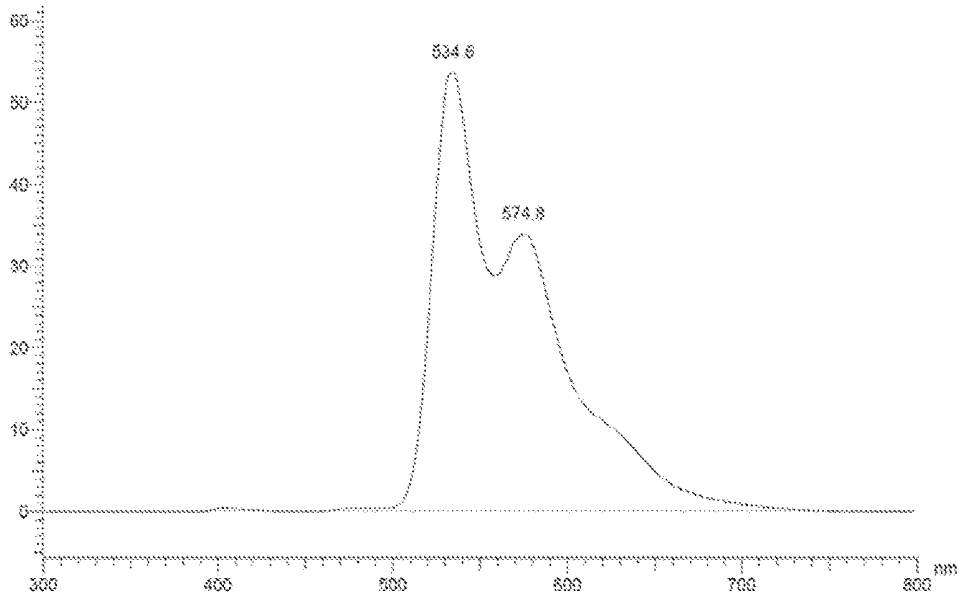
nm

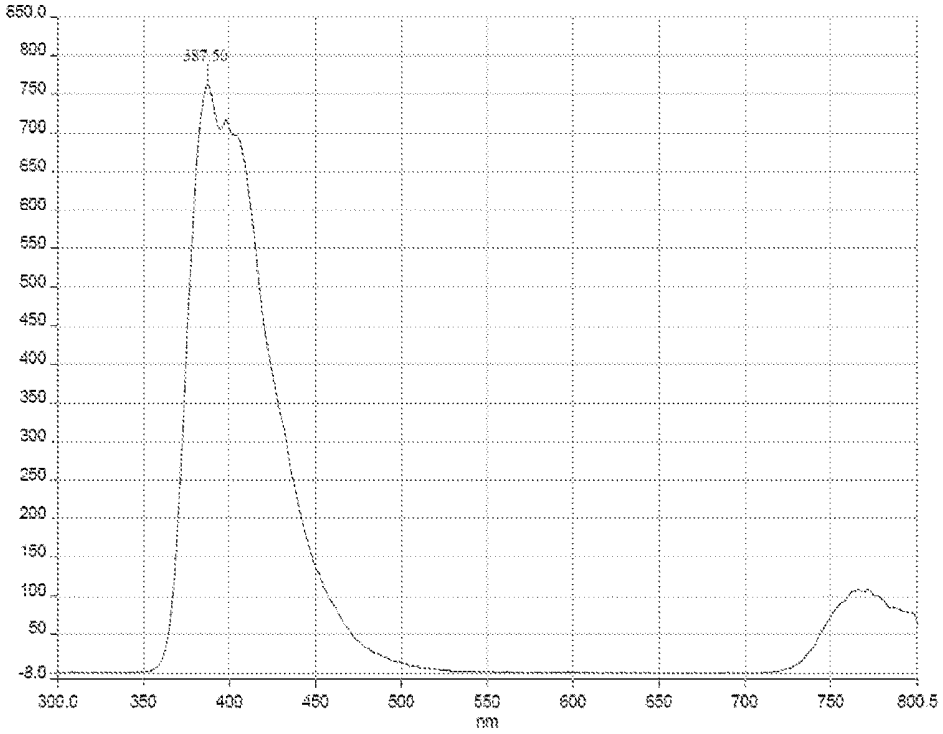
[Figure 12]



[Figure 13]



[Figure 14]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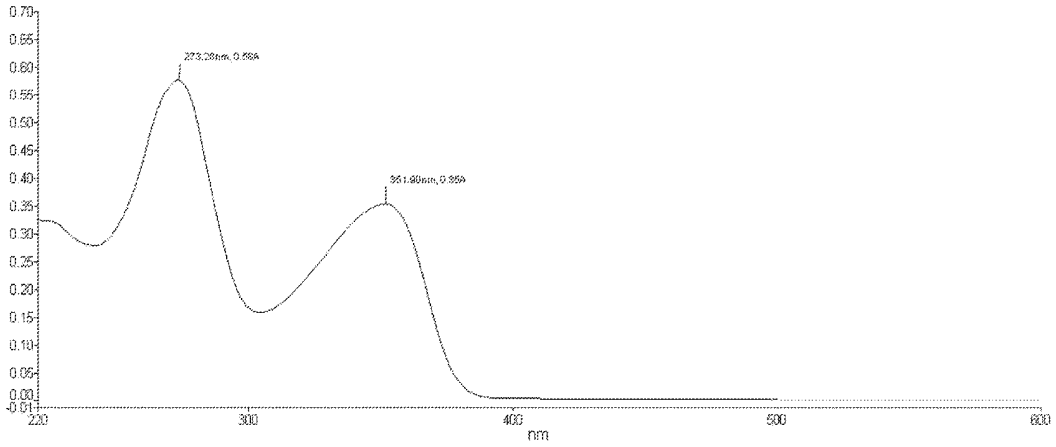
(nm)

[Figure 15]


A
nm
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361.80nm, 0.35A
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0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
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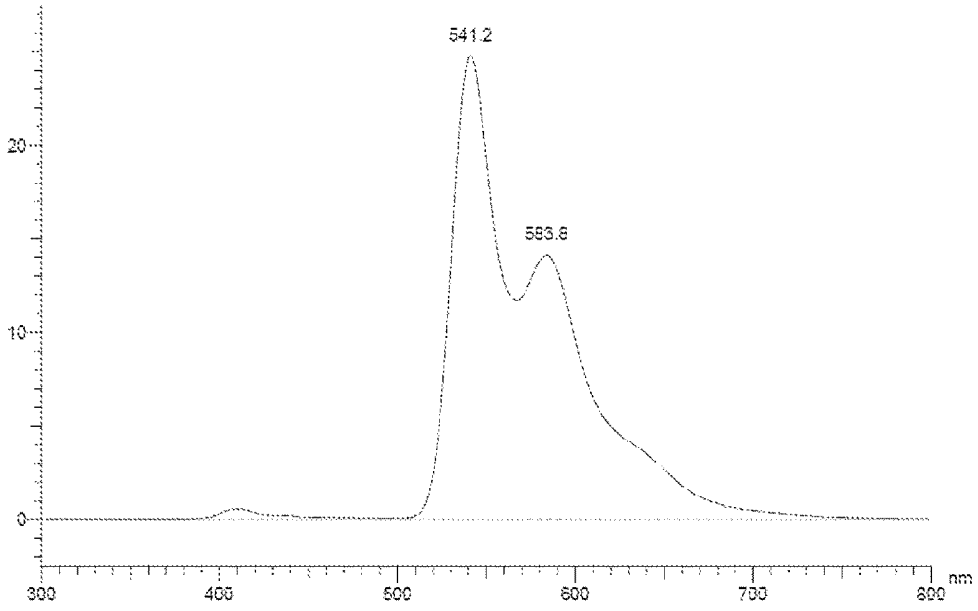
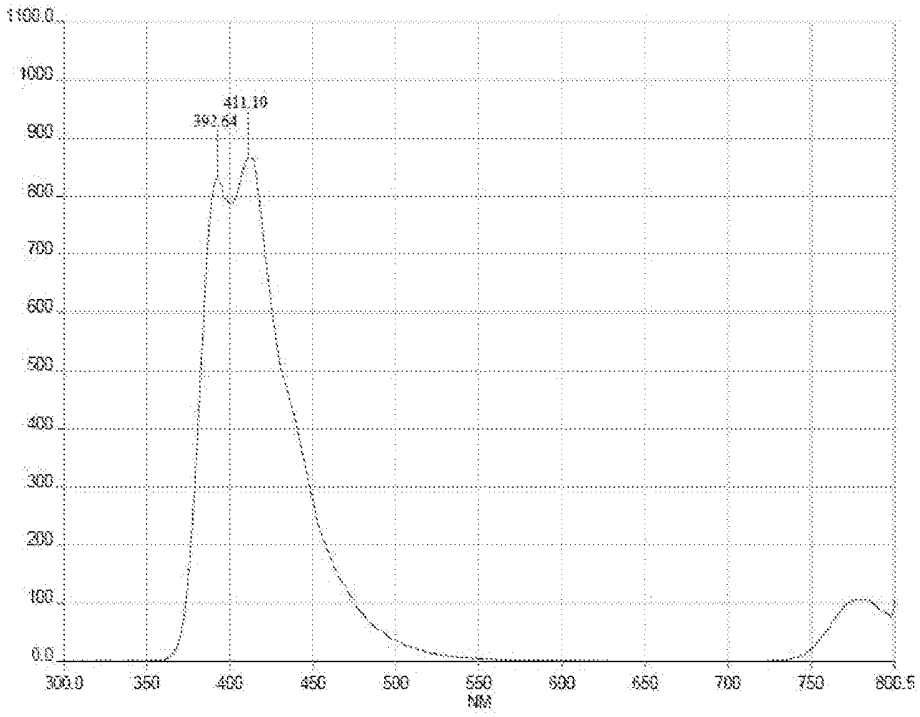
0.05
0.00
-0.01
220
300
400
500
600

[Figure 16]



[Figure 17]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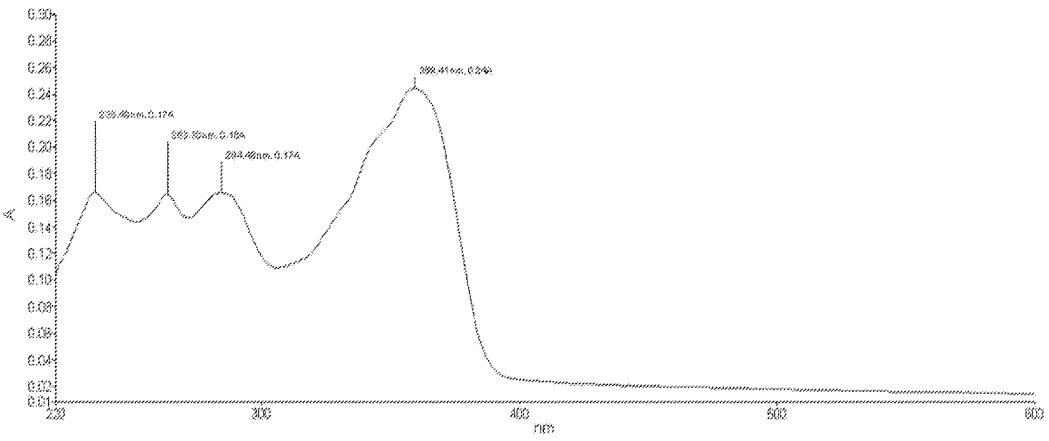
NM

[Figure 18]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0.24
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0.20
0.18
0.16
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0.12
0.10
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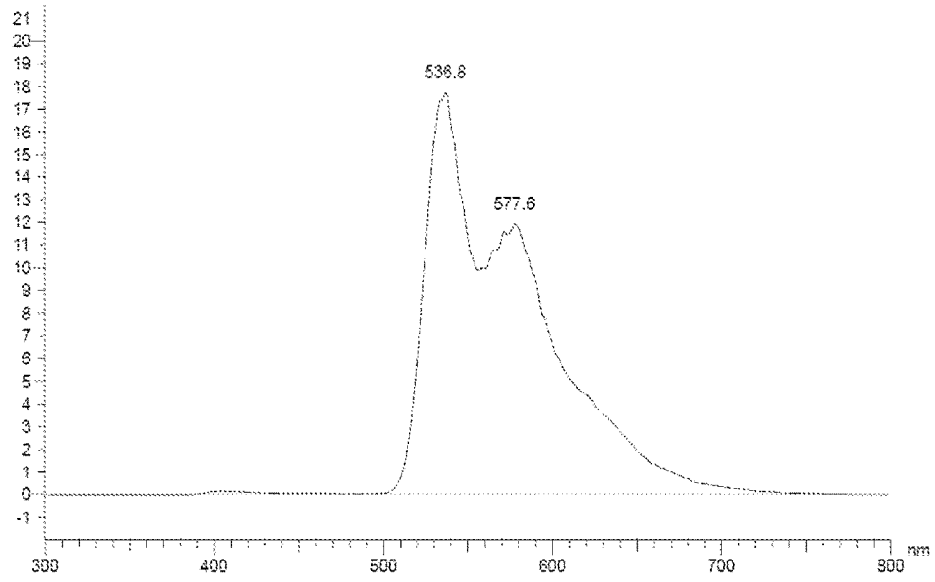
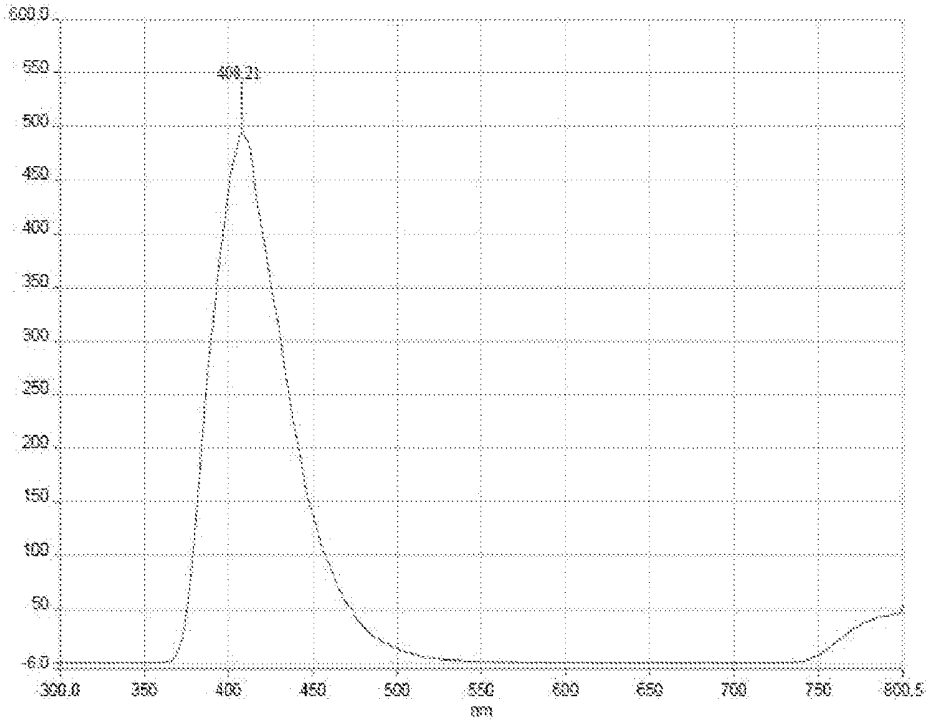
0.06
0.04
0.02
0.01
A
200
300
400
500
600
nm

[Figure 19]



[Figure 20]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200
150
100
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498.31
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400
450
500
550
600
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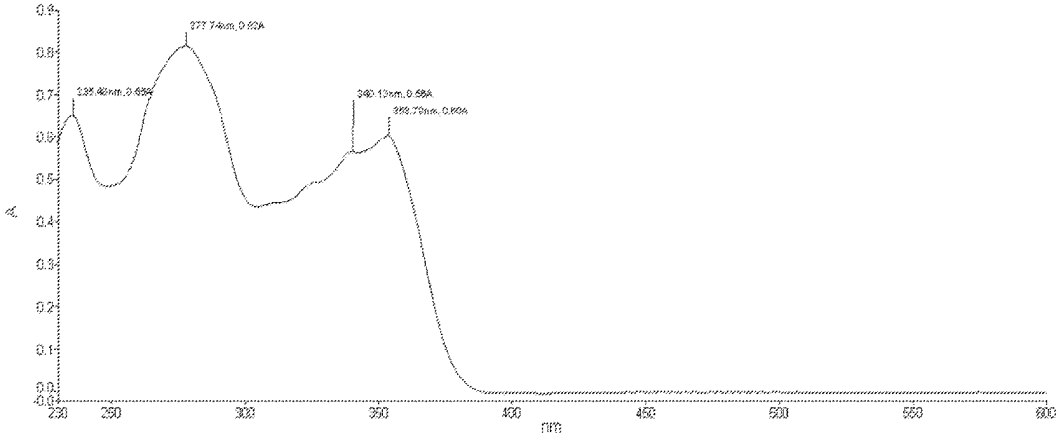
700
750
800.5
nm

[Figure 21]



HETEROCYCLIC COMPOUND AND ORGANIC LIGHT EMITTING DEVICE USING SAME

TECHNICAL FIELD

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2015-0170140 filed in the Korean Intellectual Property Office on Dec. 1, 2015, the entire contents of which are incorporated herein by reference.

[0002] The present application relates to a hetero-cyclic compound and an organic light emitting device using the same.

BACKGROUND ART

[0003] An electroluminescence device is a kind of self-emitting type display device, and has an advantage in that the viewing angle is wide, the contrast is excellent, and the response speed is fast.

[0004] An organic light emitting device has a structure in which an organic thin film is disposed between two electrodes. When a voltage is applied to an organic light emitting device having the structure, electrons and holes injected from the two electrodes combine with each other in an organic thin film to make a pair, and then, emit light while being extinguished. The organic thin film may be composed of a single layer or multi layers, if necessary.

[0005] A material for the organic thin film may have a light emitting function, if necessary. For example, as the material for the organic thin film, it is also possible to use a compound, which may itself constitute a light emitting layer alone, or it is also possible to use a compound, which may serve as a host or a dopant of a host-dopant-based light emitting layer. In addition, as a material for the organic thin film, it is also possible to use a compound, which may perform a function such as hole injection, hole transport, electron blocking, hole blocking, electron transport or electron injection.

[0006] In order to improve the performance, service life, or efficiency of the organic light emitting device, there is a continuous need for developing a material for an organic thin film.

DISCLOSURE

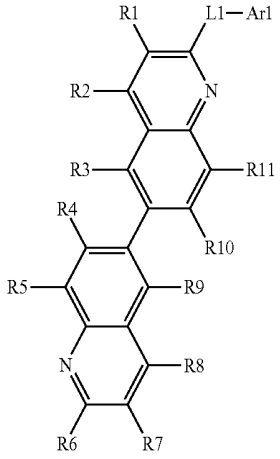
Technical Problem

[0007] It is necessary to perform studies on an organic light emitting device comprising a compound having a chemical structure, which may satisfy conditions required for a material which is available for the organic light emitting device, for example, appropriate energy levels, electrochemical stability, thermal stability, and the like, and may perform various functions required for the organic light emitting device according to the substituent.

Technical Solution

[0008] An exemplary embodiment of the present application provides a hetero-cyclic compound represented by the following Chemical Formula 1:

[Chemical Formula 1]



[0009] In Chemical Formula 1,

[0010] L1 is a direct bond; or a substituted or unsubstituted C_6 to C_{60} arylene group,

[0011] Ar1 comprises at least one of N, O, and S, and is a substituted or unsubstituted C_2 to C_{60} heteroaryl group,

[0012] R1 to R11 are the same as or different from each other, and are each independently selected from the group consisting of hydrogen; deuterium; a halogen group; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_2 to C_{60} alkenyl group; a substituted or unsubstituted C_2 to C_{60} alkynyl group; a substituted or unsubstituted C_1 to C_{60} alkoxy group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_2 to C_{60} heterocycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; a substituted or unsubstituted C_2 to C_{60} heteroaryl group; —SiRR'R"; —P(=O)RR'; and an amine group which is unsubstituted or substituted with a C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{60} aryl group, or a C_2 to C_{60} heteroaryl group, or two or more adjacent groups are bonded to each other to form a substituted or unsubstituted aliphatic or aromatic hydrocarbon ring, and

[0013] R, R', and R" are the same as or different from each other, and are each independently hydrogen; deuterium; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; or a substituted or unsubstituted C_2 to C_{60} heteroaryl group.

[0014] Further, another exemplary embodiment of the present application provides an organic light emitting device comprising a positive electrode, a negative electrode, and an organic material layer having one or more layers disposed between the positive electrode and the negative electrode, in which one or more layers of the organic material layer comprise the hetero-cyclic compound.

Advantageous Effects

[0015] A hetero-cyclic compound according to an exemplary embodiment of the present application may be used as a material for an organic material layer of an organic light emitting device. The hetero-cyclic compound may be used as a material for a hole injection layer, a hole transporting layer, a light emitting layer, an electron transporting layer, an electron injection layer, a charge producing layer, and the

like in an organic light emitting device. In particular, the hetero-cyclic compound represented by Chemical Formula 1 may be used as a material for an electron transporting layer, a hole transporting layer, or a light emitting layer of an organic light emitting device. In addition, when the hetero-cyclic compound represented by Chemical Formula 1 is used for an organic light emitting device, the driving voltage of the device may be lowered, the light efficiency of the device may be improved, and the service life characteristics of the device may be improved due to the thermal stability of the compound.

DESCRIPTION OF DRAWINGS

[0016] FIGS. **1** to **3** each are a view schematically illustrating a stacking structure of an organic light emitting device according to an exemplary embodiment of the present application.

[0017] FIG. **4** illustrates a measurement graph of LTPL of Compound 6 at a wavelength of 270 nm.

[0018] FIG. **5** illustrates a measurement graph of PL of Compound 6 at a wavelength of 271 nm.

[0019] FIG. **6** illustrates a measurement graph of UV of Compound 6.

[0020] FIG. **7** illustrates a measurement graph of LTPL of Compound 7 at a wavelength of 352 nm.

[0021] FIG. **8** illustrates a measurement graph of PL of Compound 7 at a wavelength of 273 nm.

[0022] FIG. **9** illustrates a measurement graph of UV of Compound 7.

[0023] FIG. **10** illustrates a measurement graph of LTPL of Compound 11 at a wavelength of 270 nm.

[0024] FIG. **11** illustrates a measurement graph of PL of Compound 11 at a wavelength of 270 nm.

[0025] FIG. **12** illustrates a measurement graph of UV of Compound 11.

[0026] FIG. **13** illustrates a measurement graph of LTPL of Compound 12 at a wavelength of 352 nm.

[0027] FIG. **14** illustrates a measurement graph of PL of Compound 12 at a wavelength of 273 nm.

[0028] FIG. **15** illustrates a measurement graph of UV of Compound 12.

[0029] FIG. **16** illustrates a measurement graph of LTPL of Compound 13 at a wavelength of 359 nm.

[0030] FIG. **17** illustrates a measurement graph of PL of Compound 13 at a wavelength of 284 nm.

[0031] FIG. **18** illustrates a measurement graph of UV of Compound 13.

[0032] FIG. **19** illustrates a measurement graph of LTPL of Compound 16 at a wavelength of 354 nm.

[0033] FIG. **20** illustrates a measurement graph of PL of Compound 16 at a wavelength of 354 nm.

[0034] FIG. **21** illustrates a measurement graph of UV of Compound 16.

EXPLANATION OF REFERENCE NUMERALS AND SYMBOLS

[0035] **100**: Substrate

[0036] **200**: Positive electrode

[0037] **300**: Organic material layer

[0038] **301**: Hole injection layer

[0039] **302**: Hole transporting layer

[0040] **303**: Light emitting layer

[0041] **304**: Hole blocking layer

[0042] **305**: Electron transporting layer

[0043] **306**: Electron injection layer

[0044] **400**: Negative electrode

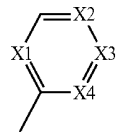
BEST MODE

[0045] Hereinafter, the present application will be described in detail.

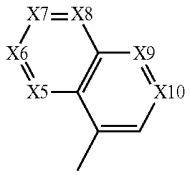
[0046] A hetero-cyclic compound according to an exemplary embodiment of the present application is represented by Chemical Formula 1. More specifically, the hetero-cyclic compound represented by Chemical Formula 1 may be used as a material for an organic material layer of an organic light emitting device by the structural characteristics of the core structure and the substituent as described above.

[0047] According to an exemplary embodiment of the present application, Ar1 of Chemical Formula 1 may be represented by any one of the following Chemical Formulae 2 to 6.

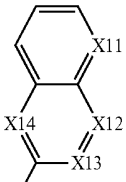
[Chemical Formula 2]



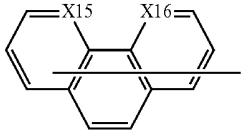
[Chemical Formula 3]



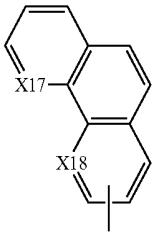
[Chemical Formula 4]



[Chemical Formula 5]



[Chemical Formula 6]



[0048] In Chemical Formulae 2 to 6,

[0049] at least one of X1 to X4 is N, O, or S, and the others are CR12,

[0050] at least one of X5 to X10 is N, O, or S, and the others are CR13,

[0051] at least one of X11 to X14 is N, O, or S, and the others are CR14,

[0052] at least one of X51 and X16 is N, O, or S, and the other is CR15,

[0053] at least one of X17 and X18 is N, O, or S, and the other is CR16,

[0054] R12 to R16 are the same as or different from each other, and are each independently selected from the group consisting of hydrogen; deuterium; a halogen group; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_2 to C_{60} alkenyl group; a substituted or unsubstituted C_2 to C_{60} alkynyl group; a substituted or unsubstituted C_1 to C_{60} alkoxy group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_2 to C_{60} heterocycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; a substituted or unsubstituted C_2 to C_{60} heteroaryl group; —SiRR'R"; —P(=O)RR'; and an amine group which is unsubstituted or substituted with a C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{60} aryl group, or a C_2 to C_{60} heteroaryl group, or two or more adjacent groups are bonded to each other to form a substituted or unsubstituted aliphatic or aromatic hydrocarbon ring, and

[0055] R, R', and R" are the same as or different from each other, and are each independently hydrogen; deuterium; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; or a substituted or unsubstituted C_2 to C_{60} heteroaryl group.

[0056] According to an exemplary embodiment of the present application, R6 of Chemical Formula 1 is -(L2)m-(Z)n,

[0057] L2 is a substituted or unsubstituted C_6 to C_{60} arylene; or a substituted or unsubstituted C_2 to C_{60} heteroarylene,

[0058] Z is a substituted or unsubstituted C_6 to C_{60} aryl group; or a substituted or unsubstituted C_2 to C_{60} heteroaryl group,

[0059] m is an integer from 0 to 5, and

[0060] n is an integer from 1 to 3.

[0061] When m and n each are an integer of 2 or more, a plurality of L2 and Z are each the same as or different from each other.

[0062] In an exemplary embodiment of the present application, R1 to R5 and R7 to R11 of Chemical Formula 1 may be hydrogen or deuterium.

[0063] In the present application, the substituents of Chemical Formula 1 will be more specifically described as follows.

[0064] In the present specification, "substituted or unsubstituted" means being unsubstituted or substituted with one or more substituents selected from the group consisting of deuterium; a halogen group; —CN; a C_1 to C_{60} alkyl group; a C_2 to C_{60} alkenyl group; a C_2 to C_{60} alkynyl group; a C_3 to C_{60} cycloalkyl group; a C_2 to C_{60} heterocycloalkyl group; a C_6 to C_{60} aryl group; a C_2 to C_{60} heteroaryl group; —SiRR'R"; —P(=O)RR'; a C_1 to C_{20} alkylamine group; a C_6 to C_{60} arylamine group; and a C_2 to C_{60} heteroarylamine group, being unsubstituted or substituted with a substituent to which two or more substituents among the substituents are bonded, or being unsubstituted or substituted with a substituent to which two or more substituents selected among the substituents are linked. For example, "the substituent to which two or more substituents are linked" may be a biphenyl group. That is, the biphenyl group may also be an aryl group, and may be interpreted as a substituent to which two phenyl groups are linked. The additional substituents may also be additionally substituted. R, R', and R" are the same as or different from each other, and are each independently hydrogen; deuterium; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; or a substituted or unsubstituted C_2 to C_{60} heteroaryl group.

[0065] According to an exemplary embodiment of the present application, the "substituted or unsubstituted" means being unsubstituted or substituted with one or more substituents selected from the group consisting of deuterium, a halogen group, —CN, SiRR'R", P(=O)RR', a C_1 to C_{20} straight or branched alkyl group, a C_6 to C_{60} aryl group, and a C_2 to C_{60} heteroaryl group, and

[0066] R, R', and R" are the same as or different from each other, and are each independently hydrogen; deuterium; —CN; a C_1 to C_{60} alkyl group which is unsubstituted or substituted with deuterium, a halogen group, —CN, a C_1 to C_{20} alkyl group, a C_6 to C_{60} aryl group, and a C_2 to C_{60} heteroaryl group; a C_3 to C_{60} cycloalkyl group which is unsubstituted or substituted with deuterium, halogen, —CN, a C_1 to C_{20} alkyl group, a C_6 to C_{60} aryl group, and a C_2 to C_{60} heteroaryl group; a C_6 to C_{60} aryl group which is unsubstituted or substituted with deuterium, halogen, —CN, a C_1 to C_{20} alkyl group, a C_6 to C_{60} aryl group, and a C_2 to C_{60} heteroaryl group; or a C_2 to C_{60} heteroaryl group which is unsubstituted or substituted with deuterium, halogen, —CN, a C_1 to C_{20} alkyl group, a C_6 to C_{60} aryl group, and a C_2 to C_{60} heteroaryl group.

[0067] The term "substitution" means that a hydrogen atom bonded to a carbon atom of a compound is changed into another substituent, and a position to be substituted is not limited as long as the position is a position at which the hydrogen atom is substituted, that is, a position at which the substituent may be substituted, and when two or more are substituted, the two or more substituents may be the same as or different from each other.

[0068] In the present specification, the halogen may be fluorine, chlorine, bromine or iodine.

[0069] In the present specification, the alkyl group comprises a straight-chain or branched-chain having 1 to 60 carbon atoms, and may be additionally substituted with another substituent. The number of carbon atoms of the alkyl group may be 1 to 60, specifically 1 to 40, and more specifically 1 to 20. Specific examples thereof include a methyl group, an ethyl group, a propyl group, an n-propyl group, an isopropyl group, a butyl group, an n-butyl group, an isobutyl group, a tert-butyl group, a sec-butyl group, a 1-methyl-butyl group, a 1-ethyl-butyl group, a pentyl group, an n-pentyl group, an isopentyl group, a neopentyl group, a tert-pentyl group, a hexyl group, an n-hexyl group, a 1-methylpentyl group, a 2-methylpentyl group, a 4-methyl-2-pentyl group, a 3,3-dimethylbutyl group, a 2-ethylbutyl group, a heptyl group, an n-heptyl group, a 1-methylhexyl group, a cyclopentylmethyl group, a cyclohexylmethyl group, an octyl group, an n-octyl group, a tert-octyl group, a 1-methylheptyl group, a 2-ethylhexyl group, a 2-propylpentyl group, an n-nonyl group, a 2,2-dimethylheptyl group, a 1-ethyl-propyl group, a 1,1-dimethyl-propyl group, an isohexyl group, a 2-methylpentyl group, a 4-methylhexyl group, a 5-methylhexyl group, and the like, but are not limited thereto.

[0070] In the present specification, the alkenyl group comprises a straight-chain or branched-chain having 2 to 60 carbon atoms, and may be additionally substituted with another substituent. The number of carbon atoms of the alkenyl group may be 2 to 60, specifically 2 to 40, and more specifically 2 to 20. Specific examples thereof include a vinyl group, a 1-propenyl group, an isopropenyl group, a 1-butenyl group, a 2-butenyl group, a 3-butenyl group, a 1-pentenyl group, a 2-pentenyl group, a 3-pentenyl group, a 3-methyl-1-butenyl group, a 1,3-butadienyl group, an allyl group, a 1-phenylvinyl-1-yl group, a 2-phenylvinyl-1-yl group, a 2,2-diphenylvinyl-1-yl group, a 2-phenyl-2-(naphthyl-1-yl)vinyl-1-yl group, a 2,2-bis(diphenyl-1-yl)vinyl-1-yl group, a stilbenyl group, a styrenyl group, and the like, but are not limited thereto.

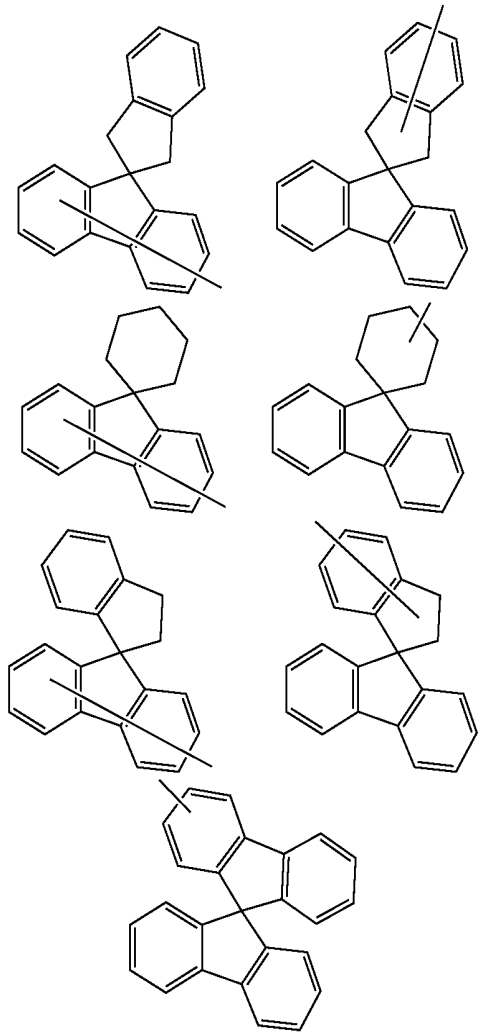
[0071] In the present specification, the alkynyl group comprises a straight-chain or branched-chain having 2 to 60 carbon atoms, and may be additionally substituted with another substituent. The number of carbon atoms of the alkynyl group may be 2 to 60, specifically 2 to 40, and more specifically 2 to 20.

[0072] In the present specification, the cycloalkyl group comprises a monocycle or polycycle having 3 to 60 carbon atoms, and may be additionally substituted with another substituent. Here, the polycycle means a group in which a cycloalkyl group is directly linked to or fused with another cyclic group. Here, another cyclic group may also be a cycloalkyl group, but may also be another kind of cyclic group, for example, a heterocycloalkyl group, an aryl group, a heteroaryl group, and the like. The number of carbon atoms of the cycloalkyl group may be 3 to 60, specifically 3 to 40, and more specifically 5 to 20. Specific examples thereof include a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, a 3-methylcyclopentyl group, a 2,3-dimethylcyclopentyl group, a cyclohexyl group, a 3-methylcyclohexyl group, a 4-methylcyclohexyl group, a 2,3-dimethylcyclohexyl group, a 3,4,5-trimethylcyclohexyl group, a 4-tert-butylcyclohexyl group, a cycloheptyl group, a cyclooctyl group, and the like, but are not limited thereto.

[0073] In the present specification, the heterocycloalkyl group comprises O, S, Se, N, or Si as a heteroatom, includes a monocycle or polycycle having 2 to 60 carbon atoms, and may be additionally substituted with another substituent. Here, the polycycle means a group in which a heterocycloalkyl group is directly linked to or fused with another cyclic group. Here, another cyclic group may also be a heterocycloalkyl group, but may also be another kind of cyclic group, for example, a cycloalkyl group, an aryl group, a heteroaryl group, and the like. The number of carbon atoms of the heterocycloalkyl group may be 2 to 60, specifically 2 to 40, and more specifically 3 to 20.

[0074] In the present specification, the aryl group comprises a monocycle or polycycle having 6 to 60 carbon atoms, and may be additionally substituted with another substituent. Here, the polycycle means a group in which an aryl group is directly linked to or fused with another cyclic group. Here, another cyclic group may also be an aryl group, but may also be another kind of cyclic group, for example, a cycloalkyl group, a heterocycloalkyl group, a heteroaryl group, and the like. The aryl group includes a spiro group. The number of carbon atoms of the aryl group may be 6 to 60, specifically 6 to 40, and more specifically 6 to 25. Specific examples of the aryl group include a phenyl group, a biphenyl group, a triphenyl group, a naphthyl group, an anthryl group, a chrysenyl group, a phenanthrenyl group, a perylenyl group, a fluoranthenyl group, a triphenylenyl group, a phenalenyl group, a pyrenyl group, a tetracenyl group, a pentacenyl group, a fluorenyl group, an indenyl group, an acenaphthylenyl group, a benzofluorenyl group, a spirobifluorenyl group, a 2,3-dihydro-1H-indenyl group, a fused cyclic group thereof, and the like, but are not limited thereto.

[0075] In the present specification, the spiro group is a group comprising a spiro structure, and may have 15 to 60 carbon atoms. For example, the spiro group may include a structure in which a 2,3-dihydro-1H-indene group or a cyclohexane group is spiro-bonded to a fluorenyl group. Specifically, the spiro group may include any one of the groups of the following structural formulae.



[0076] In the present specification, the heteroaryl group comprises S, O, Se, N, or Si as a heteroatom, comprises a monocycle or polycycle having 2 to 60 carbon atoms, and may be additionally substituted with another substituent. Here, the polycycle means a group in which a heteroaryl group is directly linked to or fused with another cyclic group. Here, another cyclic group may also be a heteroaryl

group, but may also be another kind of cyclic group, for example, a cycloalkyl group, a heterocycloalkyl group, an aryl group, and the like. The number of carbon atoms of the heteroaryl group may be 2 to 60, specifically 2 to 40, and more specifically 3 to 25. Specific examples of the heteroaryl group comprise a pyridyl group, a pyrrolyl group, a pyrimidyl group, a pyridazinyl group, a furanyl group, a thiophene group, an imidazolyl group, a pyrazolyl group, an oxazolyl group, an isoxazolyl group, a thiazolyl group, an isothiazolyl group, a triazolyl group, a furazanyl group, an oxadiazolyl group, a thiadiazolyl group, a dithiazolyl group, a tetrazolyl group, a pyranyl group, a thiopyranyl group, a diazinyl group, an oxazinyl group, a thiazinyl group, a dioxynyl group, a triazinyl group, a tetrazinyl group, a quinolyl group, an isoquinolyl group, a quinazolinyl group, an isoquinazolinyl group, a quinozolilyl group, a naphthyridyl group, an acridinyl group, a phenanthridinyl group, an imidazopyridinyl group, a diaza naphthalenyl group, a triazaindene group, an indolyl group, an indolizinyl group, a benzothiazolyl group, a benzoxazolyl group, a benzimidazolyl group, a benzothiophene group, a benzofuran group, a dibenzothiophene group, a dibenzofuran group, a carbazolyl group, a benzocarbazolyl group, a dibenzocarbazolyl group, a phenazinyl group, a dibenzosilole group, spirobi (dibenzosilole), a dihydrophenazinyl group, a phenoxazinyl group, a phenanthridyl group, an imidazopyridinyl group, a thienyl group, an indolo[2,3-a]carbazolyl group, an indolo[2,3-b] carbazolyl group, an indolinyl group, a 10,11-dihydrodibenzo[b,f]azepin group, a 9,10-dihydroacridinyl group, a phenanthrazinyl group, a phenothiazinyl group, a phthalazinyl group, a naphthylidinyl group, a phenanthrolinyl group, a benzo[c][1,2,5]thiadiazolyl group, a 5,10-dihydrodibenzo [b,e][1,4]azasilinyl, a pyrazolo[1,5-c]quinazolinyl group, a pyrido[1,2-b]indazolyl group, a pyrido[1,2-a]imidazo[1,2-e] indolinyl group, a 5,11-dihydroindeno[1,2-b]carbazolyl group, and the like, but are not limited thereto.

[0077] In the present specification, the amine group may be selected from the group consisting of a monoalkylamine group; a monoarylamine group; a monoheteroarylamine group; —NH_2; a dialkylamine group; a diarylamine group; a diheteroarylamine group; an alkylarylamine group; an alkylheteroarylamine group; and an arylheteroarylamine group, and the number of carbon atoms thereof is not particularly limited, but is preferably 1 to 30. Specific examples of the amine group comprise a methylamine group, a dimethylamine group, an ethylamine group, a diethylamine group, a phenylamine group, a naphthylamine group, a biphenylamine group, a dibiphenylamine group, an anthracenylamine group, a 9-methyl-anthracenylamine group, a diphenylamine group, a phenylnaphthylamine group, a ditolylamine group, a phenyltolylamine group, a triphenylamine group, a biphenylnaphthylamine group, a phenylbiphenylamine group, a biphenylfluorenylamine group, a phenyltriphenylenylamine group, a biphenyltriphenylenylamine group, and the like, but are not limited thereto.

[0078] In the present specification, the arylene group means that there are two bonding positions in an aryl group, that is, a divalent group. The above-described description on the aryl group may be applied to the arylene group, except for a divalent arylene group. Further, the heteroarylene group means that there are two bonding positions in a heteroaryl group, that is, a divalent group. The above-described description on the heteroaryl group may be applied to the heteroarylene group, except for a divalent heteroarylene group.

[0079] According to an exemplary embodiment of the present application, Chemical Formula 1 may be represented by any one of the following compounds, but is not limited thereto.

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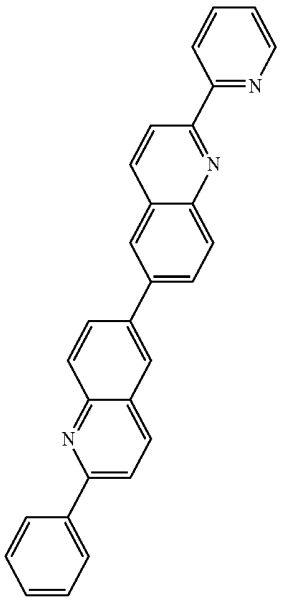

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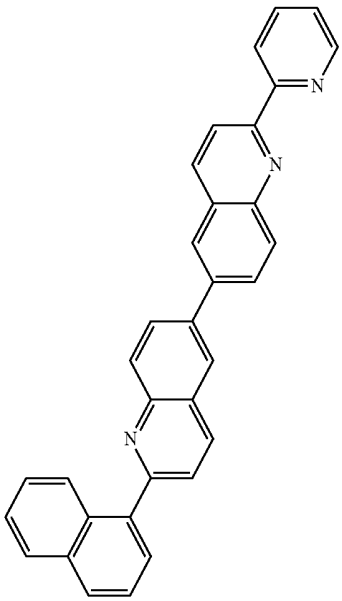

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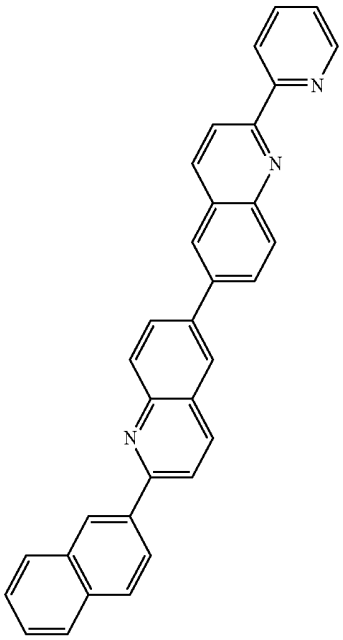

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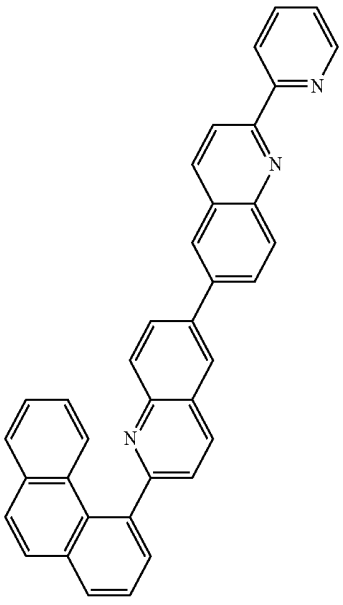

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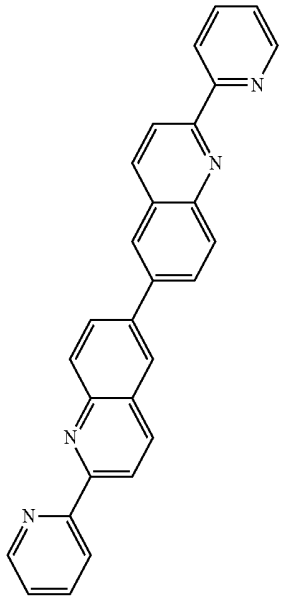

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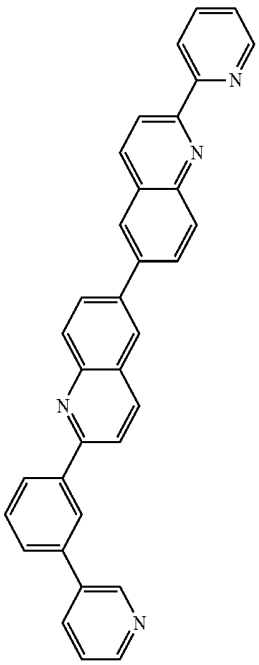

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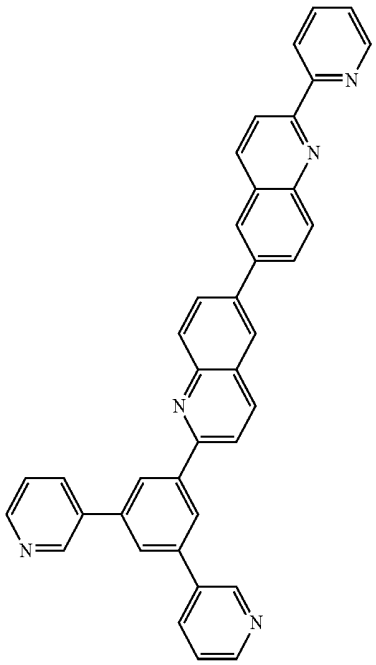

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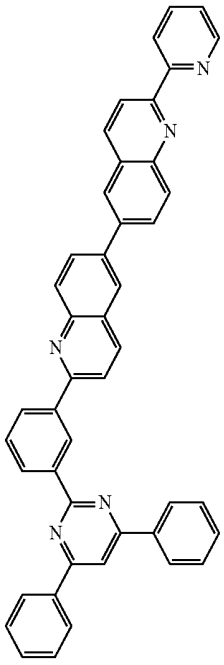

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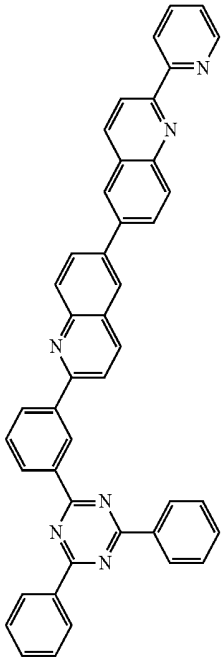

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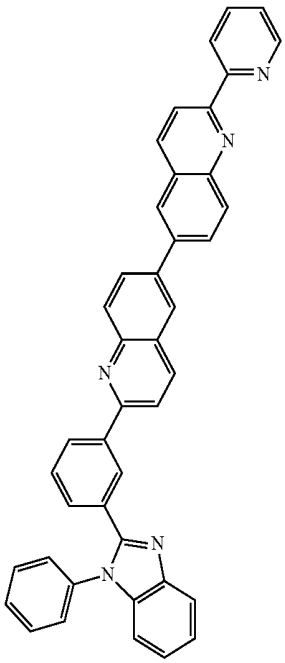

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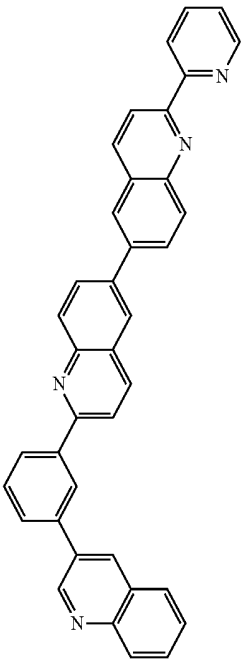

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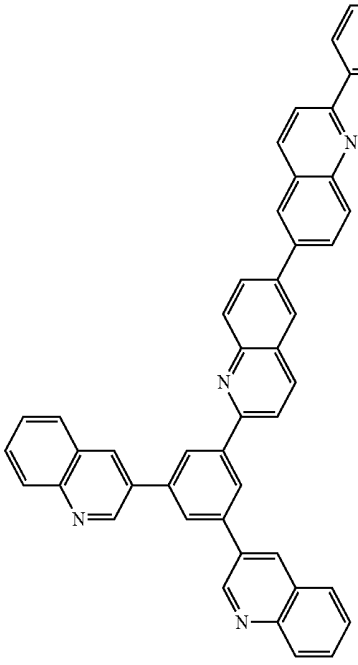

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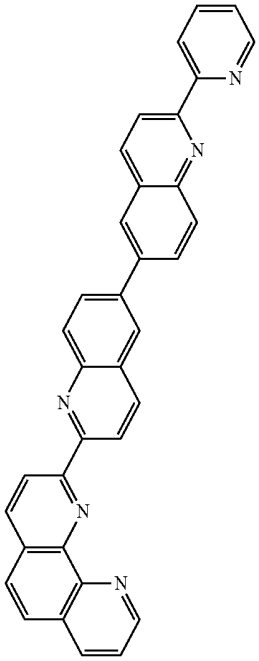

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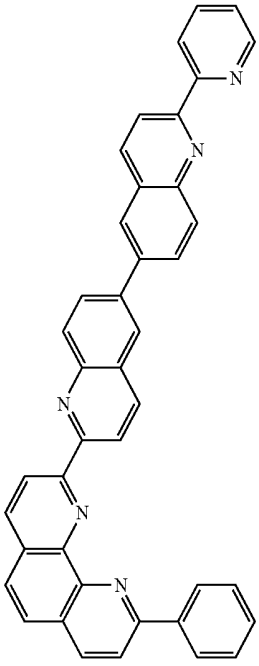

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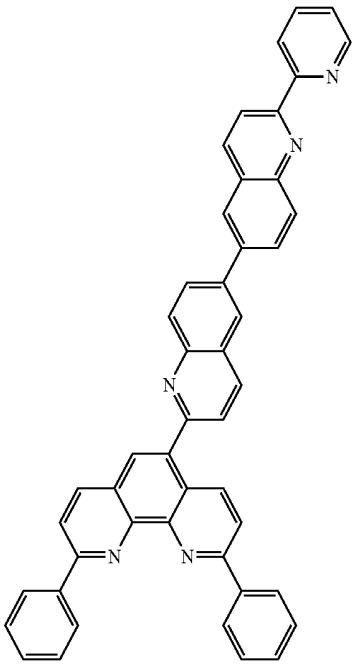

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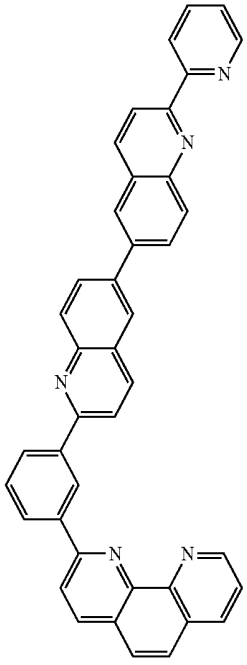

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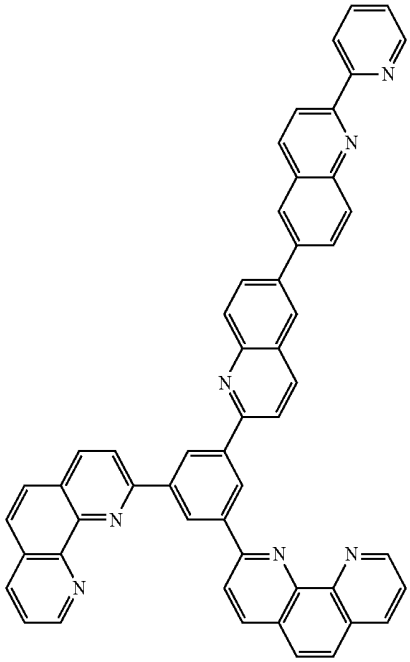

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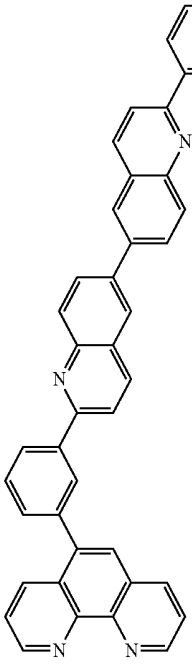

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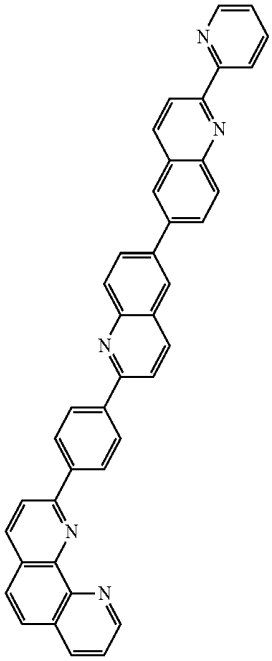

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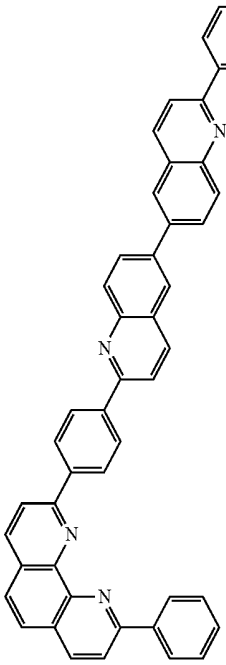

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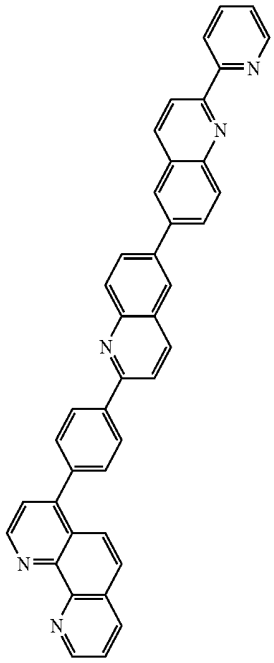

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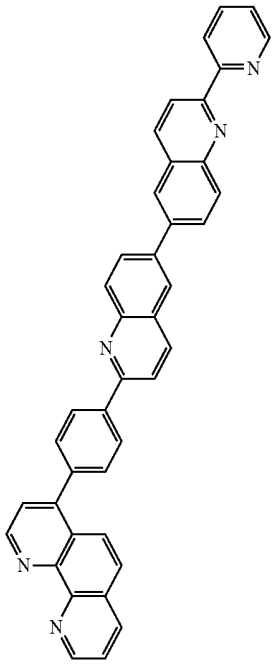

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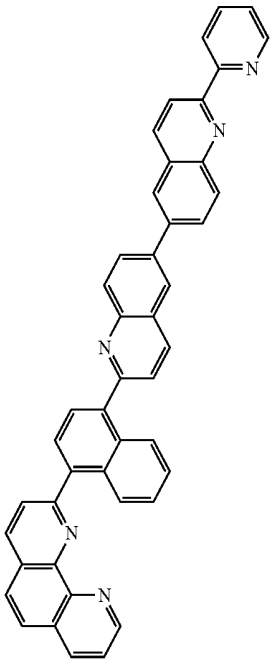

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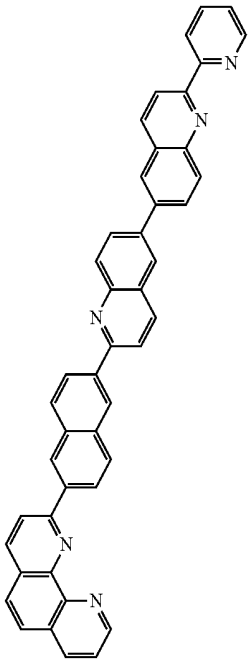

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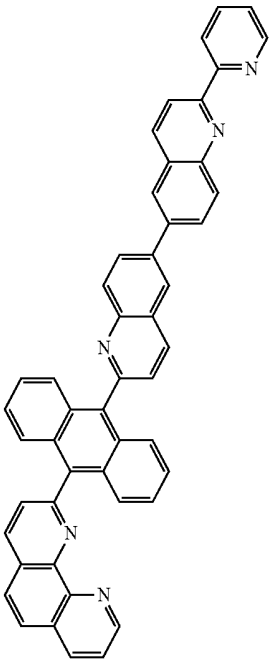

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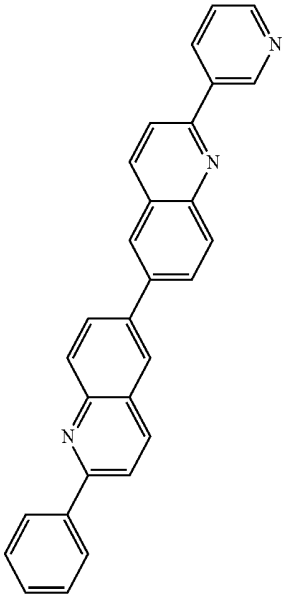

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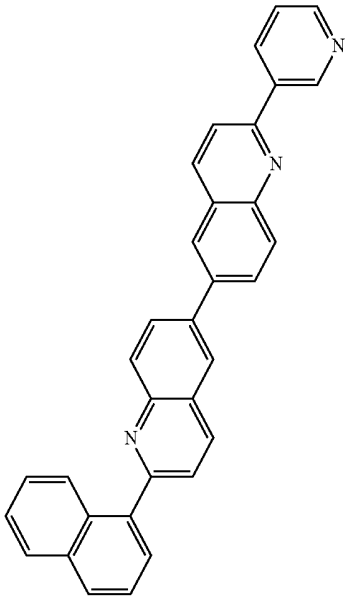

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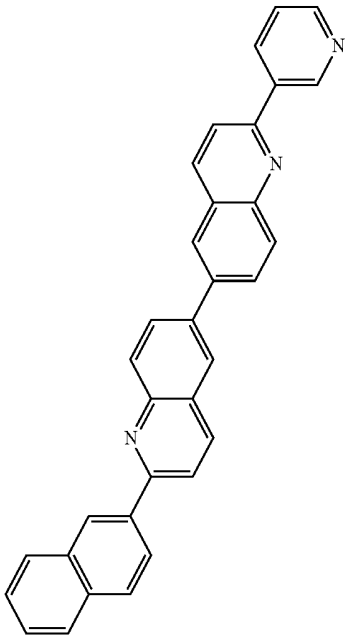

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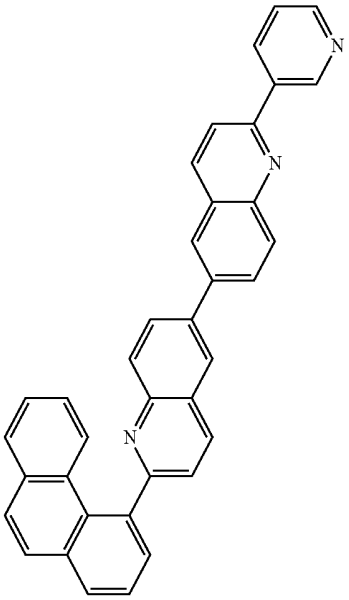

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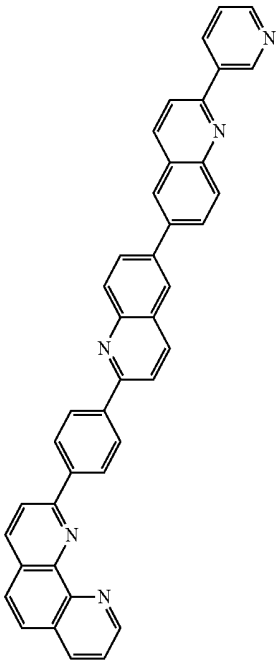

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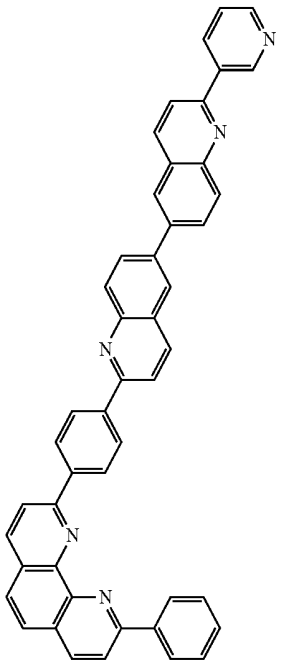

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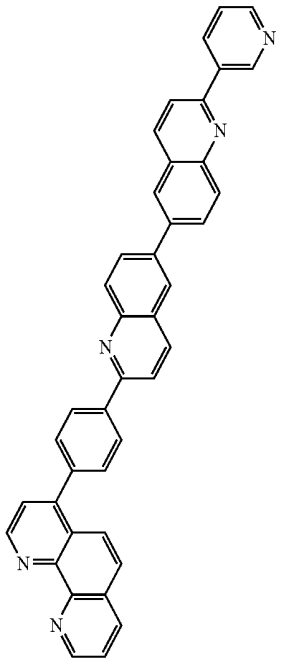

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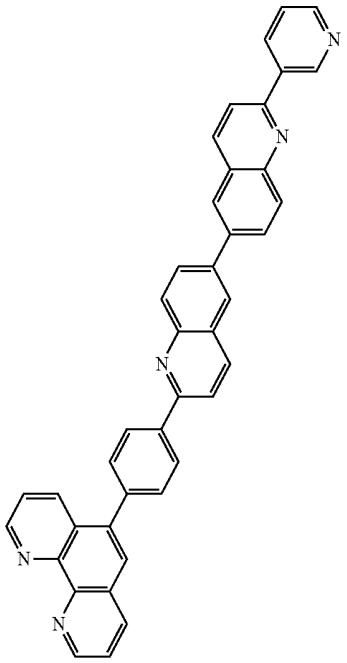

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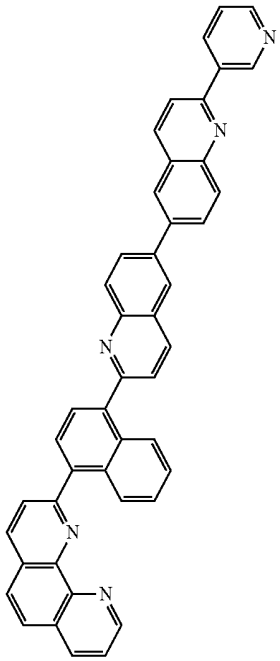

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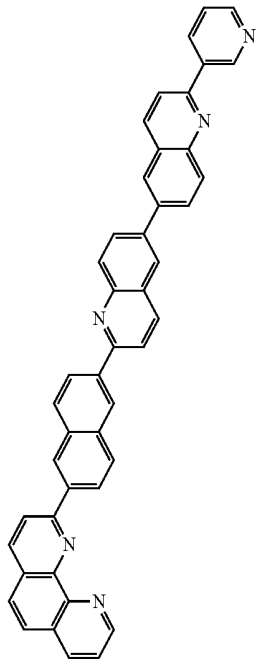

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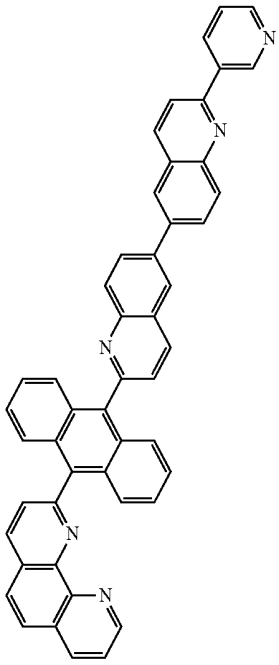

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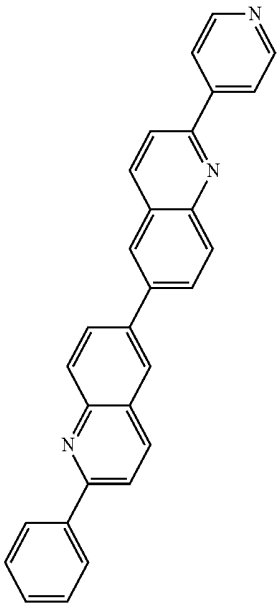

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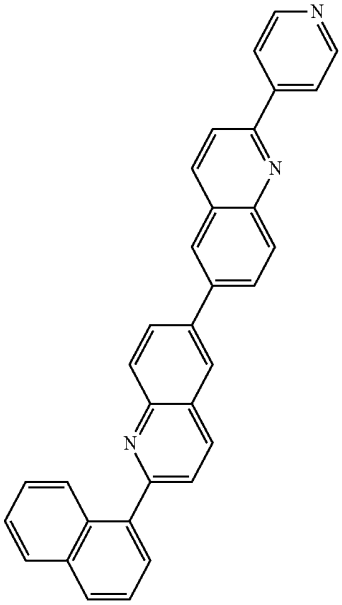

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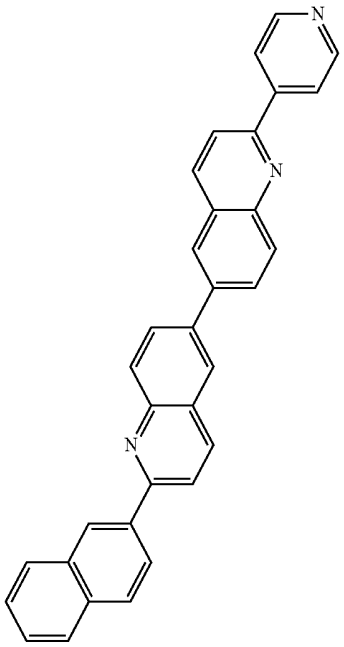

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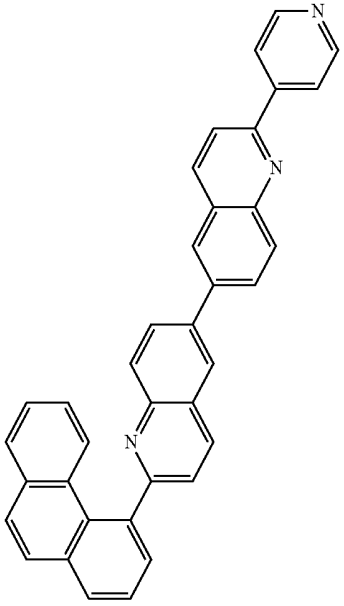

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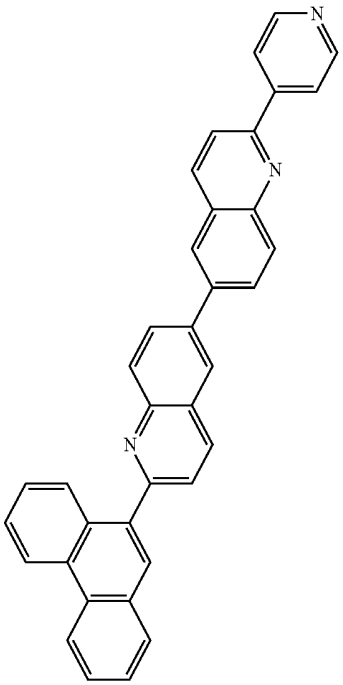

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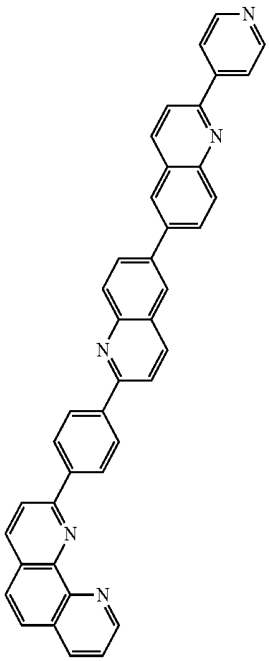

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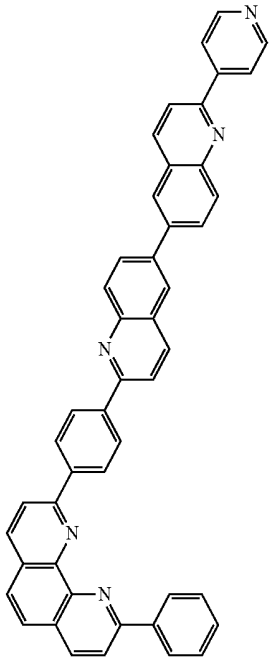

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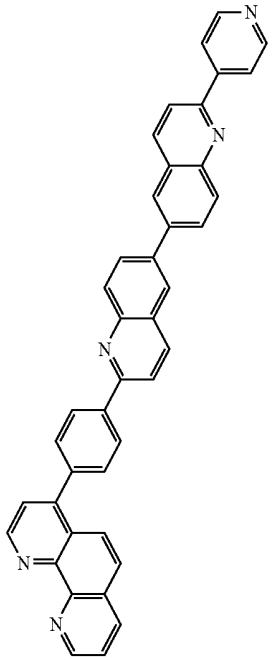

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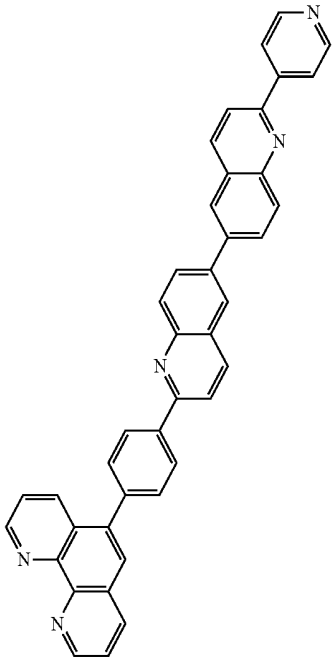

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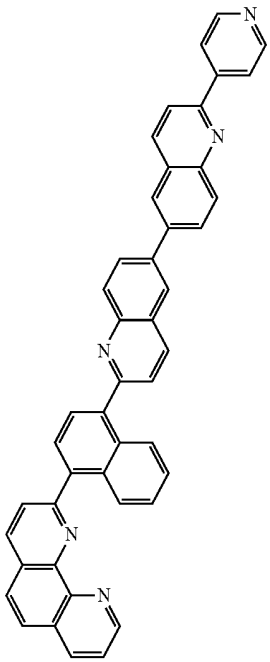

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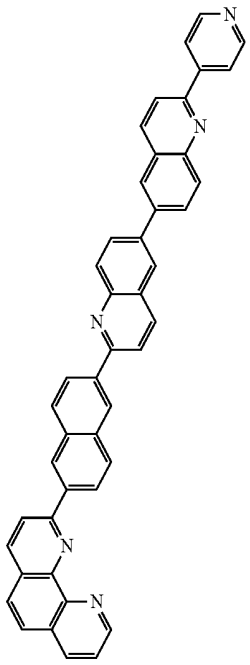

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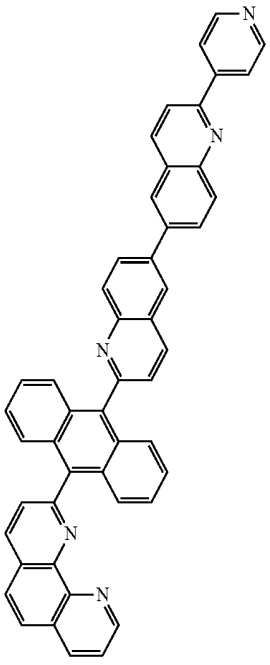

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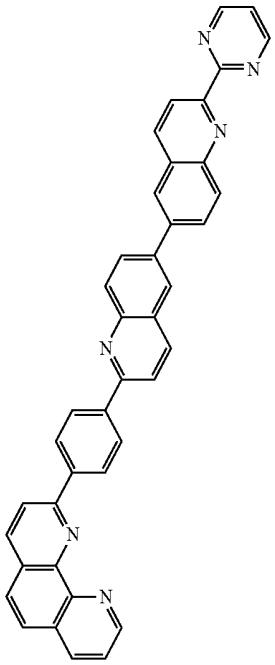

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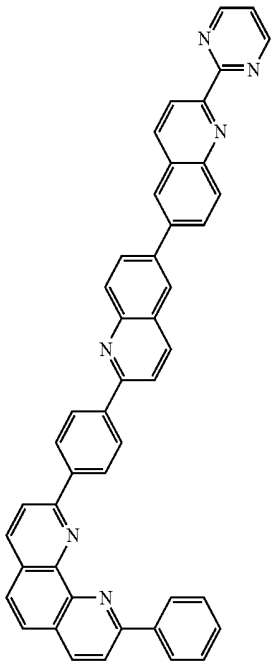

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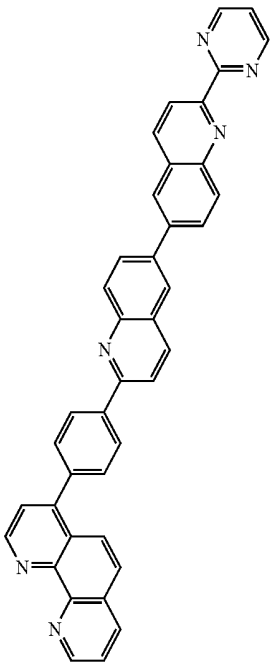

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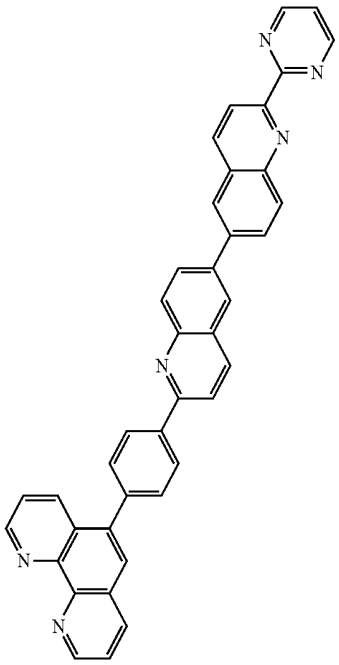

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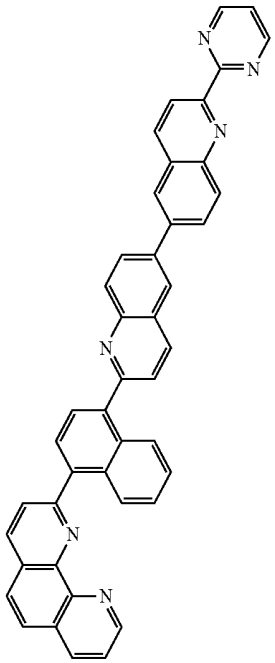

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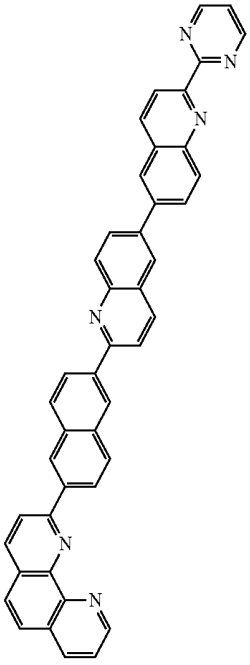

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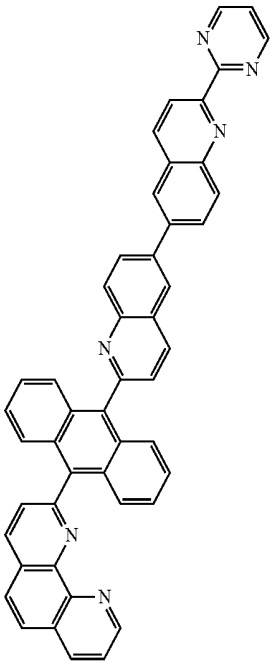

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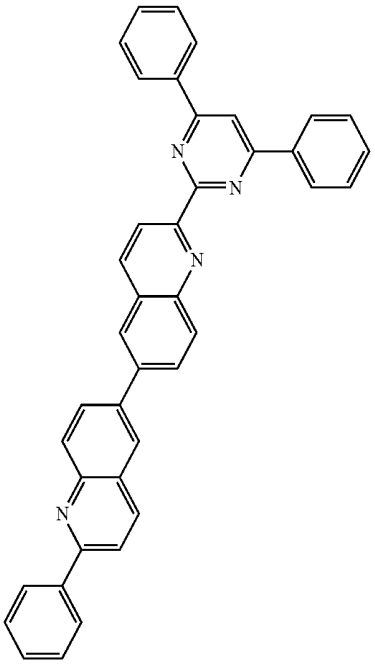

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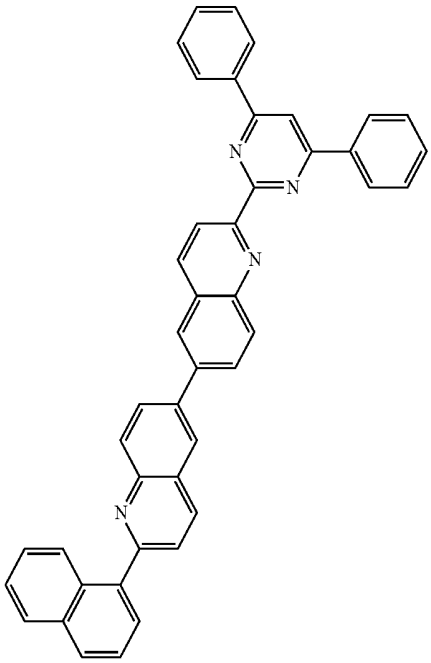

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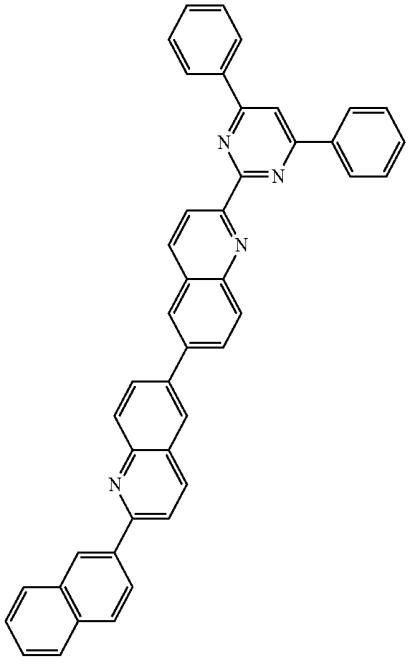

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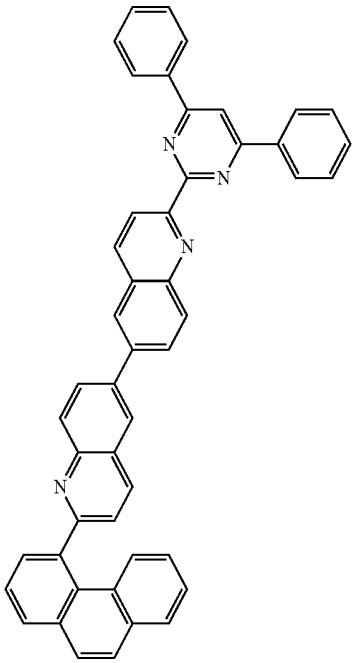

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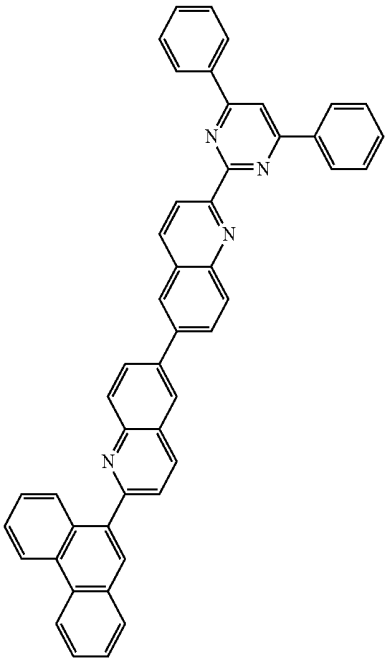

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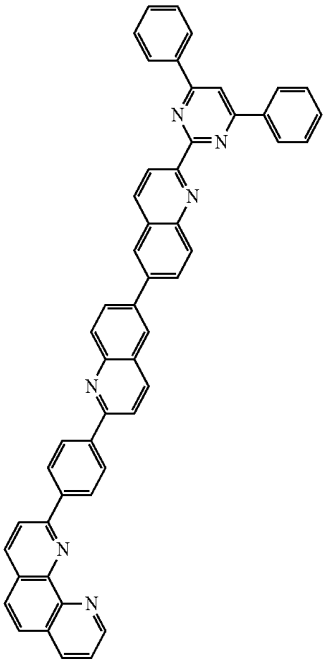

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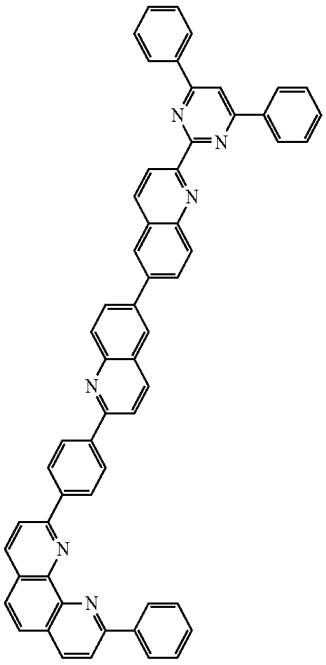

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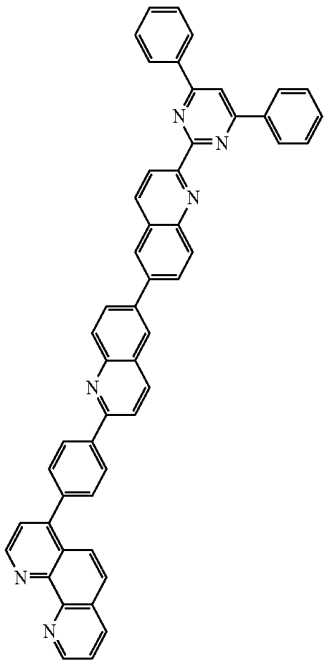

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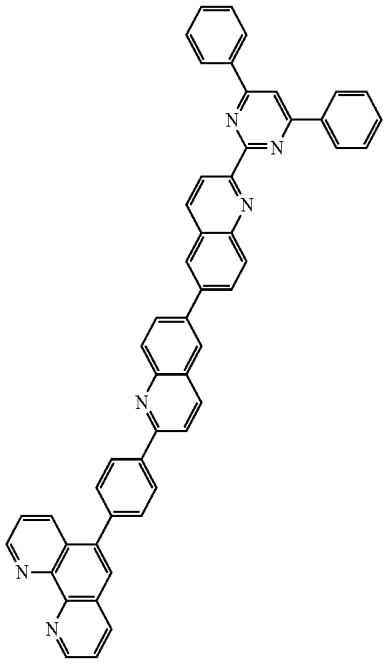

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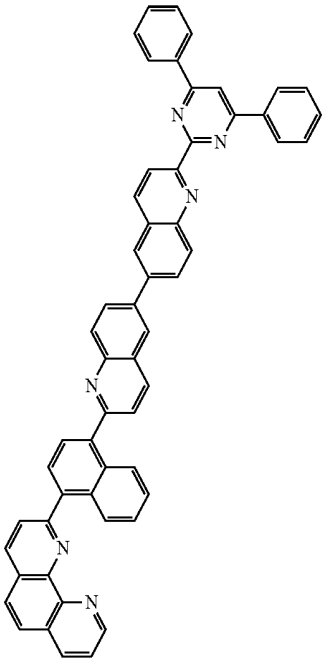

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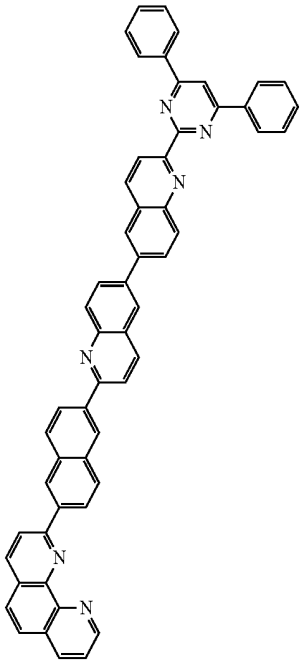

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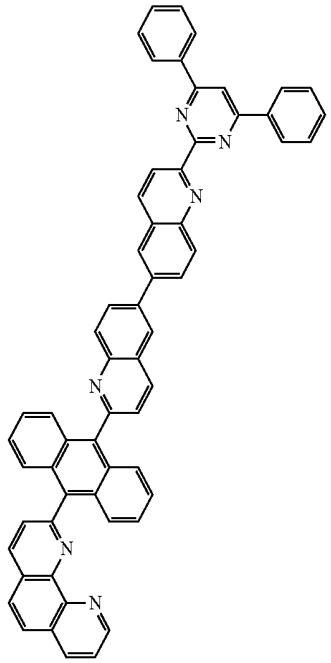

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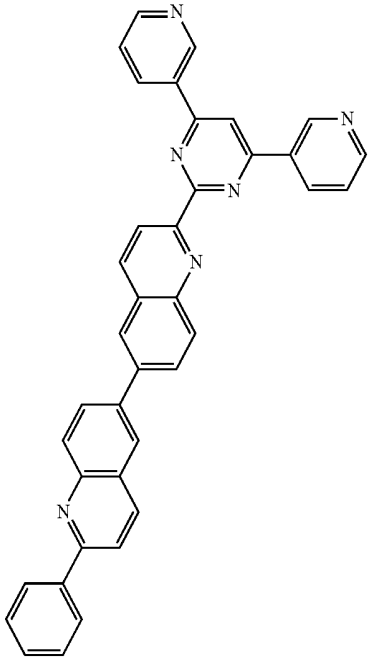

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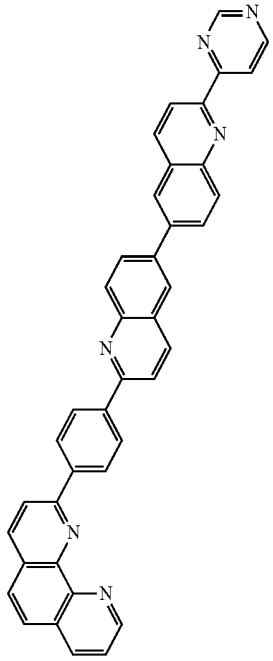

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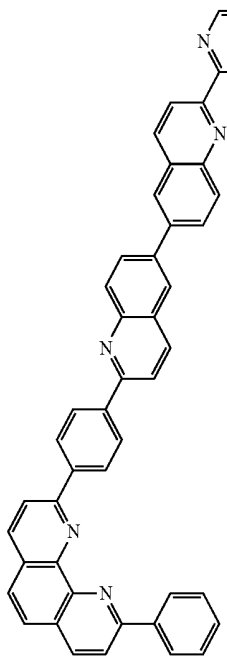

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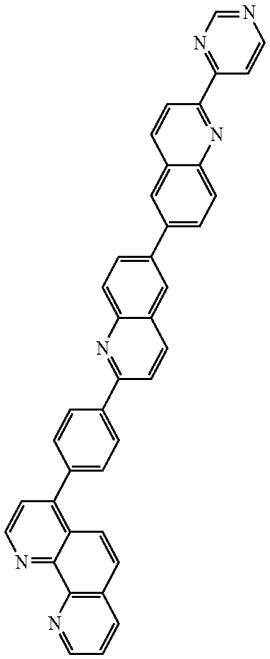

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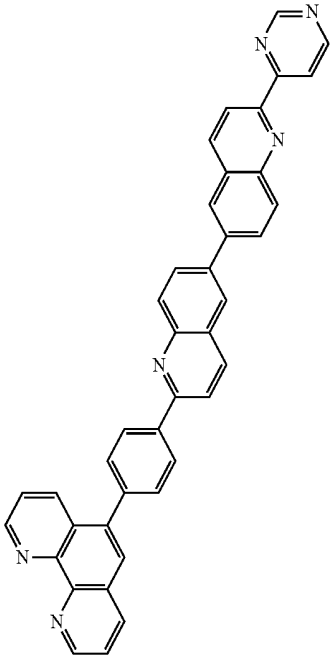

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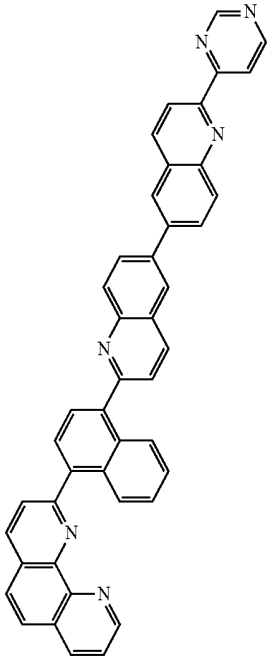

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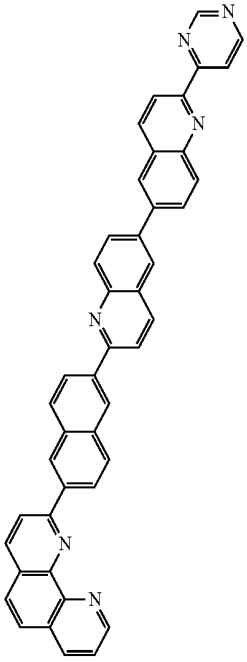

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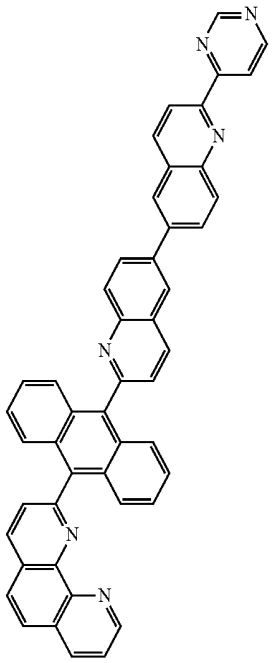

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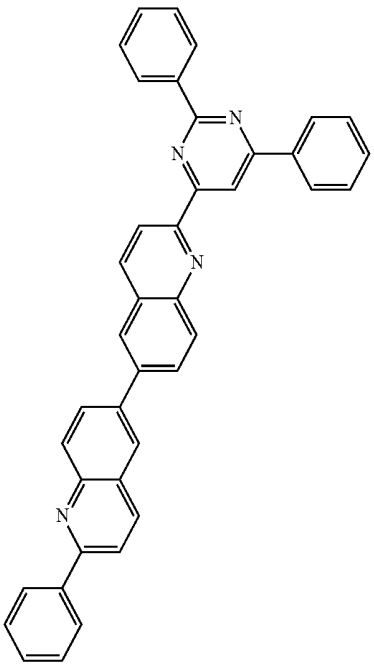

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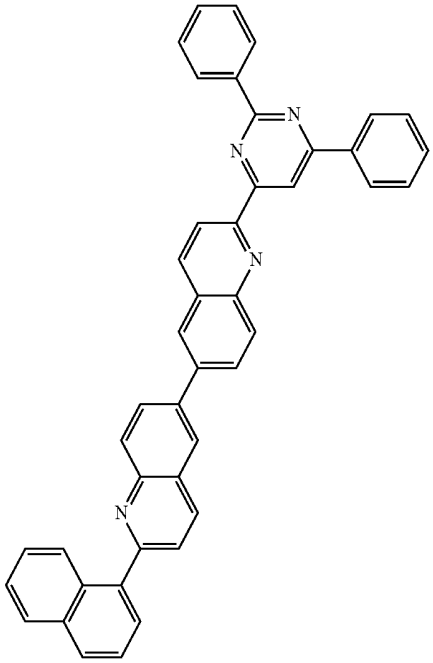

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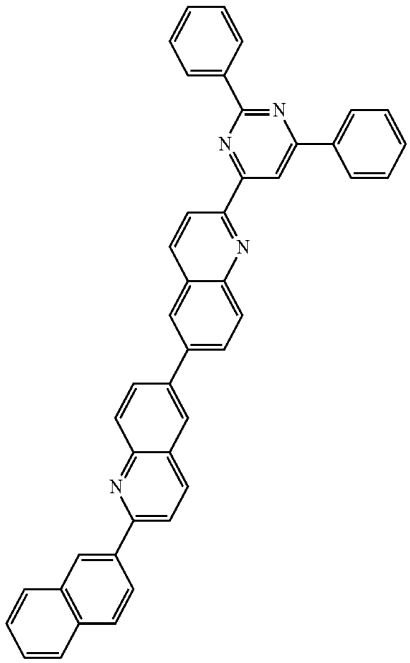

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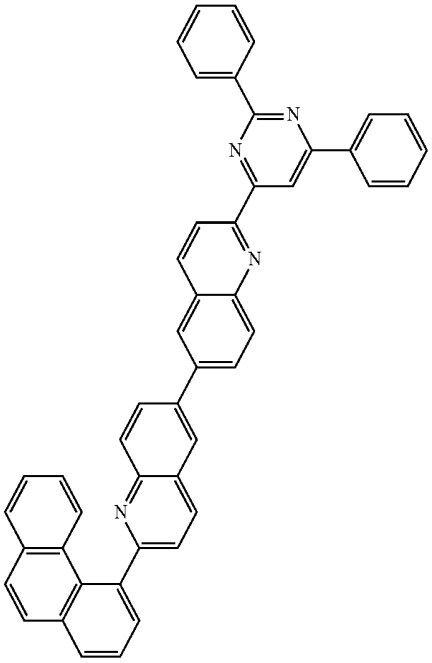

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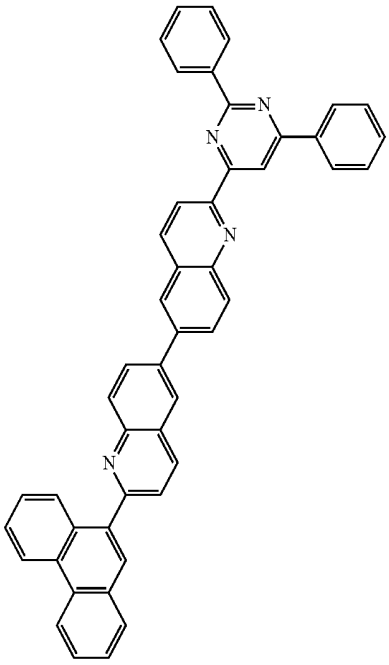

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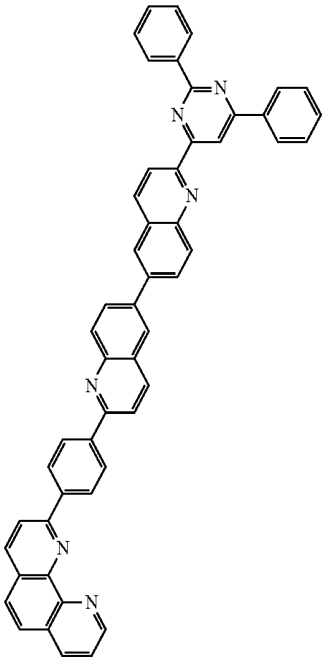

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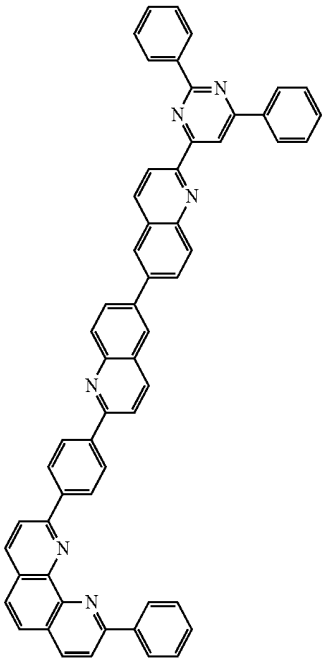

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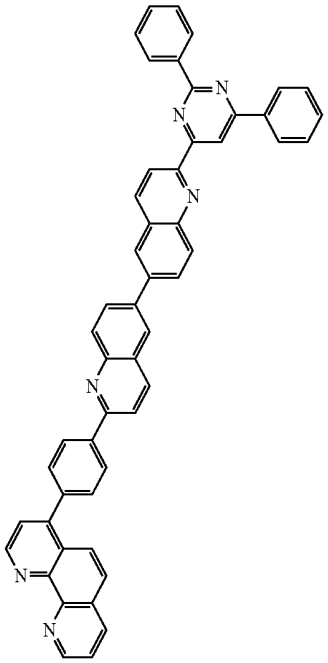

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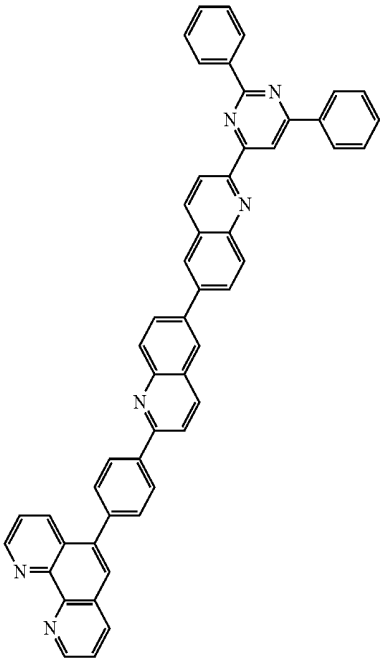

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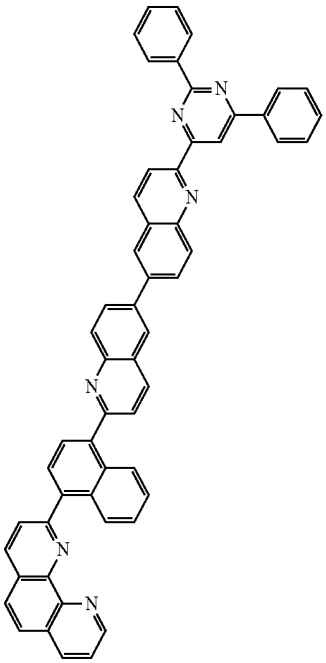

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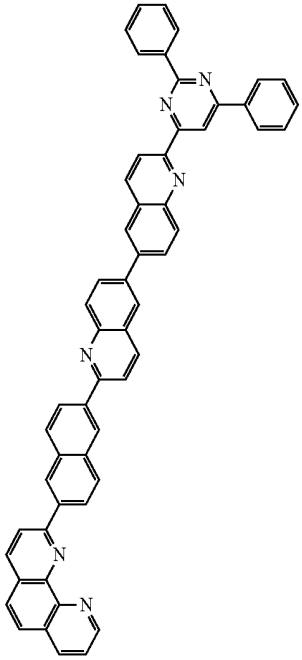

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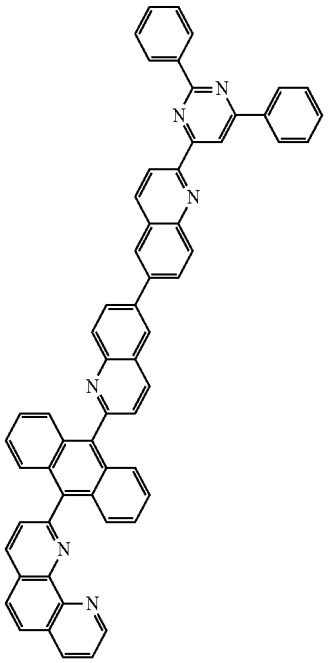

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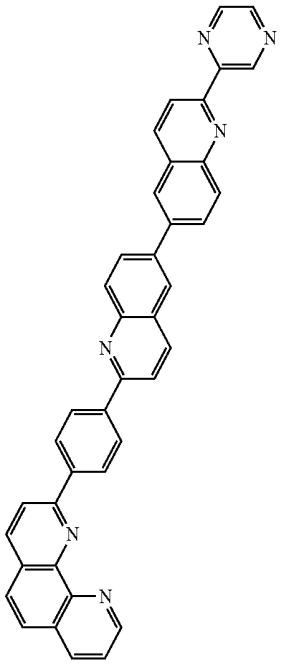

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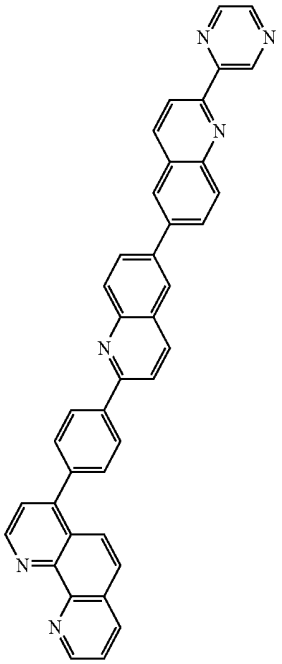

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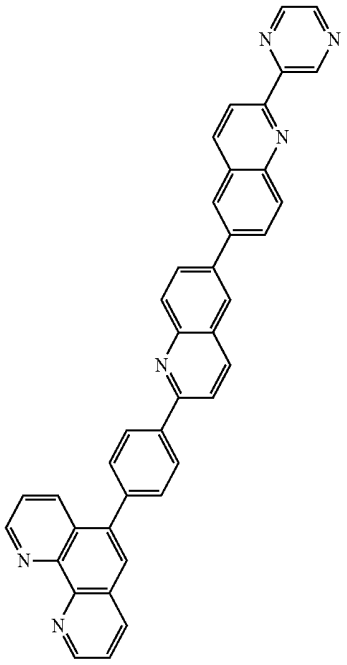

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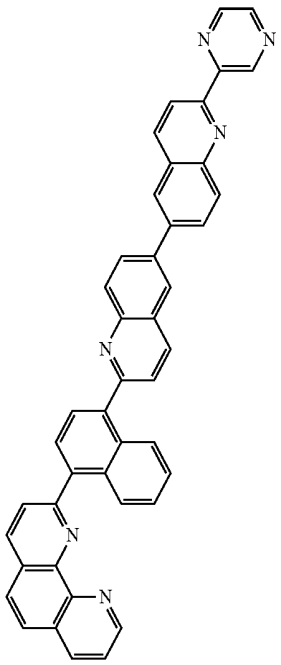

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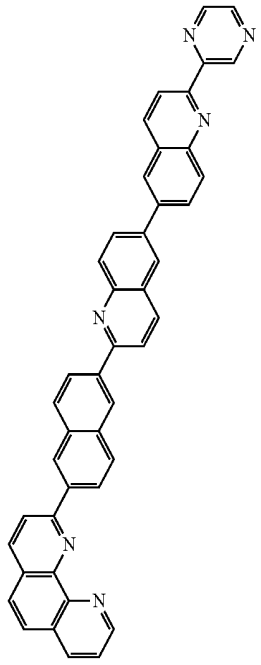

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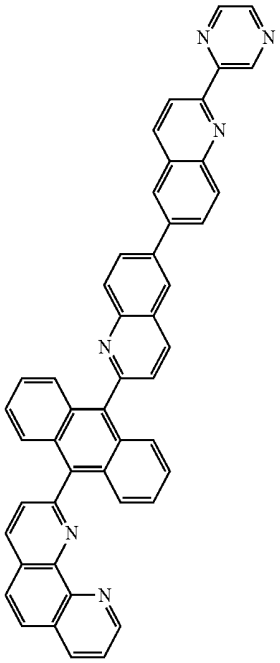

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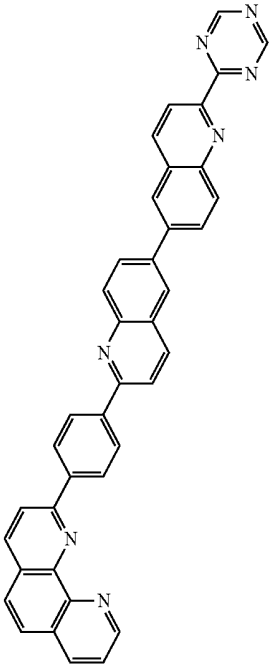

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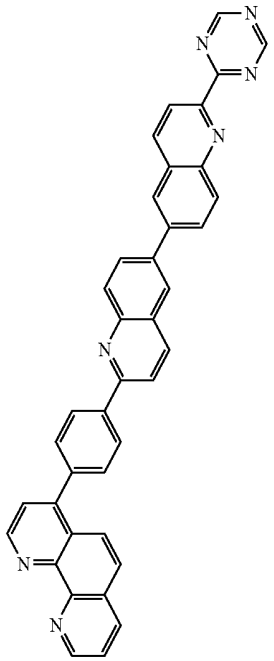

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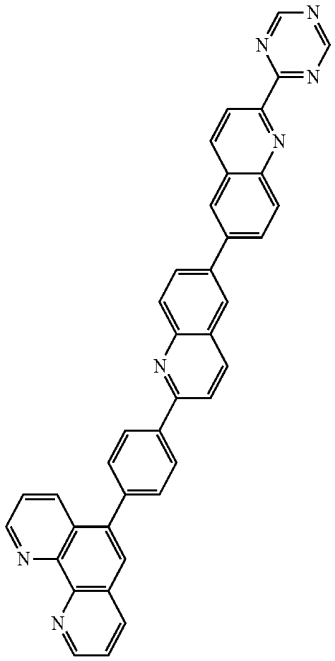

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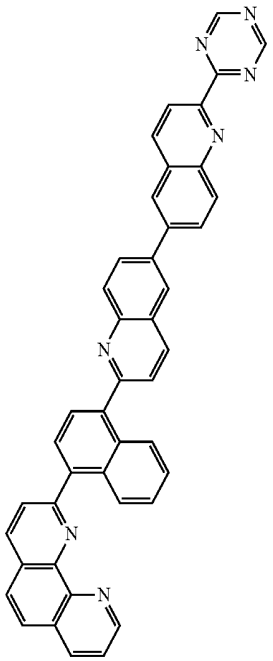

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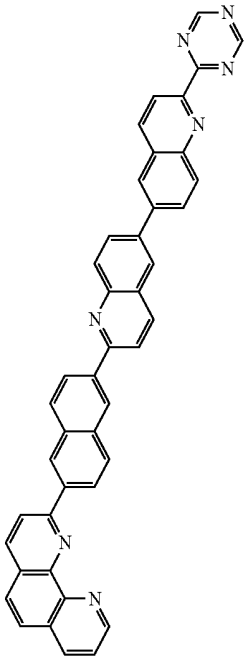

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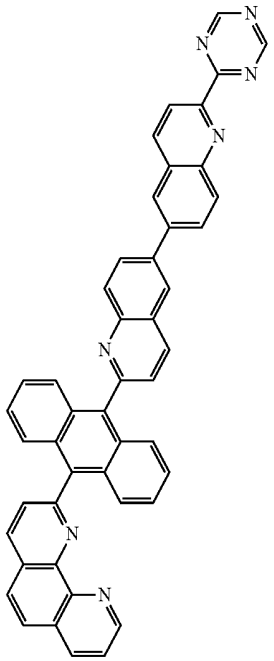

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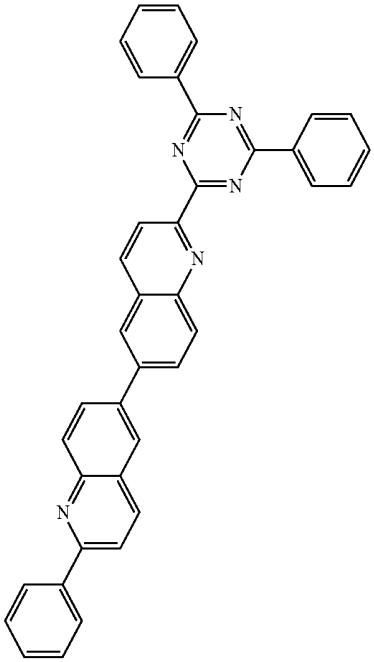

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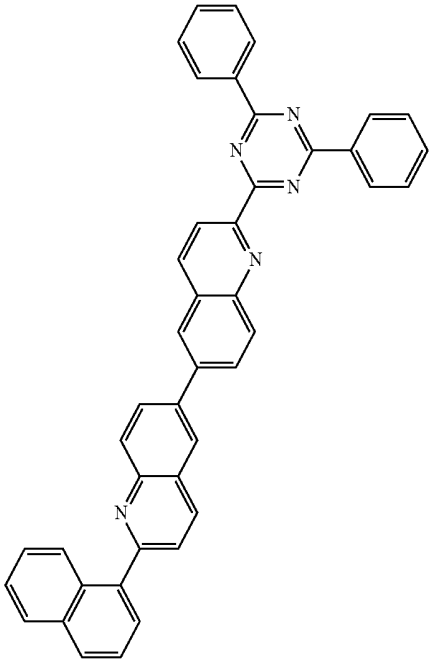

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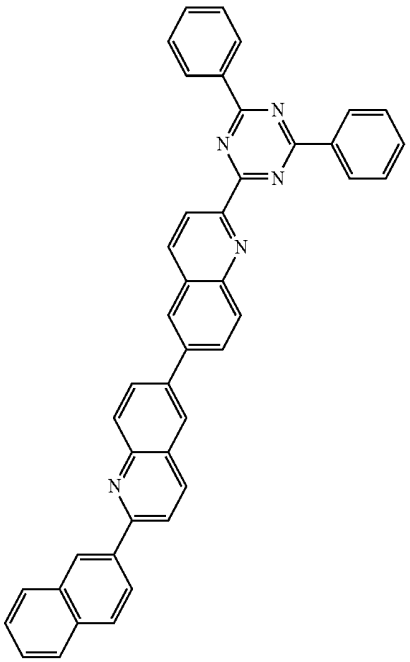

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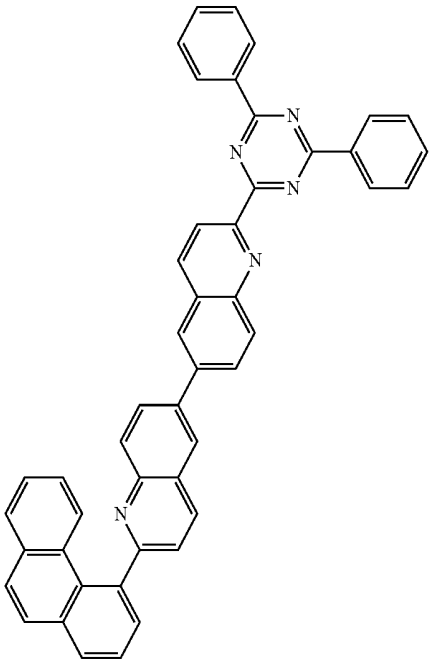

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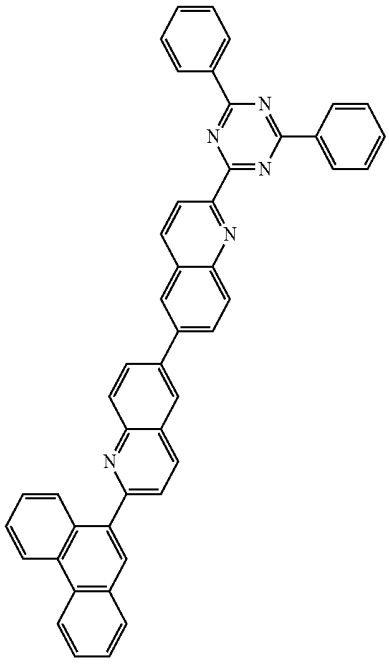

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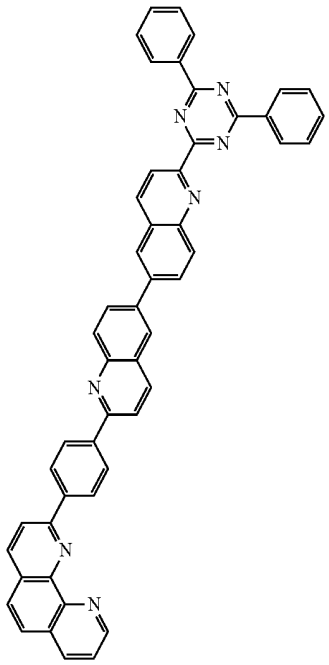

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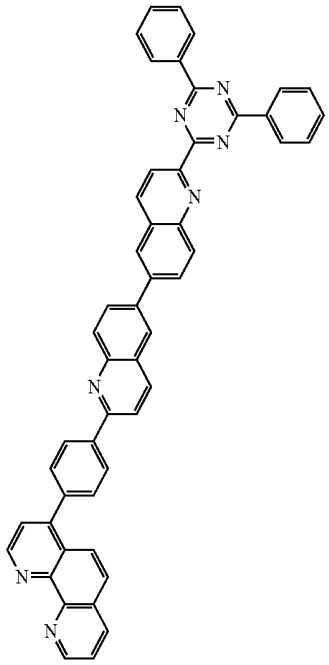

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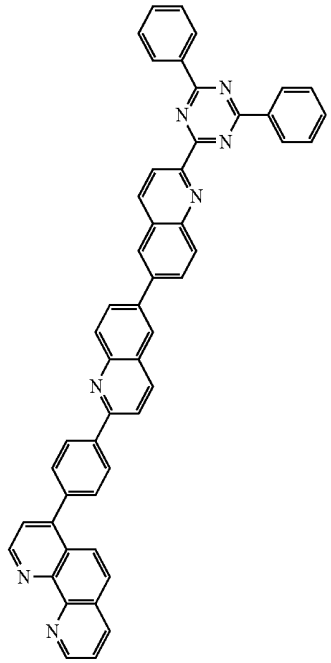

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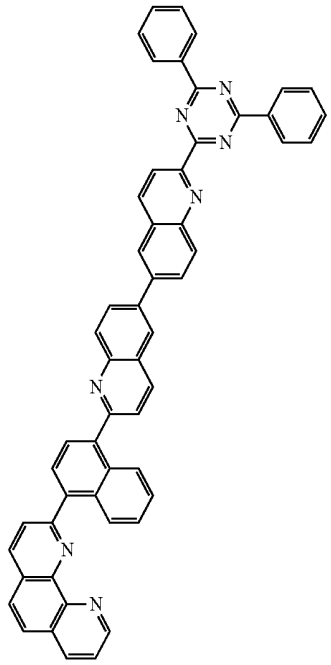

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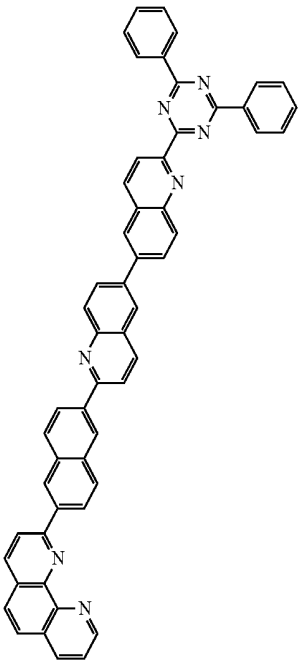

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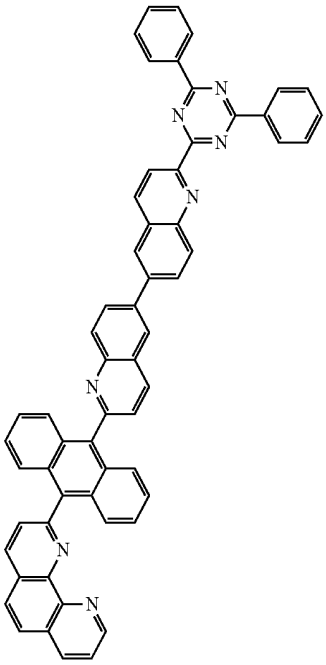

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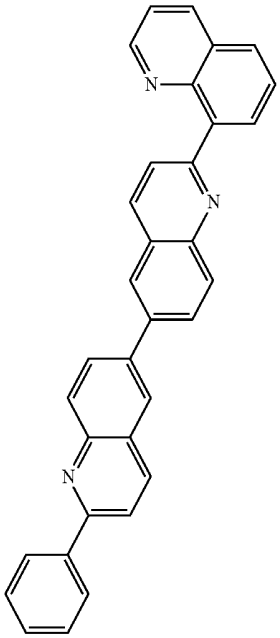

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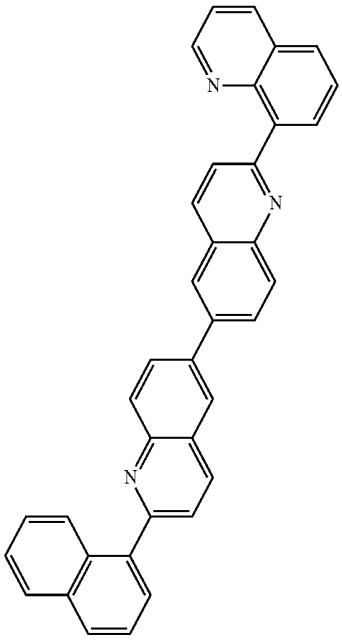

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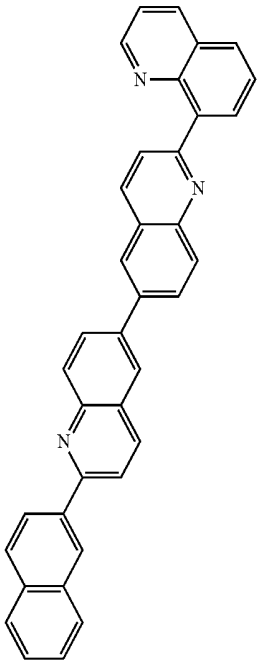

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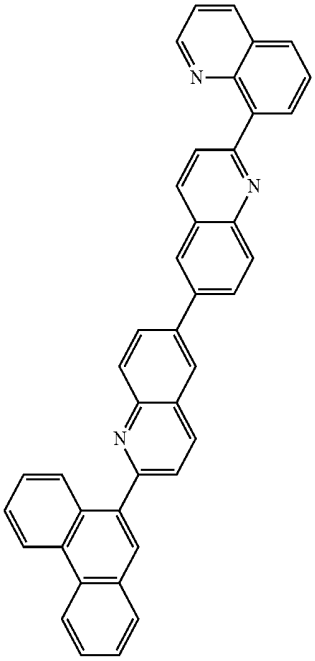

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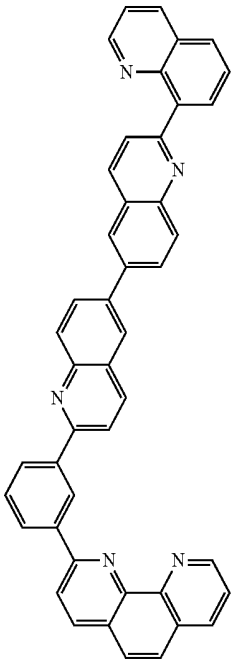

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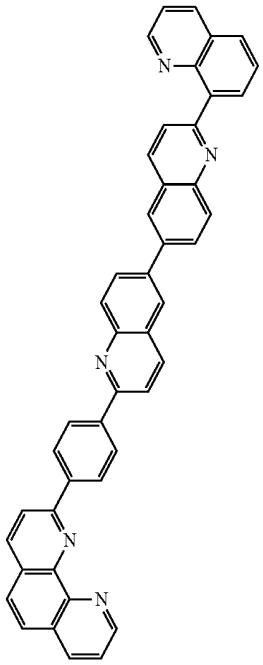

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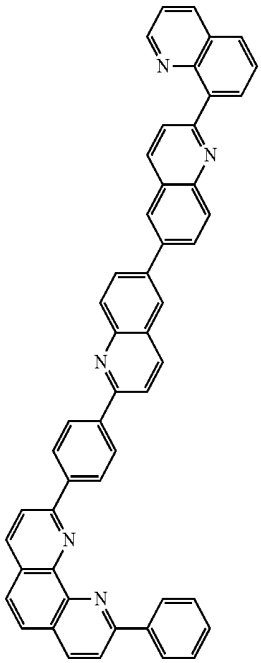

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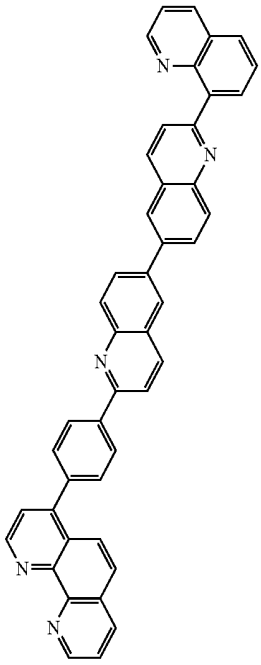

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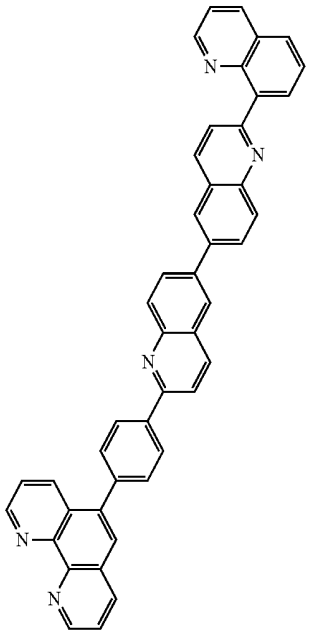

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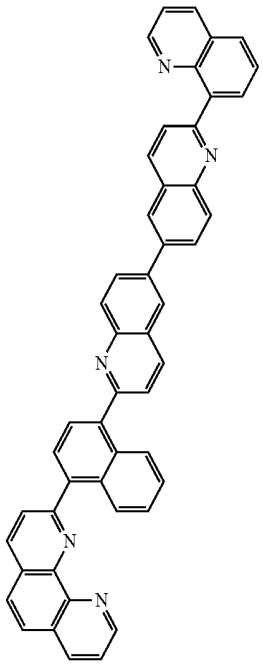

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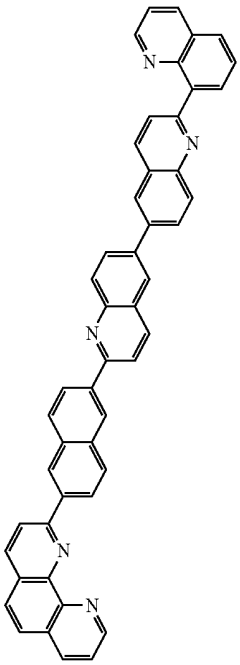

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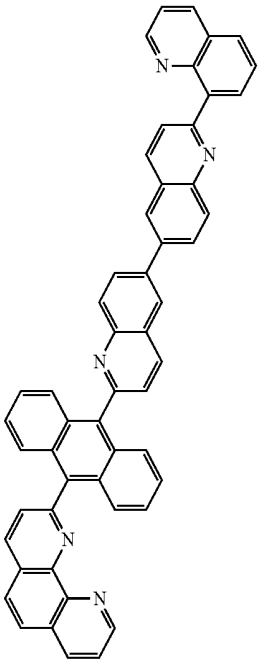

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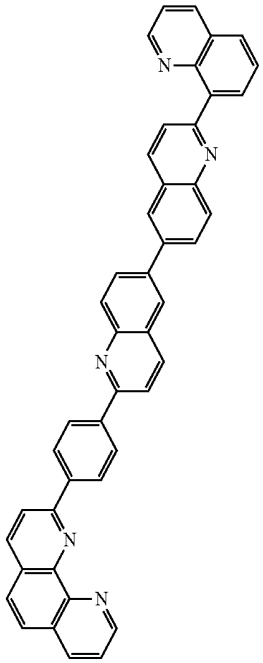

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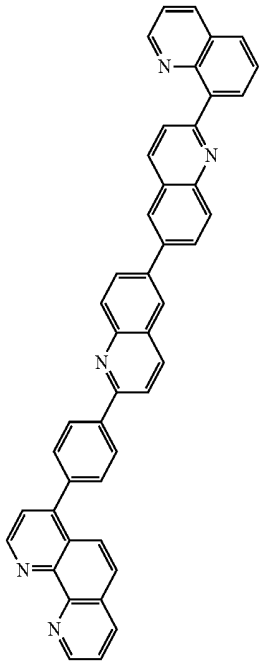

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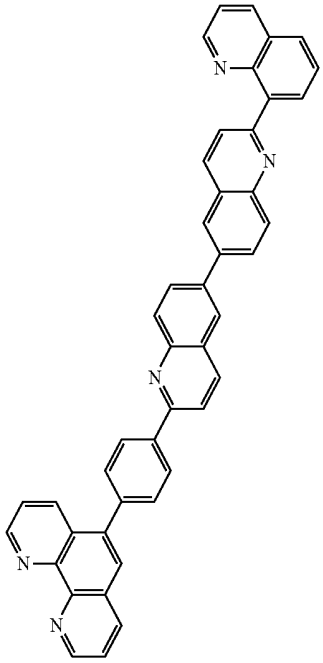

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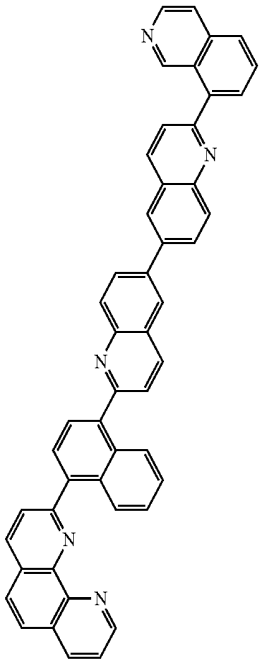

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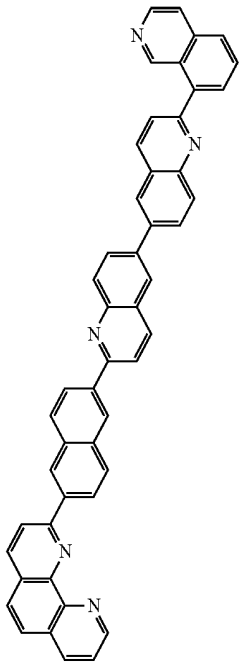

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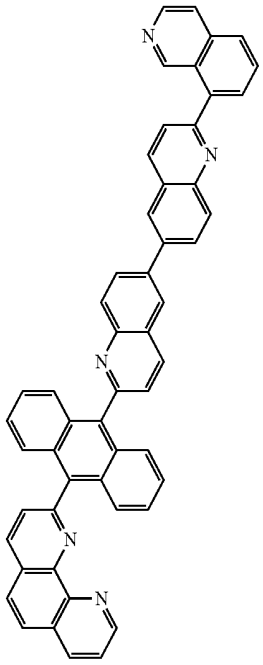

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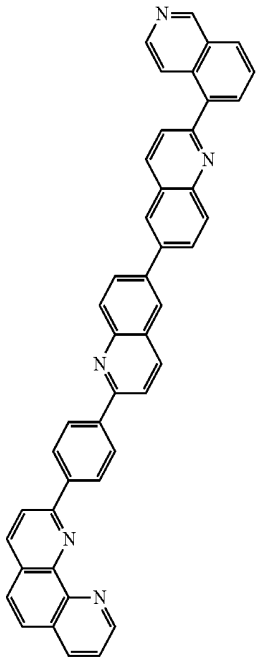

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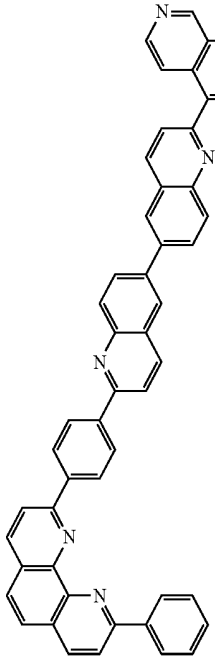

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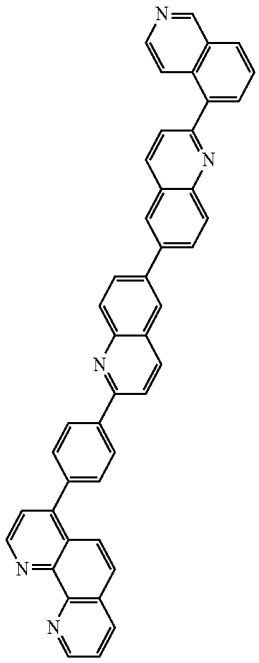

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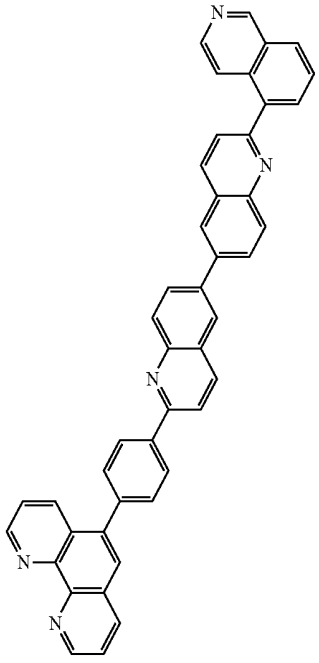

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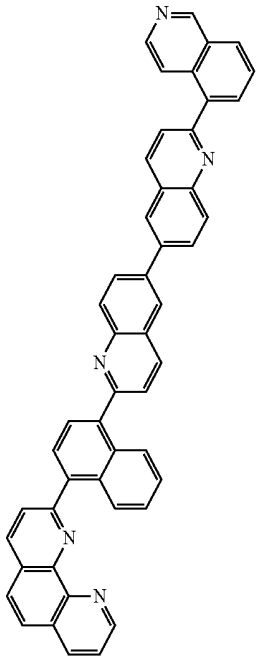

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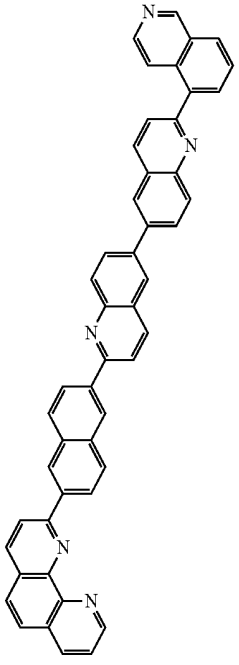

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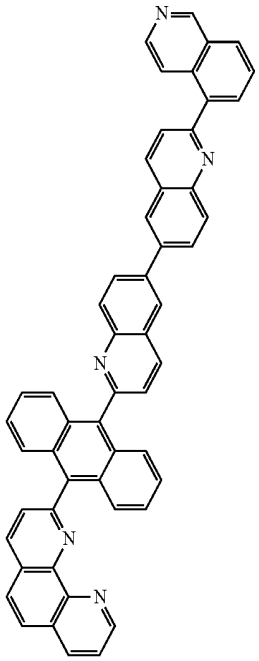

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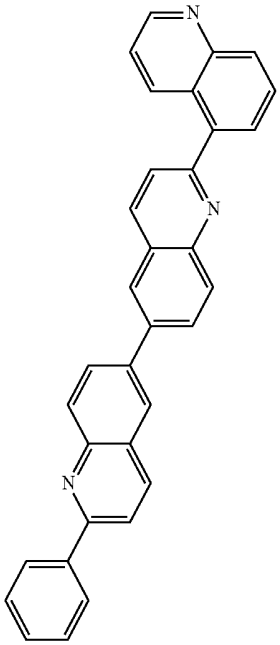

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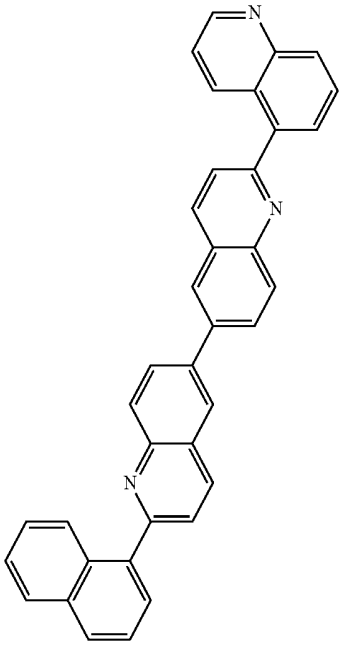

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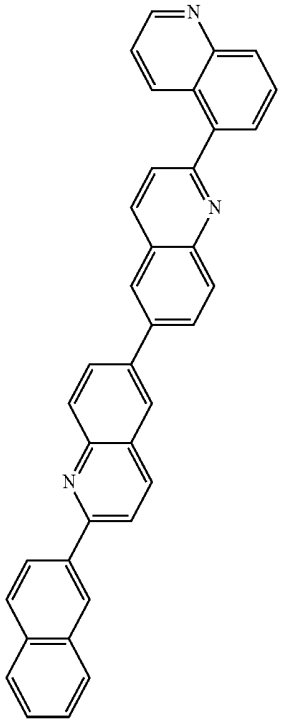

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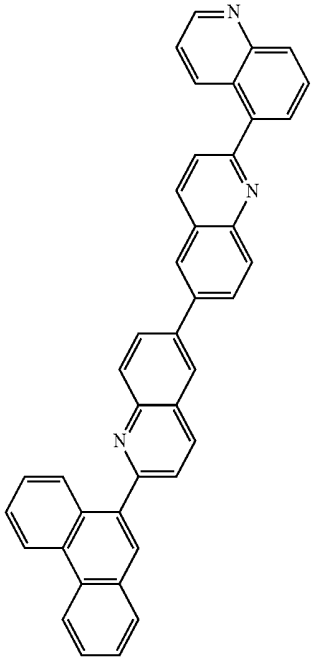

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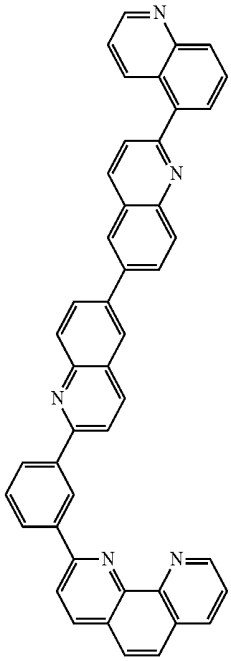

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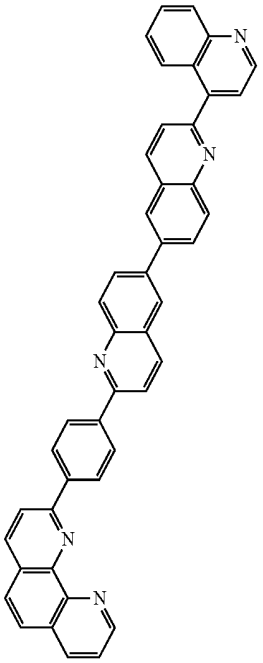

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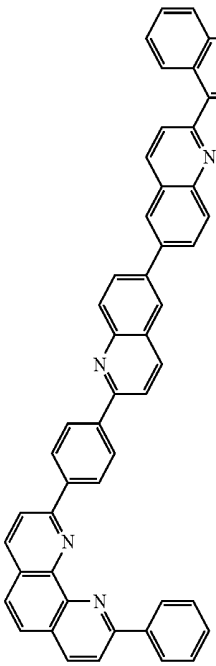

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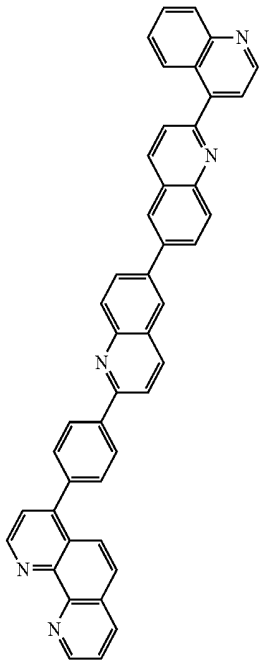

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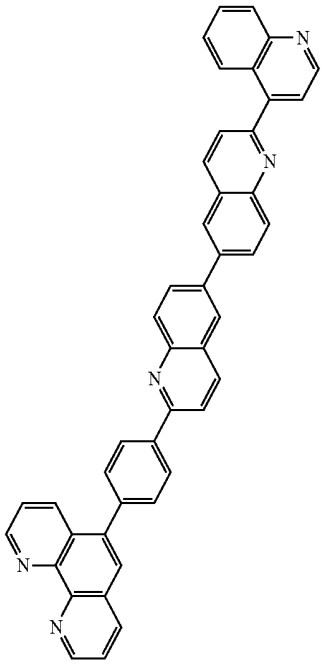

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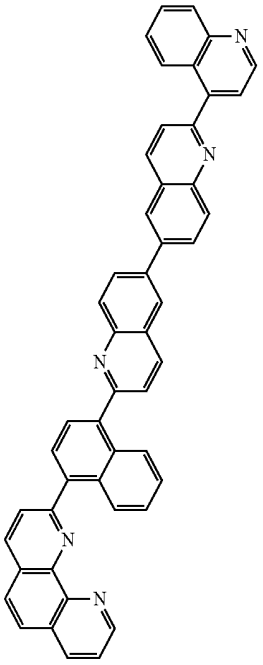

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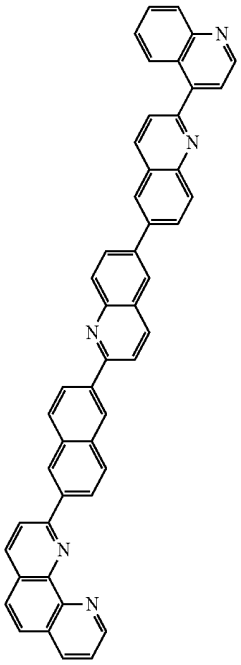

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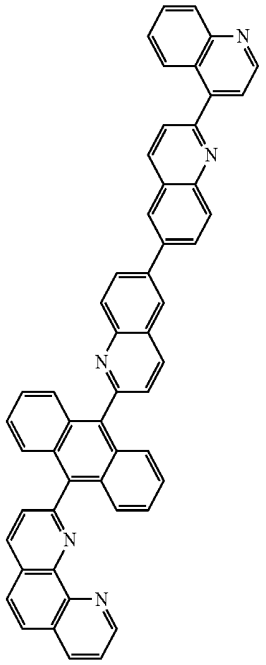

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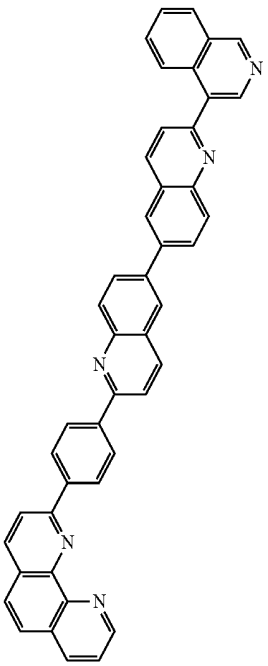

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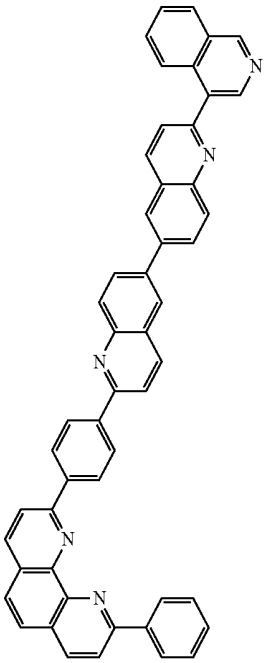

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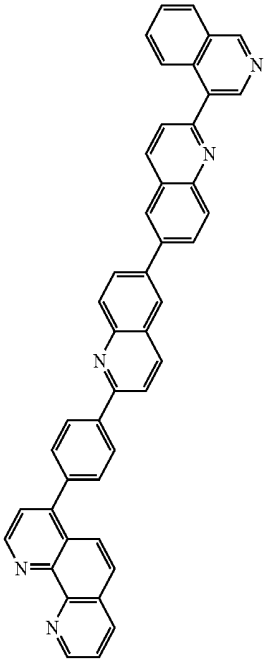

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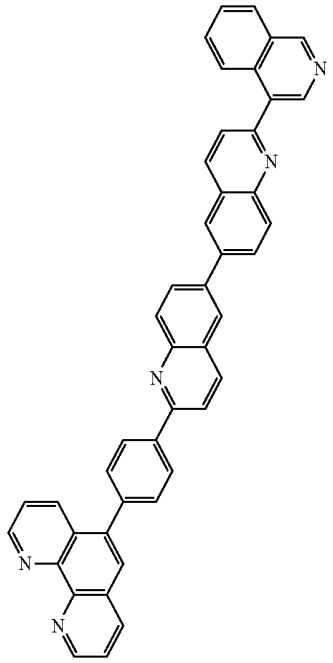

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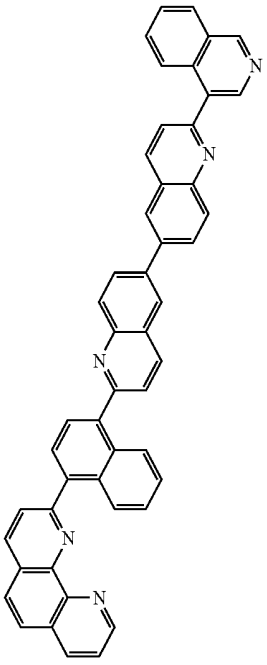

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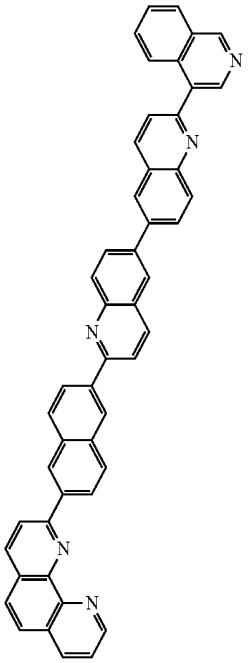

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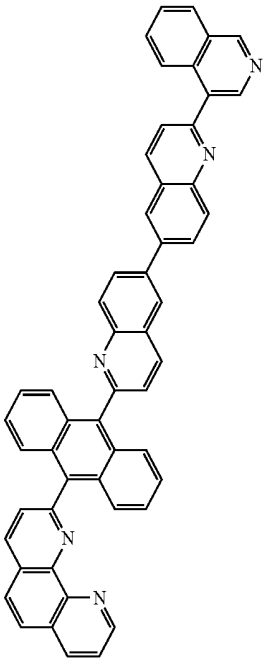

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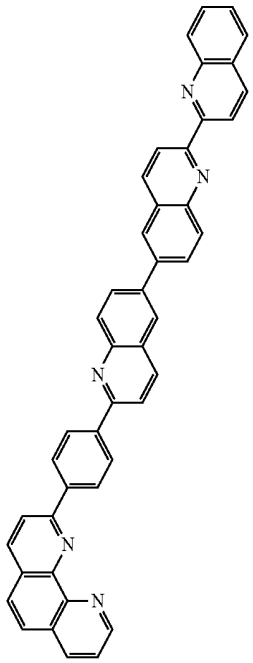

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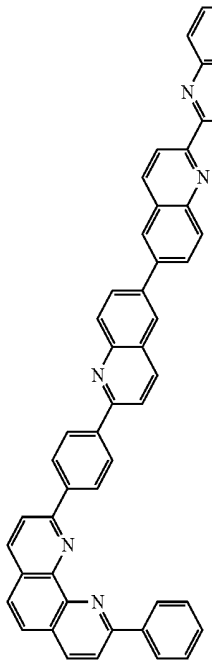

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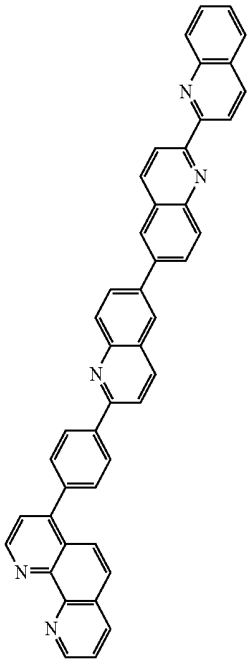

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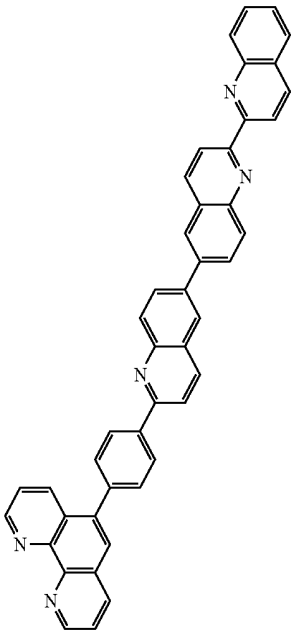

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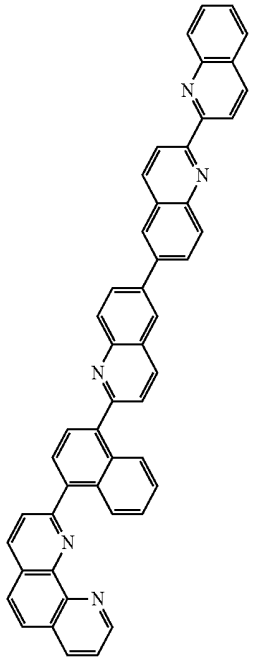

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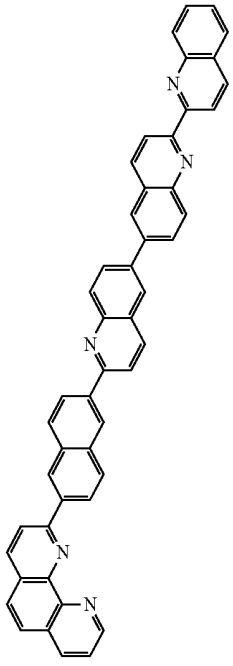

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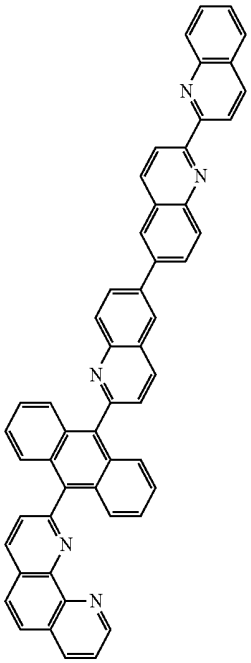

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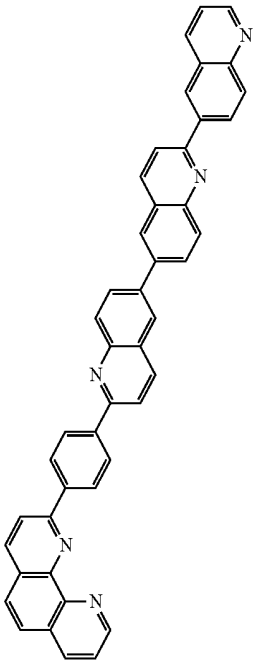

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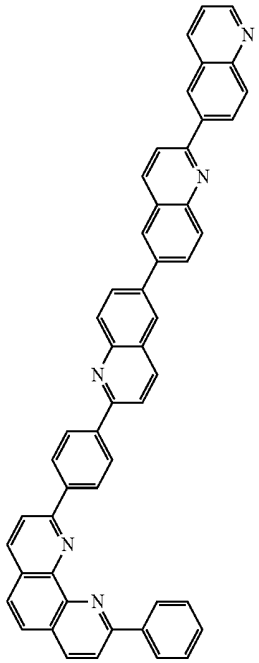

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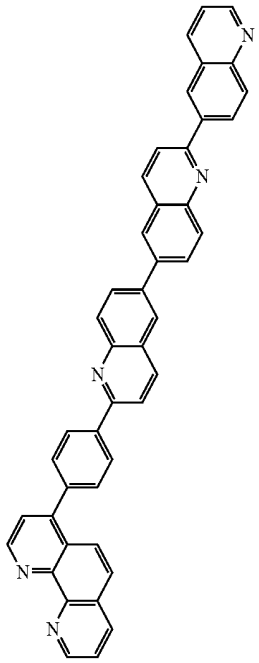

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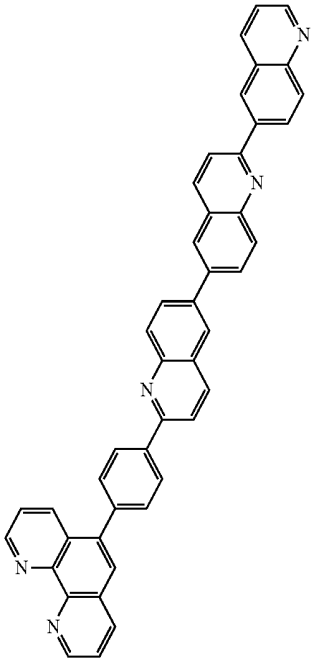

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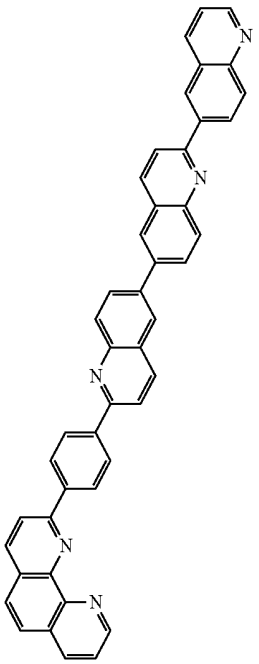

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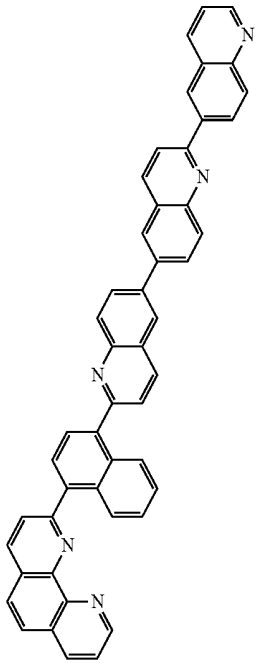

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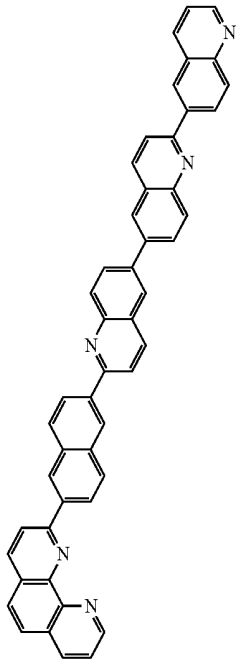

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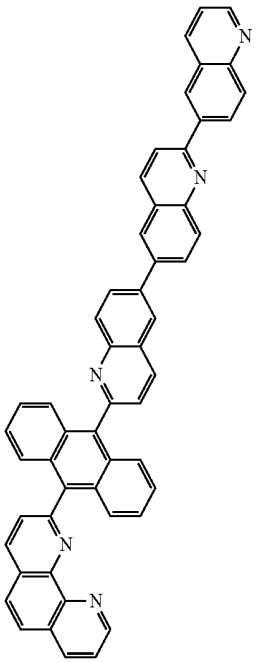

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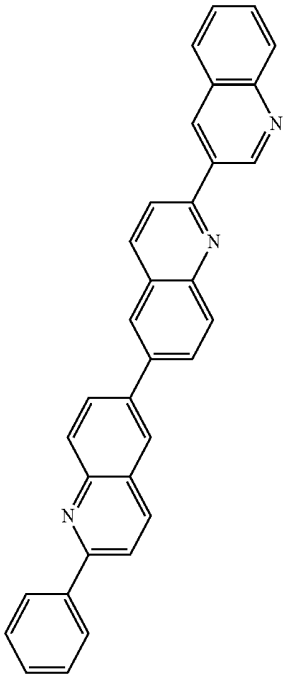

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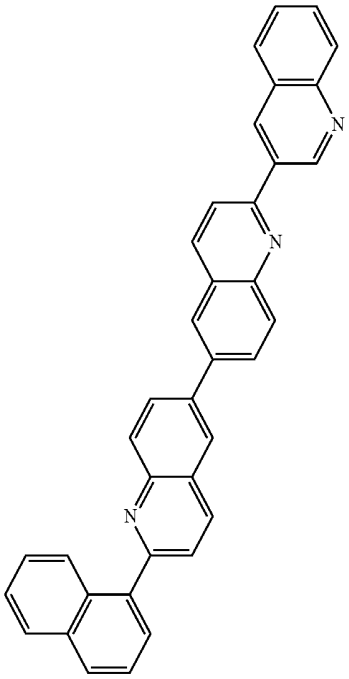

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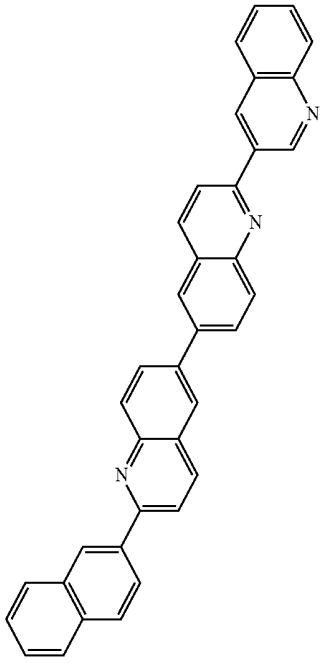

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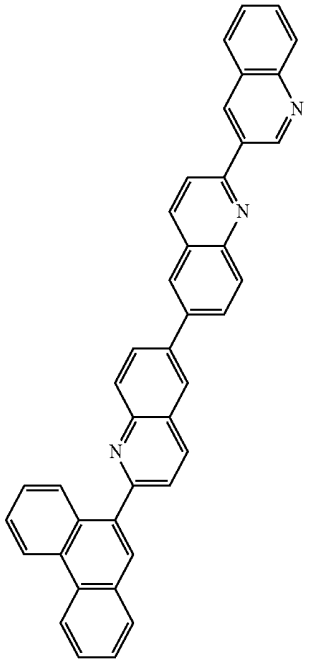

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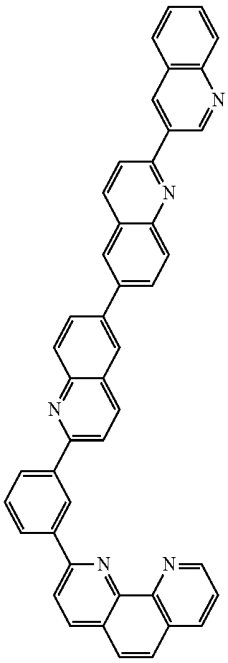

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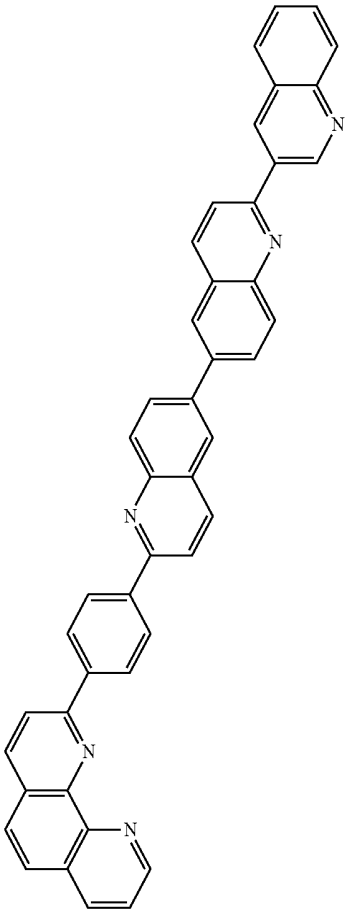

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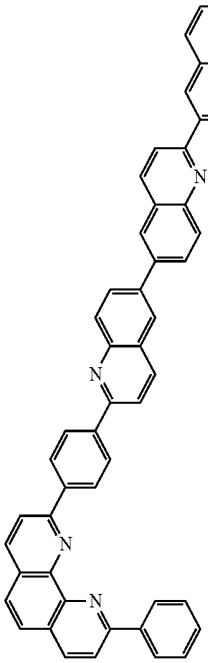

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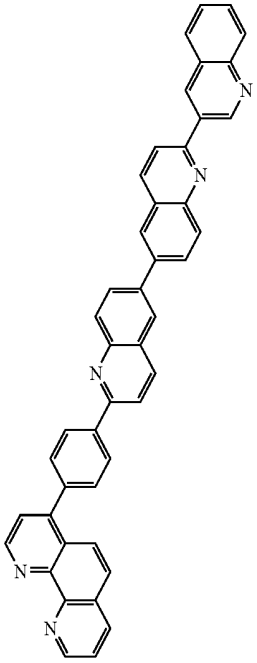

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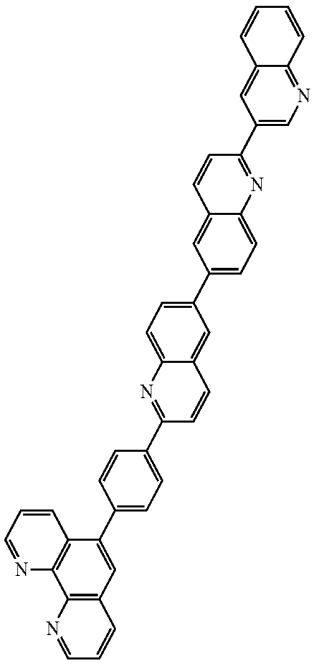

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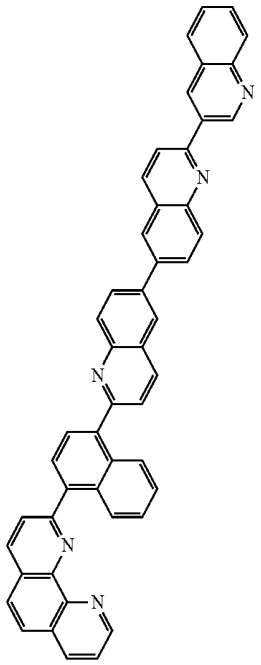

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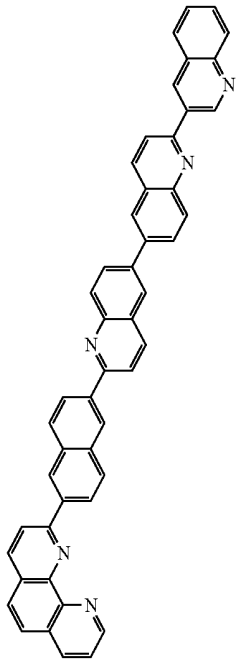

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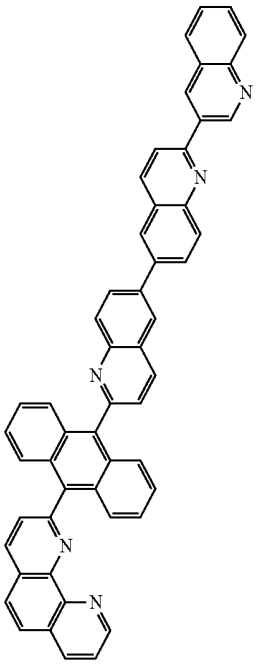

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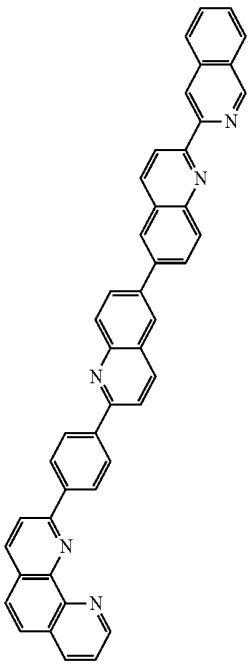

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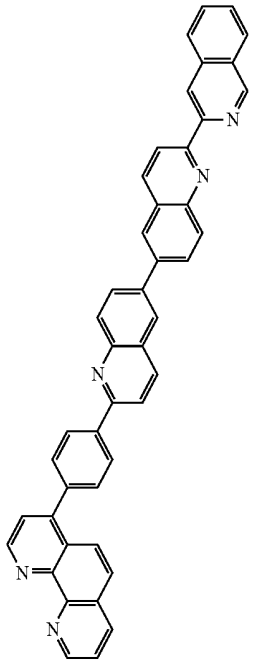

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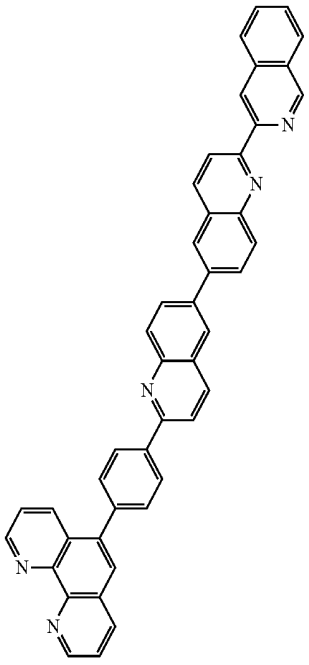

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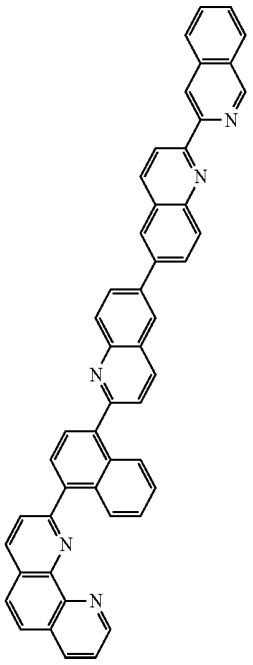

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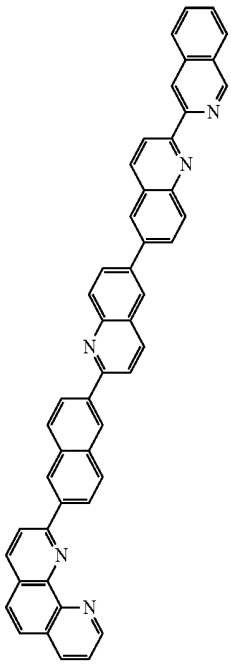

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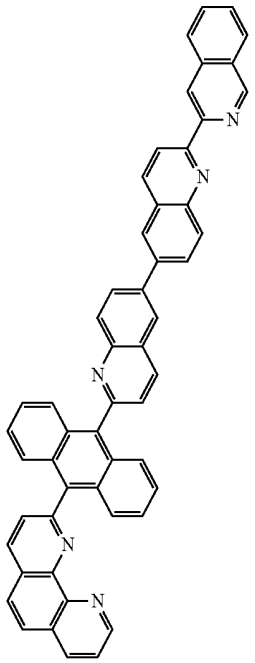

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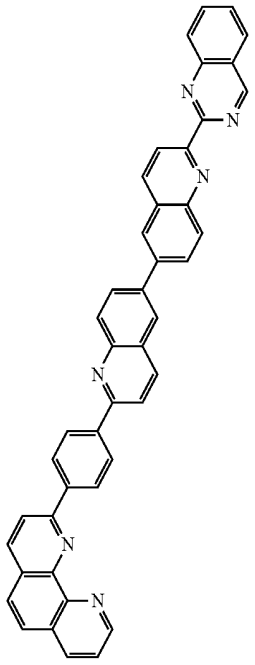

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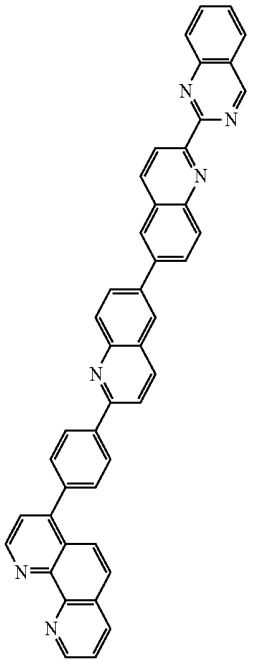

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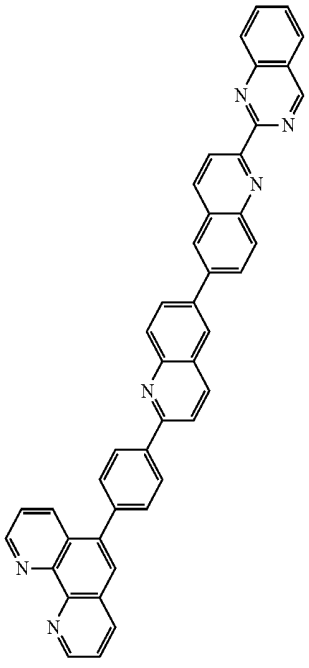

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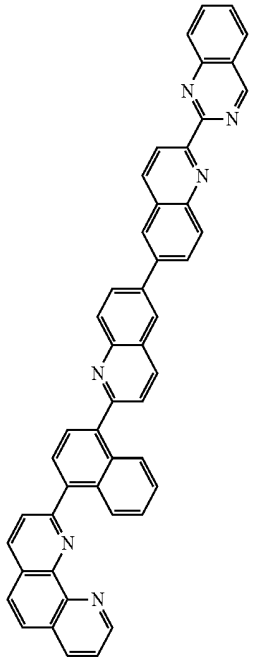

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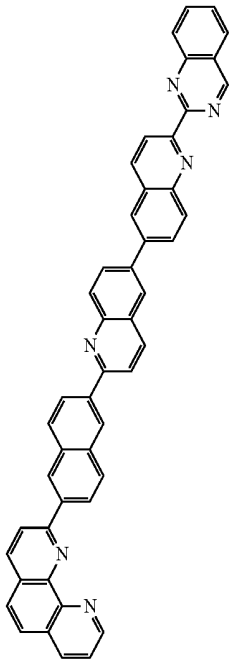

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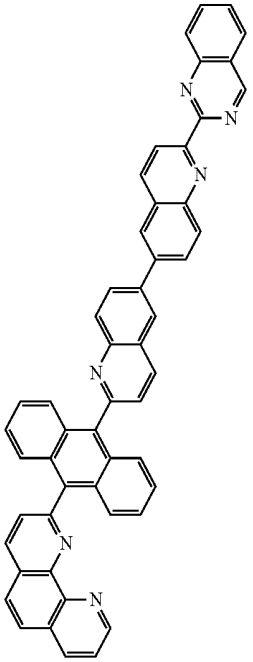

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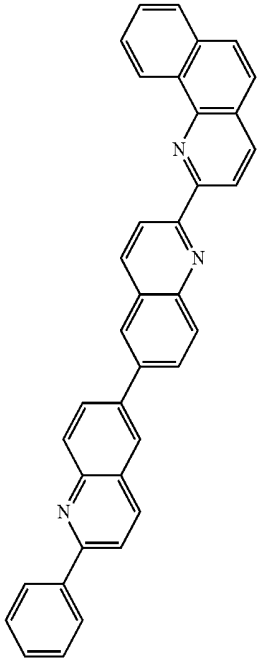

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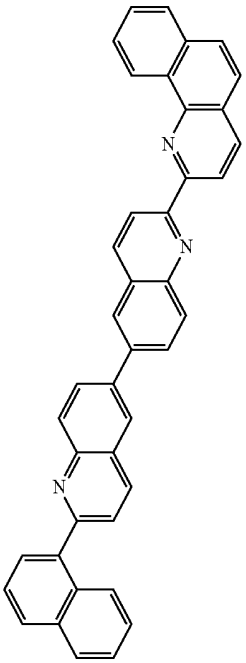

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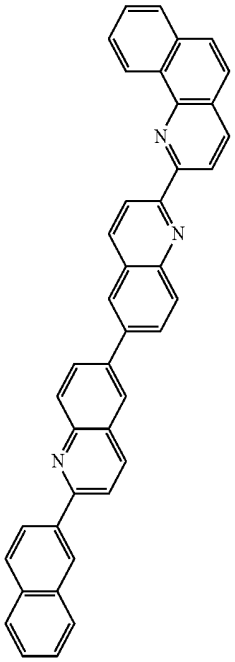

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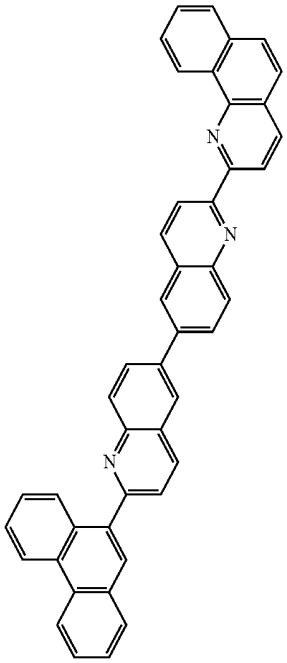

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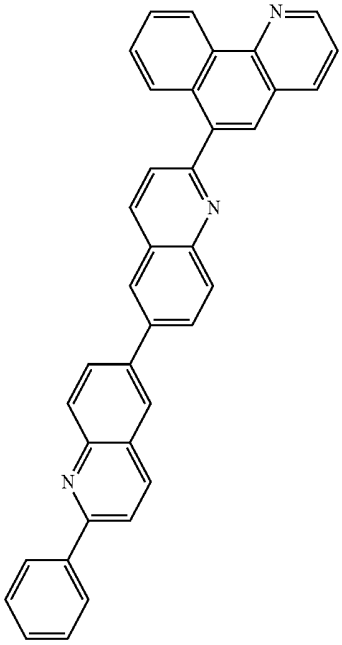

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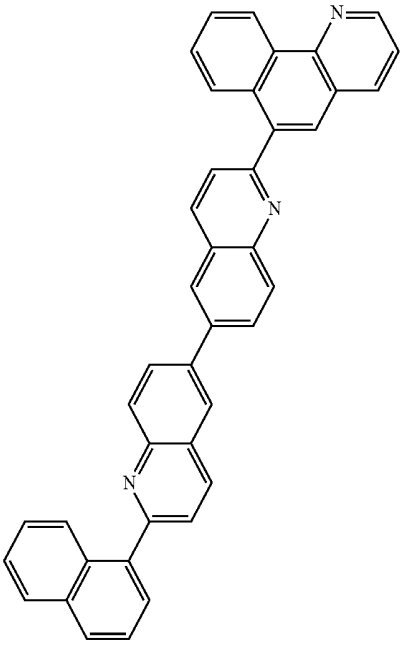

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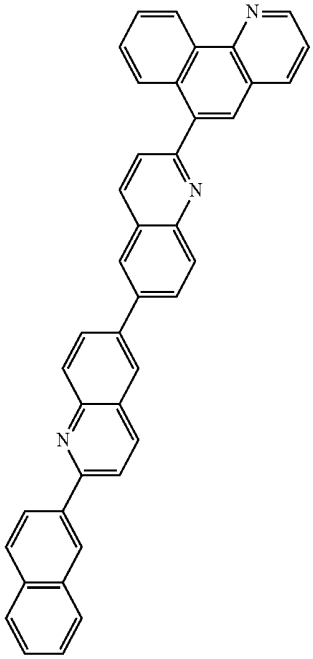

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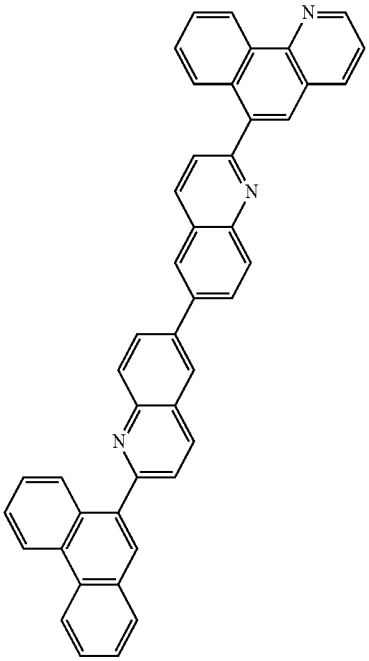

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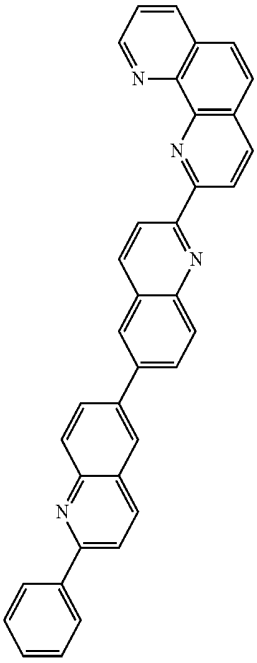

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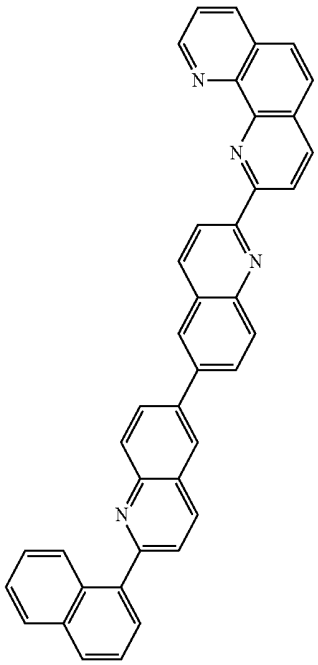

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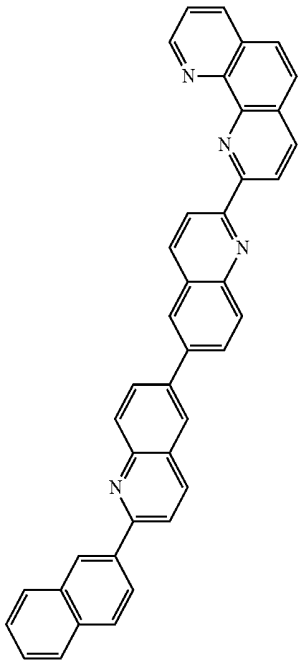

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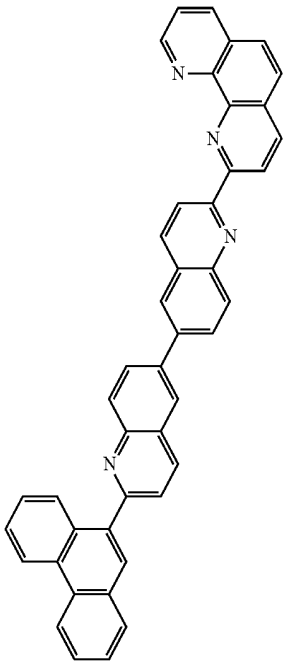

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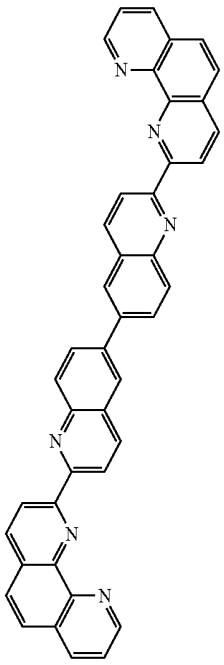

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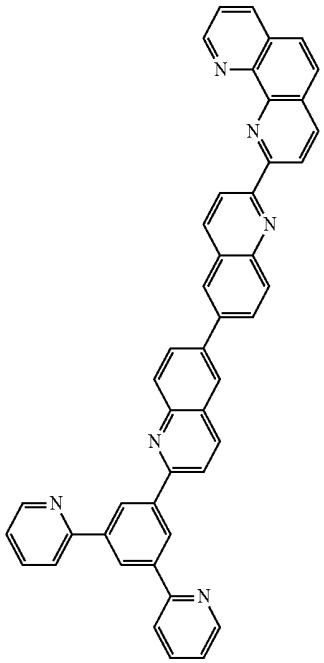

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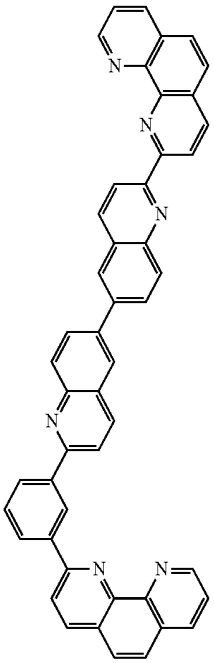

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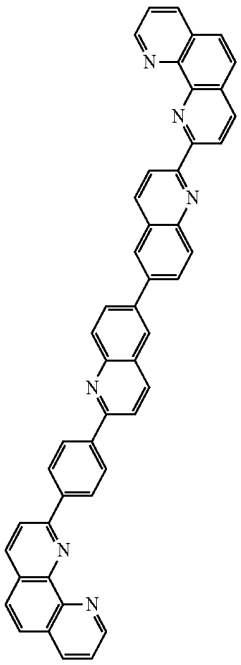

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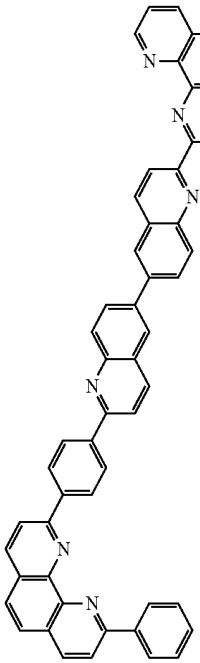

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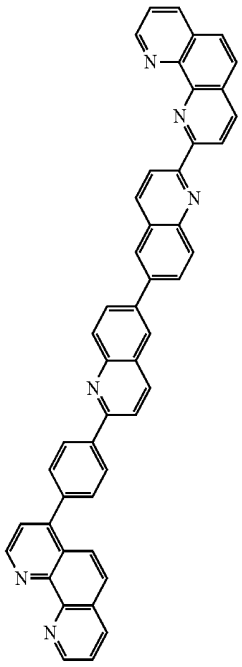

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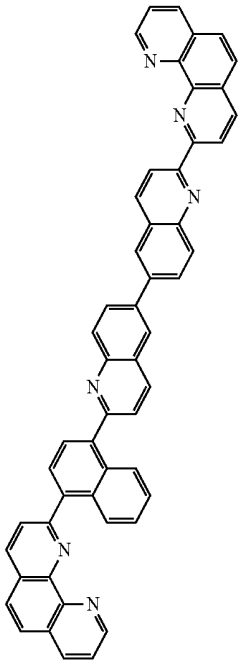

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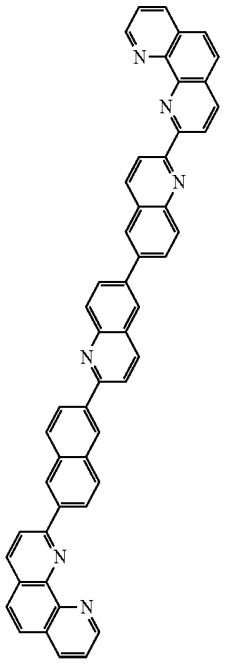

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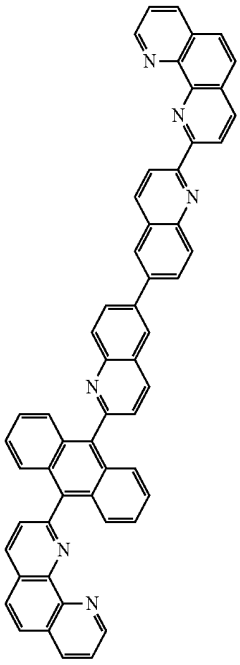

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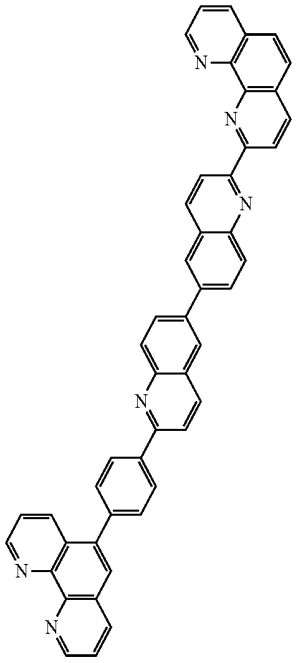

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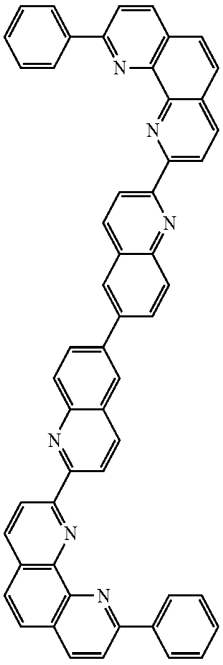

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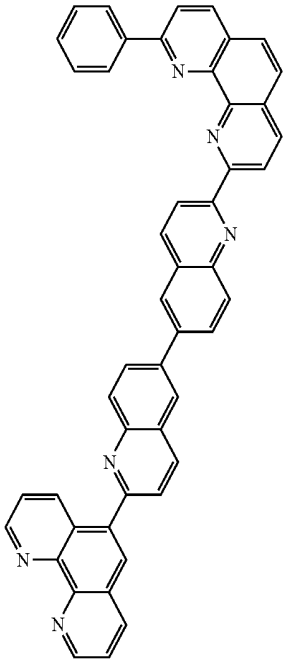

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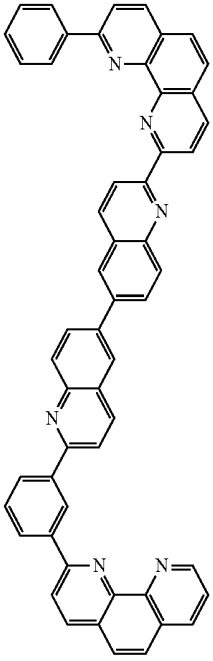

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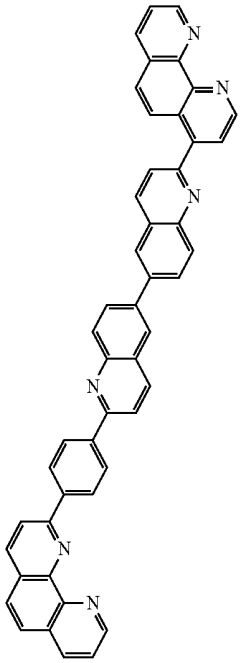

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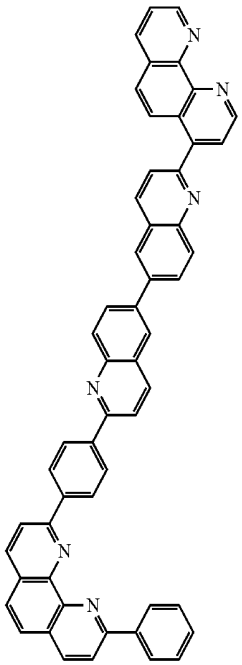

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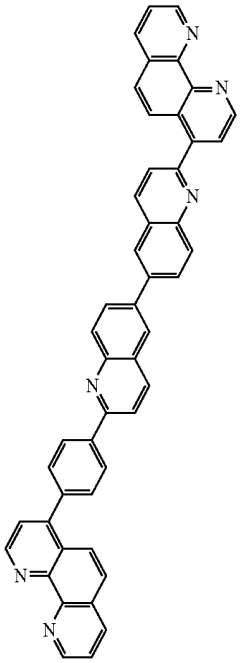

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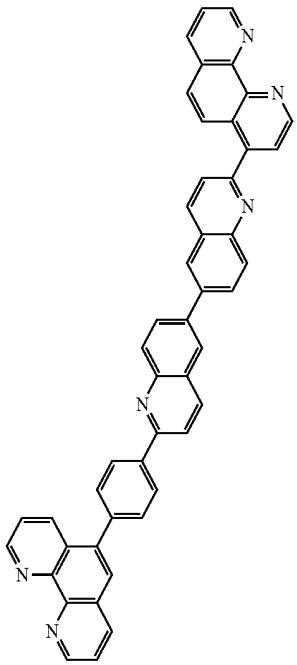

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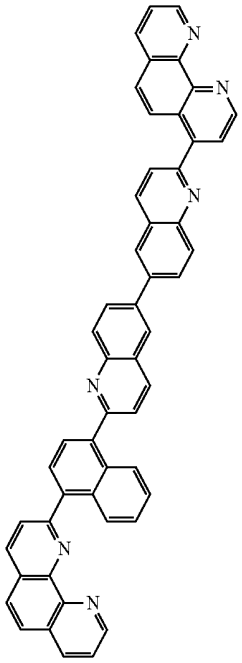

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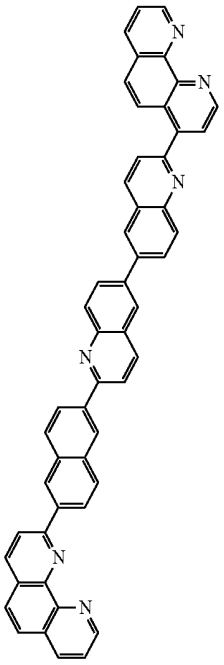

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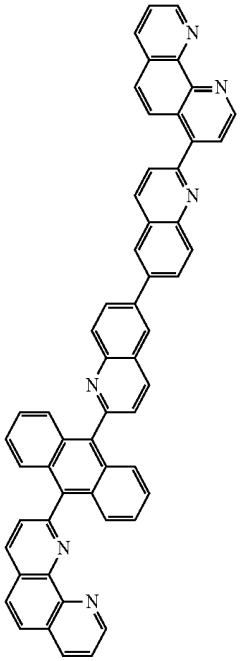

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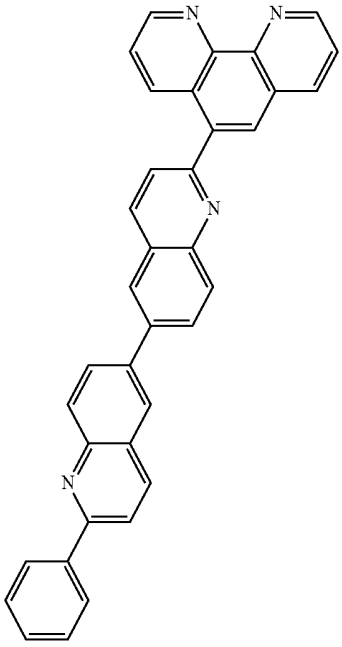

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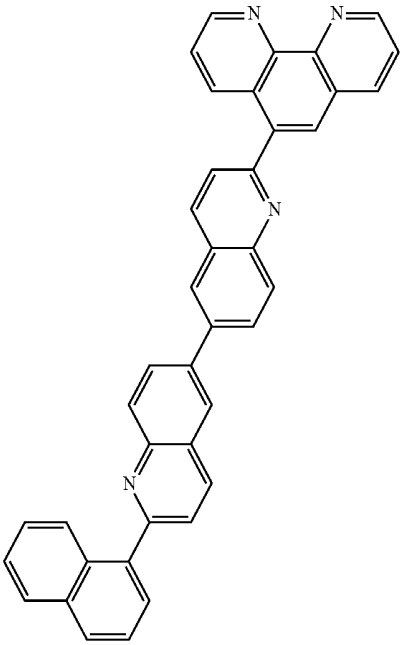

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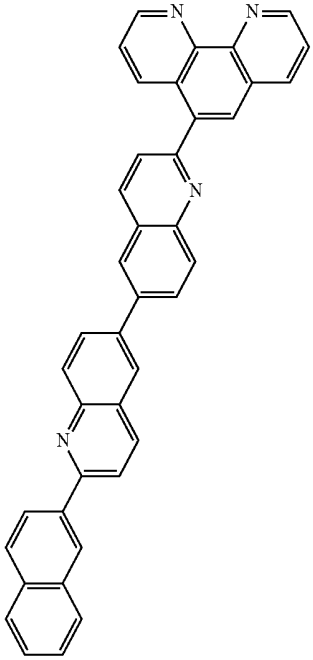

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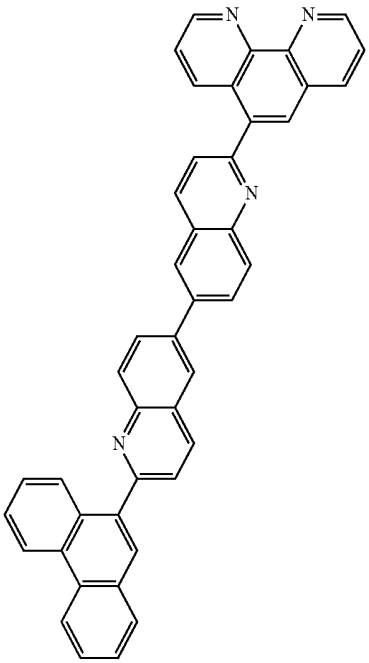

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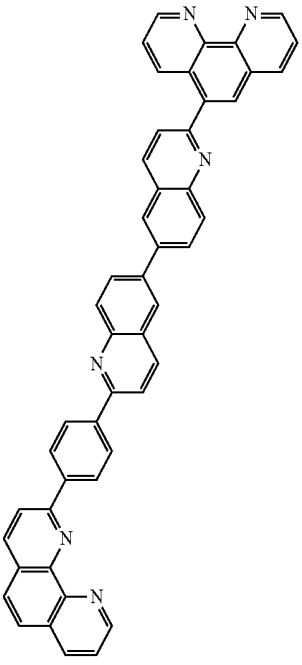

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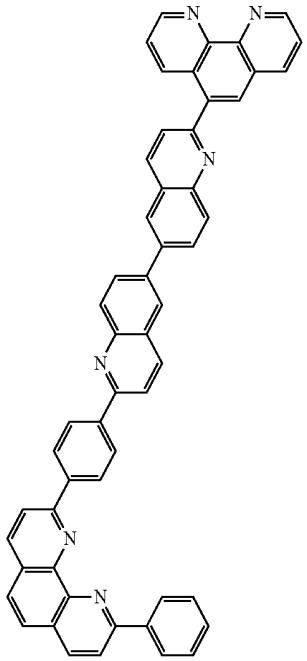

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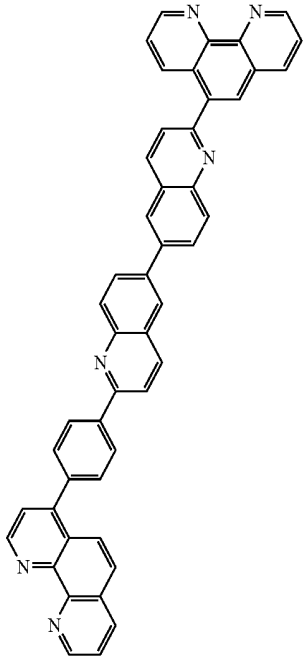

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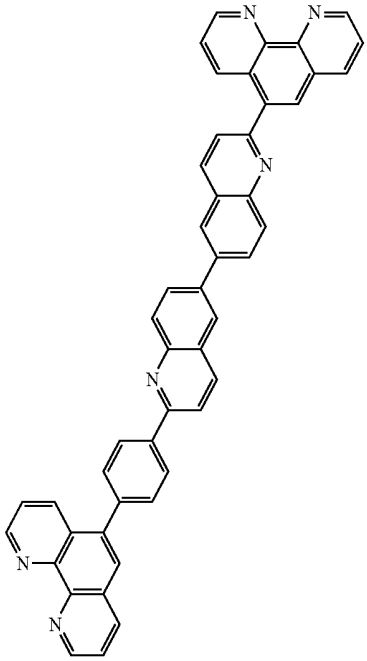

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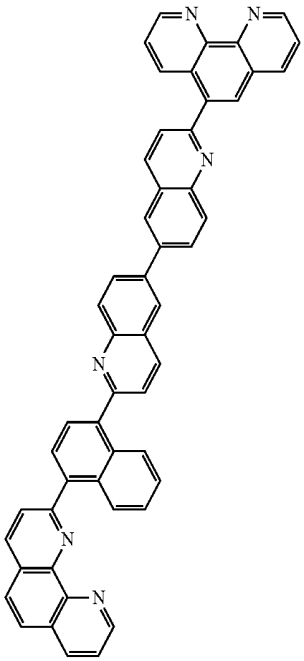

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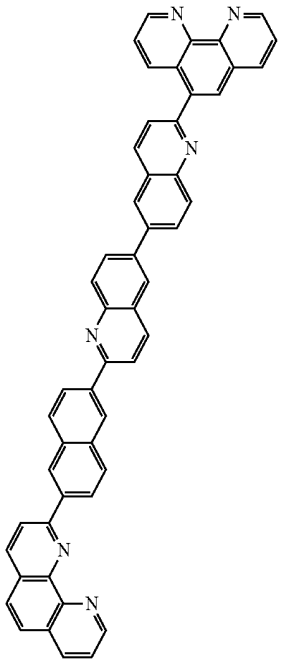

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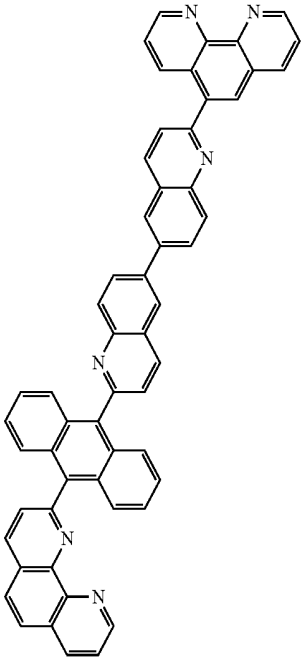

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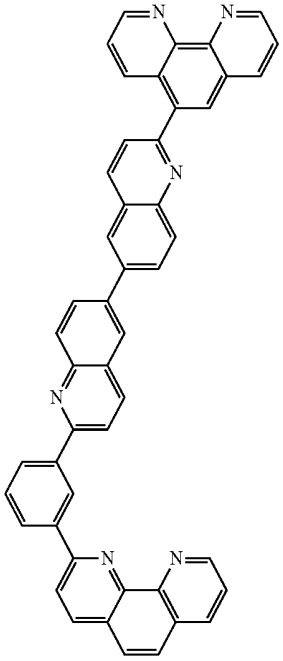

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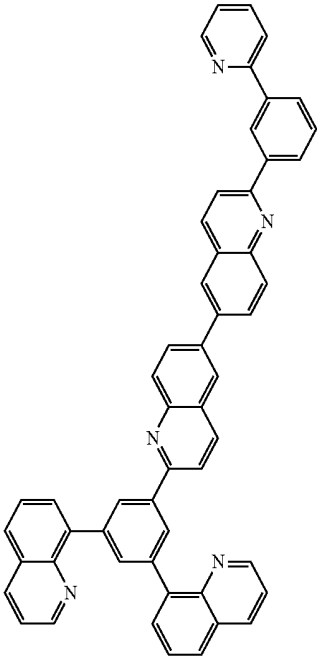

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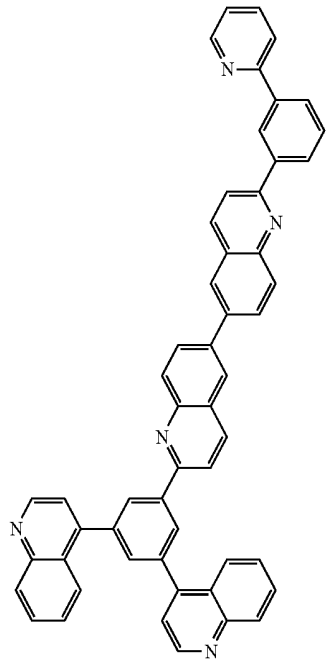

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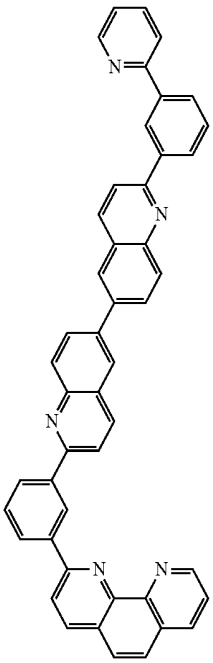

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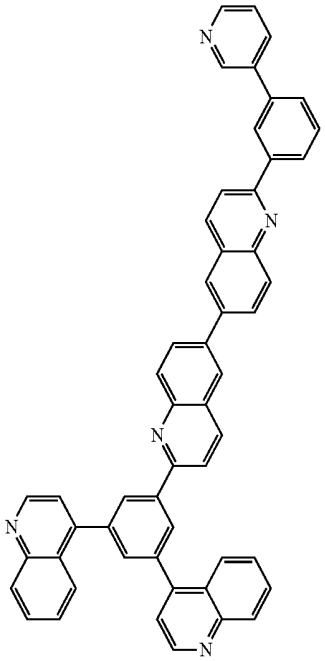

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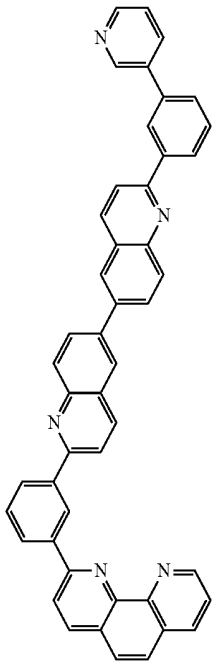

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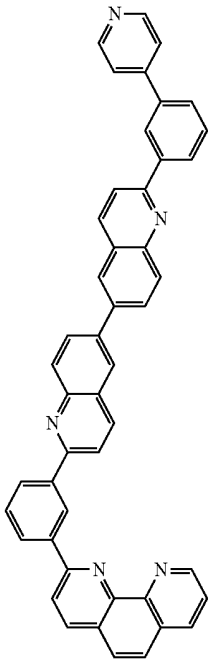

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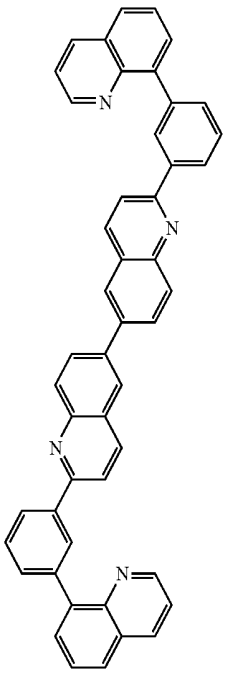

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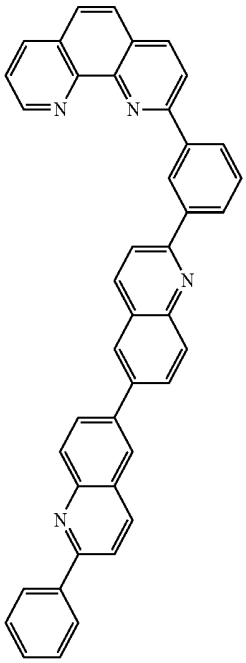

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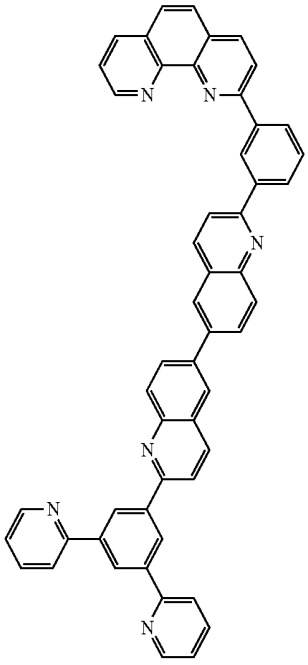

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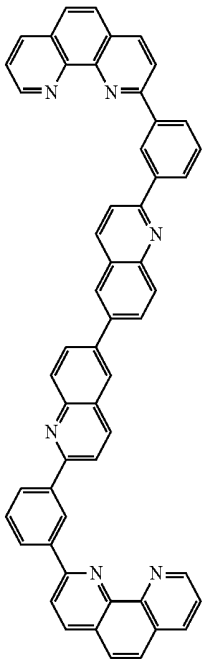

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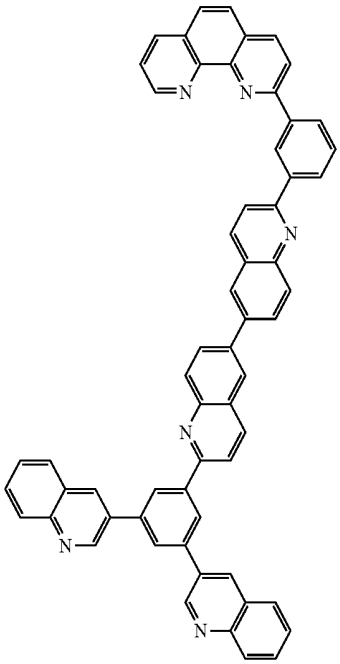

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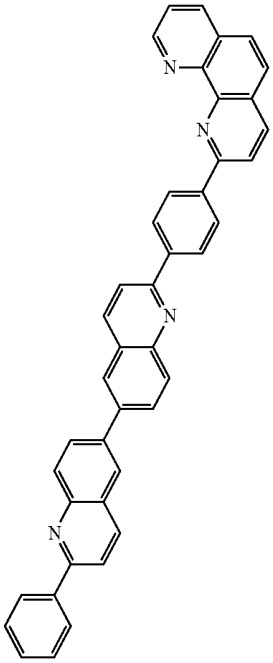

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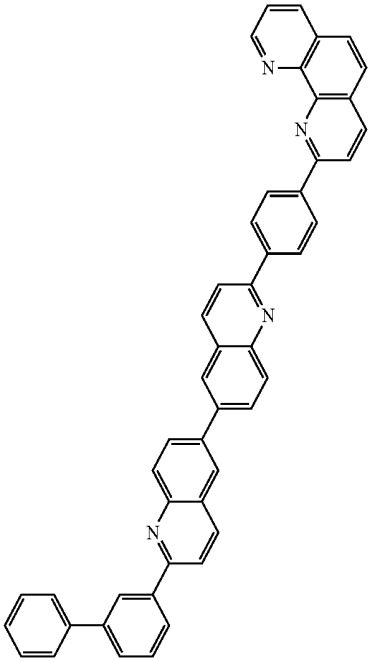

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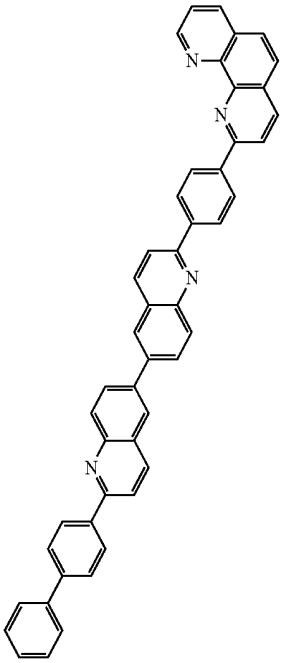

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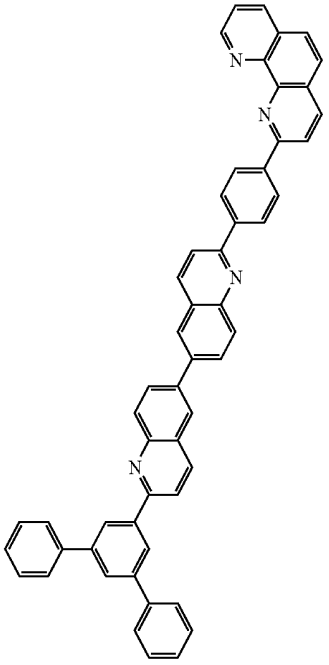

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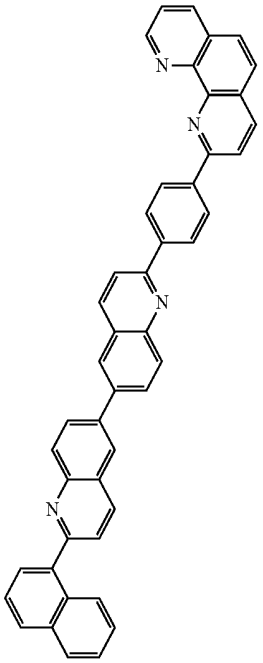

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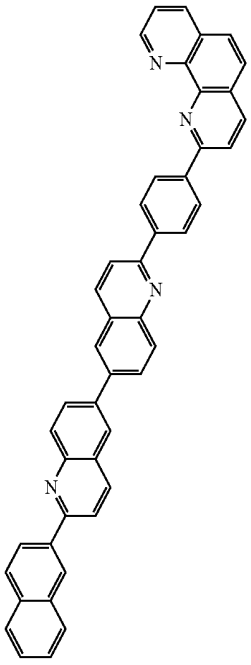

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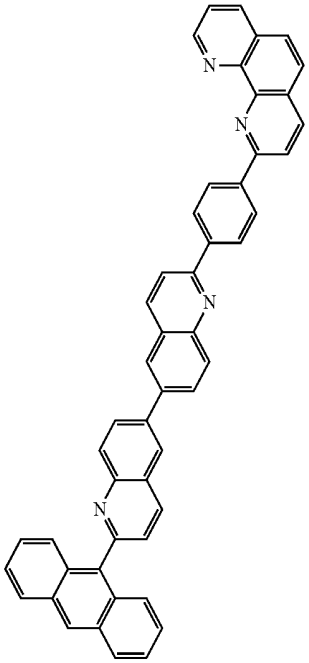

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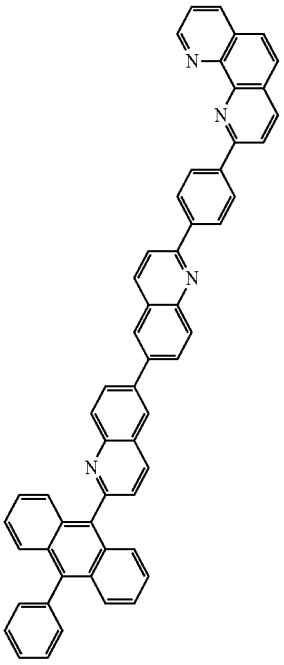

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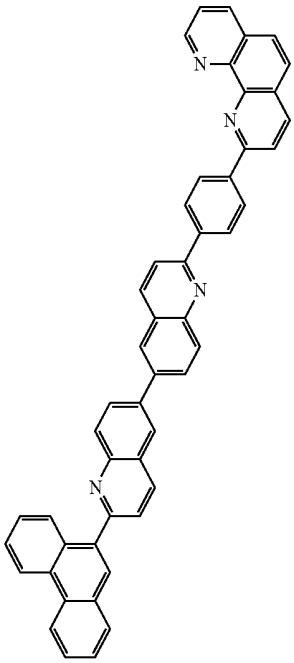

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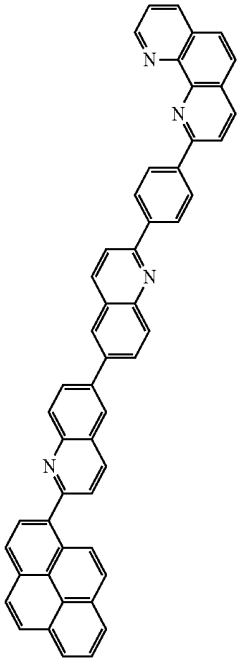

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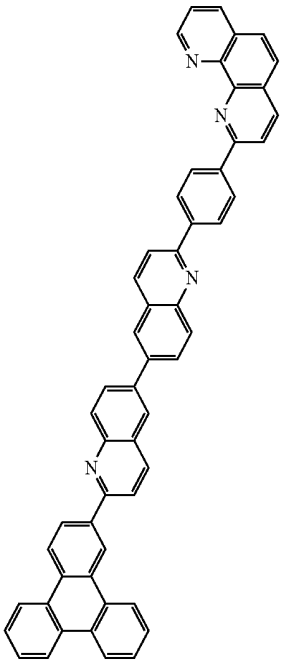

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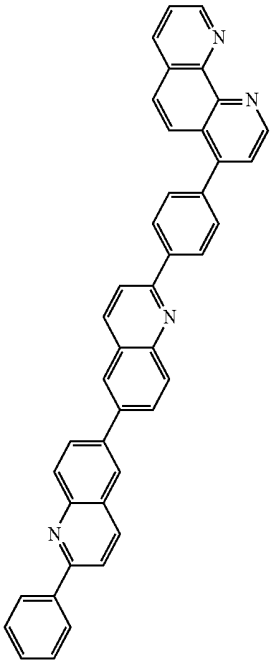

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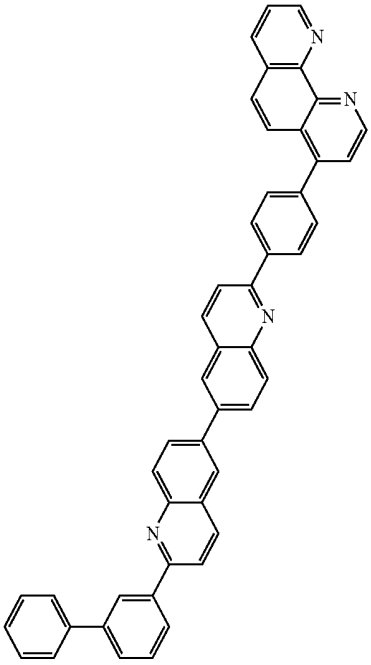

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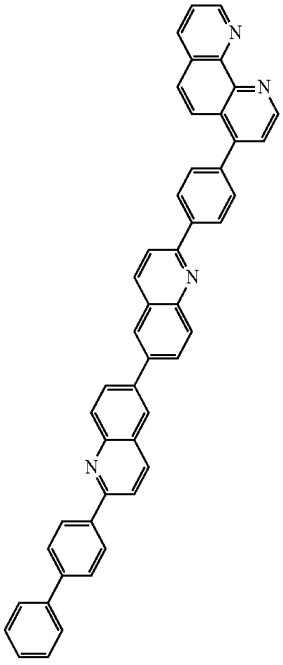

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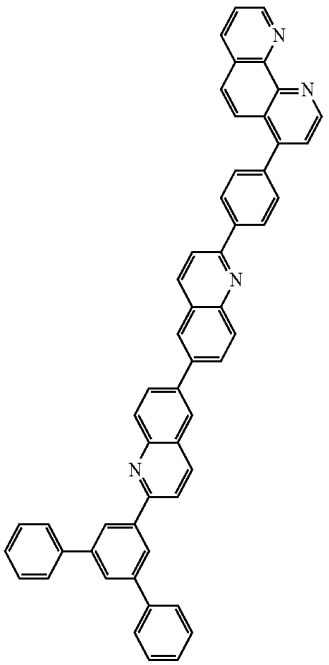

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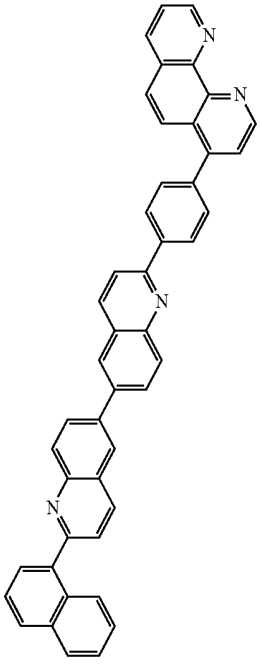

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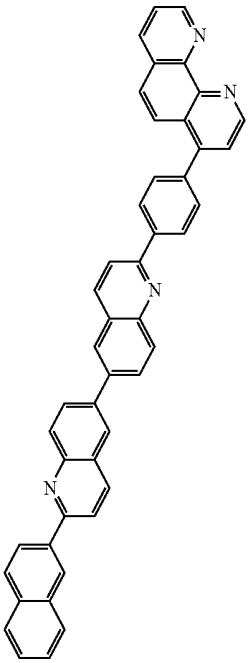

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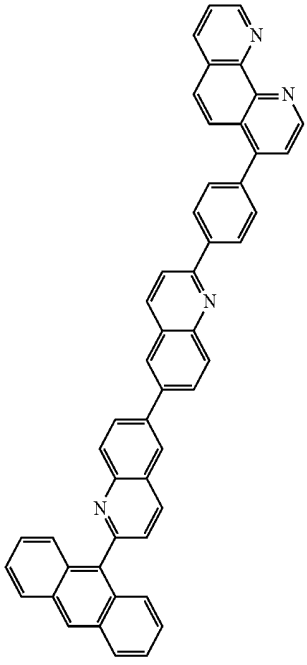

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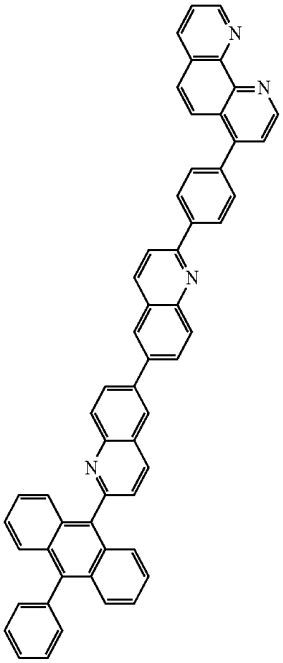

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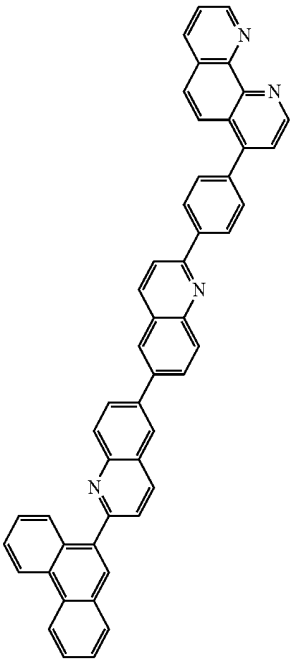

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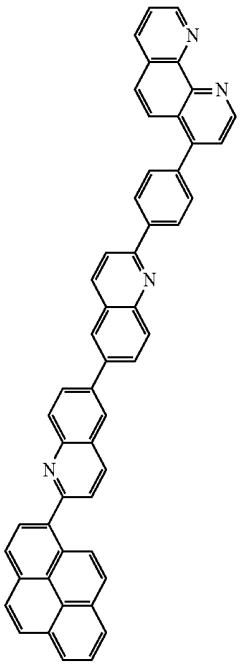

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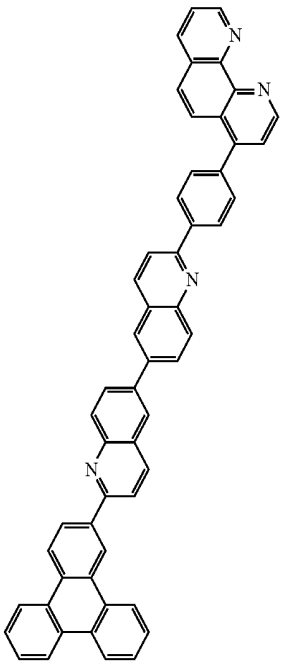

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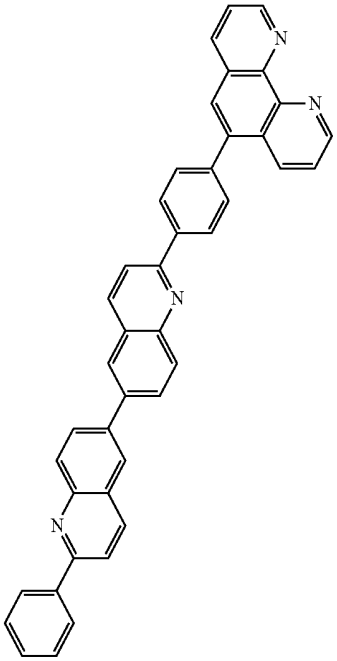

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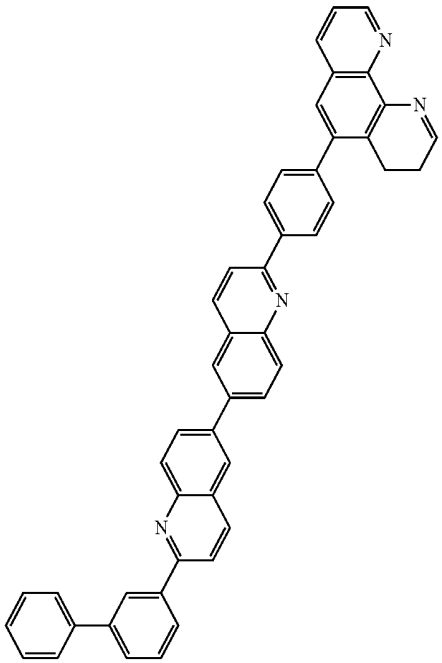

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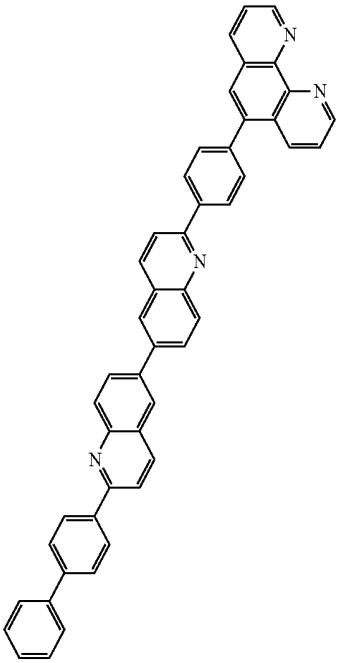

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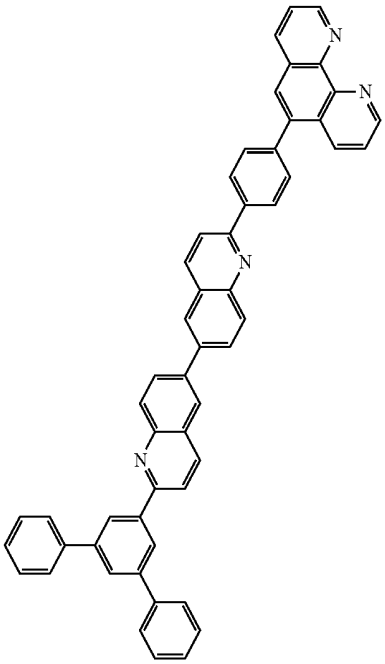

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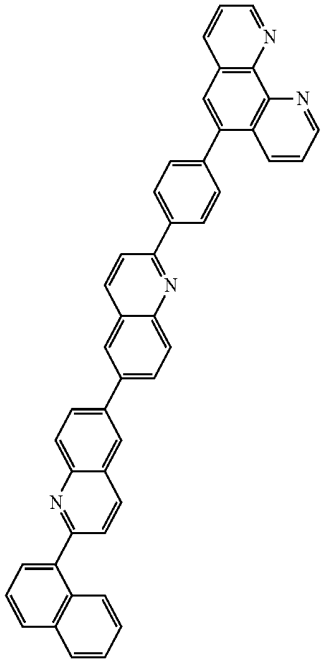

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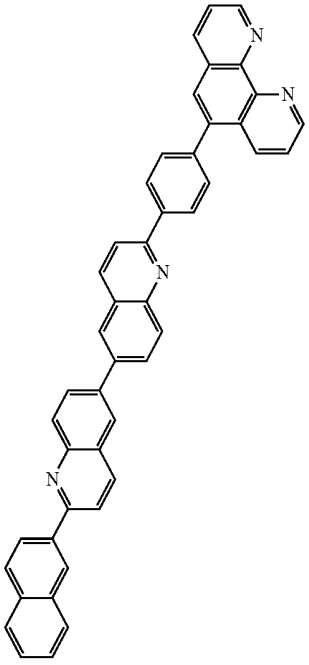

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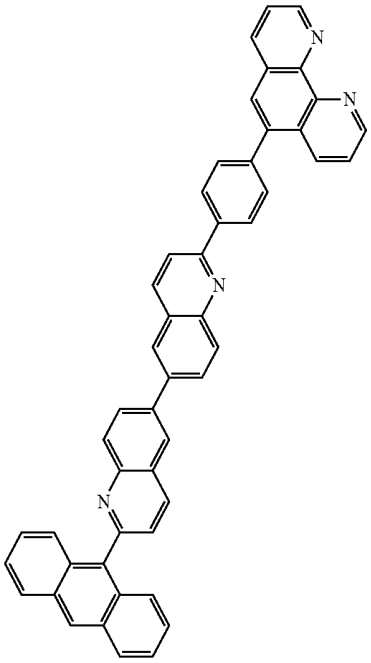

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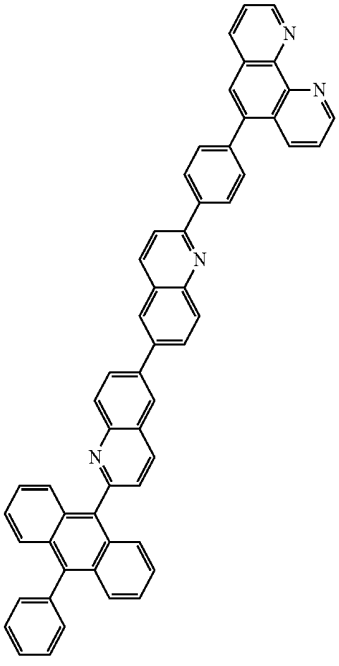

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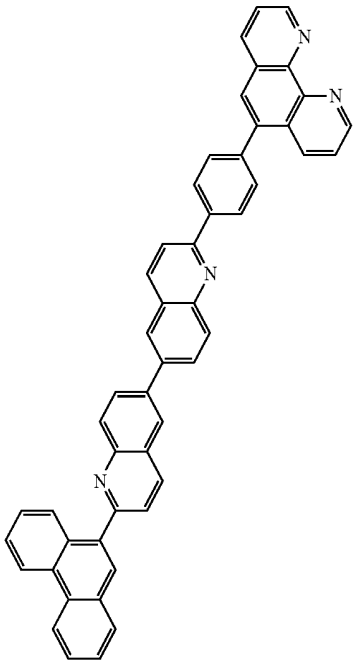

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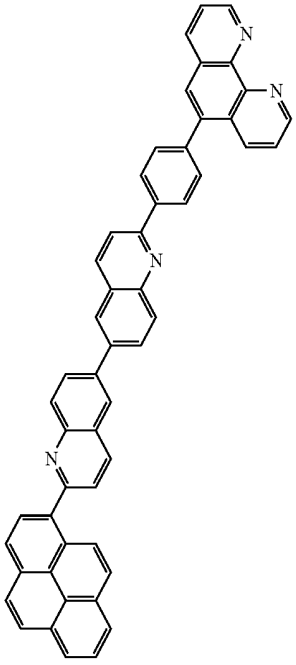

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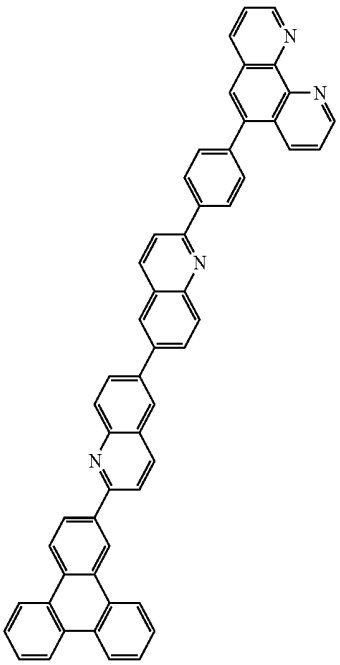

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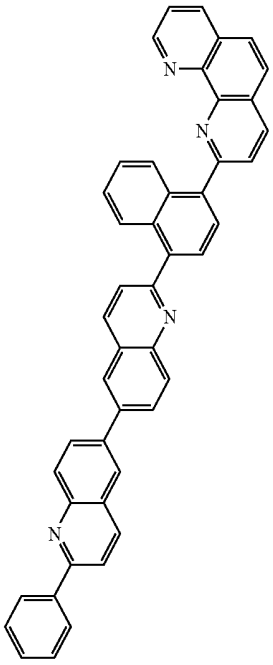

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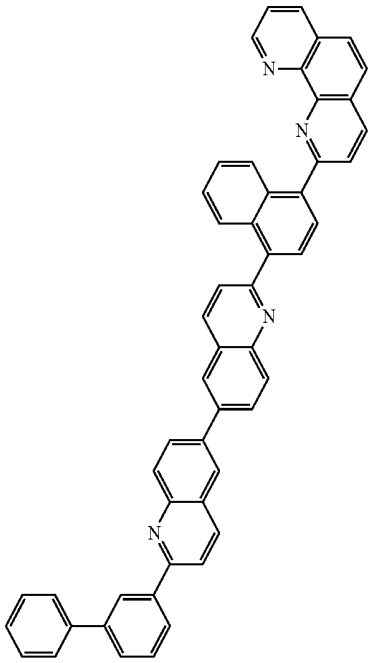

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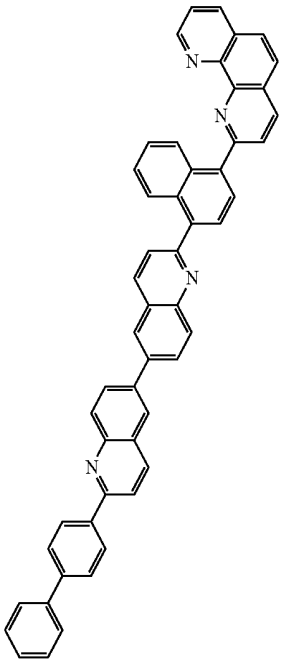

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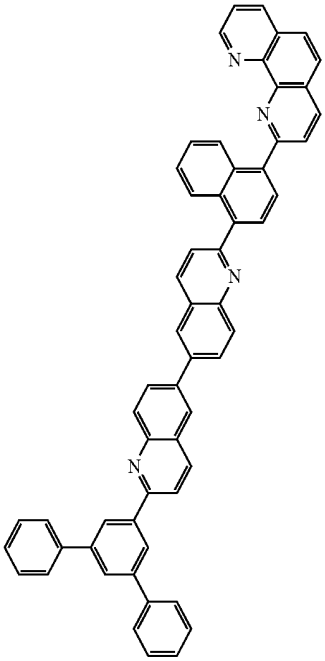

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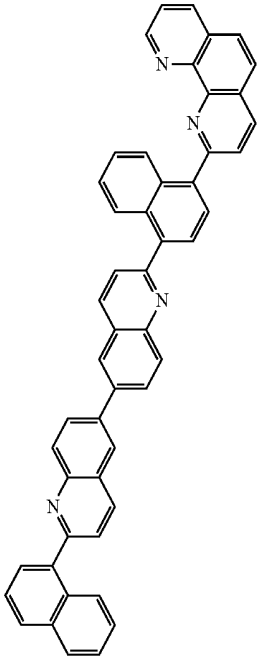

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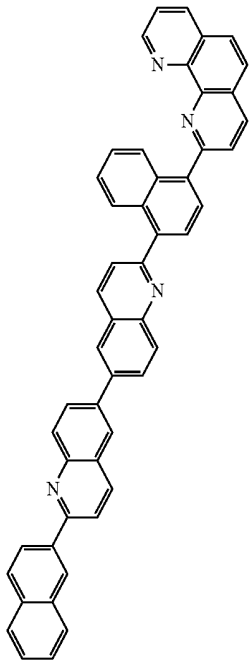

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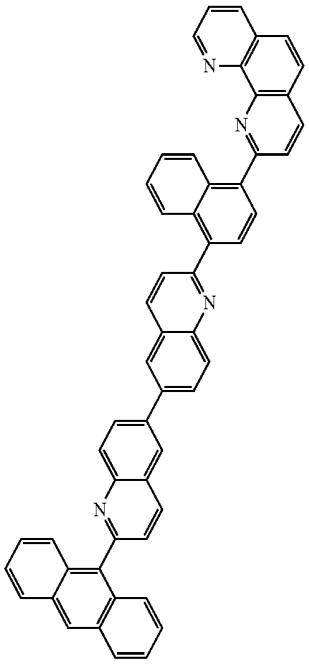

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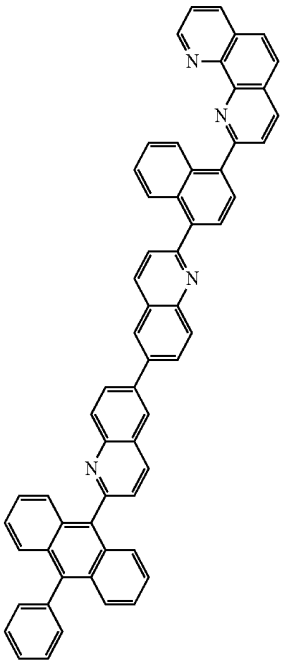

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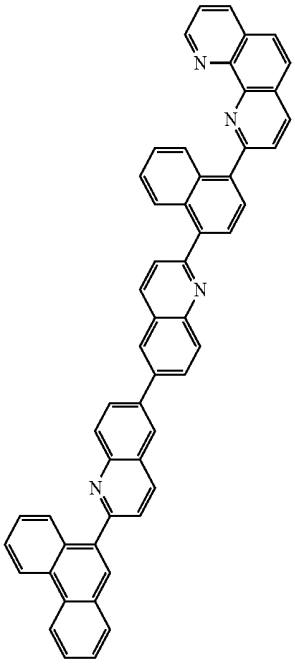

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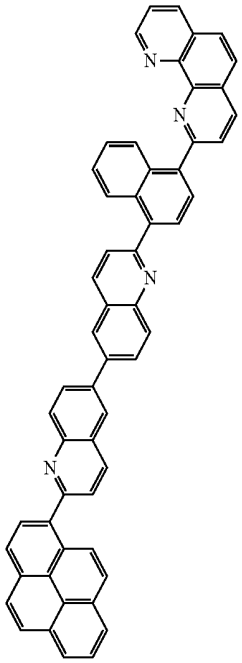

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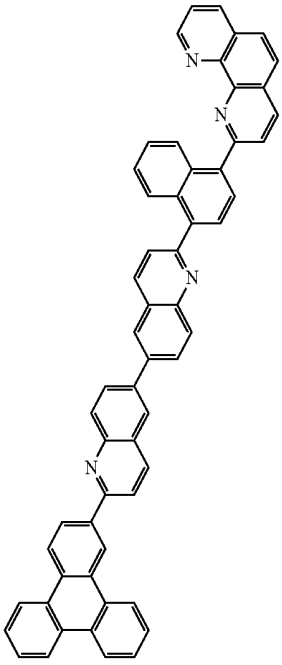

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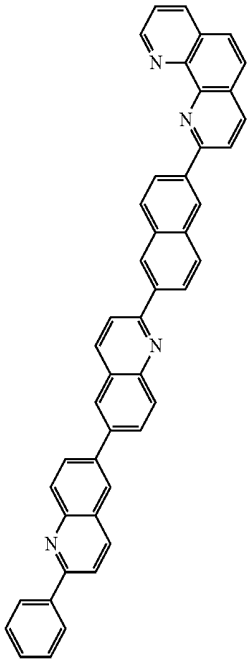

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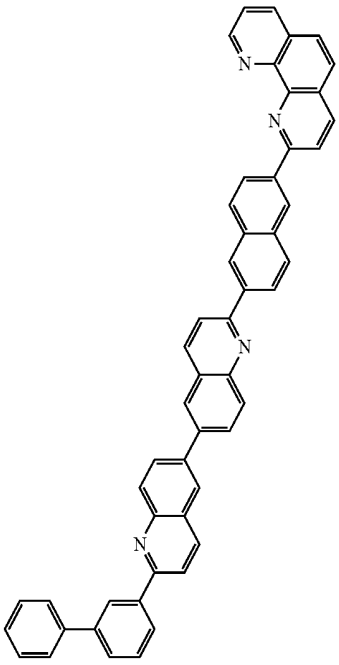

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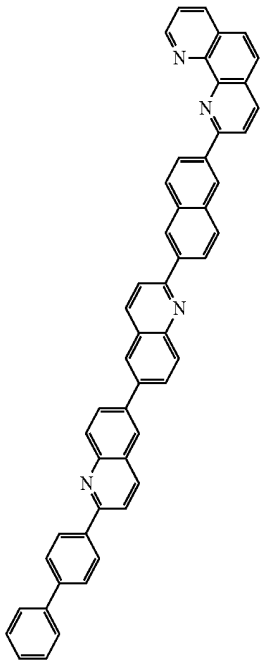

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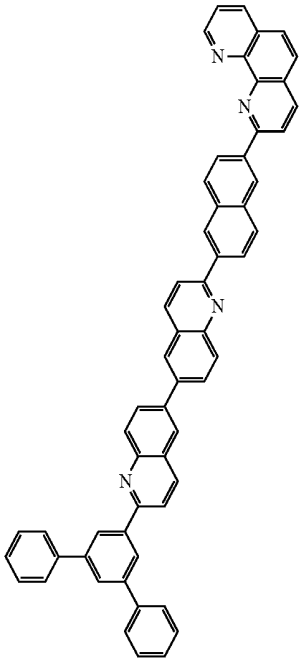

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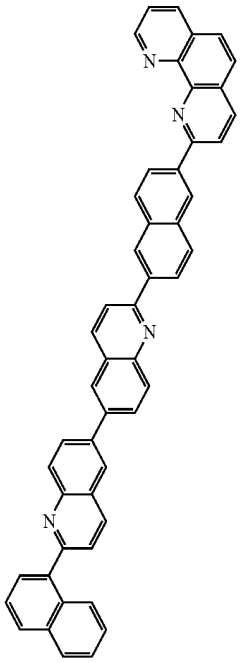

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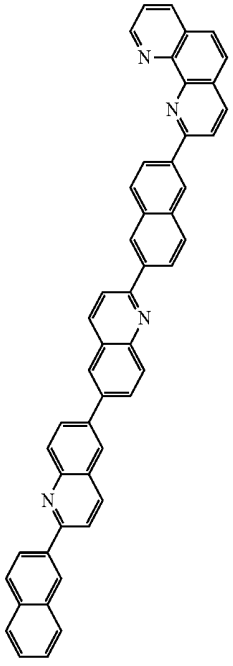

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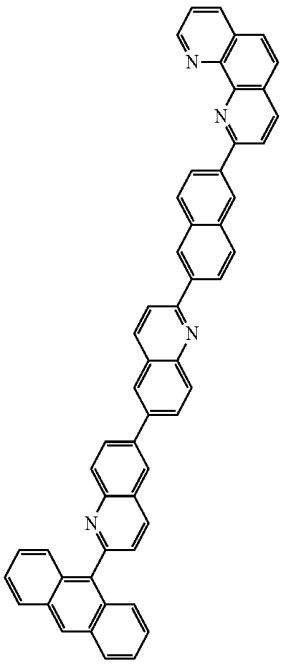

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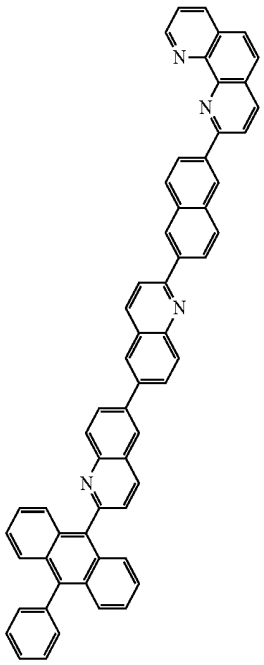

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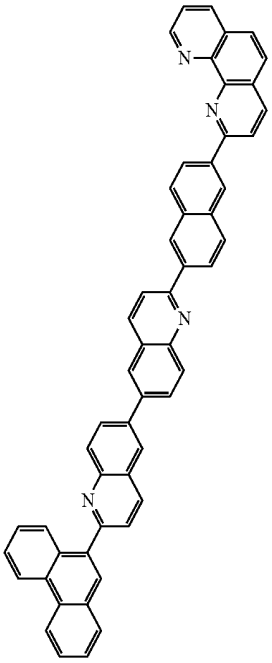

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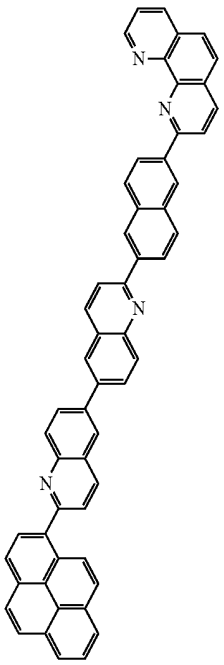

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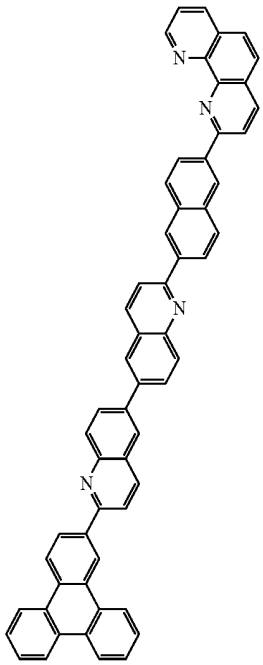

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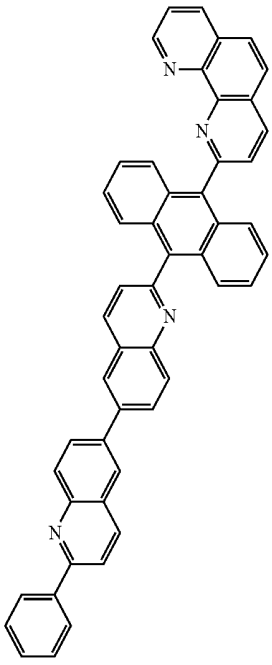

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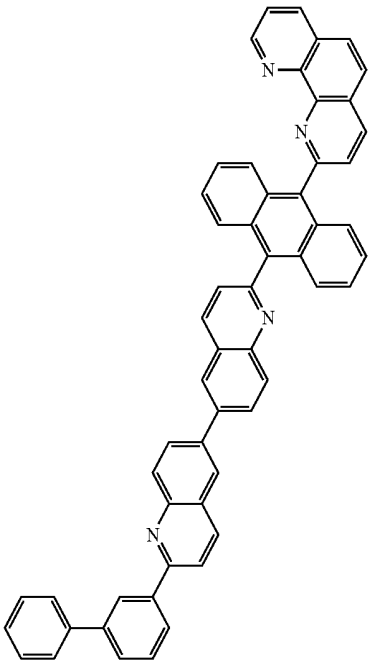

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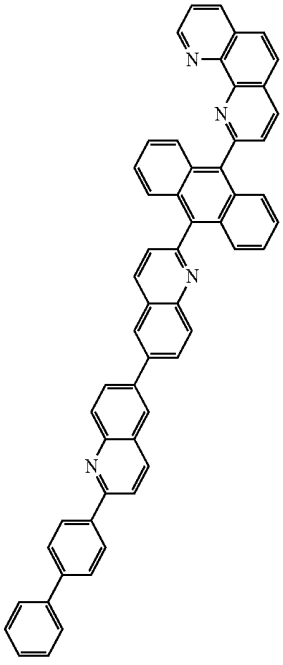

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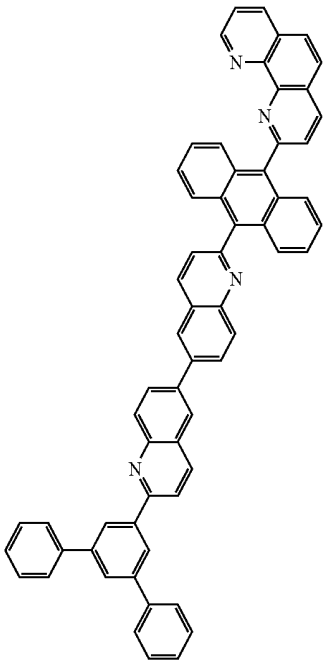

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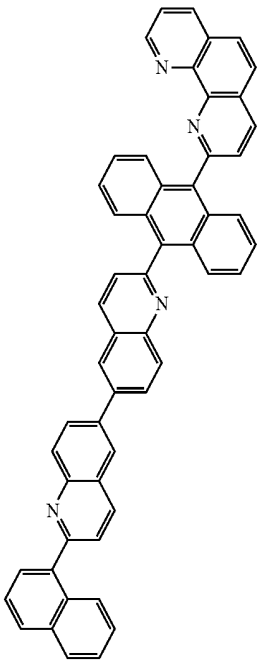

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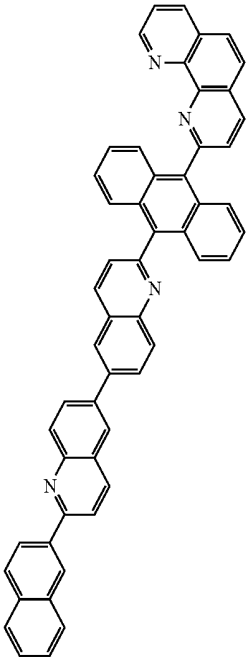

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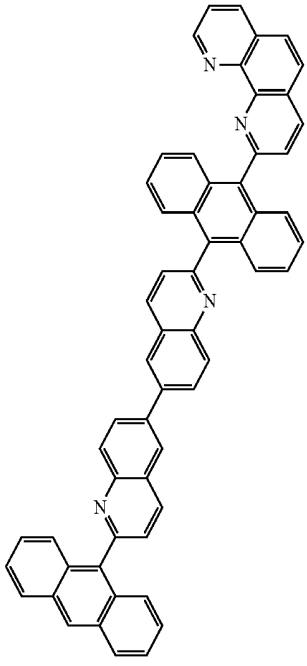

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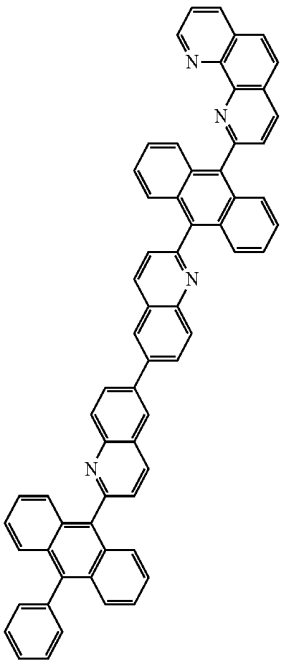

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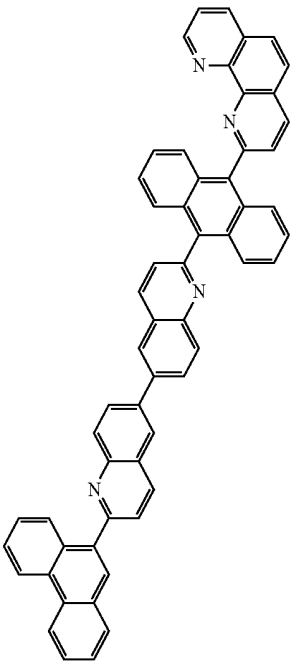

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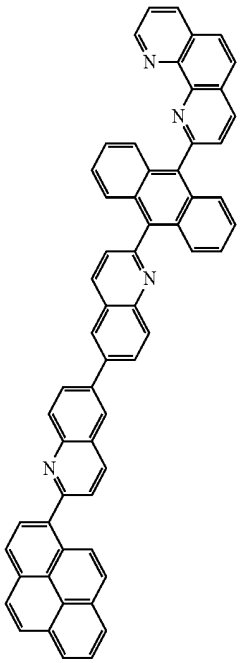

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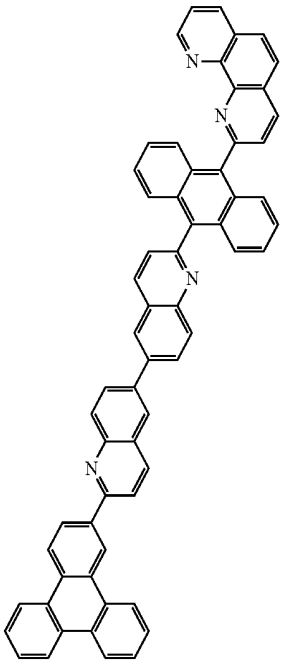

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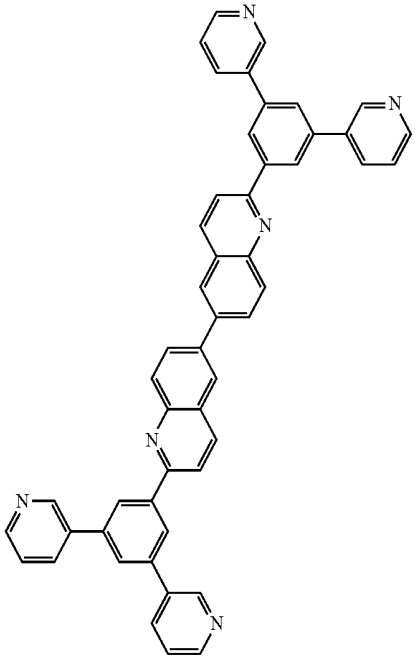

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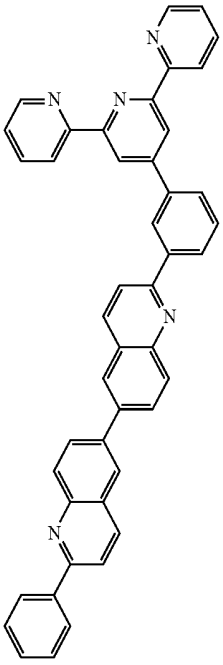

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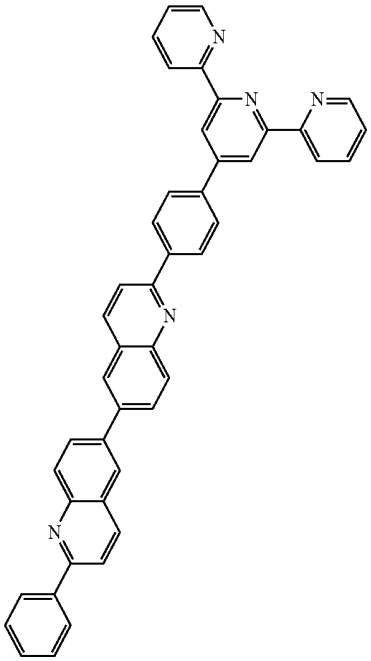

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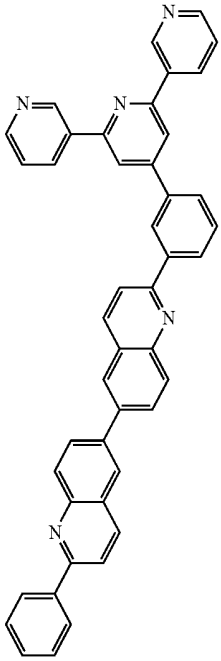

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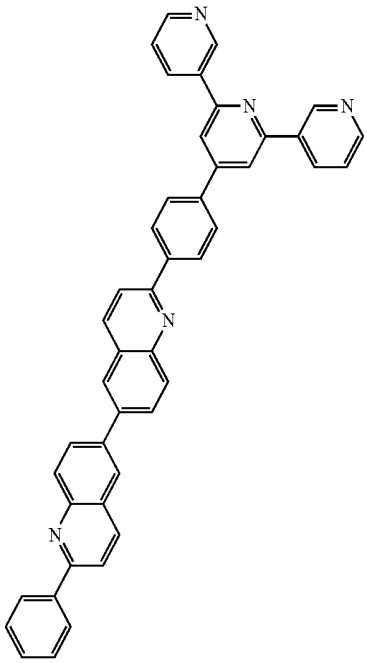

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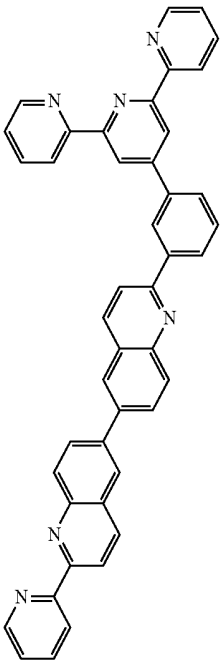

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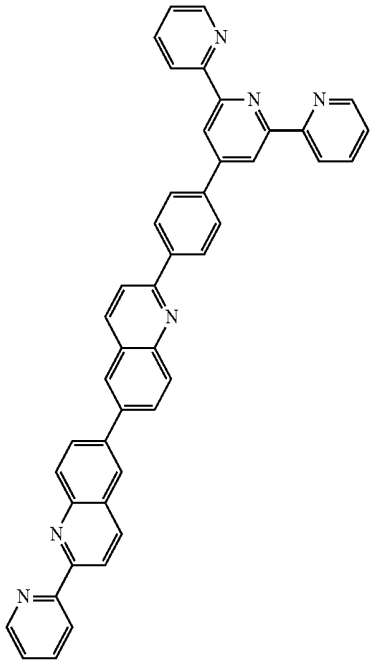

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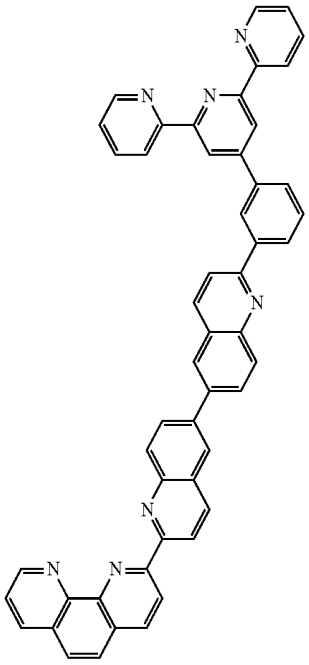

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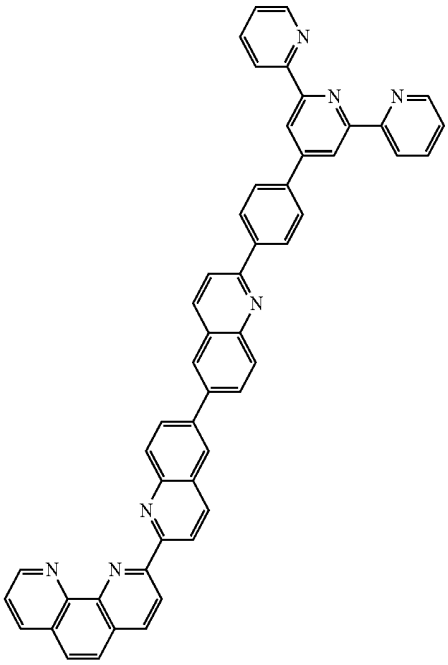

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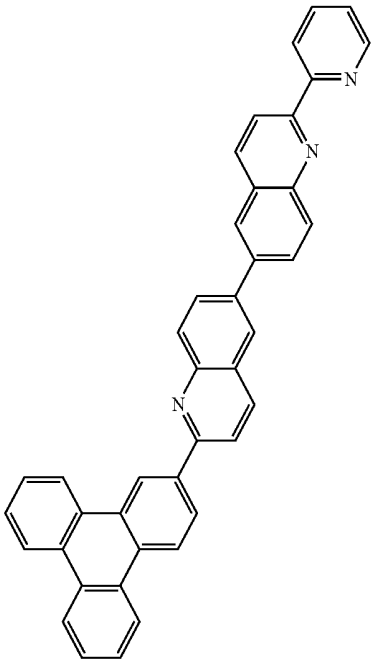

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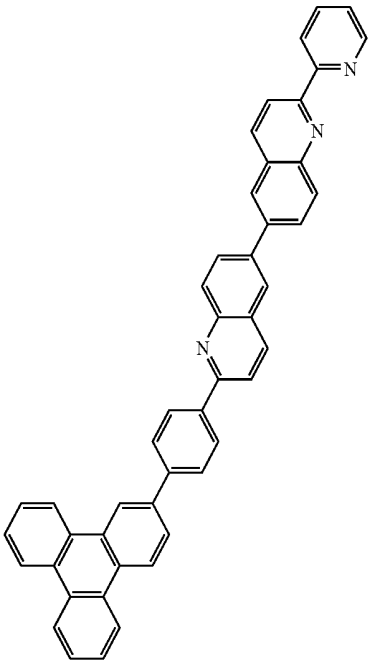

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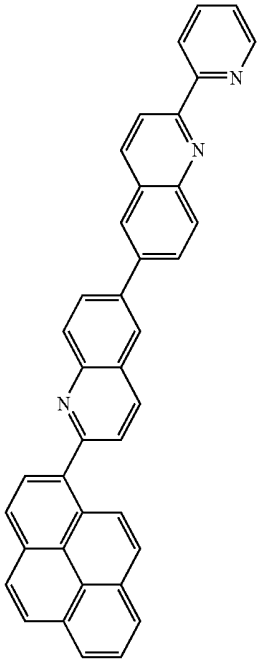

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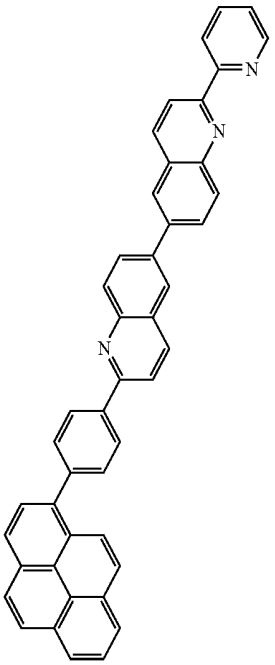


[0080] Further, it is possible to synthesize a compound having inherent characteristics of a substituent introduced by introducing various substituents into the structure of Chemical Formula 1. For example, a substituent usually used for a hole injection layer material, a material for transporting holes, a light emitting layer material, and an electron transporting layer material, which are used for manufacturing an organic light emitting device, may be introduced into the core structure to synthesize a material which satisfies conditions required for each organic material layer.

[0081] In addition, it is possible to finely adjust an energy band gap by introducing various substituents into the structure of Chemical Formula 1, and meanwhile, it is possible to improve characteristics at the interface between organic materials and diversify the use of material.

[0082] Meanwhile, the hetero-cyclic compound has a high glass transition temperature (Tg) and thus has excellent thermal stability. The increase in thermal stability becomes an important factor which provides driving stability to a device.

[0083] The hetero-cyclic compound according to an exemplary embodiment of the present application may be prepared by a multi-step chemical reaction. Some intermediate compounds are first prepared, and the compound of Chemical Formula 1 may be prepared from the intermediate compounds. More specifically, the hetero-cyclic compound according to an exemplary embodiment of the present application may be prepared based on the Preparation Examples to be described below.

[0084] Another exemplary embodiment of the present application provides an organic light emitting device comprising the hetero-cyclic compound represented by Chemical Formula 1.

[0085] The organic light emitting device according to an exemplary embodiment of the present application may be manufactured by typical manufacturing methods and materials of the organic light emitting device, except that the above-described hetero-cyclic compound is used to form an organic material layer having one or more layers.

[0086] The hetero-cyclic compound may be formed as an organic material layer by not only a vacuum deposition method, but also a solution application method when an organic light emitting device is manufactured. Here, the solution application method means spin coating, dip coating, inkjet printing, screen printing, a spray method, roll coating, and the like, but is not limited thereto.

[0087] Specifically, the organic light emitting device according to an exemplary embodiment of the present application comprises a positive electrode, a negative electrode, and an organic material layer having one or more layers disposed between the positive electrode and the negative electrode, in which one or more layers of the organic material layer comprise the hetero-cyclic compound represented by Chemical Formula 1.

[0088] FIGS. **1** to **3** exemplify the stacking sequence of the electrodes and the organic material layer of the organic light emitting device according to an exemplary embodiment of the present application. However, the scope of the present application is not intended to be limited by these drawings, and the structure of the organic light emitting device known in the art may also be applied to the present application.

[0089] According to FIG. **1**, an organic light emitting device in which a positive electrode **200**, an organic material layer **300**, and a negative electrode **400** are sequentially stacked on a substrate **100** is illustrated. However, the organic light emitting device is not limited only to such a structure, and as in FIG. **2**, an organic light emitting device in which a negative electrode, an organic material layer, and a positive electrode are sequentially stacked on a substrate may also be implemented.

[0090] FIG. **3** exemplifies a case where an organic material layer is a multilayer. An organic light emitting device according to FIG. **3** comprises a hole injection layer **301**, a hole transporting layer **302**, a light emitting layer **303**, a hole blocking layer **304**, an electron transporting layer **305**, and an electron injection layer **306**. However, the scope of the present application is not limited by the stacking structure as described above, and if necessary, the other layers except for the light emitting layer may be omitted, and another necessary functional layer may be further added.

[0091] The organic light emitting device according to the present specification may be manufactured by the materials and methods known in the art, except that one or more layers of the organic material layer comprise the hetero-cyclic compound represented by Chemical Formula 1.

[0092] The hetero-cyclic compound represented by Chemical Formula 1 may alone constitute one or more layers of the organic material layer of the organic light emitting device. However, the hetero-cyclic compound represented by Chemical Formula 1 may be mixed with another material, if necessary, to constitute an organic material layer.

[0093] The hetero-cyclic compound represented by Chemical Formula 1 may be used as a material for an electron transporting layer, an electron transferring layer, a charge producing layer, a hole blocking layer, or a light emitting layer, and the like in an organic light emitting device. As an example, the hetero-cyclic compound represented by Chemical Formula 1 may be used as a material for an electron transferring layer, an electron transporting layer, or a charge producing layer of an organic light emitting device.

[0094] In addition, the hetero-cyclic compound represented by Chemical Formula 1 is used as a host of an electron transferring layer, an electron transporting layer, or a charge producing layer of an organic light emitting device, and the electron transferring layer, the electron transporting layer, or the charge producing layer may additionally comprise one or more n-type dopants selected from alkali metals and alkaline earth metals.

[0095] Furthermore, the hetero-cyclic compound represented by Chemical Formula 1 may be used as a material for a light emitting layer in an organic light emitting device. As an example, the hetero-cyclic compound represented by Chemical Formula 1 may be used as a material for a phosphorescent host of a light emitting layer in an organic light emitting device.

[0096] In the organic light emitting device according to an exemplary embodiment of the present application, materials other than the hetero-cyclic compound of Chemical Formula 1 will be exemplified below, but these materials are illustrative only and are not for limiting the scope of the present application, and may be replaced with materials publicly known in the art.

[0097] As a positive electrode material, materials having a relatively high work function may be used, and a transparent conductive oxide, a metal or a conductive polymer, and the like may be used. Specific examples of the positive electrode material comprise: a metal such as vanadium, chromium, copper, zinc, and gold, or an alloy thereof; a metal oxide such as zinc oxide, indium oxide, indium tin oxide (ITO), and indium zinc oxide (IZO); a combination of a metal and an oxide, such as ZnO:Al or $SnOz_2$:Sb; a conductive polymer such as poly(3-methylthiophene), poly[3,4-(ethylene-1,2-dioxy)thiophene] (PEDOT), polypyrrole, and polyaniline; and the like, but are not limited thereto.

[0098] As a material for the negative electrode, materials having a relatively low work function may be used, and a metal, a metal oxide, or a conductive polymer, and the like may be used. Specific examples of the negative electrode material comprise: a metal such as magnesium, calcium, sodium, potassium, titanium, indium, yttrium, lithium, gadolinium, aluminum, silver, tin, and lead, or an alloy thereof; a multi-layer structured material such as LiF/Al or LiO_2/Al; and the like, but are not limited thereto.

[0099] As a hole injection material, a publicly-known hole injection material may also be used, and it is possible to use, for example, a phthalocyanine compound such as copper phthalocyanine disclosed in U.S. Pat. No. 4,356,429 or starburst-type amine derivatives described in the document [Advanced Material, 6, p. 677 (1994)], for example, tris(4-carbazoyl-9-ylphenyl)amine (TCTA), 4,4',4"-tris[phenyl(m-tolyl)amino]triphenylamine (m-MTDATA), 1,3,5-tris[4-(3-methylphenylphenylamino)phenyl]benzene (m-MTDAPB), polyaniline/dodecylbenzenesulfonic acid or poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate), which is a soluble conductive polymer, polyaniline/camphor sulfonic acid or polyaniline/poly(4-styrene-sulfonate), and the like.

[0100] As a hole transport material, a pyrazoline derivative, an arylamine-based derivative, a stilbene derivative, a triphenyldiamine derivative, and the like may be used, and a low-molecular weight or polymer material may also be used.

[0101] As an electron transport material, it is possible to use an oxadiazole derivative, anthraquinodimethane and a derivative thereof, benzoquinone and a derivative thereof, naphthoquinone and a derivative thereof, anthraquinone and a derivative thereof, tetracyanoanthraquinodimethane and a derivative thereof, a fluorenone derivative, diphenyldicyanoethylene and a derivative thereof, a diphenoquinone derivative, a metal complex of 8-hydroxyquinoline and a derivative thereof, and the like, and a low-molecular weight material and a polymer material may also be used.

[0102] As an electron injection material, for example, LiF is representatively used in the art, but the present application is not limited thereto.

[0103] As a light emitting material, a red, green, or blue light emitting material may be used, and if necessary, two or more light emitting materials may be mixed and used. Further, as the light emitting material, a fluorescent material may also be used, but a phosphorescent material may also be used. As the light emitting material, it is also possible to use alone a material which emits light by combining holes and electrons each injected from a positive electrode and a negative electrode, but materials in which a host material and a dopant material are involved in light emission together may also be used.

[0104] The organic light emitting device according to an exemplary embodiment of the present application may be a top emission type, a bottom emission type, or a dual emission type according to the material to be used.

[0105] The hetero-cyclic compound according to an exemplary embodiment of the present application may act even in organic electronic devices including organic solar cells, organic photoconductors, organic transistors, and the like, based on the principle similar to those applied to organic light emitting devices.

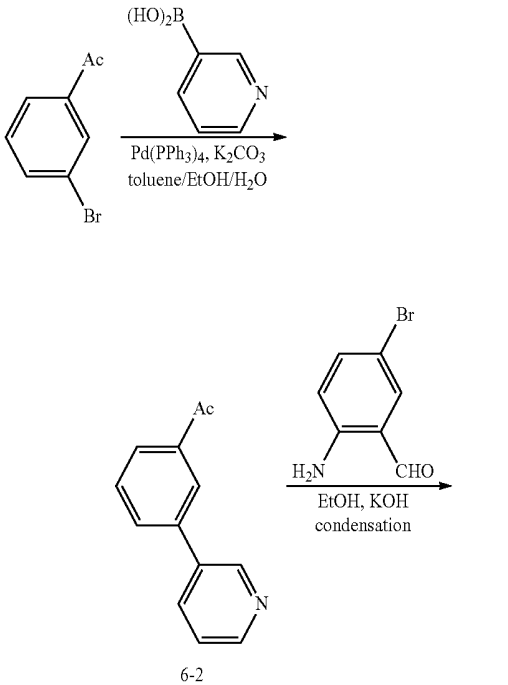
MODE FOR INVENTION

[0106] Hereinafter, the present specification will be described in more detail through Examples, but these Examples are provided only for exemplifying the present application, and are not intended to limit the scope of the present application.

Examples

<Preparation Example 1> Preparation of Compound 6

[0107]



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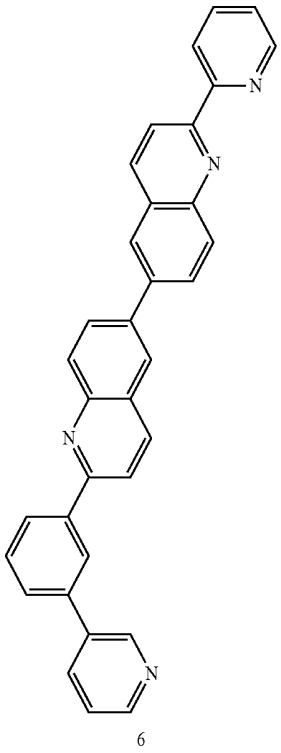


[0108] Preparation of Compound 6-2

[0109] A compound pyridin-3-ylboronic acid (12.4 g, 100 mmol) and 1-(3-bromophenyl)ethan-1-one (20 g, 100 mmol) were dissolved in 200 mL of toluene, and then $Pd(PPh_3)_4$ (3.4 g, 3 mmol) and K_2CO_3 (41 g, 300 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. EtOH (40 mL) and H_2O (40 mL) were additionally added dropwise to a reaction vessel, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 6-2 (18 g, 91%).

[0110] Preparation of Compound 6-1

[0111] Compound 6-2 (18 g, 91.2 mmol) and 2-amino-5-bromobenzaldehyde (38 g, 91.2 mmol) were dissolved in EtOH (300 mL), and then KOH (91.2 mmol) was added to the resulting solution in a reaction vessel, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 6-1 (26 g, 80%).

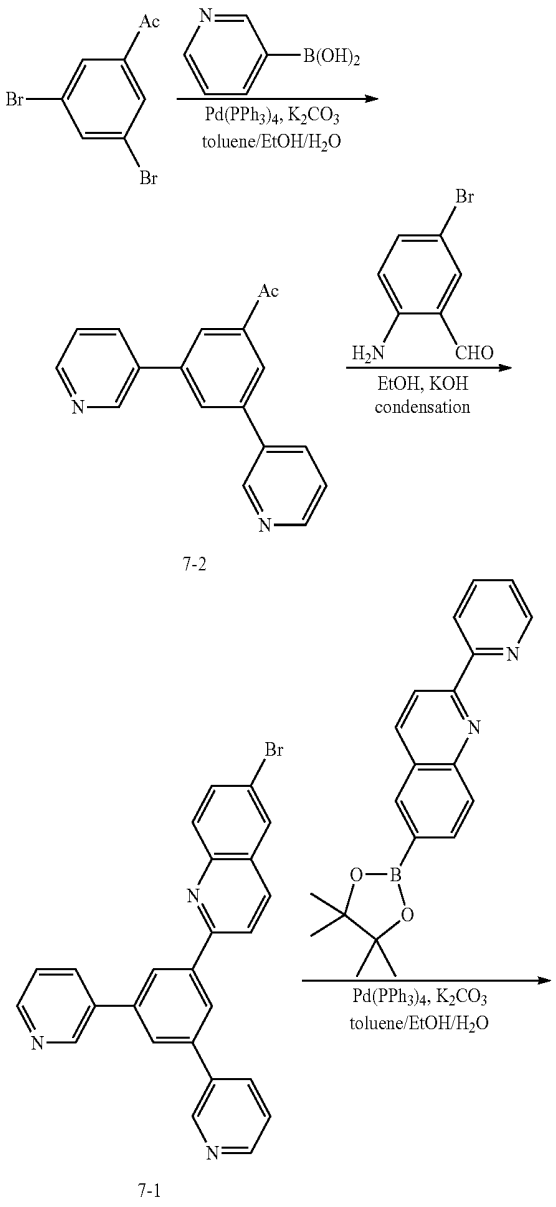
[0112] Preparation of Compound 6

[0113] Compound 6-1 (8 g, 22.2 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (7.4 g, 22.2 mmol) were dissolved in toluene (50 mL),

and then $Pd(PPh_3)_4$ (2.3 g, 2 mmol) and K_2CO_3 (8.3 g, 60 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. H_2O (10 mL) and EtOH (6 mL) were additionally added dropwise to a reaction vessel, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 6 (7 g, 65%).

<Preparation Example 2> Preparation of Compound 7

[0114]



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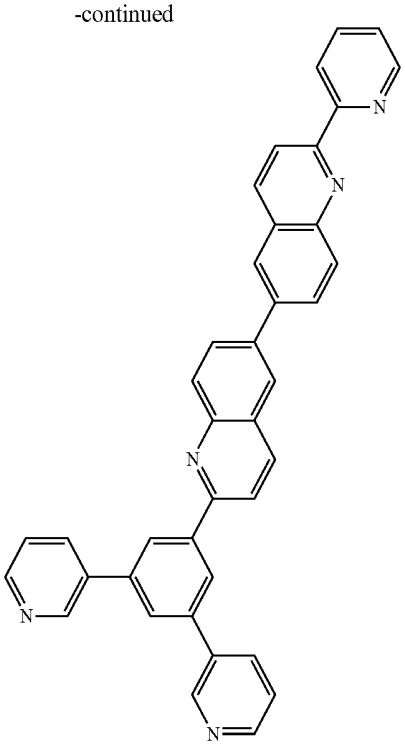


7

[0115] Preparation of Compound 7-2

[0116] A compound pyridin-3-ylboronic acid (23 g, 187 mmol) and 1-(3,5-dibromophenyl)ethan-1-one (23.6 g, 85 mmol) were dissolved in 500 mL of toluene, and then $Pd(PPh_3)_4$ (4.9 g, 4.3 mmol) and K_2CO_3 (35.2 g, 255 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. EtOH (100 mL) and H_2O (100 mL) were added dropwise to a reaction vessel, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 7-2 (16 g, 70%).

[0117] Preparation of Compound 7-1

[0118] Compound 7-2 (6.2 g, 22.6 mmol) and 2-amino-5-bromobenzaldehyde (4.52 g, 22.6 mmol) were dissolved in EtOH (150 mL), and then KOH (22.6 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 7-1 (9.6 g, 97%).

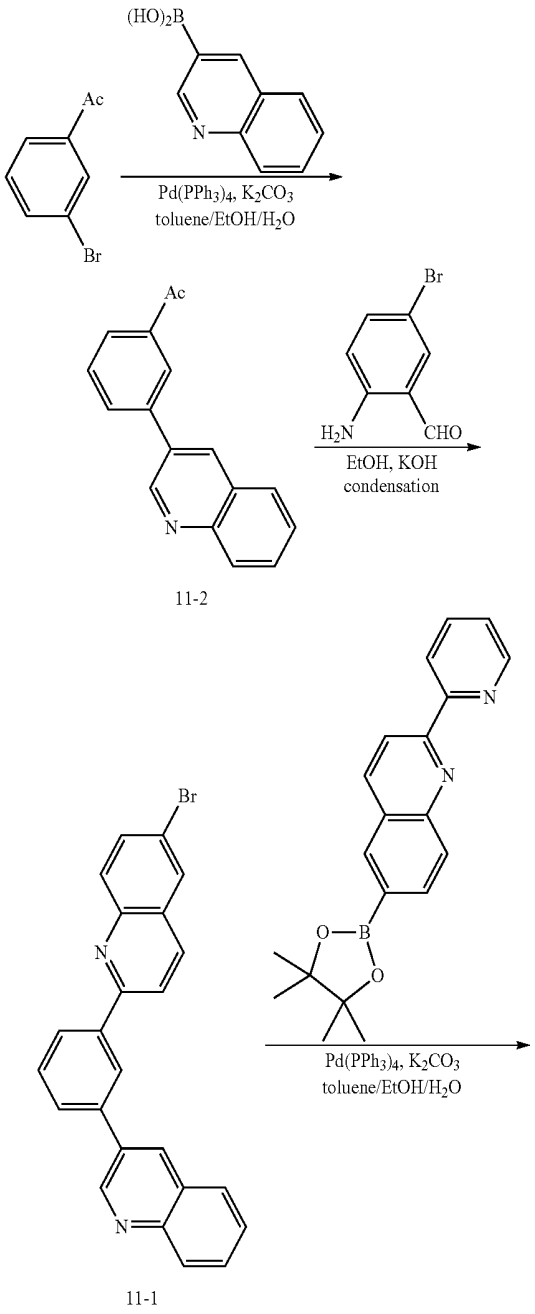
[0119] Preparation of Compound 7

[0120] Compound 7-1 (8.8 g, 20 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (6.5 g, 20 mmol) were dissolved in toluene (50 mL), and

then $Pd(PPh_3)_4$ (2.3 g, 2 mmol) and K_2CO_3 (8.3 g, 60 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (10 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 7 (6.8 g, 67%).

<Preparation Example 4> Preparation of Compound 11

[0121]



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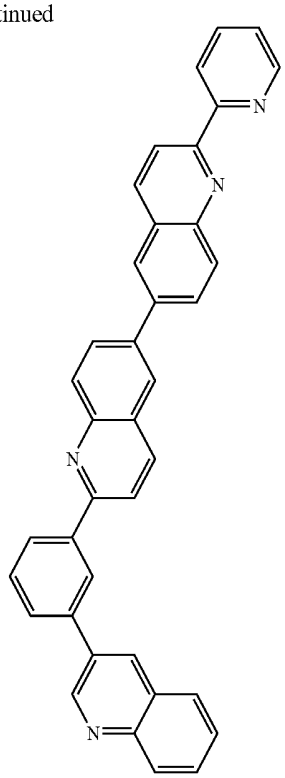


11

[0122] Preparation of Compound 11-2

[0123] A compound quinolin-3-ylboronic acid (26 g, 151 mmol) and 1-(3-bromophenyl)-ethan-1-one (30 g, 151 mmol) were dissolved in 300 mL of toluene, and then $Pd(PPh_3)_4$ (5.2 g, 4.5 mmol) and K_2CO_3 (63 g, 450 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. EtOH (60 mL) and H_2O (60 mL) were additionally added dropwise to a reaction vessel, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 11-2 (25 g, 68%).

[0124] Preparation of Compound 11-1

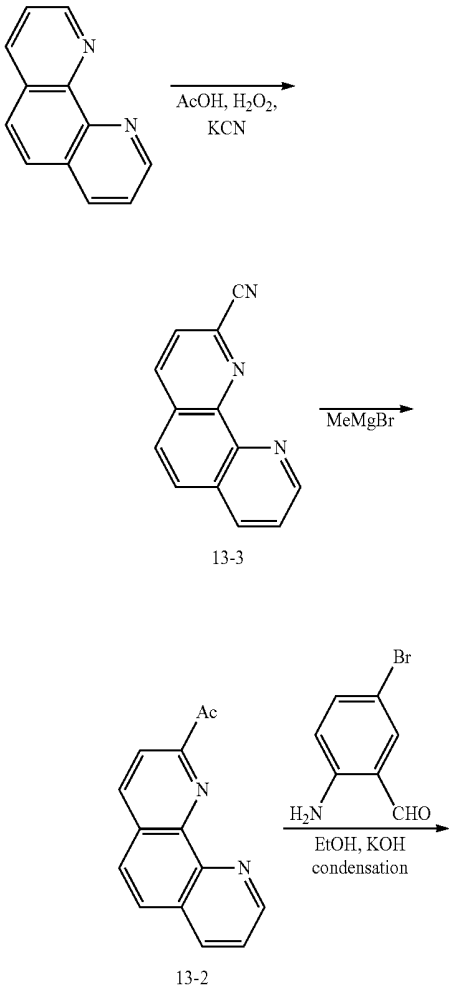
[0125] Compound 11-2 (25 g, 102.7 mmol) and 2-amino-5-bromobenzaldehyde (20.5 g, 102.7 mmol) were dissolved in EtOH (200 mL), and then KOH (102.7 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 11-1 (22 g, 52%).

[0126] Preparation of Compound 11

[0127] Compound 11-1 (6.8 g, 16.5 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 12.9 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 11 (7.1 g, 80%).

<Preparation Example 4> Preparation of Compound 13

[0128]



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13-3

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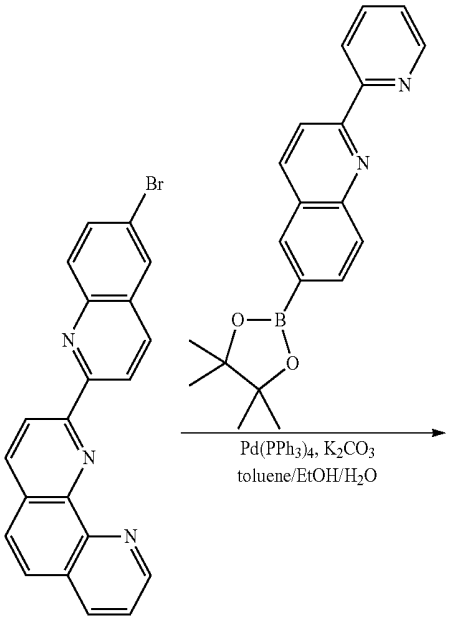

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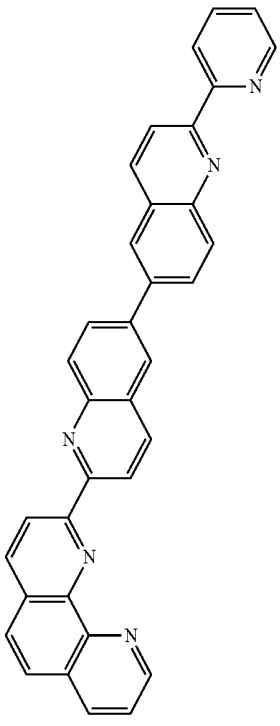


13

[0129] Preparation of Compound 13-3

[0130] A compound 1,10-phenanthroline (50 g, 250 mmol) was dissolved in AcOH (60 mL), and then 30% H_2O_2 (60 mL) was added thereto, and the resulting mixture was refluxed for 4 hours. After the reaction was completed, the

reaction product was cooled to normal temperature, and then the pH was adjusted to 11 by using a saturated aqueous KOH solution. And then, an extraction was performed by using chloroform. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator. KCN (38 g) was added to 38 g of the thus obtained yellow solid, the resulting mixture was dissolved in water, and then benzoyl chloride (38 mL) was slowly added dropwise thereto. After the mixture was stirred at normal temperature for 4 hours, it was confirmed that the reaction was terminated, and then the resulting product was filtered with a paper filter. The filtered solute was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 13-3 (28 g, 54%).

[0131] Preparation of Compound 13-2

[0132] Compound 13-3 (20 g, 97.5 mmol) was dissolved in THF (50 mL), and then 9.7 mL of MeMgBr(3M) was slowly added dropwise thereto at −78° C. It was confirmed that the reaction was terminated by warming the mixture to normal temperature, and an extraction was performed with an aqueous NH_4Cl solution and dichloromethane. After the organic layer was dried over anhydrous $MgSO_4$, the solvent was removed by using a rotary evaporator, and then the resulting product was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 13-2 (10 g, 46%).

[0133] Preparation of Compound 13-1

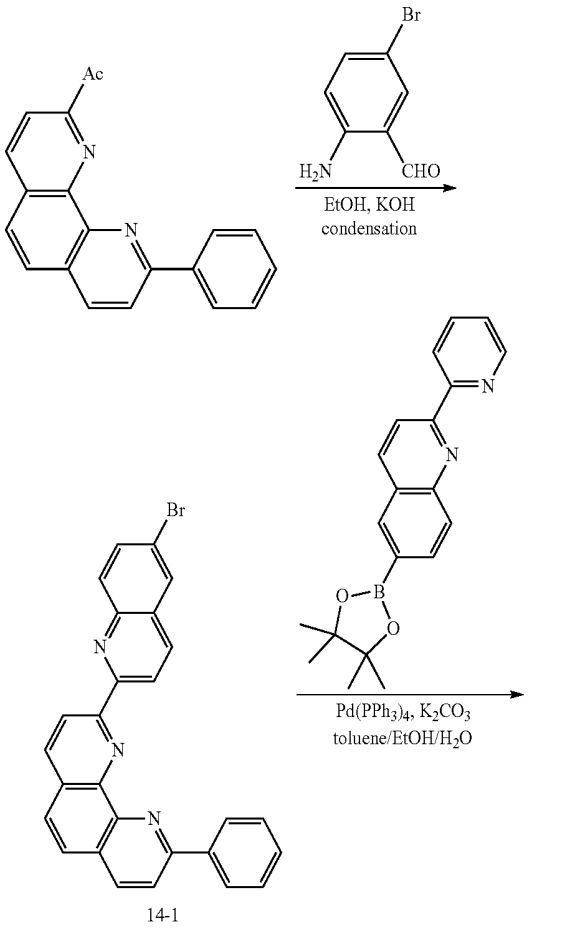
[0134] After Compound 13-2 (10 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 13-1 (14.6 g, 84%).

[0135] Preparation of Compound 13

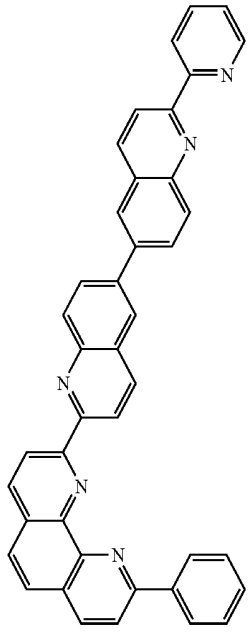
[0136] Compound 13-1 (5.8 g, 15.0 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.7 g, 1.5 mmol) and K_2CO_3 (6.2 g, 45 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 13 (6.2 g, 81%).

<Preparation Example 5> Preparation of Compound 14

[0137]



14-1



14

[0138] Preparation of Compound 14-1

[0139] After a compound 1-(9-phenyl-1,10-phenanthrolin-2-yl)ethan-1-one (13.4 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH

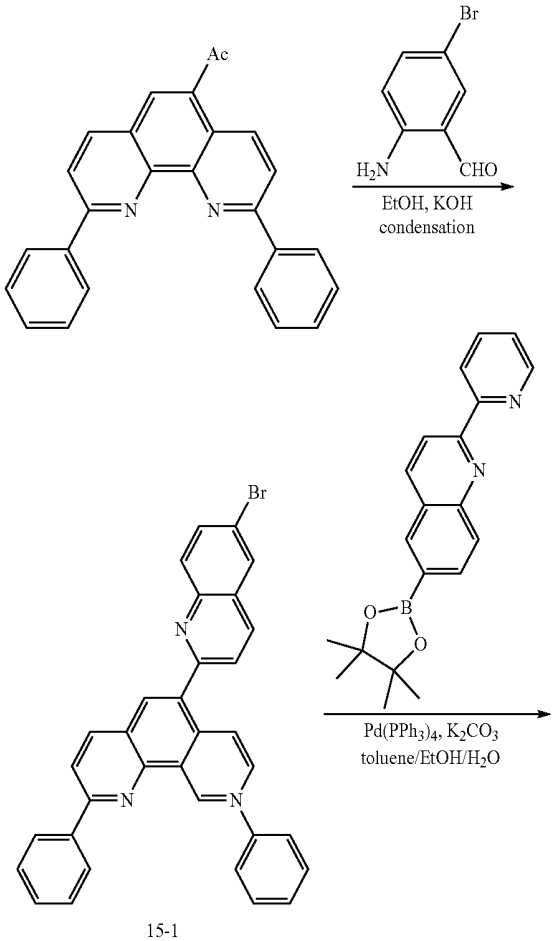
(200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 14-1 (18.5 g, 89%).

[0140] Preparation of Compound 14

[0141] Compound 14-1 (8.7 g, 15 mmol) and a compound 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 14 (5.5 g, 62%).

<Preparation Example 6> Preparation of Compound 15

[0142]



15-1

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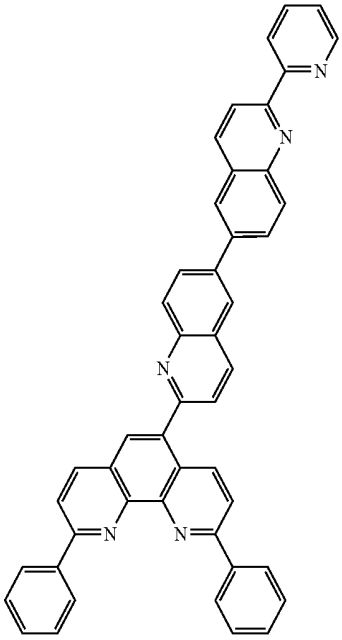


15

[0143] Preparation of Compound 15-1

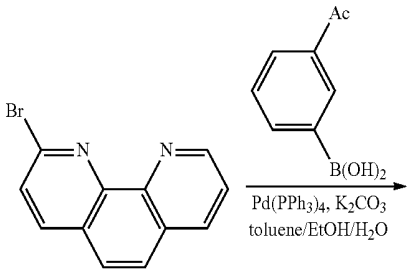
[0144] After a compound 1-(2,9-diphenyl-1,10-phenanthrolin-5-yl)ethan-1-one (3.7 g, 10 mmol) and 2-amino-5-bromobenzaldehyde (2 g, 10 mmol) were dissolved in EtOH (200 mL), 3 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 15-1 (5.2 g, 96%).

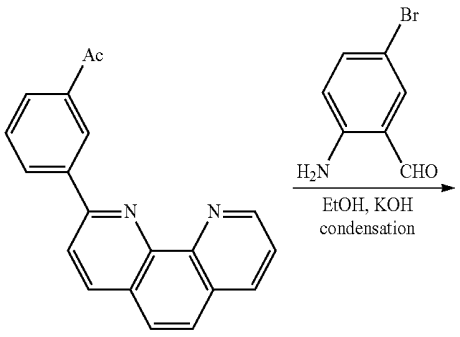
[0145] Preparation of Compound 15

[0146] Compound 15-1 (5.2 g, 9.6 mmol) and a compound 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (3.2 g, 9.6 mmol) were dissolved in toluene (25 mL), and then $Pd(PPh_3)_4$ (1.1 g, 0.96 mmol) and K_2CO_3 (3.9 g, 28.8 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (5 mL) and EtOH (5 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 15 (5.2 g, 81%).

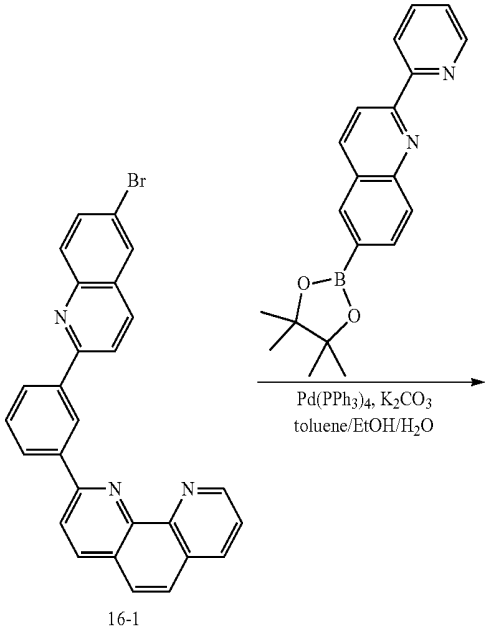
<Preparation Example 7> Preparation of Compound 16

[0147]





16-2



16-1

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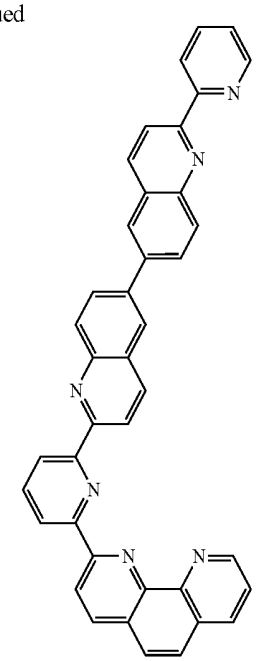


16

[0148] Preparation of Compound 16-2

[0149] A compound 2-bromo-1,10-phenanthroline (31.6 g, 121.9 mmol) and 1-(3-bromophenyl)ethan-1-one (20 g, 122 mmol) were dissolved in 200 mL of toluene, and then $Pd(PPh_3)_4$ (4.2 g, 3.65 mmol) and K_2CO_3 (50 g, 366 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. EtOH (40 mL) and H_2O (40 mL) were sequentially added dropwise to a reaction vessel, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 16-2 (28 g, 78%).

[0150] Preparation of Compound 16-1

[0151] Compound 16-2 (10.8 g, 36.2 mmol) and 2-amino-5-bromobenzaldehyde (7.24 g, 36.2 mmol) were dissolved in EtOH (150 mL), and then KOH (43.4 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered reactant was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 16-1 (15.2 g, 91%).

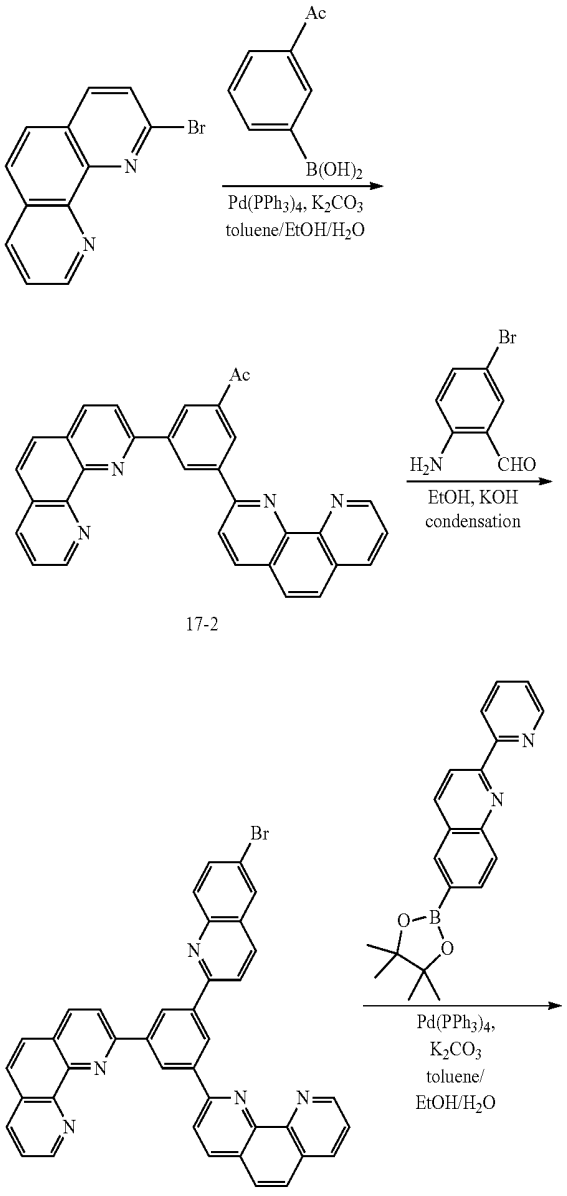
[0152] Preparation of Compound 16

[0153] Compound 16-1 (6.8 g, 14.8 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15.5 mmol) were dissolved in toluene (50 mL), and then $Pd(PPh_3)_4$ (1.4 g, 1.5 mmol) and K_2CO_3 (6.1 g, 38.7 mmol) were added to the resulting solution, and the

resulting mixture was stirred for 10 minutes. H_2O (6 mL) and EtOH (6 mL) were sequentially added to a reaction vessel, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 16 (4.8 g, 55%).

<Preparation Example 8> Preparation of Compound 17

[0154]



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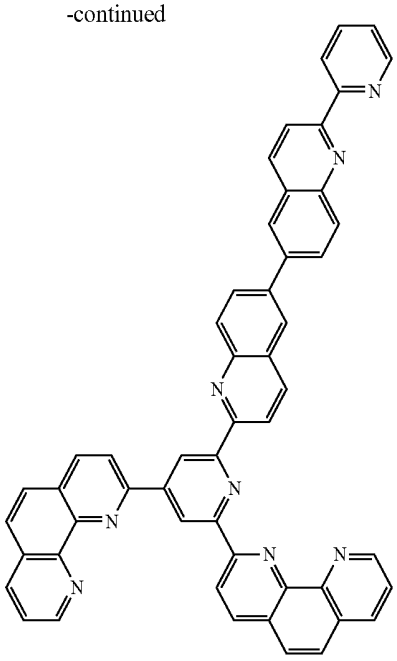


17

[0155] Preparation of Compound 17-2

[0156] A compound 2-bromo-1,10-phenanthroline (31.6 g, 122 mmol) and 1-(3-bromophenyl)ethan-1-one (10 g, 61 mmol) were dissolved in 140 mL of toluene, and then $Pd(PPh_3)_4$ (2.1 g, 1.82 mmol) and K_2CO_3 (50 g, 366 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. EtOH (25 mL) and H_2O (25 mL) were sequentially added dropwise to a reaction vessel, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 17-2 (24.4 g, 84%).

[0157] Preparation of Compound 17-1

[0158] Compound 17-2 (24.4 g, 51.2 mmol) and 2-amino-5-bromobenzaldehyde (10.2 g, 51.2 mmol) were dissolved in EtOH (250 mL), and then KOH (51.2 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered reactant was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 17-1 (25.6 g, 78%).

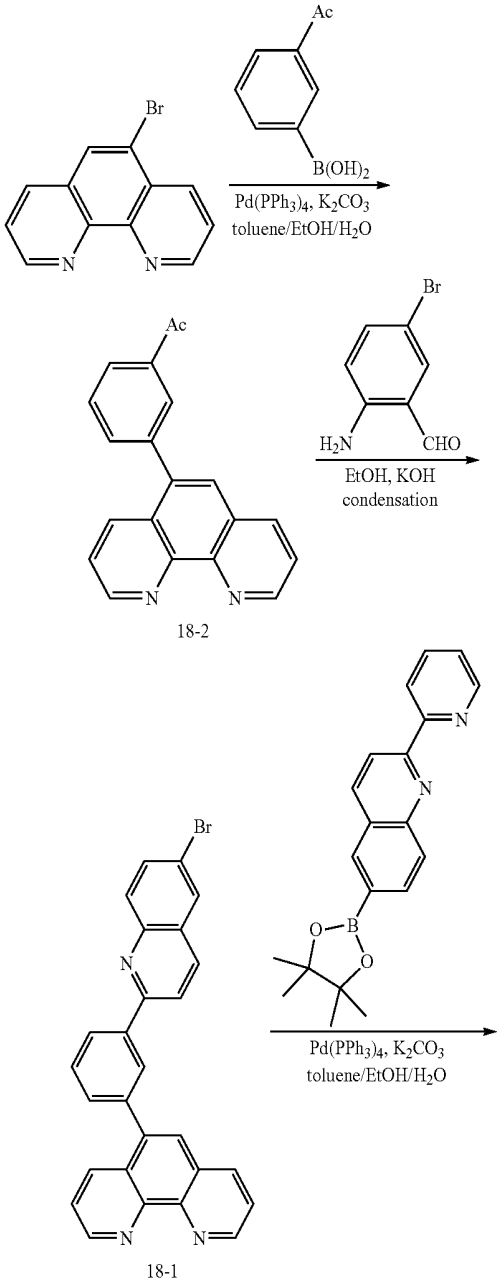
[0159] Preparation of Compound 17

[0160] Compound 17-1 (8.0 g, 12.5 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (4.2 g, 12.5 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.4 g, 1.3 mmol) and K_2CO_3 (5.8 g, 37.6 mmol) were added to the resulting solution, and the

resulting mixture was stirred for 10 minutes. H_2O (6 mL) and EtOH (6 mL) were sequentially added to a reaction vessel, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 17 (4.7 g, 49%).

<Preparation Example 9> Preparation of Compound 18

[0161]



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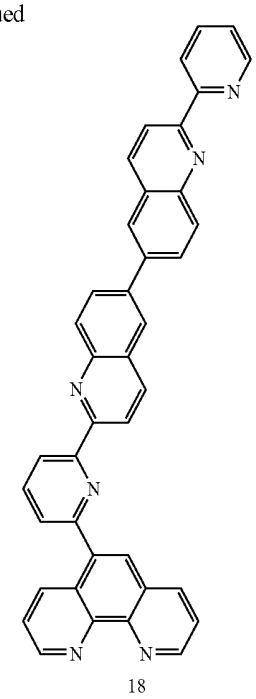


18

[0162] Preparation of Compound 18-2

[0163] A compound 5-bromo-1,10-phenanthroline (31.6 g, 122 mmol) and 1-(3-bromophenyl)ethan-1-one (20 g, 122 mmol) were dissolved in 250 mL of toluene, and then $Pd(PPh_3)_4$ (4.2 g, 3.65 mmol) and K_2CO_3 (50 g, 366 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. EtOH (50 mL) and H_2O (50 mL) were sequentially added dropwise to a reaction vessel, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 18-2 (28.7 g, 80%).

[0164] Preparation of Compound 18-1

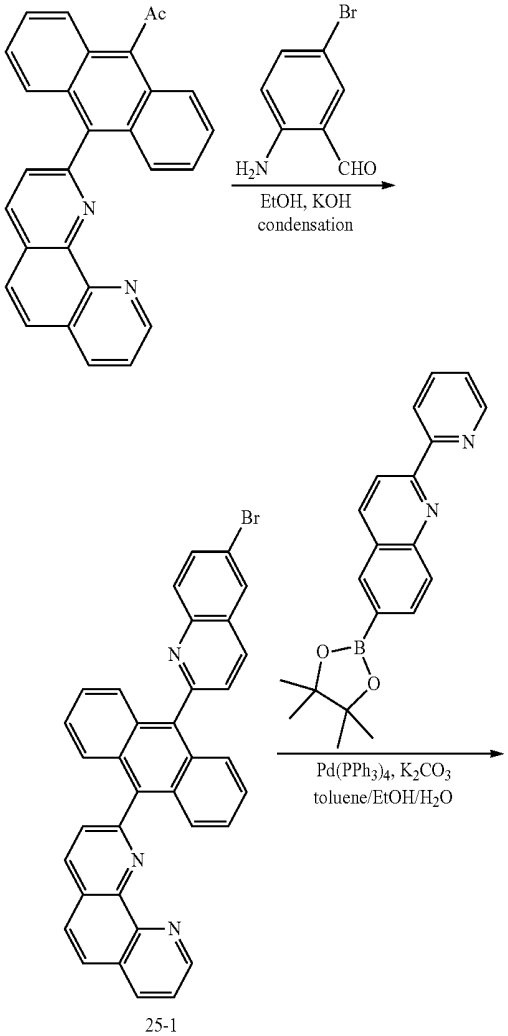
[0165] Compound 18-2 (28.7 g, 97.6 mmol) and 2-amino-5-bromobenzaldehyde (19.5 g, 97.6 mmol) were dissolved in EtOH (300 mL), and then KOH (97.6 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered reactant was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 18-1 (37.9 g, 84%).

[0166] Preparation of Compound 18

[0167] Compound 18-1 (6.9 g, 15 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.4 g, 1.5 mmol) and K_2CO_3 (6.1 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. H_2O (6 mL) and EtOH (6 mL) were sequentially added to a reaction vessel, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 18 (7.6 g, 87%).

<Preparation Example 10> Preparation of Compound 25

[0168]



25-1

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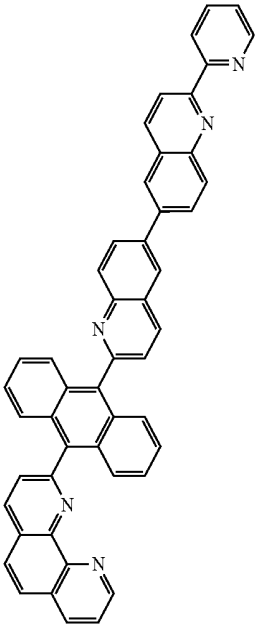


25

[0169] Preparation of Compound 25-1

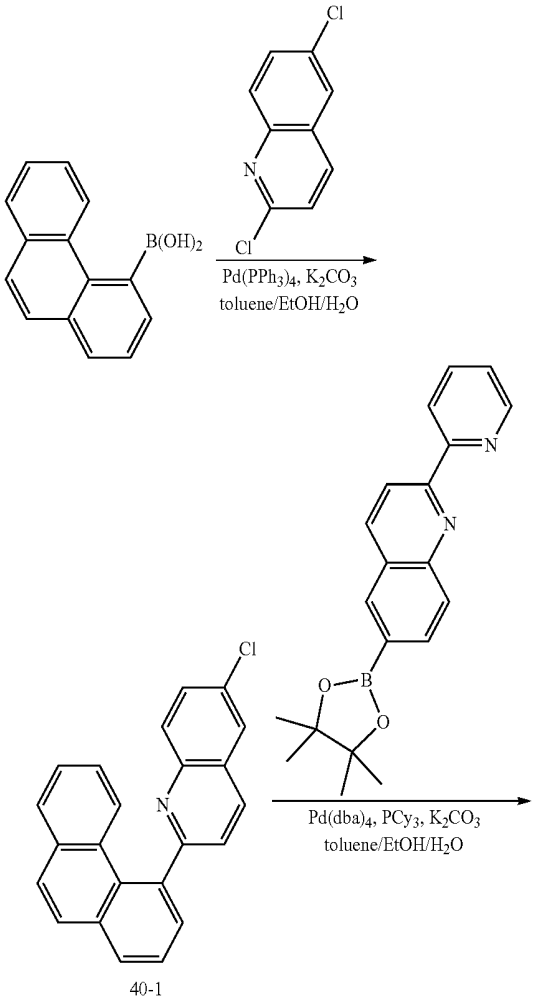
[0170] After a compound 1-(10-(1,10-phenanthrolin-2-yl)anthracen-9-yl)ethan-1-one (17.9 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 25-1 (19 g, 76%).

[0171] Preparation of Compound 25

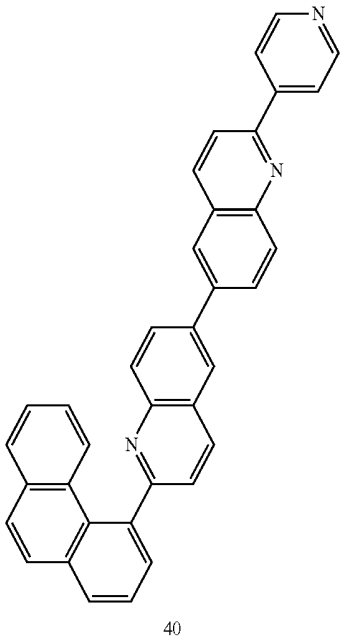
[0172] Compound 25-1 (8.4 g, 15 mmol) and a compound 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 25 (8.2 g, 80%).

<Preparation Example 11> Preparation of Compound 40

[0173]



40-1



40

[0174] Preparation of Compound 40-1

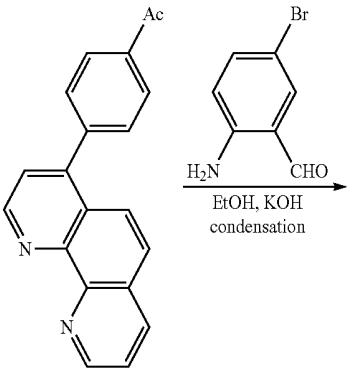
[0175] A compound phenanthren-4-ylboronic acid (10 g, 45 mmol) and 2,6-dichloroquinoline (9.8 g, 49.5 mmol) were dissolved in toluene (100 mL), and then $Pd(PPh_3)_4$ (2.6 g, 2.3 mmol) and K_2CO_3 (18.6 g, 135 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. And then, H_2O (20 mL) and EtOH (20 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 40-1 (5.9 g, 39%).

[0176] Preparation of Compound 40

[0177] Compound 40-1 (5.9 g, 17.6 mmol) and 2-(pyridin-4-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.8 g, 17.6 mmol) were dissolved in toluene (40 mL), and then $Pd(PPh_3)_2$ (0.88 mmol), PCy_3 (0.88 mmol), and K_2CO_3 (7.3 g, 135 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (8 mL) and EtOH (8 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 40 (7.1 g, 79%).

<Preparation Example 12> Preparation of Compound 44

[0178]



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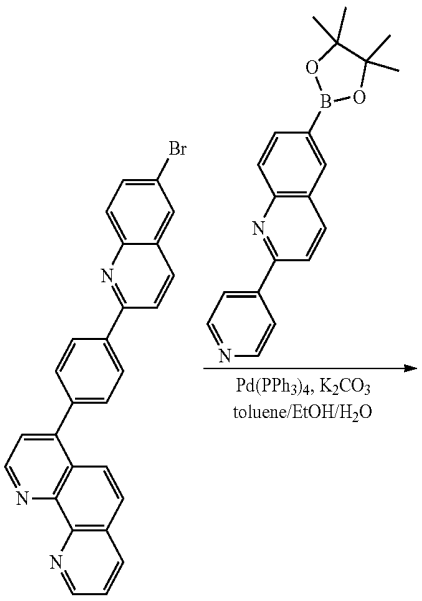
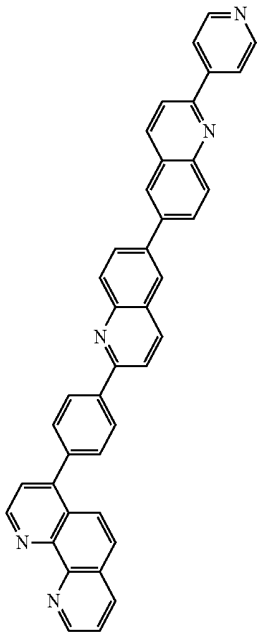


44-1



44

[0179] Preparation of Compound 44-1

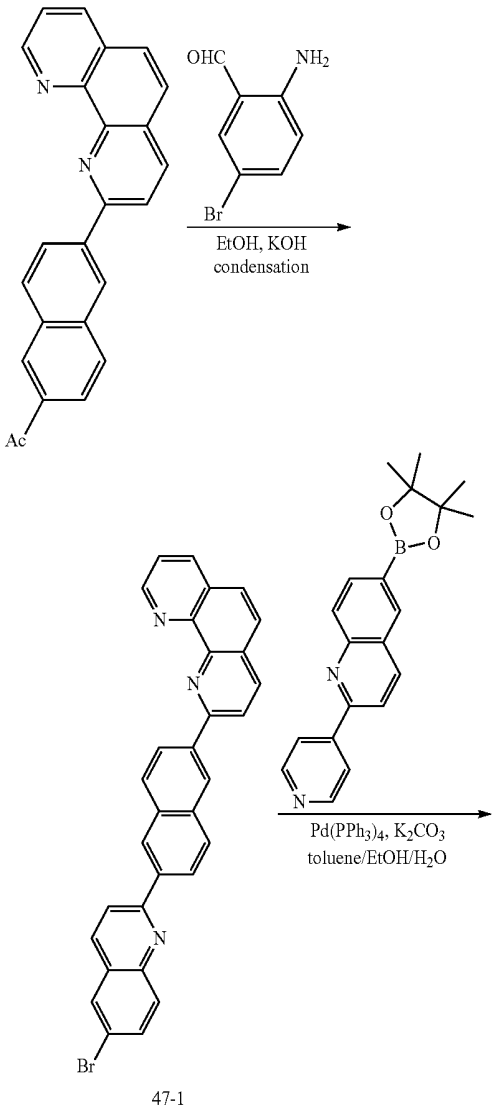
[0180] After a compound 1-(4-(1,10-phenanthrolin-4-yl) phenyl)ethan-1-one (13.4 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 44-1 (16.4 g, 79%).

[0181] Preparation of Compound 44

[0182] A compound 2-(pyridin-4-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (6.6 g, 20 mmol) and Compound 44-1 (9.2 g, 20 mmol) were dissolved in toluene (40 mL), and then $Pd(PPh_3)_4$ (2.3 g, 2 mmol) and K_2CO_3 (8.3 g, 60 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (8 mL) and EtOH (8 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 44 (9.0 g, 77%).

<Preparation Example 13> Preparation of Compound 47

[0183]



47-1

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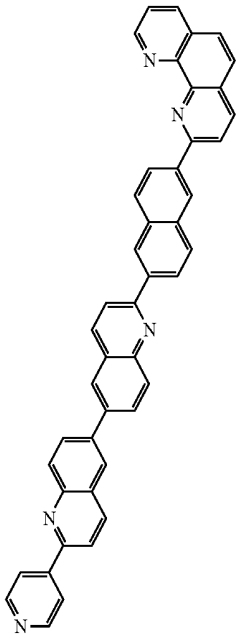


47

[0184] Preparation of Compound 47-1

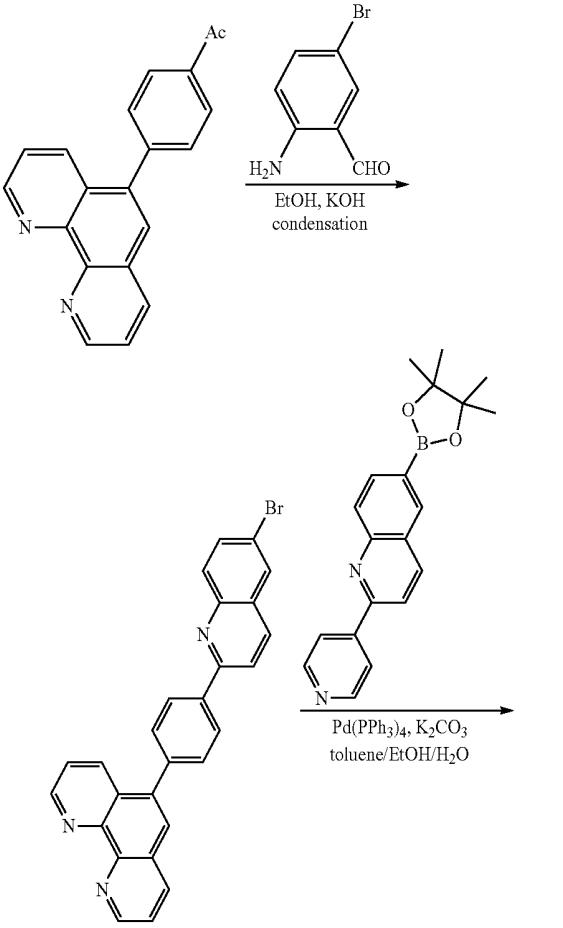
[0185] After a compound 1-(6-(1,10-phenanthrolin-2-yl) naphthalen-2-yl)ethan-1-one (15.7 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 47-1 (20 g, 88%).

[0186] Preparation of Compound 47

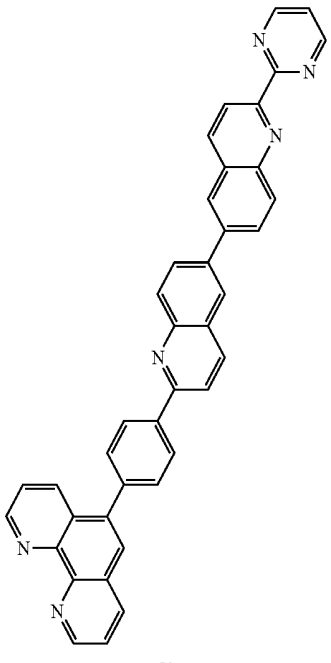
[0187] Compound 47-1 (7.7 g, 15 mmol) and a compound 2-(pyridin-4-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 47 (7.5 g, 79%).

<Preparation Example 14> Preparation of Compound 52

[0188]



52-1



52

[0189] Preparation of Compound 52-1

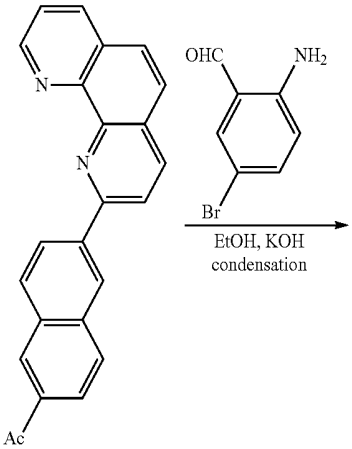
[0190] After a compound 1-(4-(1,10-phenanthrolin-5-yl) phenyl)ethan-1-one (13.4 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 52-1 (16.8 g, 81%).

[0191] Preparation of Compound 52

[0192] A compound 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (4.8 g, 14.4 mmol) and Compound 52-1 (6.6 g, 14.4 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 52 (6.5 g, 77%).

<Preparation Example 15> Preparation of Compound 68

[0193]



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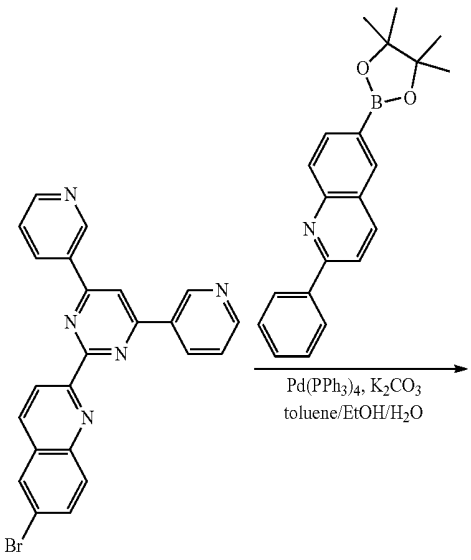
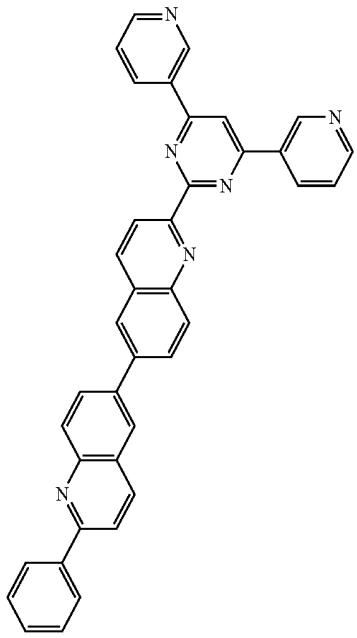


68-1



68

[0194] Preparation of Compound 68-2

[0195] A compound pyridin-3-ylboronic acid (5.3 g, 42.8 mmol) and 1-(4,6-dibromopyridin-2-yl)ethan-1-one (10 g, 35.7 mmol) were dissolved in 50 mL of toluene, and then $Pd(PPh_3)_4$ (1.1 g, 1.0 mmol) and K_2CO_3 (14.8 g, 107 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. And then, EtOH (10 mL) and H_2O (10 mL) were added dropwise thereto, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled

water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 68-2 (7.8 g, 80%).

[0196] Preparation of Compound 68-1

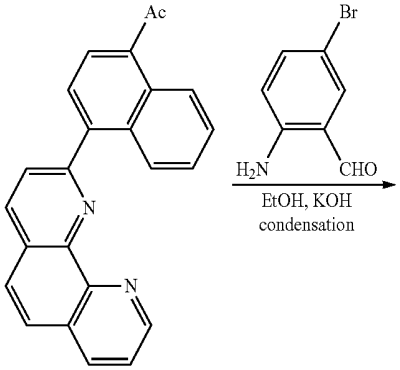
[0197] Compound 68-2 (7.8 g, 28.6 mmol) and 2-amino-5-bromobenzaldehyde (5.72 g, 28.6 mmol) were dissolved in EtOH (150 mL), and then KOH (28.6 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 68-1 (11.3 g, 90%).

[0198] Preparation of Compound 68

[0199] Compound 68-1 (10 g, 22.7 mmol) and 2-phenyl-6-(4,4,5,5-tertmethyl-1,3,2-dioxaborolan-2-yl)quinoline (9.0 g, 27.2 mmol) were dissolved in toluene (50 mL), and then $Pd(PPh_3)_4$ (0.8 g, 0.7 mmol) and K_2CO_3 (9.4 g, 68 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (10 mL) and EtOH (10 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 68 (6.8 g, 67%).

<Preparation Example 16> Preparation of Compound 91

[0200]



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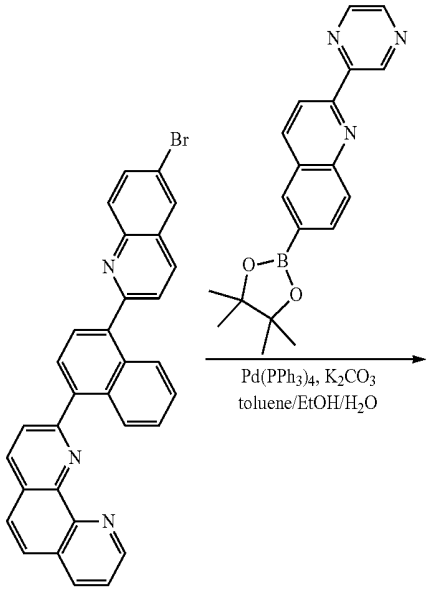
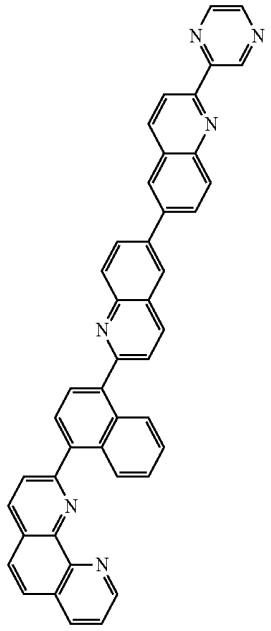


91-1



91

[0201] Preparation of Compound 91-1

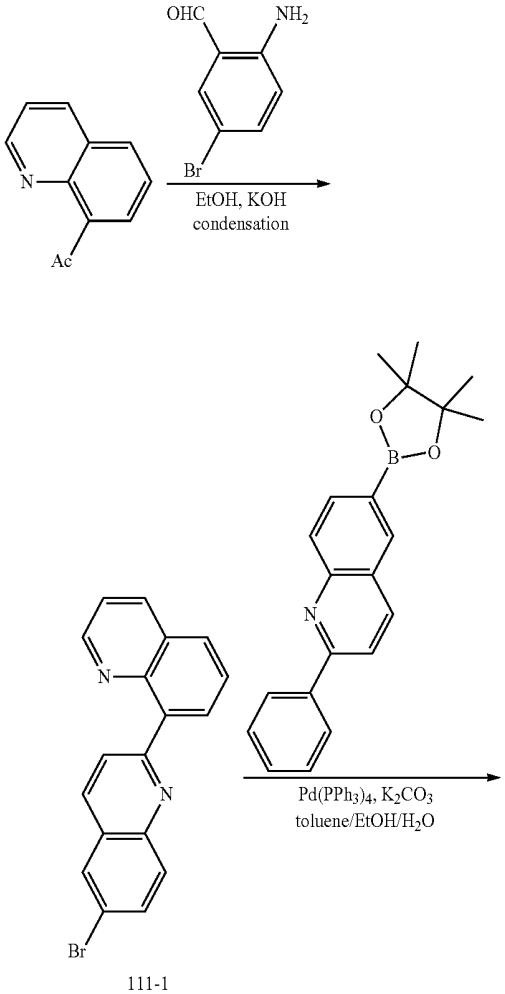
[0202] After a compound 1-(4-(1,10-phenanthrolin-2-yl) naphthalen-1-yl)ethan-1-one (15.7 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 91-1 (21.8 g, 95%).

[0203] Preparation of Compound 91

[0204] A compound 2-(pyrazin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15 mmol) and Compound 91-1 (7.7 g, 15 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 10 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 91 (7.1 g, 74%).

<Preparation Example 17> Preparation of Compound 111

[0205]



111-1

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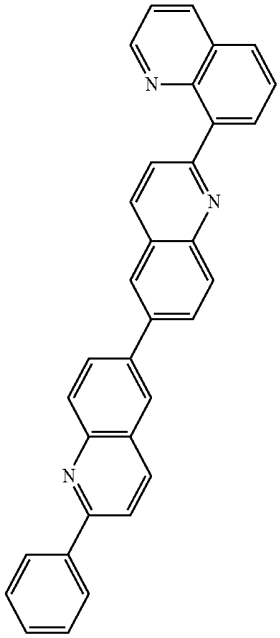


111

[0206] Preparation of Compound 111-1

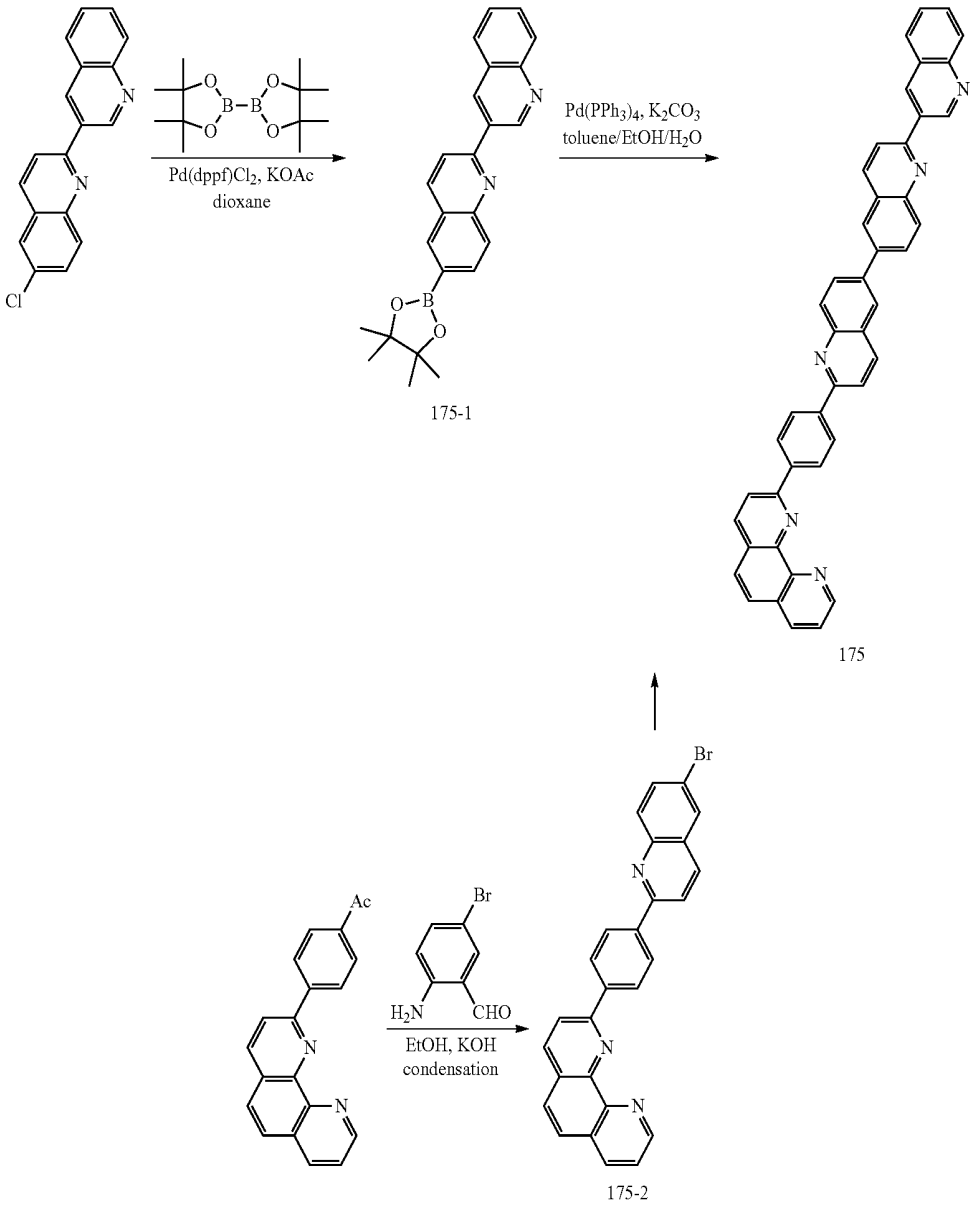
[0207] A compound 1-(quinolin-8-yl)ethan-1-one (10 g, 58.5 mmol) and 2-amino-5-bromobenzaldehyde (11.7 g, 58.5 mmol) were dissolved in EtOH (150 mL), and then KOH (58.5 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 111-1 (16 g, 83%).

[0208] Preparation of Compound 111

[0209] Compound 111-1 (8 g, 23.9 mmol) and 2-phenyl-6-(4,4,5,5-tertmethyl-1,3,2-dioxaborolan-2-yl)quinoline (9.5 g, 28.7 mmol) were dissolved in toluene (50 mL), and then $Pd(PPh_3)_4$ (0.8 g, 0.7 mmol) and K_2CO_3 (9.9 g, 71.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (10 mL) and EtOH (10 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 111 (8.5 g, 78%).

<Preparation Example 18> Preparation of Compound 175

[0210]



[0211] Preparation of Compound 175-1

[0212] A compound 6-chloro-2,3'-biquinoline (5.5 g, 18.9 mmol), 4,4,4',4',5,5,5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (6.7 g, 26.5 mmol), $Pd(dppf)_2Cl_2$ (1.5 g, 2.1 mmol), and KOAc (5.6 g, 56.7 mmol) were put into a reaction vessel, dioxane (0.3 M) was added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. After the extracted organic layer was dried over anhydrous Na_2SO_4, the solvent was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 175-1 (5.5 g, 76%).

[0213] Preparation of Compound 175-2

[0214] After a compound 1-(4-(1,10-phenanthrolin-2-yl) phenyl)ethan-1-one (13.4 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 175-2 (17 g, 82%).

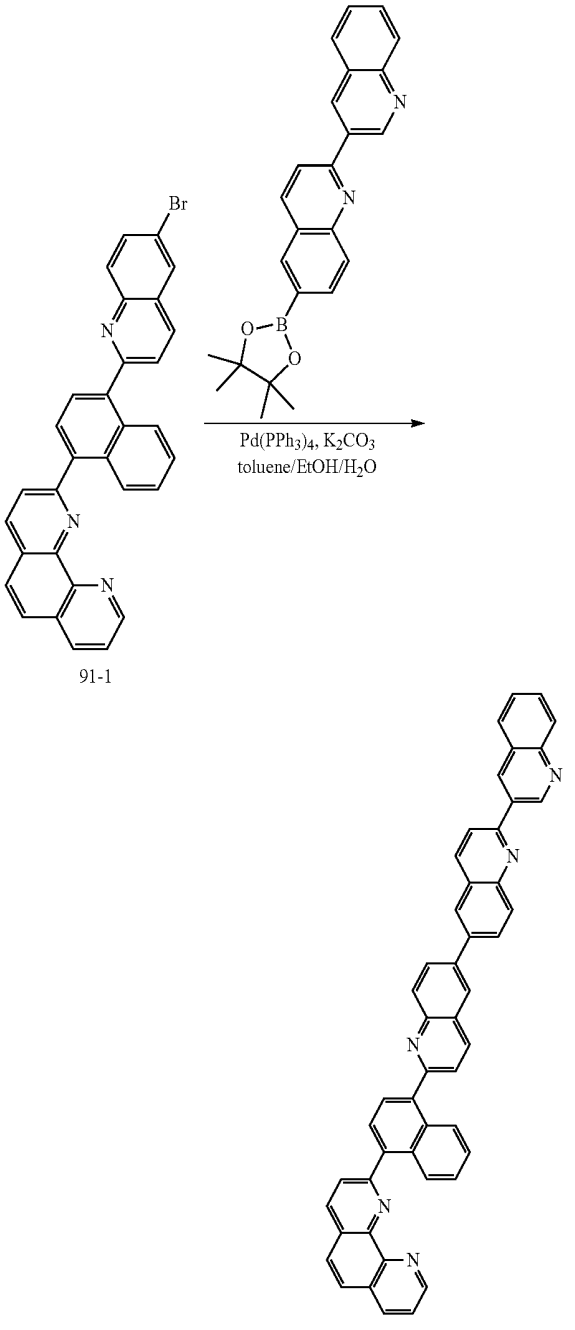
[0215] Preparation of Compound 175

[0216] Compound 175-1 (5.5 g, 14.4 mmol) and Compound 175-2 (6.6 g, 14.4 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and

the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 175 (7.3 g, 74%).

<Preparation Example 19> Preparation of Compound 179

[0217]

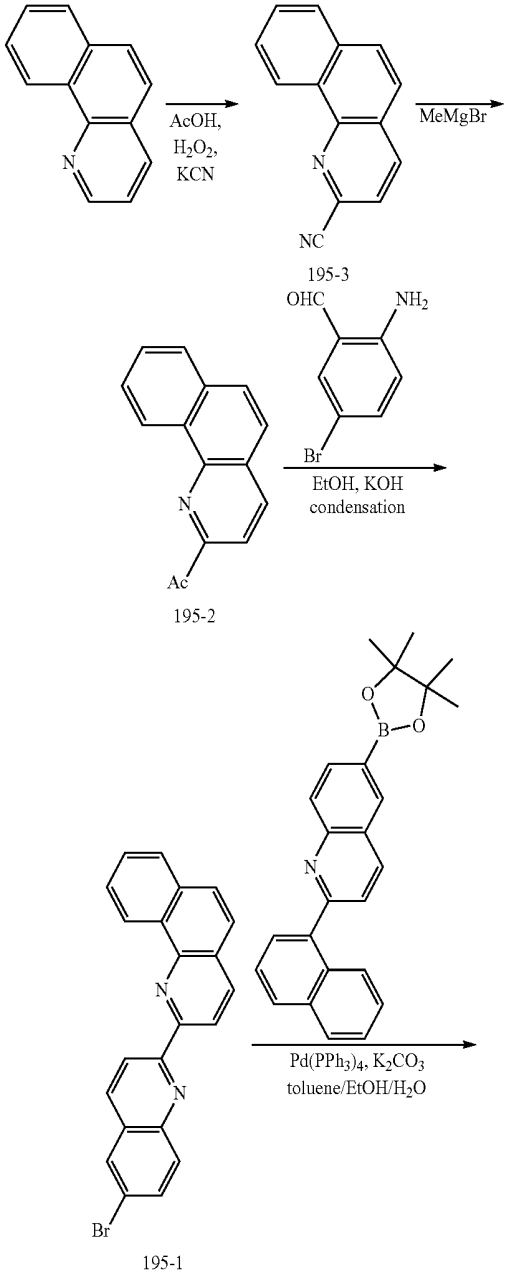


[0218] Preparation of Compound 179

[0219] Compound 91-1 (7.7 g, 15.0 mmol) and a compound 6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-2,3'-biquinoline (5.7 g, 15 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 10 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 179 (8.4 g, 82%).

<Preparation Example 20> Preparation of Compound 195

[0220]



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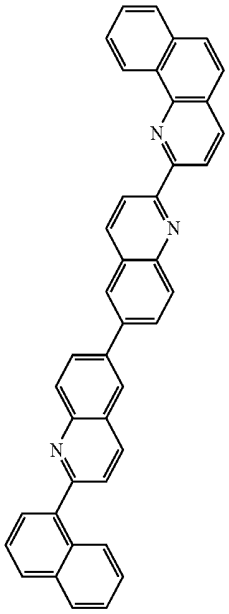


195

[0221] Preparation of Compound 195-3

[0222] A compound 1,10-phenanthroline (50 g, 250 mmol) was dissolved in AcOH (60 mL), and then 30% H_2O_2 (60 mL) was added thereto, and the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then the pH was adjusted to 11 by using a saturated aqueous KOH solution. And then, an extraction was performed by using chloroform. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator. KCN (38 g) was added to 38 g of the thus obtained yellow solid, the resulting mixture was dissolved in water, and then benzoyl chloride (38 mL) was slowly added dropwise thereto. After the mixture was stirred at normal temperature for 4 hours, it was confirmed that the reaction was terminated, and then the resulting product was filtered with a paper filter. The filtered solute was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 195-3 (28 g, 54%).

[0223] Preparation of Compound 195-2

[0224] Compound 195-3 (20 g, 97.5 mmol) was dissolved in THF (50 mL), and then 9.7 mL of MeMgBr(3M) was slowly added dropwise thereto at −78° C. It was confirmed that the reaction was terminated by warming the mixture to normal temperature, and an extraction was performed with an aqueous NH_4Cl solution and dichloromethane. After the organic layer was dried over anhydrous $MgSO_4$, the solvent was removed by using a rotary evaporator, and then the resulting product was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 195-2 (10 g, 46%).

[0225] Preparation of Compound 195-1

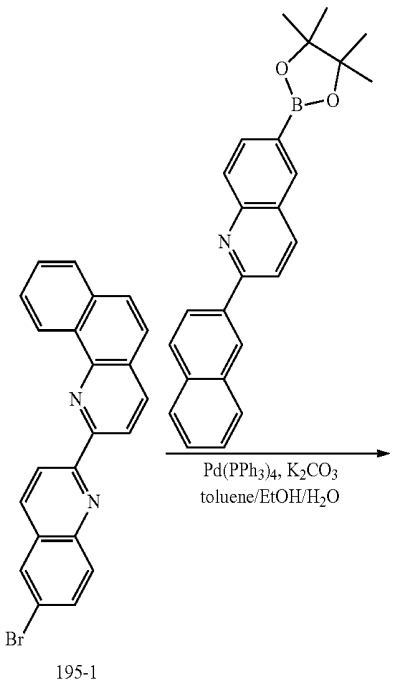
[0226] After Compound 195-2 (10 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 195-1 (14.6 g, 84%).

[0227] Preparation of Compound 195

[0228] Compound 195-1 (5.8 g, 15.0 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl) quinoline (5.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.7 g, 1.5 mmol) and K_2CO_3 (6.2 g, 45 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 195 (6.7 g, 80%).

<Preparation Example 21> Preparation of Compound 196

[0229]



195-1

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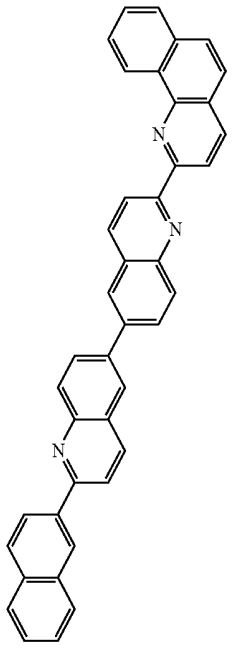

196

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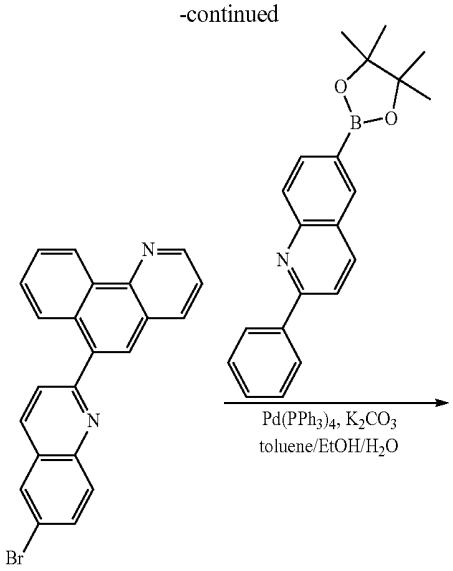
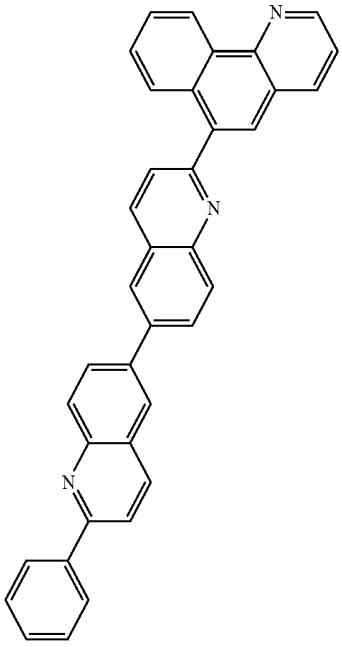


198-1



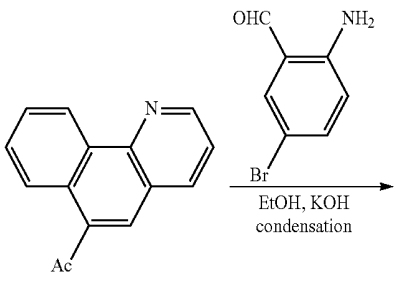
198

[0230] Preparation of Compound 196

[0231] Compound 195-1 (5.8 g, 15.0 mmol) and 2-naphthyl-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.7 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.7 g, 1.5 mmol) and K_2CO_3 (6.2 g, 45 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 196 (7.0 g, 83%).

<Preparation Example 22> Preparation of Compound 198

[0232]



[0233] Preparation of Compound 198-1

[0234] After a compound 1-(benzo[h]quinolin-6-yl)ethan-1-one (9.9 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 198-1 (15.9 g, 92%).

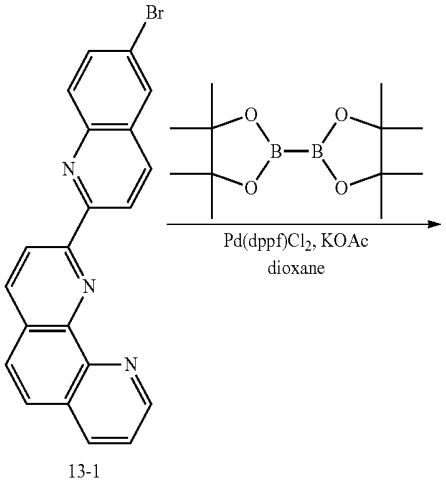
[0235] Preparation of Compound 198

[0236] Compound 198-1 (5.8 g, 15.0 mmol) and 2-phenyl-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline

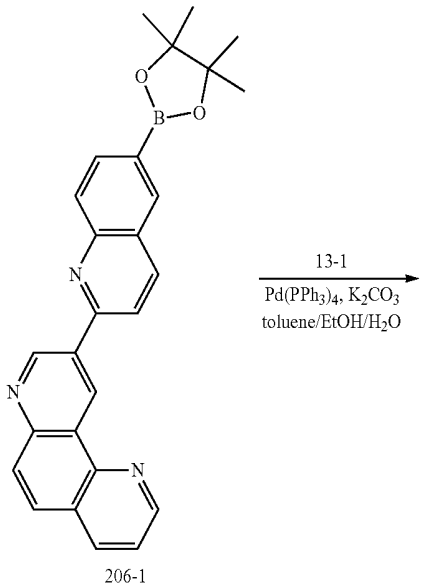
(5.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.7 g, 1.5 mmol) and K_2CO_3 (6.2 g, 45 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 198 (5.8 g, 76%).

<Preparation Example 23> Preparation of Compound 206

[0237]



13-1



206-1

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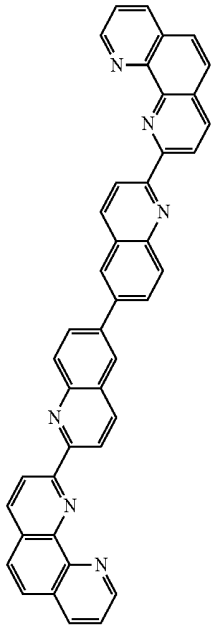


206

[0238] Preparation of Compound 206-1

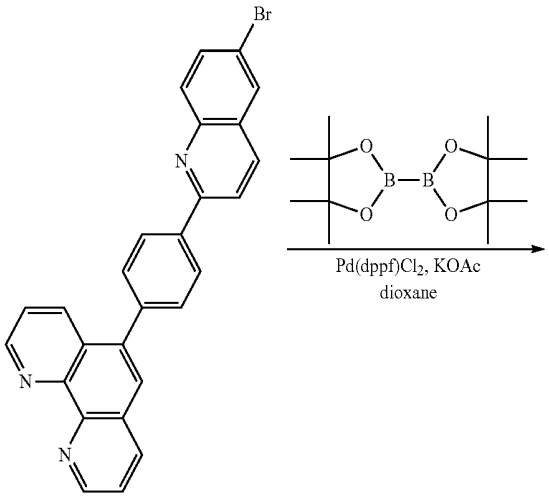
[0239] Compound 13-1 (14.6 g, 37.8 mmol), 4,4,4',4',5,5,5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (13.3 g, 52.9 mmol), $Pd(dppf)_2Cl_2$ (3 g, 4.2 mmol), and KOAc (11.1 g, 113.4 mmol) were put into a reaction vessel, dioxane (0.3 M) was added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. After the extracted organic layer was dried over anhydrous Na_2SO_4, the solvent was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 206-1 (9.8 g, 60%).

[0240] Preparation of Compound 206

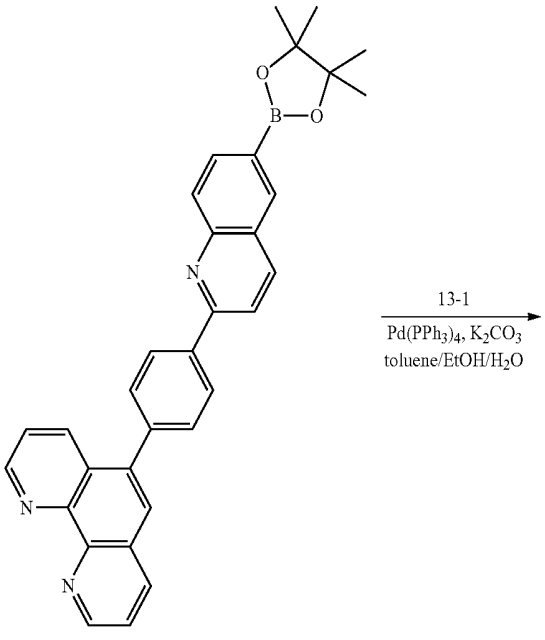
[0241] Compound 206-1 (6.1 g, 14.2 mmol) and Compound 13-1 (5.0 g, 12.9 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2C_{03} (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 206 (7 g, 80%).

<Preparation Example 24> Preparation of Compound 215

[0242]



52-1



215-1

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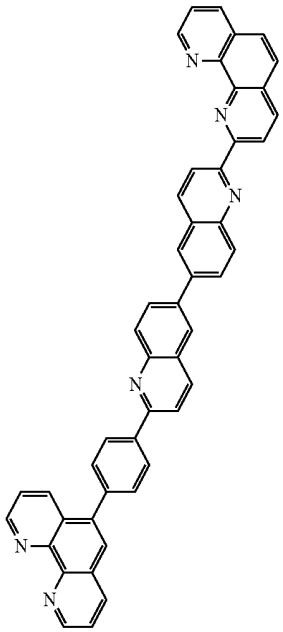


215

[0243] Preparation of Compound 215-1

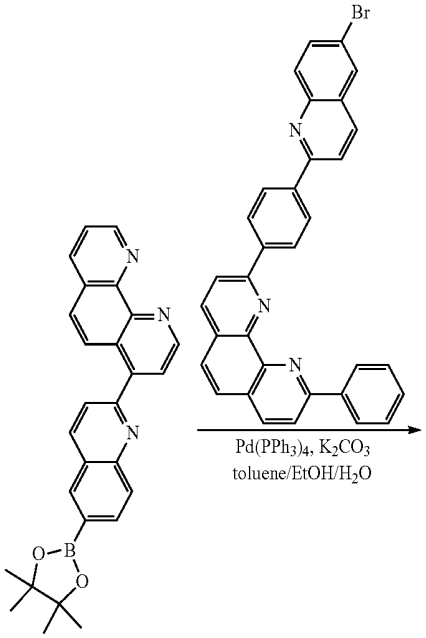
[0244] Compound 52-1 (19.5 g, 42.3 mmol), 4,4,4',4',5,5,5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (12.9 g, 50.8 mmol), $Pd(dppf)_2Cl_2$ (3 g, 4.2 mmol), and KOAc (12.4 g, 126.9 mmol) were put into a reaction vessel, dioxane (0.3 M) was added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. After the extracted organic layer was dried over anhydrous Na_2SO_4, the solvent was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 215-1 (18.6 g, 72%).

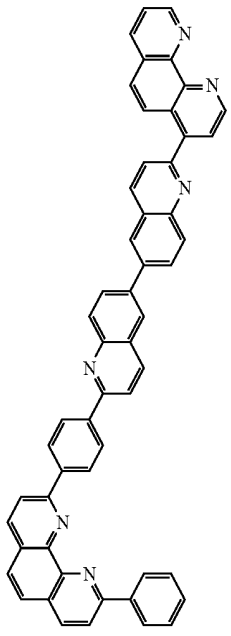
[0245] Preparation of Compound 215

[0246] Compound 215-1 (7.2 g, 14.2 mmol) and Compound 13-1 (5.0 g, 12.9 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 215 (6.4 g, 66%).

<Preparation Example 25> Preparation of Compound 220

[0247]





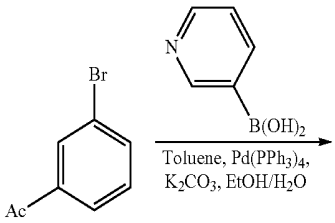
220

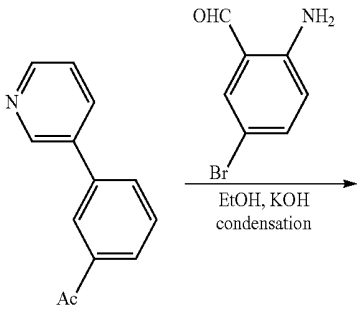
[0248] Preparation of Compound 220

[0249] A compound 4-(6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinolin-2-yl)-1,10-phenanthroline (6.0 g, 13.8 mmol) and a compound 2-(4-(6-bromoquinolin-2-yl) phenyl)-9-phenyl-1,10-phenanthroline (7.5 g, 13.8 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.6 g, 1.4 mmol) and K_2CO_3 (5.7 g, 41.4 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 220 (8.6 g, 82%).

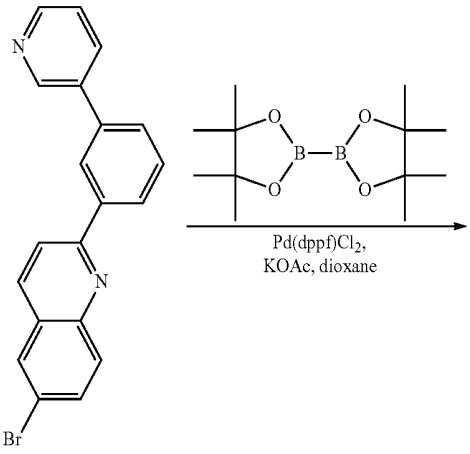
<Preparation Example 26> Preparation of Compound 241

[0250]



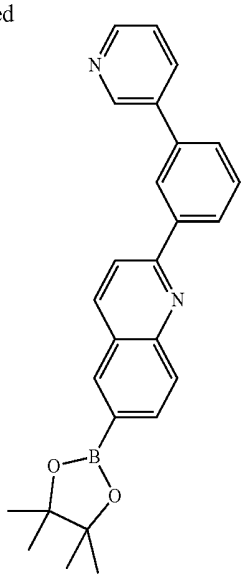


241-3

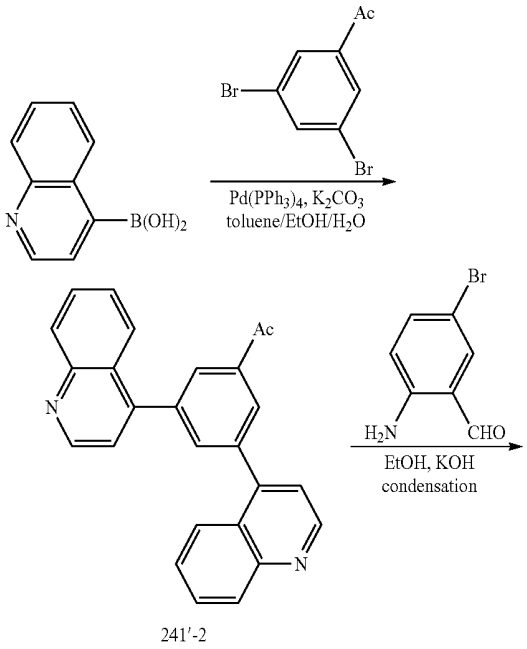


241-2

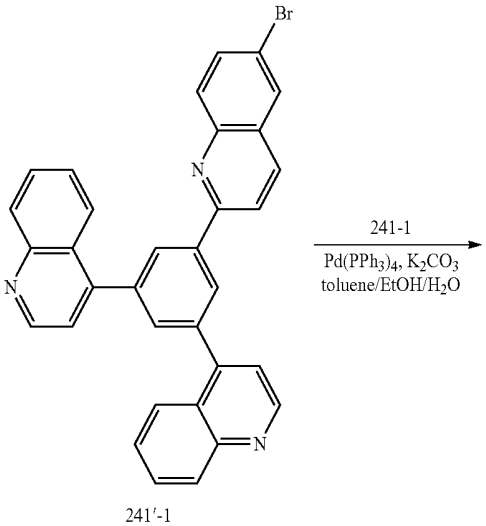
-continued



241-1

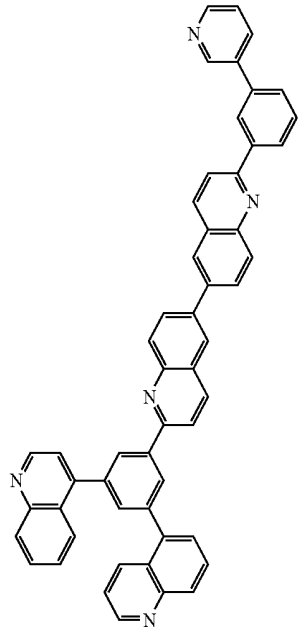


241′-2



241′-1

-continued



241

[0251] Preparation of Compound 241-3

[0252] A compound 1-(3-bromophenyl)ethan-1-one (20 g, 100 mmol) and pyridin-3-ylboronic acid (12.3 g, 100 mmol) were dissolved in toluene (100 mL), and then $Pd(PPh_3)_4$ (5.7 g, 5 mmol) and K_2CO_3 (41.5 g, 300 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. And then, EtOH (20 mL) and H_2O (20 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 241-3 (16.8 g, 85%).

[0253] Preparation of Compound 241-2

[0254] Compound 241-3 (16.8 g, 85 mmol) and 2-amino-5-bromobenzaldehyde (17 g, 85 mmol) were dissolved in EtOH (300 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 241-2 (27.6 g, 90%).

[0255] Preparation of Compound 241-1

[0256] Compound 241-2 (27.6 g, 76 mmol), 4,4,4',4',5,5,5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (23.1 g, 91 mmol), $Pd(dppf)_2Cl_2$ (2.8 g, 3.8 mmol), and KOAc (22 g, 228 mmol) were put into a reaction vessel, dioxane (0.3 M) was added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. After the organic layer was dried over anhydrous $MgSO_4$, the solvent was removed by a rotary evaporator, and then the resulting product was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 241-1 (19.2 g, 62%).

[0257] Preparation of Compound 241'-2

[0258] A compound quinolin-3-ylboronic acid (16.2 g, 94 mmol) and 1-(3,5-dibromophenyl)ethan-1-one (11.8 g, 43 mmol) were dissolved in 250 mL of toluene, and then $Pd(PPh_3)_4$ (2.5 g, 2.2 mmol) and K_2CO_3 (17.6 g, 123 mmol) were added thereto, and the resulting mixture was stirred for 10 minutes. EtOH (50 mL) and H_2O (50 mL) were added dropwise to a reaction vessel, and then the resulting mixture was refluxed at high temperature. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 241'-2 (13 g, 81%).

[0259] Preparation of Compound 241'-**1**

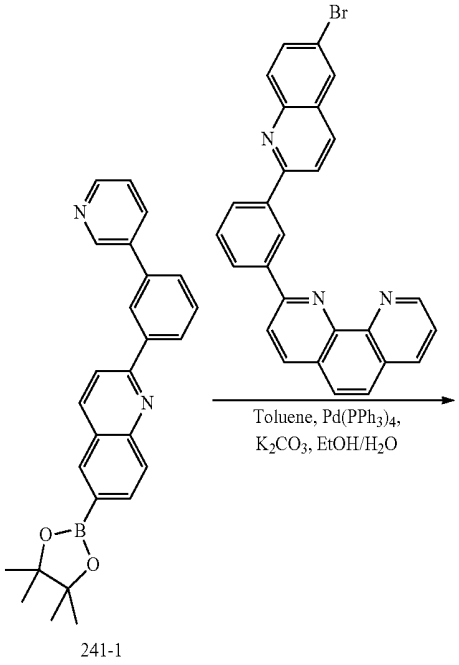
[0260] Compound 241'-2 (8.4 g, 22.6 mmol) and 2-amino-5-bromobenzaldehyde (4.52 g, 22.6 mmol) were dissolved in EtOH (150 mL), and then KOH (22.6 mmol) was added to the resulting solution, and the resulting mixture was heated to 80° C. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 241'-1 (11.2 g, 92%).

[0261] Preparation of Compound 241

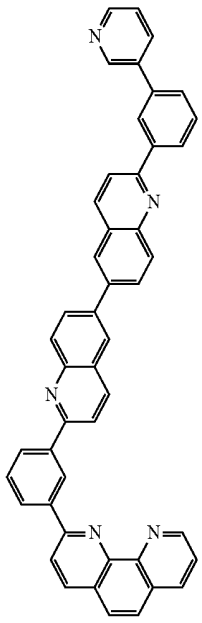
[0262] Compound 241'-1 (10.8 g, 20 mmol) and Compound 241-1 (8.2 g, 20 mmol) were dissolved in toluene (50 mL), and then $Pd(PPh_3)_4$ (2.3 g, 2 mmol) and K_2CO_3 (8.3 g, 60 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (10 mL) and EtOH (6 mL) were added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 241 (8.8 g, 69%).

<Preparation Example 27> Preparation of Compound 242

[0263]



241-1



242

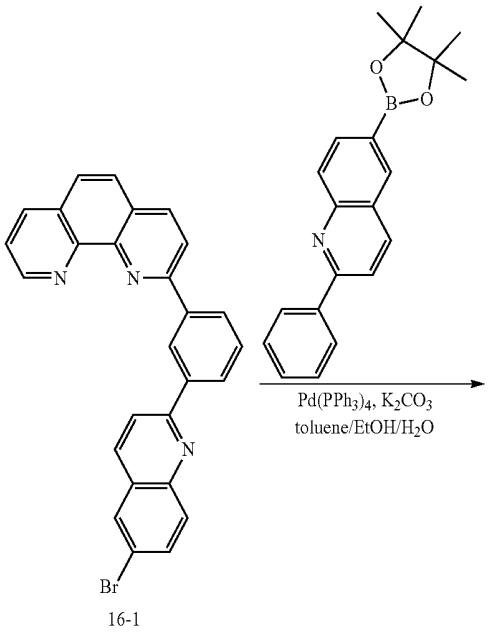
[0264] Preparation of Compound 242

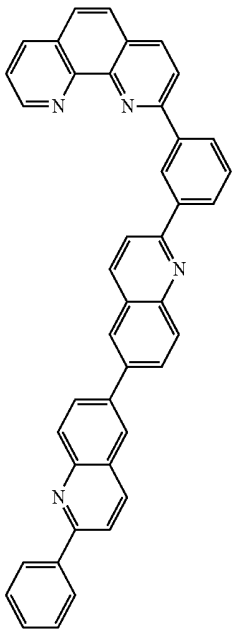
[0265] Compound 241-1 (4.4 g, 10.8 mmol) and Compound 16-1 (4.5 g, 9.8 mmol) were dissolved in toluene (40 mL), and then $Pd(PPh_3)_4$ (0.6 g, 0.5 mmol) and K_2CO_3 (2.8 g, 29.4 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, EtOH (8 mL) and H_2O (8 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted

organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 242 (3.9 g, 60%).

<Preparation Example 28> Preparation of Compound 245

[0266]





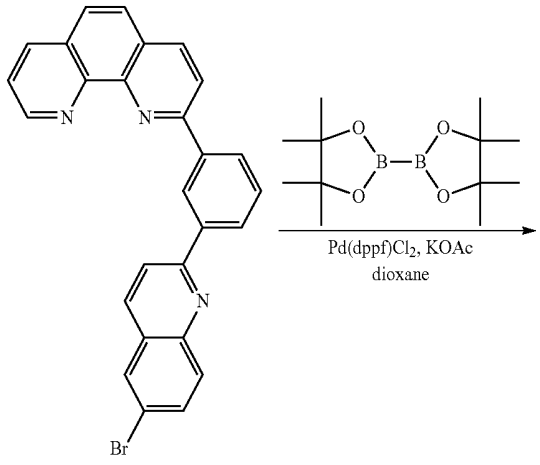
245

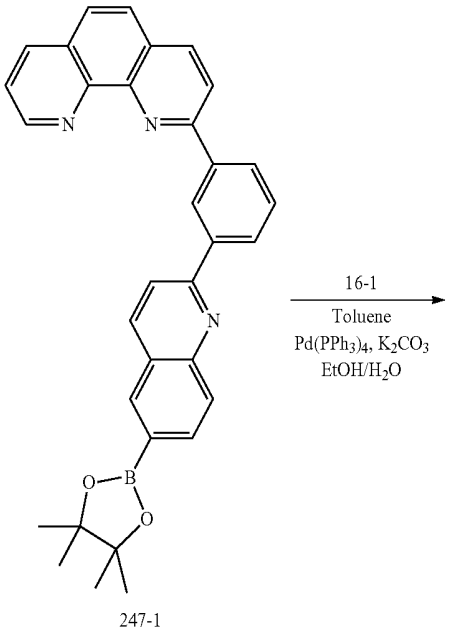
[0267] Preparation of Compound 245

[0268] Compound 16-1 (6.8 g, 14.8 mmol) and 2-phenyl-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15.5 mmol) were dissolved in toluene (50 mL), and then $Pd(PPh_3)_4$ (1.7 g, 1.5 mmol) and K_2CO_3 (6.1 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. H_2O (6 mL) and EtOH (6 mL) were sequentially added to a reaction vessel, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 245 (6.0 g, 68%).

<Preparation Example 29> Preparation of Compound 247

[0269]





247-1

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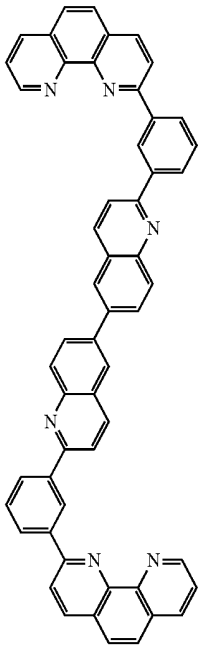


247

[0270] Preparation of Compound 247-1

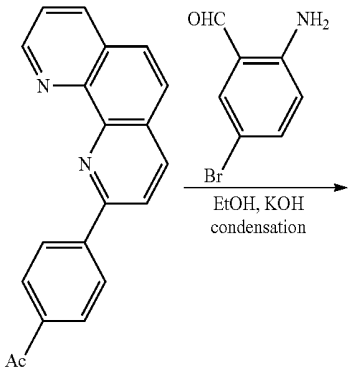
[0271] Compound 16-1 (12.6 g, 27 mmol), 4,4,4',4',5,5,5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (10 g, 37.8 mmol), $Pd(dppf)_2Cl_2$ (1.0 g, 1.4 mmol), and KOAc (7.9 g, 81 mmol) were put into a reaction vessel, dioxane (0.3 M) was added thereto, and then the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and ethyl acetate. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using dichloromethane and hexane as an eluent to obtain Target Compound 247-1 (8.5 g, 62%).

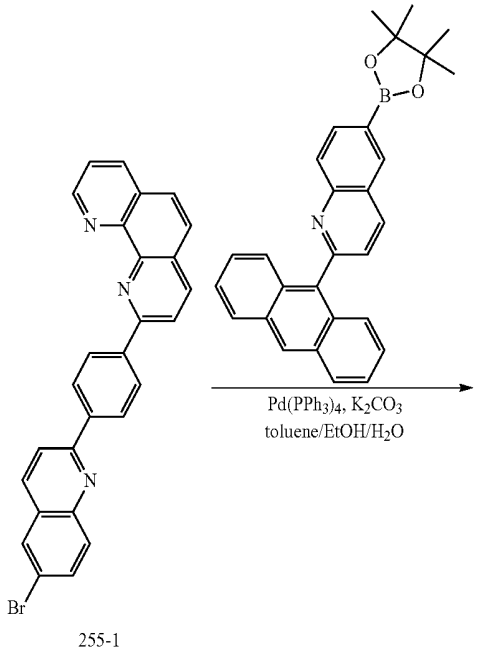
[0272] Preparation of Compound 247

[0273] Compound 247-1 (7.4 g, 14.7 mmol) and Compound 16-1 (5.7 g, 14.7 mmol) were dissolved in toluene (50 mL), and then $Pd(PPh_3)_4$ (1.6 g, 1.4 mmol) and K_2CO_3 (6.1 g, 44.3 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, EtOH (10 mL) and H_2O (10 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 247 (6 g, 54%).

<Preparation Example 30> Preparation of Compound 255

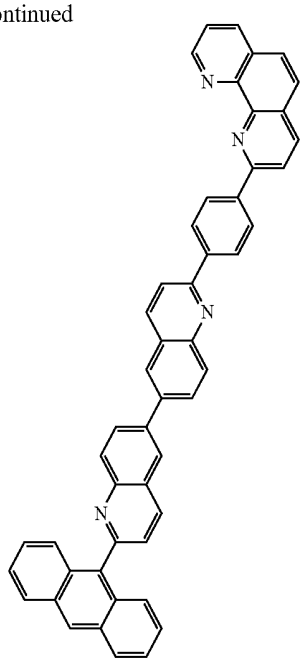
[0274]





255-1

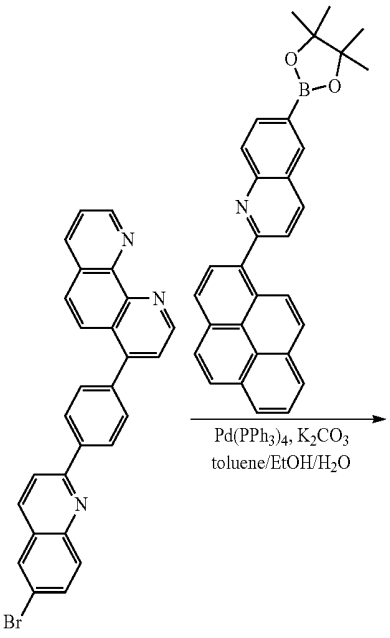
-continued



255

<Preparation Example 31> Preparation of Compound 269

[0279]



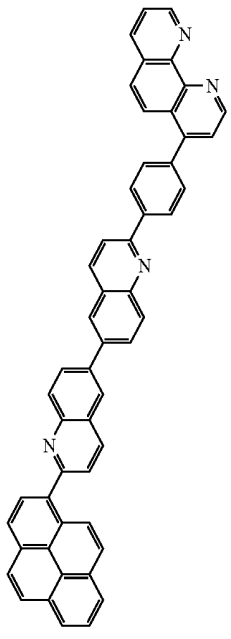
44-1

[0275] Preparation of Compound 255-1

[0276] After a compound 1-(4-(1,10-phenanthrolin-2-yl) phenyl)ethan-1-one (13.4 g, 45 mmol) and 2-amino-5-bromobenzaldehyde (9 g, 45 mmol) were dissolved in EtOH (200 mL), 5 mL of a saturated KOH solution was added dropwise to EtOH, and then the resulting mixture was refluxed for 4 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then the solvent was removed by using a rotary evaporator. And then, the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 255-1 (17 g, 82%).

[0277] Preparation of Compound 255

[0278] Compound 255-1 (6.9 g, 15.0 mmol) and 2-(anthracen-9-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (6.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.7 g, 1.5 mmol) and K_2CO_3 (6.2 g, 45 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 255 (7.4 g, 72%).



269

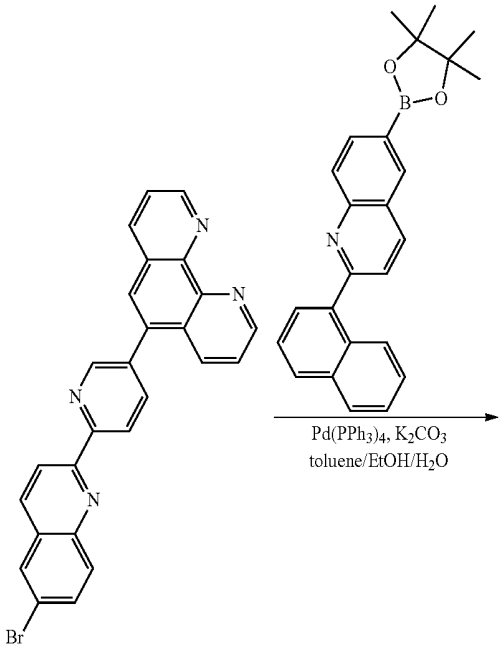
[0280] Preparation of Compound 269

[0281] Compound 44-1 (6.9 g, 15.0 mmol) and 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (6.8 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.7 g, 1.5 mmol) and K_2CO_3 (6.2 g, 45 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The extracted organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column

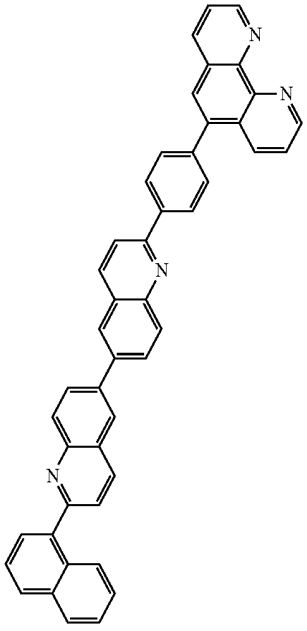
chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 269 (6.8 g, 64%).

<Preparation Example 32> Preparation of Compound 275

[0282]



52-1



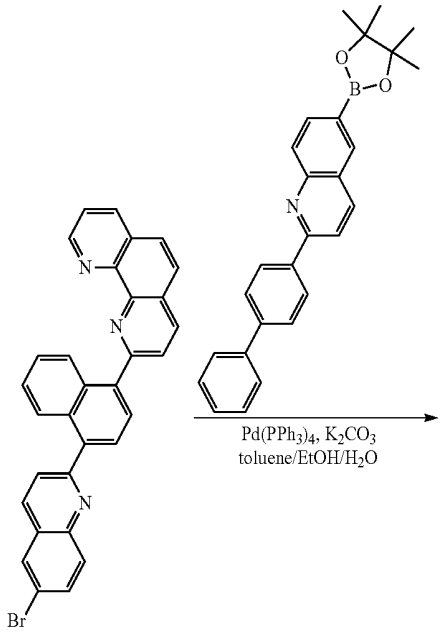
275

[0283] Preparation of Compound 275

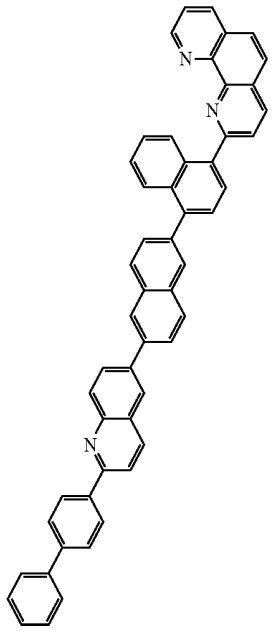
[0284] Compound 52-1 (6.6 g, 14.4 mmol) and a compound 2-(naphthalen-1-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.5 g, 14.4 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 275 (7.7 g, 84%).

<Preparation Example 33> Preparation of Compound 284

[0285]



91-1



284

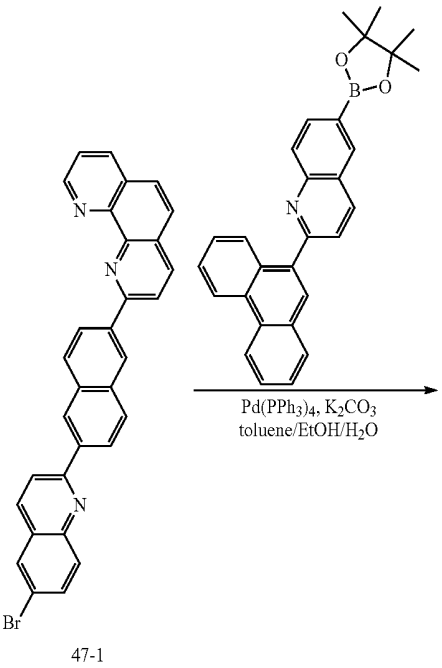
[0286] Preparation of Compound 284

[0287] Compound 91-1 (7.7 g, 15 mmol) and a compound 2-([1,1'-biphenyl]-4-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (12.1 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting

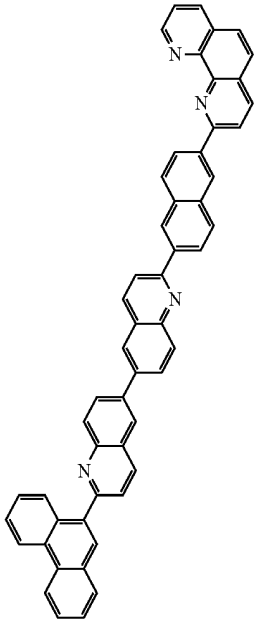
solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 18 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 284 (7.0 g, 66%).

<Preparation Example 34> Preparation of Compound 301

[0288]



47-1



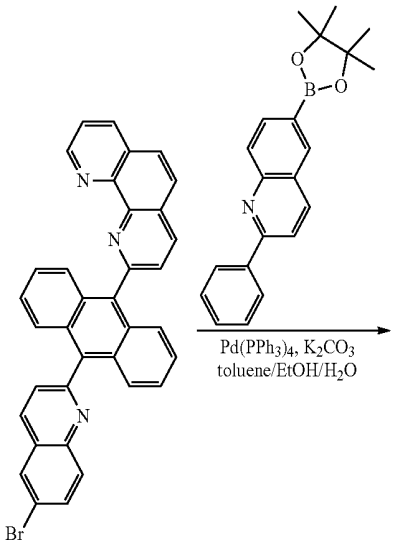
301

[0289] Preparation of Compound 301

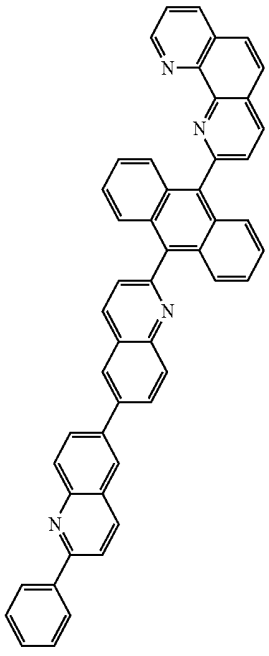
[0290] Compound 47-1 (7.7 g, 15 mmol) and a compound 2-(phenanthren-9-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (6.5 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 12 hours. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 301 (6.5 g, 59%).

<Preparation Example 35> Preparation of Compound 304

[0291]



25-1



304

[0292] Preparation of Compound 304

[0293] Compound 25-1 (8.4 g, 15 mmol) and a compound 2-(pyridin-2-yl)-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)quinoline (5.0 g, 15.0 mmol) were dissolved in toluene (30 mL), and then $Pd(PPh_3)_4$ (1.5 g, 1.3 mmol) and K_2CO_3 (5.3 g, 38.7 mmol) were added to the resulting solution, and the resulting mixture was stirred for 10 minutes. And then, H_2O (6 mL) and EtOH (6 mL) were added thereto, and the resulting mixture was refluxed for 12 hours. After the reaction was completed, the reaction product was cooled to normal temperature, and then an extraction was performed with distilled water and dichloromethane. The organic layer was dried over anhydrous Na_2SO_4, and then filtered. The solvent of the filtered organic layer was removed by using a rotary evaporator, and then the residue was purified with column chromatography using ethyl acetate and hexane as an eluent to obtain Target Compound 304 (7.4 g, 74%).

[0294] Compounds were prepared in the same manner as in the Preparation Examples, and the synthesis confirmation results thereof are shown in the following Tables 1 to 4.

TABLE 1

Structure	1H-NMR (δ, ppm)
Compound 7	($CDCl_3$, 400 MHz) δ = 9.08 (2H, s), 8.76~8.62 (5H, m), 8.46~8.33 (6H, m), 8.21~8.07 (7H, m), 7.95~7.84 (2H, d), 7.50~7.39 (3H, m)
Compound 13	($CDCl_3$, 400 MHz) δ = 9.32~9.28 (1H, m), 9.15 (1H, d), 8.79~8.75 (1H, m), 8.74~8.68 (1H, m), 8.64 (1H, d), 8.49~8.45 (1H, m), 8.41~8.17 (10H, m), 7.94~7.84 (3H, m), 7.70 (1H, dd), 7.42~7.37 (1H, m)
Compound 14	($CDCl_3$, 400 MHz) δ = 9.32~9.29 (1H, m), 9.13 (1H, d), 8.73~8.68 (1H, m), 8.62 (1H, d), 850~8.44 (1H, m), 8.40~8.17 (12H, m), 7.94~7.83 (3H, m), 7.71 (1H, dd), 7.56~7.48 (3H, m), 7.41~7.37 (1H, m)
Compound 16	($CDCl_3$, 400 MHz) δ = 9.28 (1H, dd), 9.12~9.11 (1H, m), 8.78~8.76 (1H, m), 8.71~8.68 (1H, m), 8.63 (1H, d), 8.56~8.52 (1H, m), 8.39~8.12 (13H, m), 7.93~7.72 (4H, m), 7.66 (1H, dd), 7.40~7.27 (1H, m)
Compound 17	($CDCl_3$, 400 MHz) δ = 9.48 (1H, dd), 9.31 (5H, m), 8.95~8.67 (9H, m), 8.45 (1H, d), 8.31 (2H, s), 8.02 (2H, m), 7.89 (3H, m), 7.77 (4H, m), 7.49 (3H, m), 7.23 (1H, dd)
Compound 18	(CDCl3, 400 MHz) δ = 9.28 (1H, dd), 9.15 (1H, m), 9.02 (1H, d), 8.91 (2H, m), 8.74~8.60 (5H, m), 8.40 (2H, d), 8.38 (1H, d), 8.29 (1H, s), 8.25 (1H, s), 8.00 (4H, m), 8.92 (1H, m), 7.55~7.32 (4H, m), 7.24 (1H, dd)
Compound 25	($CDCl_3$, 400 MHz) δ = 9.28 (1H, dd), 9.03 (1H, d), 8.85 (2H, m), 8.84~8.62 (5H, m), 8.61 (4H, m), 8.35 (1H, s), 8.27 (1H, s), 8.24 (1H, d), 8.02 (3H, m), 7.87~7.65 (6H, m), 7.51 (2H, m), 7.32 (1H, dd)
Compound 40	($CDCl_3$, 400 MHz) δ = 9.42 (1H, dd), 9.15 (2H, d), 9.00 (1H, d), 8.83~8.62 (8H, m), 8.48 (1H, d), 8.30 (3H, m), 8.15~7.73 (6H, m), 7.56 (1H, d)
Compound 44	($CDCl_3$, 400 MHz) δ = 9.34 (1H, dd), 9.02~8.75 (5H, m), 8.52~8.25 (7H, m), 7.98 (1H, s), 7.84 (1H, s), 7.82~7.71 (4H, m), 7.56 (1H, dd), 7.48 (1H, d), 7.42 (1H, d), 7.25 (2H, d), 7.12 (1H, d)
Compound 47	($CDCl_3$, 400 MHz) δ = 9.25 (2H, s), 9.20 (1H, dd), 9.18 (2H, d), 8.89~8.62 (10H, m), 8.33~8.81 (5H, m), 8.19~8.09 (3H, m), 7.96 (2H, m), 7.73 (2H, m)
Compound 52	(CDCl3, 400 MHz) δ = 9.37 (1H, dd), 9.25 (1H, d), 9.18 (3H, m), 8.72 (4H, m), 8.31 (1H, d), 8.22 (2H, d), 8.04~7.88 (2H, m), 7.94 (1H, m), 7.85 (2H, d), 7.64~7.42 (7H, m)
Compound 68	($CDCl_3$, 400 MHz) δ = 8.74 (1H, d), 8.69~8.29 (9H, m), 8.14~8.06 (4H, m), 7.96~7.91 (2H, m), 7.72~7.59 (3H, m), 7.56~7.48 (3H, m), 7.28 (1H, d)
Compound 91	($CDCl_3$, 400 MHz) δ = 9.25 (2H, m), 9.11 (2H, d), 9.01 (1H, d), 8.73 (2H, m), 8.44 (1H, d), 8.40 (1H, d), 8.30 (1H, m), 8.21 (3H, m), 8.05 (1H, d), 8.02 (4H, m), 7.99 (1H, d), 7.97~7.85 (4H, m), 7.67 (1H, dd), 7.63 (1H, m), 7.51 (1H, m)
Compound 111	($CDCl_3$, 400 MHz) δ = 9.02~8.98 (2H, m), 8.72 (2H, s), 8.66 (1H, s), 8.34~8.02 (7H, m), 7.94~7.87 (3H, m), 7.66~7.51 (4H, m), 7.40 (2H, s)
Compound 195	($CDCl_3$, 400 MHz) δ = 8.97 (1H, d,), 8.70 (1H, s), 8.51~8.25 (9H, m), 8.15~7.88 (9H, m), 7.72~7.52 (2H, m) 7.49~7.42 (2H, m), 7.36 (1H, s)
Compound 196	($CDCl_3$, 400 MHz) δ = 9.41 (1H, dd), 9.28 (1H, dd), 9.02 (1H, m), 8.72~8.65 (3H, m), 8.48~8.34 (3H, m), 8.21 (1H, d), 8.10 (2H, m), 8.08~7.91 (4H, m), 7.84 (1H, m), 7.77 (2H, m), 7.52~7.21 (9H, m)
Compound 198	($CDCl_3$, 400 MHz) δ = 9.01~8.88 (2H, m), 8.44~8.28 (7H, m), 8.11 (1H, d), 7.96 (2H, s), 7.86 (1H, m), 7.77 (2H, d), 7.58~7.33 (8H, m)
Compound 204	($CDCl_3$, 400 MHz) δ = 9.33~9.26 (1H, m), 9.14 (1H, d), 8.79~8.76 (1H, m), 8.73~8.69 (1H, m), 8.67 (1H, d), 8.48~8.45 (1H, m), 8.44~8.18 (10H, m), 7.94~7.84 (5H, m), 7.71 (1H, dd), 7.42~7.37 (2H, m)
Compound 206	($CDCl_3$, 400 MHz) δ = 8.84~8.78 (2H, m), 8.64~8.43 (6h, m), 8.38~8.29 (6H, m), 8.14 (2H, s), 8.07 (2H, s), 7.80~7.72 (4H, m), 7.59~7.56 (2H, m)
Compound 212	(CDCl3, 400 MHz) δ = 9.38~9.25 (3H, m), 9.16 (1H, d), 8.79~8.75 (1H, m), 8.74~8.68 (3H, m), 8.64 (1H, d), 8.49~8.45 (1H, m), 8.41~8.17 (8H, m), 8.11 (2H, d), 7.94~7.84 (1H, m), 7.70 (1H, dd), 7.42~7.37 (1H, m), 7.36~7.32 (3H, m), 7.25 (2H, d)
Compound 241	($CDCl_3$, 400 MHz) δ = 9.28 (2H, m), 9.12 (1H, s), 8.83~8.27 (9H, m), 8.61 (2H, d), 8.44 (1H, s), 8.33 (2H, s), 8.18~8.01 (5H, m), 7.90~7.68 (7H, m), 7.45 (3H, m), 7.20 (1H, dd)
Compound 242	($CDCl_3$, 400 MHz) δ = 9.28 (1H, s), 8.92~8.80 (6H, m), 8.69~8.66 (2H, m), 8.59~8.45 (6H, m), 8.33~8.21 (5H, m), 7.83~7.73 (3H, m), 7.48~7.41 (2H, m), 7.36~7.31 (4H, m)

TABLE 1-continued

Structure	1H-NMR (δ, ppm)
Compound 245	($CDCl_3$, 400 MHz) δ = 9.28 (1H, dd), 8.71~8.68 (1H, m), 8.63 (1H, d), 8.56~8.5 (3H, m), 8.39~8.12 (13H, m), 7.93~7.72 (3H, m), 7.66 (1H, dd), 7.58 (2H, m), 7.49 (1H, m)
Compound 247	($CDCl_3$, 400 MHz) δ = 8.84~8.77 (2H,), 8.72~8.64 (6H, m), 8.56~8.53 (2H, m), 8.20~8.08 (6H, m), 8.01~7.96 (2H, m), 7.90~7.84 (2H, m), 7.80~7.62 (4H, m), 7.54~7.49 (2H, m), 7.37~7.31 (2H, m), 7.29~7.25 (4H, m)
Compound 255	($CDCl_3$, 400 MHz) δ = 9.25 (1H, dd), 9.15~9.11 (1H, m), 8.78~8.73 (1H, m), 8.71~8.68 (1H, m), 8.63 (1H, d), 8.58 (1H, s), 8.56~8.52 (1H, m), 8.50 (2H, d), 8.39~8.12 (10H, m), 8.03 (2H, d), 7.93~7.72 (2H, m), 7.80 (2H, d), 7.57~7.53 (4H, m), 7.40~7.27 (1H, m)
Compound 275	(CDCl3, 400 MHz) δ = 9.41 (1H, dd), 9.28 (1H, dd), 9.02 (1H, m), 8.72~8.65 (3H, m), 8.48~8.34 (3H, m), 8.21 (1H, d), 8.10 (2H, m), 8.08~7.91 (4H, m), 7.84 (1H, m), 7.77 (2H, m), 7.52~7.21 (9H, m)
Compound 284	($CDCl_3$, 400 MHz) δ = 9.22 (1H, dd), 9.02 (1H, d), 8.75 (2H, m), 8.47 (1H, d), 8.41 (1H, d), 8.37 (2H, d), 8.31 (1H, m), 8.21 (3H, m), 8.06 (1H, d), 8.02 (4H, m), 7.98 (1H, d), 7.95~7.86 (4H, m), 7.82 (2H, d), 7.73 (2H, d), 7.66 (1H, dd), 7.62 (1H, m), 7.52 (3H, m), 7.43 (1H, m)
Compound 304	($CDCl_3$, 400 MHz) δ = 9.24 (1H, dd), 8.88~8.64 (8H, m), 8.58 (4H, m), 8.31 (1H, s), 8.29 (1H, s), 8.05 (1H, d), 7.98 (2H, d), 7.8~7.63 (10H, m), 7.52 (2H, m)

TABLE 2

Compound	HOMO (eV)	Band gap (eV)	LUMO (eV)	Compound	HOMO (eV)	Band gap (eV)	LUMO (eV)
Compound 6	−6.24	3.29	−2.95	Compound 7	−6.18	3.28	−2.9
Compound 11	−6.04	3.28	−2.76	Compound 13	−6.34	3.21	−3.13
Compound 14	−6.33	3.13	−3.20	Compound 15	−6.26	3.04	−3.22
Compound 16	−6.31	3.28	−3.03	Compound 17	−6.25	3.28	−2.97
Compound 18	−6.48	3.36	−3.12	Compound 25	−5.70	2.66	−3.04
Compound 40	−6.38	3.16	−3.22	Compound 44	−6.59	3.25	−3.34
Compound 47	−6.10	2.82	−3.28	Compound 52	−6.43	3.19	−3.24
Compound 68	−6.46	3.19	−3.27	Compound 91	−6.11	2.87	−3.24
Compound 111	−6.27	3.25	−3.02	Compound 175	−6.25	3.02	−3.23
Compound 179	−6.11	2.92	−3.19	Compound 195	−6.26	3.18	−3.08
Compound 196	−6.25	3.08	−3.17	Compound 198	−6.34	3.25	−3.09
Compound 206	−6.30	3.17	−3.13	Compound 215	−6.03	2.89	−3.14
Compound 220	−6.29	3.05	−3.24	Compound 241	−6.50	3.28	−3.22
Compound 242	−6.13	3.05	−3.08	Compound 245	−6.26	3.30	−2.96
Compound 247	−6.13	3.05	−3.08	Compound 255	−5.81	2.68	−3.13
Compound 269	−5.91	2.72	−3.19	Compound 275	−6.31	3.18	−3.13
Compound 284	−6.06	3.02	−3.04	Compound 301	−6.04	2.89	−3.15
Compound 304	−5.71	2.74	−2.97	NPB	−5.10	3.52	−1.58

TABLE 3

Compound	FD-MASS	Compound	FD-MASS	Compound	FD-MASS
Compound 6	486.18	Compound 7	563.21	Compound 11	536.20
Compound 13	511.18	Compound 14	587.21	Compound 15	663.24
Compound 16	587.21	Compound 17	765.26	Compound 18	587.21
Compound 25	687.24	Compound 40	509.19	Compound 44	587.21
Compound 47	637.23	Compound 52	588.21	Compound 68	564.21
Compound 91	638.22	Compound 111	459.17	Compound 175	637.23
Compound 179	687.24	Compound 195	559.20	Compound 196	559.20
Compound 198	509.19	Compound 206	612.21	Compound 212	738.25
Compound 220	764.27	Compound 241	739.27	Compound 242	663.24
Compound 245	586.22	Compound 247	764.27	Compound 255	686.25
Compound 269	710.25	Compound 275	636.23	Compound 284	712.26
Compound 301	736.26	Compound 304	686.25		

TABLE 4

	Td	Tg	Tm
Compound 6	455° C.	ND	250° C., 258° C.
Compound 7	489° C.	ND	301° C.
Compound 11	483.13° C.	ND	290° C.
Compound 13	469° C.	ND	349° C.
Compound 16	495° C.	122° C.	290° C.

[0295] Table 1 shows NMR values, and Table 2 shows HOMO, LUMO, and BAND GAP values according to the calculation results of molecules.

Experimental Example 1

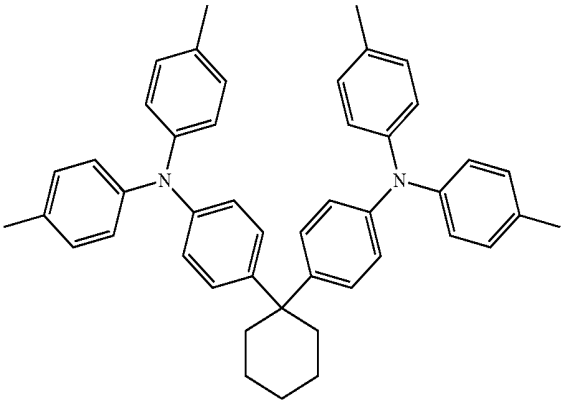
[0296] 1) Manufacture of Organic Light Emitting Device

[0297] A glass substrate thinly coated with ITO to have a thickness of 1,500 Å was ultrasonically washed with distilled water. When the washing with distilled water is finished, the glass substrate was ultrasonically washed with a solvent such as acetone, methanol, and isopropyl alcohol, was dried and then was subjected to UVO treatment for 5 minutes by using UV in a UV washing machine. Thereafter, the substrate was transferred to a plasma washing machine (PT), and then was subjected to plasma treatment in order to implement an ITO work function and remove a residual film in a vacuum state, and thus, was transferred to a thermal deposition equipment for organic deposition.

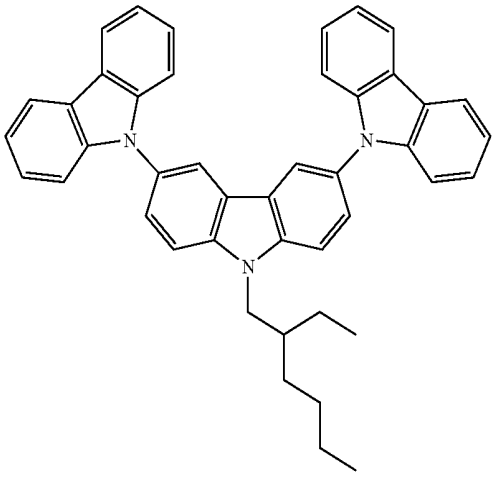
[0298] An organic material having a 2-stack white organic light device (WOLED) structure was formed on the ITO transparent electrode (positive electrode). For a first stack, a hole transporting layer was first formed by thermally vacuum depositing TAPC to have a thickness of 300 Å. The hole transporting layer was formed, and then a light emitting layer was thermally vacuum deposited thereon as follows. The light emitting layer was deposited to have a thickness of 300 Å by doping a host TCzl with a blue phosphorescent dopant FIrpic at a concentration of 8%. An electron transporting layer was formed to have a thickness of 400 Å by using TmPyPB, and then a charge producing layer was formed to have a thickness of 100 Å by doping the compound described in the following Table 5 with Cs_2CO_3 at a concentration of 20%.

[0299] For a second stack, a hole injection layer was first formed by thermally vacuum depositing MoO_3 to have a thickness of 50 Å. A hole transporting layer, which is a common layer, was formed to have a thickness of 100 Å by doping TAPC with MoO_3 at a concentration of 20%, and then depositing TAPC to have a thickness of 300 Å. A light emitting layer was deposited thereon to have a thickness of 300 Å by doping a host TCzl with a green phosphorescent dopant $Ir(ppy)_3$ at a concentration of 8%, and then an electron transporting layer was formed to have a thickness of 600 Å by using TmPyPB. Finally, lithium fluoride (LiF) was deposited to have a thickness of 10 Å on the electron transporting layer to form an electron injection layer, and then aluminum (Al) was deposited to have a thickness of 1,200 Å on the electron injection layer to form a negative electrode, thereby manufacturing an organic electroluminescence device.

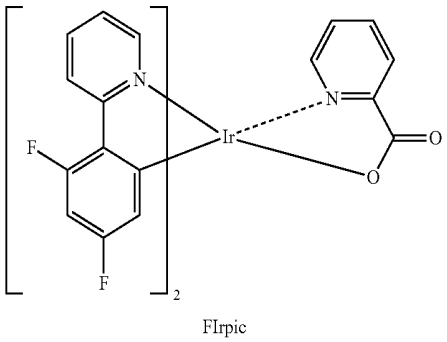
[0300] Meanwhile, all the organic compounds required for manufacturing an OLED were subjected to vacuum sublimed purification under 10^{-6} to 10^{-8} torr for each material, and then used for the manufacture of OLED.



TAPC



TCzl



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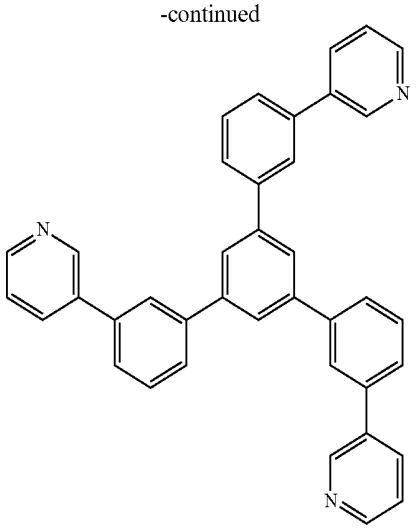
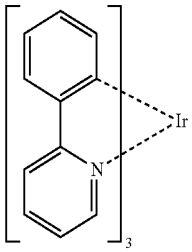


TmPyPb



Ir(ppy)3

[0301] 2) Driving Voltage and Light Emitting Efficiency of Organic Electroluminescence Device

[0302] For the organic electroluminescence device manufactured as described above, the electroluminescent (EL) characteristics were measured using M7000 manufactured by McScience Inc., and the measurement results were used to measure T_{95} through a service life measurement device (M6000) manufactured by McScience Inc., when the reference brightness was 3,500 cd/m^2. The results of measuring the driving voltage, light emitting efficiency, external quantum efficiency, and color coordinate (CIE) of the white organic electroluminescence device manufactured according to the present invention are shown as in Table 5.

TABLE 5

	Compound	Driving voltage (V)	Light emitting efficiency (cd/A)	External quantum efficiency (%)	CIE (x, y)
Example 1	6	7.52	65.31	32.45	(0.229, 0.481)
Example 2	7	7.41	64.86	31.92	(0.220, 0.480)
Example 3	11	7.15	65.25	35.23	(0.234, 0.483)
Example 4	13	8.08	61.92	30.18	(0.226, 0.433)
Example 5	14	8.33	62.27	25.06	(0.210, 0.424)
Example 6	15	7.52	68.80	32.24	(0.209, 0.422)
Example 7	16	7.65	68.23	34.15	(0.234, 0.463)

TABLE 5-continued

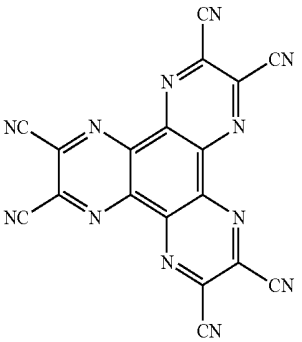
	Compound	Driving voltage (V)	Light emitting efficiency (cd/A)	External quantum efficiency (%)	CIE (x, y)
Example 8	17	7.66	67.14	30.06	(0.208, 0.421)
Example 9	18	7.49	71.18	30.08	(0.212, 0.420)
Example 10	25	7.53	67.13	33.02	(0.207, 0.421)
Example 11	28	8.35	58.95	23.75	(0.212, 0.390)
Example 12	40	7.44	64.18	27.06	(0.212, 0.425)
Example 13	44	7.34	65.83	34.92	(0.208, 0.420)
Example 14	47	7.56	62.05	26.04	(0.215, 0.422)
Example 15	48	7.52	66.06	34.45	(0.234, 0.478)
Example 16	52	8.11	60.37	27.38	(0.208, 0.419)
Example 17	59	7.58	68.68	22.65	(0.217, 0.463)
Example 18	72	7.64	64.52	32.54	(0.210, 0.423)
Example 19	84	8.12	60.43	28.73	(0.216, 0.483)
Example 20	89	7.93	58.25	22.31	(0.201, 0.483)
Example 21	91	7.43	67.57	32.46	(0.208, 0.418)
Example 22	175	7.58	65.28	32.98	(0.210, 0.422)
Example 23	179	7.55	67.70	29.74	(0.208, 0.419)
Example 24	196	7.88	64.86	26.95	(0.208, 0.422)
Example 25	198	7.90	65.34	31.02	(0.209, 0.420)
Example 26	215	7.72	67.13	32.08	(0.213, 0.427)
Example 27	220	7.56	65.73	31.22	(0.209, 0.420)
Example 28	241	6.94	68.16	33.04	(0.208, 0.419)
Example 29	245	7.42	66.15	29.16	(0.212, 0.420)
Example 30	255	8.35	62.93	25.72	(0.209, 0.416)
Example 31	269	8.08	64.84	32.90	(0.208, 0.420)
Example 32	275	7.58	67.30	32.81	(0.208, 0.419)
Example 33	284	7.56	66.21	31.93	(0.207, 0.414)
Example 34	301	7.63	66.12	31.14	(0.206, 0.415)
Example 35	304	7.82	62.77	25.27	(0.210, 0.424)
Comparative Example 1	TmPyPB	8.68	53.95	20.73	(0.214, 0.443)

[0303] As can be seen from the results in Table 5, the organic electroluminescence device using a charge producing layer material of the white organic electroluminescence device of the present invention has a low driving voltage and significantly improved light emitting efficiency as compared to Comparative Example 1.

Experimental Example 2

[0304] 1) Manufacture of Organic Light Emitting Device

[0305] A glass substrate thinly coated with ITO to have a thickness of 1,500 Å was ultrasonically washed with distilled water. When the washing with distilled water is finished, the glass substrate was ultrasonically washed with a solvent such as acetone, methanol, and isopropyl alcohol, was dried and then was subjected to UVO treatment for 5 minutes by using UV in a UV washing machine. Thereafter, the substrate was transferred to a plasma washing machine (PT), and then was subjected to plasma treatment in order to implement an ITO work function and remove a residual film in a vacuum state, and thus, was transferred to a thermal deposition equipment for organic deposition. An organic material having a single stack structure was formed on the ITO transparent electrode (positive electrode). HAT-CN was deposited to have a thickness of 50 Å as a hole injection layer, NPD, which is a hole transporting layer, was doped with DNTPD at a concentration within 10% and deposited to have a thickness of 1,500 Å and formed, and TCTA was continuously deposited to have a thickness of 200 Å. Subsequently, a light emitting layer including an ADN host and a t-Bu-perylene dopant was formed to have a thickness of 250 Å. Subsequently, Alq_3, which is an electron transporting layer, was film-formed to have a thickness of 250 Å, the compound described in the following Table 6 was doped with lithium, which is an alkali metal, to film-form an N-type charge producing layer having a thickness of 100 Å, and Al as a negative electrode was film-formed to have a thickness of approximately 1,000 Å, thereby manufacturing an organic electroluminescence device.



HAT-CN

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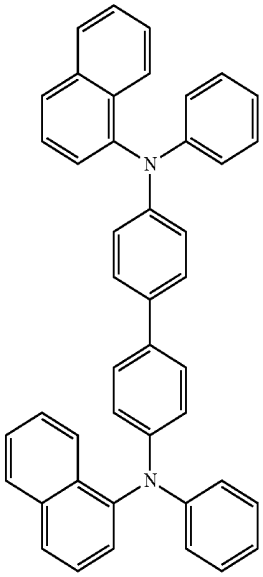
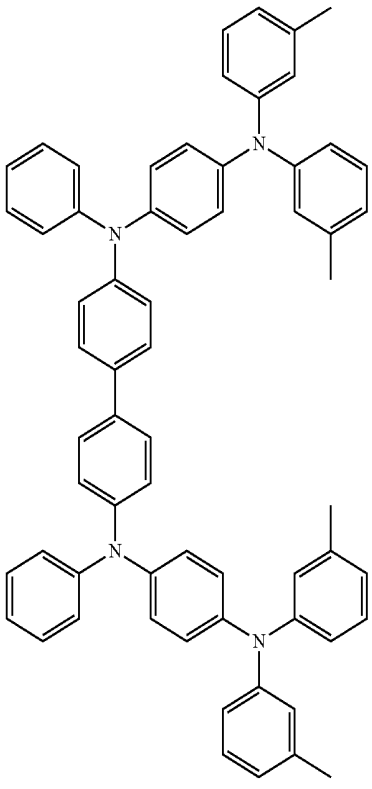


NPD



DNTPD

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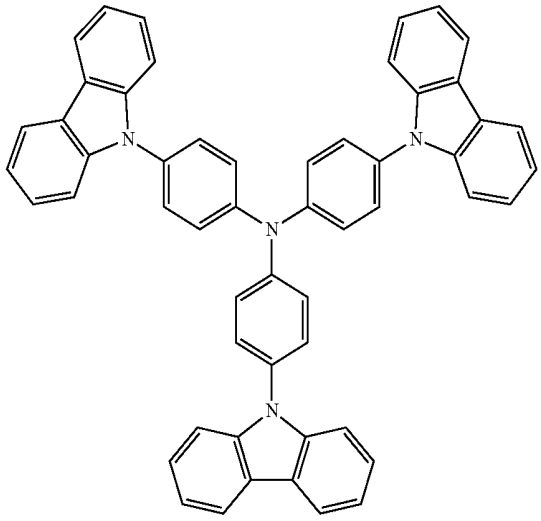
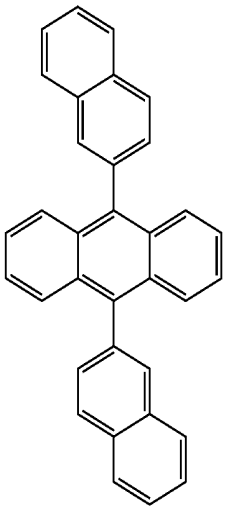
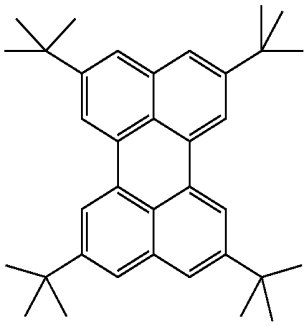


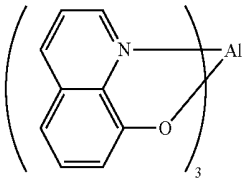
TCTA



ADN



t-Bu-Perylene



Alq3

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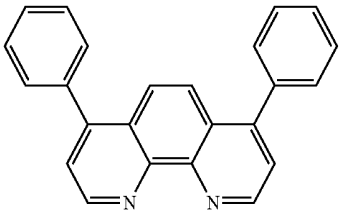


Bphen

TABLE 6

	Compound	Driving voltage (V)	Light emitting efficiency (cd/A)	External quantum efficiency (%)	CIE (x, y)
Example 1	6	5.48	6.53	8.11	(0.134 0.107)
Example 2	7	5.38	6.49	7.98	(0.134 0.100)
Example 3	11	5.10	6.53	8.81	(0.134 0.106)
Example 4	13	5.92	6.19	7.55	(0.134 0.101)
Example 5	14	6.19	6.23	6.27	(0.134 0.110)
Example 6	15	5.33	6.88	8.06	(0.134 0.099)
Example 7	16	5.47	6.82	8.54	(0.134 0.099)
Example 8	17	5.51	6.71	7.52	(0.134 0.100)
Example 9	18	5.35	7.12	7.52	(0.134 0.100)
Example 10	25	5.41	6.71	8.26	(0.134 0.104)
Example 11	28	6.23	5.90	5.94	(0.134 0.111)
Example 12	40	5.38	6.42	6.77	(0.134 0.106)
Example 13	44	5.17	6.58	8.73	(0.134 0.105)
Example 14	47	5.30	6.21	6.51	(0.134 0.108)
Example 15	48	5.48	6.61	8.61	(0.134 0.105)
Example 16	52	6.05	6.04	6.85	(0.134 0.110)
Example 17	59	5.39	6.87	5.66	(0.134 0.110)
Example 18	72	5.49	6.45	8.14	(0.134 0.099)
Example 19	84	6.00	6.04	7.18	(0.134 0.101)
Example 20	89	5.86	5.83	5.58	(0.134 0.110)

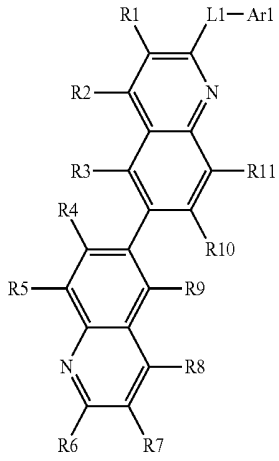
TABLE 6-continued

	Compound	Driving voltage (V)	Light emitting efficiency (cd/A)	External quantum efficiency (%)	CIE (x, y)
Example 21	91	5.26	6.76	8.12	(0.134 0.099)
Example 22	175	5.39	6.53	8.25	(0.134 0.099)
Example 23	179	5.46	6.77	7.44	(0.134 0.100)
Example 24	196	5.62	6.49	6.74	(0.134 0.106)
Example 25	198	5.85	6.53	7.76	(0.134 0.100)
Example 26	215	5.58	6.71	8.02	(0.134 0.099)
Example 27	220	5.24	6.57	7.81	(0.134 0.100)
Example 28	241	4.58	6.82	8.26	(0.134 0.099)
Example 29	245	5.17	6.62	7.29	(0.134 0.100)
Example 30	255	6.22	6.29	6.43	(0.134 0.109)
Example 31	269	5.92	6.48	8.23	(0.134 0.100)
Example 32	275	5.45	6.73	8.20	(0.134 0.099)
Example 33	284	5.36	6.62	7.98	(0.134 0.100)
Example 34	301	5.68	6.61	7.79	(0.134 0.100)
Example 35	304	5.79	6.28	6.32	(0.134 0.109)
Comparative Example 2	Bphen	8.22	5.63	5.72	(0.134 0.110)

[0306] As can be seen from the results in Table 6, the organic electroluminescence device using a charge producing layer material of the white organic electroluminescence device of the present invention has a low driving voltage and significantly improved light emitting efficiency as compared to Comparative Example 2.

1. A hetero-cyclic compound represented by the following Chemical Formula 1:

[Chemical Formula 1]



in Chemical Formula 1,

L1 is a direct bond; or a substituted or unsubstituted C_6 to C_{60} arylene group,

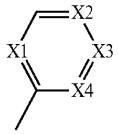
Ar1 comprises at least one of N, O, and S, and is a substituted or unsubstituted C_2 to C_{60} heteroaryl group,

R1 to R11 are the same as or different from each other, and are each independently selected from the group consisting of hydrogen; deuterium; a halogen group; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_2 to C_{60} alkenyl group; a substituted or unsubstituted C_2 to C_{60} alkynyl group; a substituted or unsubstituted C_1 to C_{60} alkoxy group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_2 to C_{60} heterocycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; a substituted or unsubstituted C_2 to C_{60} heteroaryl group; —SiRR'R"; —P(=O)RR'; and an amine group which is unsubstituted or substituted with a C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{60} aryl group, or a C_2 to C_{60} heteroaryl group, or two or more adjacent groups are bonded to each other to form a substituted or unsubstituted aliphatic or aromatic hydrocarbon ring, and

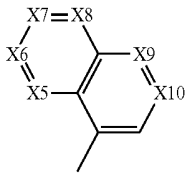
R, R', and R" are the same as or different from each other, and are each independently hydrogen; deuterium; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; or a substituted or unsubstituted C_2 to C_{60} heteroaryl group.

2. The hetero-cyclic compound of claim **1**, wherein Ar1 of Chemical Formula 1 is represented by any one of the following Chemical Formulae 2 to 6:

[Chemical Formula 2]



[Chemical Formula 3]



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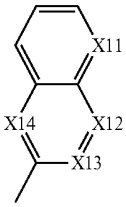

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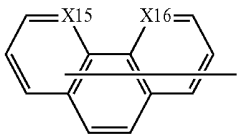
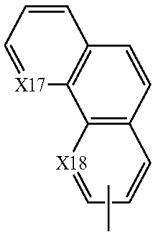
[Chemical Formula 5]



[Chemical Formula 6]



in Chemical Formulae 2 to 6,

at least one of X1 to X4 is N, O, or S, and the others are CR12,

at least one of X5 to X10 is N, O, or S, and the others are CR13,

at least one of X11 to X14 is N, O, or S, and the others are CR14,

at least one of X15 and X16 is N, O, or S, and the other is CR15,

at least one of X17 and X18 is N, O, or S, and the other is CR16,

R12 to R16 are the same as or different from each other, and are each independently selected from the group consisting of hydrogen; deuterium; a halogen group; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_2 to C_{60} alkenyl group; a substituted or unsubstituted C_2 to C_{60} alkynyl group; a substituted or unsubstituted C_1 to C_{60} alkoxy group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_2 to C_{60} heterocycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; a substituted or unsubstituted C_2 to C_{60} heteroaryl group; —SiRR'R"; —P(=O)RR'; and an amine group which is unsubstituted or substituted with a C_1 to C_{20} alkyl group, a substituted or unsubstituted C_6 to C_{60} aryl group, or a C_2 to C_{60} heteroaryl group, or two or more adjacent groups are bonded to each other to form a substituted or unsubstituted aliphatic or aromatic hydrocarbon ring, and

R, R', and R" are the same as or different from each other, and are each independently hydrogen; deuterium; —CN; a substituted or unsubstituted C_1 to C_{60} alkyl group; a substituted or unsubstituted C_3 to C_{60} cycloalkyl group; a substituted or unsubstituted C_6 to C_{60} aryl group; or a substituted or unsubstituted C_2 to C_{60} heteroaryl group.

3. The hetero-cyclic compound of claim **1**, wherein R6 of Chemical Formula 1 is -(L2)m-(Z)n,

L2 is a substituted or unsubstituted C_6 to C_{60} arylene; or a substituted or unsubstituted C_2 to C_{60} heteroarylene,

Z is a substituted or unsubstituted C_6 to C_{60} aryl group; or a substituted or unsubstituted C_2 to C_{60} heteroaryl group,

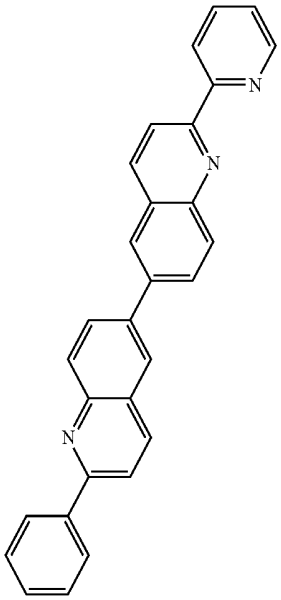
m is an integer from 0 to 5, and

n is an integer from 1 to 3.

4. The hetero-cyclic compound of claim **1**, wherein R1 to R5 and R7 to R11 of Chemical Formula 1 are hydrogen or deuterium.

5. The hetero-cyclic compound of claim **1**, wherein Chemical Formula 1 is represented by any one of the following compounds:

1



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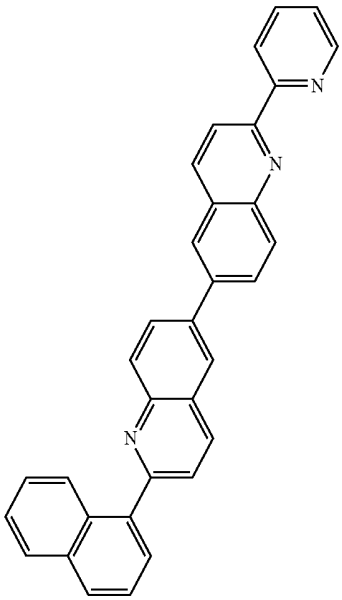

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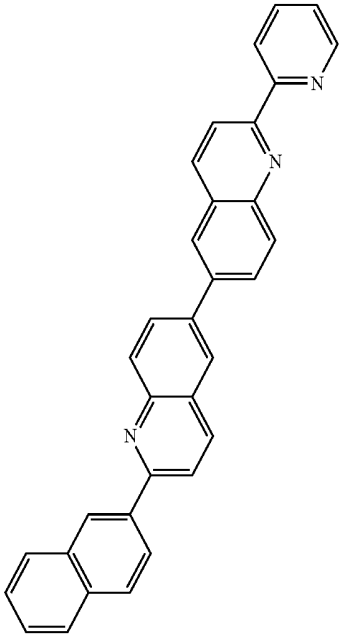

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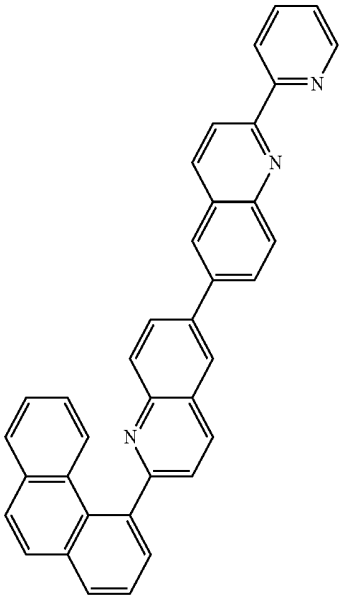

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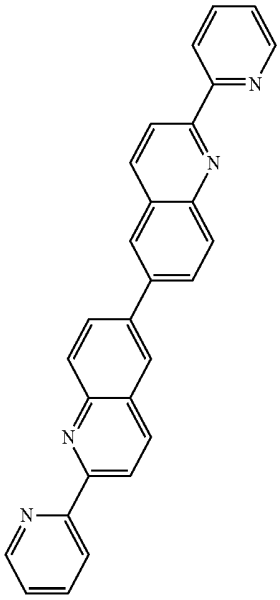

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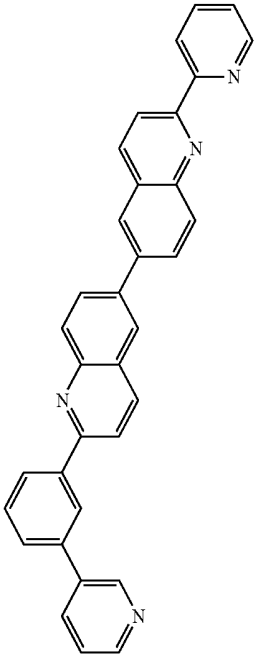

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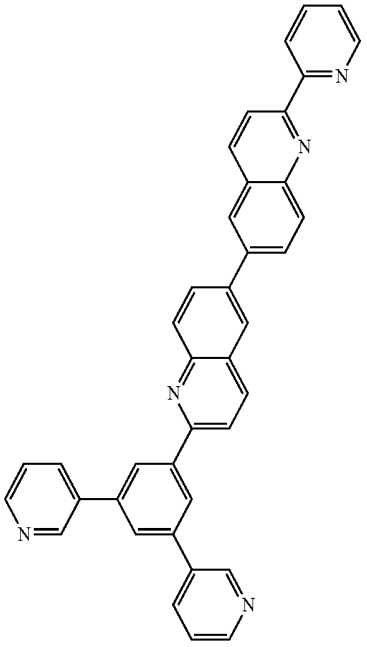

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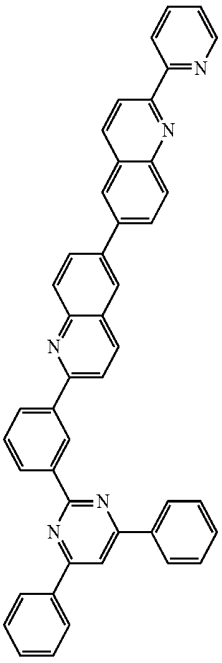

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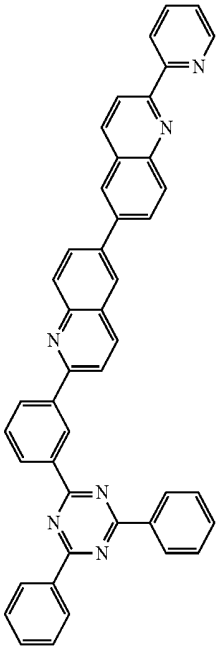

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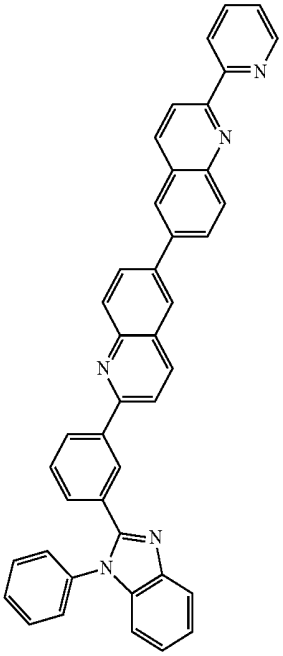

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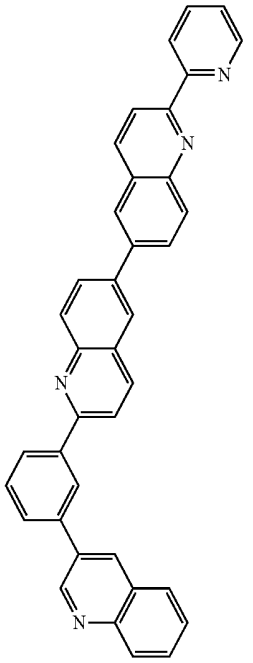

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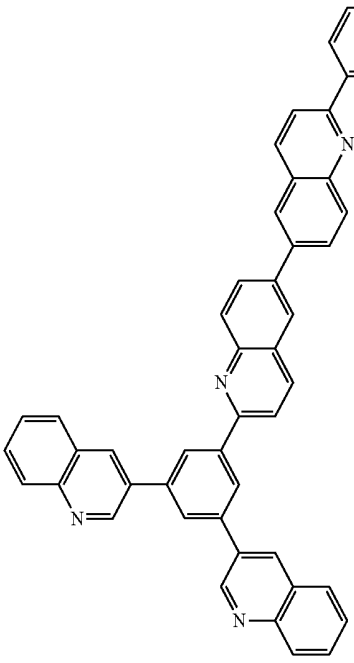

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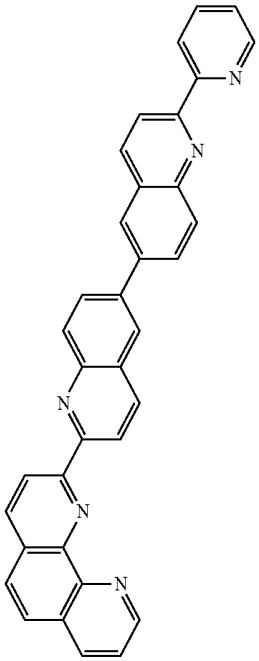

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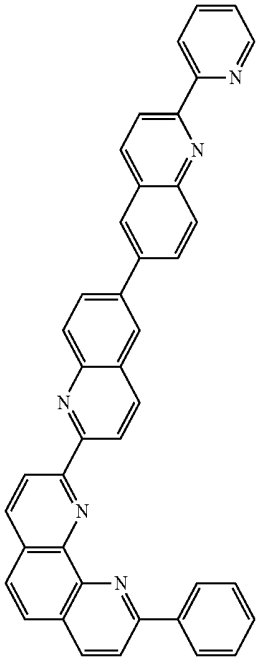

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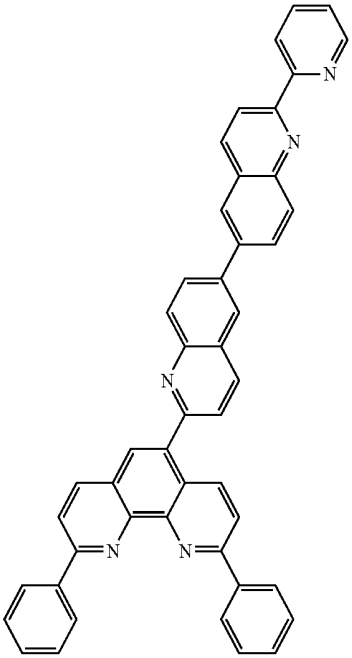

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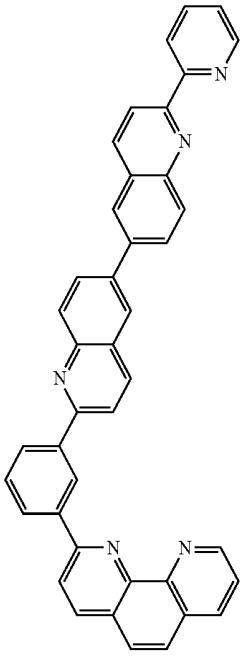

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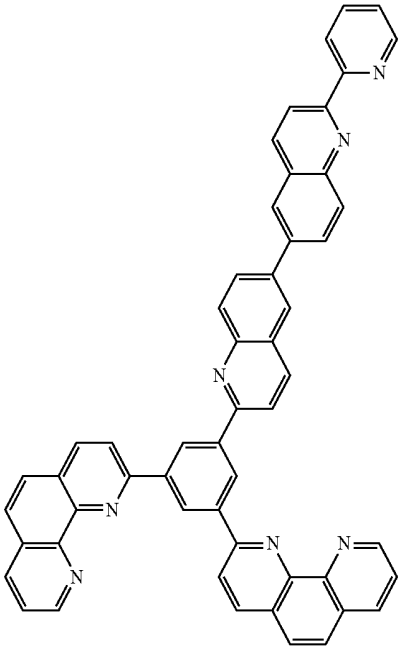

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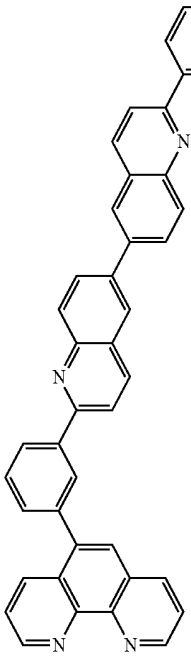

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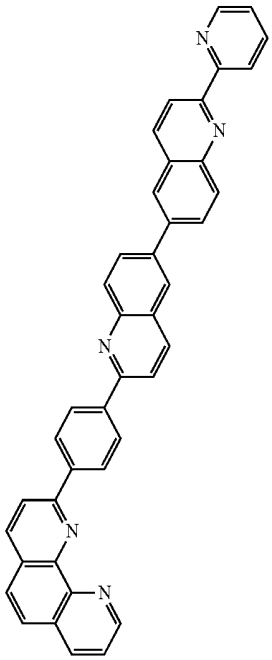

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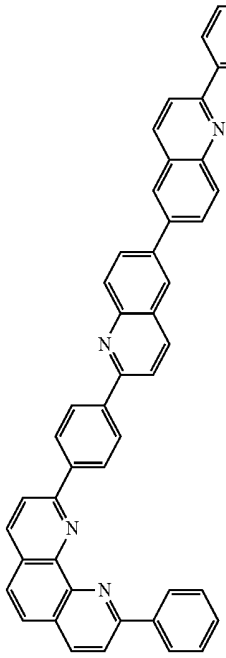

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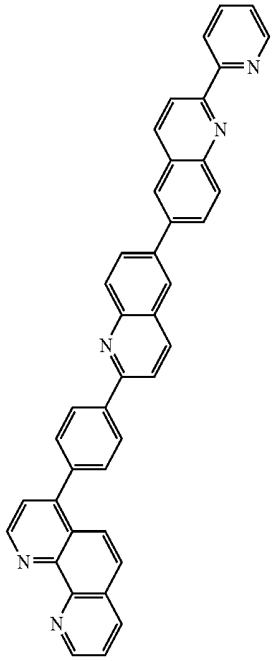

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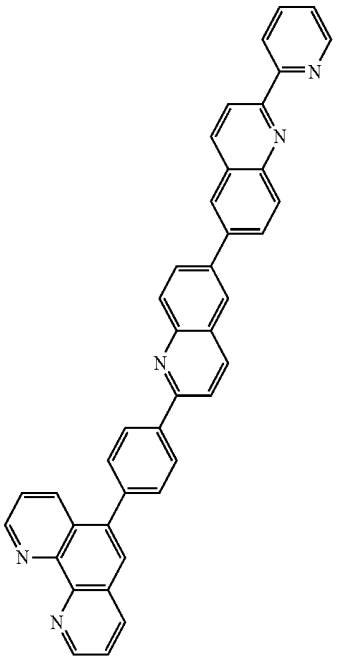

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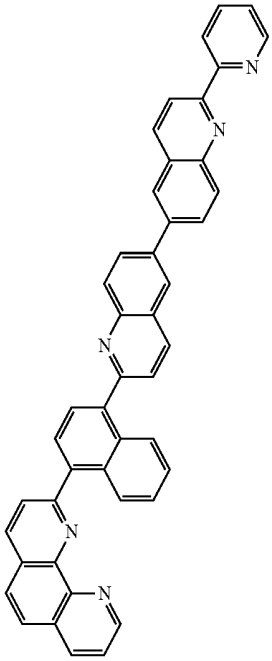

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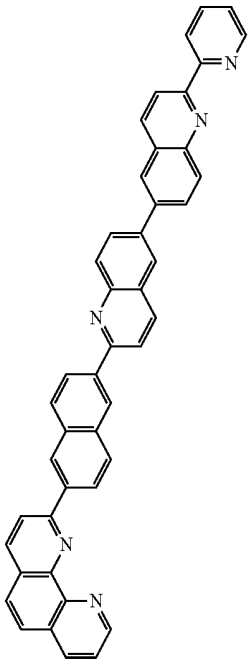

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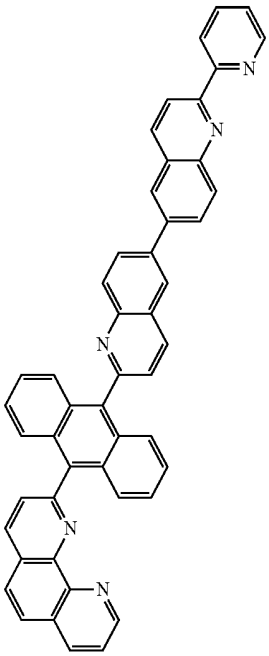

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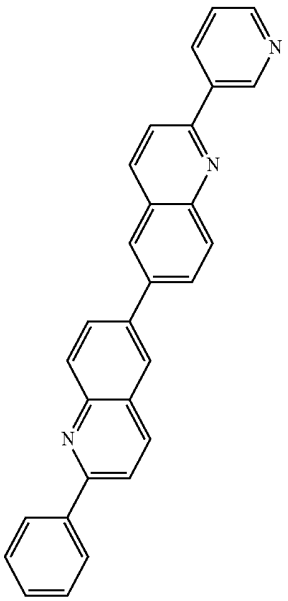

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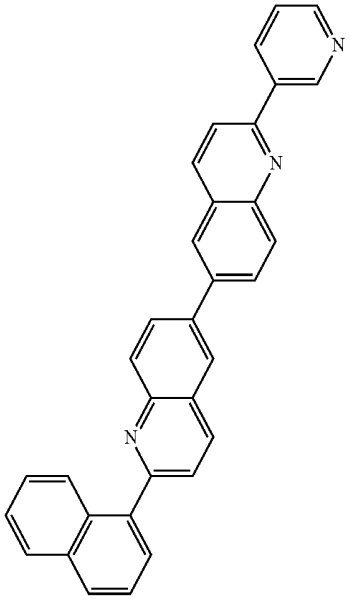

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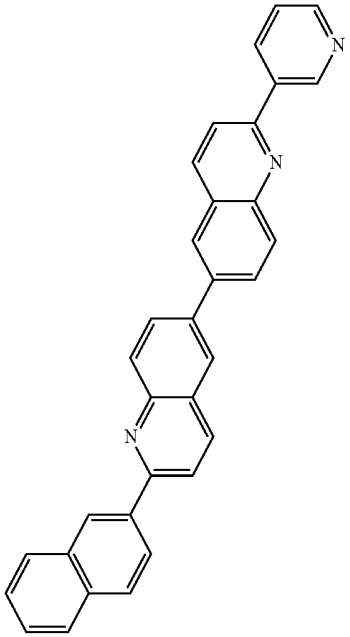

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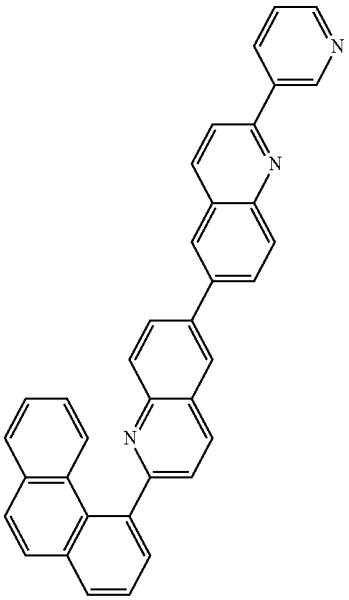

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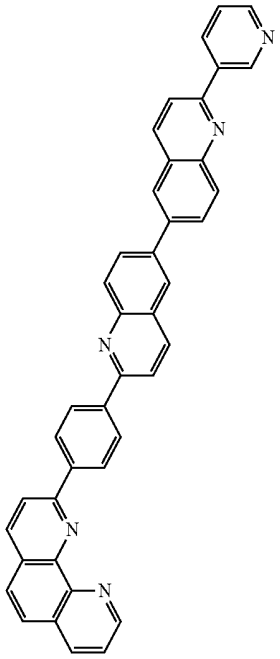

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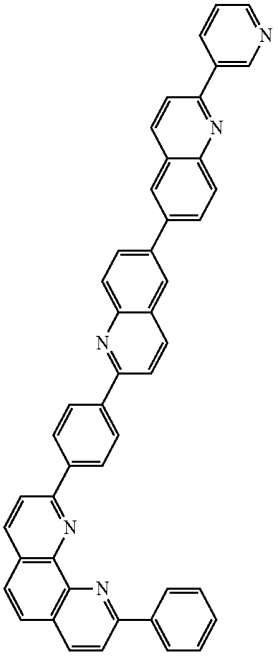

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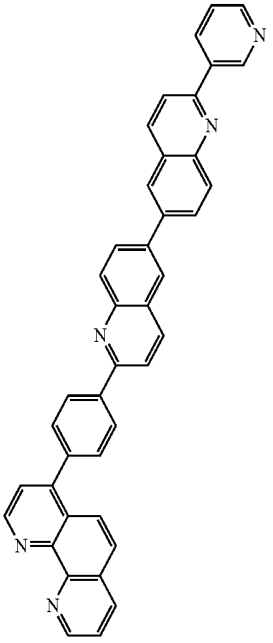

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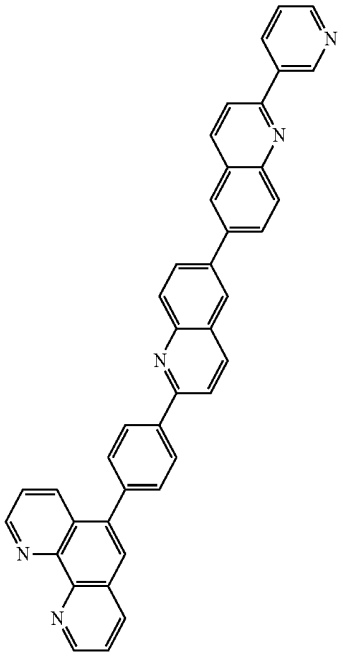

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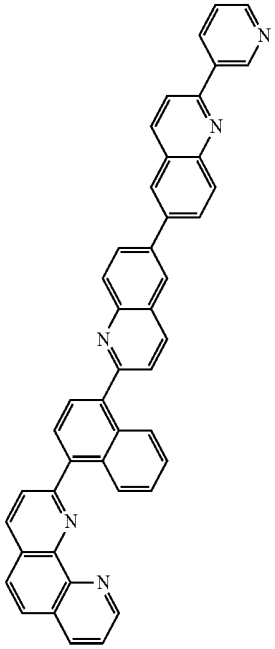

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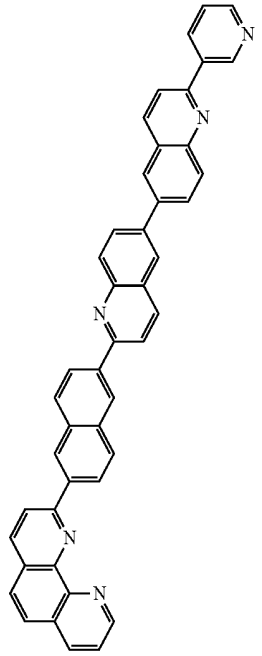

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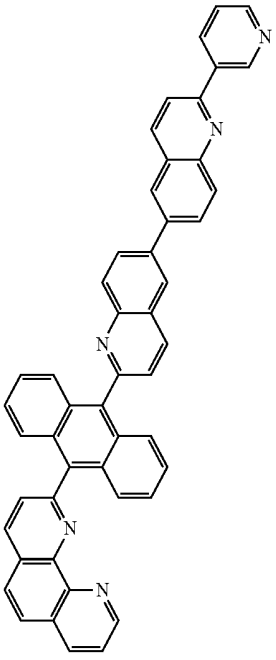

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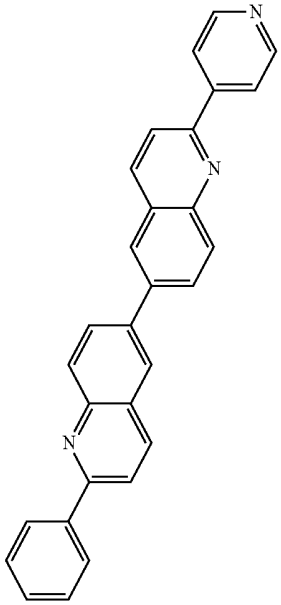

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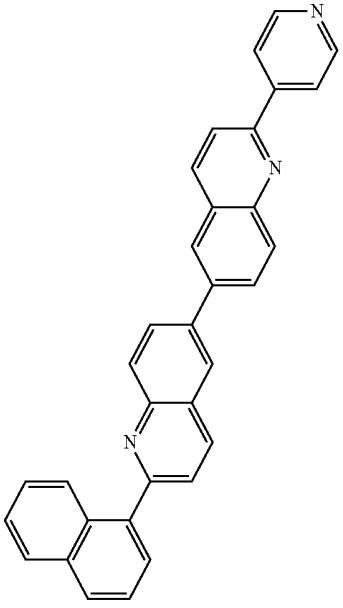

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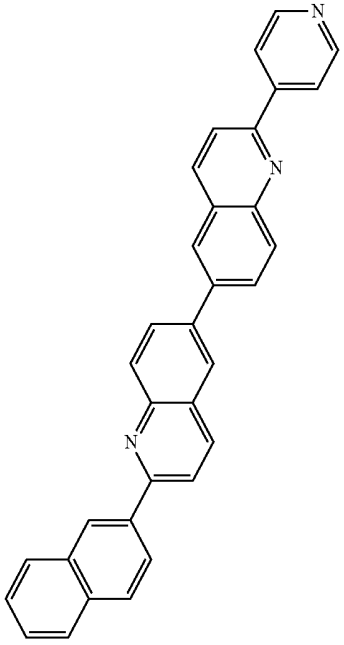

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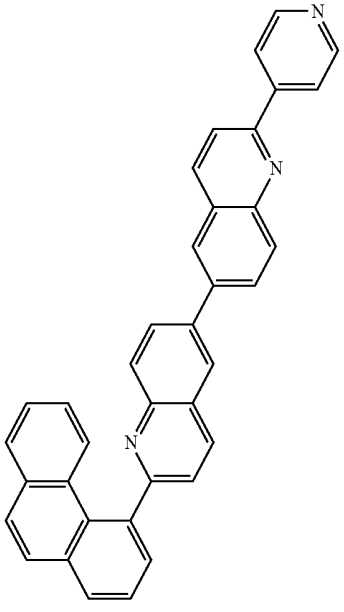

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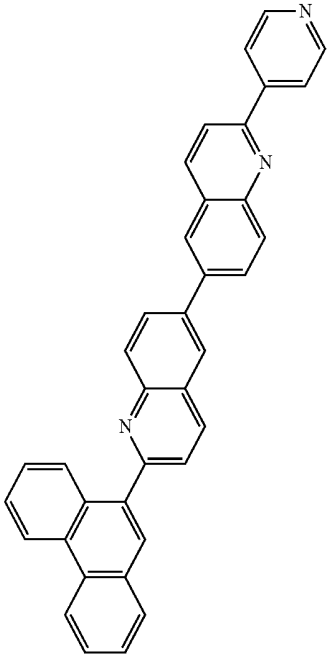

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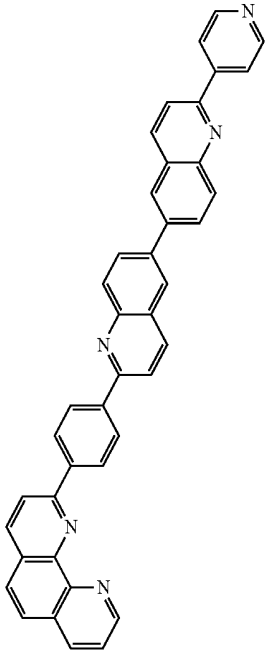

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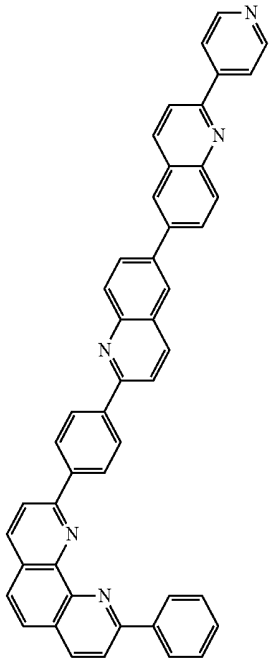

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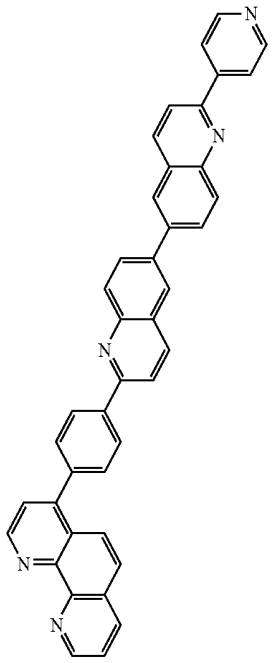

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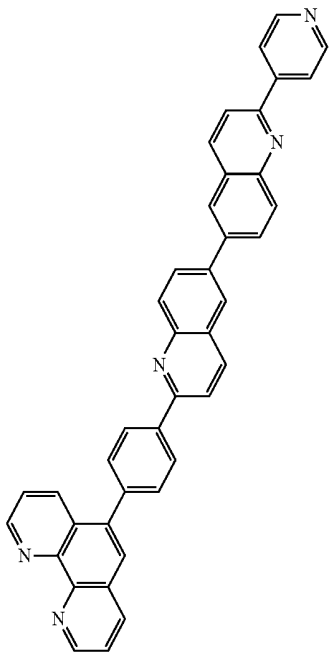

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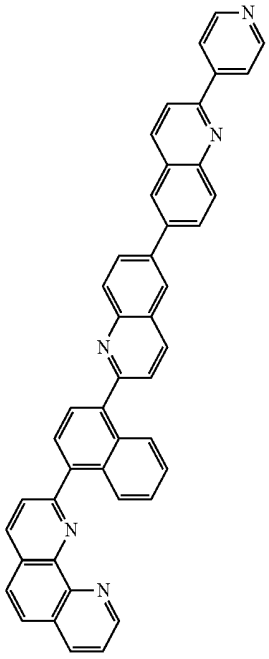

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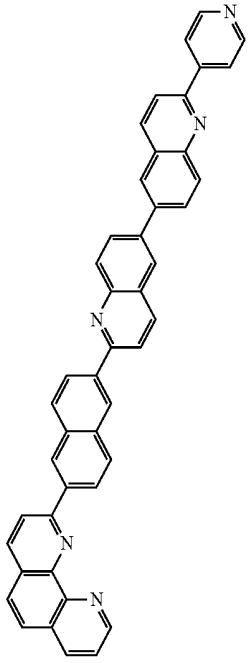

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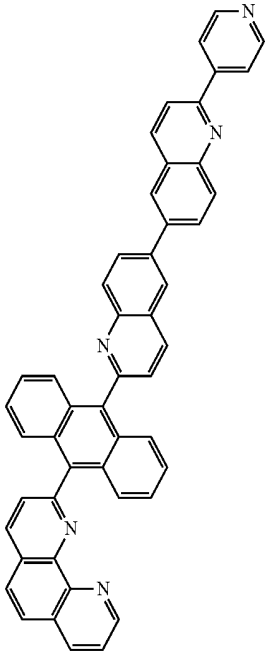

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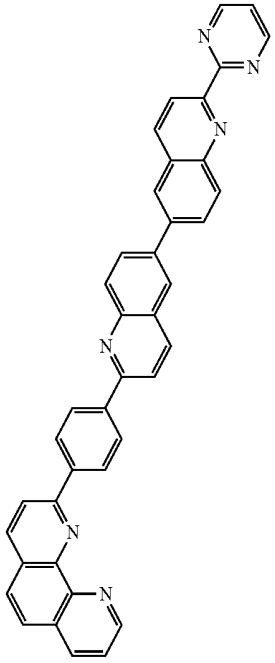

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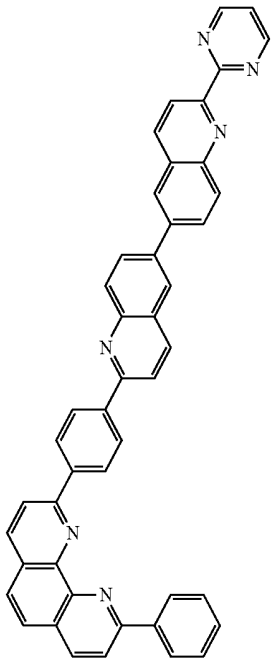

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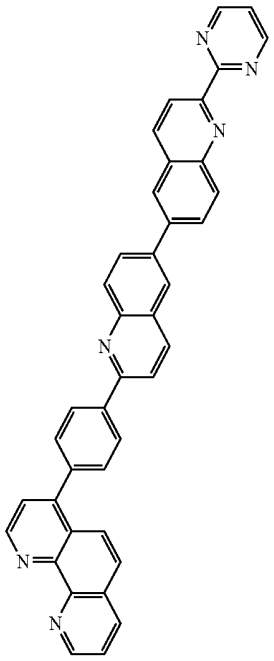

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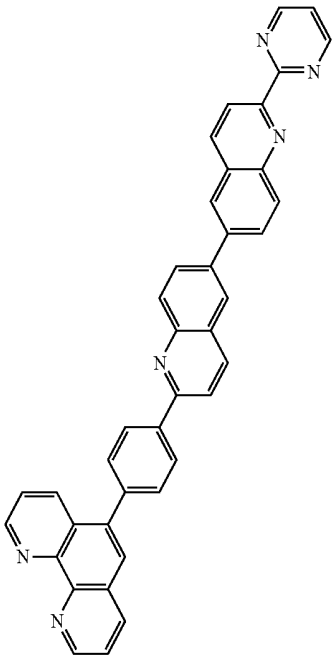

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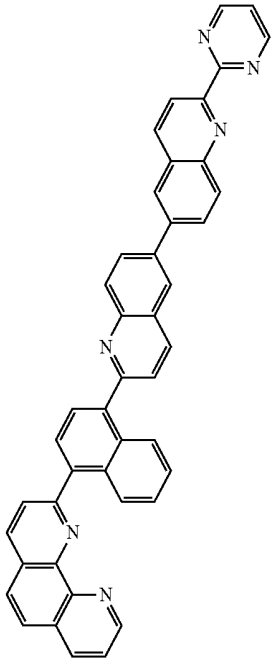

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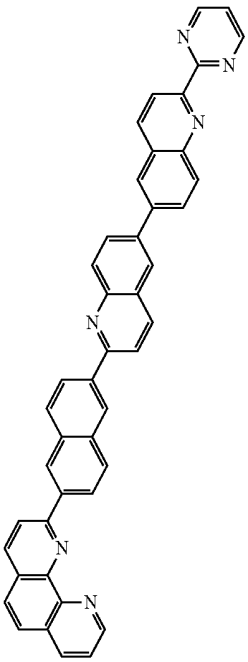

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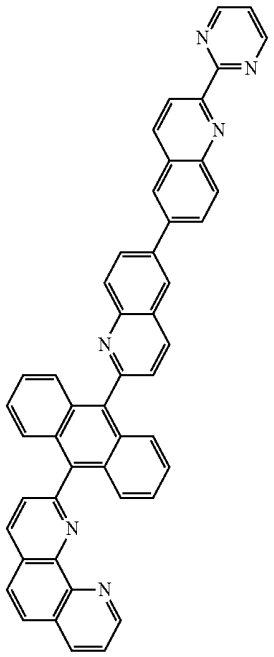

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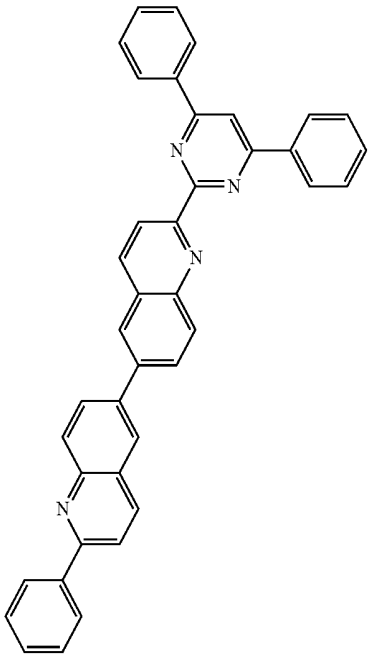

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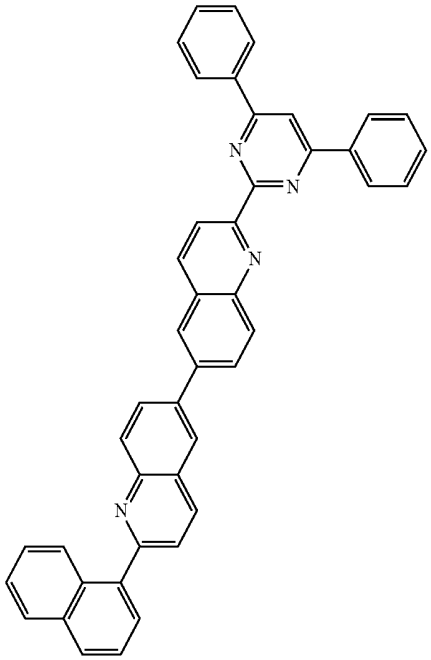

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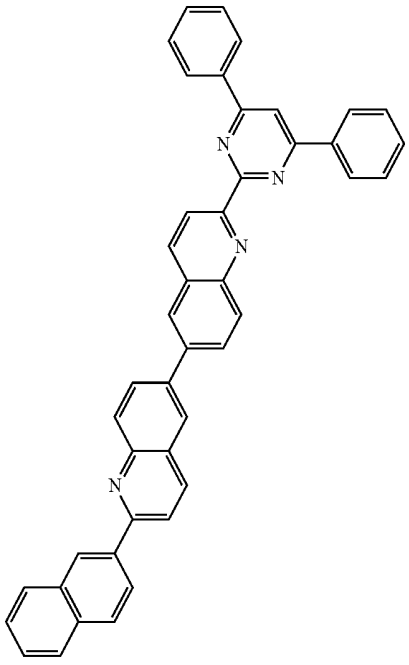

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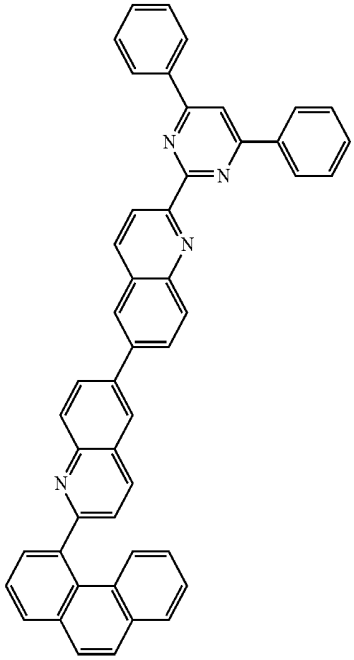

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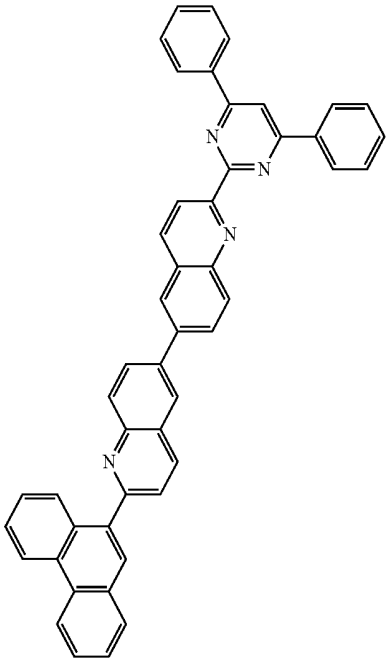

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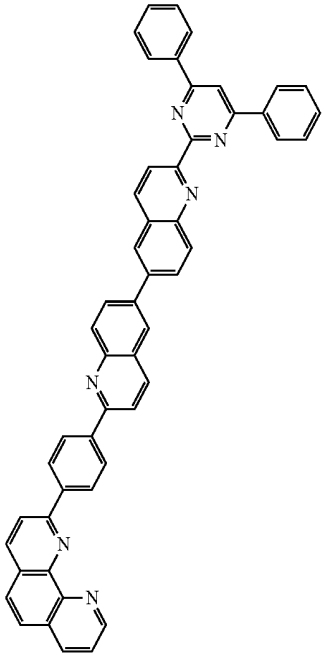

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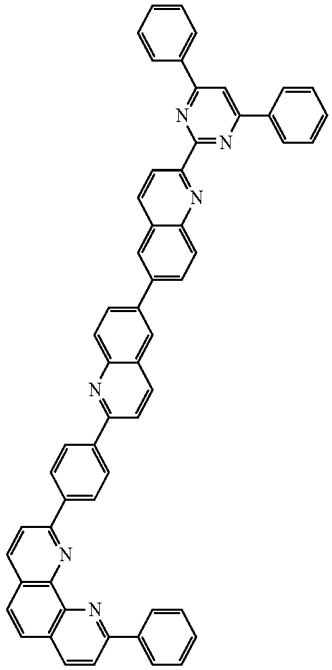

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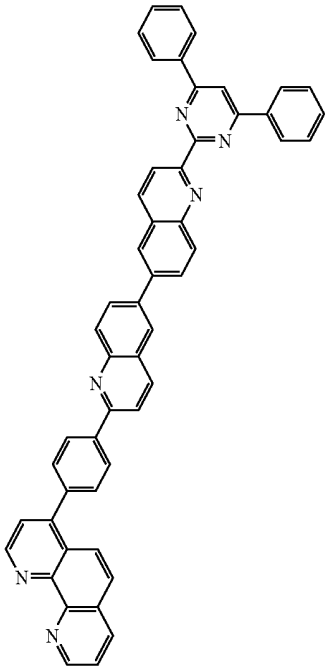

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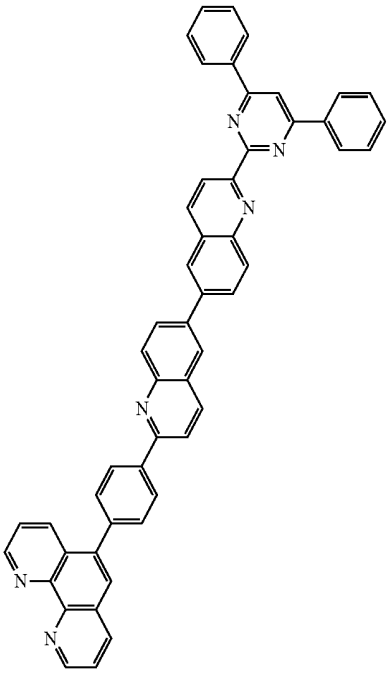

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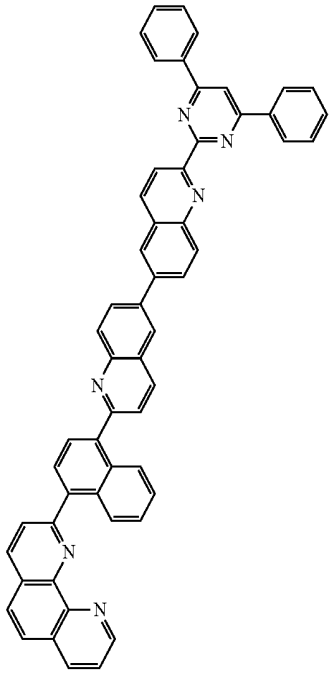

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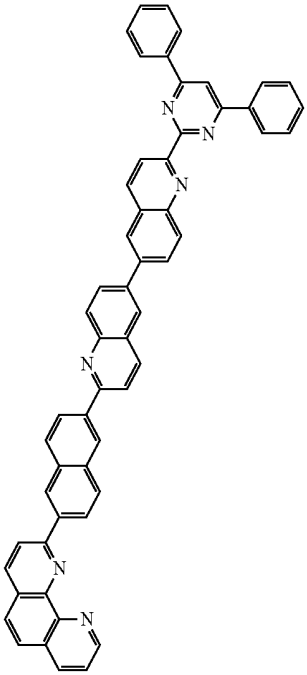

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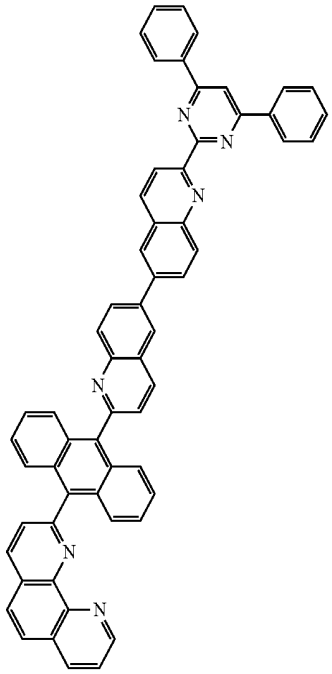

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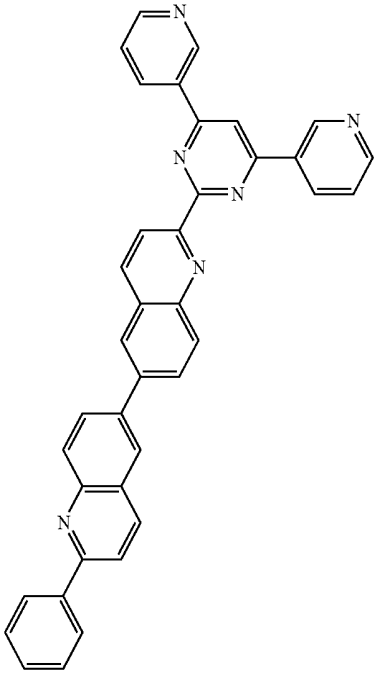

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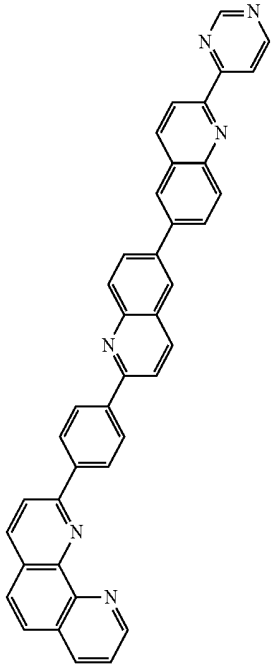

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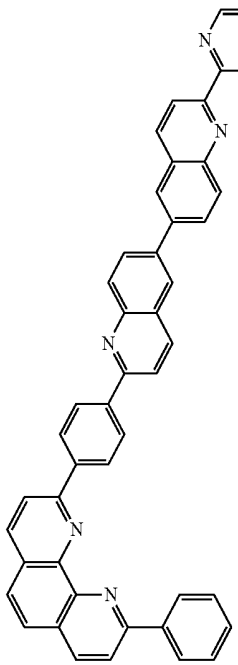

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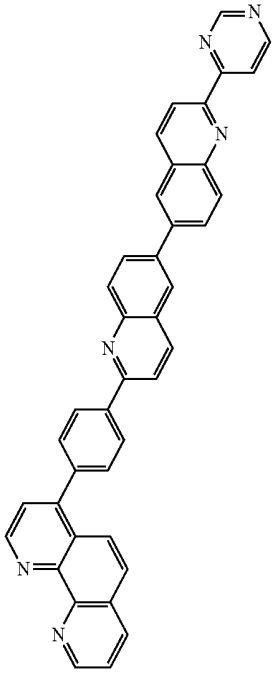

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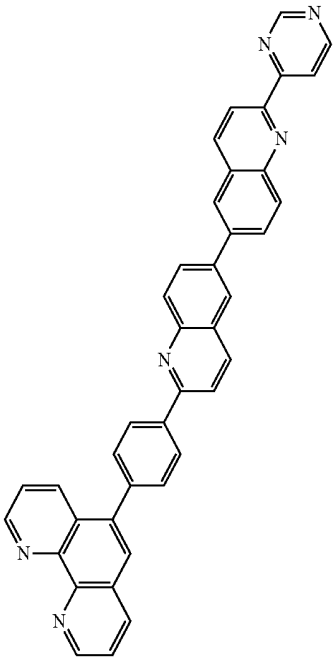

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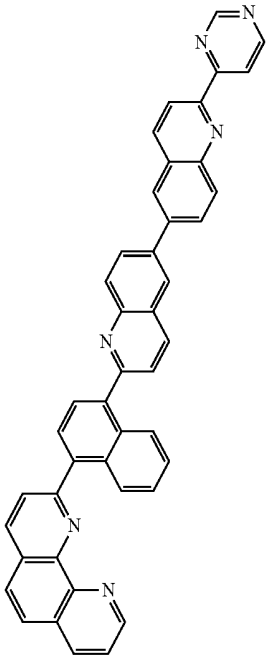

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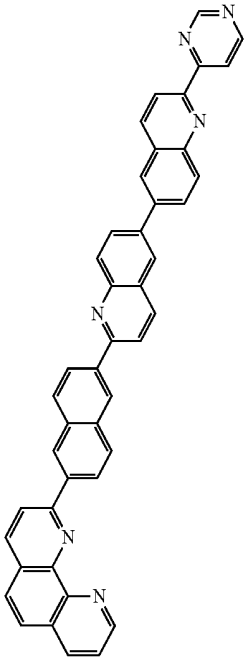

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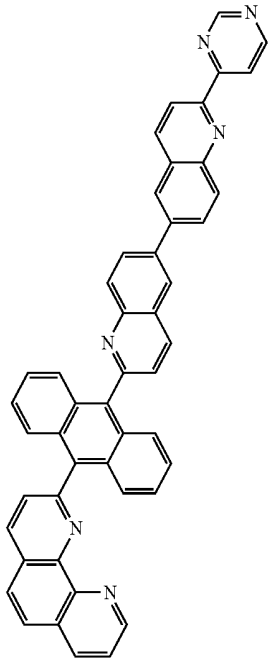

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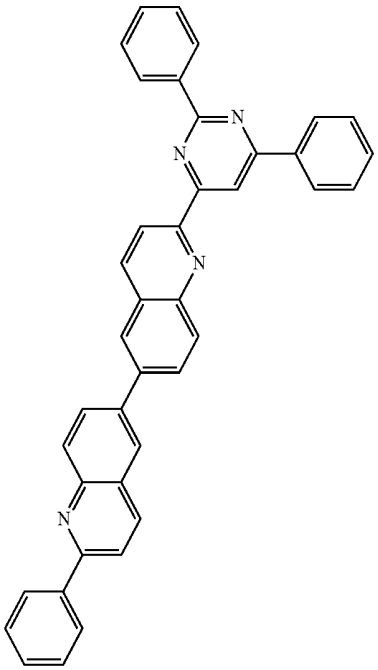

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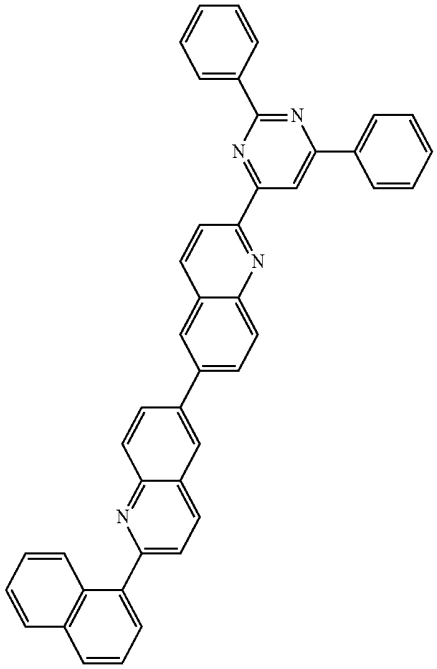

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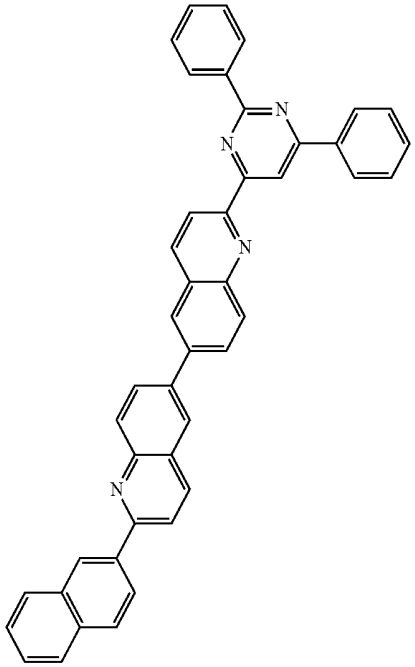

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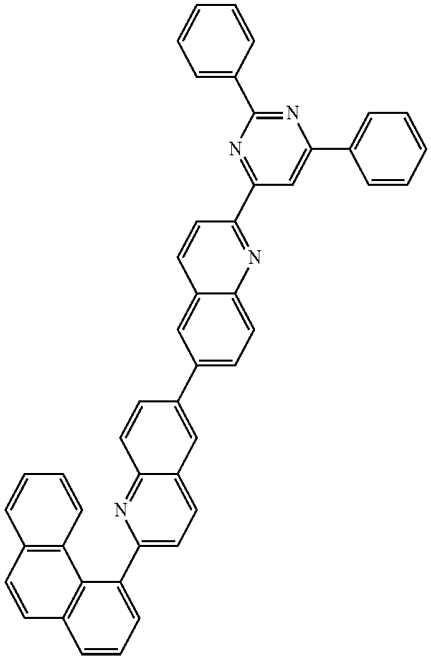

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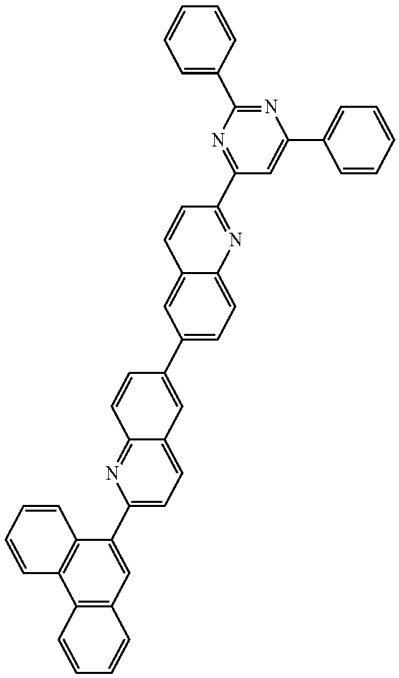

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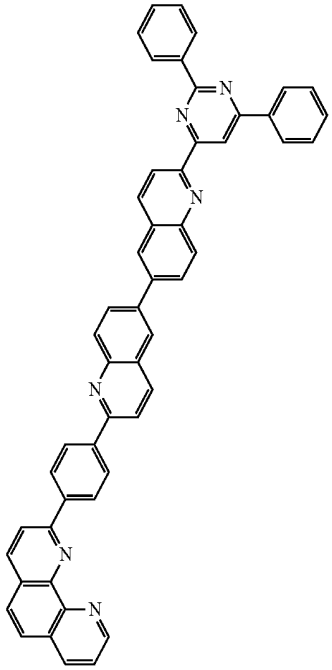

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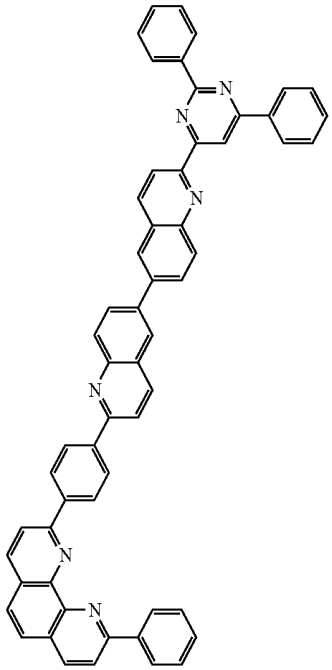

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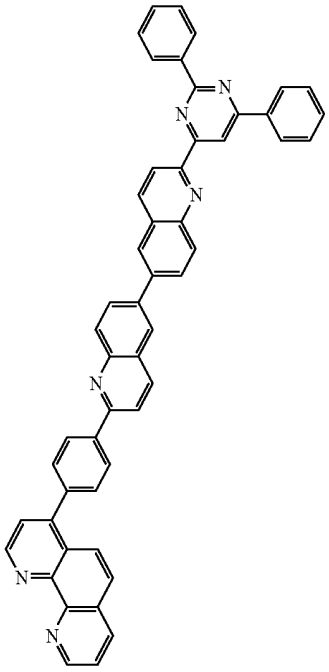

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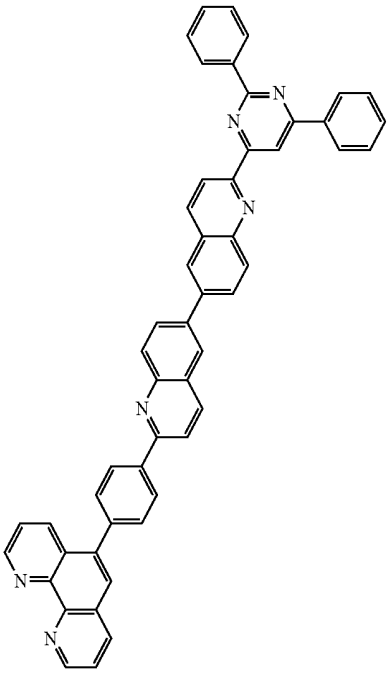

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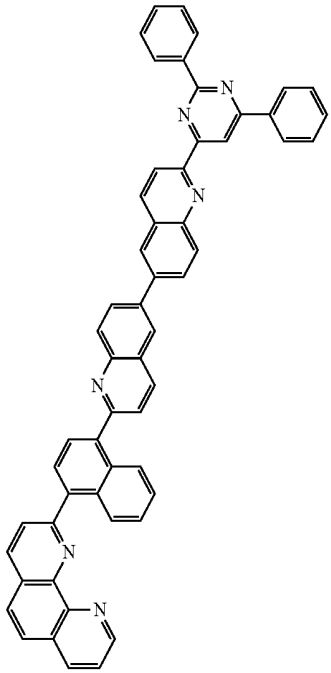

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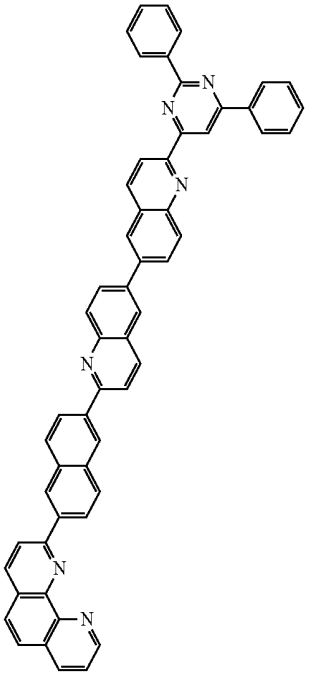

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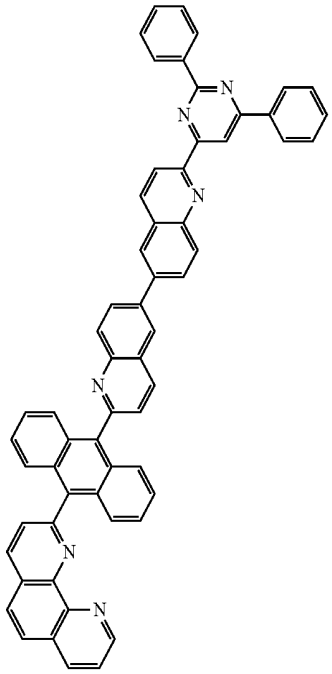

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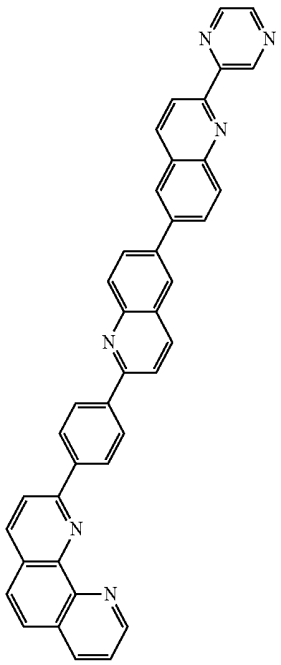

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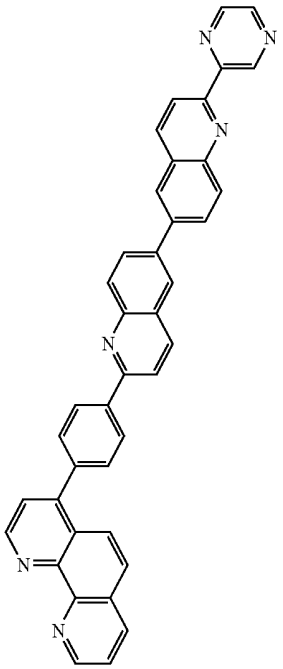

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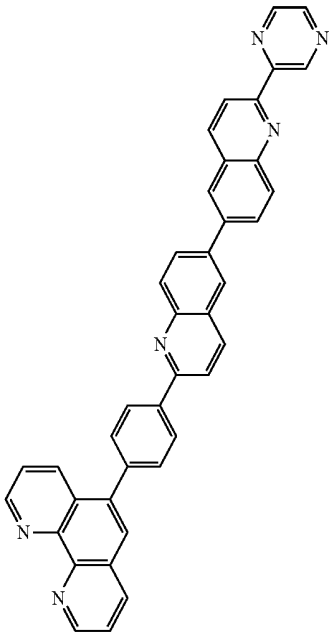

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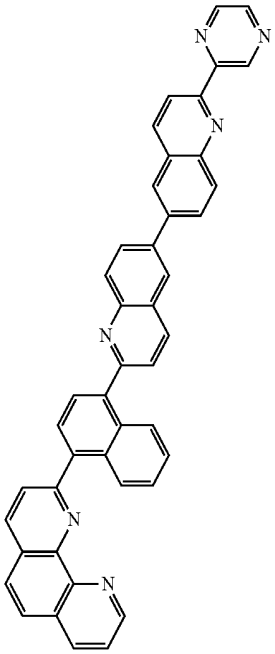

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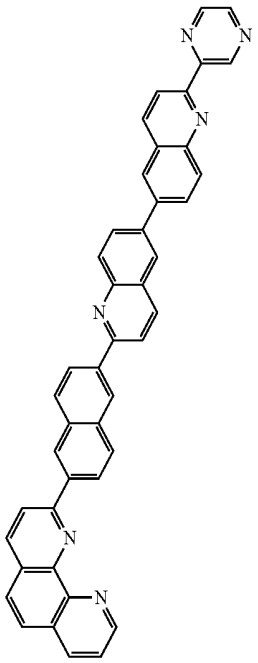

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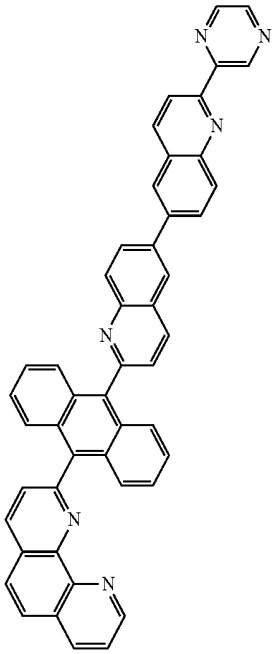

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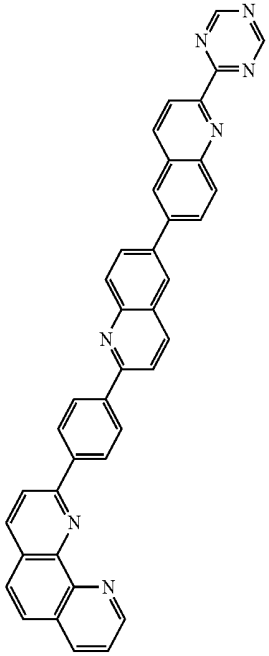

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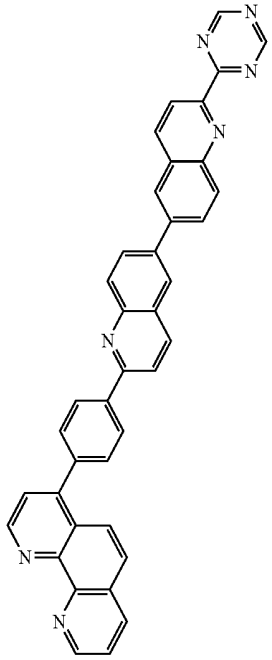

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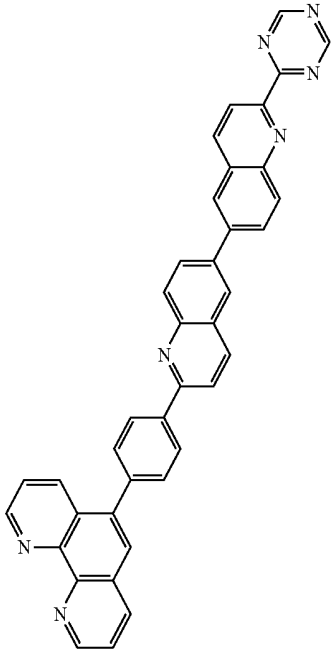

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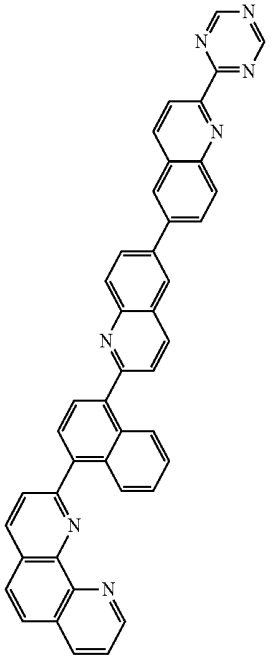

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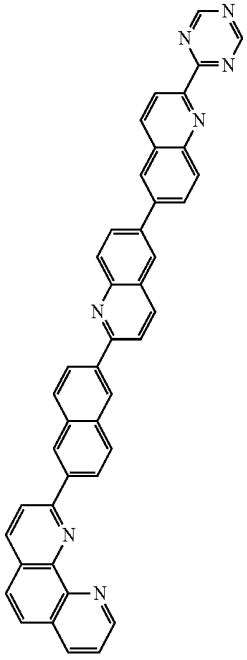

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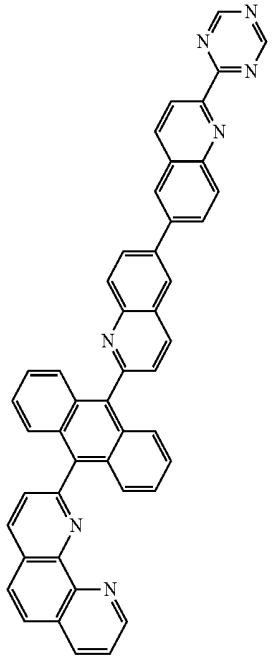

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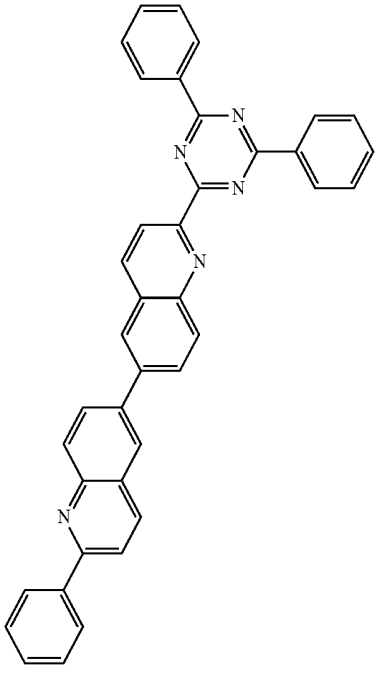

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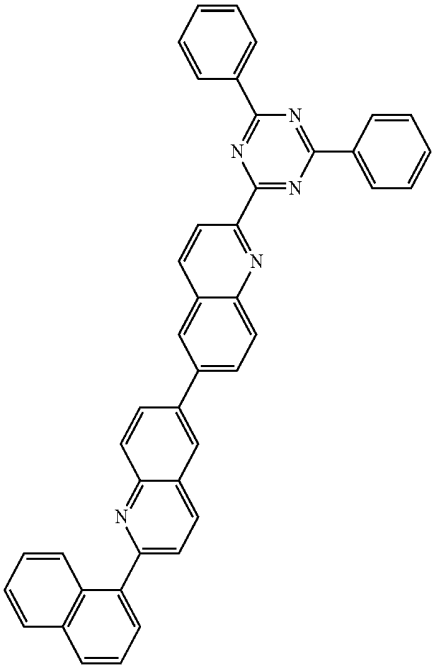

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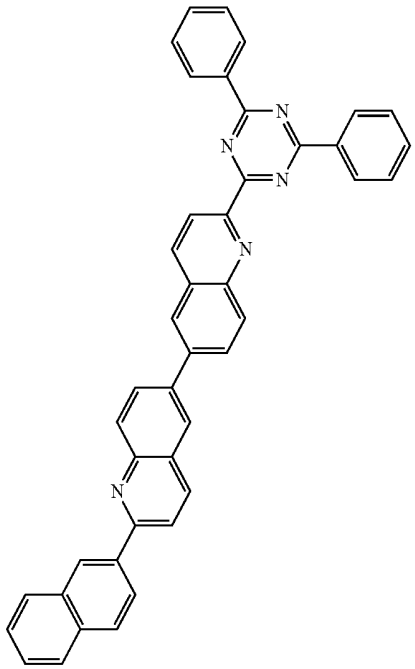

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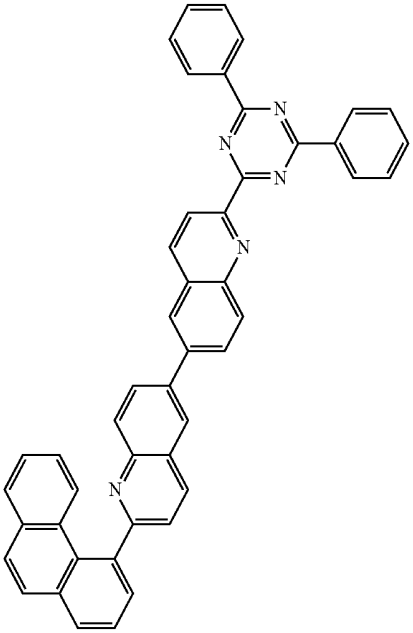

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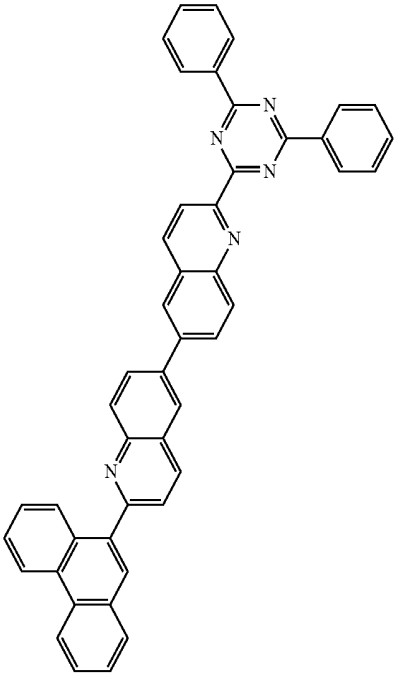

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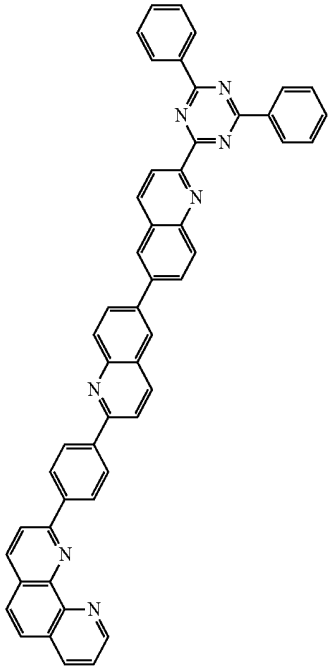

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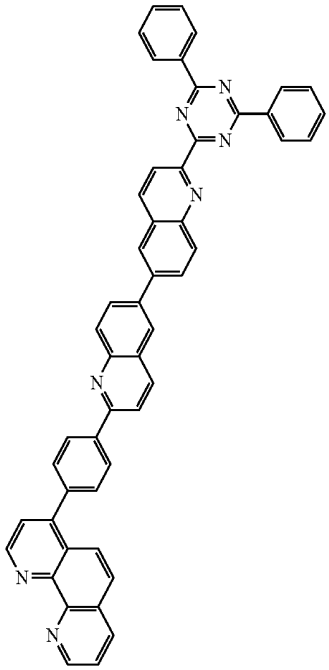

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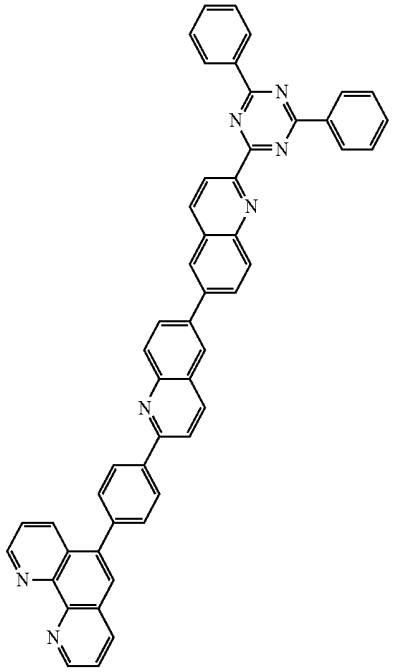

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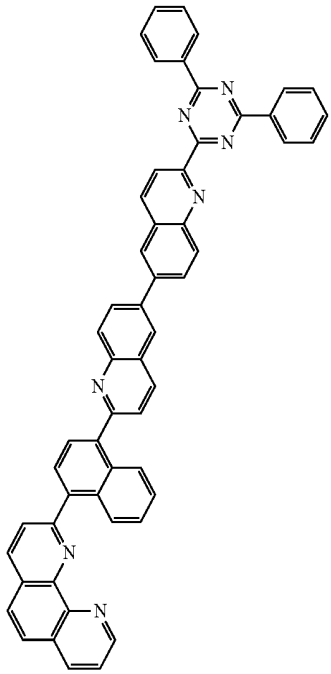

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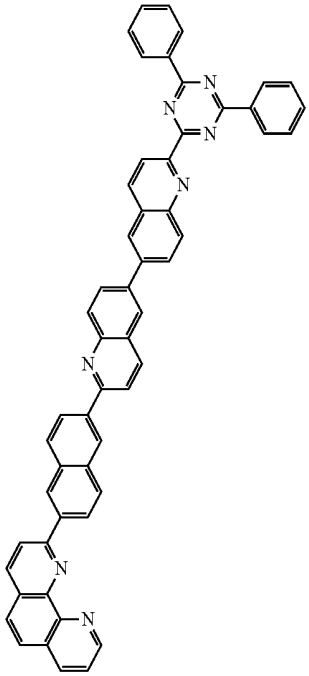

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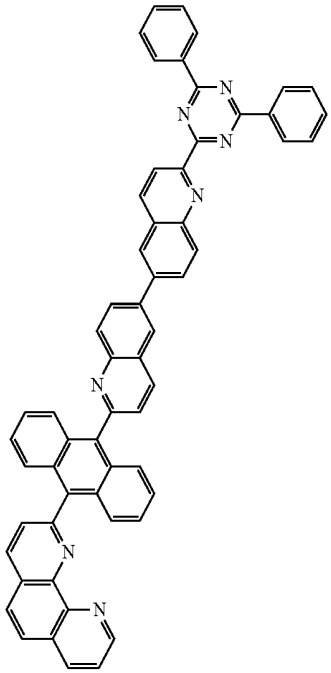

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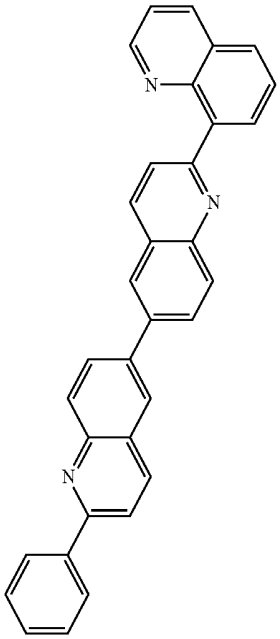

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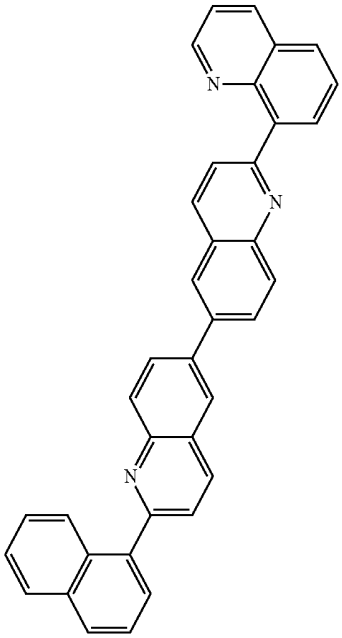

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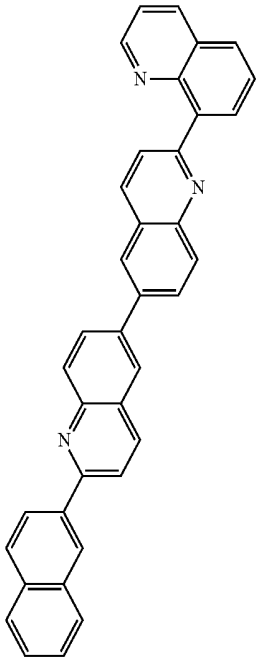

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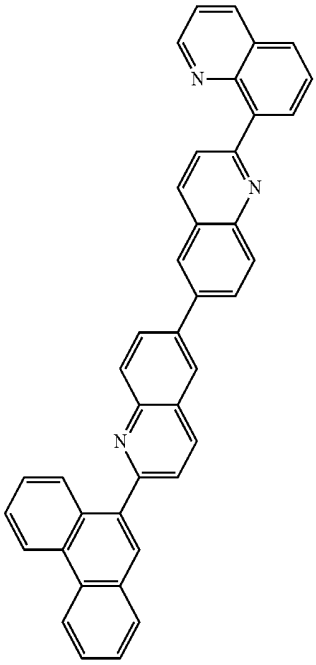

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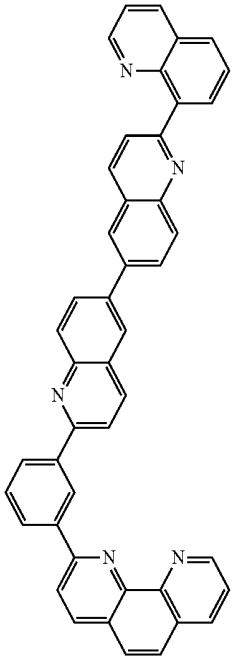

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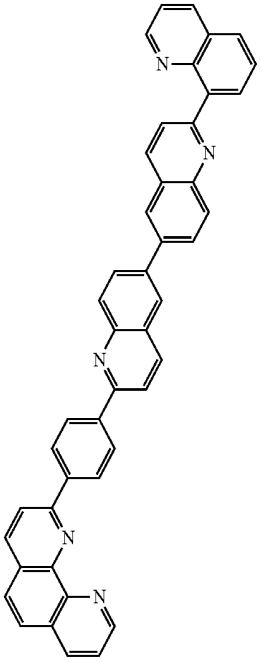

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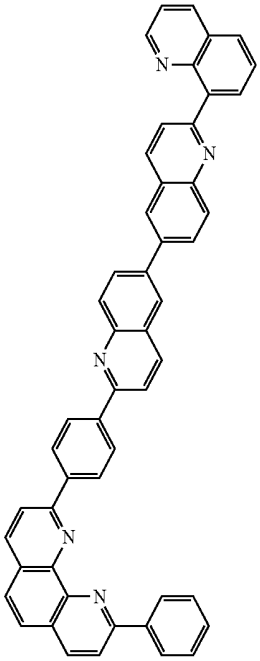

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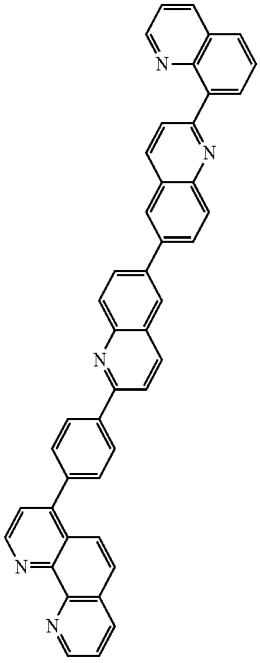

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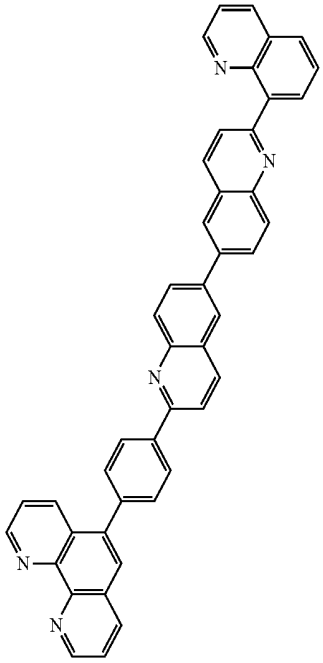

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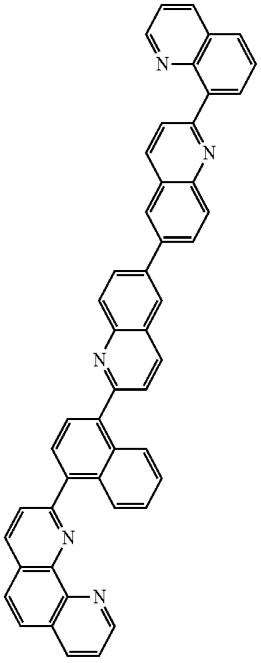

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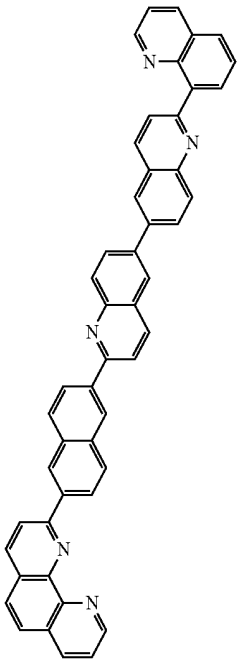

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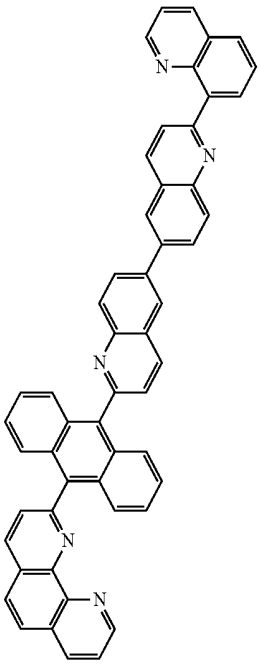

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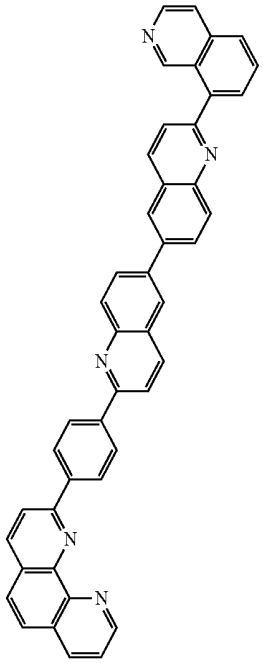

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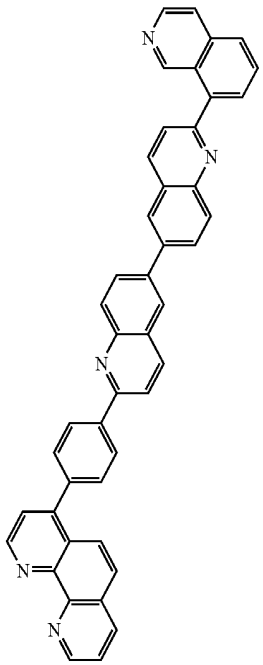

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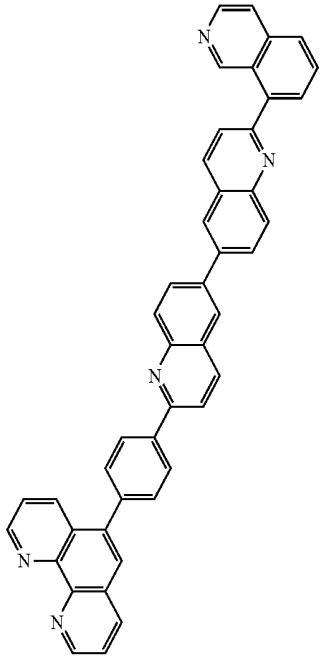

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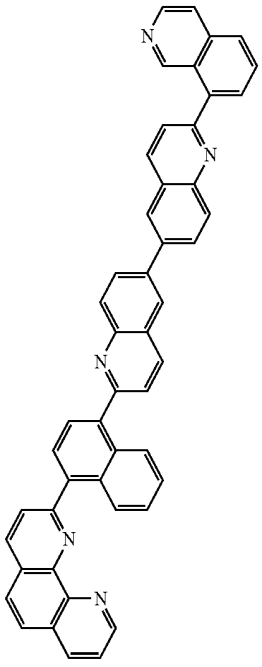

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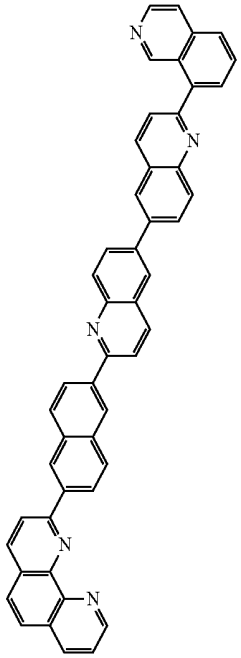

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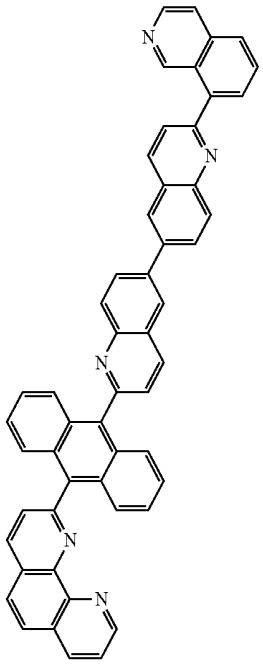

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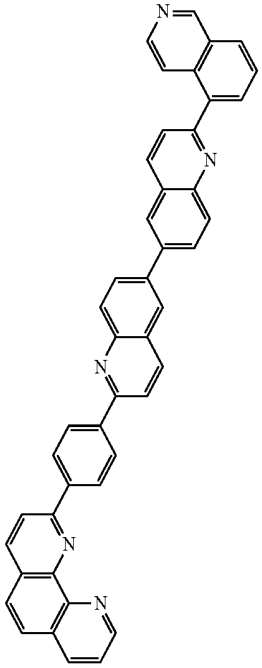

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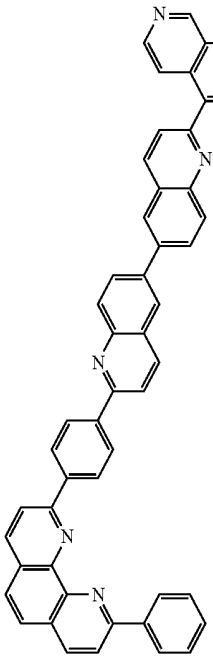

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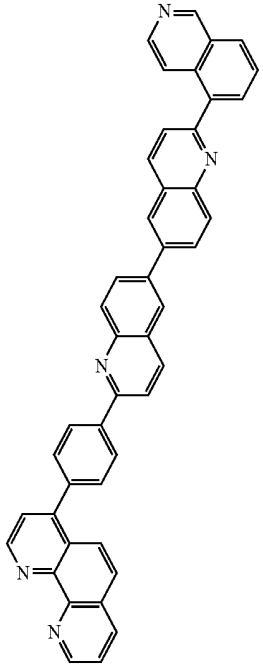

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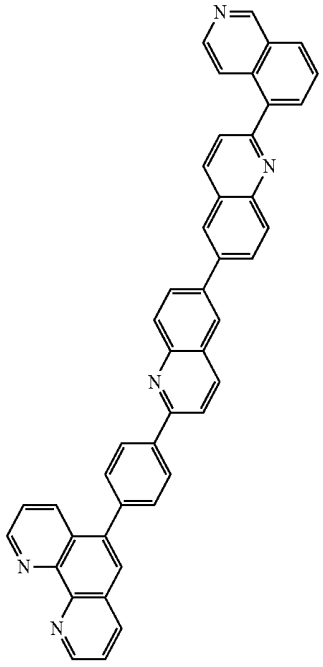

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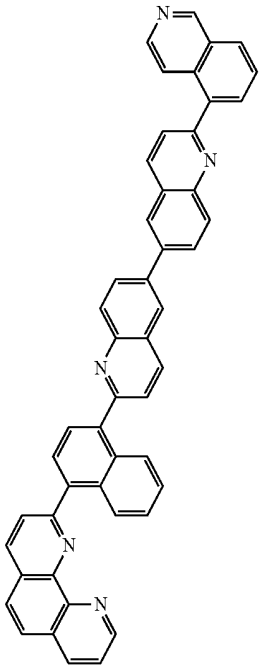

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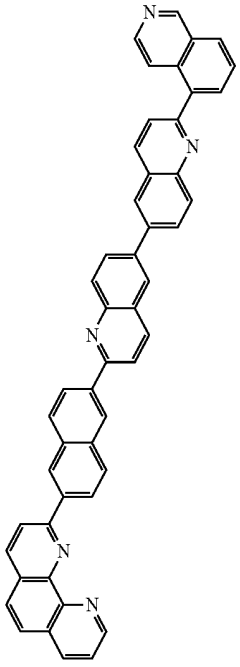

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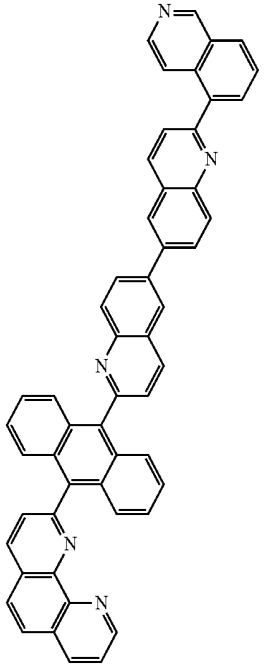

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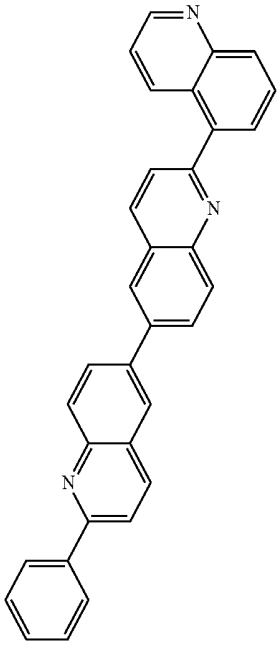

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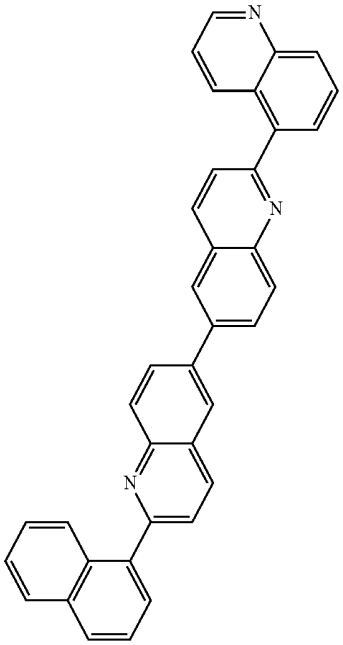

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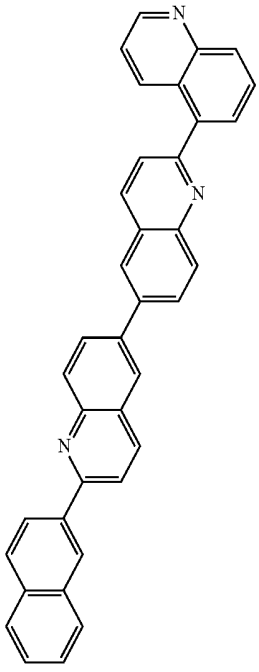

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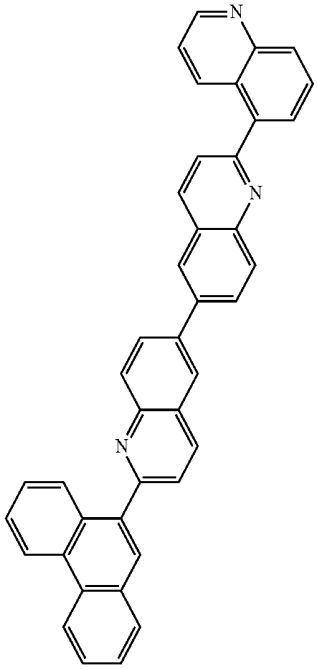

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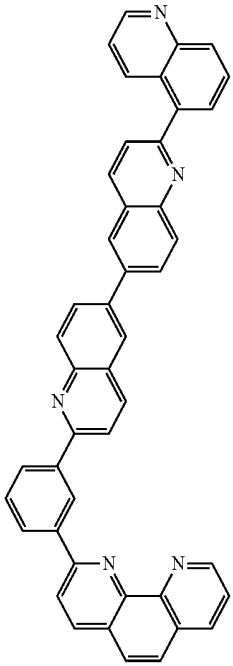

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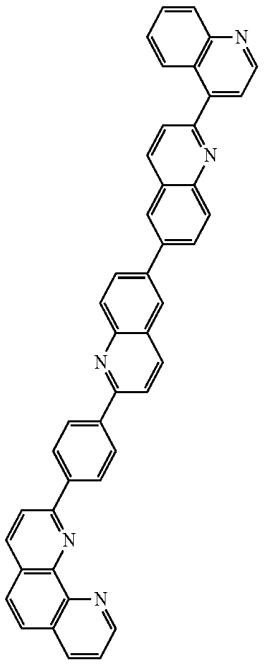

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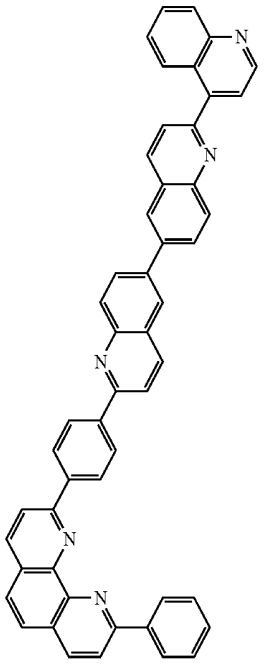

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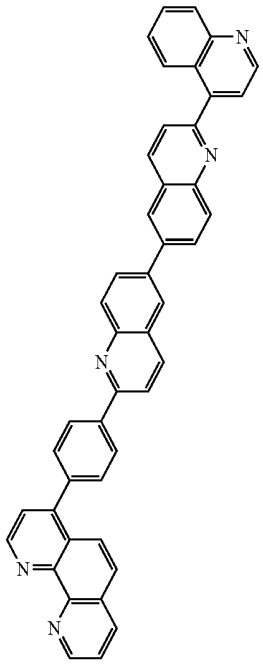

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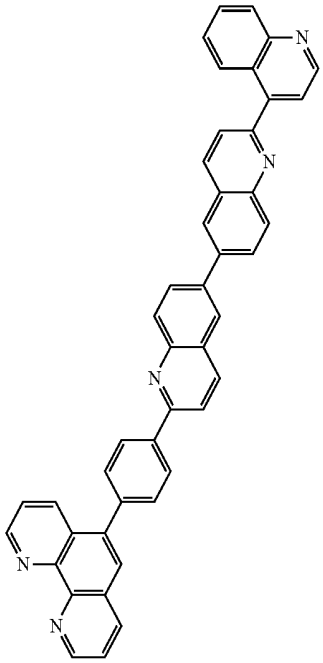

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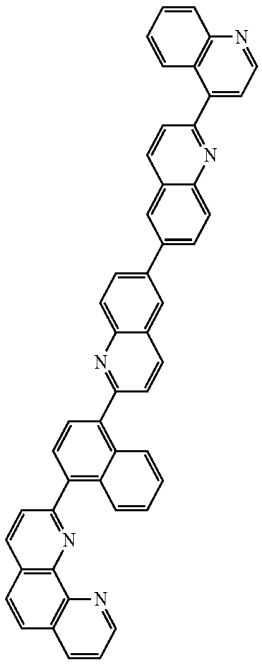

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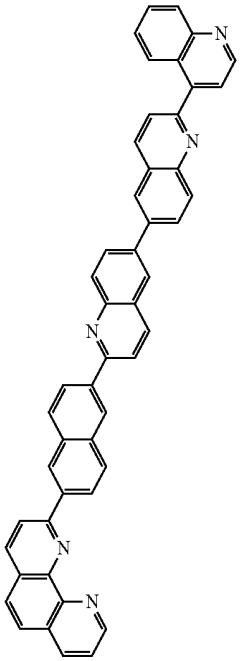

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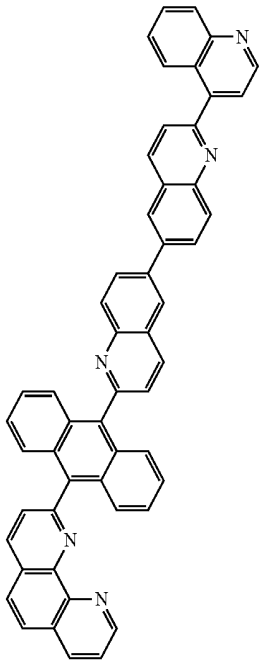

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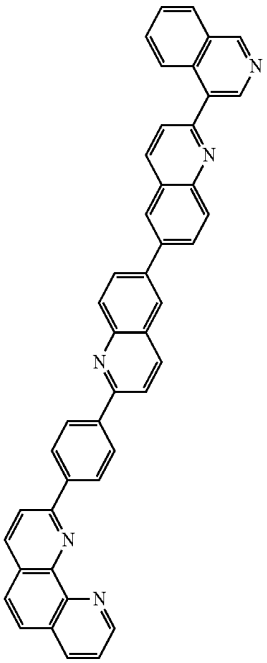

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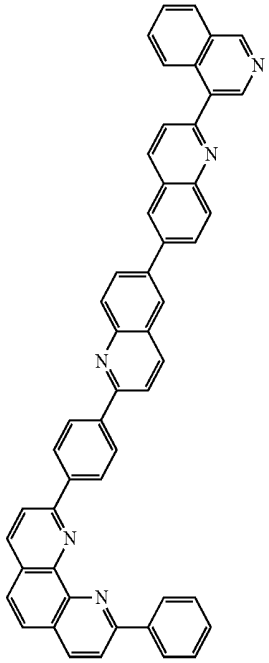

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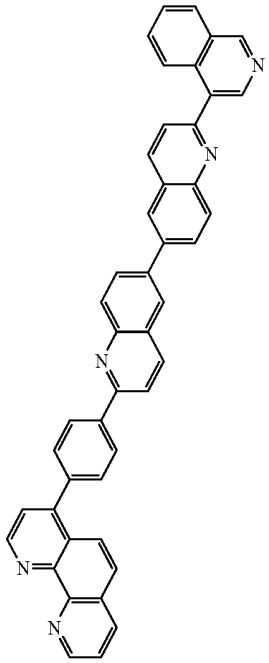

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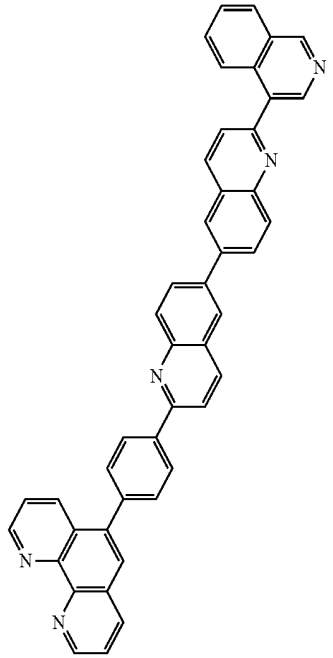

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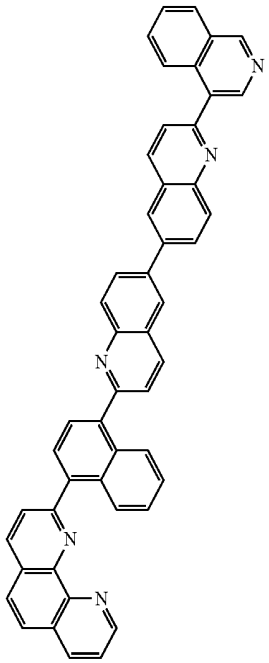

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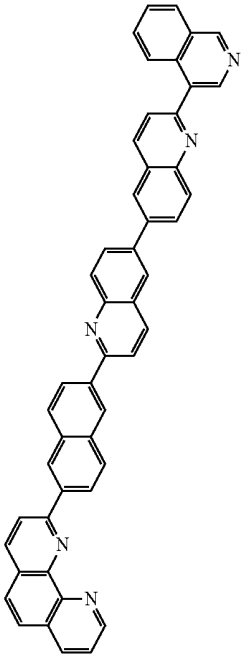

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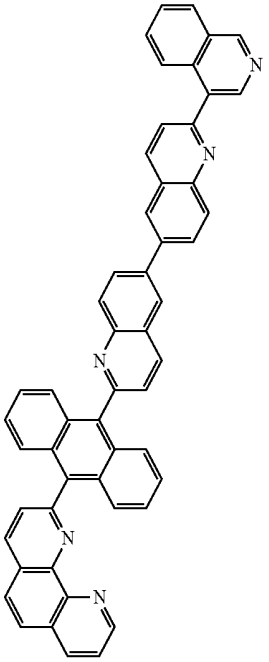

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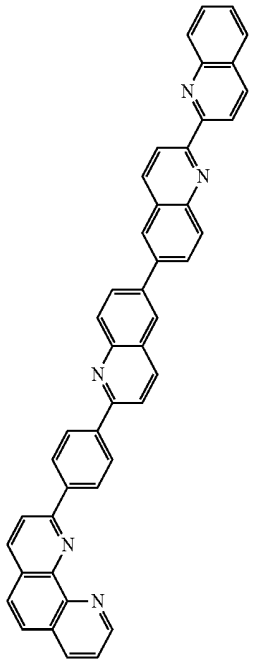

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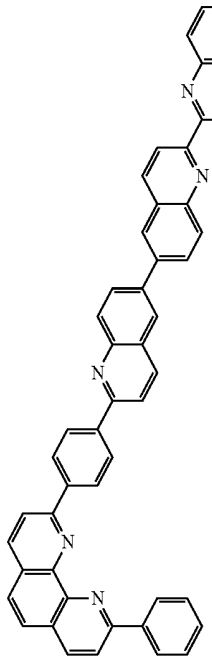

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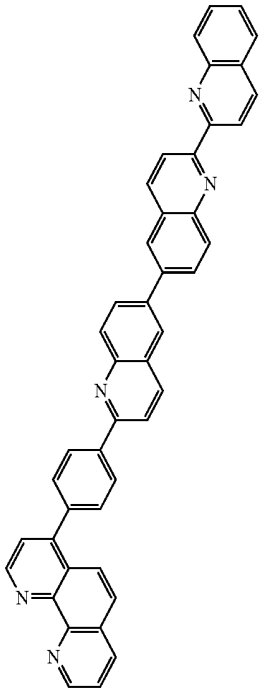

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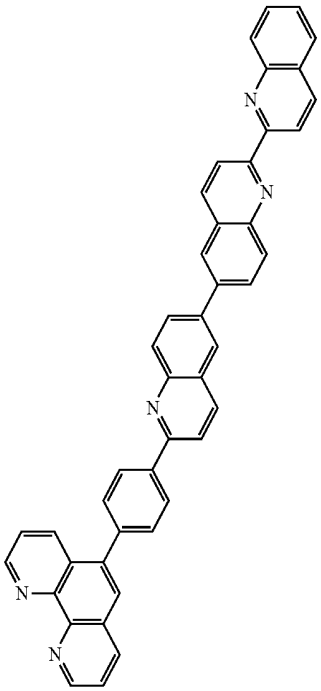

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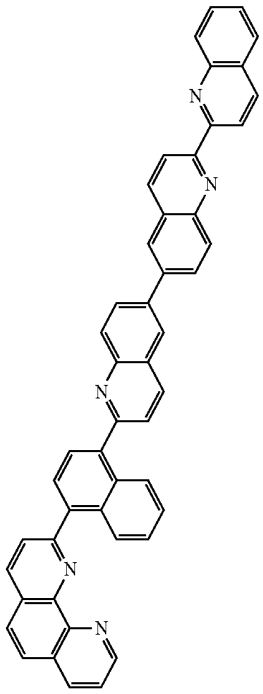

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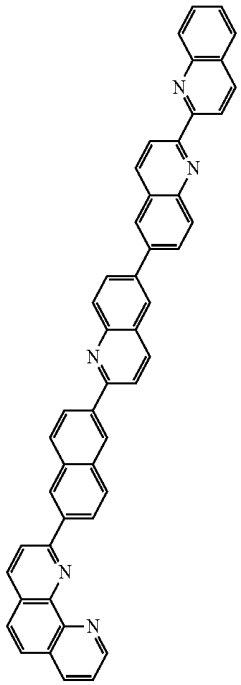

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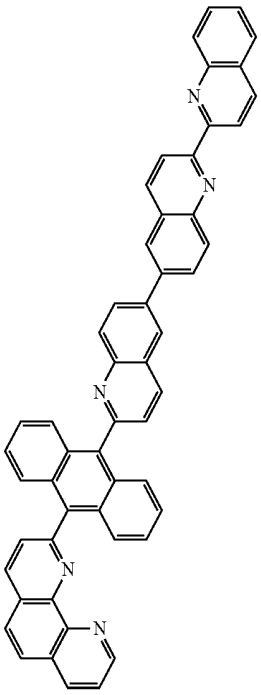

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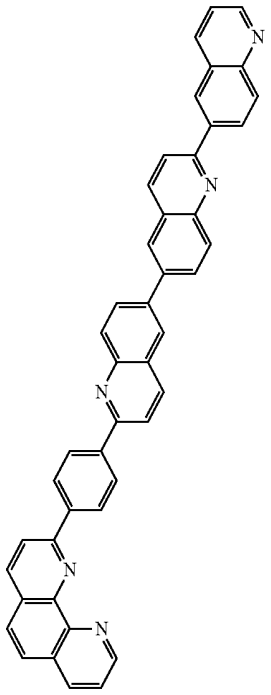

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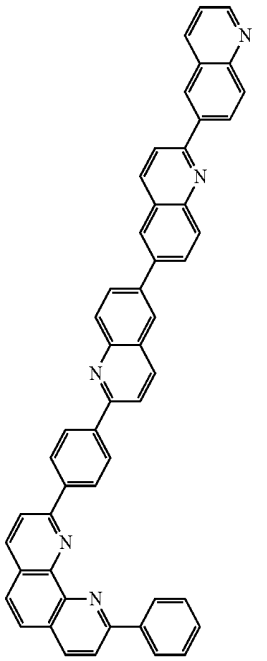

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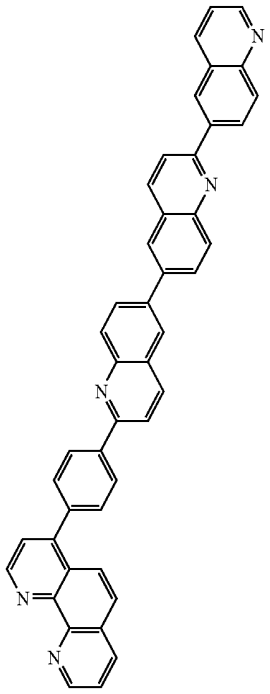

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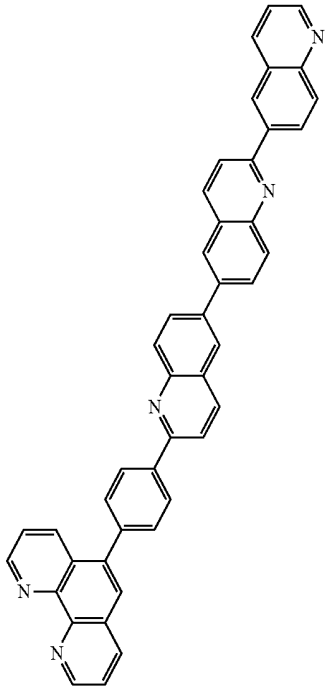

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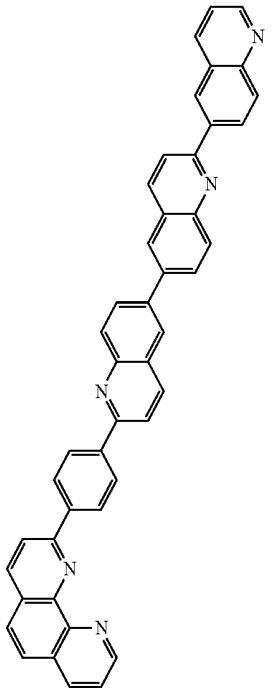

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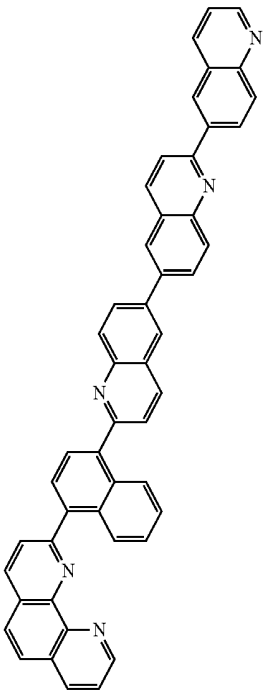

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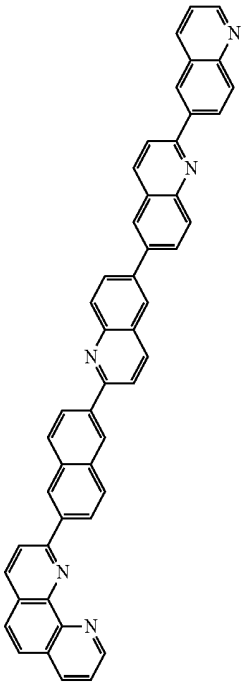

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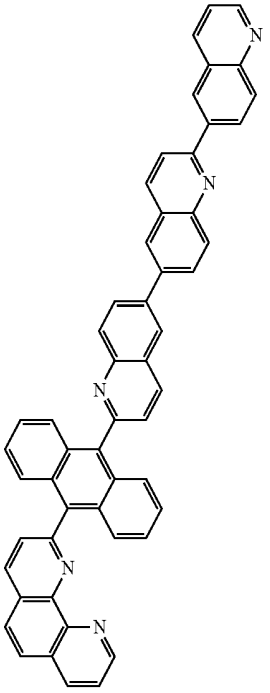

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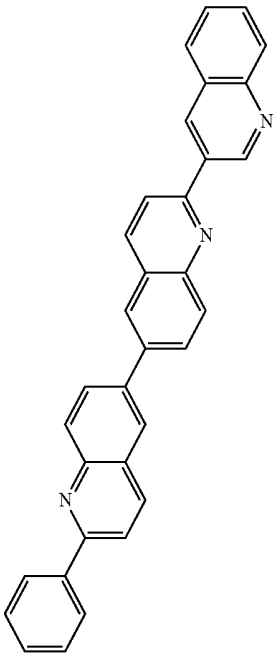

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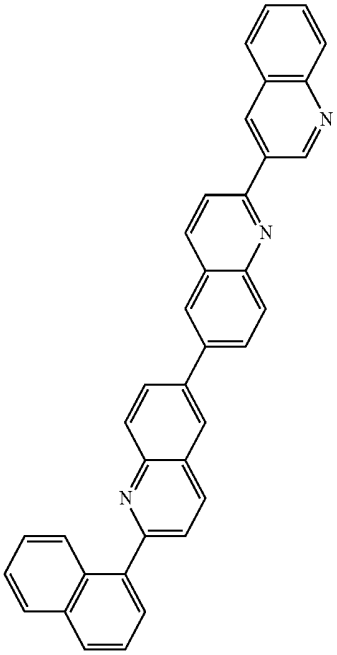

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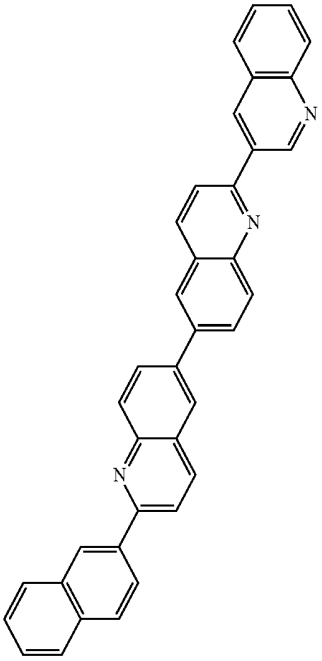

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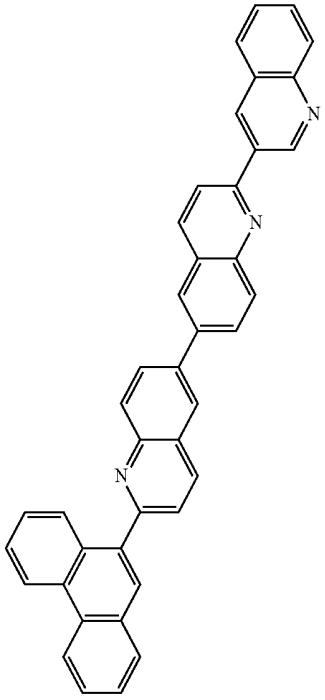

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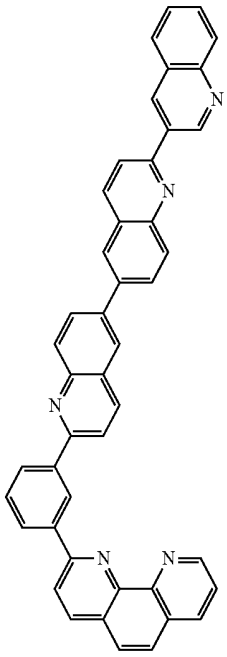

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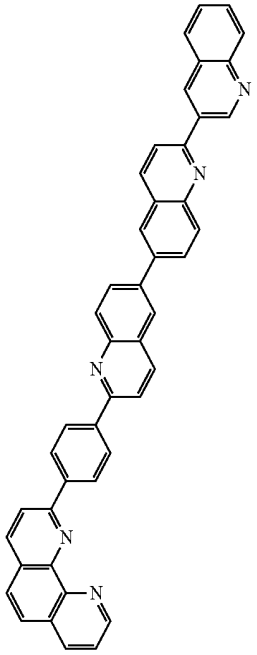

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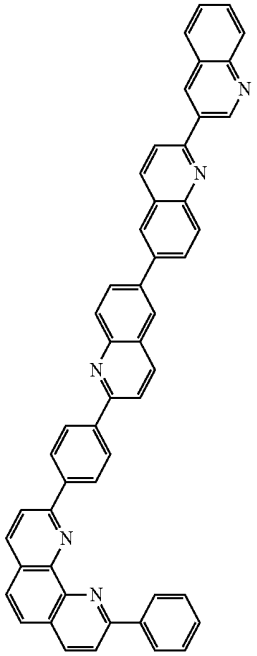

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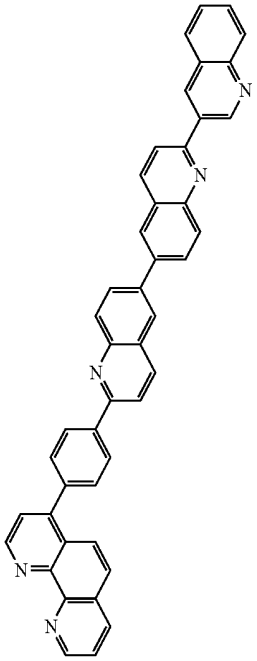

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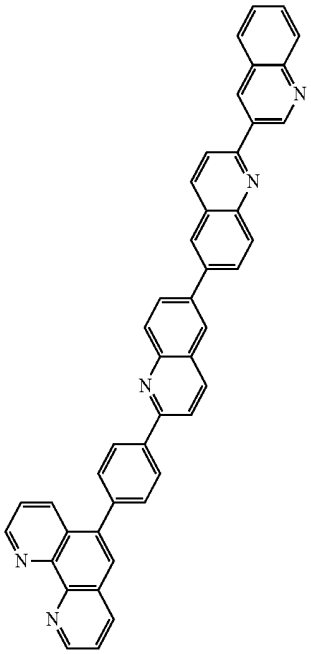

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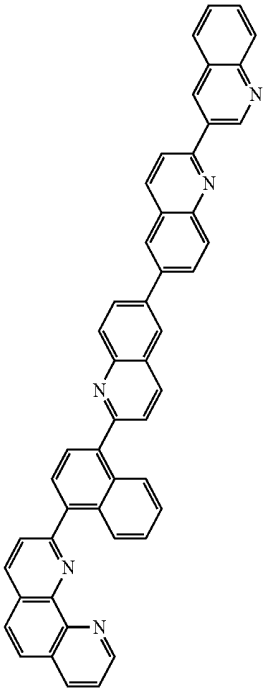

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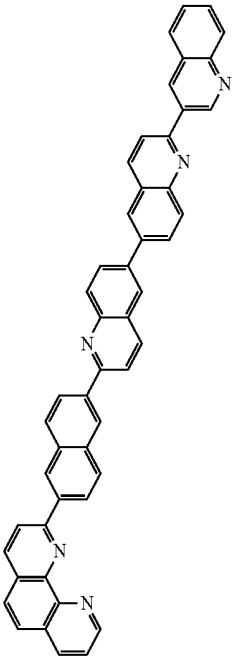

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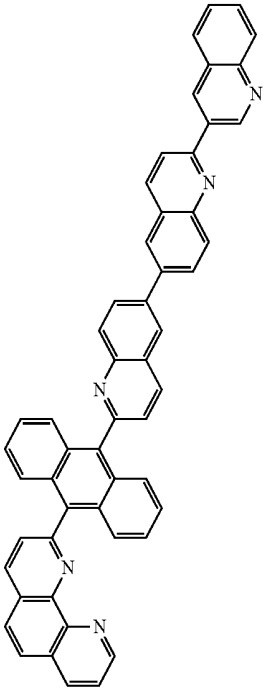

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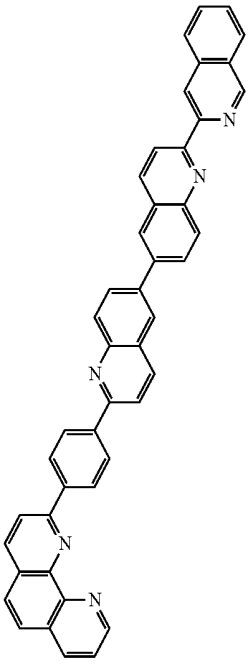

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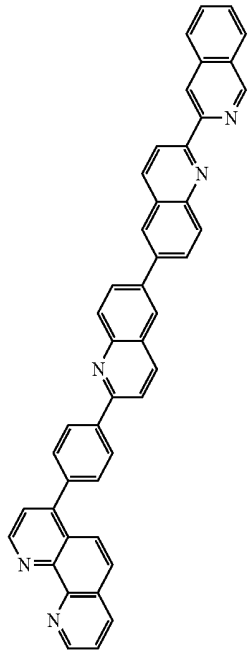

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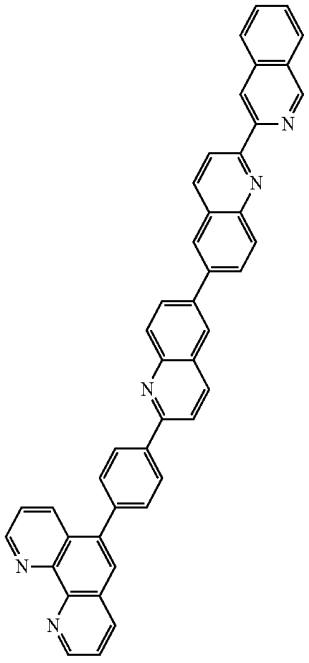

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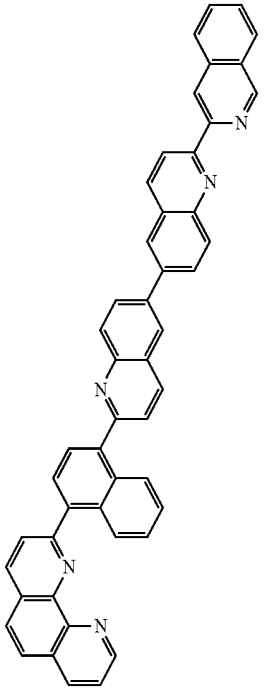

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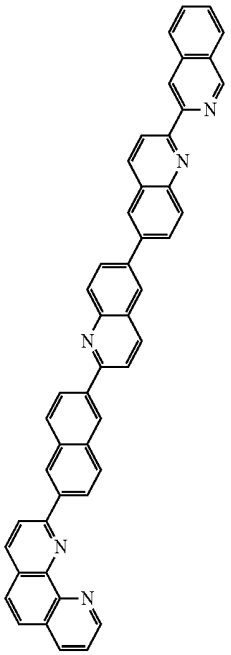

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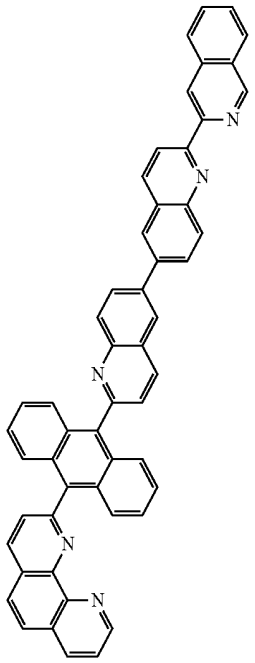

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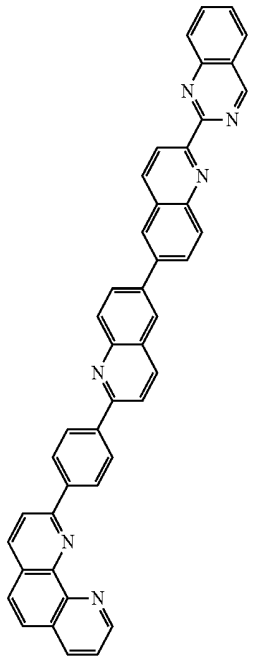

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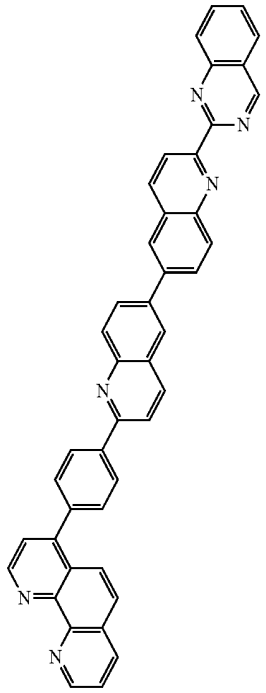

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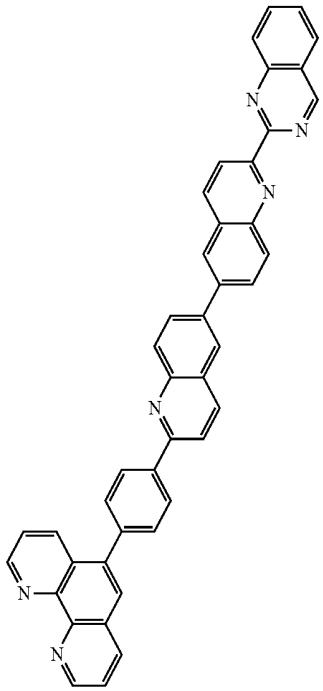

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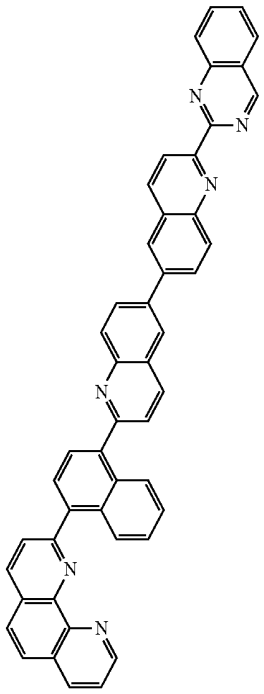

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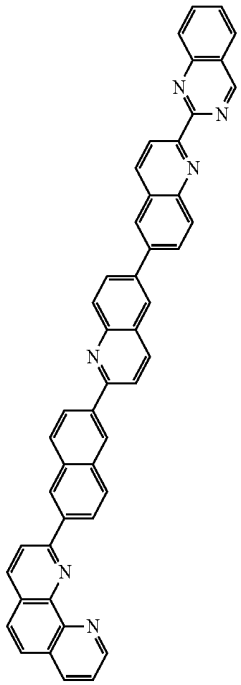

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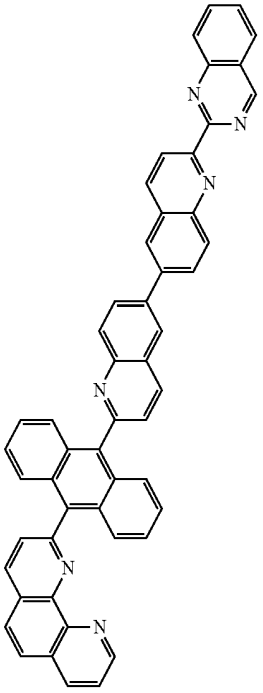

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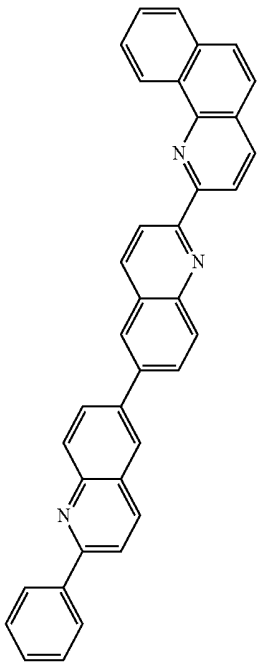

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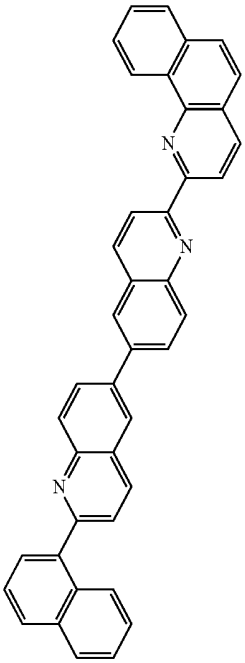

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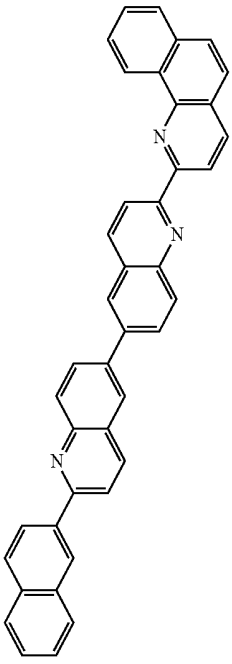

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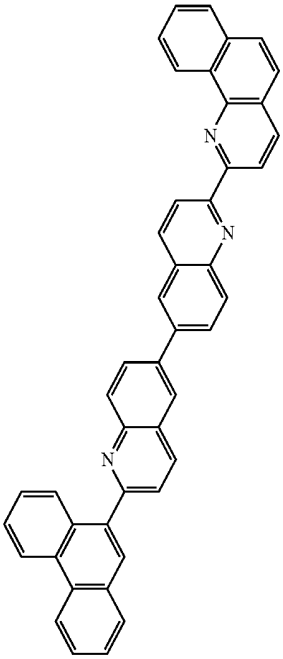

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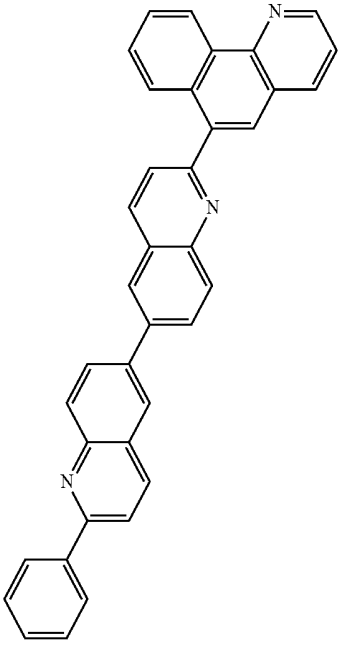

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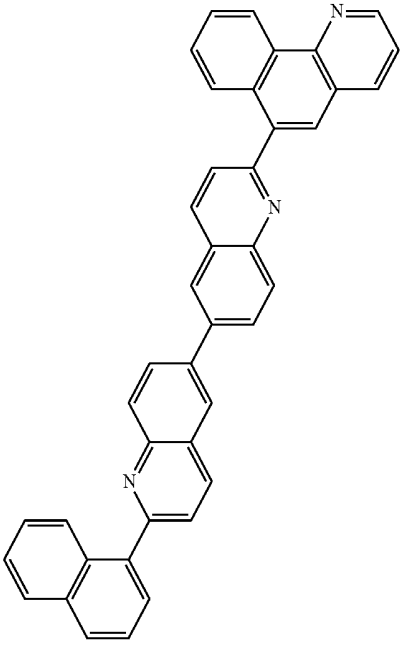

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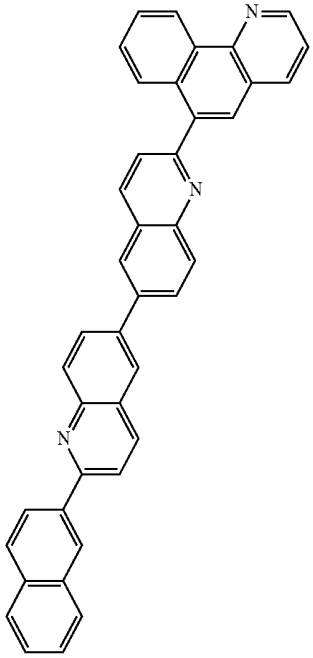

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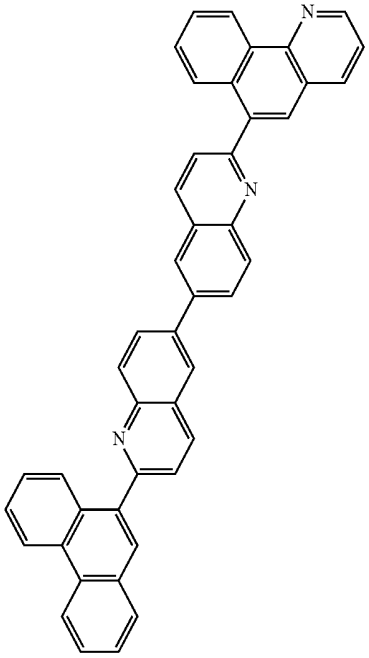

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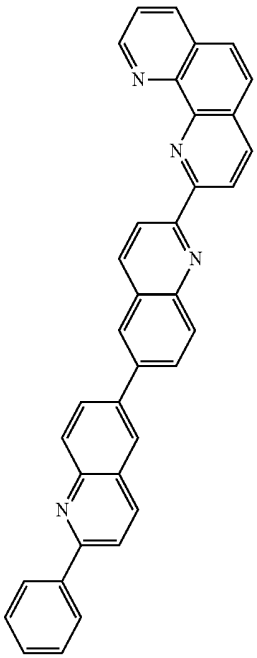

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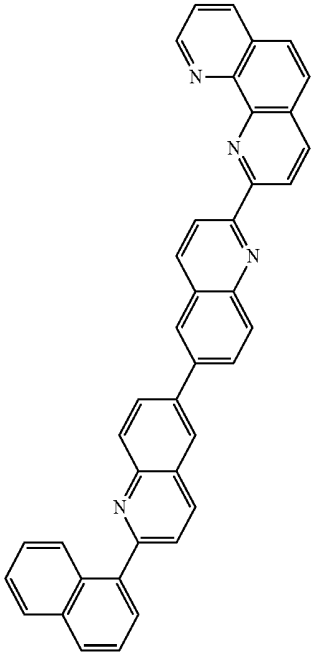

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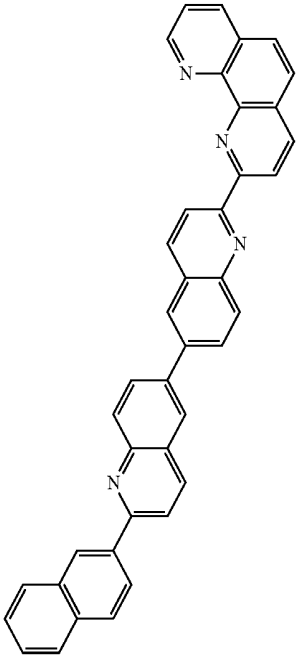

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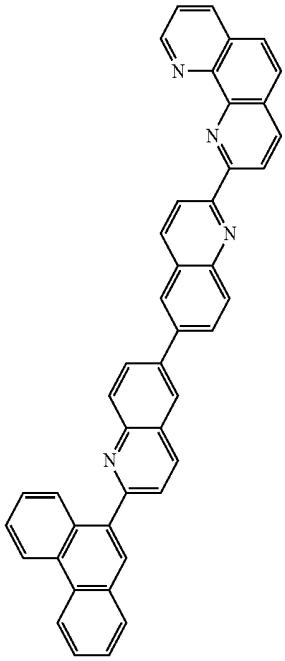

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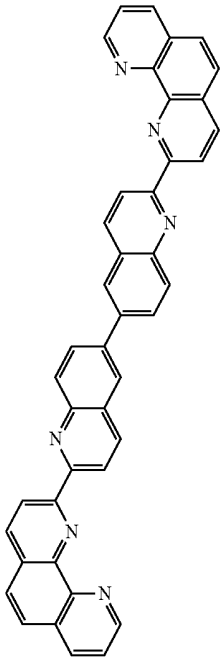

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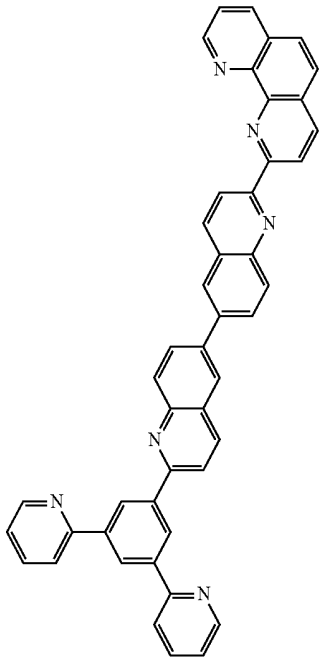

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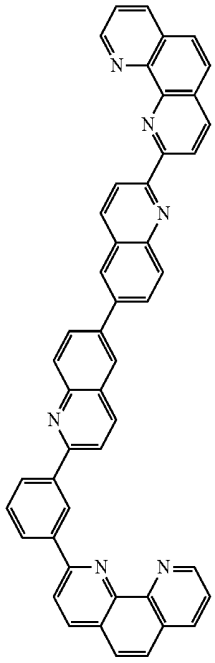

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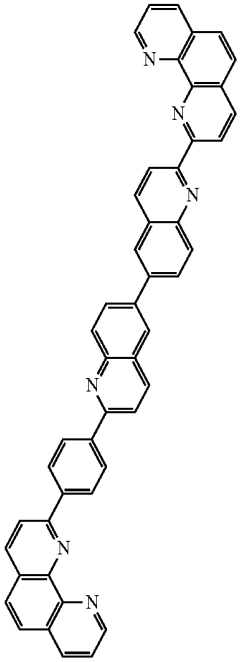

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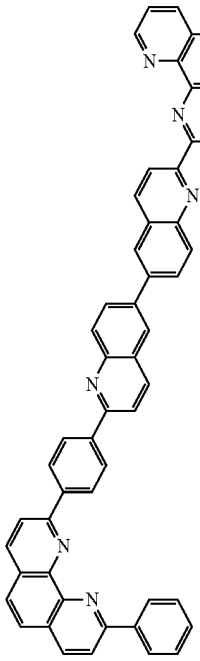

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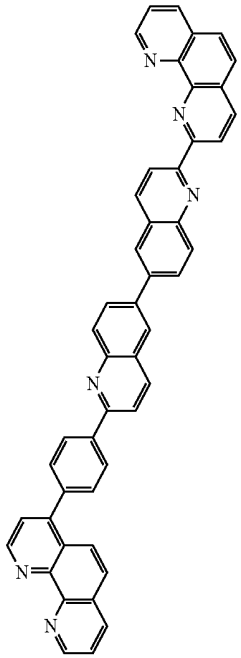

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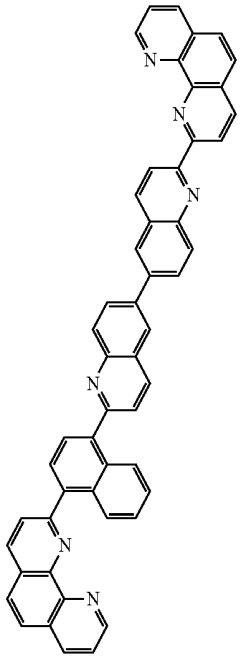

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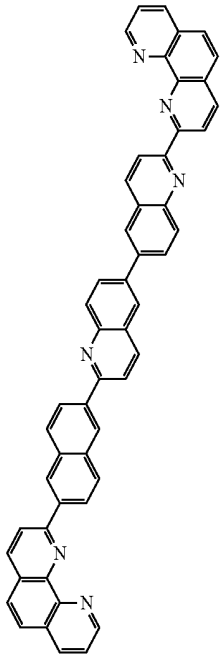

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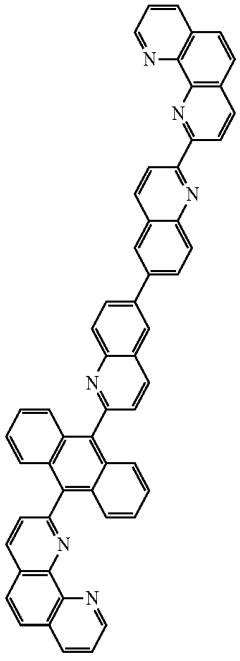

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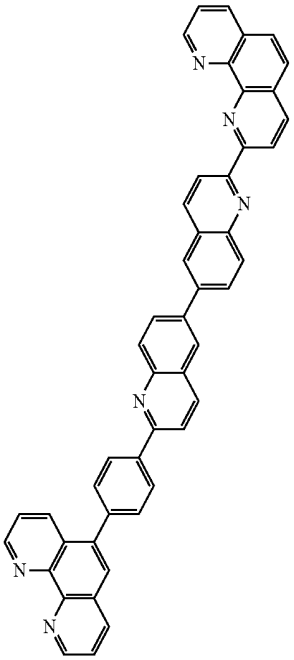

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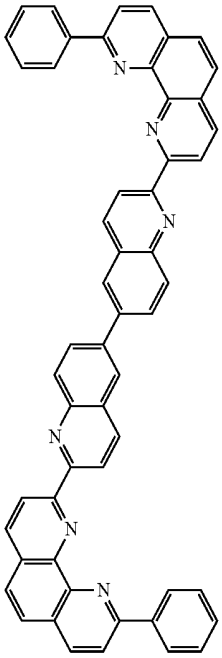

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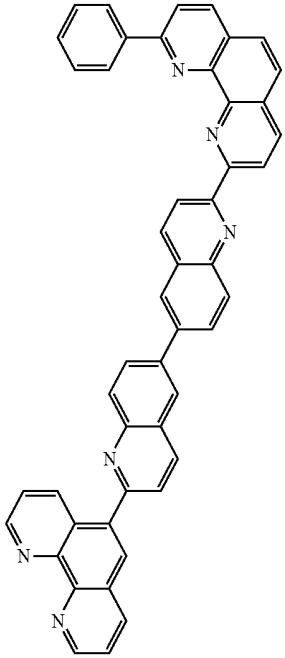

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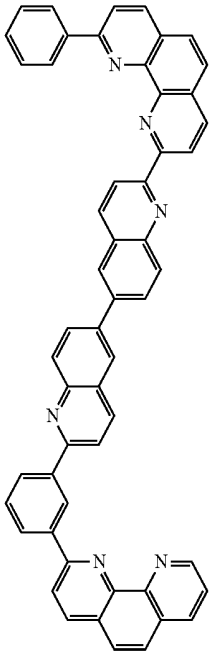

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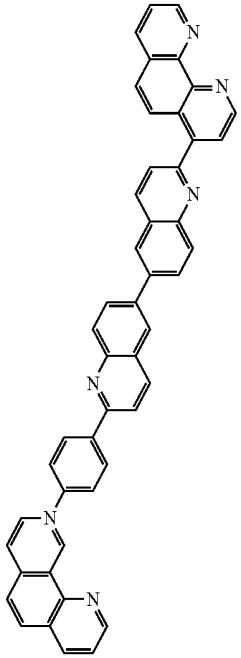

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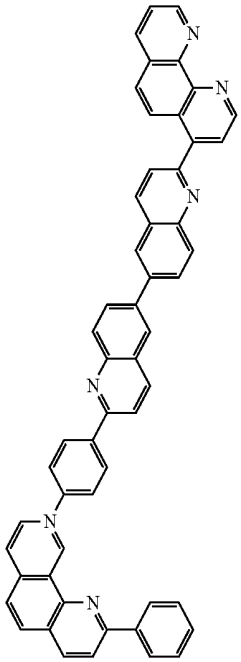

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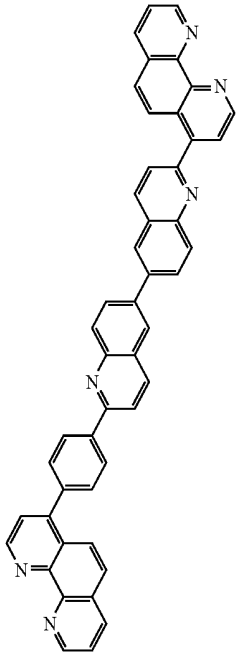

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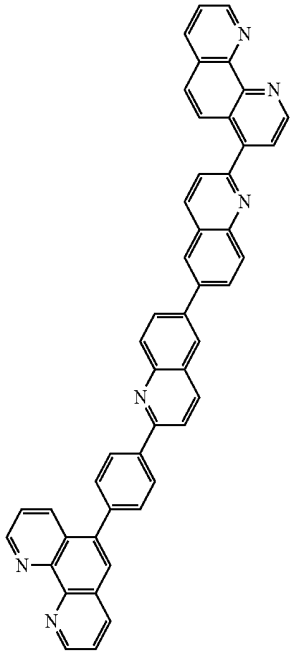

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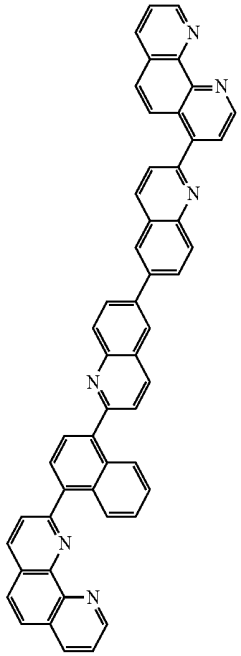

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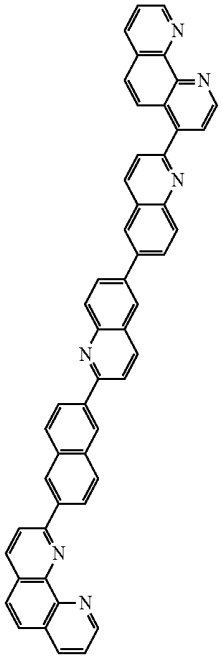

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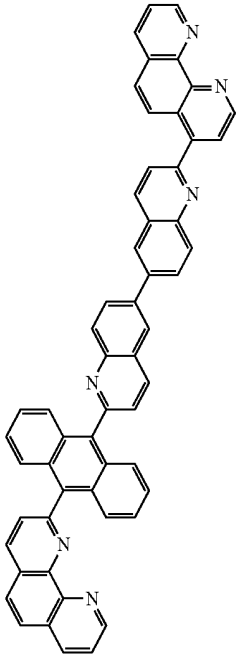

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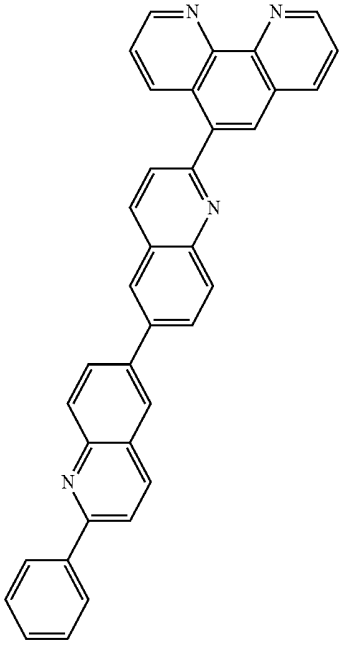

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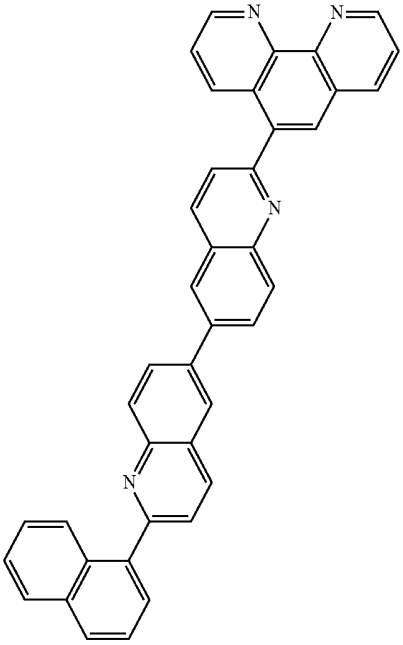

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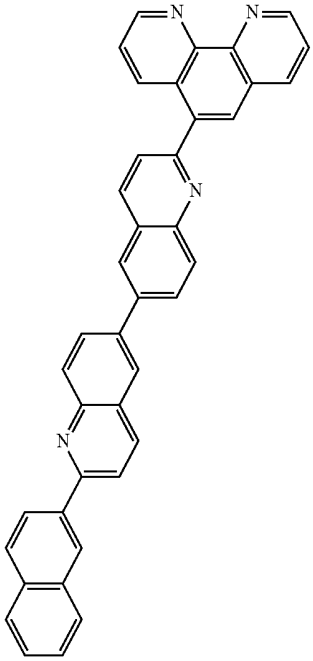

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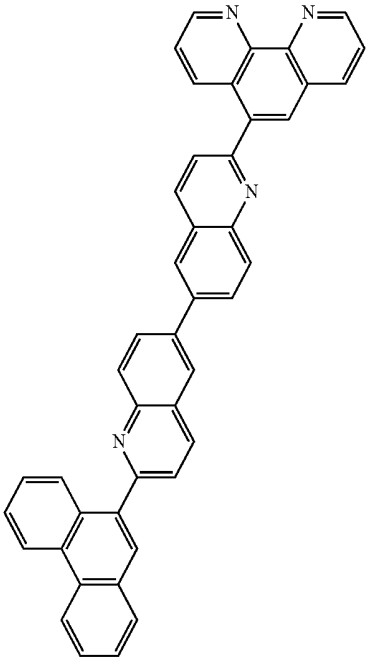

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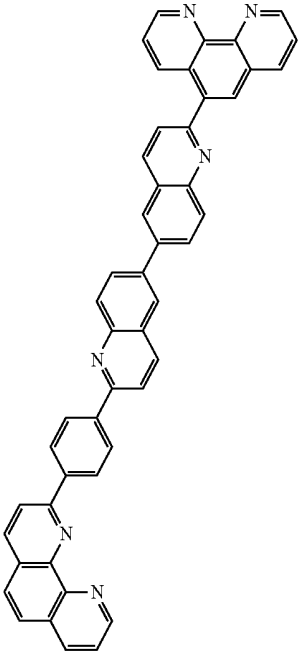

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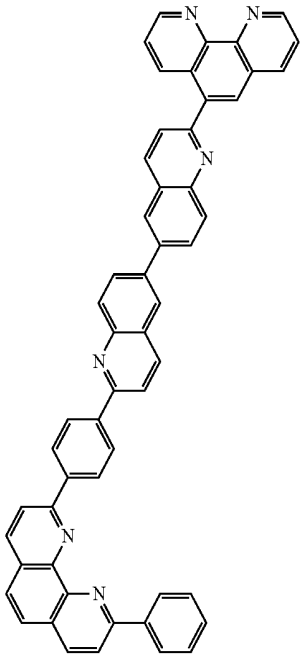

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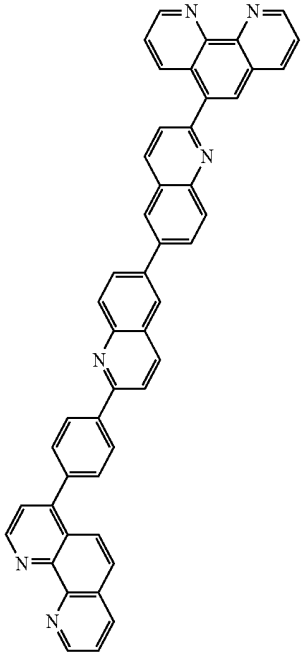

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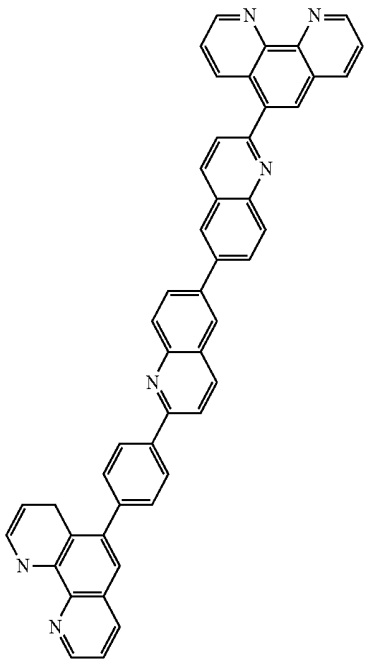

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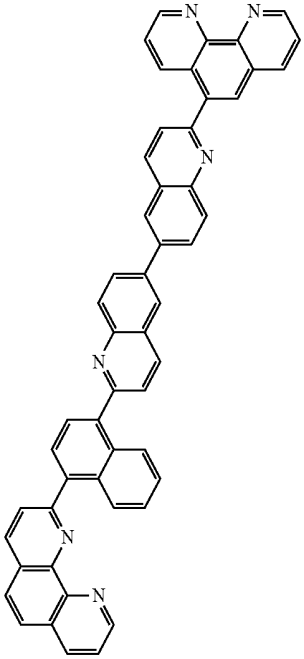

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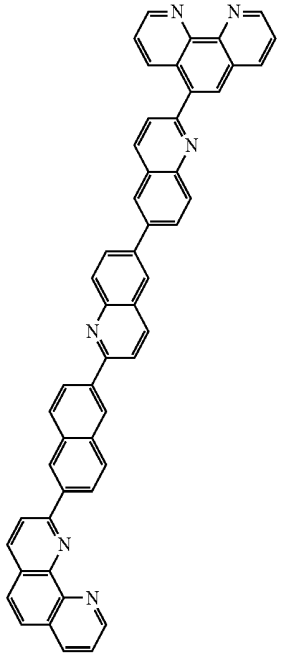

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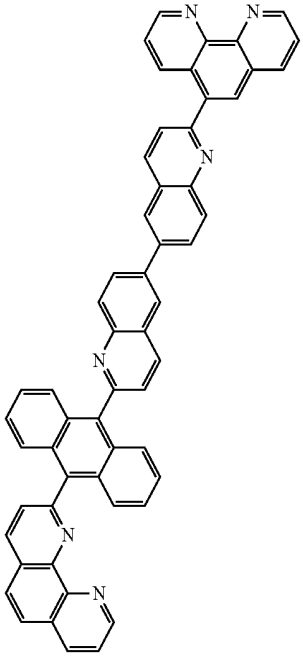

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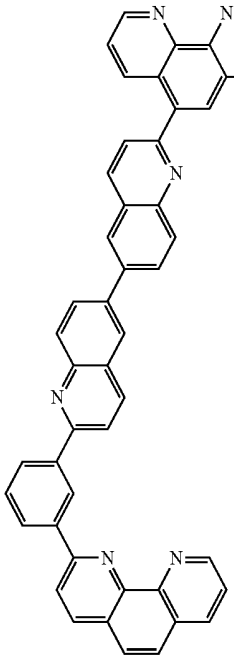

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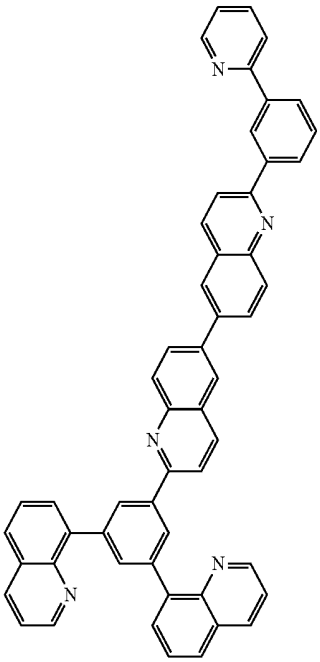

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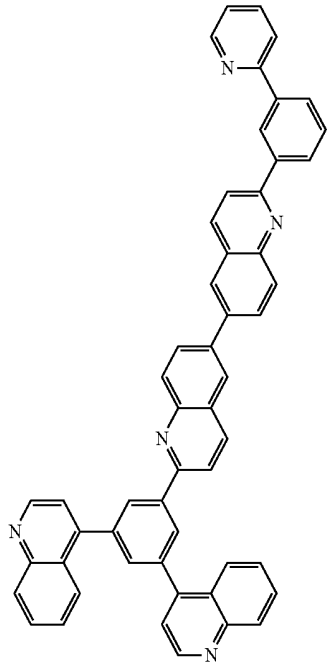

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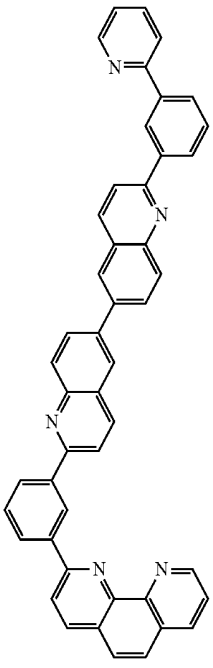

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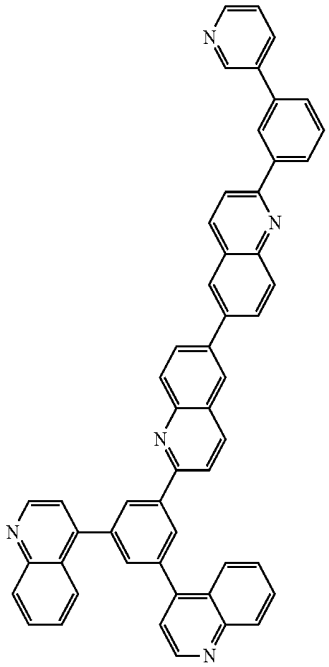

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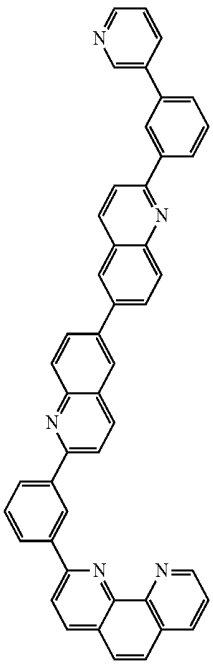

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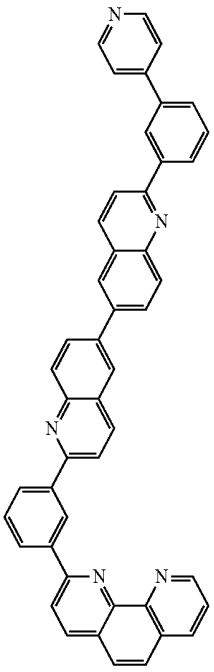

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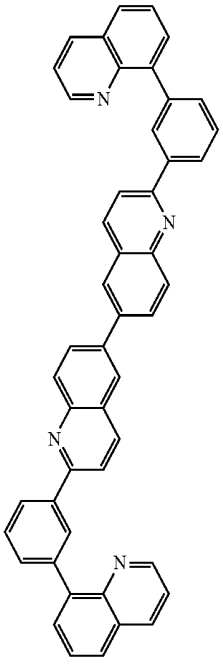

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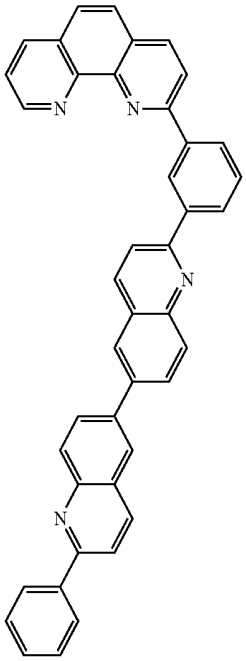

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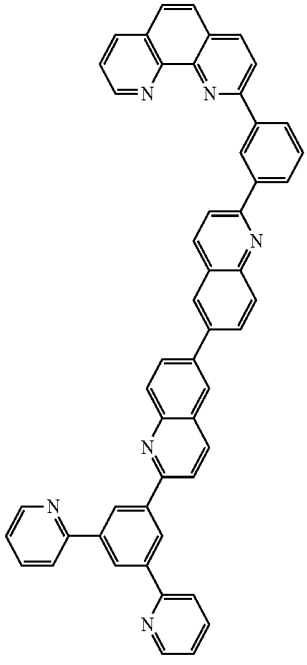

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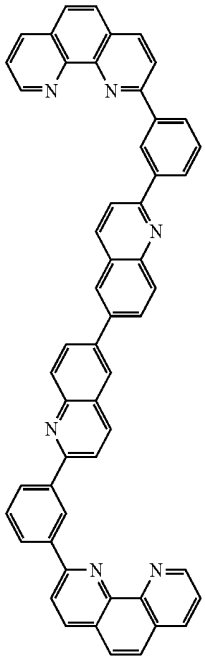

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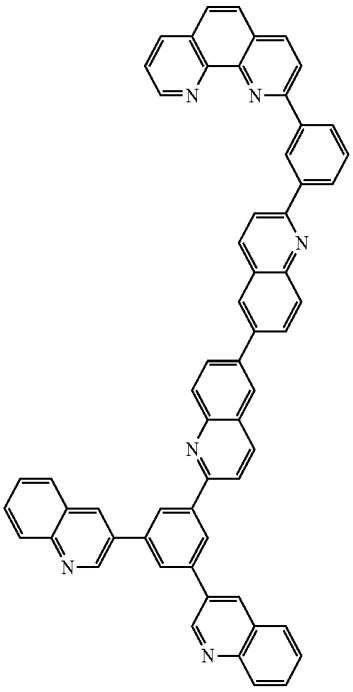

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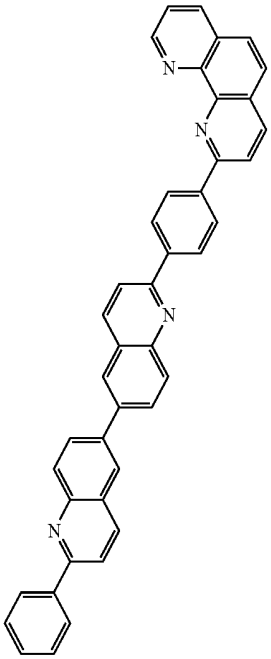

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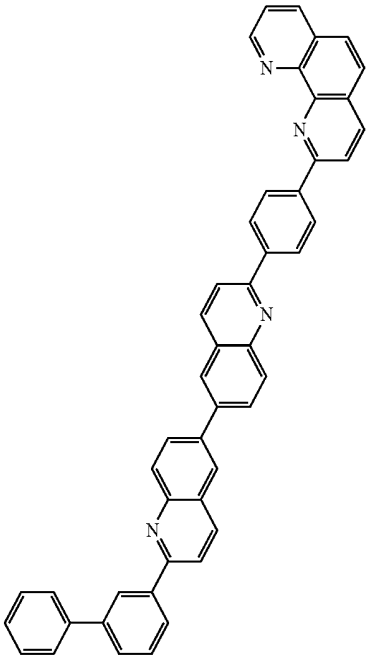

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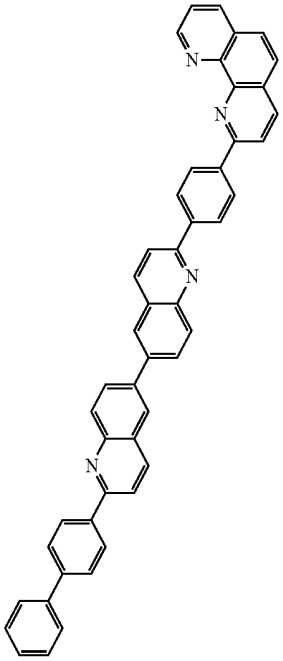

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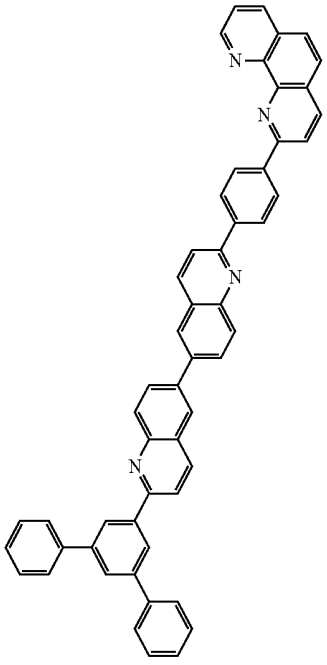

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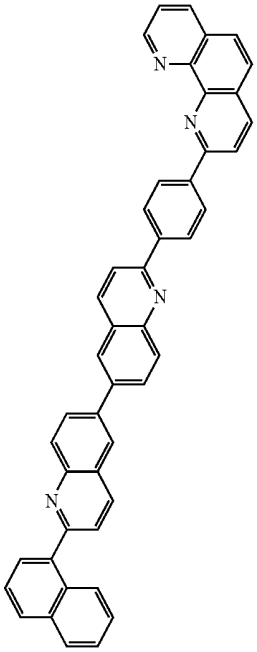

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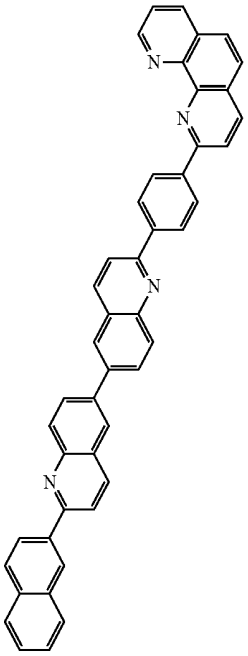

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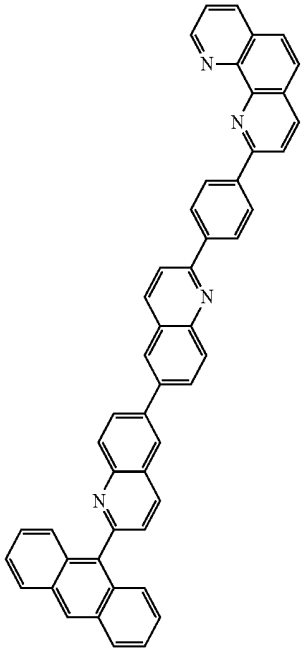

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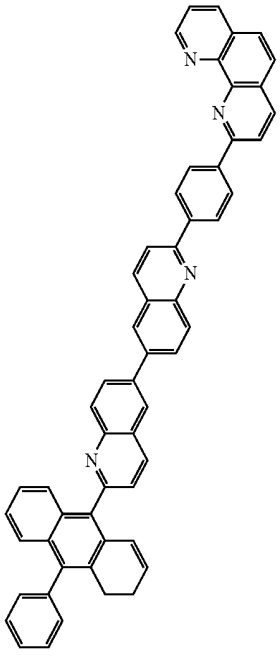

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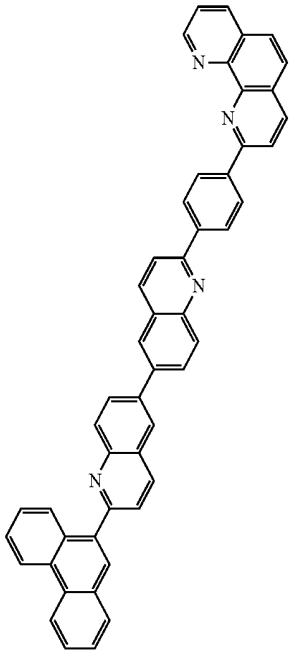

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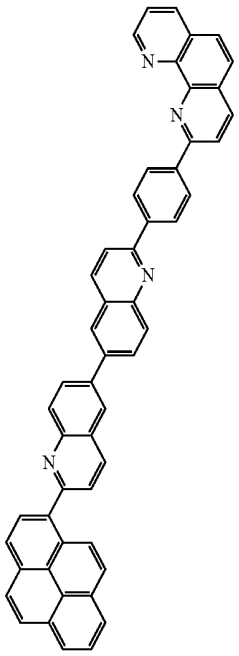

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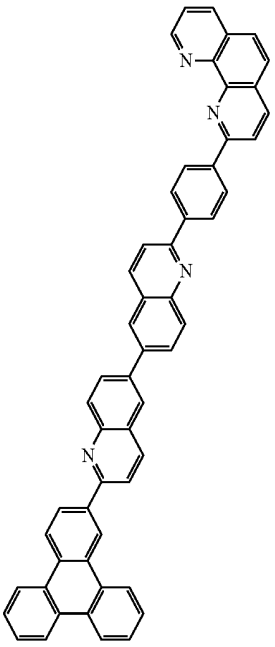

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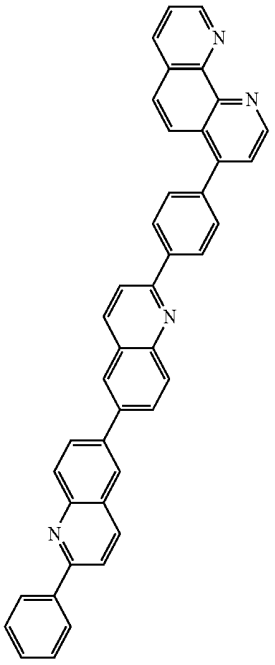

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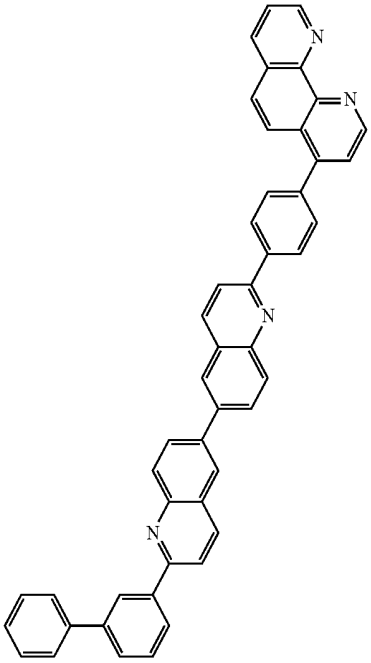

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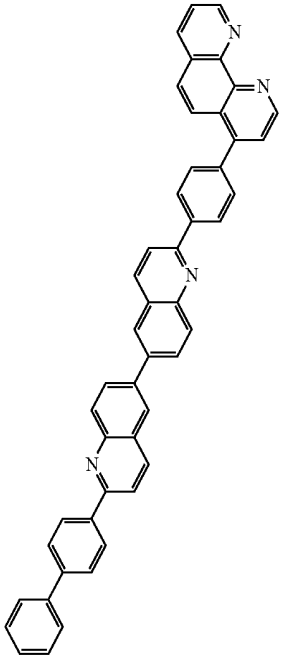

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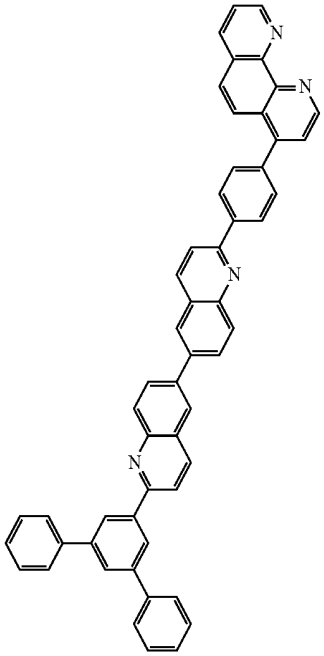

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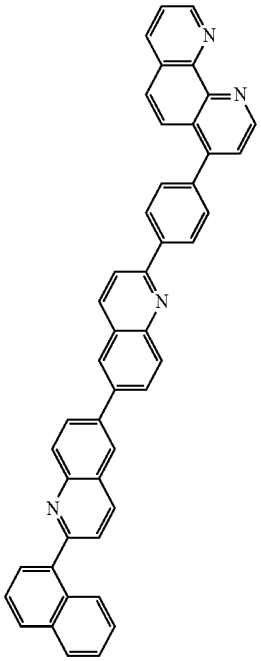

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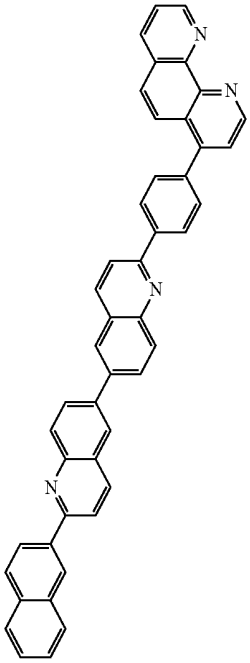

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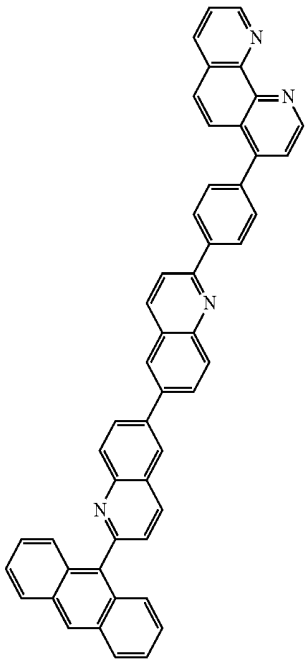

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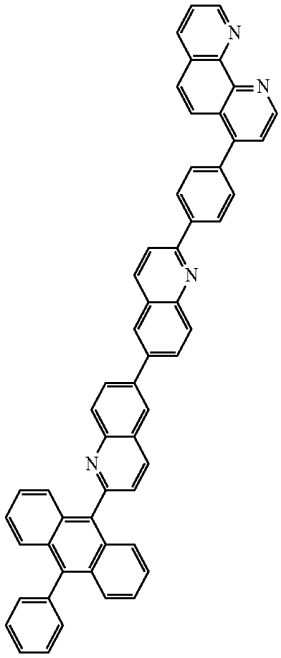

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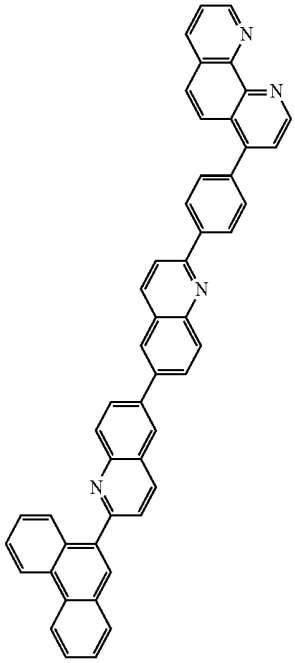

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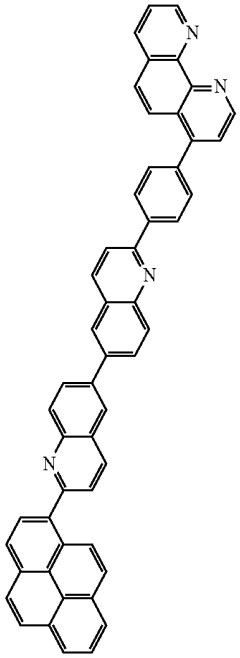

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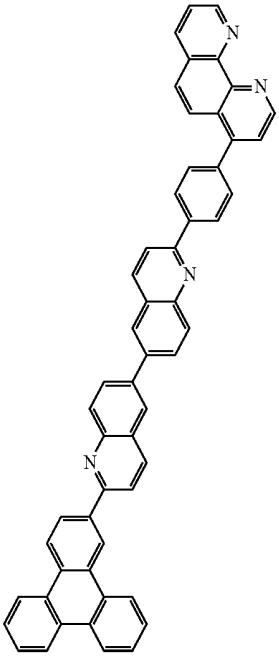

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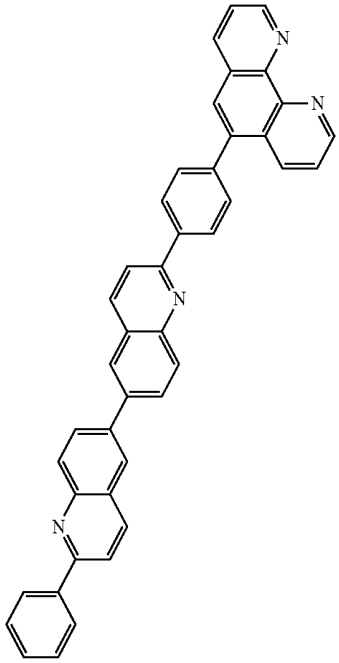

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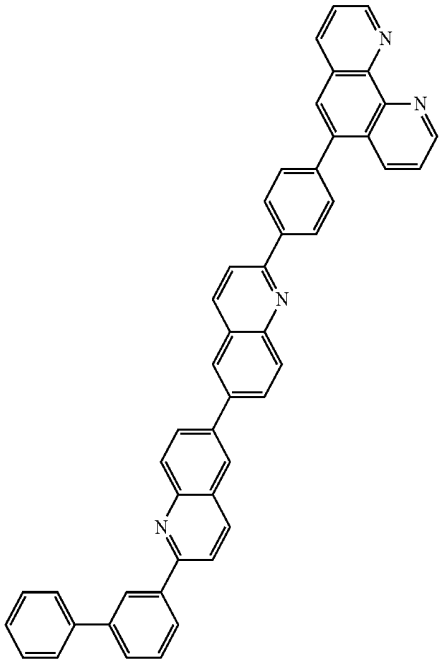

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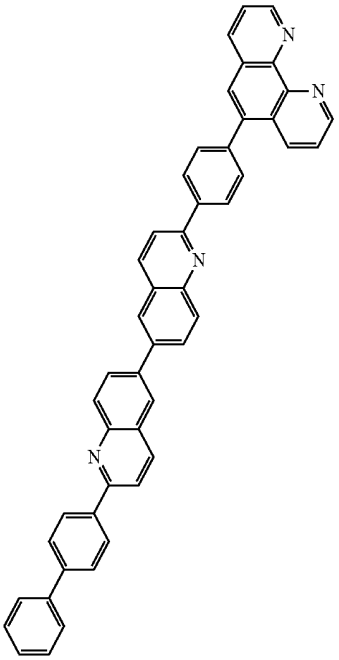

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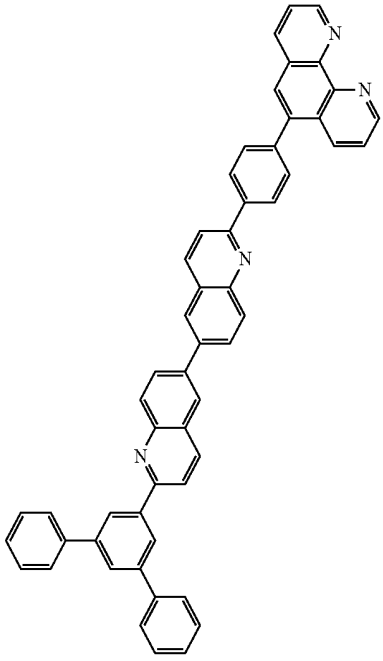

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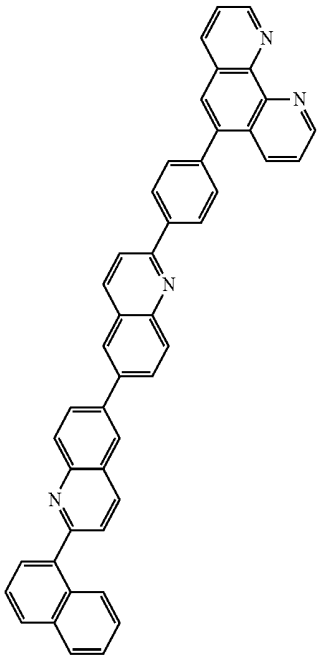

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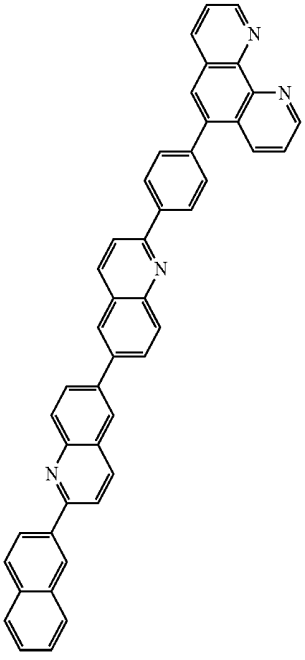

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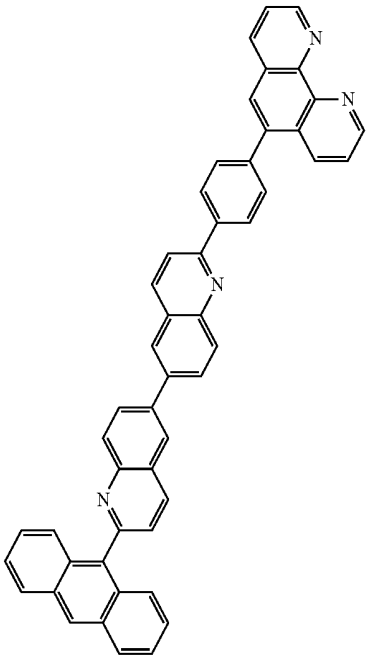

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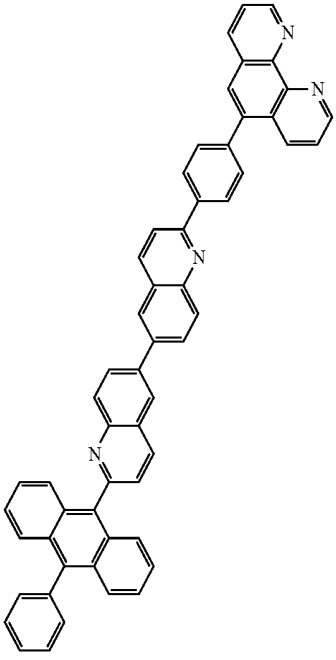

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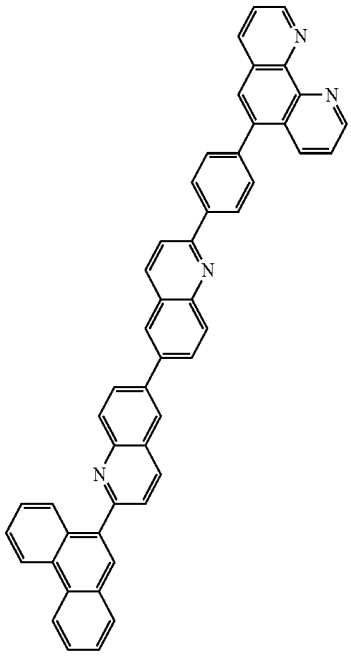

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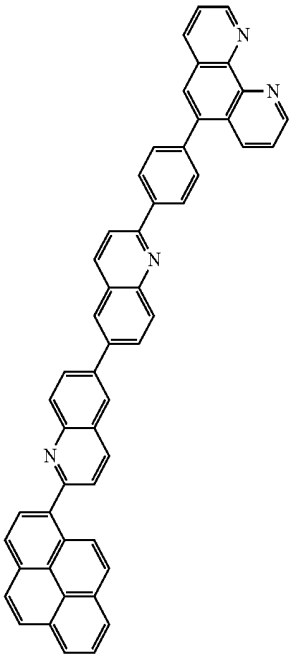

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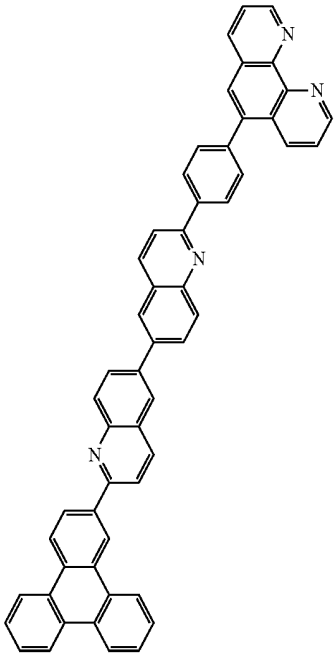

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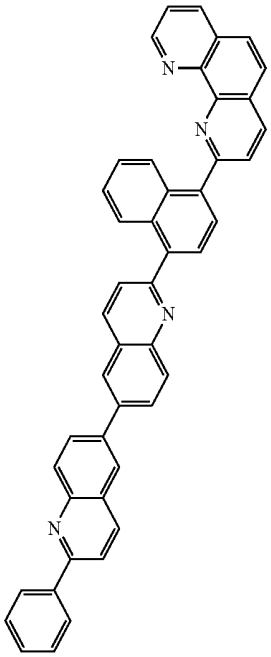

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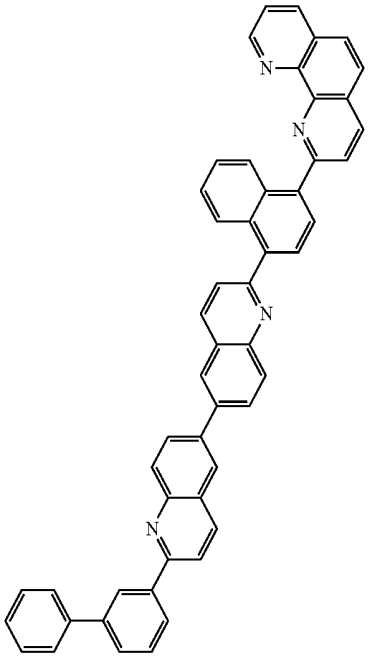

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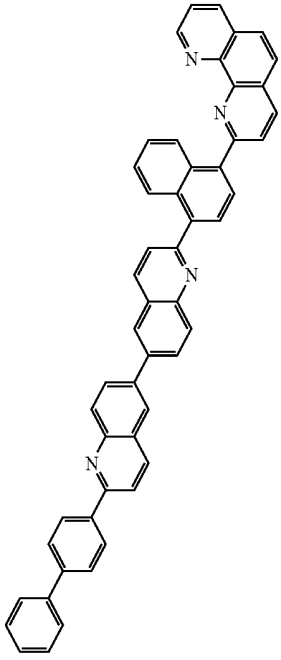

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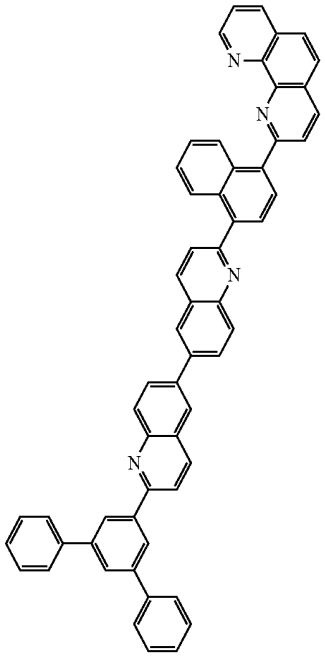

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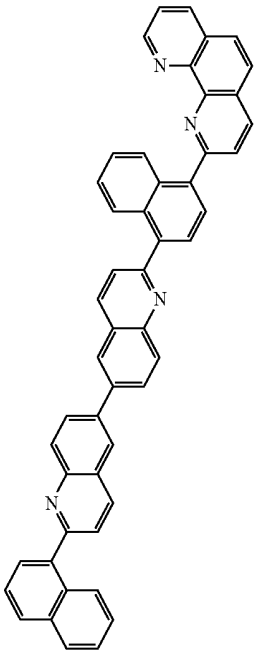

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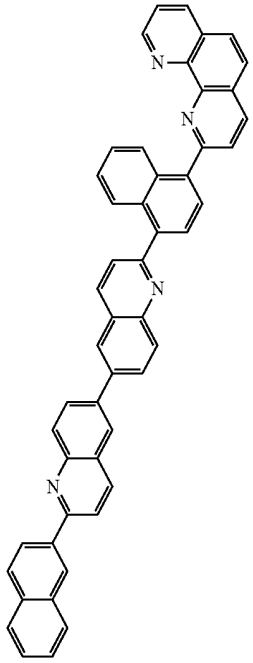

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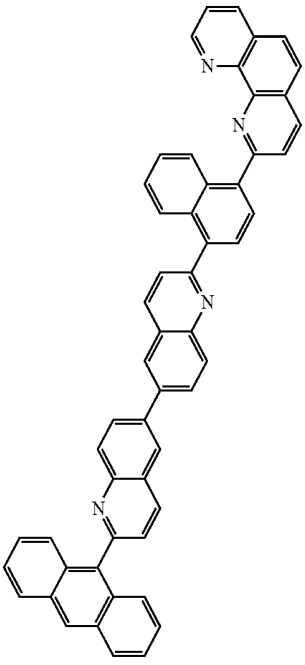

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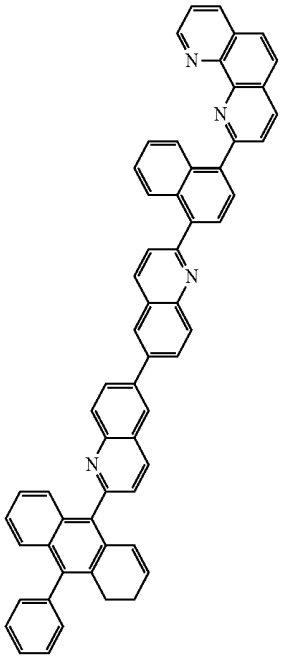

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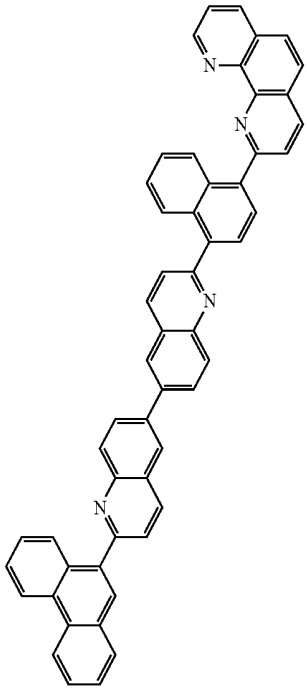

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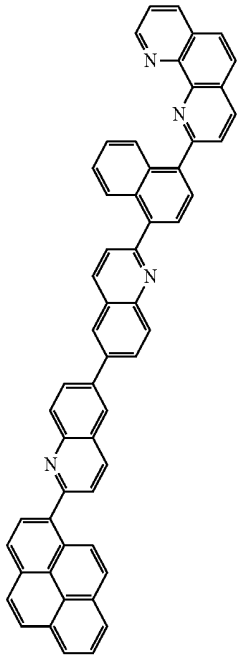

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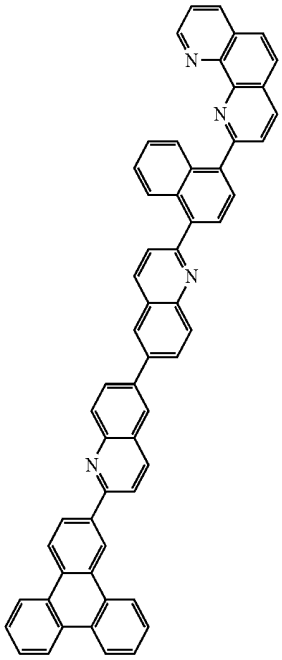

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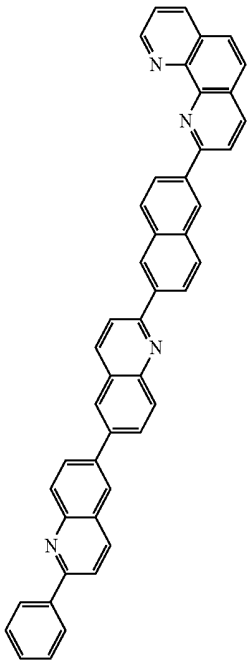

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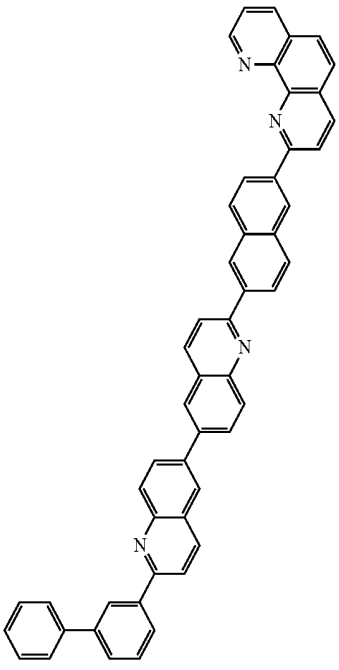

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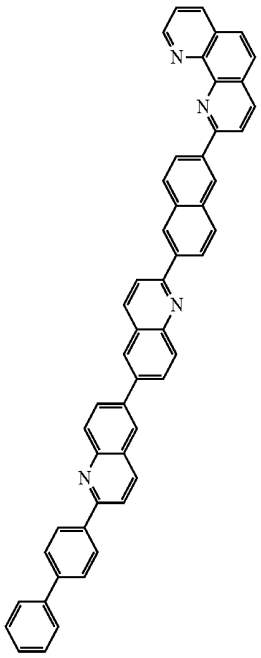

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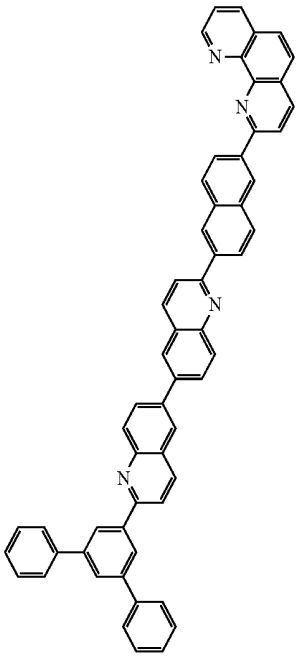

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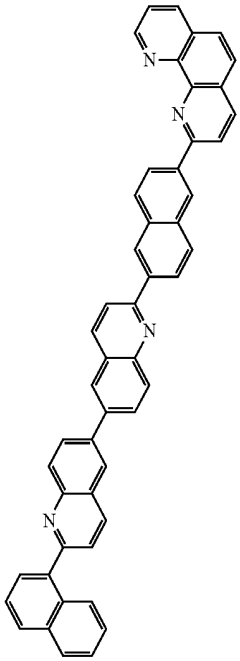

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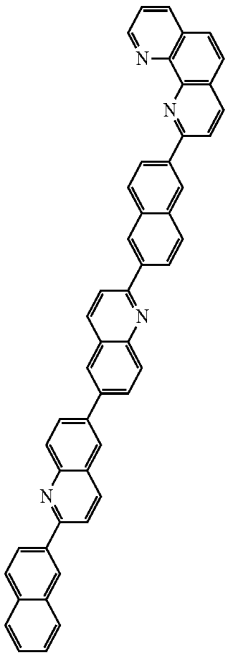

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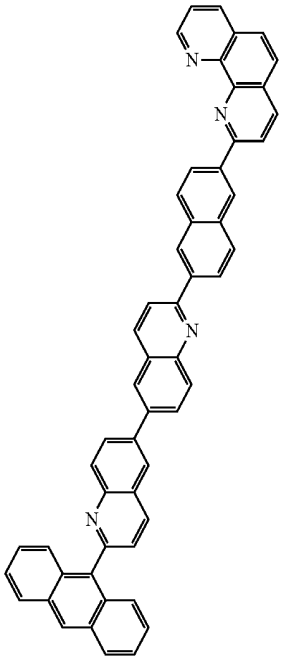

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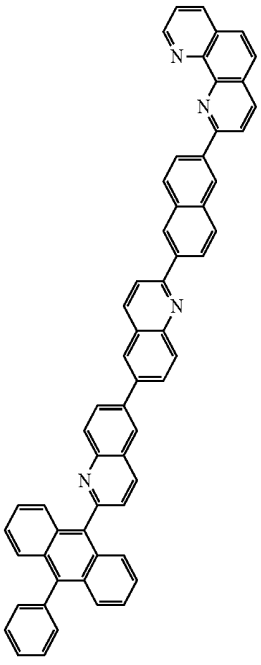

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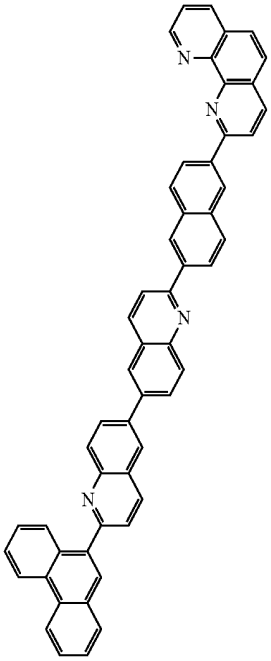

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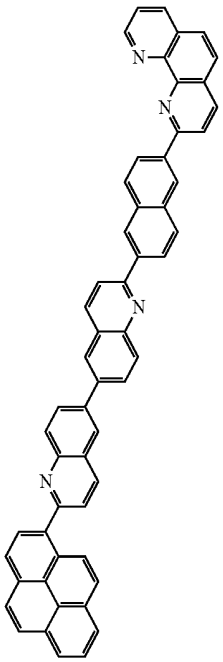

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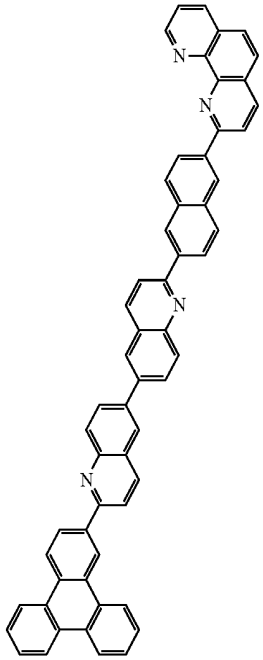

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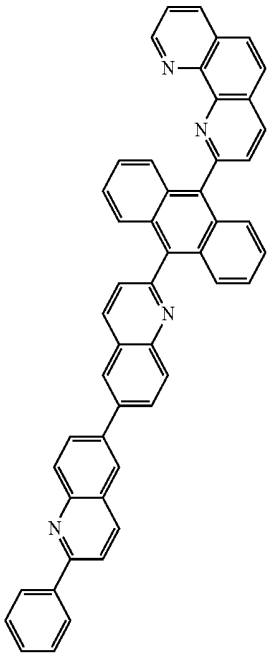

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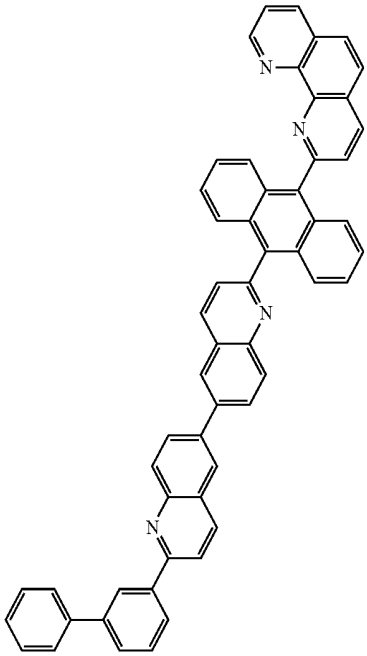

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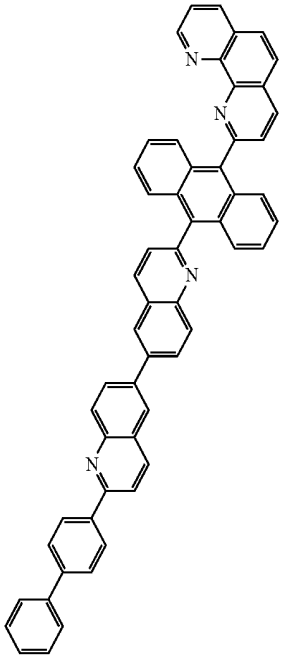

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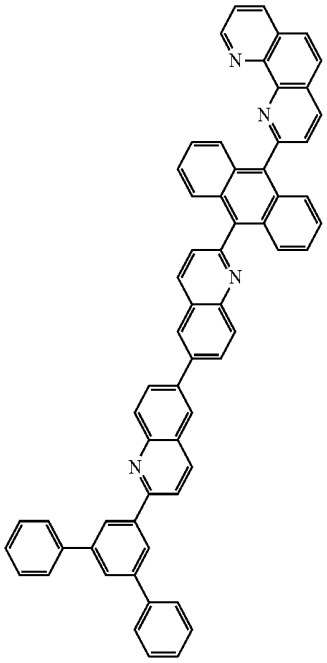

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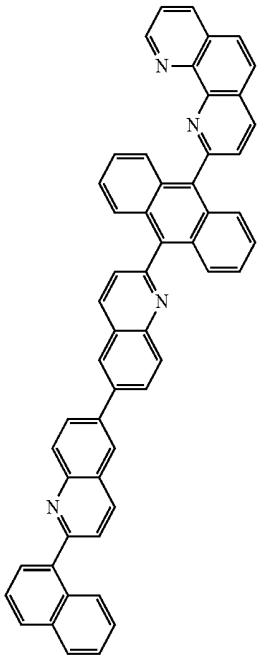

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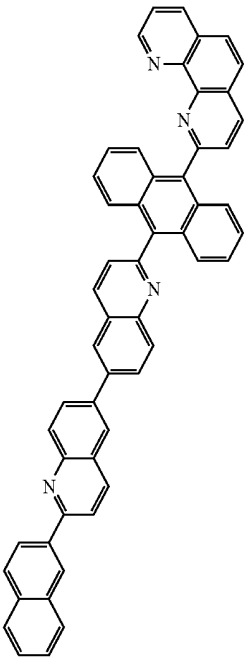

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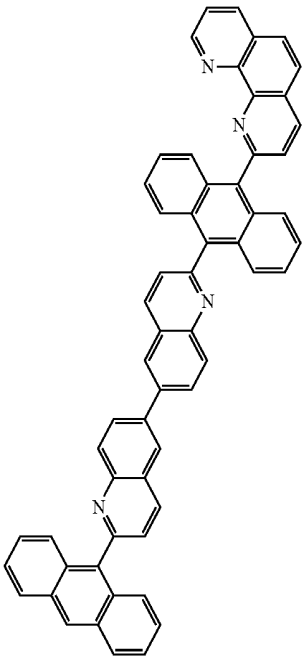

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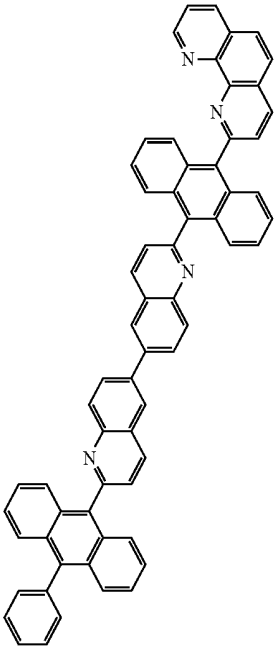

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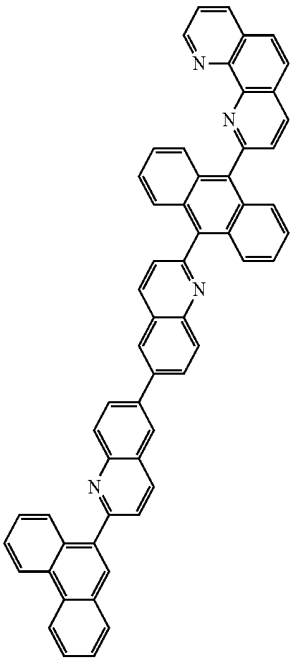

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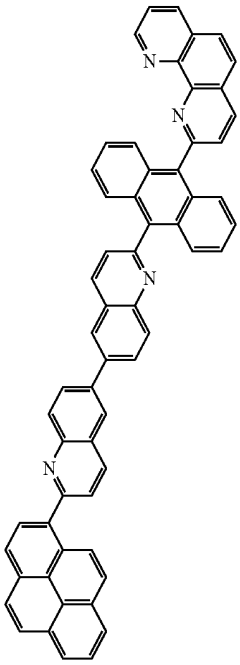

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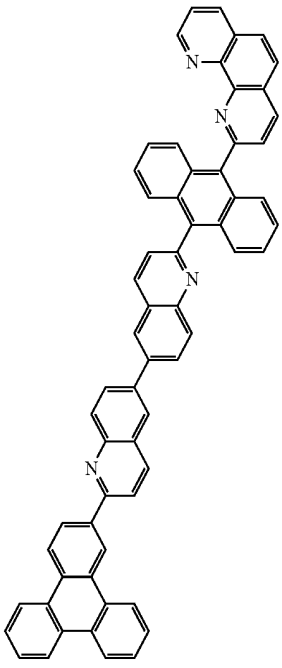

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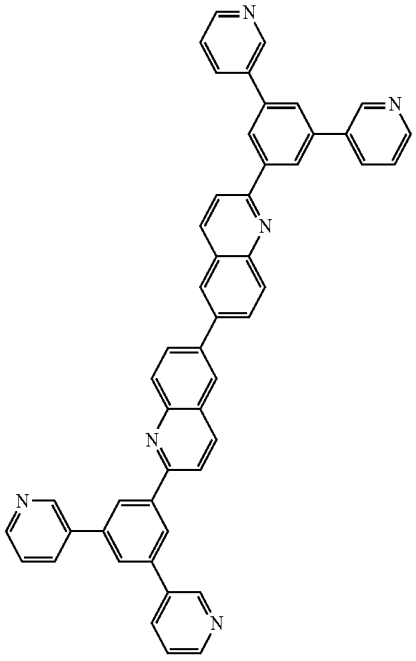

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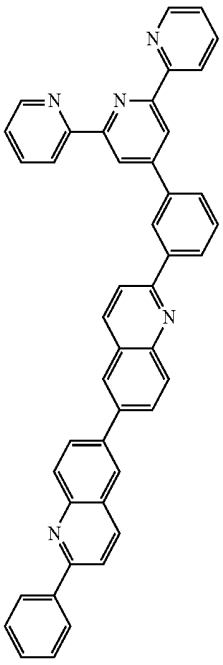

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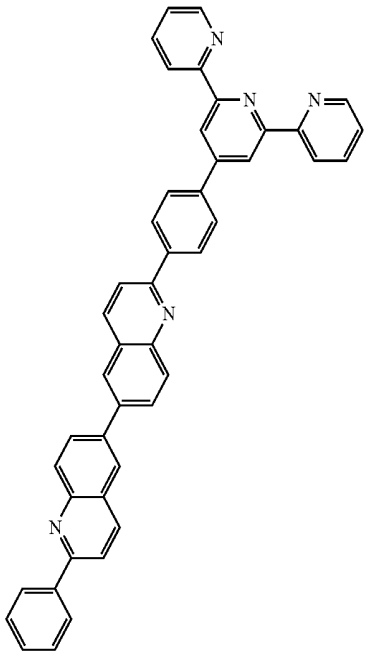

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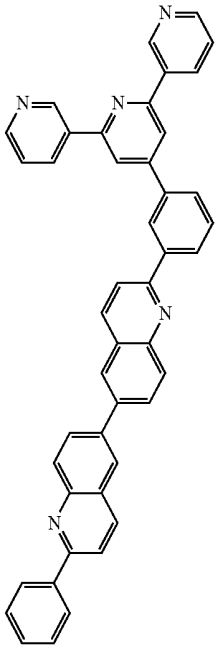

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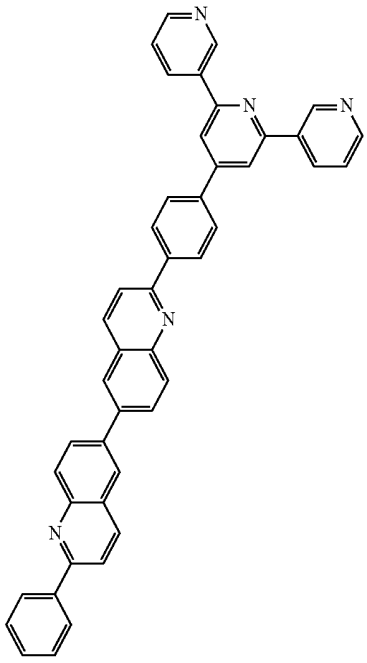

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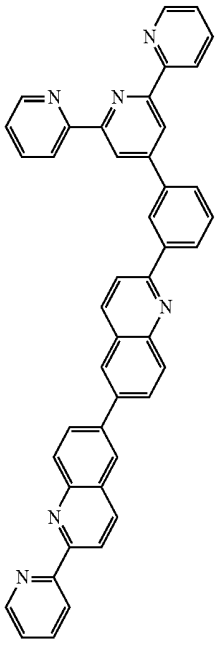

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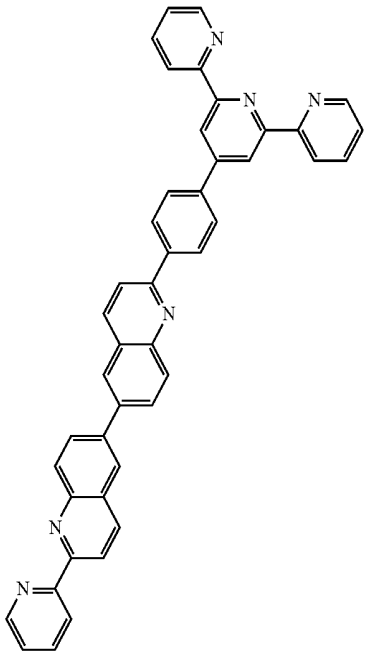

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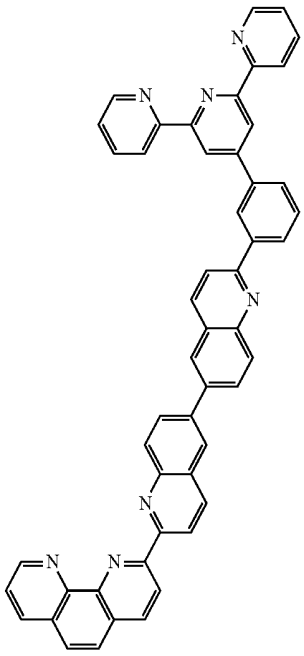

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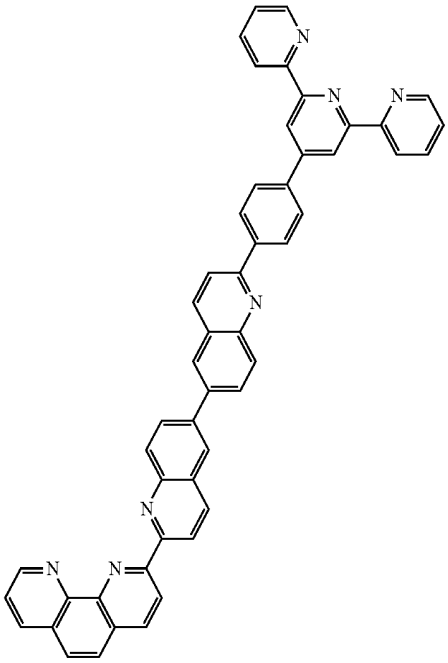

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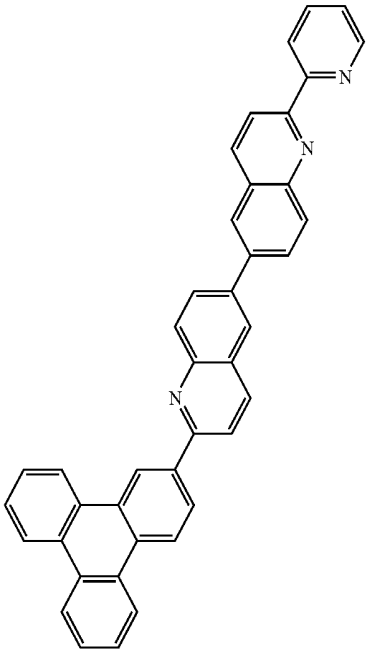

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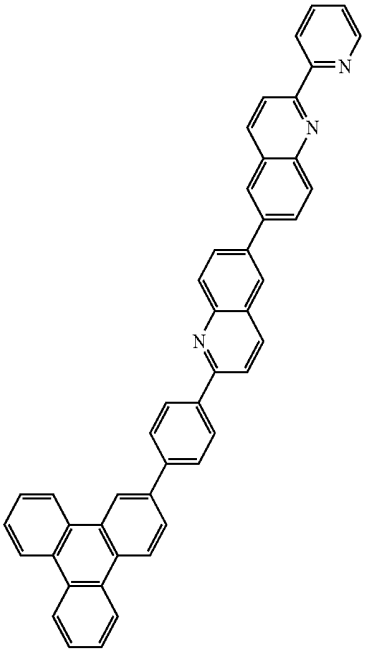

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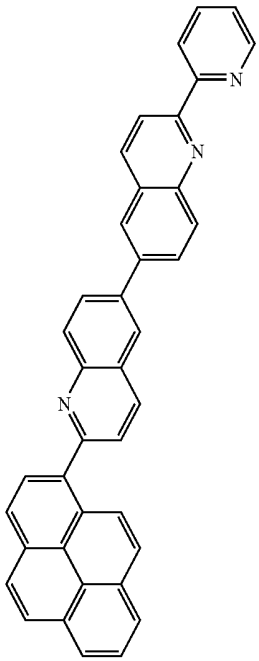

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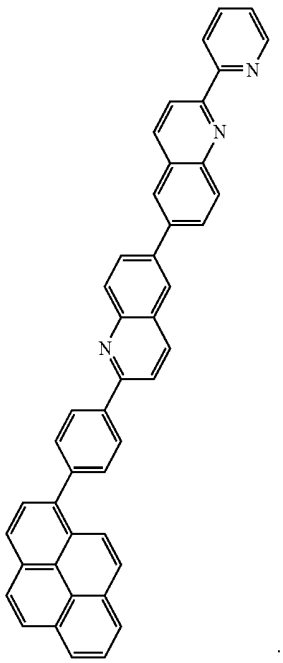

6. An organic light emitting device comprising:

a positive electrode;

a negative electrode; and

an organic material layer having one or more layers disposed between the positive electrode and the negative electrode,

wherein one or more layers of the organic material layer comprise the hetero-cyclic compound of claim **1**.

7. The organic light emitting device of claim **6**, wherein the organic material layer comprises at least one layer of a hole blocking layer, an electron injection layer, an electron transferring layer, an electron transporting layer, and a charge producing layer, and at least one layer of the hole blocking layer, the electron injection layer, the electron transferring layer, the electron transporting layer, and the charge producing layer comprises the hetero-cyclic compound.

8. The organic light emitting device of claim **6**, wherein the organic material layer comprises a light emitting layer, and the light emitting layer comprises the hetero-cyclic compound.

9. The organic light emitting device of claim **6**, wherein the organic material layer comprises one or more layers of a hole injection layer, a hole transporting layer, and a layer which injects and transports holes simultaneously, and one layer of the layers comprises the hetero-cyclic compound.

* * * * *

专利名称(译)	杂环化合物和使用其的有机发光器件		
公开(公告)号	US20180366652A1	公开(公告)日	2018-12-20
申请号	US15/780402	申请日	2016-12-01
[标]申请(专利权)人(译)	喜星素材股份有限公司		
申请(专利权)人(译)	喜星材料有限公司.		
当前申请(专利权)人(译)	喜星材料有限公司.		
[标]发明人	MO JUN TAE JUNG YONG GEUN JEONG WON JANG CHOI DAE HYUK LEE JOO DONG		
发明人	MO, JUN-TAE JUNG, YONG-GEUN JEONG, WON-JANG CHOI, DAE-HYUK LEE, JOO-DONG		
IPC分类号	H01L51/00 C07D401/14 C07D471/04		
CPC分类号	H01L51/0067 C07D401/14 H01L51/0072 C07D471/04 H01L51/5096 H01L51/5056 H01L51/5072 H01L51/5088 H01L51/5092 H01L51/5012 H01L51/56 H01L2251/558 H01L51/001 H01L2251/552 H01L51/5004 C07D215/04 C07D519/00 C09B57/00 C09K11/06 H01L51/0052 H01L51/0054 H01L51/0081 H01L51/0085 H01L51/5278		
优先权	1020150170140 2015-12-01 KR		
外部链接	Espacenet USPTO		

摘要(译)

本申请提供可显着改善有机发光器件的使用寿命，效率，电化学稳定性和热稳定性的杂环化合物，以及其中所述杂环化合物包含在有机发光器件中的有机发光器件复合层。