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(54) **MULTI-COMPONENT HOST MATERIAL
AND AN ORGANIC
ELECTROLUMINESCENCE DEVICE
COMPRISING THE SAME**

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(57)

ABSTRACT

The present invention relates to a multi-component host material and an organic electroluminescent device comprising the same. By comprising a specific combination of the multi-component host compounds, the organic electroluminescent device according to the present invention can provide high luminous efficiency and excellent lifespan characteristics.

MULTI-COMPONENT HOST MATERIAL AND AN ORGANIC ELECTROLUMINESCENCE DEVICE COMPRISING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to a multi-component host material and an organic electroluminescence device comprising the same.

BACKGROUND ART

[0002] An electroluminescence device (EL device) is a self-light-emitting device which has advantages in that it provides a wider viewing angle, a greater contrast ratio, and a faster response time. The first organic EL device was developed by Eastman Kodak, by using small aromatic diamine molecules, and aluminum complexes as materials for forming a light-emitting layer [Appl. Phys. Lett. 51, 913, 1987].

[0003] An organic EL device (OLED) is a device changing electronic energy to light by applying electricity to an organic electroluminescent material, and generally has a structure comprising an anode, a cathode, and an organic layer between the anode and the cathode. The organic layer of an organic EL device may be comprised of a hole injection layer, a hole transport layer, an electron blocking layer, a light-emitting layer (which comprises host and dopant materials), an electron buffer layer, a hole blocking layer, an electron transport layer, an electron injection layer, etc., and the materials used for the organic layer are categorized by their functions in hole injection material, hole transport material, electron blocking material, light-emitting material, electron buffer material, hole blocking material, electron transport material, electron injection material, etc. In the organic EL device, due to an application of a voltage, holes are injected from the anode to the light-emitting layer, electrons are injected from the cathode to the light-emitting layer, and excitons of high energies are formed by a recombination of the holes and the electrons. By this energy, luminescent organic compounds reach an excited state, and light emission occurs by emitting light from energy due to the excited state of the luminescent organic compounds returning to a ground state.

[0004] The most important factor determining luminous efficiency in an organic EL device is light-emitting materials. A light-emitting material must have high quantum efficiency, high electron and hole mobility, and the formed light-emitting material layer must be uniform and stable. Light-emitting materials are categorized into blue, green, and red light-emitting materials dependent on the color of the light emission, additionally yellow or orange light-emitting materials. In addition, light-emitting materials can also be categorized into host and dopant materials according to their functions. Recently, the development of an organic EL device providing high efficiency and long lifespan is an urgent issue. In particular, considering EL characteristic requirements for a middle or large-sized panel of OLED, materials showing better characteristics than conventional ones must be urgently developed. The host material which acts as a solvent in a solid state and transfers energy needs to have high purity and a molecular weight appropriate for vacuum deposition. Furthermore, the host material needs to have high glass transition temperature and high thermal

degradation temperature to achieve thermal stability, high electro-chemical stability to achieve long lifespan, ease of forming amorphous thin film, good adhesion to materials of adjacent layers, and non-migration to other layers.

[0005] A light-emitting material can be used as a combination of a host and a dopant to improve color purity, luminous efficiency, and stability. Generally, an EL device having excellent characteristics has a structure comprising a light-emitting layer formed by doping a dopant to a host. Since host materials greatly influence the efficiency and lifespan of the EL device when using a dopant/host material system as a light emitting material, their selection is important.

[0006] Korean Patent Appln. Laying-Open No. 10-2008-0080306 discloses an organic electroluminescent device using a compound wherein two carbazoles are linked via an arylene as a host material, and International Publication No. WO 2013/112557 A1 discloses an organic electroluminescent device using a compound wherein a biscarbazole is linked to a carbazole via an arylene as a host material. However, the references fail to disclose an organic electroluminescent device using a compound wherein a biscarbazole comprising an aryl is linked to a dibenzothiophene or dibenzofuran directly or via an arylene, and a compound wherein a carbazole is linked to a heteroaryl directly or via an arylene as a multi-component host.

DISCLOSURE OF THE INVENTION

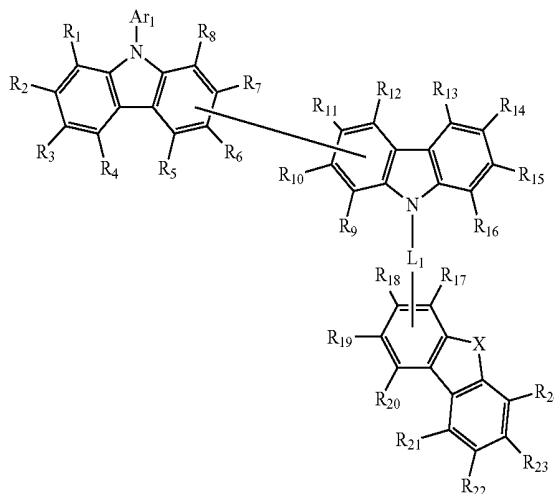
Problems to be Solved

[0007] The objective of the present invention is to provide an organic electroluminescent device having improved lifespan characteristics.

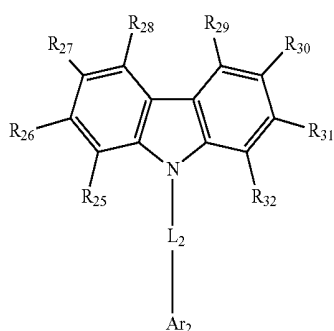
Solution to Problems

[0008] The present inventors found that the above objective can be achieved by an organic electroluminescent device comprising at least one light-emitting layer between an anode and a cathode, wherein the light-emitting layer comprises a host and a phosphorescent dopant, the host consists of multi-component host compounds, at least a first host compound of the multi-component host compounds is represented by the following formula 1, and a second host compound is represented by the following formula 2:

(1)



-continued



(2)

[0018] The compound represented by formula 1 can be represented by formula 3, 4, 5, or 6:

[0009] wherein

[0010] Ar₁ represents a substituted or unsubstituted (C6-C30)aryl;

[0011] L₁ and L₂ each independently represent a single bond, or a substituted or unsubstituted (C6-C30)arylene;

[0012] X represents O or S;

[0013] R₁ to R₃₂ each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur;

[0014] Ar₂ represents a substituted or unsubstituted 3- to 30-membered heteroaryl; and the heteroaryl contains at least one hetero atom selected from B, N, O, S, Si, and P.

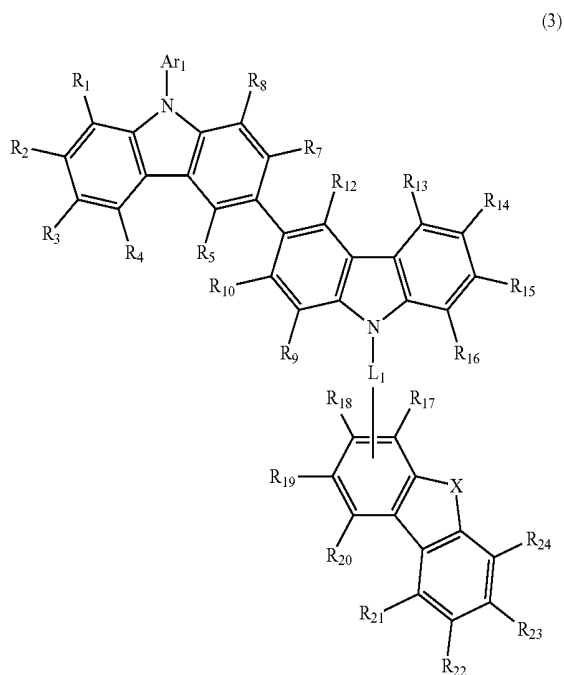
Effects of the Invention

[0015] According to the present invention, an organic electroluminescent device having high efficiency and long lifespan is provided, and it is possible to manufacture a display device or a lighting device using the organic electroluminescent device.

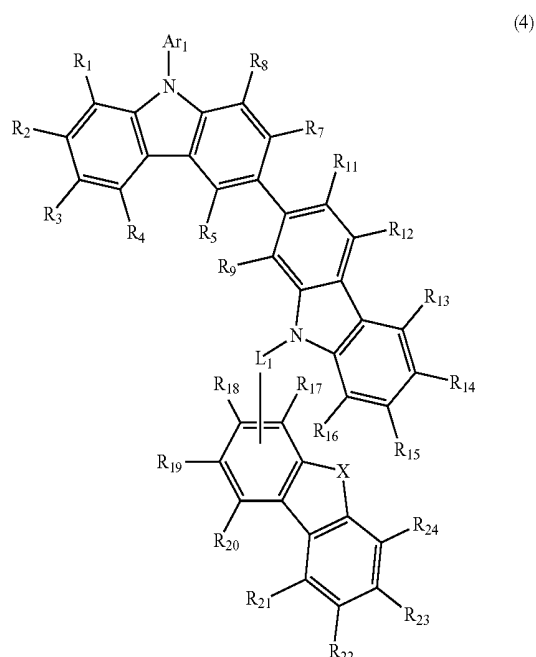
EMBODIMENTS OF THE INVENTION

[0016] Hereinafter, the present invention will be described in detail. However, the following description is intended to explain the invention, and is not meant in any way to restrict the scope of the invention.

[0017] Hereinafter, the organic electroluminescent device comprising the organic electroluminescent compounds of formulae 1 and 2 will be described in detail.

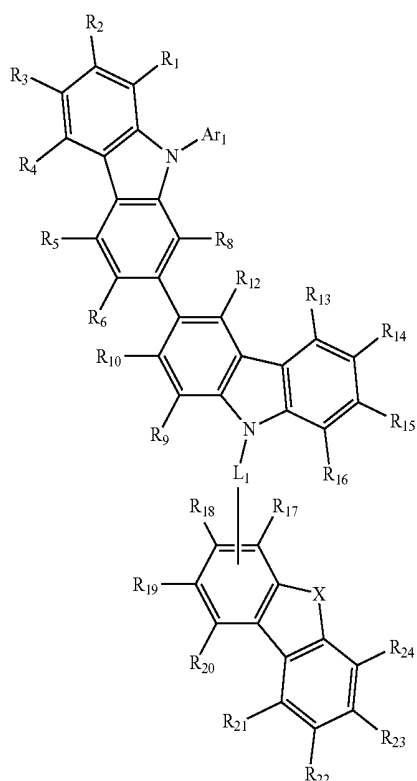


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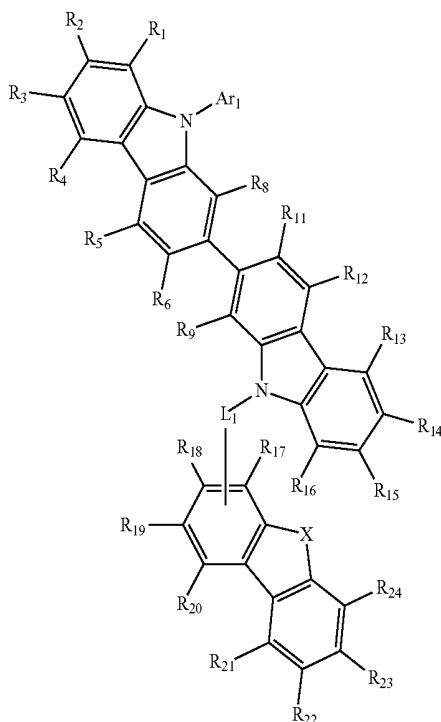


(4)

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(5)



(6)

[0019] wherein

[0020] Ar₁, L₁, X, and R₁ to R₂₄ are as defined in formula 1.[0021] In formula 1 above, L₁ represents a single bond, or a substituted or unsubstituted (C6-C30)arylene, preferably represents a single bond, or a substituted or unsubstituted

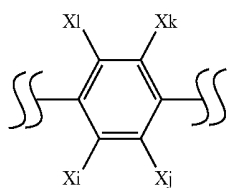
(C6-C15)arylene, and more preferably represents a single bond, or an unsubstituted (C6-C15)arylene.

[0022] In formula 1 above, X represents O or S.

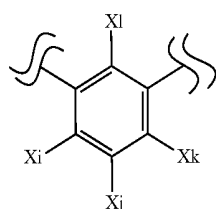
[0023] In formula 1 above, Ar₁ represents a substituted or unsubstituted (C6-C30)aryl, preferably represents a substituted or unsubstituted (C6-C20)aryl, and more preferably represents a (C6-C20)aryl unsubstituted or substituted with a (C6-C20)aryl.[0024] In formula 1 above, R₁ to R₂₄ each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur, and preferably, each independently represent hydrogen.[0025] In formula 2 above, L₂ represents a single bond, or a substituted or unsubstituted (C6-C30)arylene, preferably represents a single bond, or a substituted or unsubstituted (C6-C15)arylene, and more preferably represents a single bond, or a (C6-C15)arylene unsubstituted or substituted with a tri(C6-C15)arylsilyl.[0026] In formula 2 above, Ar₂ represents a substituted or unsubstituted 3- to 30-membered heteroaryl, preferably represents a substituted or unsubstituted 5- to 11-membered nitrogen-containing heteroaryl, and more preferably represents a 6- to 10-membered nitrogen-containing heteroaryl unsubstituted or substituted with an unsubstituted (C6-C18)aryl, a (C6-C12)aryl substituted with a cyano, a (C6-C12)aryl substituted with a (C1-C6)alkyl, a (C6-C12)aryl substituted with a tri(C6-C12)arylsilyl, or a 6- to 15-membered heteroaryl.[0027] In addition, Ar₂ may represent a monocyclic heteroaryl selected from the group consisting of pyrrolyl, imidazolyl, pyrazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, pyridyl, pyrazinyl, pyrimidinyl, and pyridazinyl, or a fused heteroaryl selected from the group consisting of benzoimidazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolyl, quinazolinyl, naphthyridinyl, quinoxalinyl, carbazolyl, and phenanthrydinyl, and preferably may represent triazinyl, pyrimidinyl, quinolyl, isoquinolyl, quinazolinyl, naphthyridinyl, or quinoxalinyl.[0028] In formula 2 above, R₂₅ to R₃₂ each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or are linked to an adjacent substituent(s) to form a

substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur, and preferably, each independently represent hydrogen, a cyano, a substituted or unsubstituted (C6-C15)aryl, a substituted or unsubstituted 10- to 20-membered heteroaryl, or a substituted or unsubstituted tri(C6-C10)arylsilyl; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C6-C20) aromatic ring, and more preferably, each independently represent hydrogen, a cyano, a (C6-C15)aryl unsubstituted or substituted with a tri(C6-C10)arylsilyl, a 10- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted tri(C6-C10)arylsilyl; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted benzene, a substituted or unsubstituted indole, a substituted or unsubstituted benzindole, a substituted or unsubstituted indene, a substituted or unsubstituted benzofuran, or a substituted or unsubstituted benzothio-
phene.

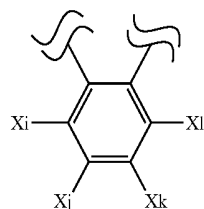
[0029] In addition, L_1 and L_2 each independently can be represented by one of the following formulae 7 to 19:



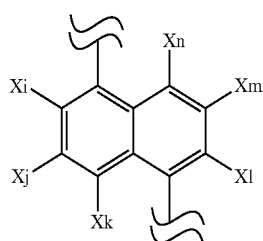
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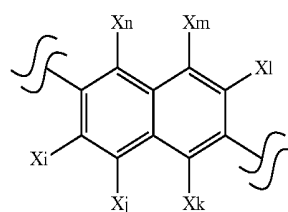


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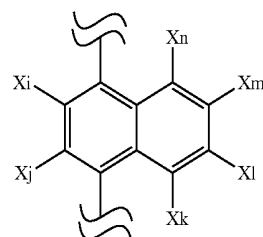


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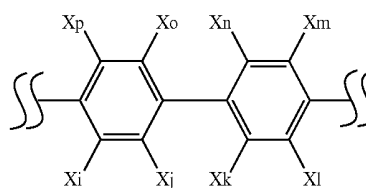
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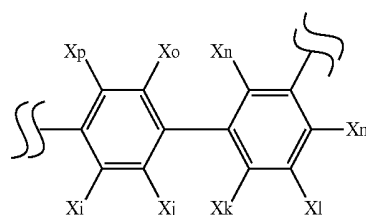
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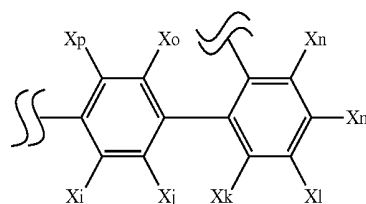
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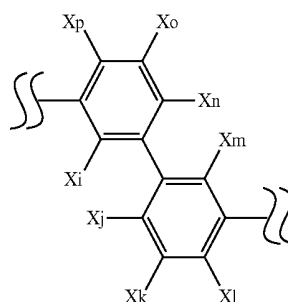
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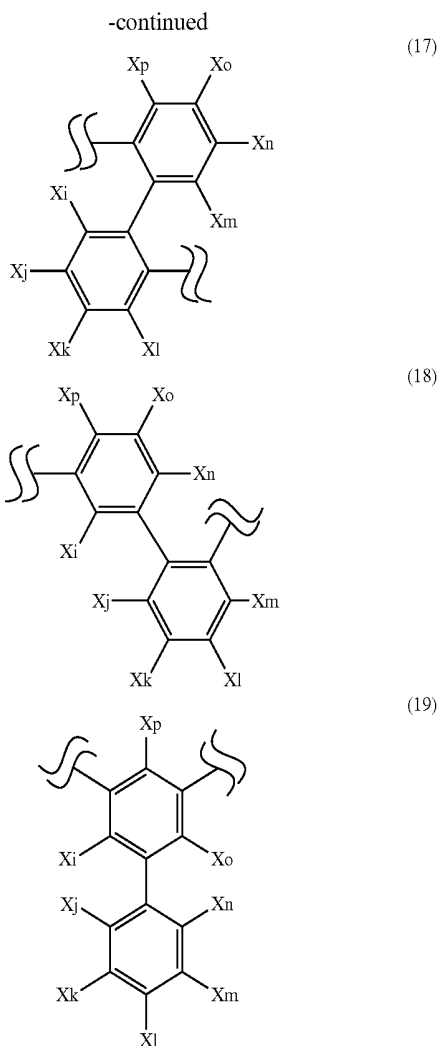
(14)



(15)



(16)



[0030] wherein

[0031] Xi to Xp each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur.

[0032] Herein, “(C1-C30)alkyl” is meant to be a linear or branched alkyl having 1 to 30 carbon atoms, in which the number of carbon atoms is preferably 1 to 20, more preferably 1 to 10, and includes methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, tert-butyl, etc.; “(C2-C30)alkenyl” is meant to be a linear or branched alkenyl having 2 to 30 carbon atoms, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-bute-

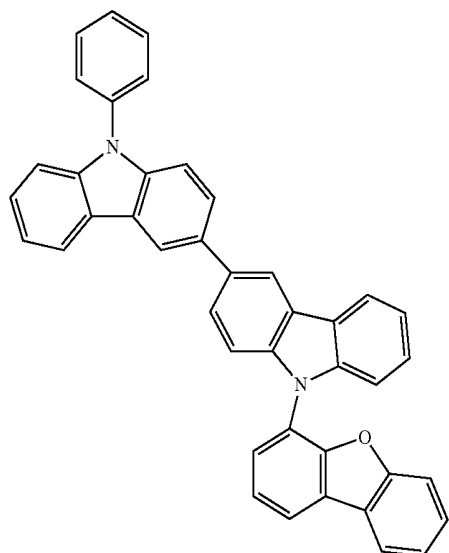
nyl, 2-methylbut-2-enyl, etc.; “(C2-C30)alkynyl” is meant to be a linear or branched alkynyl having 2 to 30 carbon atoms, in which the number of carbon atoms is preferably 2 to 20, more preferably 2 to 10, and includes ethynyl, 1-propynyl, 2-propynyl, 1-butylnyl, 2-butylnyl, 3-butylnyl, 1-methylpent-2-ynyl, etc.; “(C3-C30)cycloalkyl” is a mono- or polycyclic hydrocarbon having 3 to 30 carbon atoms, in which the number of carbon atoms is preferably 3 to 20, more preferably 3 to 7, and includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc.; “3- to 7-membered heterocycloalkyl” is a cycloalkyl having 3 to 7 ring backbone atoms, preferably 5 to 7, including at least one heteroatom selected from B, N, O, S, Si, and P, preferably O, S, and N, and includes tetrahydrofuran, pyrrolidine, thiolan, tetrahydropyran, etc.; “(C6-C30)aryl(ene)” is a monocyclic or fused ring derived from an aromatic hydrocarbon having 6 to 30 carbon atoms, in which the number of carbon atoms is preferably 6 to 20, more preferably 6 to 15, and includes phenyl, biphenyl, terphenyl, naphthyl, binaphthyl, phenyl-naphthyl, naphthylphenyl, fluorenyl, phenylfluorenyl, benzofluorenyl, dibenzofluorenyl, phenanthrenyl, phenyl-phenanthrenyl, anthracenyl, indenyl, triphenylenyl, pyrenyl, tetracenyl, perylenyl, chrysenyl, naphthacenyl, fluoranthenyl, etc.; “3- to 30-membered heteroaryl” is an aryl having 3 to 30 ring backbone atoms, including at least one, preferably 1 to 4 heteroatoms selected from the group consisting of B, N, O, S, Si, and P; is a monocyclic ring, or a fused ring condensed with at least one benzene ring; may be partially saturated; may be one formed by linking at least one heteroaryl or aryl group to a heteroaryl group via a single bond(s); and includes a monocyclic ring-type heteroaryl including furyl, thiophenyl, pyrrolyl, imidazolyl, pyrazolyl, thiazolyl, thiadiazolyl, isothiazolyl, isoxazolyl, oxazolyl, oxadiazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, furazanyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl including benzofuranyl, benzothiophenyl, isobenzofuranyl, dibenzofuranyl, dibenzothiophenyl, benzoimidazolyl, benzothiazolyl, benzoisothiazolyl, benzoisoxazolyl, benzoxazolyl, isoindolyl, indolyl, benzoindolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolyl, quinazolinyl, quinoxalinyl, carbazoyl, phenoxazinyl, phenanthridinyl, benzodioxolyl, etc.; “nitrogen-containing 5- to 30-membered heteroaryl” is an aryl having 5 to 30 ring backbone atoms, preferably 5 to 20, and more preferably 5 to 15, including at least one heteroatom, N; is a monocyclic ring, or a fused ring condensed with at least one benzene ring; may be partially saturated; may be one formed by linking at least one heteroaryl or aryl group to a heteroaryl group via a single bond(s); and includes a monocyclic ring-type heteroaryl including pyrrolyl, imidazolyl, pyrazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, pyridyl, pyrazinyl, pyrimidinyl, pyridazinyl, etc., and a fused ring-type heteroaryl including benzoimidazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolyl, quinazolinyl, quinoxalinyl, carbazoyl, phenanthridinyl, etc. Further, “halogen” includes F, Cl, Br, and I.

[0033] Herein, “substituted” in the expression “substituted or unsubstituted” means that a hydrogen atom in a certain functional group is replaced with another atom or group, i.e. a substituent. The substituents of the substituted alkyl, the substituted alkenyl, the substituted alkynyl, the substituted cycloalkyl, the substituted aryl(ene), the substituted heteroaryl, the substituted trialkylsilyl, the substituted triaryl-

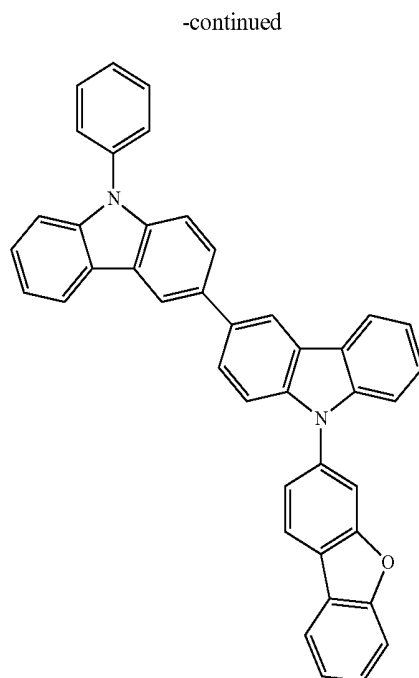
silyl, the substituted dialkylarylsilyl, the substituted mono- or di-arylamino, and the substituted mono- or polycyclic, alicyclic or aromatic ring in Ar₁, Ar₂, L₁, L₂, and R₁ to R₃₂ in formulae 1 and 2 each independently are at least one selected from the group consisting of deuterium, a halogen, a cyano, a carboxyl, a nitro, a hydroxyl, a (C1-C30)alkyl, a halo(C1-C30)alkyl, a (C2-C30)alkenyl, a (C2-C30)alkynyl, a (C1-C30)alkoxy, a (C1-C30)alkylthio, a (C3-C30)cycloalkyl, a (C3-C30)cycloalkenyl, a 3- to 7-membered heterocycloalkyl, a (C6-C30)aryloxy, a (C6-C30)arylthio, a 3- to 30-membered heteroaryl unsubstituted or substituted with a (C6-C30)aryl, a (C6-C30)aryl unsubstituted or substituted with a cyano, a 3- to 30-membered heteroaryl, or a tri(C6-C30)arylsilyl, a tri(C1-C30)alkylsilyl, a tri(C6-C30)arylsilyl, a di(C1-C30)alkyl(C6-C30)arylsilyl, a (C1-C30)alkyldi(C6-C30)arylsilyl, an amino, a mono- or di-(C1-C30)alkylamino, a mono- or di-(C6-C30)arylamino, a (C1-C30)alkyl(C6-C30)arylamino, a (C1-C30)alkylcarbonyl, a (C1-C30)alkoxycarbonyl, a (C6-C30)arylcarbonyl, a di(C6-C30)arylboronyl, a di(C1-C30)alkylboronyl, a (C1-C30)alkyl(C6-C30)arylboronyl, a (C6-C30)aryl(C1-C30)alkyl, and a (C1-C30)alkyl(C6-C30)aryl, and preferably are at least one selected from the group consisting of a cyano, a (C1-C6)alkyl, a 5- to 15-membered heteroaryl, a (C6-C18)aryl, a (C6-C18)aryl substituted with a cyano, a (C6-C18)aryl substituted with a tri(C6-C12)arylsilyl, a tri(C6-C12)arylsilyl, and a (C1-C6)alkyl(C6-C18)aryl.

[0034] In formulae 1 and 2, the triarylsilyl is preferably a triphenylsilyl.

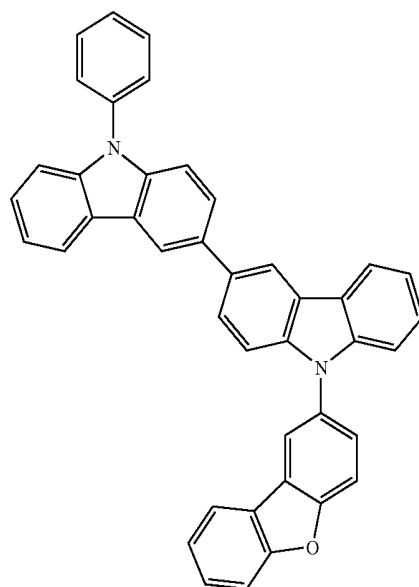
[0035] The first host compound represented by formula 1 includes the following compounds, but is not limited thereto:



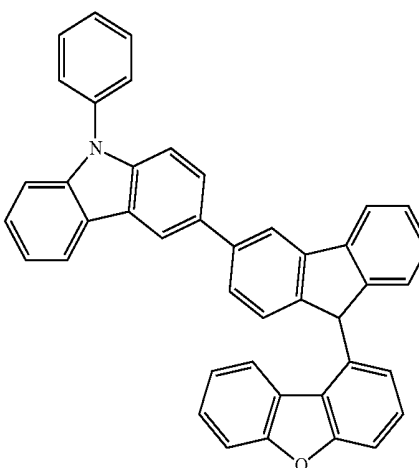
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A-2



A-3

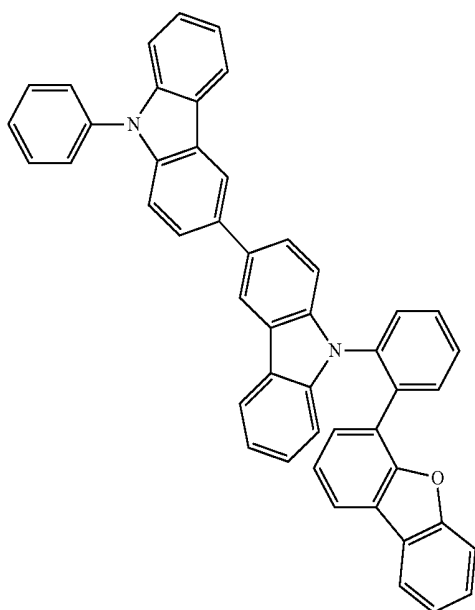


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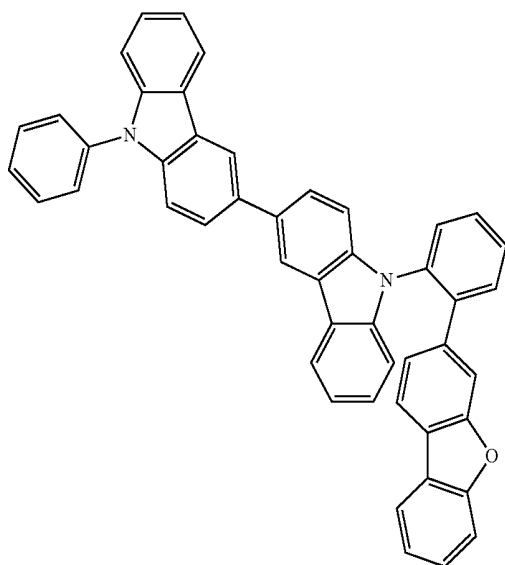
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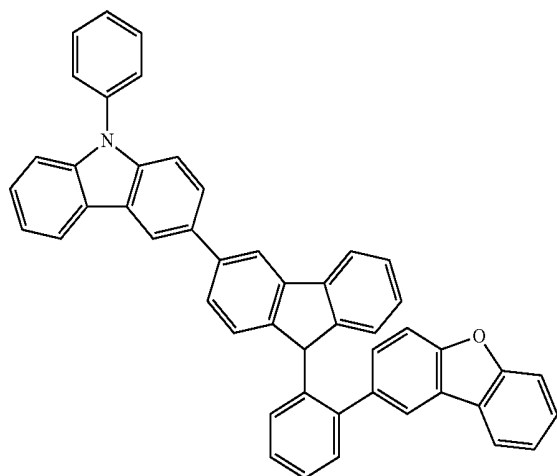
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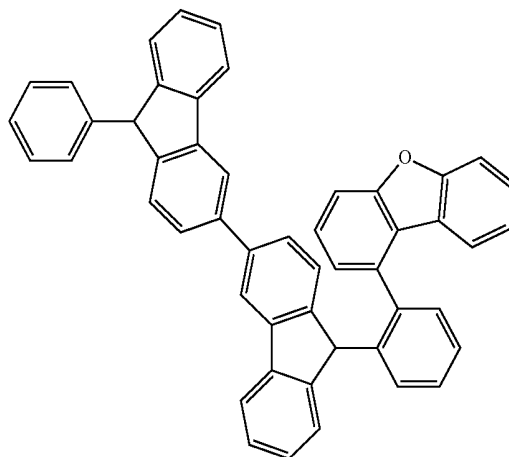


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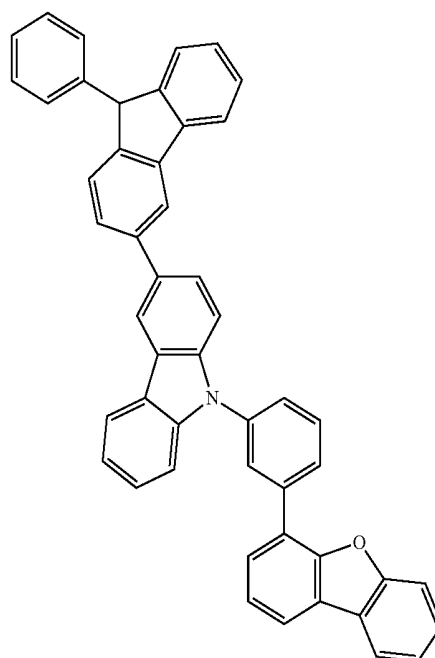


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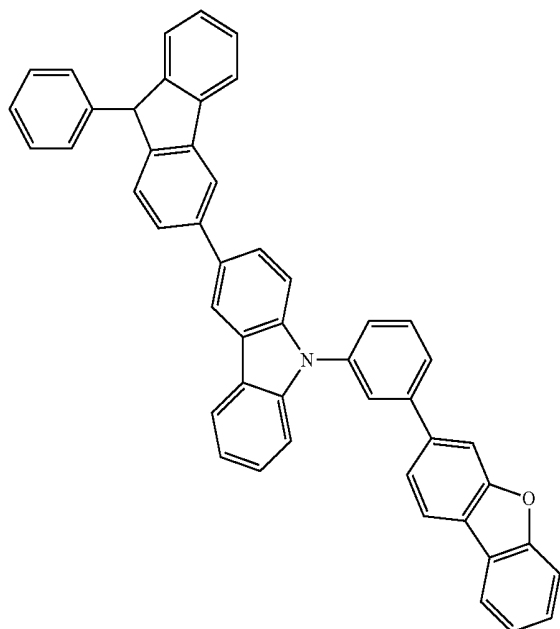


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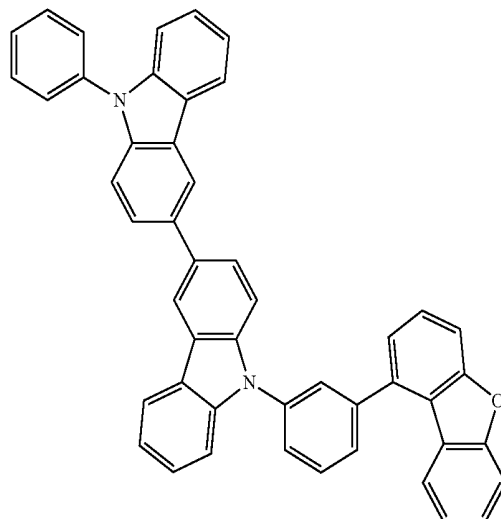
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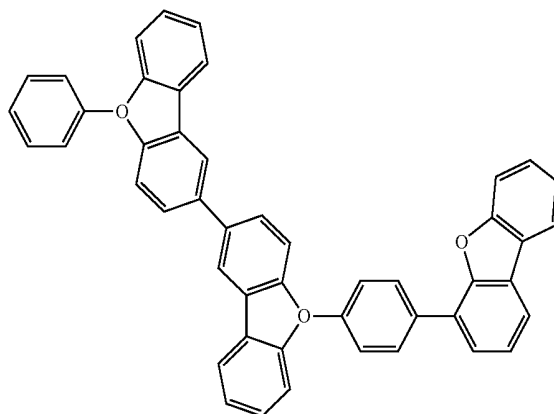


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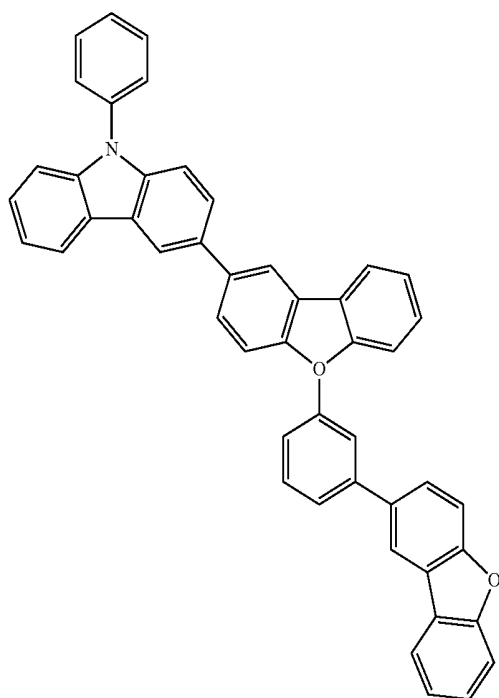
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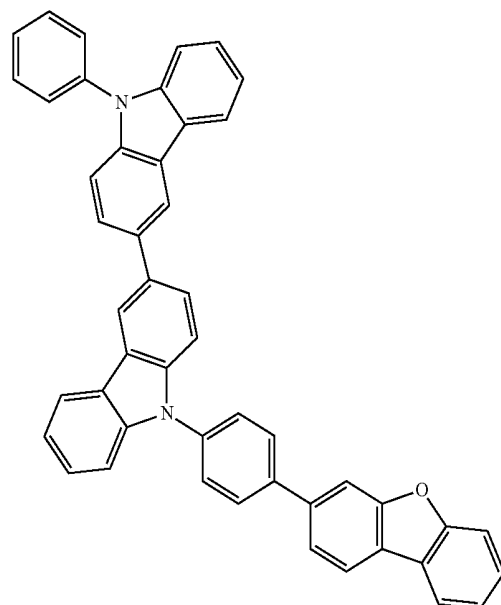
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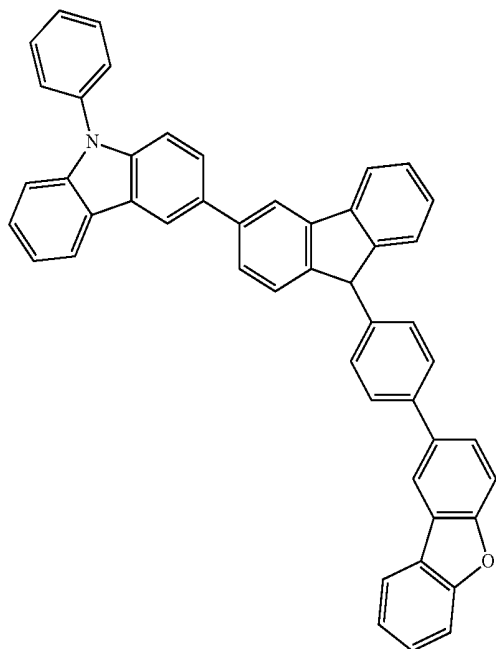


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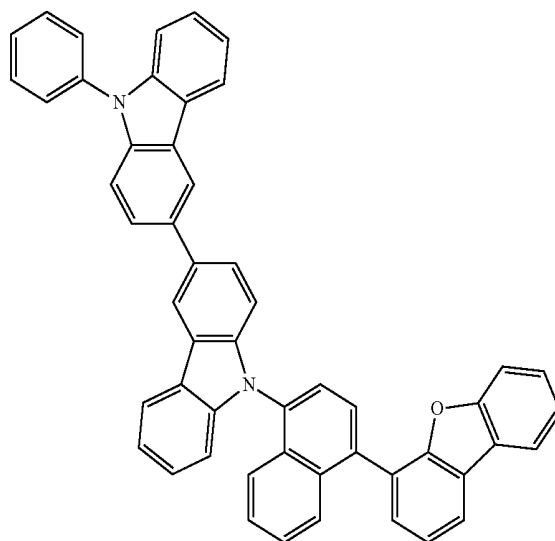
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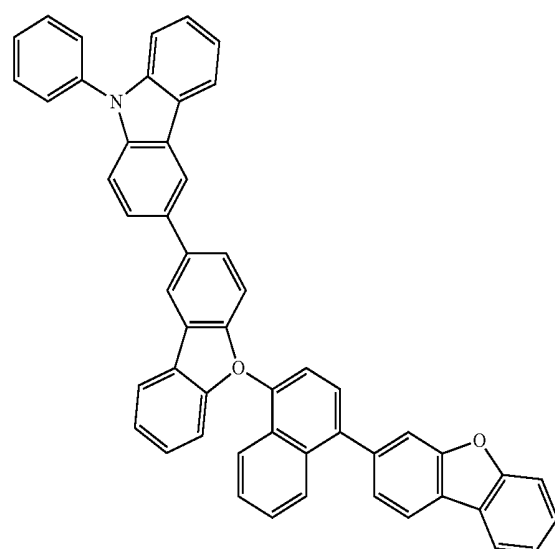
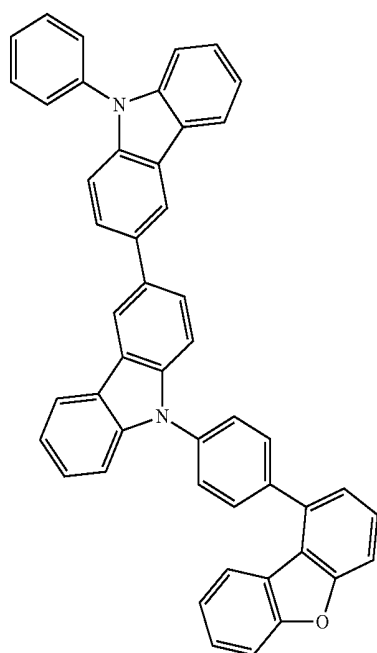
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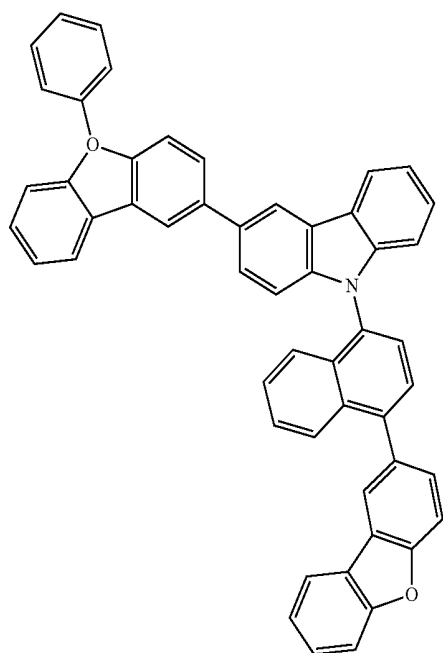


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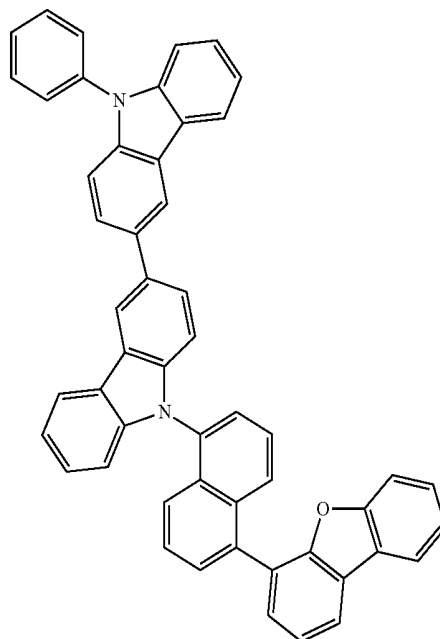


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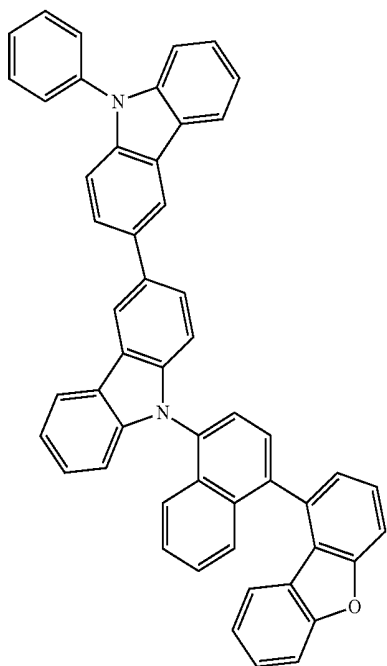


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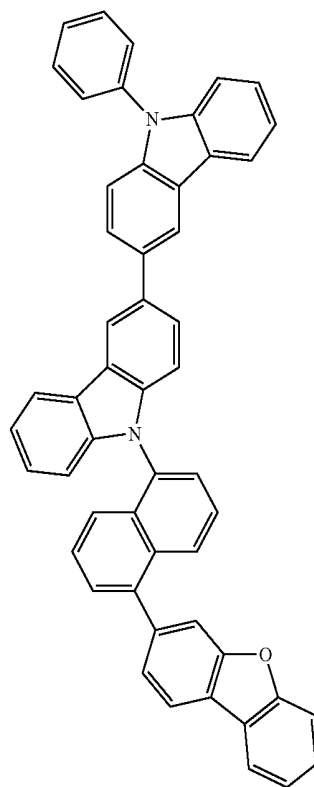
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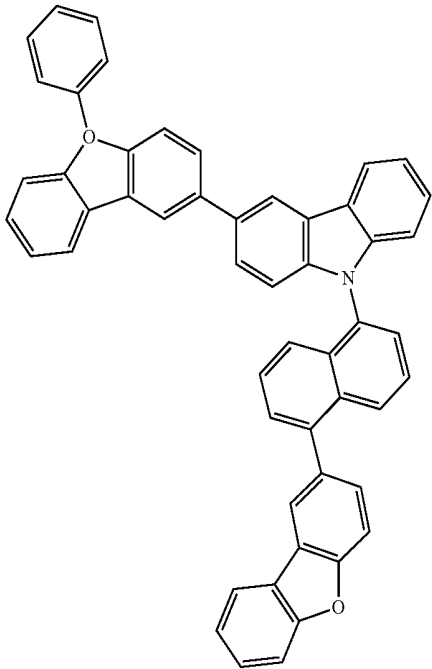


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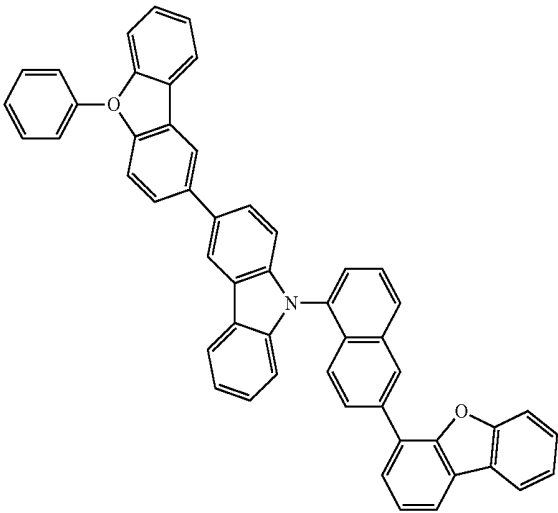


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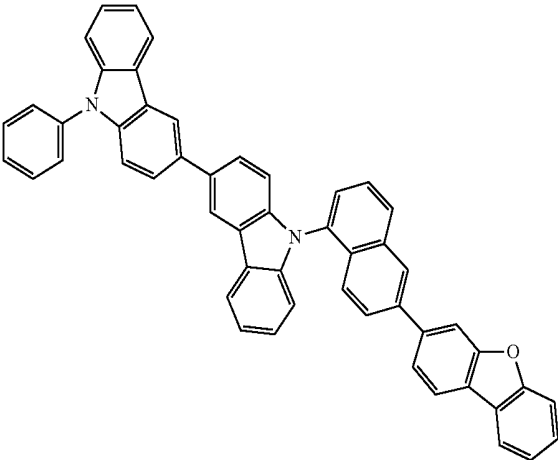
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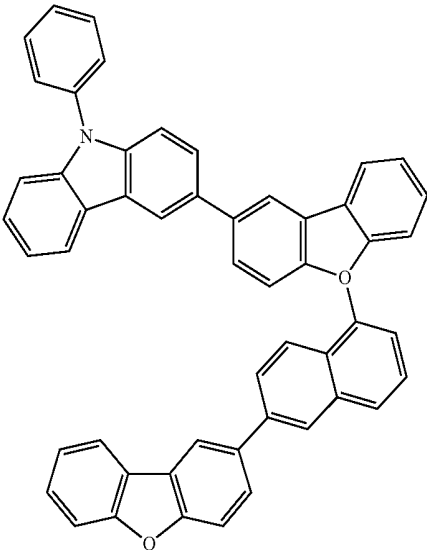
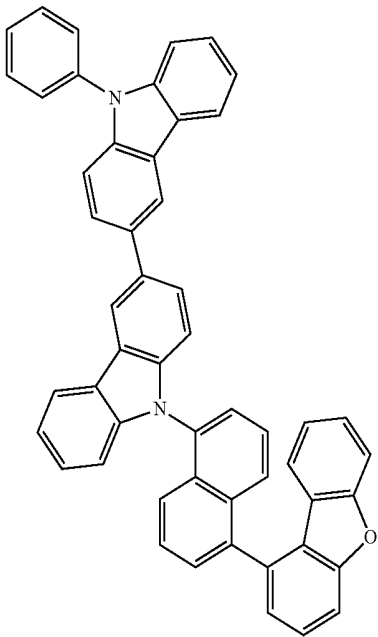
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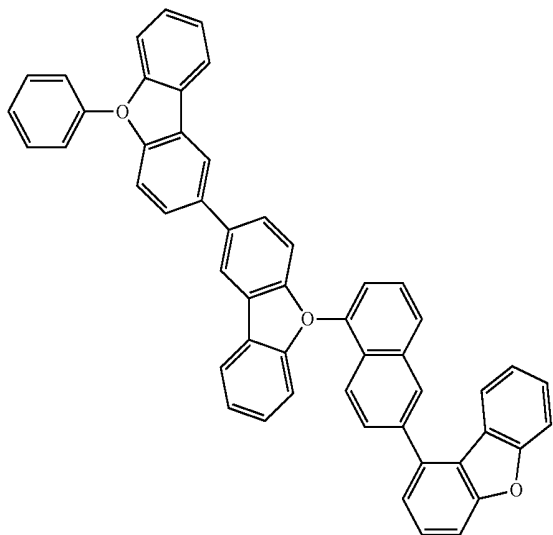
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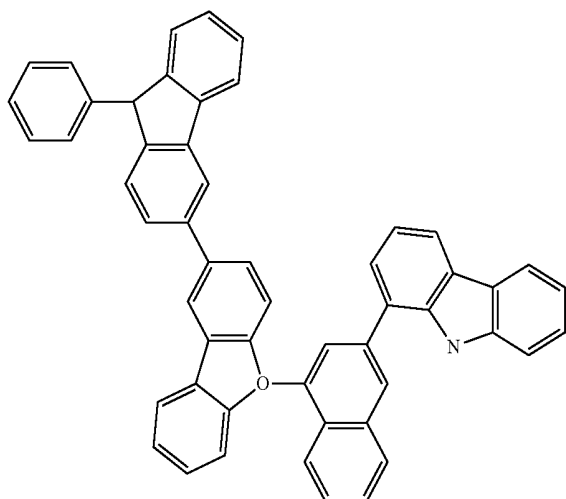


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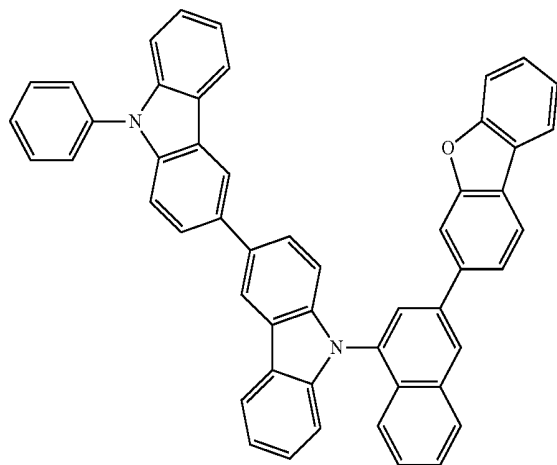
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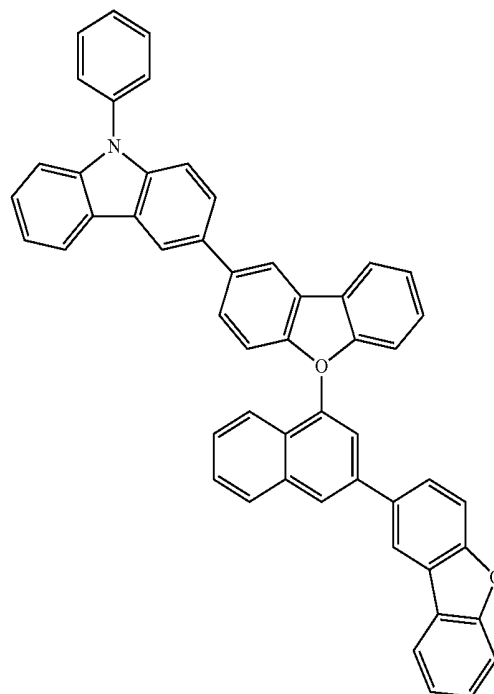


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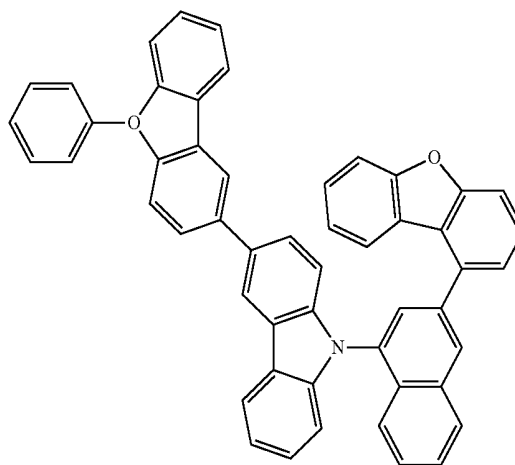


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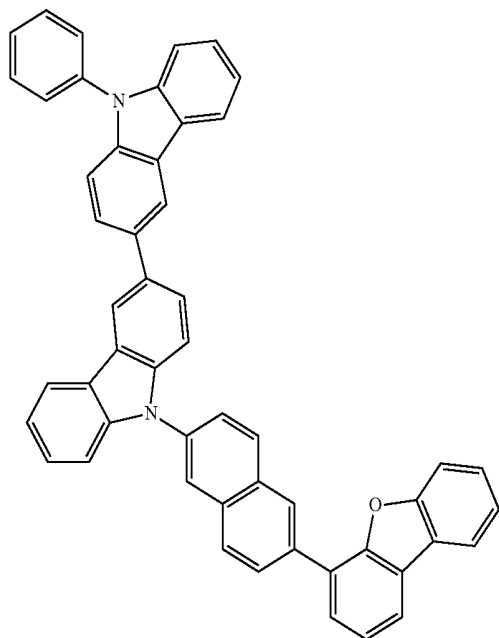


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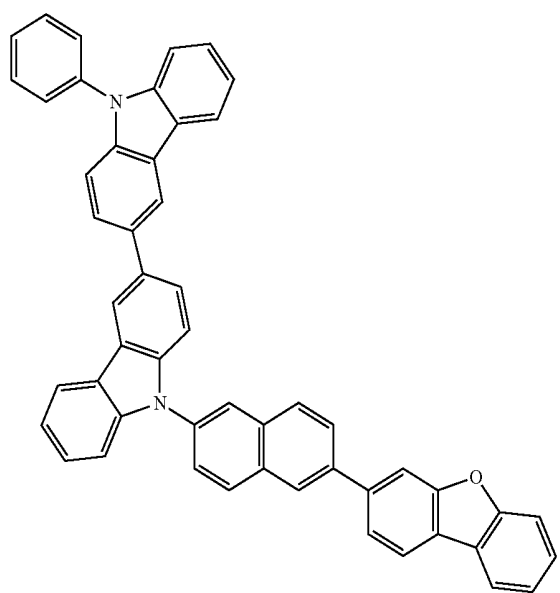


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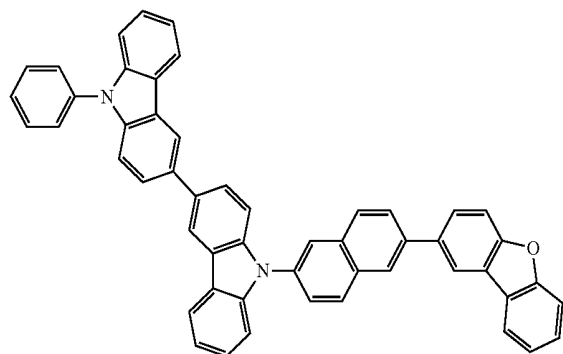
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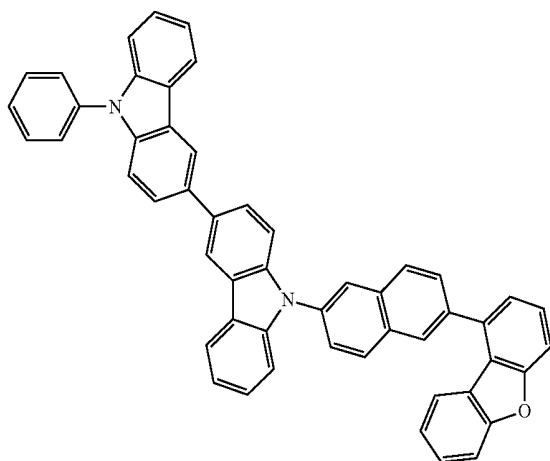


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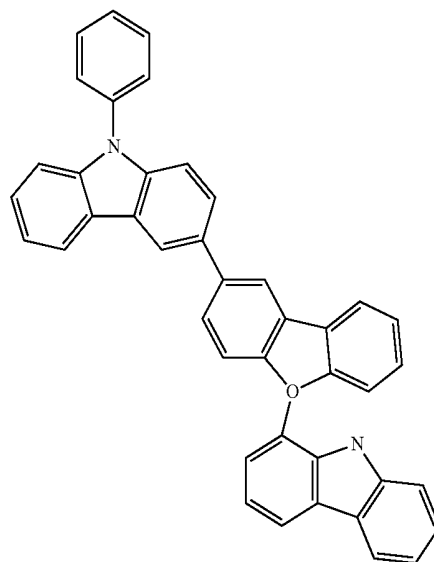


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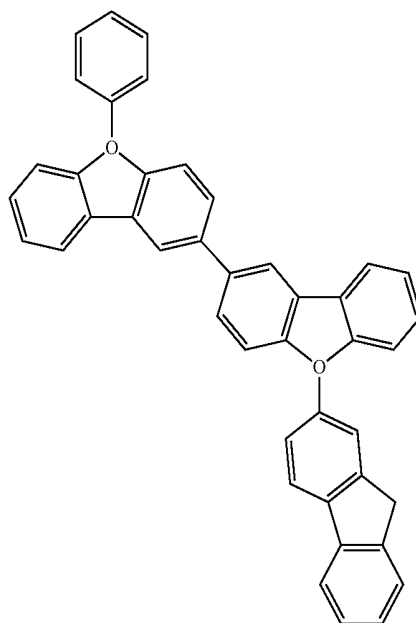
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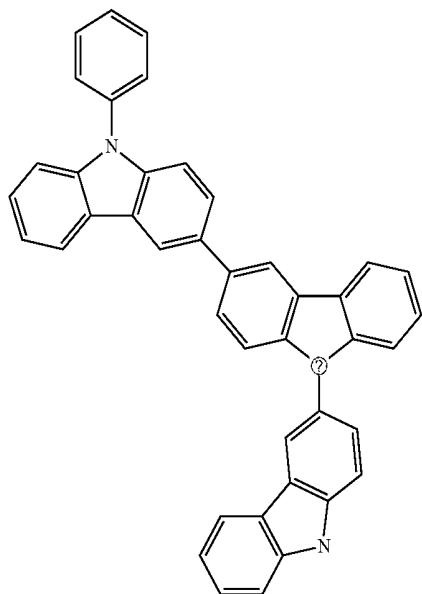
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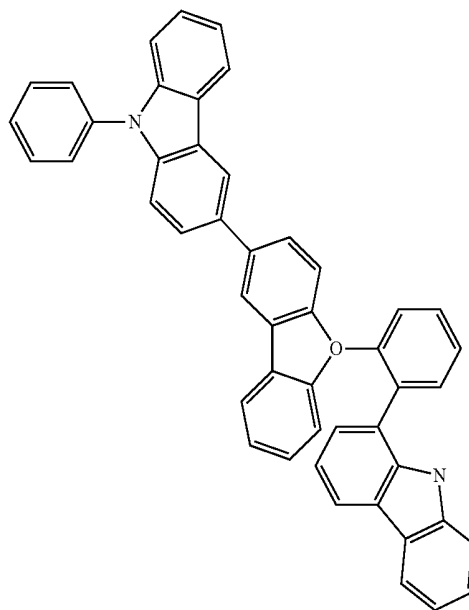


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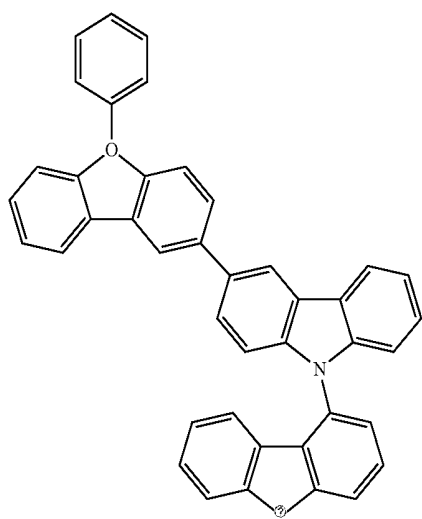


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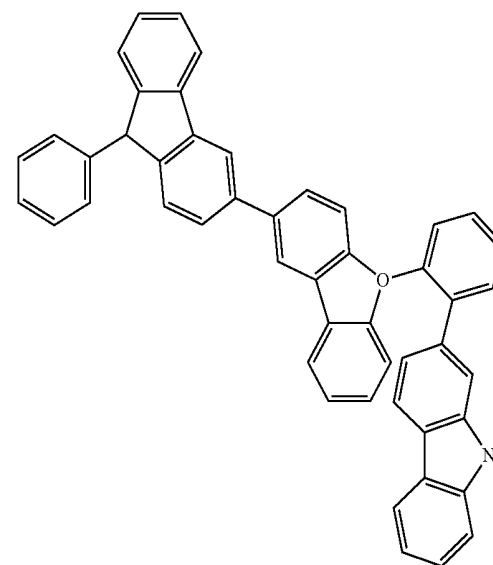
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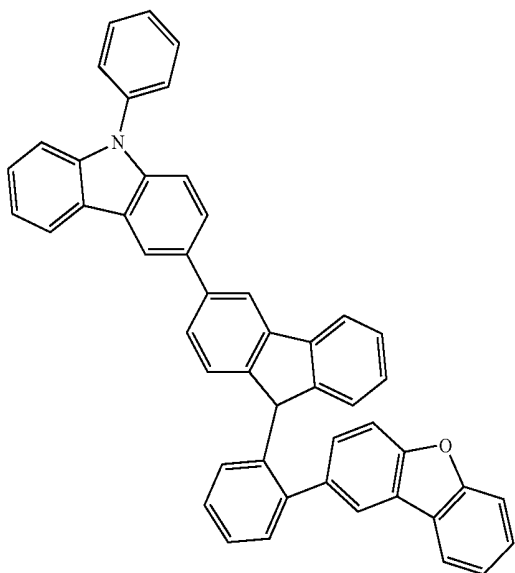
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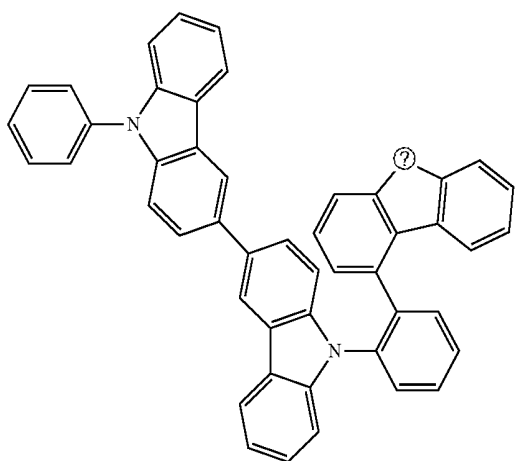
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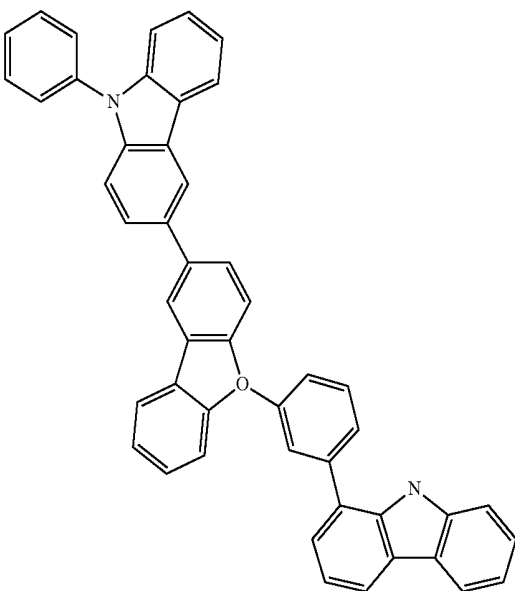
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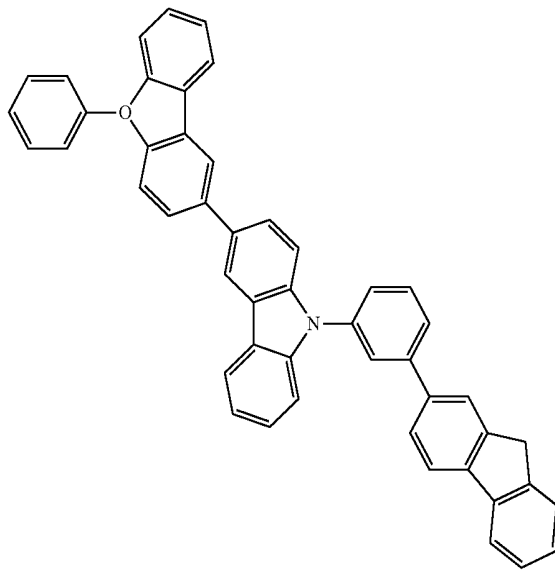


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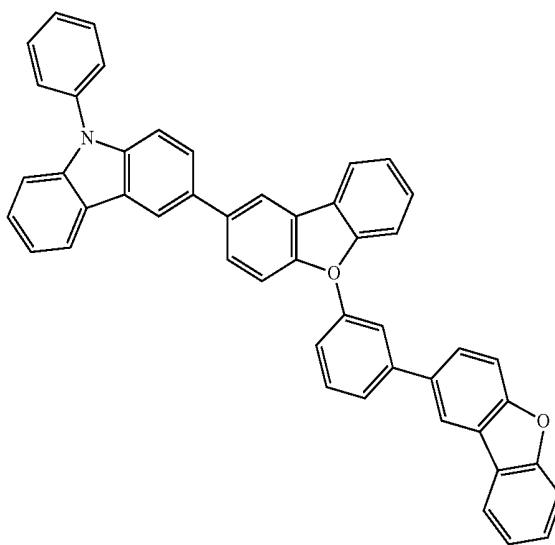


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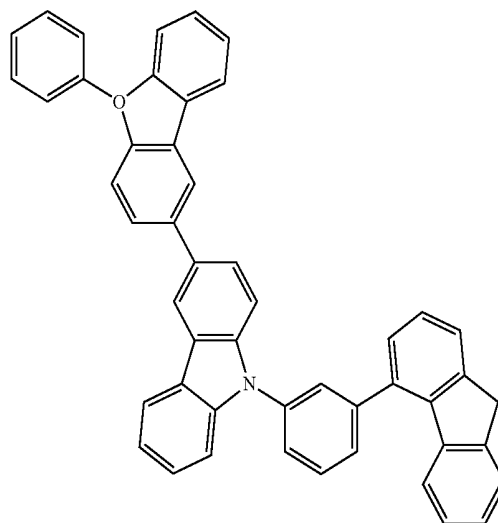
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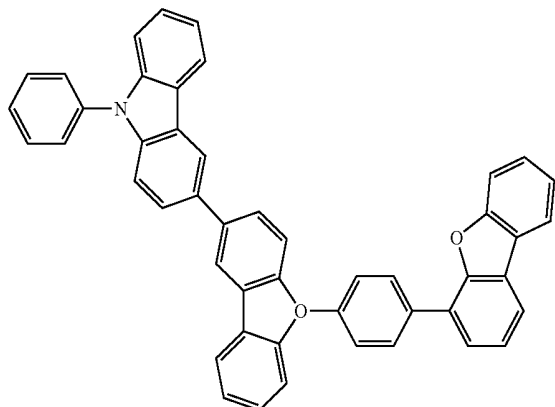


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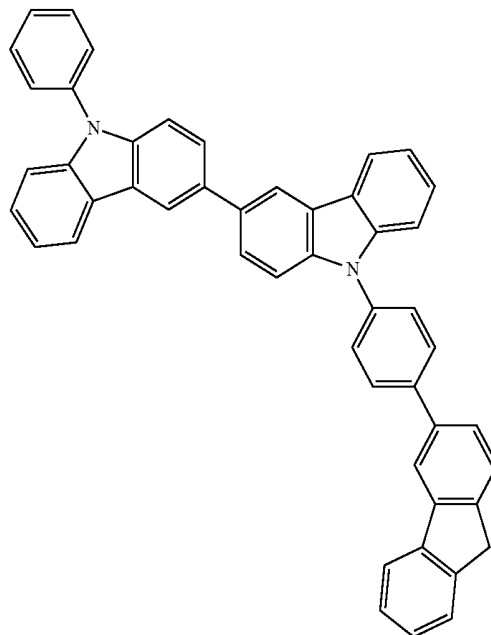
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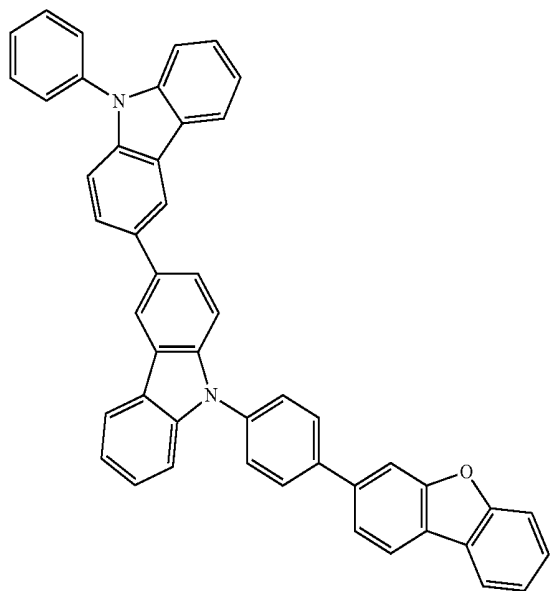


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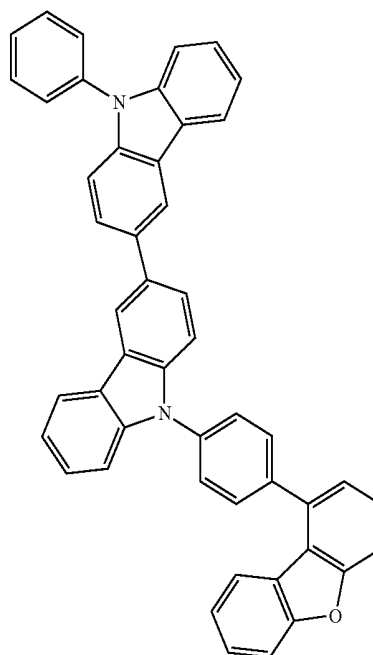
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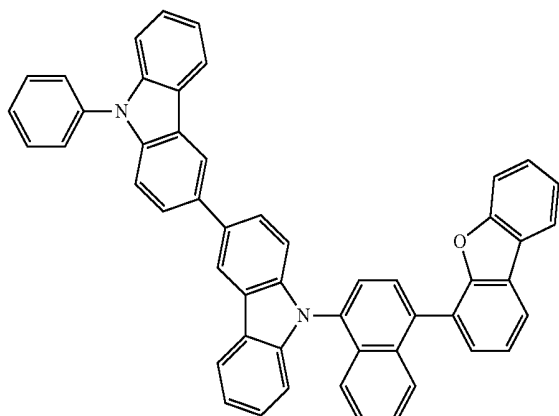


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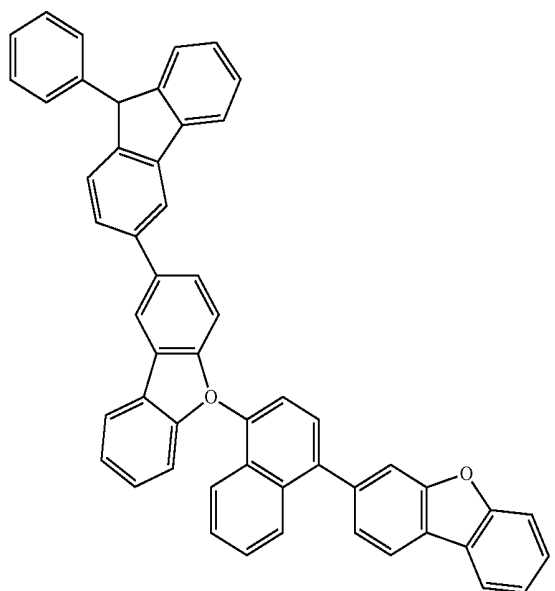


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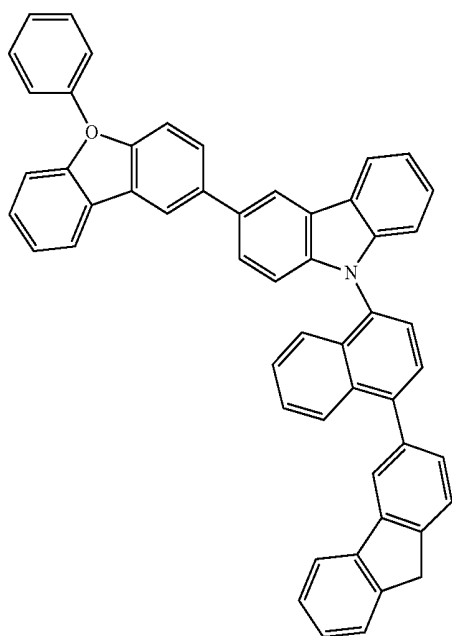
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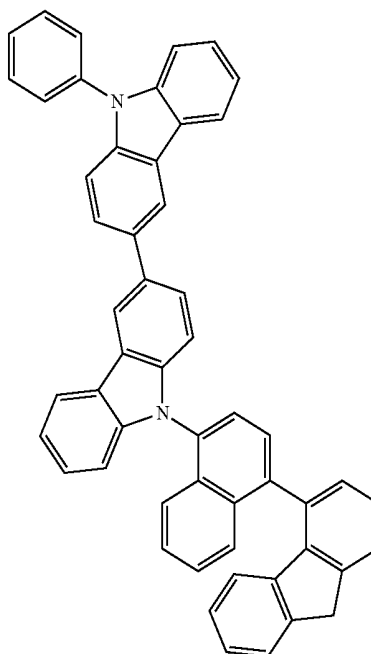


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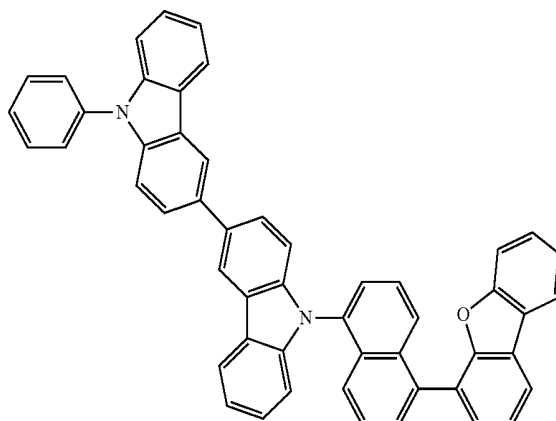


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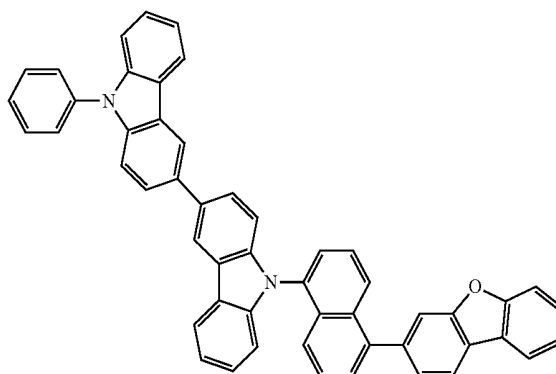
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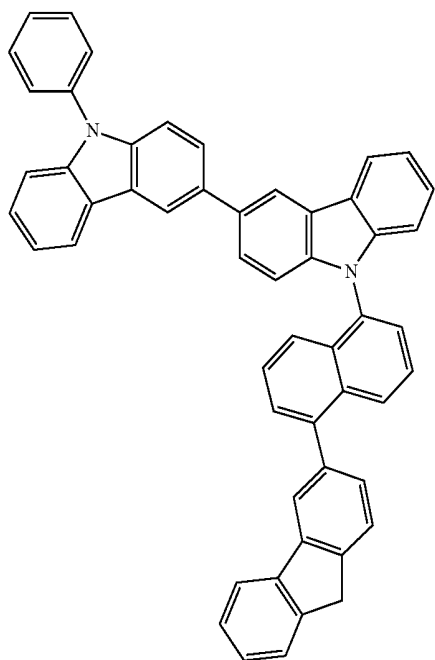


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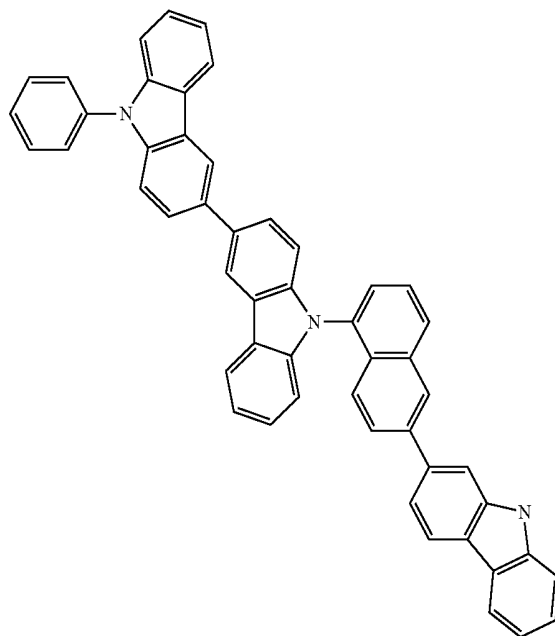
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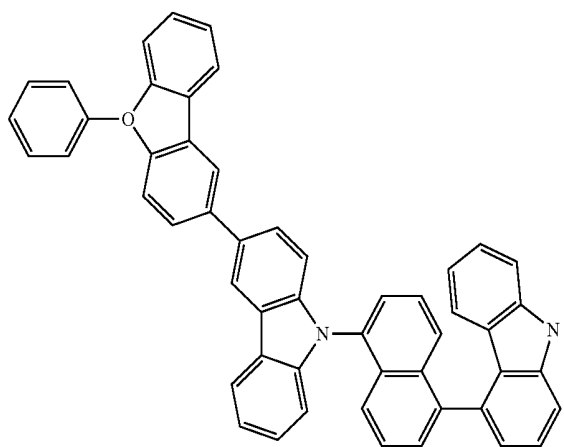


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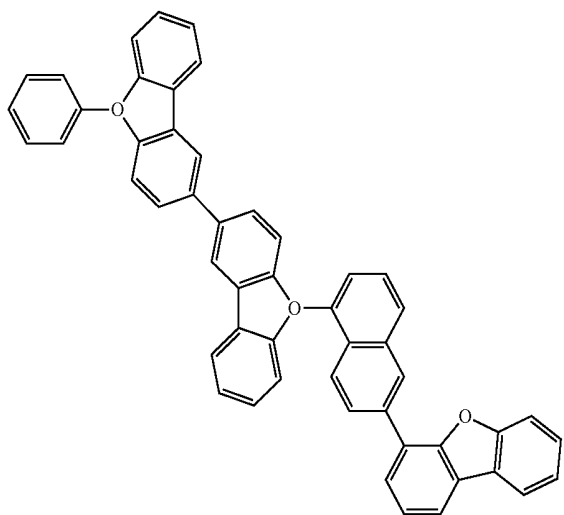
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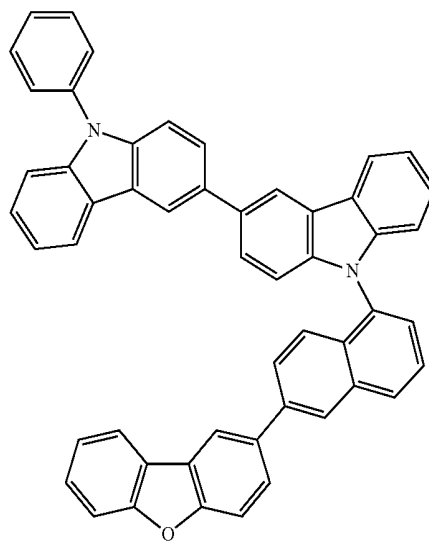
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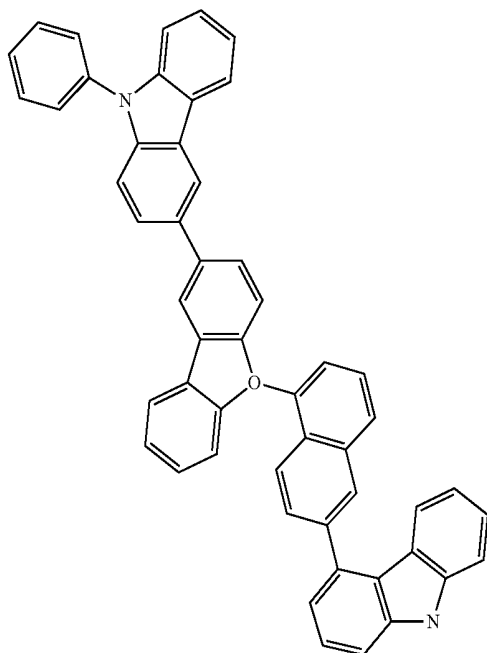


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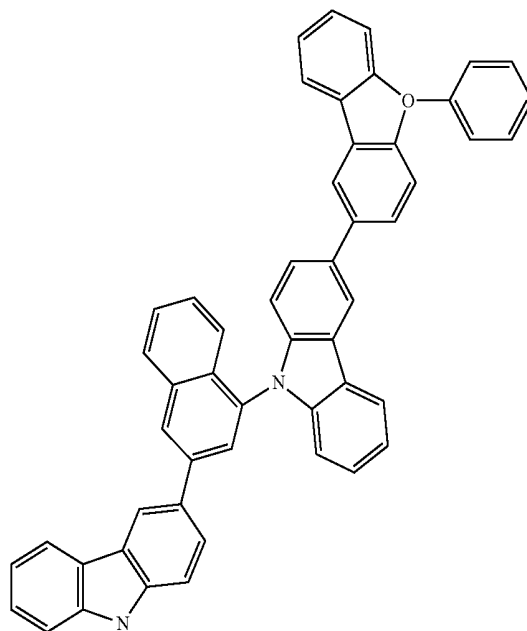
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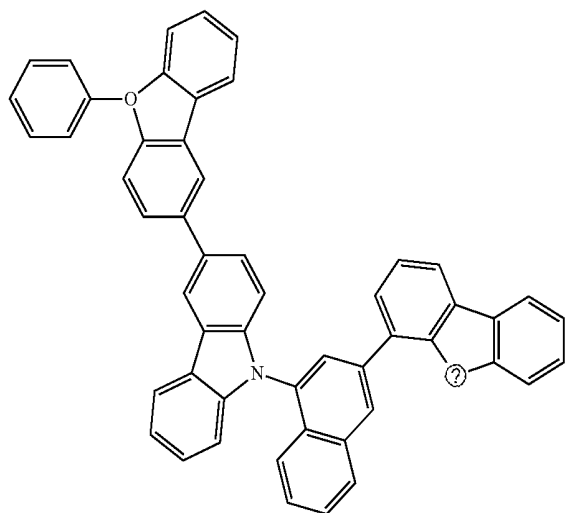


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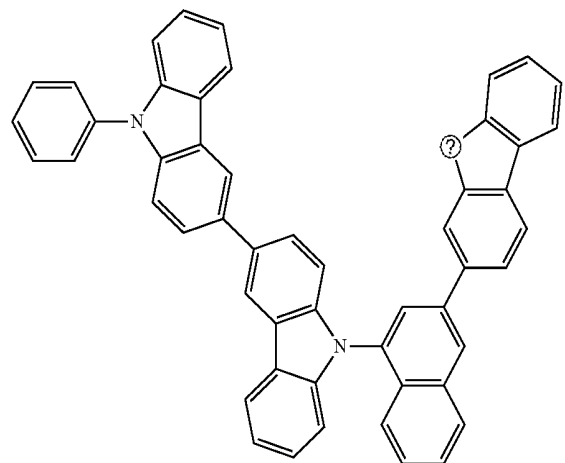
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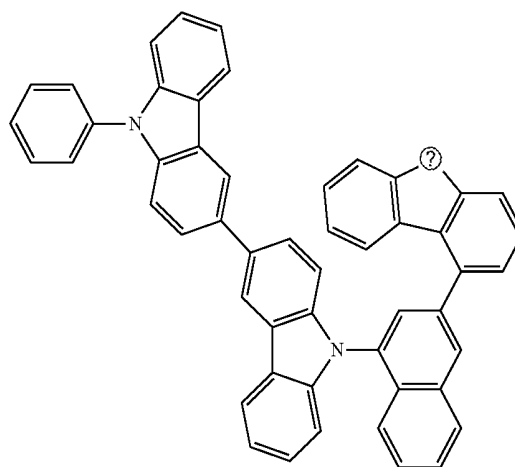
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A-66

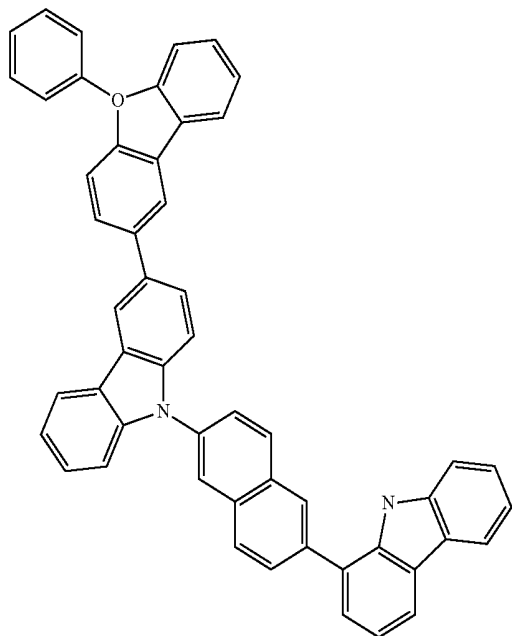


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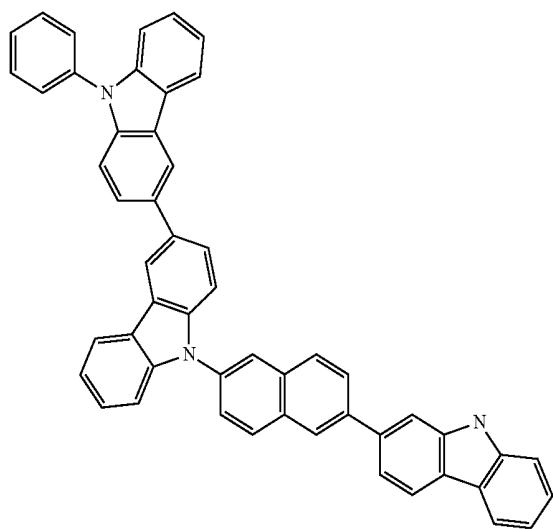


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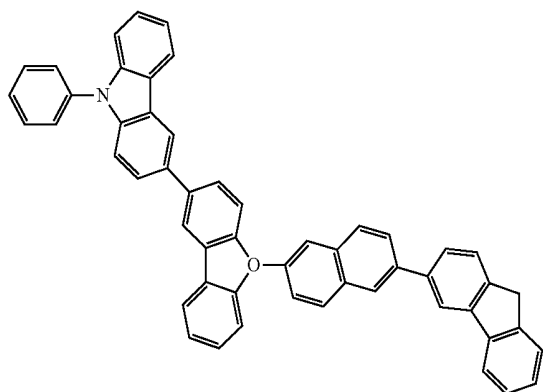
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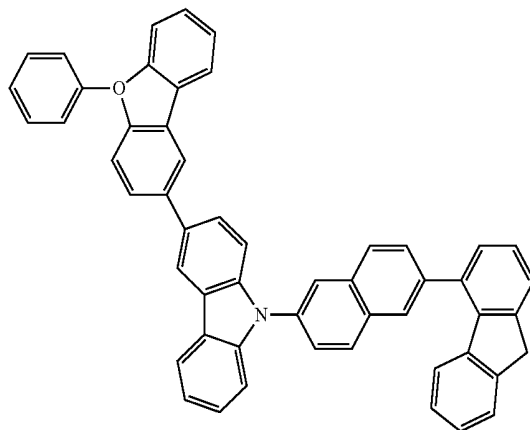


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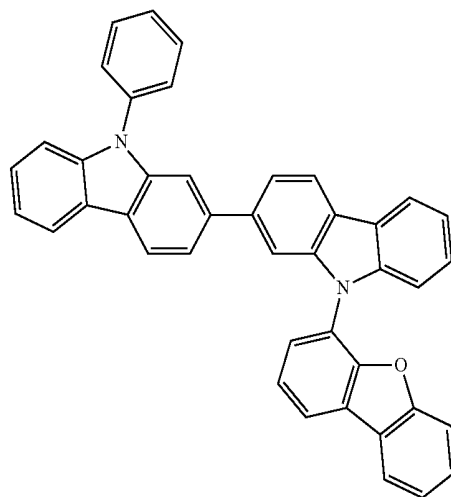


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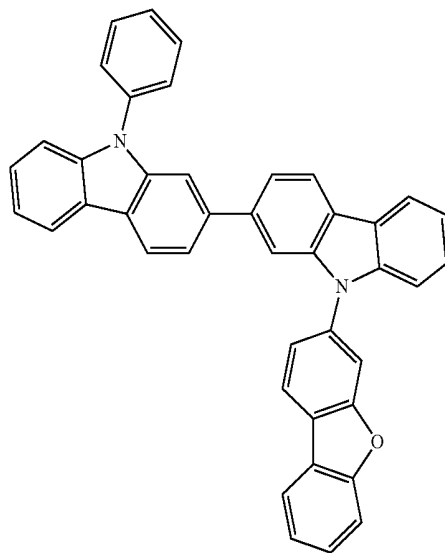
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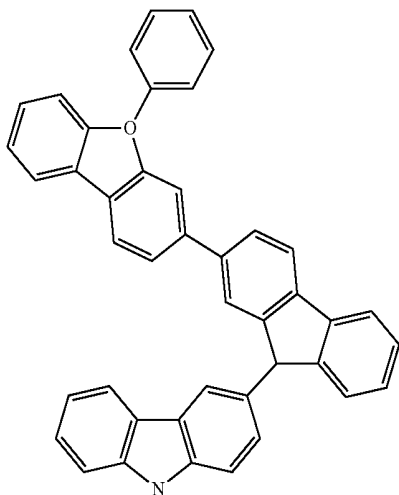
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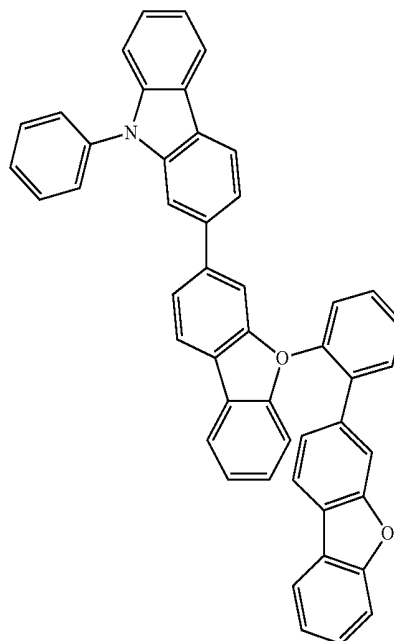


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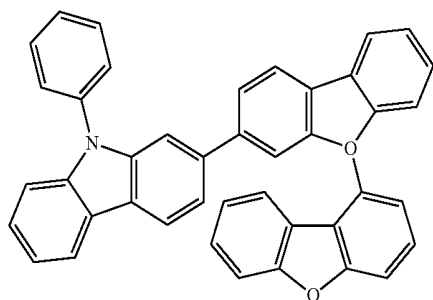


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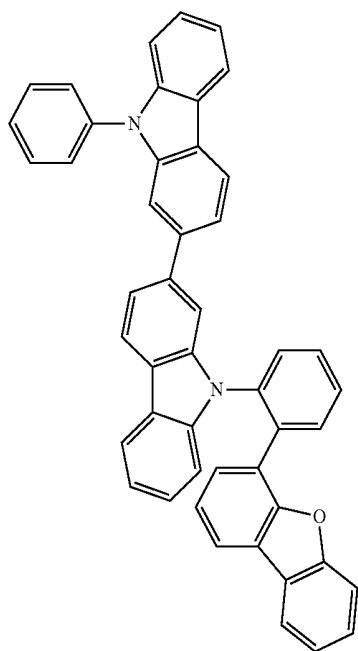
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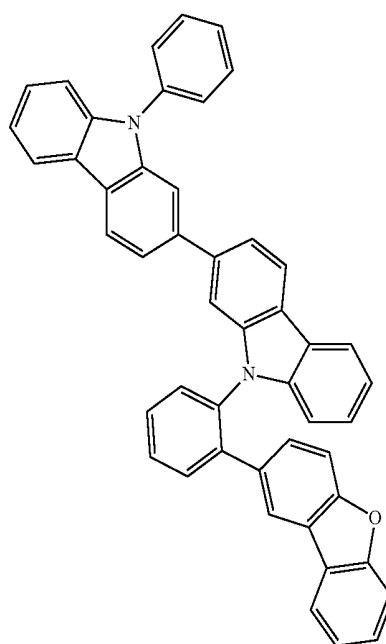
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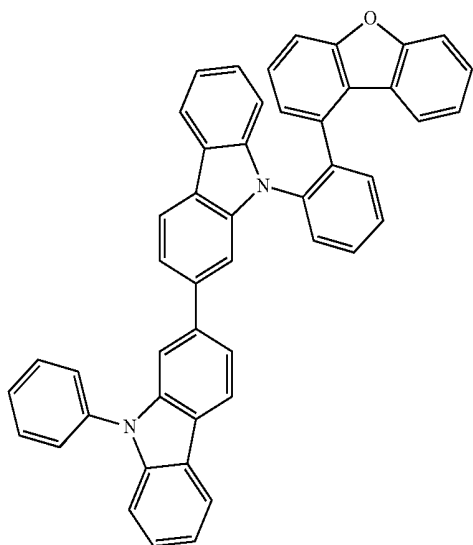


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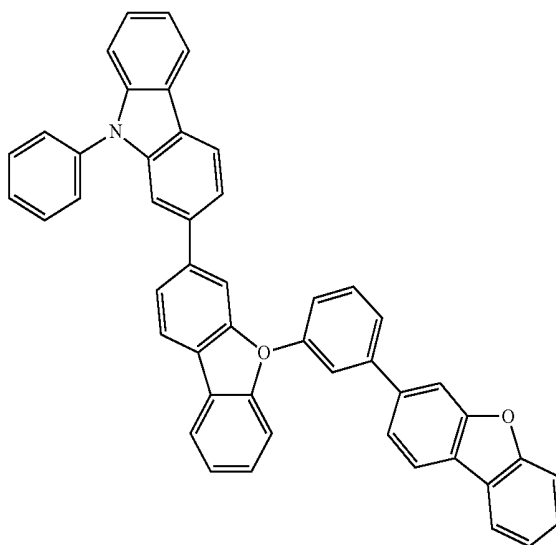
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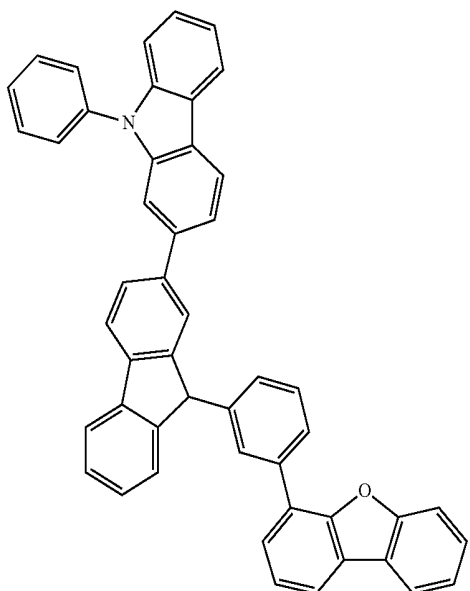


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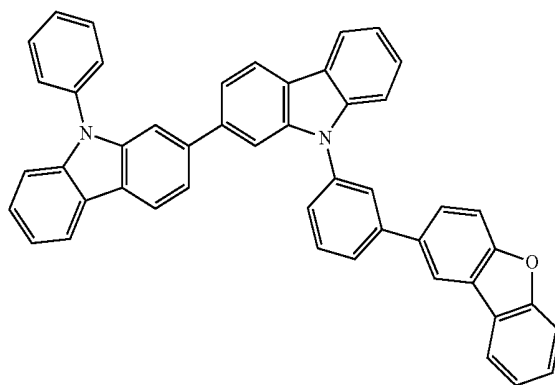
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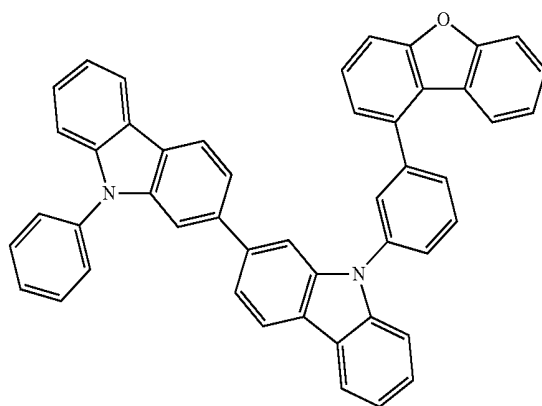
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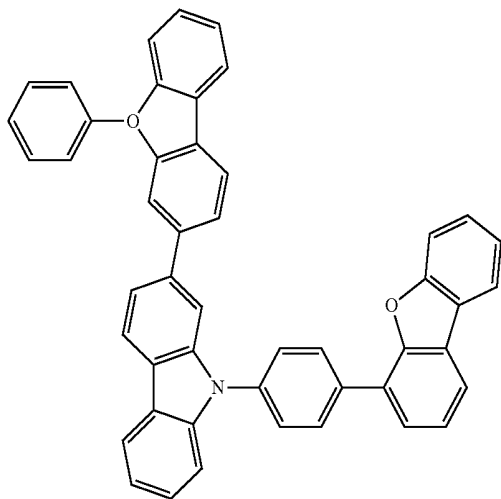


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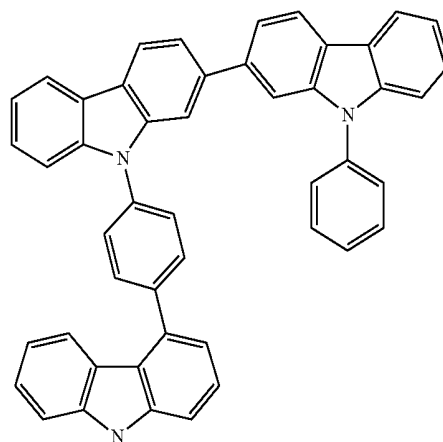
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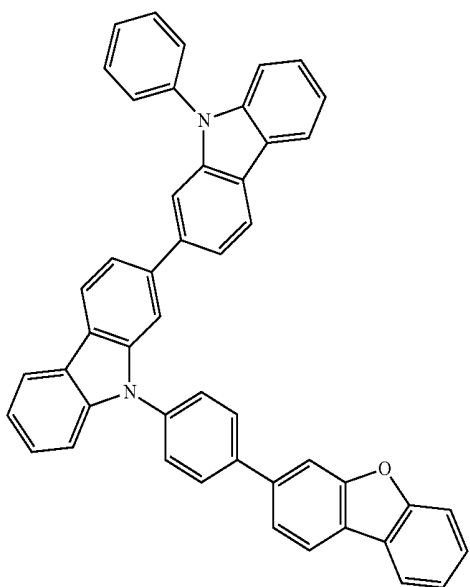


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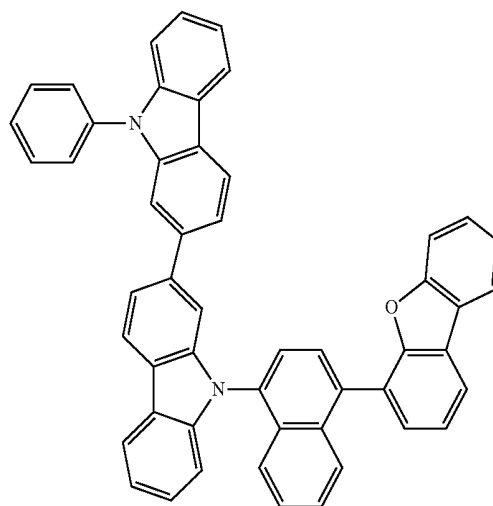
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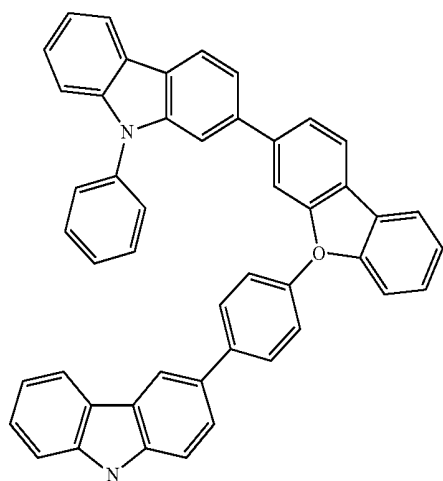
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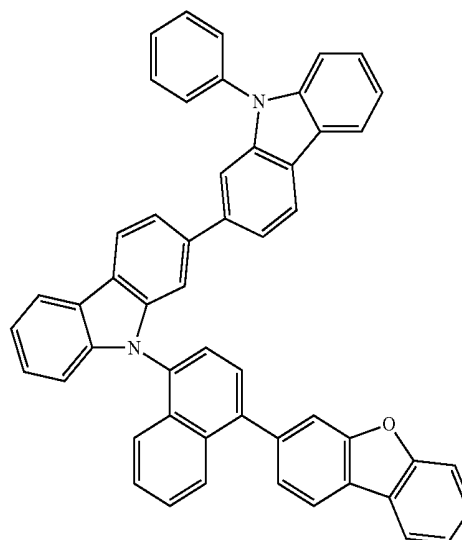
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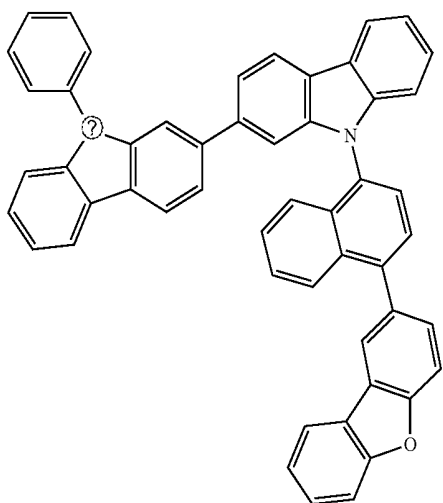
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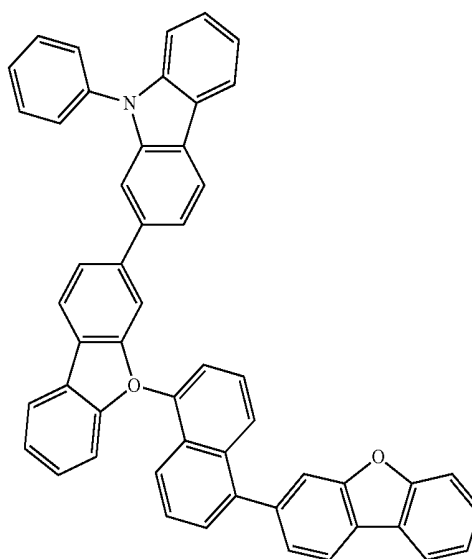


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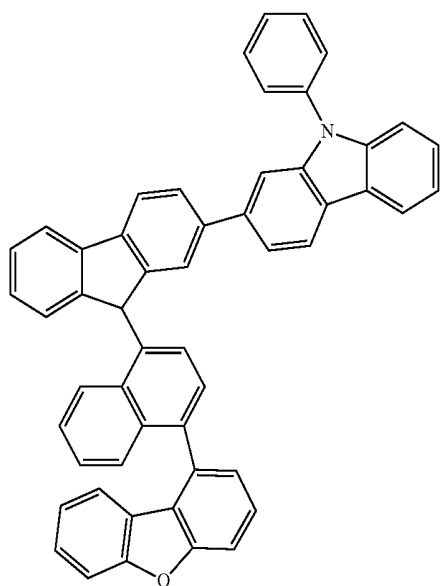


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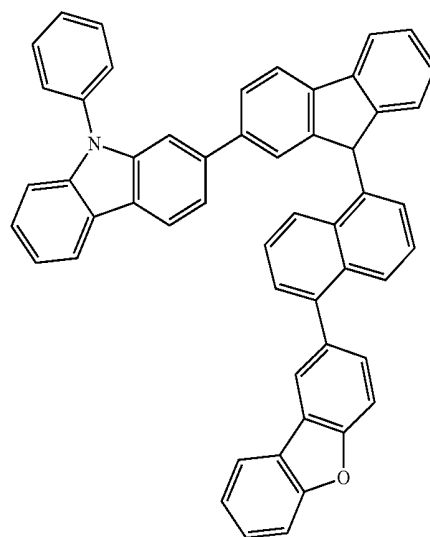
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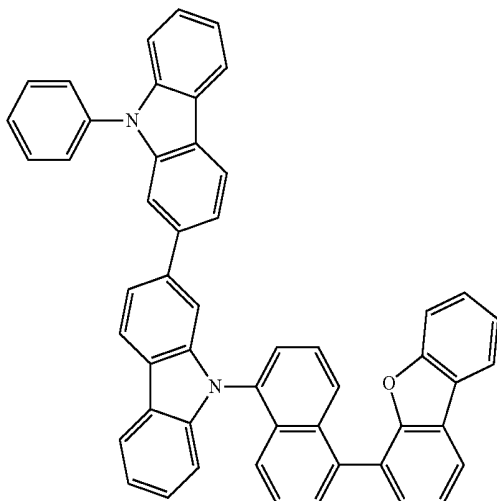
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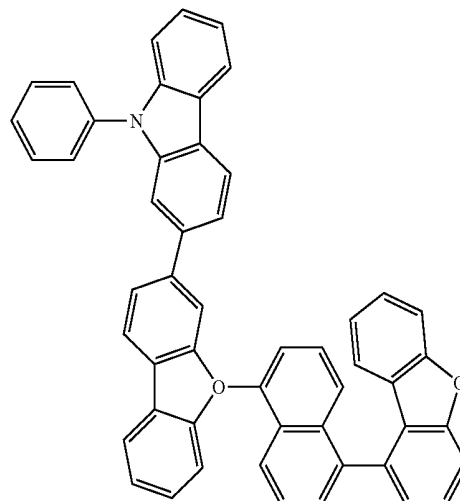
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A-95

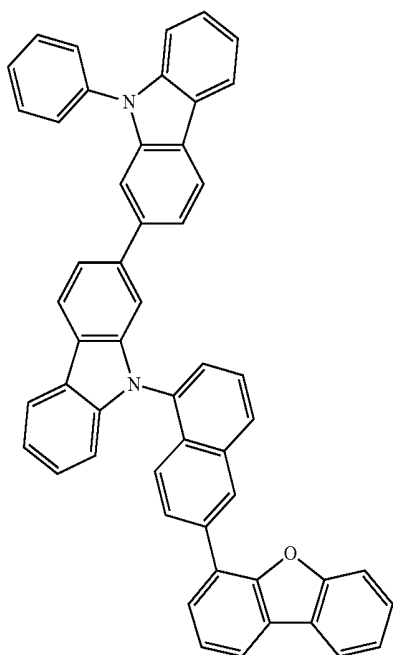


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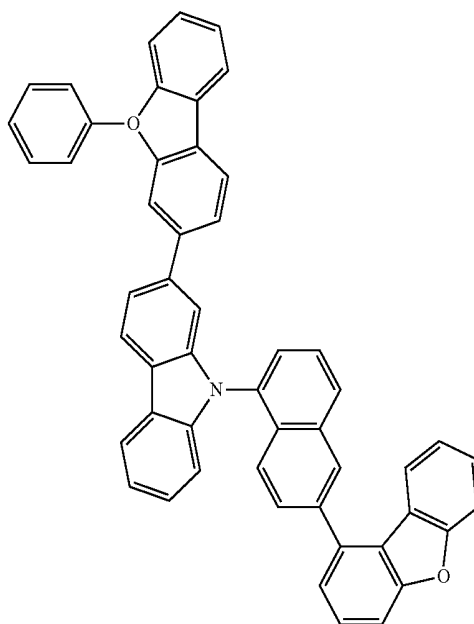
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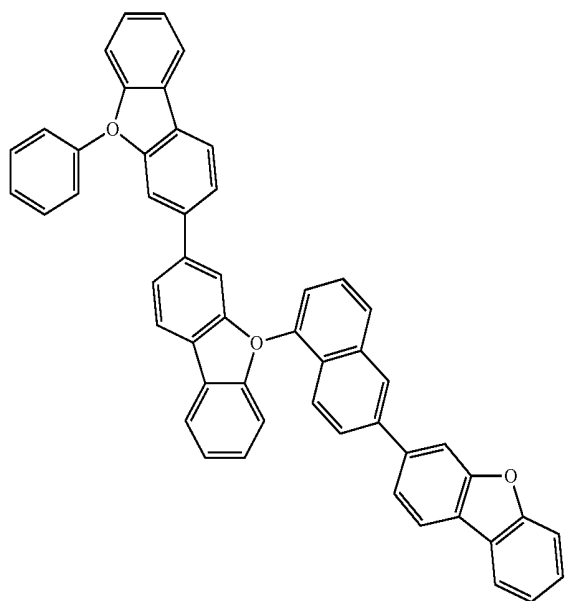
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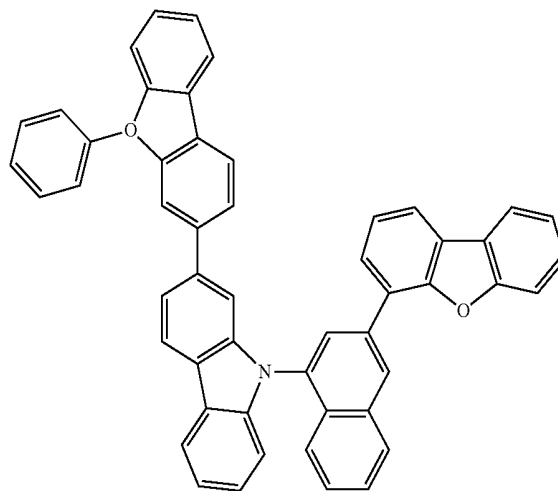
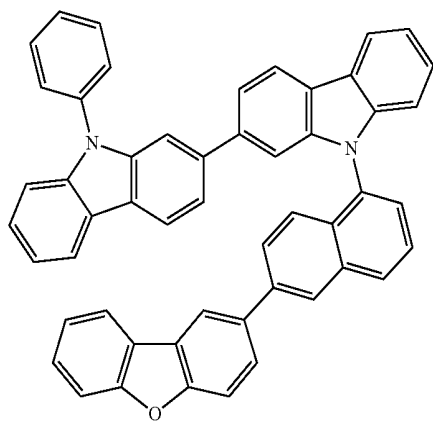


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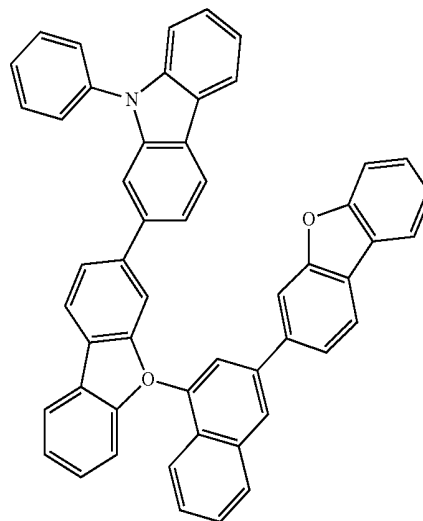


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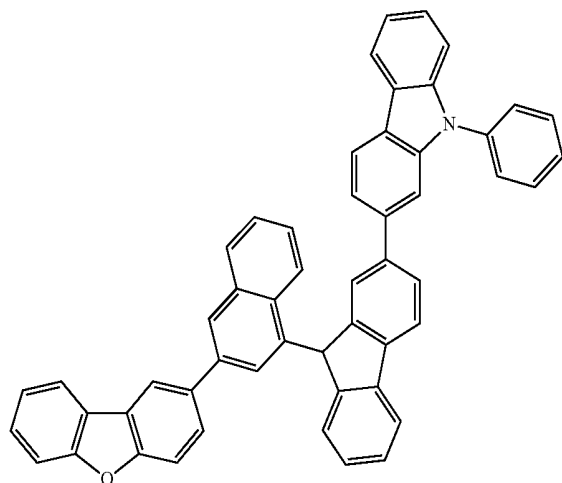
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A-102



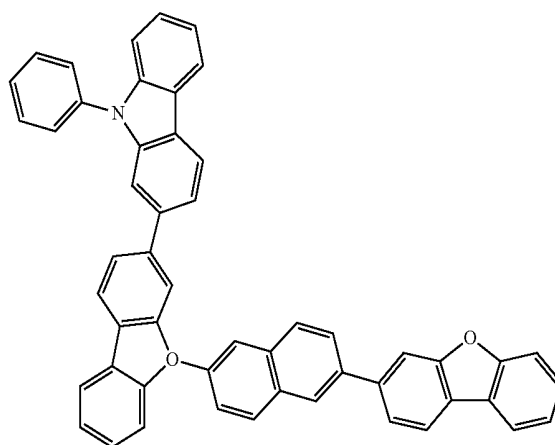
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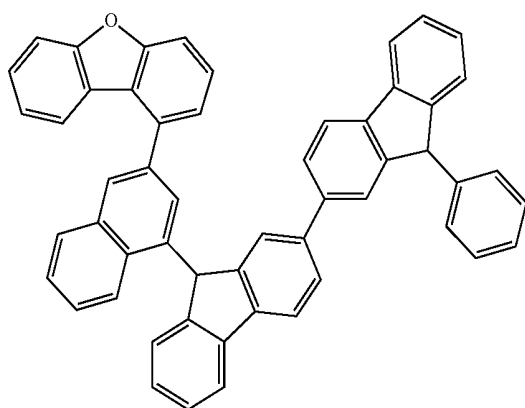
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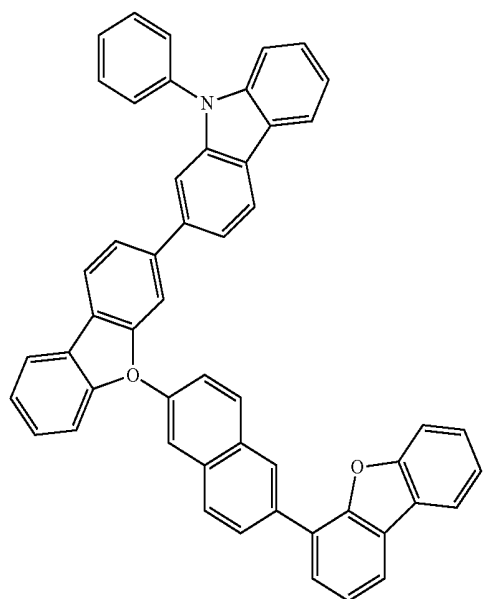


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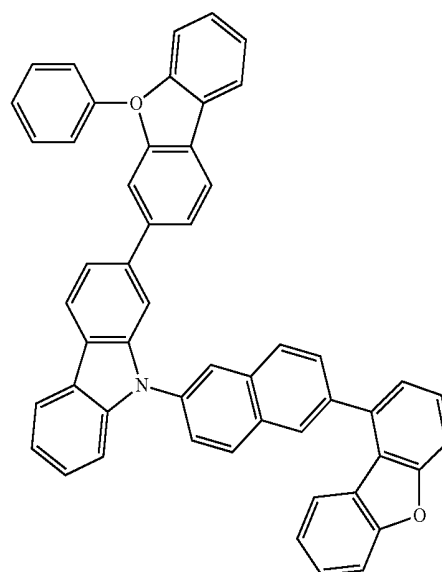
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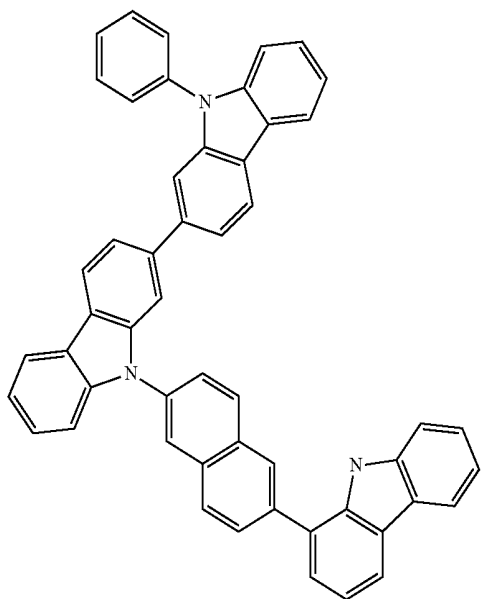
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A-108

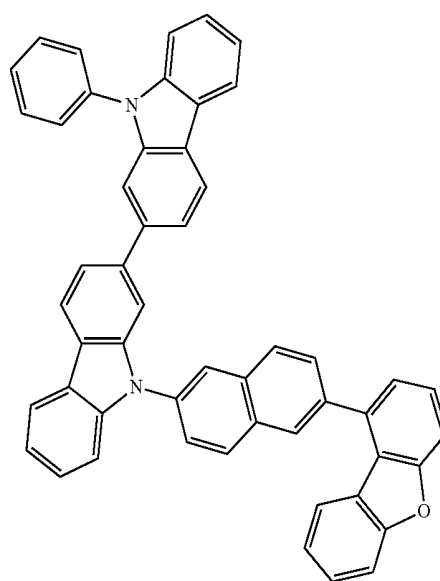


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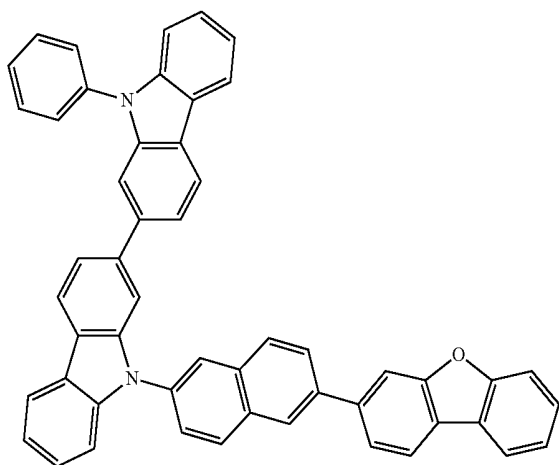
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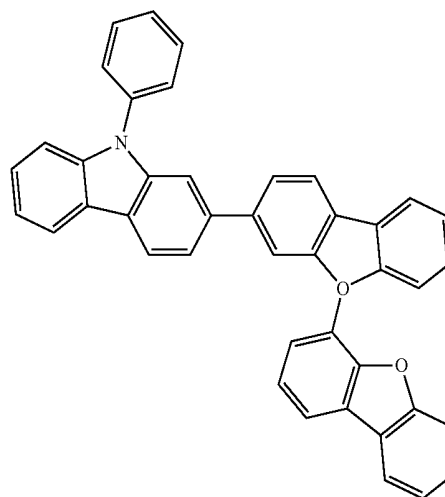


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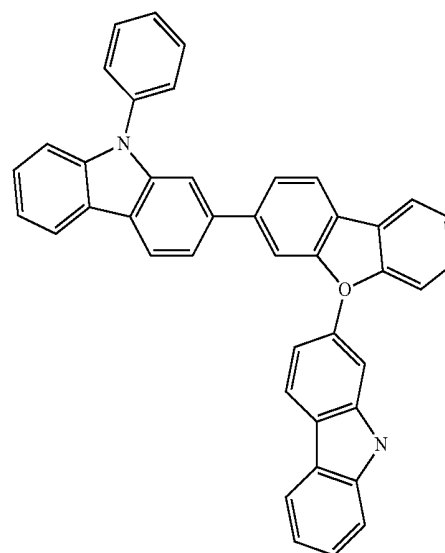
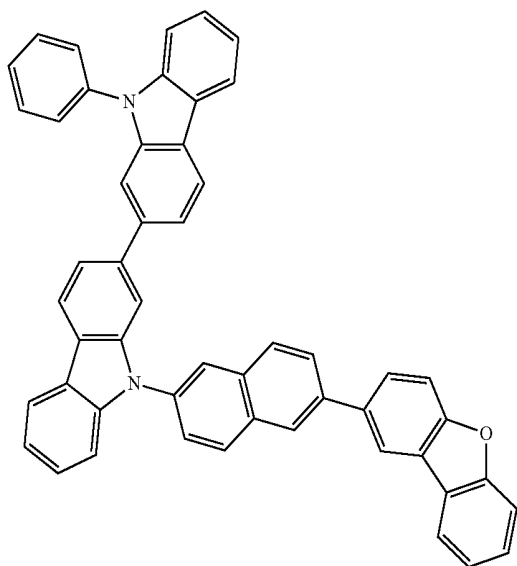
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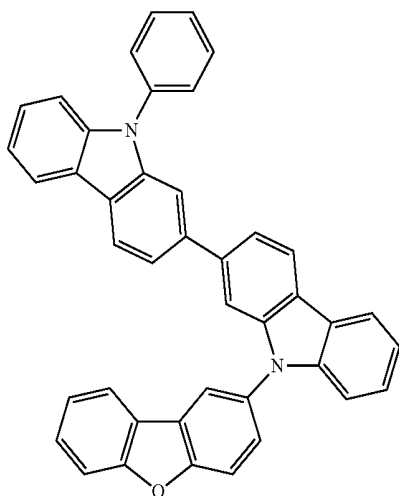
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A-114

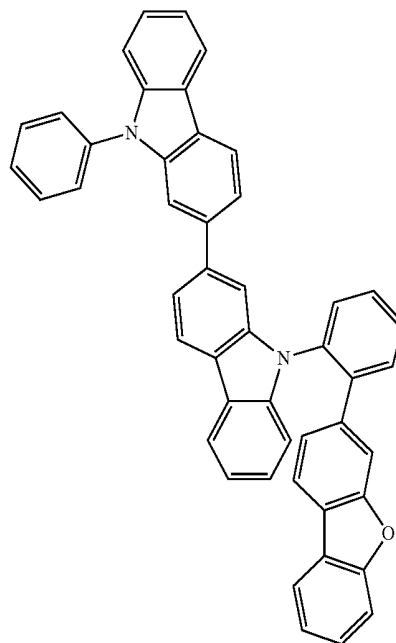
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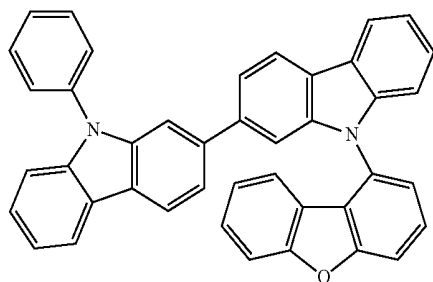


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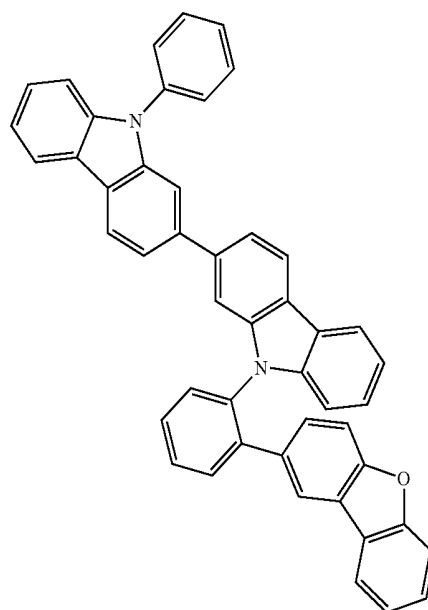
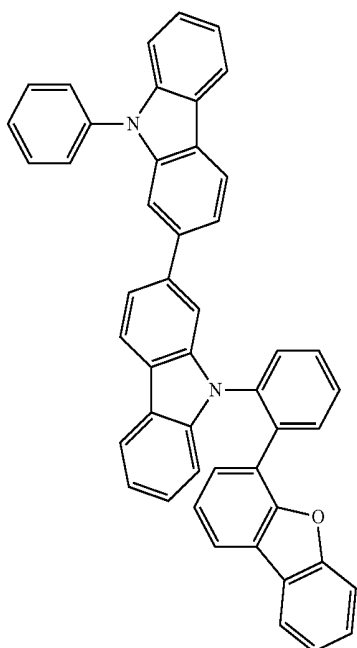


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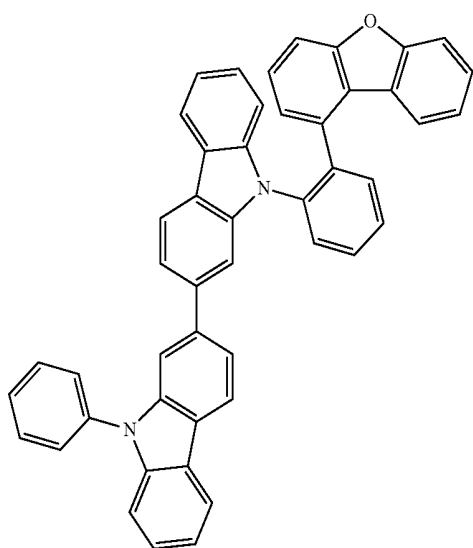


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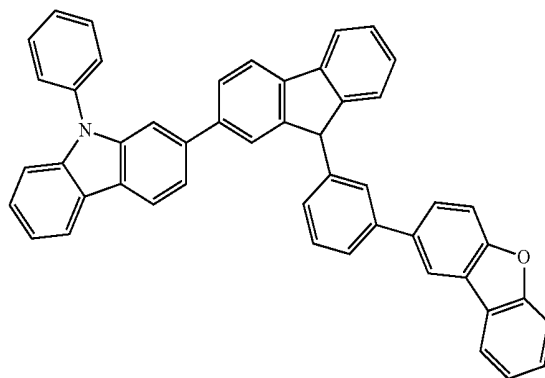


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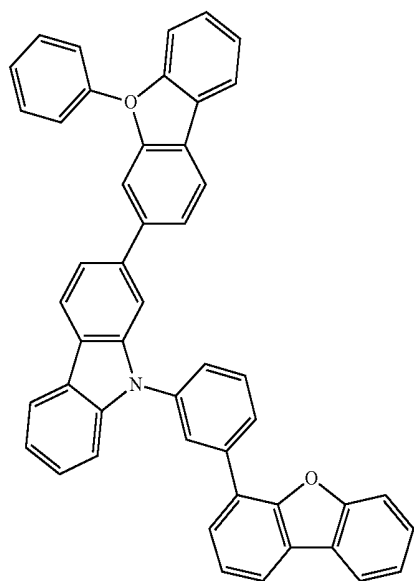


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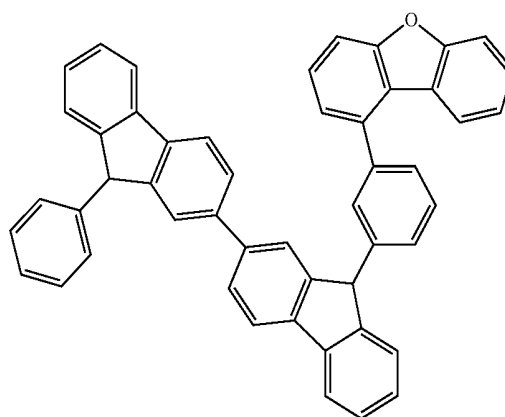
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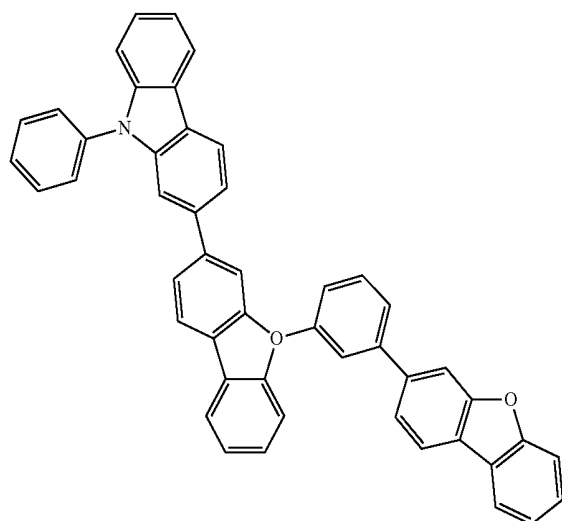
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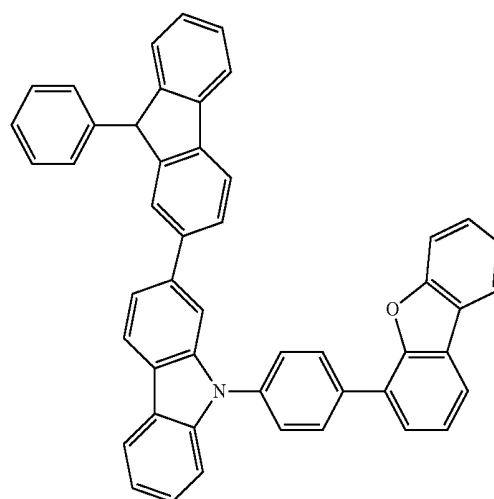
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A-124



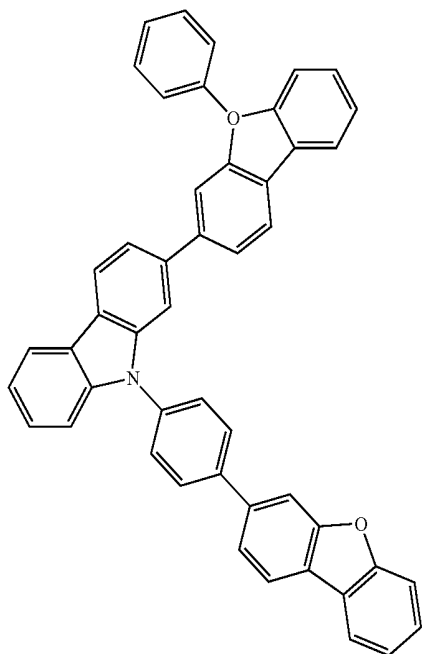
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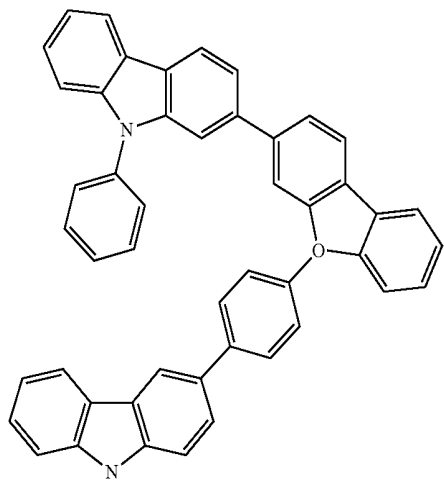
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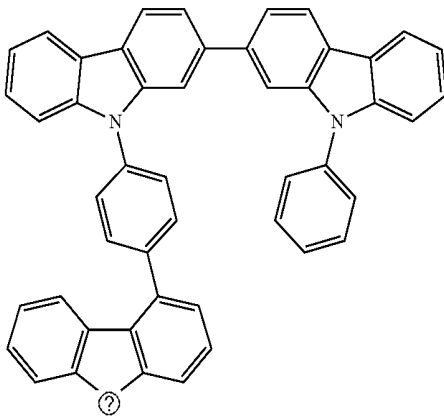
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A-127

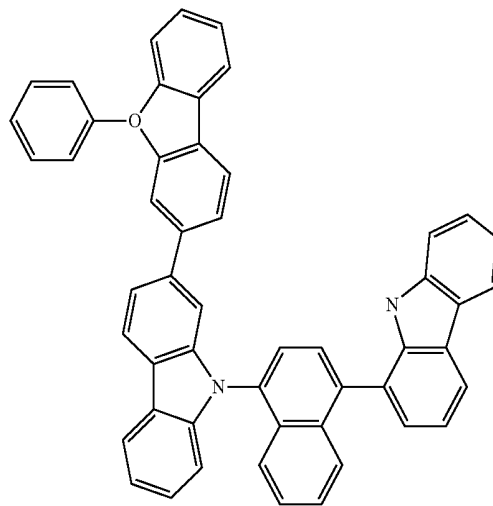


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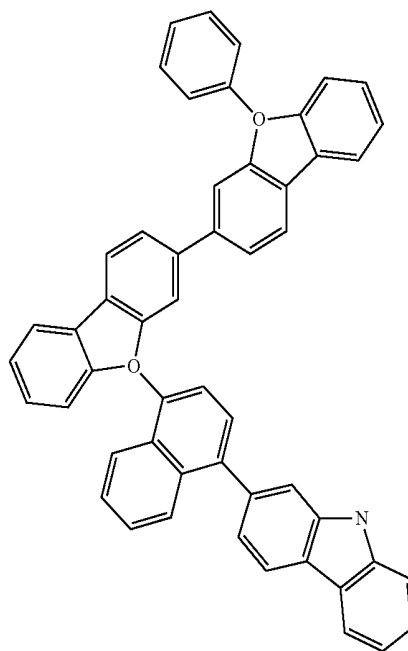


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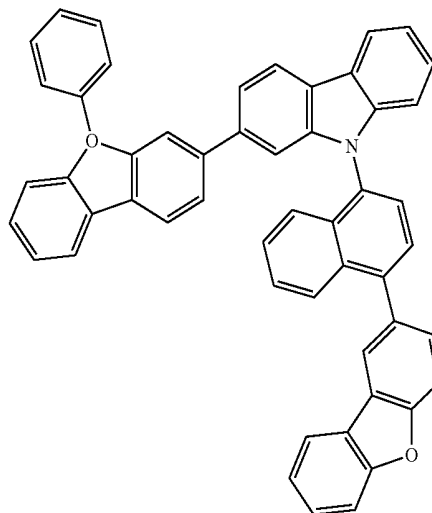
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A-130

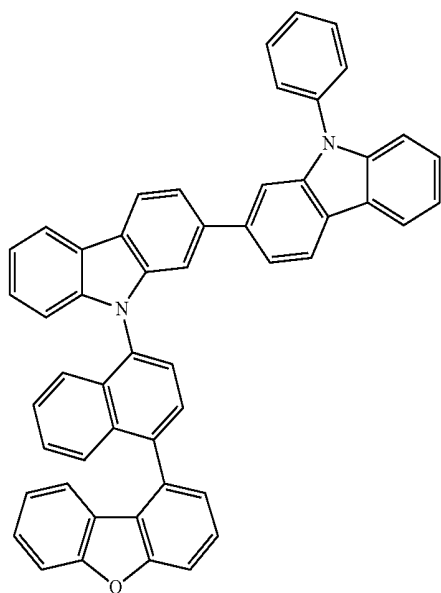


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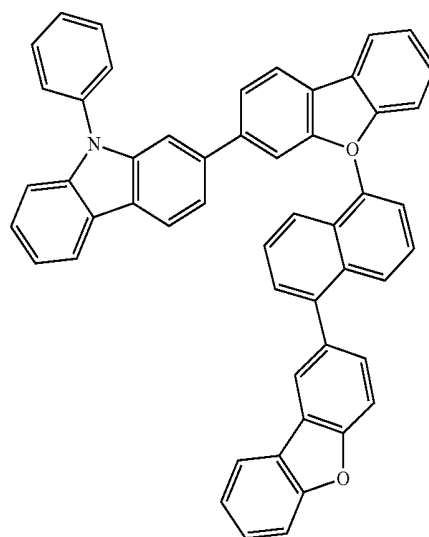
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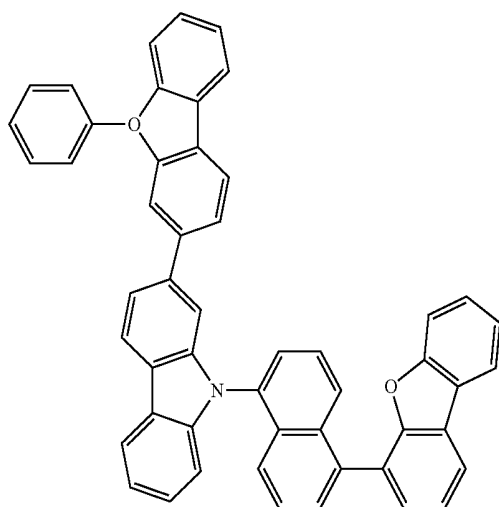
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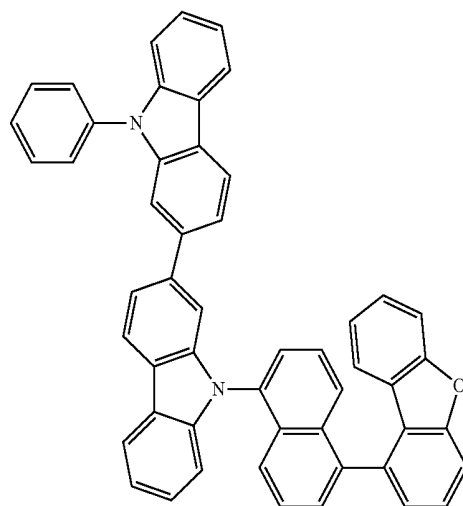
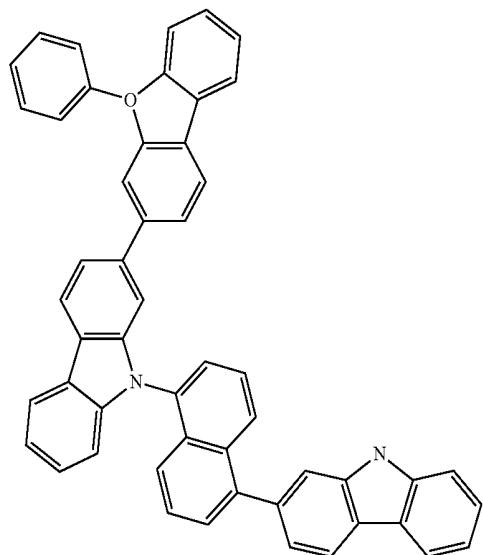


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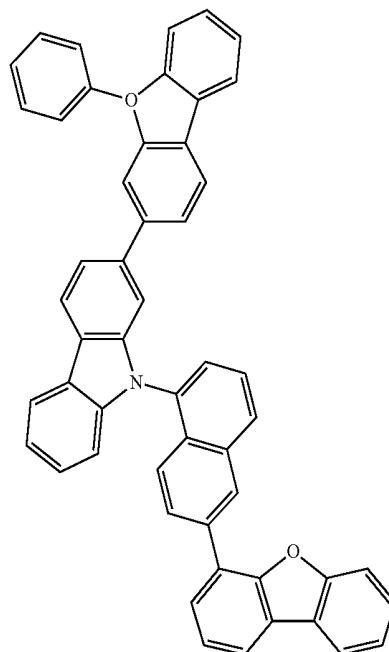
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A-134

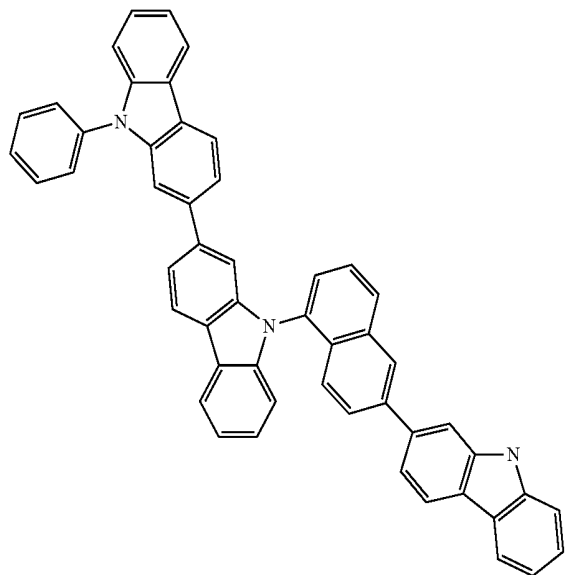


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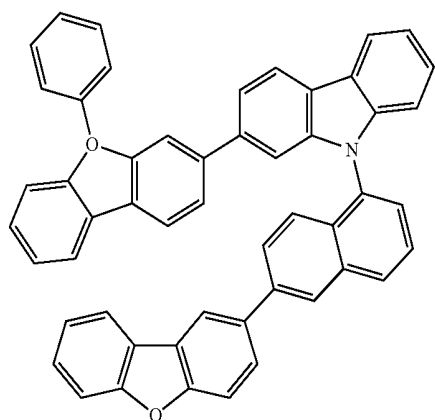


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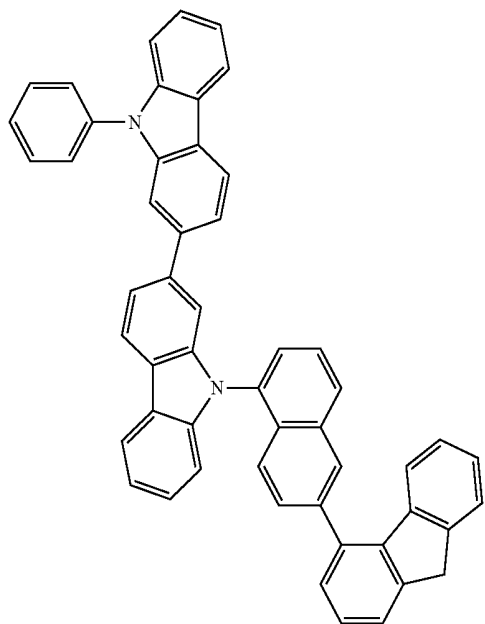
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A-139

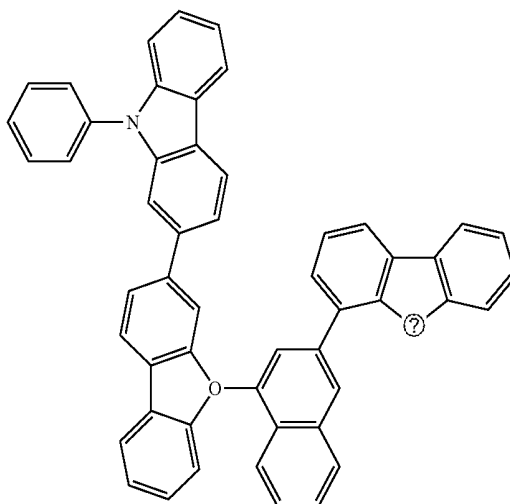


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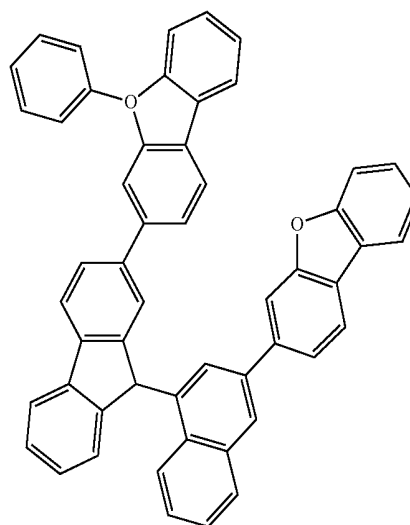


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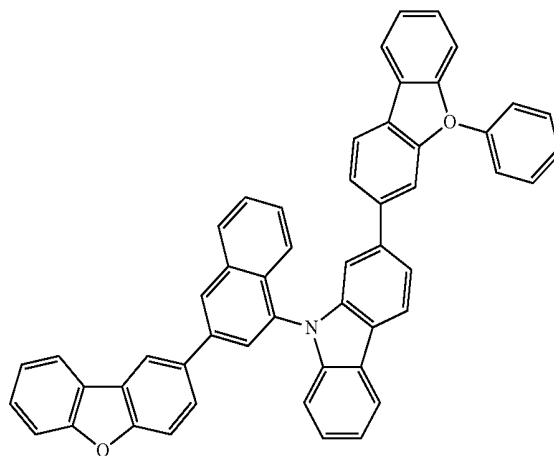
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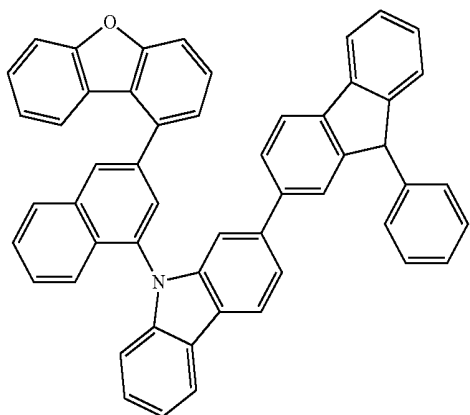
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A-143

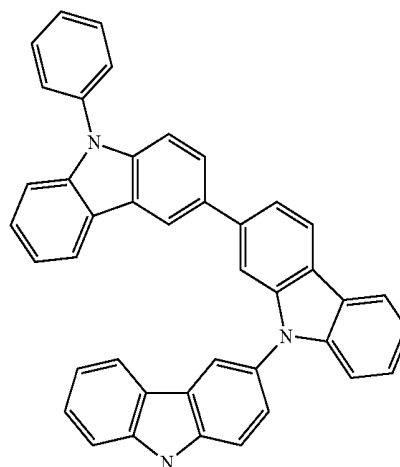


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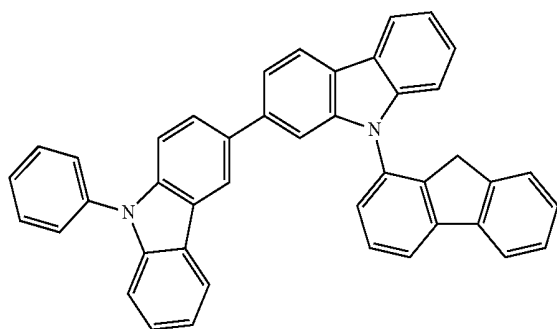
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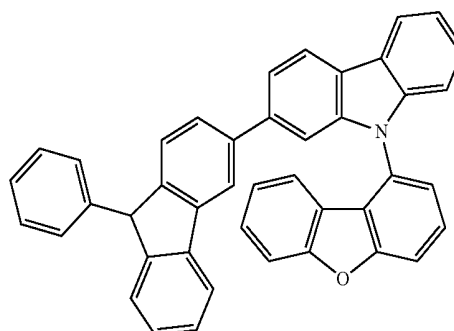


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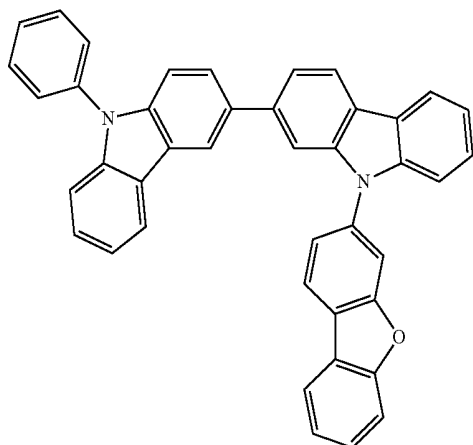
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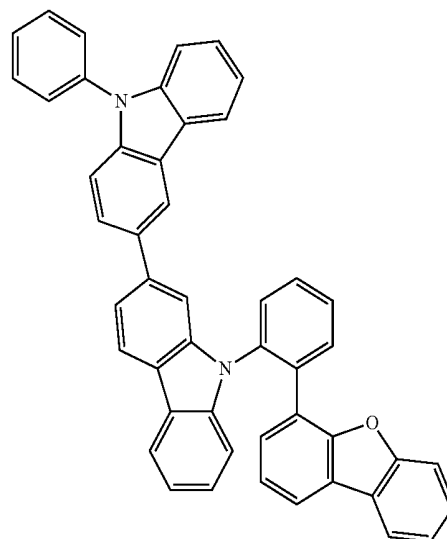
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A-146

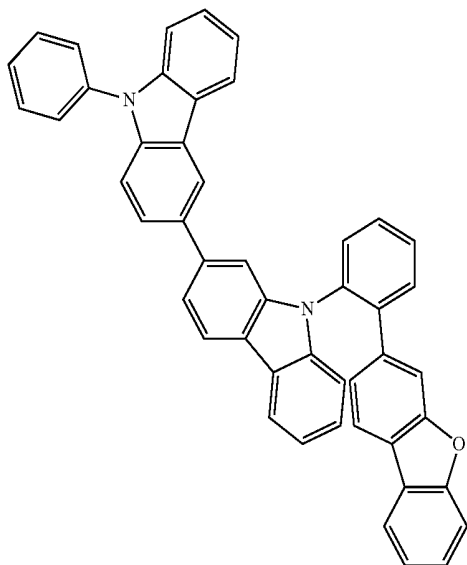


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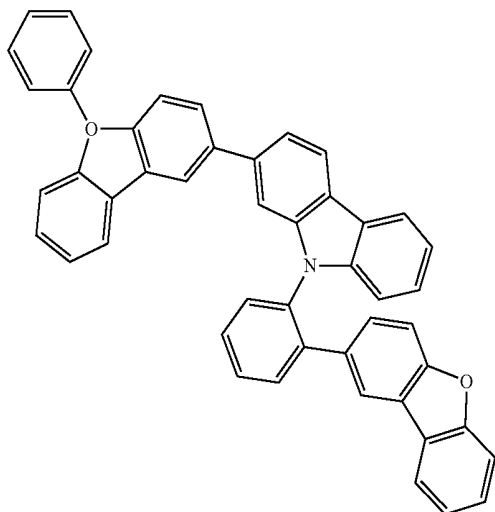


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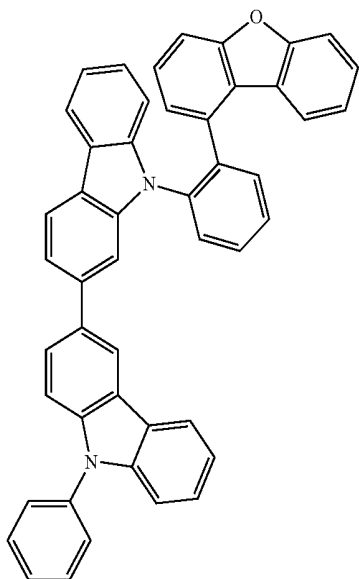
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A-151

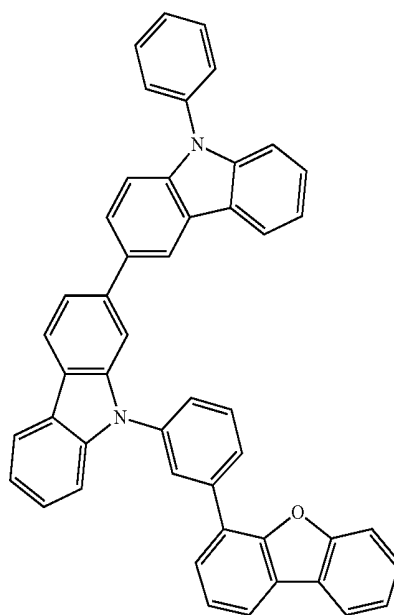


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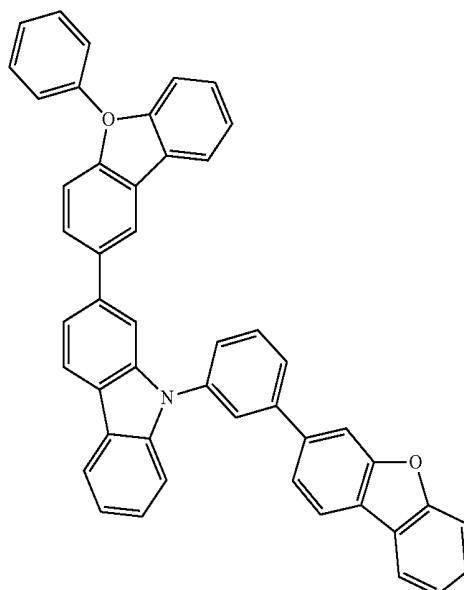


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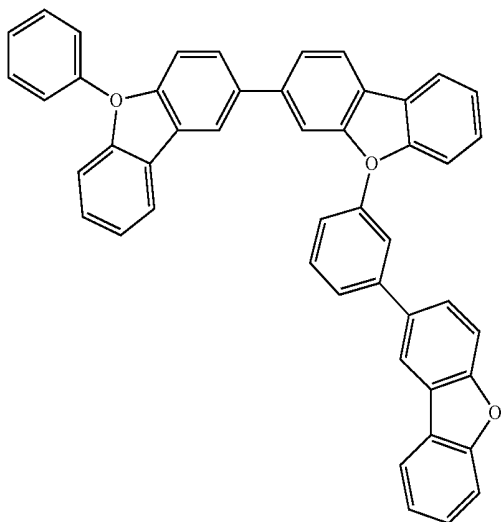


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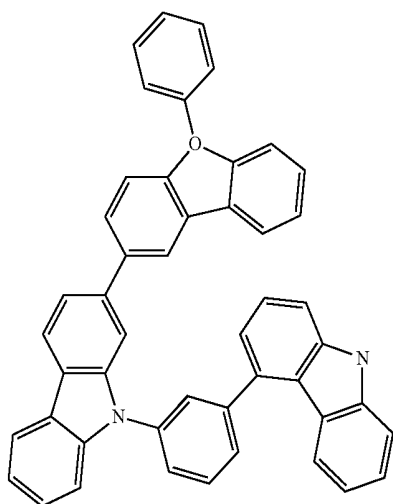


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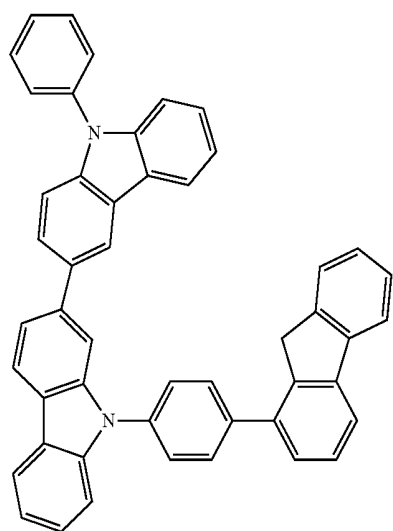
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A-156

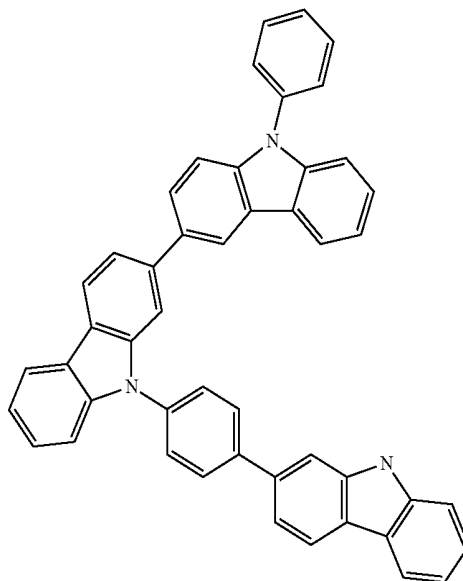


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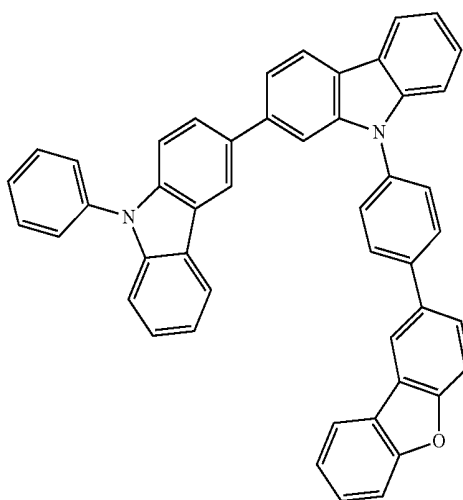


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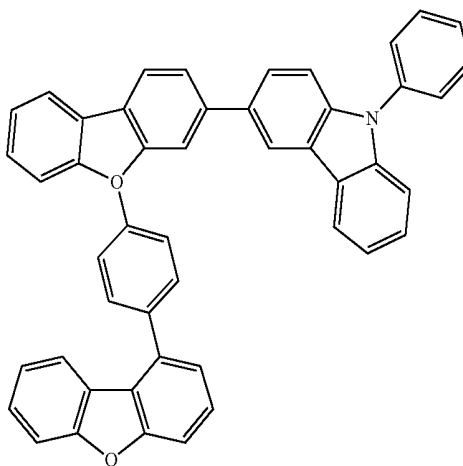
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A-159

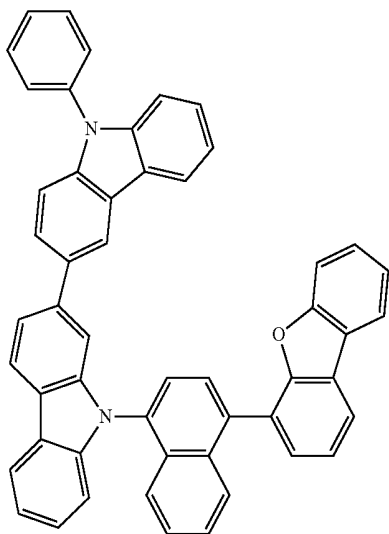


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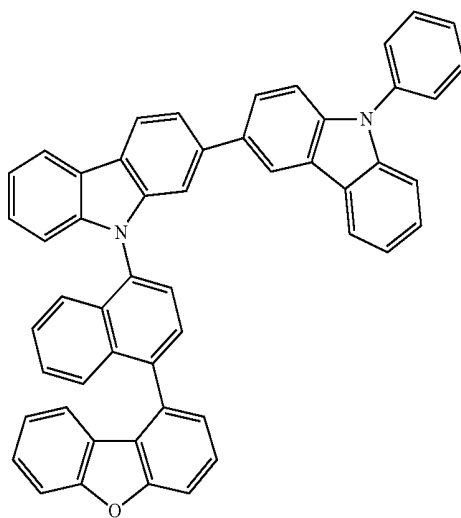
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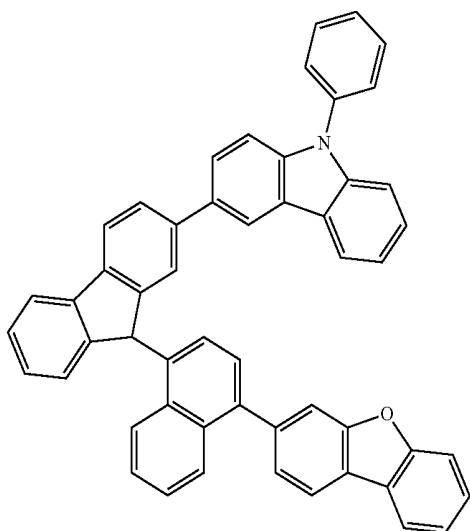


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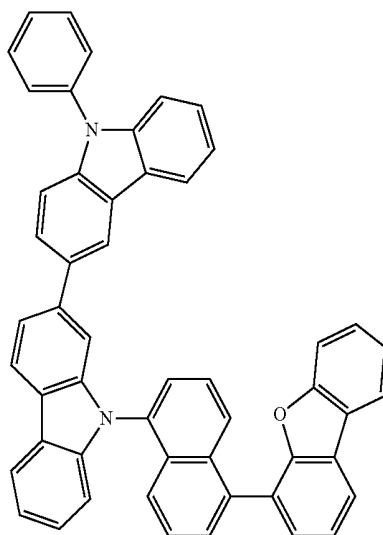
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A-162

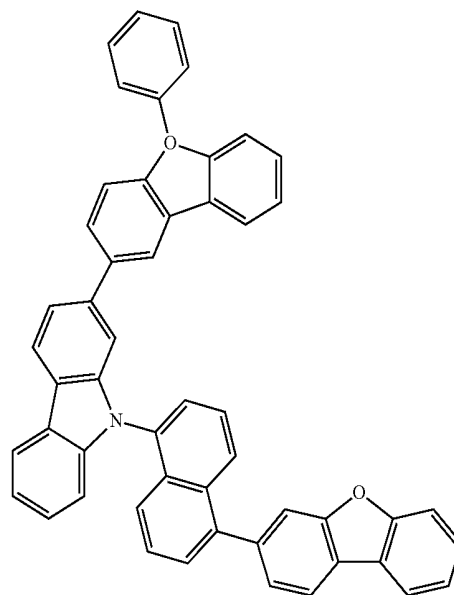
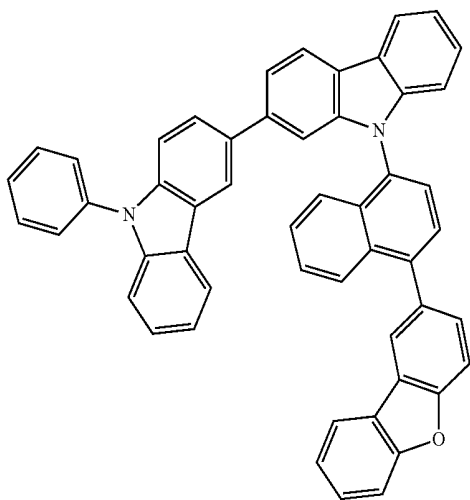


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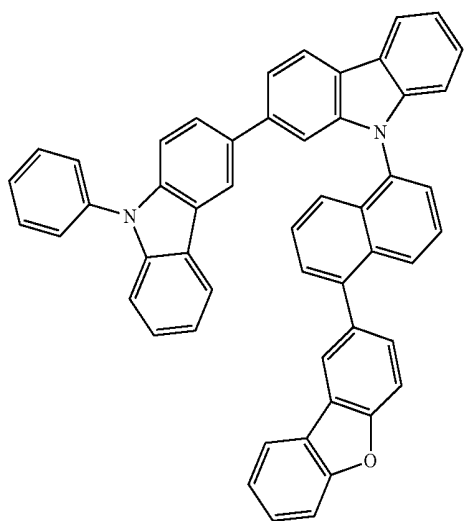


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A-163

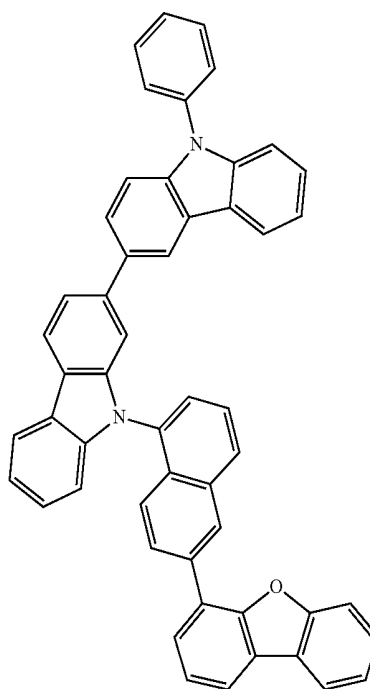


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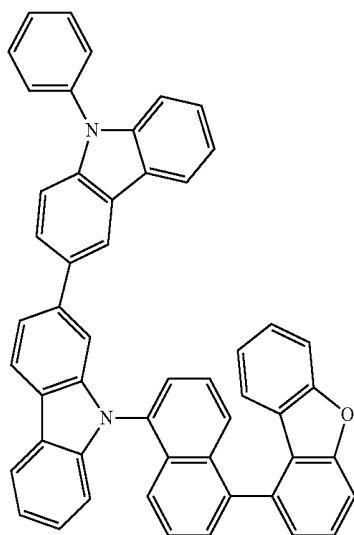
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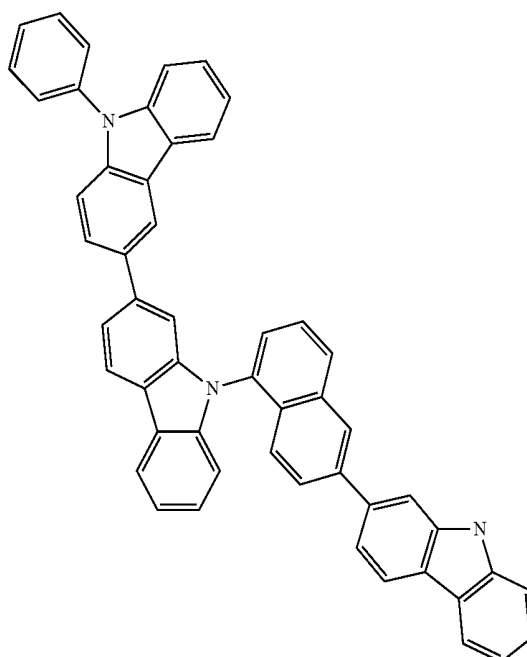


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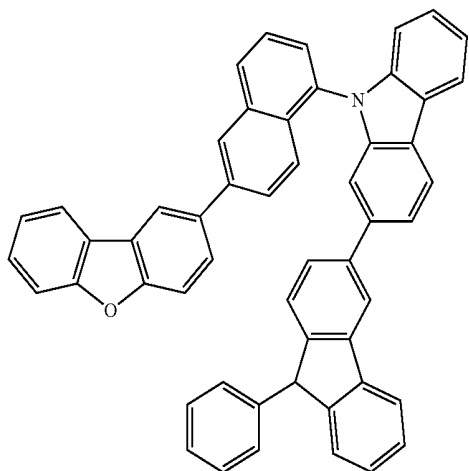
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A-170

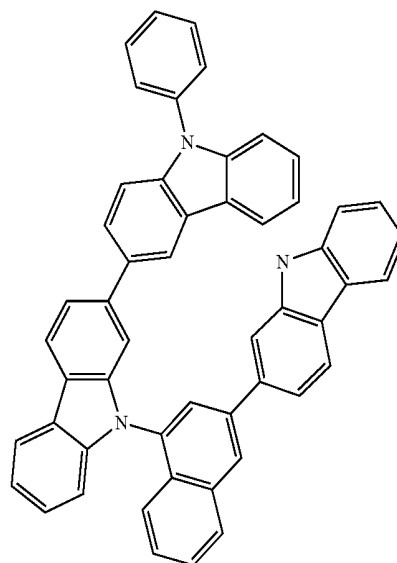


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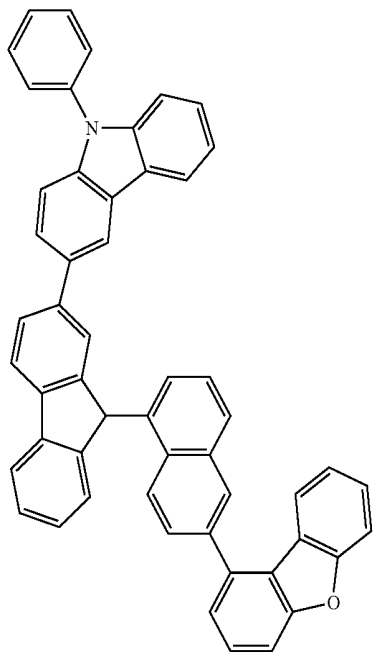
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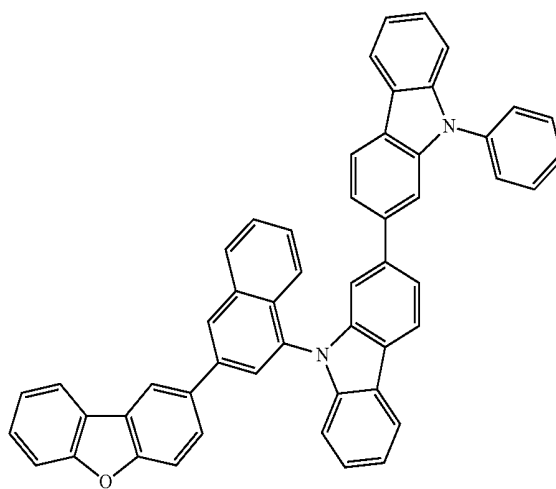


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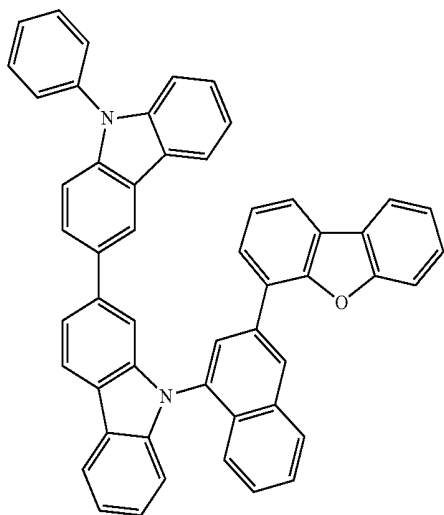
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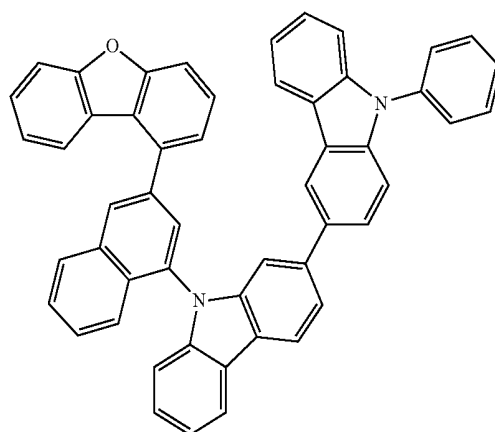
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A-173

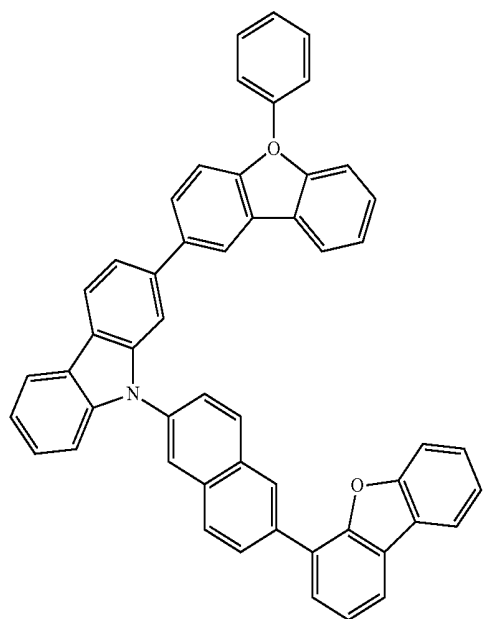


A-176



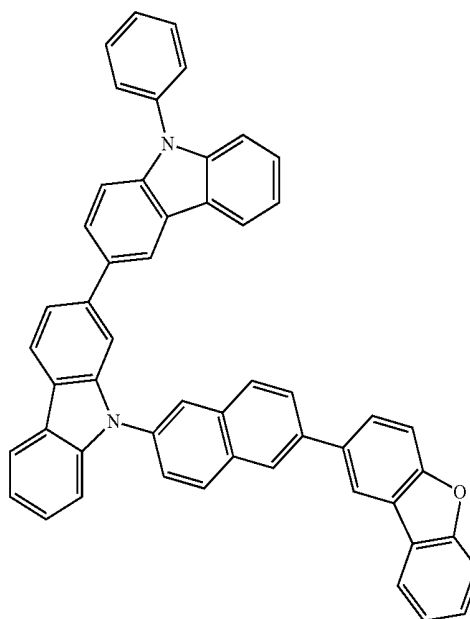
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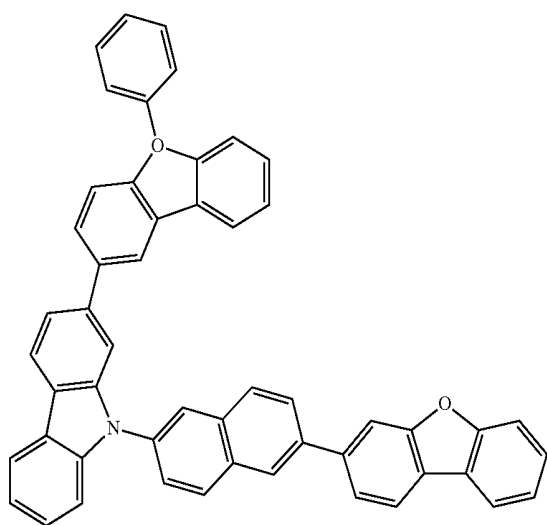


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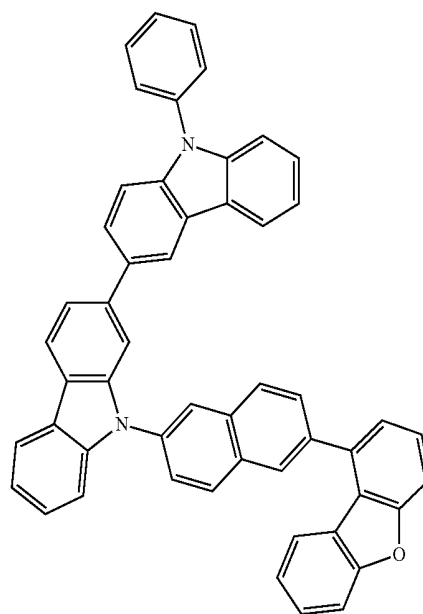
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A-178

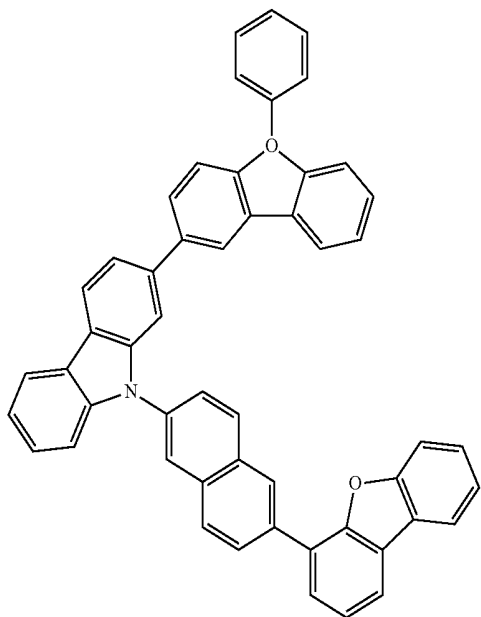


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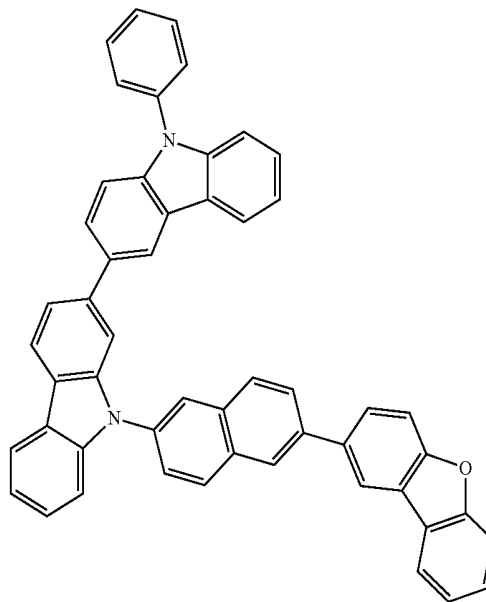
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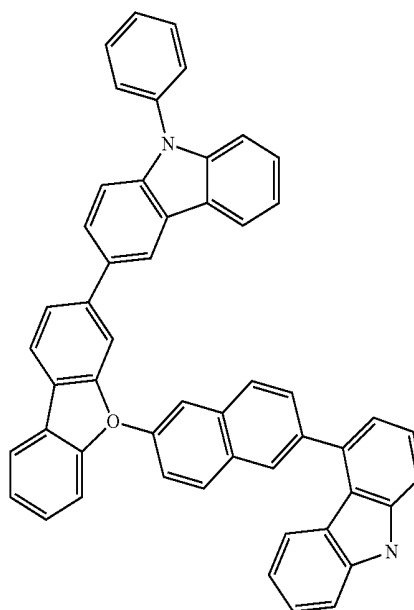
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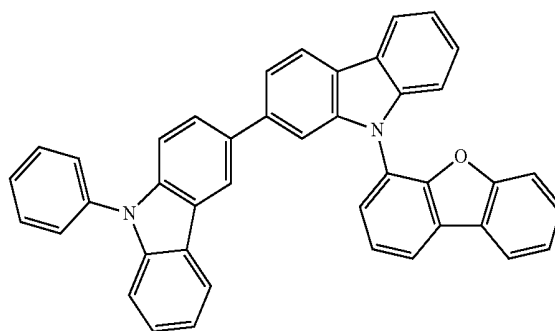
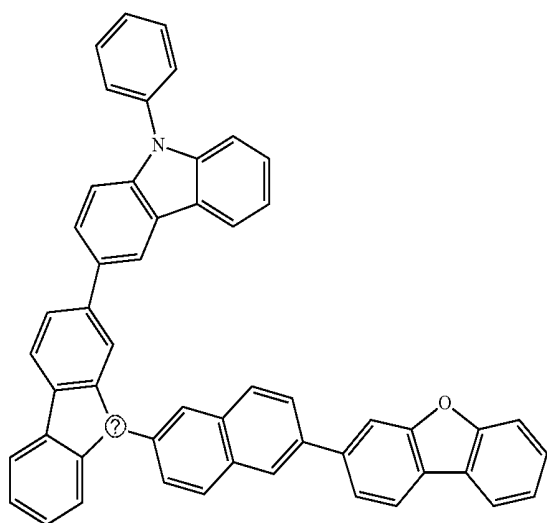


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A-182

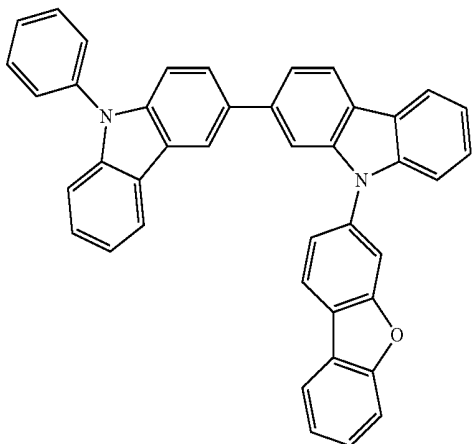


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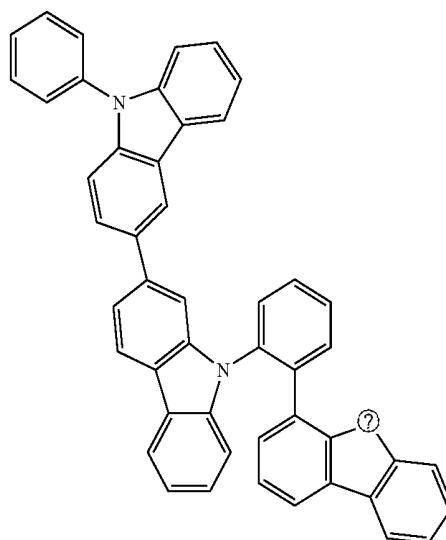
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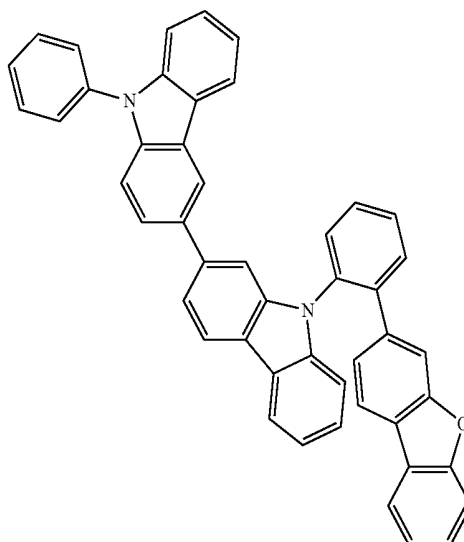


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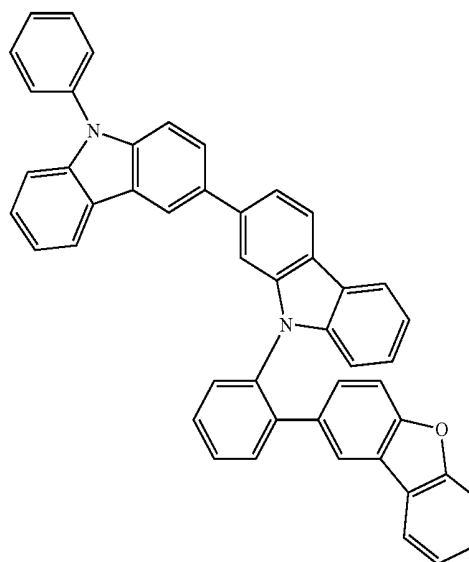
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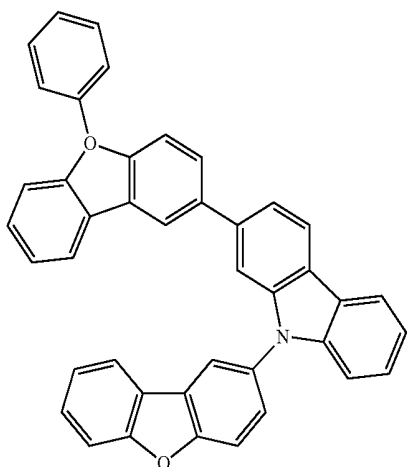
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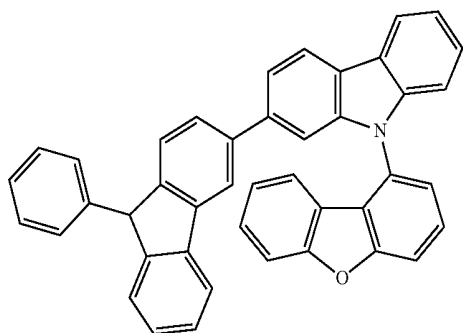
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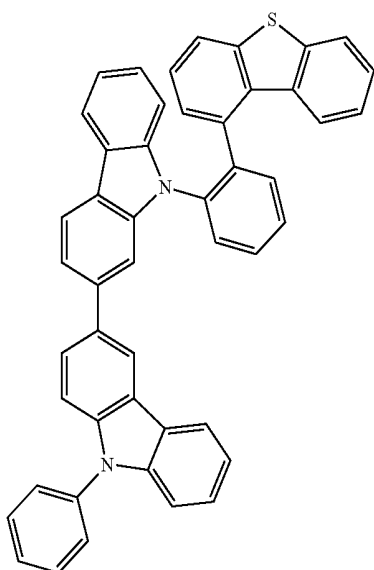
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A-188

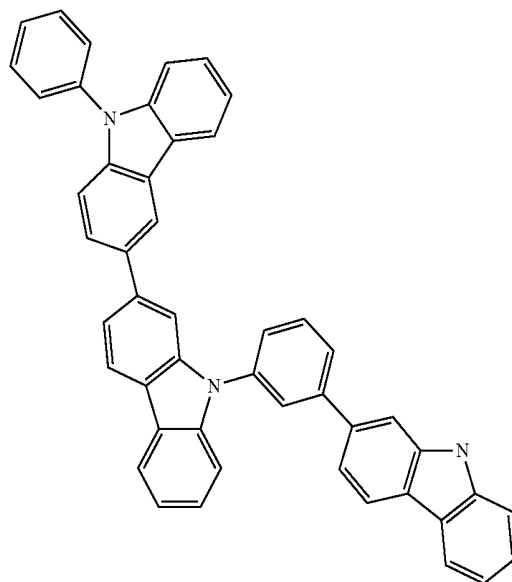


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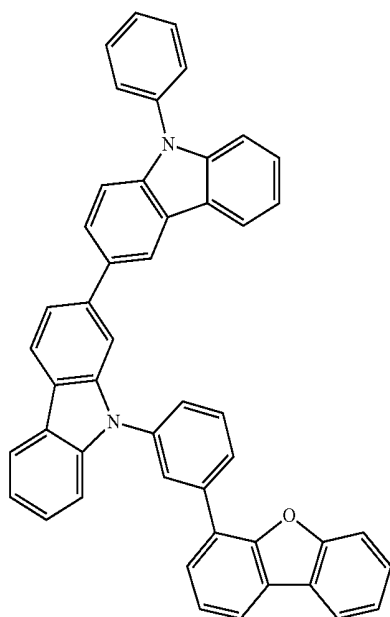


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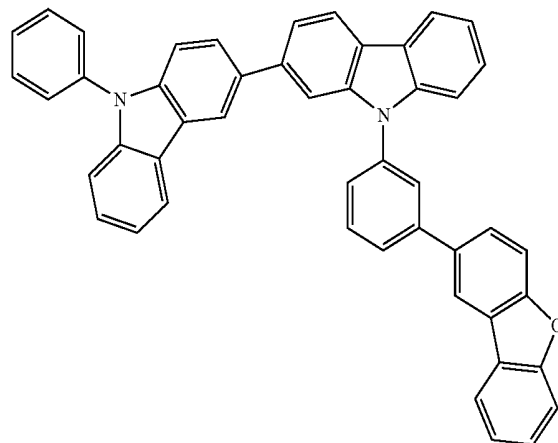
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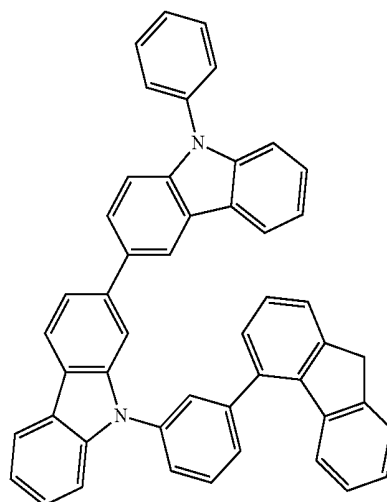
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A-193



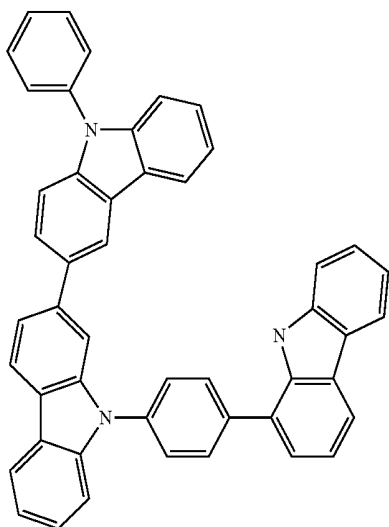
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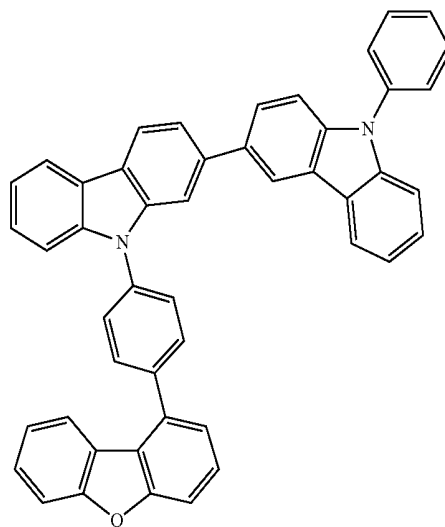
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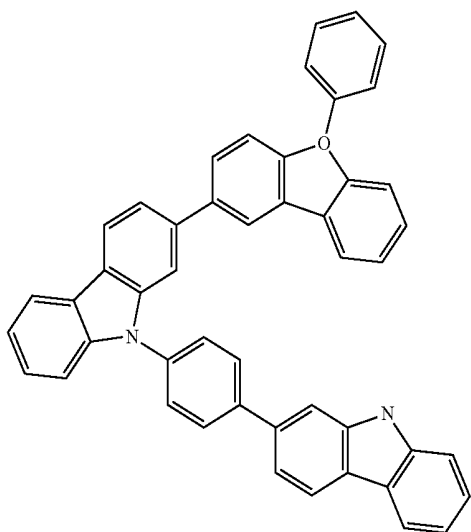


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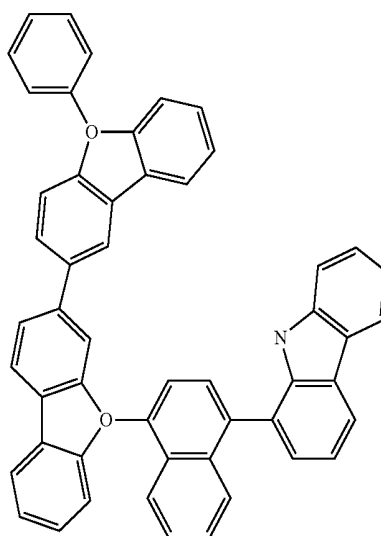
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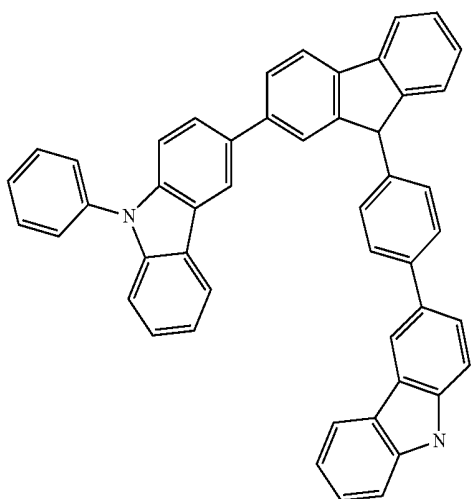
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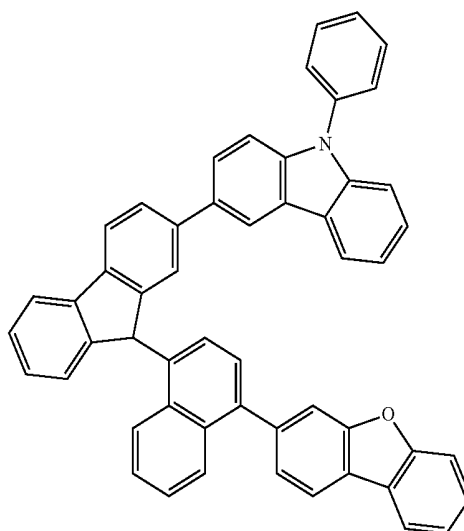
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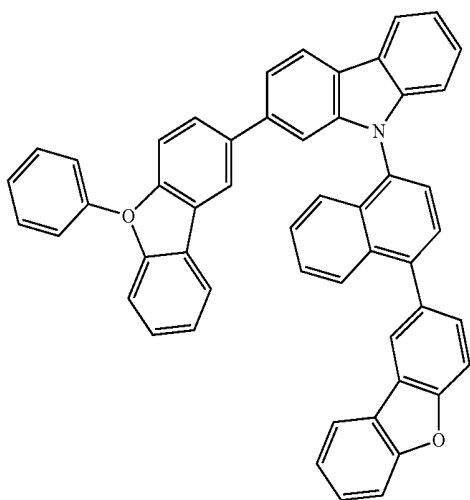
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A-202

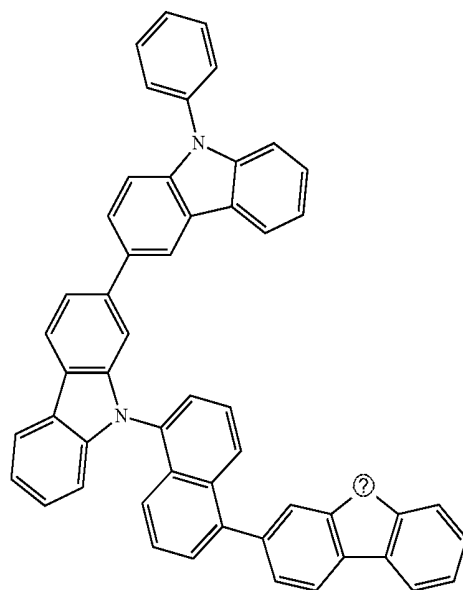


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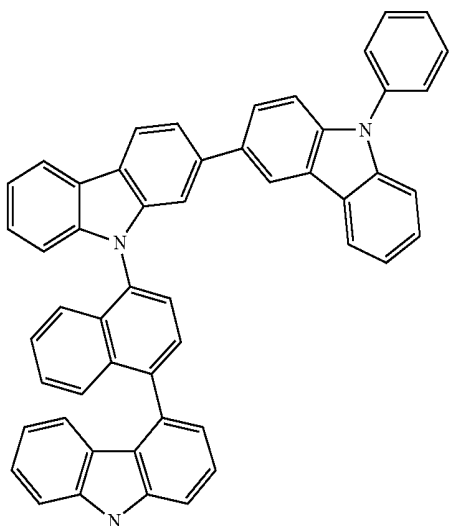


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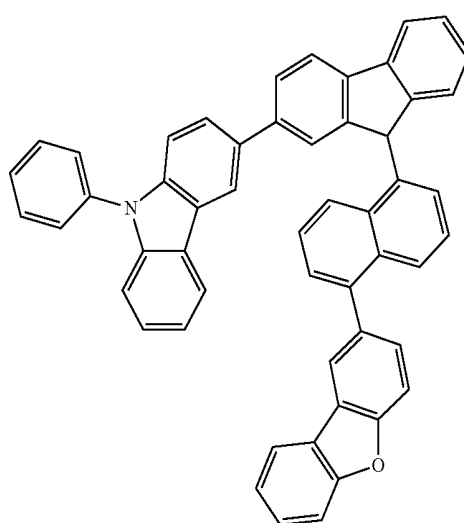
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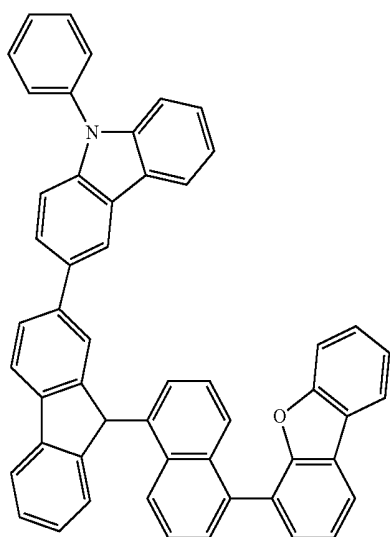
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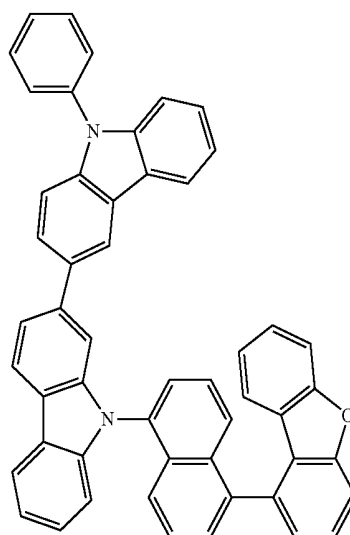
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A-207



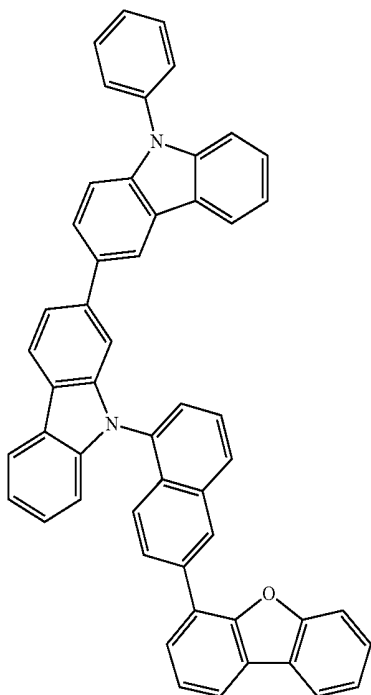
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A-208

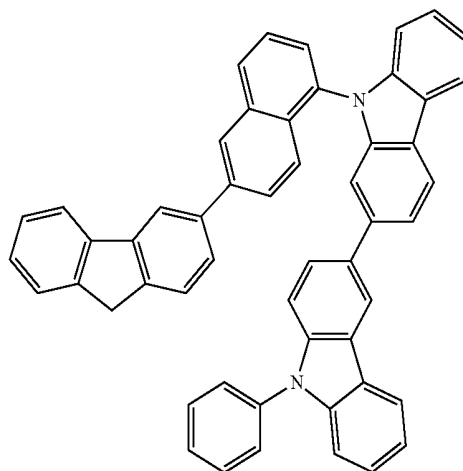
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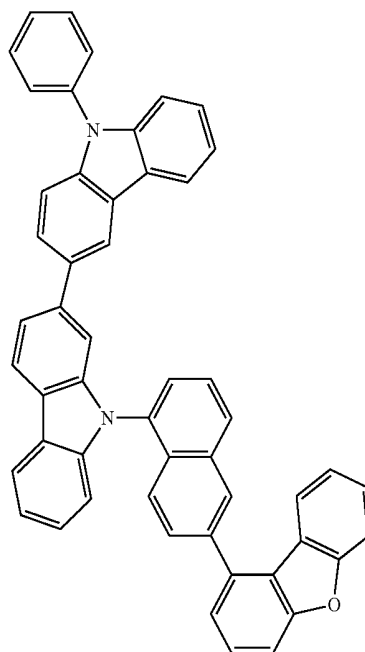


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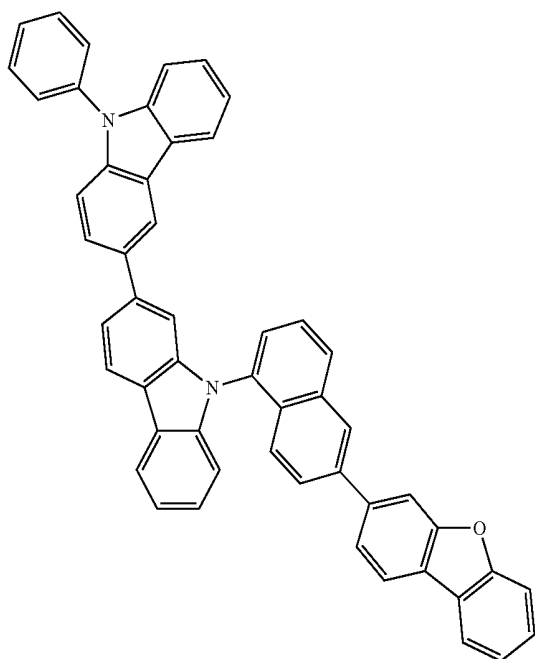
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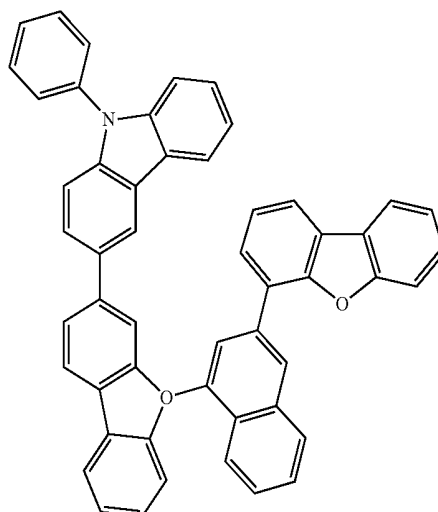
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A-210

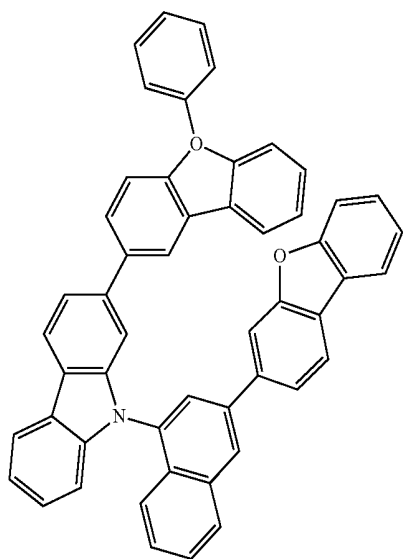


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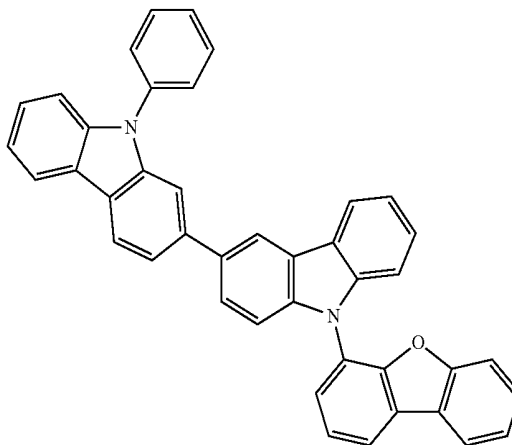
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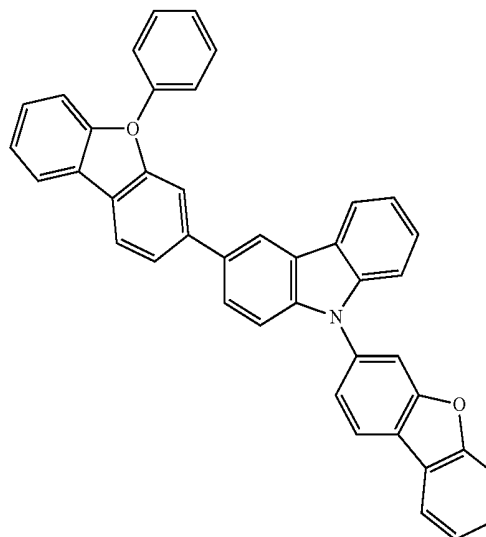


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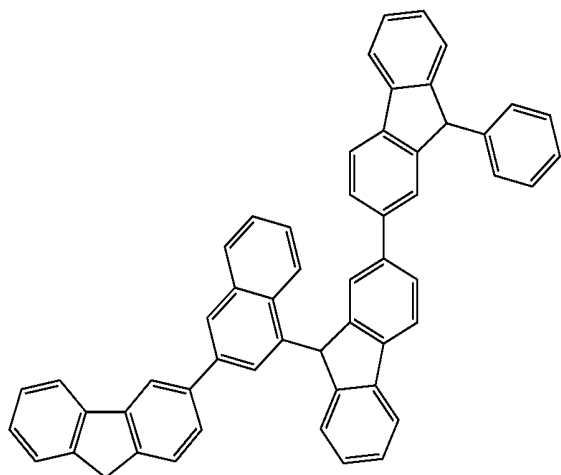
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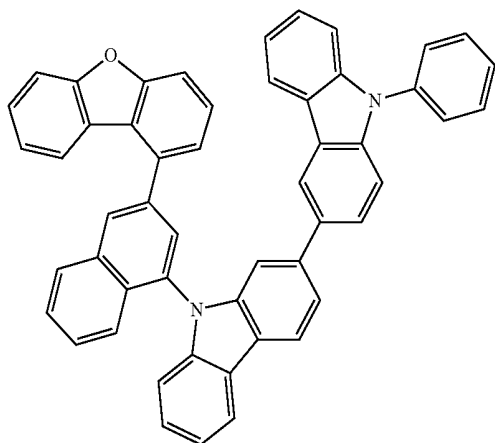
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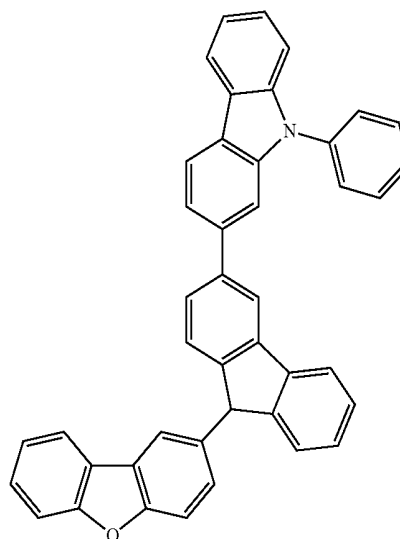
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A-216

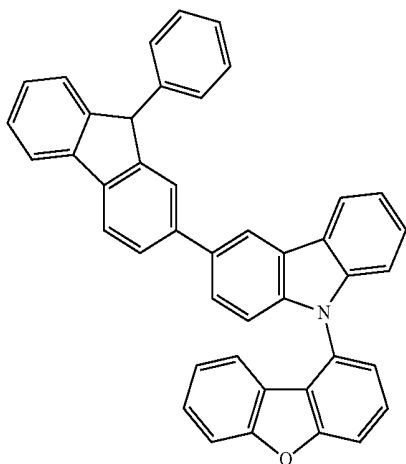


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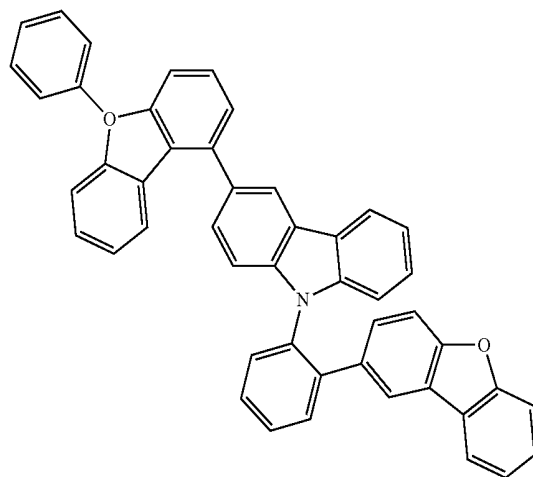
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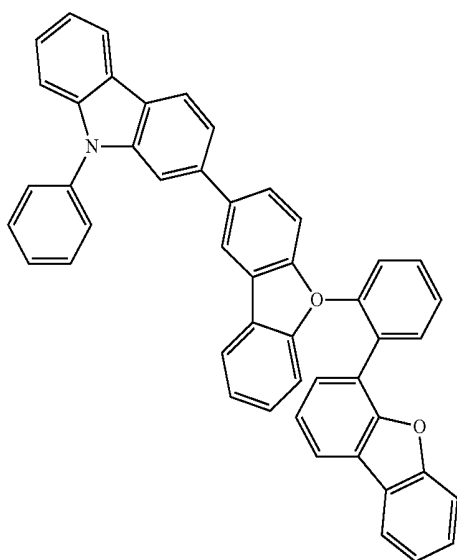


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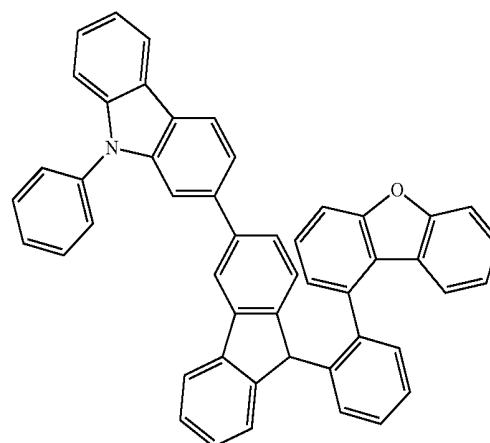
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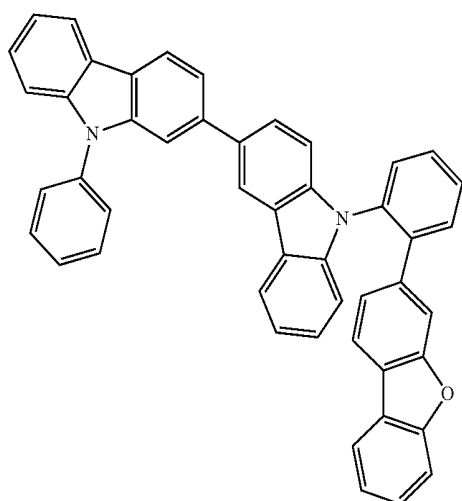
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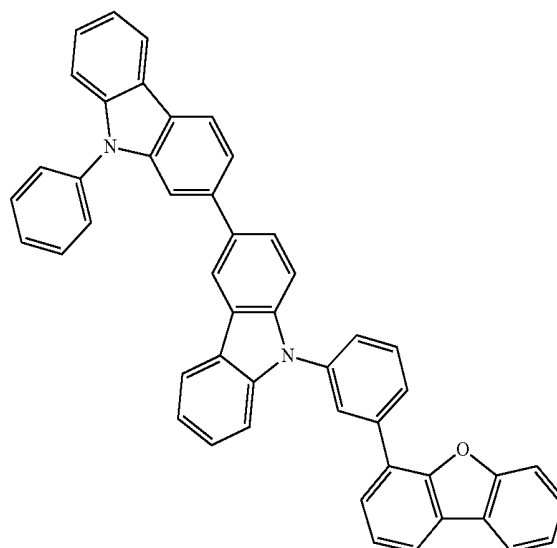
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A-226

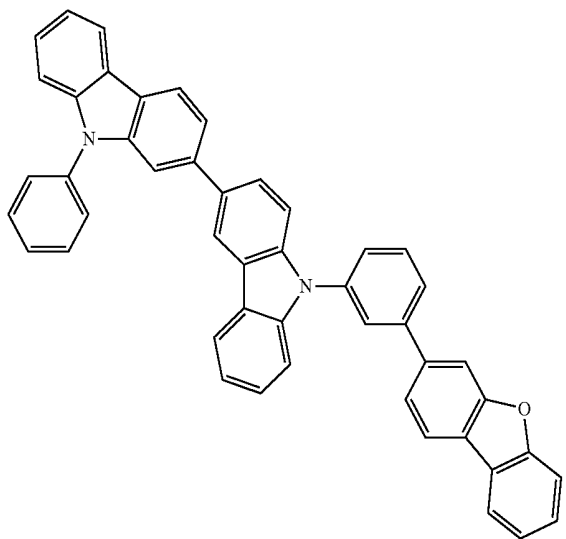


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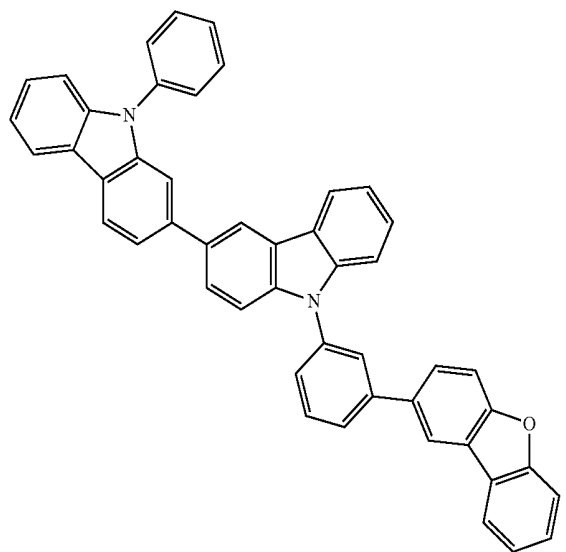


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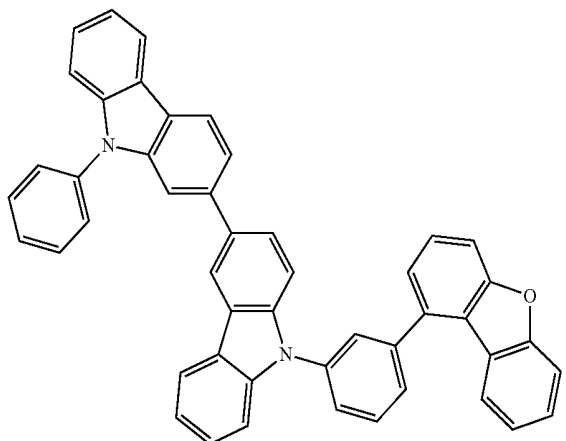
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A-228

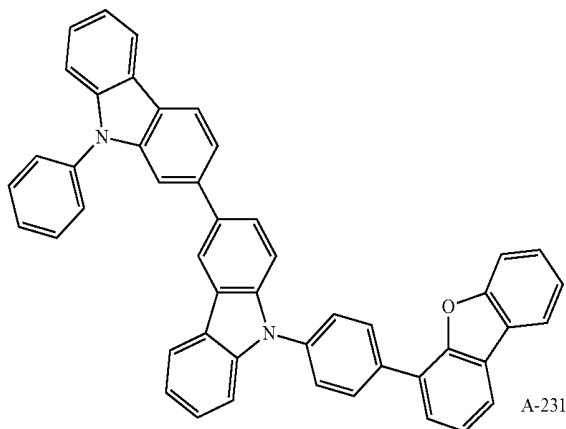


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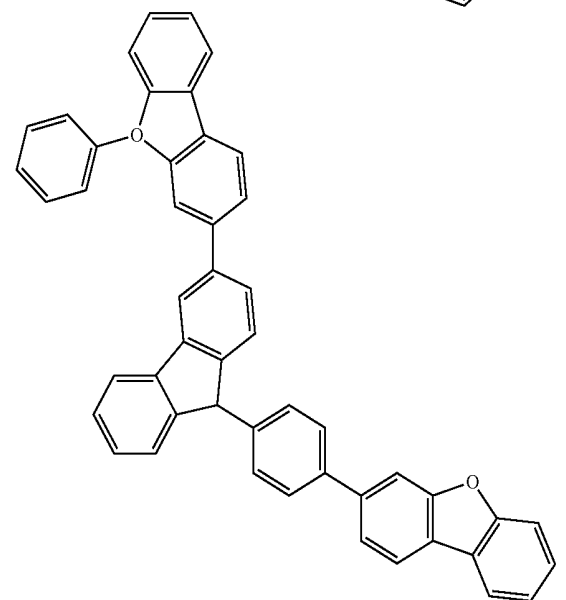


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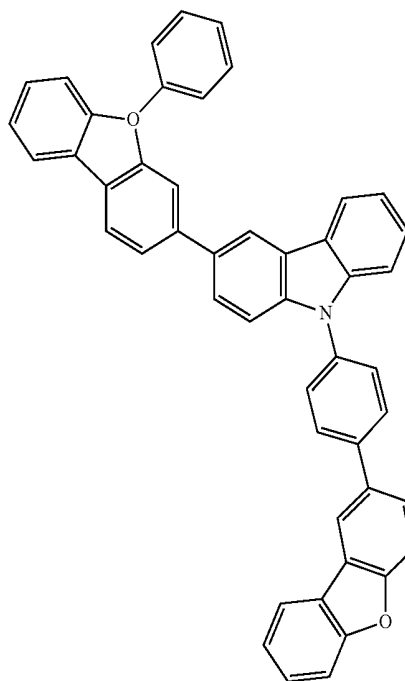
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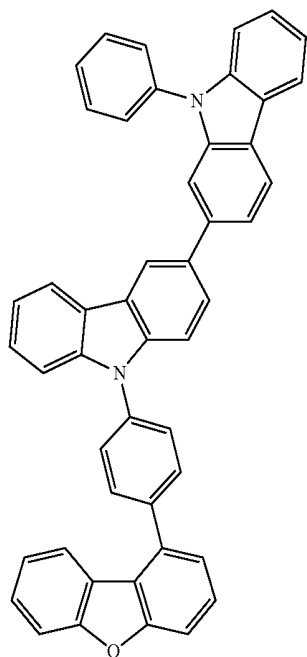


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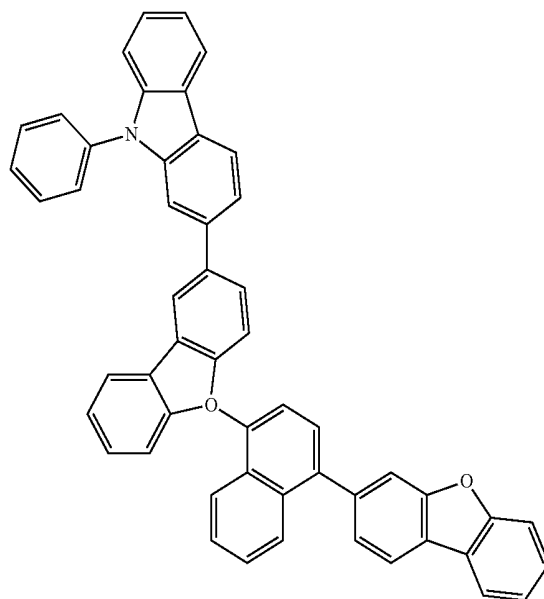
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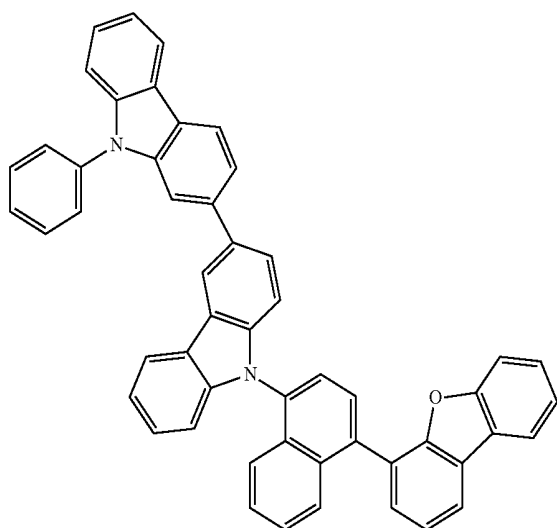


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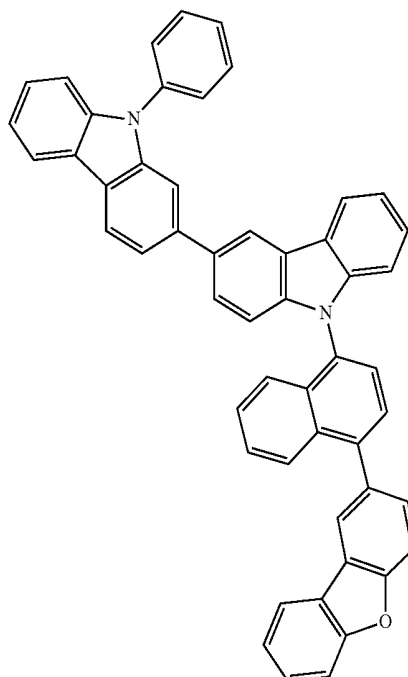
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A-234

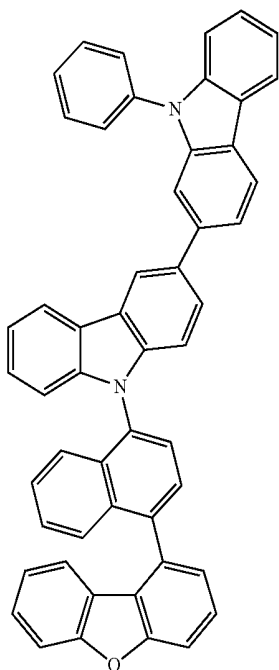


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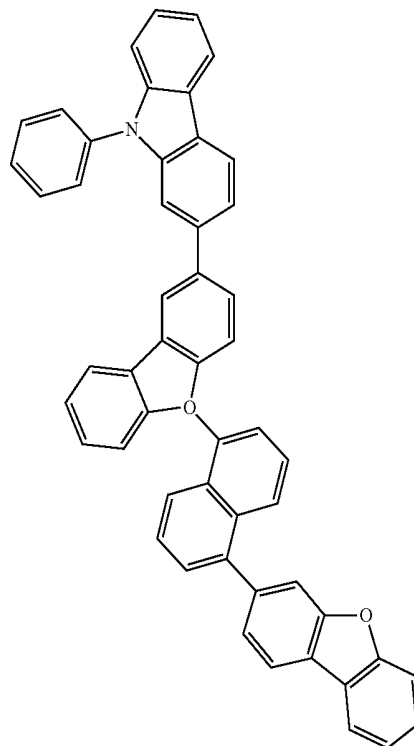
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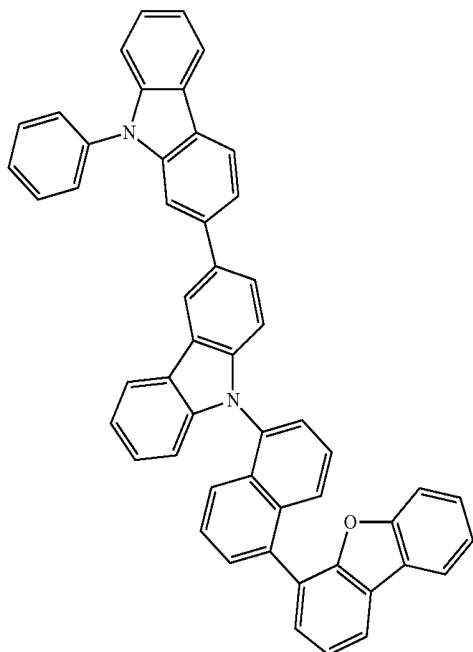


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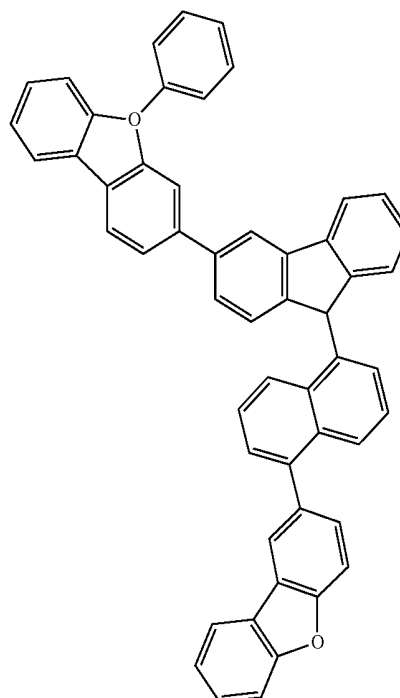
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A-238

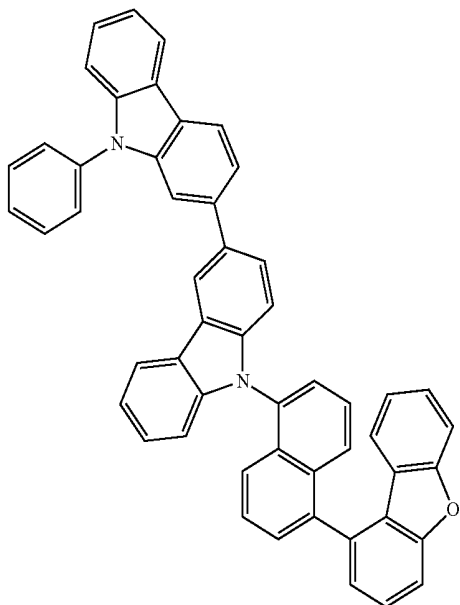


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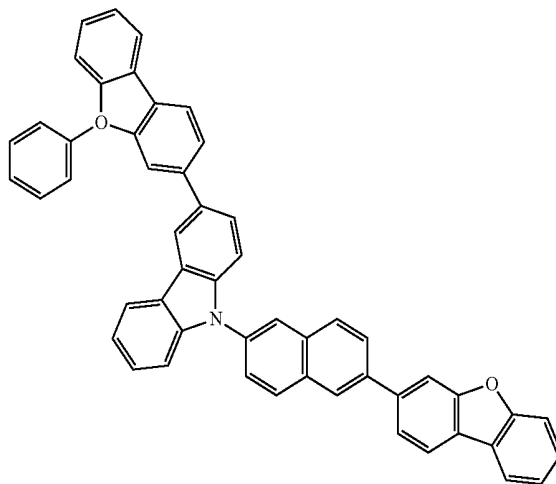
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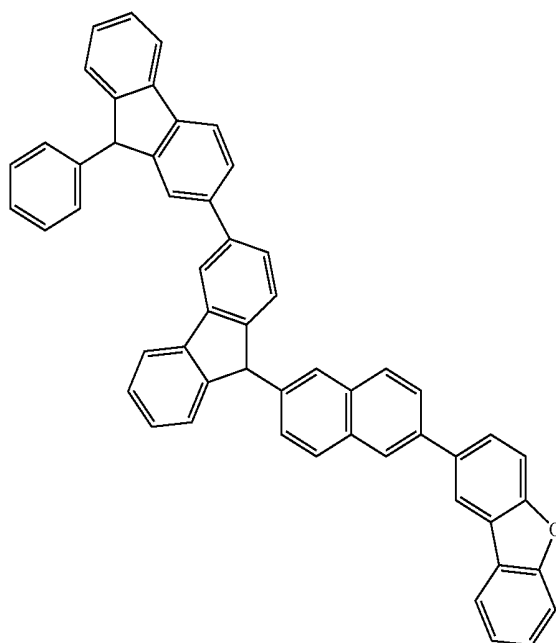
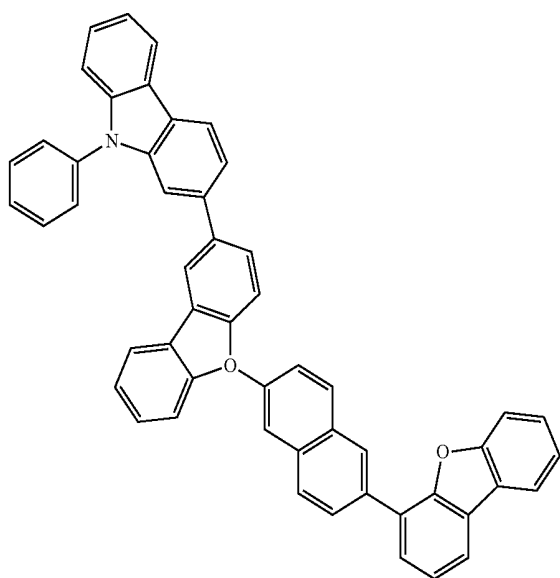
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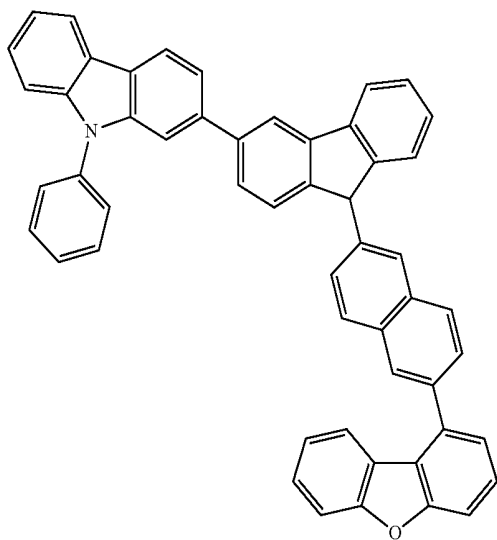
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A-250

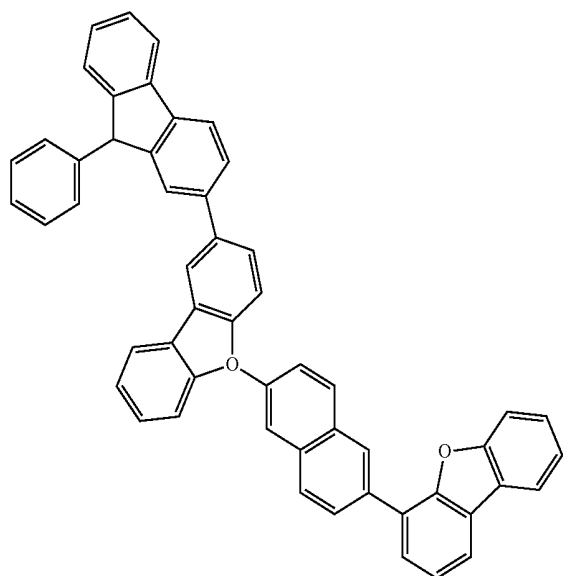


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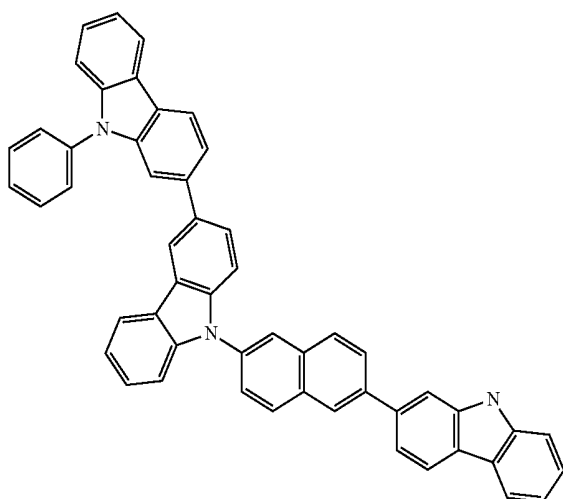
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A-254

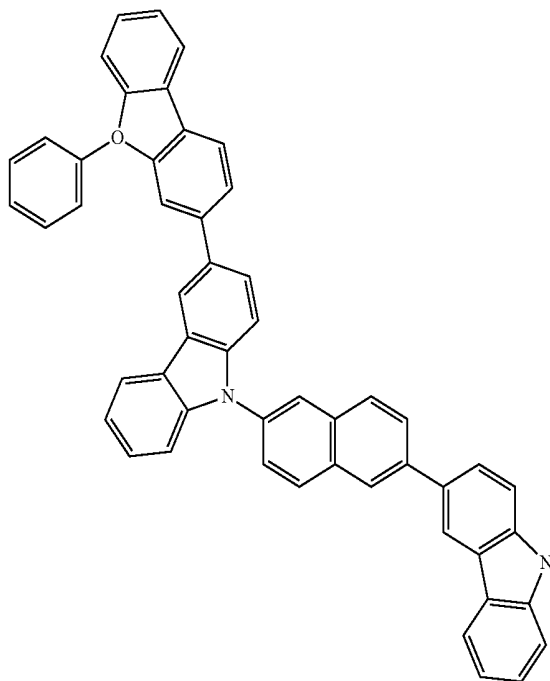


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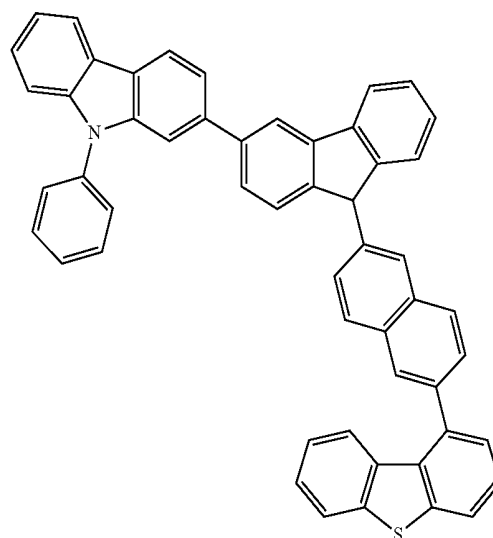


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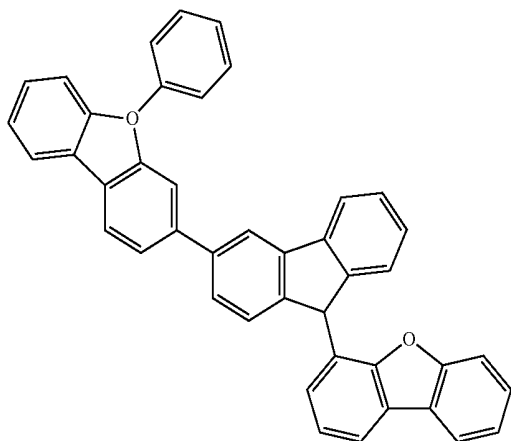


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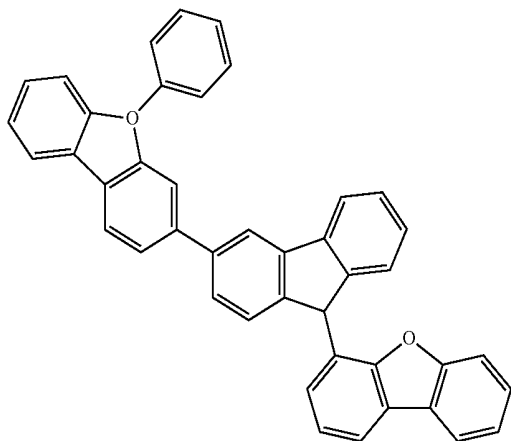


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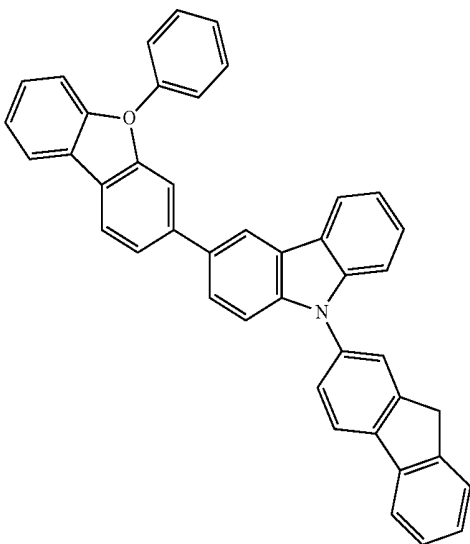
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A-258

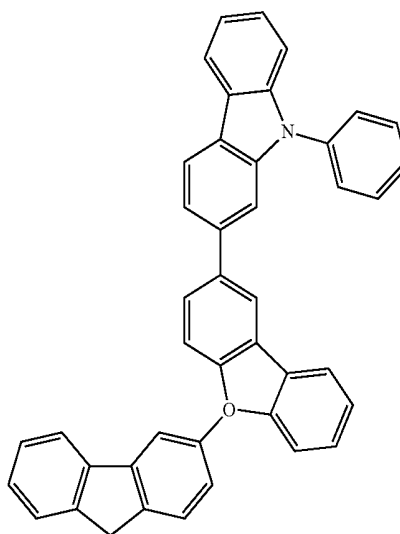


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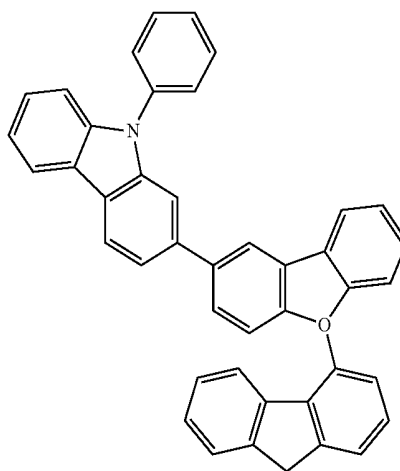


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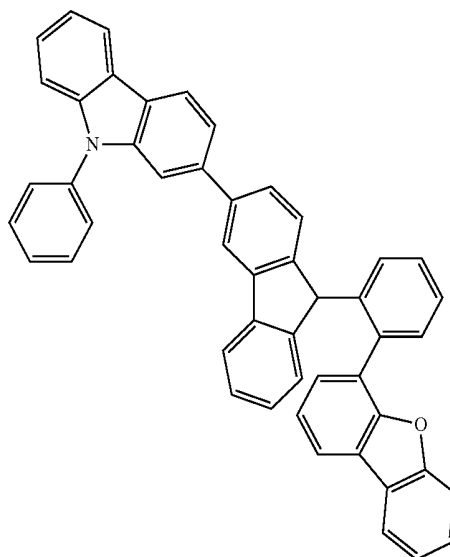
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A-261

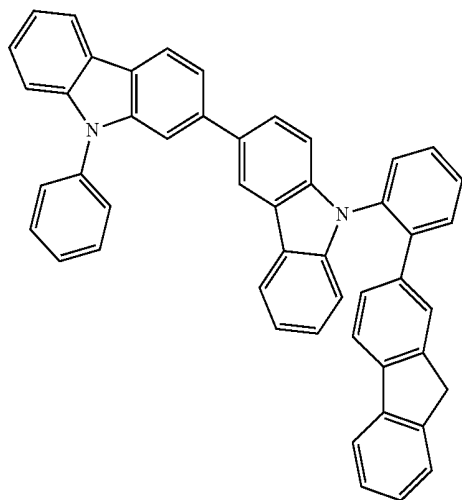


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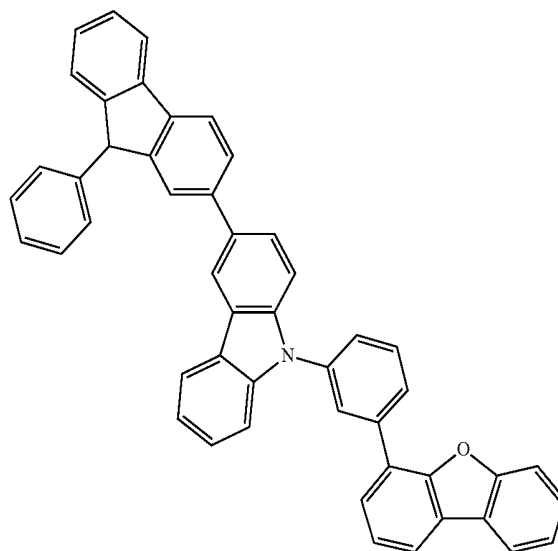
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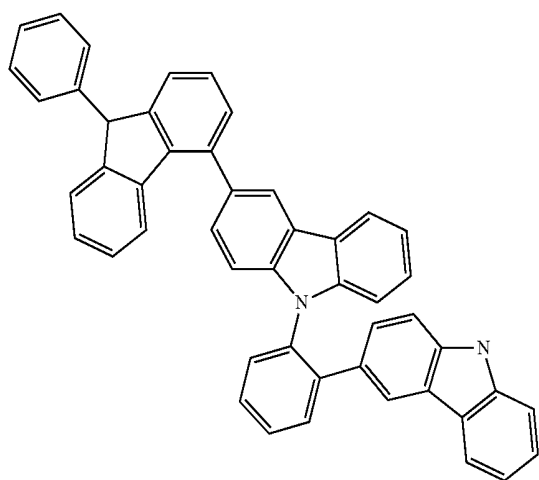


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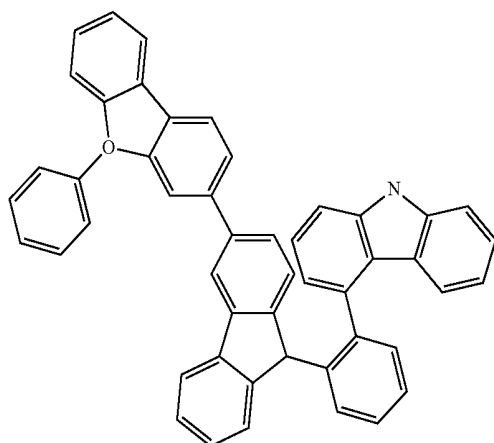
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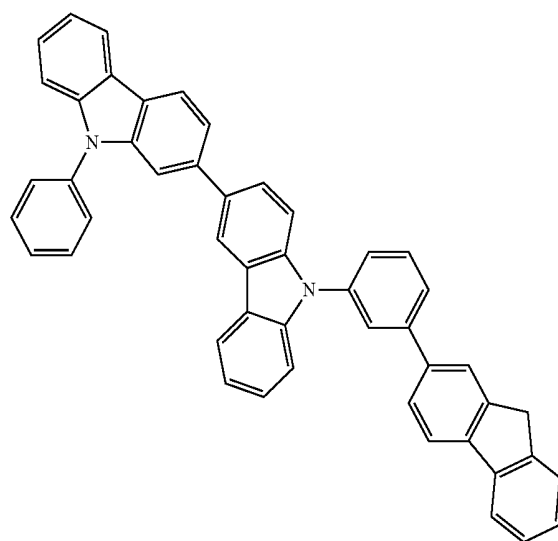
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A-265

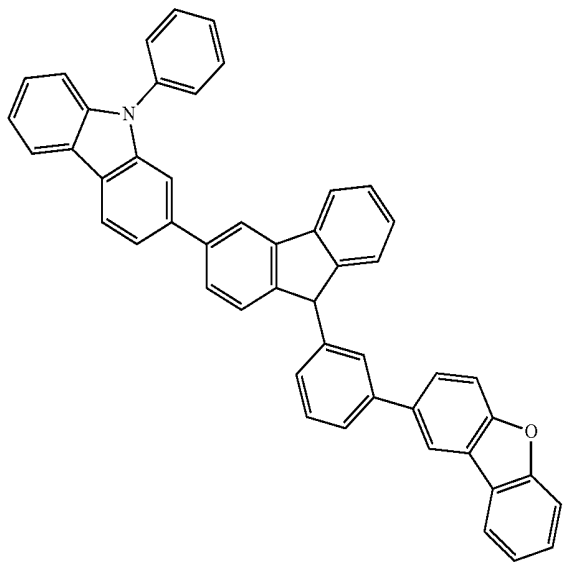


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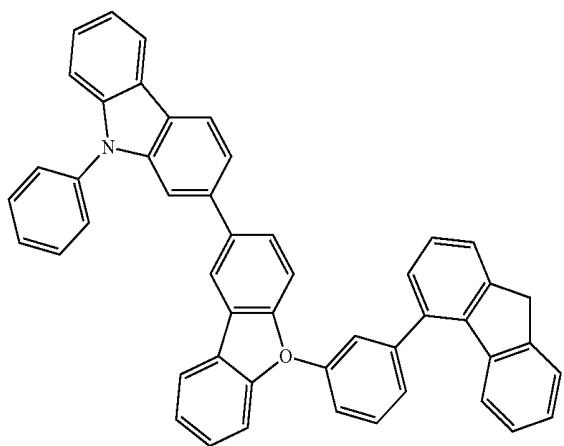


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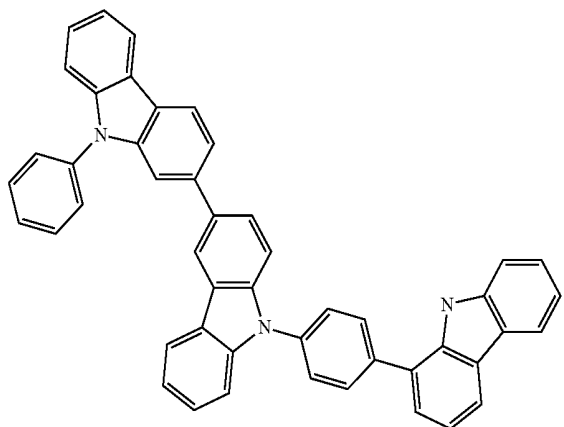
A-268



A-269

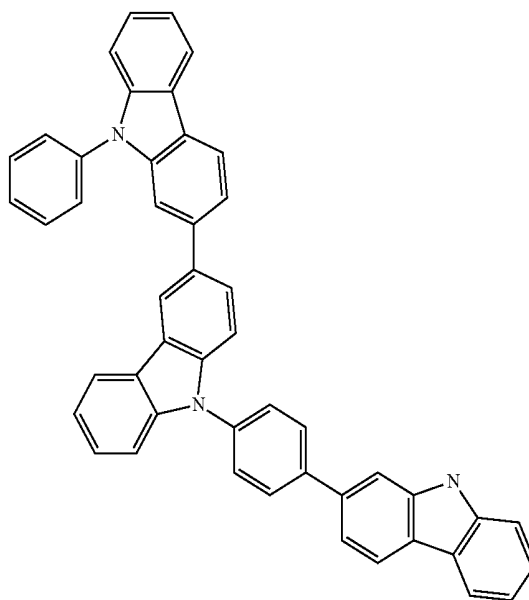


A-270

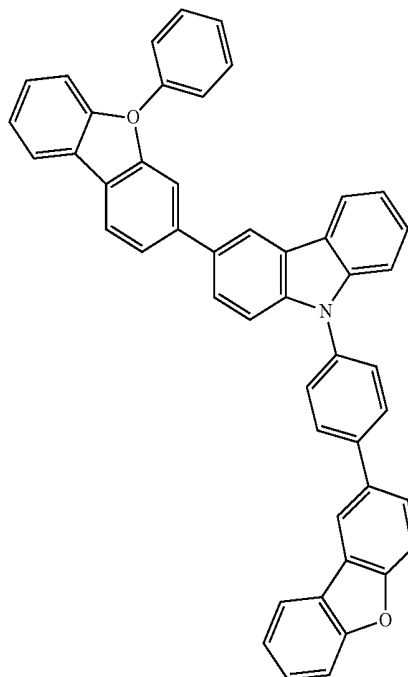


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A-271

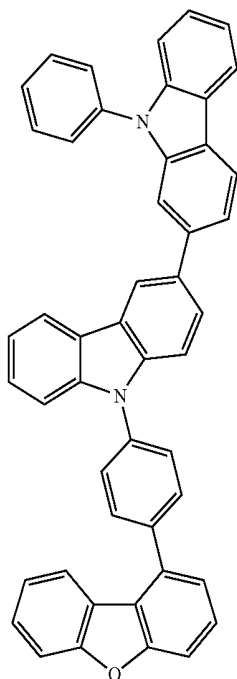


A-272



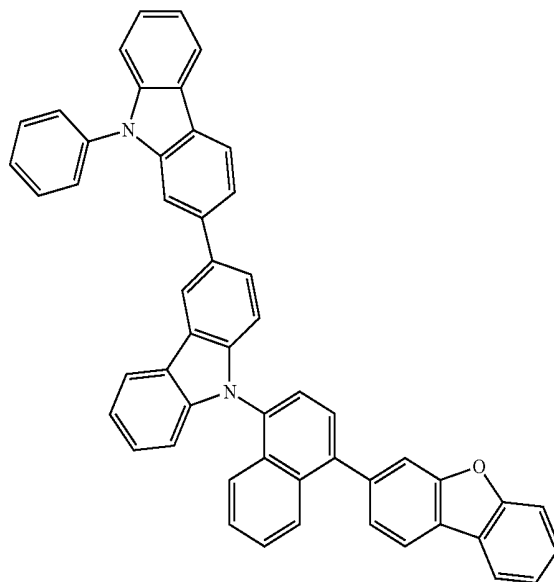
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A-273

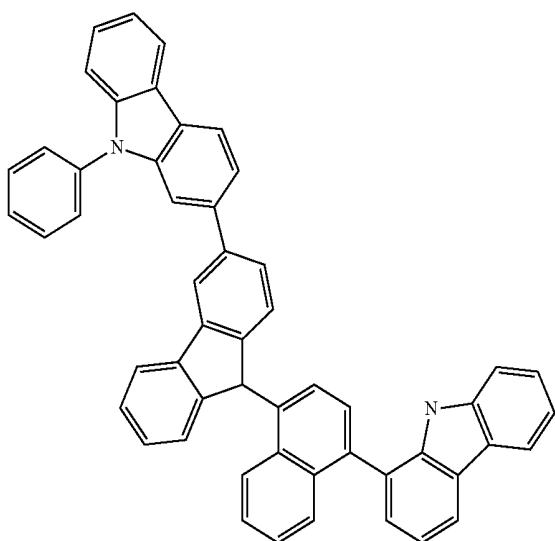


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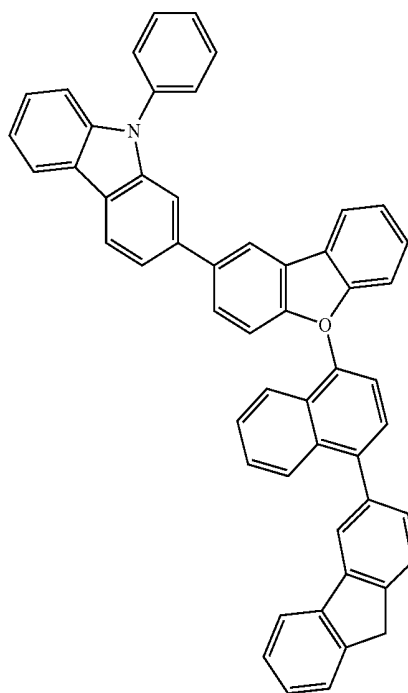
A-275



A-274

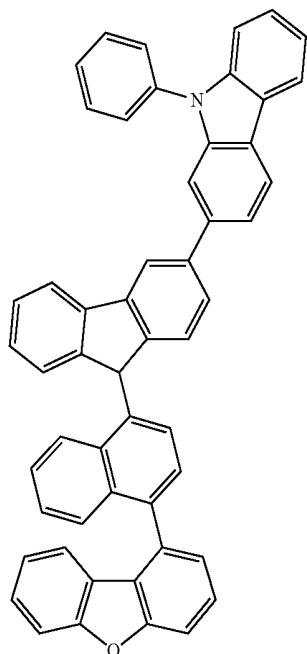


A-276



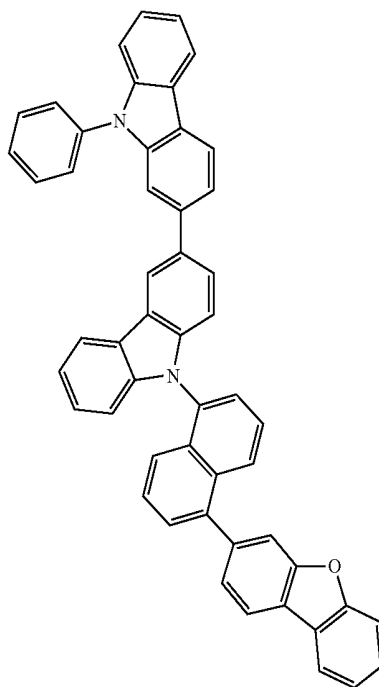
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A-277

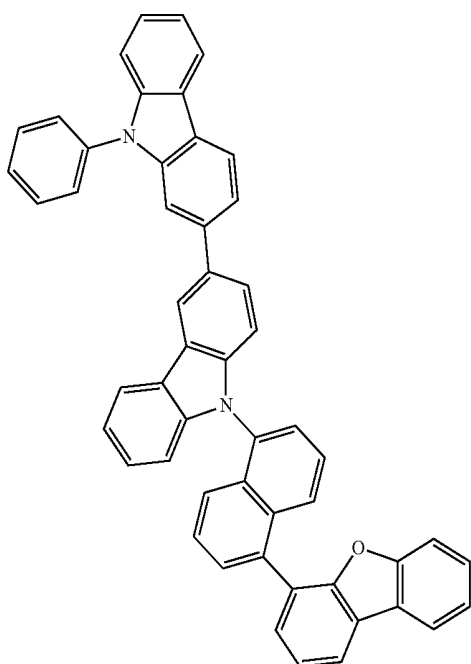


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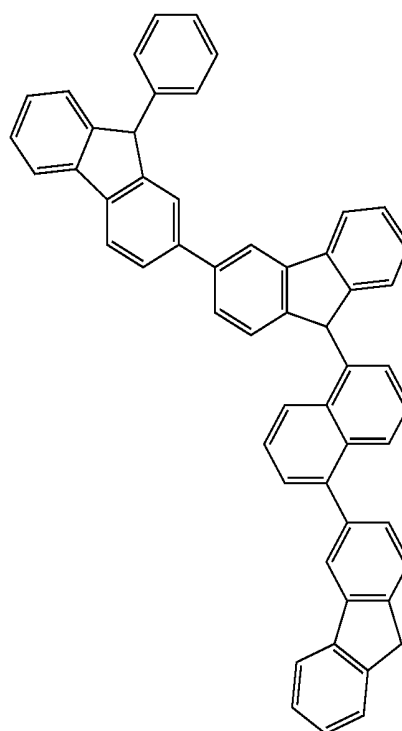
A-279



A-278

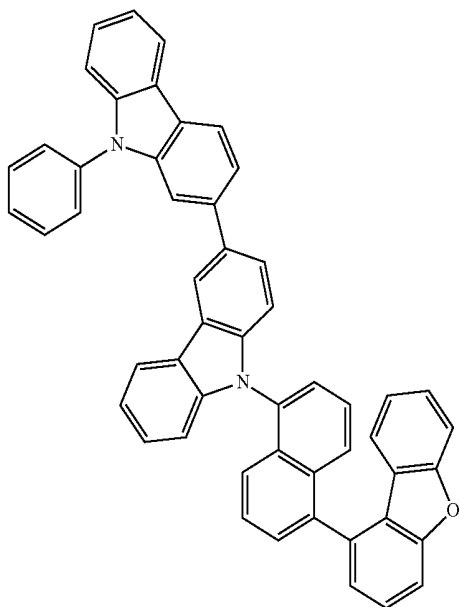


A-280



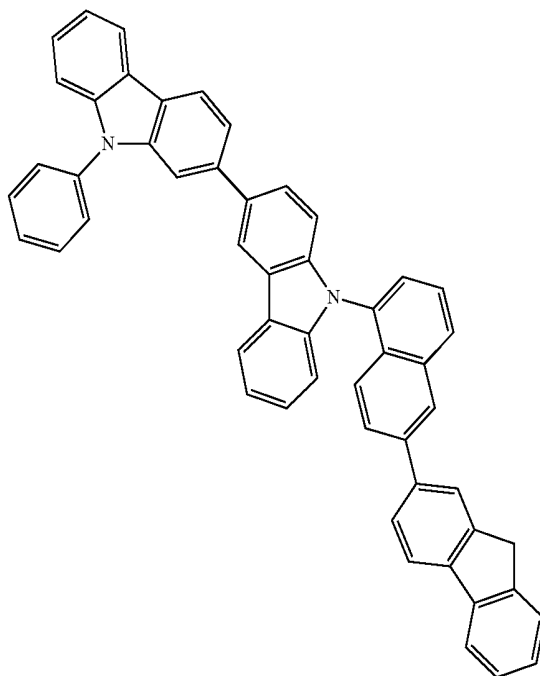
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A-281

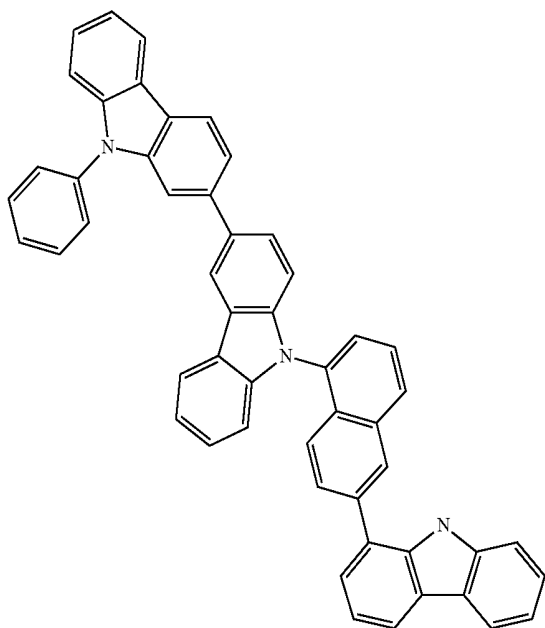


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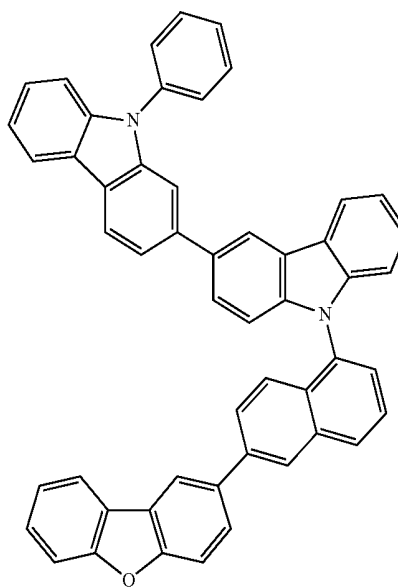
A-283



A-282

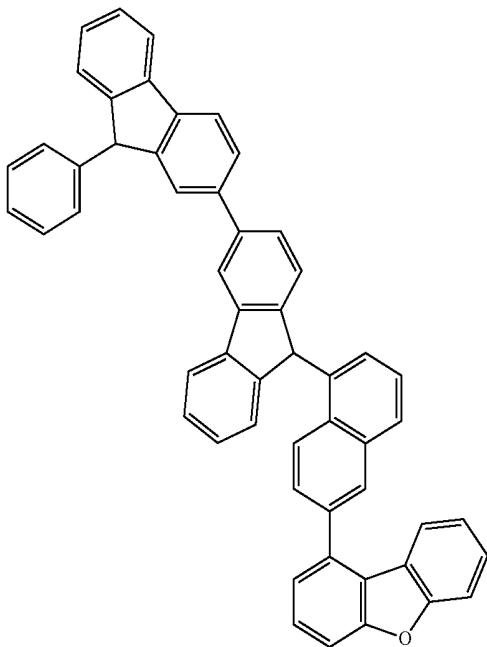


A-284



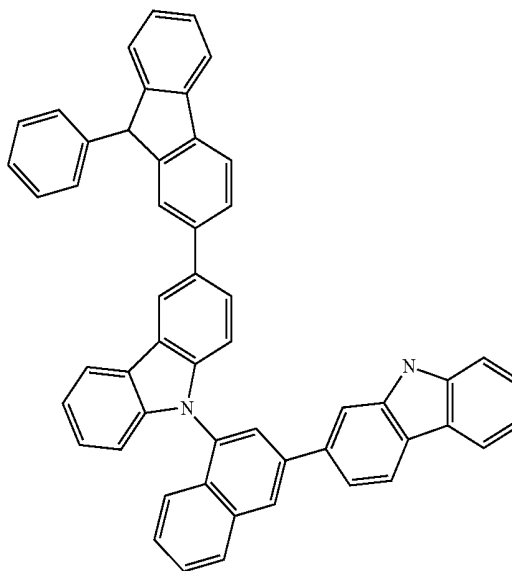
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A-285

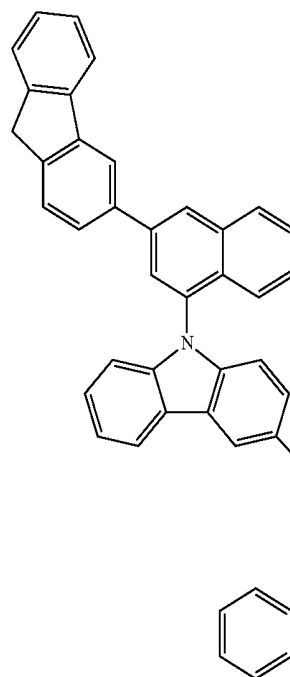


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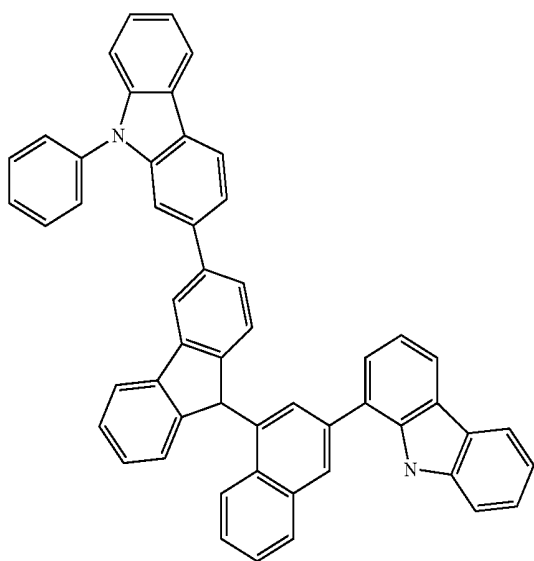
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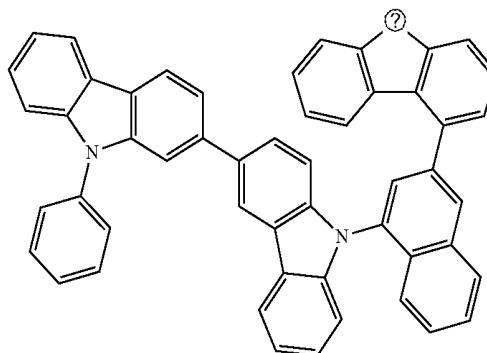
A-288



A-286

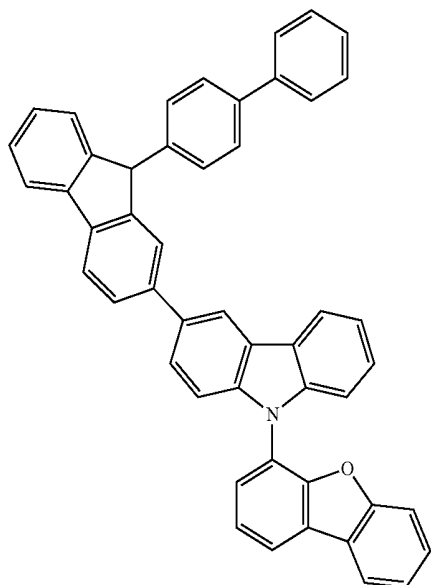


A-289



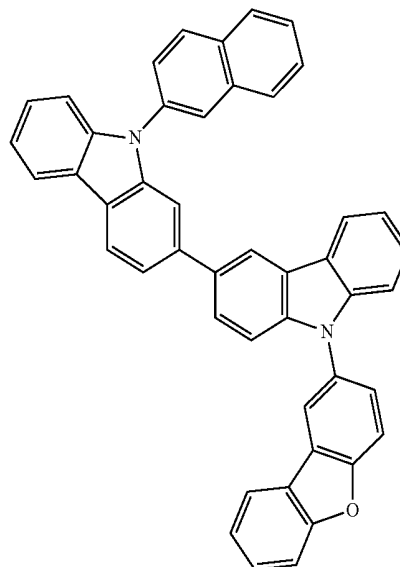
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A-290

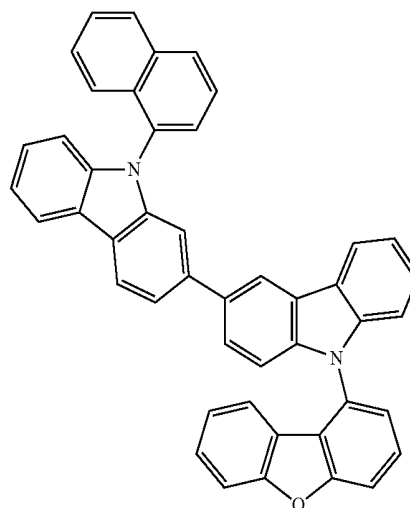


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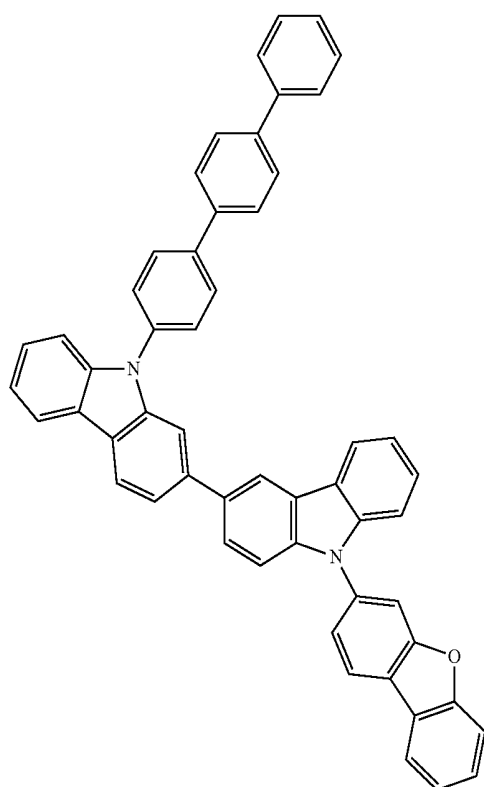
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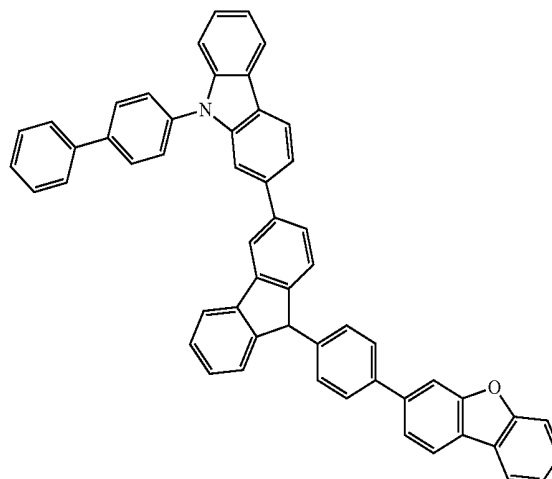
A-293



A-291

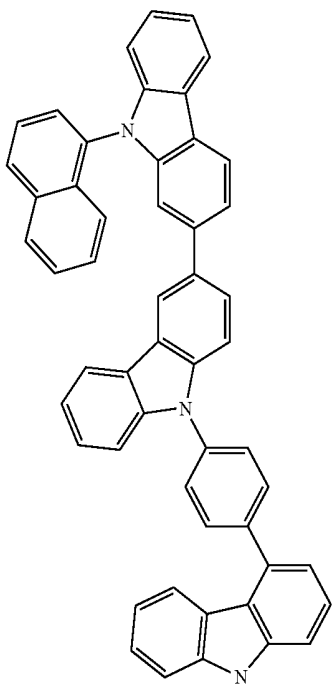


A-294



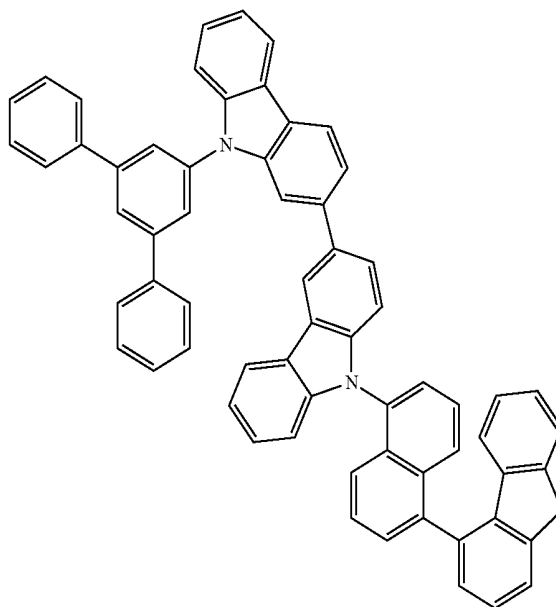
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A-295

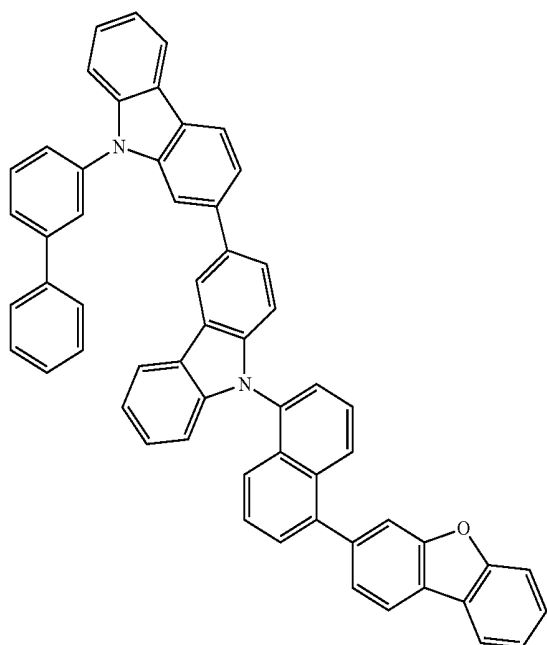


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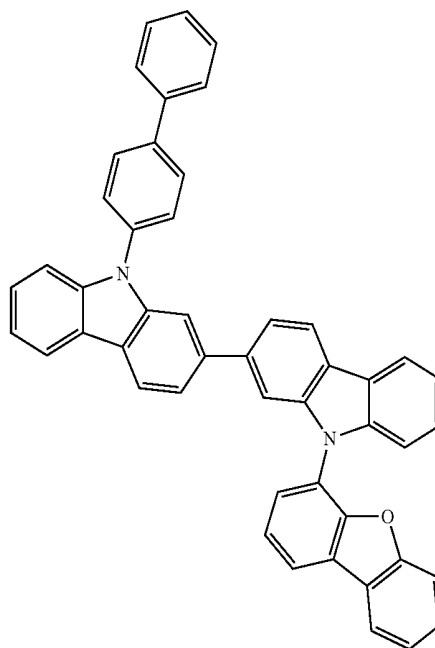
A-297



A-296

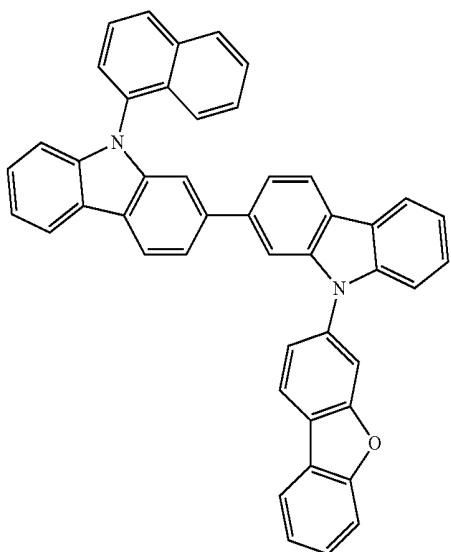


A-298



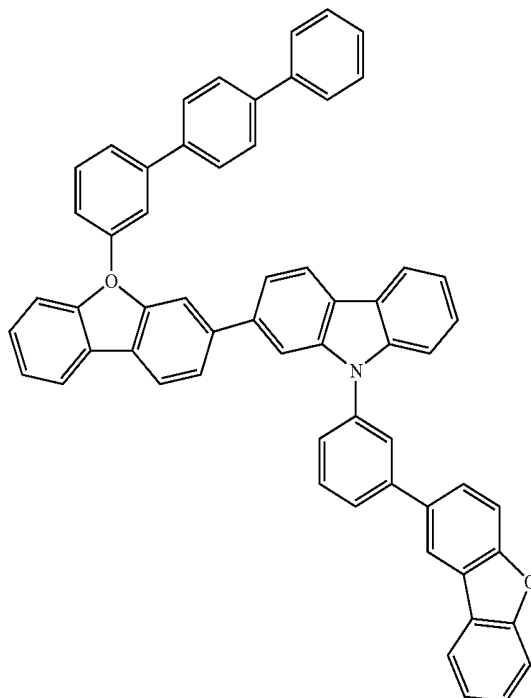
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A-299

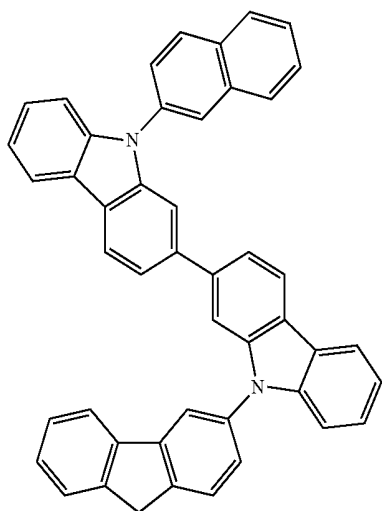


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A-302

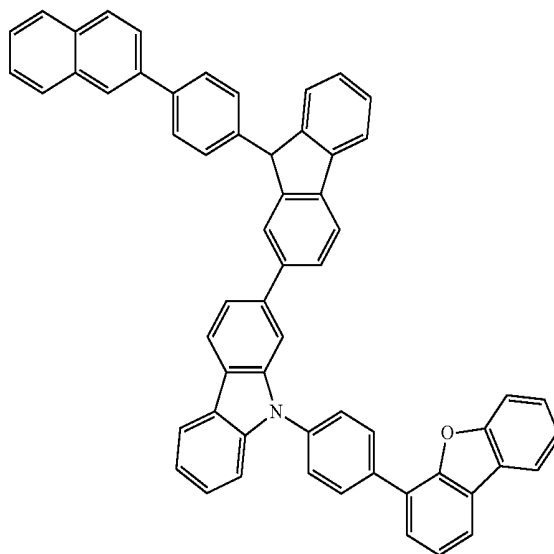
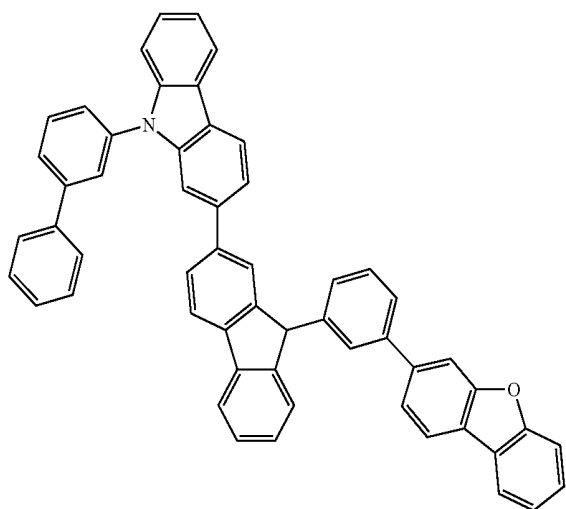


A-300



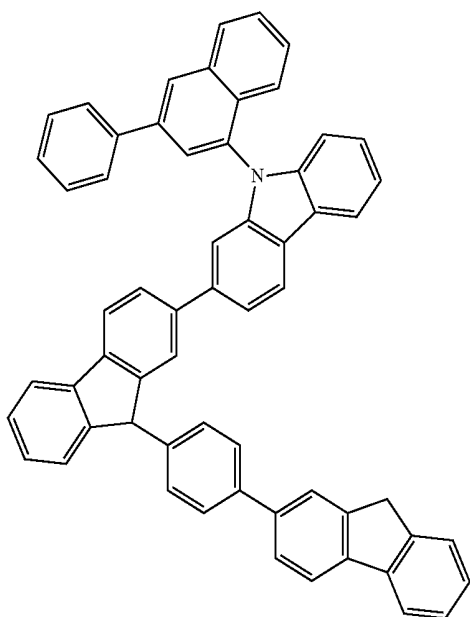
A-303

A-301



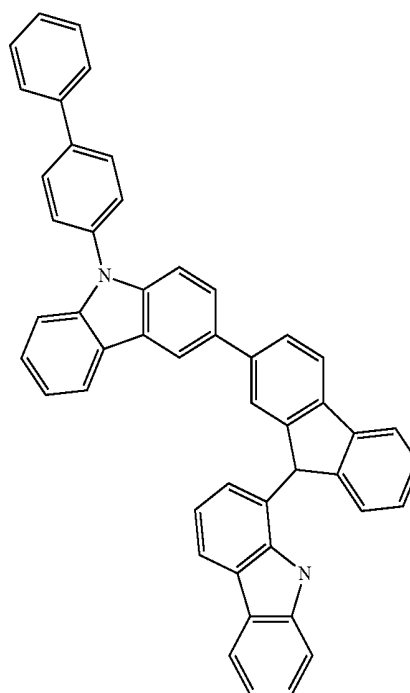
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A-304

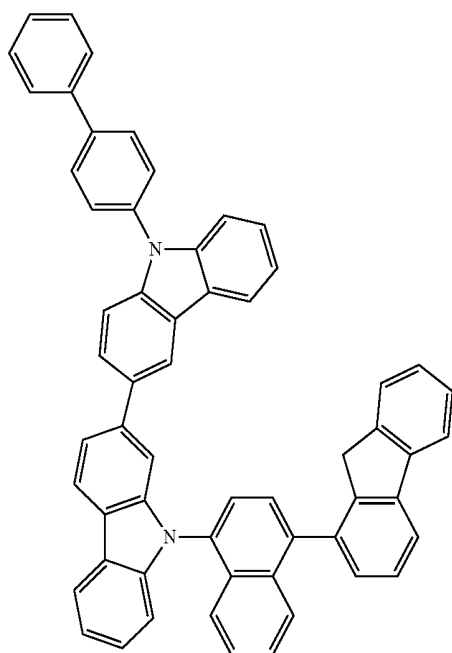


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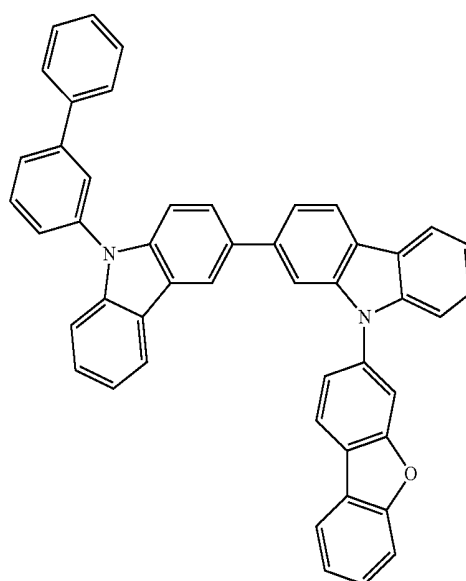
A-306



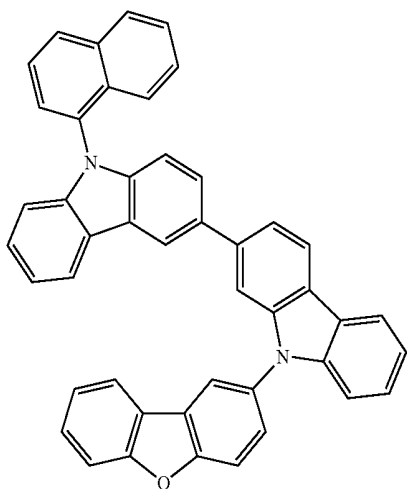
A-305



A-307

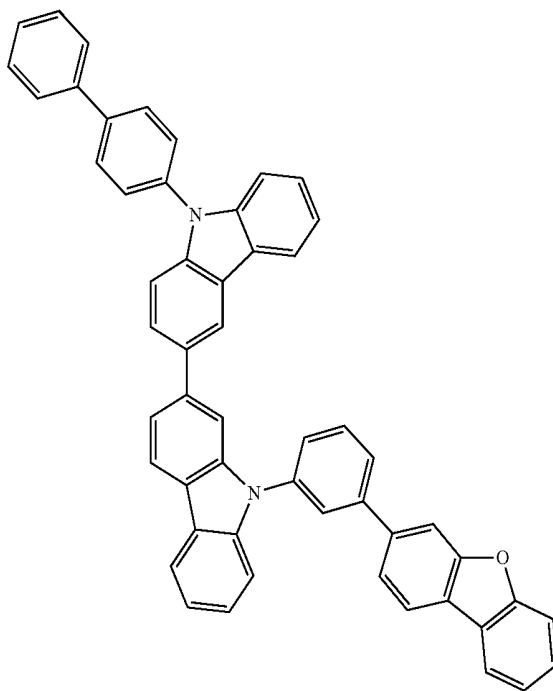


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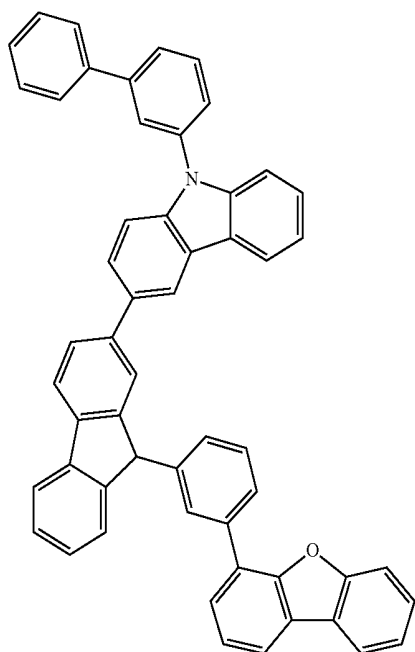
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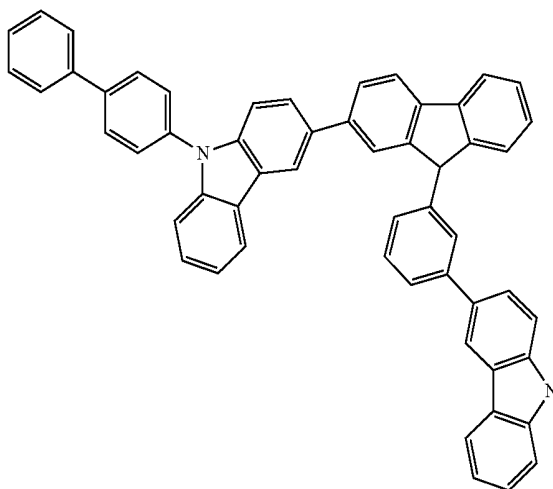


A-310

A-309

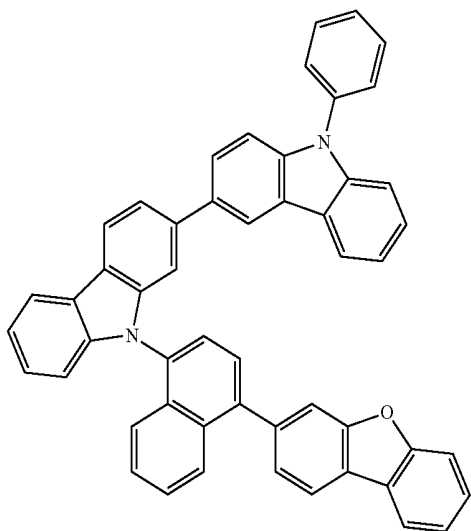


A-311



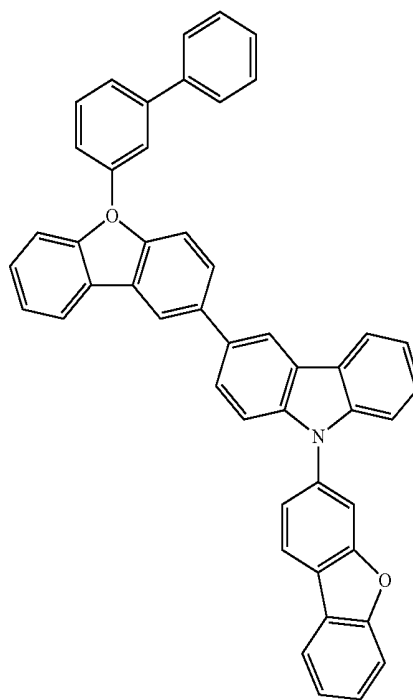
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A-312

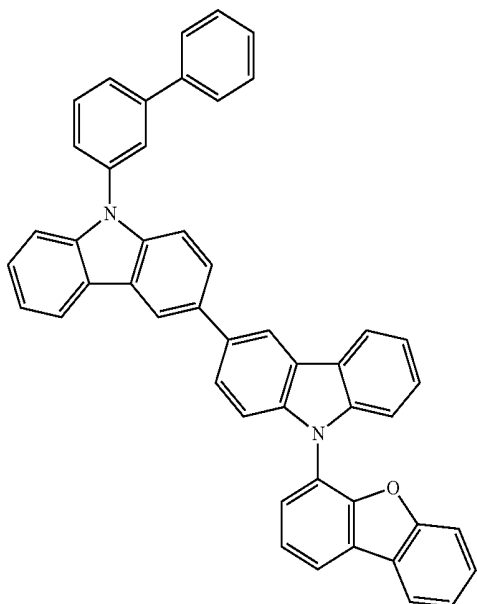


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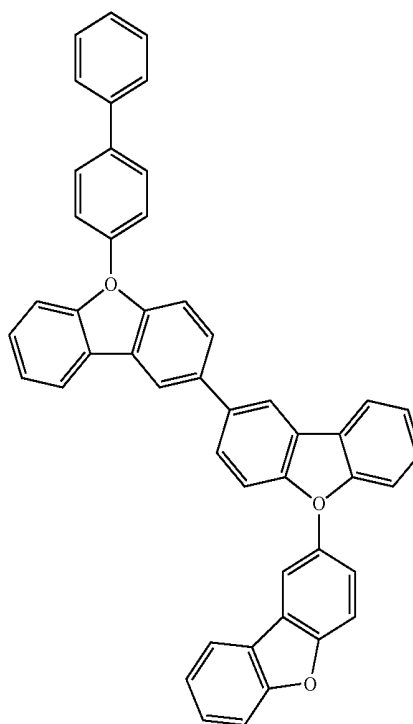
A-314



A-313

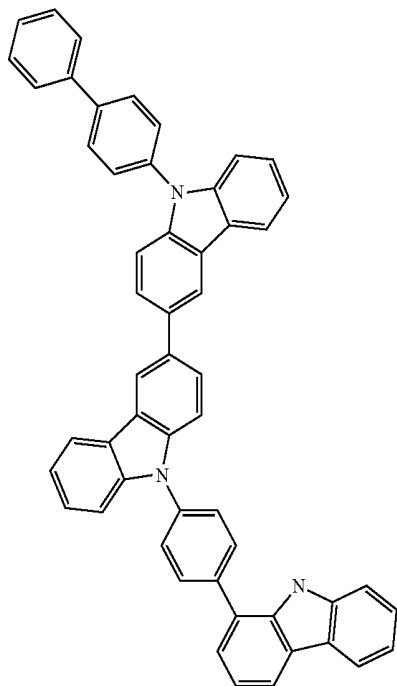


A-315



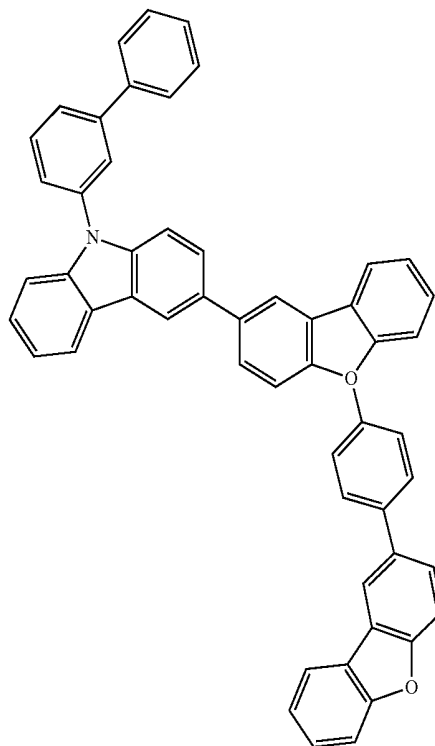
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A-316

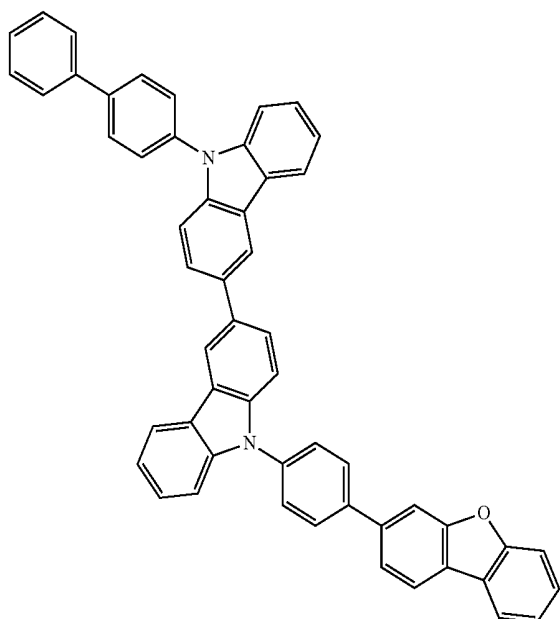


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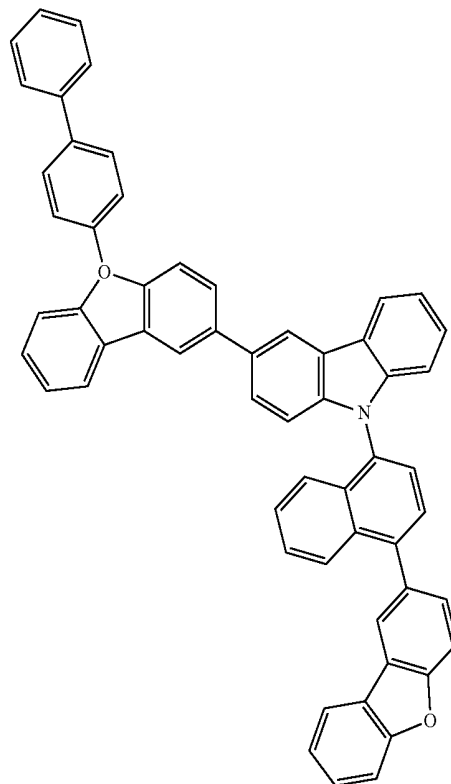
A-318



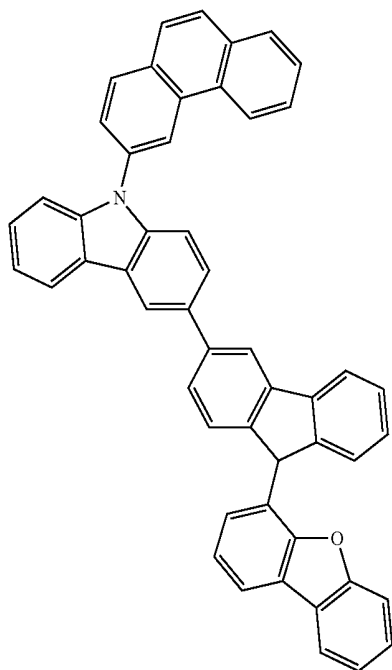
A-317



A-319



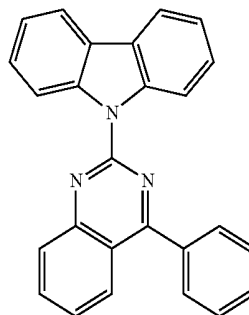
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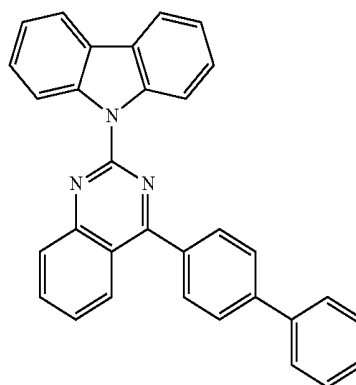
A-320

[0036] The second host compound represented by formula 2 includes the following compounds, but is not limited thereto:

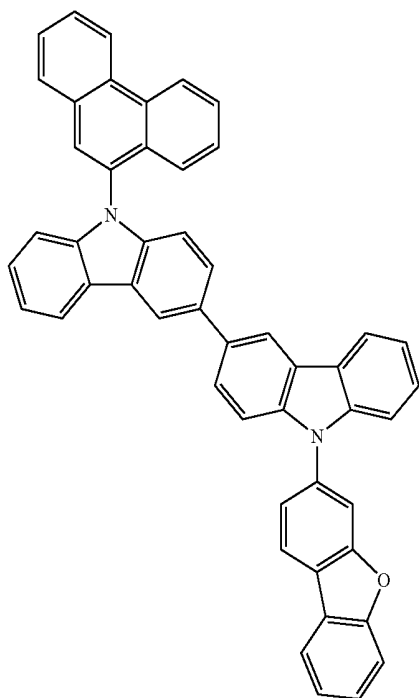
H2-1



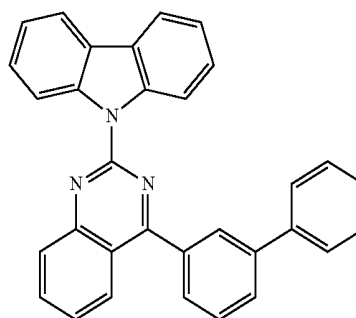
H2-2



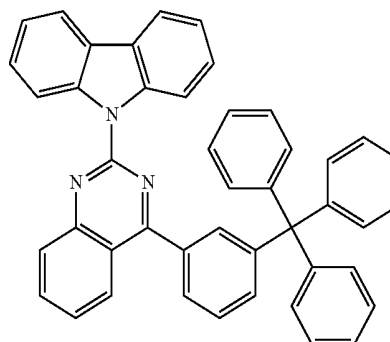
A-321



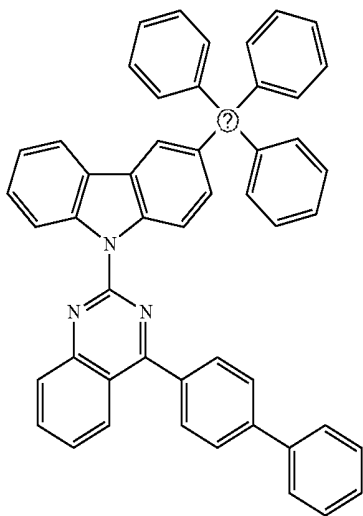
H2-3



H2-4

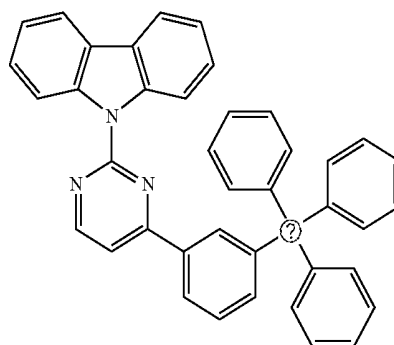


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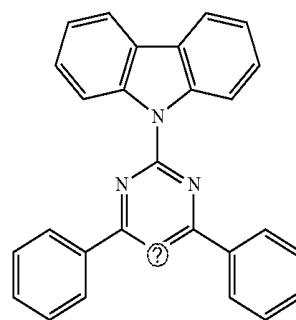
H2-5

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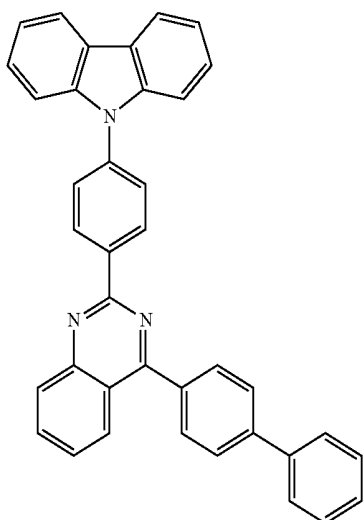


H2-8

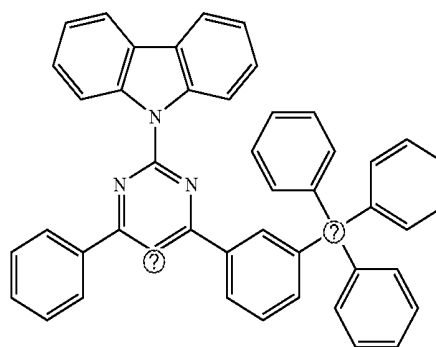
H2-9



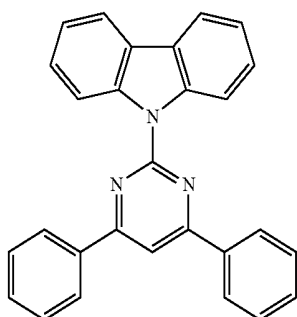
H2-6



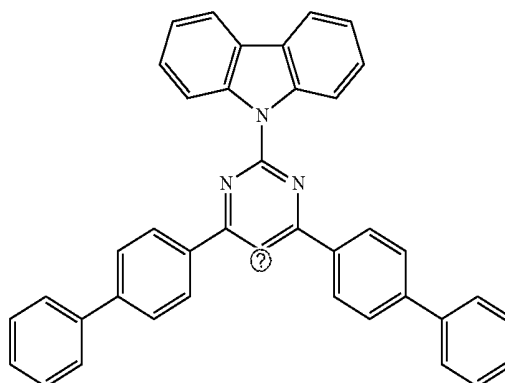
H2-10



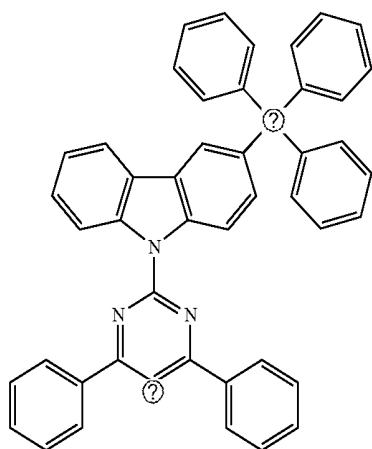
H2-7



H2-11

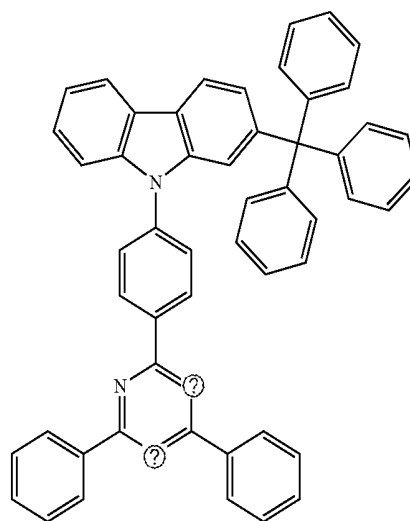


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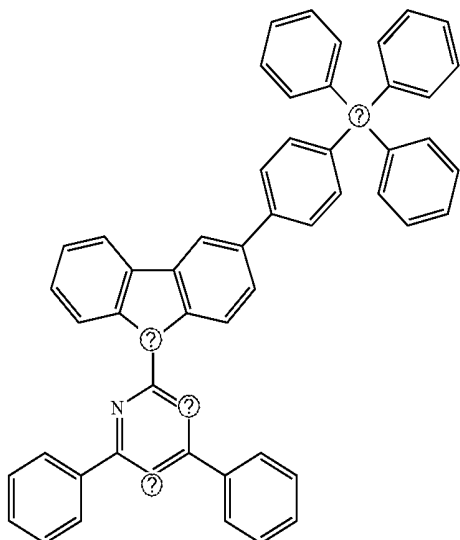
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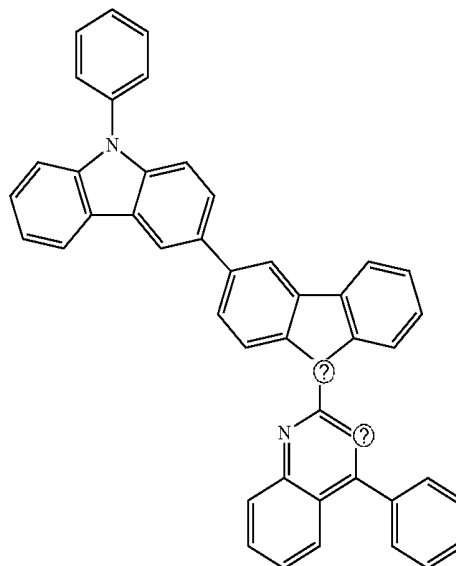


H2-15

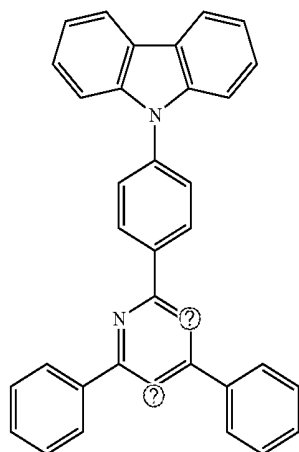
H2-13



H2-16

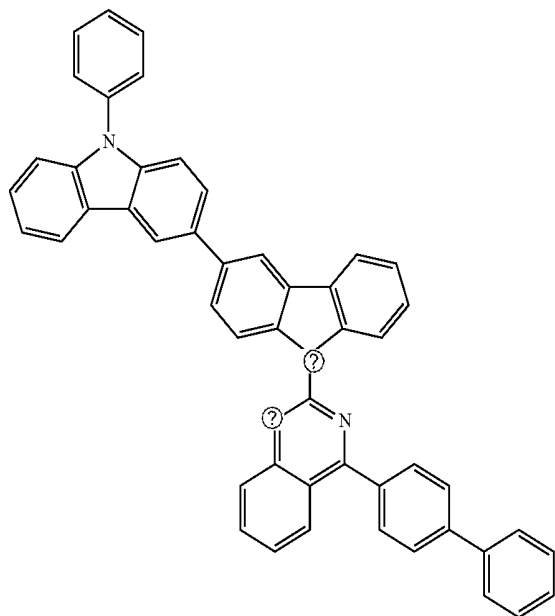


H2-14



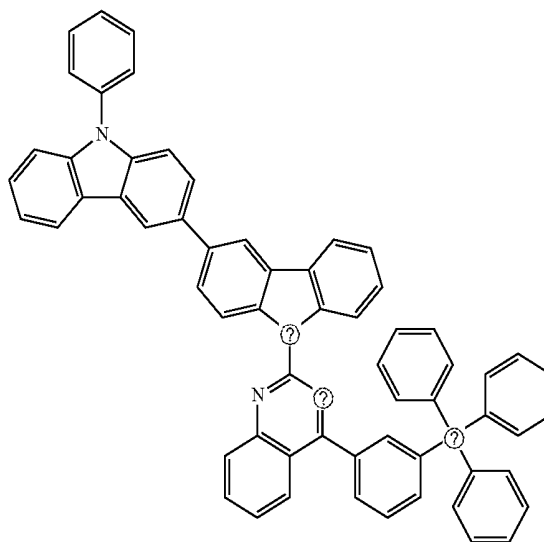
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H2-17



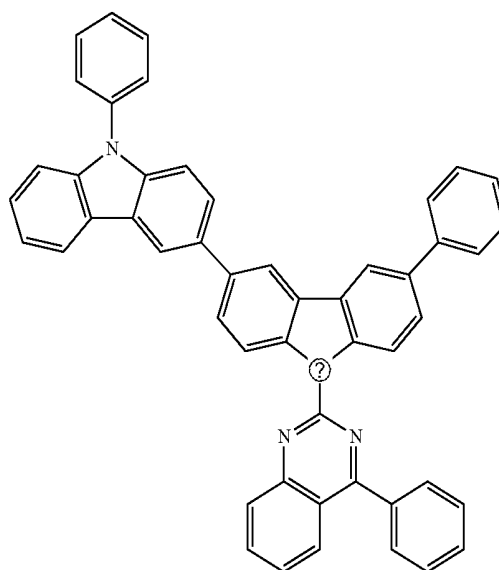
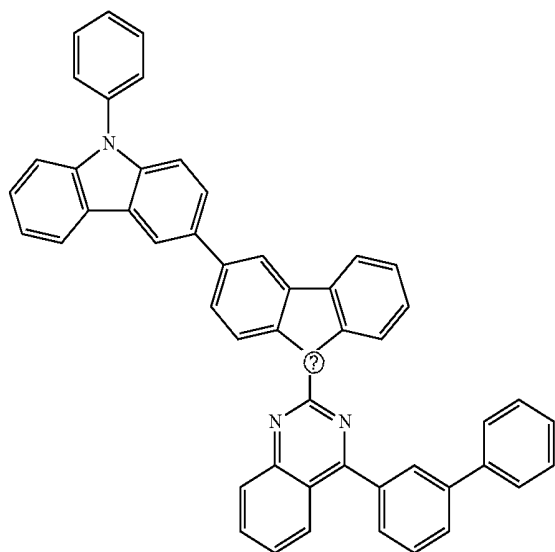
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H2-19



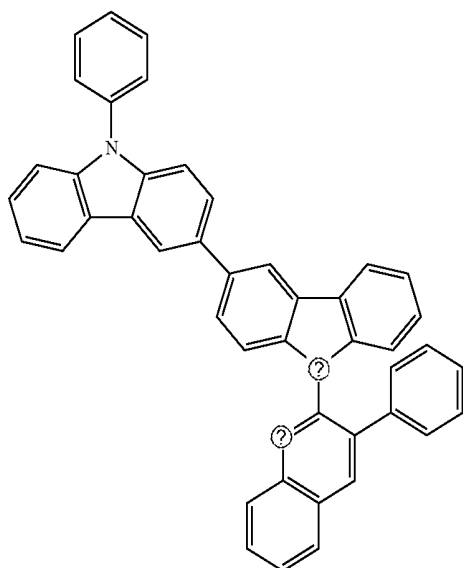
H2-20

H2-18



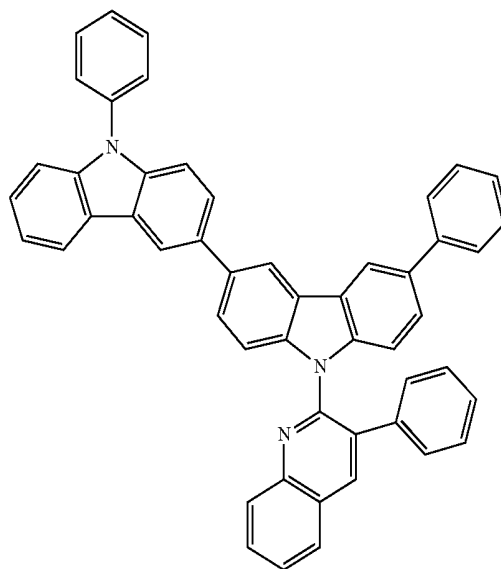
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H2-21

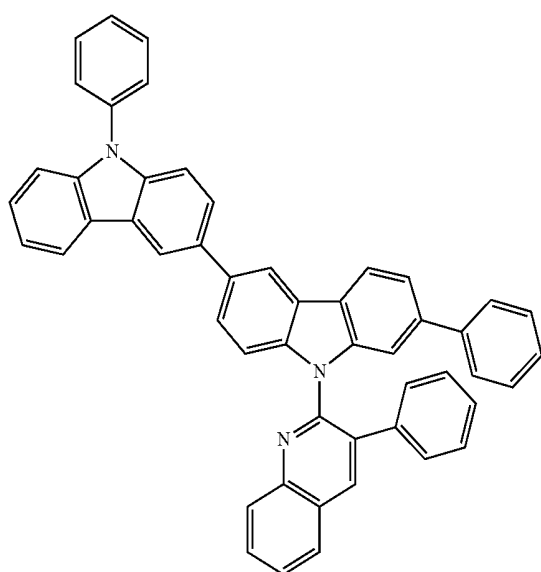


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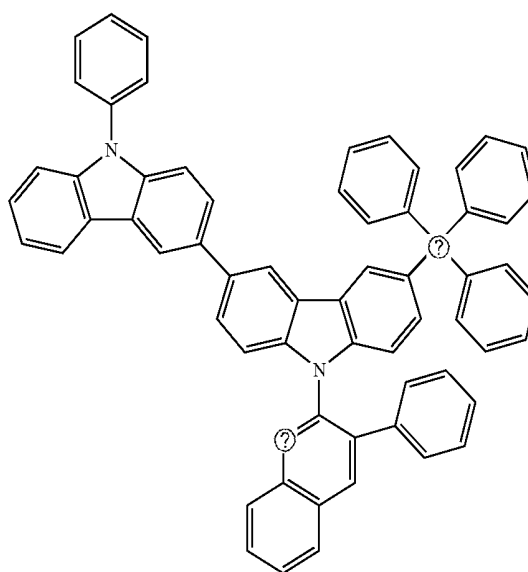
H2-23



H2-22

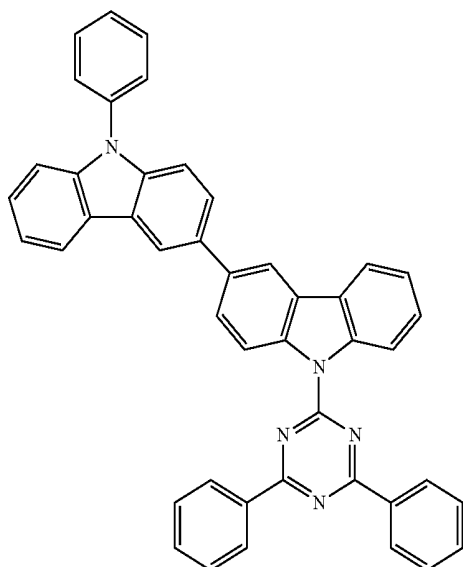


H2-24



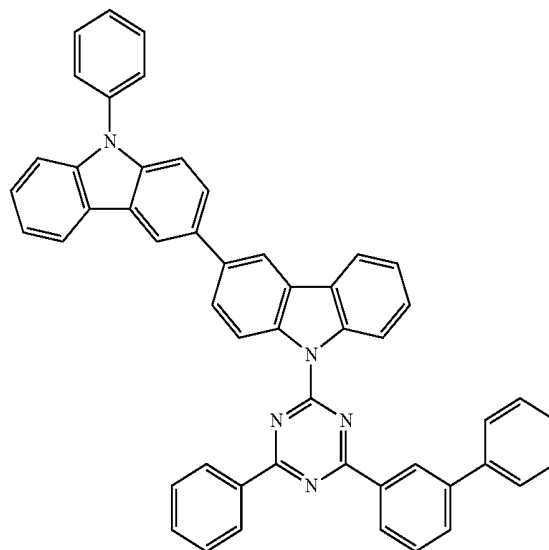
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H2-25

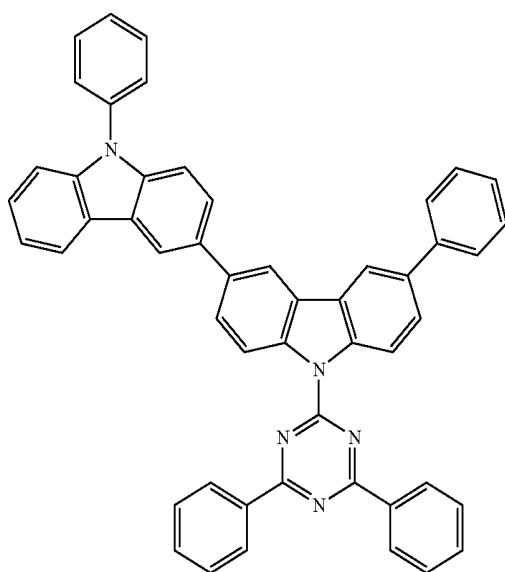


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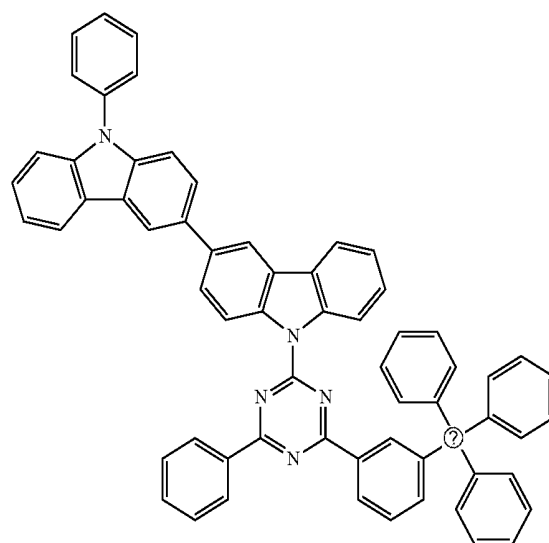
H2-27



H2-26

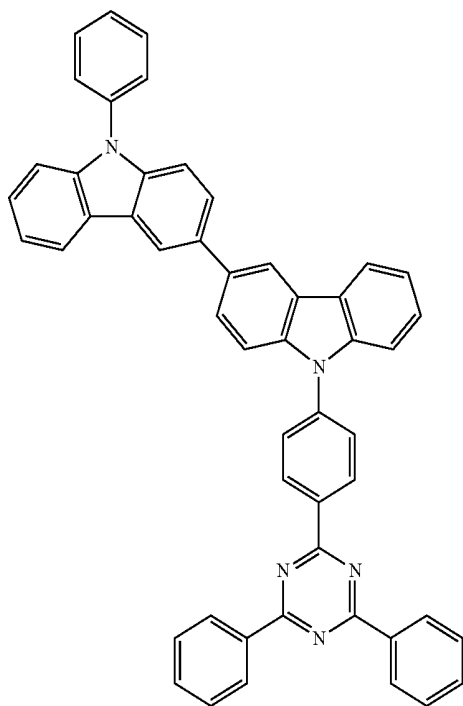


H2-28



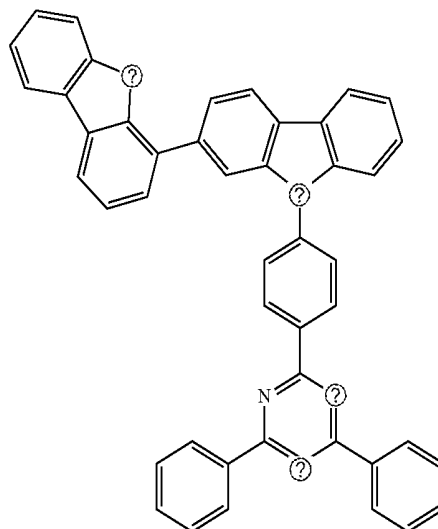
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H2-29

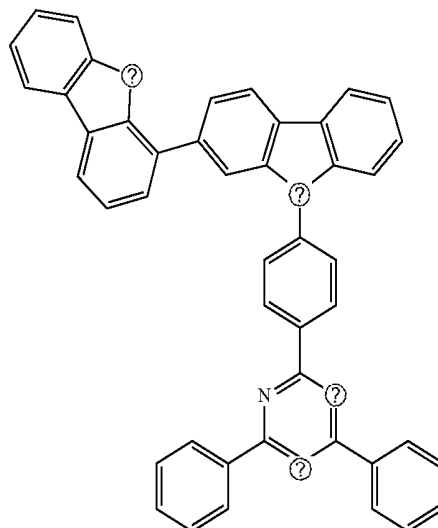


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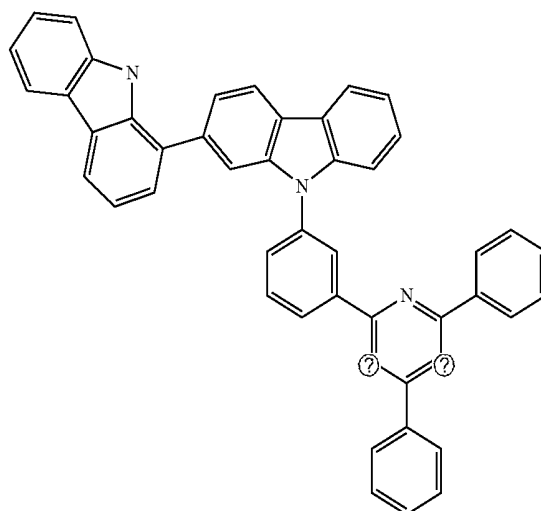
H2-31



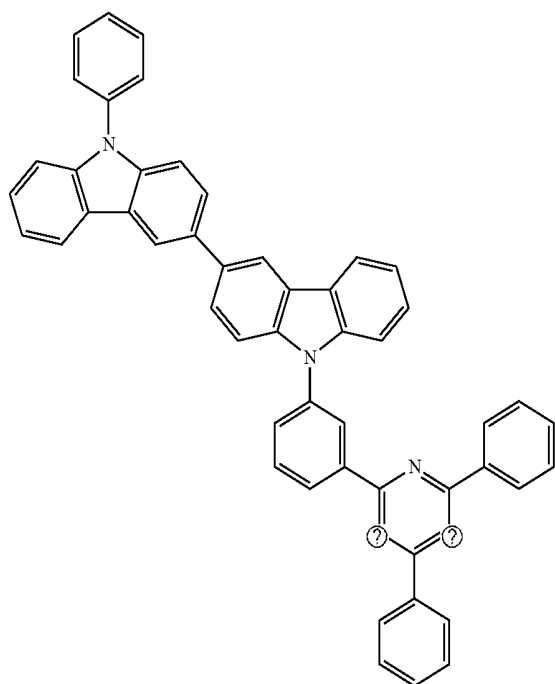
H2-32



H2-33

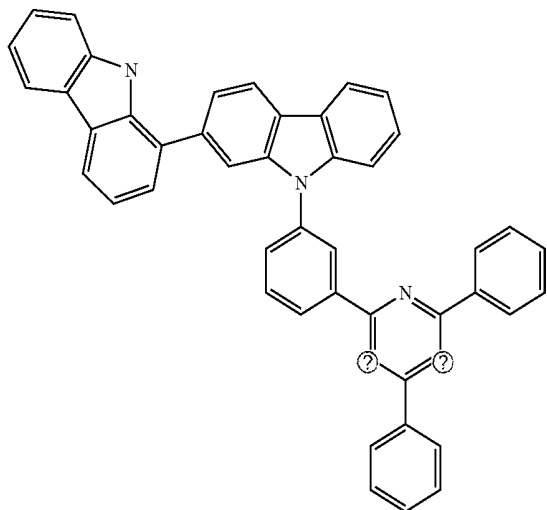


H2-30

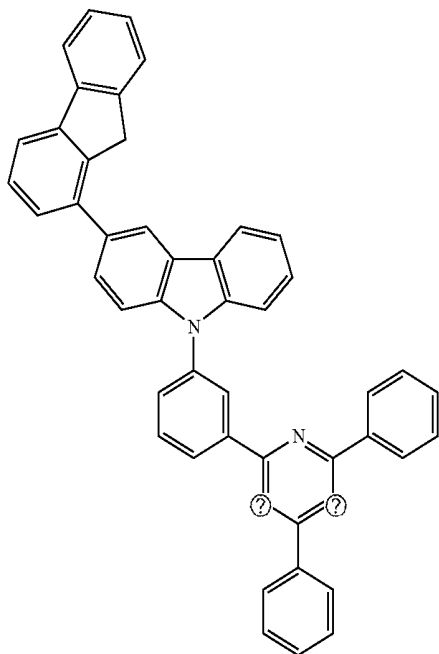


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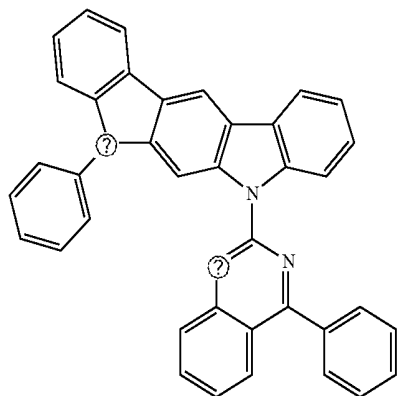
H2-34



H2-35

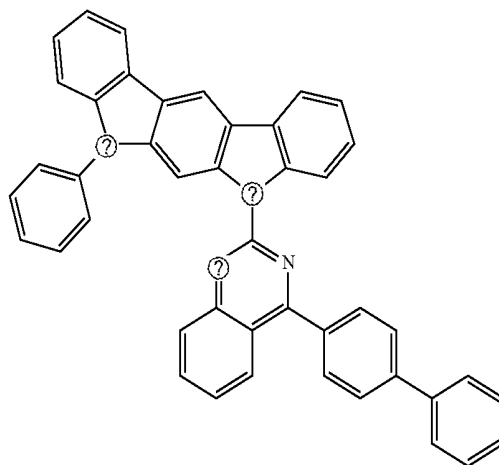


H2-36

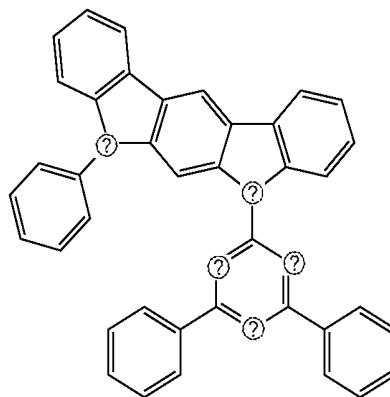


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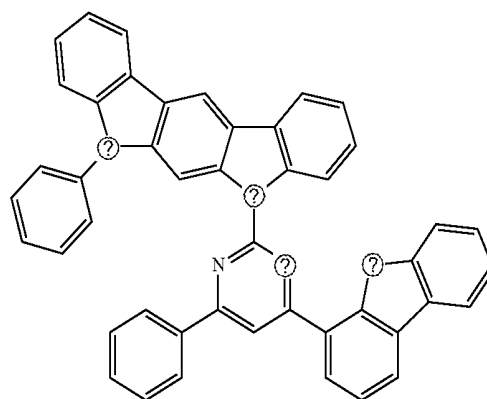
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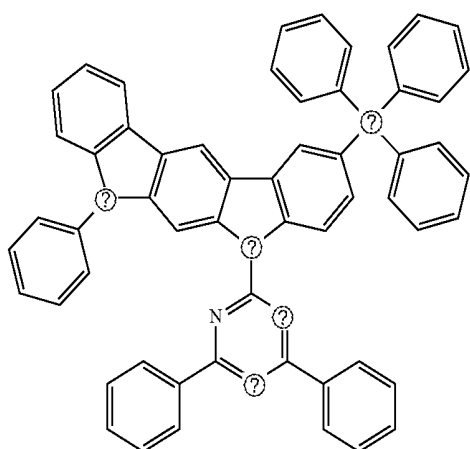
H2-38



H2-39

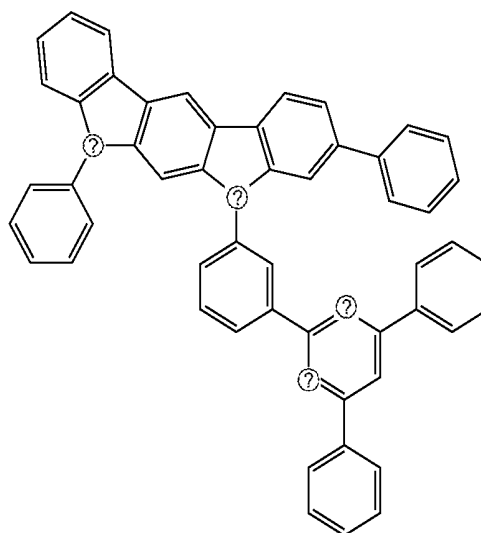


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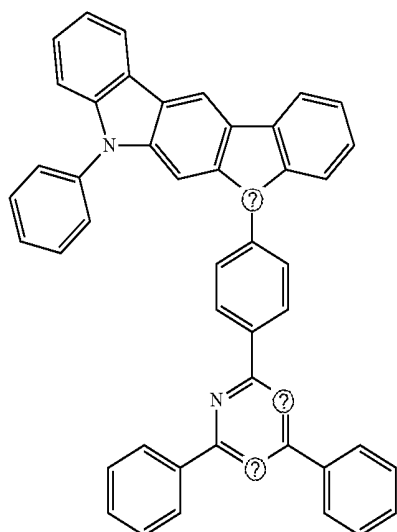


H2-40

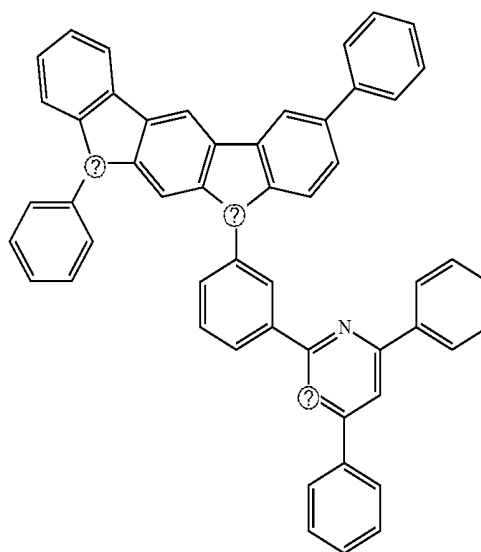
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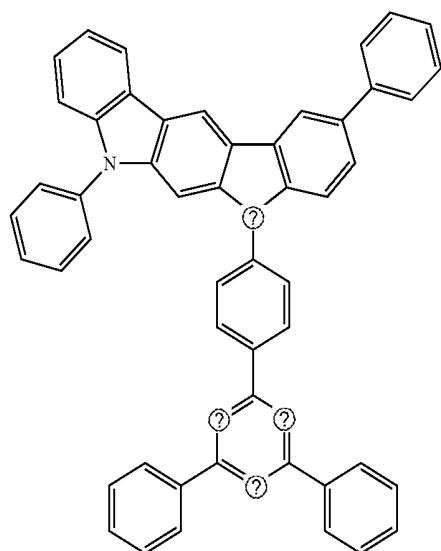
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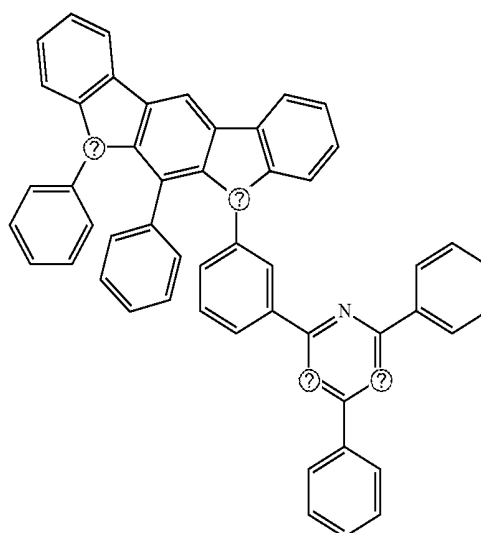
H2-41



H2-44



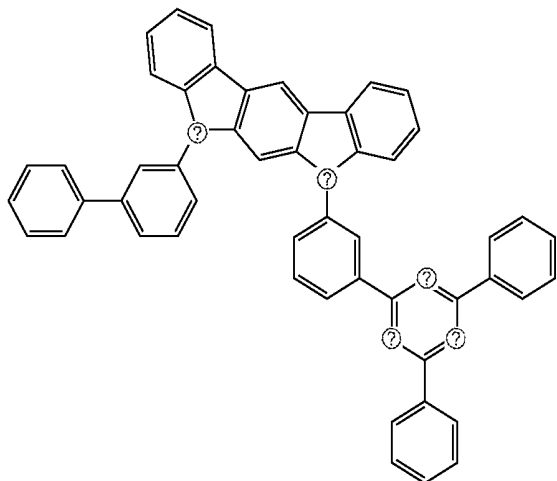
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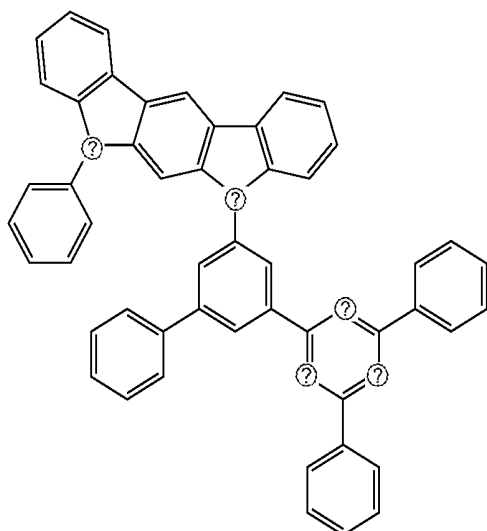
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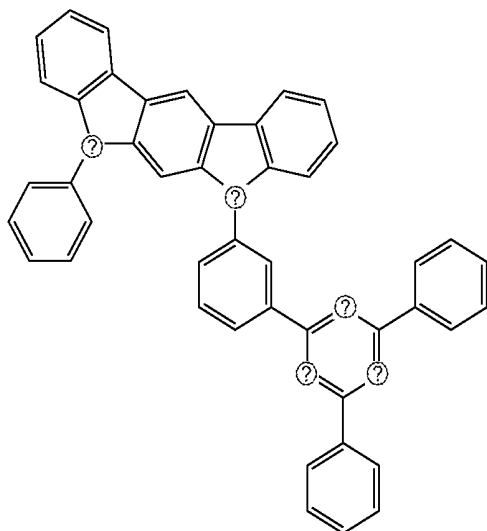
H2-46



H2-47

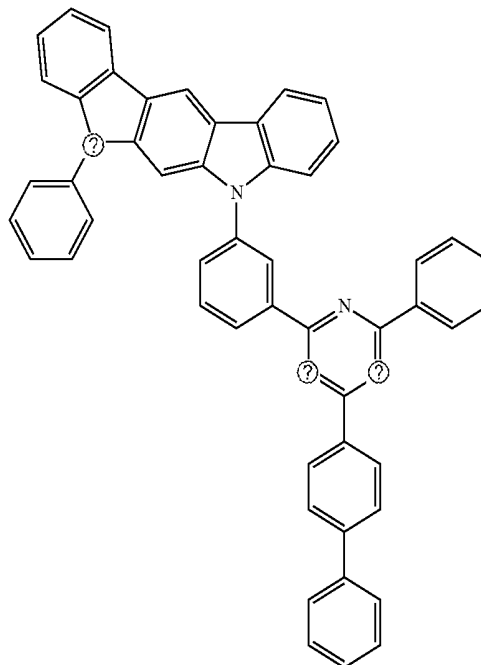


H2-48

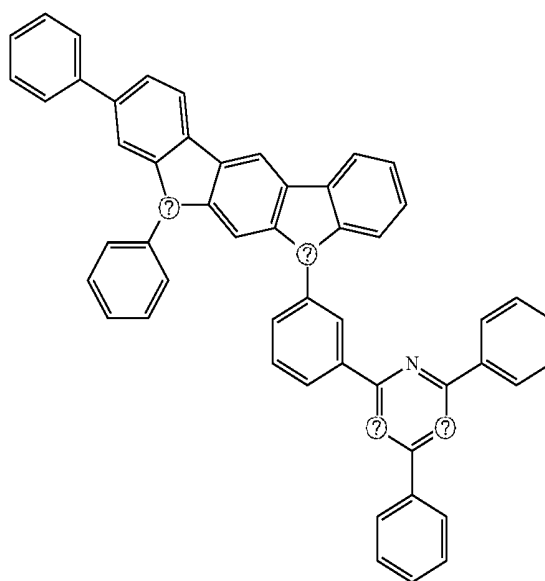


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H2-49

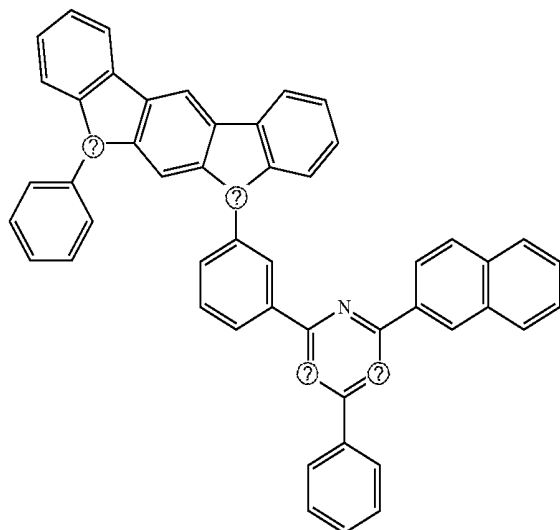


H2-50



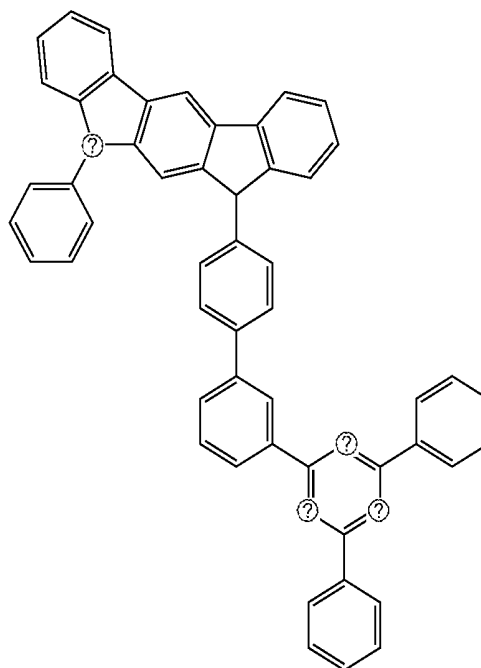
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H2-51

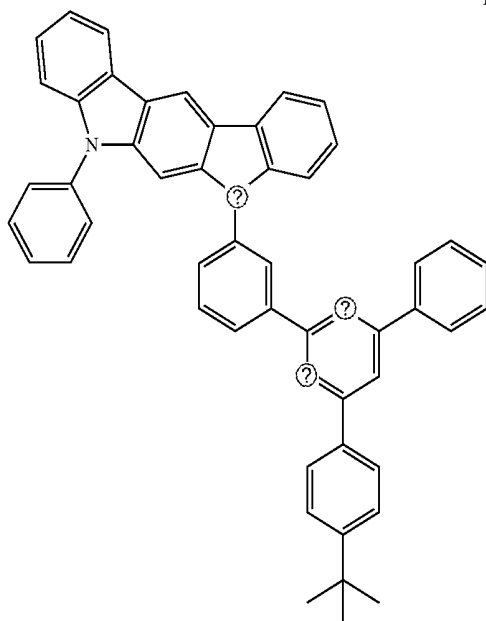


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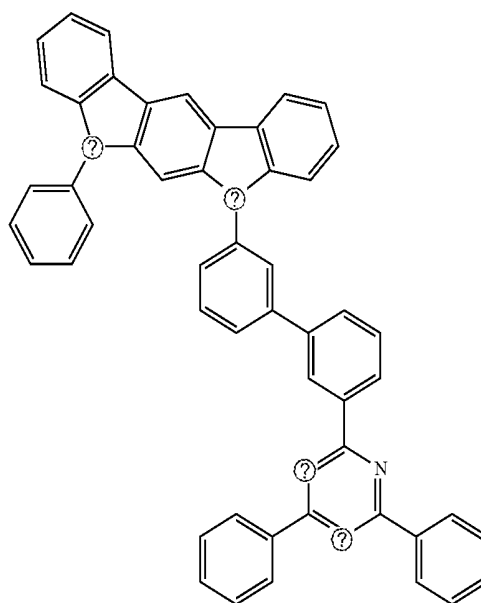
H2-53



H2-52

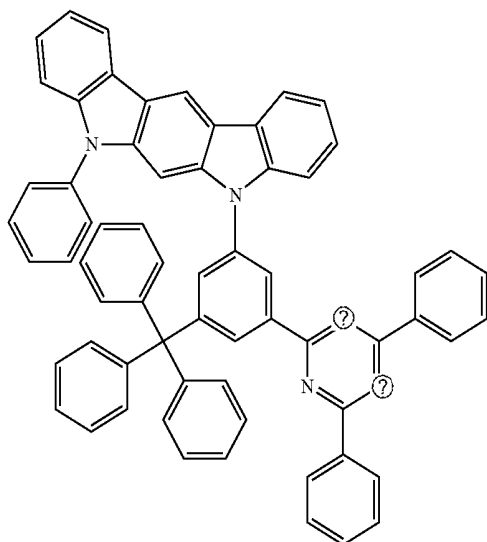


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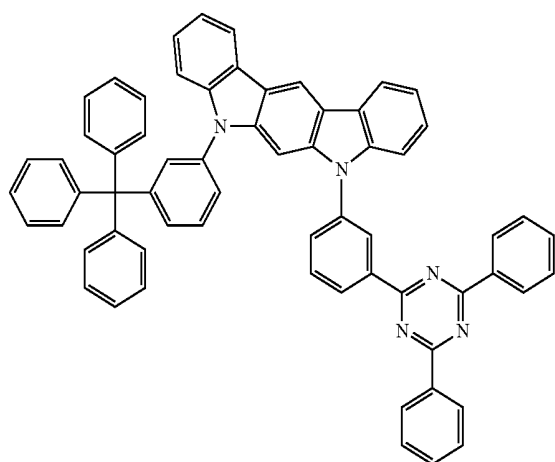


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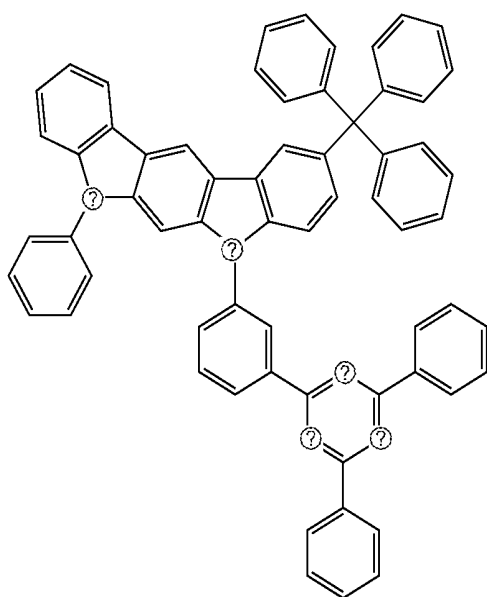
H2-55



H2-56

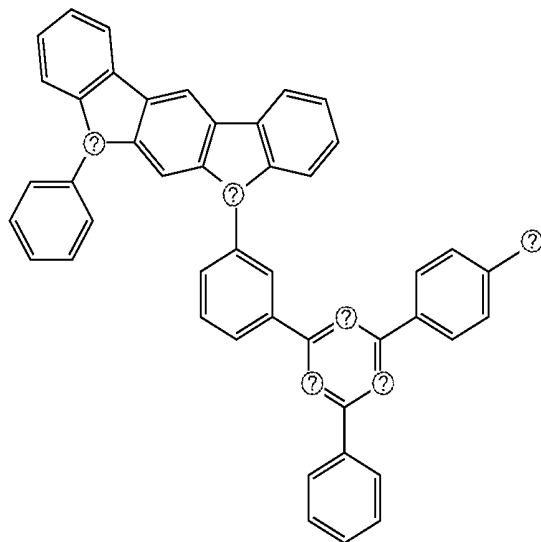


H2-57

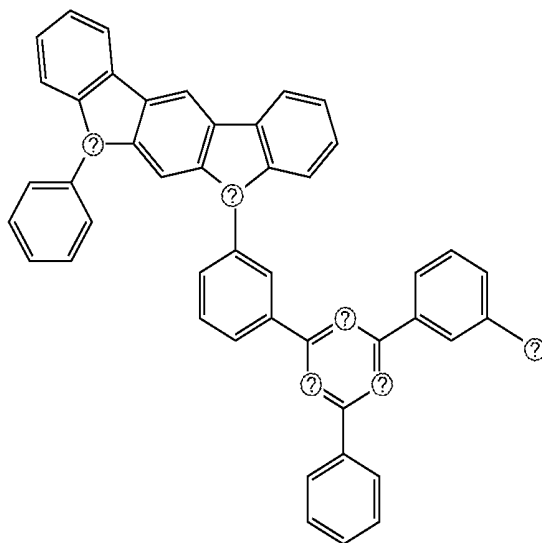


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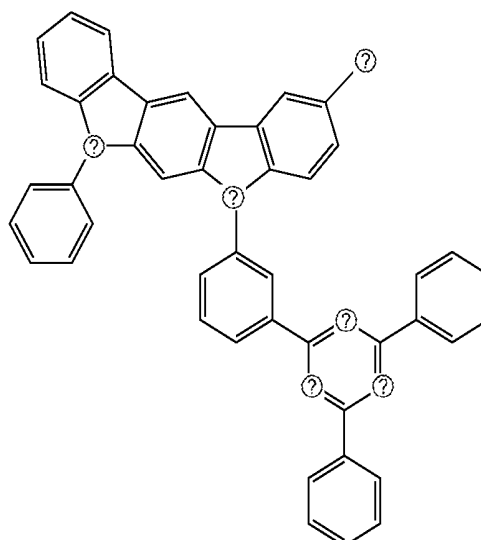
H2-58



H2-59

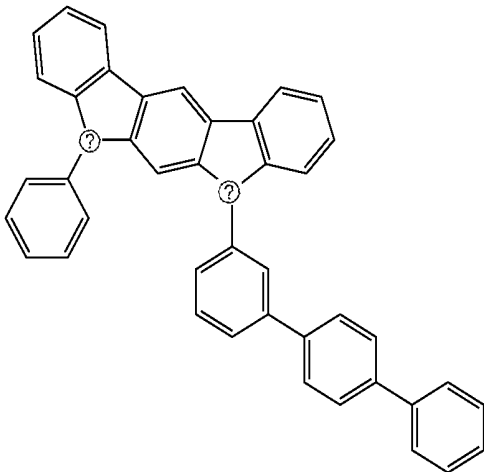


H2-60

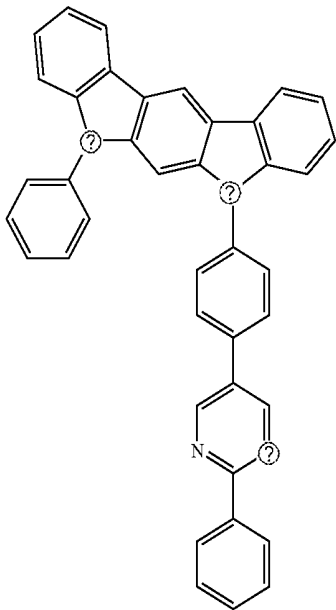


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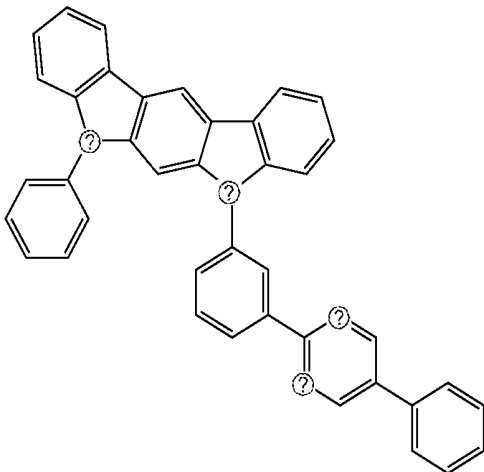
H2-61



H2-62

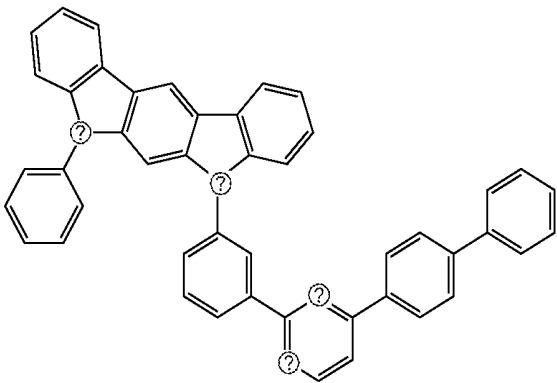


H2-63

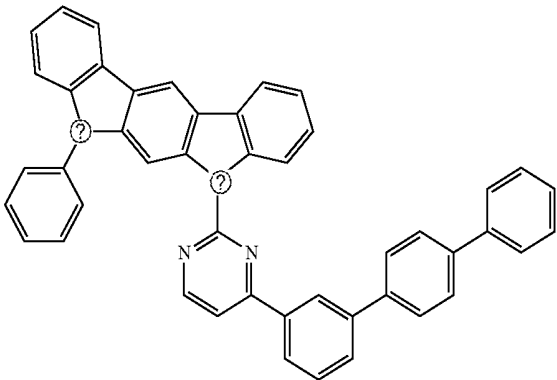


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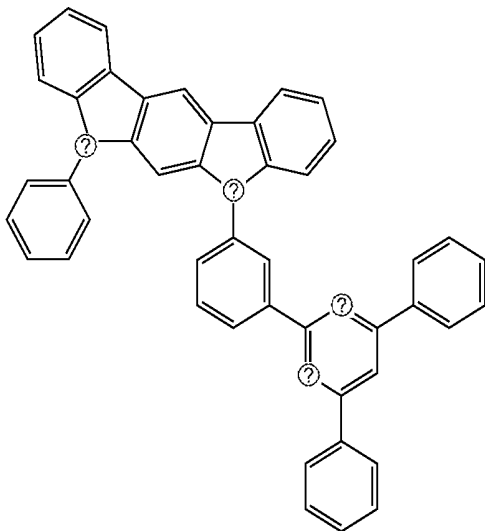
H2-64



H2-65

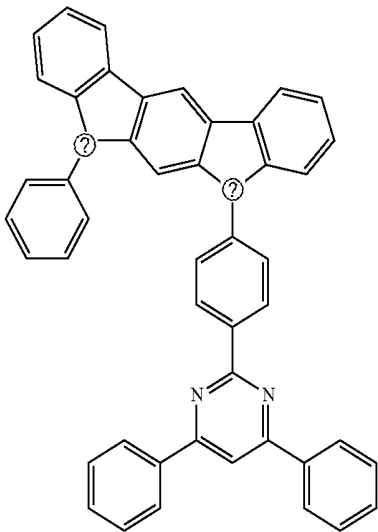


H2-66



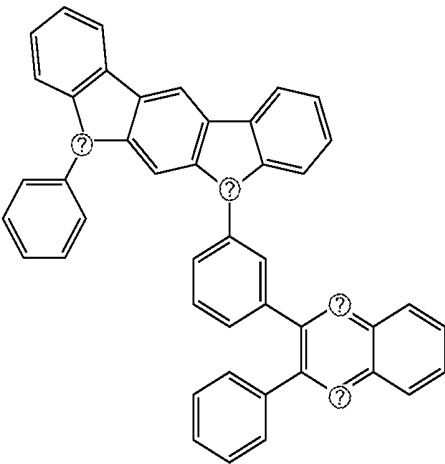
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H2-67

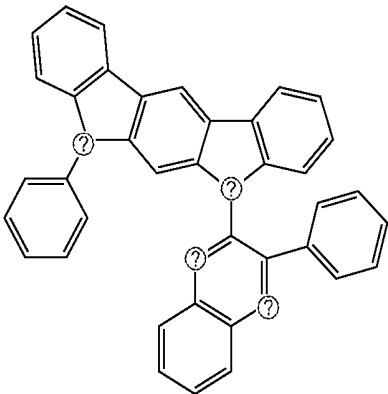


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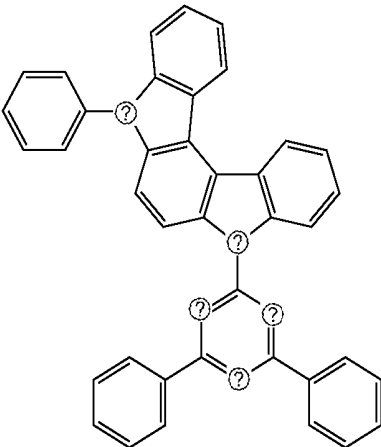
H2-70



H2-68

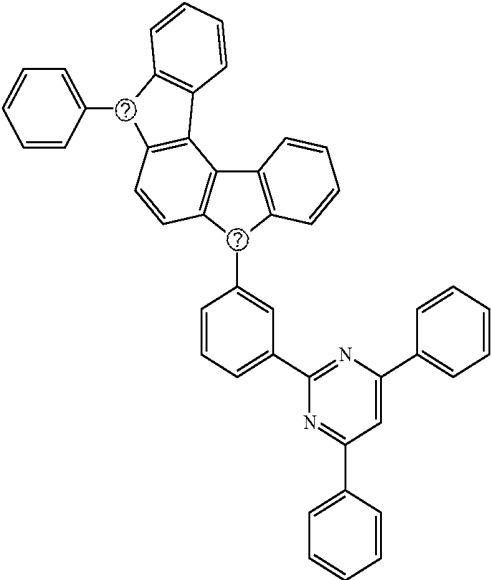
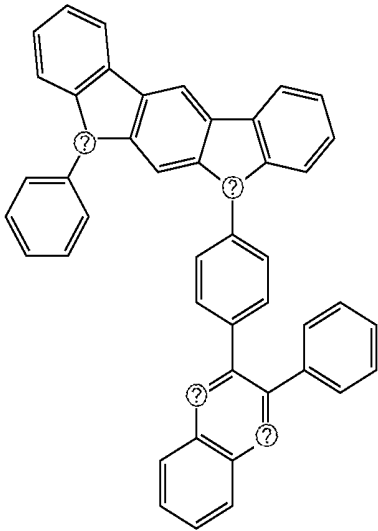


H2-71



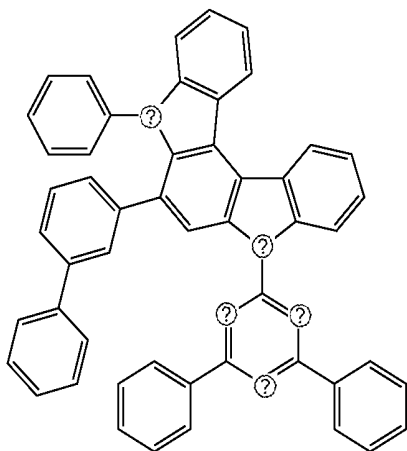
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H2-69

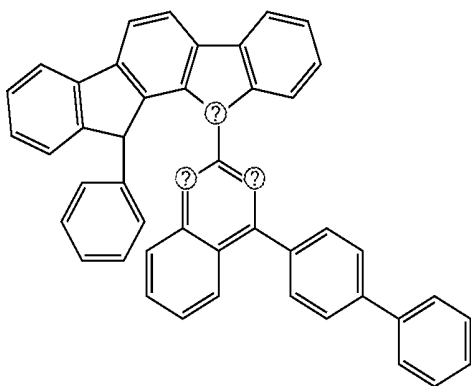


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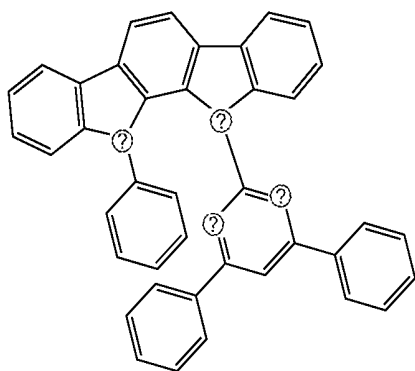
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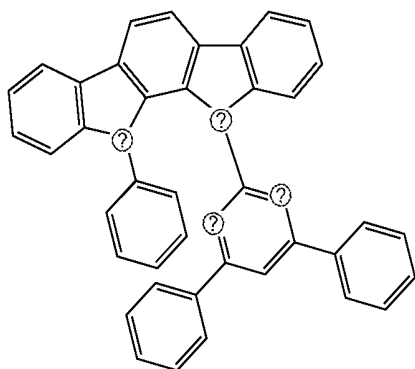
H2-74



H2-75

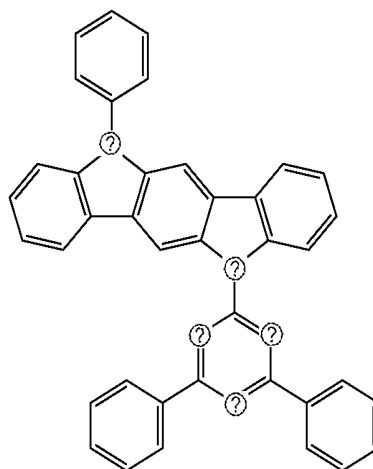


H2-76

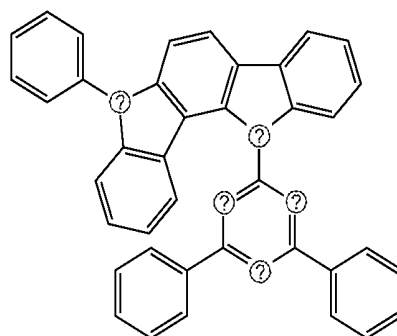


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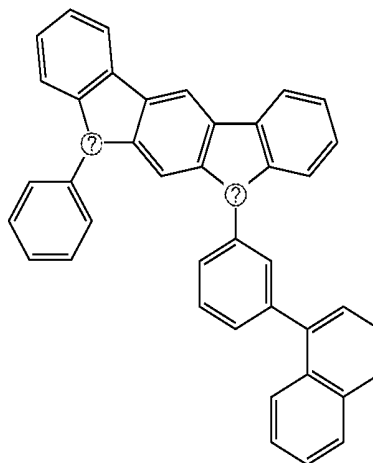
H2-77



H2-78

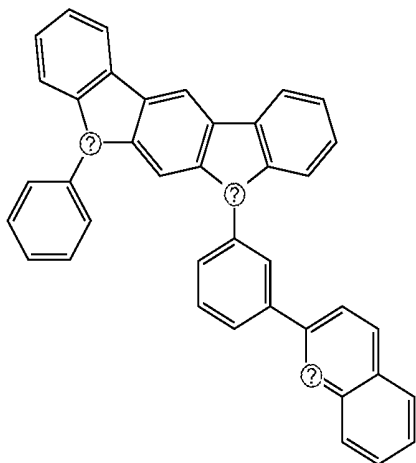


H2-79

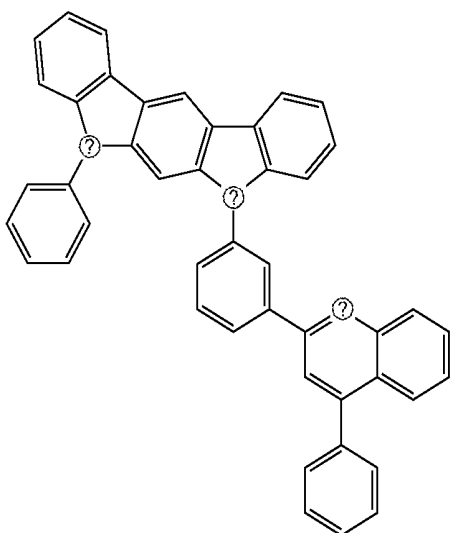


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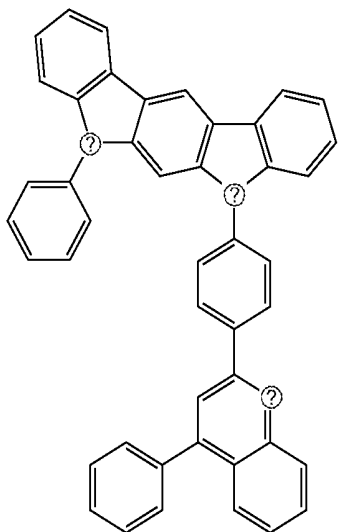
H2-80



H2-81

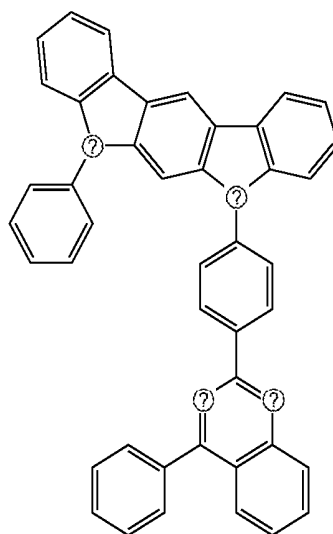


H2-82

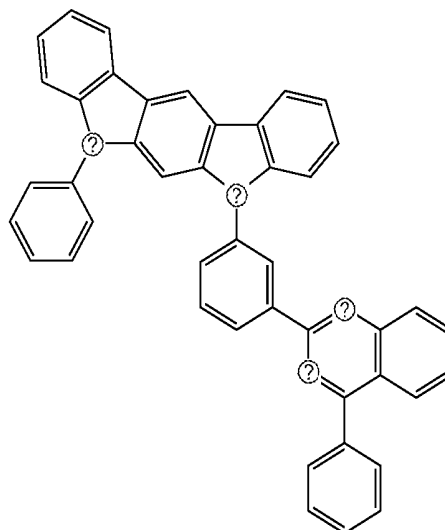


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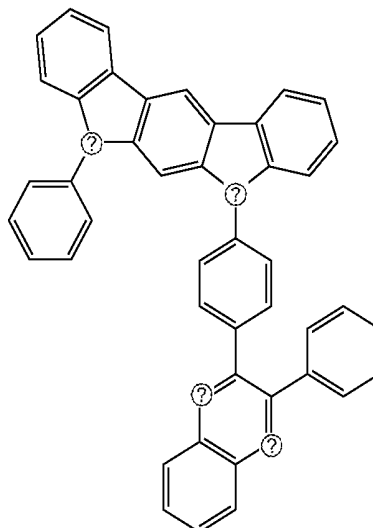
H2-83



H2-84

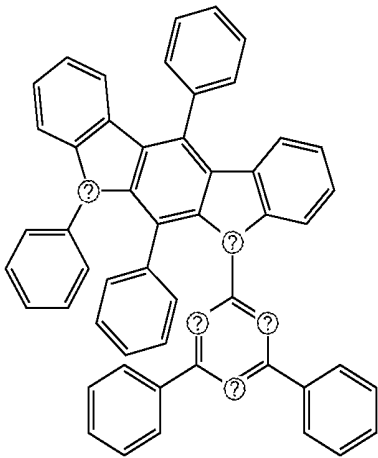


H2-85



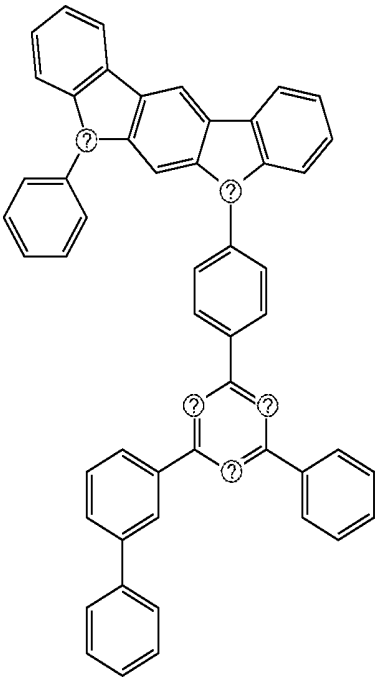
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H2-86

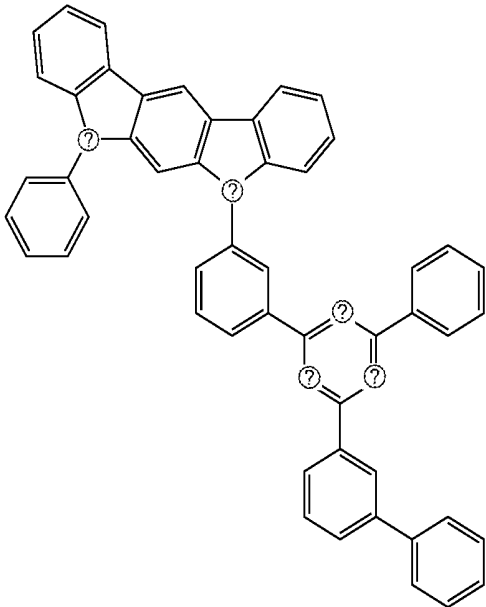


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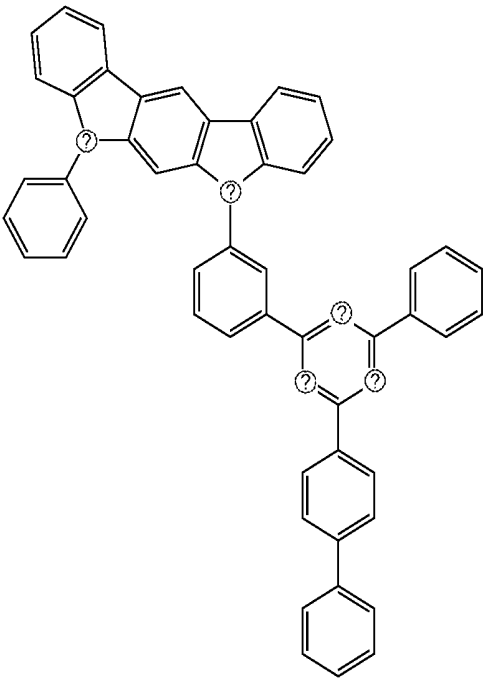
H2-88



H2-87

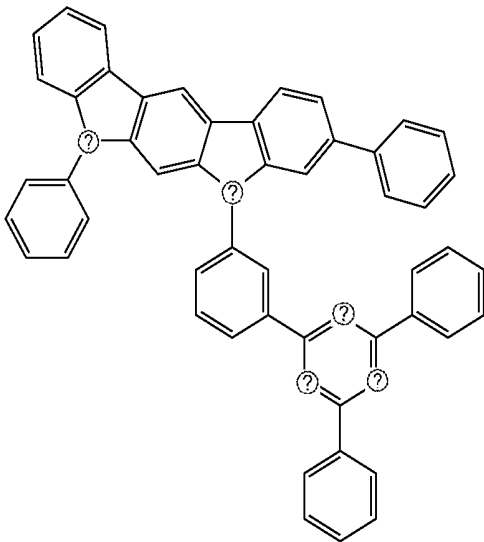


H2-89

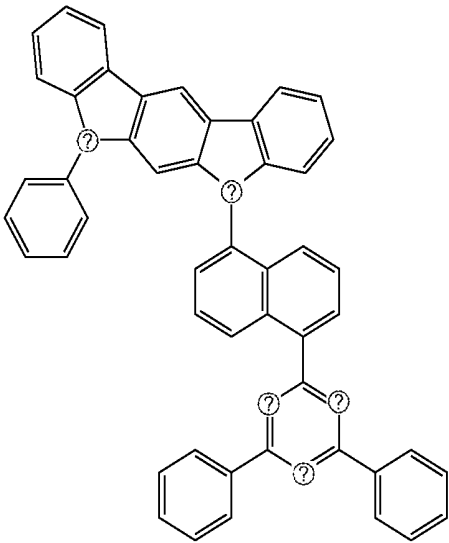


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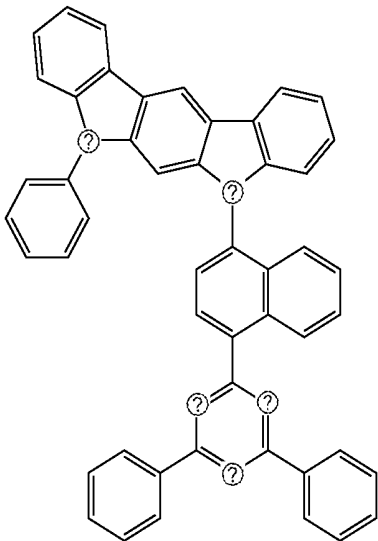
H2-90



H2-91

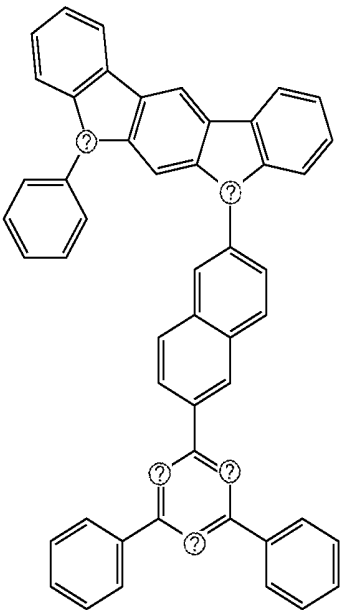


H2-92

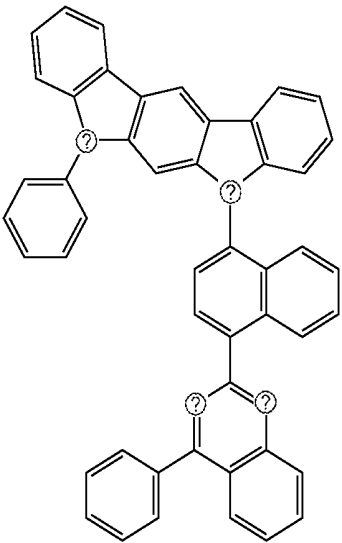


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H2-93

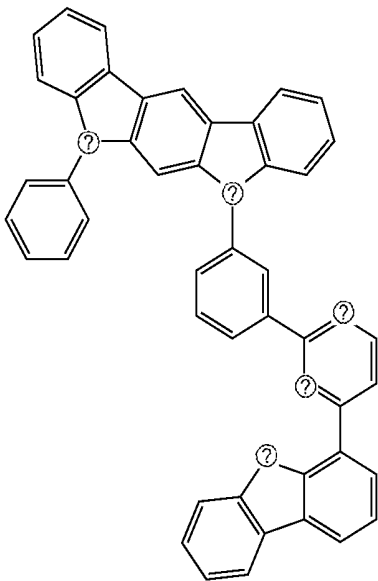


H2-94



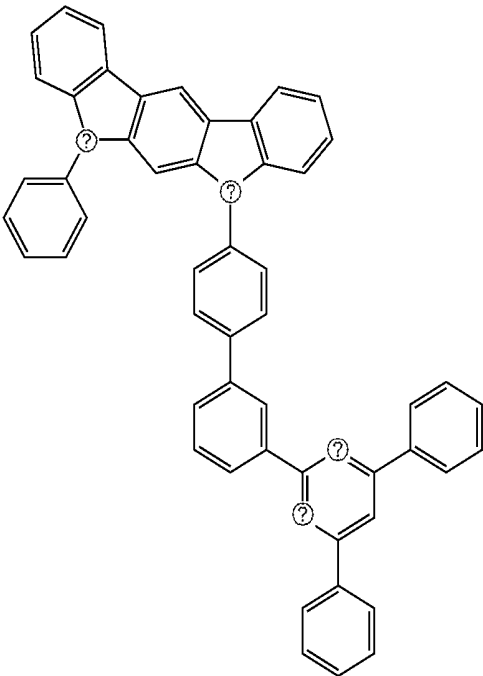
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H2-95

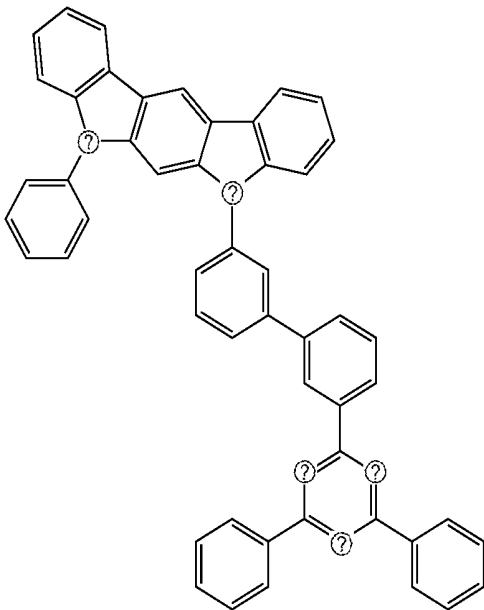


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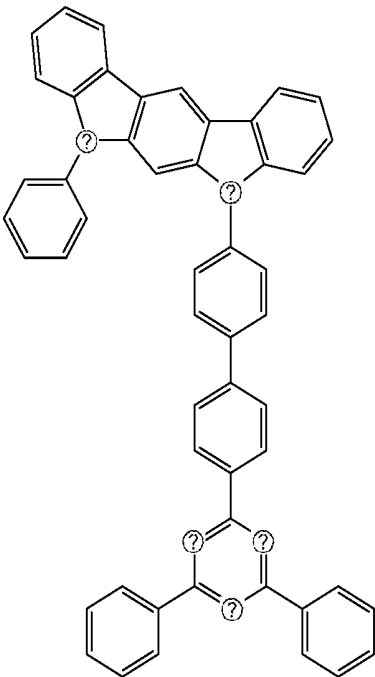
H2-97



H2-96

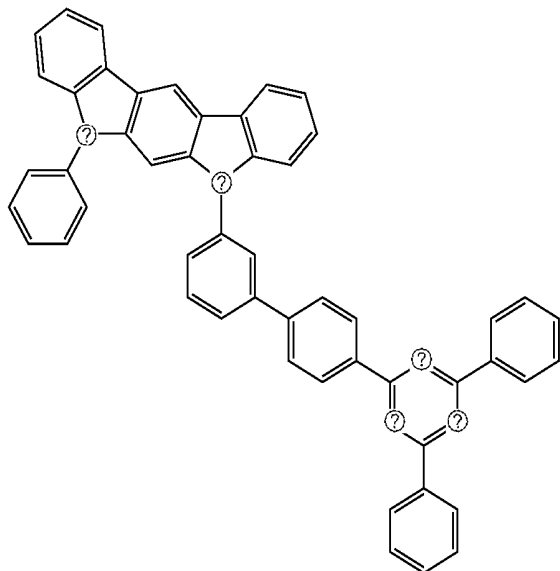


H2-98



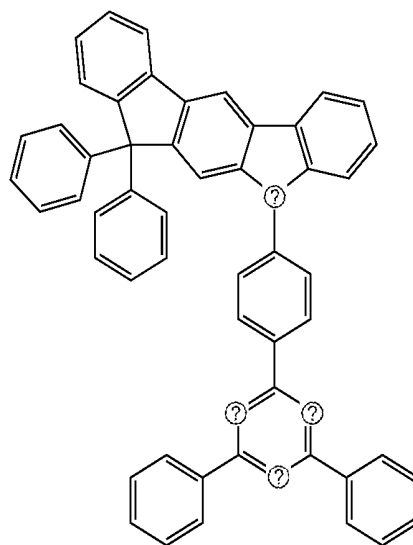
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H2-99

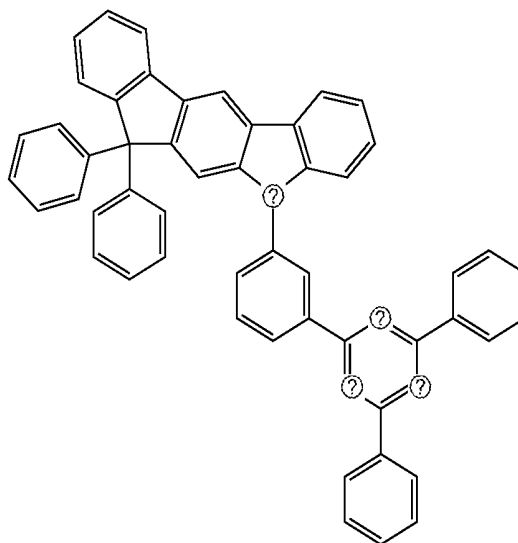


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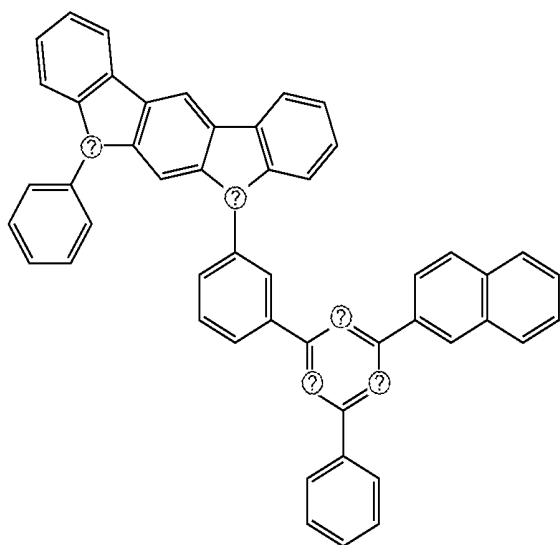
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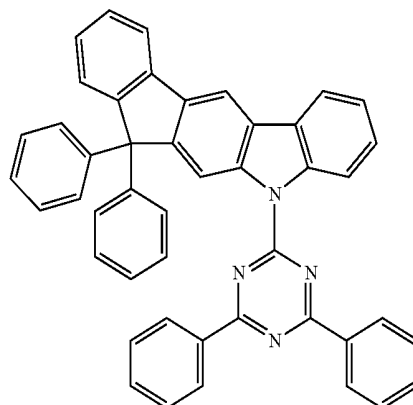
H2-102



H2-100

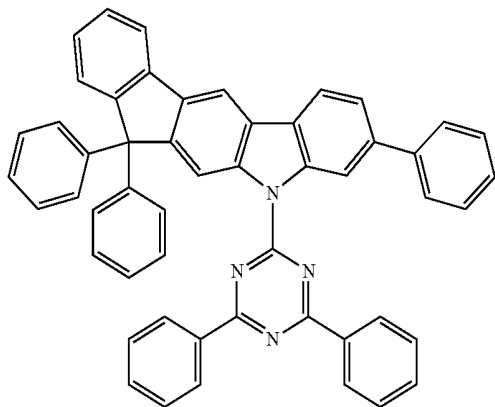


H2-103



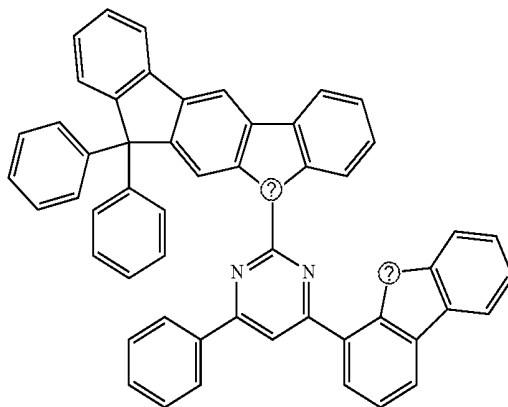
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H2-104

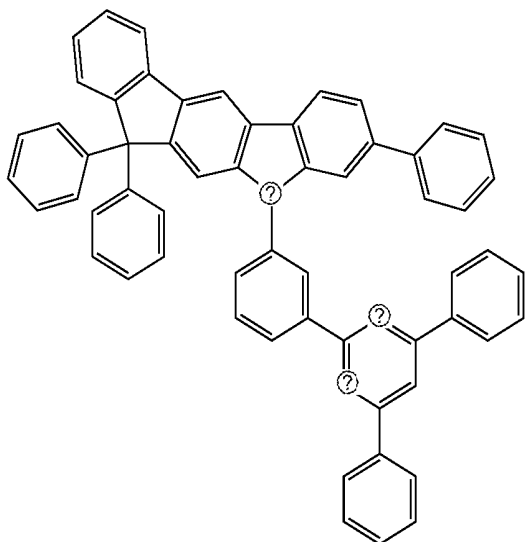


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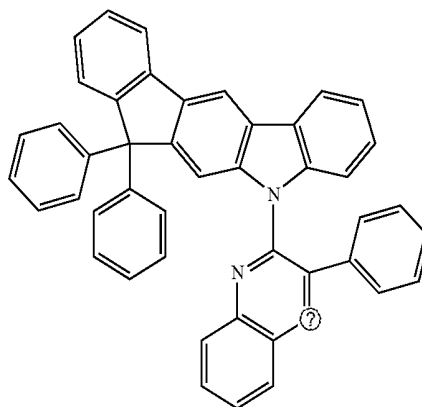
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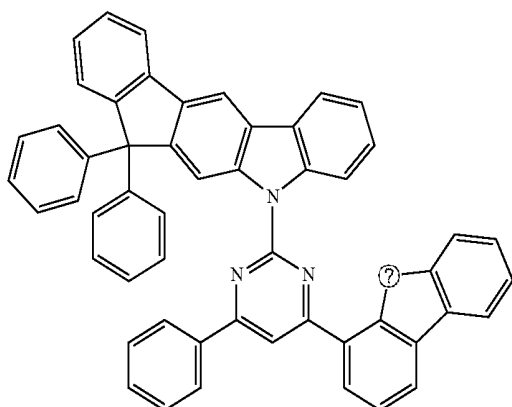
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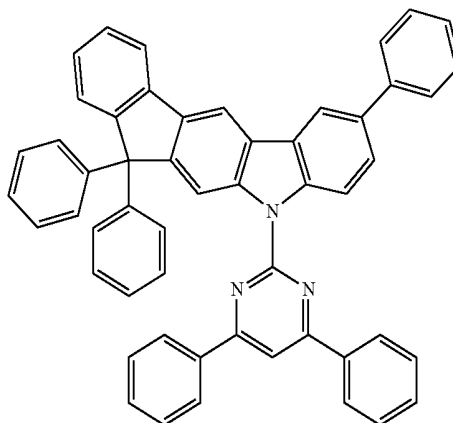
H2-108



H2-106

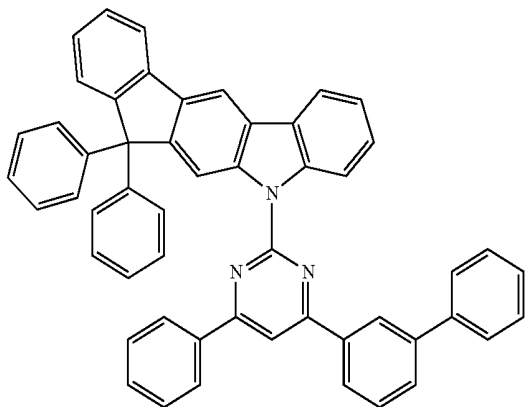


H2-109



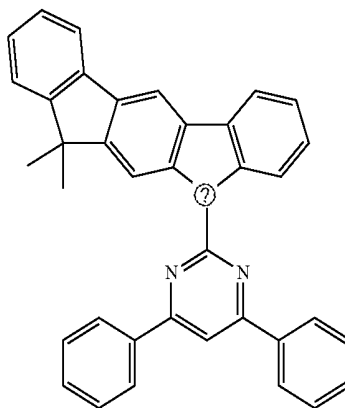
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H2-110

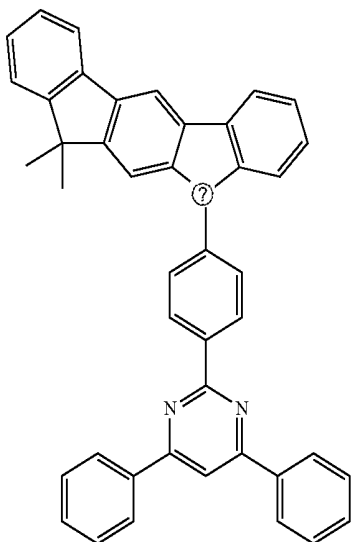


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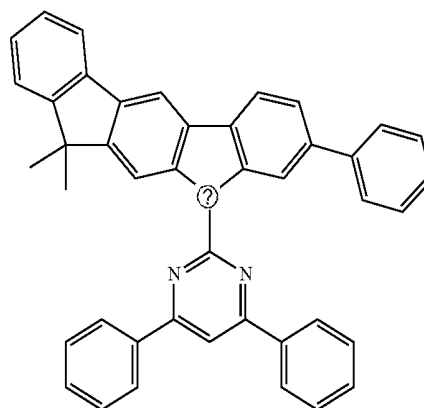
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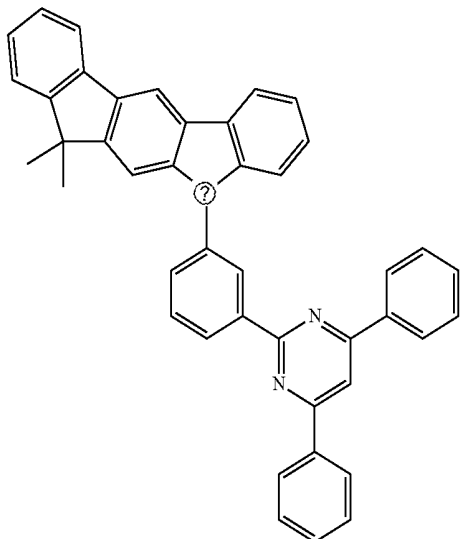
H2-111



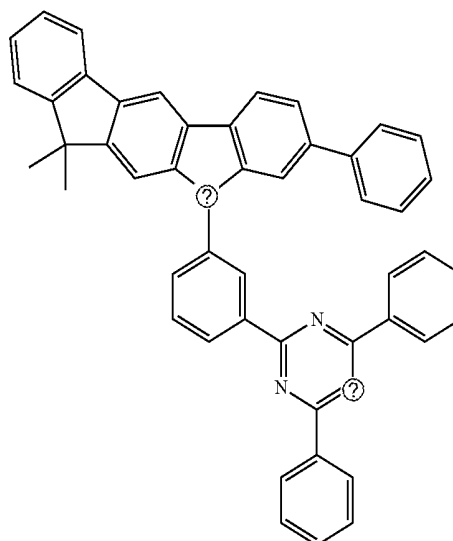
H2-114



H2-112

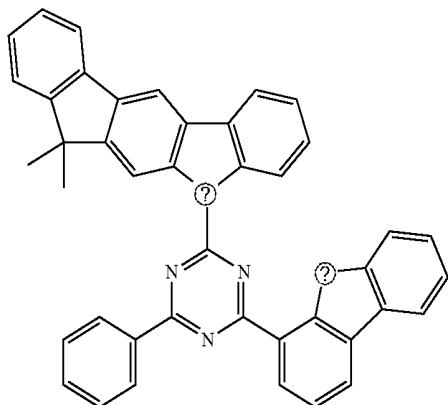


H2-115



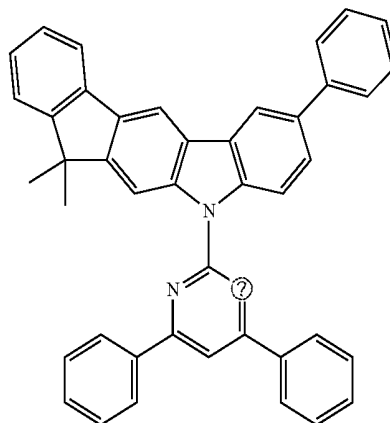
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H2-116



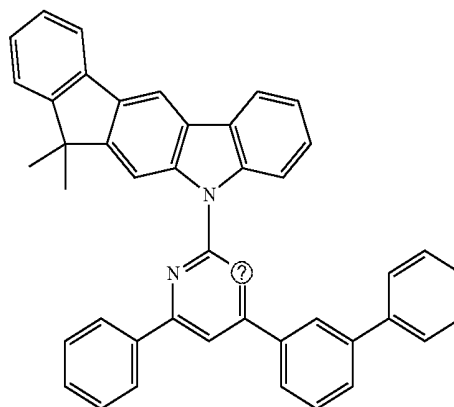
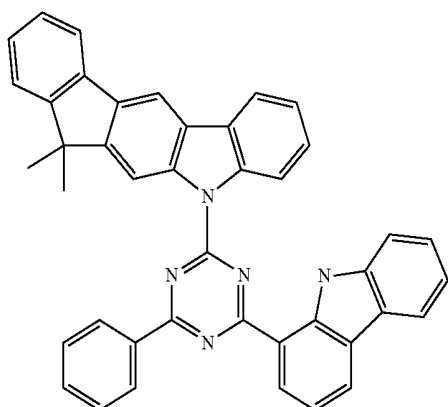
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H2-119



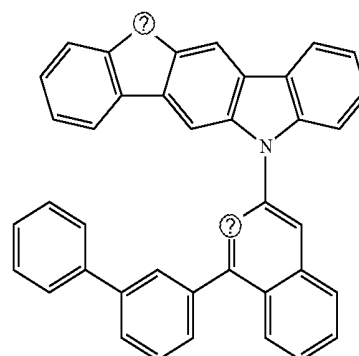
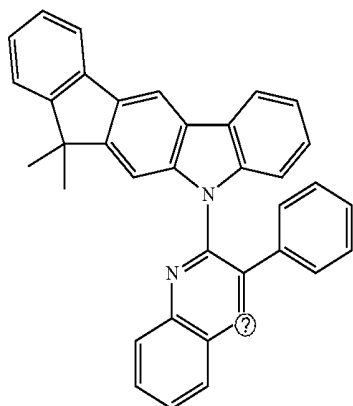
H2-120

H2-117

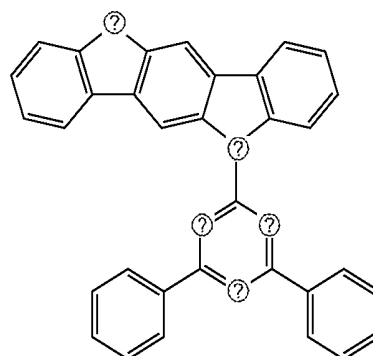


H2-121

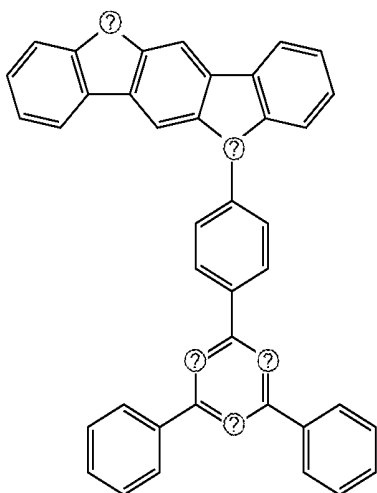
H2-118



H2-122

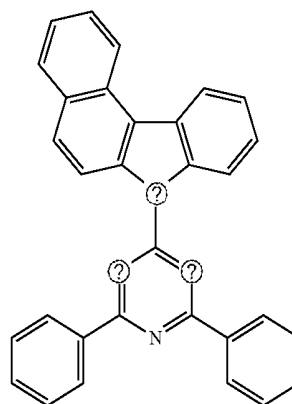


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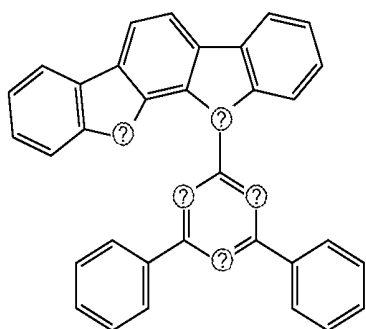


H2-123

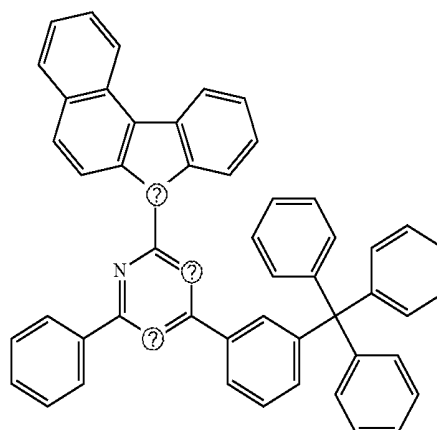
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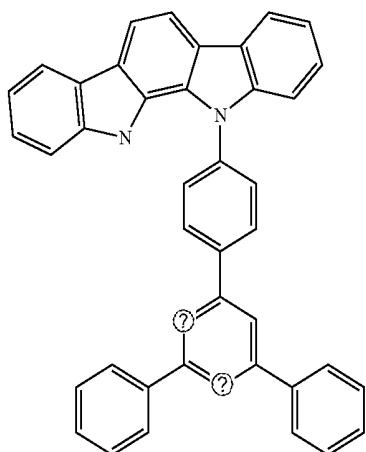
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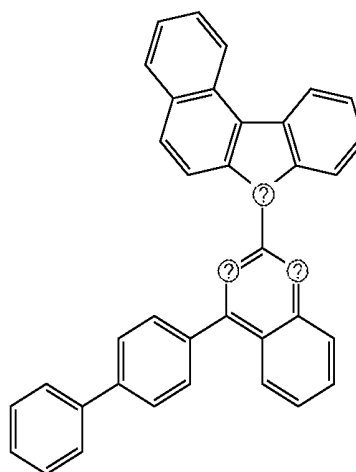
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H2-127



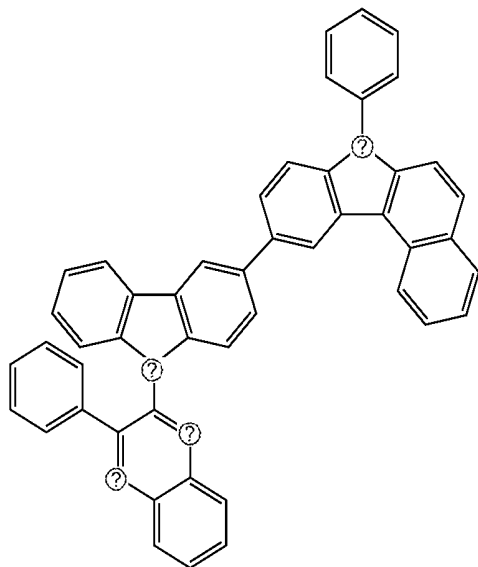
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H2-128

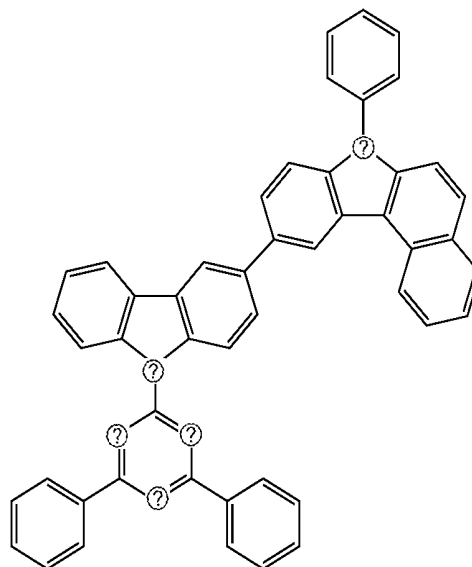
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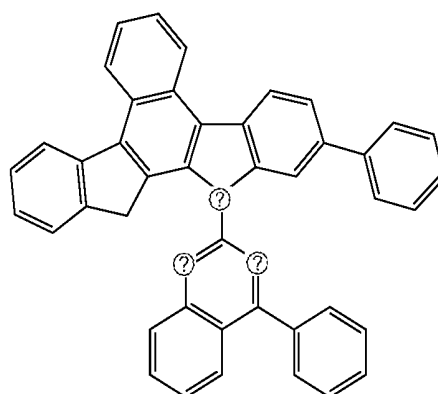


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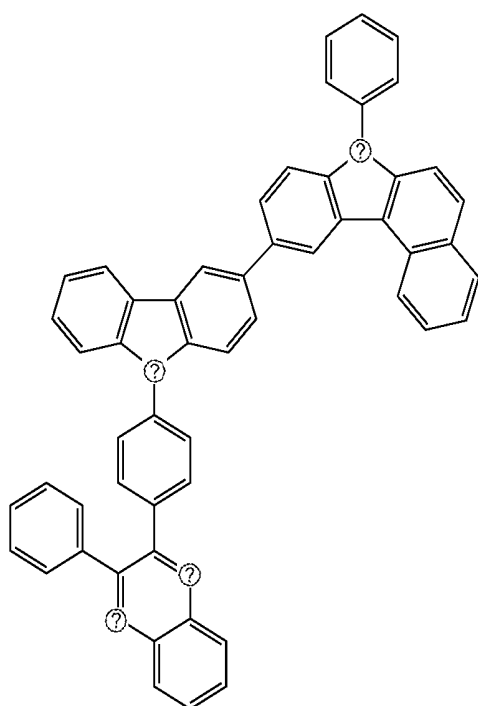
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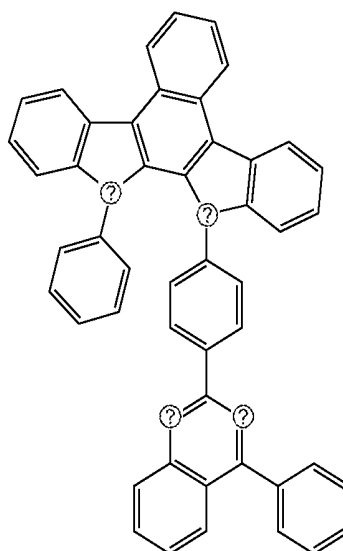
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H2-134

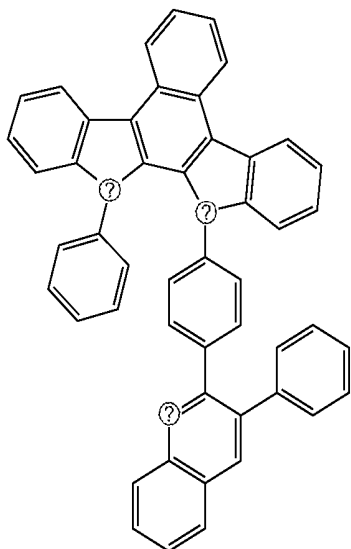


H2-137



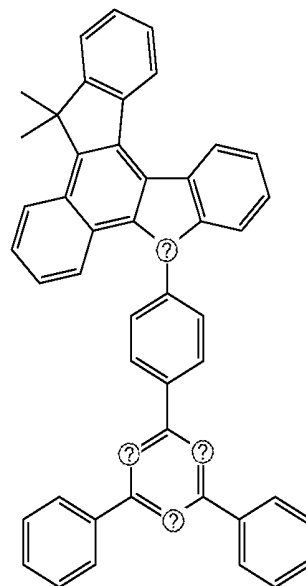
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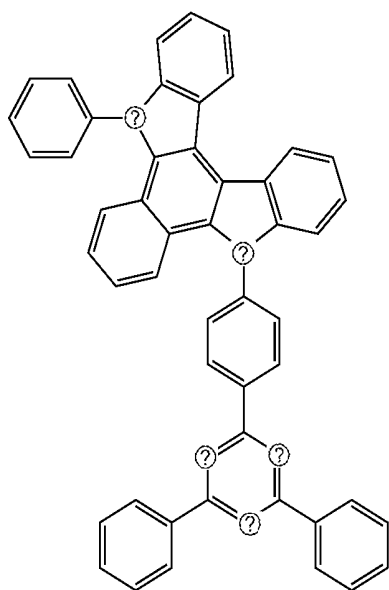


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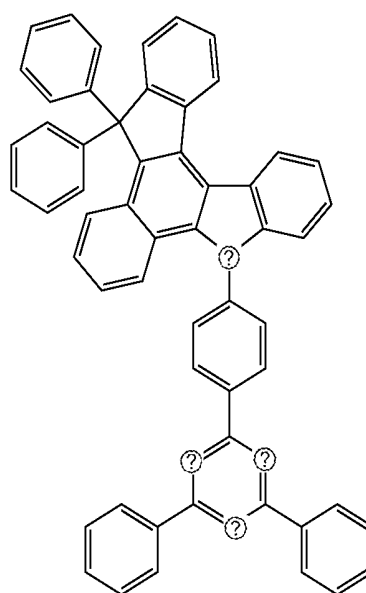
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H2-139

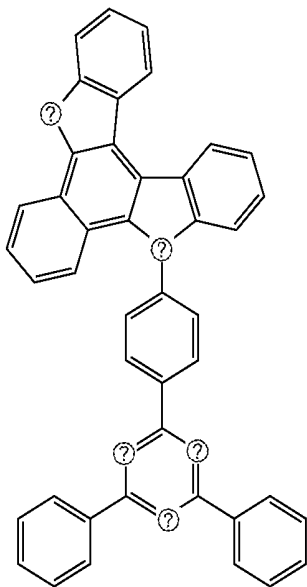


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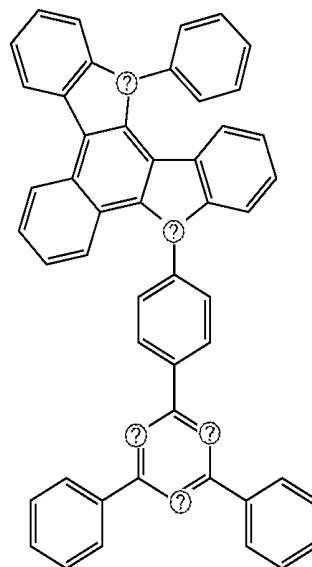
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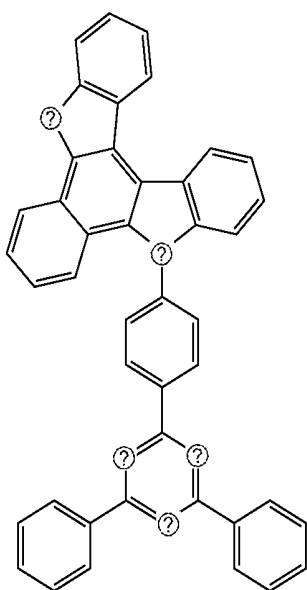


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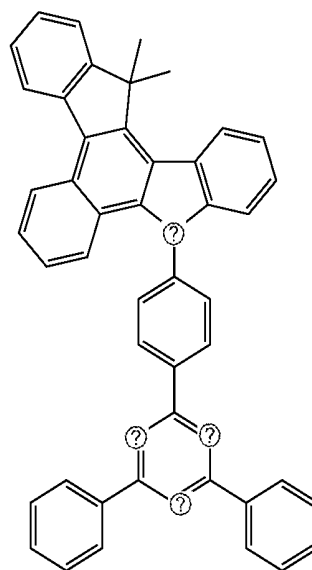
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H2-143

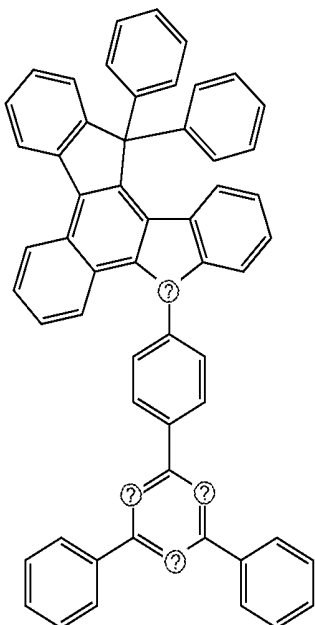


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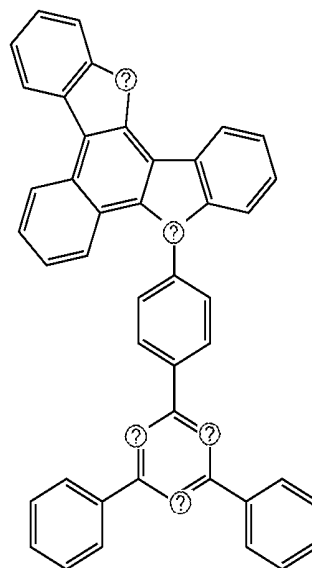
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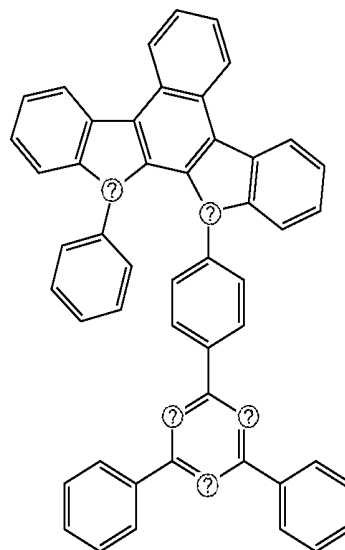


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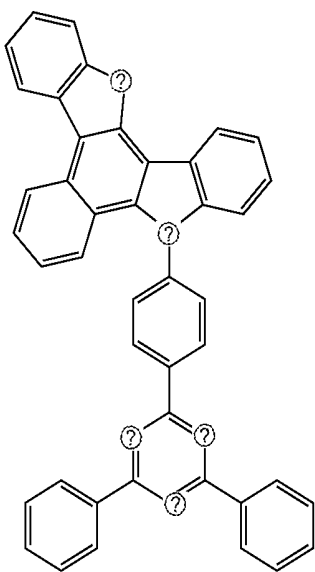
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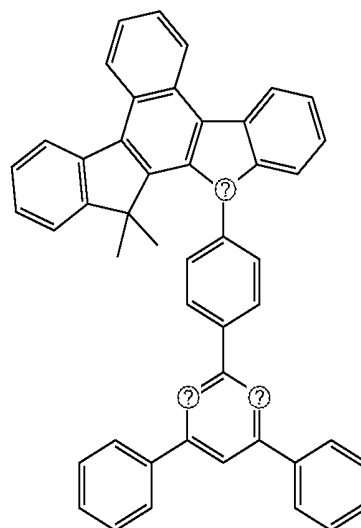
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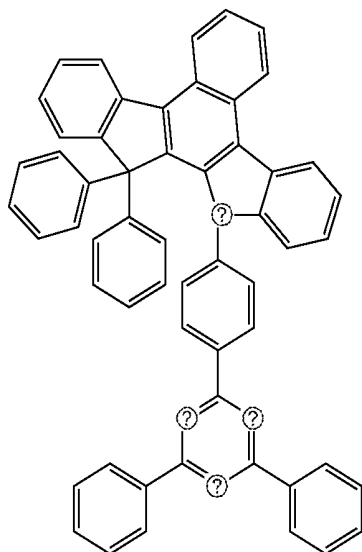
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H2-150

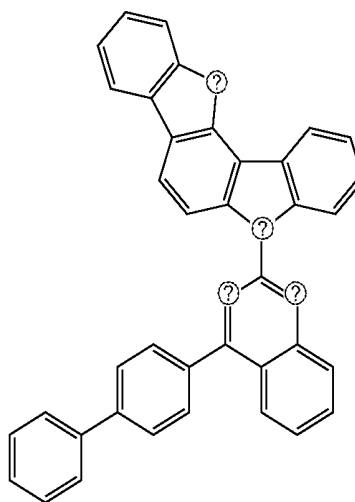


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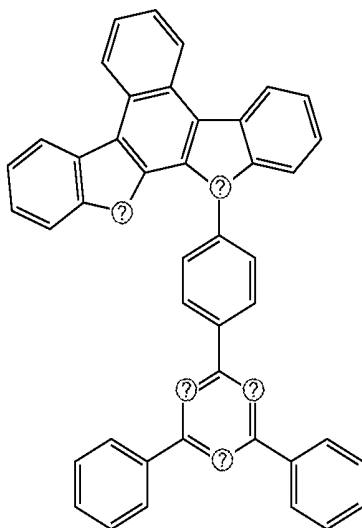
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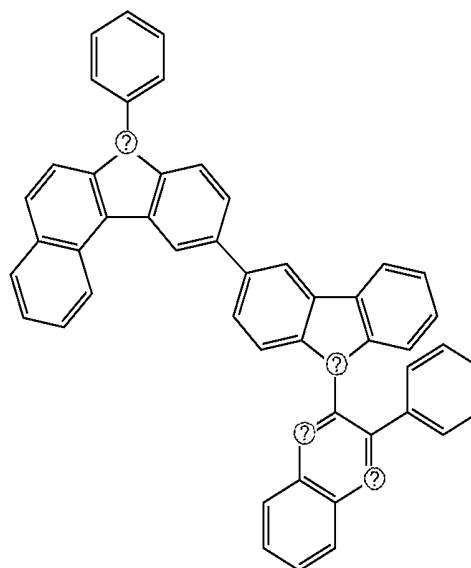


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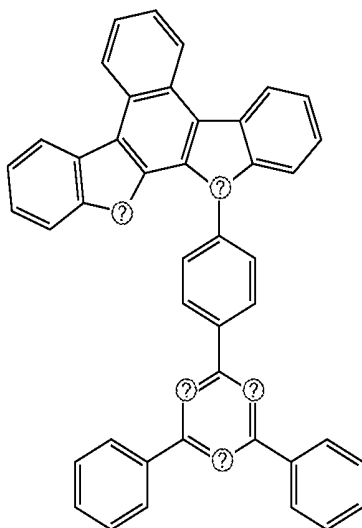
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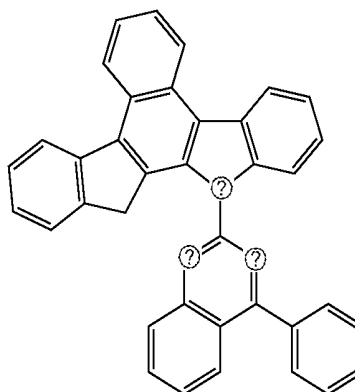
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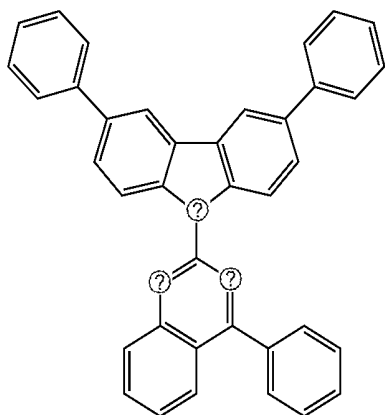
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H2-156

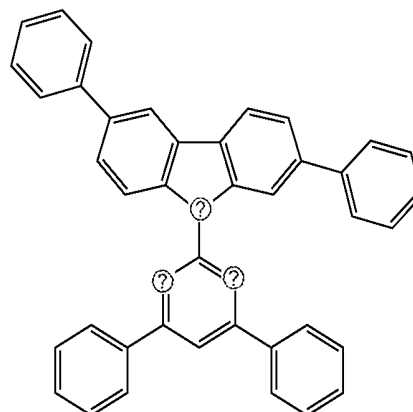


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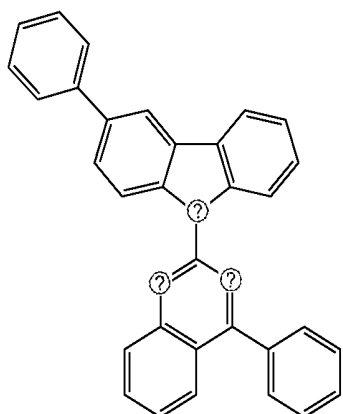


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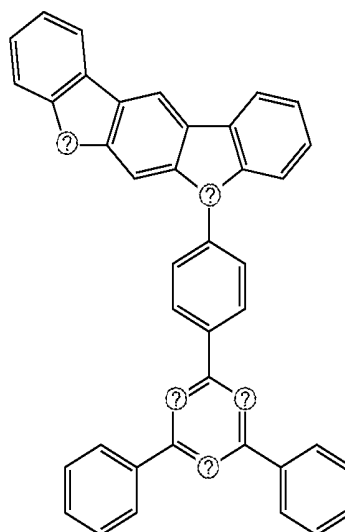
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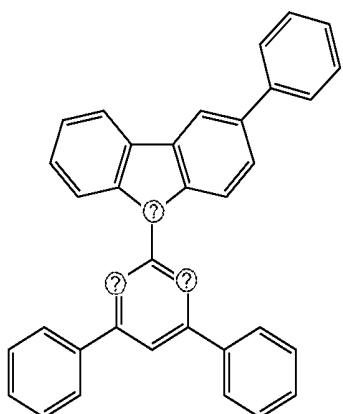
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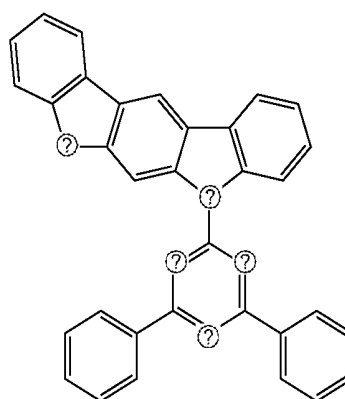
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H2-161



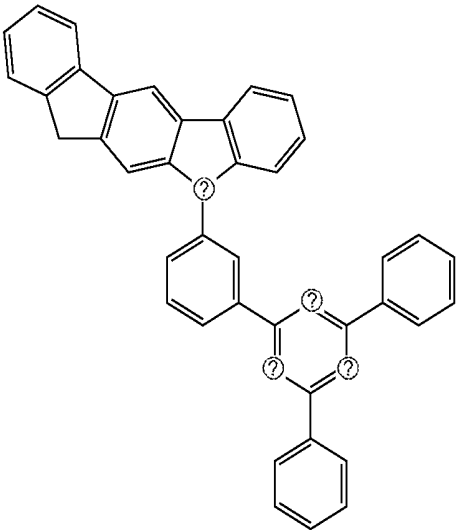
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H2-162

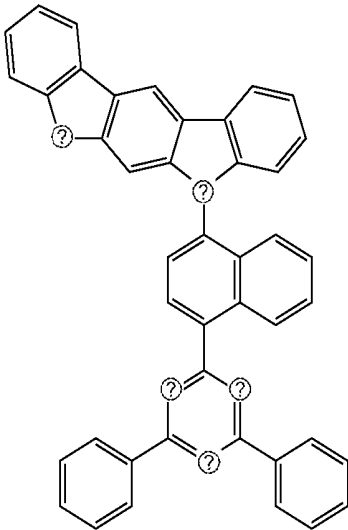
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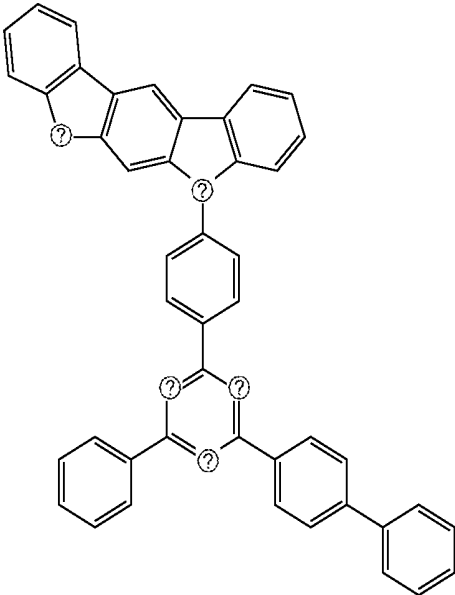
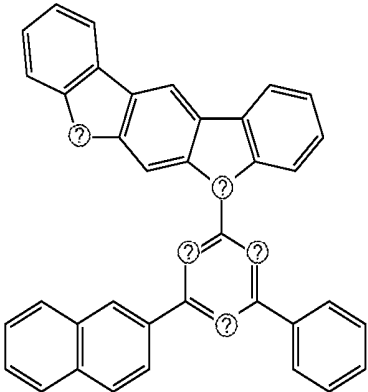
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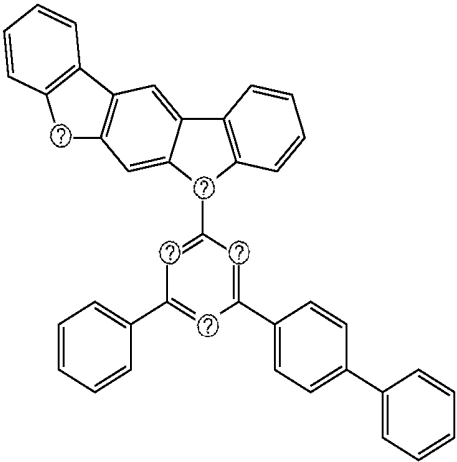


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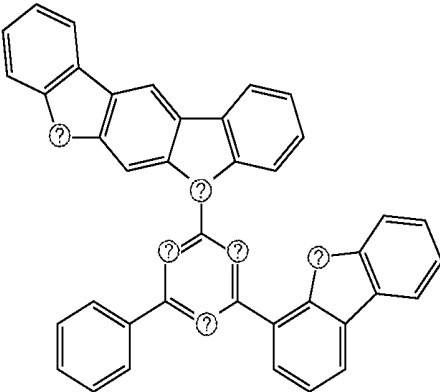
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H2-165

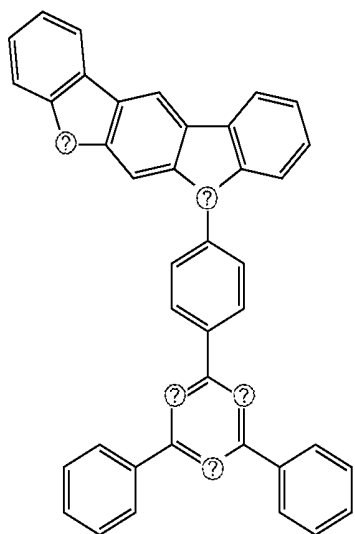


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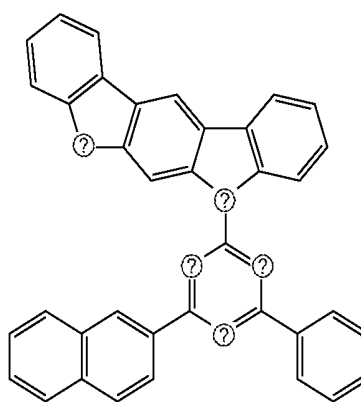
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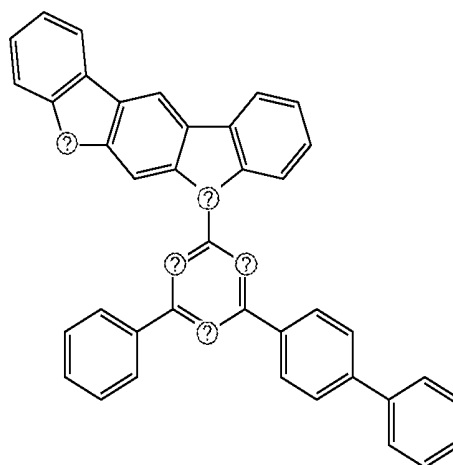


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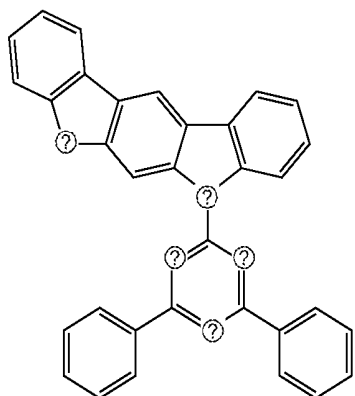
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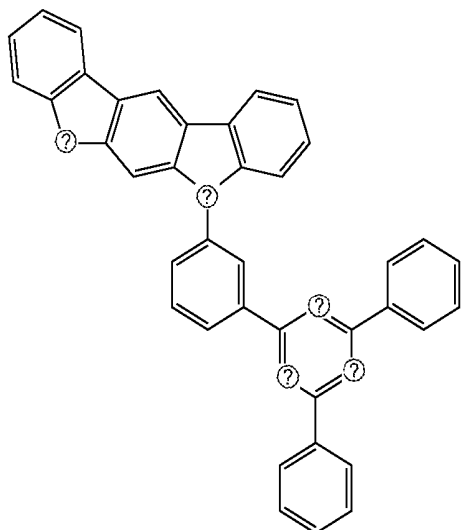
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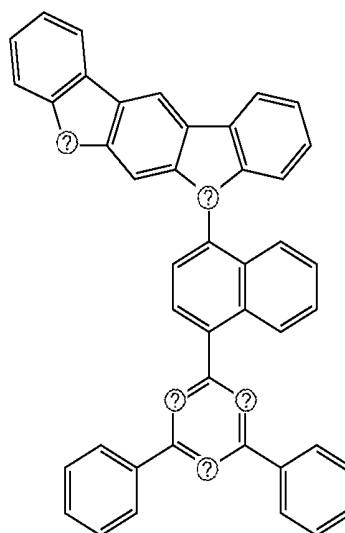
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H2-171

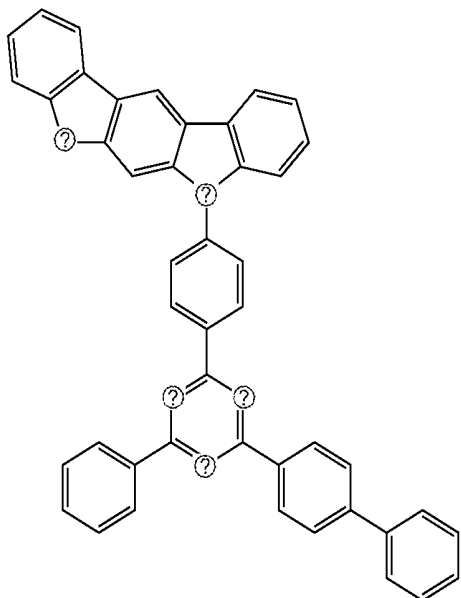


H2-174



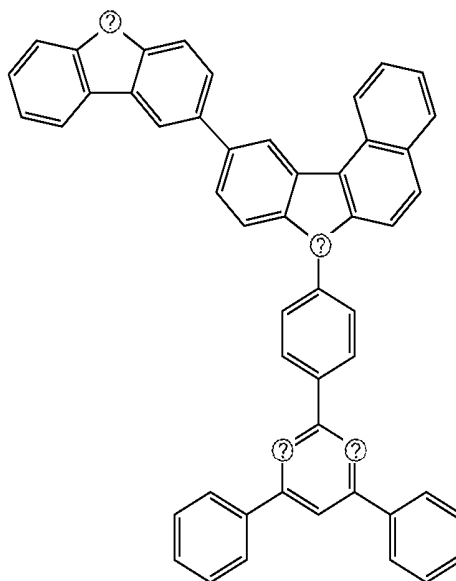
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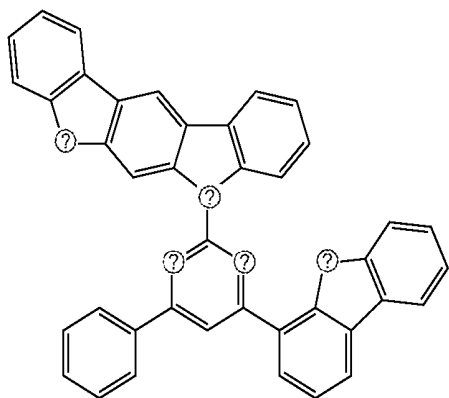


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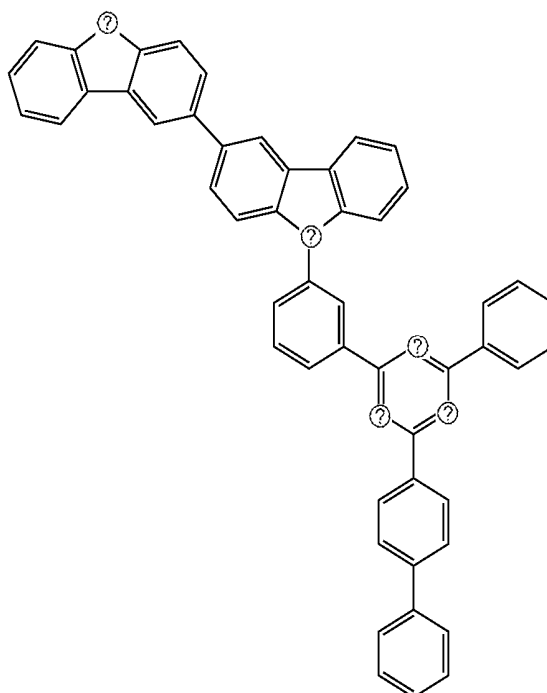
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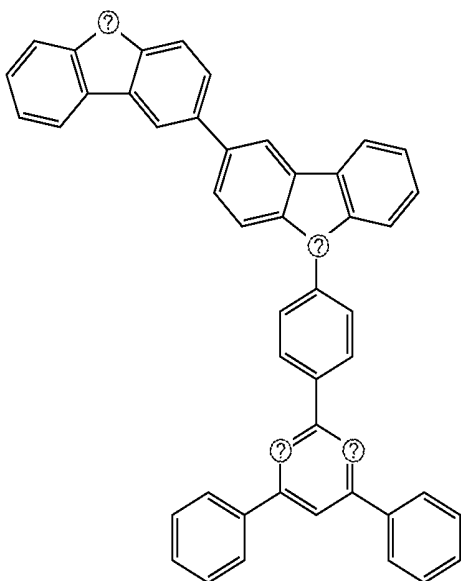
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H2-179

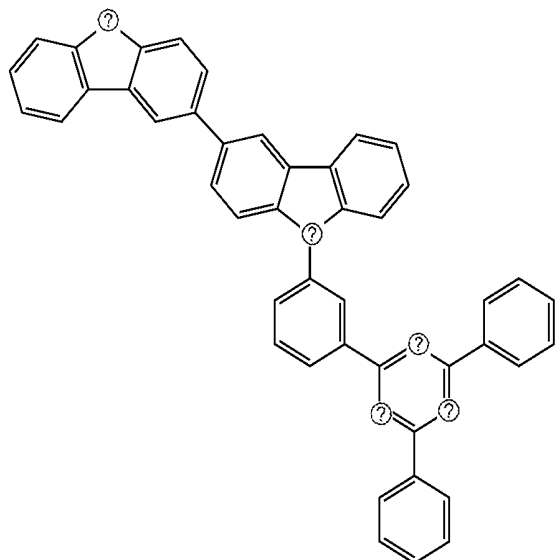


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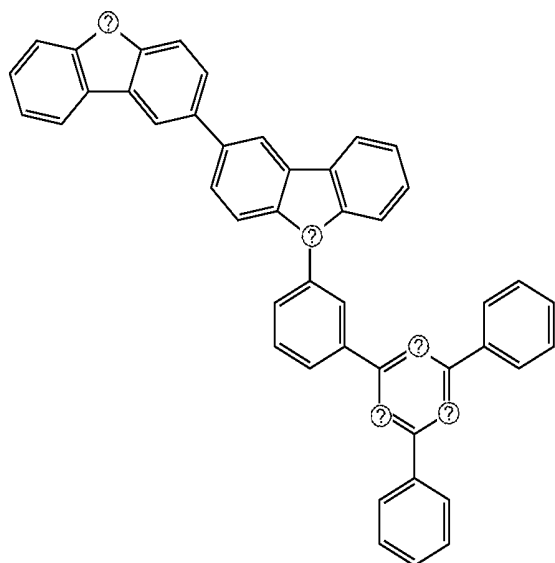


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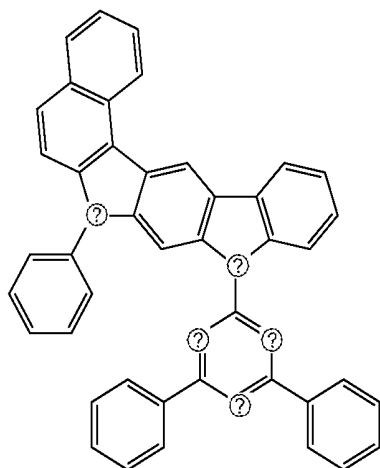
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H2-181

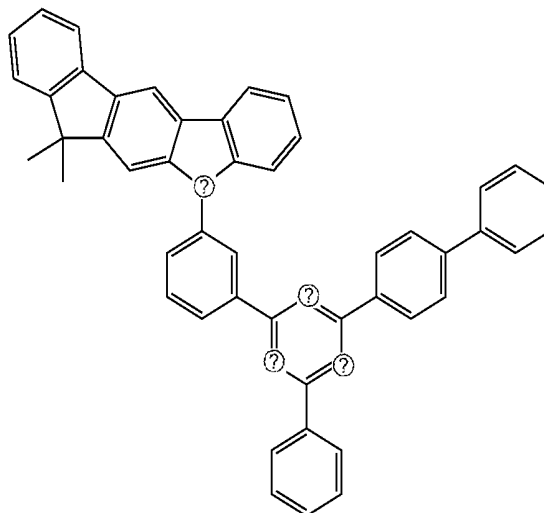


H2-182

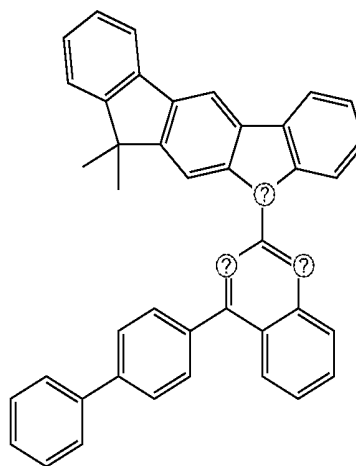


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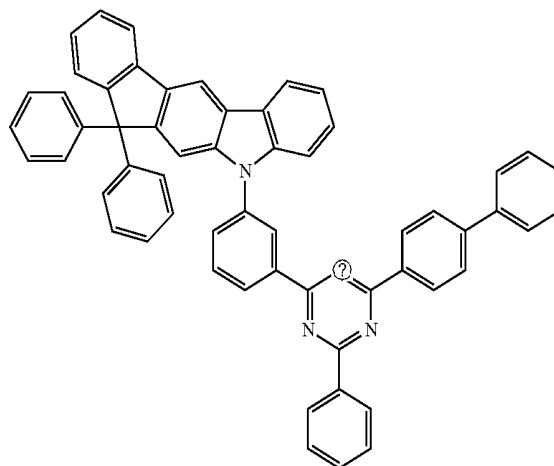
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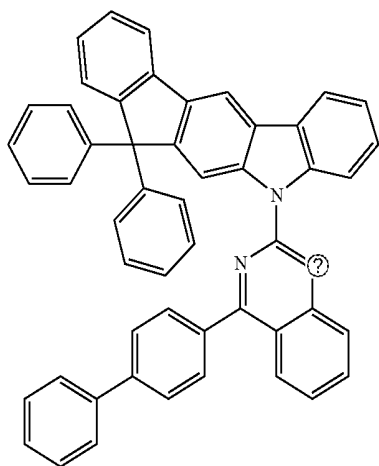
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H2-185

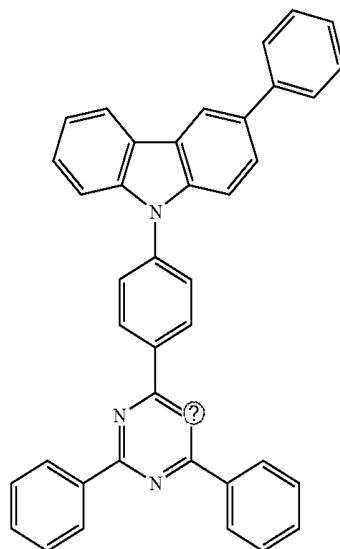


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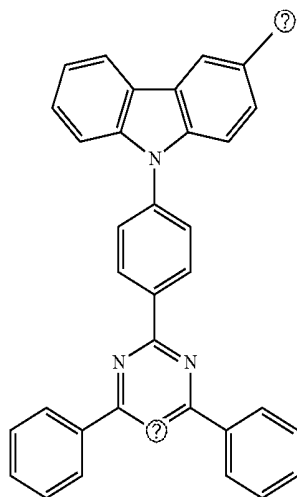
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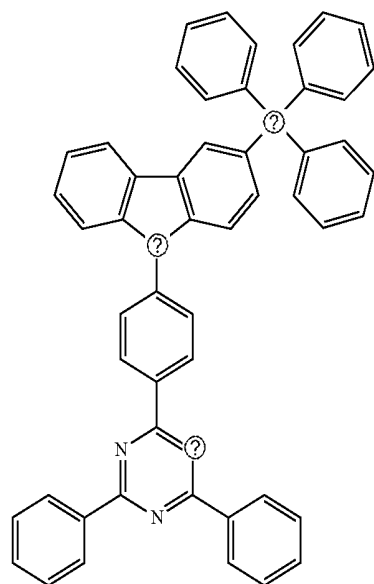


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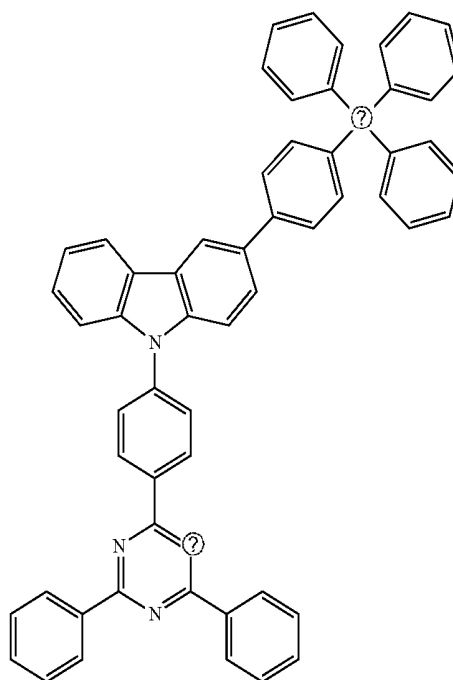
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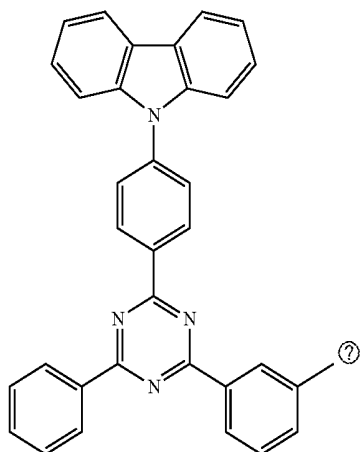
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H2-190

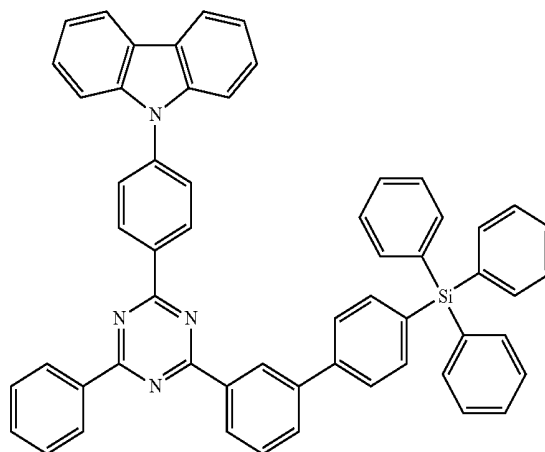


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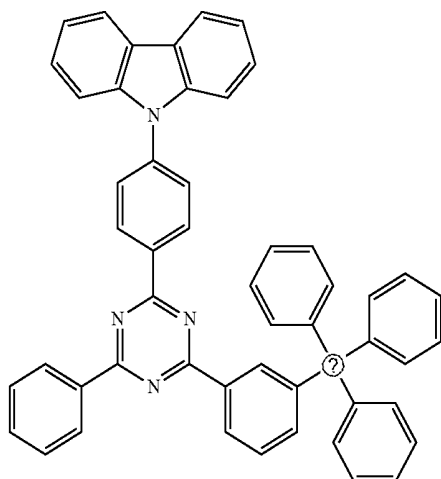
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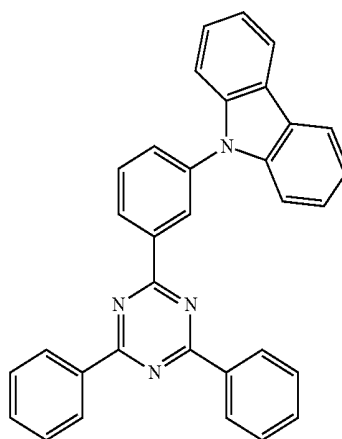
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H2-192

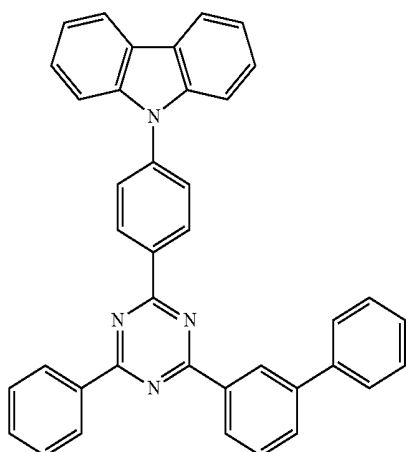


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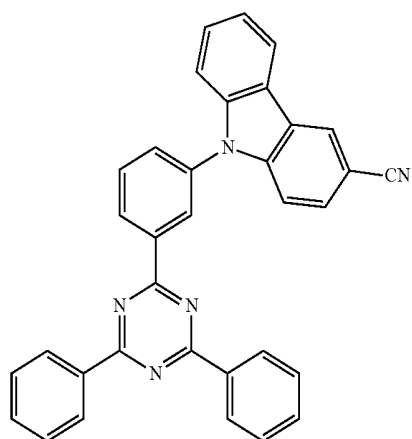
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H2-193

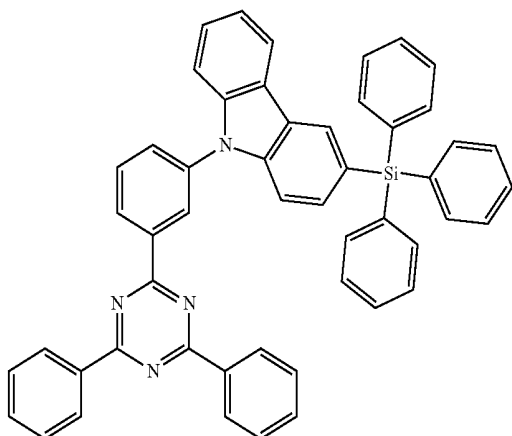


H2-196



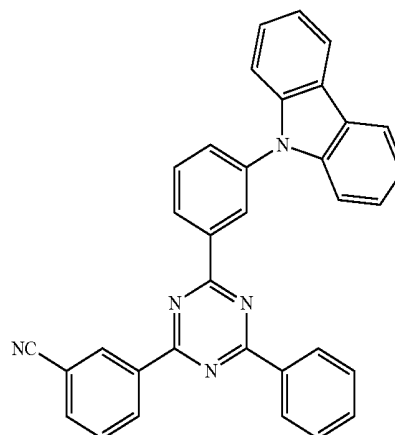
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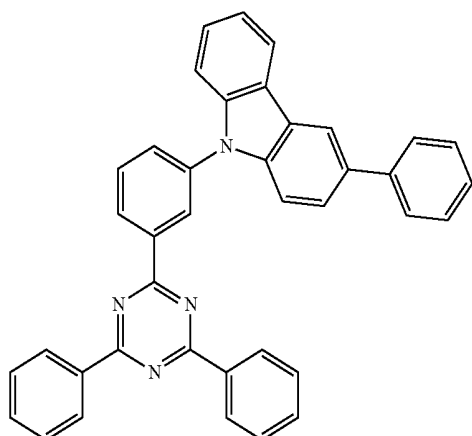


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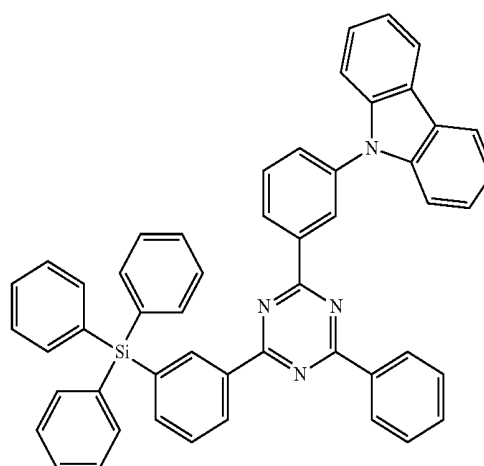
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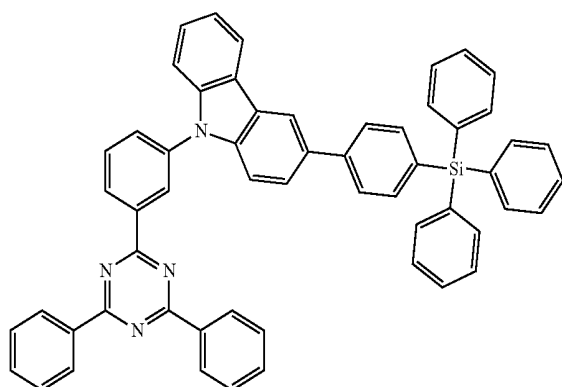
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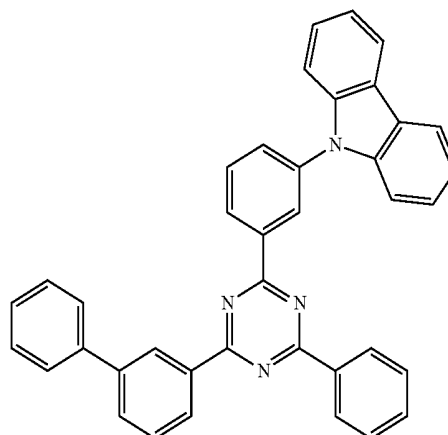
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H2-199

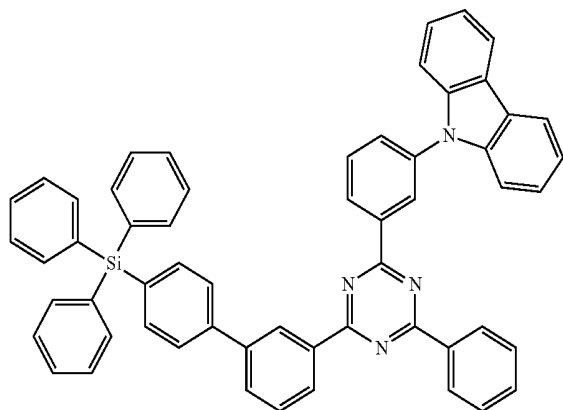


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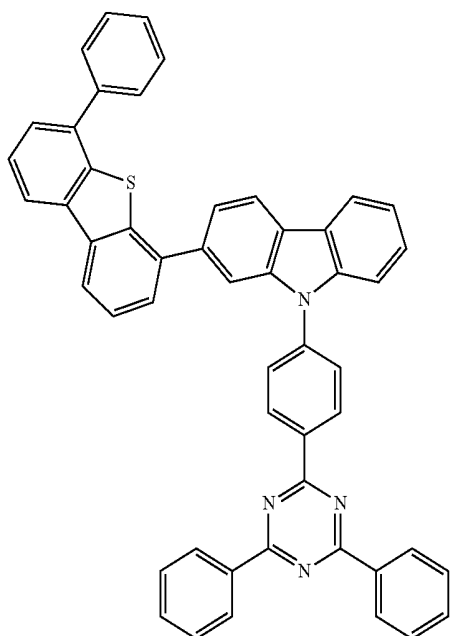


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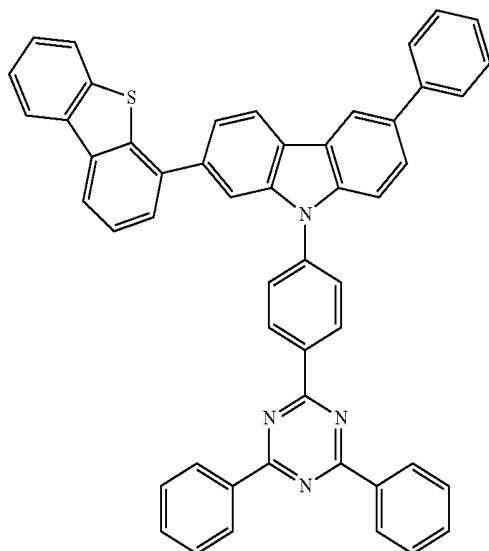
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H2-204

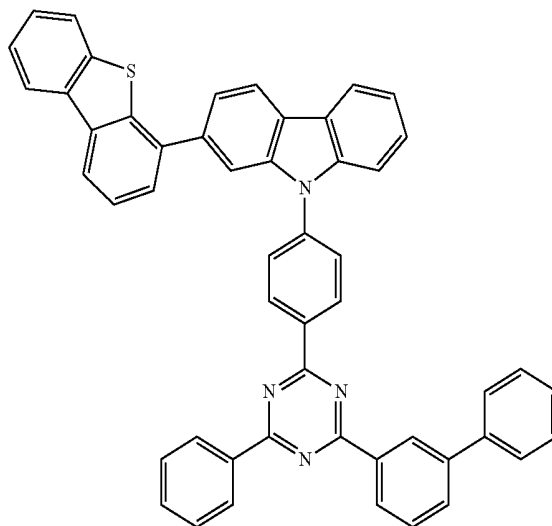


H2-205

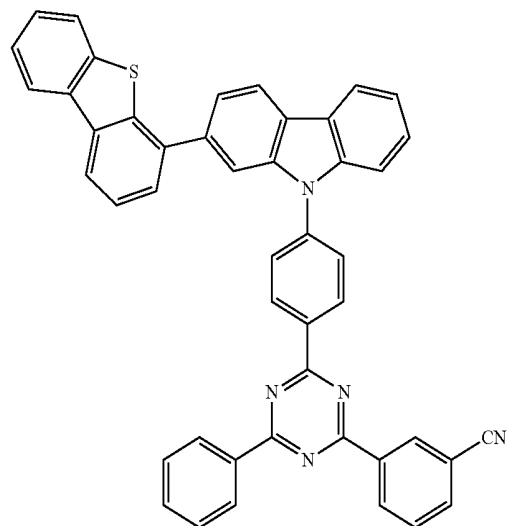


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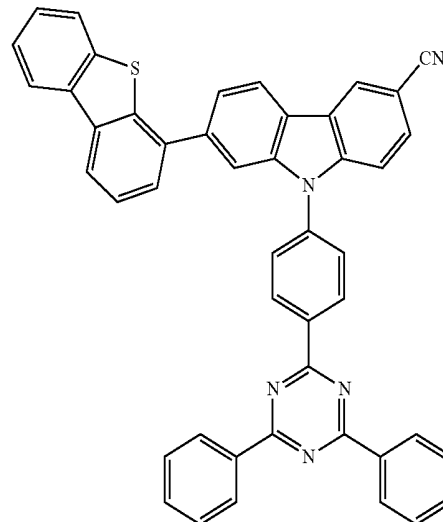
H2-206



H2-207

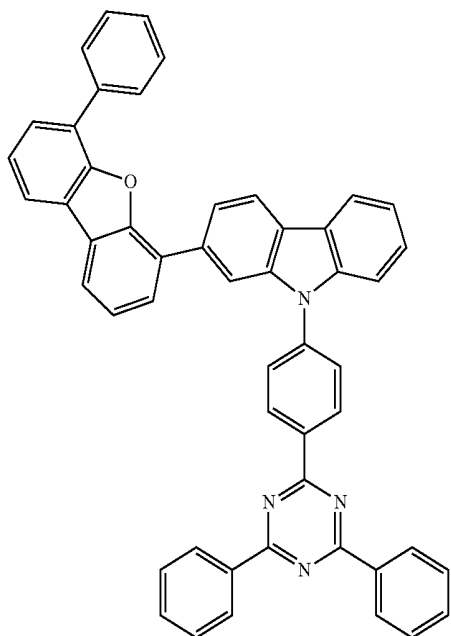


H2-208



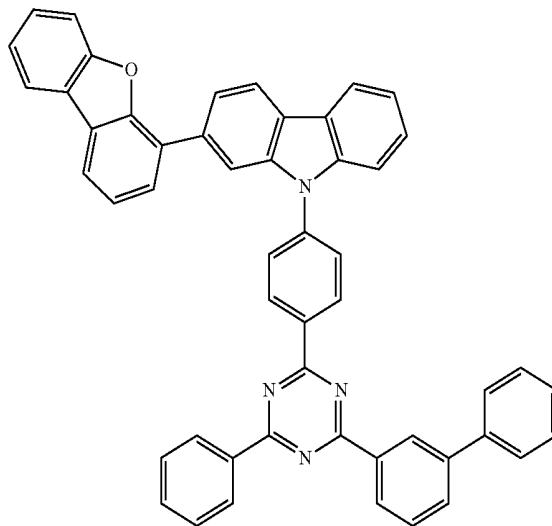
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H2-209

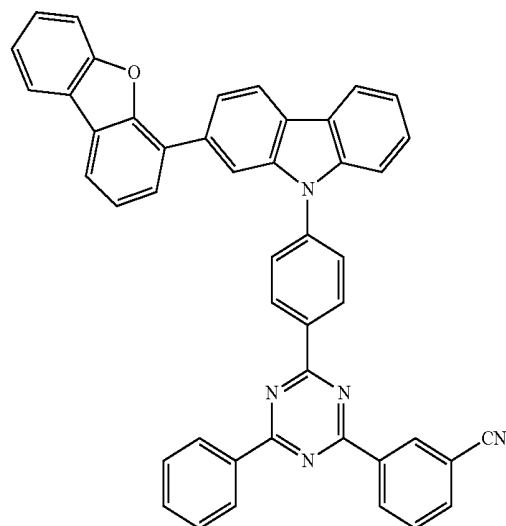


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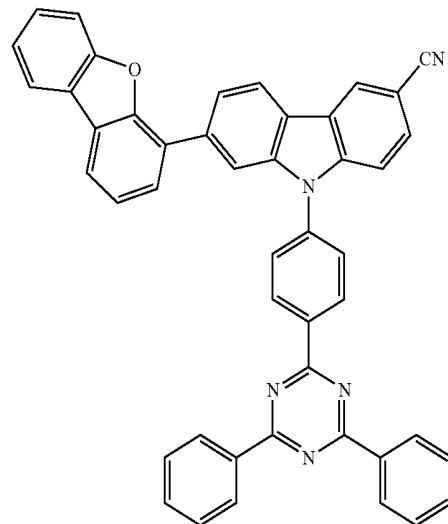
H2-211



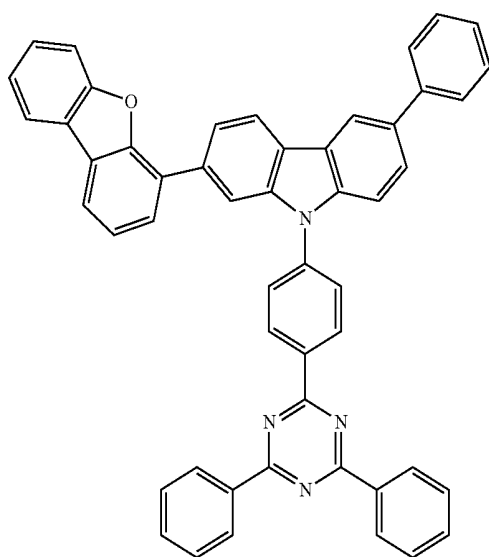
H2-212



H2-213

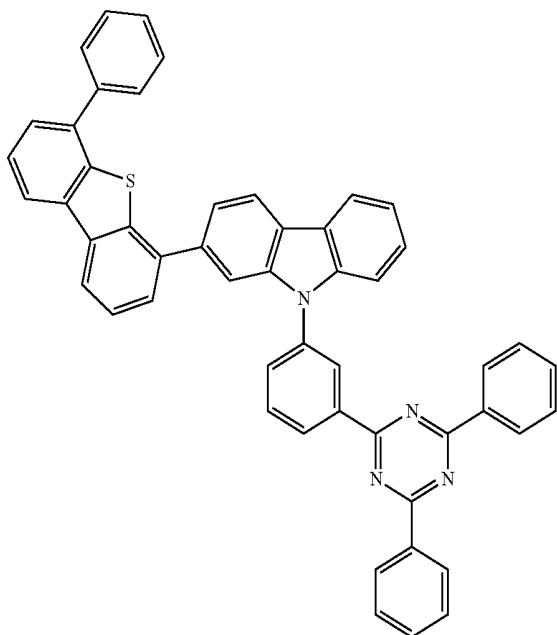


H2-210



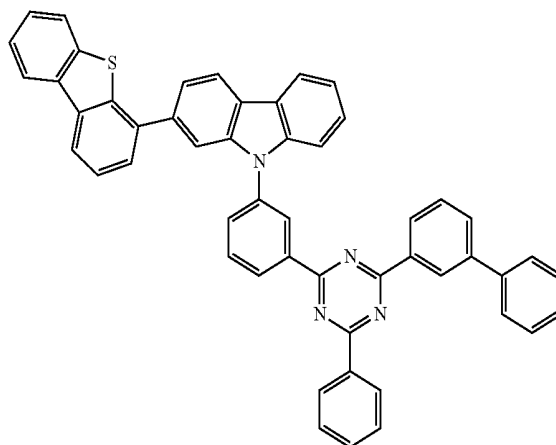
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H2-214

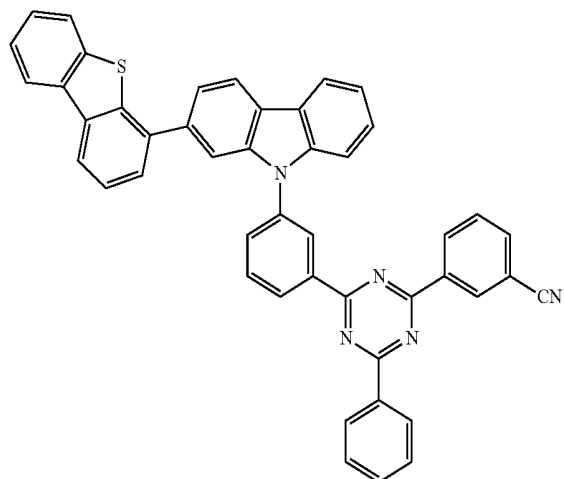


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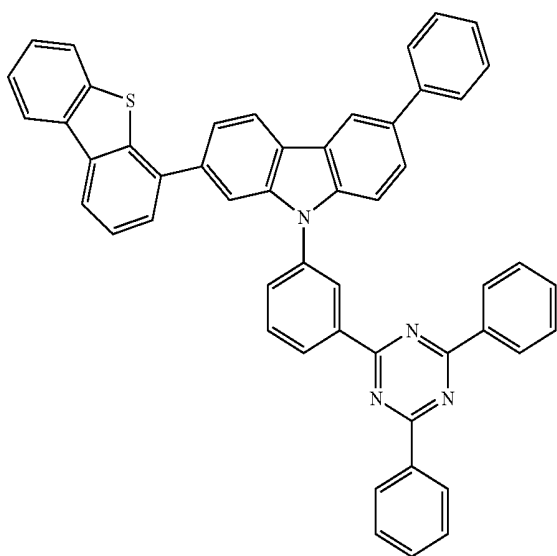
H2-216



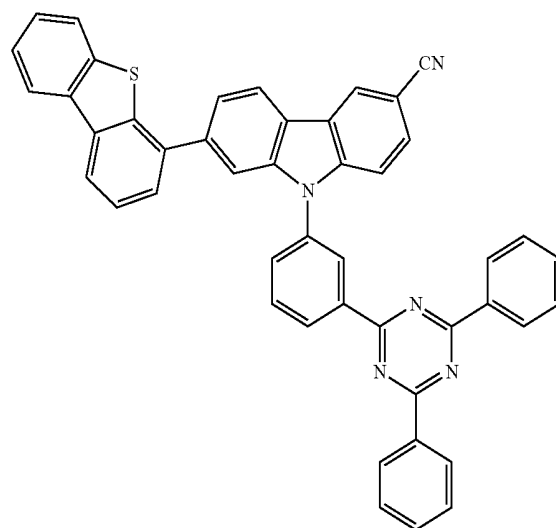
H2-217



H2-215

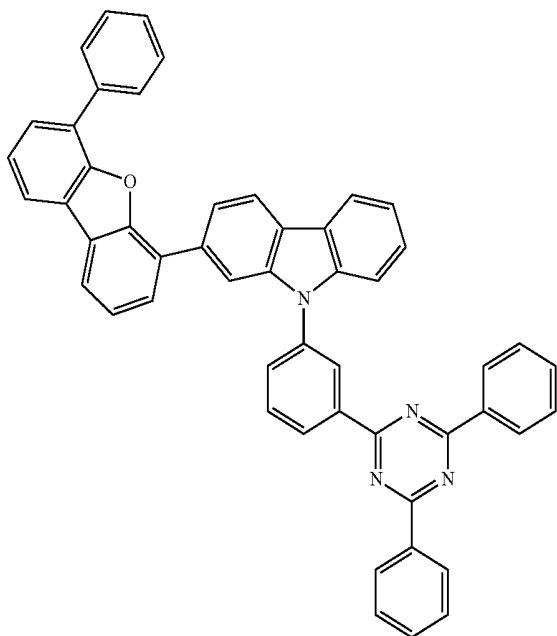


H2-218



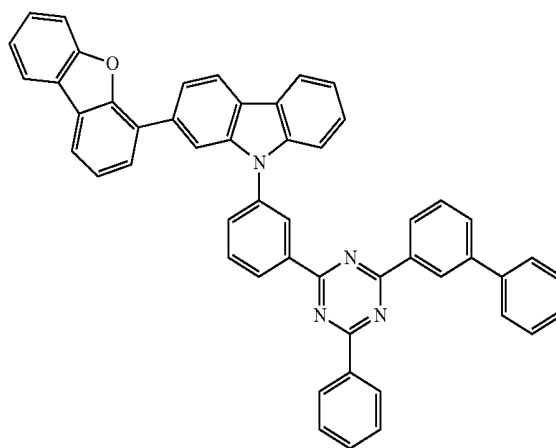
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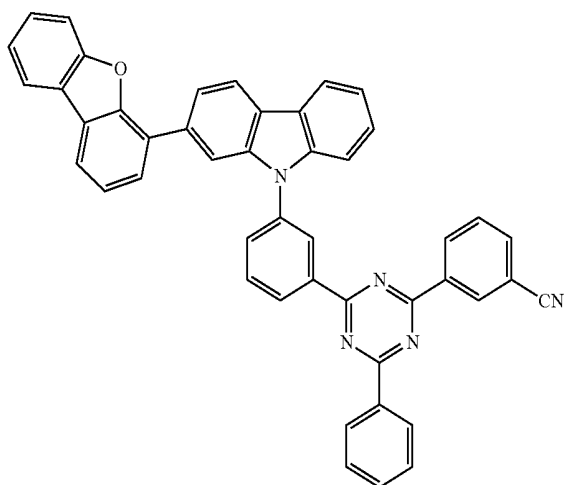


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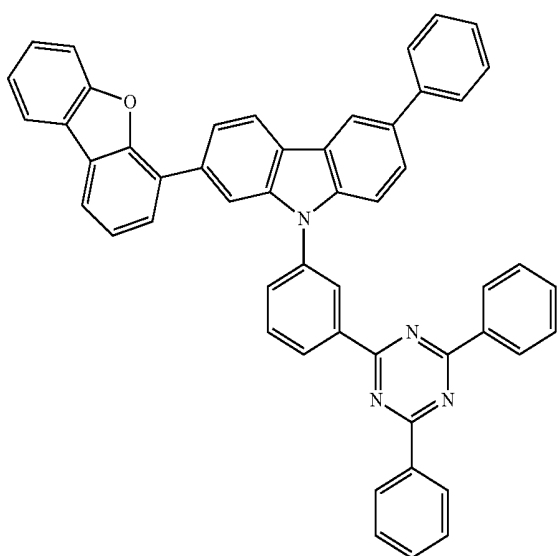
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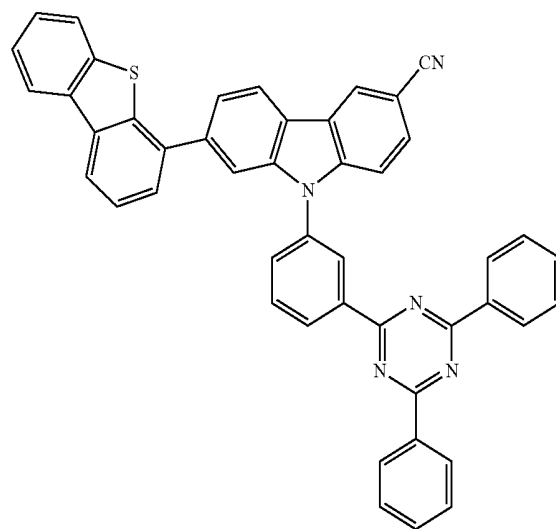
H2-222



H2-220

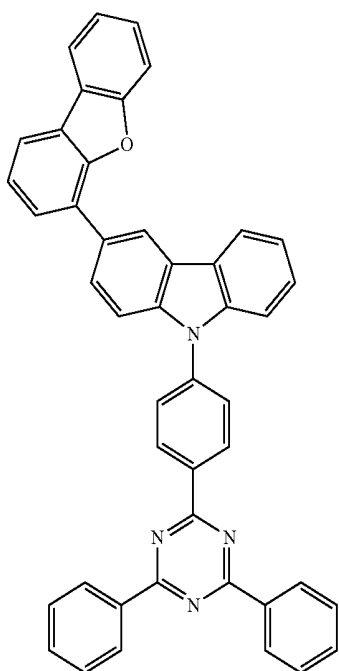


H2-223



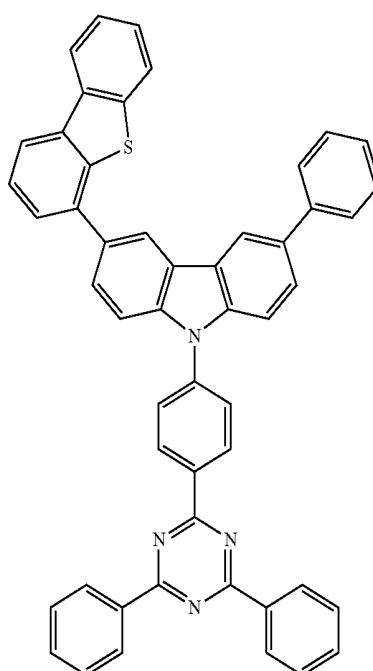
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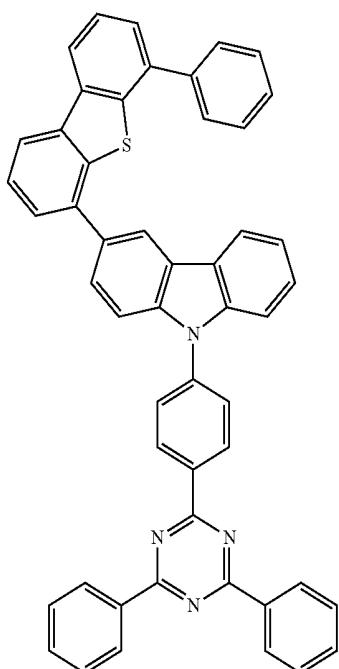


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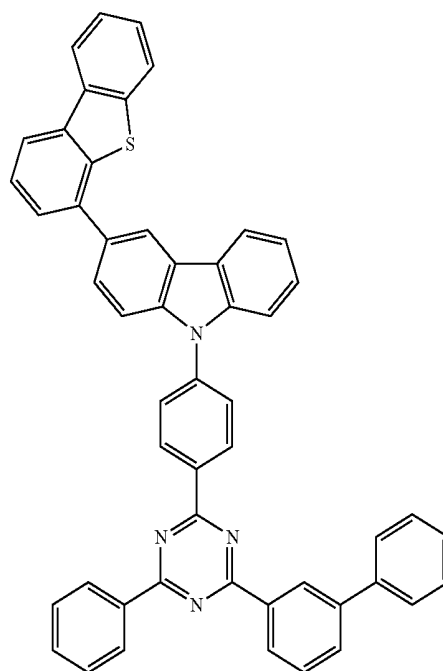
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H2-225

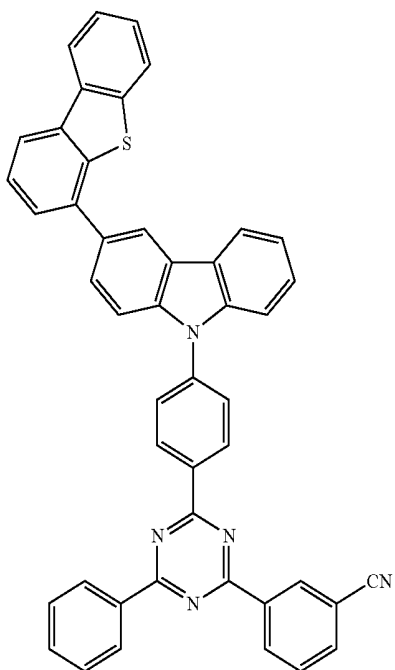


H2-227



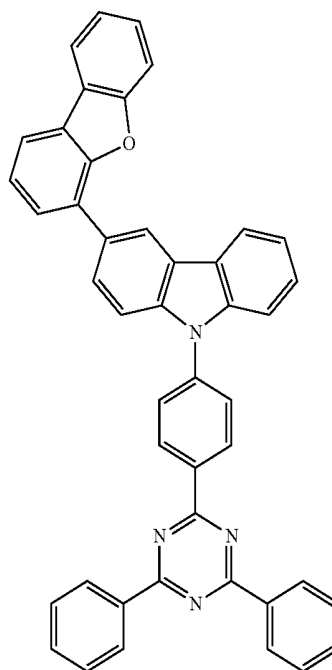
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H2-228

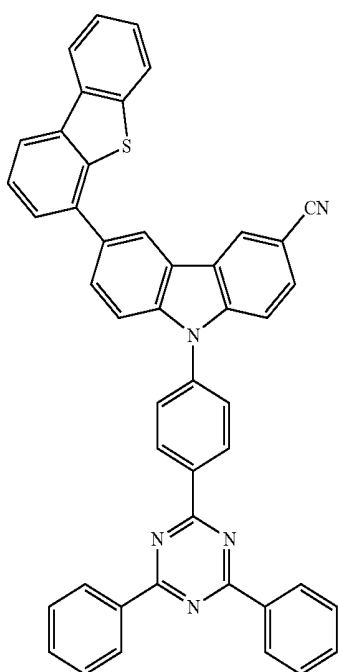


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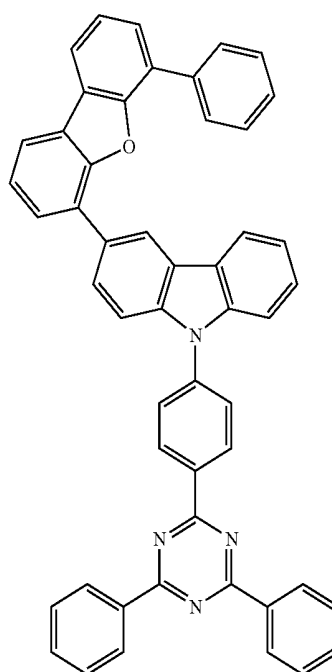
H2-230



H2-229

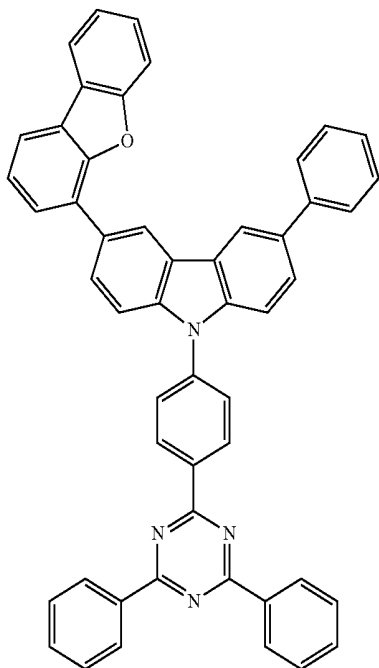


H2-231



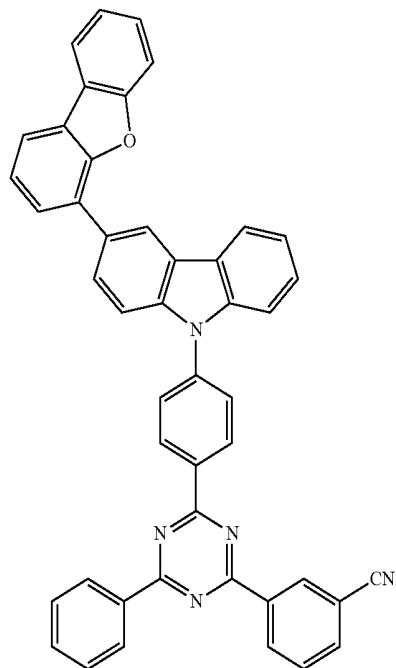
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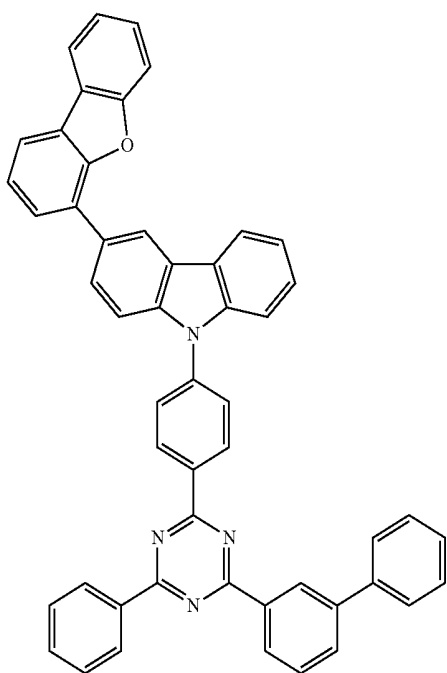


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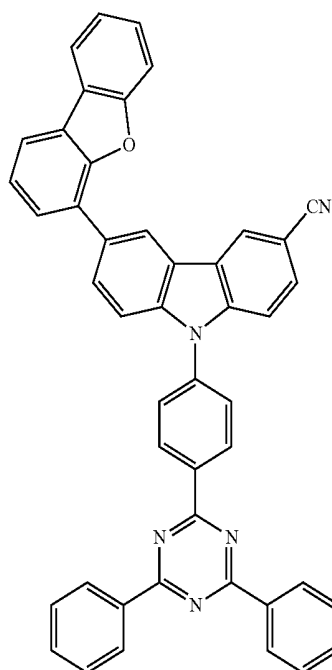
H2-234



H2-233

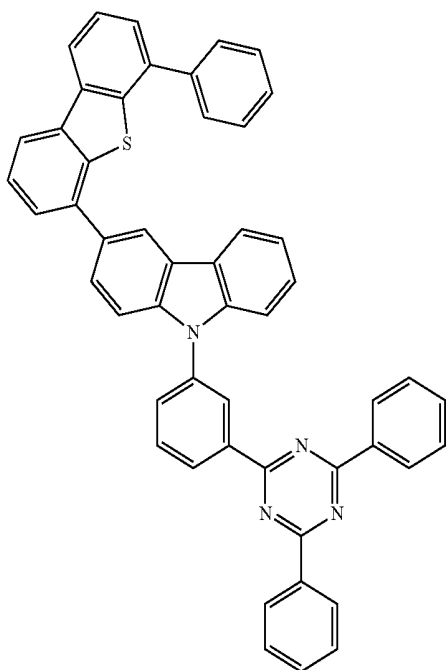


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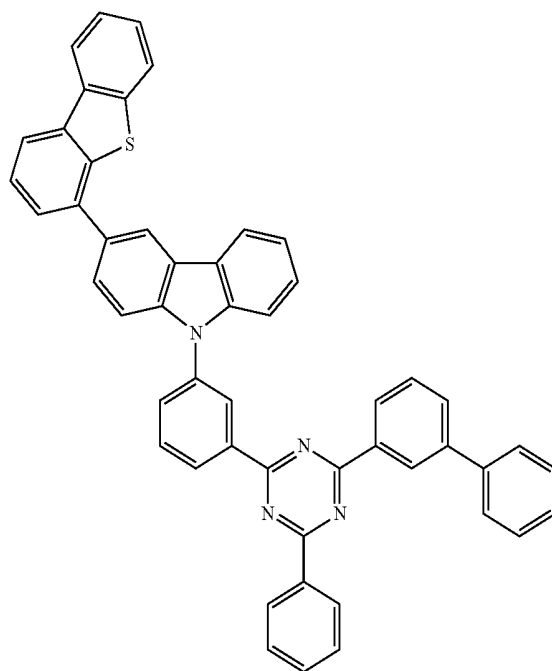
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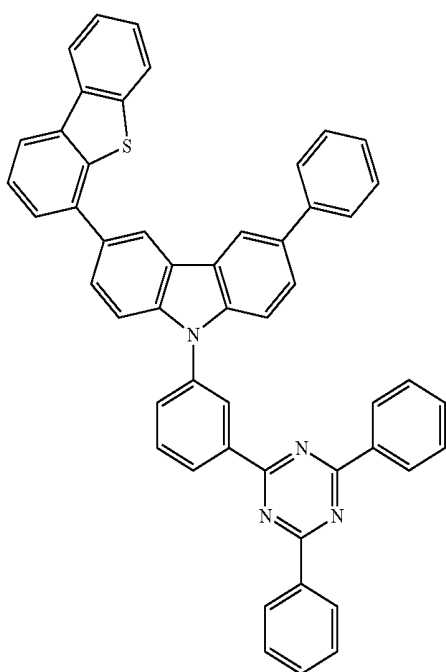


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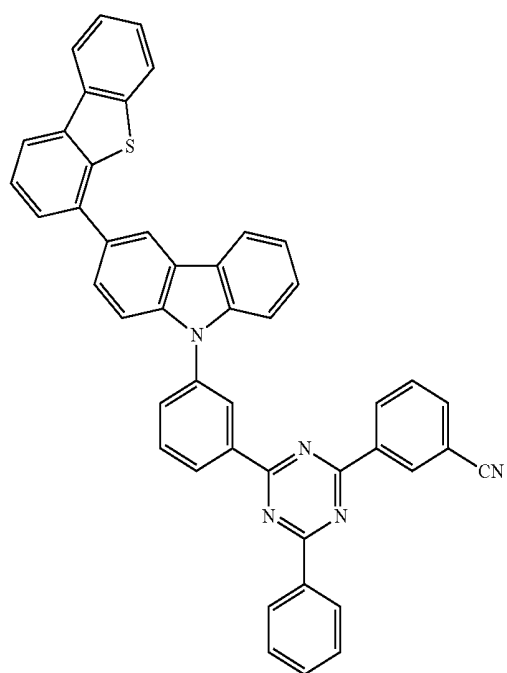
H2-238



H2-237

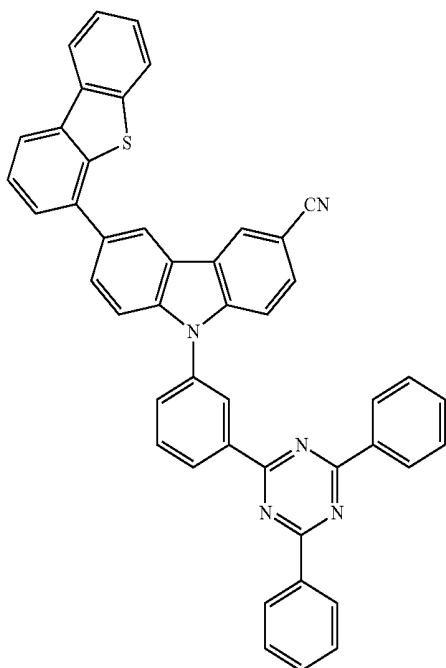


H2-239



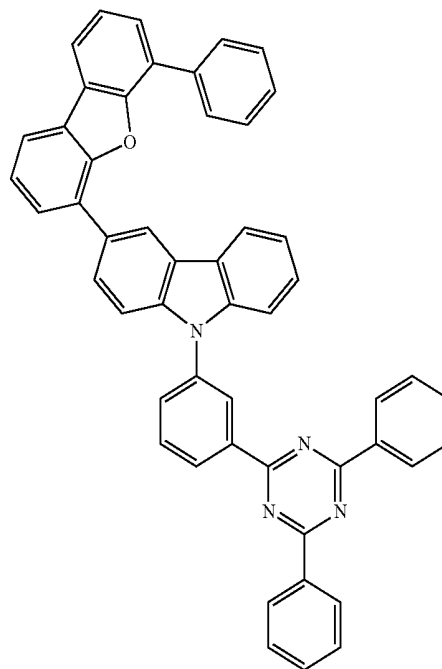
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H2-240

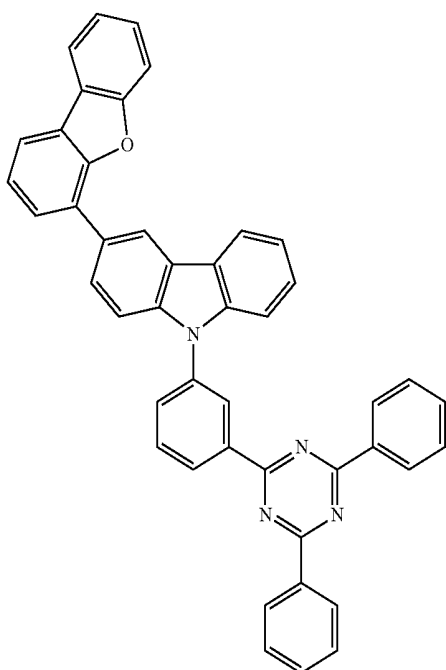


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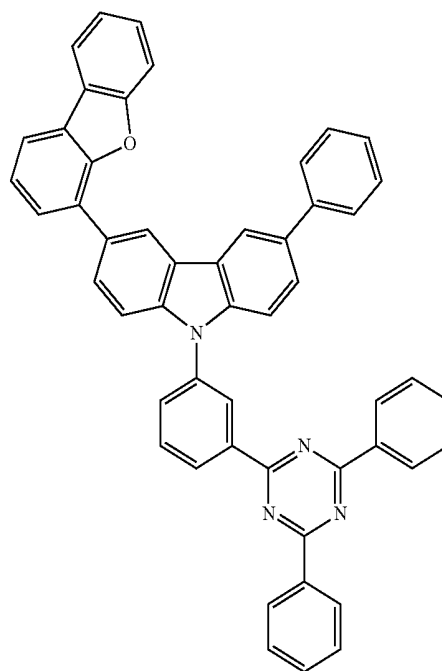
H2-242



H2-241

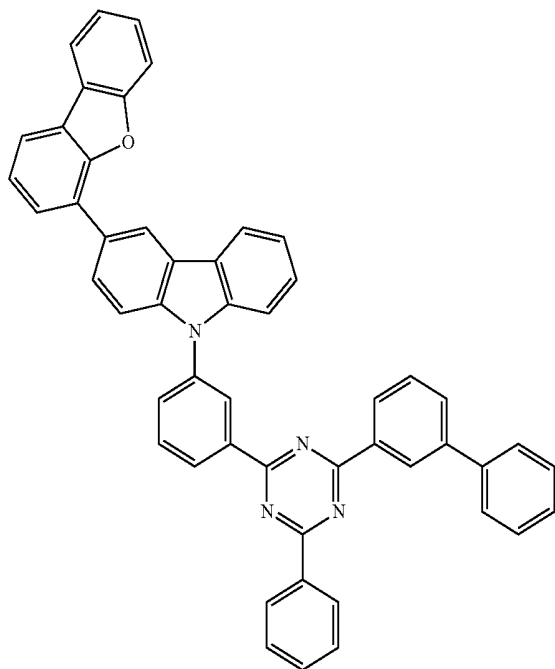


H2-243



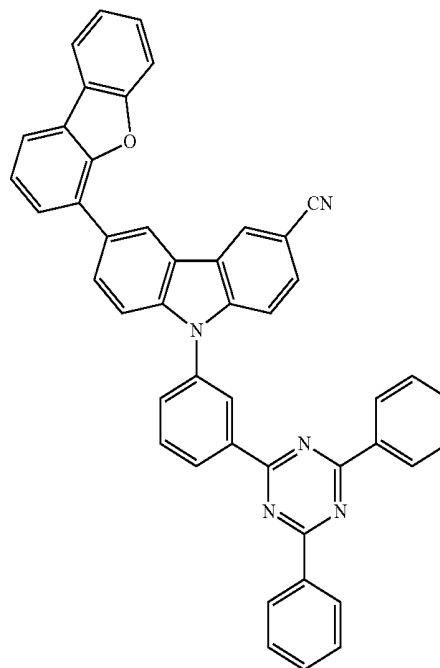
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H2-244

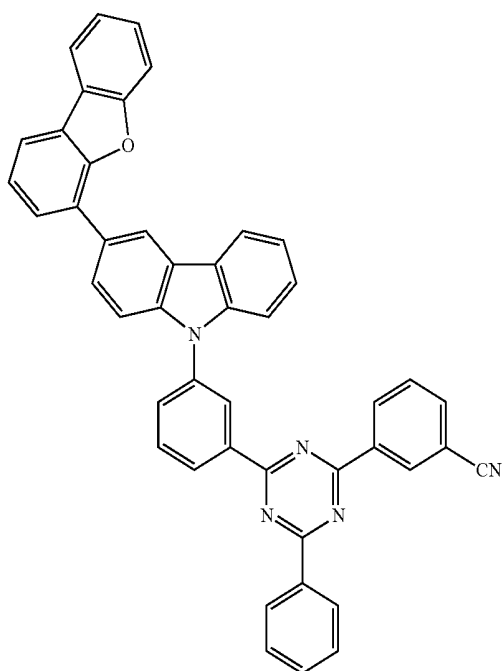


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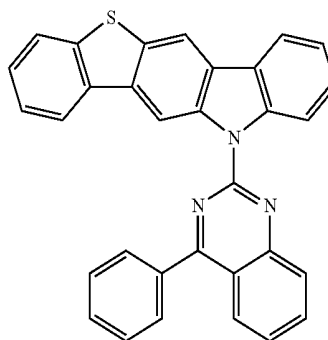
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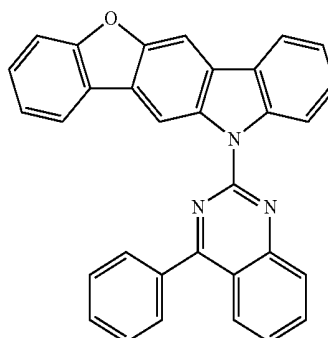
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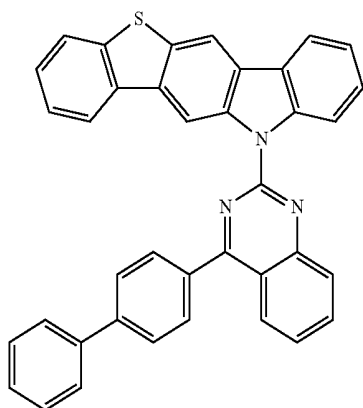
H2-247



H2-248

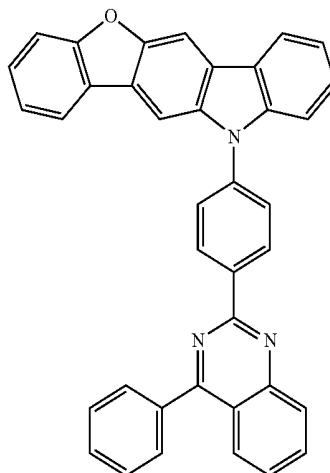


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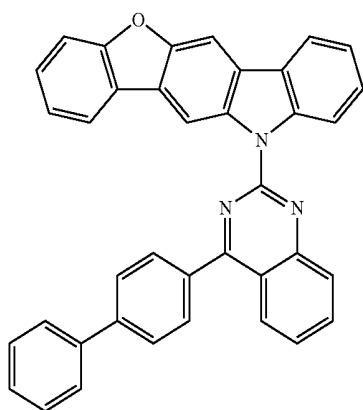


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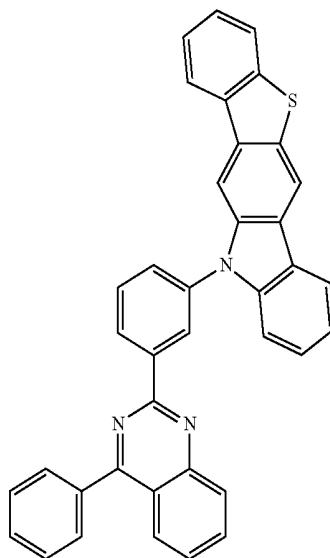
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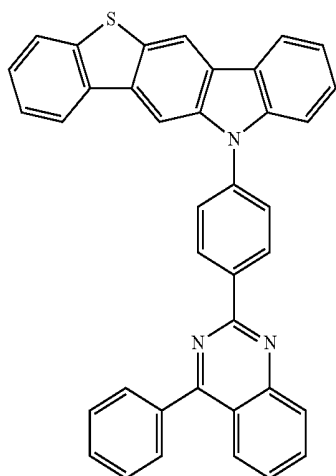
H2-252



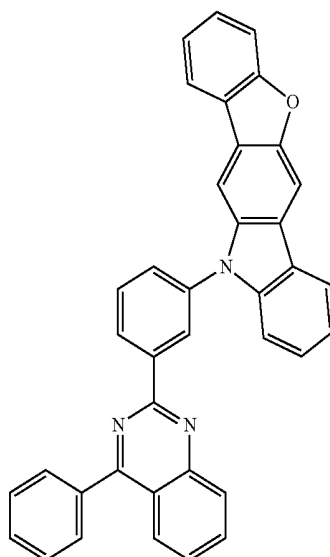
H2-250



H2-253

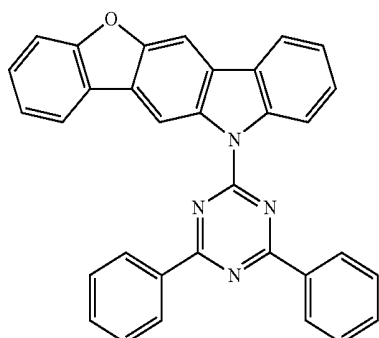


H2-251



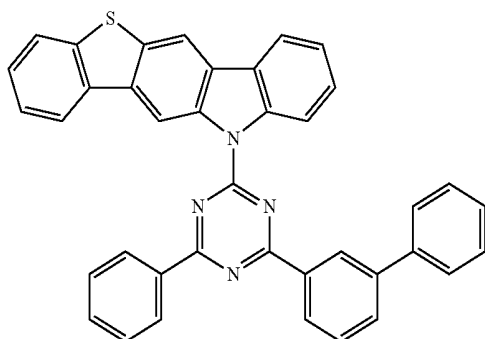
H2-254

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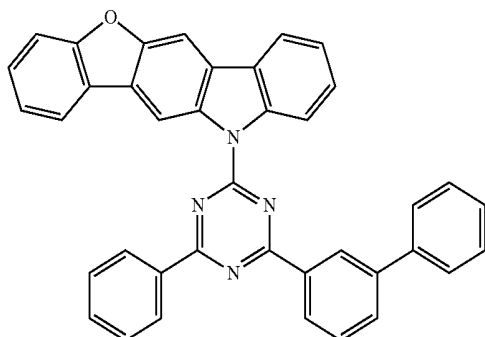


H2-255

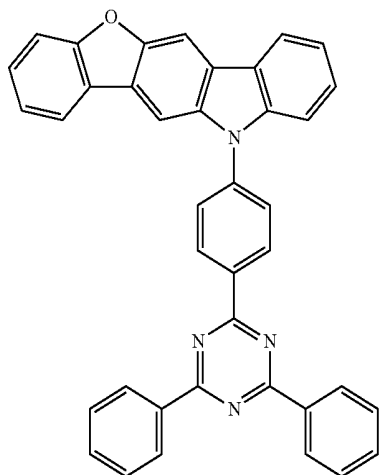
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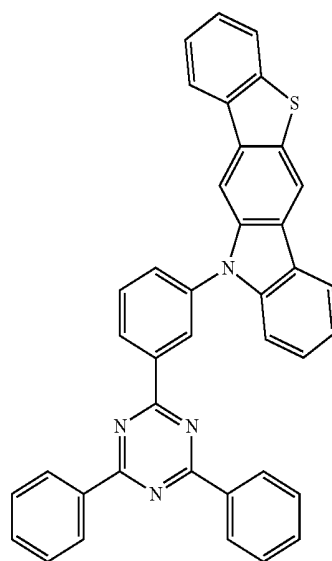
H2-257



H2-258

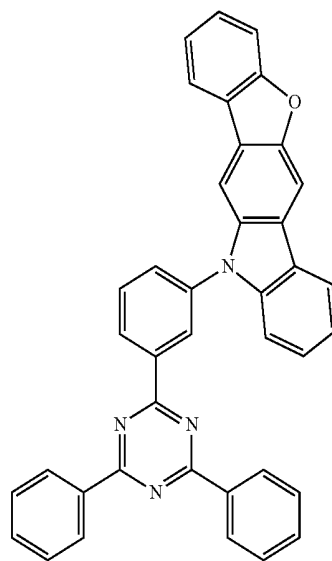


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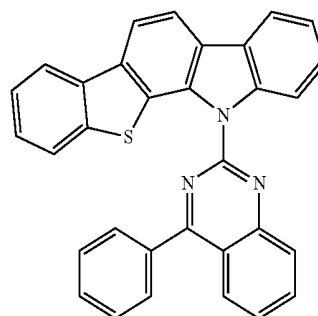


H2-259

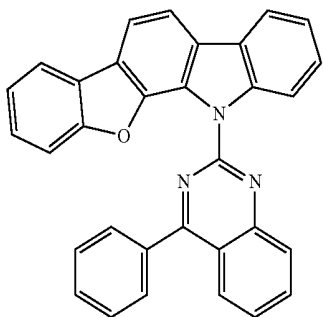
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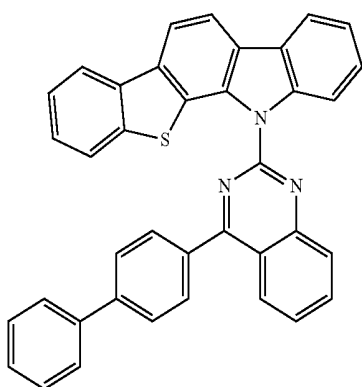
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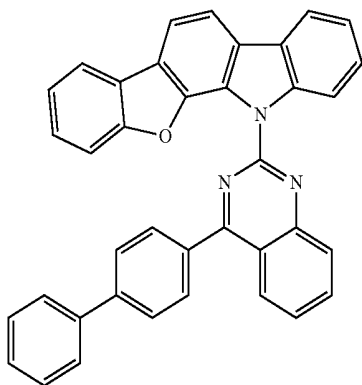
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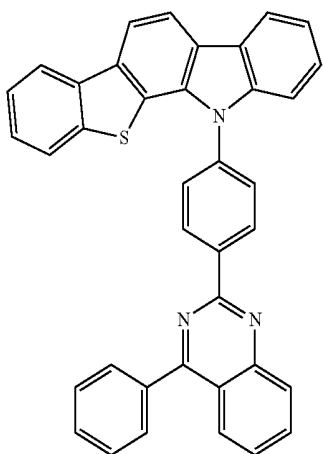
H2-262



H2-263

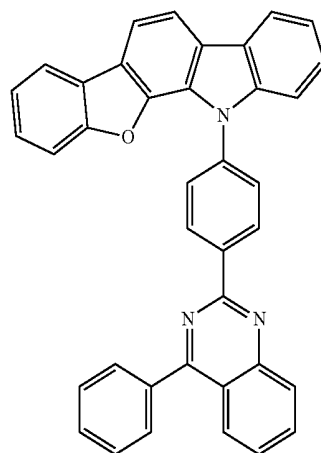


H2-264

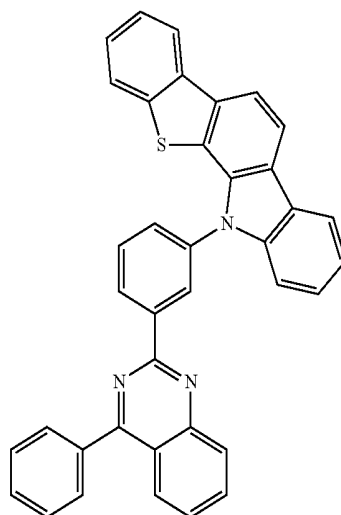


H2-265

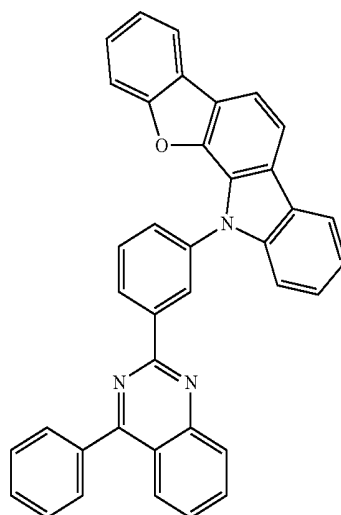
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H2-266

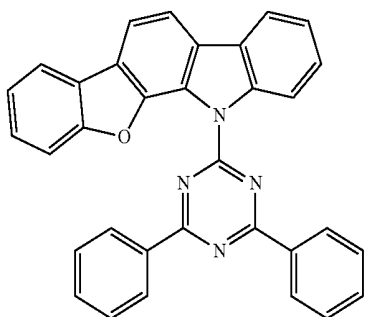


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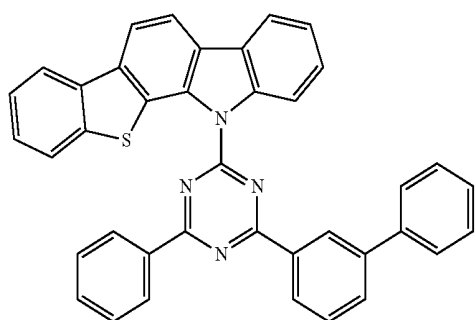


H2-268

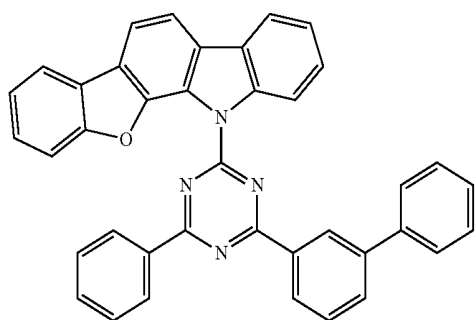
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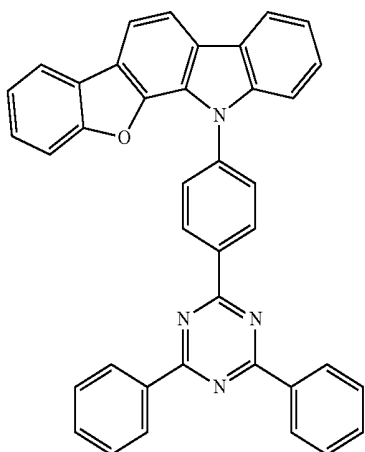
H2-269



H2-270

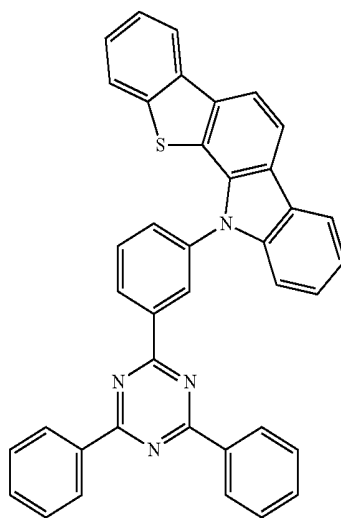


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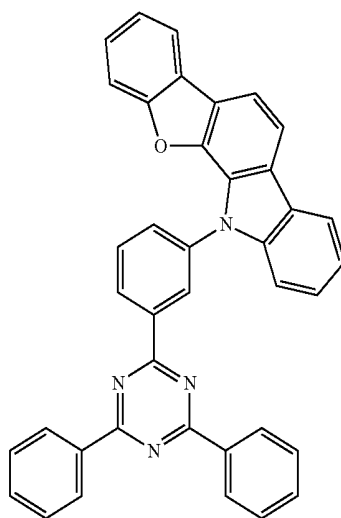


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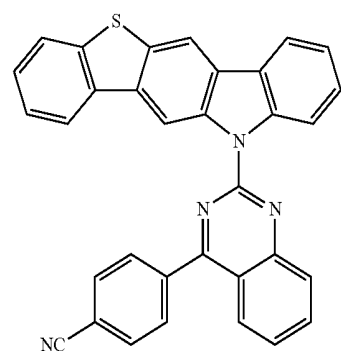
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H2-273

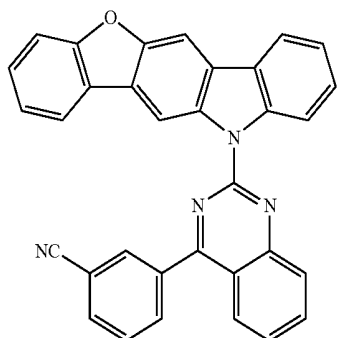


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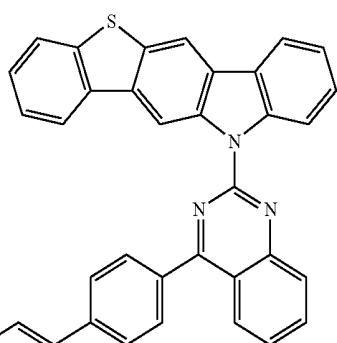


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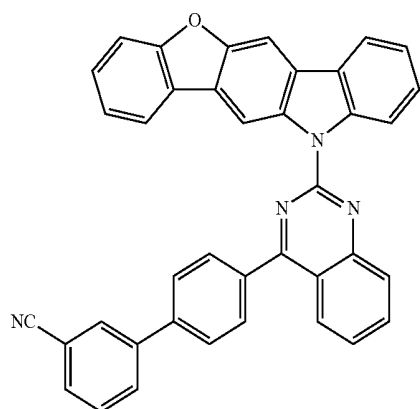
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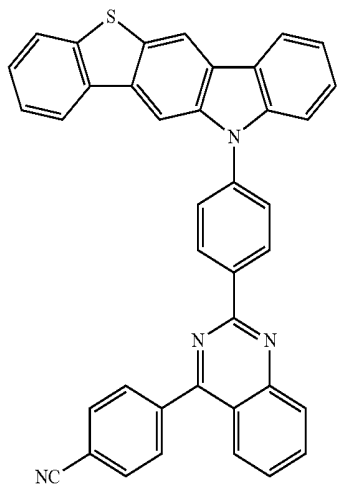
H2-276



H2-277

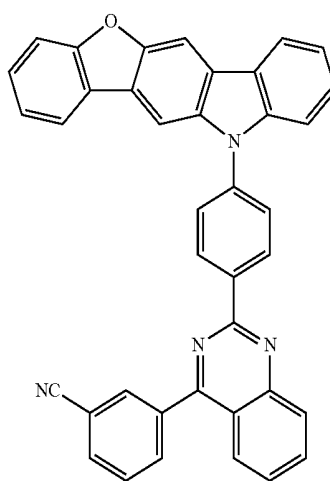


H2-278

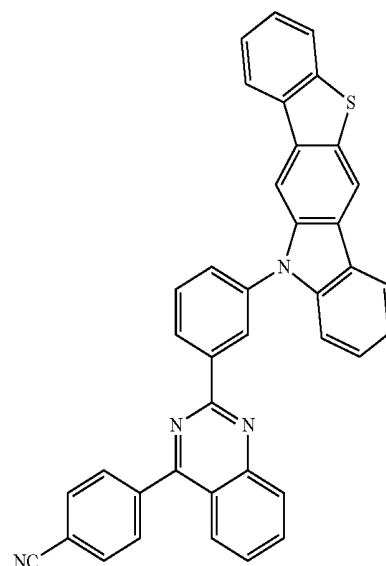


H2-279

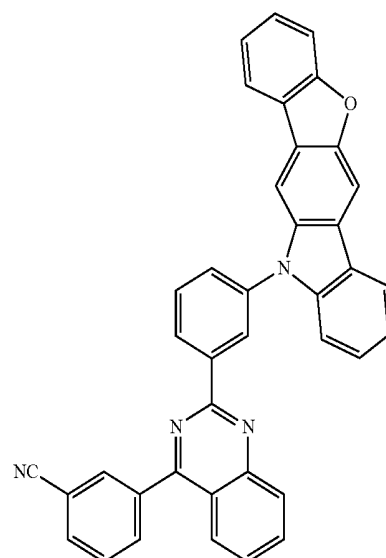
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H2-280



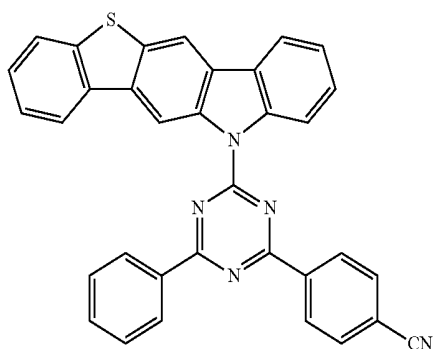
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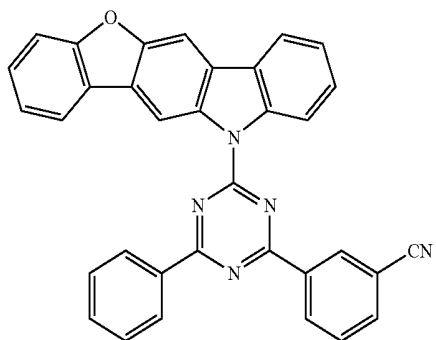
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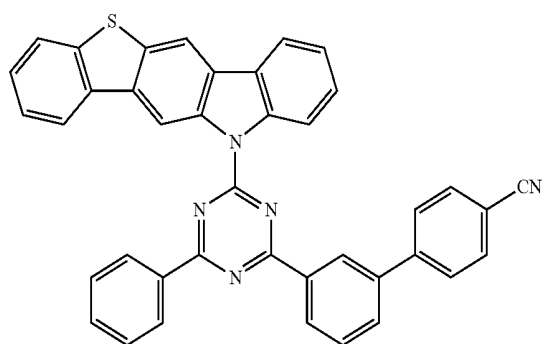
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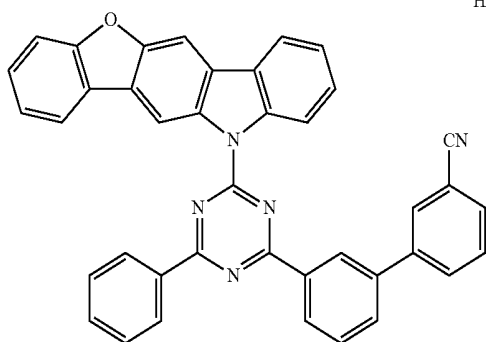
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H2-285

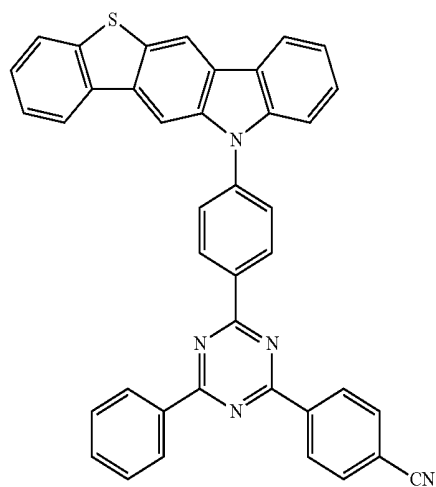


H2-286

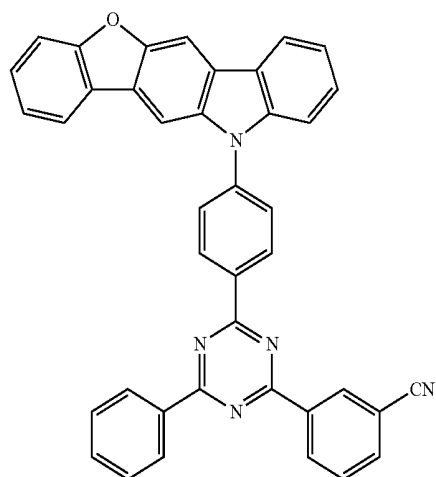


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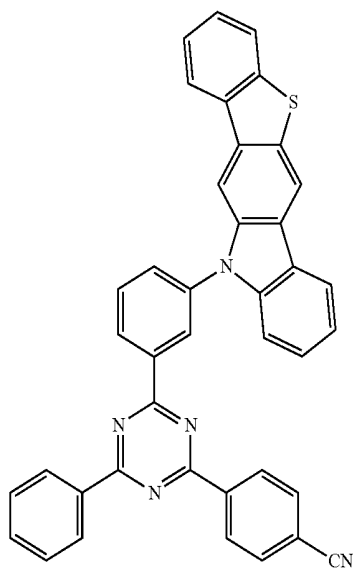
H2-287



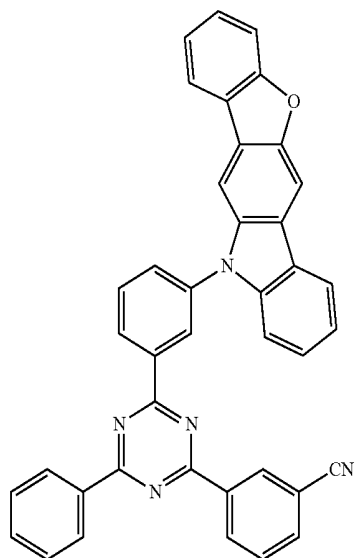
H2-288



H2-289

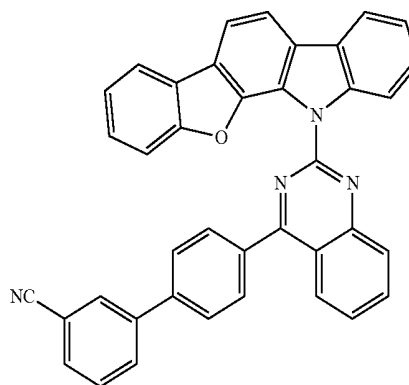


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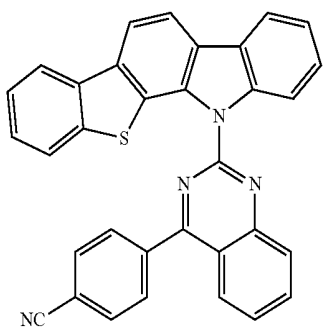


H2-290

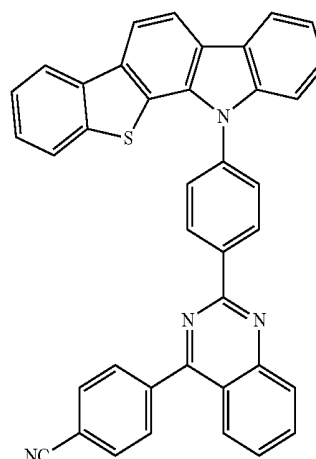
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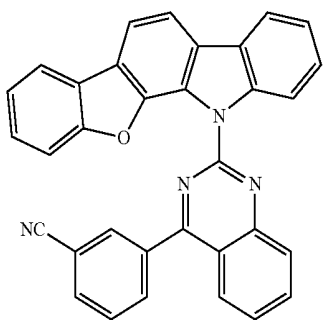
H2-294



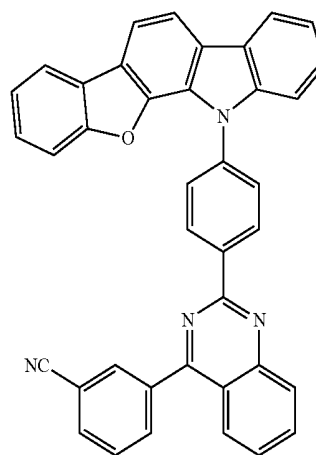
H2-291



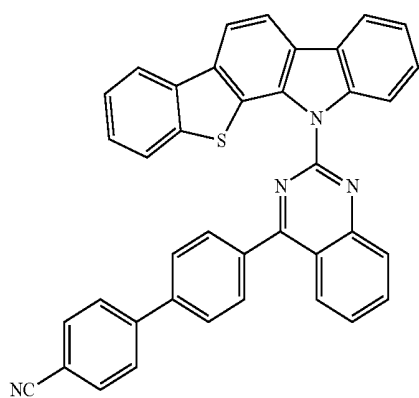
H2-295



H2-292

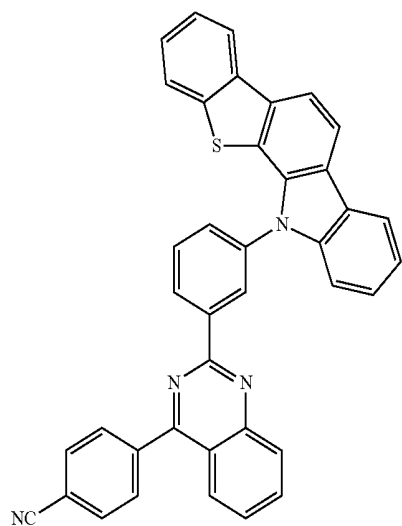


H2-296



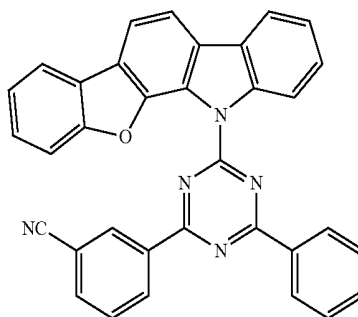
H2-293

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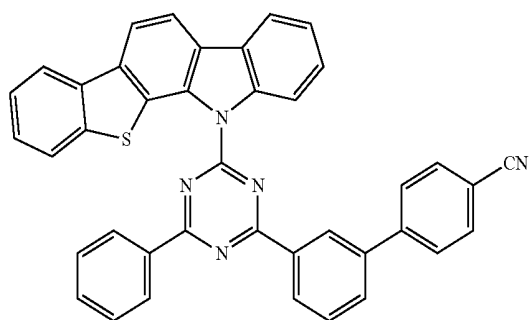
H2-297

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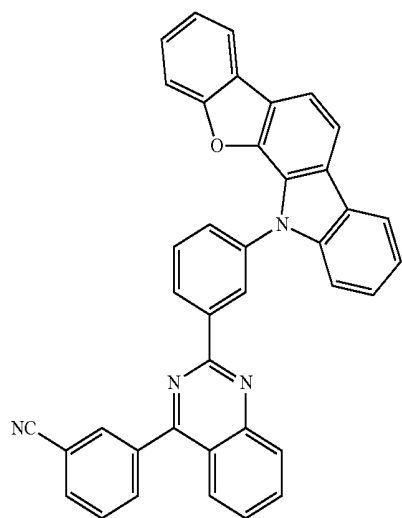


H2-300

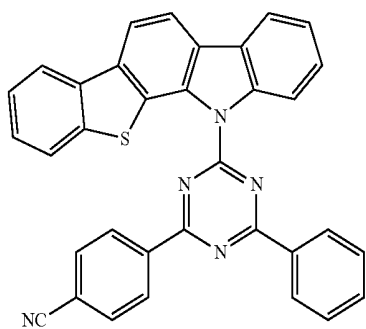
H2-301



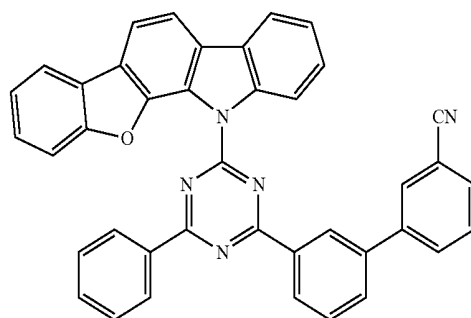
H2-298



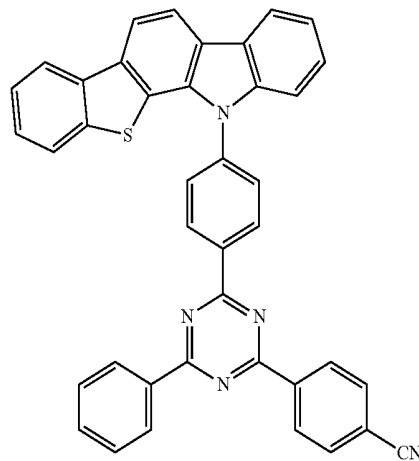
H2-299



H2-302

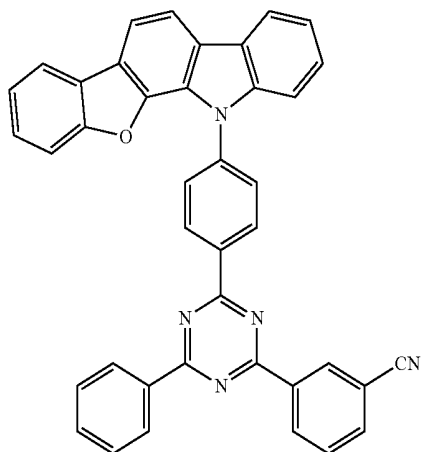


H2-303

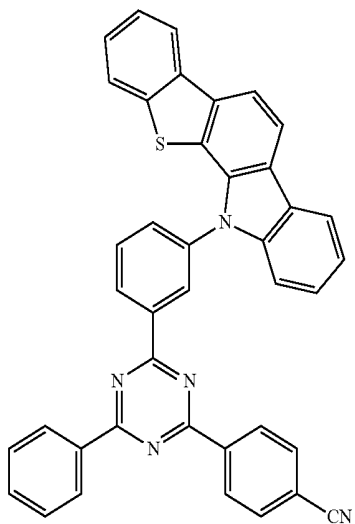


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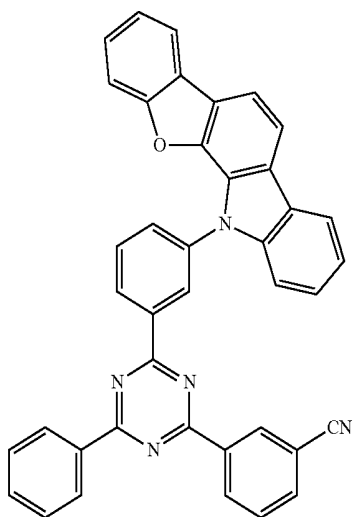
H2-304



H2-305

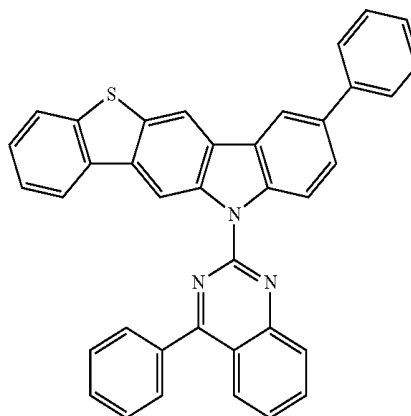


H2-306

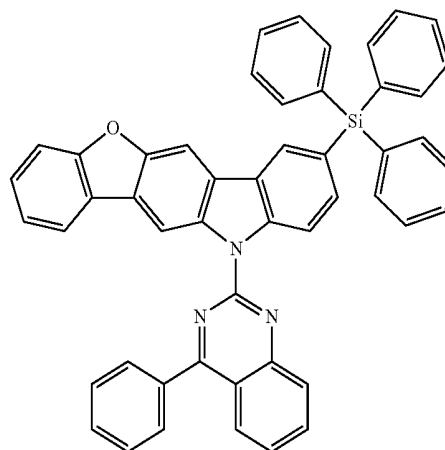


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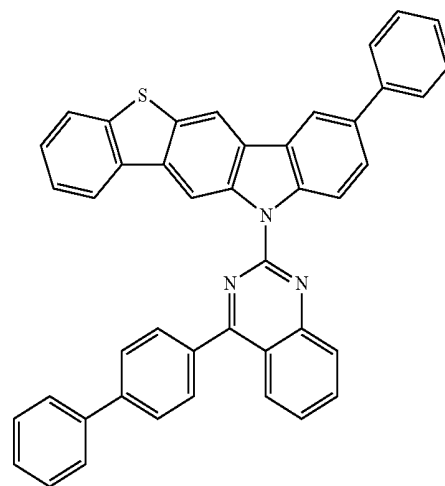
H2-307



H2-308

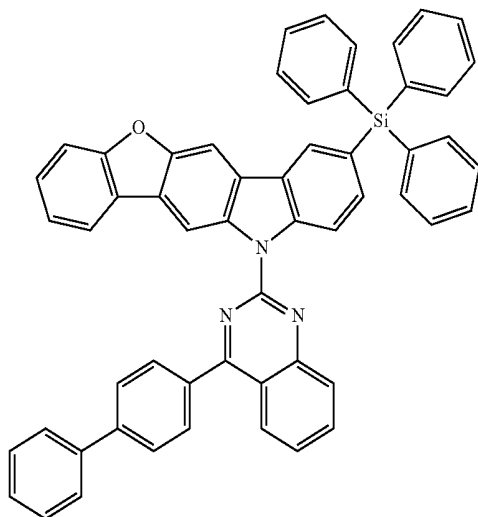


H2-309



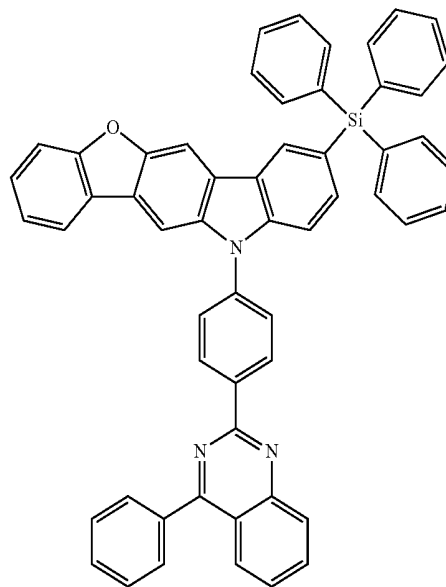
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H2-310

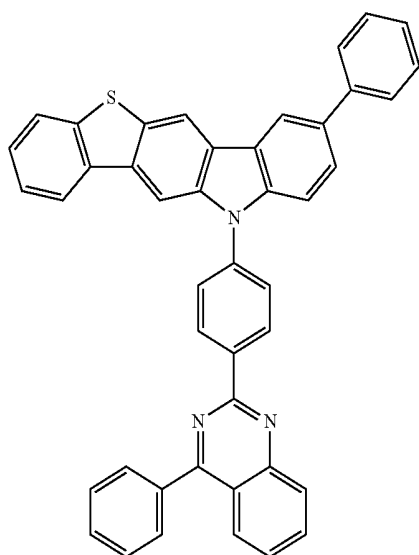


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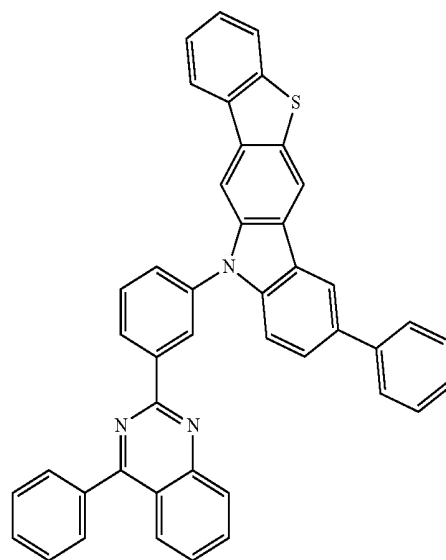
H2-312



H2-311

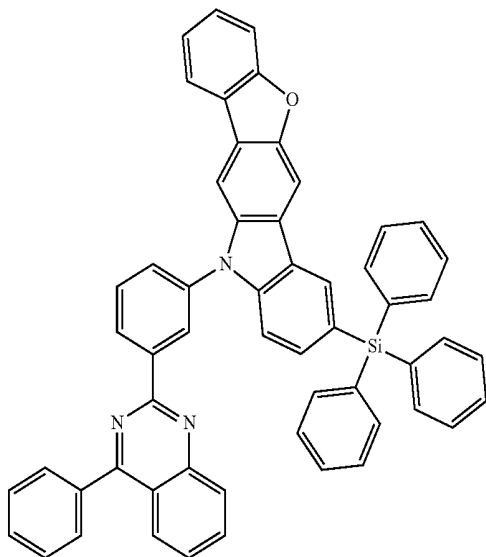


H2-313

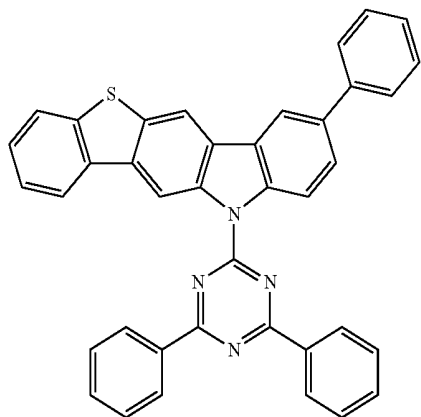


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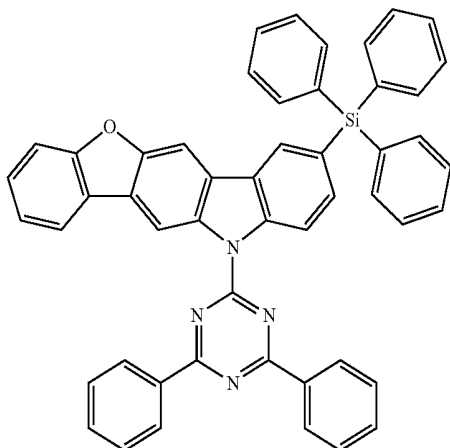
H2-314



H2-315

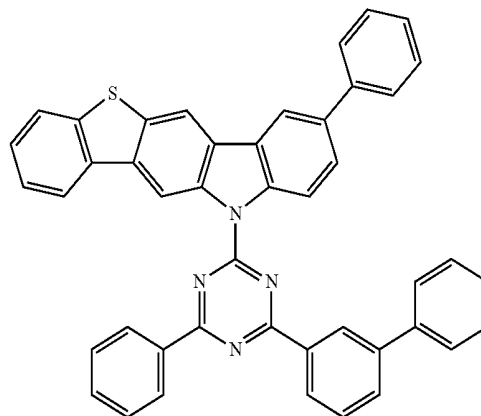


H2-316

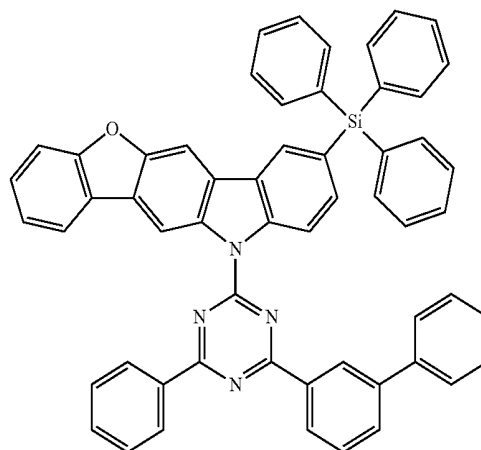


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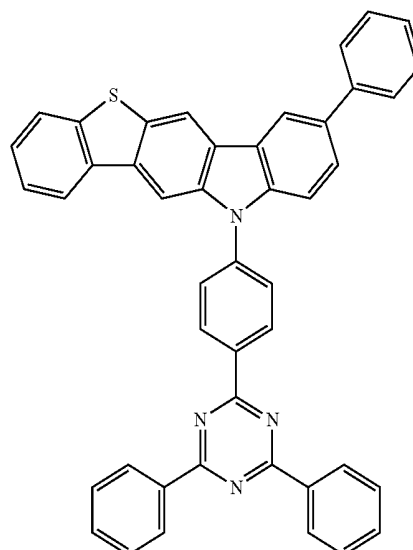
H2-317



H2-318



H2-319

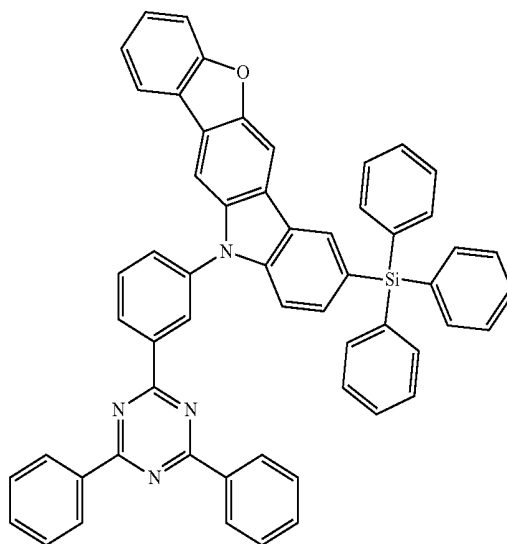
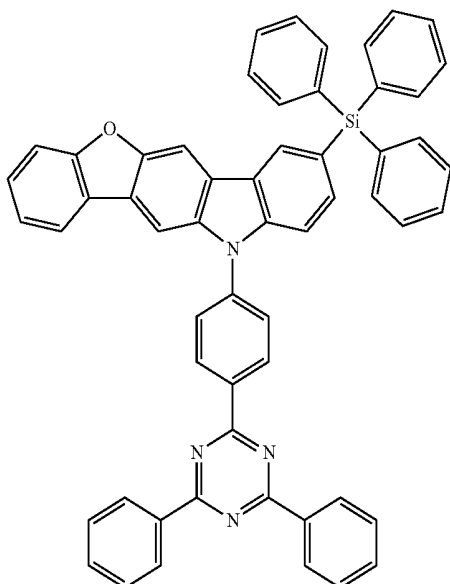


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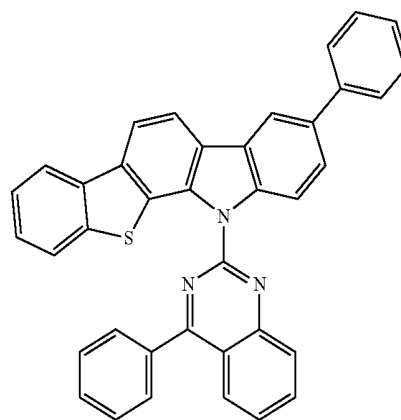
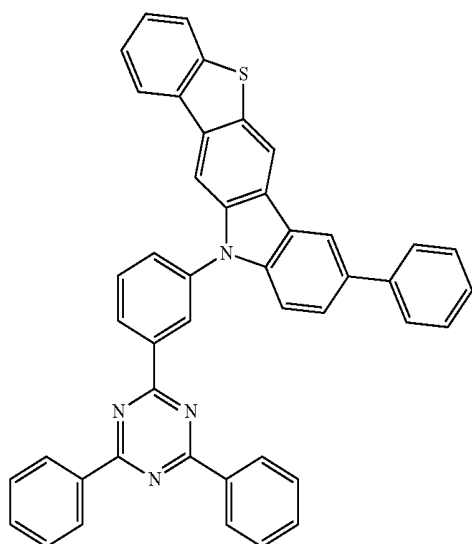
H2-322

H2-320

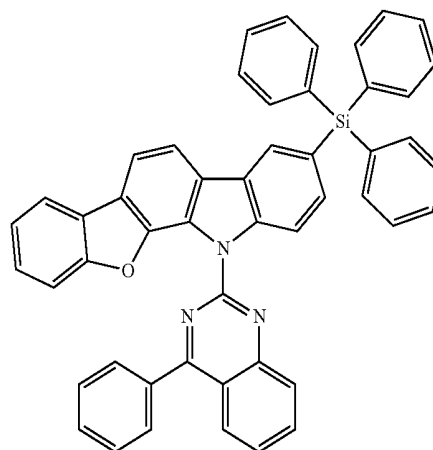


H2-323

H2-321

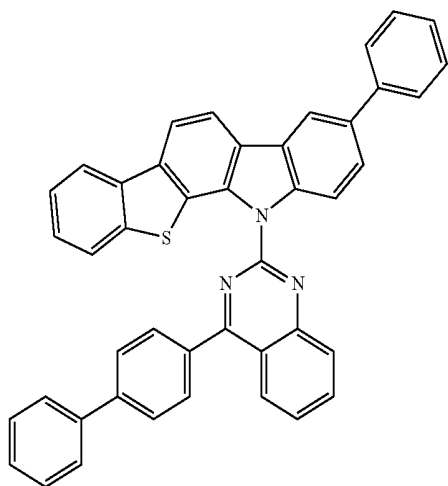


H2-324

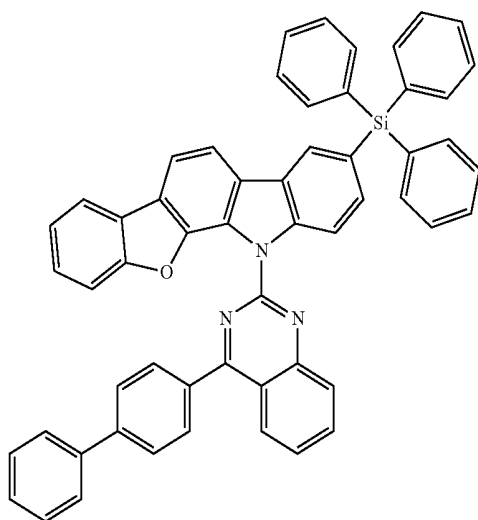


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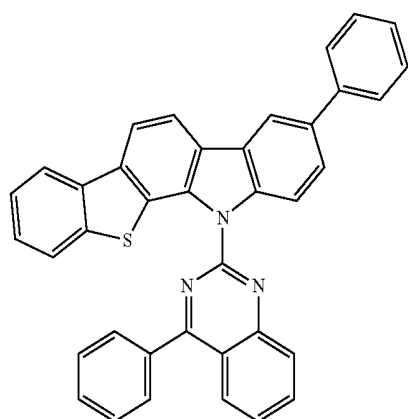
H2-325



H2-326

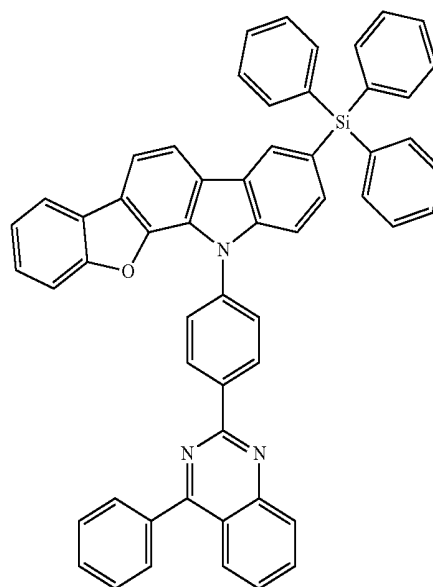


H2-327

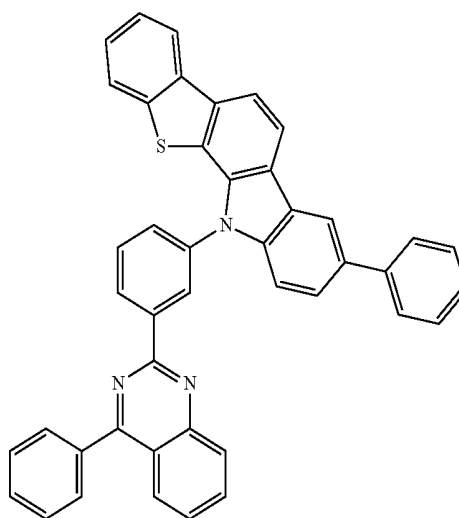


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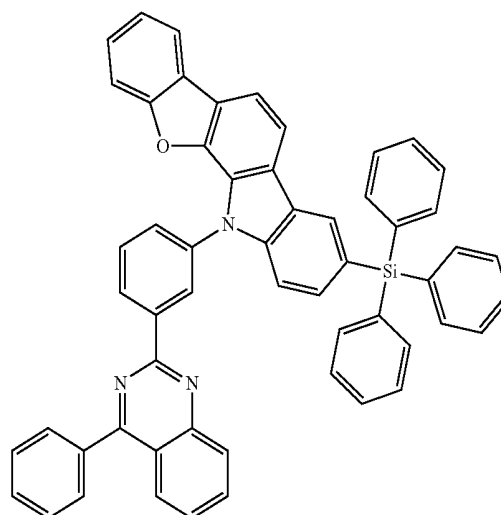
H2-328



H2-329

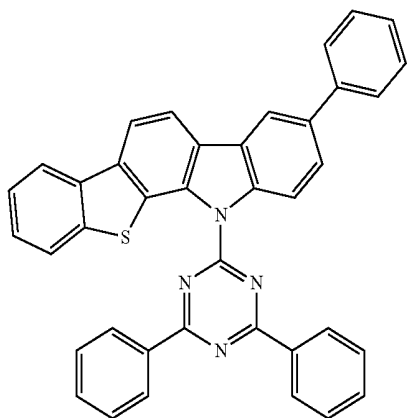


H2-330



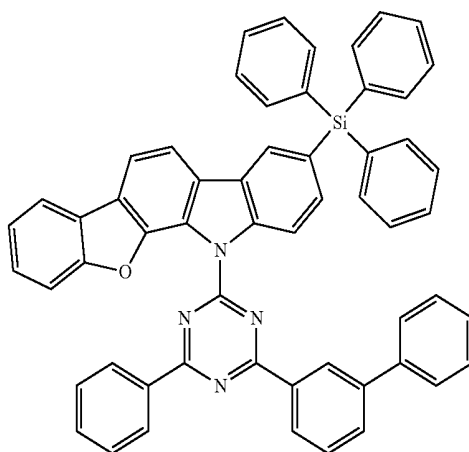
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H2-331



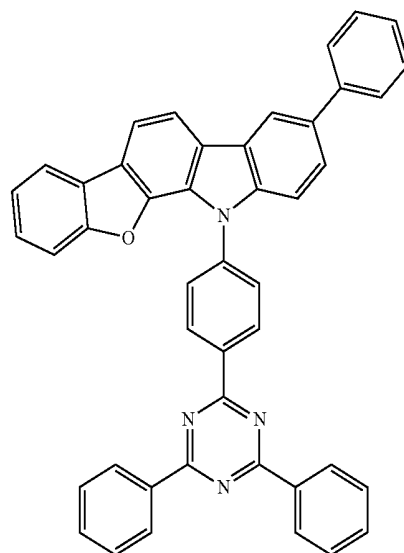
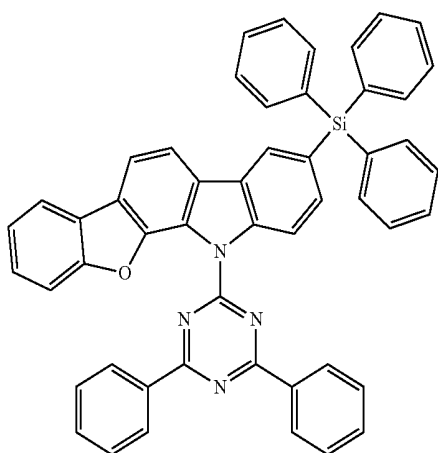
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H2-334



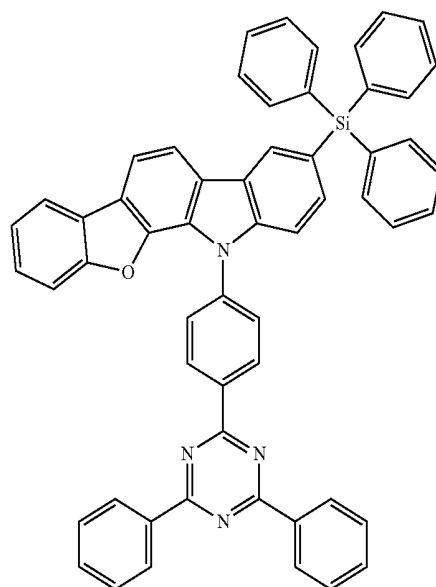
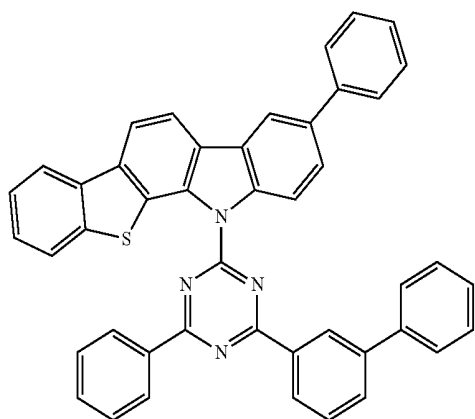
H2-335

H2-332



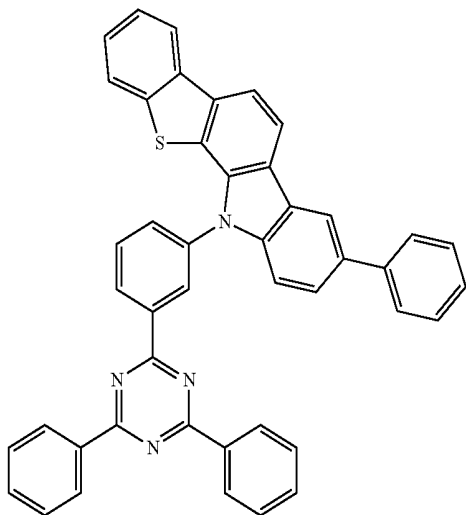
H2-336

H2-333

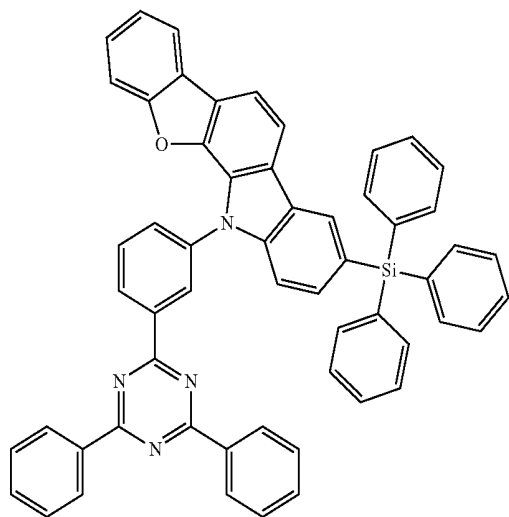


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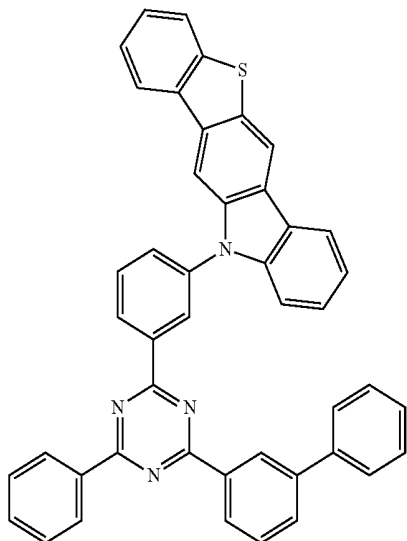
H2-337



H2-338

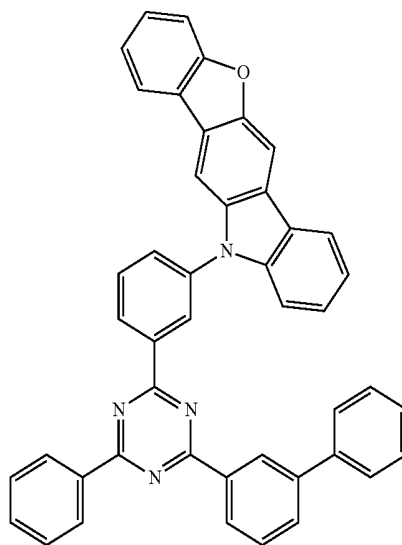


H2-339

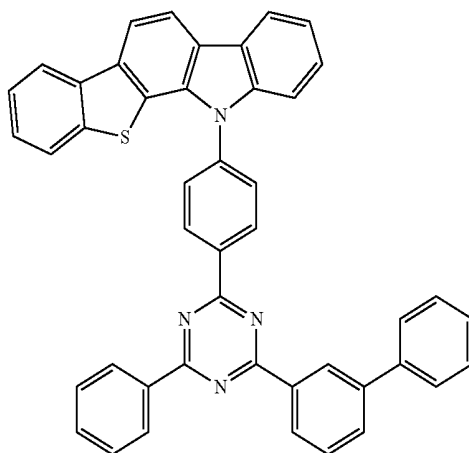


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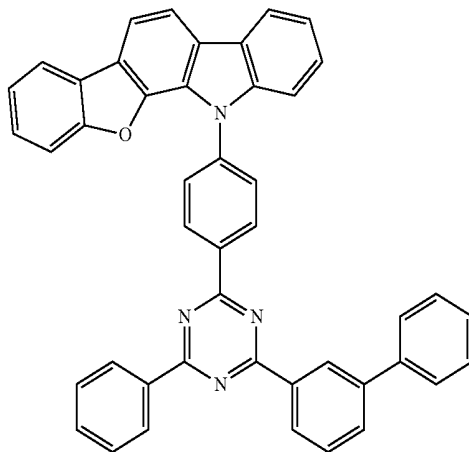
H2-340



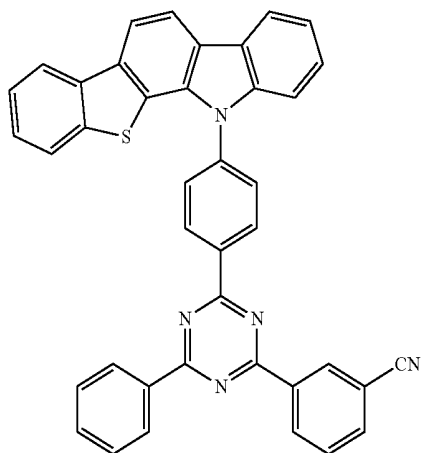
H2-341



H2-342

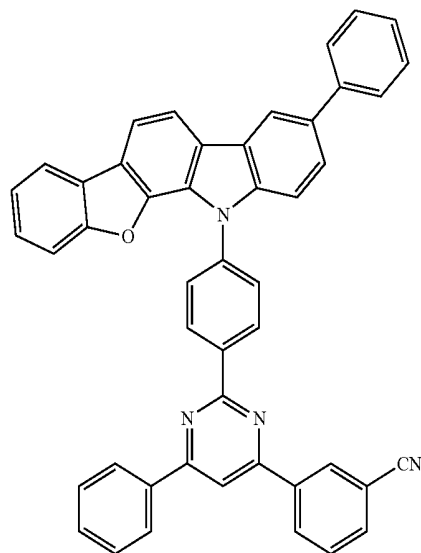


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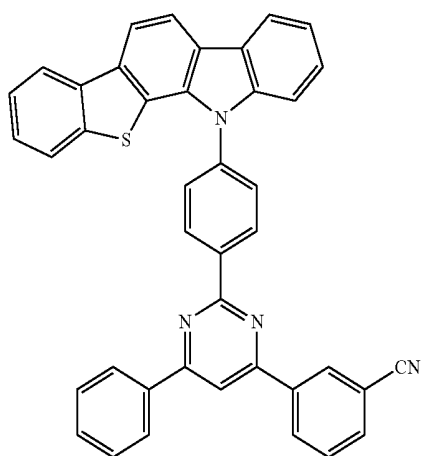


H2-343

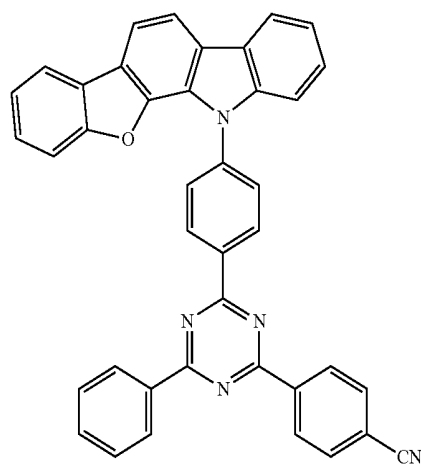
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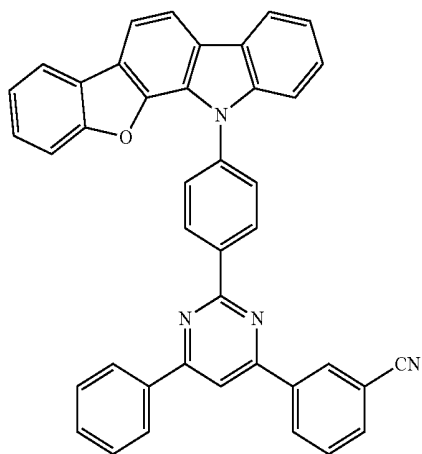
H2-346



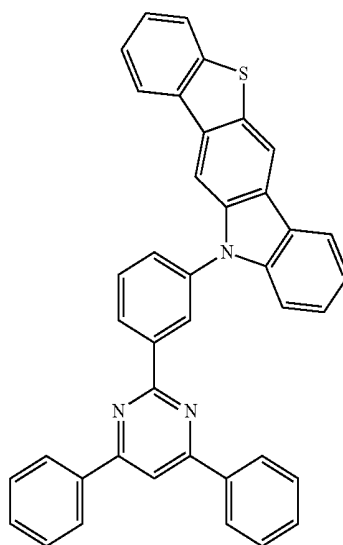
H2-344



H2-347

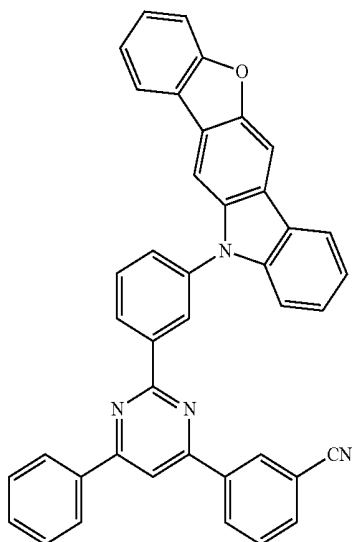


H2-345



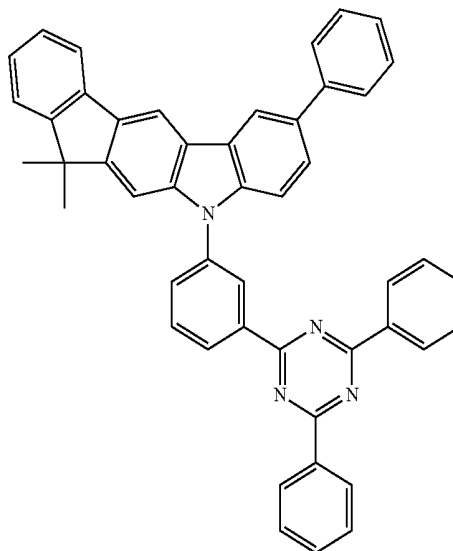
H2-348

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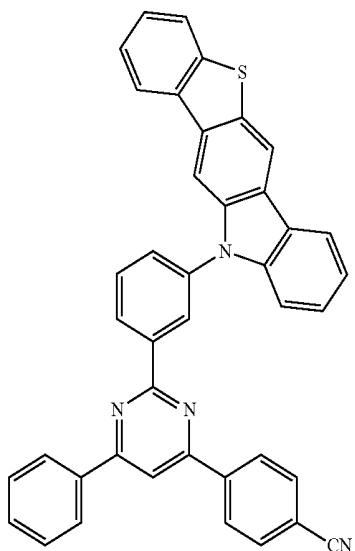
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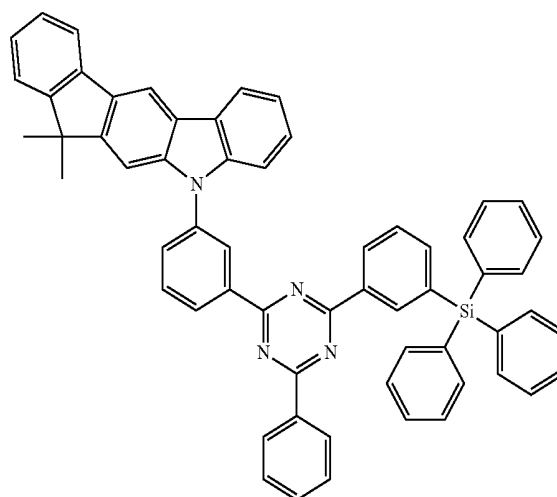


H2-352

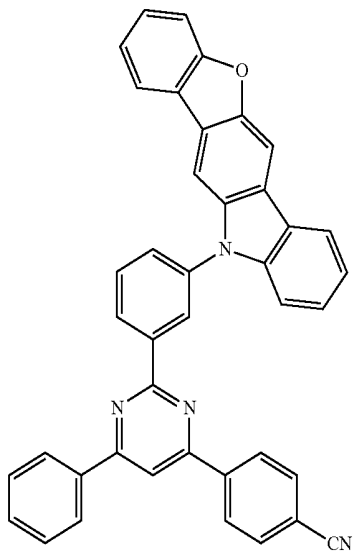
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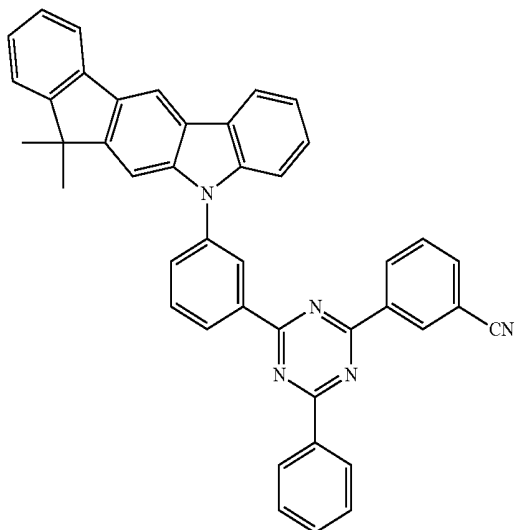
H2-353



H2-351

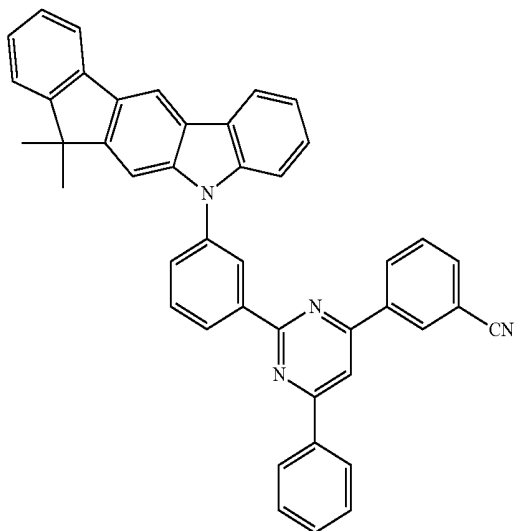


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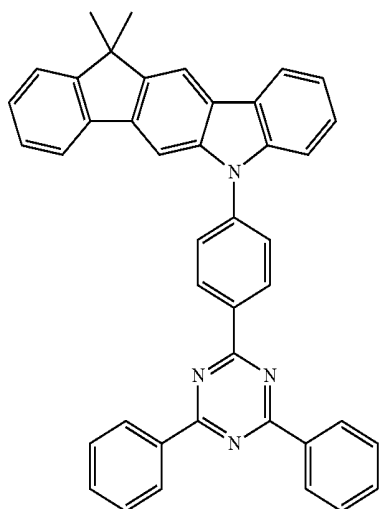


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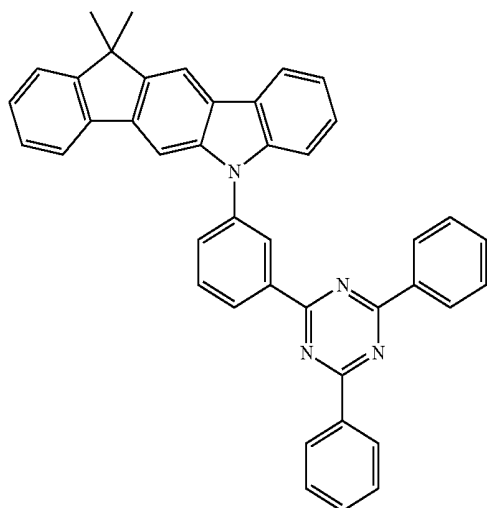
H2-355



H2-356

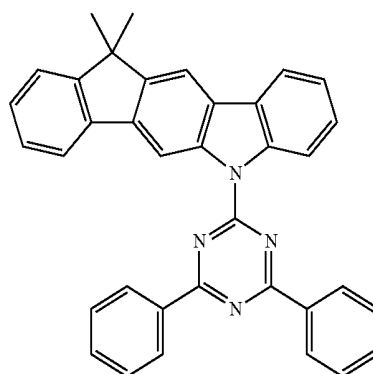


H2-357

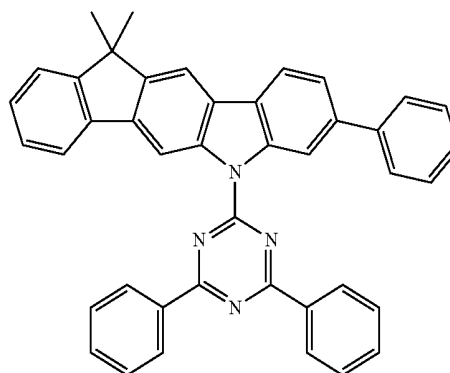


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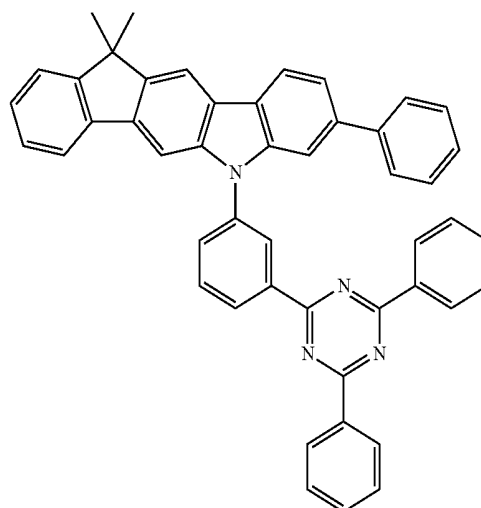
H2-358



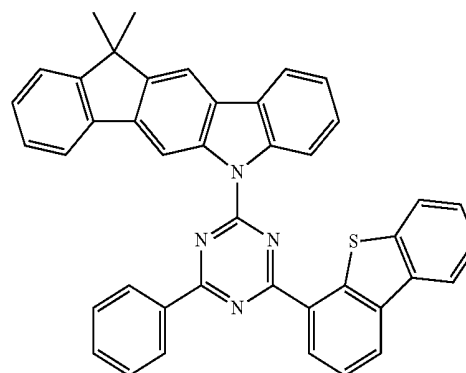
H2-359



H2-360

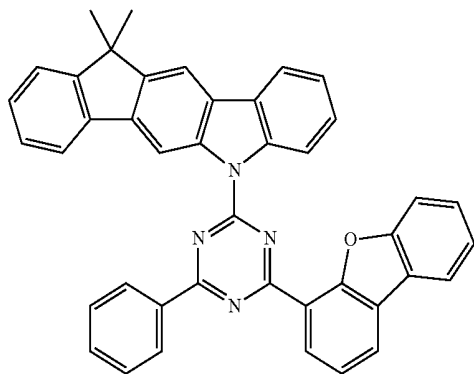


H2-361

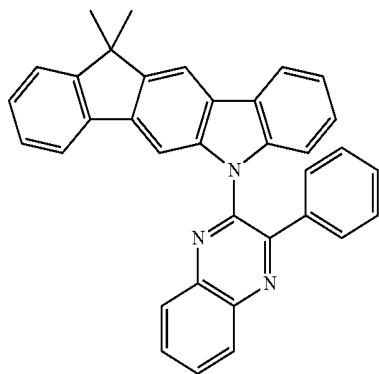


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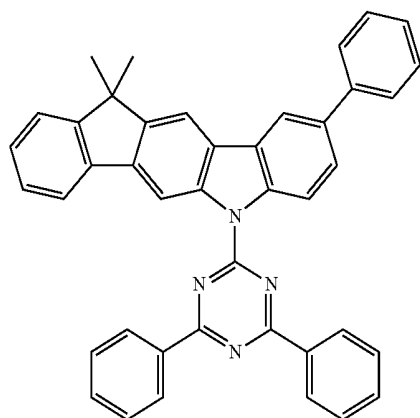
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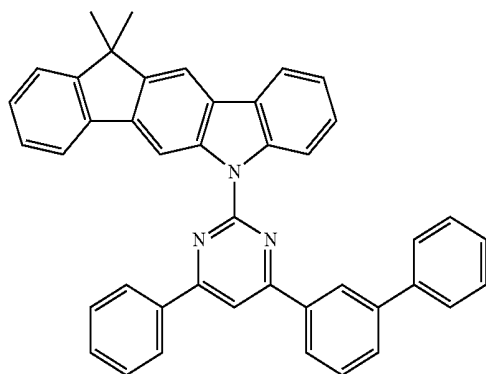
H2-363



H2-364

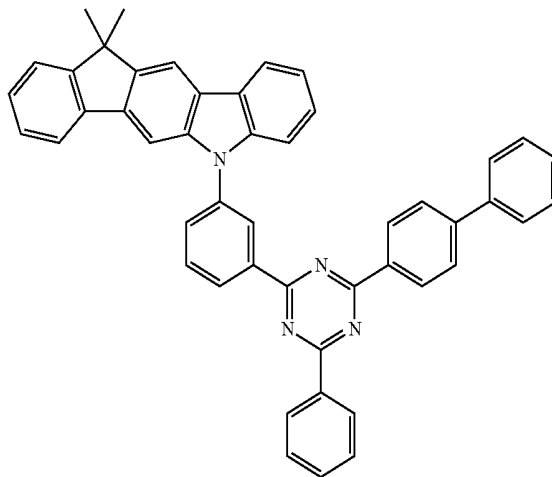


H2-365

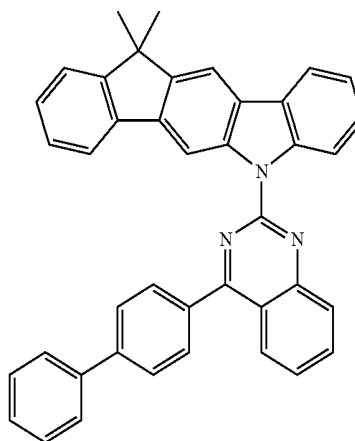


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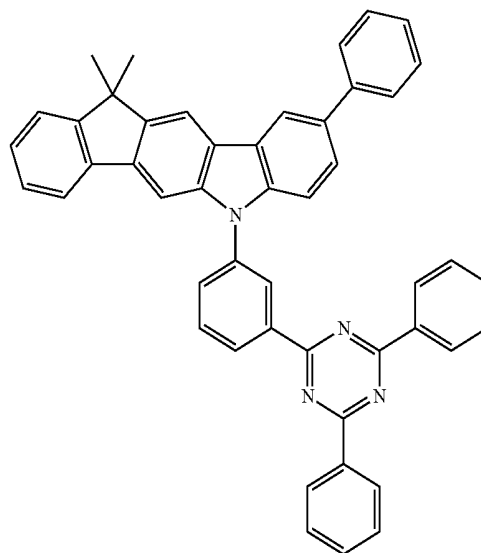
H2-366



H2-367

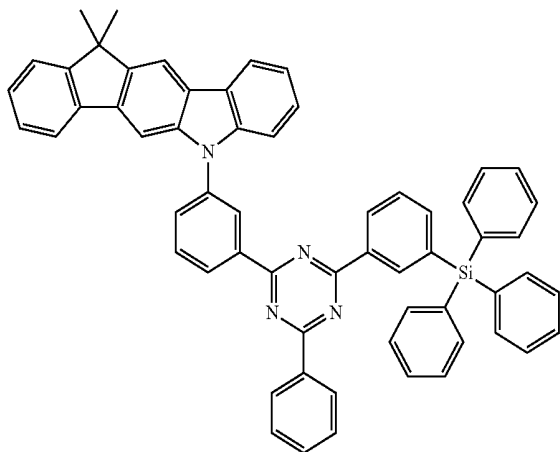


H2-368



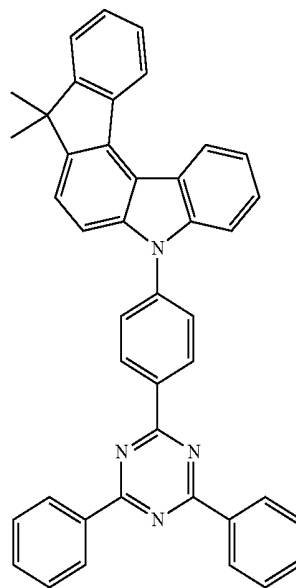
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H2-369

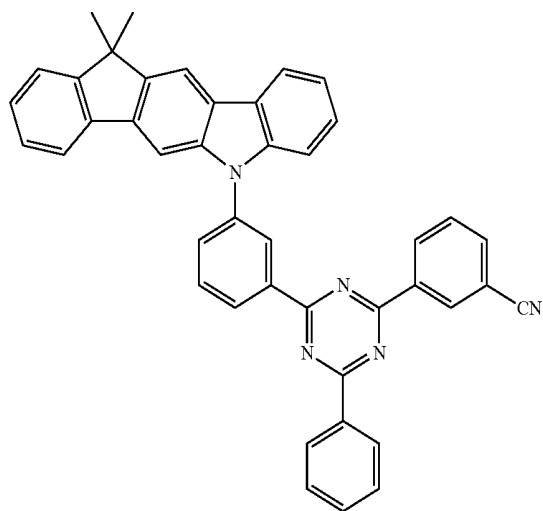


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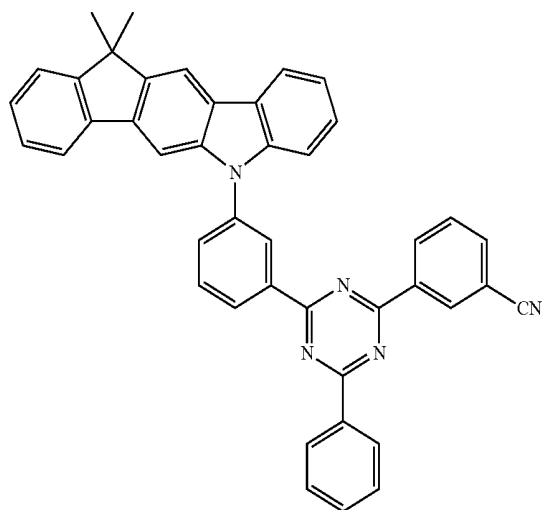
H2-372



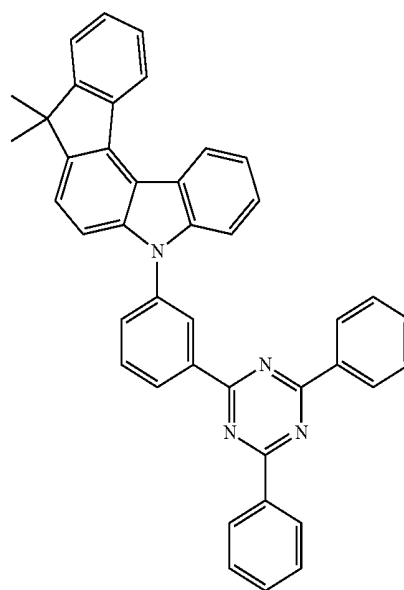
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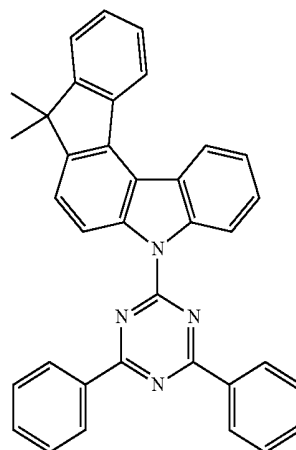
H2-371



H2-373

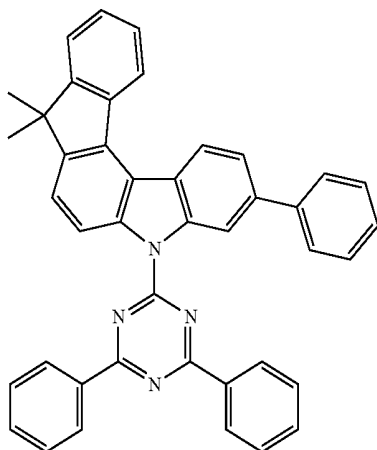


H2-374



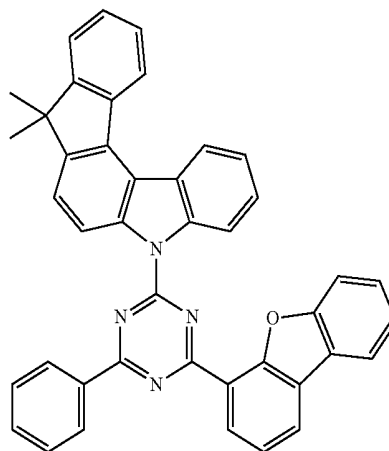
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H2-375

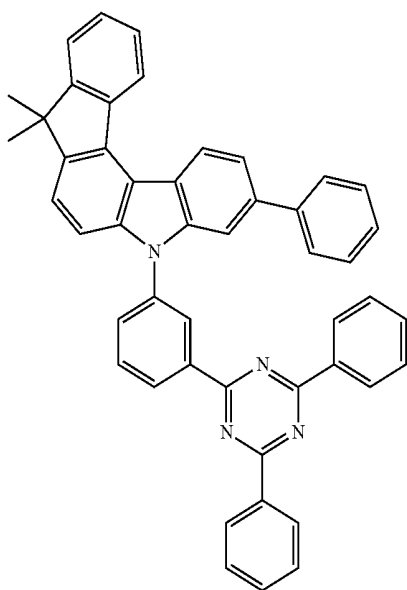


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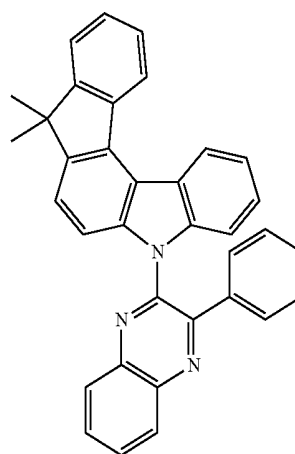
H2-378



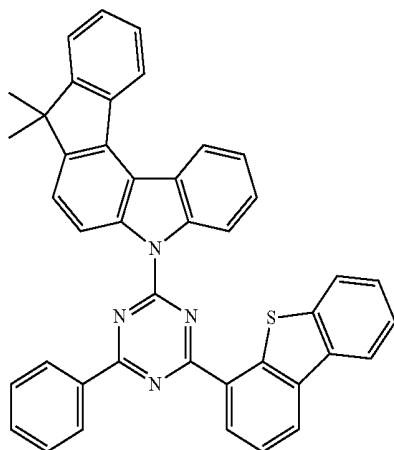
H2-376



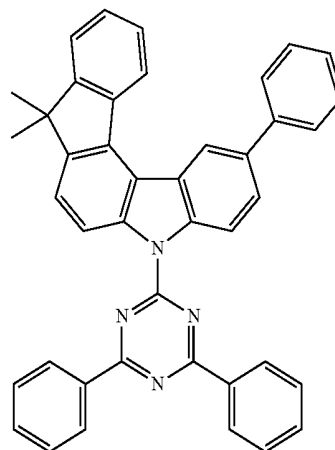
H2-379



H2-377

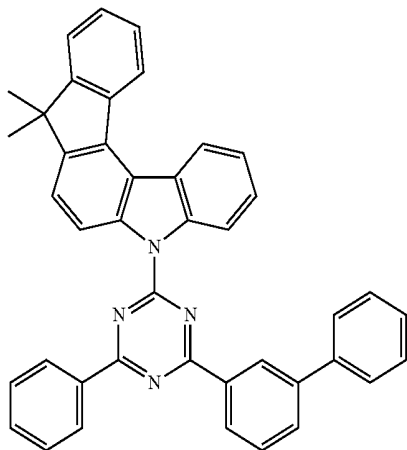


H2-380

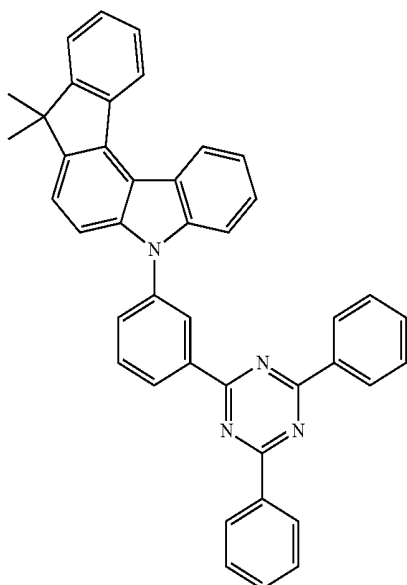


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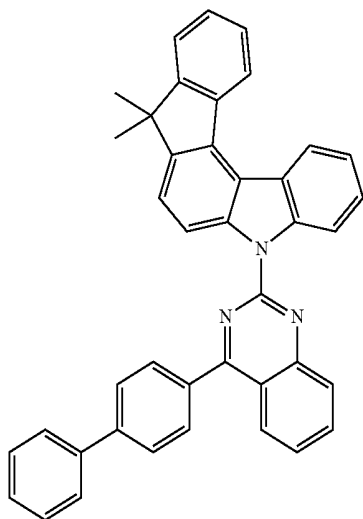
H2-381



H2-382

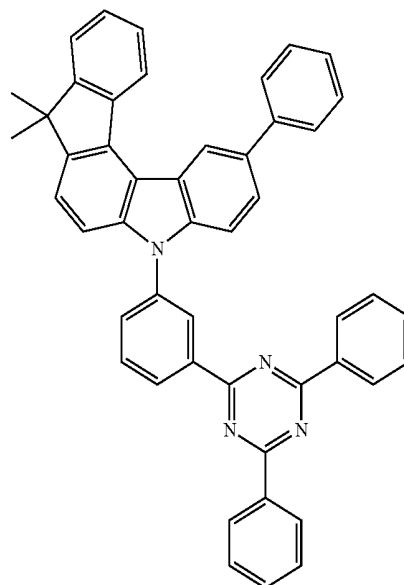


H2-383

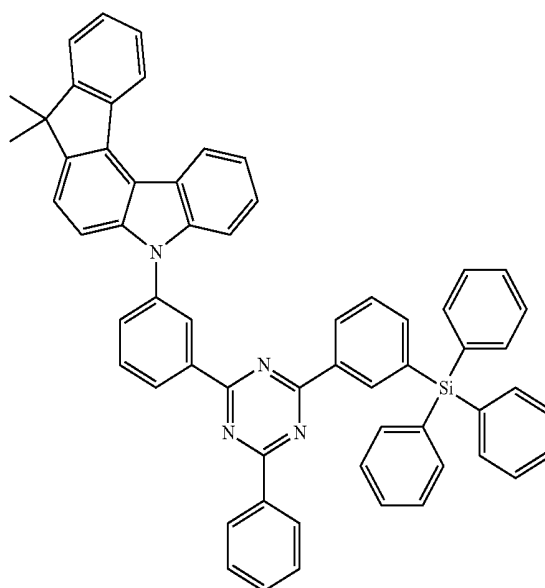


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H2-384

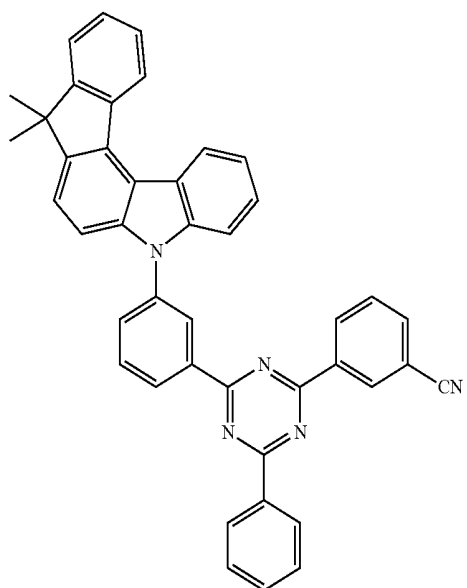


H2-385



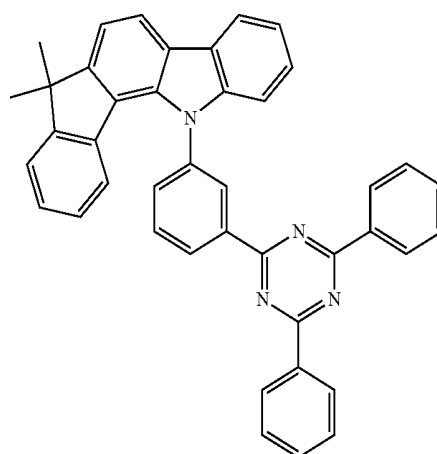
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H2-386

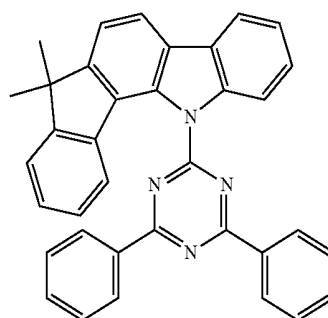


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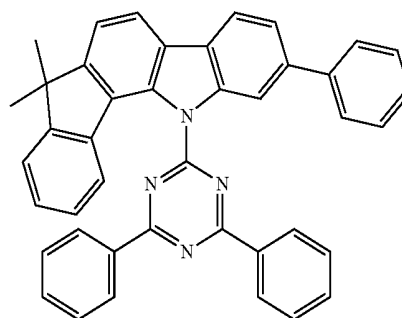
H2-389



H2-390

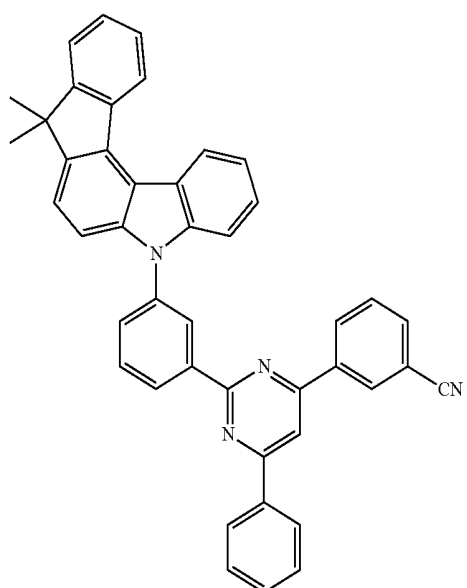


H2-391

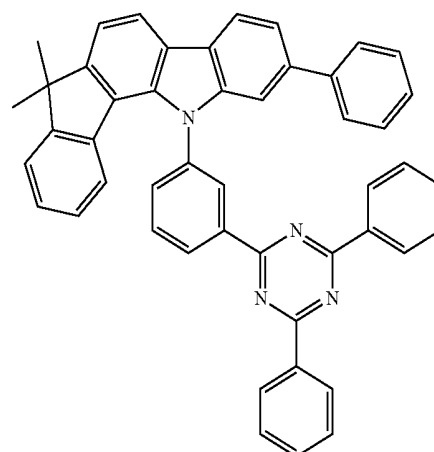
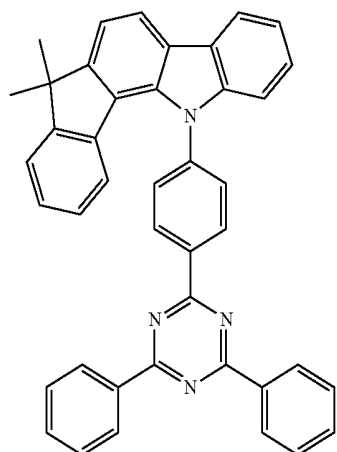


H2-392

H2-387

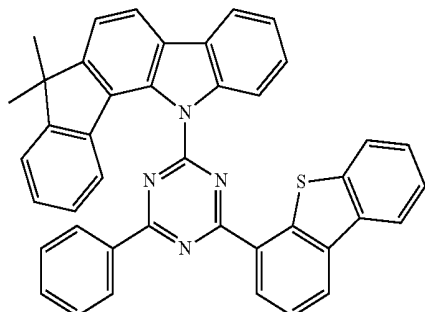


H2-388



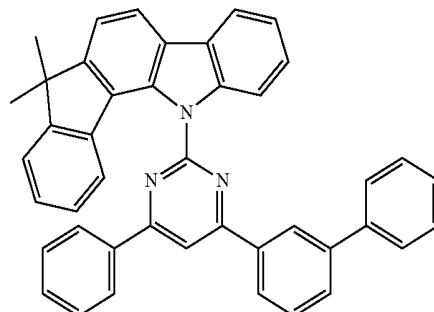
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H2-393

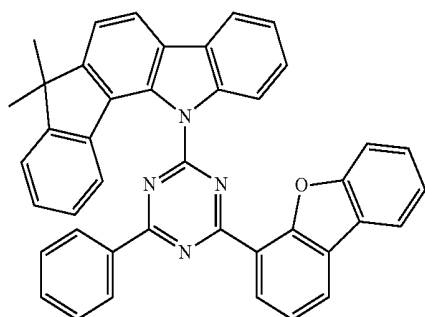


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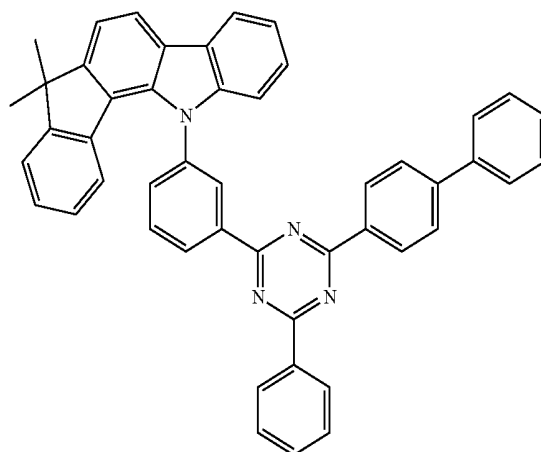
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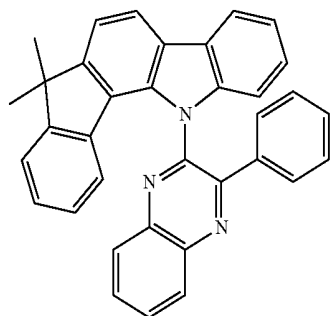
H2-394



H2-398

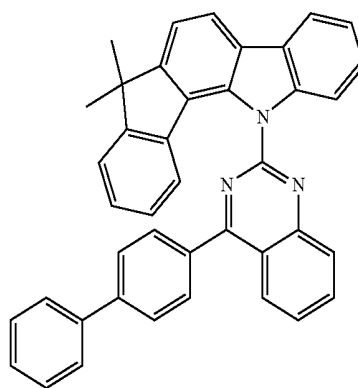
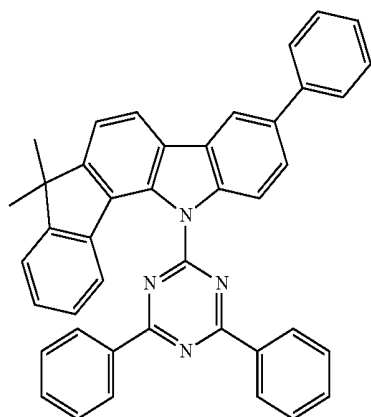


H2-395



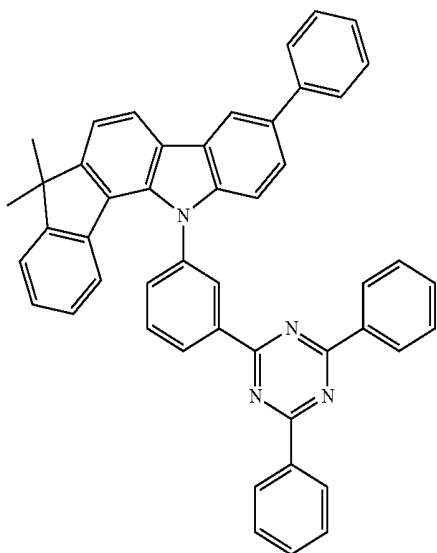
H2-399

H2-396



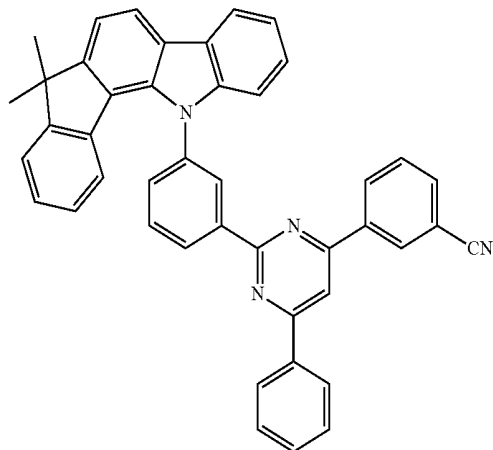
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H2-400

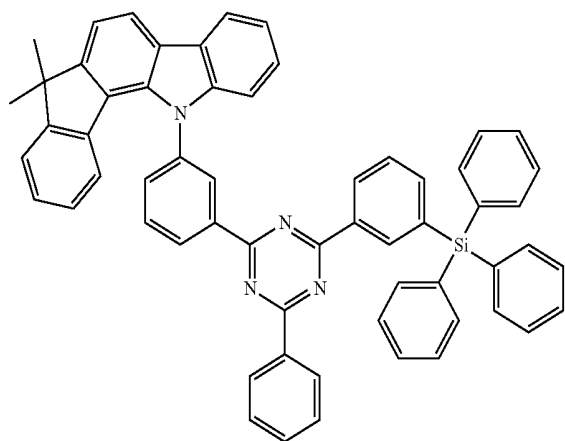


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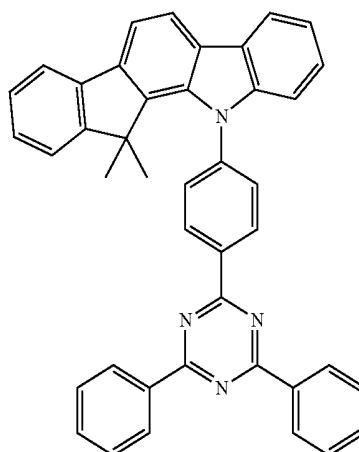
H2-403



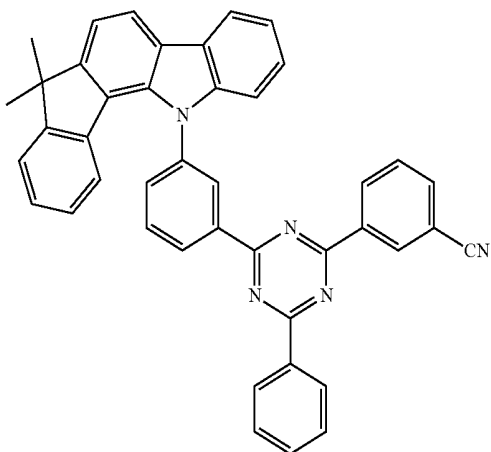
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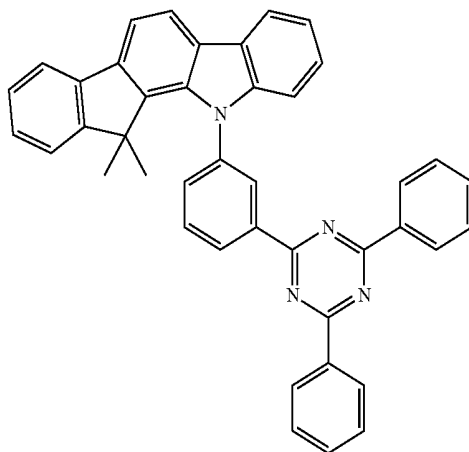
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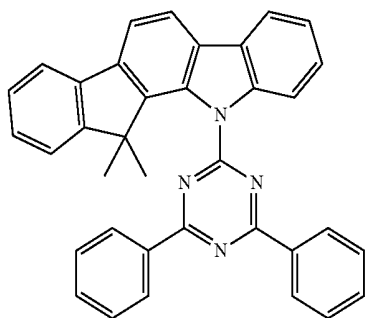
H2-402



H2-405

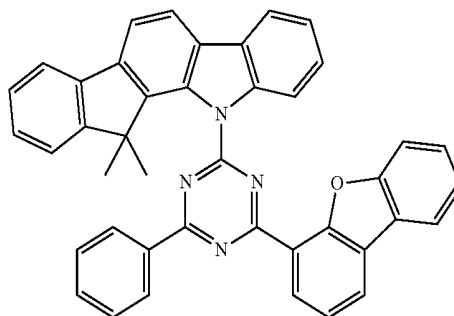


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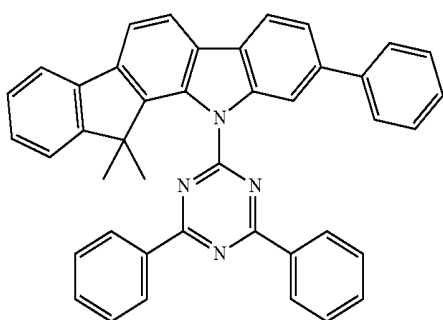
H2-406

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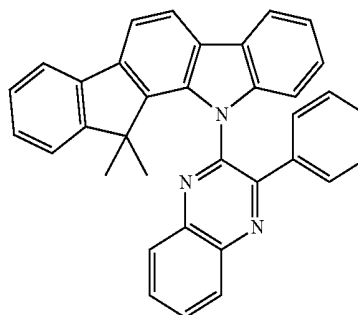


H2-410

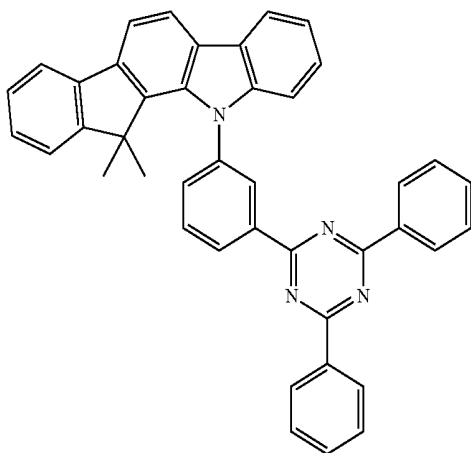
H2-407



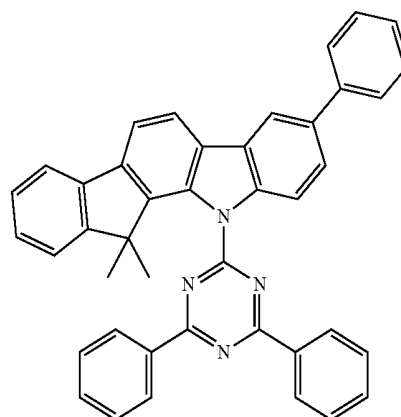
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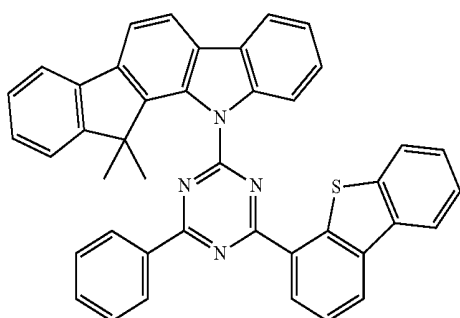
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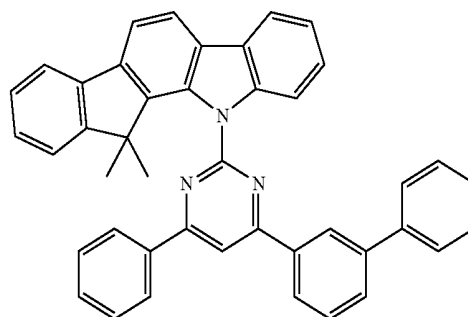
H2-412



H2-409

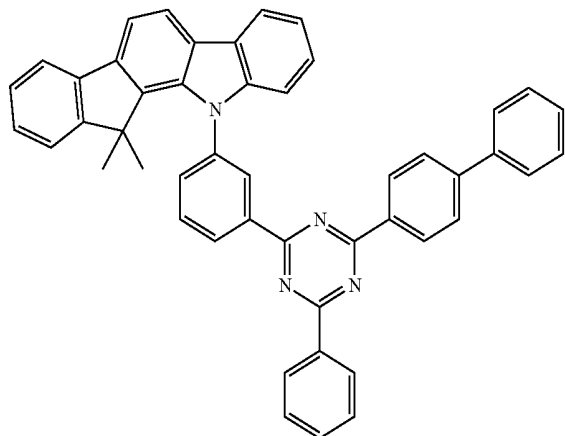


H2-413



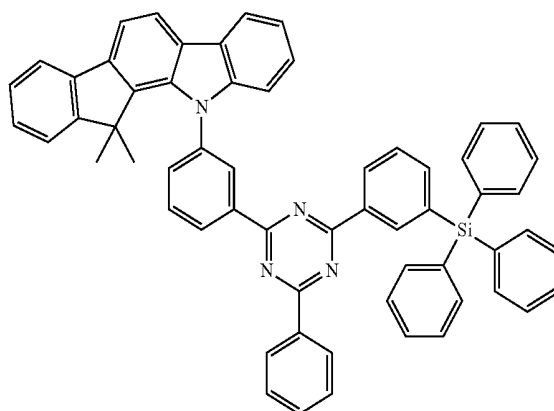
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H2-414

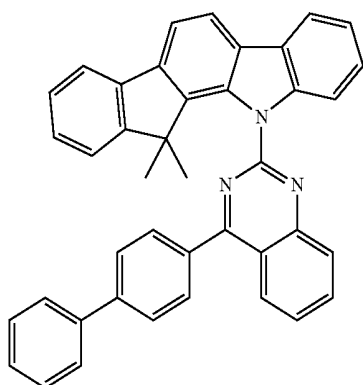


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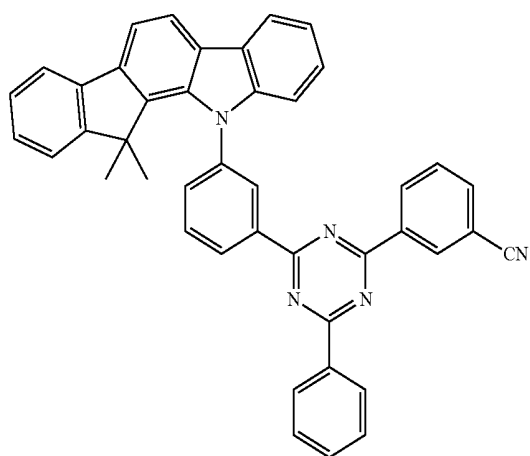
H2-417



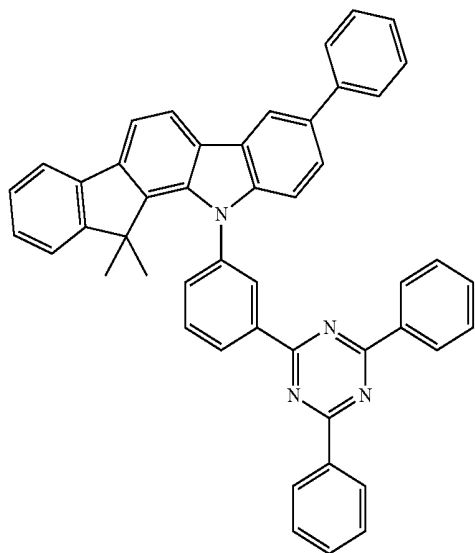
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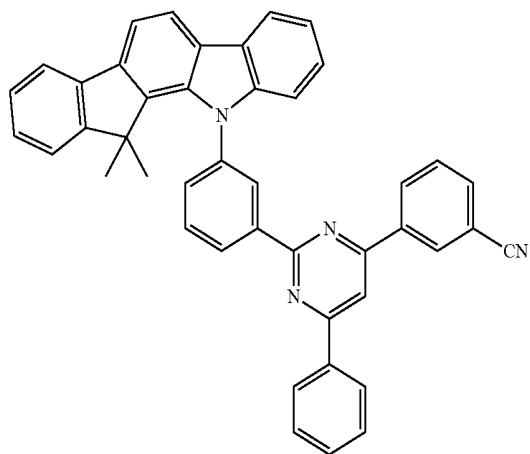
H2-418



H2-416

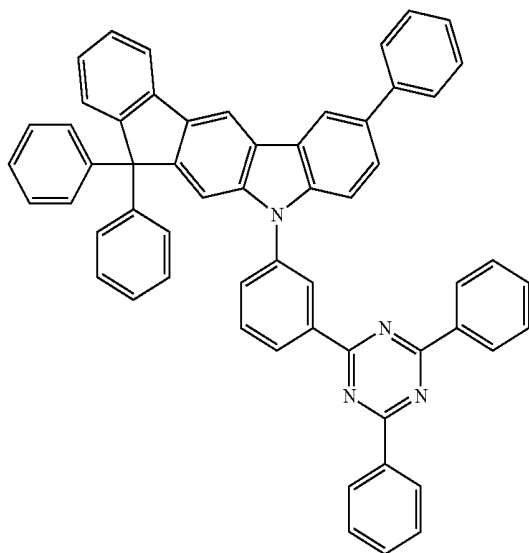


H2-419



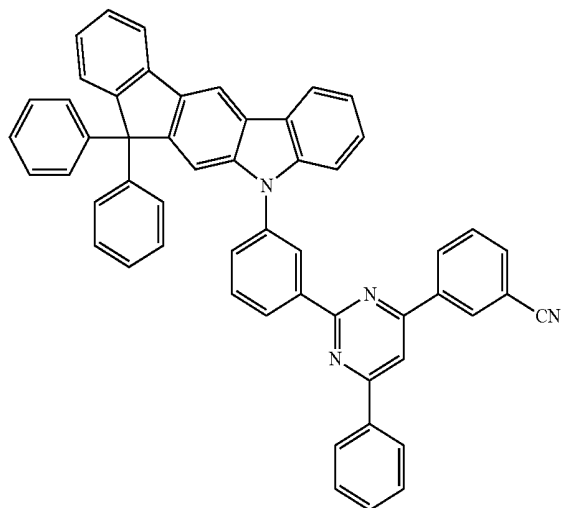
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H2-420

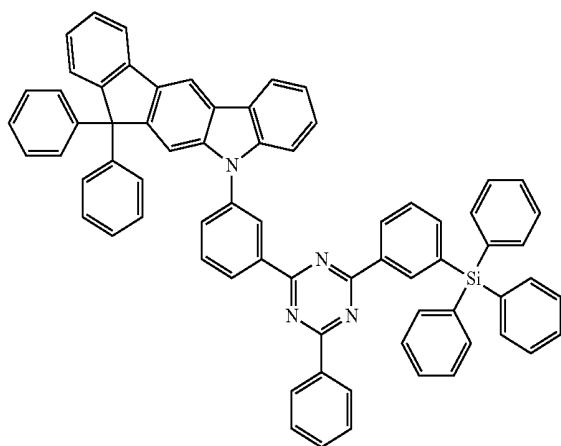


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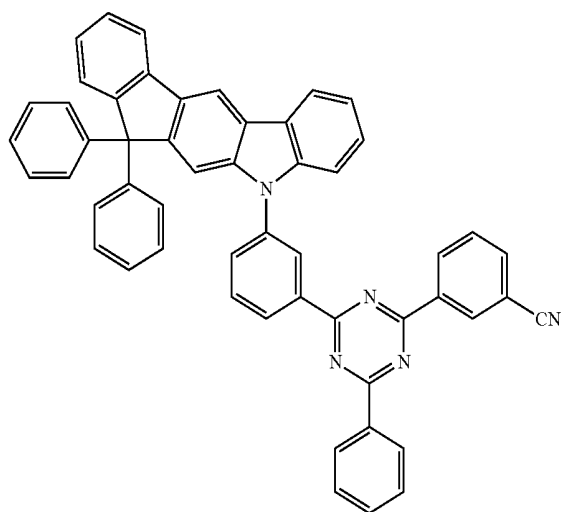
H2-423



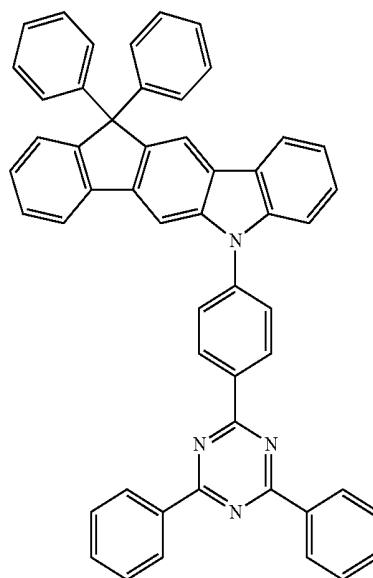
H2-421



H2-422

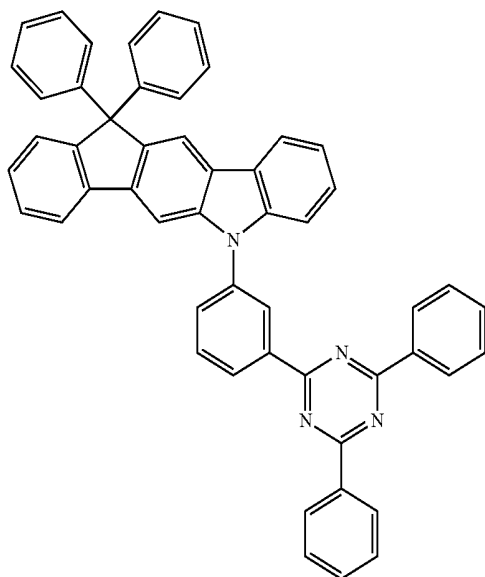


H2-424



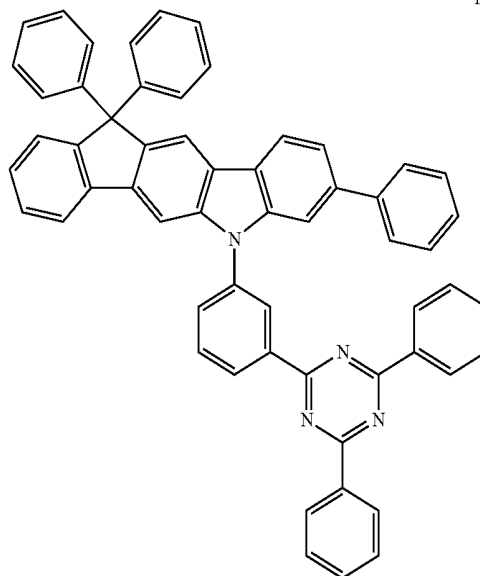
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H2-425

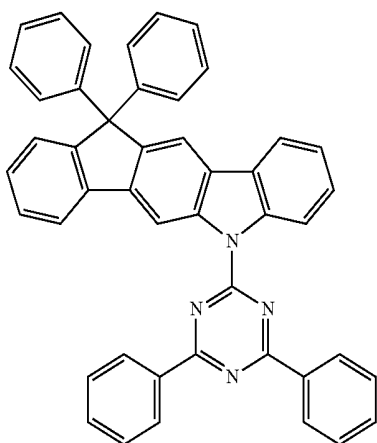


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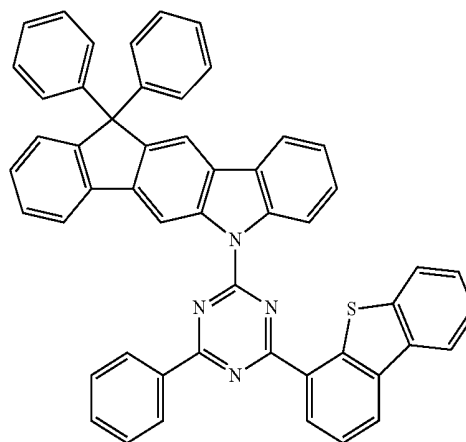
H2-428



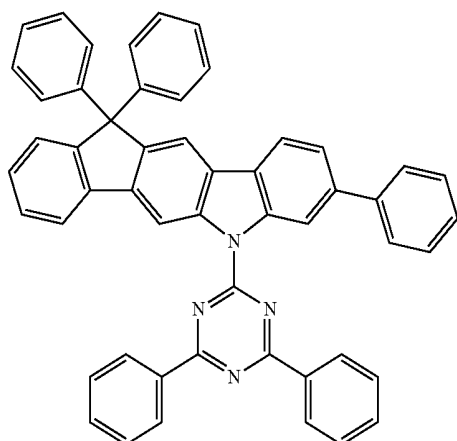
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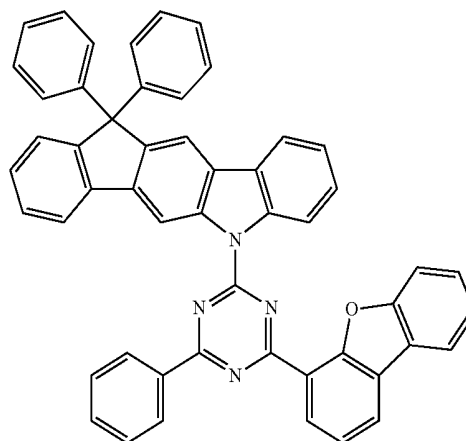
H2-429



H2-427

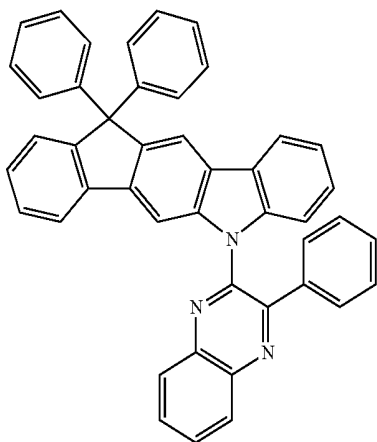


H2-430



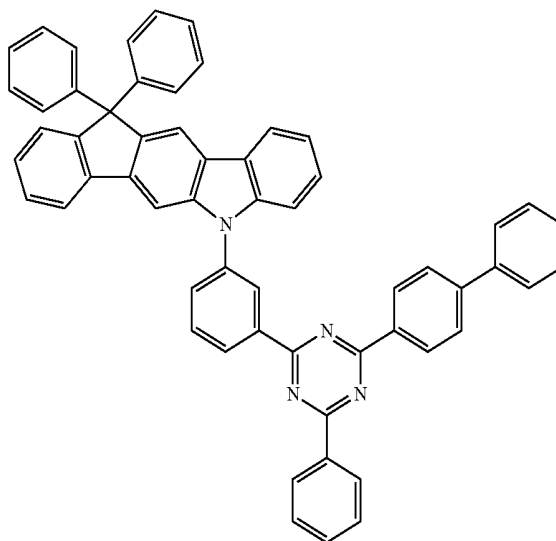
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H2-431

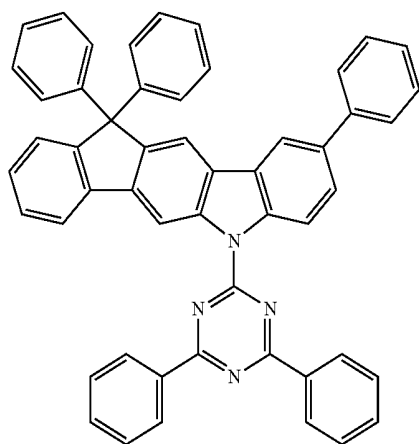


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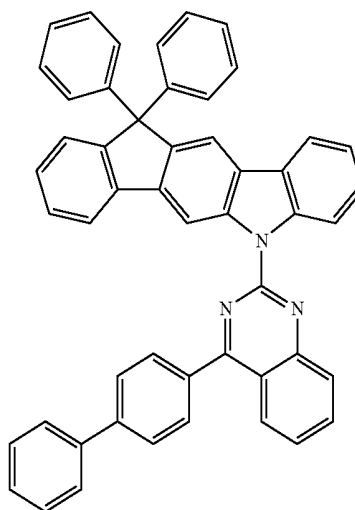
H2-434



H2-432

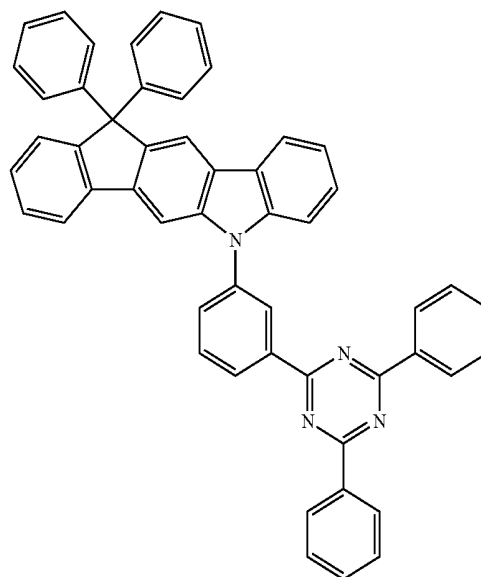
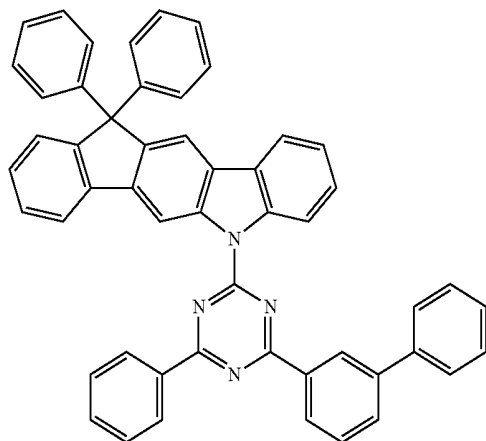


H2-435



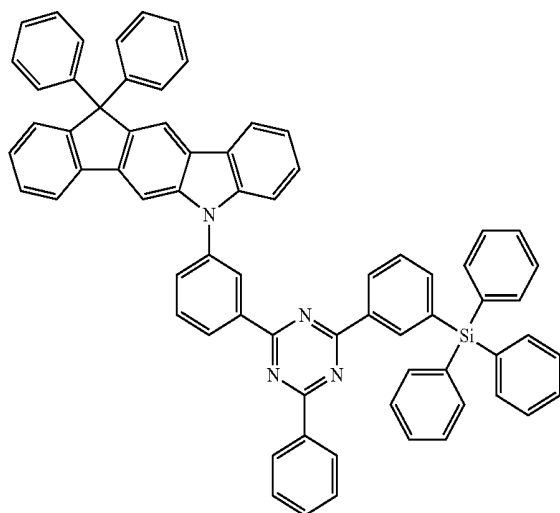
H2-436

H2-433



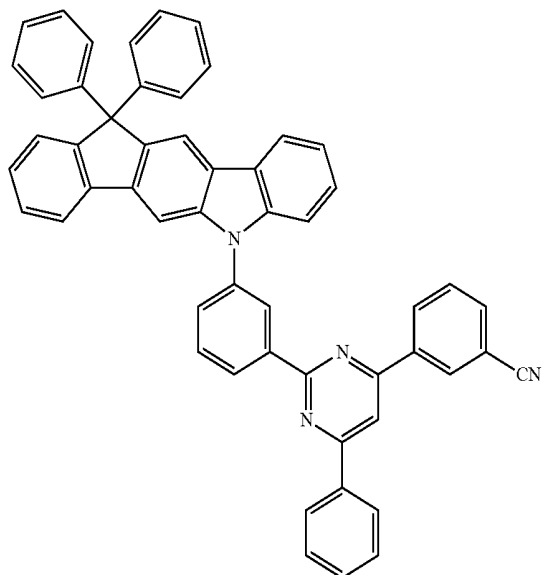
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H2-437

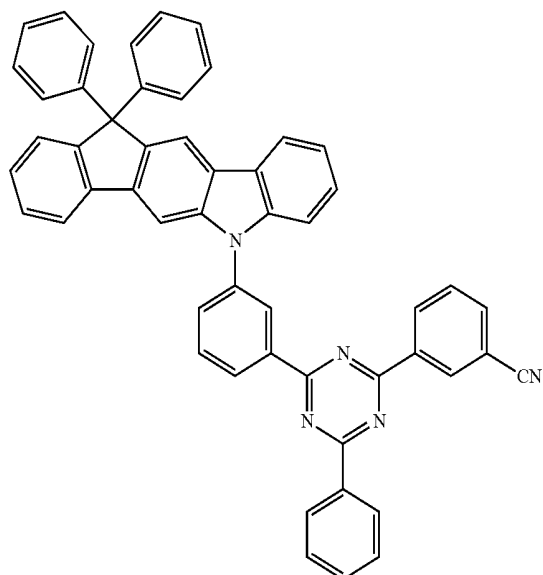


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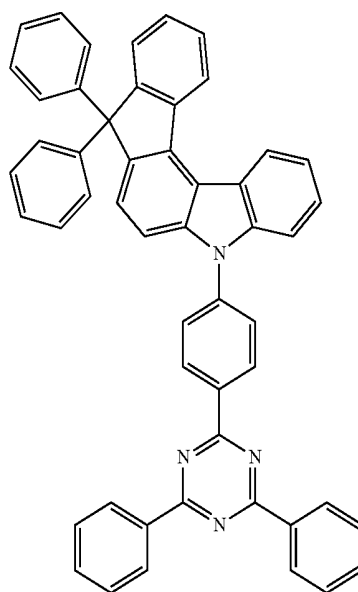
H2-439



H2-438

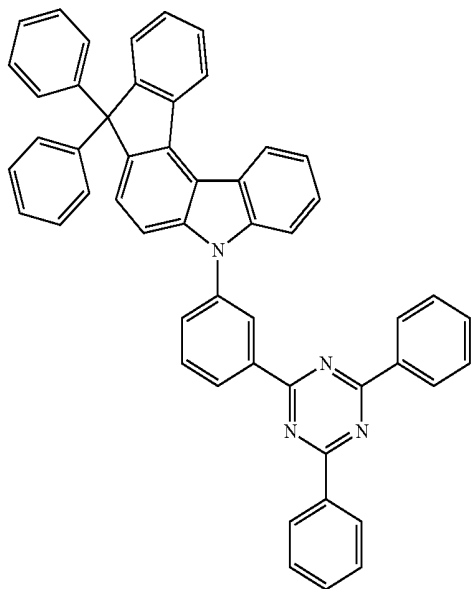


H2-440



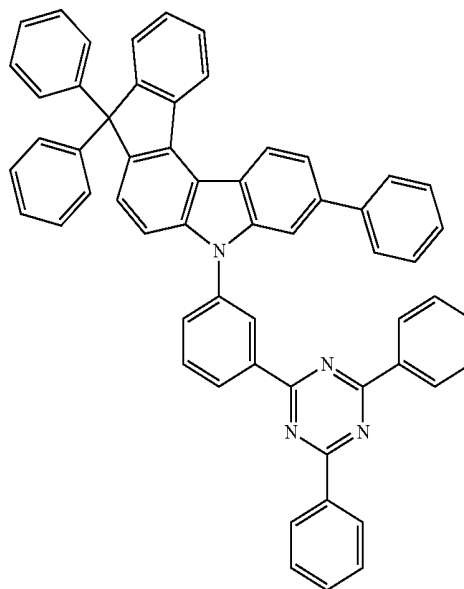
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H2-441



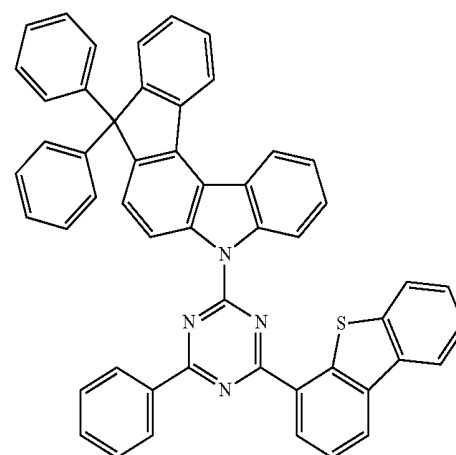
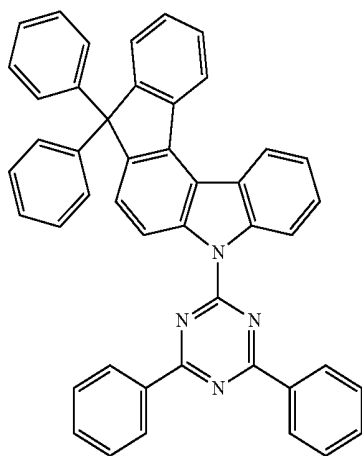
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H2-444

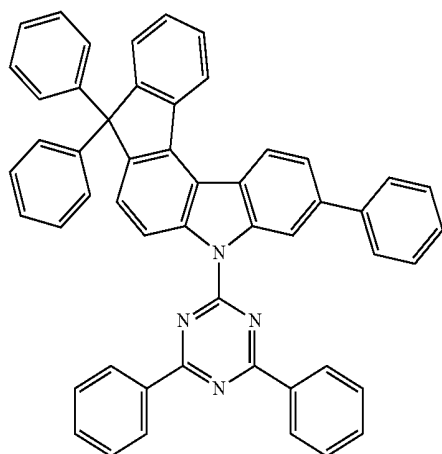


H2-445

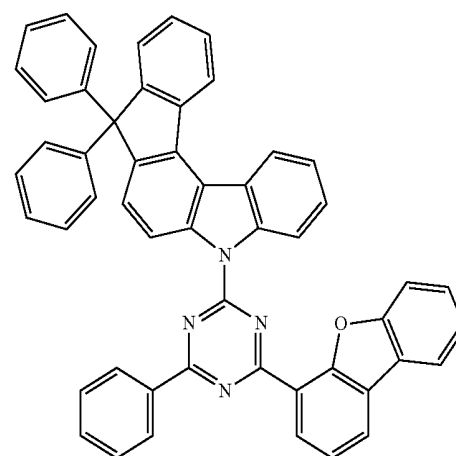
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H2-443

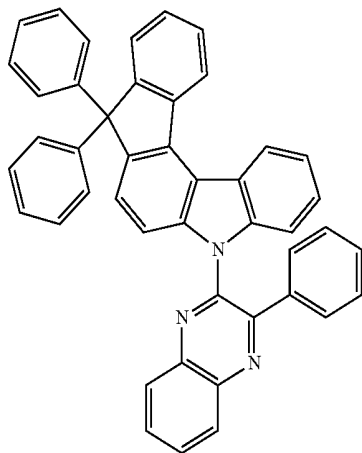


H2-446



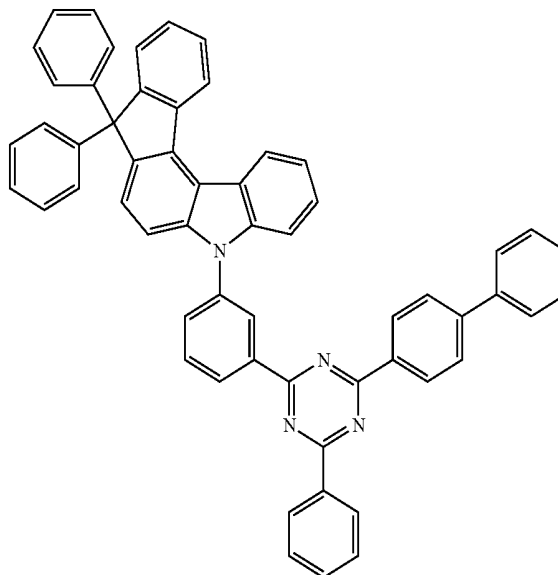
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H2-447

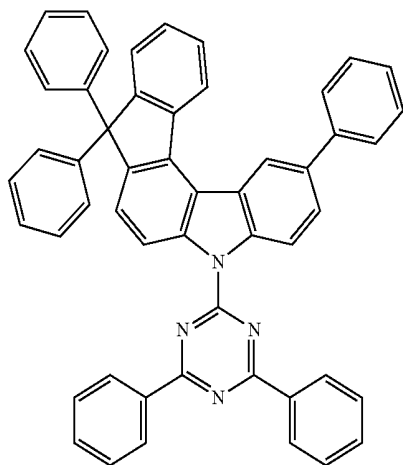


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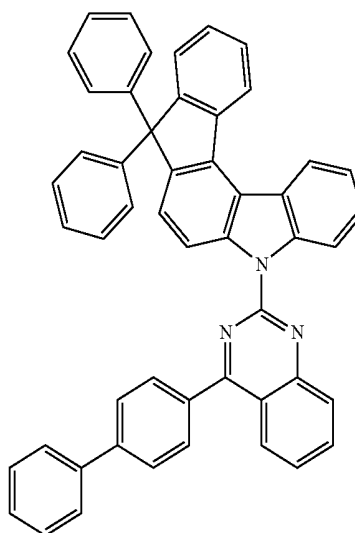
H2-450



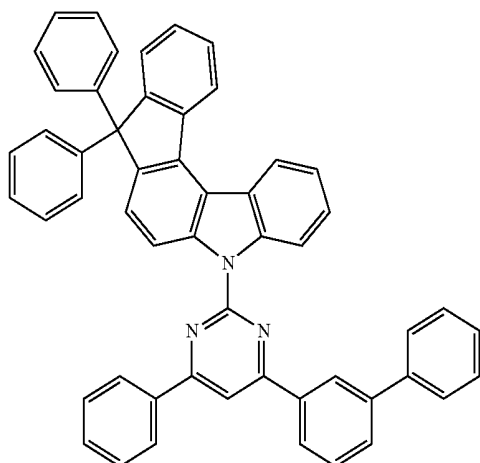
H2-448



H2-451

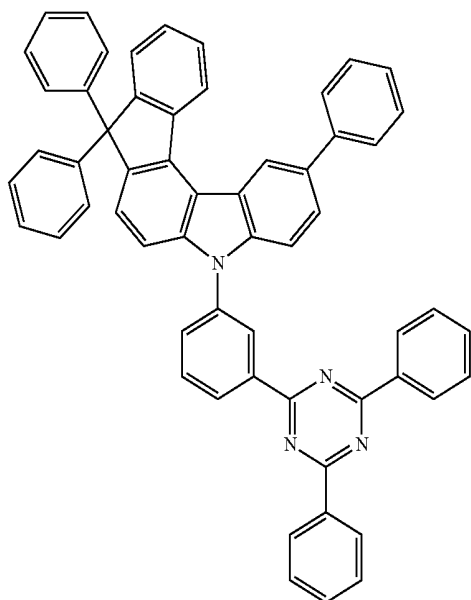


H2-449



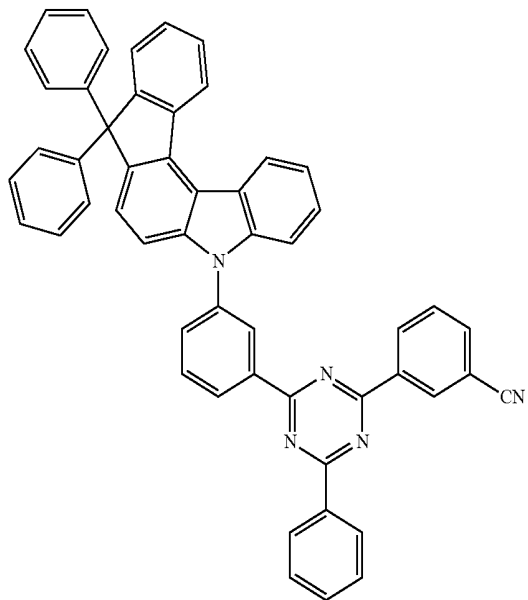
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H2-452

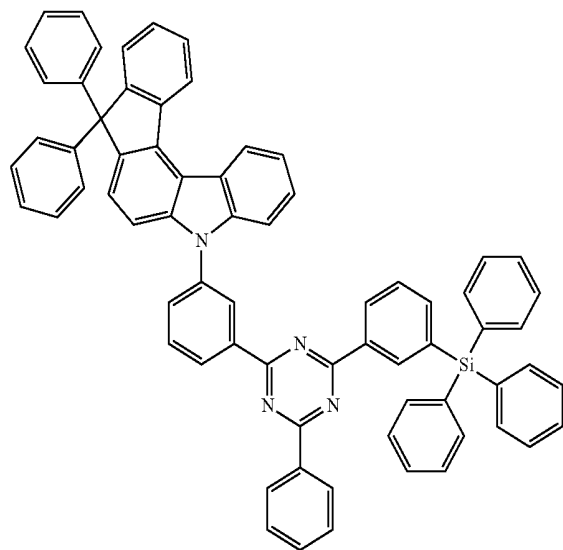


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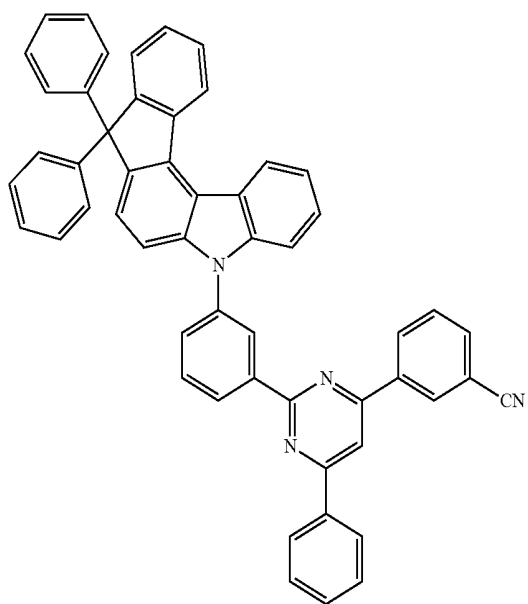
H2-454



H2-453

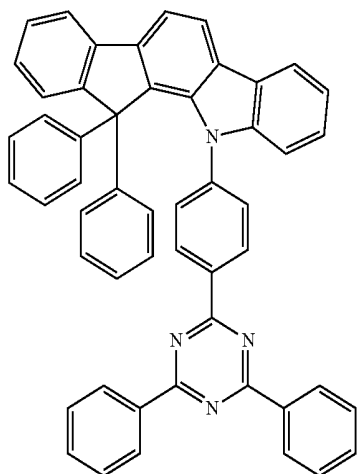


H2-455



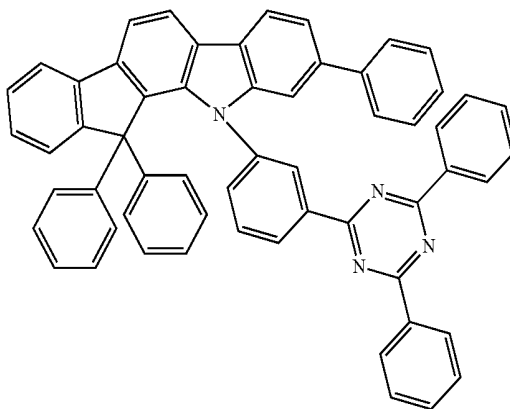
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H2-456

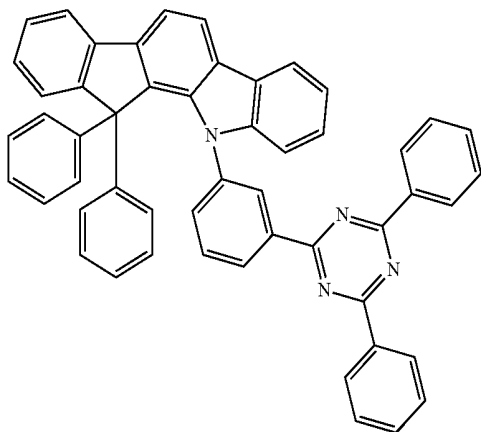


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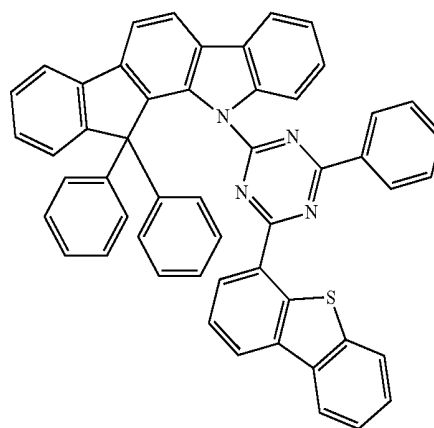
H2-460



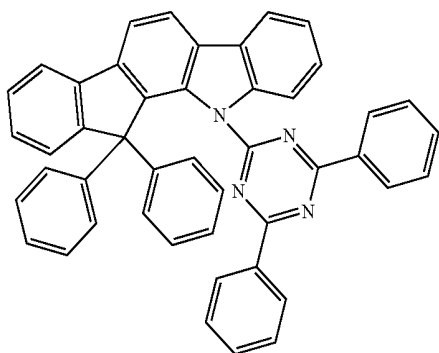
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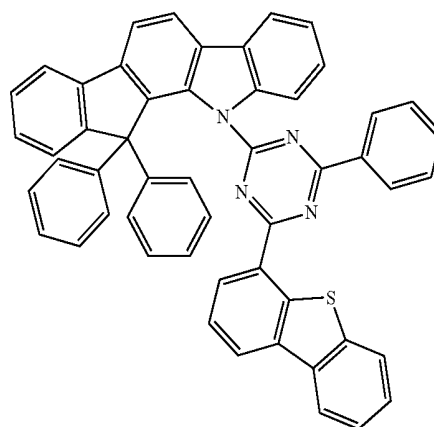
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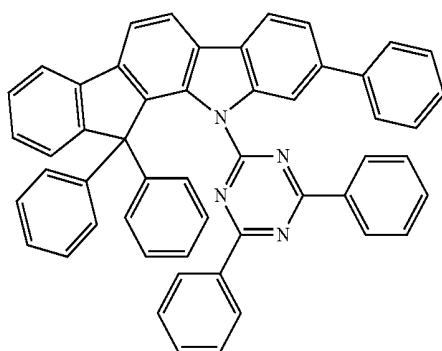
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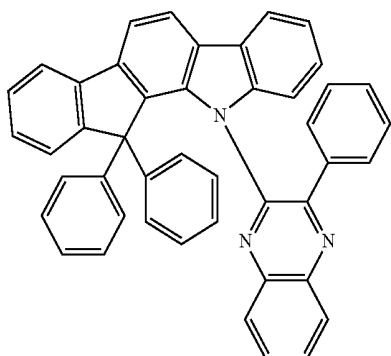
H2-462



H2-459

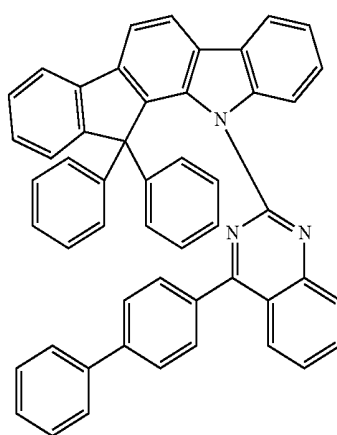


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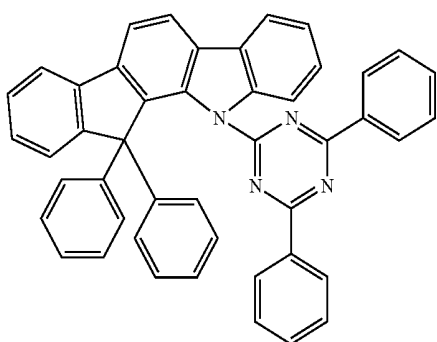


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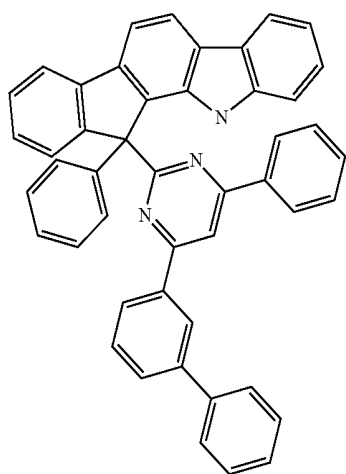
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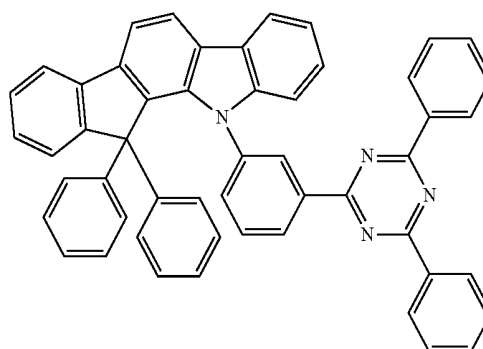
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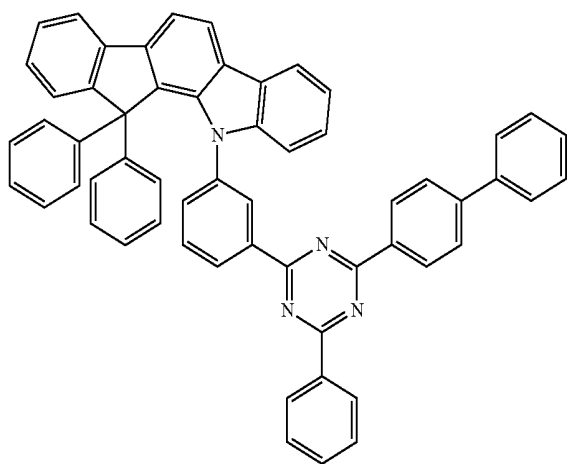
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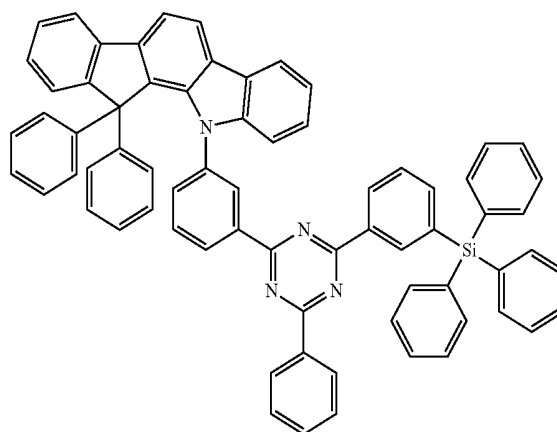
H2-465



H2-468



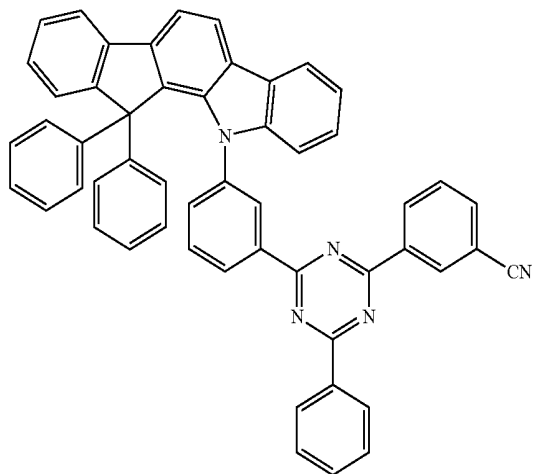
H2-466



H2-469

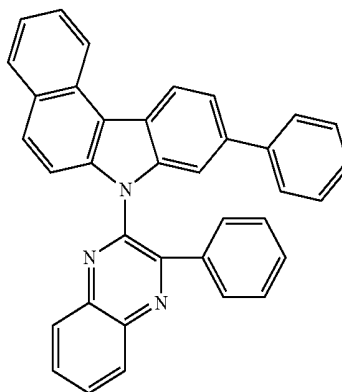
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H2-470

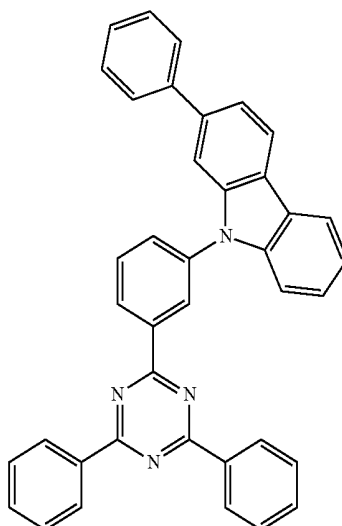


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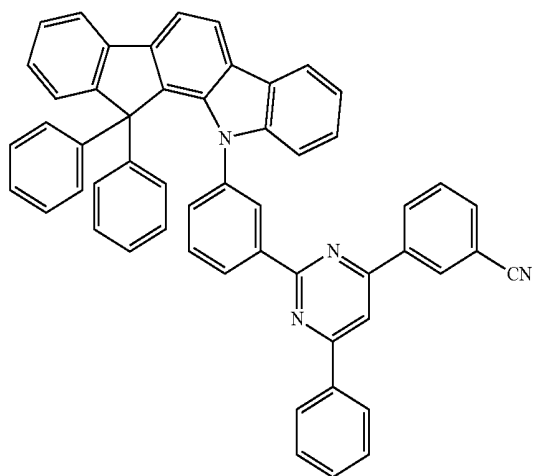
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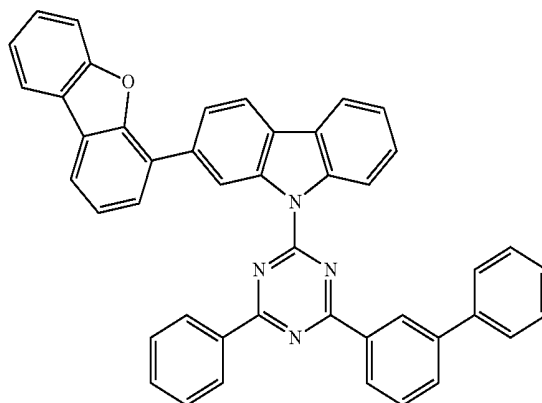
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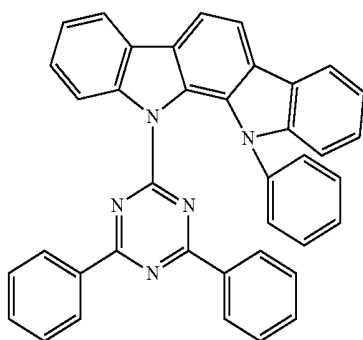
H2-471



H2-475

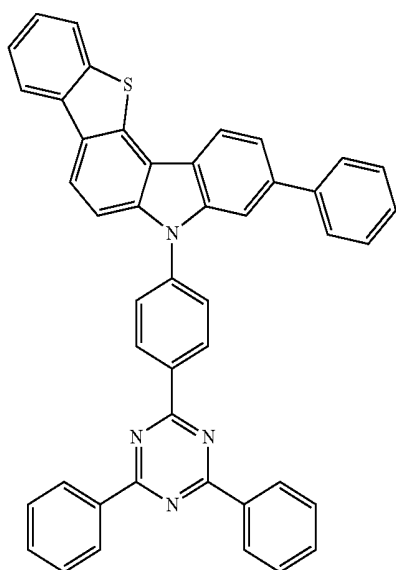


H2-472



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H2-476



[0037] The organic electroluminescent device according to the present invention comprises an anode; a cathode; and at least one organic layer between the anode and the cathode. The organic layer comprises a light-emitting layer, and the light-emitting layer comprises a host and a phosphorescent dopant. The host consists of multi-component host compounds, at least a first host compound of the multi-component host compounds is represented by formula 1, and a second host compound is represented by formula 2.

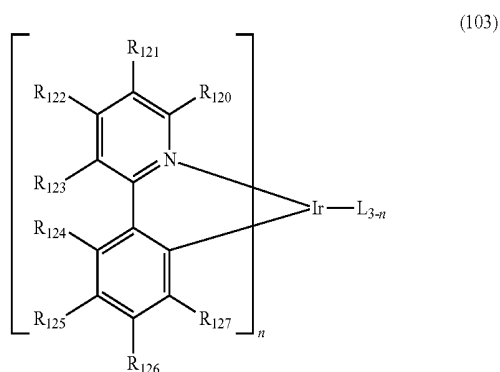
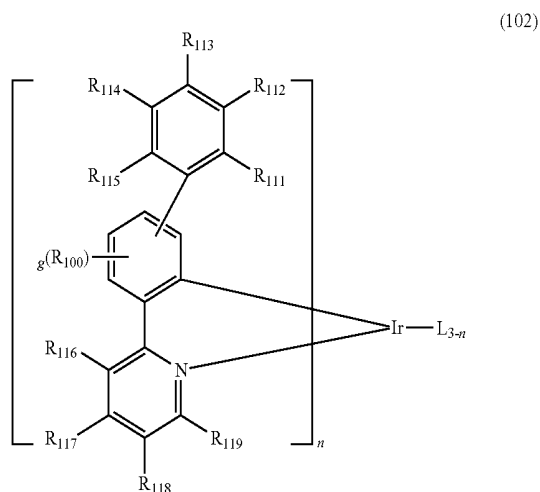
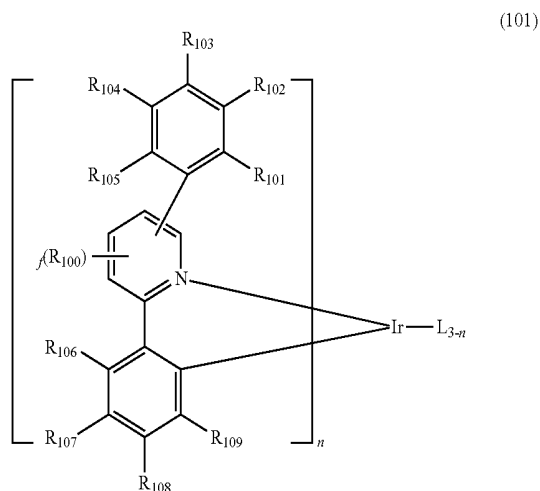
[0038] The light-emitting layer is a layer from which light is emitted, and can be a single layer or a multi layer of which two or more layers are stacked. In the light-emitting layer, it is preferable that the doping concentration of the dopant compound based on the host compound is less than 20 wt %.

[0039] The organic layer comprises a light-emitting layer, and may further comprise at least one layer selected from the group consisting of a hole injection layer, a hole transport layer, an electron transport layer, an electron injection layer, an interlayer, a hole blocking layer, and an electron blocking layer.

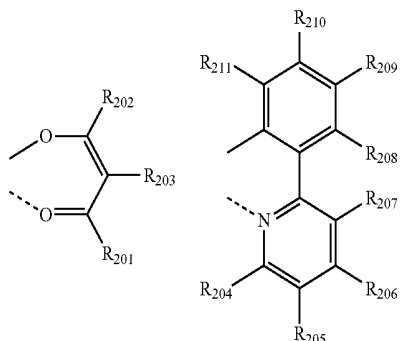
[0040] According to the organic electroluminescent device of the present invention, the weight ratio of the first host material to the second host material is in the range of 1:99 to 99:1.

[0041] The dopant is preferably at least one phosphorescent dopant. The dopant materials applied to the organic electroluminescent device according to the present invention are not limited, but may be preferably selected from metalated complex compounds of iridium, osmium, copper, and platinum, more preferably selected from ortho-metallated complex compounds of iridium, osmium, copper and platinum, and even more preferably ortho-metallated iridium complex compounds.

[0042] The phosphorescent dopant is preferably selected from compounds represented by the following formulae 101 to 103.



[0043] wherein L is selected from the following structures:



[0044] R_{100} represents hydrogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C3-C30)cycloalkyl;

[0045] R_{101} to R_{109} , and R_{111} to R_{123} each independently represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with deuterium or a halogen(s), a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C30)aryl, a cyano, or a substituted or unsubstituted (C1-C30)alkoxy; adjacent substituents of R_{106} to R_{109} may be linked to each other to form a substituted or unsubstituted, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic ring, e.g., fluorene unsubstituted or substituted with alkyl, dibenzothiophene unsubstituted or substituted with alkyl, or dibenzofuran unsubstituted or substituted with alkyl; and adjacent substituents of R_{120} to R_{123} may be linked to each other to form a substituted or unsubstituted, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic ring, e.g., quinoline unsubstituted or substituted with halogen, alkyl, or aryl;

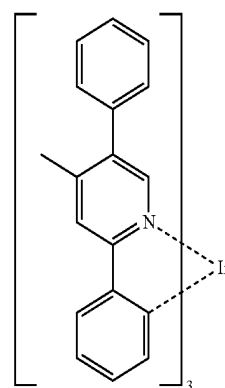
[0046] R_{124} to R_{127} each independently represent hydrogen, deuterium, a halogen, a substituted or unsubstituted (C1-C30)alkyl, or a substituted or unsubstituted (C6-C30)aryl; and adjacent substituents of R_{124} to R_{127} may be linked to each other to form a substituted or unsubstituted, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic ring, e.g., fluorene unsubstituted or substituted with alkyl, dibenzothiophene unsubstituted or substituted with alkyl, or dibenzofuran unsubstituted or substituted with alkyl;

[0047] R_{201} to R_{211} each independently represent hydrogen, deuterium, a halogen, a (C1-C30)alkyl unsubstituted or substituted with deuterium or a halogen(s), a substituted or unsubstituted (C3-C30)cycloalkyl, or a substituted or unsubstituted (C6-C30)aryl; and adjacent substituents of R_{208} to R_{211} may be linked to each other to form a substituted or unsubstituted, mono- or polycyclic, 3- to 30-membered alicyclic or (hetero)aromatic ring, e.g., fluorene unsubstituted or substituted with alkyl, dibenzothiophene unsubstituted or substituted with alkyl, or dibenzofuran unsubstituted or substituted with alkyl;

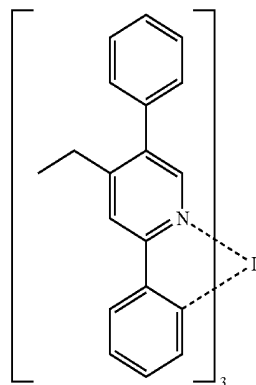
[0048] f and g each independently represent an integer of 1 to 3; where f or g is an integer of 2 or more, each of R_{100} may be the same or different; and

[0049] n represents an integer of 1 to 3.

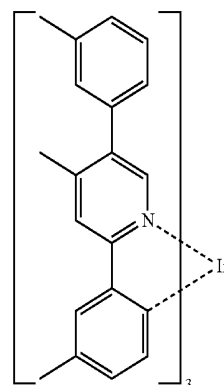
[0050] Specifically, the phosphorescent dopant materials include the following:



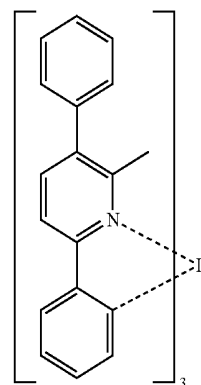
D-1



D-2

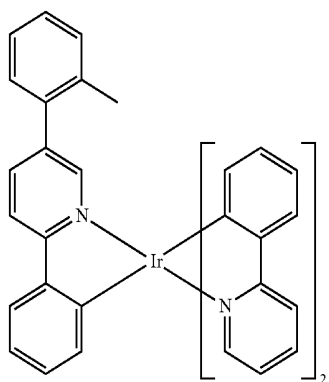


D-3



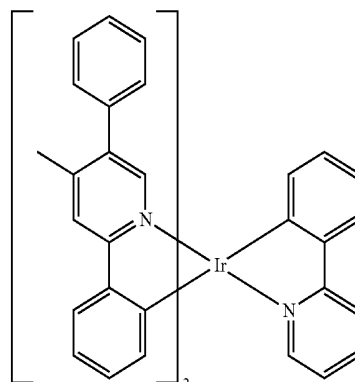
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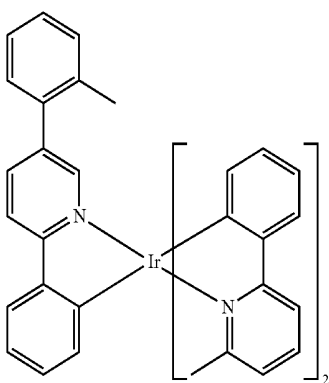


D-5

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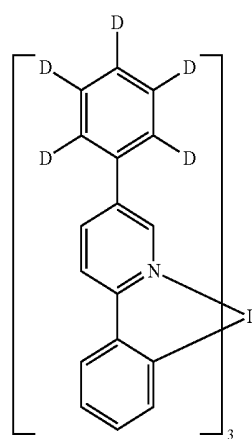


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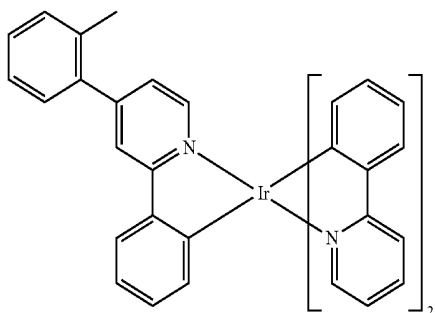


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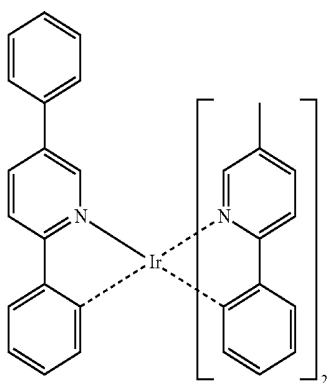
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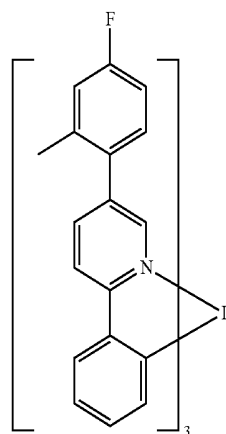
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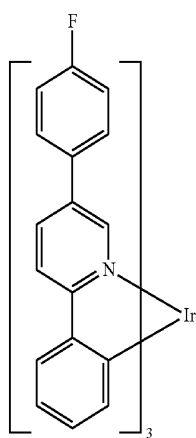
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D-11

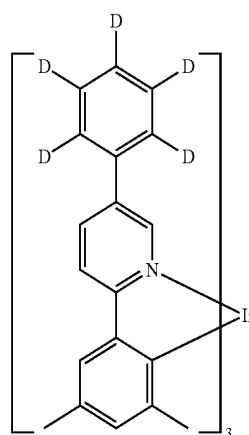


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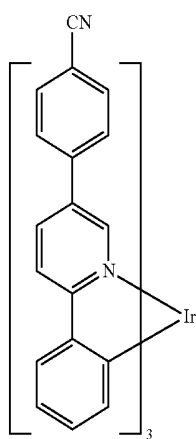
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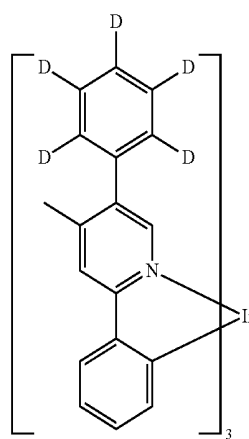


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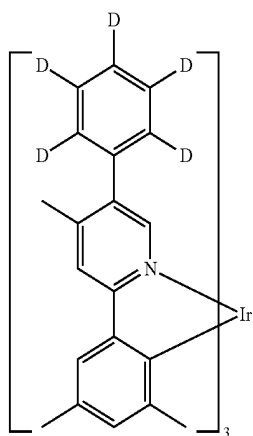
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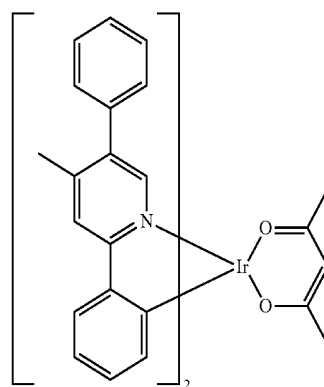
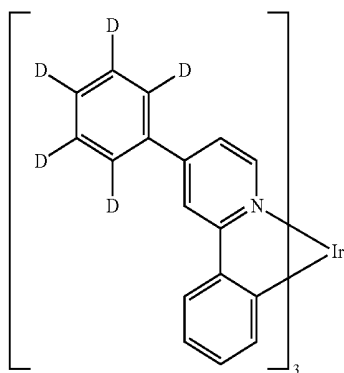
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D-17

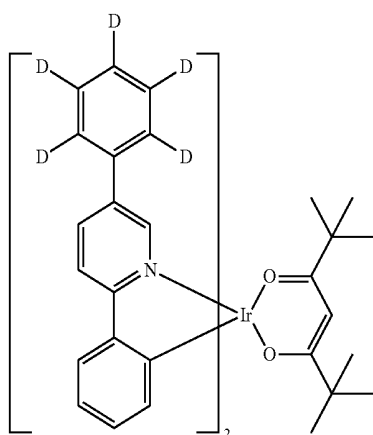


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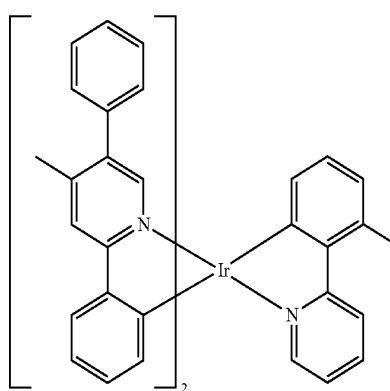
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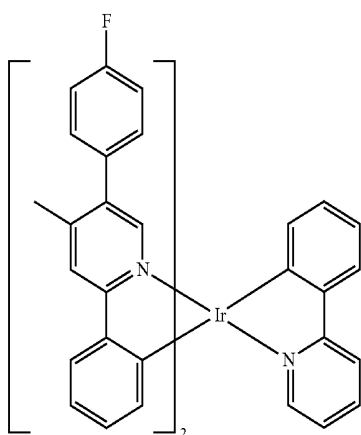


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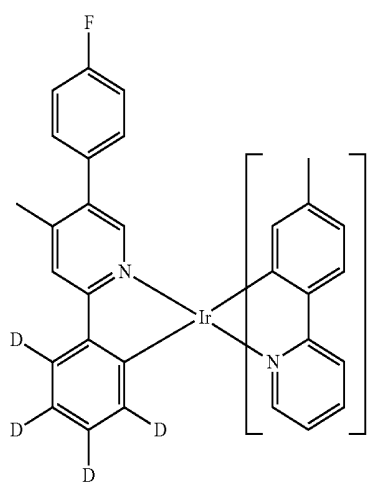
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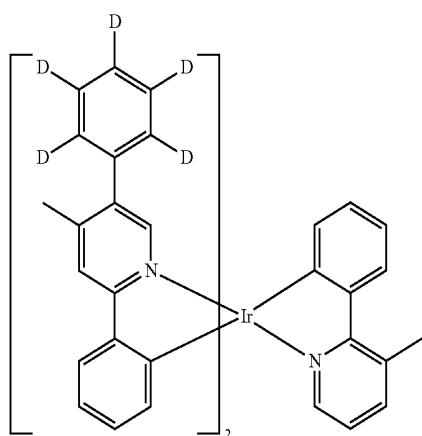
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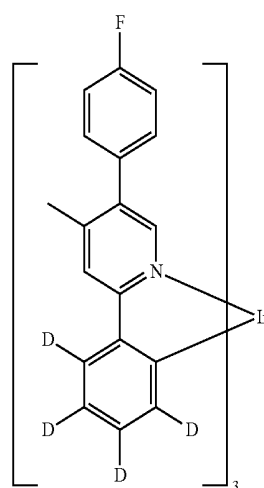
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D-23

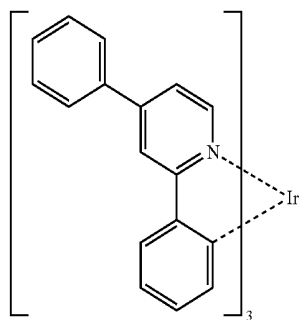
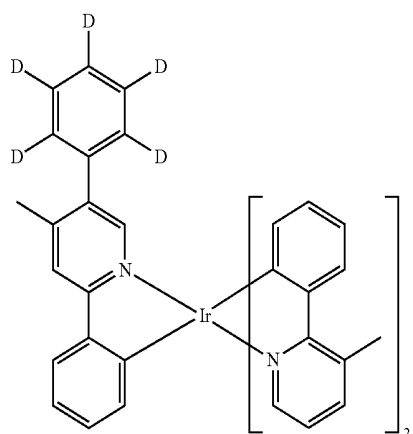
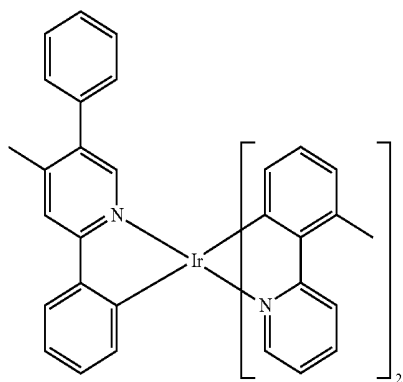
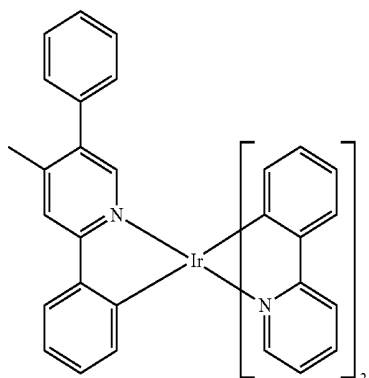


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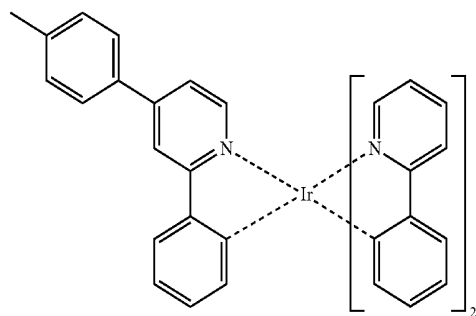
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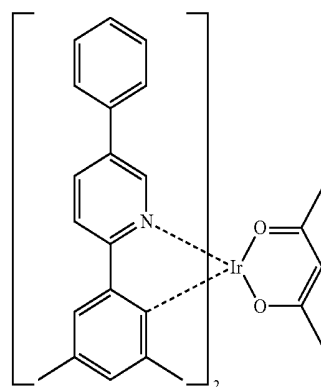
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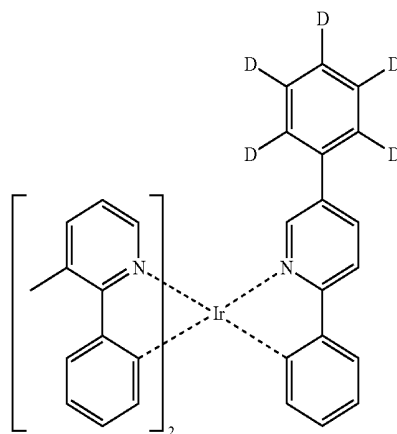
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D-26



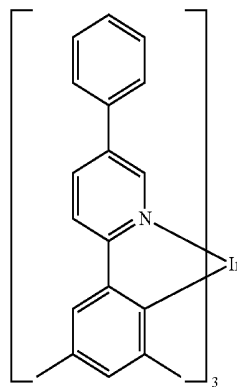
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D-27



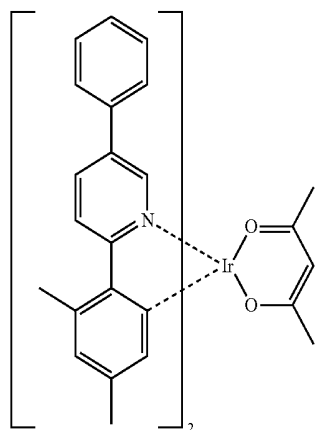
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D-28



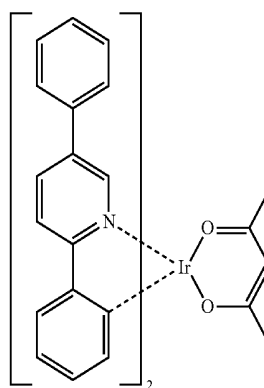
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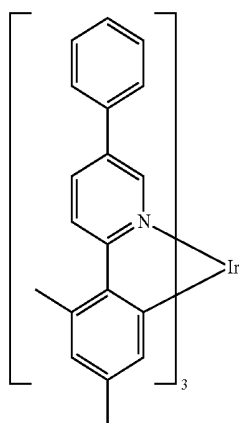


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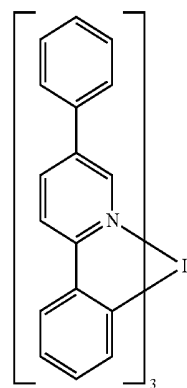
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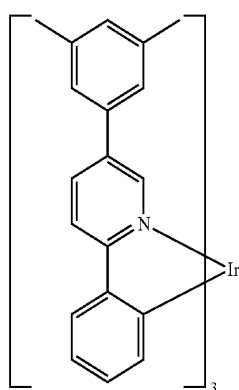
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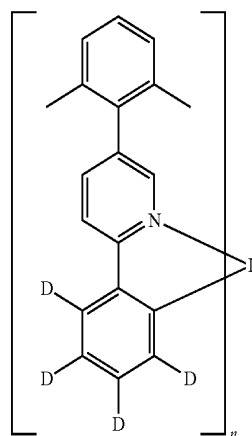
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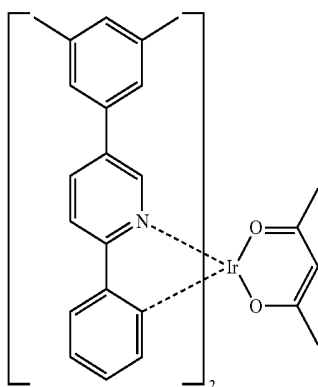
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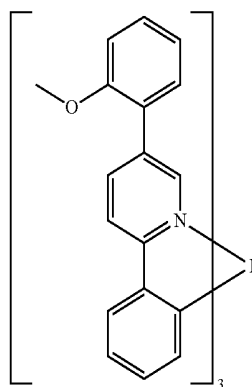
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D-39

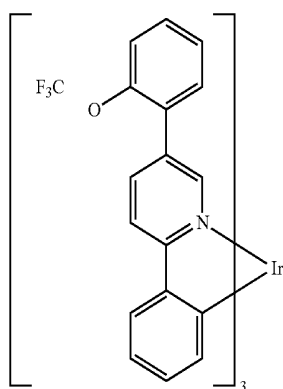


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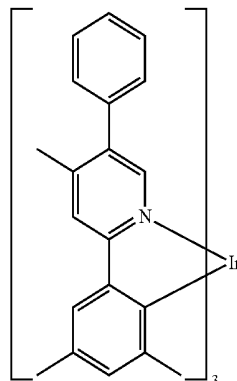
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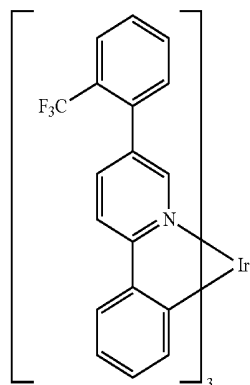


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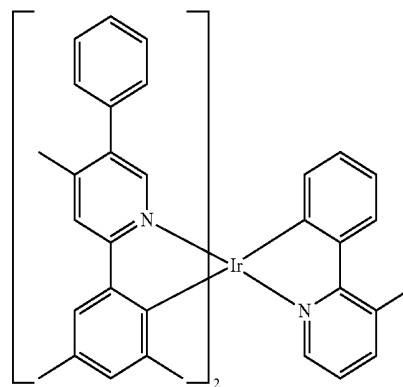
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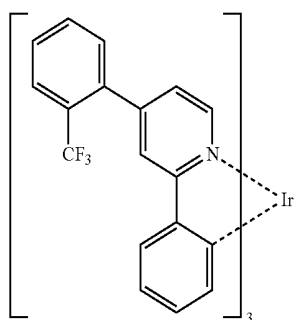
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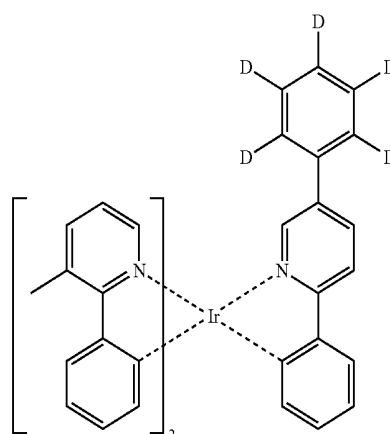
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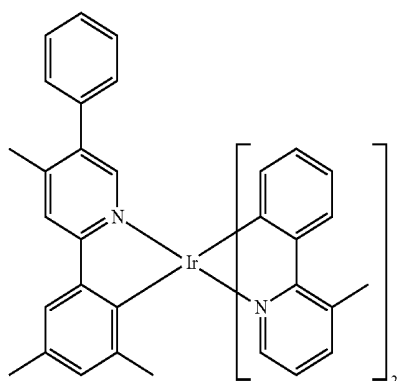
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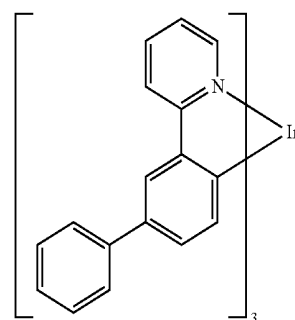
D-43



D-47

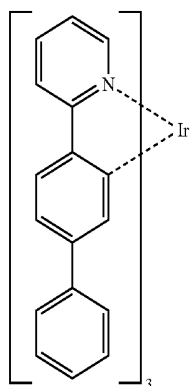


D-44



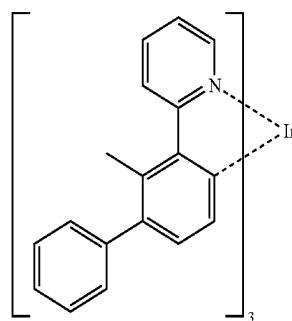
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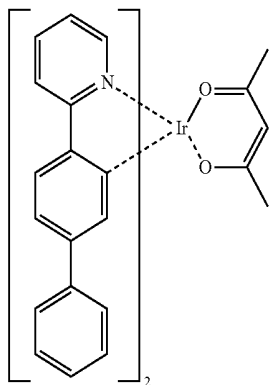


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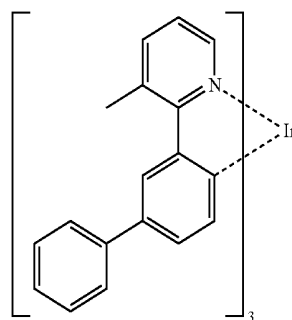
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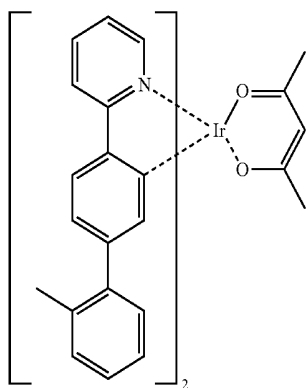
D-53



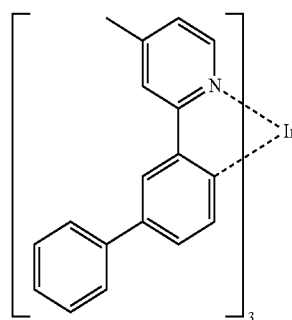
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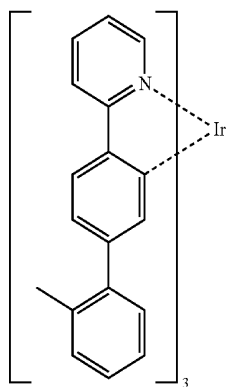
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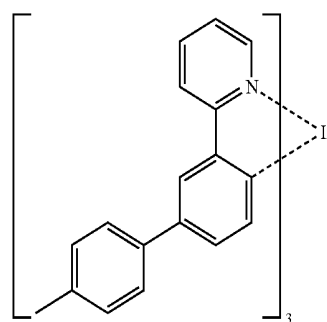
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D-55

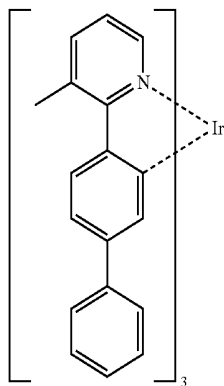


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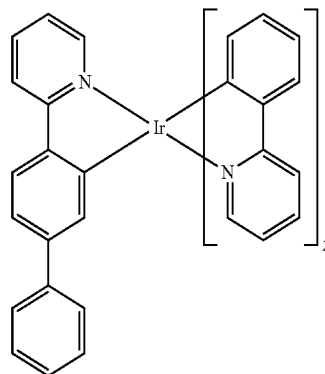
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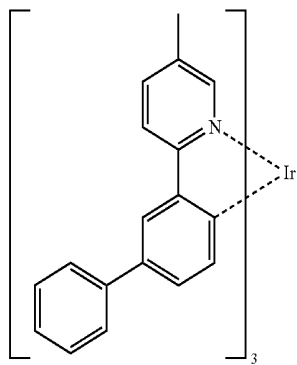


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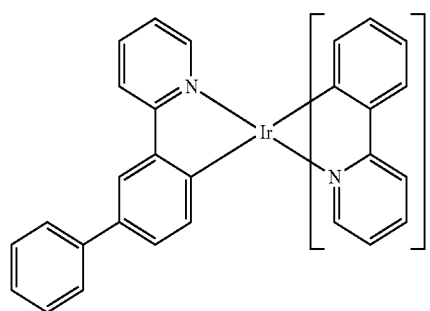
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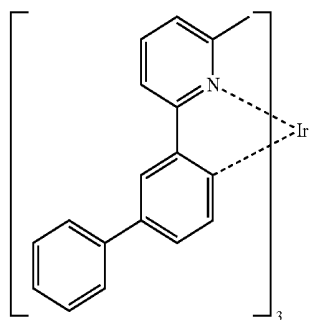
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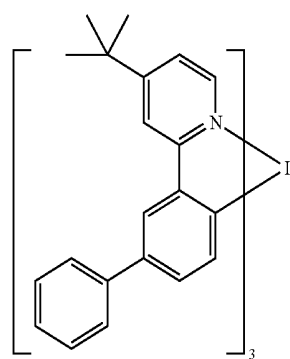
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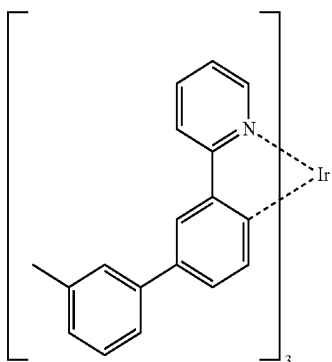
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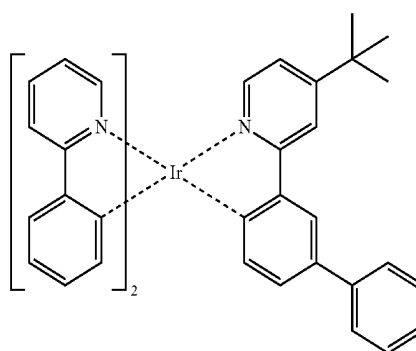
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D-60

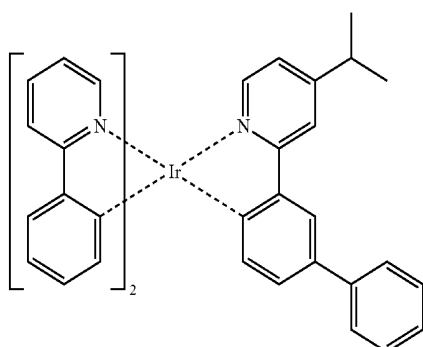


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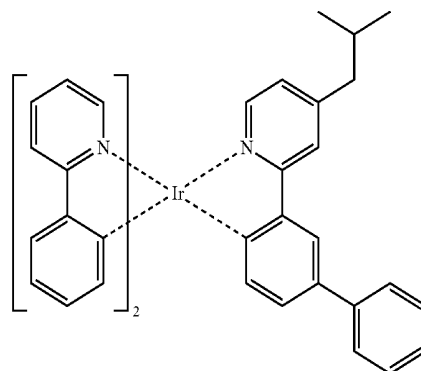
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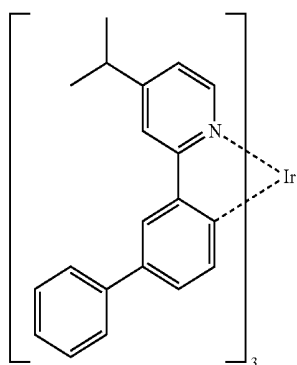
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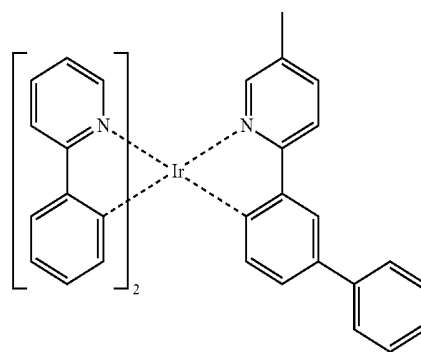


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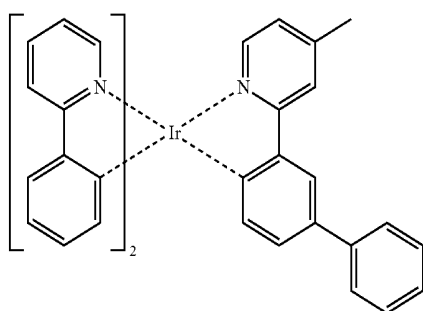
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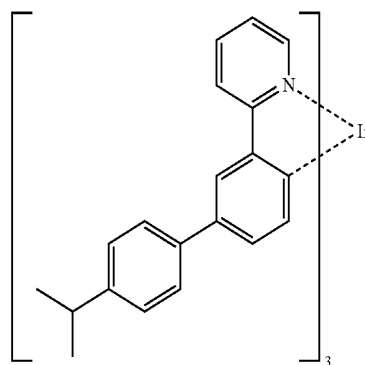
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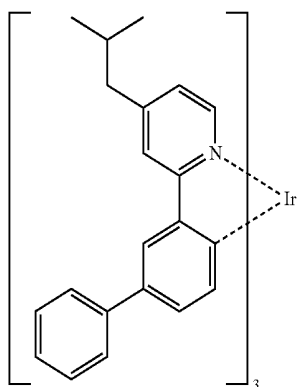
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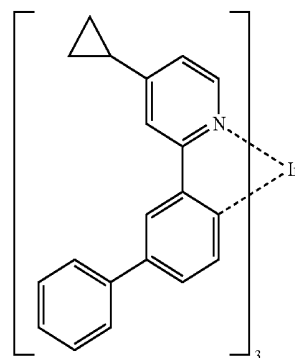
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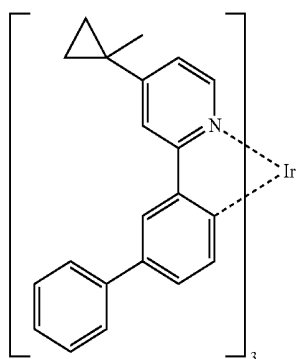
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D-72

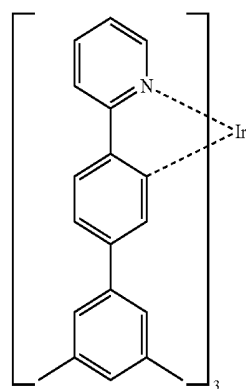


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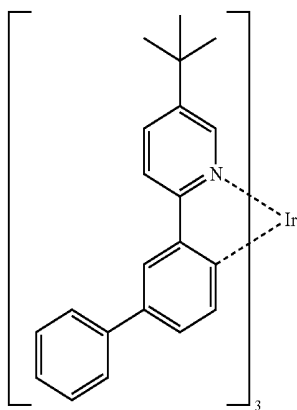


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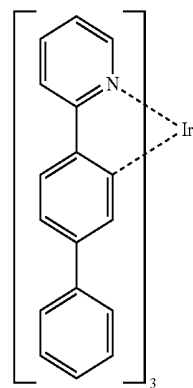
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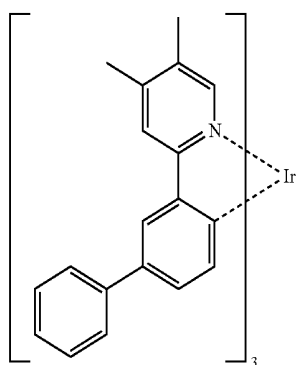
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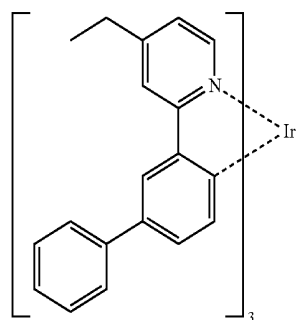
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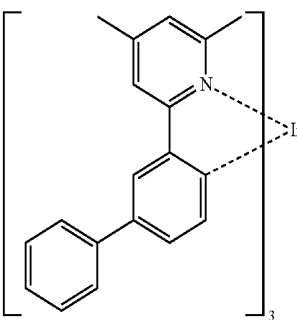
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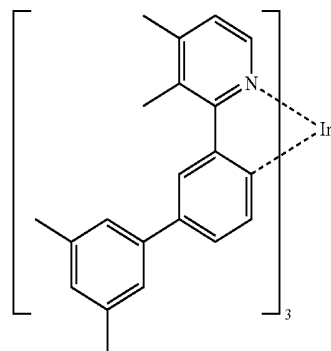
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D-79

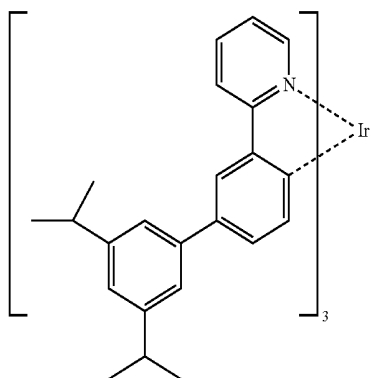


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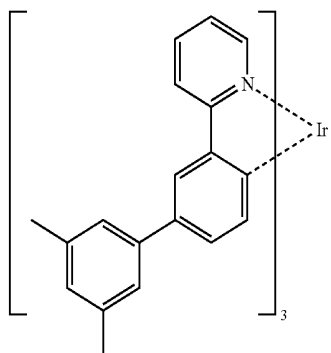


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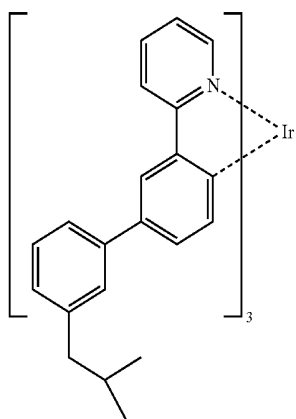
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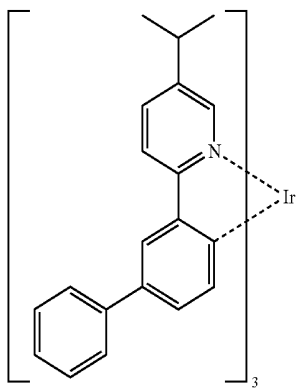
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D-82

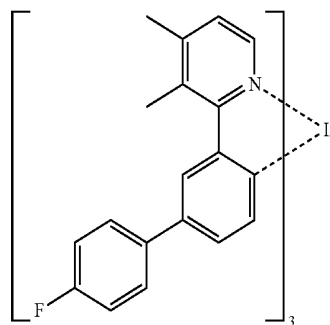


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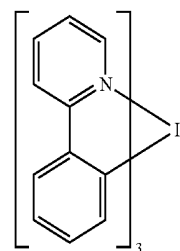


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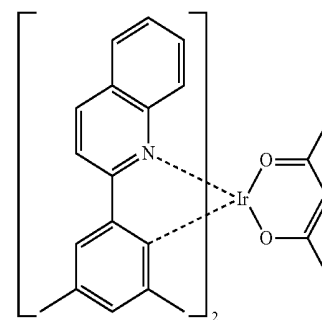
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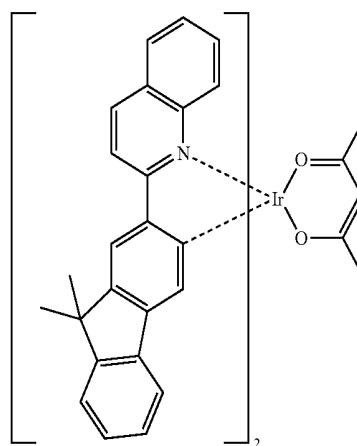
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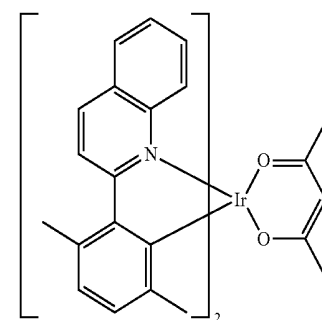
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D-87

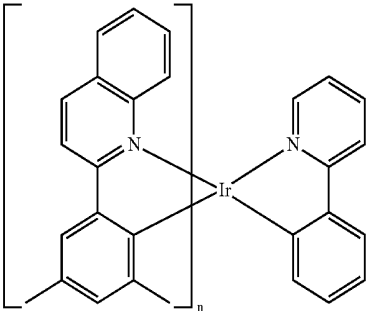


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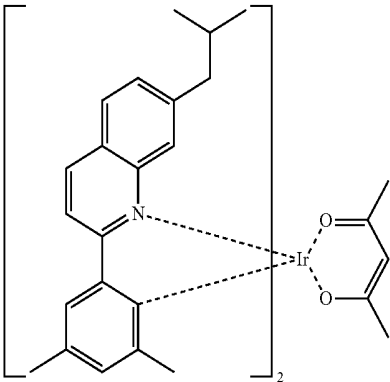
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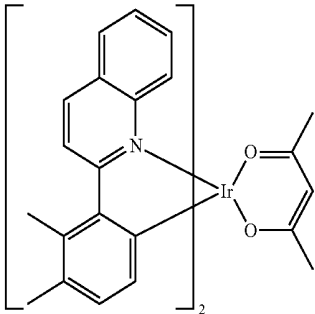


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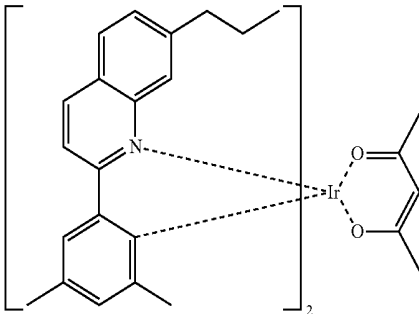
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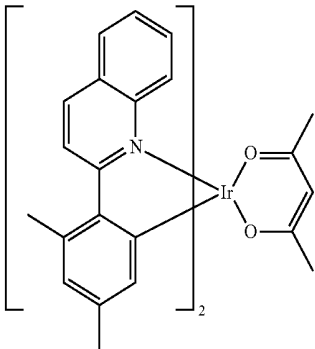
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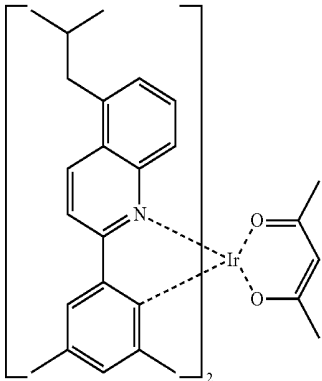
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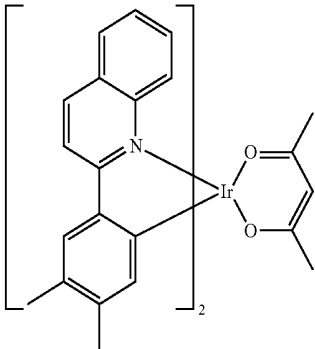
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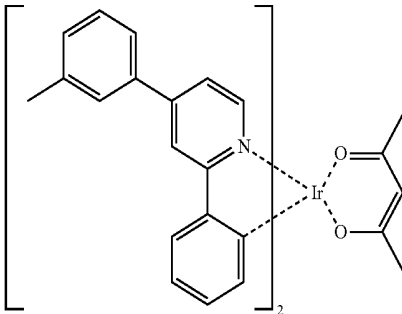
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D-96

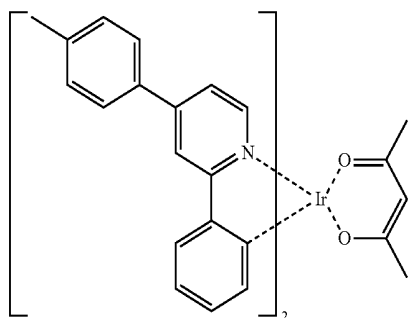


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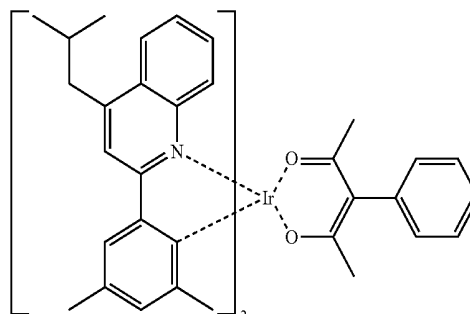
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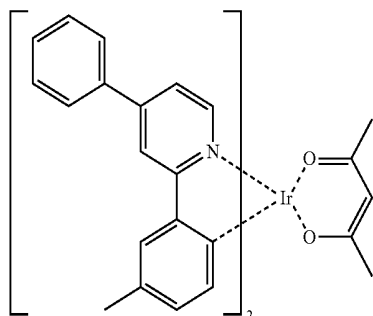


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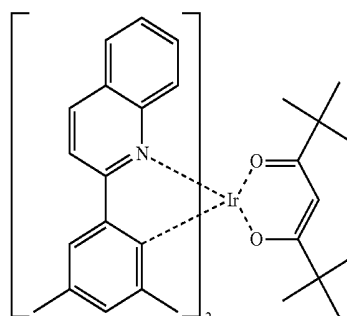
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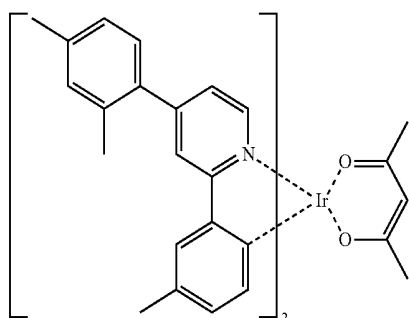
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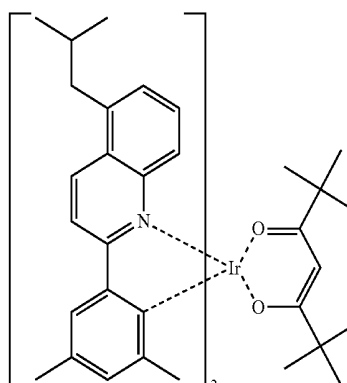
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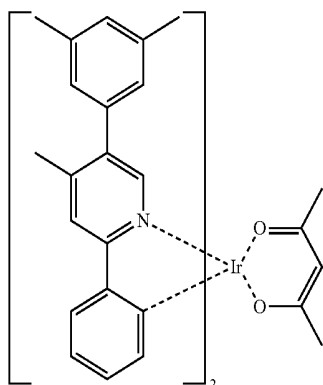
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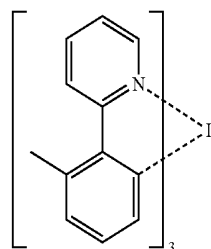
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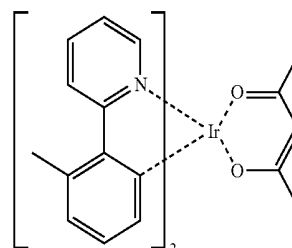
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D-101

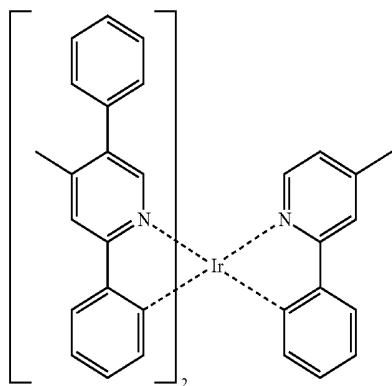


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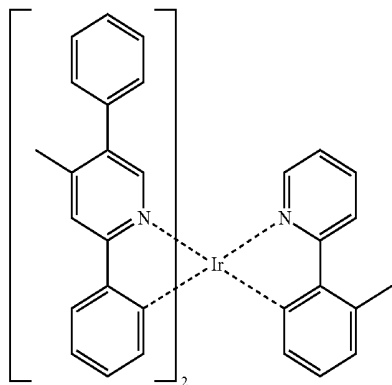


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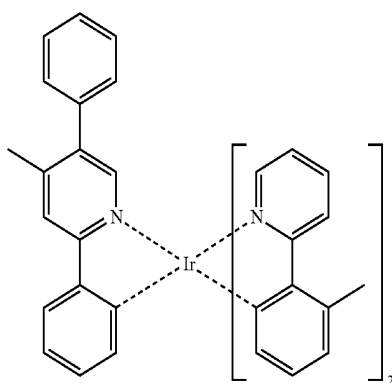
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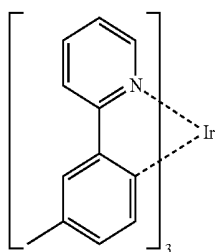
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D-108

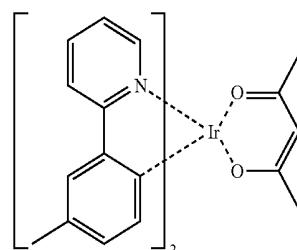


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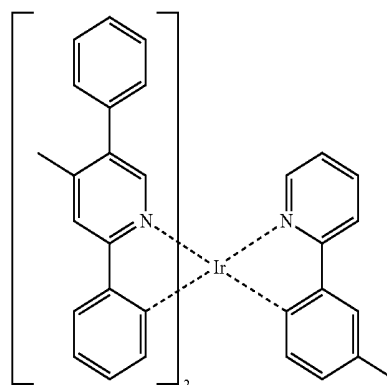


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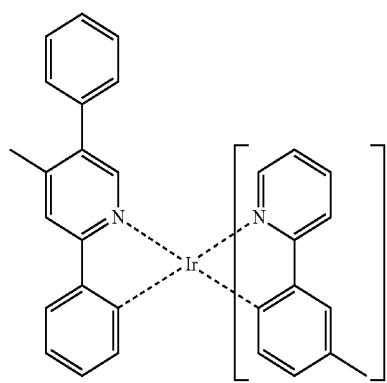
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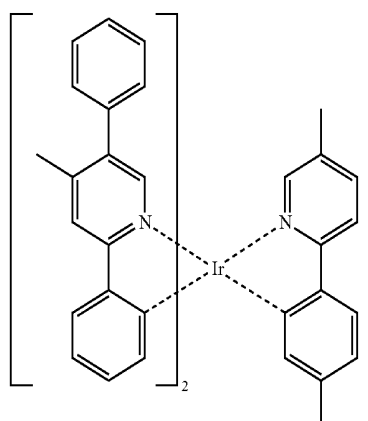
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D-112

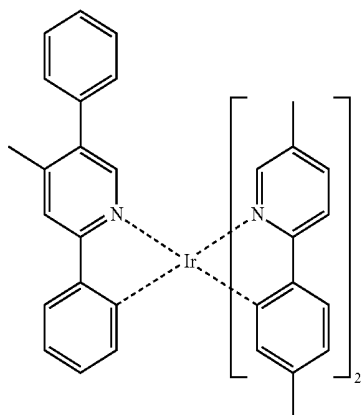


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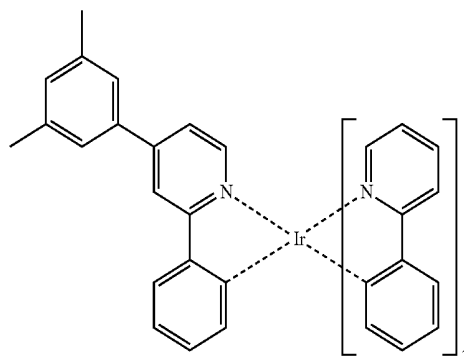
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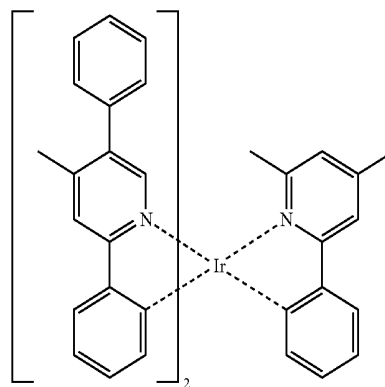
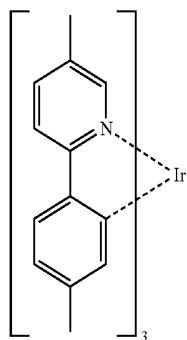
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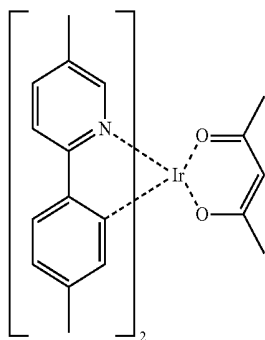
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D-116



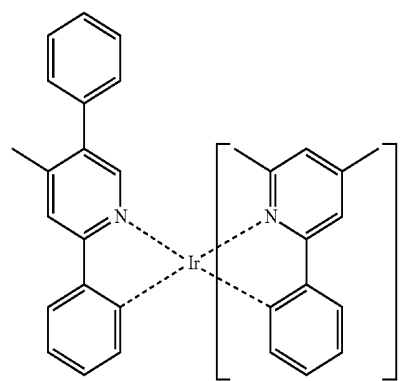
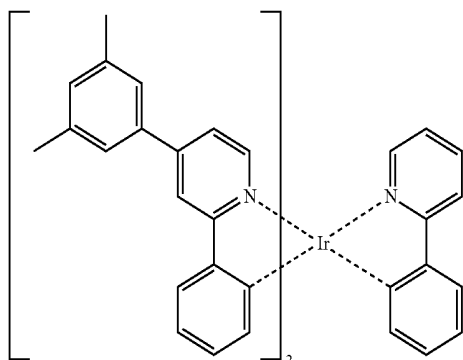
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D-117

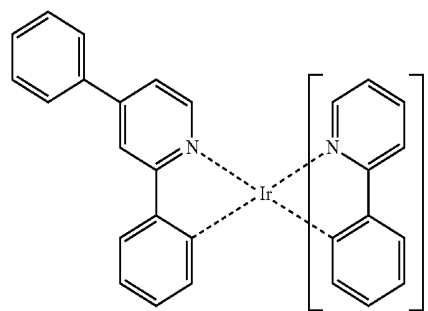


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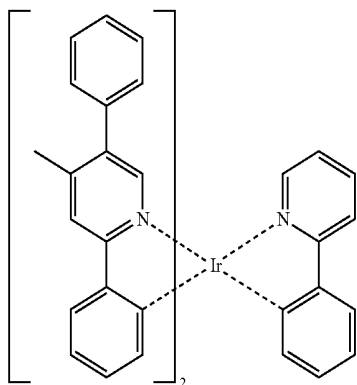
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D-122

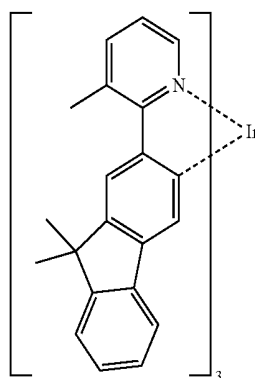


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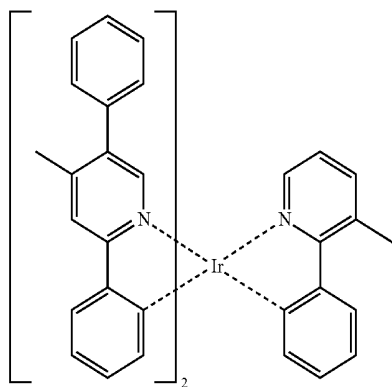
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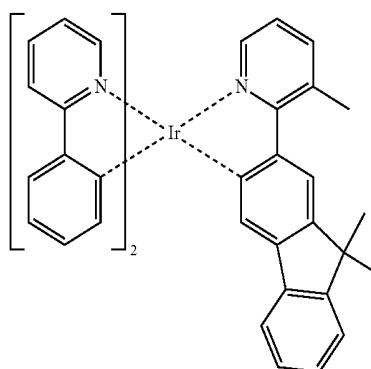


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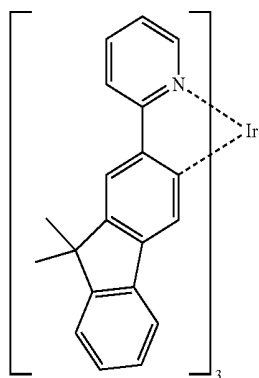
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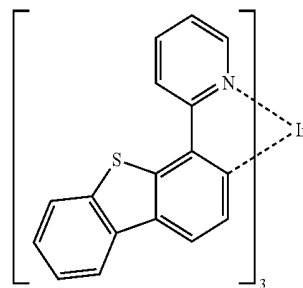
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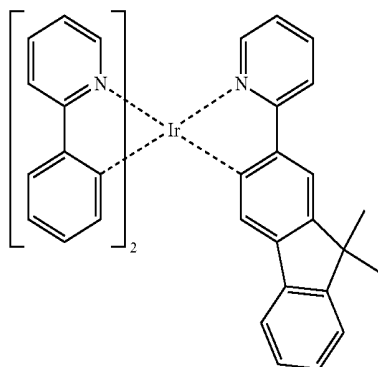
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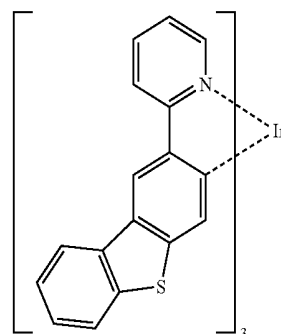
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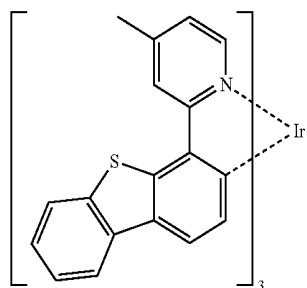
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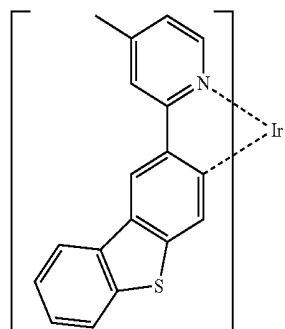
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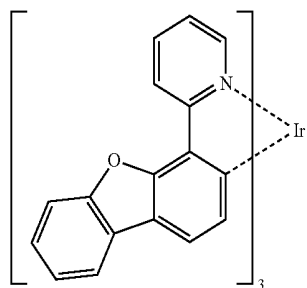
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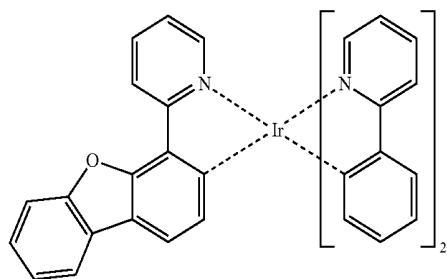
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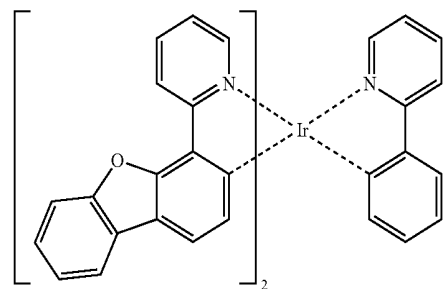
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D-133

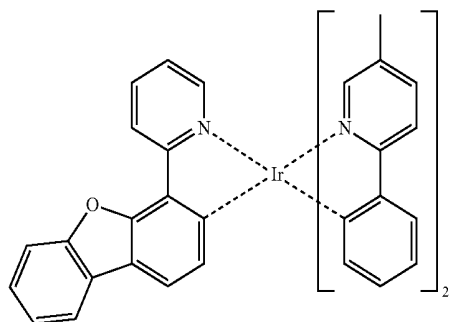


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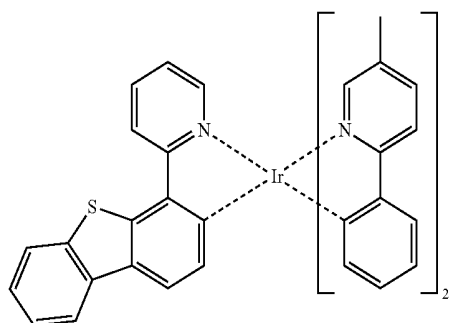


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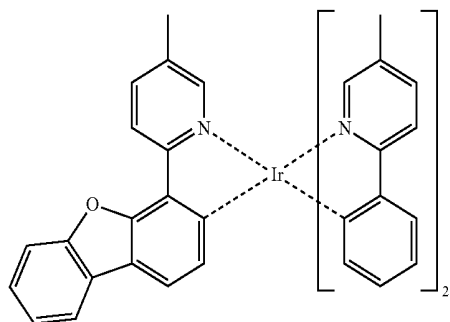
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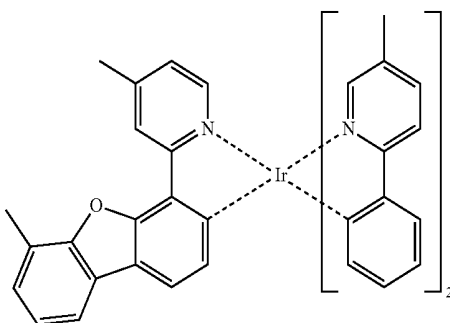
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D-137



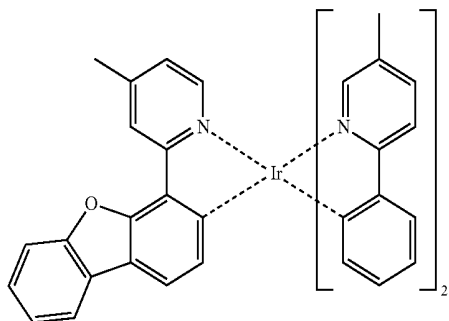
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D-139

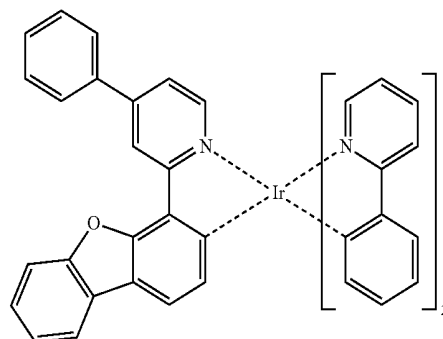
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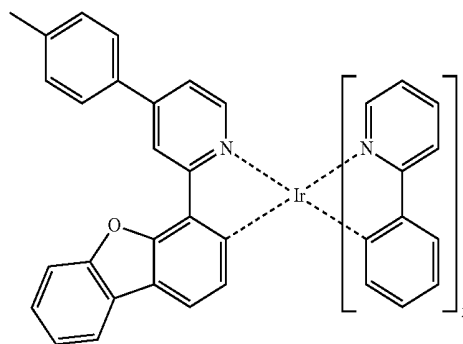


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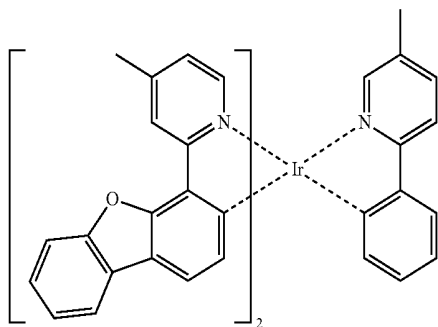
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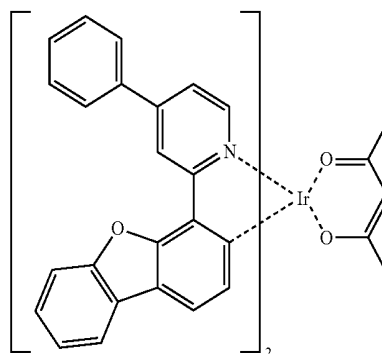
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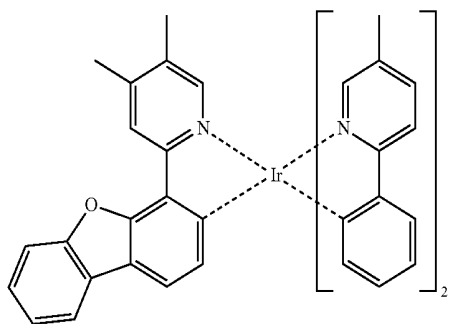
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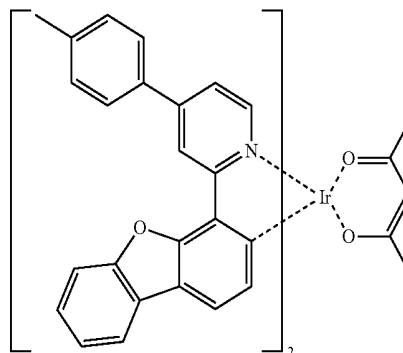
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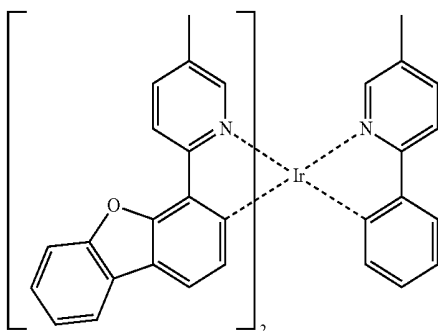
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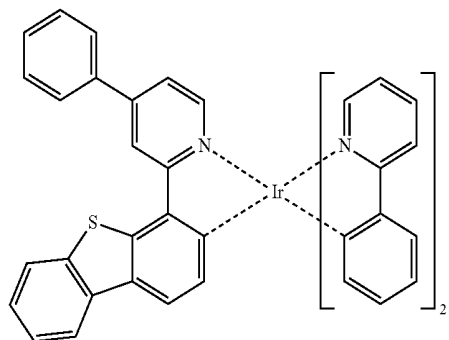
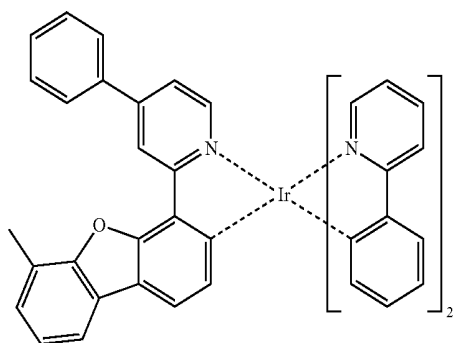
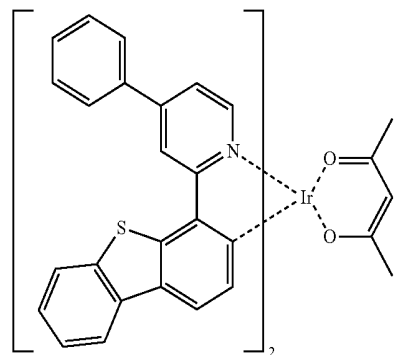
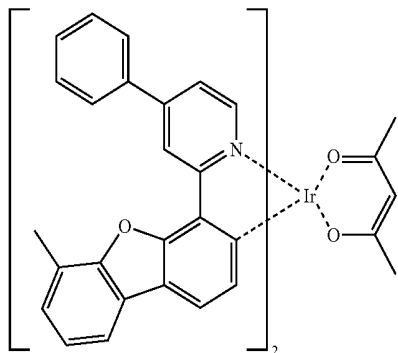
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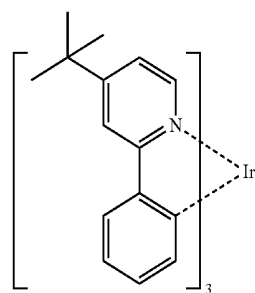
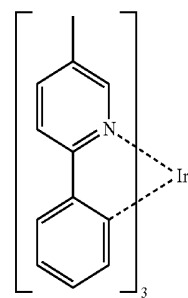
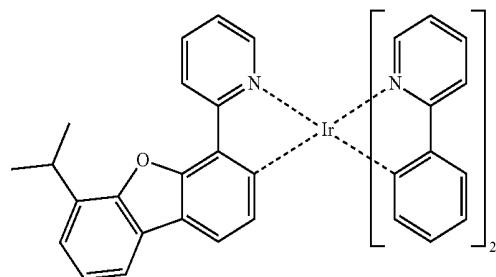
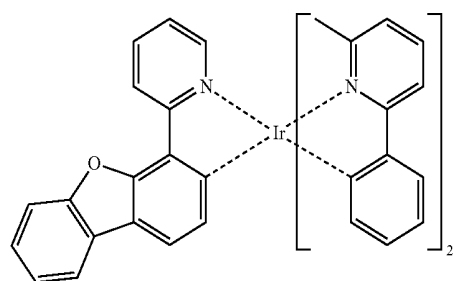
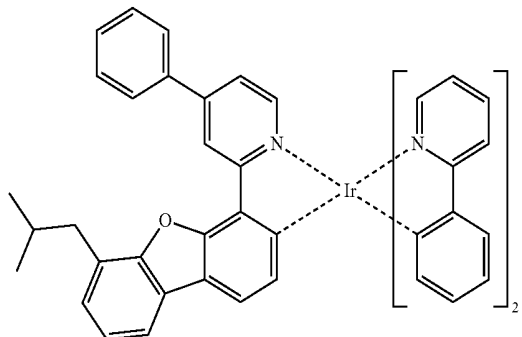
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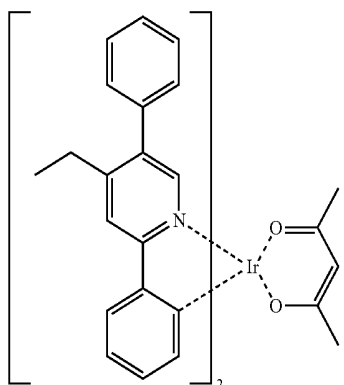
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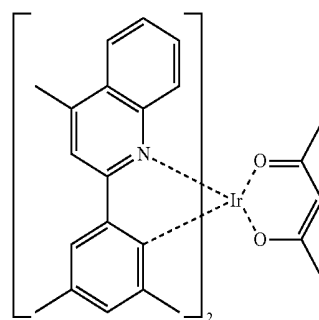


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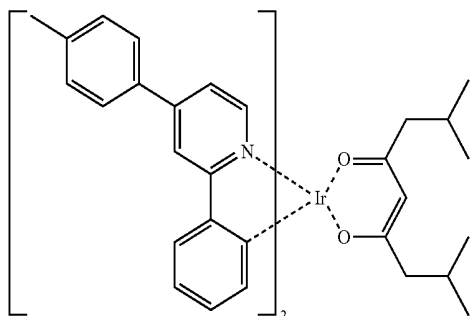


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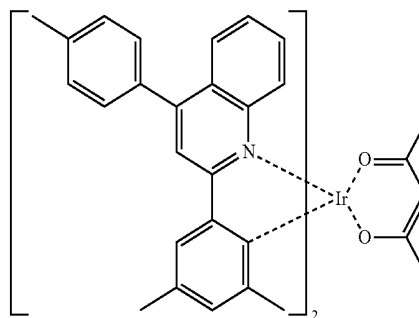
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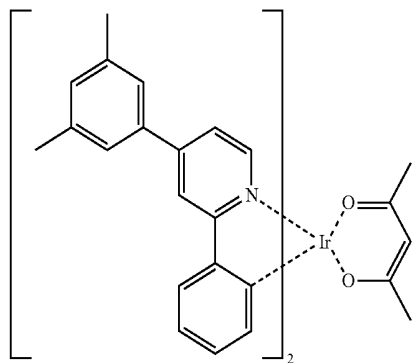
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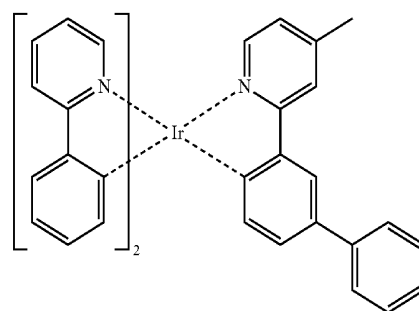
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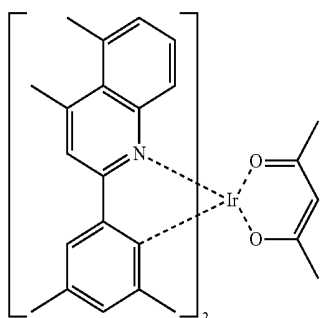
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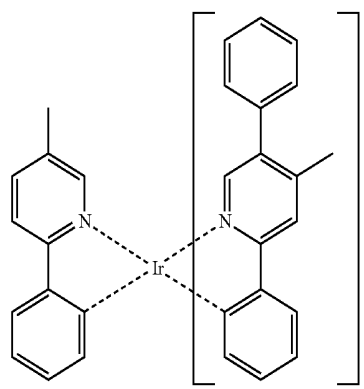
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D-163

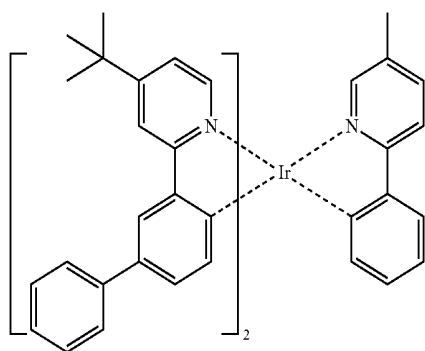
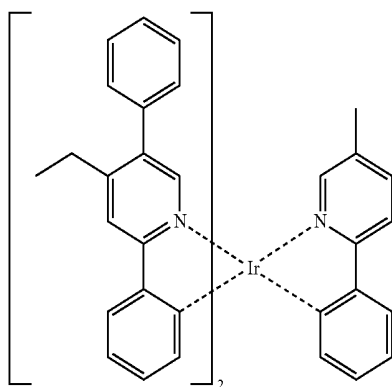
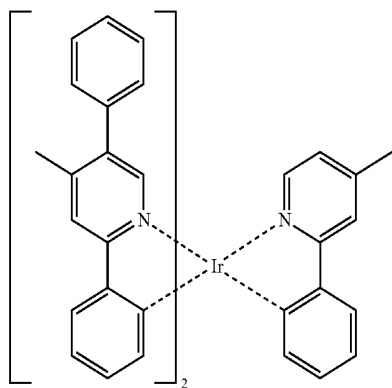
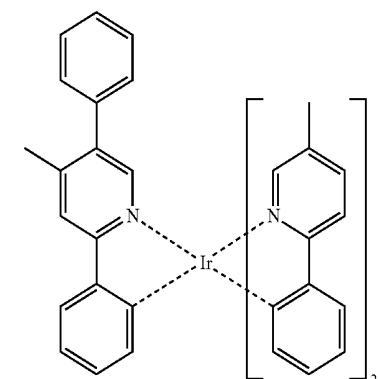


D-160



D-164

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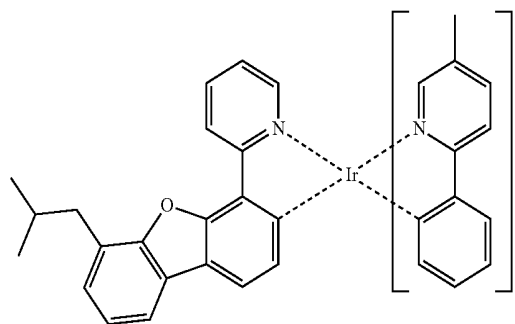
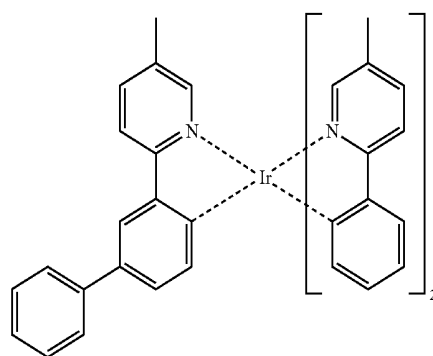
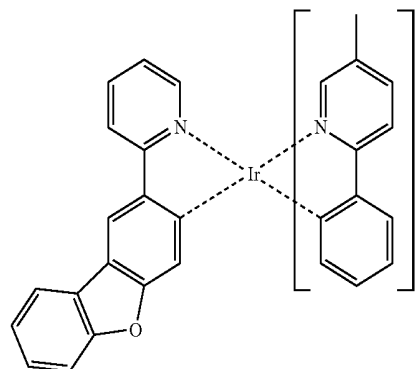
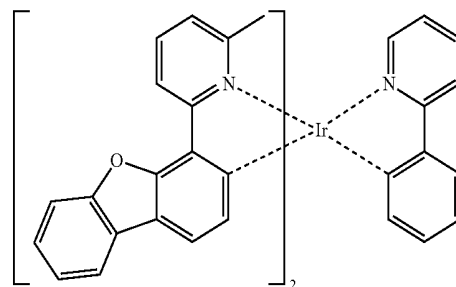
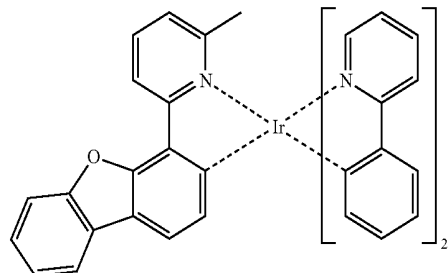
D-165

D-166

D-167

D-168

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D-169

D-170

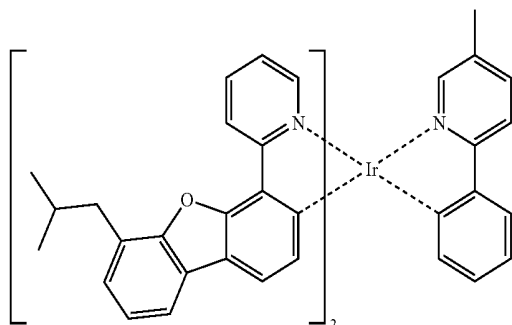
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D-172

D-173

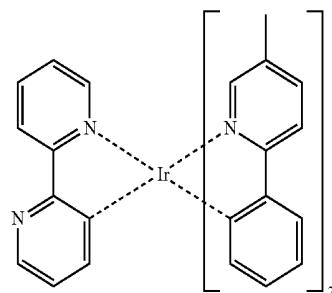
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D-174

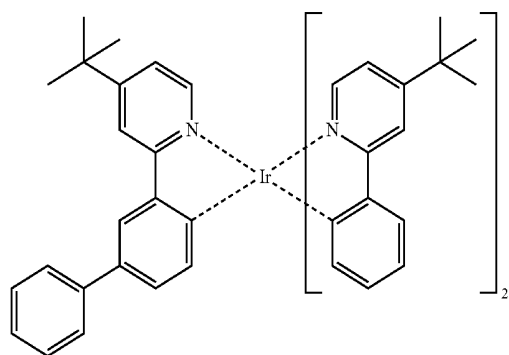


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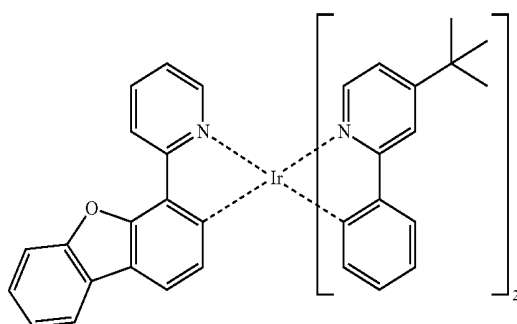
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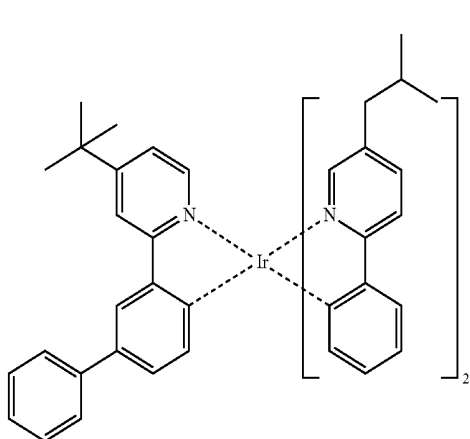
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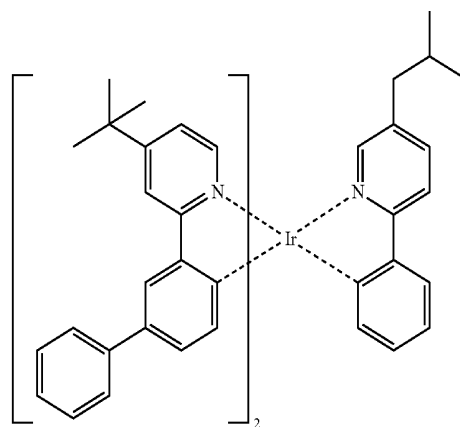
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D-180

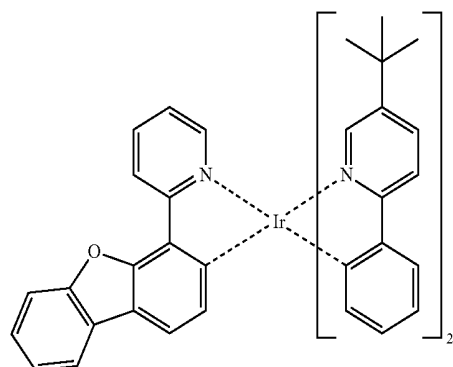
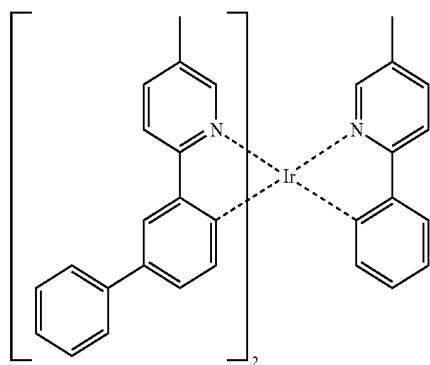


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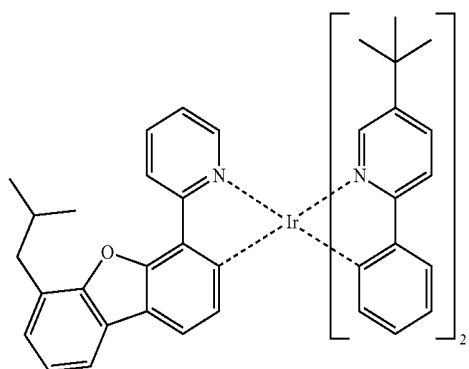


D-181

D-177

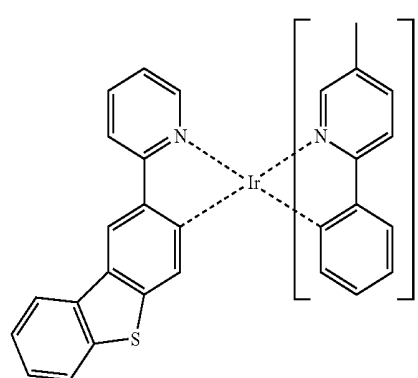


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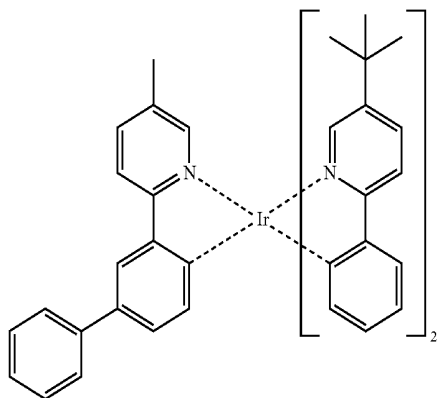
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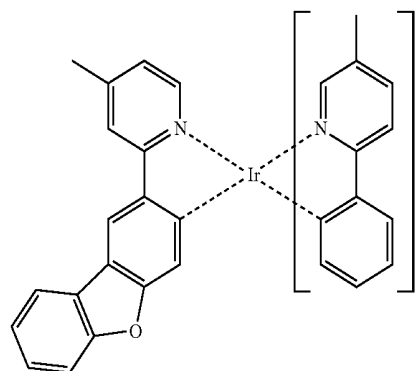


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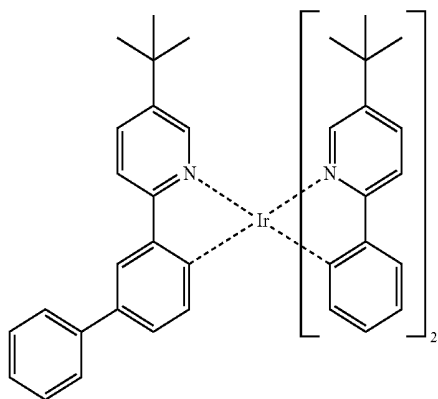
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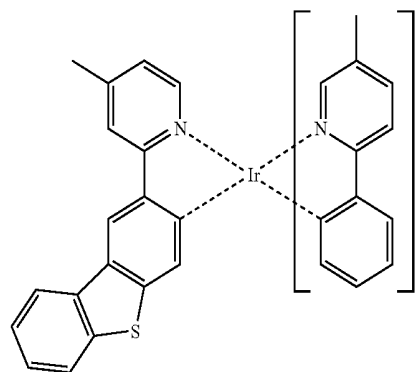
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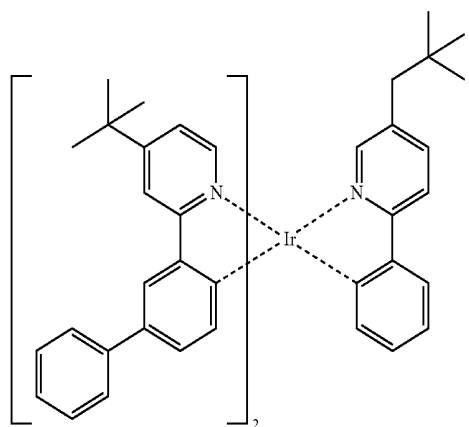
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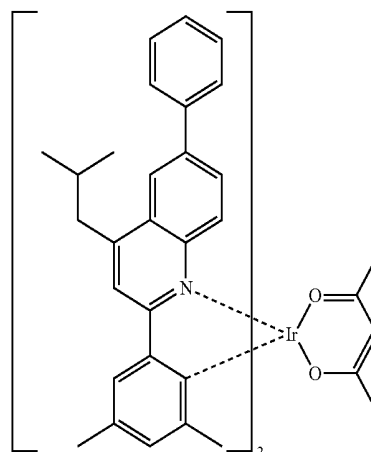
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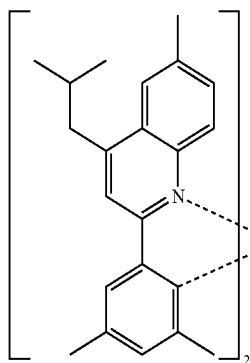
D-188



D-189

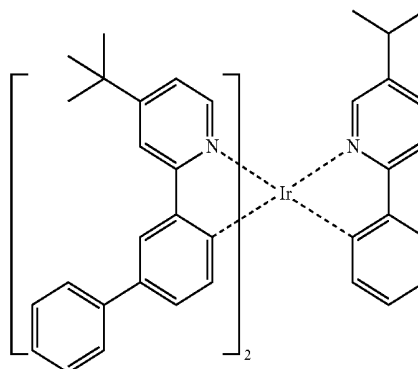


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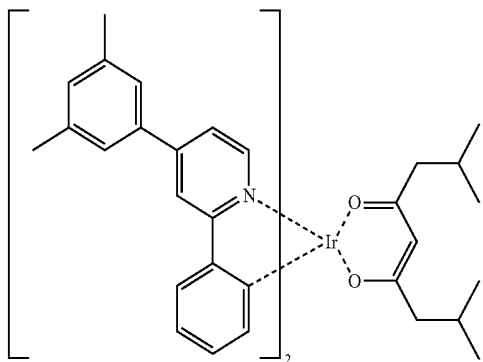
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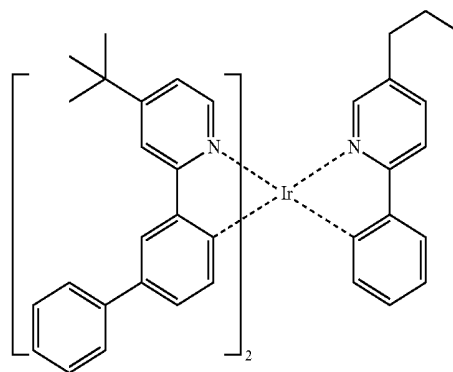


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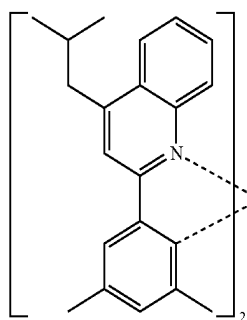
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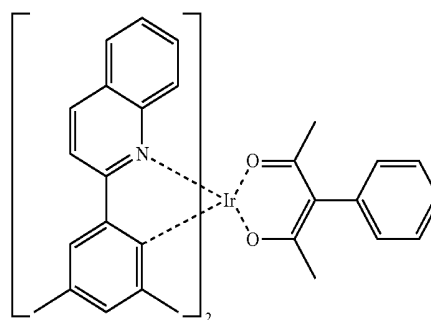
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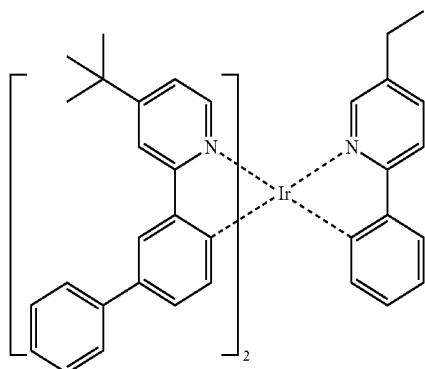
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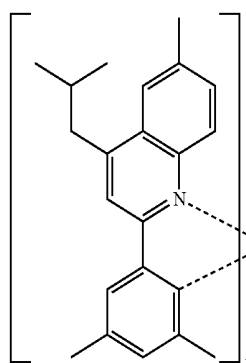
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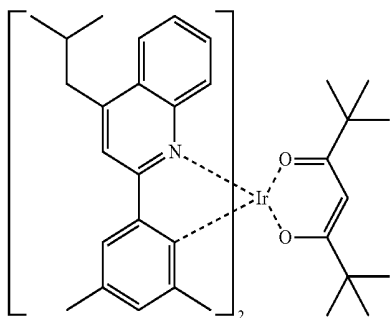
D-193



D-197

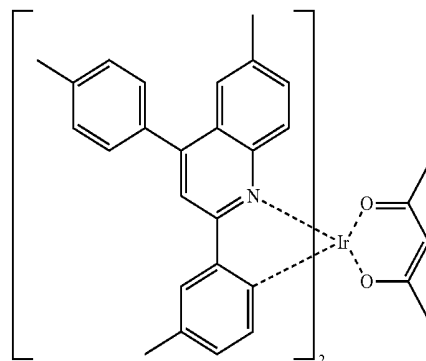


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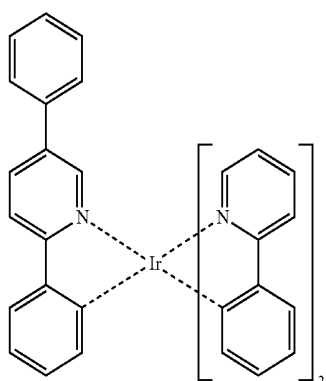
D-198

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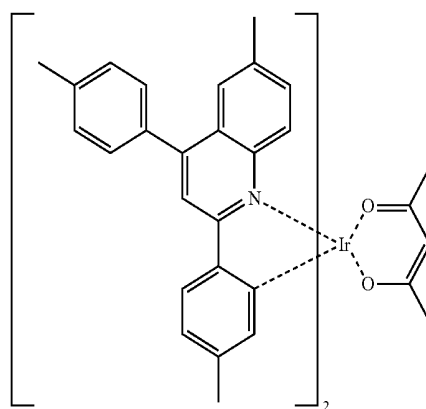


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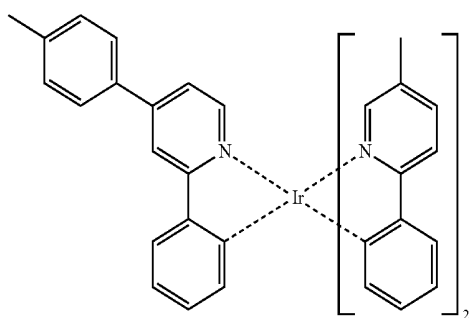
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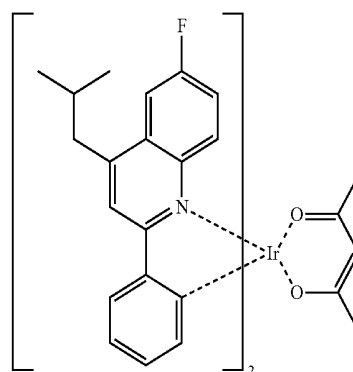
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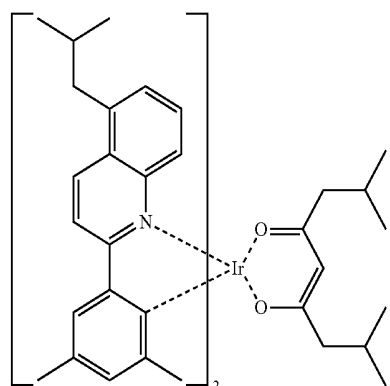
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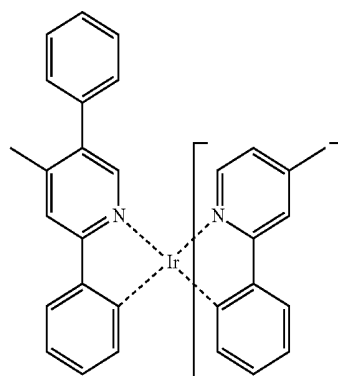
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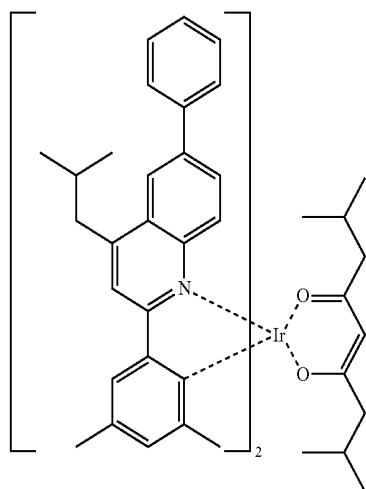
D-201



D-205

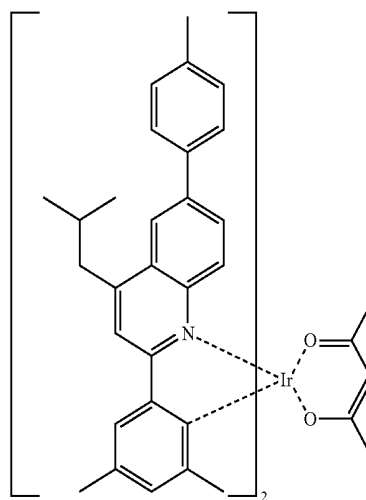


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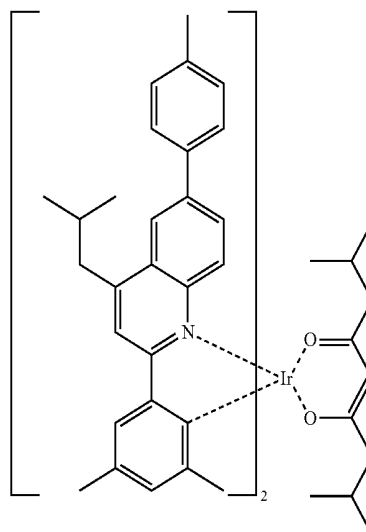
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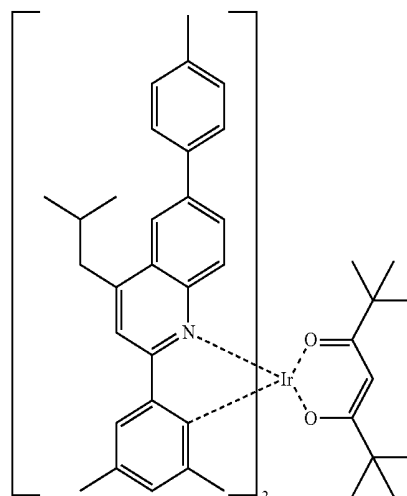


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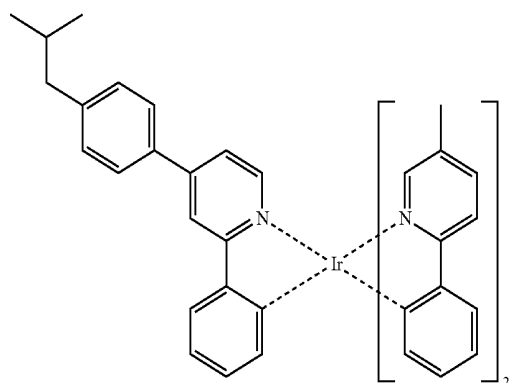
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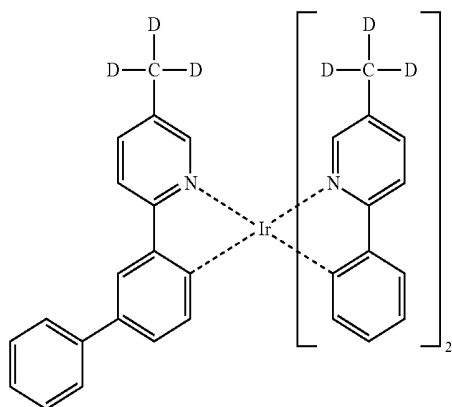
D-211



D-207

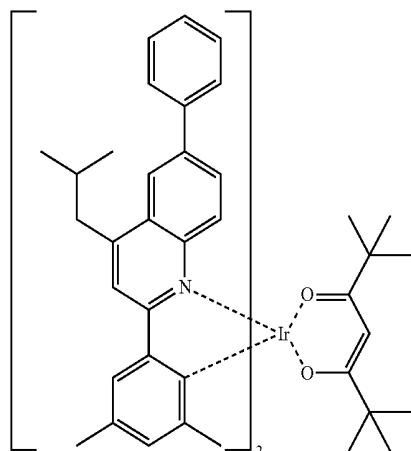


D-208



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D-212



[0051] The organic electroluminescent device according to the present invention may further comprise at least one compound selected from the group consisting of arylamine-based compounds and styrylarylamine-based compounds in the organic layer.

[0052] In addition, in the organic electroluminescent device according to the present invention, the organic layer may further comprise at least one metal selected from the group consisting of metals of Group 1, metals of Group 2, transition metals of the 4th period, transition metals of the 5th period, lanthanides and organic metals of d-transition elements of the Periodic Table, or at least one complex compound comprising said metal.

[0053] According to the present invention, at least one layer (hereinafter, "a surface layer") is preferably placed on an inner surface(s) of one or both electrode(s); selected from a chalcogenide layer, a metal halide layer and a metal oxide layer. Specifically, a chalcogenide (including oxides) layer of silicon or aluminum is preferably placed on an anode surface of an electroluminescent medium layer, and a metal halide layer or a metal oxide layer is preferably placed on a cathode surface of an electroluminescent medium layer. Such a surface layer provides operation stability for the organic electroluminescent device. Preferably, said chalcogenide includes SiO_x ($1 \leq x \leq 2$), AlO_x ($1 \leq x \leq 1.5$), SiON , SiAlON , etc.; said metal halide includes LiF , MgF_2 , CaF_2 , a rare earth metal fluoride, etc.; and said metal oxide includes Cs_2O , Li_2O , MgO , SrO , BaO , CaO , etc.

[0054] Between the anode and the light-emitting layer, a layer selected from a hole injection layer, a hole transport layer, or an electron blocking layer, or formed by a combination thereof can be used. Multi layers can be used for the hole injection layer in order to lower the hole injection barrier (or hole injection voltage) from the anode to the hole transport layer or the electron blocking layer. Two compounds can be simultaneously used in each layer. The hole transport layer and the electron blocking layer can also be formed of multi layers.

[0055] Between the light-emitting layer and the cathode, a layer selected from an electron buffer layer, a hole blocking layer, an electron transport layer, or an electron injection layer, or formed by a combination thereof can be used. Multi layers can be used for the electron buffer layer in order to control the injection of the electrons and enhance the interfacial characteristics between the light-emitting layer and

the electron injection layer. Two compounds can be simultaneously used in each layer. The hole blocking layer and the electron transport layer can also be formed of multi layers, and each layer can comprise two or more compounds.

[0056] In the organic electroluminescent device according to the present invention, a mixed region of an electron transport compound and a reductive dopant, or a mixed region of a hole transport compound and an oxidative dopant is preferably placed on at least one surface of a pair of electrodes. In this case, the electron transport compound is reduced to an anion, and thus it becomes easier to inject and transport electrons from the mixed region to an electroluminescent medium. Further, the hole transport compound is oxidized to a cation, and thus it becomes easier to inject and transport holes from the mixed region to the electroluminescent medium. Preferably, the oxidative dopant includes various Lewis acids and acceptor compounds; and the reductive dopant includes alkali metals, alkali metal compounds, alkaline earth metals, rare-earth metals, and mixtures thereof. A reductive dopant layer may be employed as a charge generating layer to prepare an electroluminescent device having two or more electroluminescent layers and emitting white light.

[0057] In order to form each layer of the organic electroluminescent device of the present invention, dry film-forming methods such as vacuum evaporation, sputtering, plasma and ion plating methods, or wet film-forming methods such as spin coating, dip coating, and flow coating methods can be used. The first and second host compounds of the present invention may be co-evaporated or mixture-evaporated.

[0058] When using a wet film-forming method, a thin film can be formed by dissolving or diffusing materials forming each layer into any suitable solvent such as ethanol, chloroform, tetrahydrofuran, dioxane, etc. The solvent can be any solvent where the materials forming each layer can be dissolved or diffused, and where there are no problems in film-formation capability.

[0059] The first and second host compounds of the present invention can be used to form a film by a co-evaporation of mixture-evaporation process.

[0060] By using the organic electroluminescent device of the present invention, a display system or a lighting system can be produced.

[0061] Hereinafter, the luminescent properties of the device comprising the host compound of the present invention will be explained in detail with reference to the following examples.

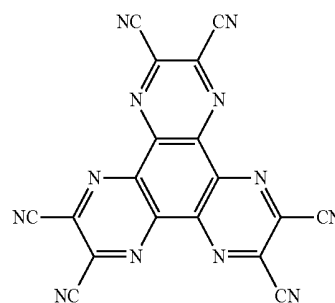
Device Example 1-1: Preparation of an OLED Device by Co-Evaporating the First Host Compound and the Second Host Compound of the Present Invention

[0062] An OLED device was produced using the organic electroluminescent compound according to the present invention. A transparent electrode indium tin oxide (ITO) thin film ($10 \Omega/\text{sq}$) on a glass substrate for an organic light-emitting diode (OLED) device (Geomatec) was subjected to an ultrasonic washing with trichloroethylene, acetone, ethanol, and distilled water, sequentially, and then was stored in isopropanol. The ITO substrate was then mounted on a substrate holder of a vacuum vapor depositing apparatus. N^4, N^4 -diphenyl- N^4, N^4 -bis(9-phenyl-9H-carbazol-3-yl)-[1,1'-biphenyl]-4,4'-diamine (compound HI-1)

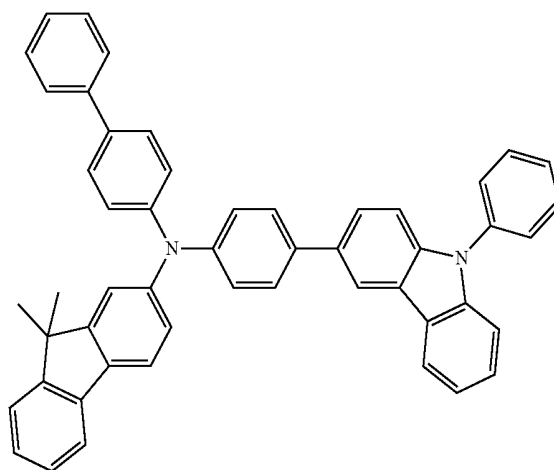
was introduced into a cell of said vacuum vapor depositing apparatus, and then the pressure in the chamber of said apparatus was controlled to 10^{-6} torr. Thereafter, an electric current was applied to the cell to evaporate the above introduced material, thereby forming a first hole injection layer having a thickness of 80 nm on the ITO substrate. Next, 1,4,5,8,9,12-hexaazatriphenylene-hexacarbonitrile (compound HI-2) was introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying an electric current to the cell, thereby forming a second hole injection layer having a thickness of 5 nm on the first hole injection layer. N-([1,1'-biphenyl]-4-yl)-9,9-dimethyl-N-(4-(9-phenyl-9H-carbazol-3-yl)phenyl)-9H-fluorene-2-amine (compound HT-1) was then introduced into another cell of said vacuum vapor depositing apparatus, and was evaporated by applying an electric current to the cell, thereby forming a first hole transport layer having a thickness of 70 nm on the second hole injection layer. As a host material, a first host compound and a second host compound were introduced into two cells of the vacuum vapor depositing apparatus, respectively. A dopant compound D-96 was introduced into another cell. The two host materials were evaporated at 1:1 rate, while the dopant was evaporated at a different rate from the host materials, so that the dopant was deposited in a doping amount of 3 wt % based on the total amount of the host and dopant to form a light-emitting layer having a thickness of 40 nm on the hole transport layer. 2,4-bis(9,9-dimethyl-9H-fluorene-2-yl)-6-(naphthalen-2-yl)-1,3,5-triazine (compound ET-1) and lithium quinolate (compound EI-1) were then introduced into two cells of the vacuum vapor depositing apparatus, respectively, and evaporated at 1:1 rate to form an electron transport layer having a thickness of 30 nm on the light-emitting layer. After depositing lithium quinolate (compound EI-1) as an electron injection layer having a thickness of 2 nm on the electron transport layer, an Al cathode having a thickness of 80 nm was deposited by another vacuum vapor deposition apparatus. Thus, an OLED device was produced.

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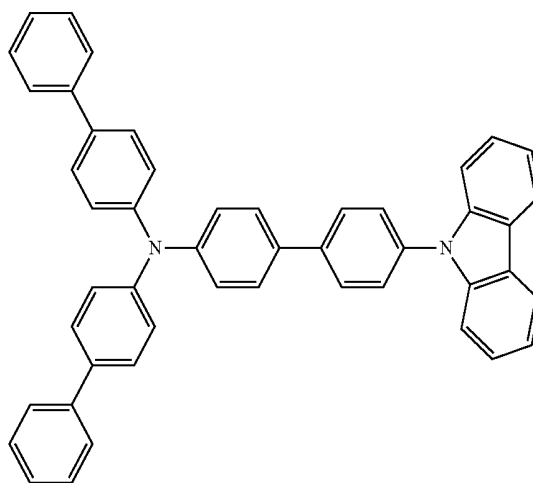
HI-2



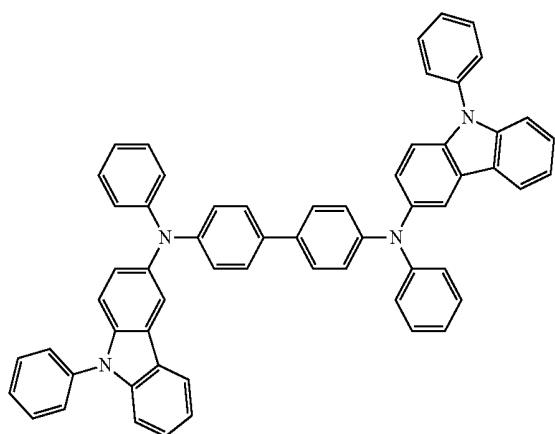
HT-1



HT-2

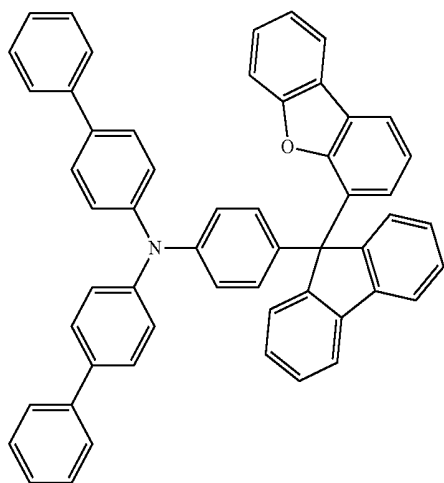


HI-1



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HT-3

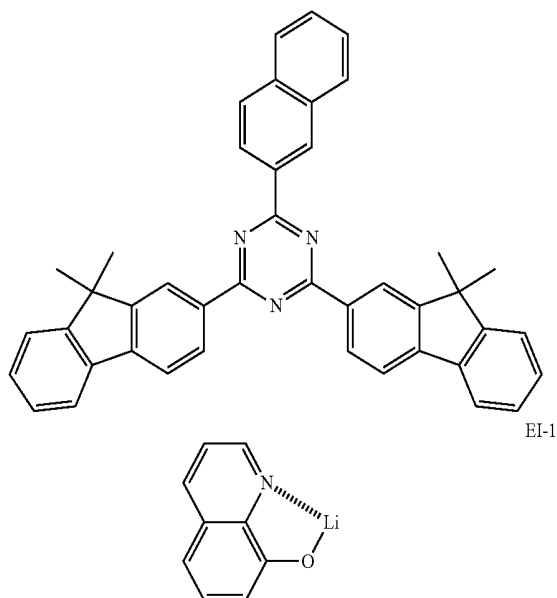


Device Examples 2-1 to 2-3: Preparation of an OLED Device by Co-Evaporating the First Host Compound and the Second Host Compound of the Present Invention

[0063] An OLED device was produced in the same manner as in Device Example 1-1, except for evaporating the first hole transport layer (compound HT-1) of 10 nm thickness, introducing N,N-di([1,1'-biphenyl]-4-yl)-(9H-carbazol-9-yl)-[1,1'-biphenyl]-4-amine (compound HT-2) into another cell of said vacuum vapor depositing apparatus, evaporating by applying an electric current to the cell, thereby forming a second hole transport layer having a thickness of 60 nm on the first hole transport layer, and using the first and second host compounds listed in Table 1 as a host.

Comparative Example 1-1: Preparation of an OLED Device Using Only the First Host Compound as a Host

ET-1



[0064] An OLED device was produced in the same manner as in Device Example 1-1, except for using only the first host compound listed in Table 1 as a host of the light-emitting layer.

Comparative Examples 2-1 to 2-3: Preparation of an OLED Device Using Only the Second Host Compound as a Host

[0065] An OLED device was produced in the same manner as in Device Examples 2-1 to 2-3, except for using only the second host compound listed in Table 1 as a host of the light-emitting layer.

[0066] The driving voltage at 1,000 nit, luminous efficiency, CIE color coordinate, and the time taken for the luminance at 5,000 nit to be reduced from 100% to 90% at a constant current of the OLEDs produced as above were measured.

[0067] Table 1 below shows the luminous characteristics of the organic electroluminescent devices produced as in Device Example 1-1, Comparative Example 1-1, Device Examples 2-1 to 2-3, and Comparative Examples 2-1 to 2-3.

TABLE 1

Device No.	HTL	Host	Dopant	Voltage [V]	Efficiency [cd/A]	Color Coordinate (x, y)	Lifespan [hr]
Device Ex. 1-1	HT-1	A-49: H2-31	D-96	4	27.8	0.667, 0.332	70
Device Ex. 2-1	HT-1/HT-2	A-49: H2-473	D-96	4.4	28.6	0.655, 0.334	215
Device Ex. 2-2	HT-1/HT-2	A-49: H2-2	D-96	4.3	27.6	0.664, 0.335	300
Device Ex. 2-3	HT-1/HT-2	A-49: H2-155	D-96	4.6	27.1	0.663, 0.336	250
Comp. Ex. 1-1	HT-1	A-49	D-96	8.1	3.7	0.651, 0.338	2
Comp. Ex. 2-1	HT-1/HT-2	H2-473	D-96	3.9	29.2	0.664, 0.335	42
Comp. Ex. 2-2	HT-1/HT-2	H2-2	D-96	4.1	28.2	0.662, 0.337	100
Comp. Ex. 2-3	HT-1/HT-2	H2-155	D-96	4.4	28.3	0.666, 0.334	195

Device Examples 3-1 to 3-13: Preparation of an OLED Device by Co-Evaporating the First Host Compound and the Second Host Compound of the Present Invention

[0068] An OLED device was produced in the same manner as in Device Example 1-1, except for evaporating the second hole injection layer of 3 nm thickness, evaporating the first hole transport layer of 40 nm thickness, not evaporating the second hole transport layer, using compound D-1 or D-25 for the dopant of the light-emitting layer, evaporating the electron transport layer of 35 nm thickness at a rate of 4:6, and using the first and second host compounds combination listed in Table 2 as a host of the light-emitting layer.

Device Example 4-1: Preparation of an OLED Device by Co-Evaporating the First Host Compound and the Second Host Compound of the Present Invention

[0069] An OLED device was produced in the same manner as in Device Examples 3-1 to 3-13, except for evaporating the first hole transport layer of 10 nm thickness, evaporating the second hole transport layer of 30 nm thickness by using compound HT-3, using compound D-136 for the dopant of the light-emitting layer, and using the first and second host compounds combination listed in Table 2 as a host of the light-emitting layer.

Comparative Example 3-1: Preparation of an OLED Device Using Only the First Host Compound as a Host

[0070] An OLED device was produced in the same manner as in Device Examples 3-1 to 3-13, except for using only

the first host compound listed in Table 2 as a host of the light-emitting layer.

Comparative Examples 4-1 to 4-12: Preparation of an OLED Device Using Only the Second Host Compound as a Host

[0071] An OLED device was produced in the same manner as in Device Examples 3-1 to 3-13, except for using only the second host compound listed in Table 2 as a host of the light-emitting layer.

Comparative Example 5-1: Preparation of an OLED Device Using Only the Second Host Compound as a Host

[0072] An OLED device was produced in the same manner as in Device Example 4-1, except for using only the second host compound listed in Table 2 as a host of the light-emitting layer.

[0073] The driving voltage at 1,000 nit, luminous efficiency, CIE color coordinate, and the time taken for the luminance at 15,000 nit to be reduced from 100% to 90% at a constant current of the OLEDs produced as above were measured.

[0074] Table 2 below shows the luminous characteristics of the organic electroluminescent devices produced as in Device Examples 3-1 to 3-13, Device Example 4-1, Comparative Example 3-1, Comparative Examples 4-1 to 4-12, and Comparative Example 5-1.

TABLE 2

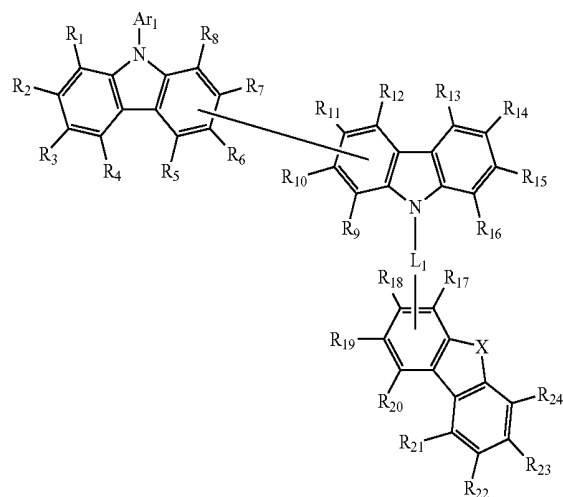
Device No.	HTL	Host	Dopant	Voltage [V]	Efficiency [cd/A]	Color Coordinate (x, y)	Lifespan [hr]
Device Ex. 3-1	HT-1	A-49: H2-474	D-25	2.9	56	0.309, 0.652	97
Device Ex. 3-2	HT-1	A-49: H2-101	D-25	2.9	52.1	0.311, 0.652	42
Device Ex. 3-3	HT-1	A-49: H2-475	D-25	3.1	48.4	0.302, 0.659	52
Device Ex. 3-4	HT-1	A-49: H2-472	D-25	2.8	54.3	0.304, 0.657	89
Device Ex. 3-5	HT-1	A-49: H2-48	D-25	2.8	53.4	0.307, 0.656	121
Device Ex. 3-6	HT-1	A-49: H2-25	D-25	3.2	47.9	0.299, 0.659	98
Device Ex. 3-7	HT-1	A-49: H2-125	D-25	2.9	54	0.310, 0.653	158
Device Ex. 3-8	HT-1	A-49: H2-31	D-25	2.9	51.7	0.302, 0.657	144
Device Ex. 3-9	HT-1	A-49: H2-101	D-1	2.7	51.7	0.320, 0.655	211
Device Ex. 3-10	HT-1	A-49: H2-32	D-1	2.8	51.6	0.322, 0.655	359
Device Ex. 3-11	HT-1	A-49: H2-474	D-1	2.8	54.2	0.320, 0.656	260
Device Ex. 3-12	HT-1	A-49: H2-31	D-1	2.9	52.5	0.322, 0.655	205
Device Ex. 3-13	HT-1	A-49: H2-48	D-1	2.7	54.2	0.322, 0.655	199
Device Ex. 4-1	HT-1/HT-3	A-49: H2-31	D-136	3.1	68.4	0.329, 0.656	270
Comp. Ex. 3-1	HT-1	A-49	D-25	5.7	3.6	0.302, 0.653	X

TABLE 2-continued

Device No.	HTL	Host	Dopant	Voltage [V]	Efficiency [cd/A]	Color Coordinate (x, y)	Lifespan [hr]
Comp. Ex. 4-1	HT-1	H2-474	D-25	2.7	56.3	0.310, 0.651	22
Comp. Ex. 4-2	HT-1	H2-101	D-25	2.8	50.3	0.315, 0.651	24
Comp. Ex. 4-3	HT-1	H2-475	D-25	3.2	58.8	0.307, 0.656	32
Comp. Ex. 4-4	HT-1	H2-472	D-25	2.6	38.8	0.305, 0.653	53
Comp. Ex. 4-5	HT-1	H2-48	D-25	2.6	49.6	0.314, 0.652	67
Comp. Ex. 4-6	HT-1	H2-25	D-25	3.1	54.2	0.308, 0.655	45
Comp. Ex. 4-7	HT-1	H2-31	D-25	2.9	42.8	0.314, 0.652	39
Comp. Ex. 4-8	HT-1	H2-101	D-1	2.8	38	0.330, 0.650	18
Comp. Ex. 4-9	HT-1	H2-32	D-1	3.1	30.1	0.328, 0.651	119
Comp. Ex. 4-10	HT-1	H2-474	D-1	2.6	45.7	0.332, 0.635	105
Comp. Ex. 4-11	HT-1	H2-31	D-1	2.9	33.5	0.323, 0.653	130
Comp. Ex. 4-12	HT-1	H2-48	D-1	2.6	41.2	0.325, 0.653	124
Comp. Ex. 5-1	HT-1/HT-3	H2-125	D-136	3	64.9	0.337, 0.649	124

[0075] The organic electroluminescent device of the present invention comprises a light-emitting layer comprising a host and a phosphorus dopant, and the host consists of a specific combination of multi-component host compounds. The device of the present invention provides superior lifespan characteristics to conventional devices.

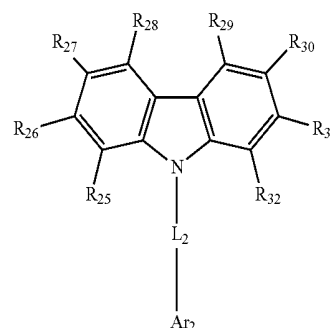
1. An organic electroluminescent device comprising at least one light-emitting layer between an anode and a cathode, wherein the light-emitting layer comprises a host and a phosphorescent dopant, the host consists of multi-component host compounds, at least a first host compound of the multi-component host compounds is represented by the following formula 1, and a second host compound is represented by the following formula 2.



(1)

-continued

(2)



wherein

Ar₁ represents a substituted or unsubstituted (C6-C30) aryl;

L₁ and L₂ each independently represent a single bond, or a substituted or unsubstituted (C6-C30)arylene;

X represents O or S;

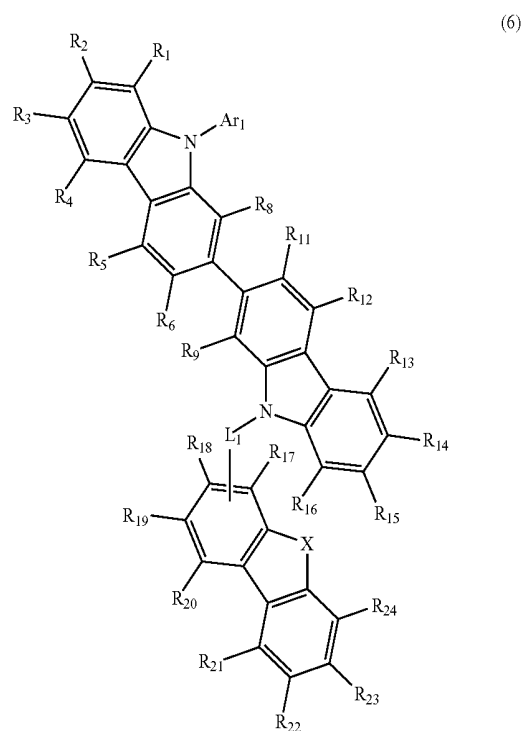
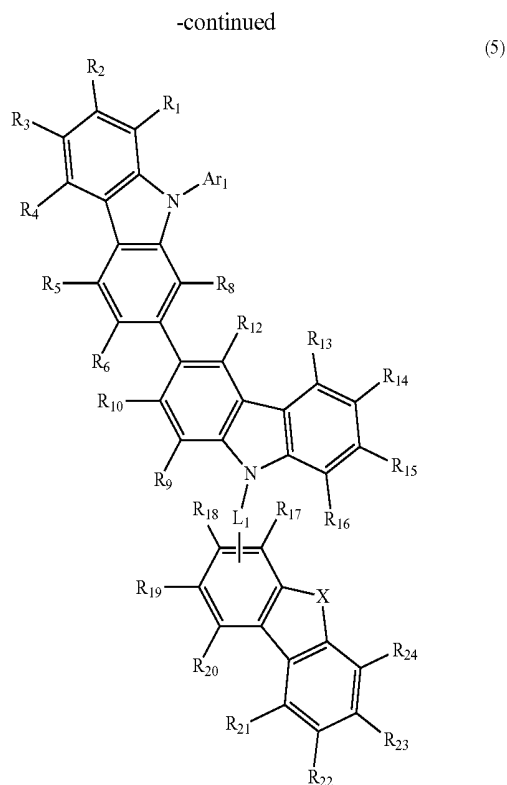
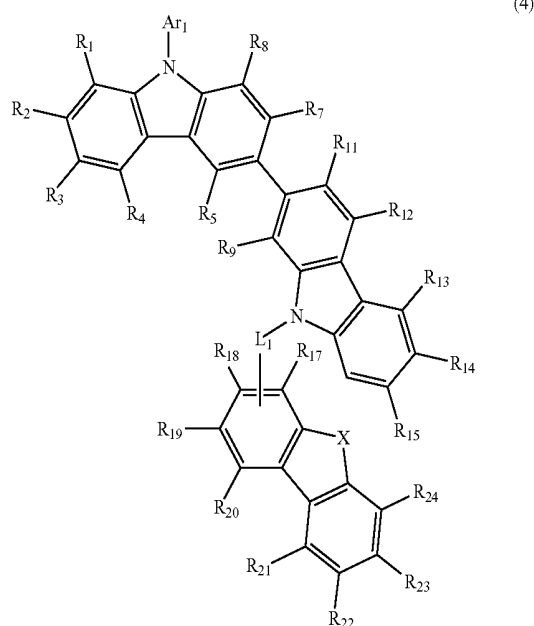
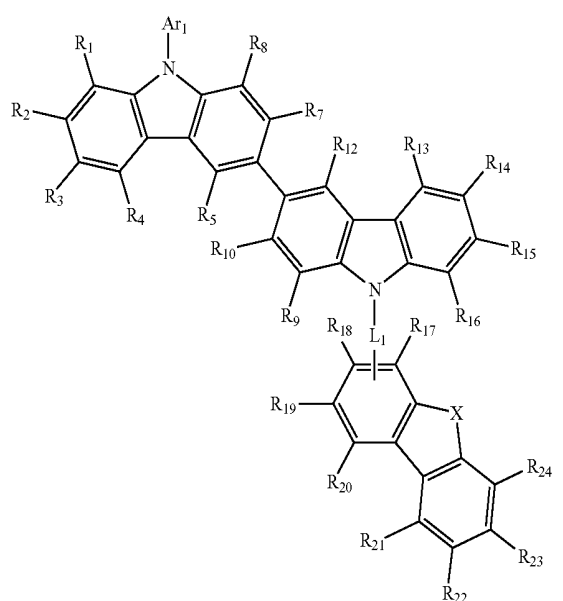
R₁ to R₃₂ each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30) alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic

ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur;

Ar₂ represents a substituted or unsubstituted 3- to 30-membered heteroaryl; and

the heteroaryl contains at least one hetero atom selected from B, N, O, S, Si, and P.

2. The organic electroluminescent device according to claim 1, wherein formula 1 is represented by one of the following formulae 3 to 6:

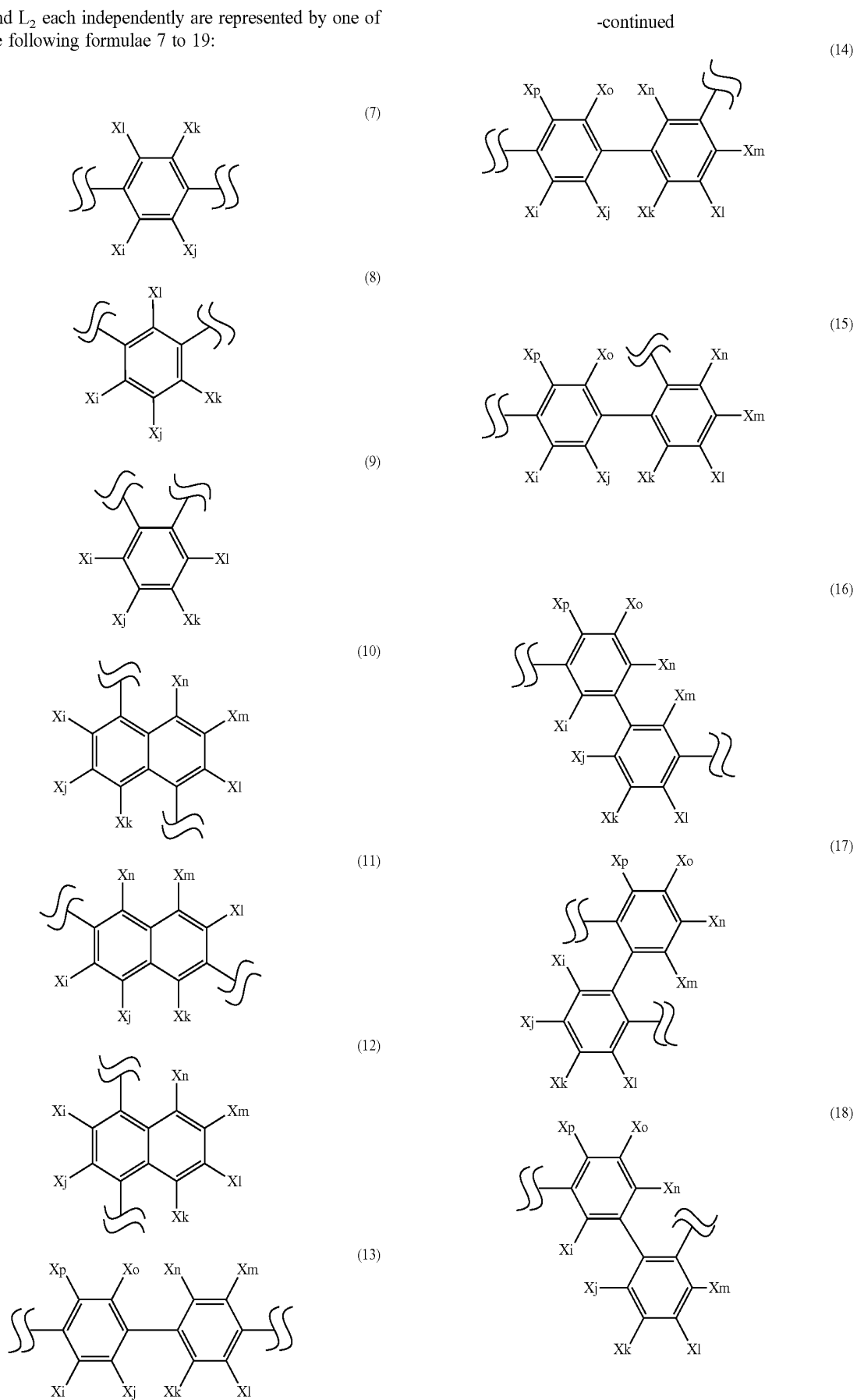


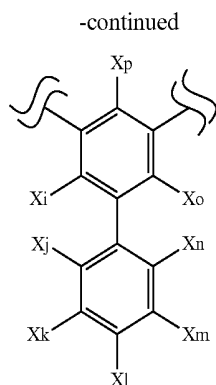
wherein

Ar₁, L₁, X, and R₁ to R₂₄ are as defined in claim 1.

3. The organic electroluminescent device according to claim 1, wherein in formulae 1 and 2,

L_1 and L_2 each independently are represented by one of the following formulae 7 to 19:

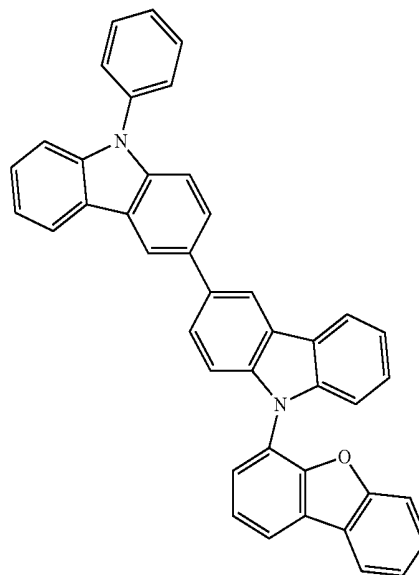




(19)

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

A-1



wherein

Xi to Xp each independently represent hydrogen, deuterium, a halogen, a cyano, a substituted or unsubstituted (C1-C30)alkyl, a substituted or unsubstituted (C2-C30)alkenyl, a substituted or unsubstituted (C2-C30)alkynyl, a substituted or unsubstituted (C3-C30)cycloalkyl, a substituted or unsubstituted (C6-C60)aryl, a substituted or unsubstituted 3- to 30-membered heteroaryl, a substituted or unsubstituted tri(C1-C30)alkylsilyl, a substituted or unsubstituted tri(C6-C30)arylsilyl, a substituted or unsubstituted di(C1-C30)alkyl(C6-C30)arylsilyl, or a substituted or unsubstituted mono- or di-(C6-C30)arylamino; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted, mono- or polycyclic, (C3-C30) alicyclic or aromatic ring, whose carbon atom(s) may be replaced with at least one hetero atom selected from nitrogen, oxygen, and sulfur.

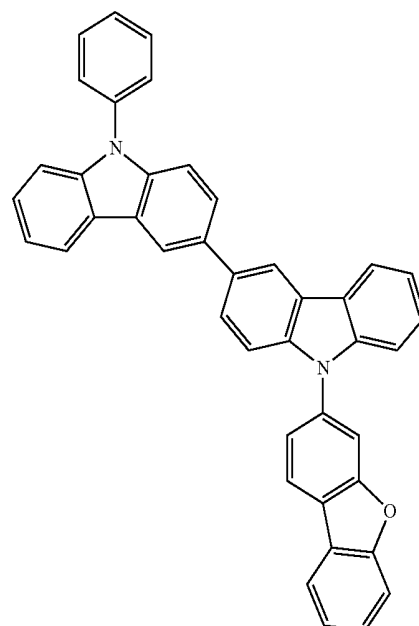
4. The organic electroluminescent device according to claim 1, wherein in formula 2,

Ar₂ represents a monocyclic heteroaryl selected from the group consisting of pyrrolyl, imidazolyl, pyrazolyl, triazinyl, tetrazinyl, triazolyl, tetrazolyl, pyridyl, pyrazinyl, pyrimidinyl, and pyridazinyl, or a fused heteroaryl selected from the group consisting of benzimidazolyl, isoindolyl, indolyl, indazolyl, benzothiadiazolyl, quinolyl, isoquinolyl, cinnolyl, quinazolinyl, naphthyridinyl, quinoxalinyl, carbazolyl, and phenanthrydinyl.

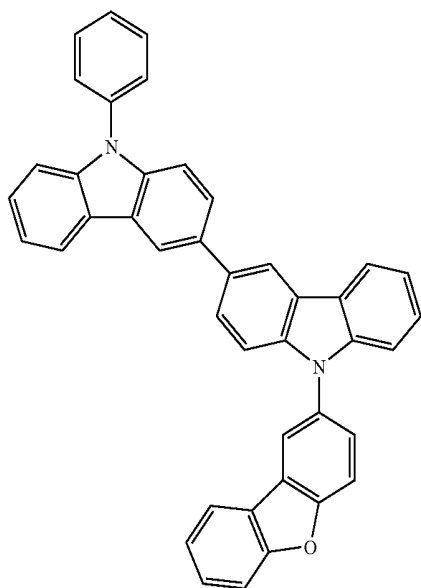
5. The organic electroluminescent device according to claim 1, wherein in formula 2,

R₂₅ to R₃₂ each independently represent hydrogen, a cyano, a (C6-C15)aryl unsubstituted or substituted with a tri(C6-C10)arylsilyl, a 10- to 20-membered heteroaryl unsubstituted or substituted with a (C6-C12)aryl, or an unsubstituted tri(C6-C10)arylsilyl; or are linked to an adjacent substituent(s) to form a substituted or unsubstituted benzene, a substituted or unsubstituted indole, a substituted or unsubstituted benzindole, a substituted or unsubstituted indene, a substituted or unsubstituted benzofuran, or a substituted or unsubstituted benzothiophene.

A-2

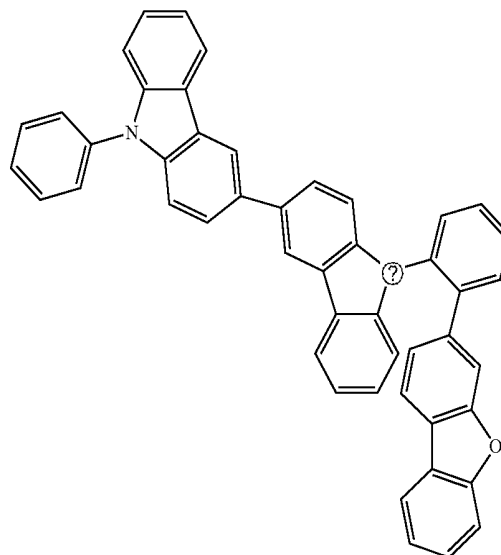


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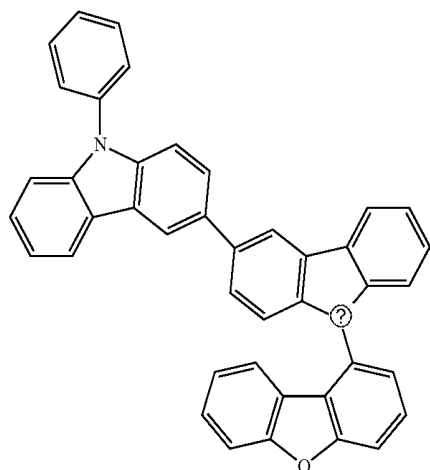


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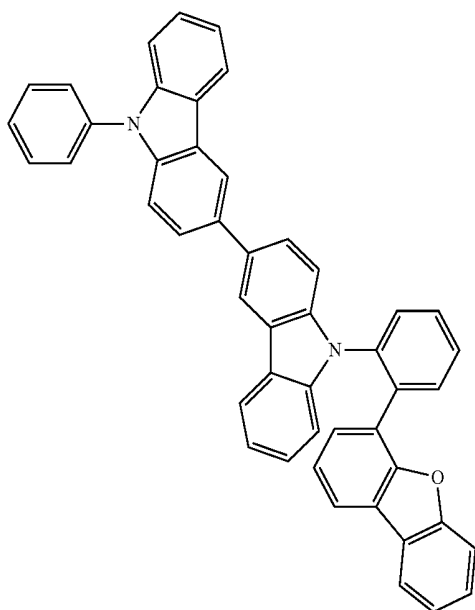
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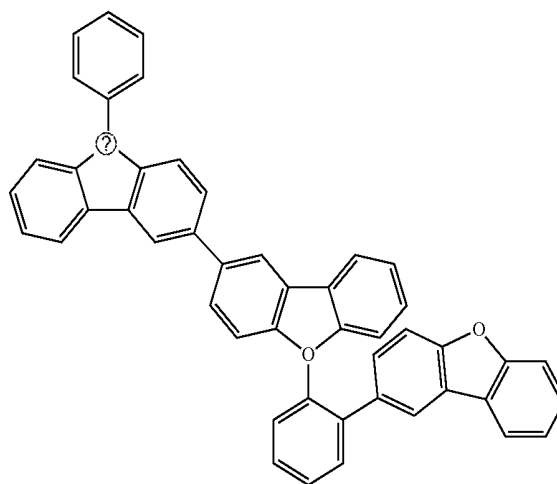
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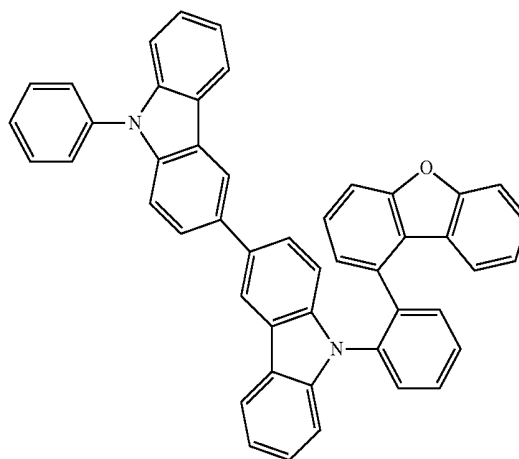
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A-5

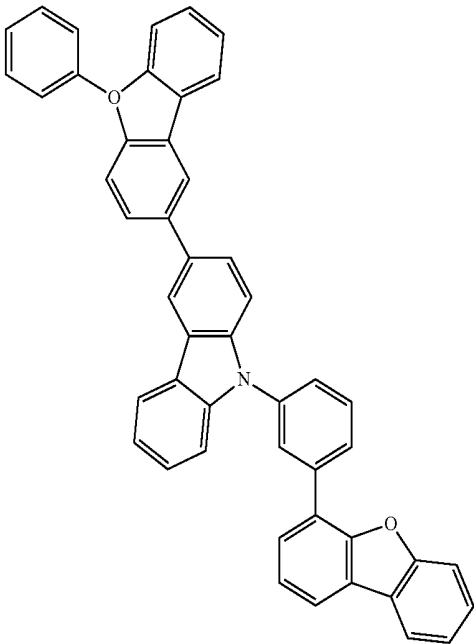


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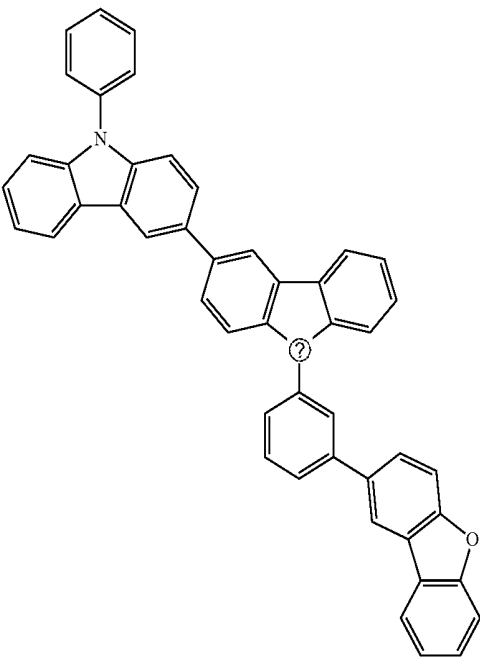


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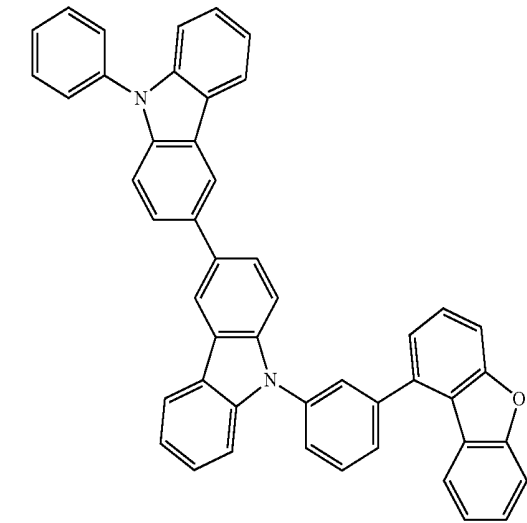
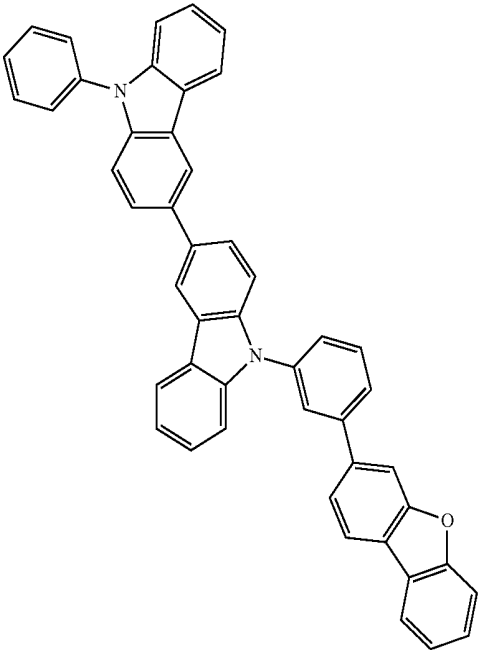
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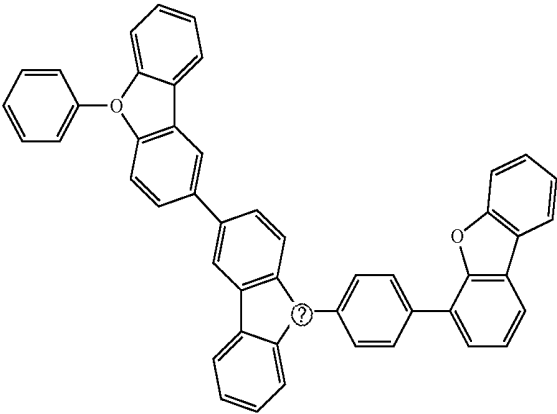
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A-10

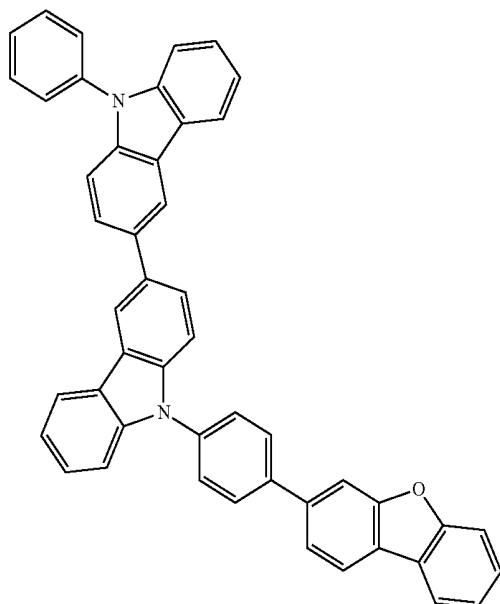


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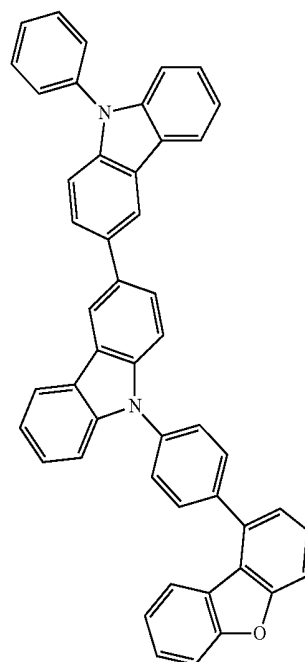
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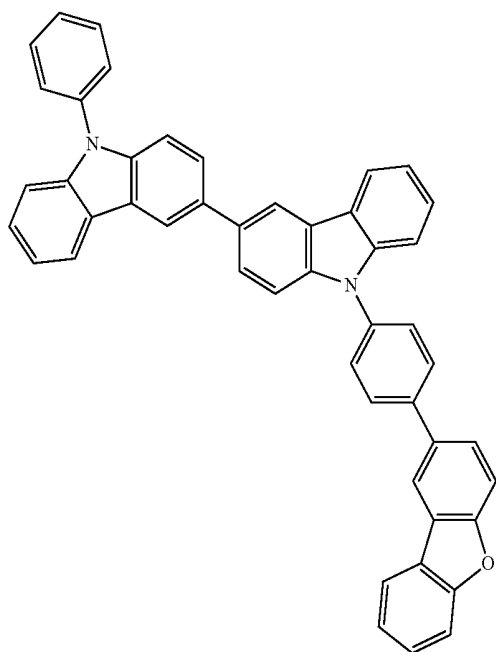


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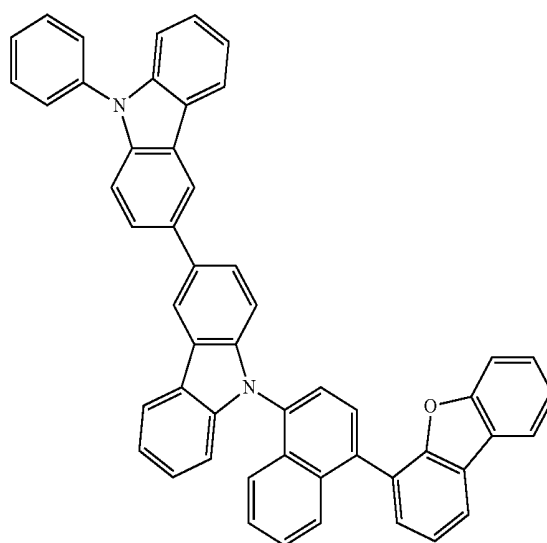
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A-15

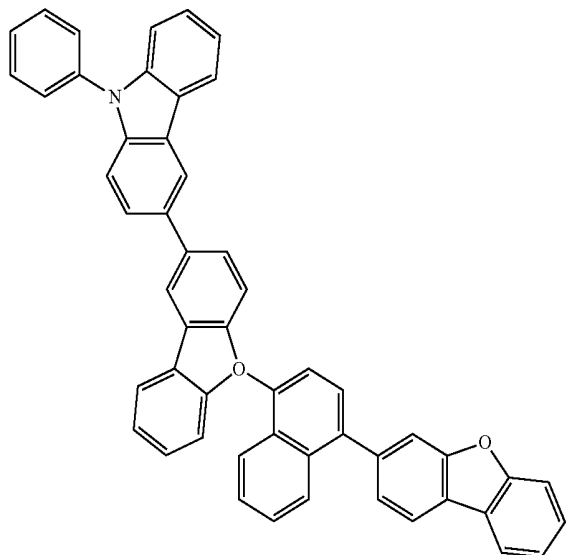


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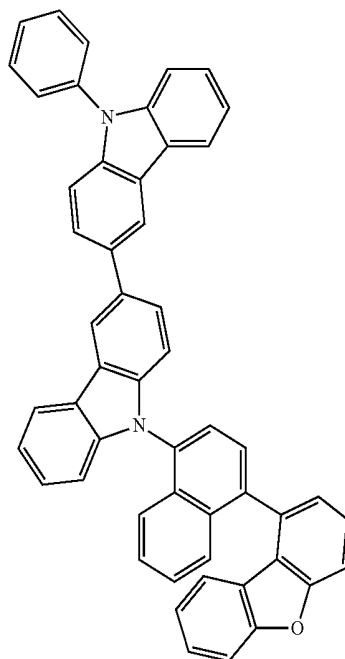
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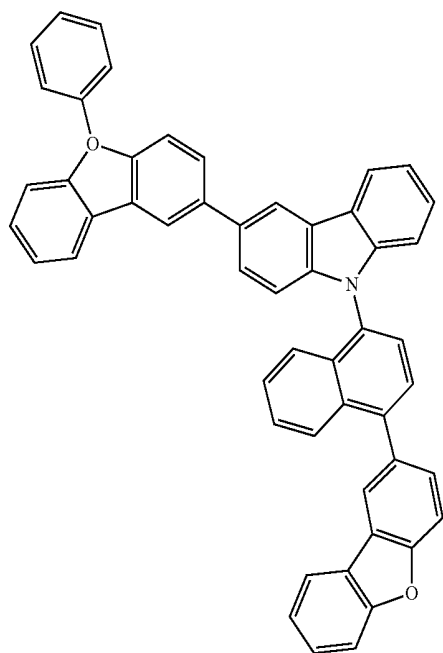


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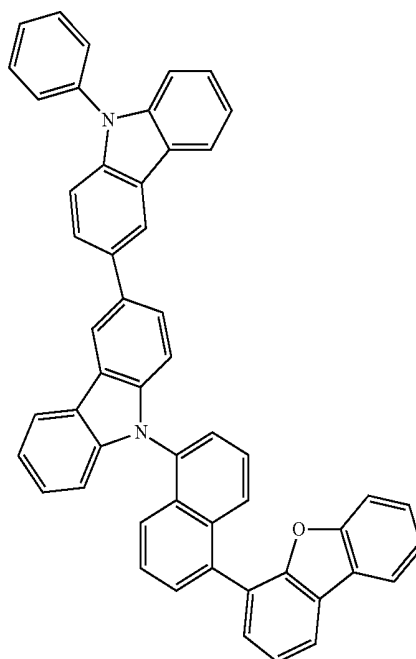
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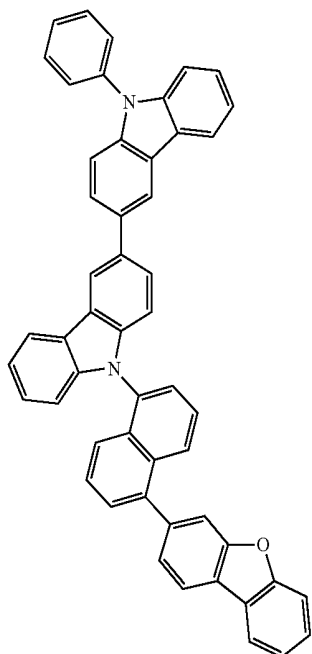
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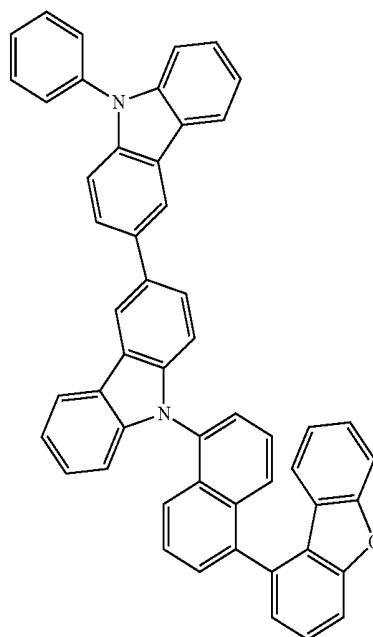


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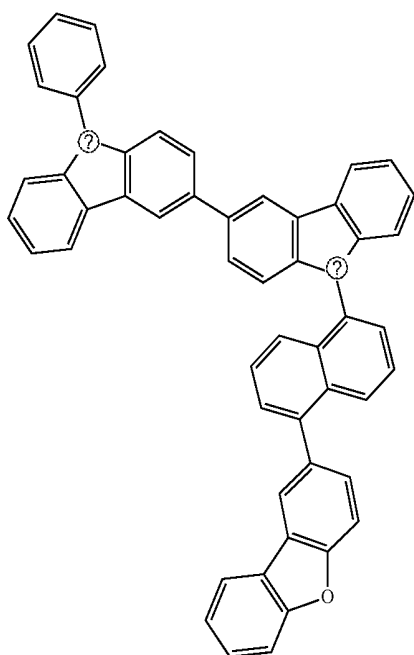


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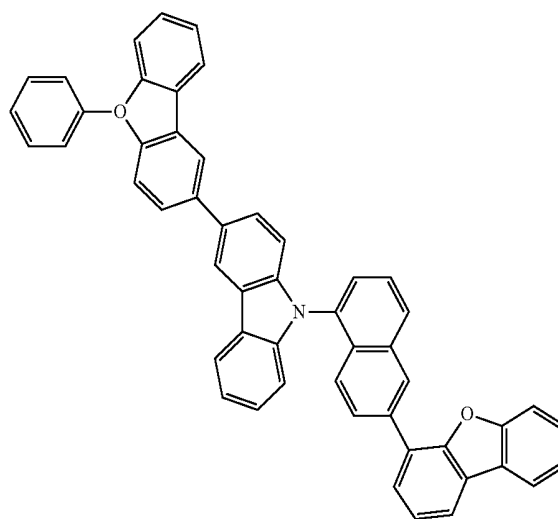
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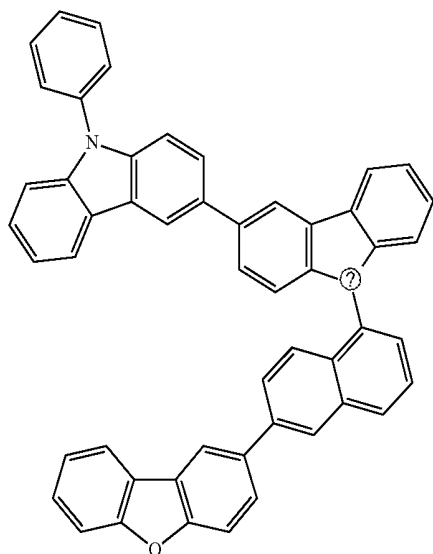
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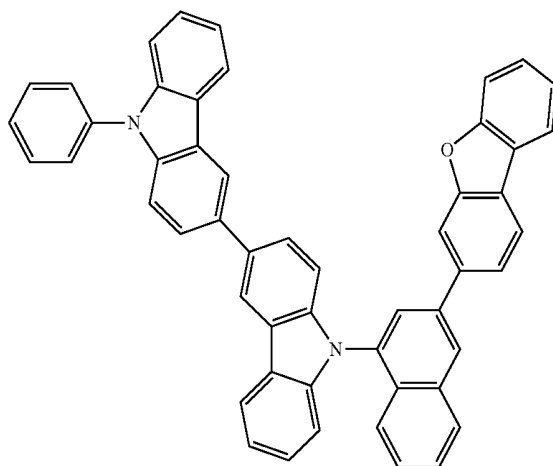
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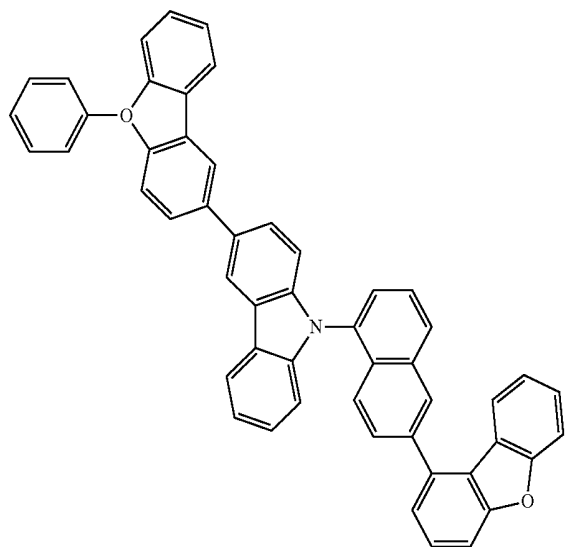
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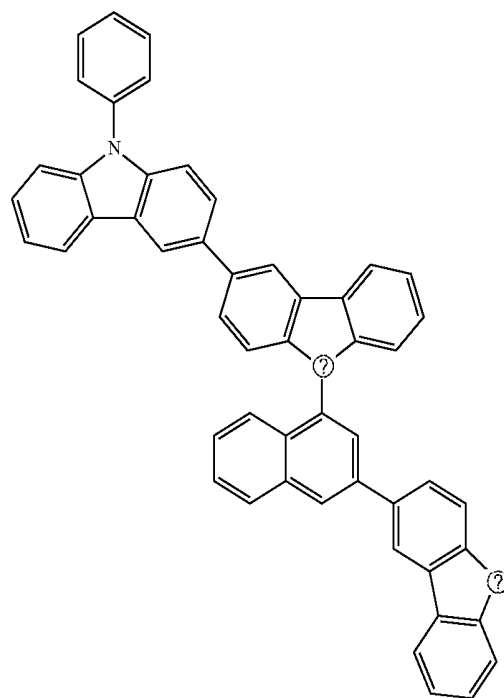
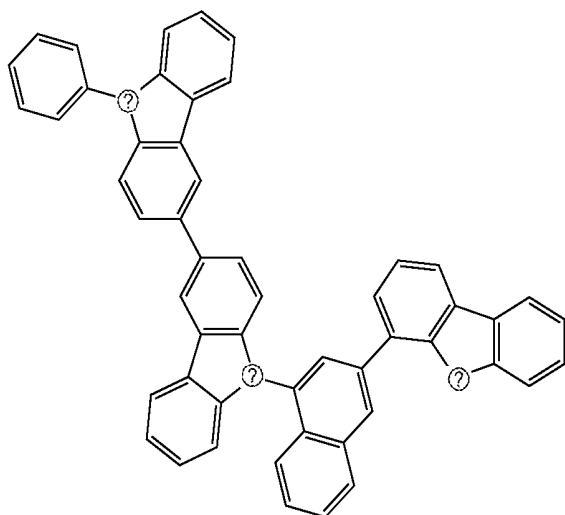


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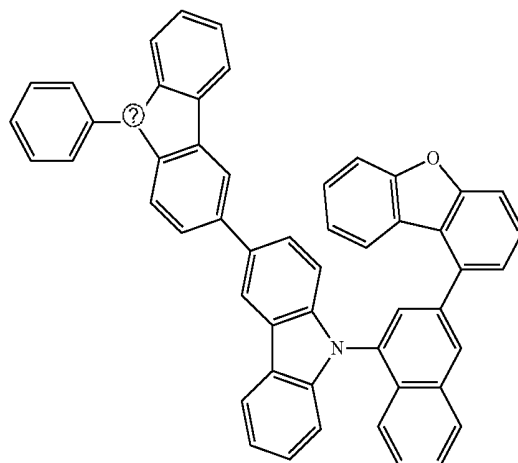
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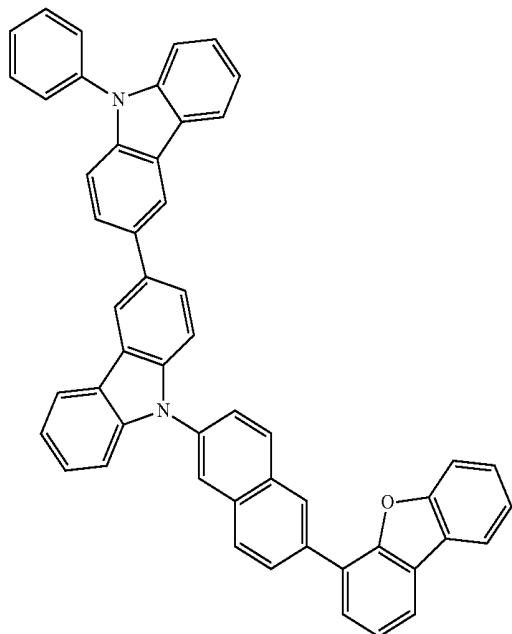


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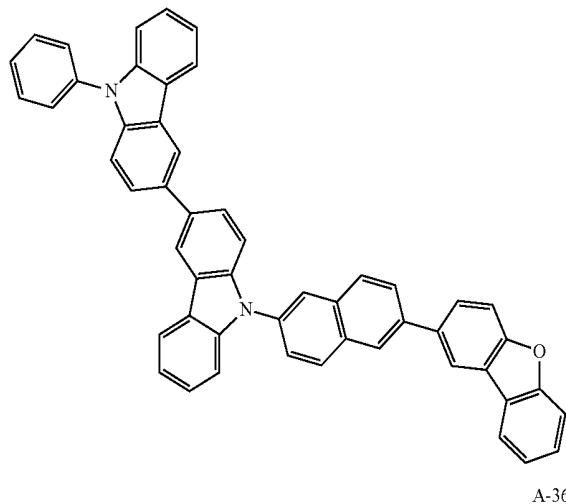
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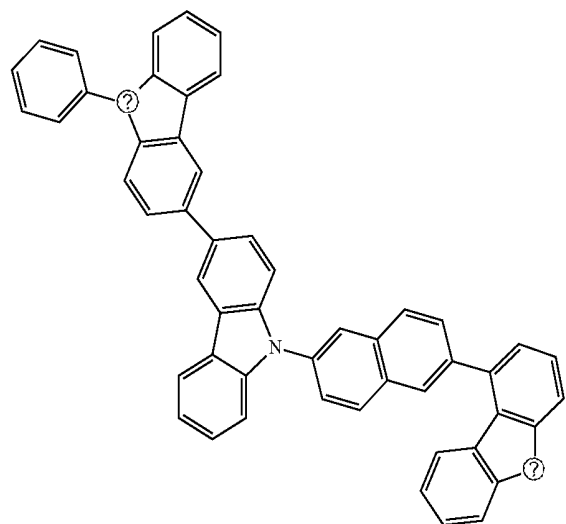


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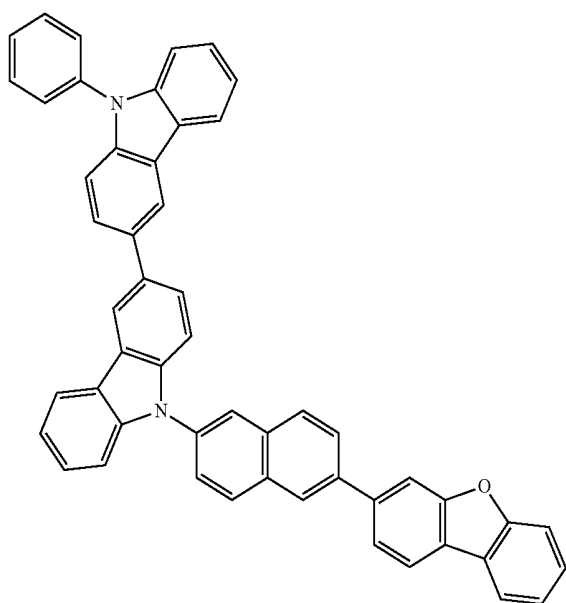
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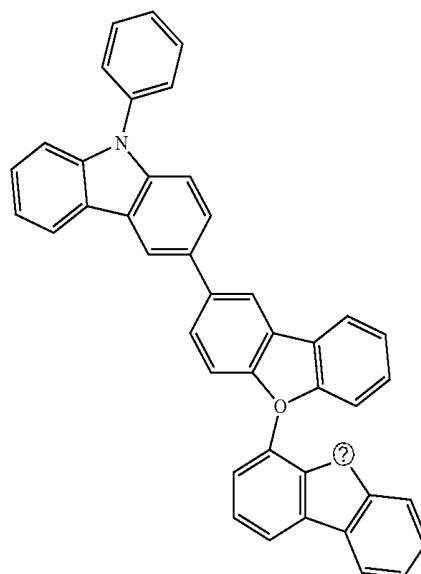
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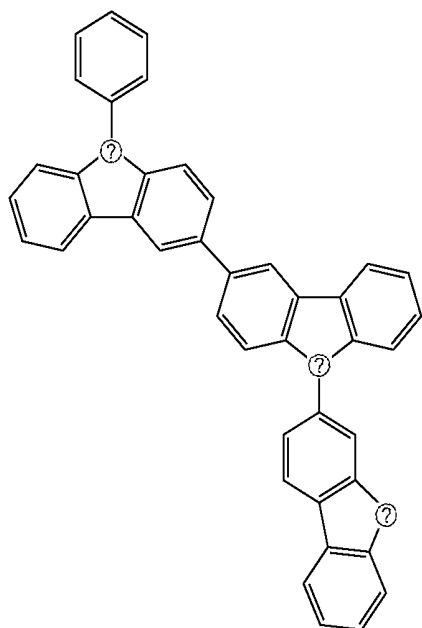
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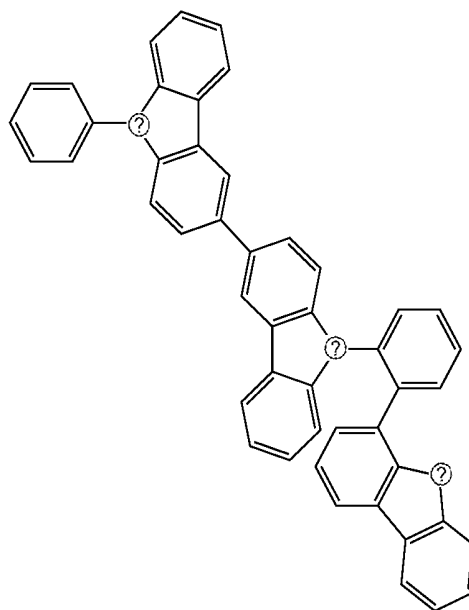


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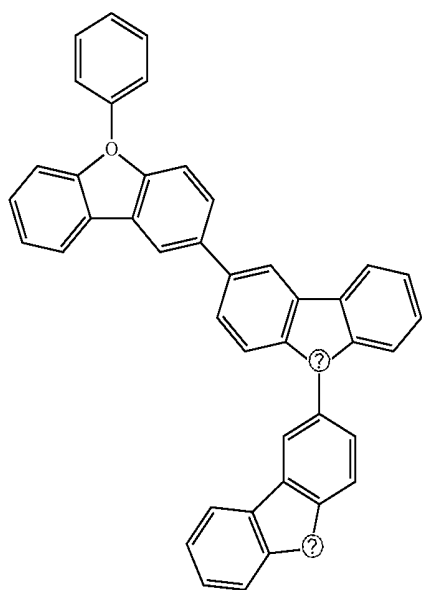


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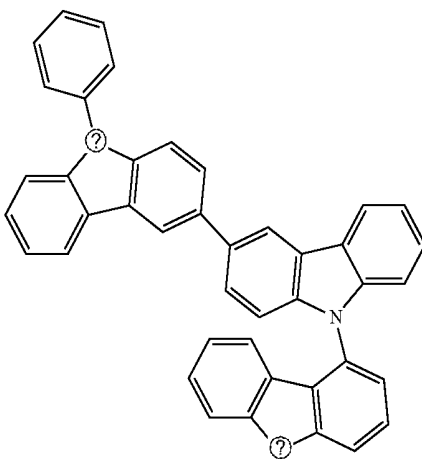
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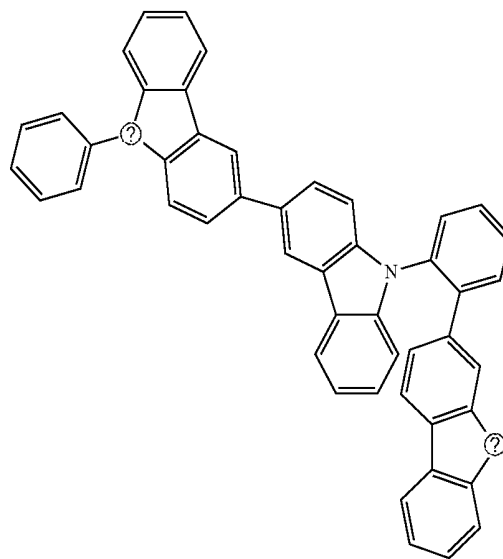
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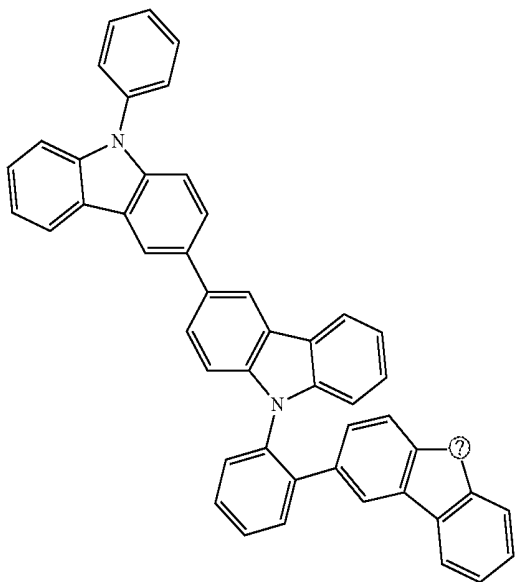
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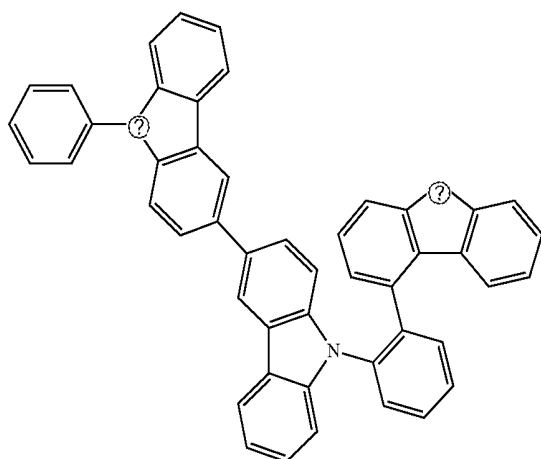
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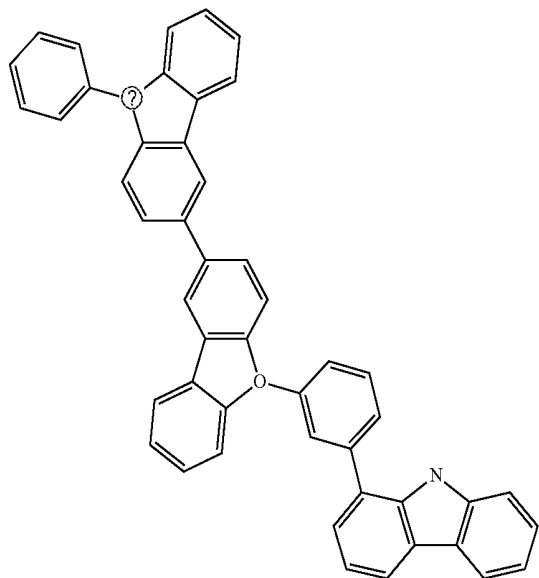
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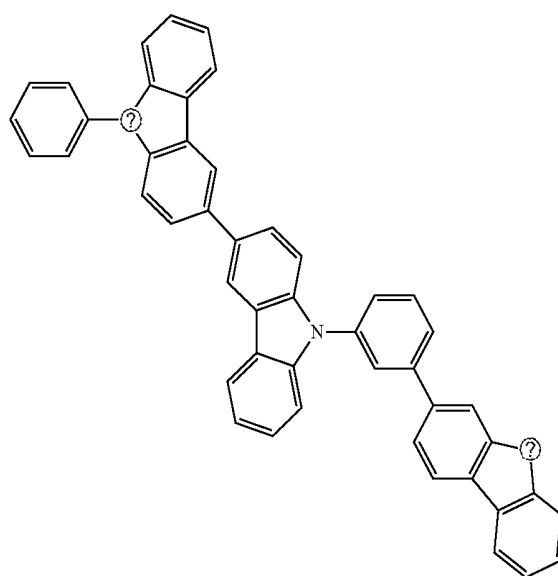


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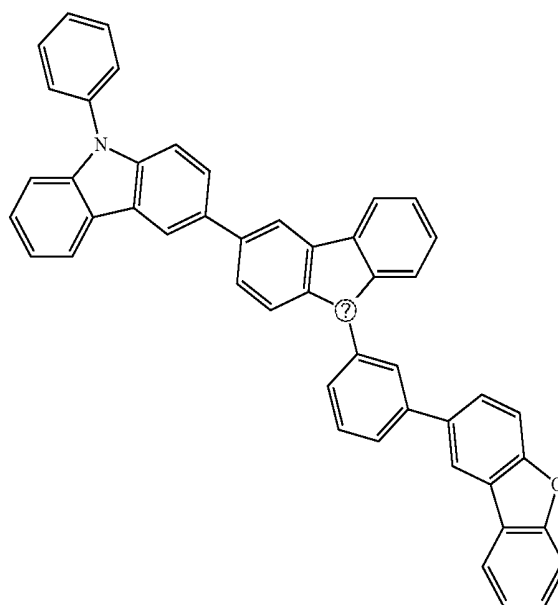


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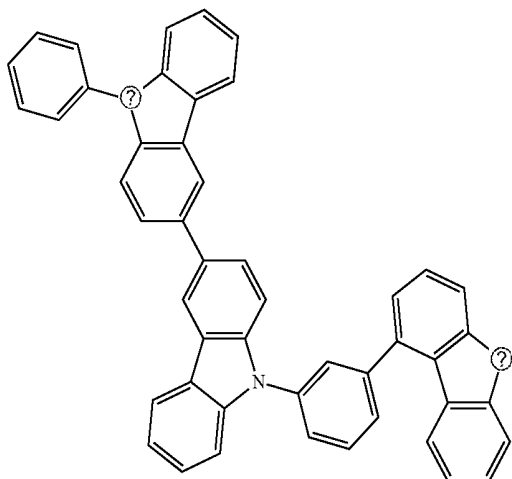


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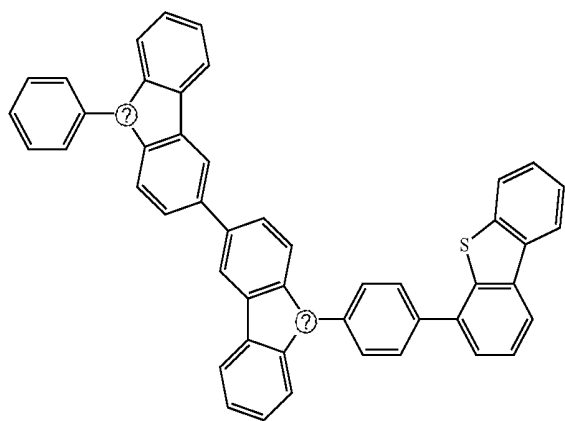


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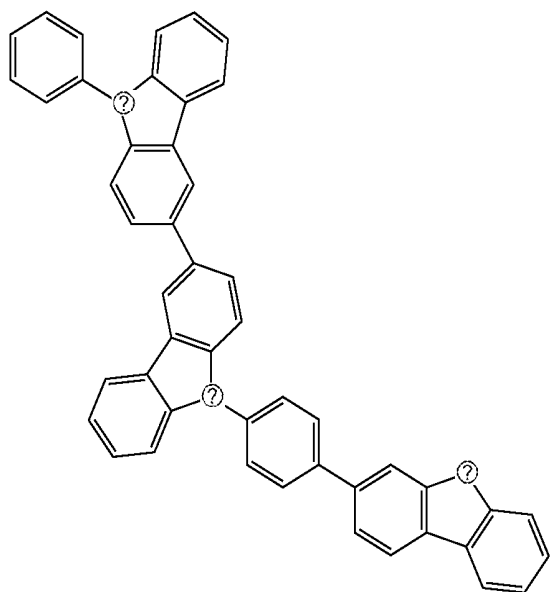
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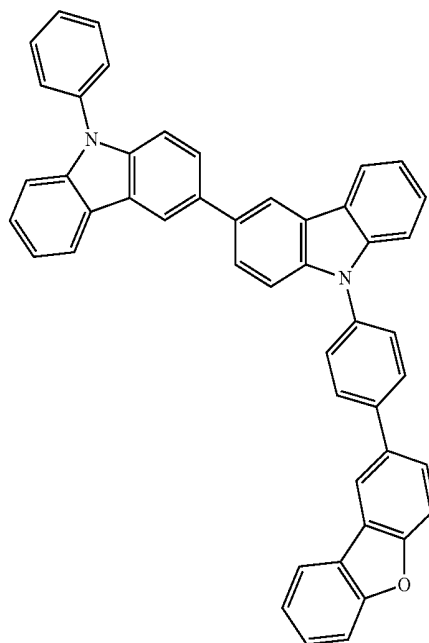


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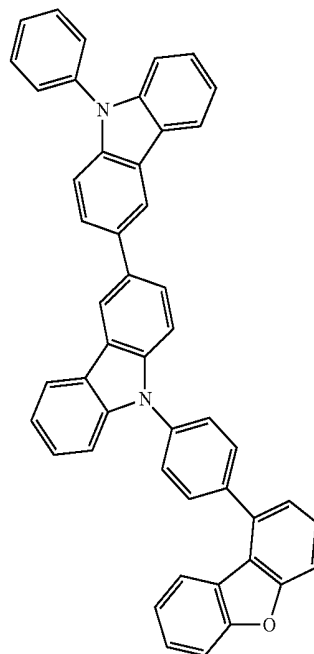


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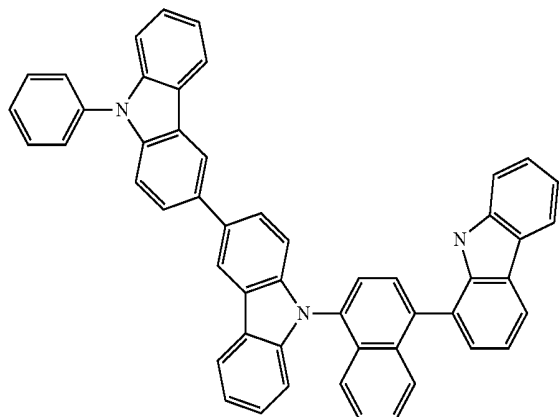


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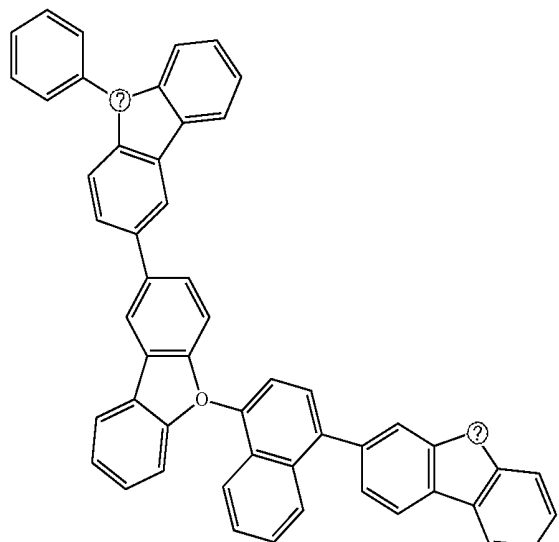


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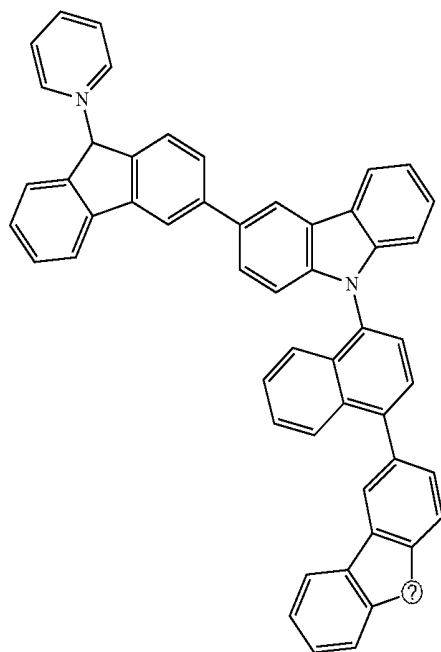
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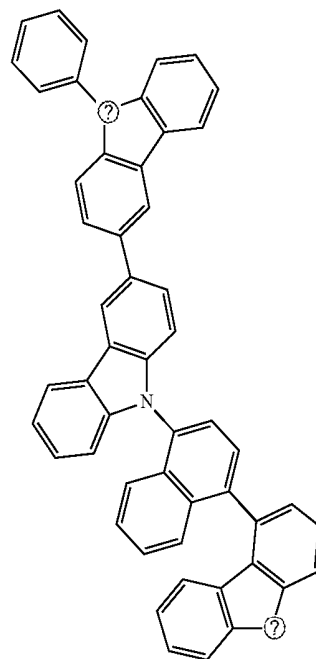


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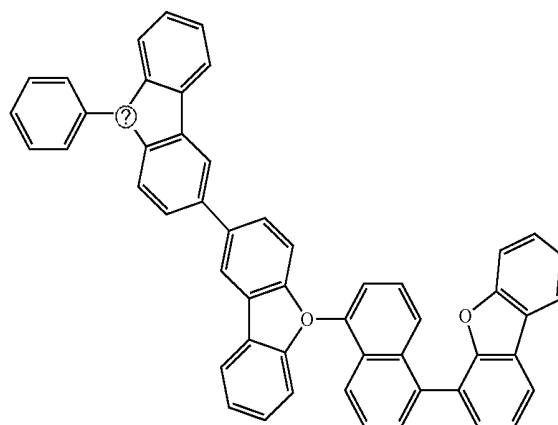


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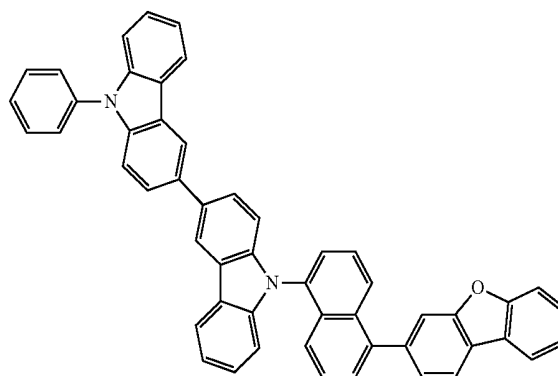
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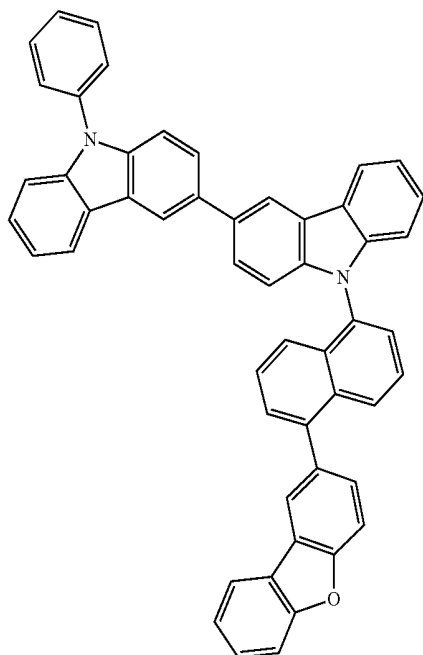


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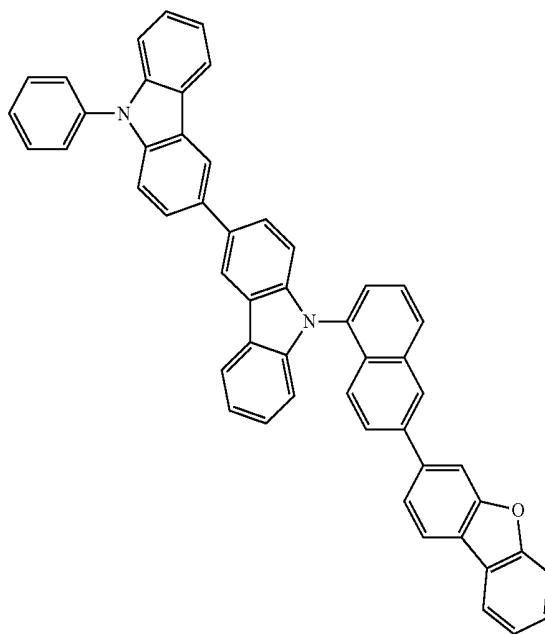
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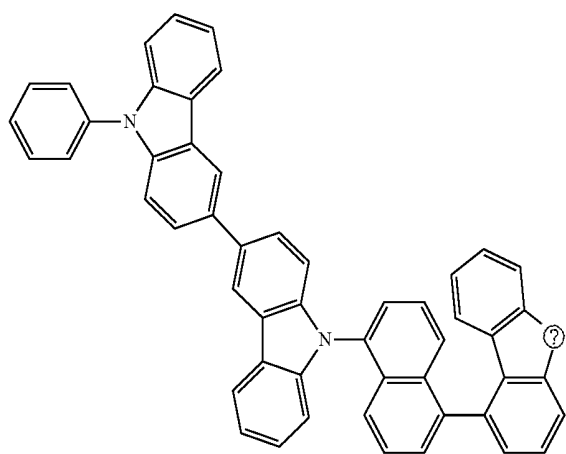


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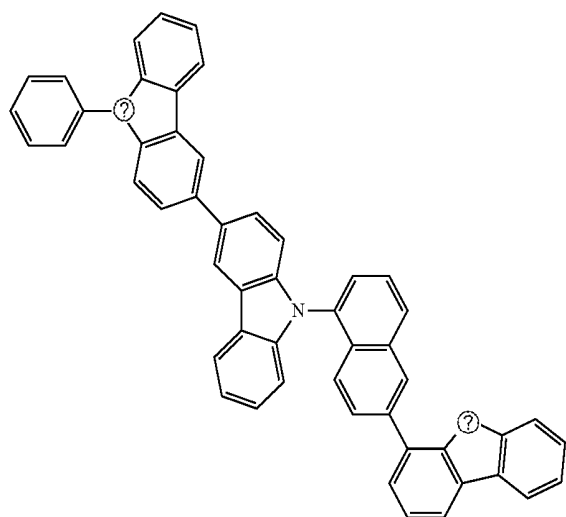
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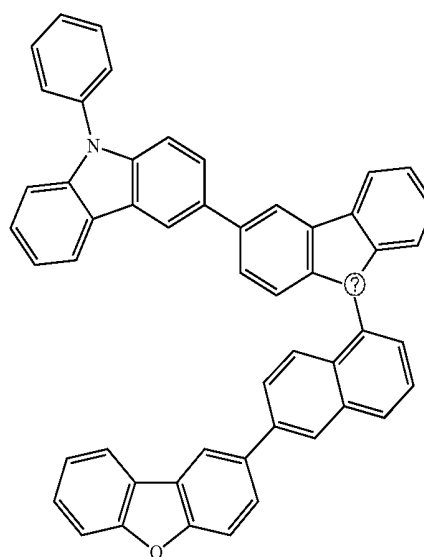
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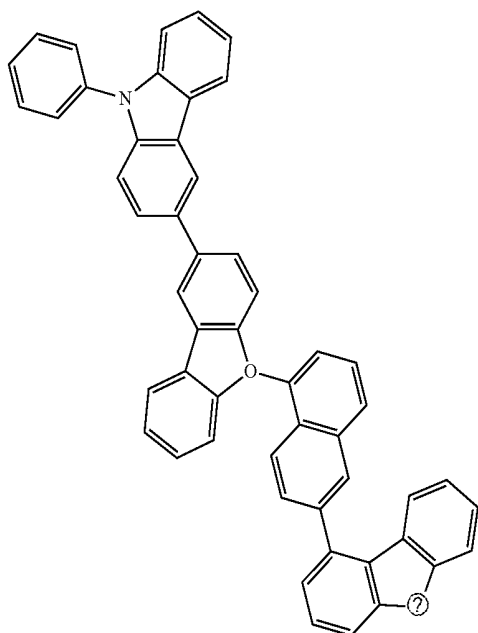


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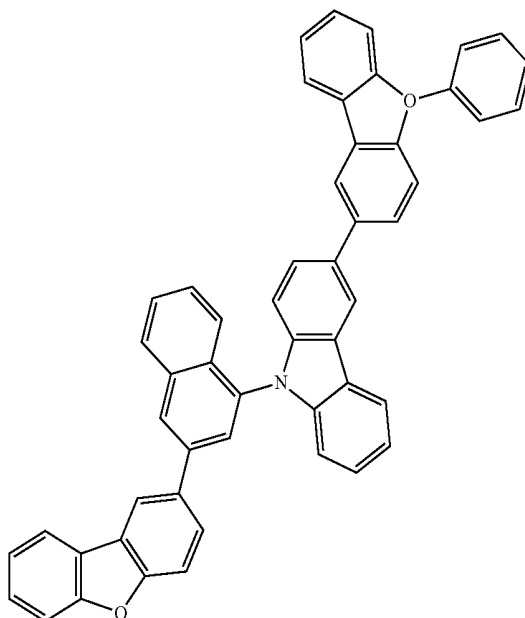
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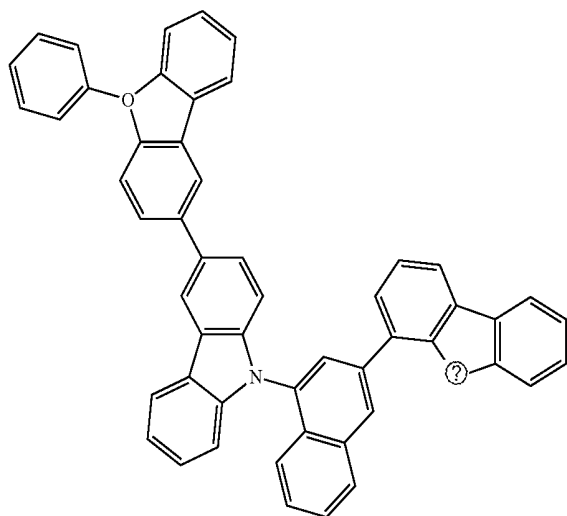


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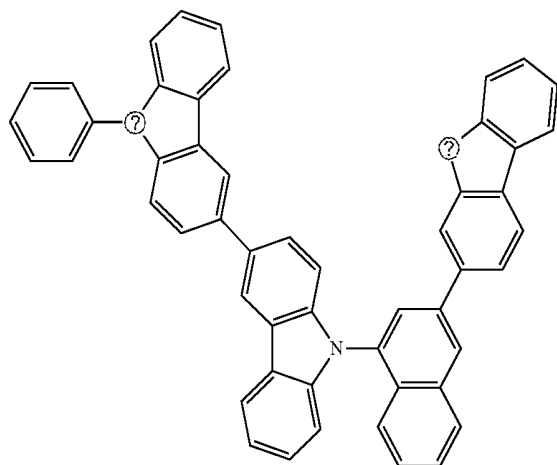
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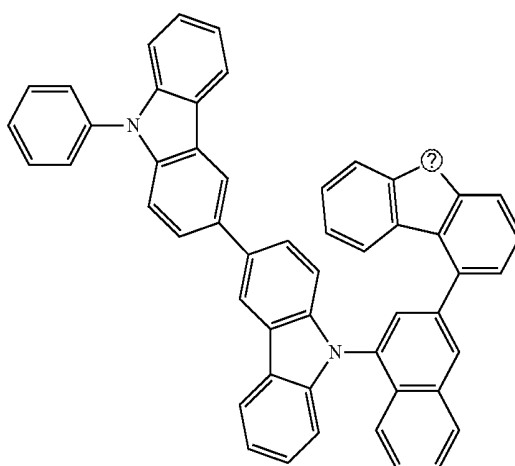
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A-66

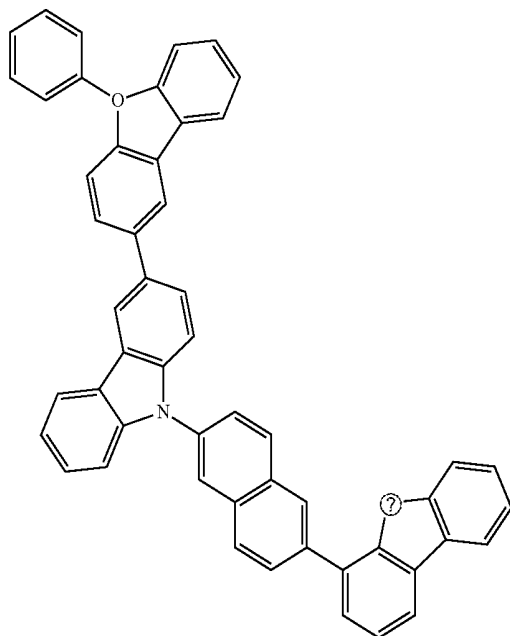


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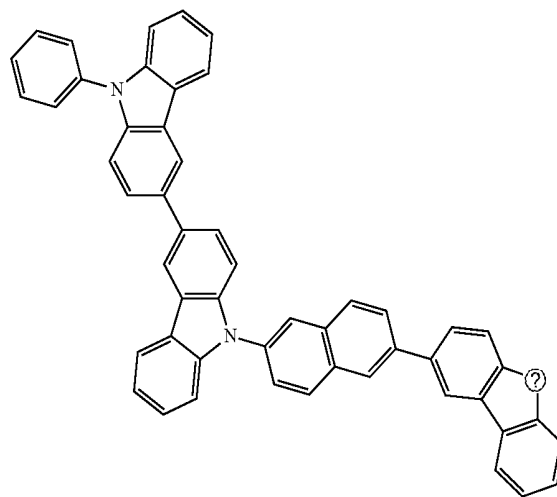
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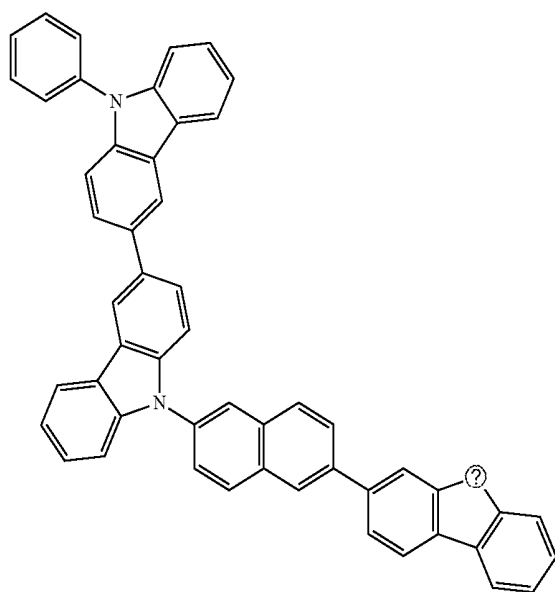
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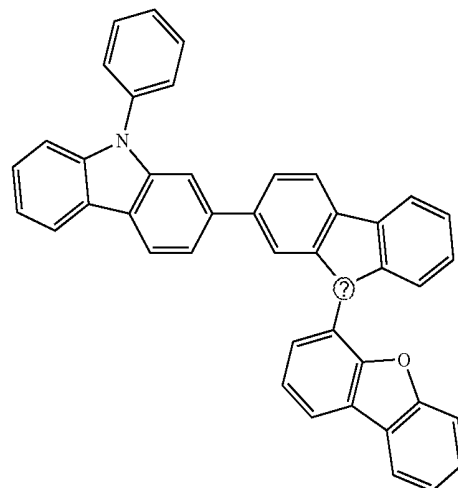


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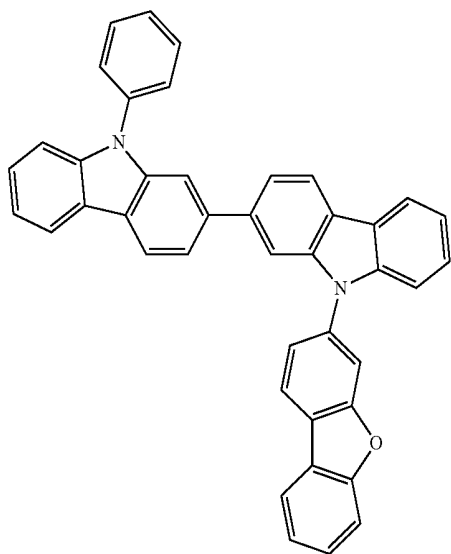
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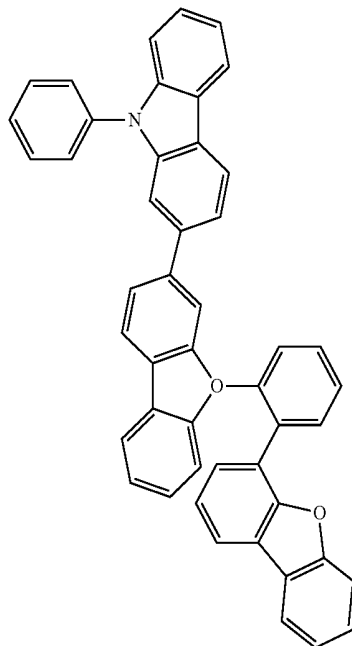


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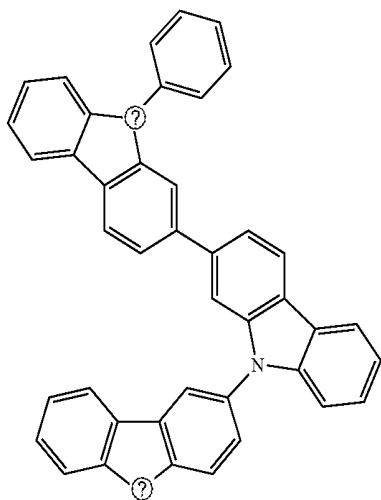
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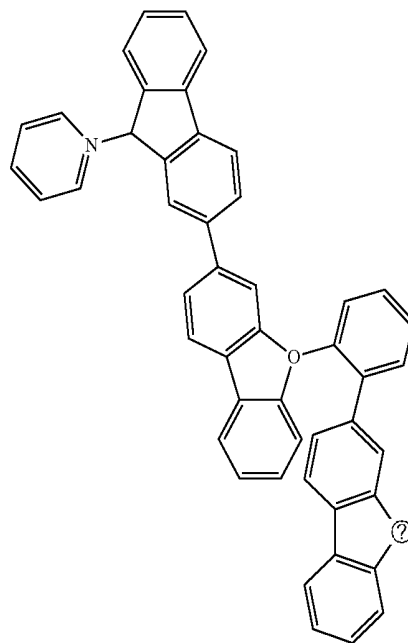


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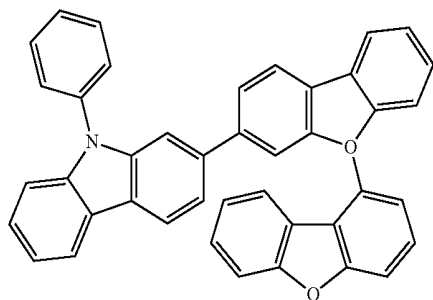
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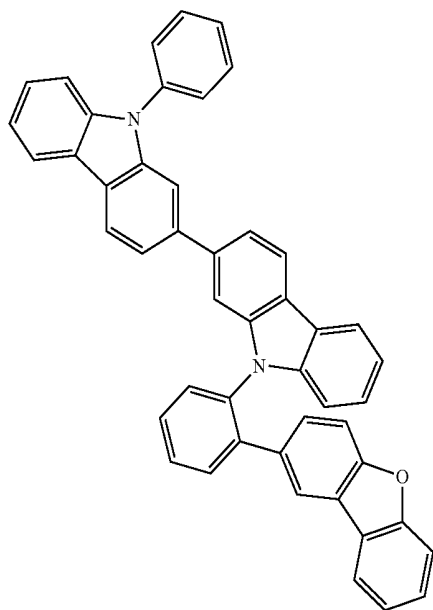
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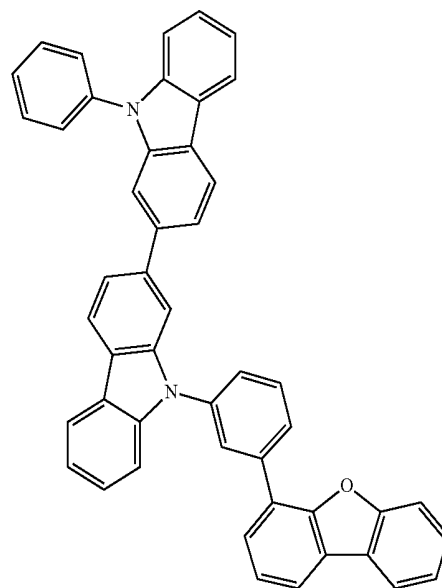


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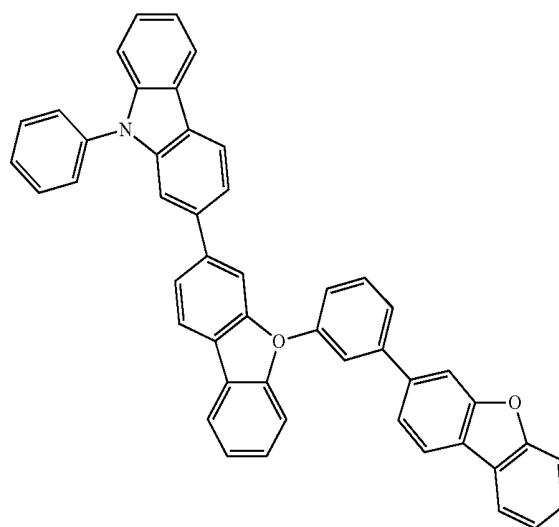
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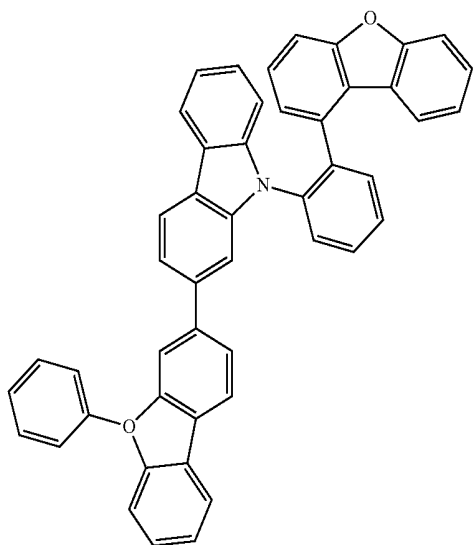


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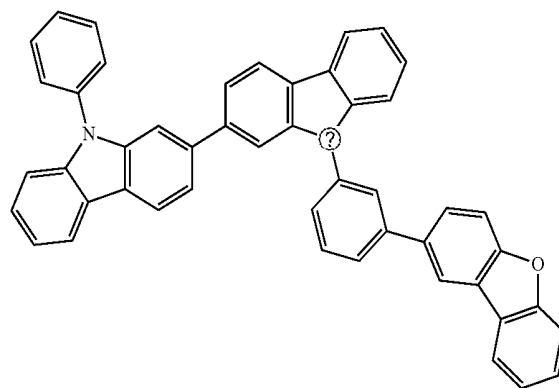
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A-80

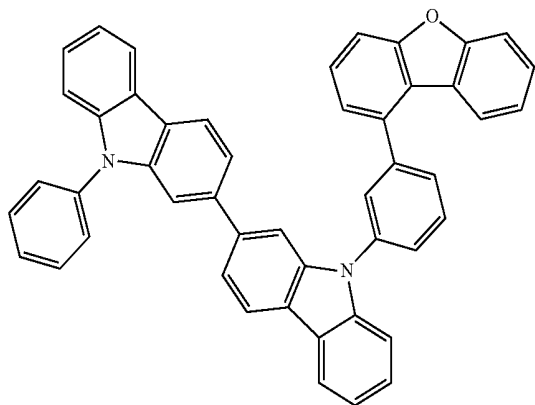


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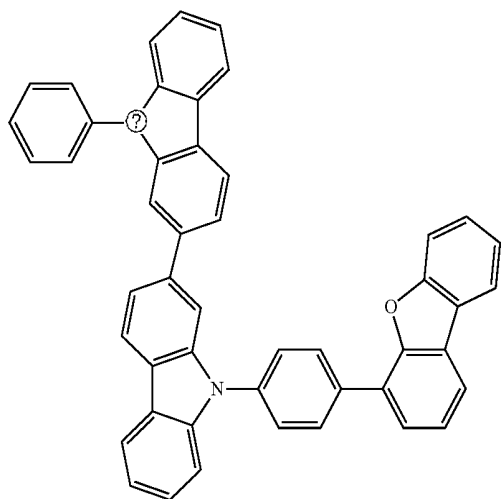


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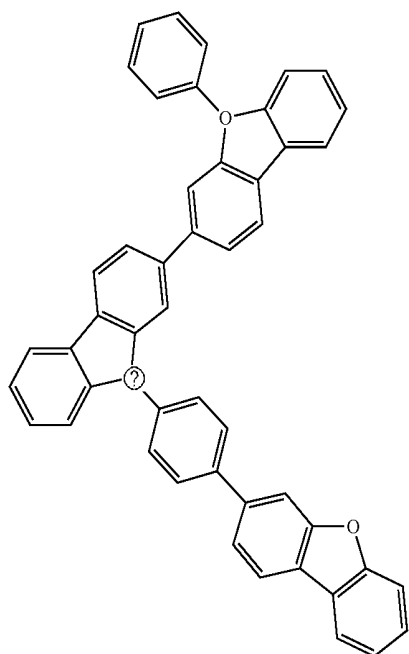
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A-85

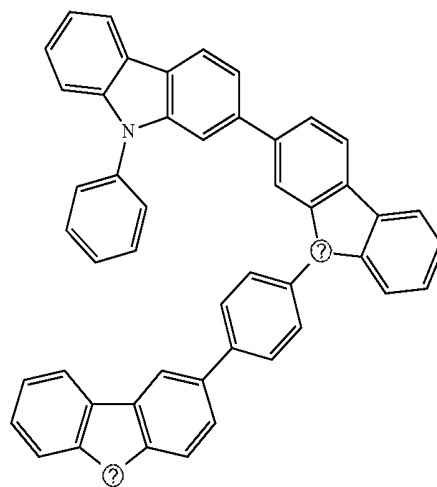


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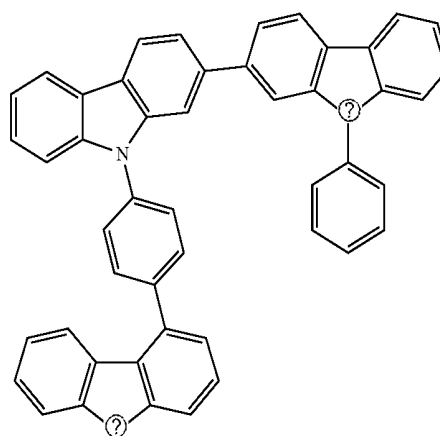


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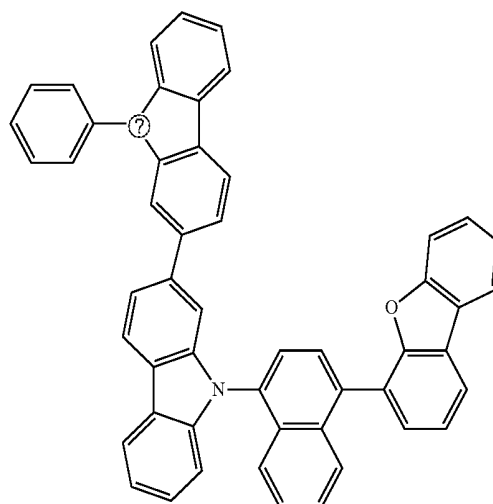
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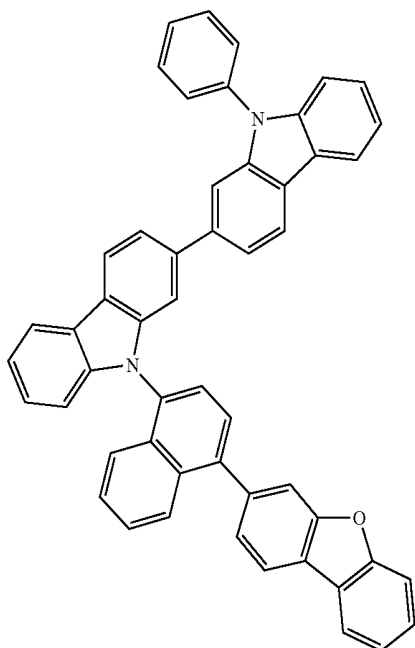
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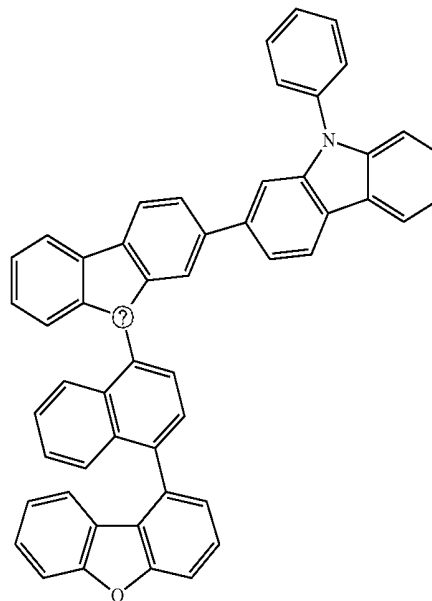


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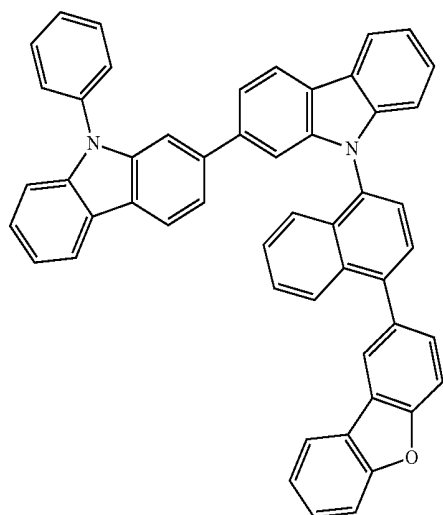


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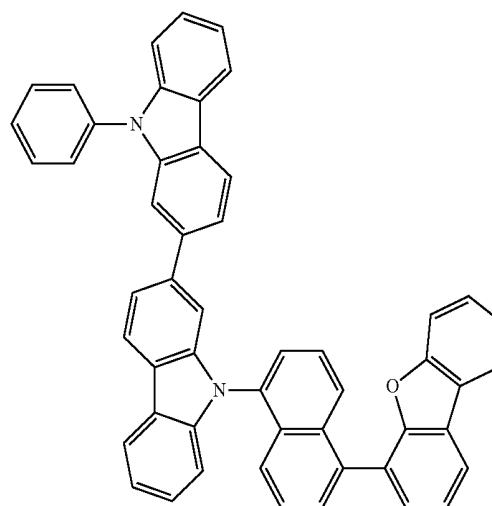
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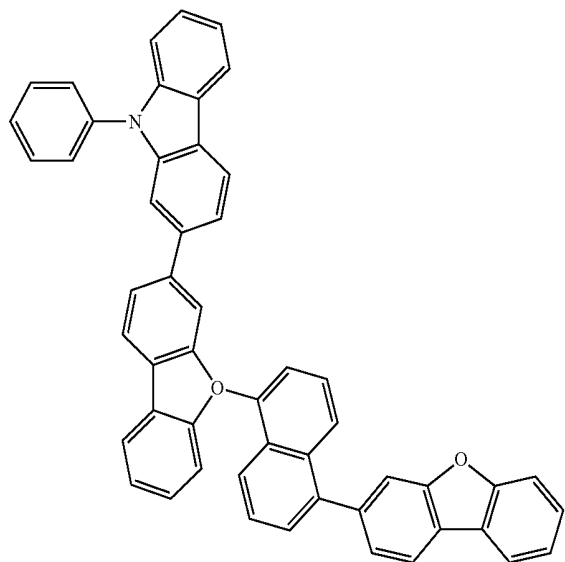
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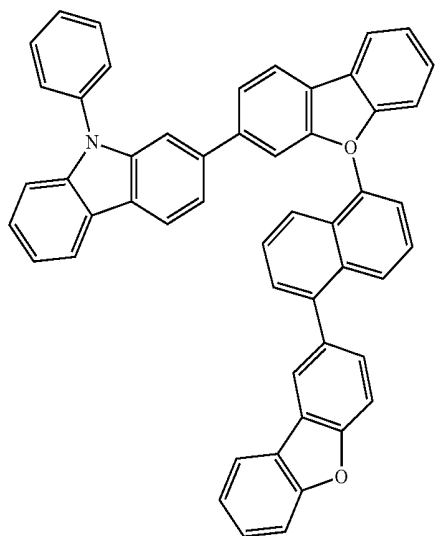
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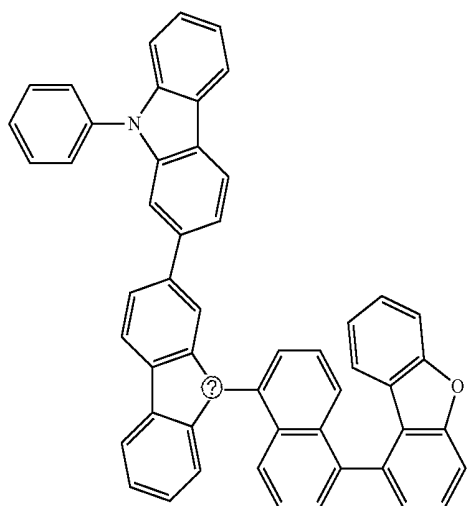
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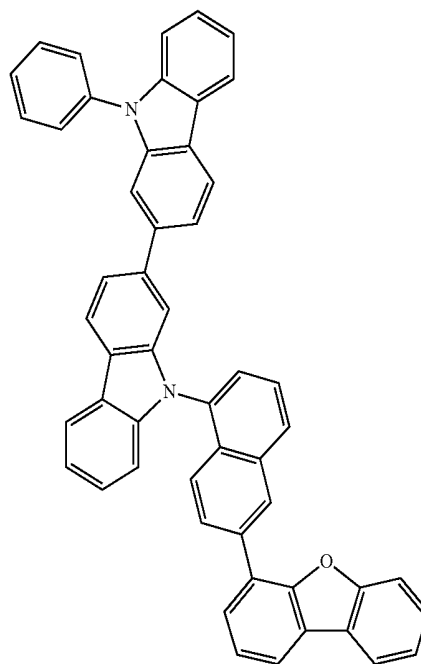


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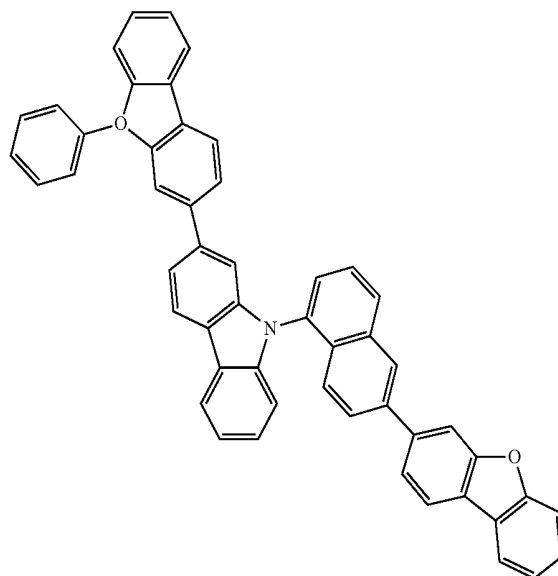


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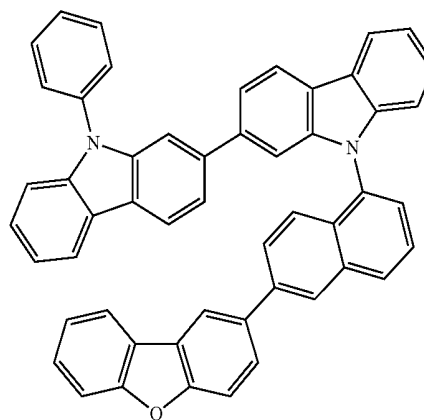
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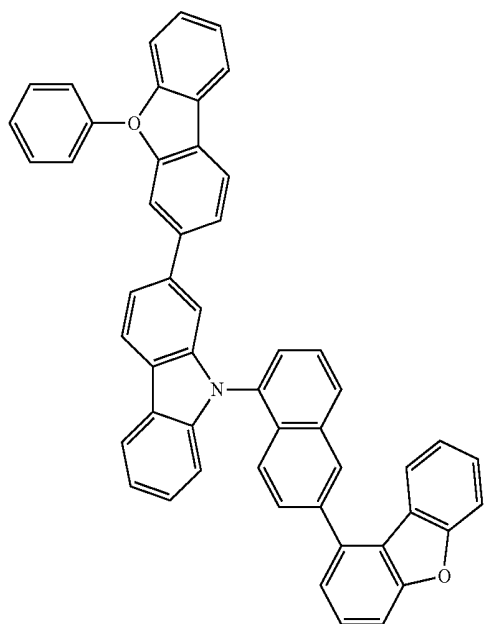


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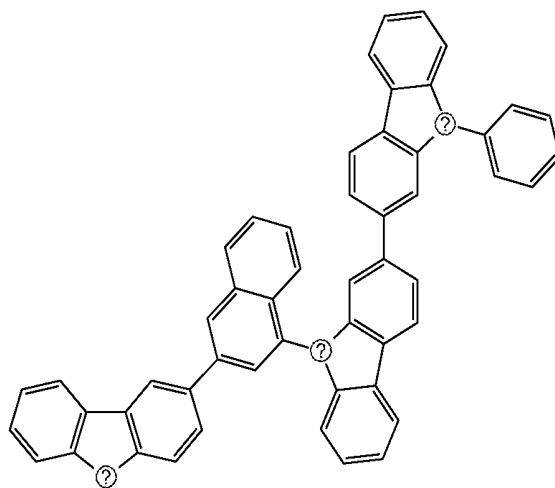
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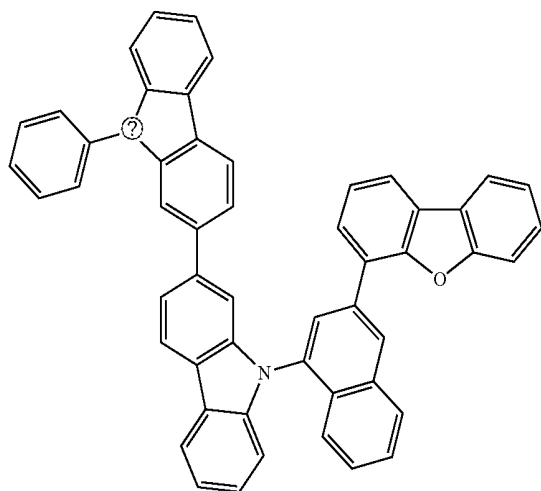


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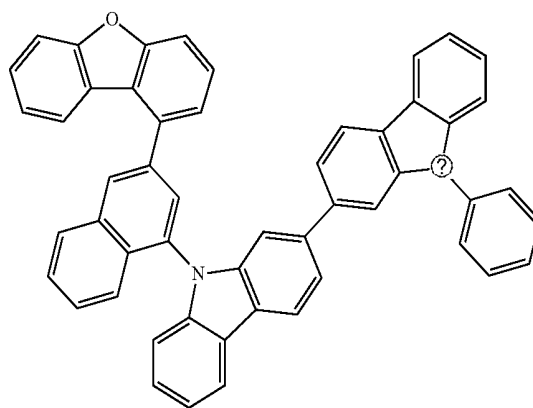
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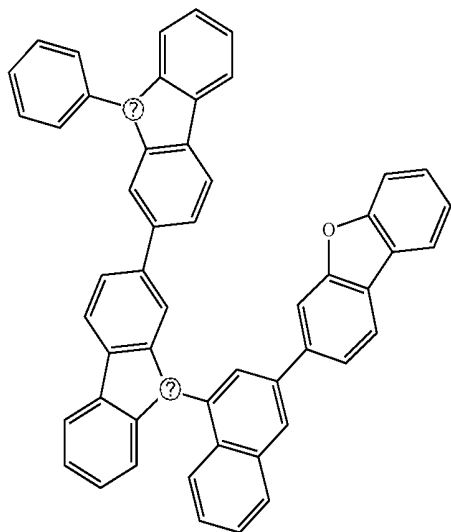
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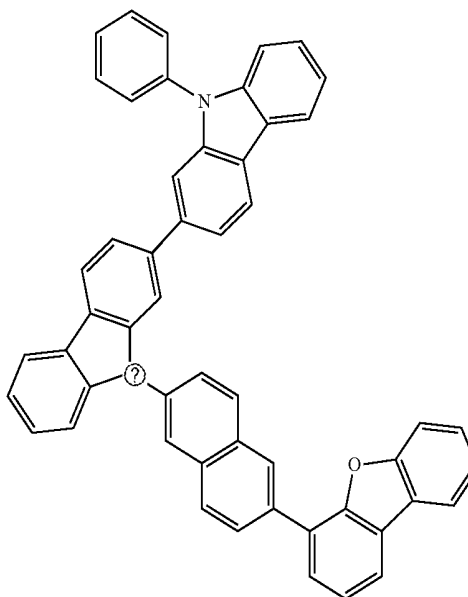
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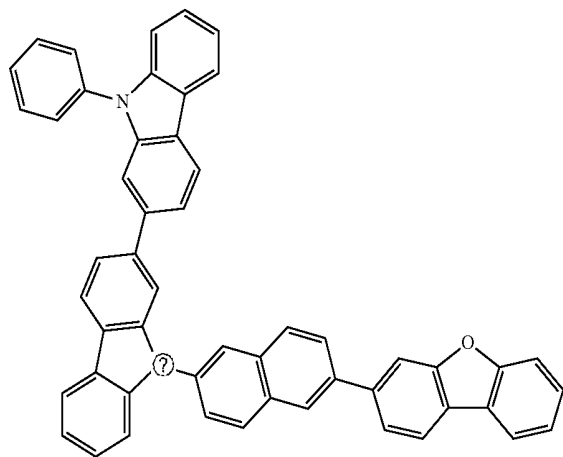


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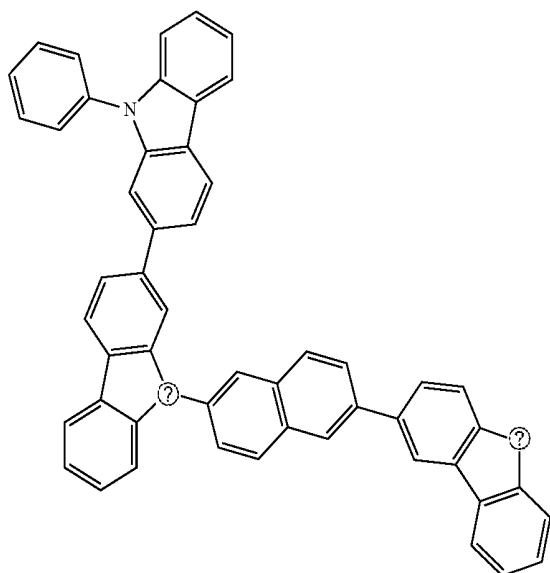


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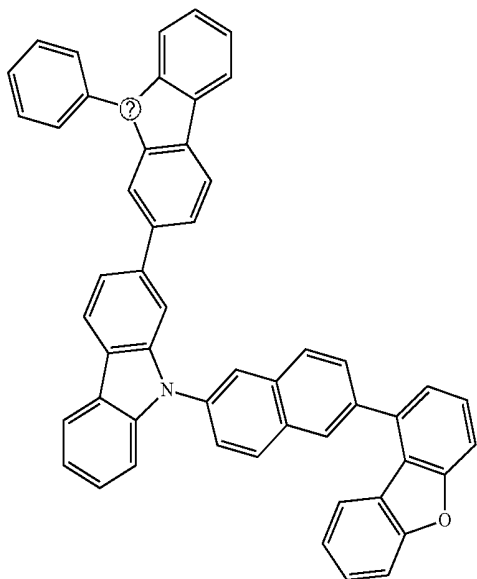
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A-107

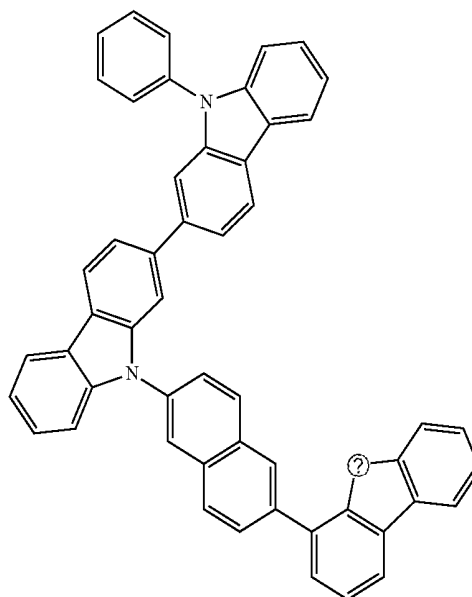


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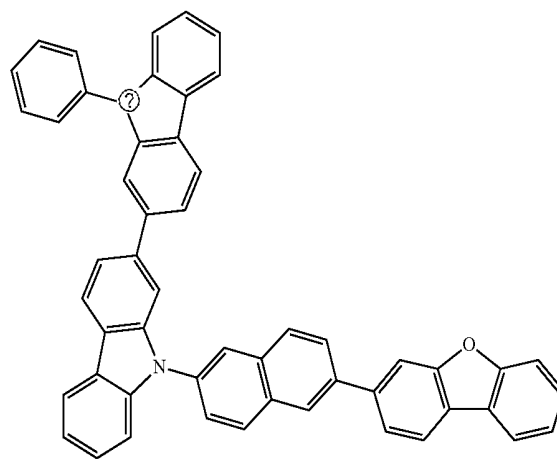


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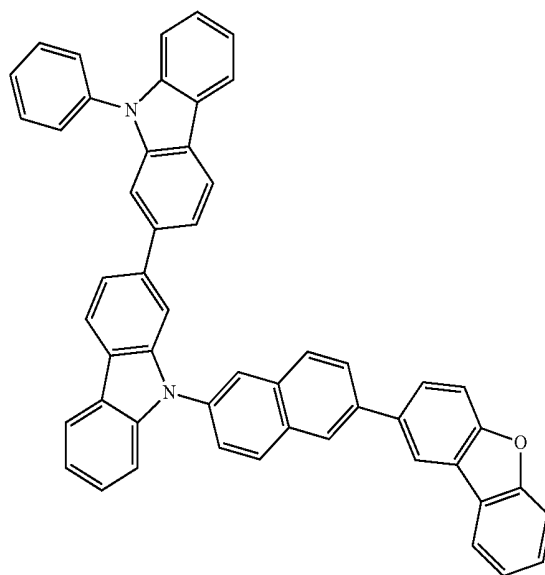
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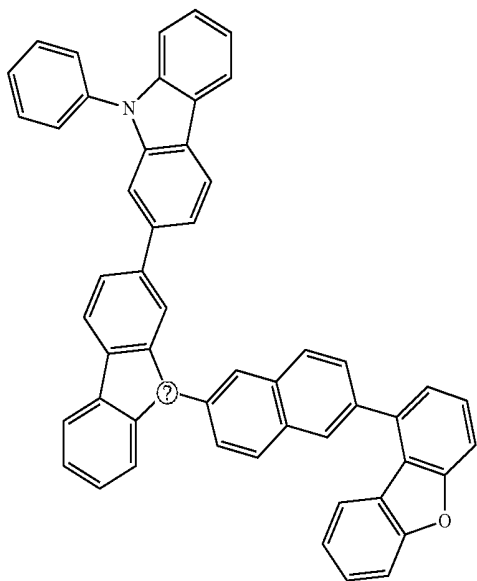


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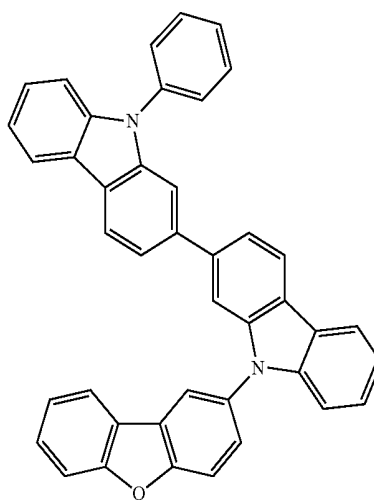
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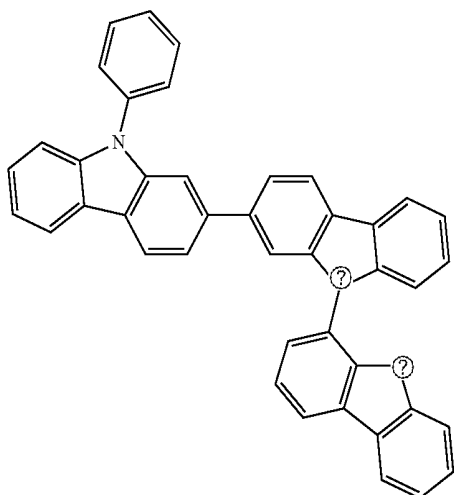


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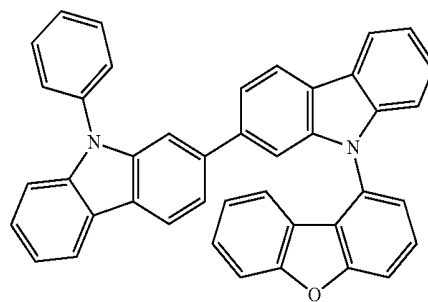
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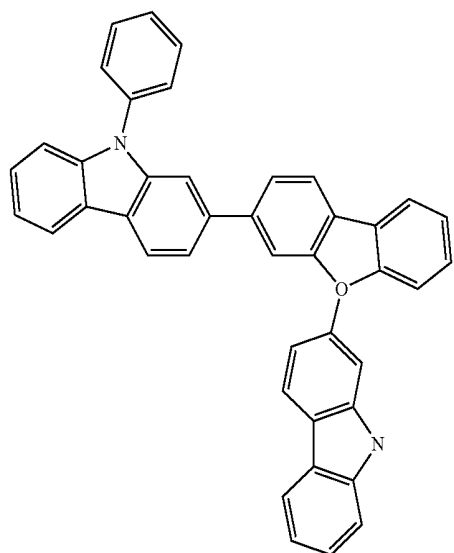
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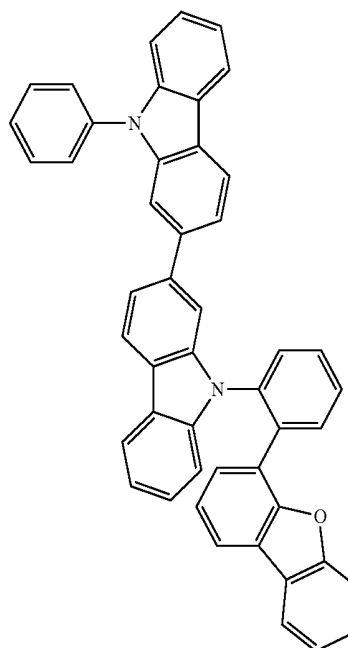
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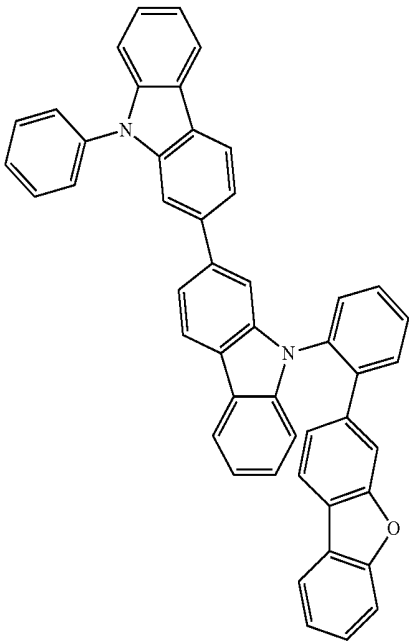
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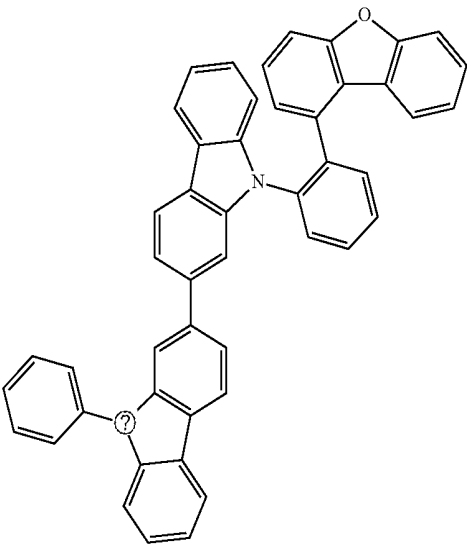


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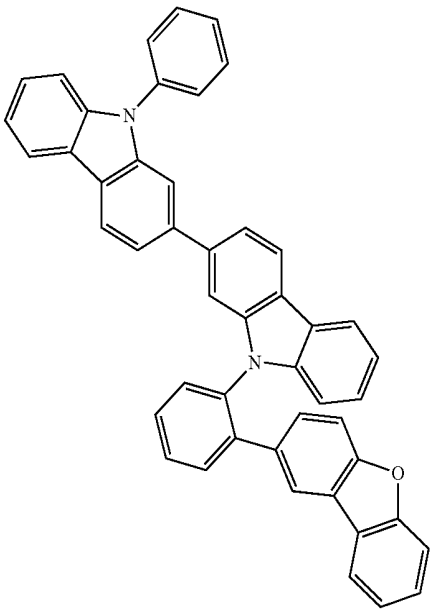


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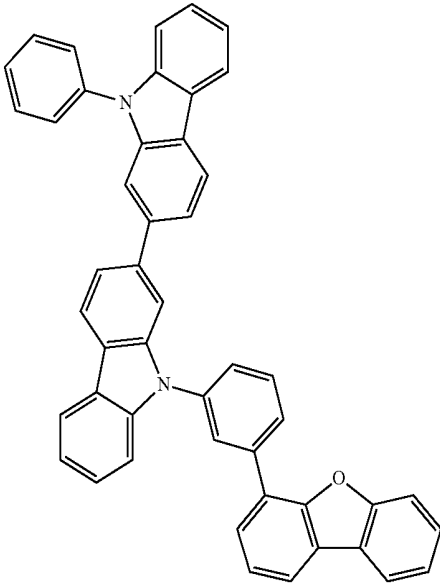
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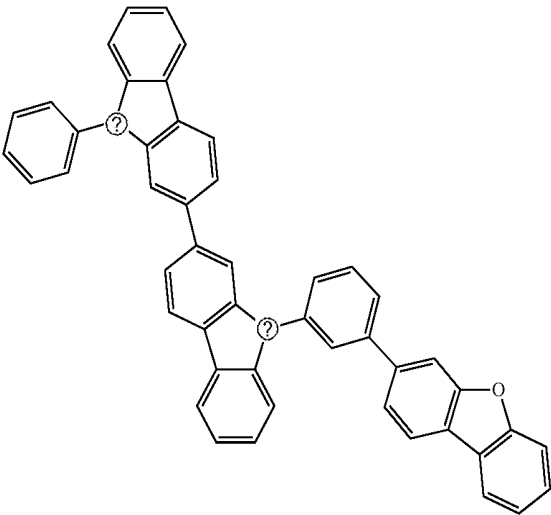
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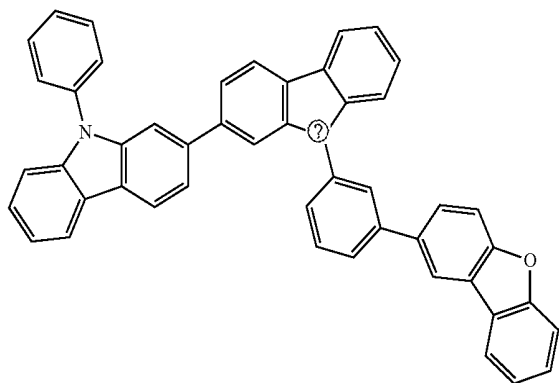
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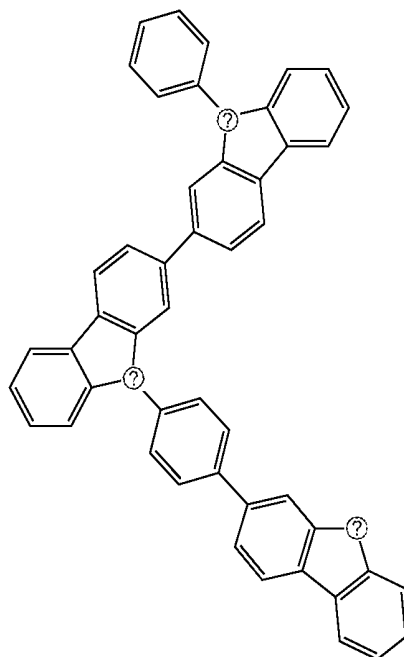
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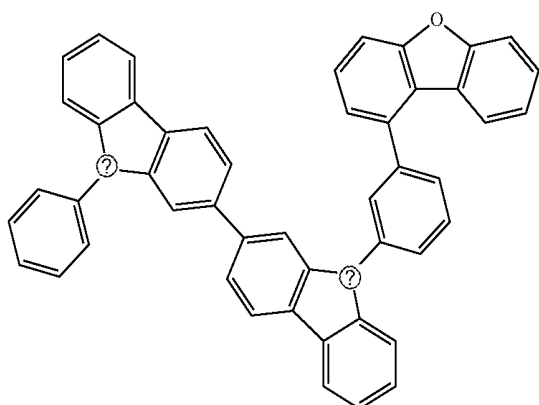


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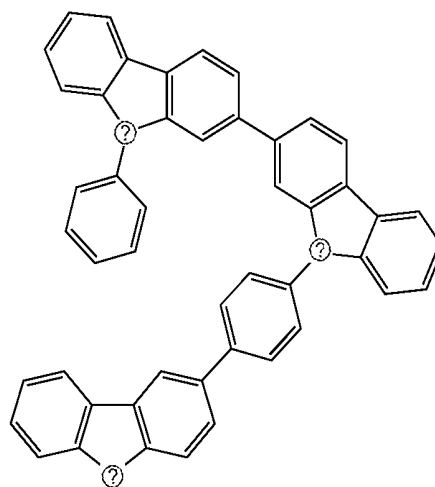
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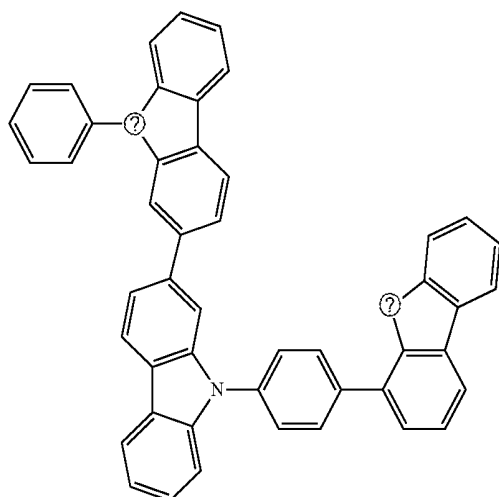
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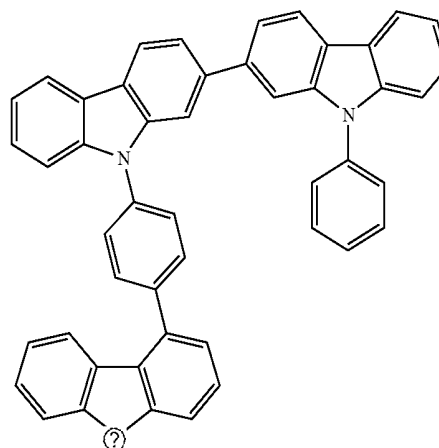
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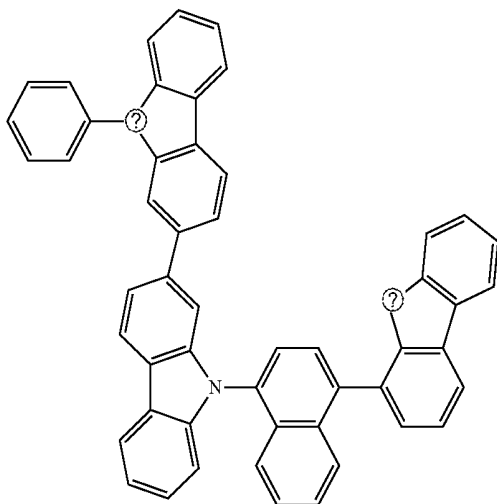


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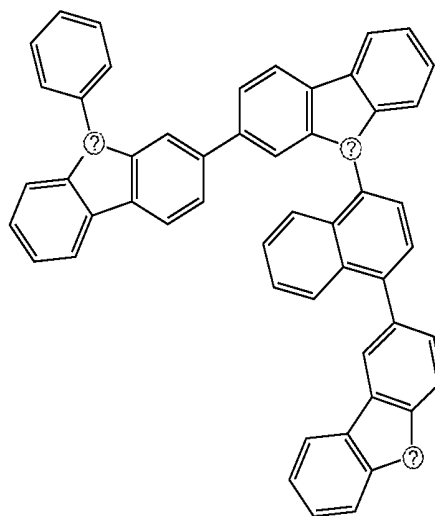
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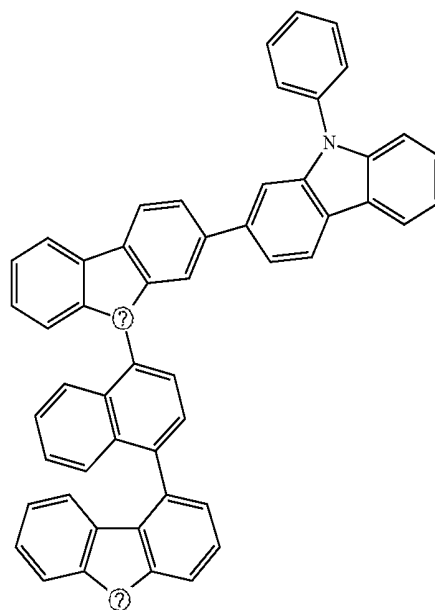


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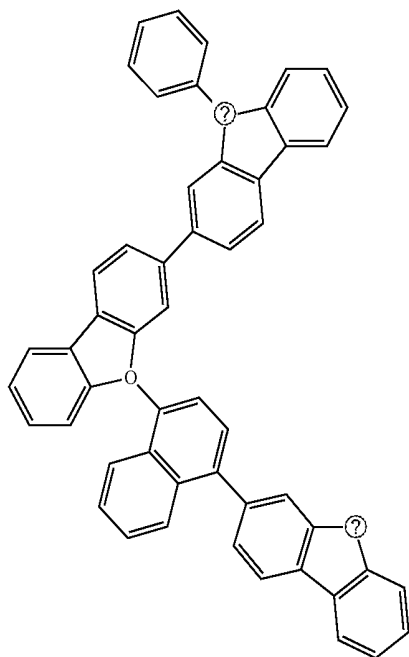
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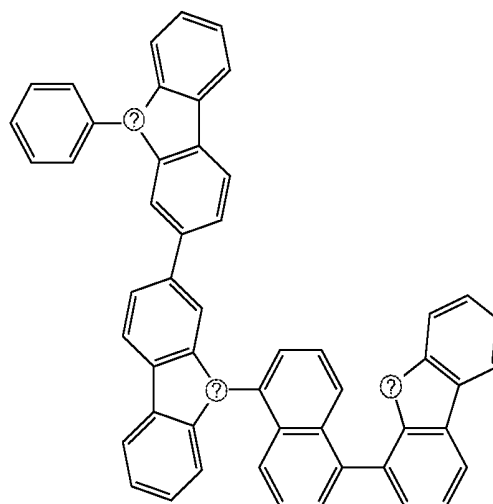
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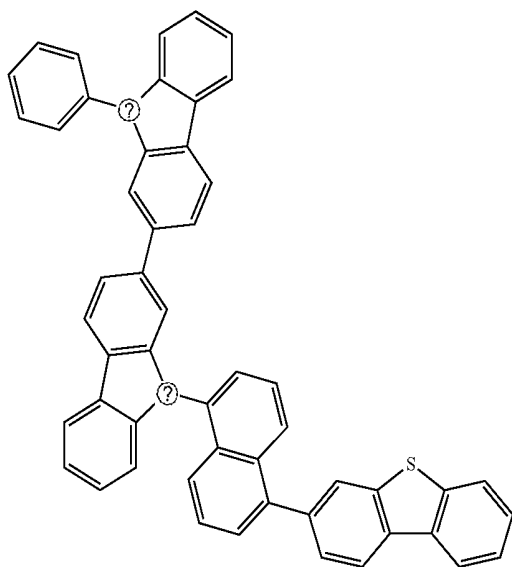


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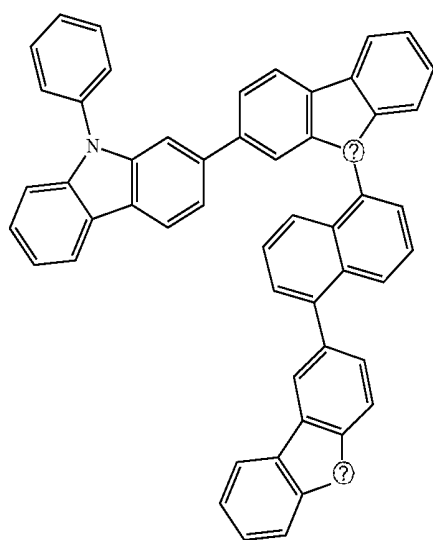


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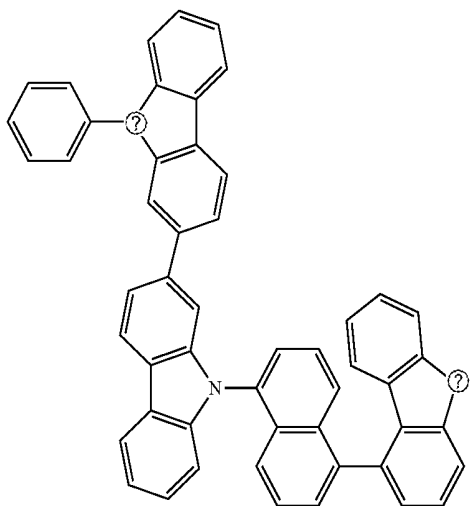
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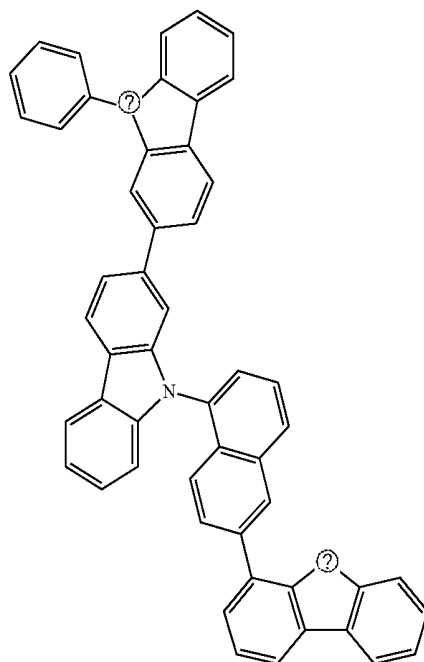


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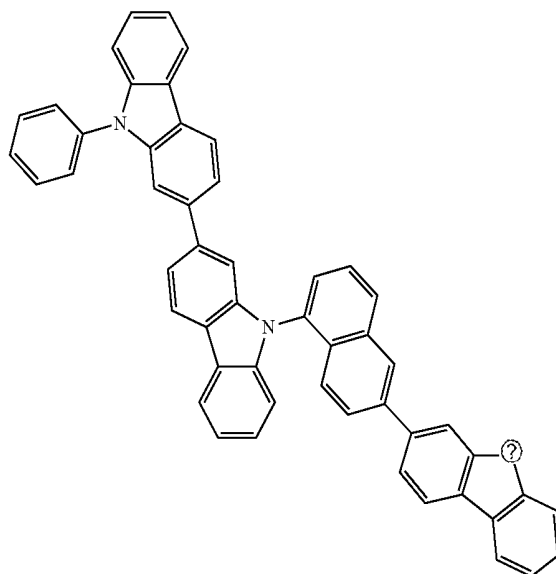


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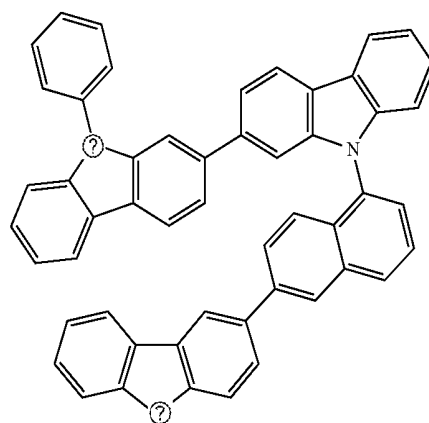
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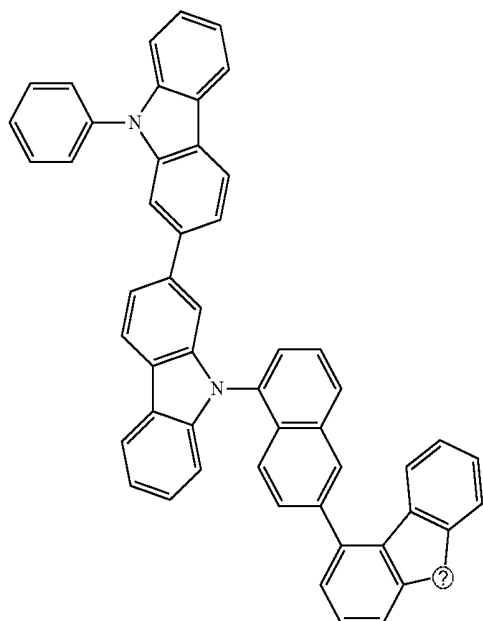


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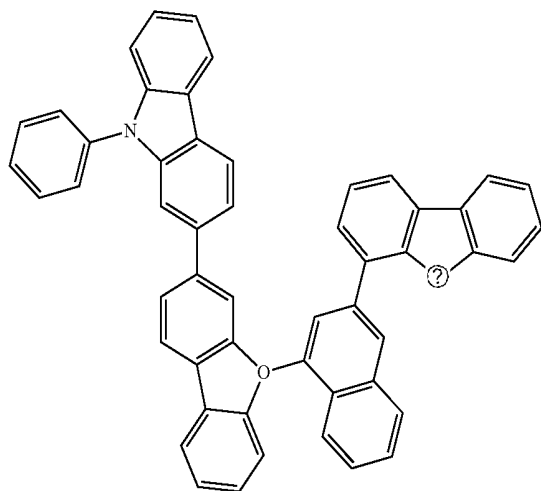


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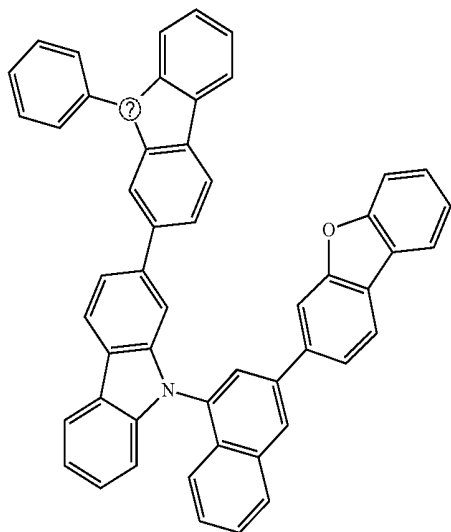
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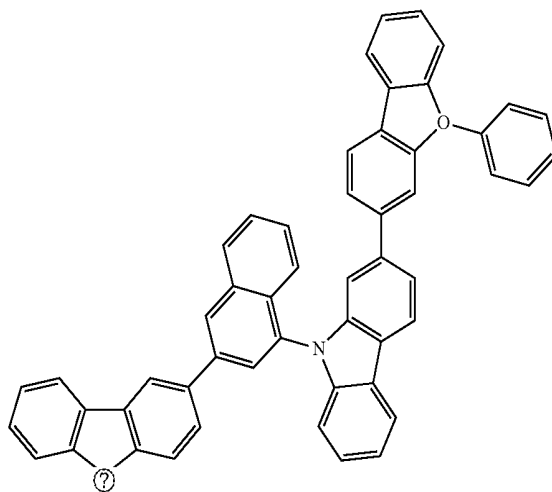


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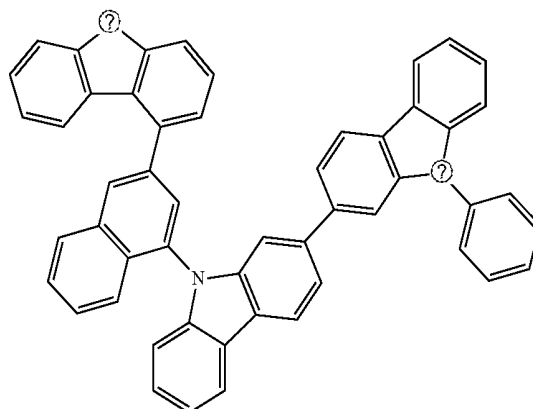


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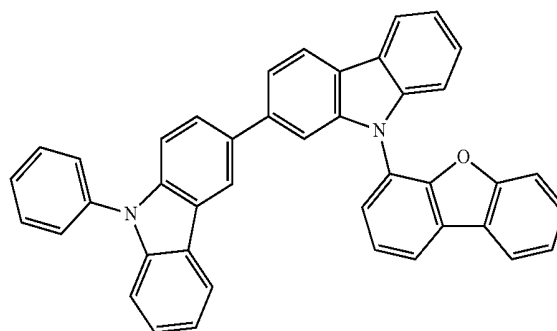
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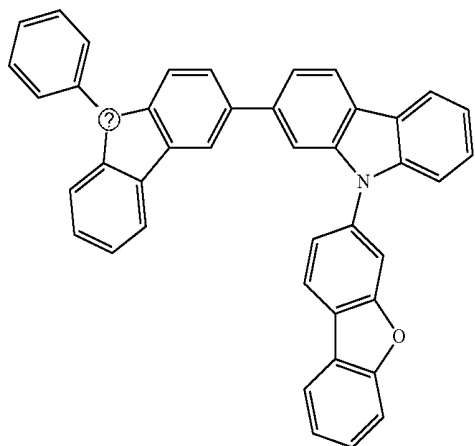
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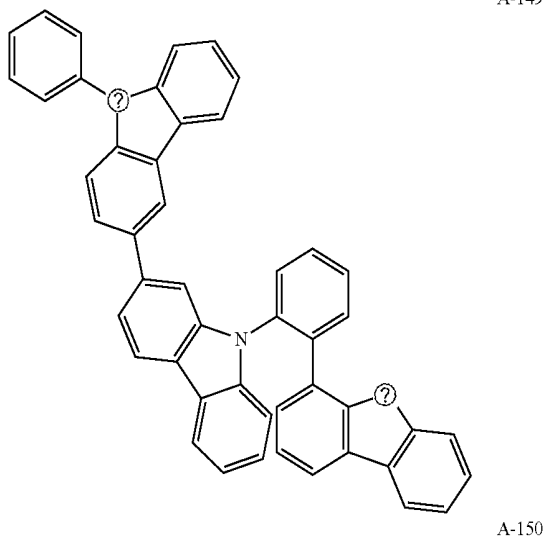
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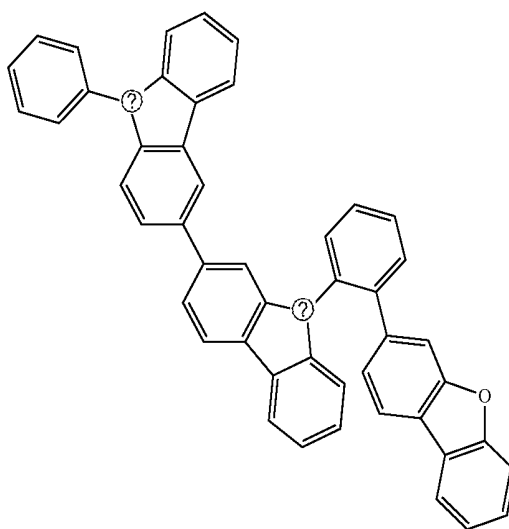
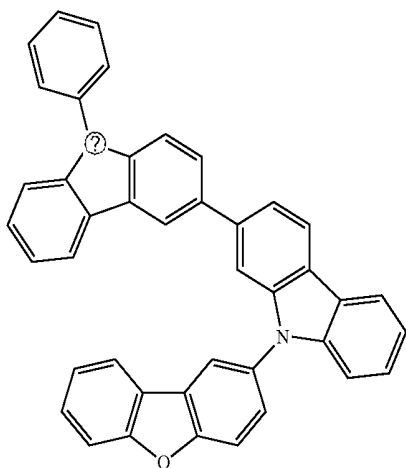


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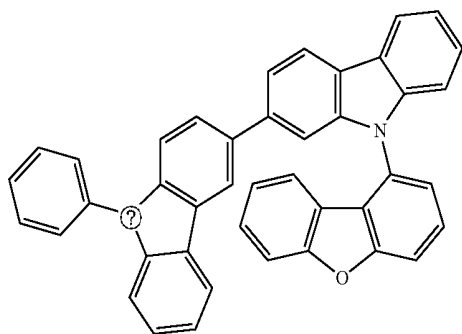


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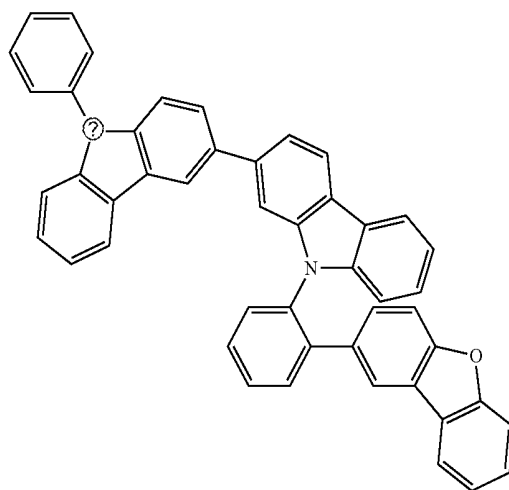
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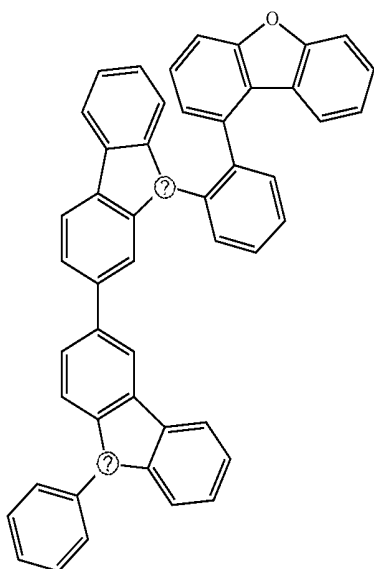
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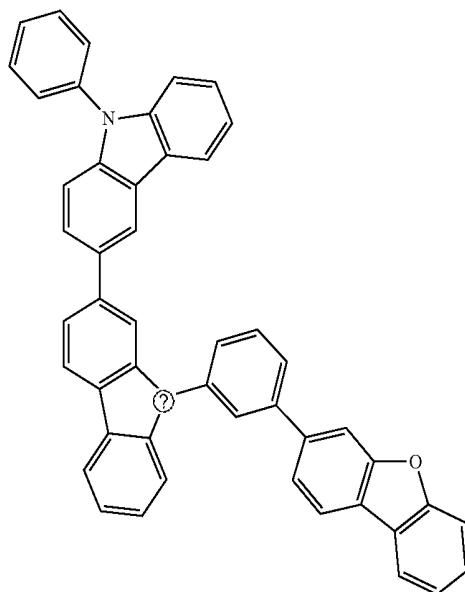


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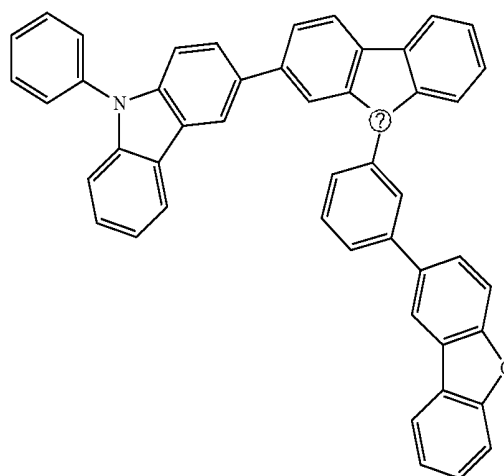
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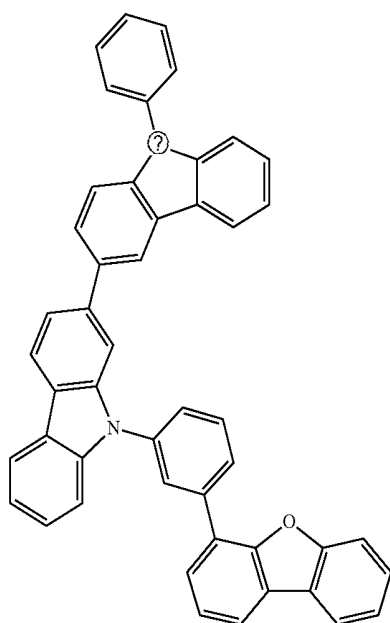


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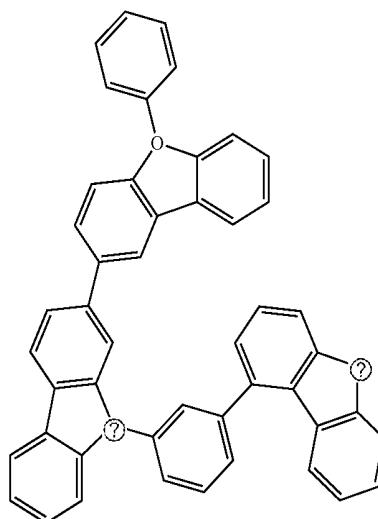
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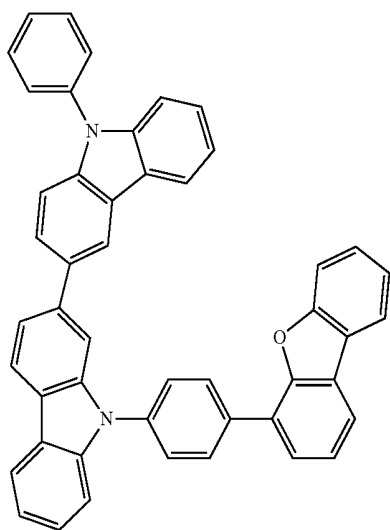
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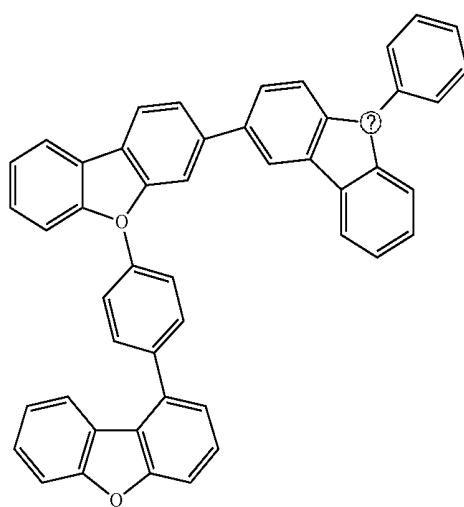


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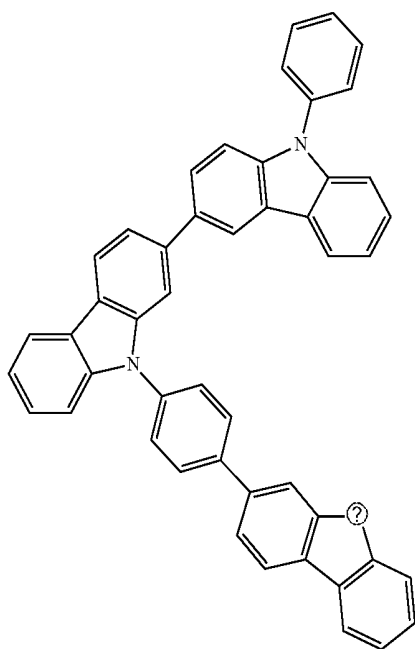


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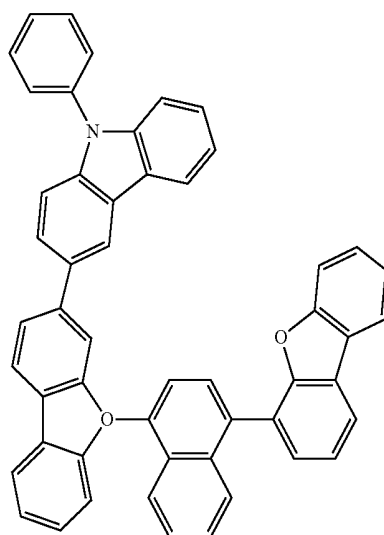
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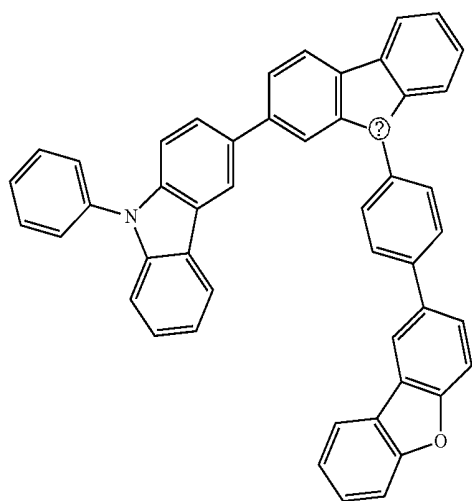
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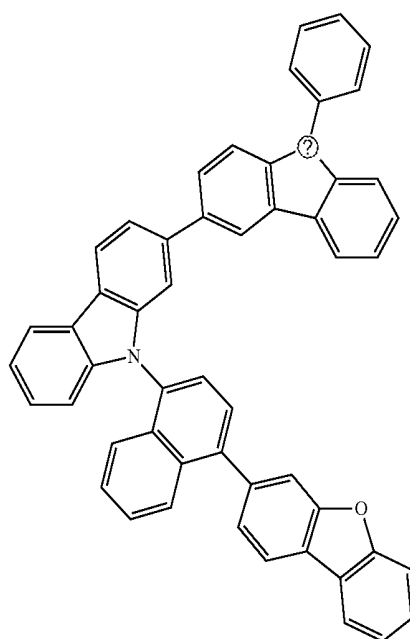
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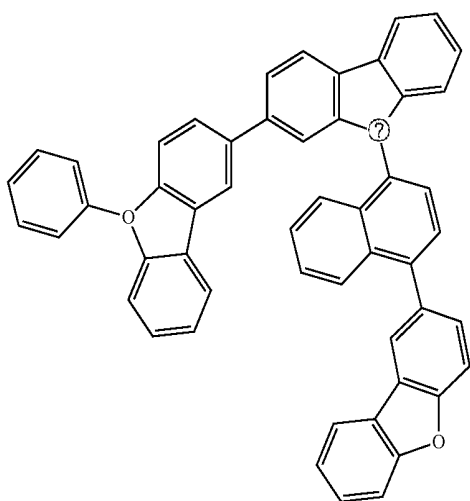


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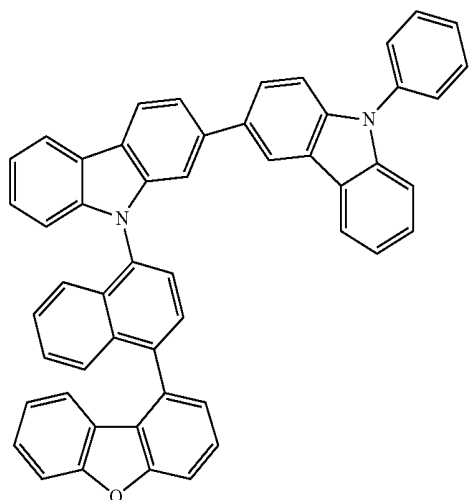


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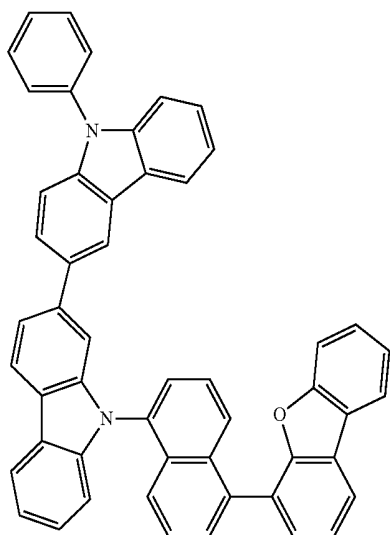
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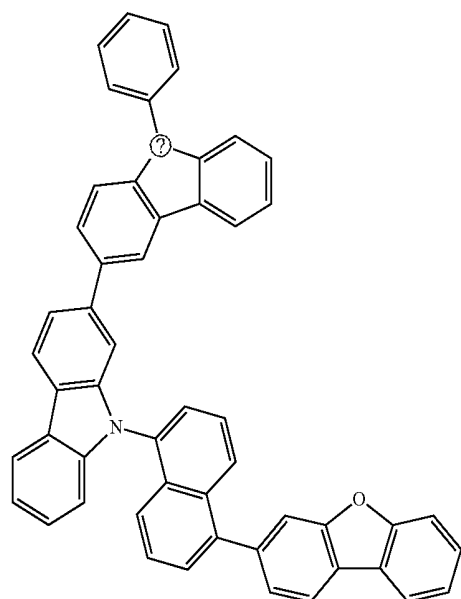
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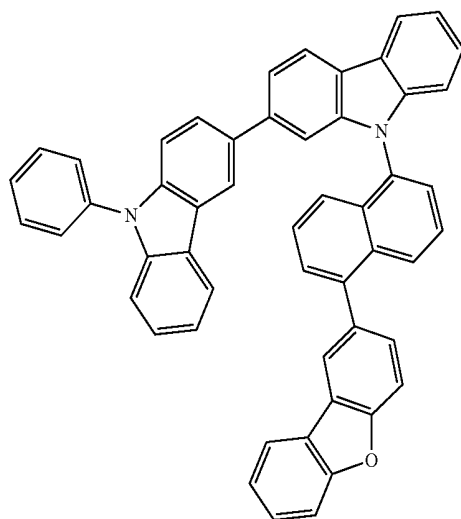


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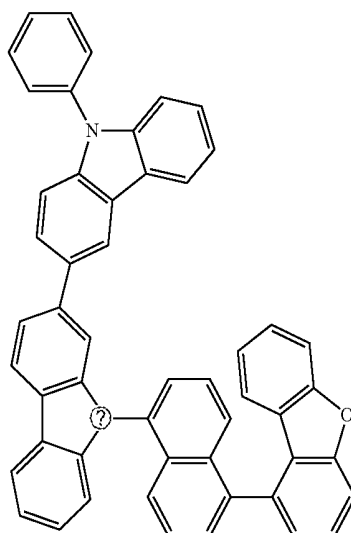


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A-167

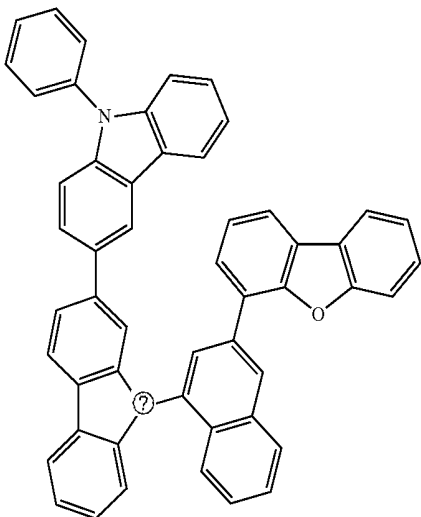
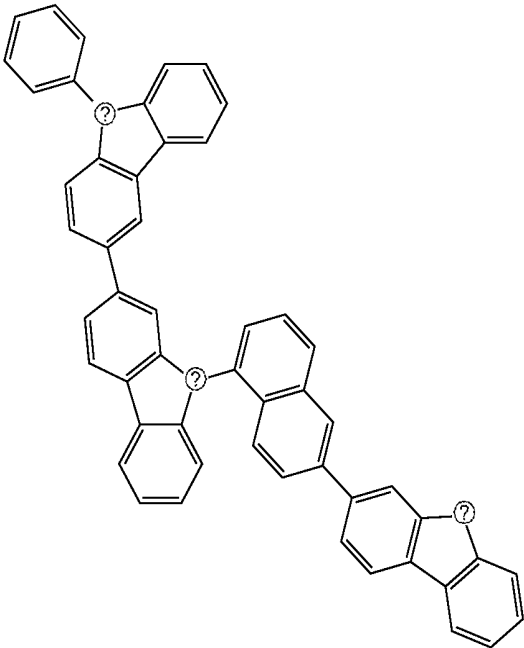
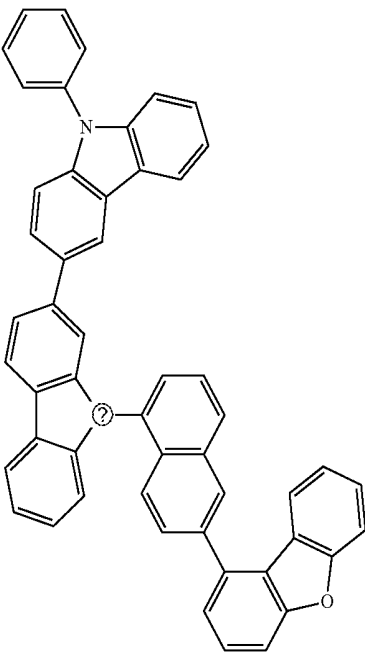
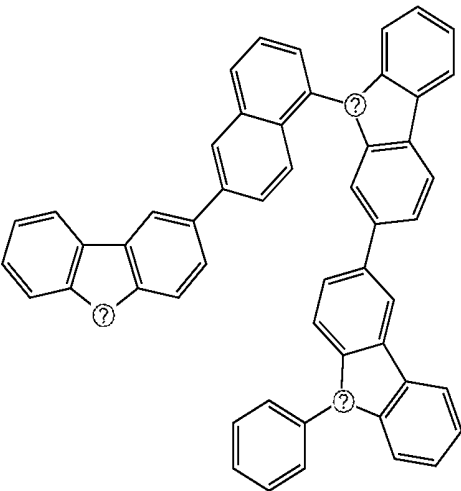
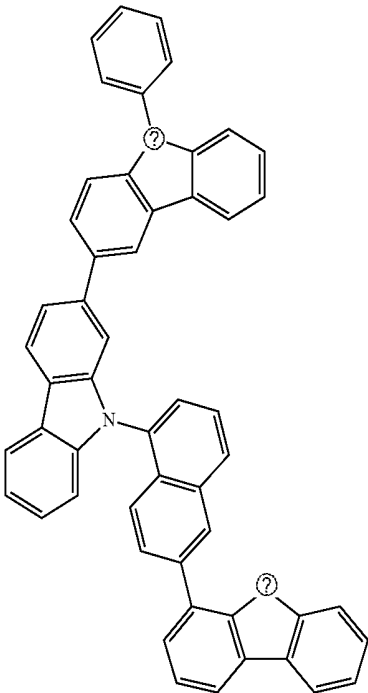


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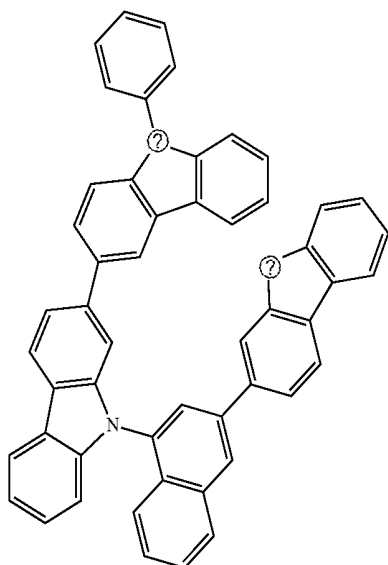
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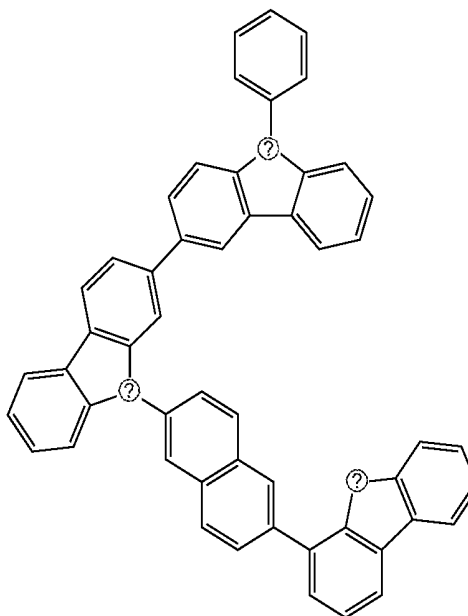
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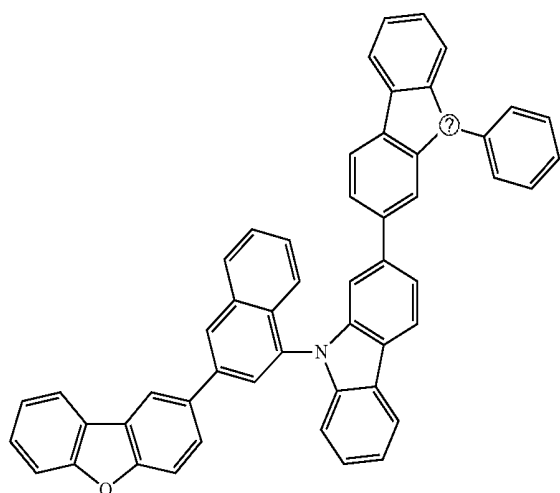


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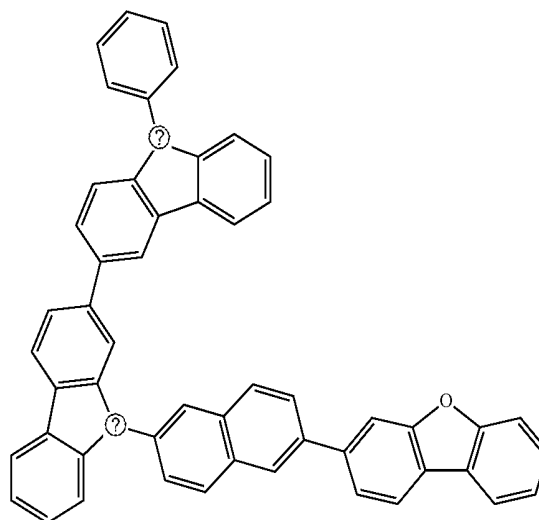
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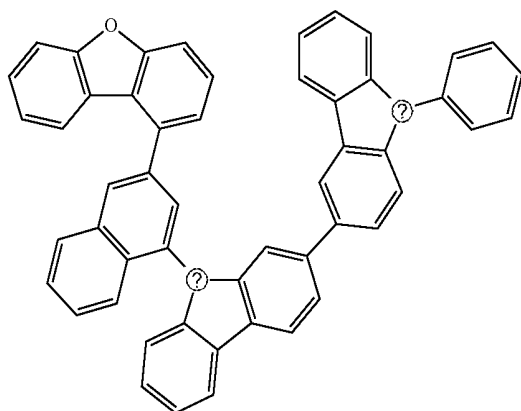
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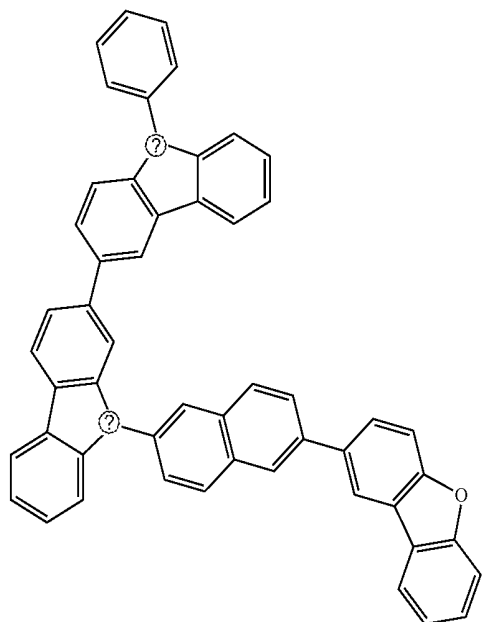


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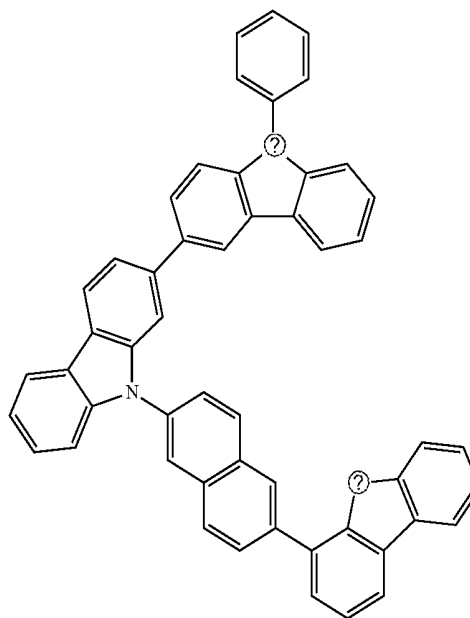
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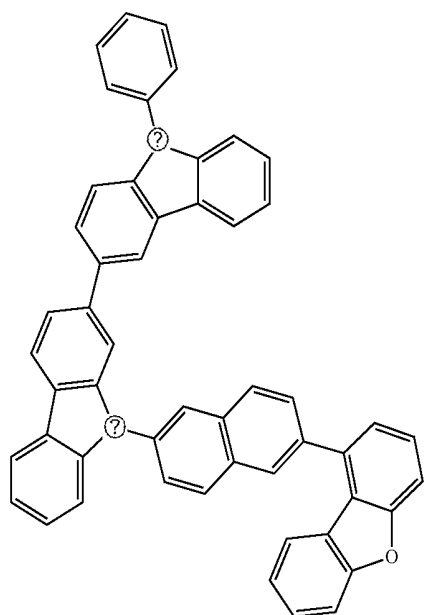


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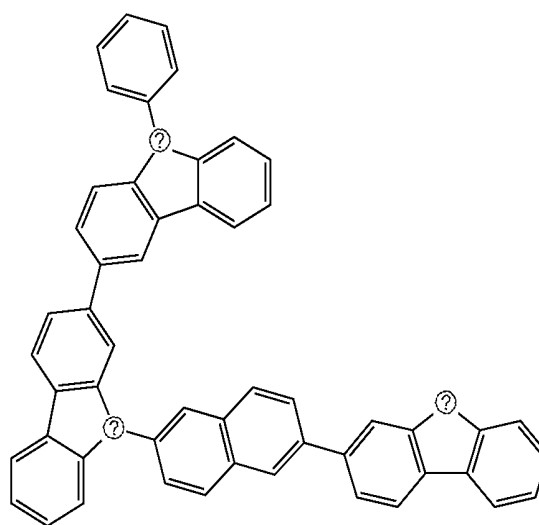
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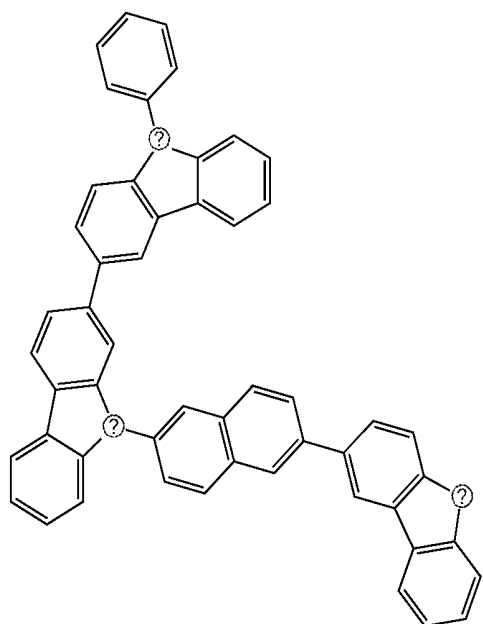
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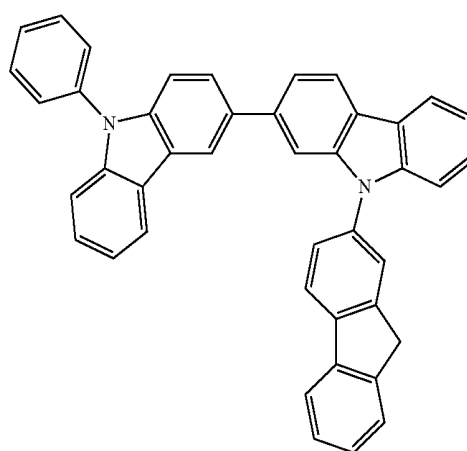
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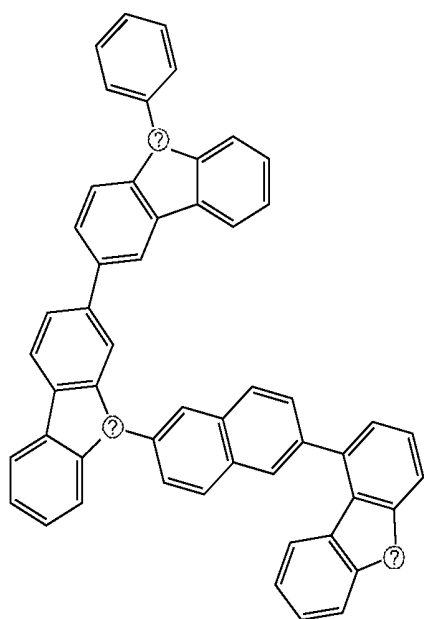
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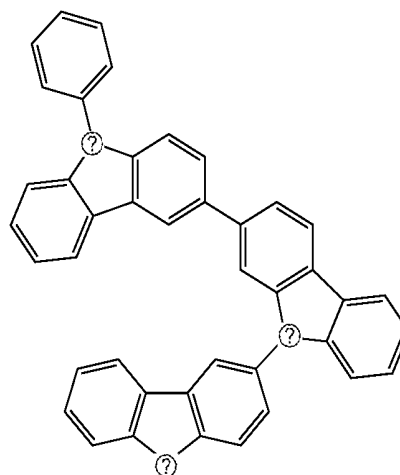
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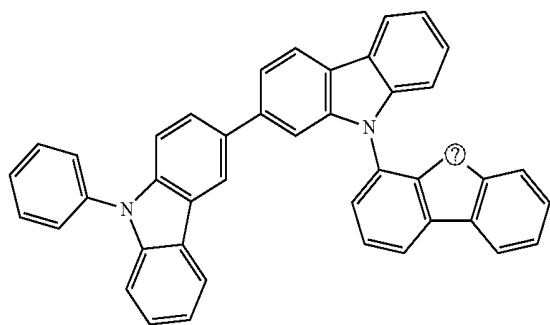
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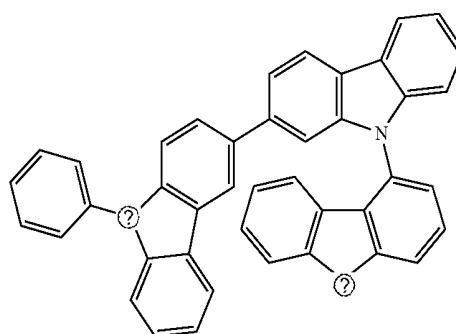
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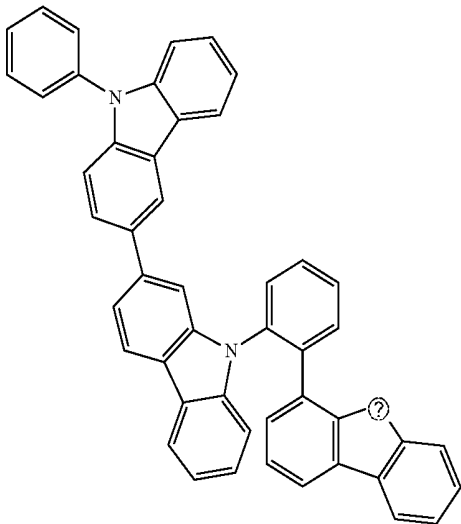


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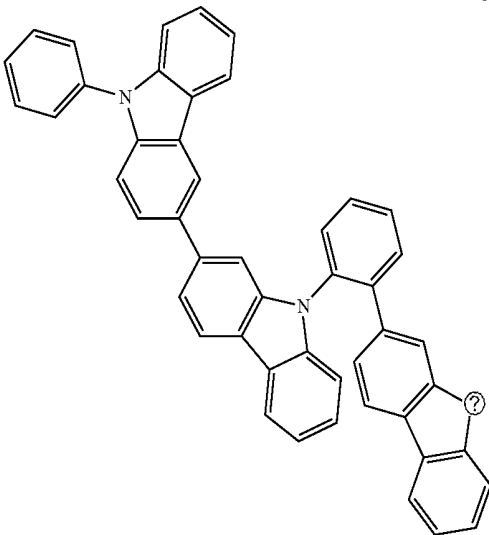


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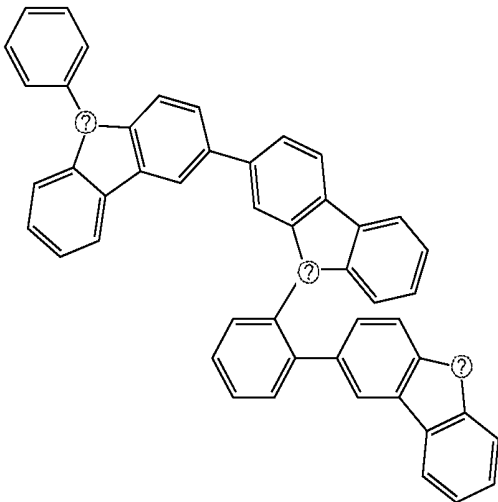
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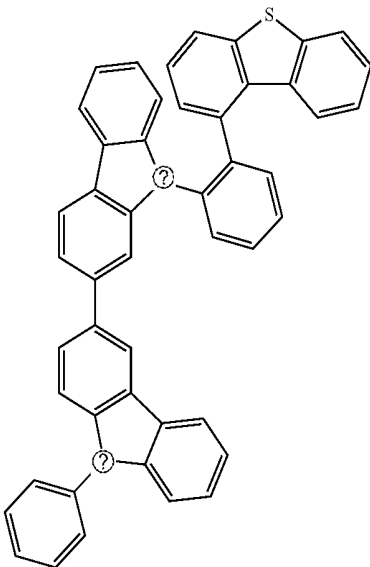


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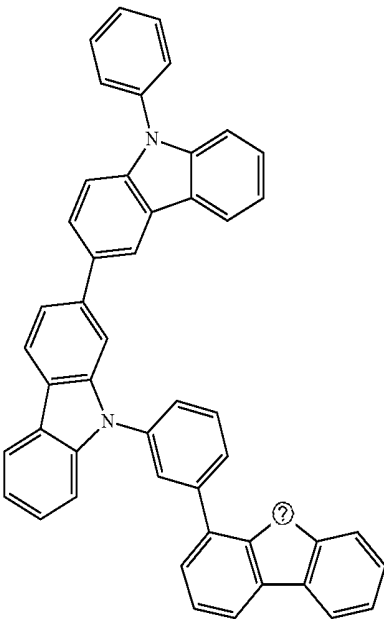


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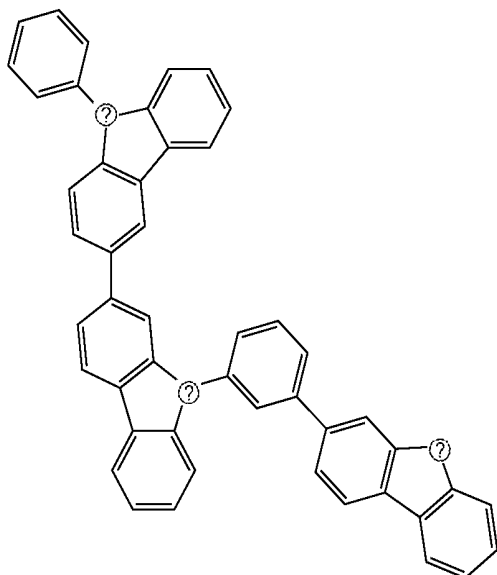


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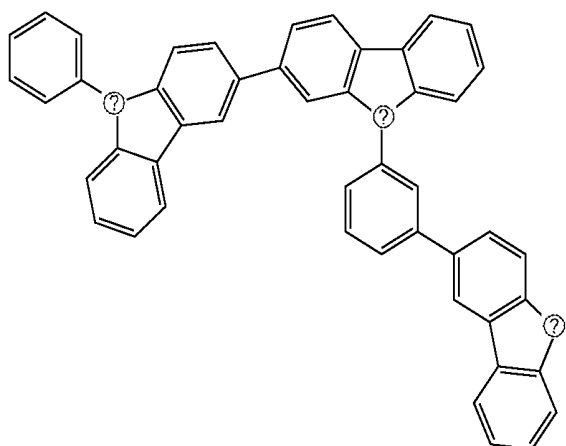


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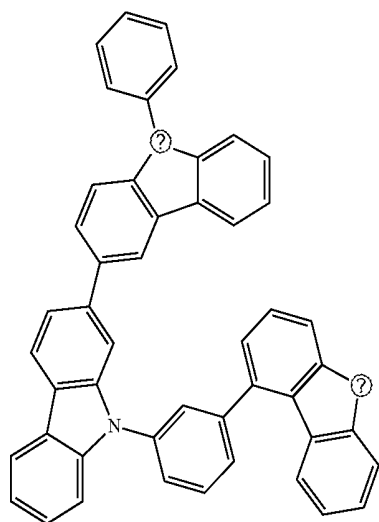
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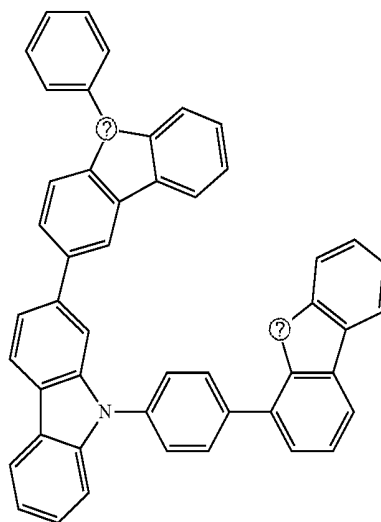


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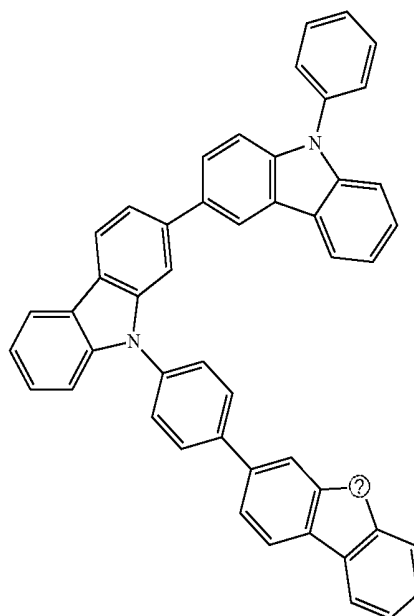


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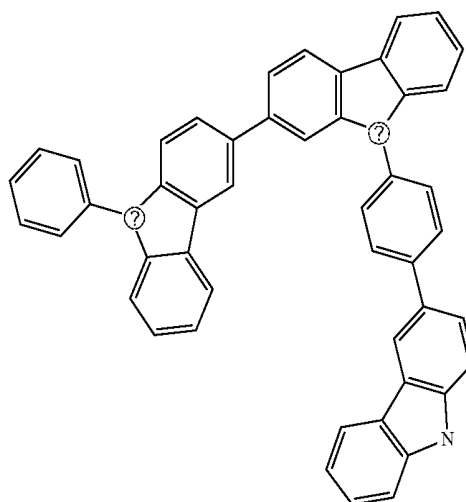
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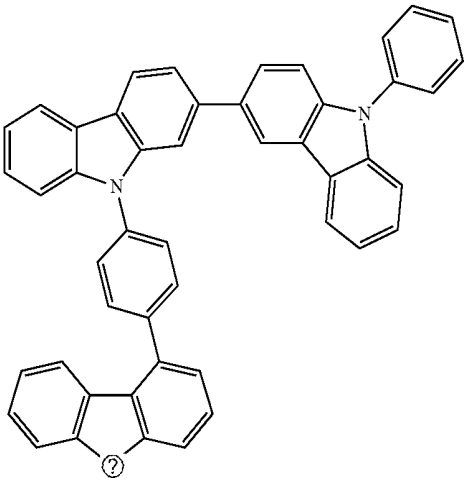
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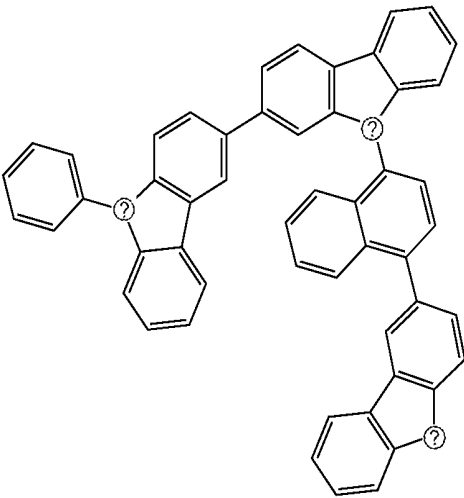
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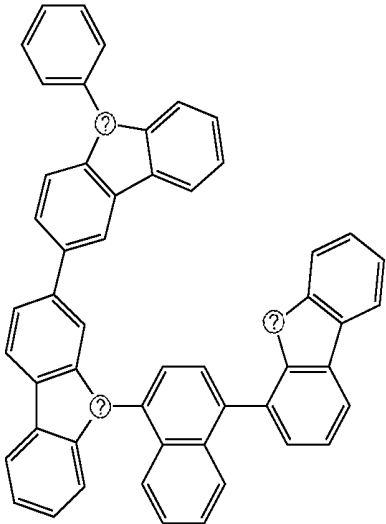
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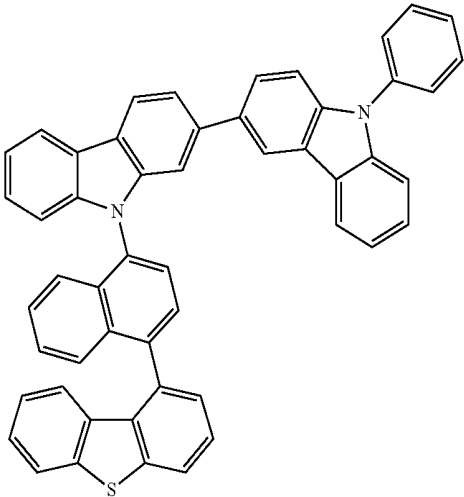
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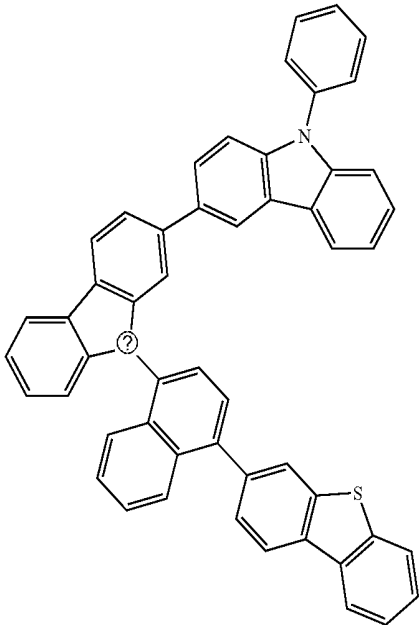
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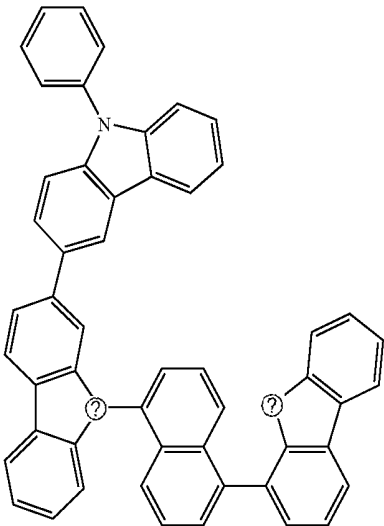
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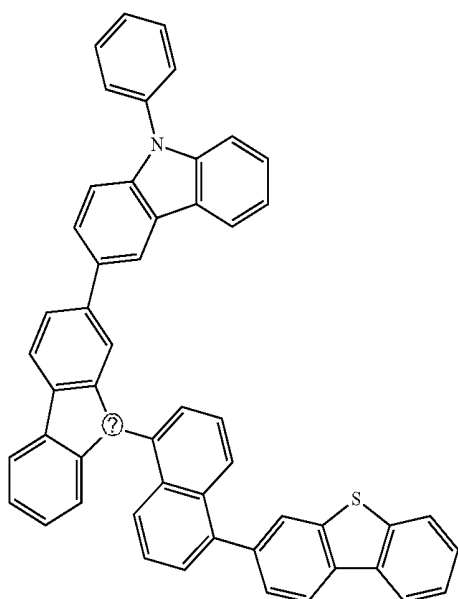


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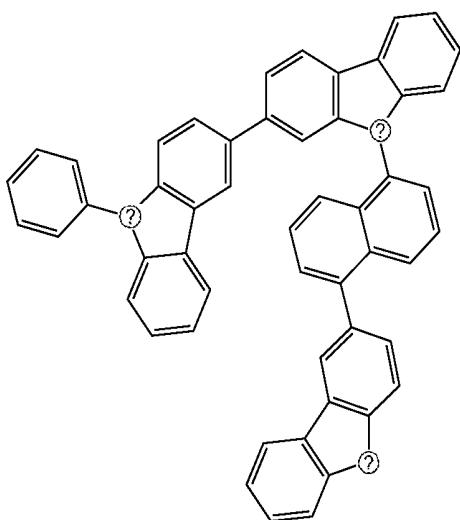


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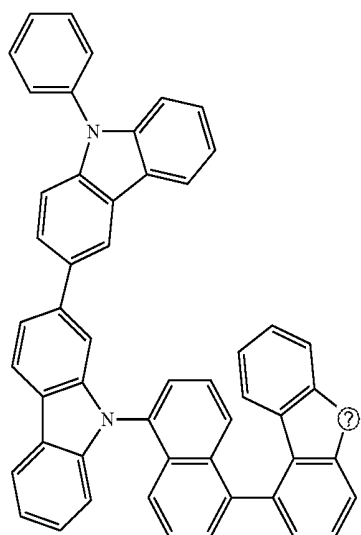
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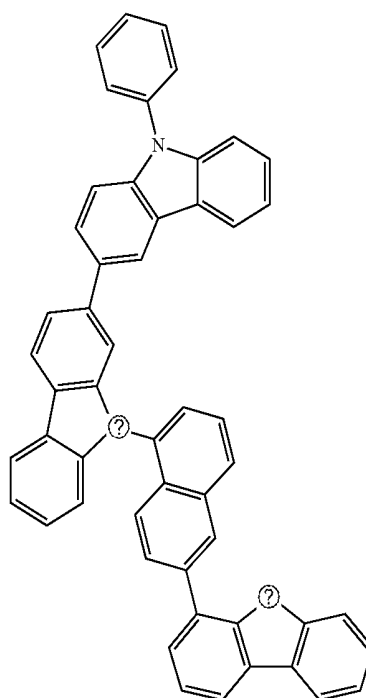


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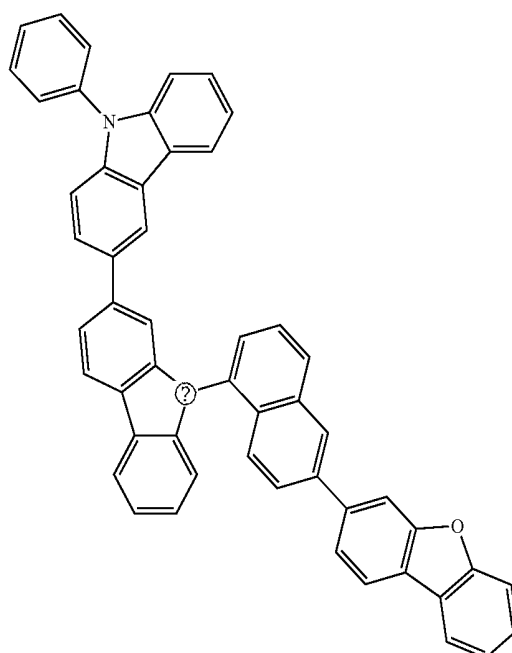


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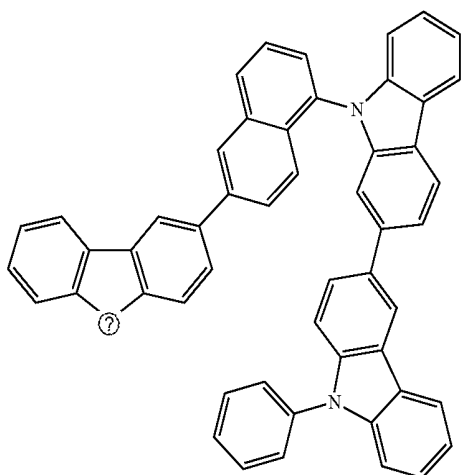
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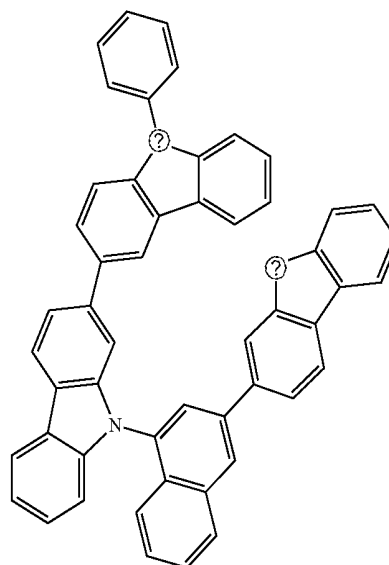


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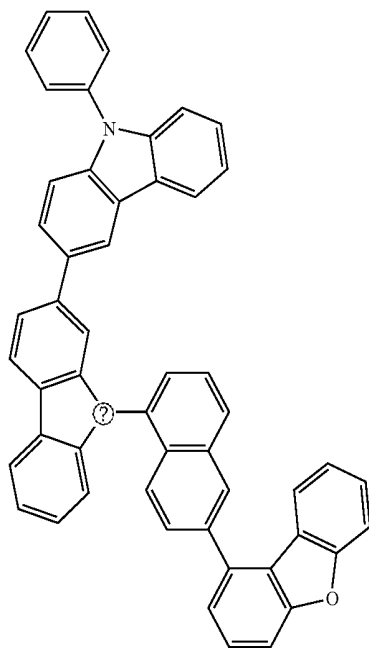


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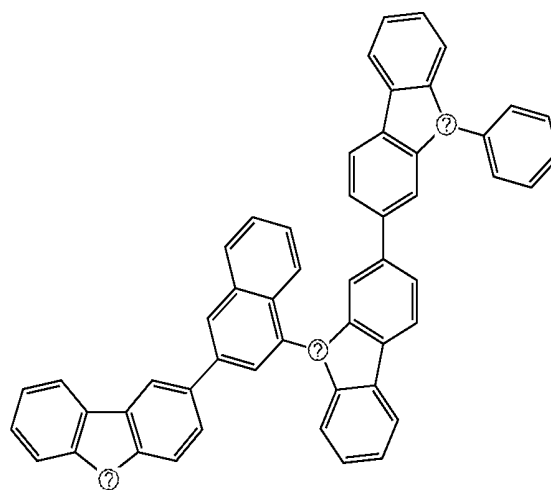
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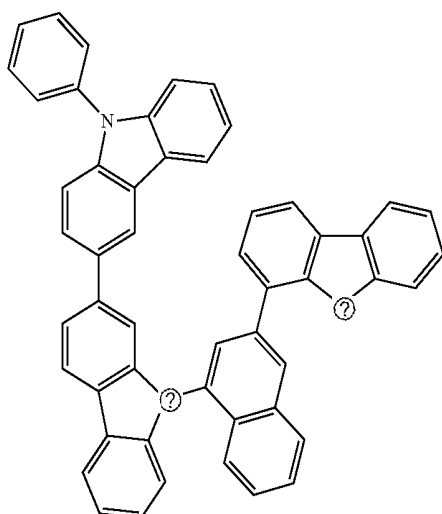
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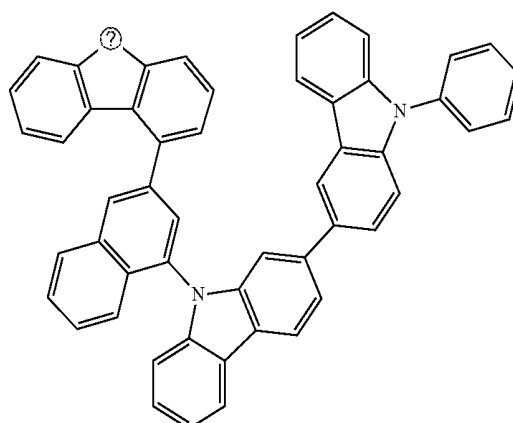
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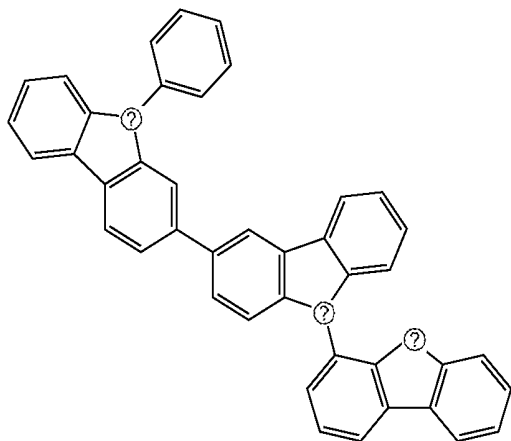
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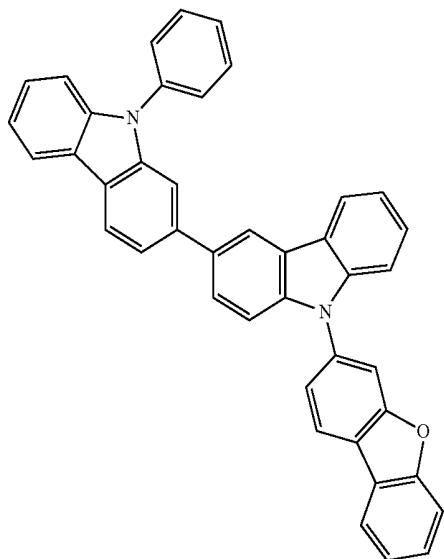
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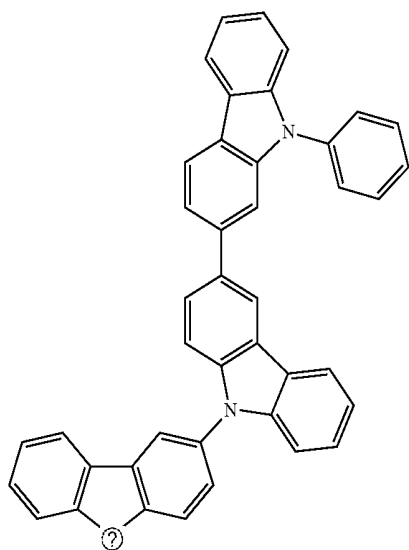
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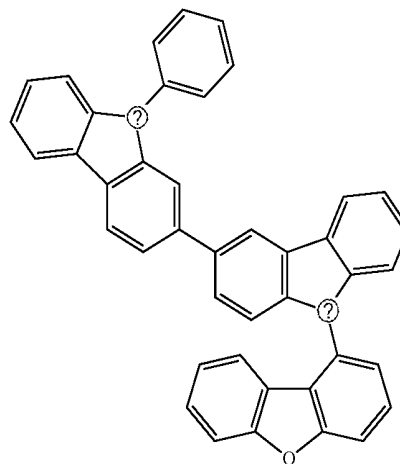


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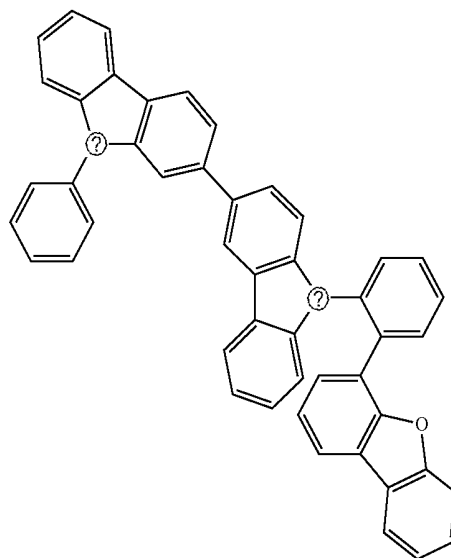


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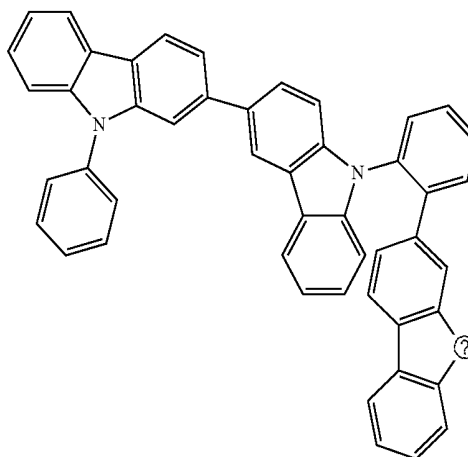
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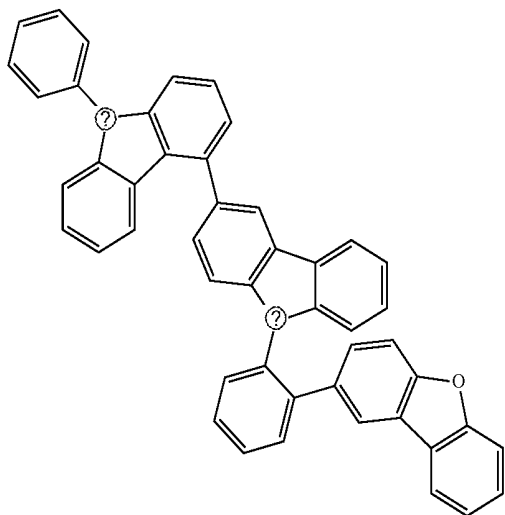


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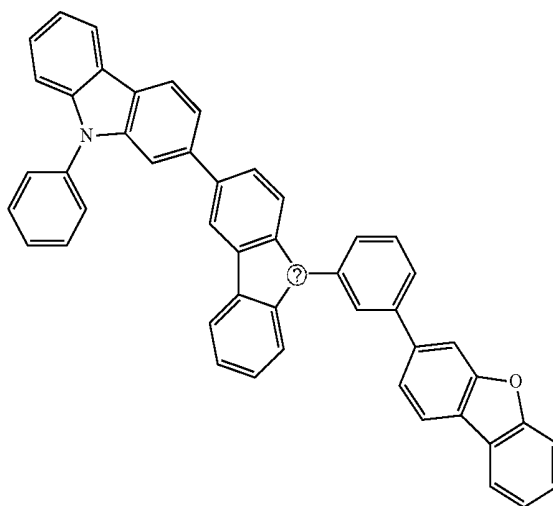
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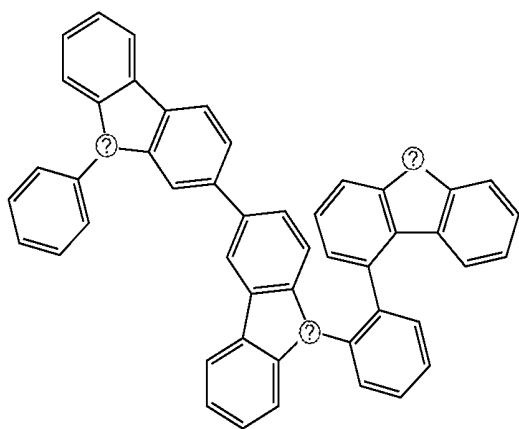
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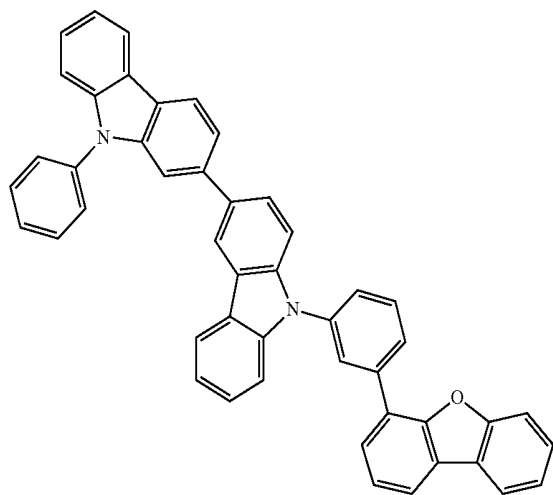


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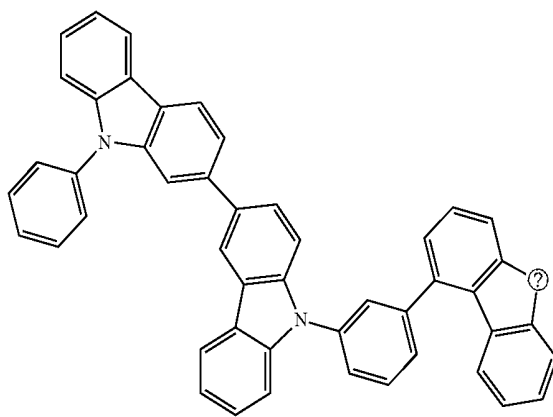
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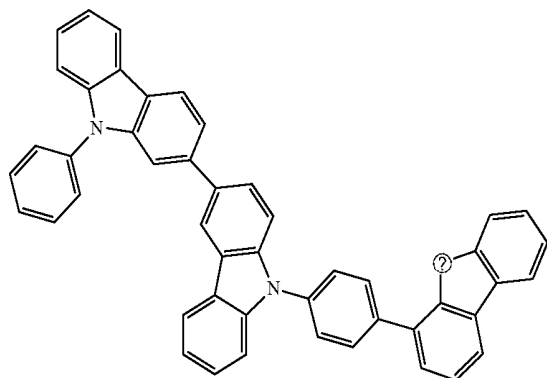


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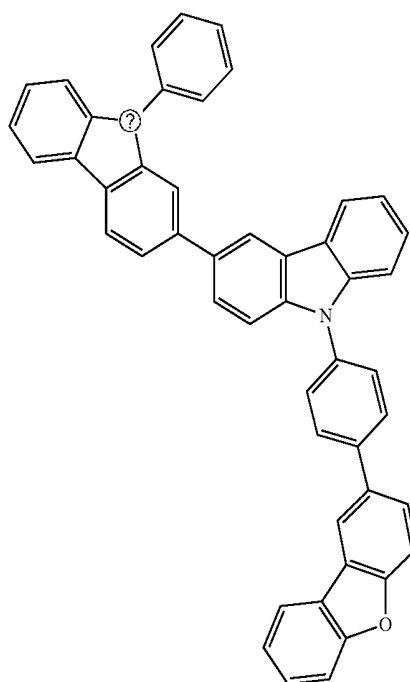
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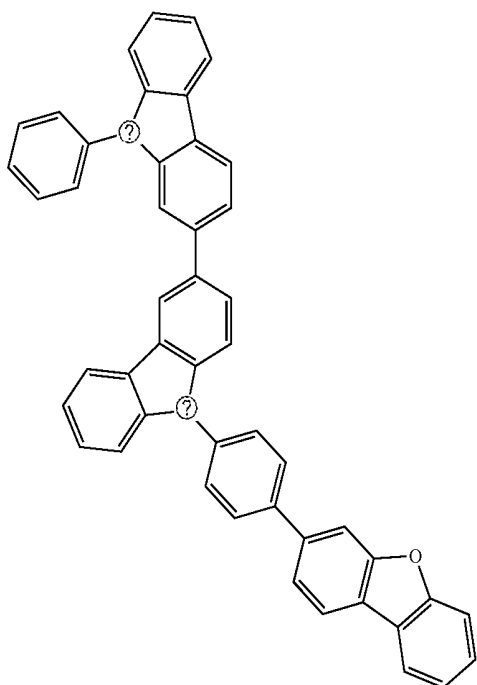


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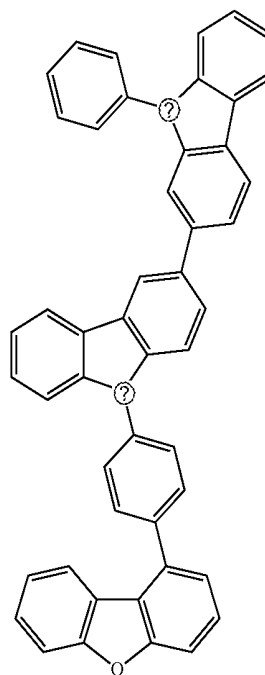
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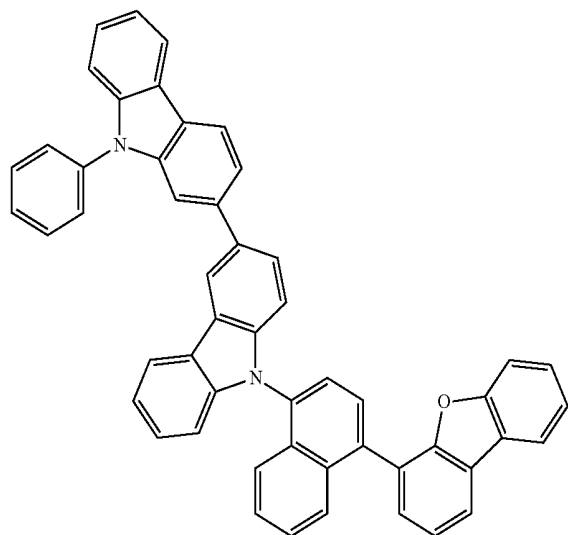


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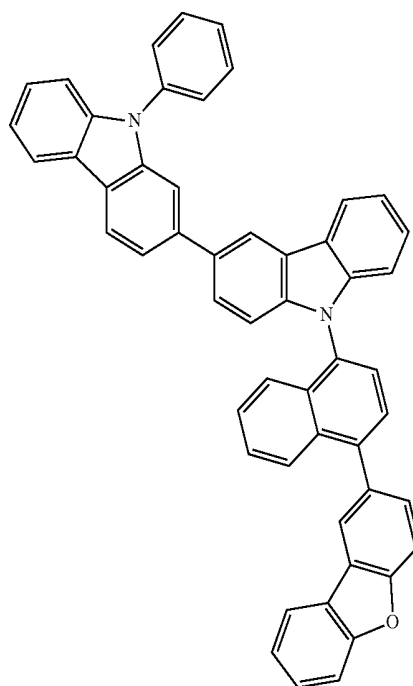
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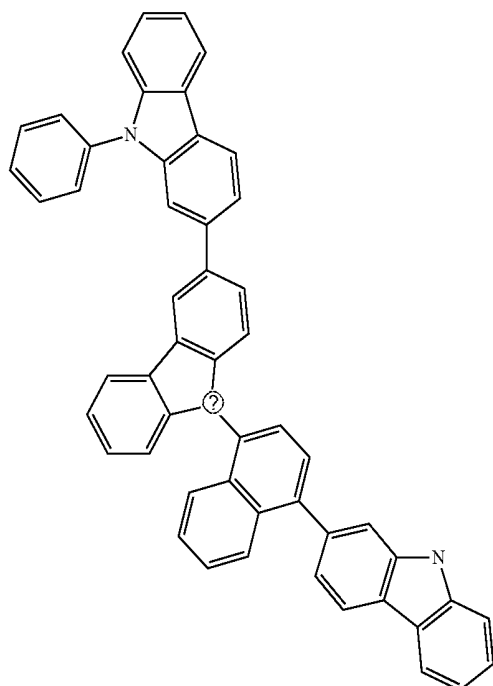


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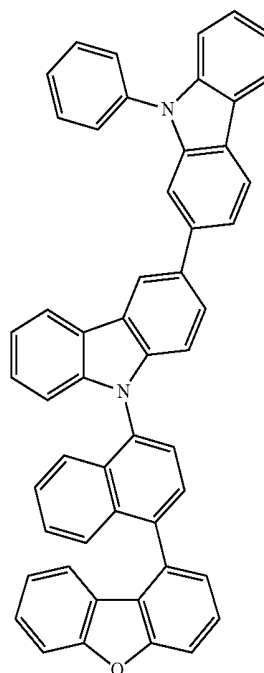
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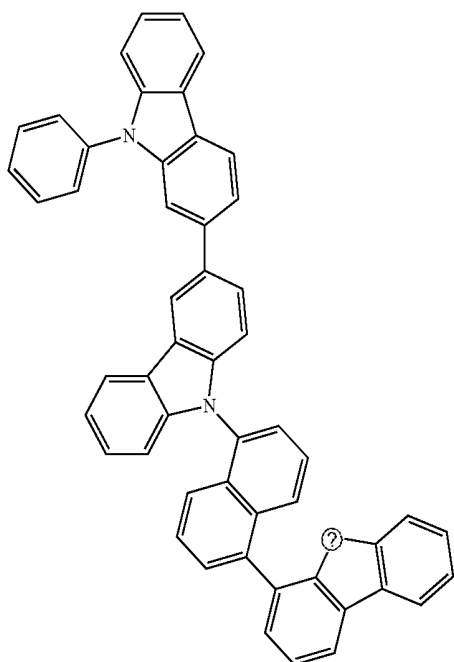


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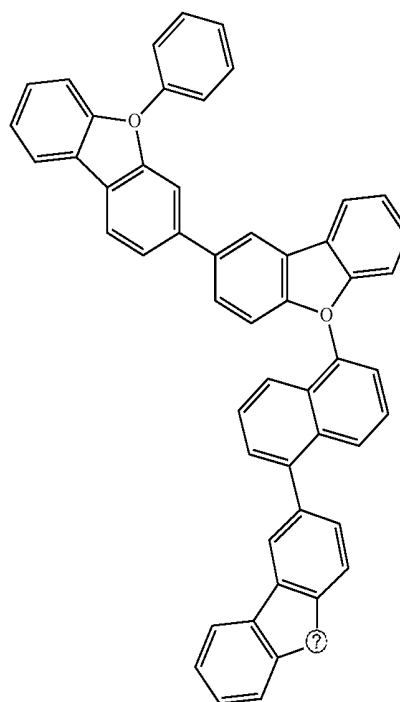
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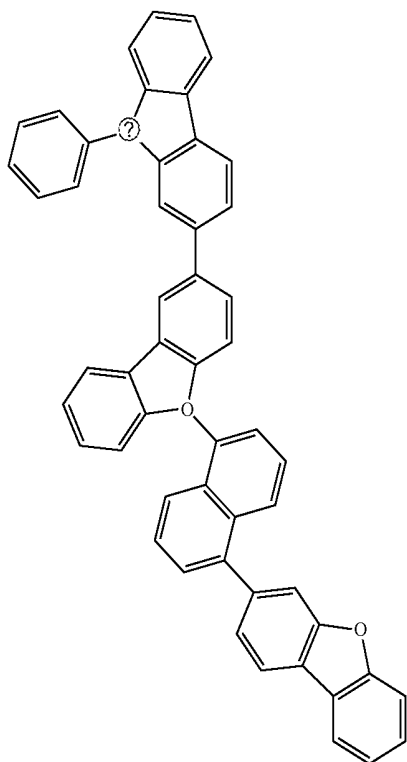


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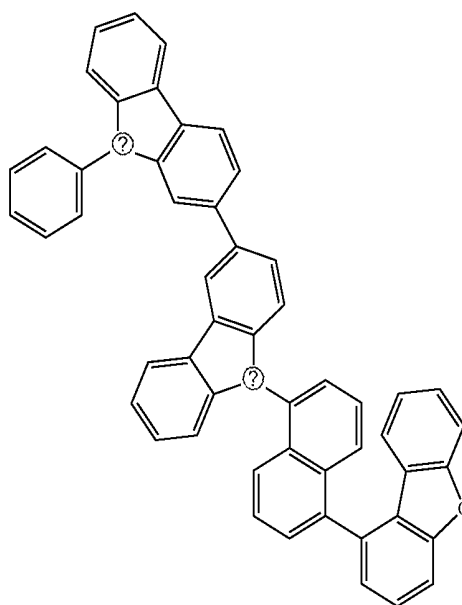
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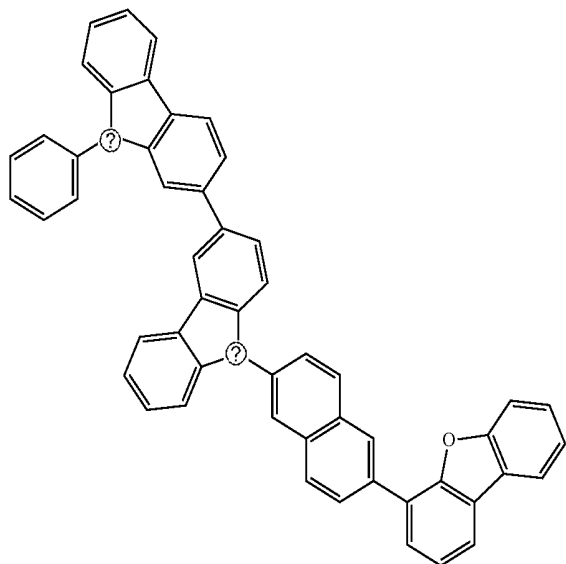
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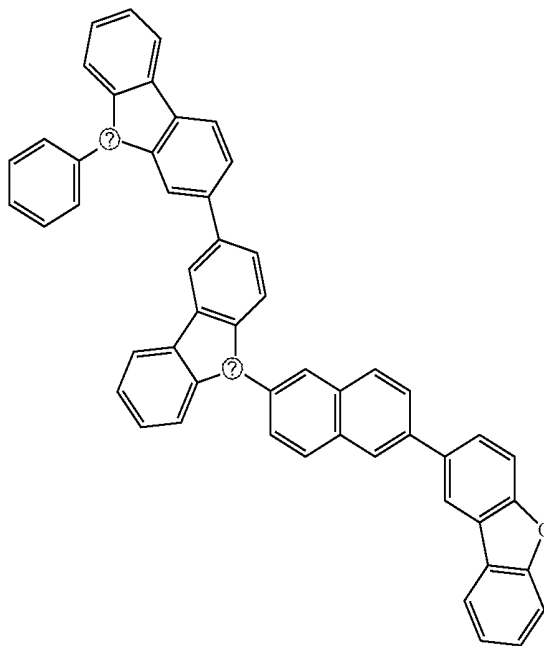
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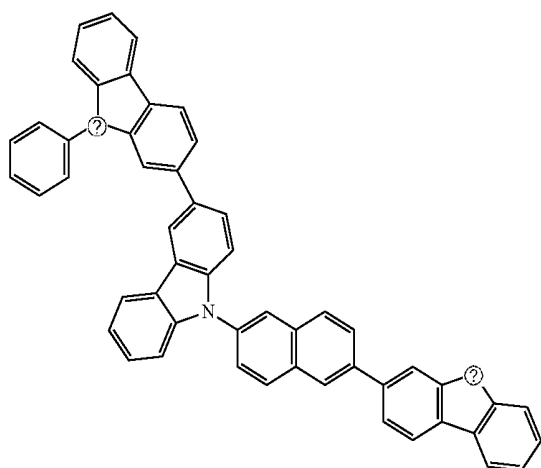
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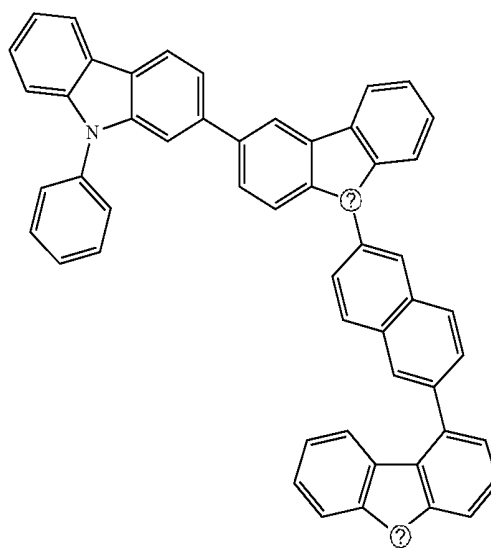
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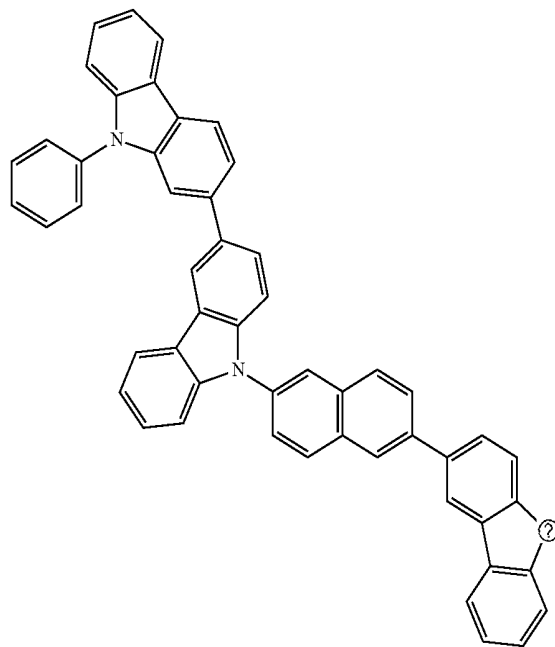
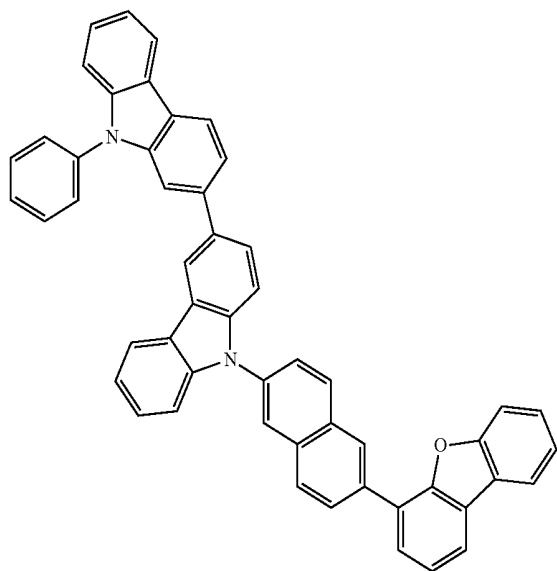


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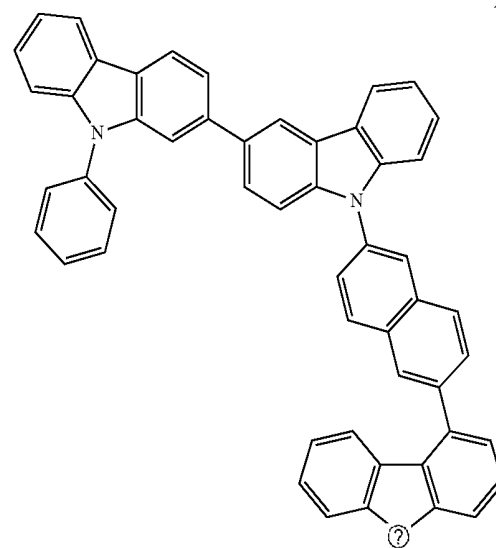
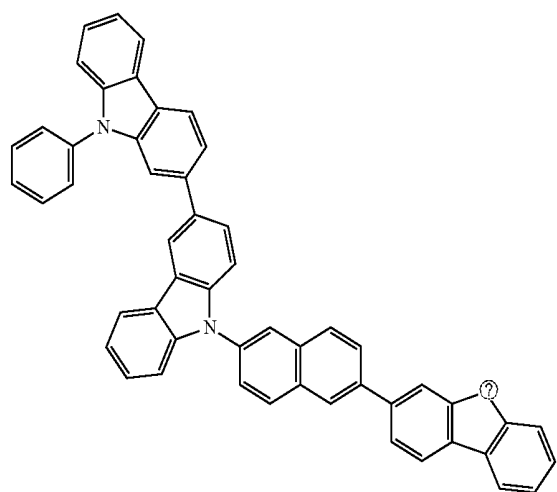
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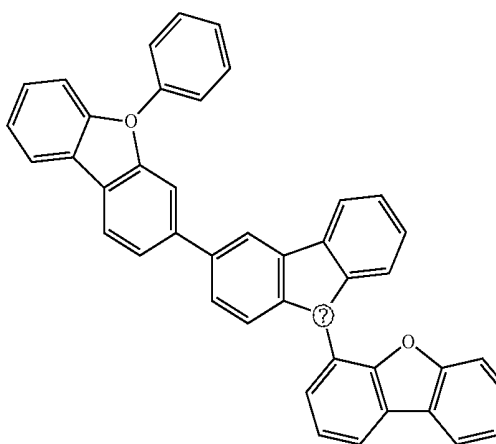


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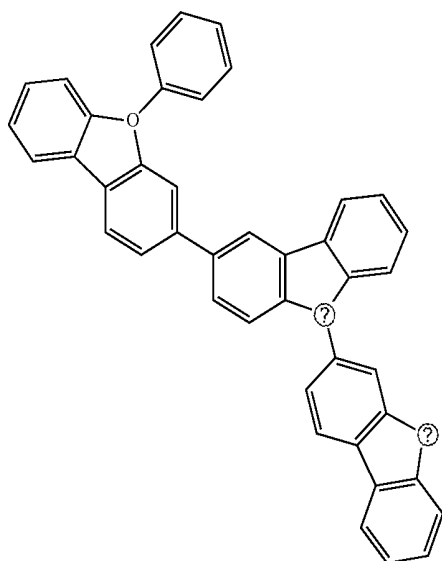
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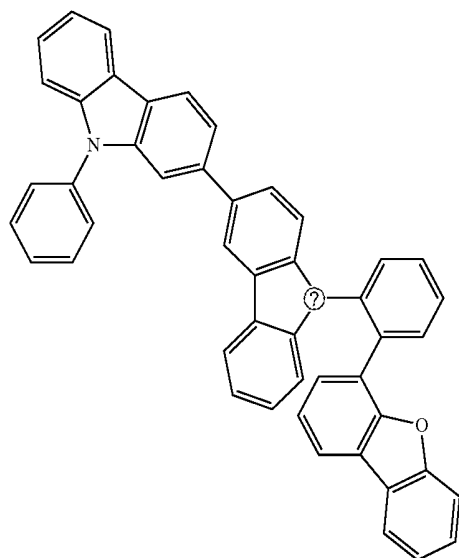
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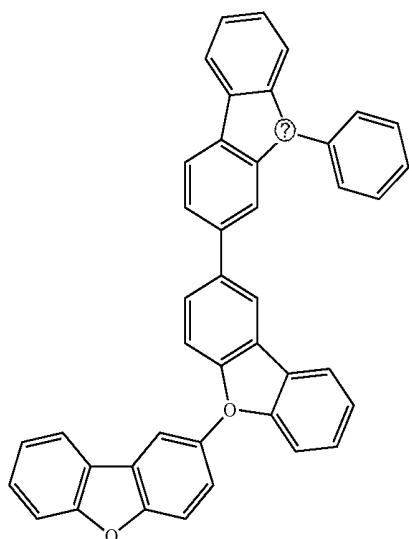
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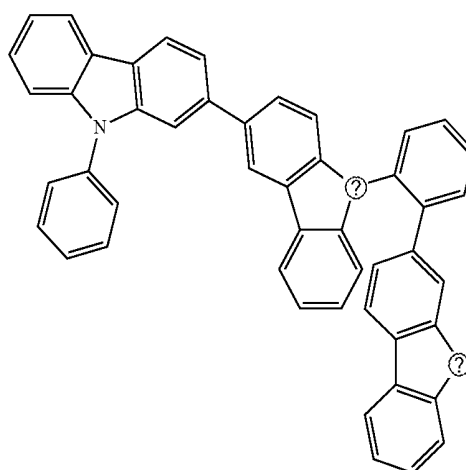
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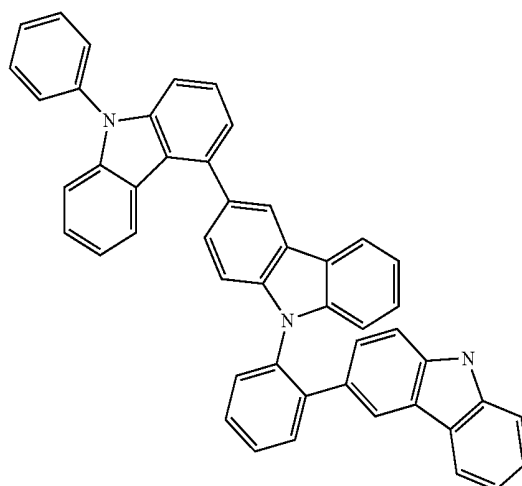
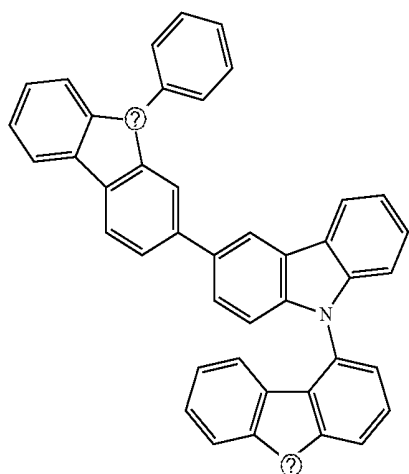


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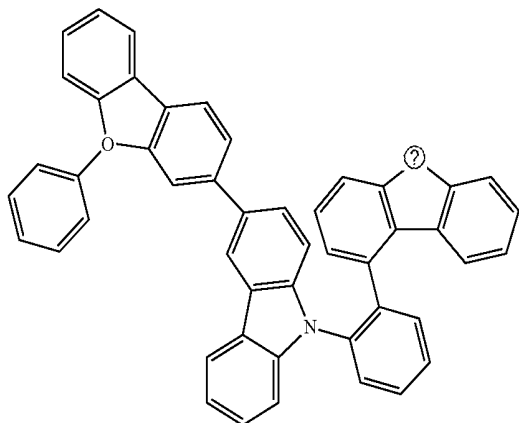
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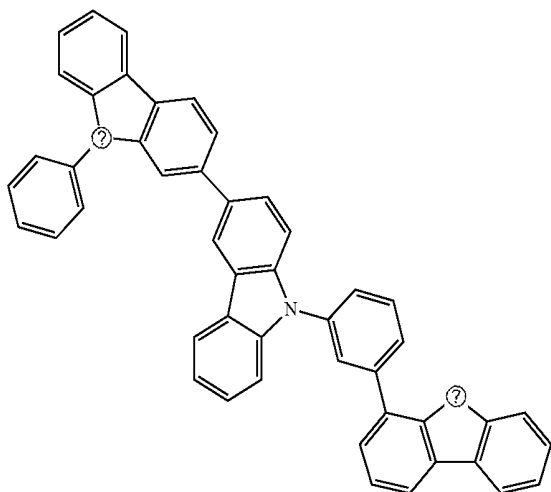


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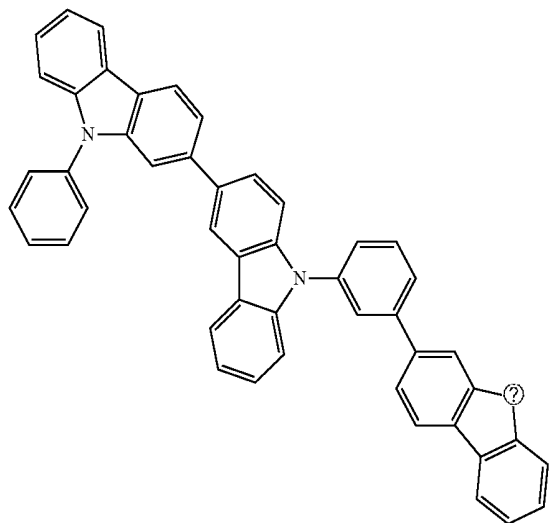
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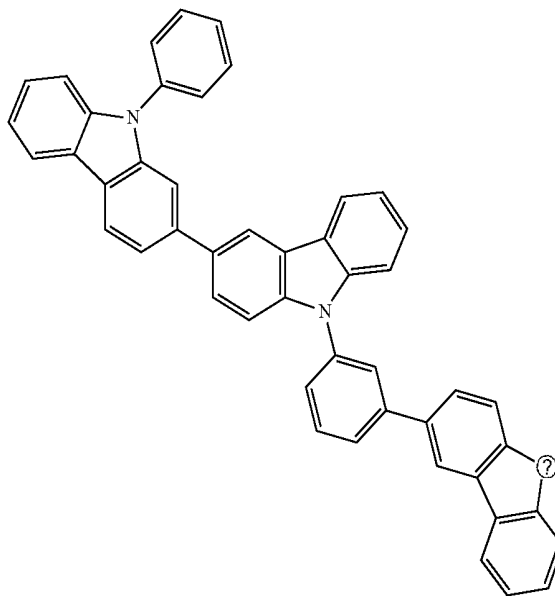


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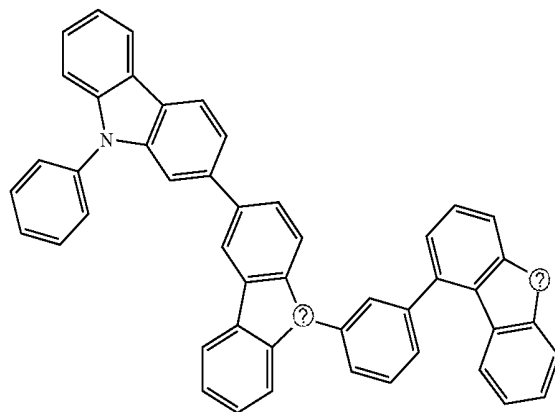


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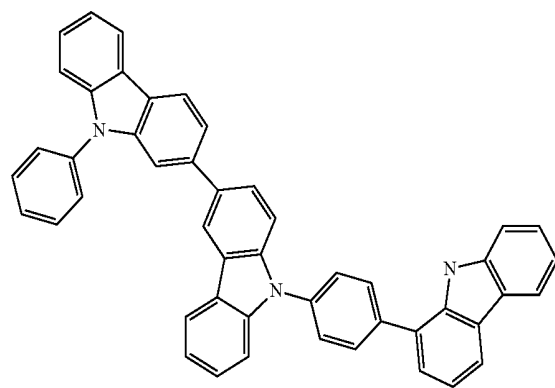
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A-269

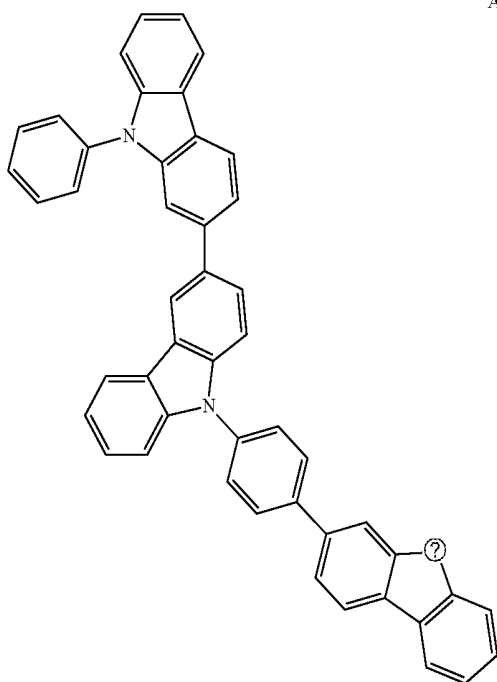


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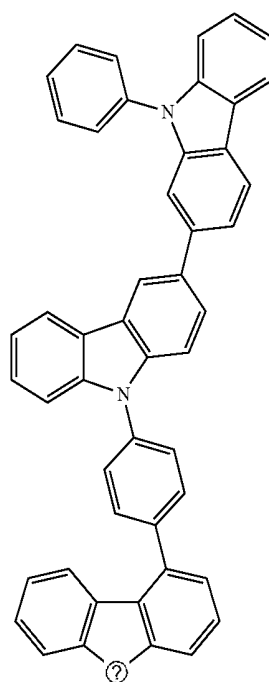
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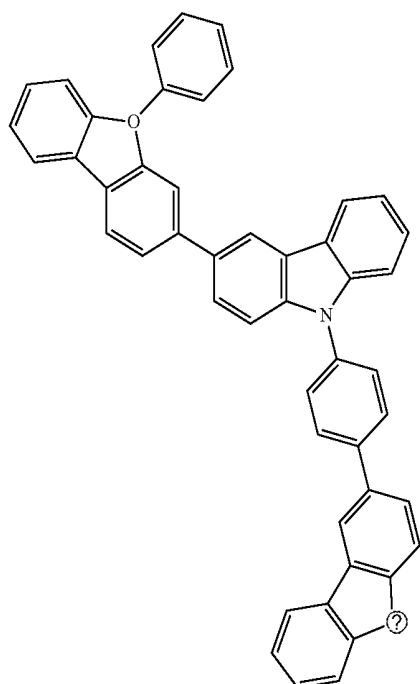


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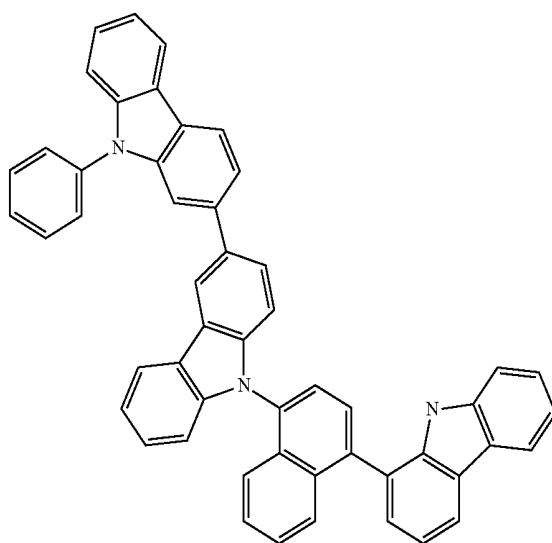
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A-272

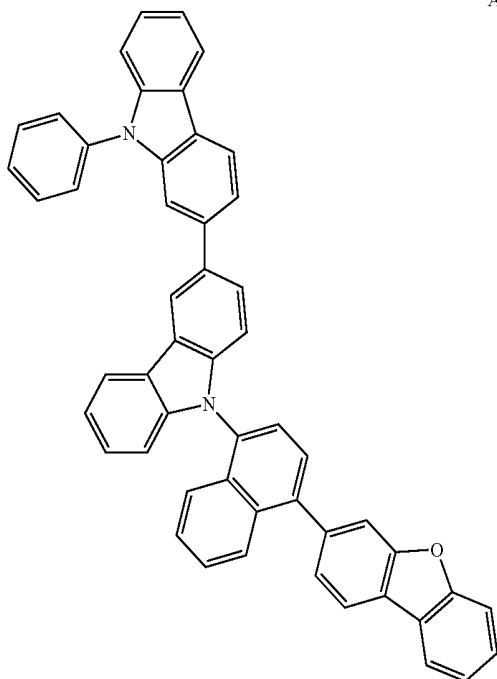


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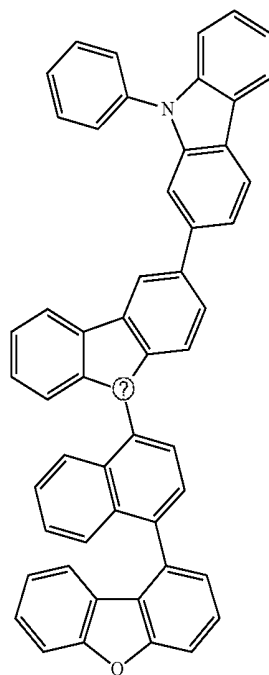
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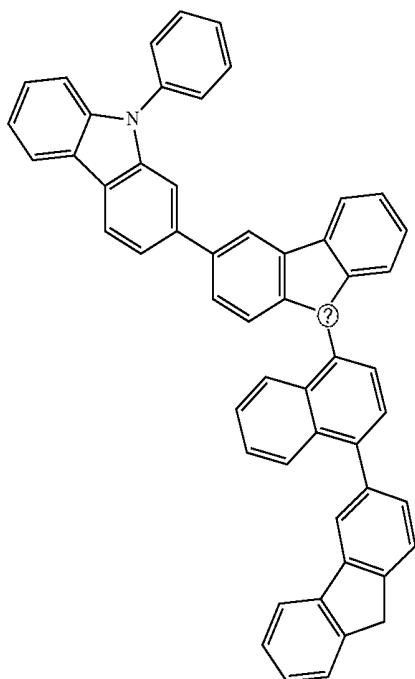


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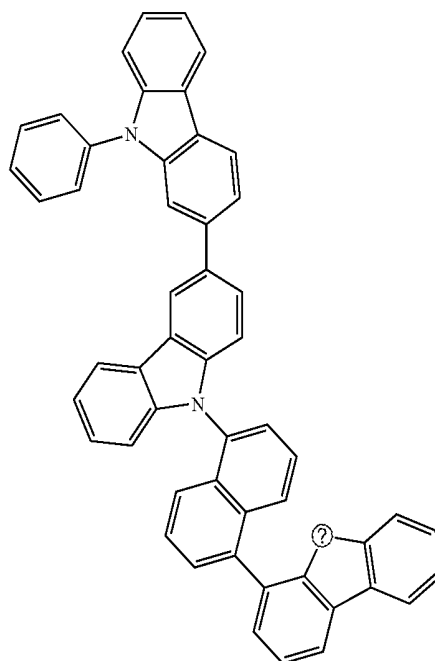
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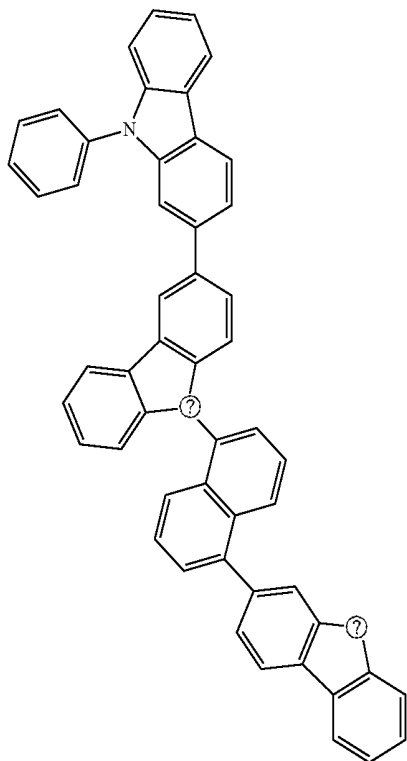


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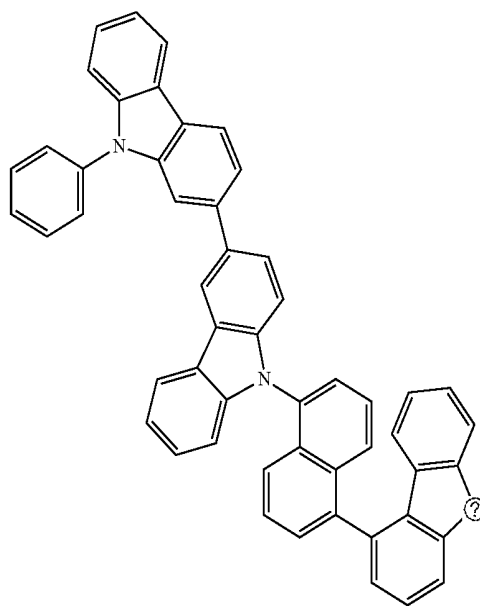
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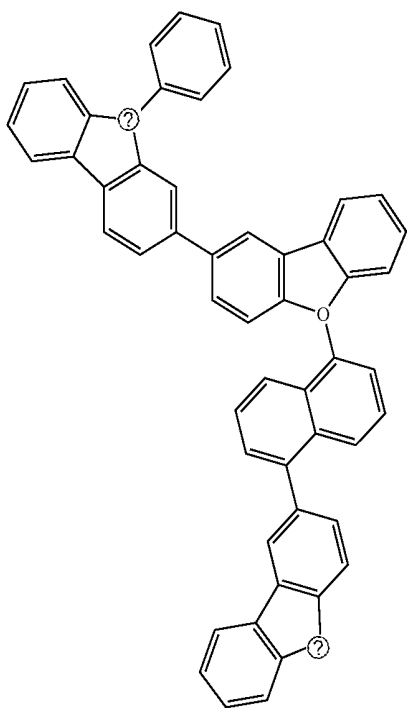


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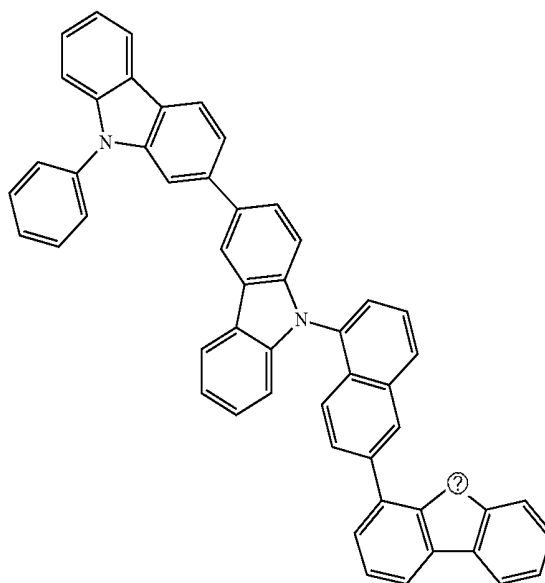
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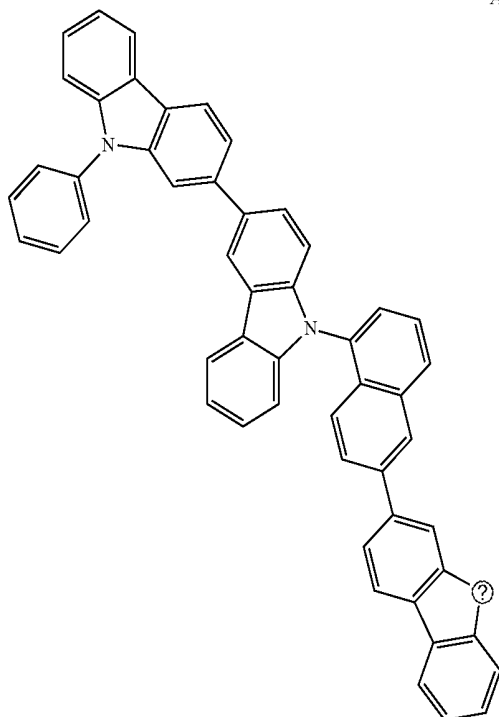


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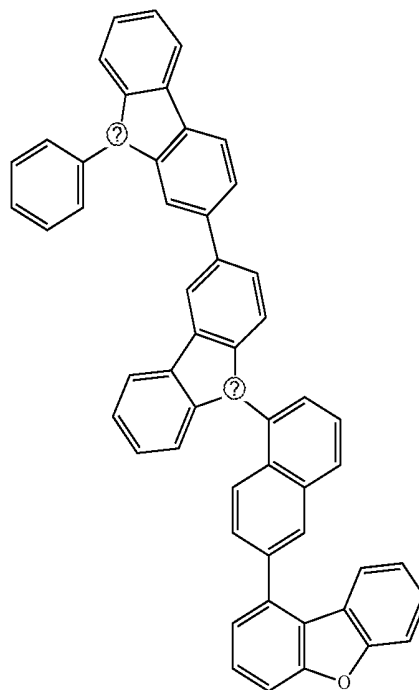
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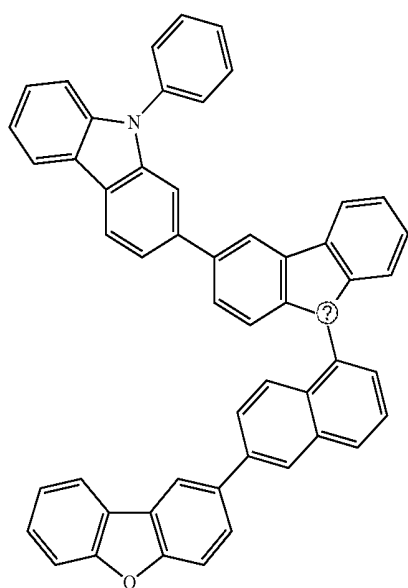


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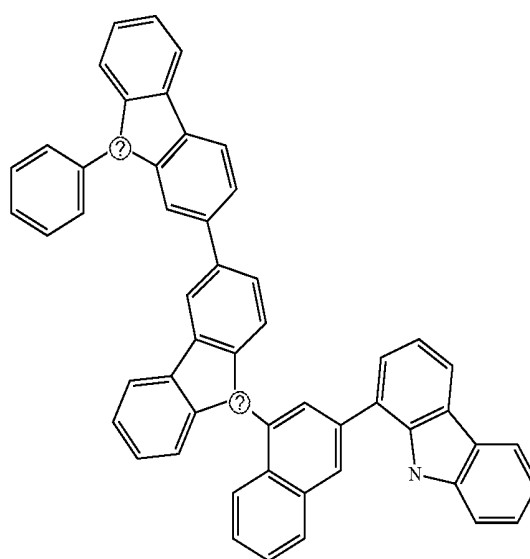
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A-284

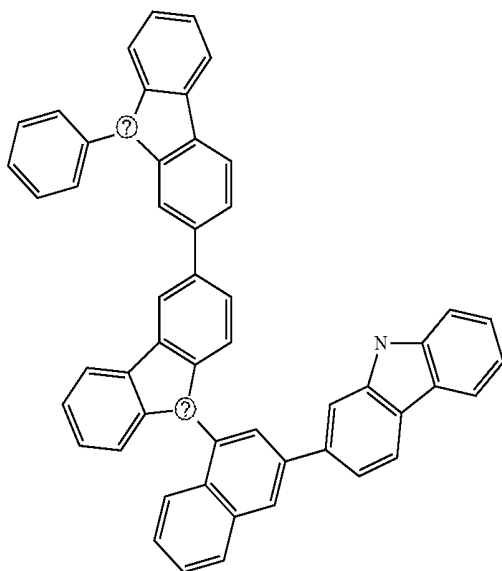


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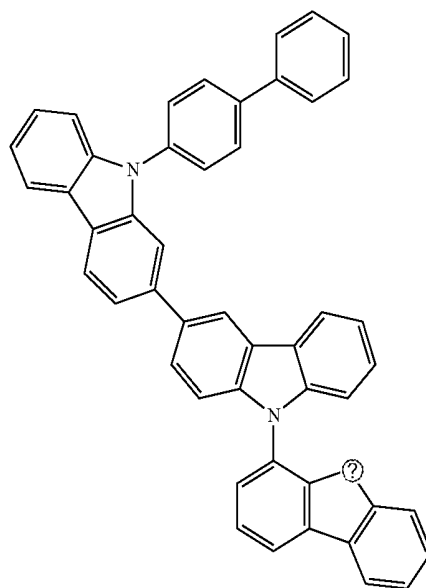
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A-287

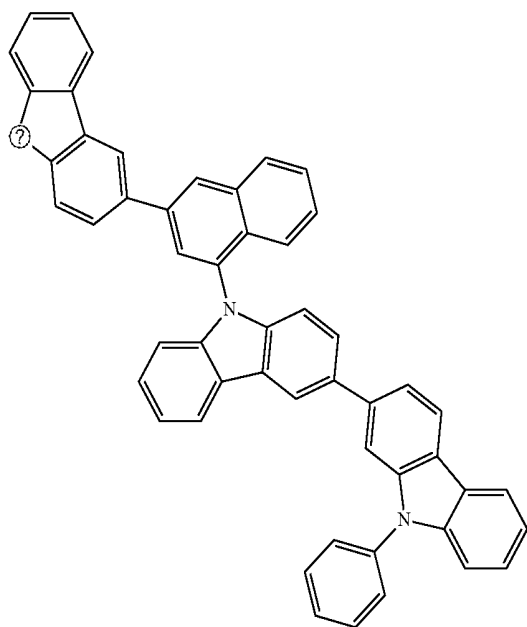


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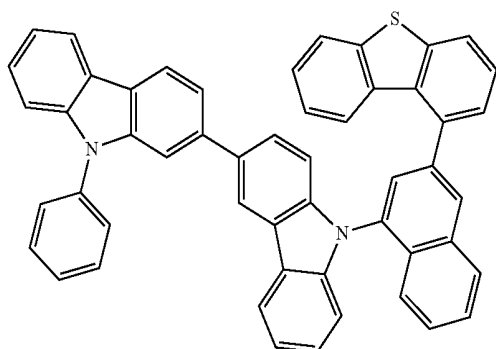
A-290



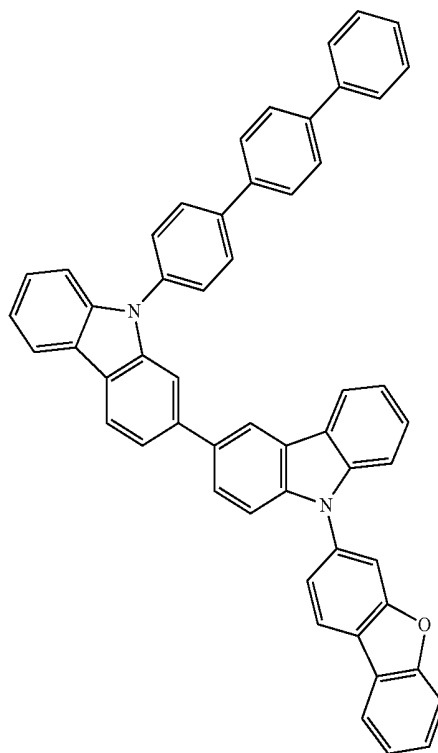
A-288



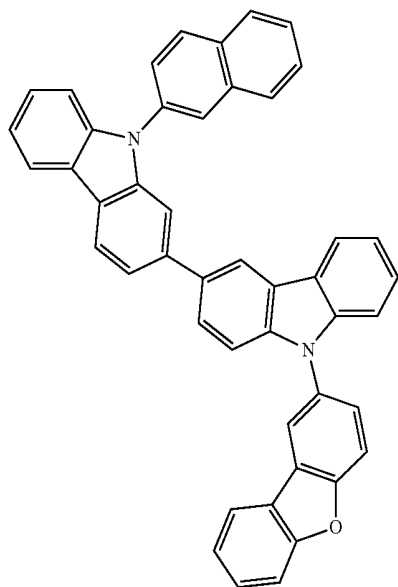
A-289



A-291

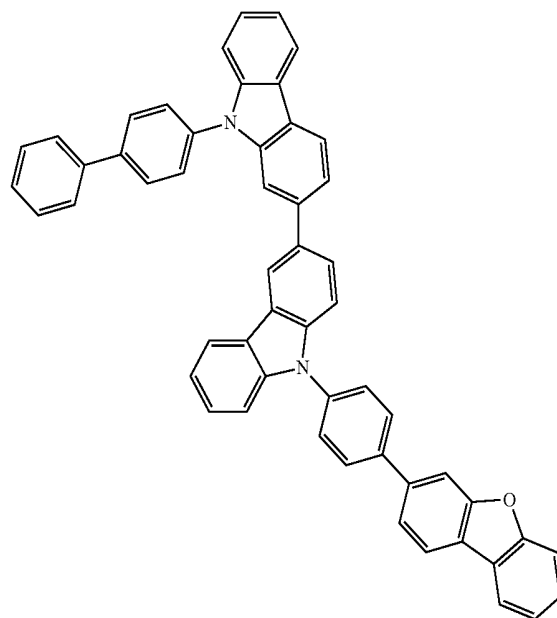


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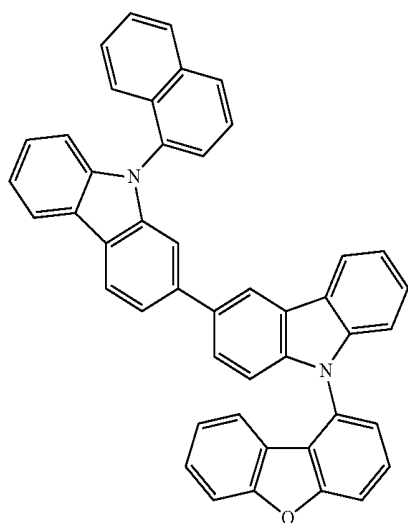


A-292

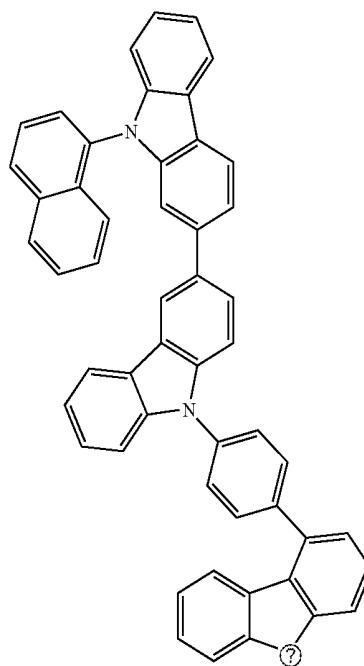
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A-294



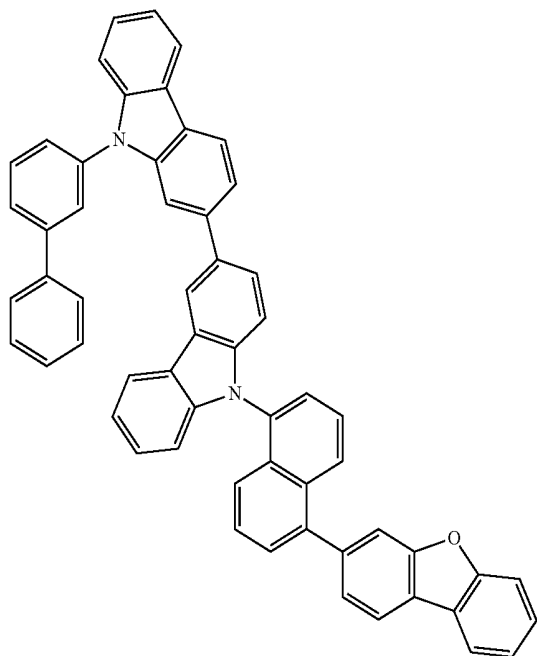
A-293



A-295

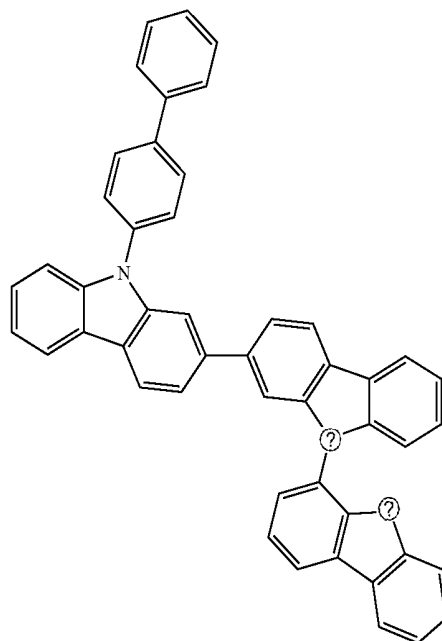
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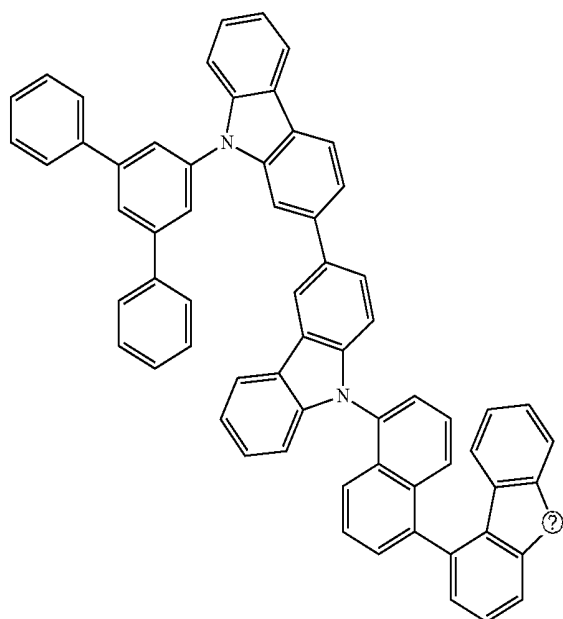


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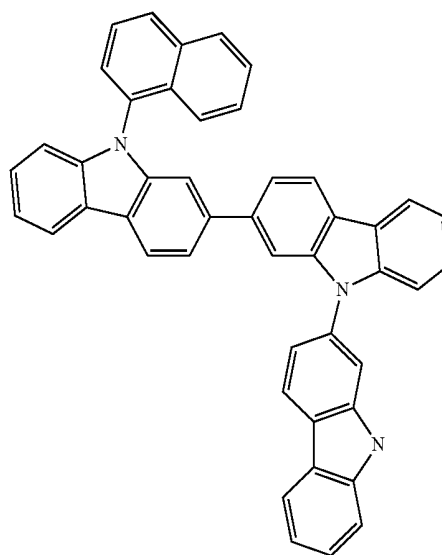
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A-297

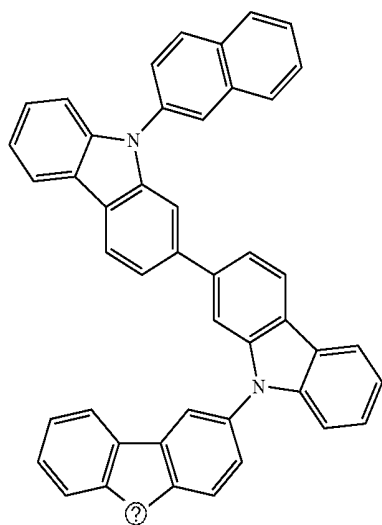


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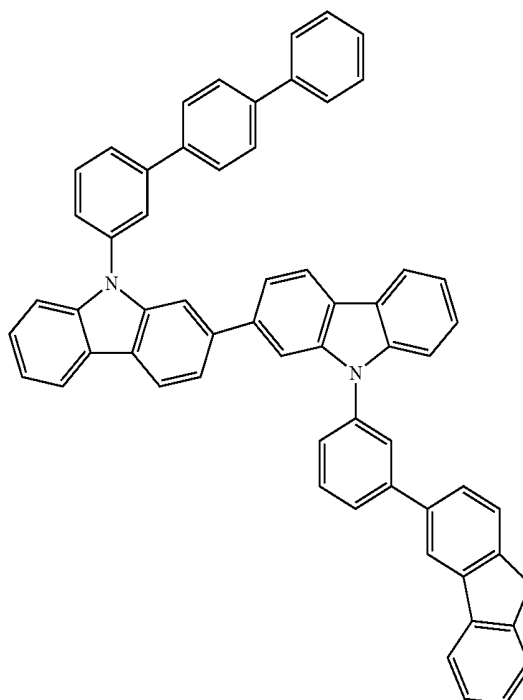
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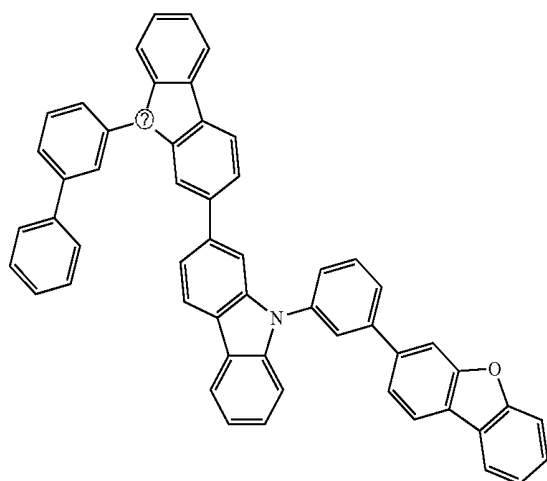


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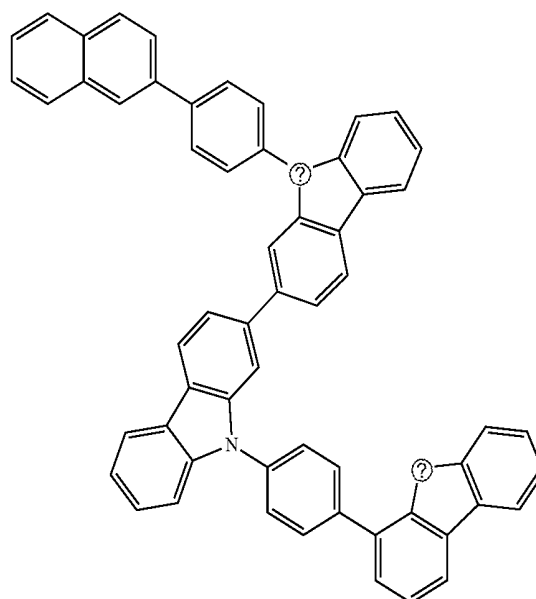
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A-301

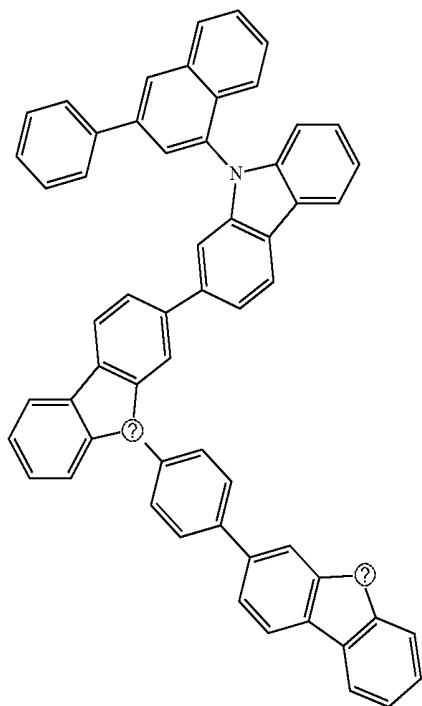


A-303



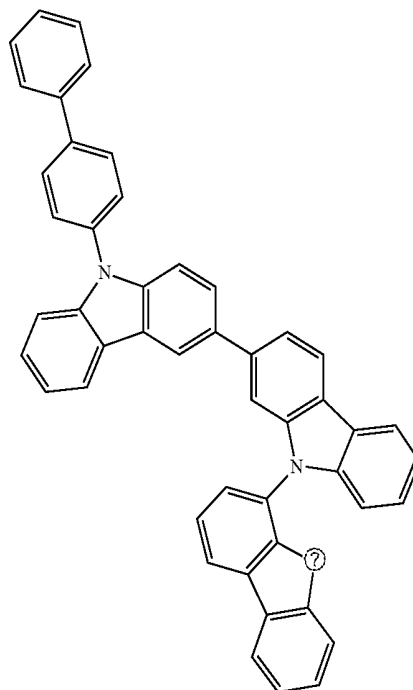
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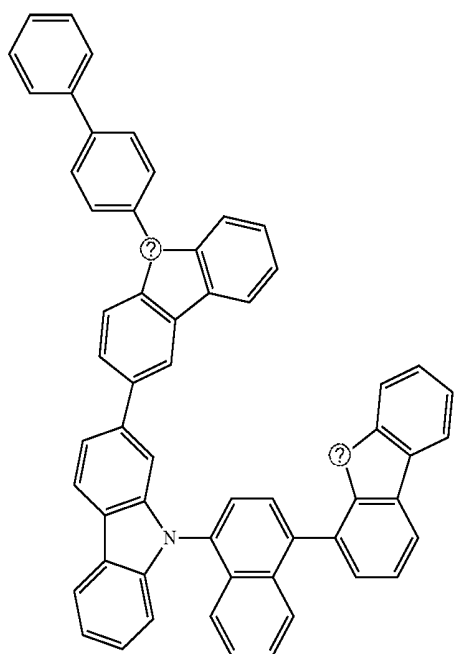


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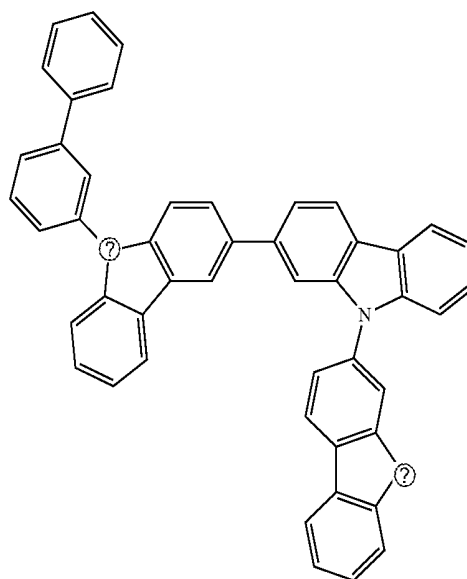
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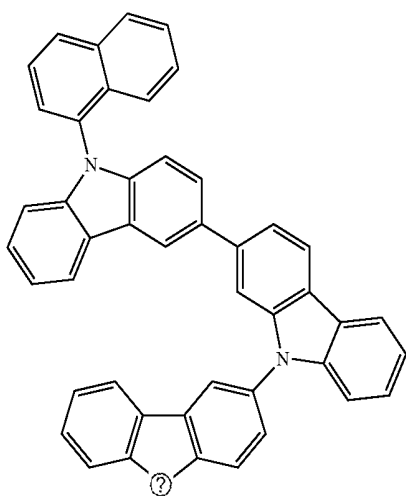
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A-307

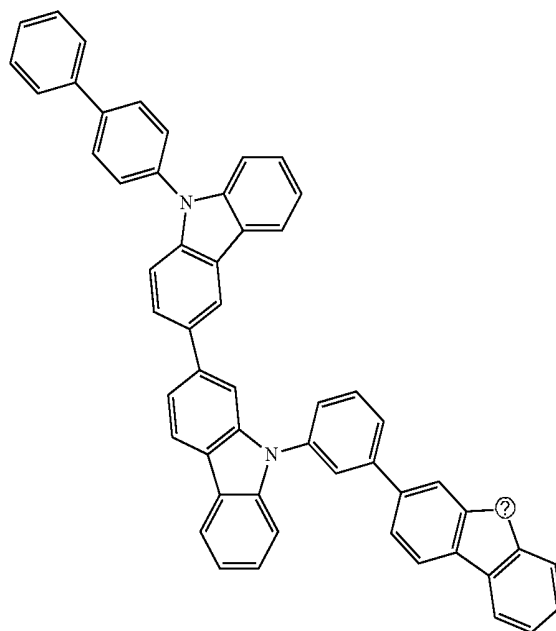


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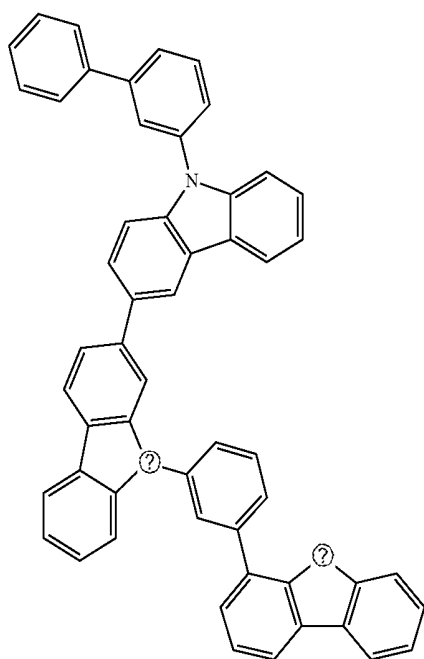
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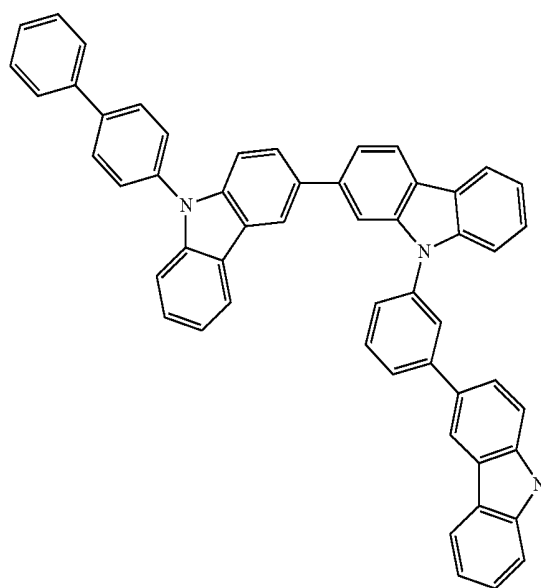


A-310

A-309

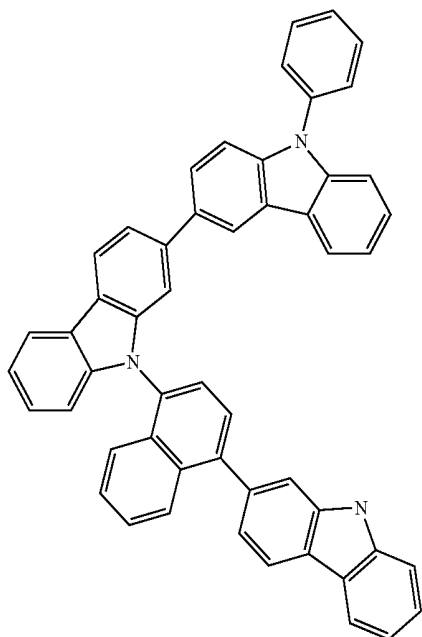


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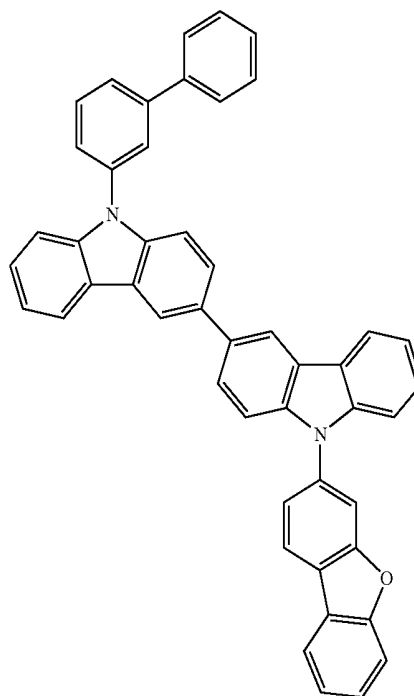
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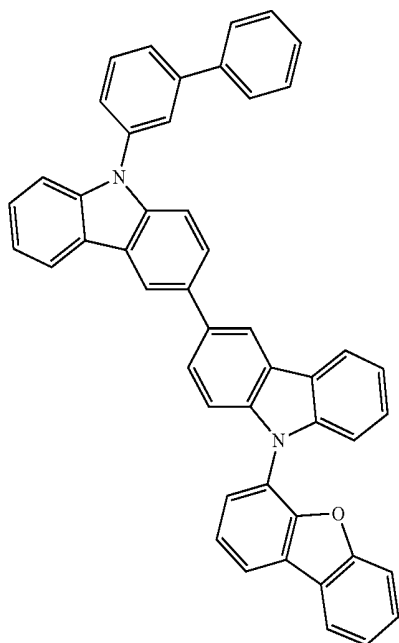


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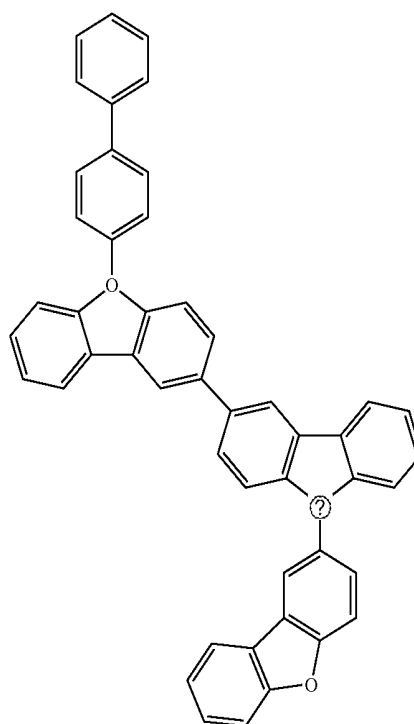
A-314



A-313

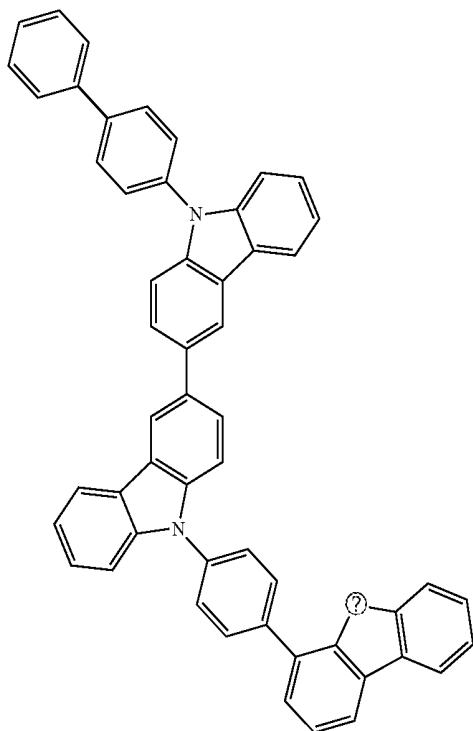


A-315



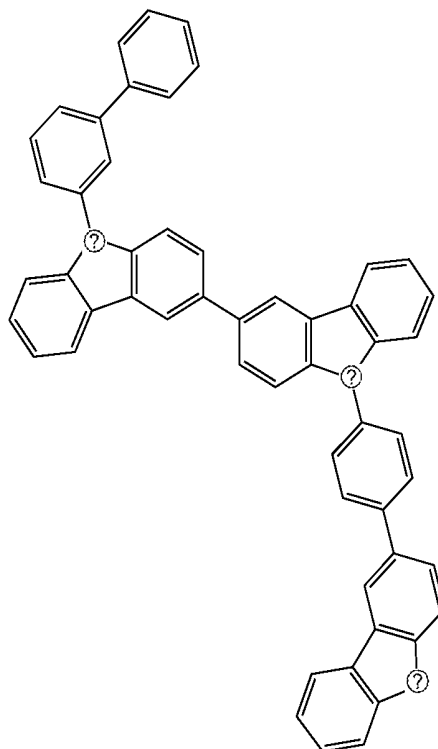
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A-316



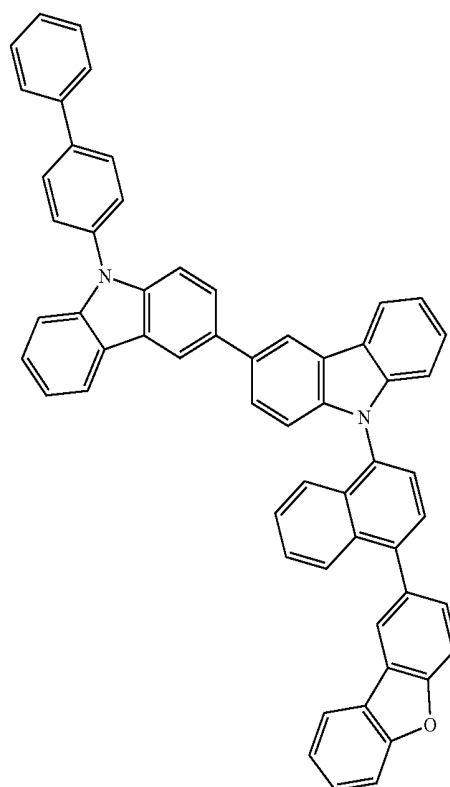
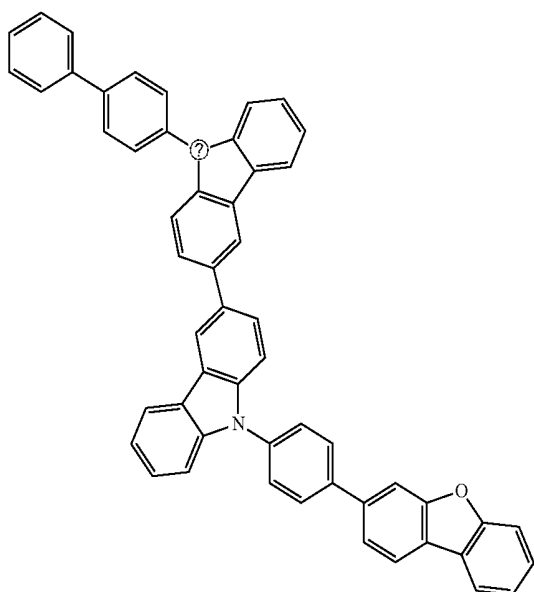
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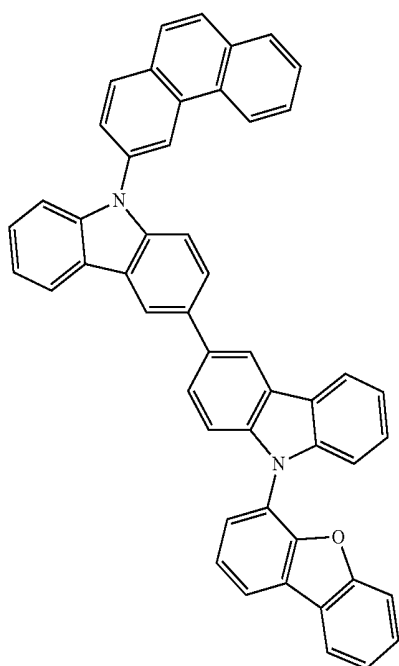


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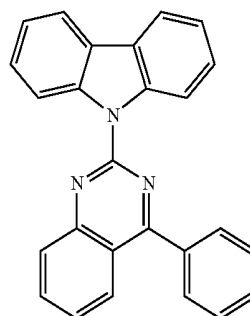
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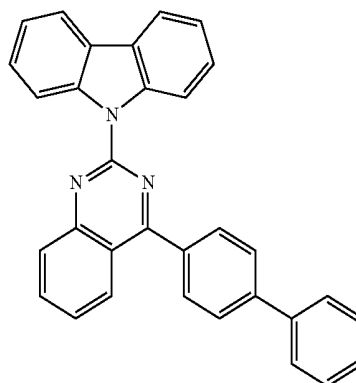
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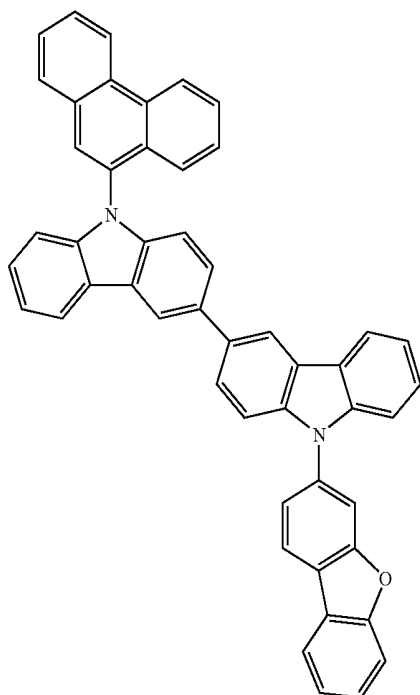
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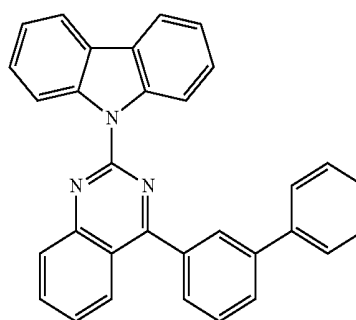
H2-1



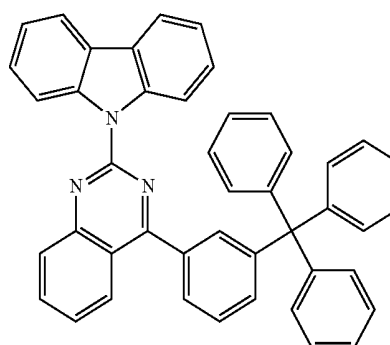
H2-2



A-321



H2-3

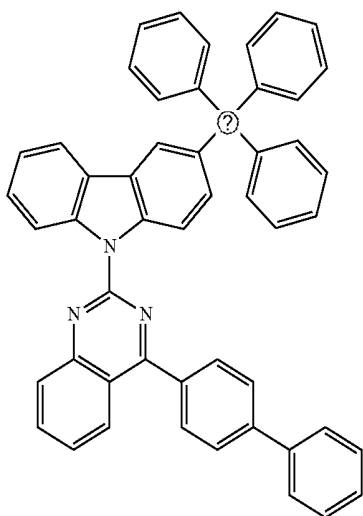


H2-4

⑦ indicates text missing or illegible when filed

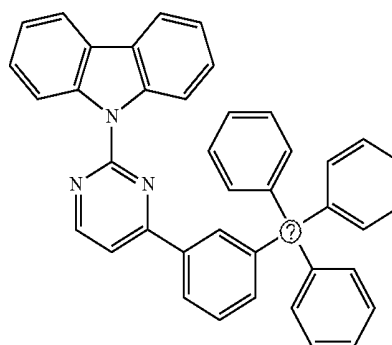
7. The organic electroluminescent device according to claim 1, wherein the compound represented by formula 2 is selected from the group consisting of:

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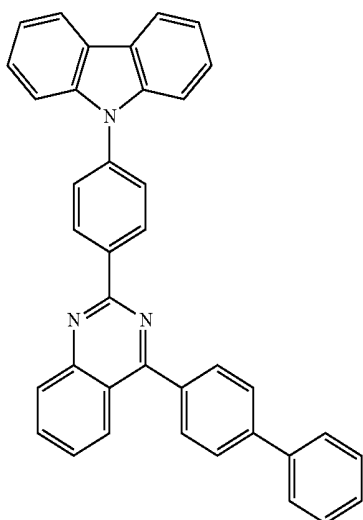


H2-5

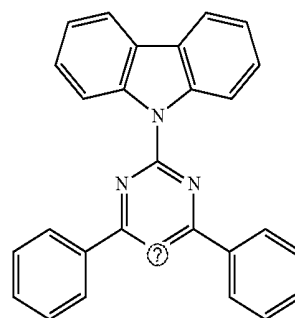
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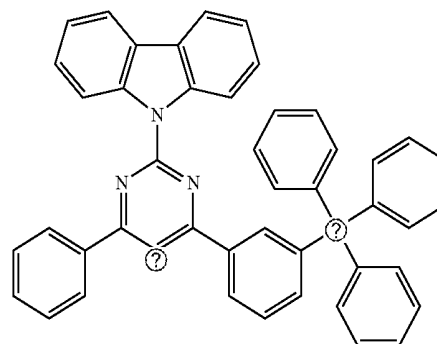
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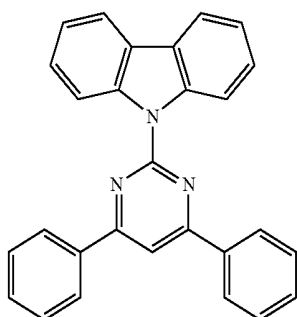
H2-6



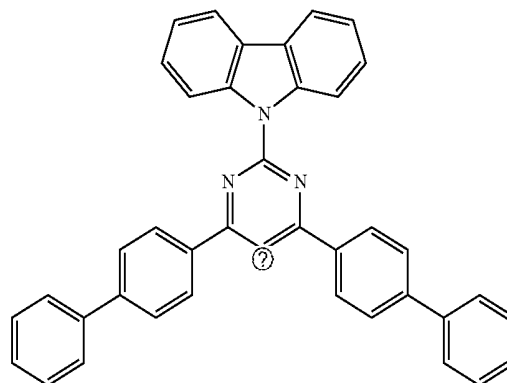
H2-9



H2-10

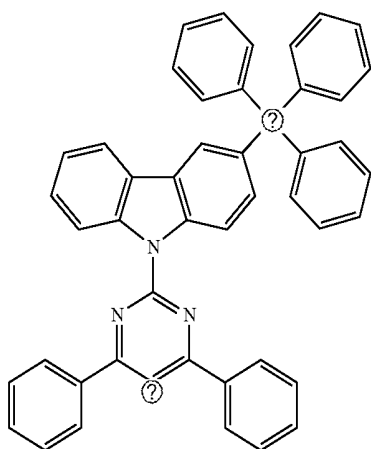


H2-7



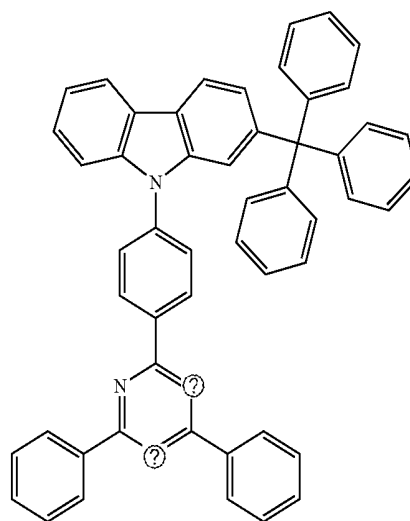
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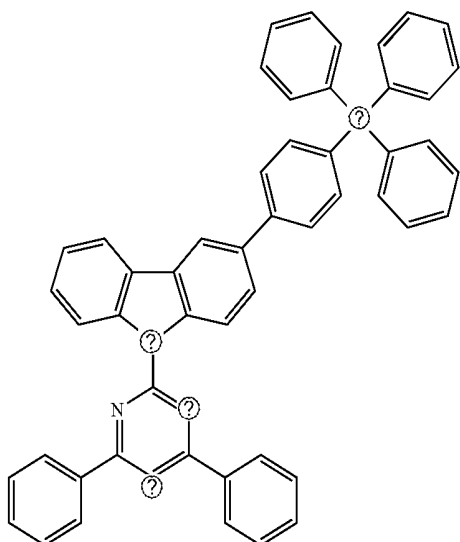


H2-12

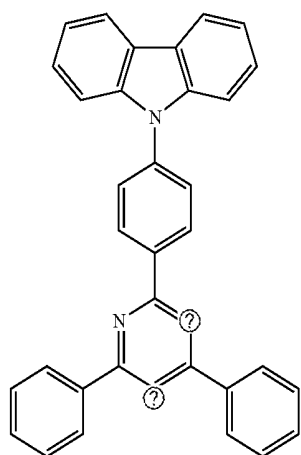
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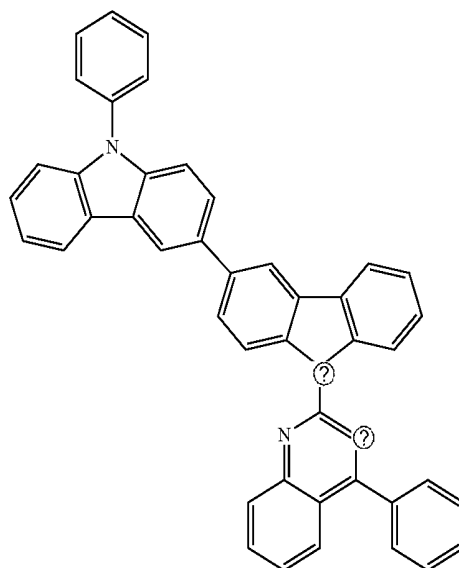
H2-15



H2-13



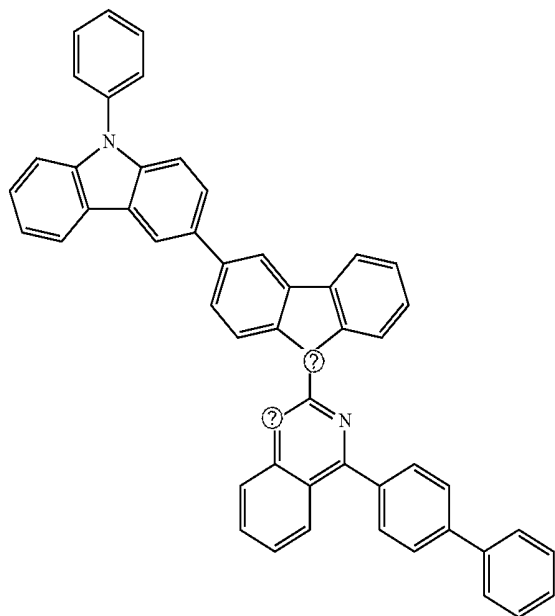
H2-14



H2-16

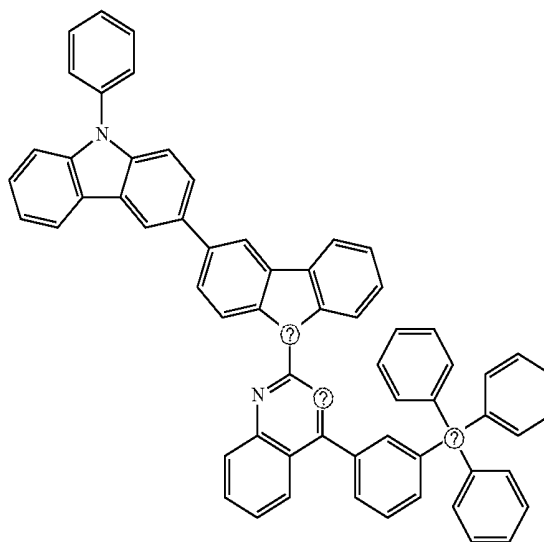
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H2-17



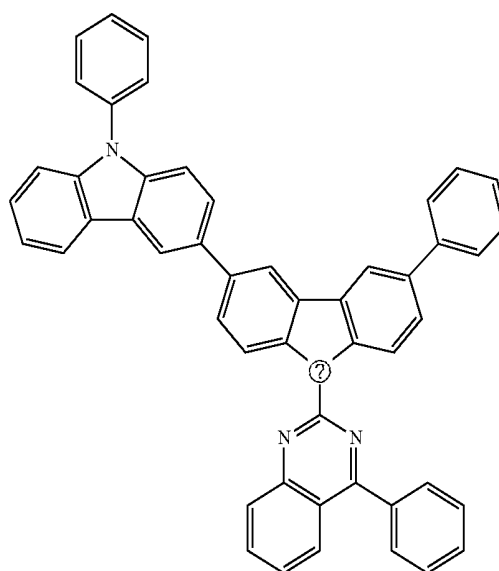
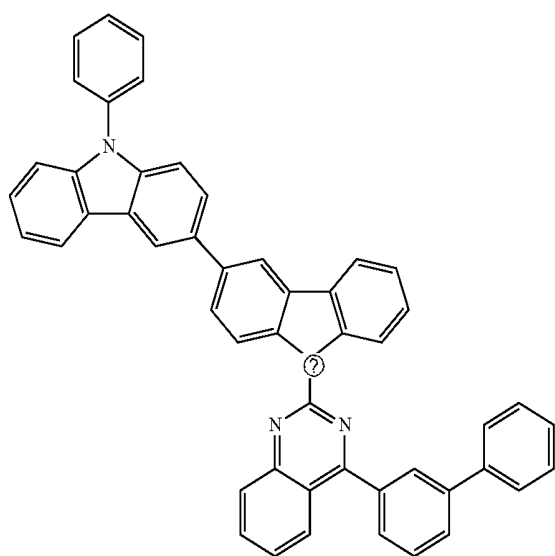
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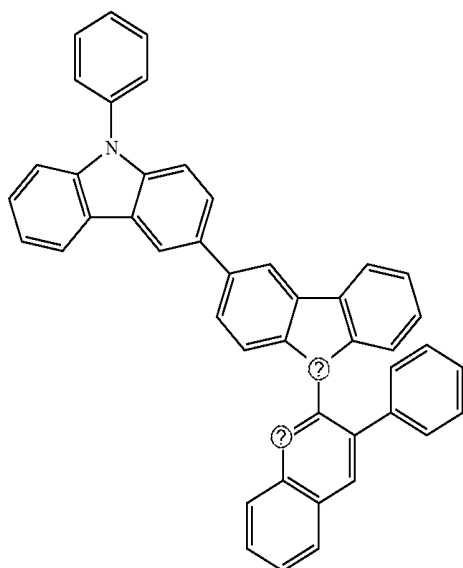
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H2-18



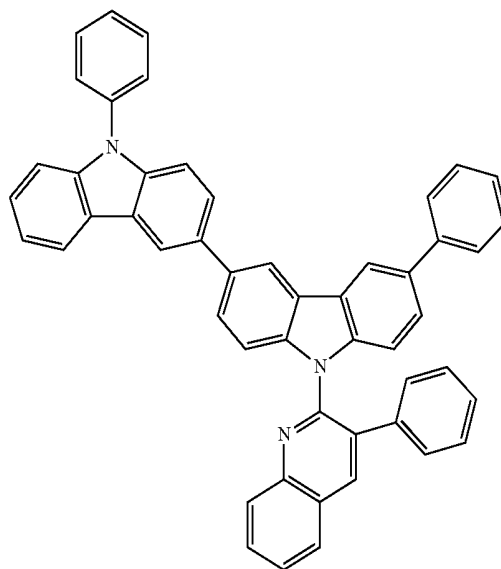
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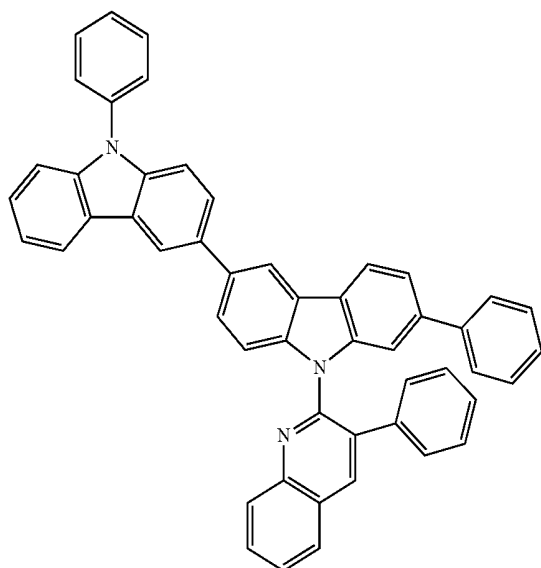


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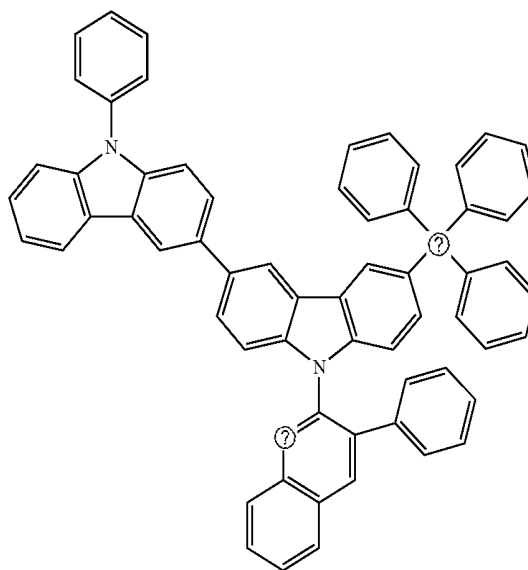
H2-23



H2-22

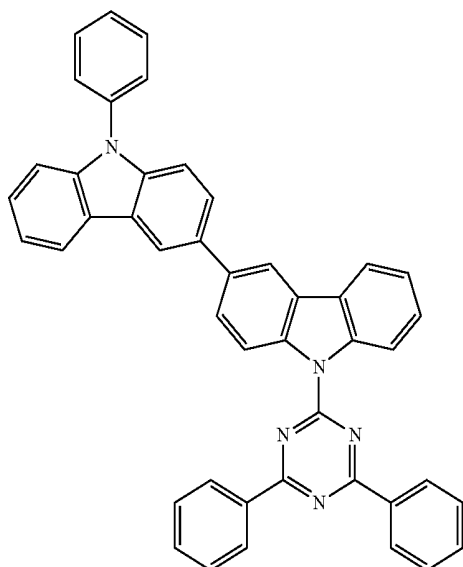


H2-24



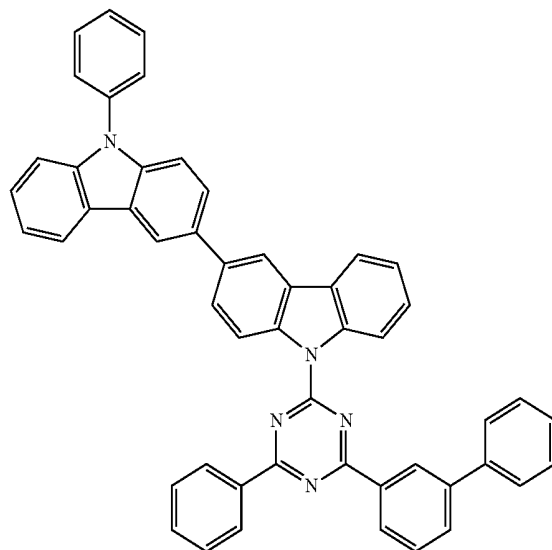
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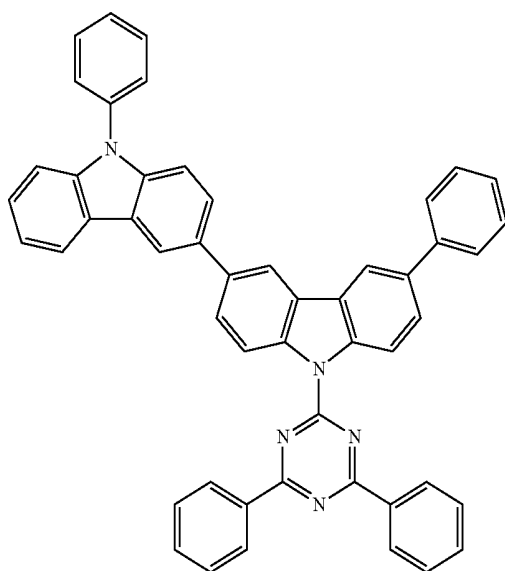


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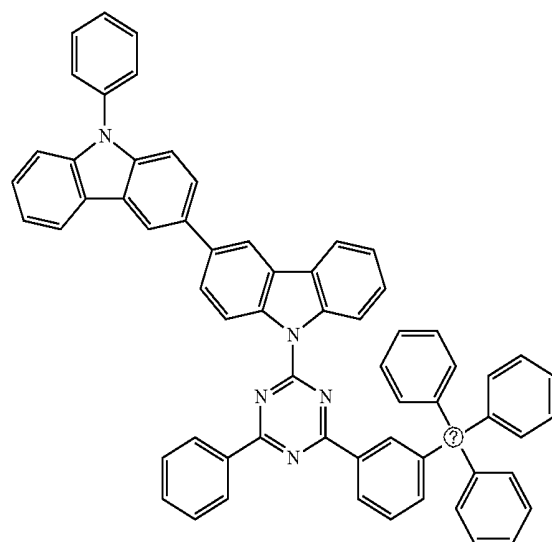
H2-27



H2-26

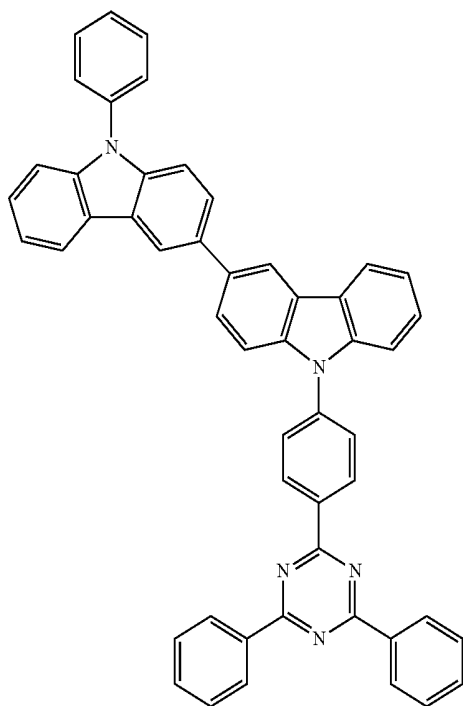


H2-28



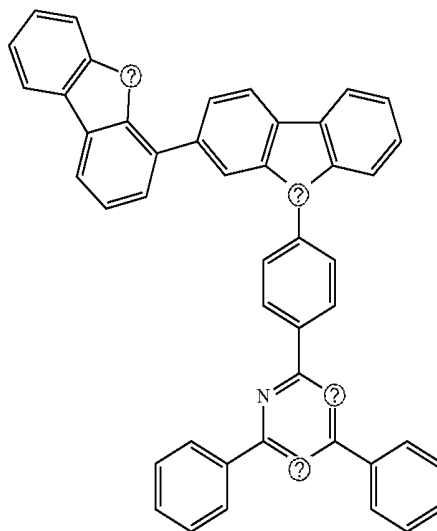
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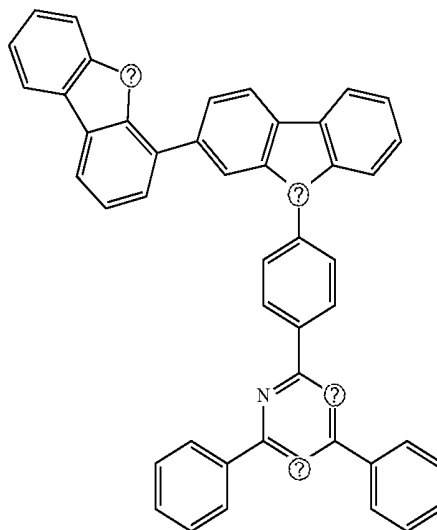


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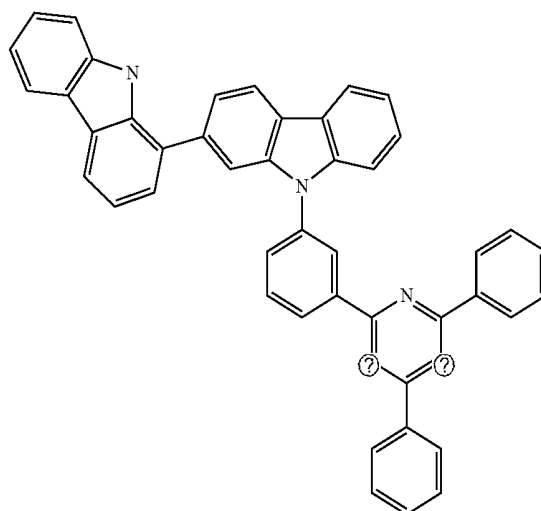
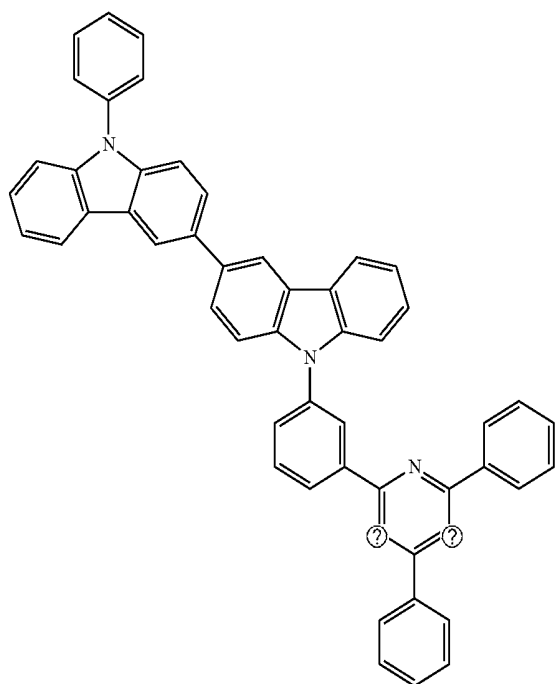


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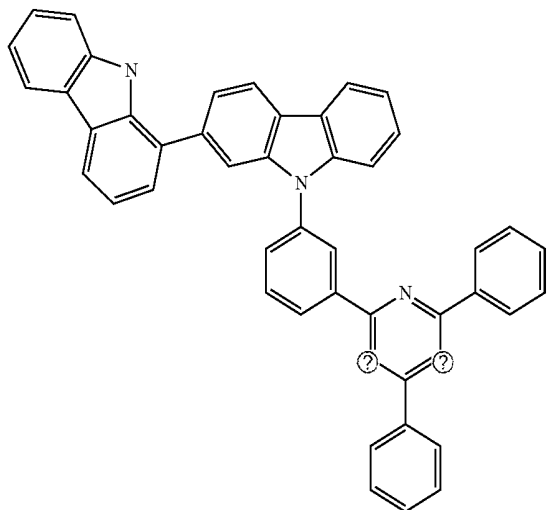
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H2-30

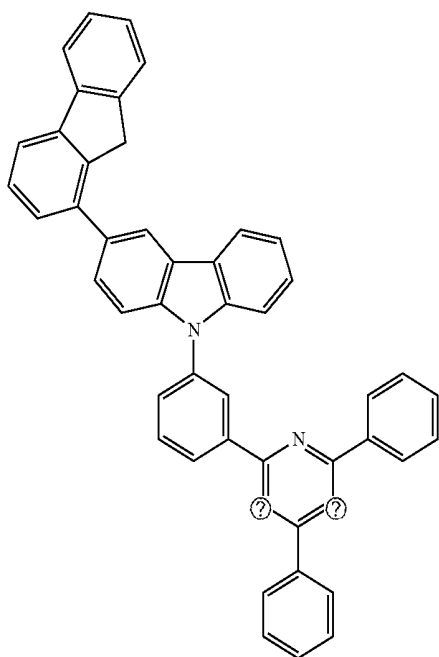


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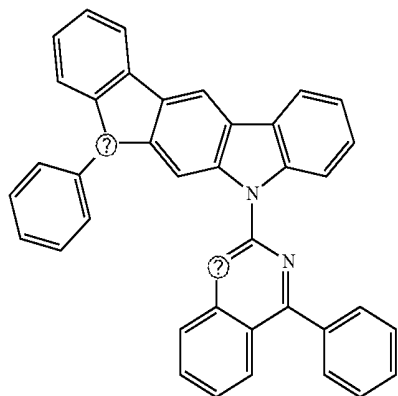
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H2-35

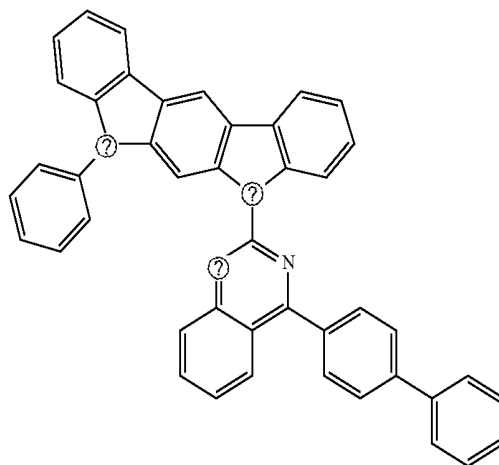


H2-36

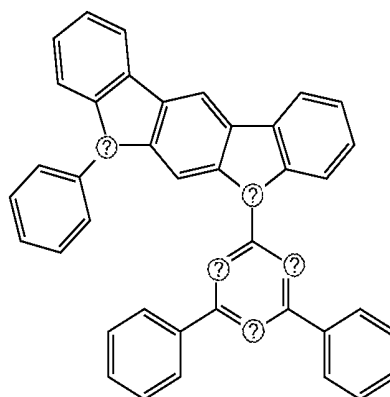


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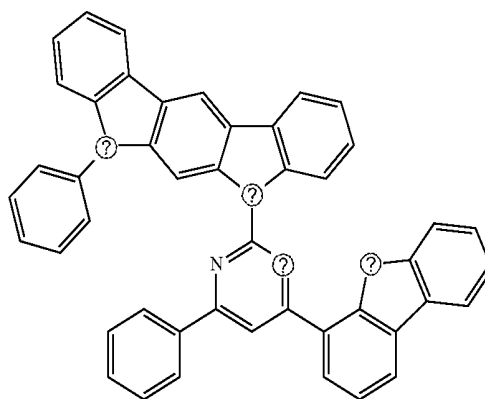
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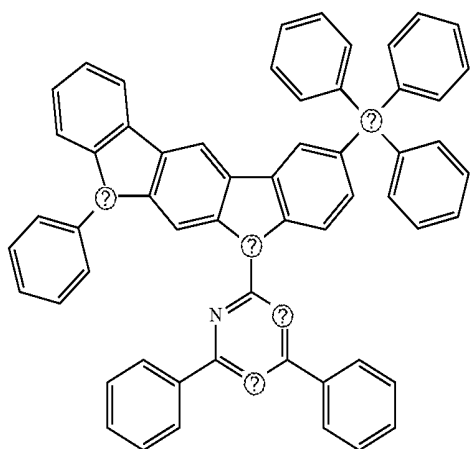
H2-38



H2-39

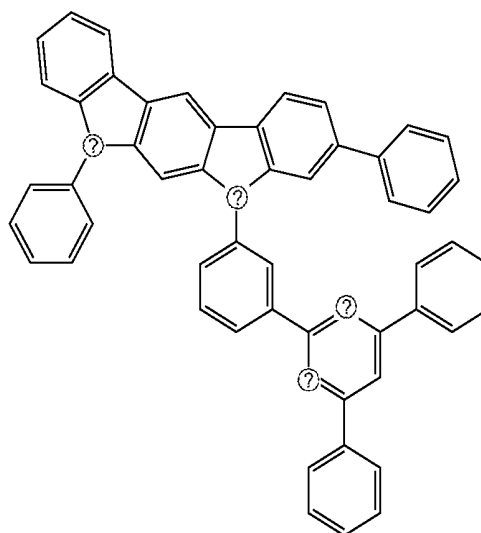


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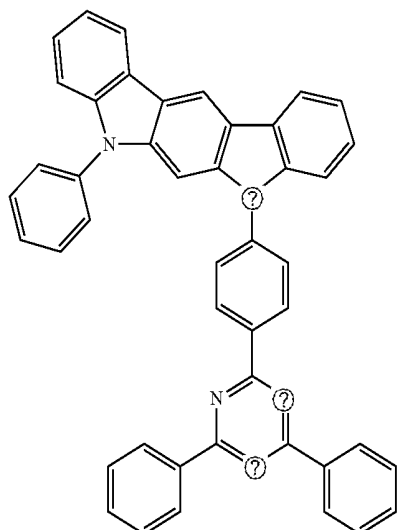
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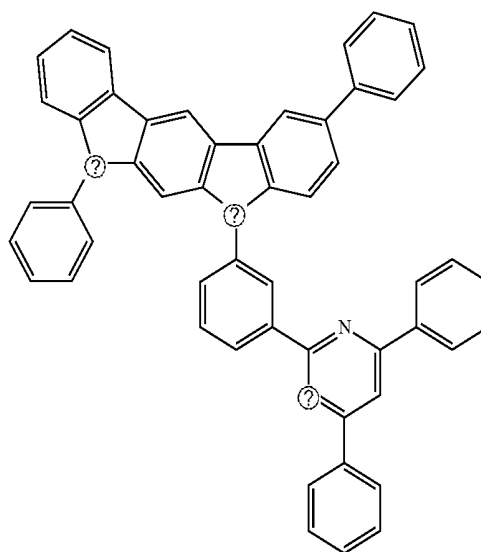


H2-43

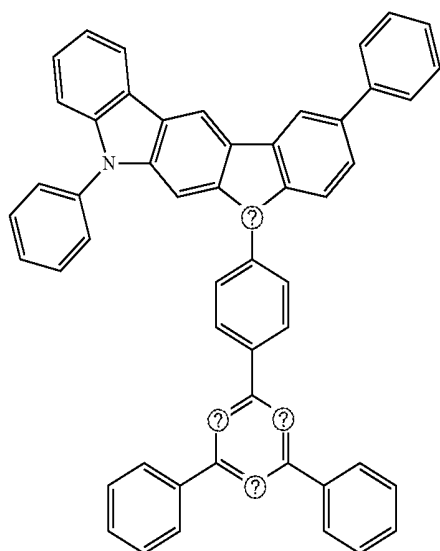
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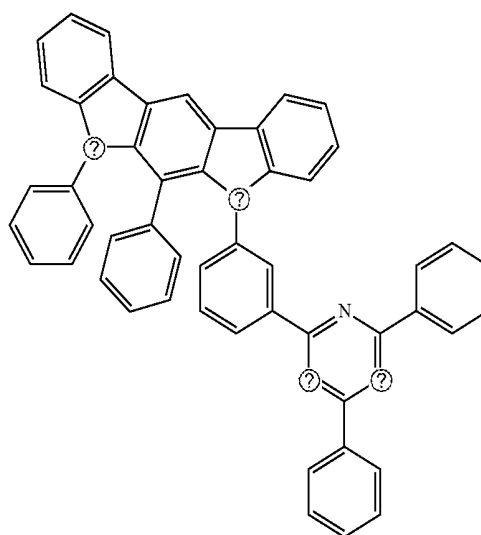
H2-44



H2-42

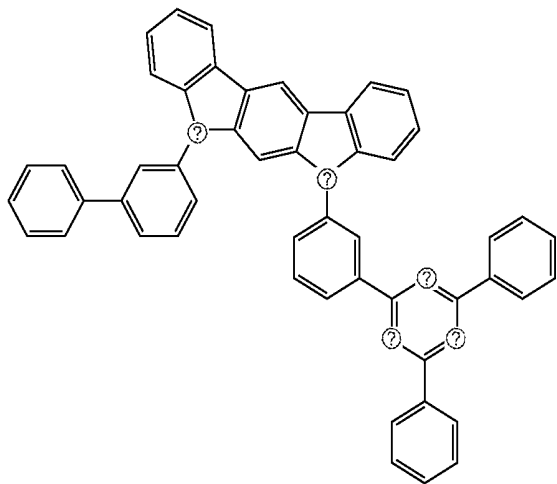


H2-45

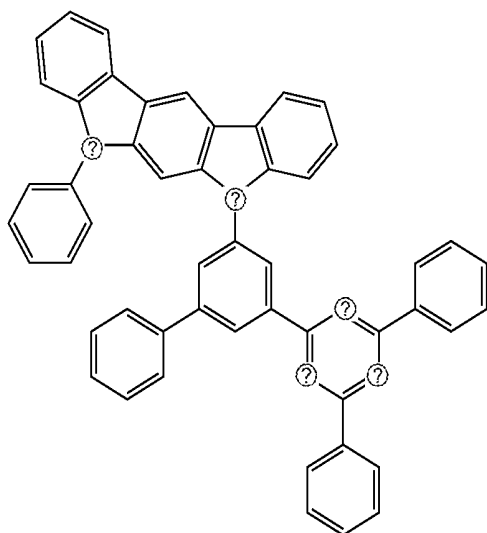


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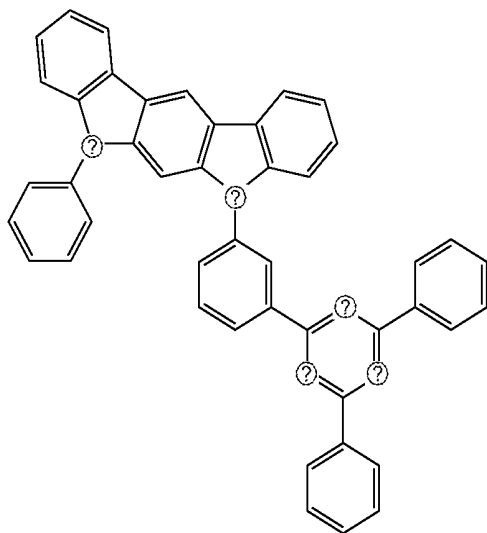
H2-46



H2-47

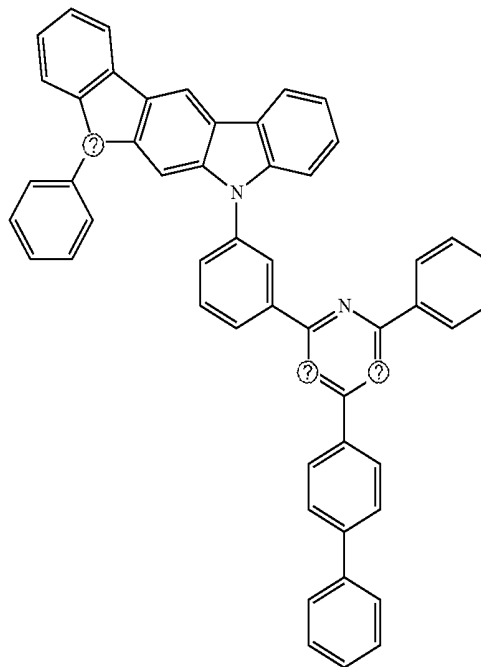


H2-48

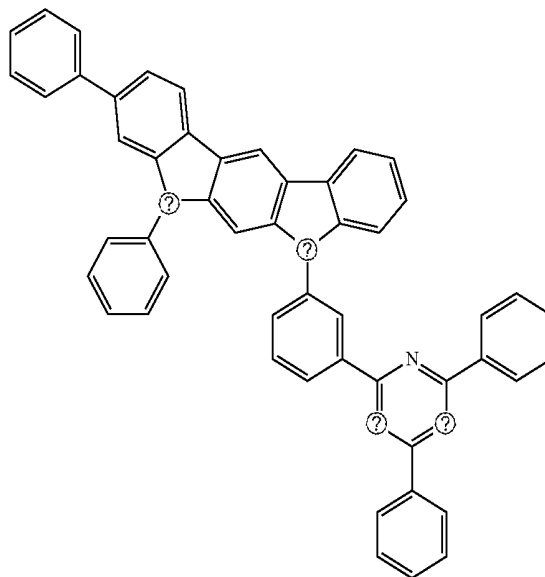


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H2-49

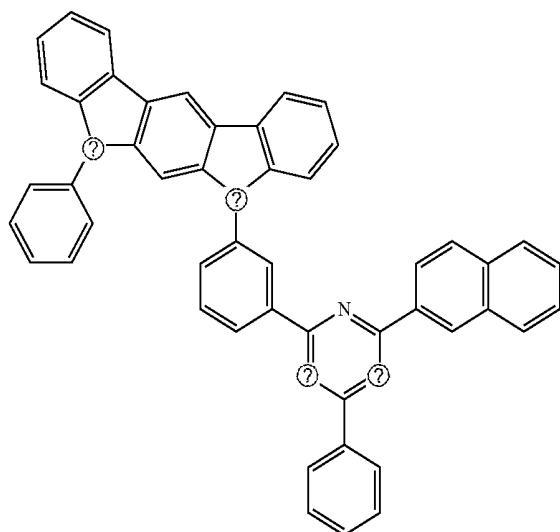


H2-50



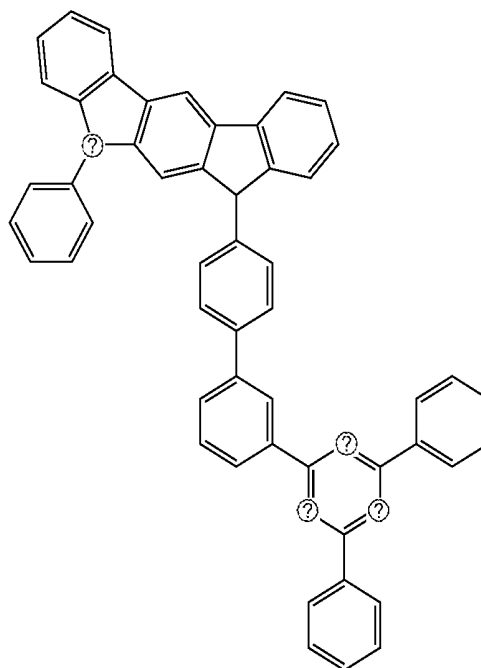
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H2-51

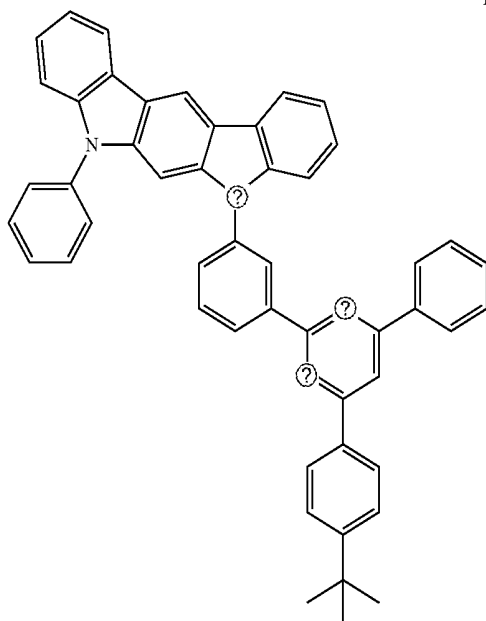


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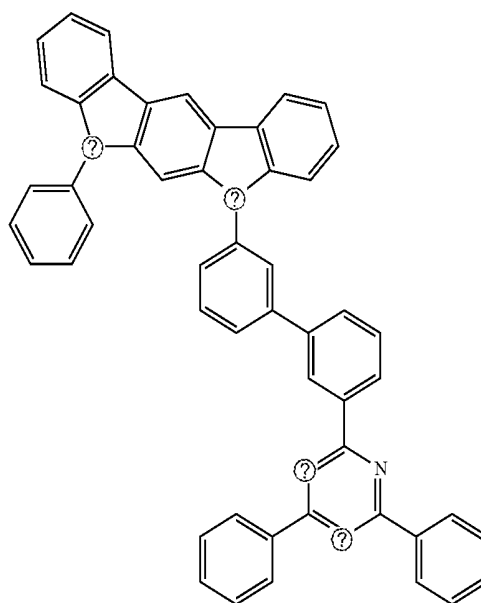
H2-53



H2-52

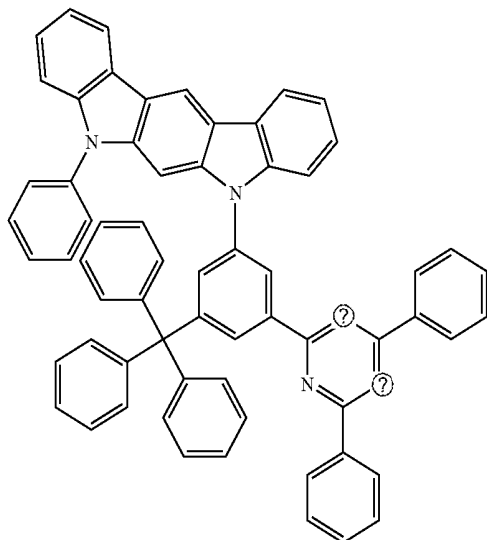


H2-54

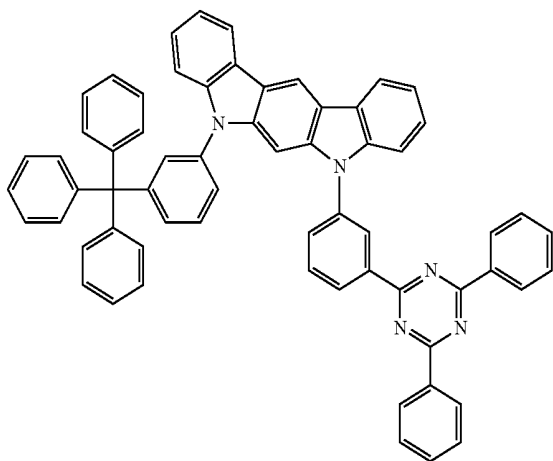


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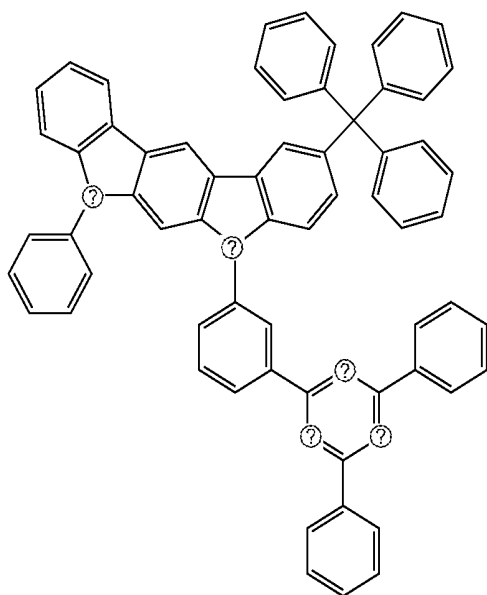
H2-55



H2-56

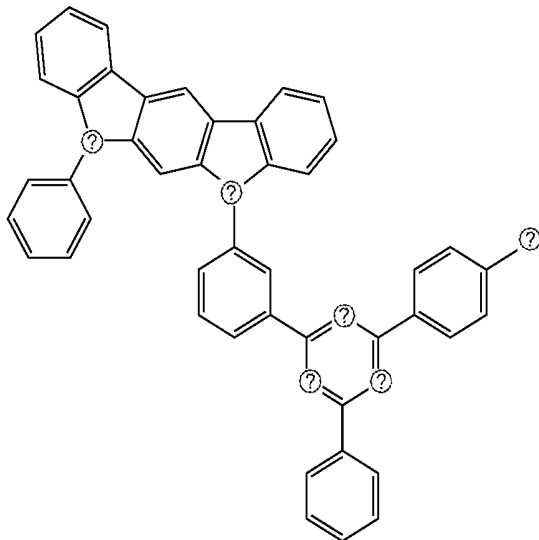


H2-57

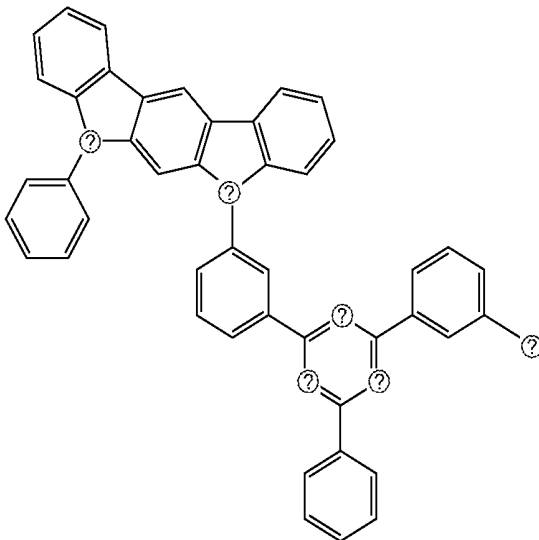


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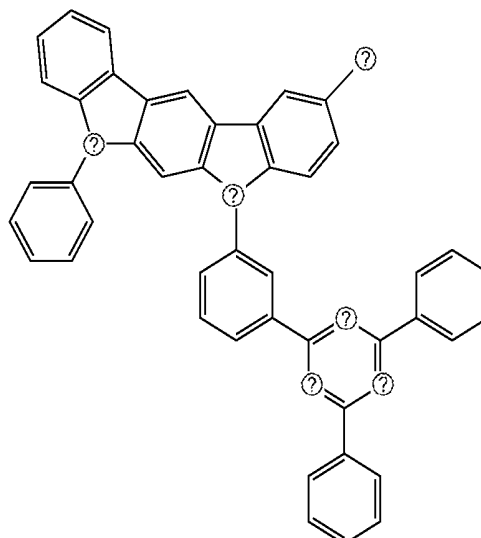
H2-58



H2-59

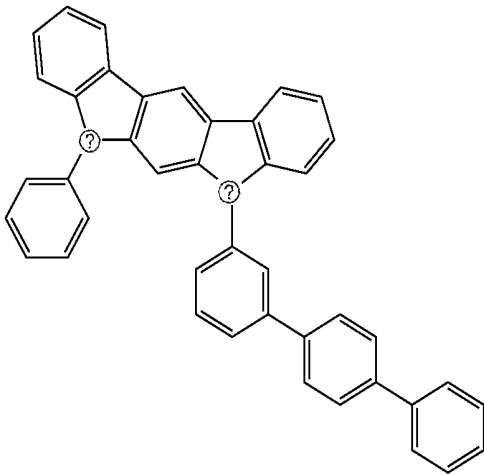


H2-60

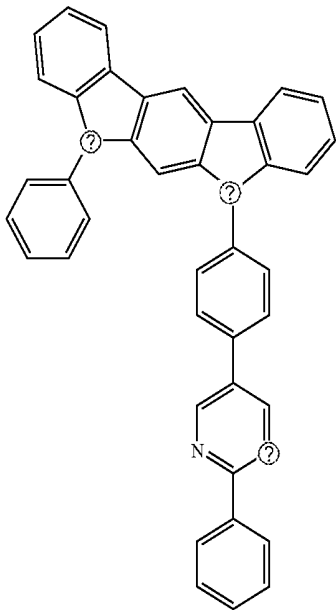


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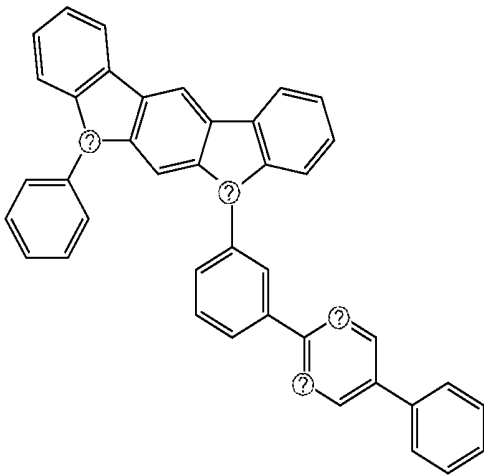
H2-61



H2-62

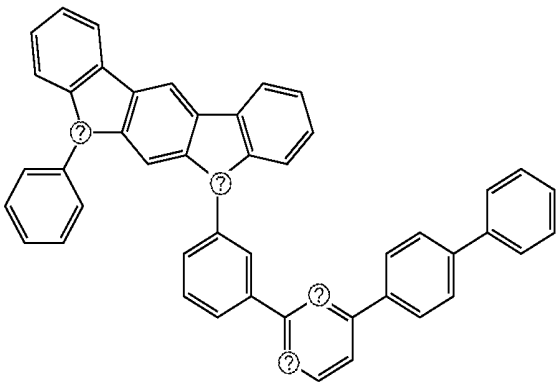


H2-63

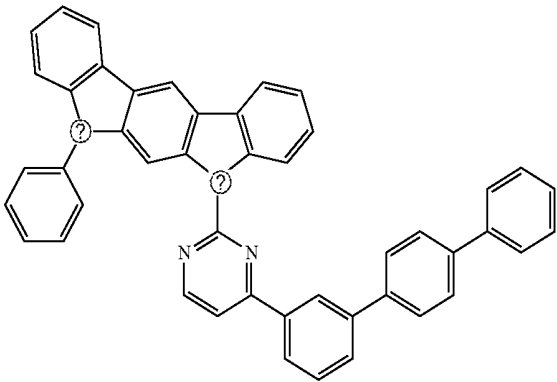


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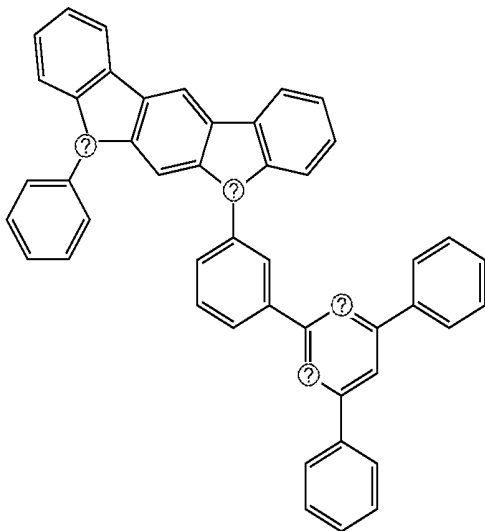
H2-64



H2-65

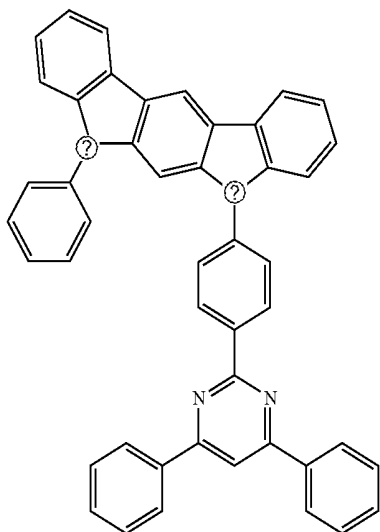


H2-66

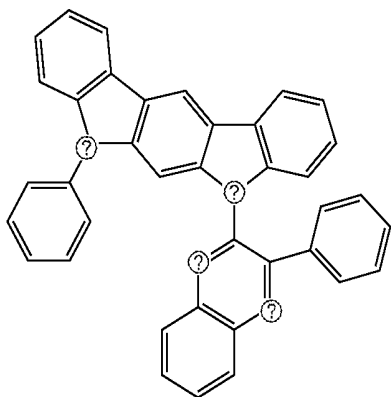


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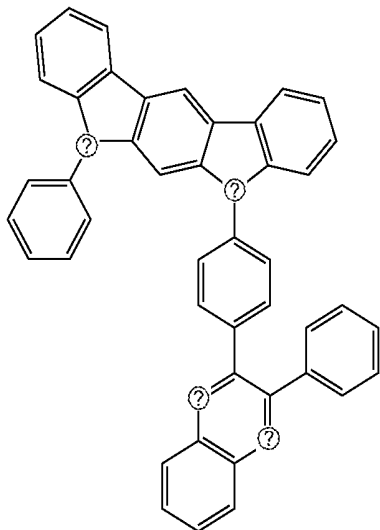
H2-67



H2-68

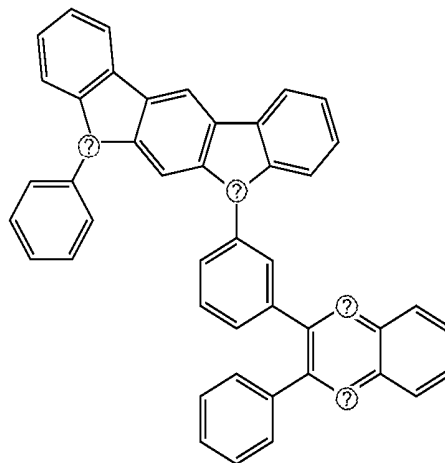


H2-69

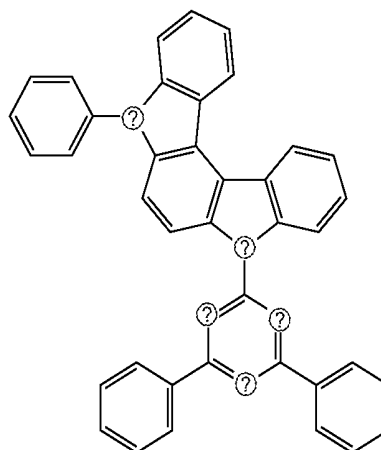


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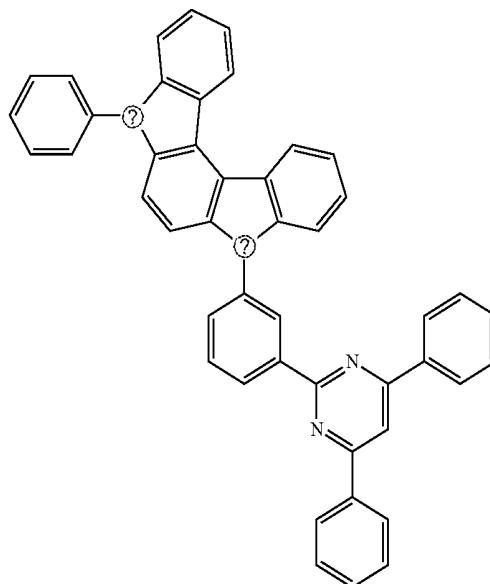
H2-70



H2-71

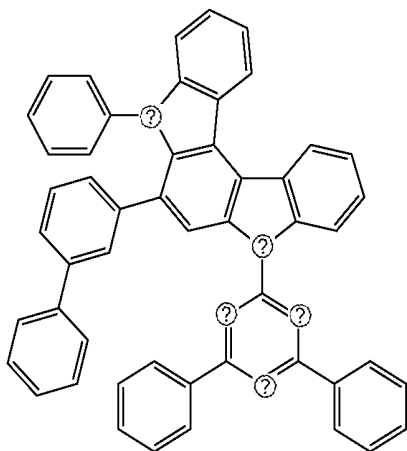


H2-72

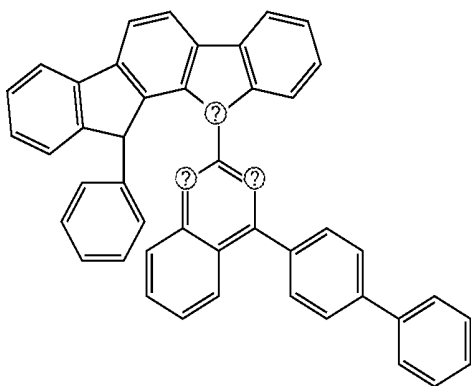


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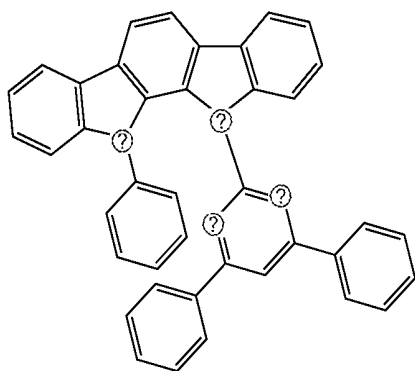
H2-73



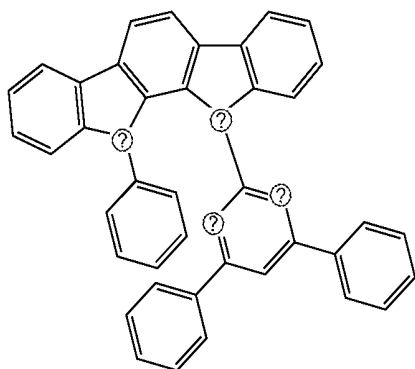
H2-74



H2-75

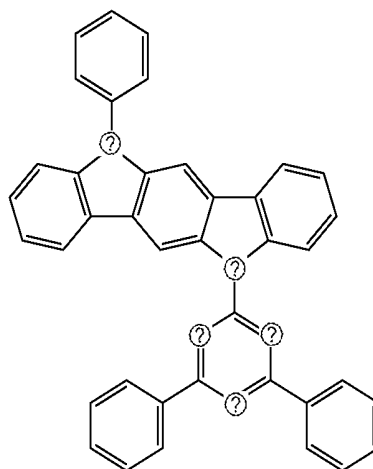


H2-76

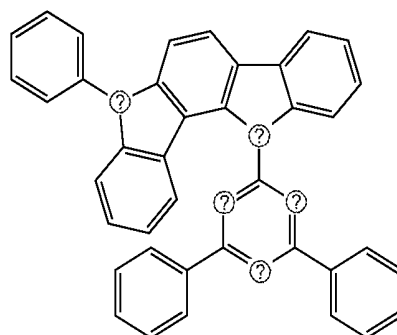


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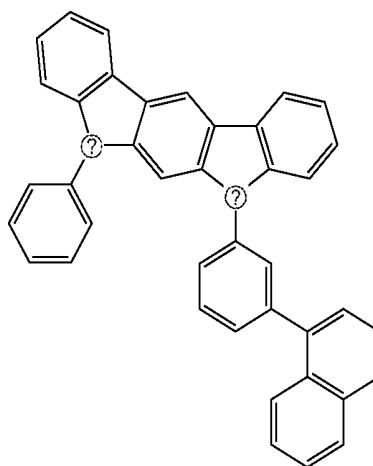
H2-77



H2-78

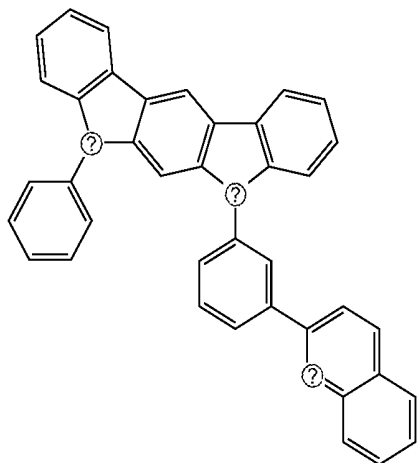


H2-79

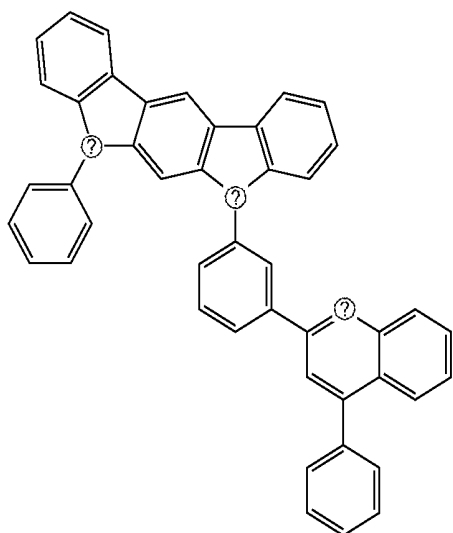


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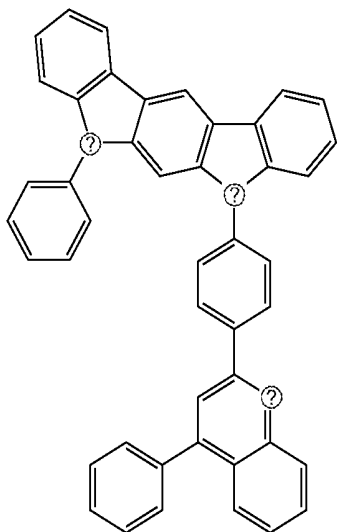
H2-80



H2-81

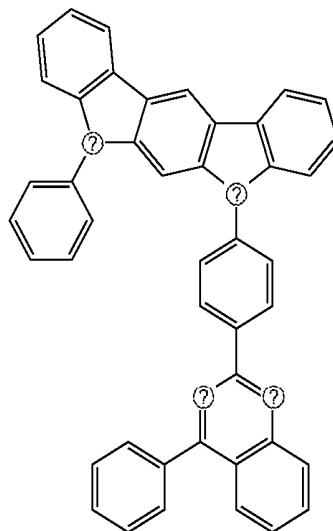


H2-82

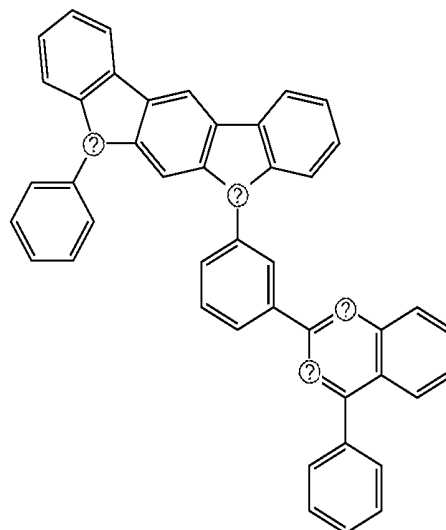


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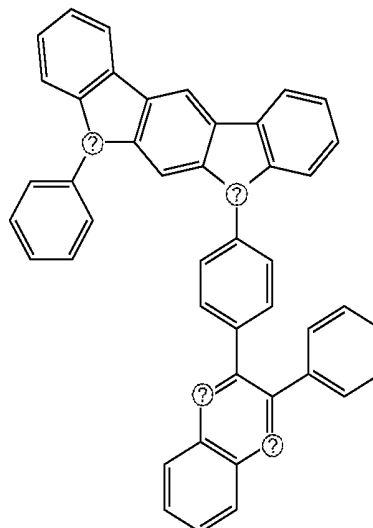
H2-83



H2-84

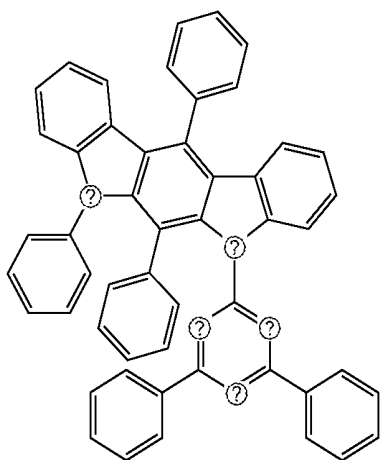


H2-85



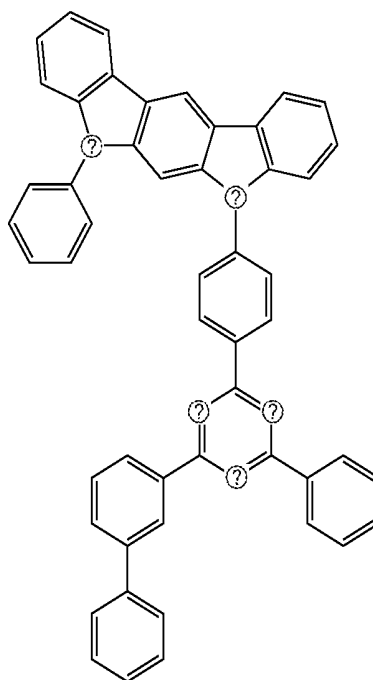
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H2-86

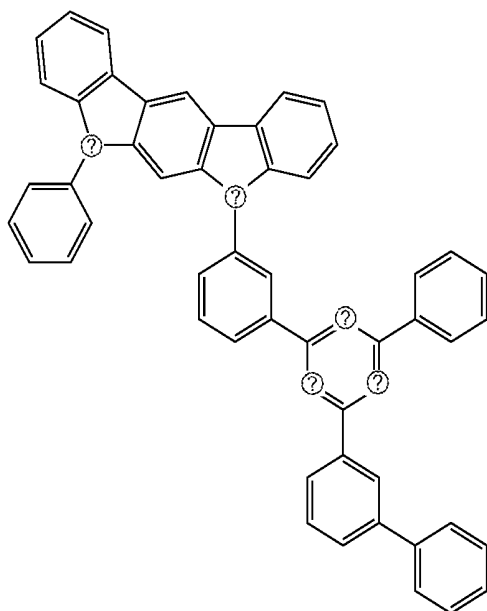


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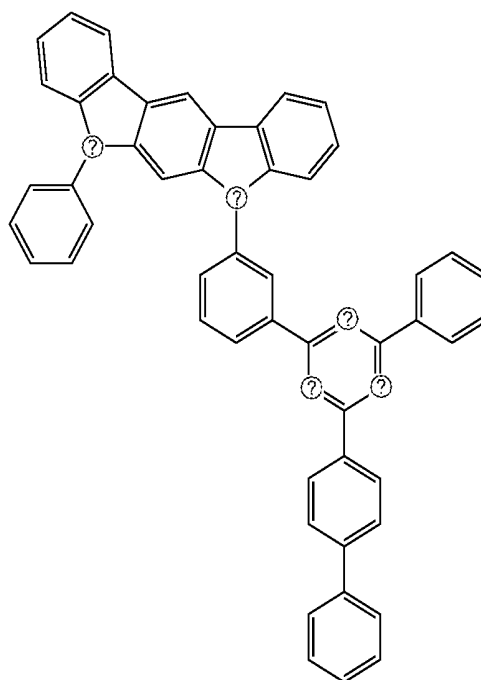
H2-88



H2-87

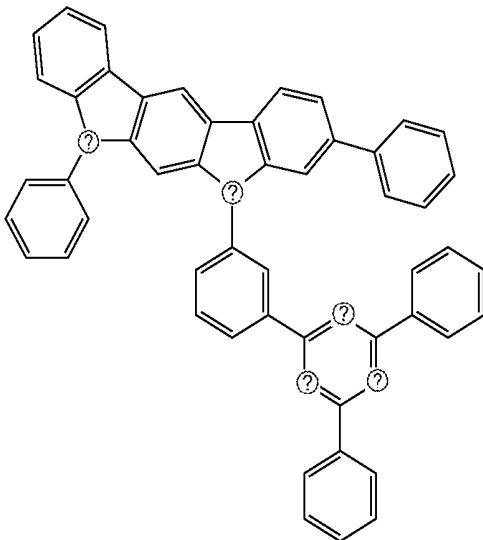


H2-89

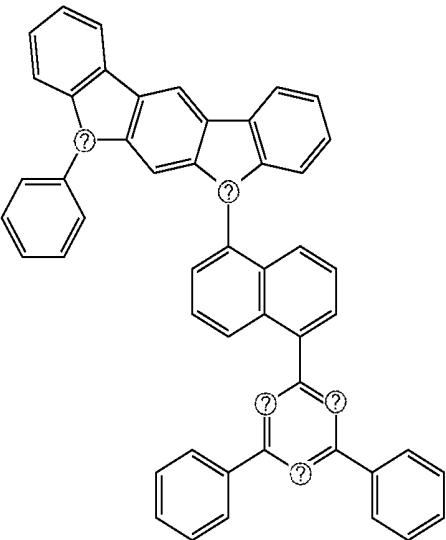


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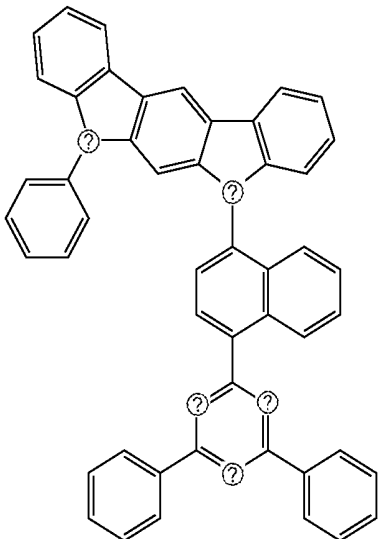
H2-90



H2-91

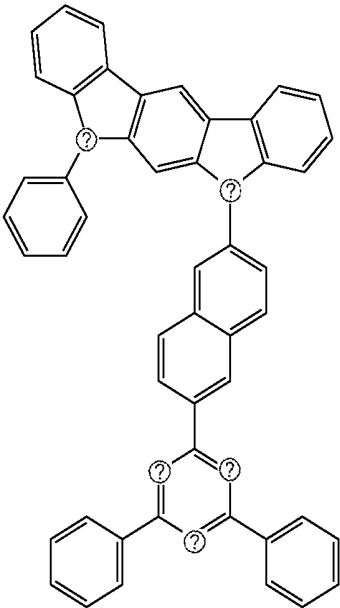


H2-92

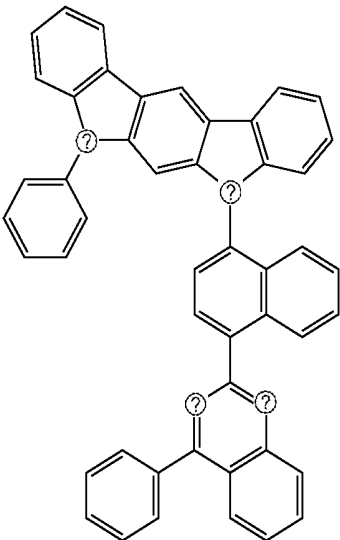


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H2-93

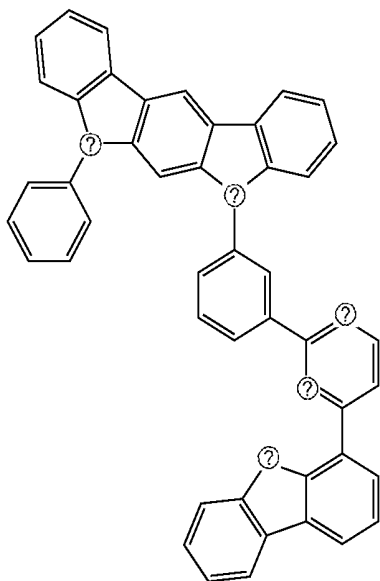


H2-94



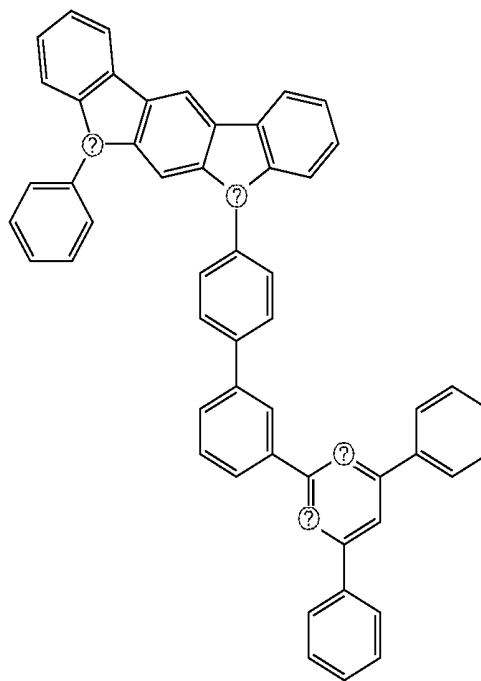
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H2-95

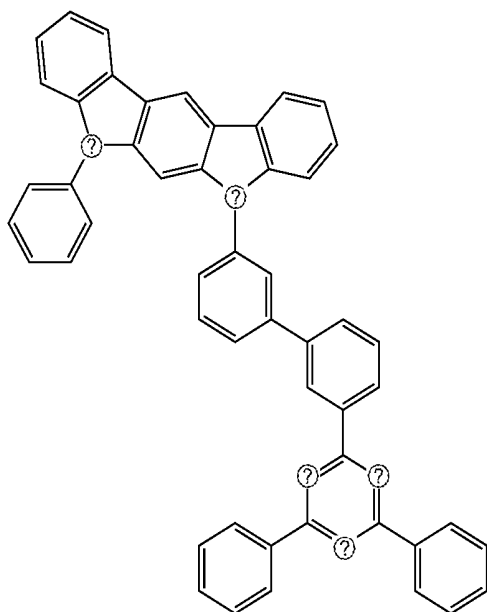


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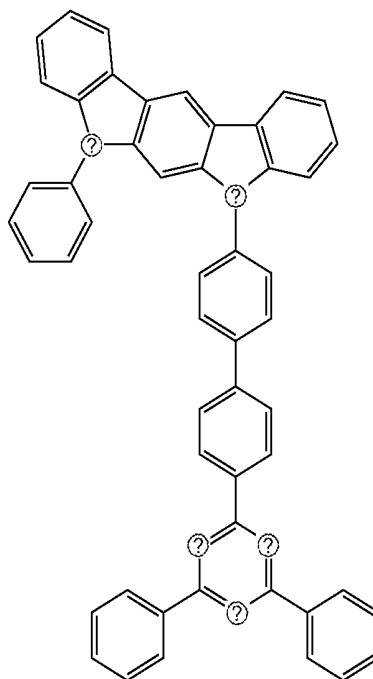
H2-97



H2-96

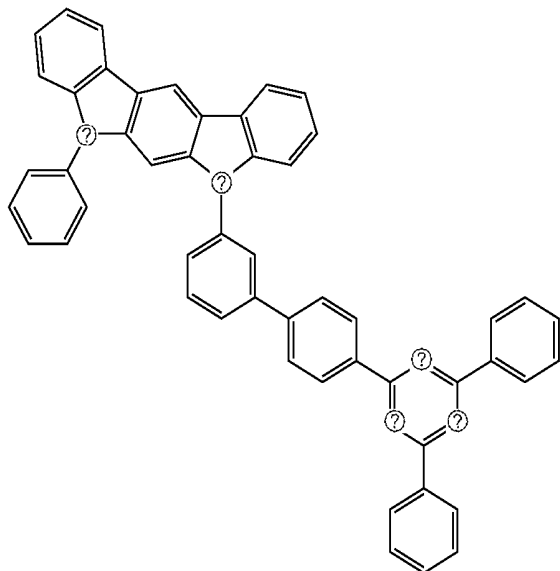


H2-98



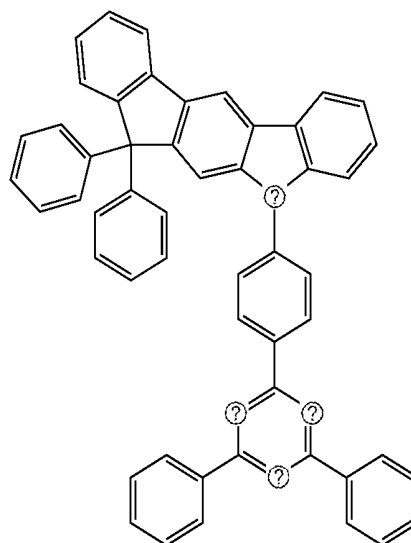
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H2-99

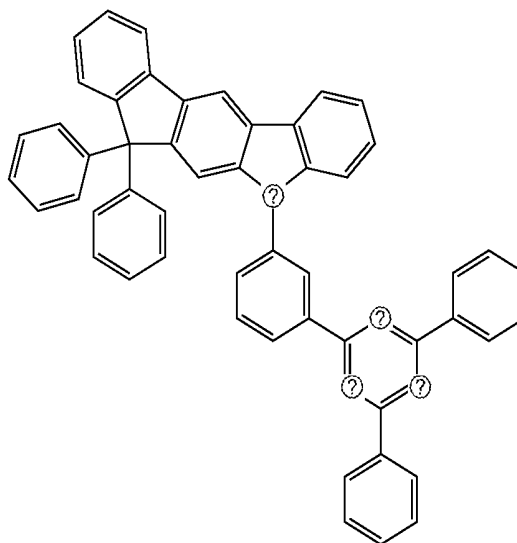


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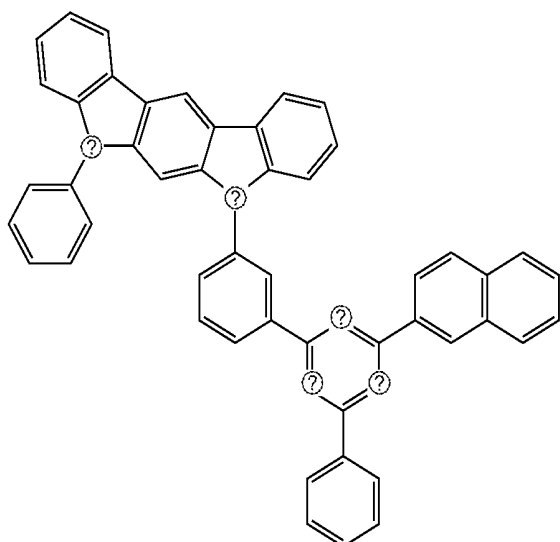
H2-101



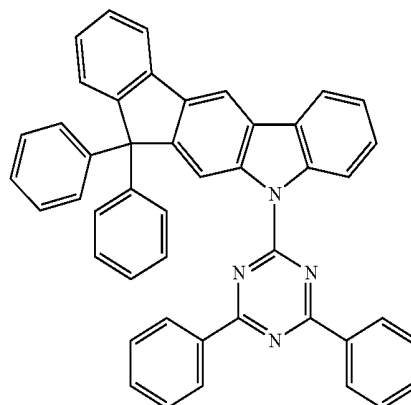
H2-102



H2-100

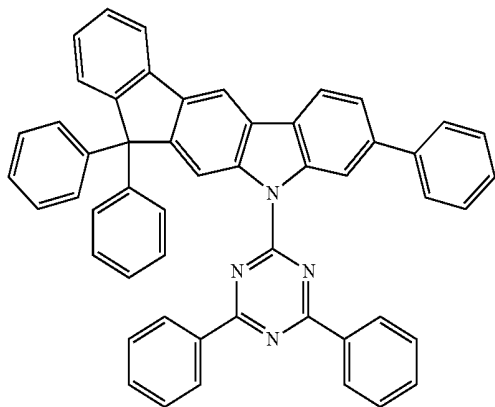


H2-103



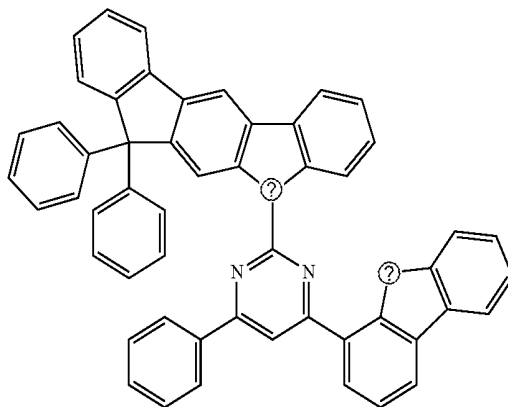
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H2-104

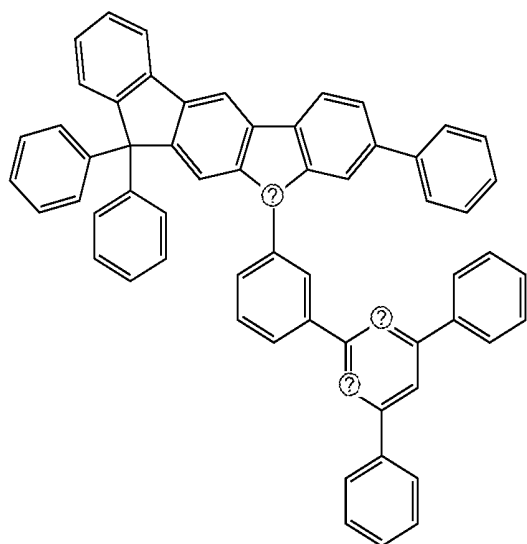


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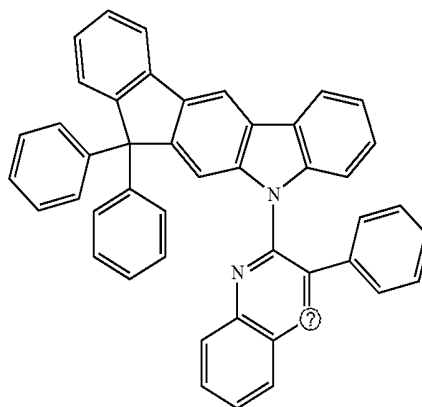
H2-107



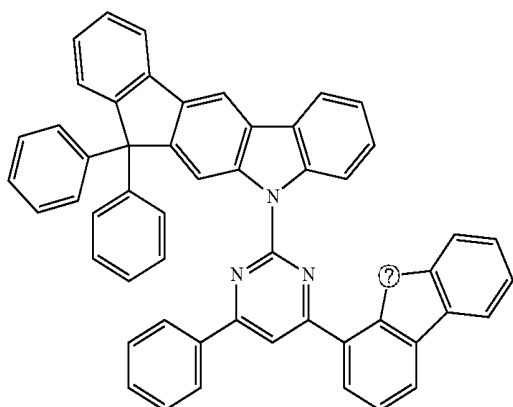
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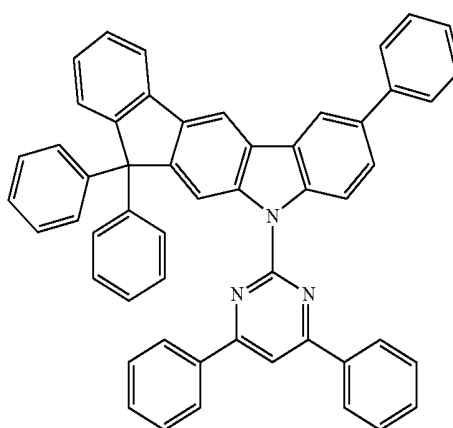
H2-108



H2-106

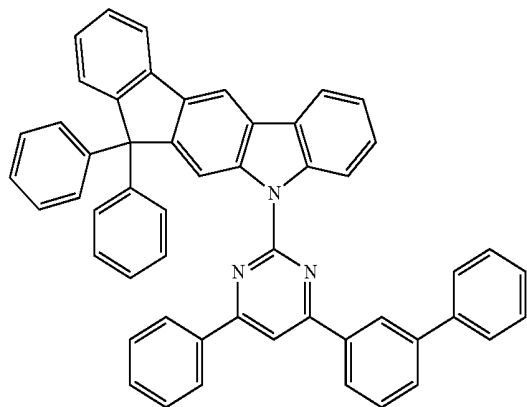


H2-109



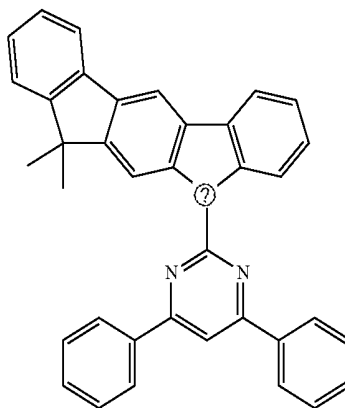
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H2-110

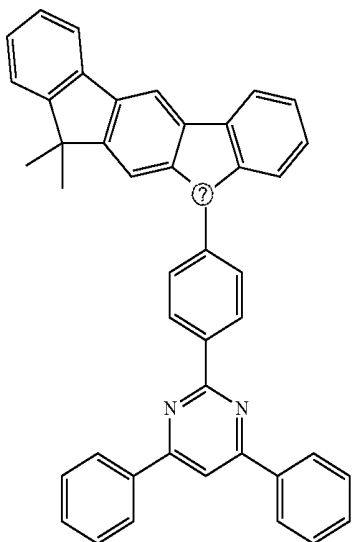


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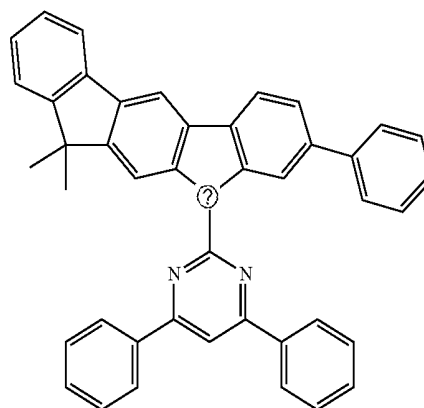
H2-113



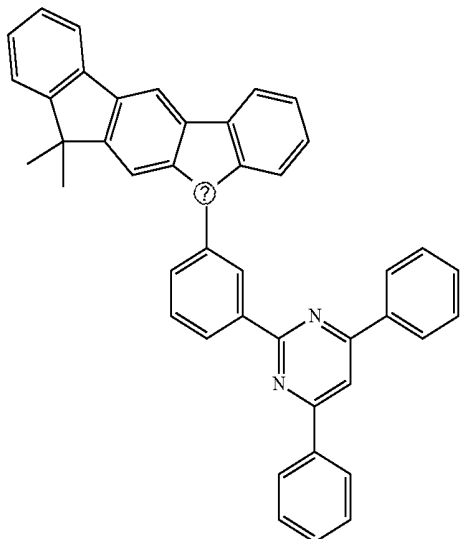
H2-111



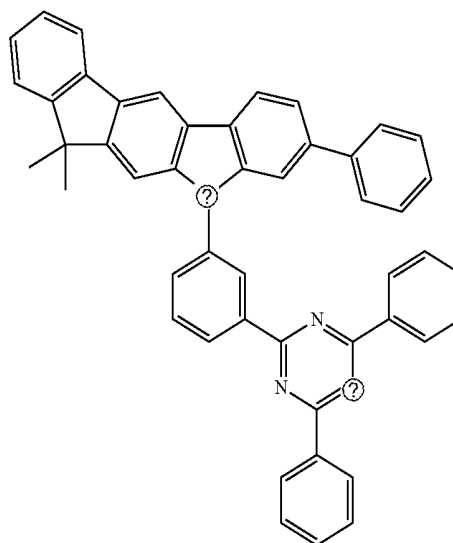
H2-114



H2-112

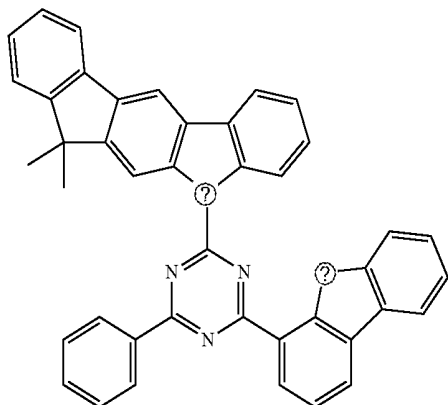


H2-115



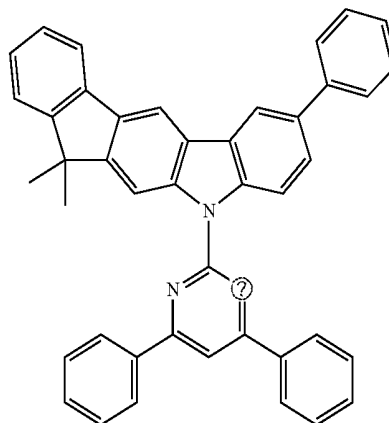
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H2-116

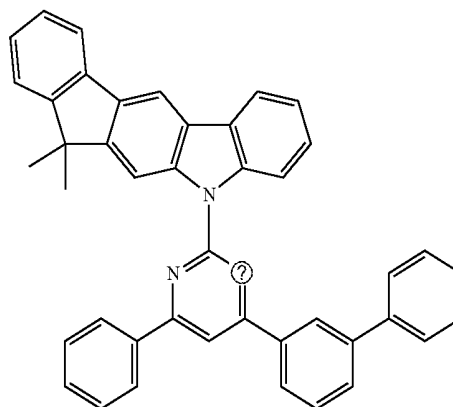


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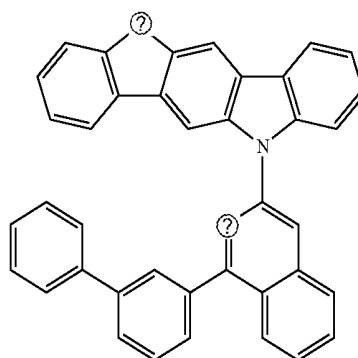
H2-119



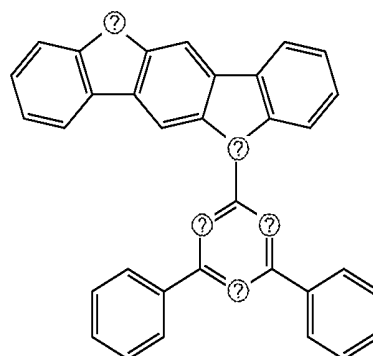
H2-120



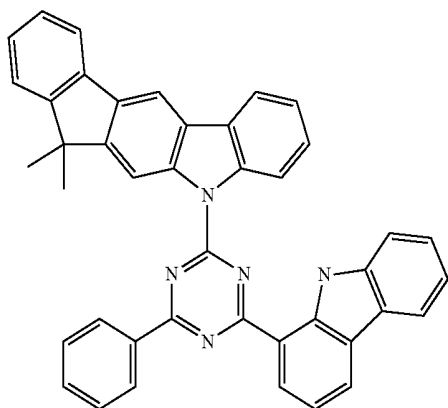
H2-121



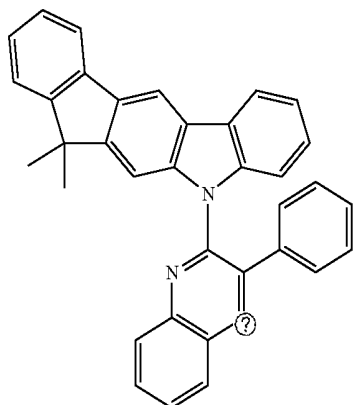
H2-122



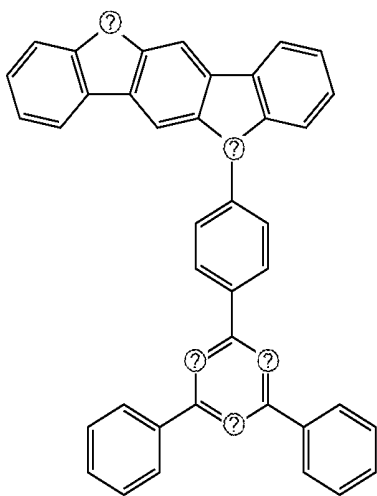
H2-117



H2-118

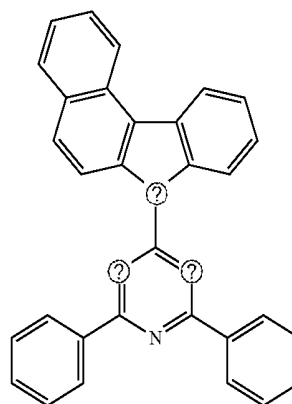


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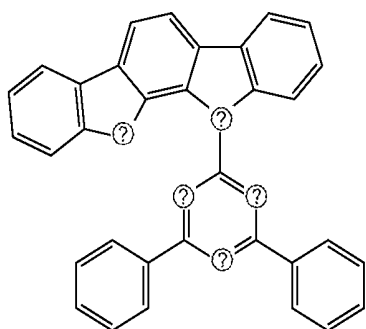


H2-123

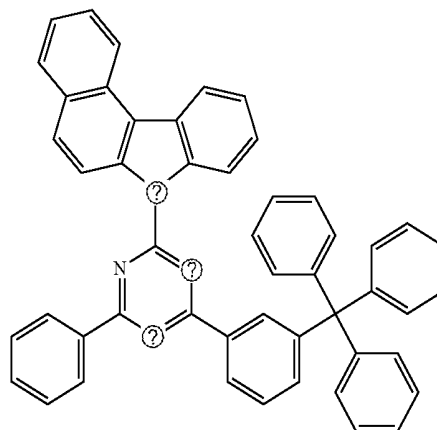
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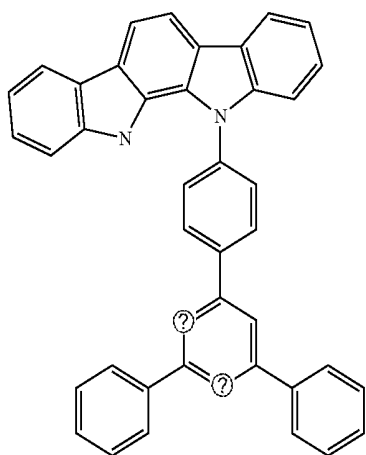
H2-126



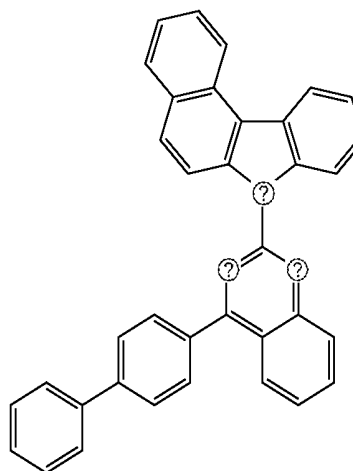
H2-124



H2-127



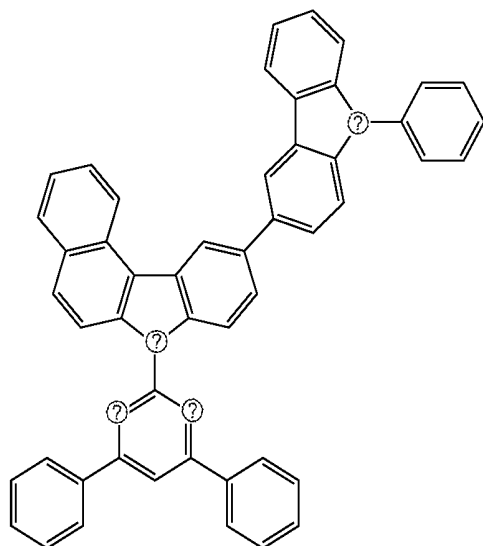
H2-125



H2-128

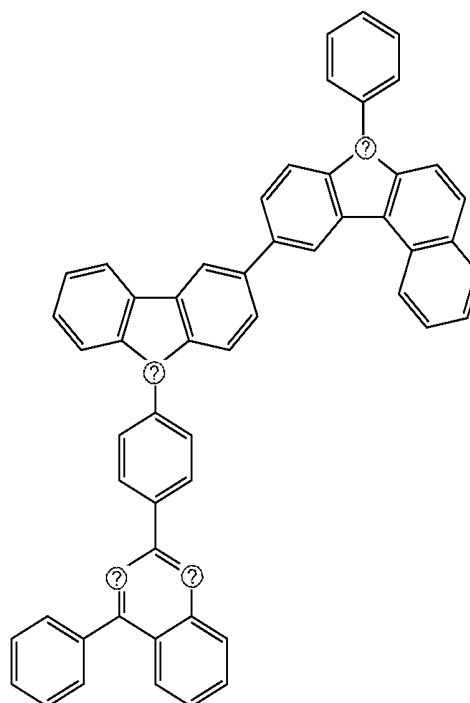
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H2-129

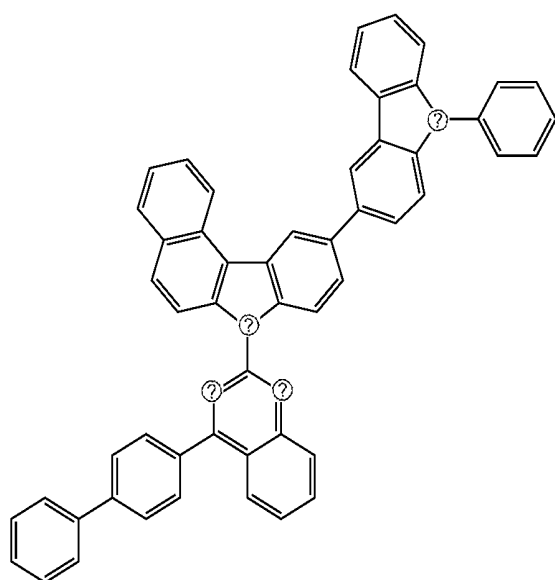


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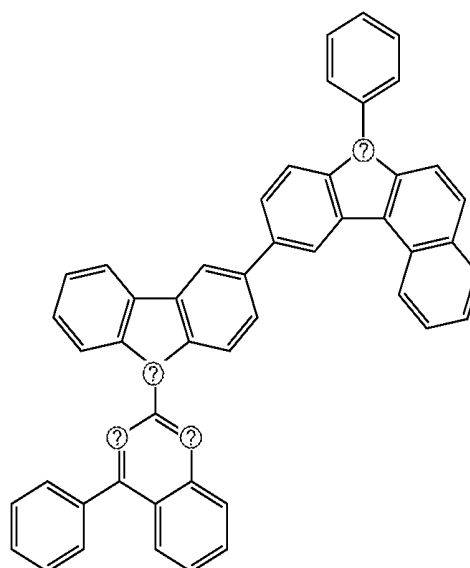
H2-131



H2-130

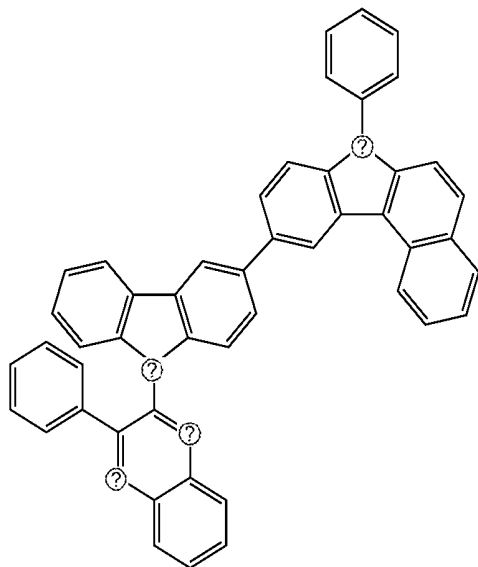


H2-132



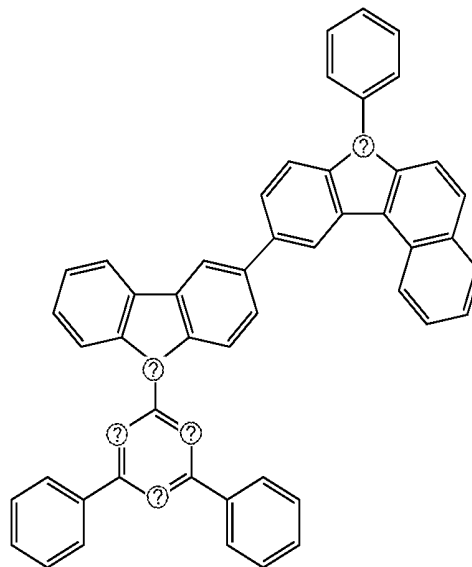
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H2-133

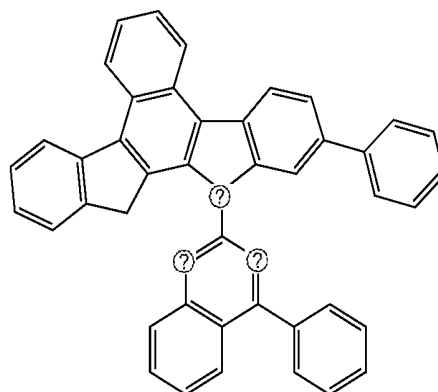


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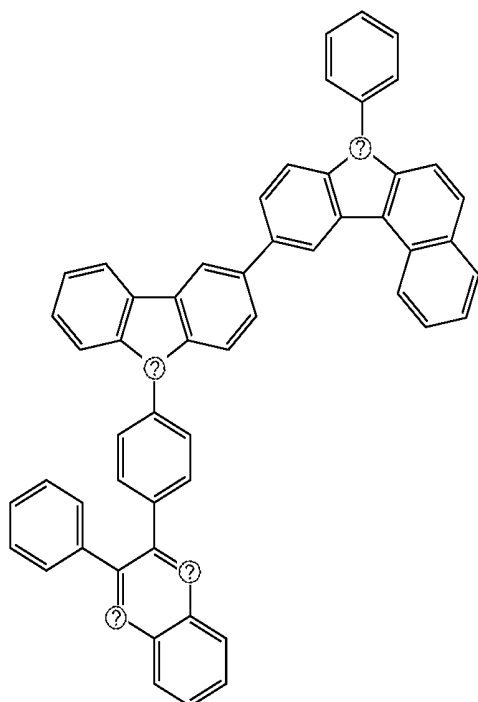
H2-135



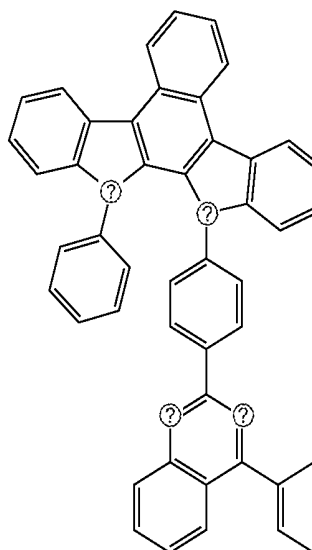
H2-136



H2-134

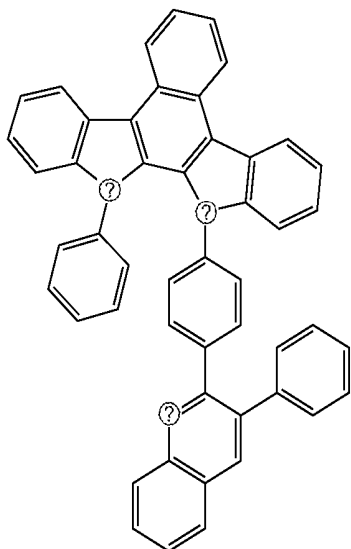


H2-137



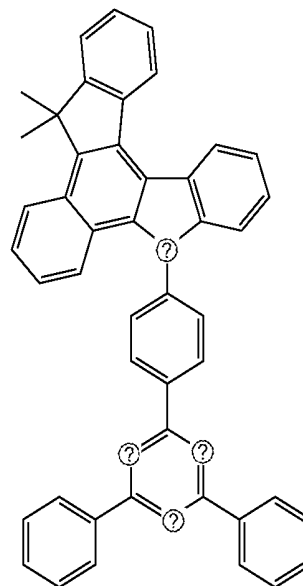
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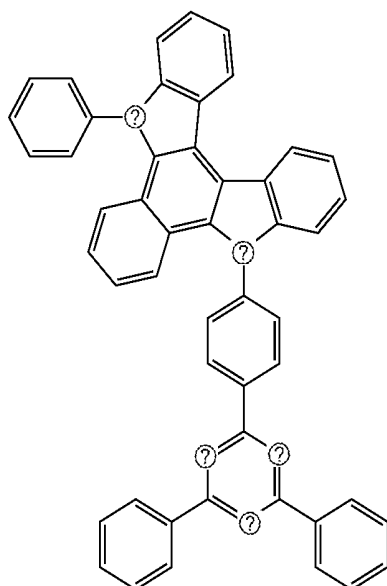


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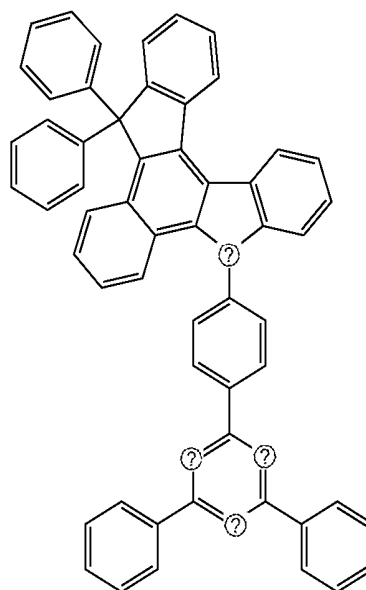
H2-140



H2-139

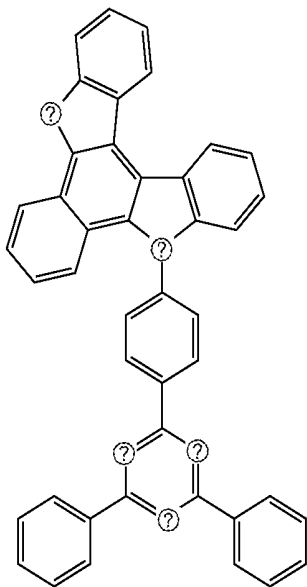


H2-141



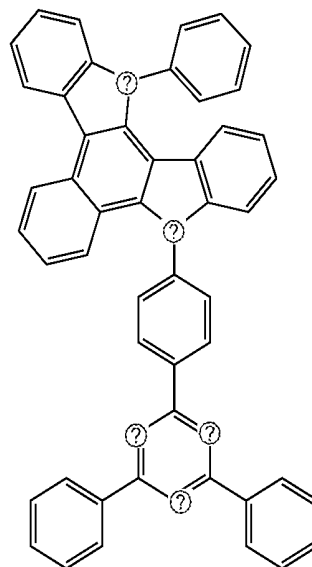
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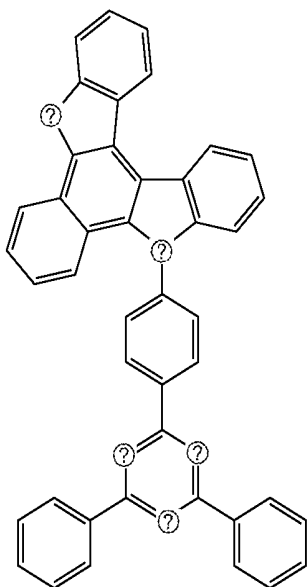


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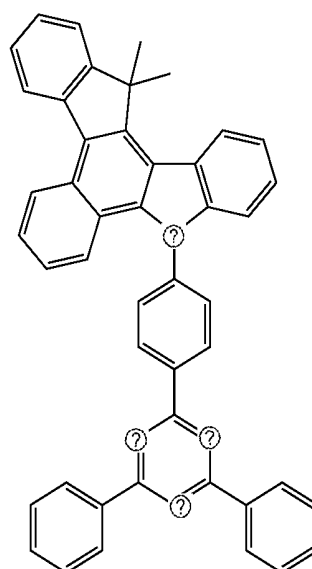
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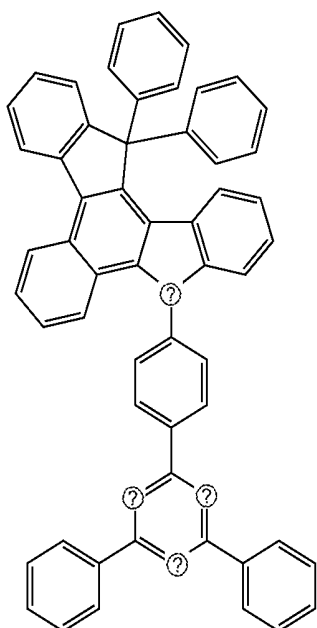
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H2-145

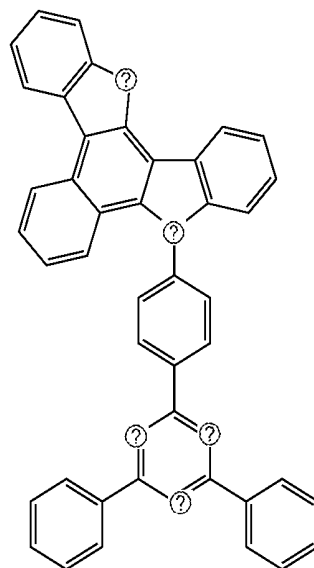


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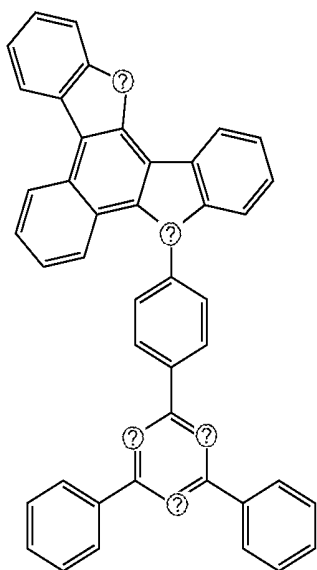


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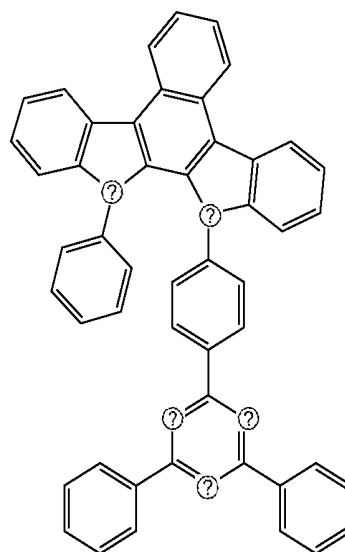
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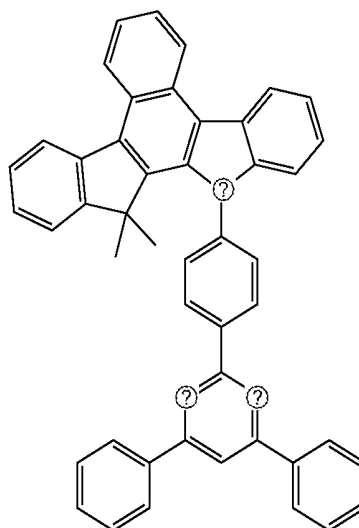
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H2-147

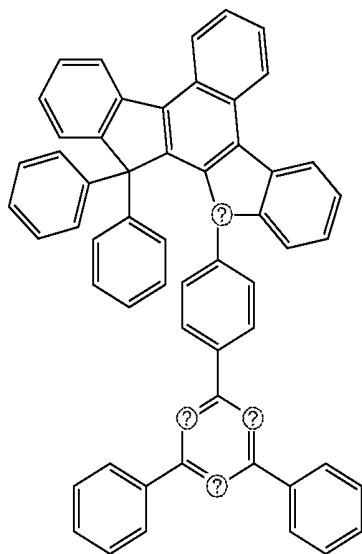


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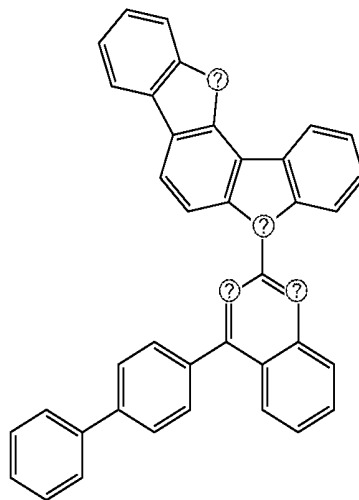
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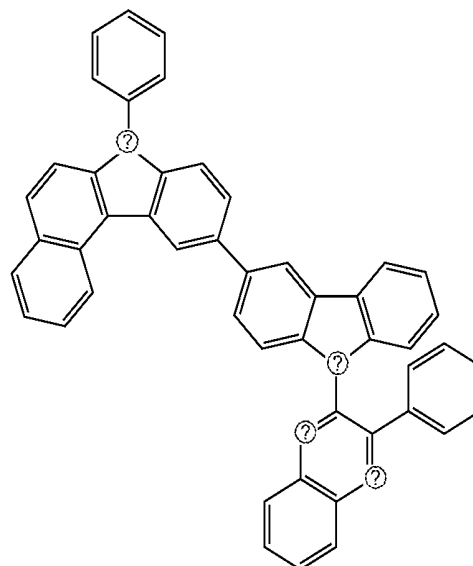
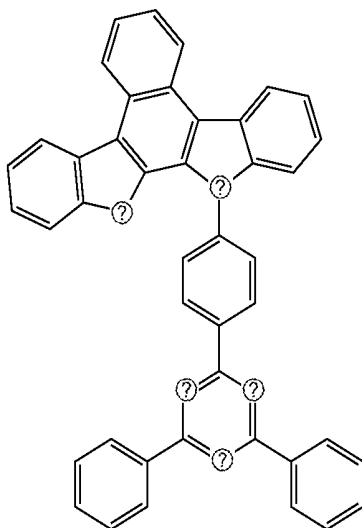
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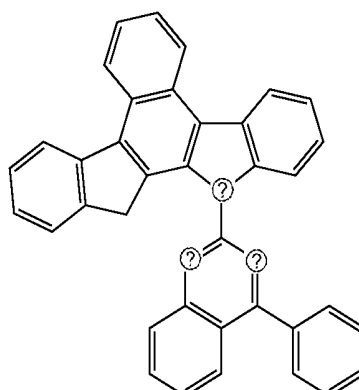
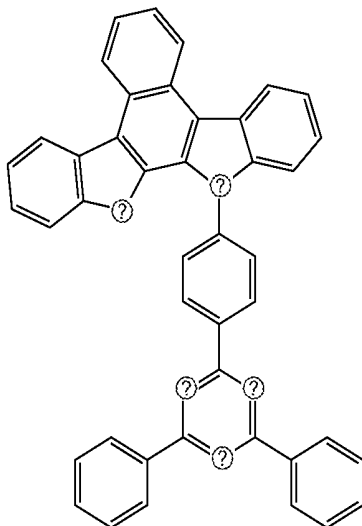
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H2-152



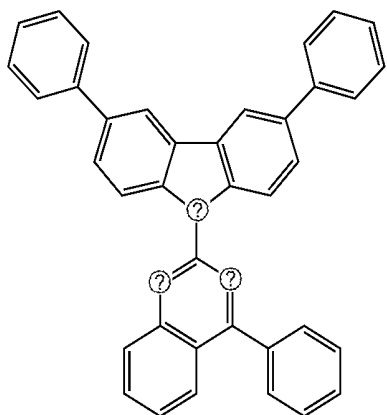
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H2-153



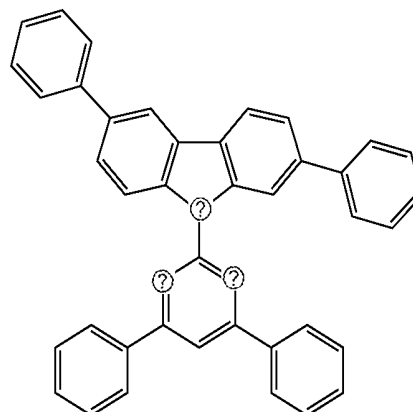
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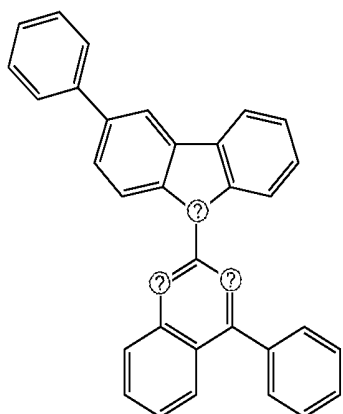


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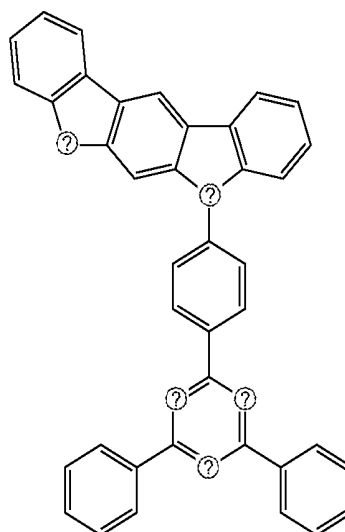
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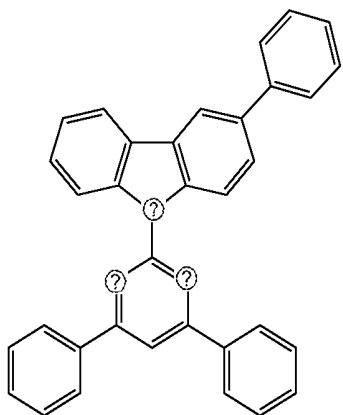
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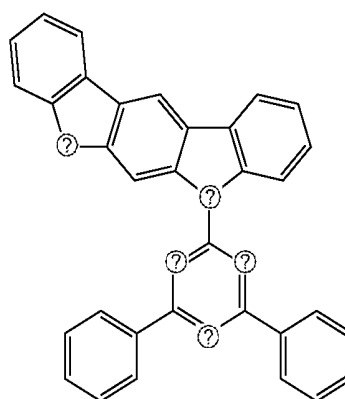
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H2-161



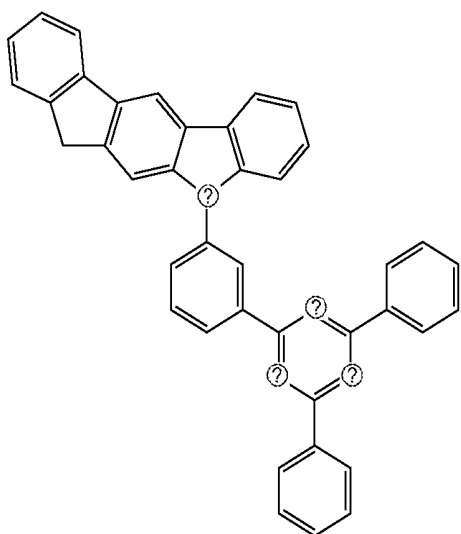
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H2-162

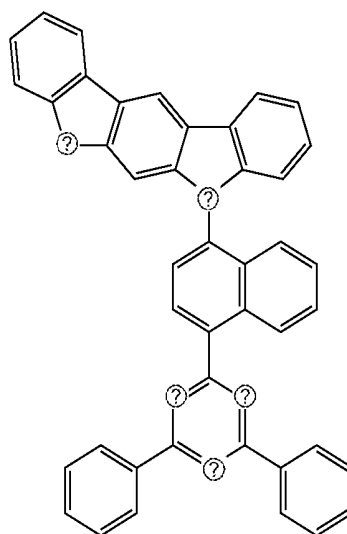
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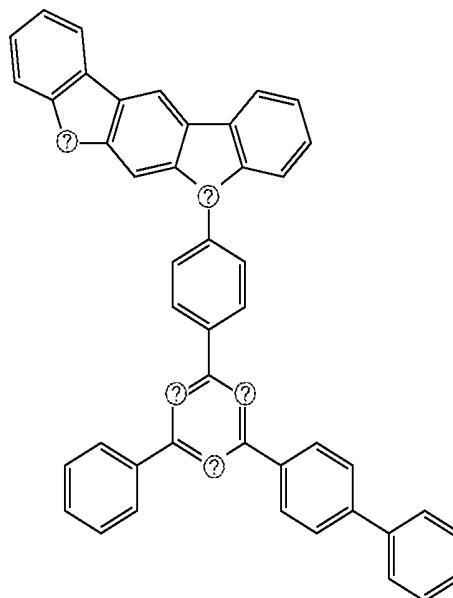
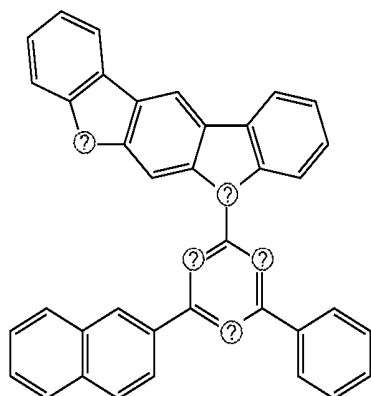
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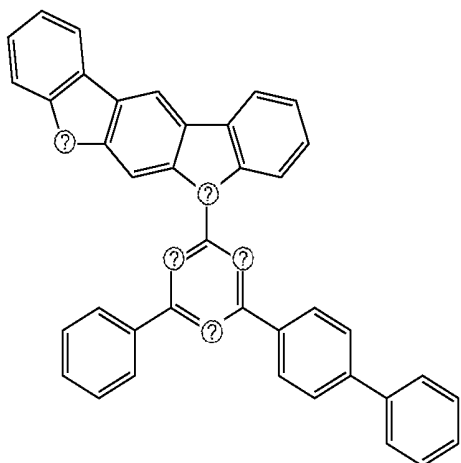


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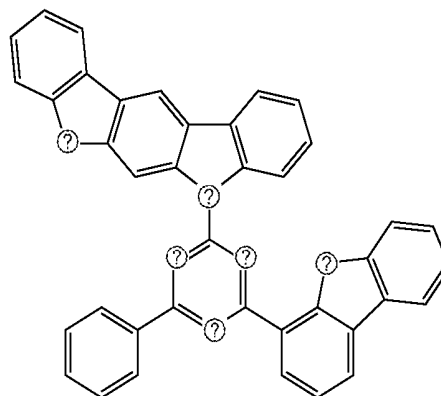
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H2-165

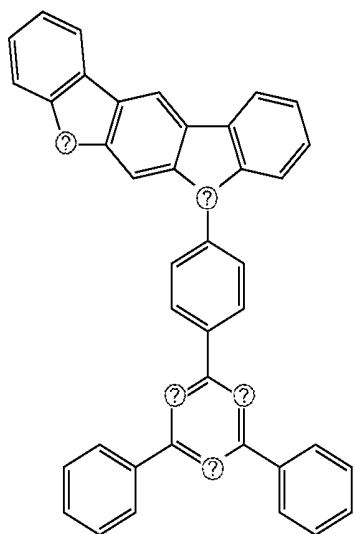


H2-168



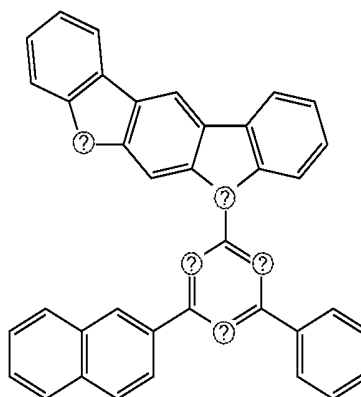
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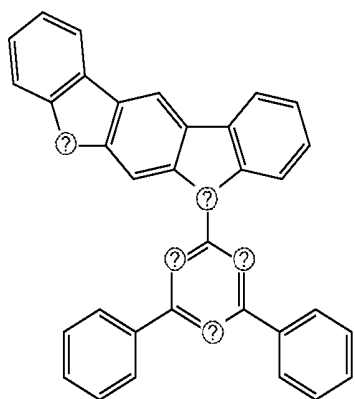


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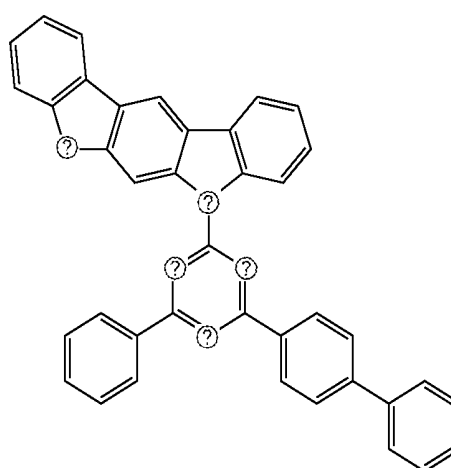
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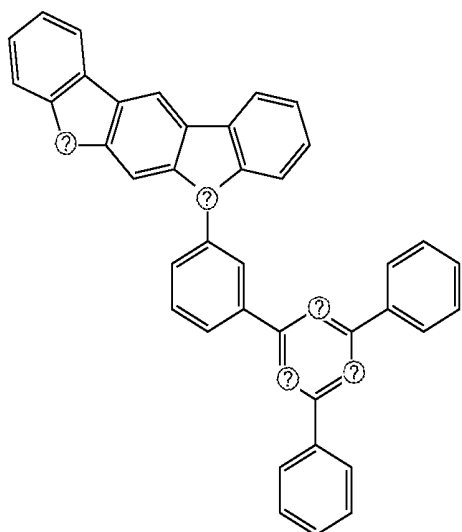
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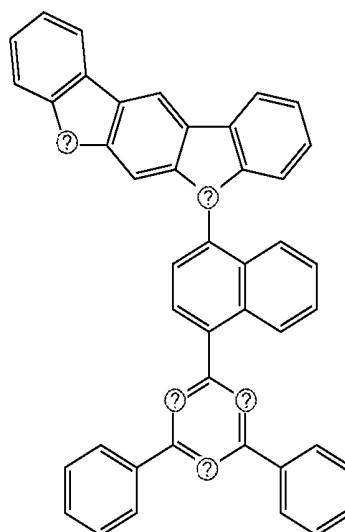
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H2-171

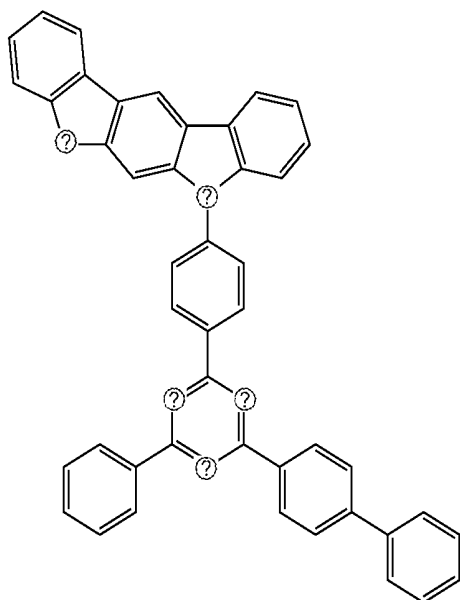


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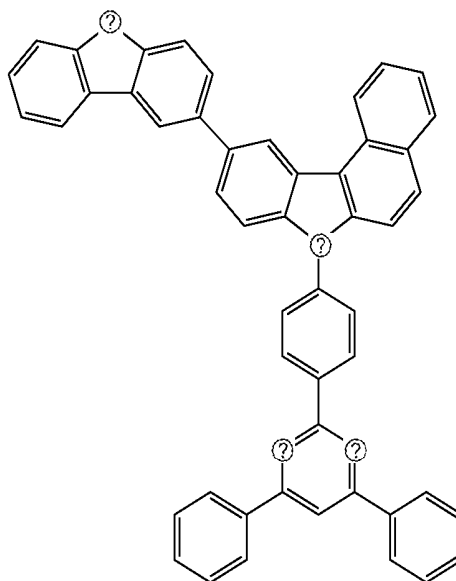
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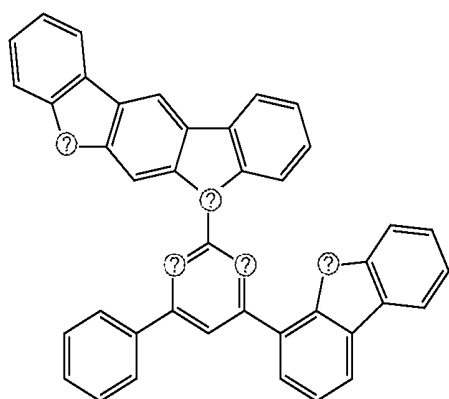


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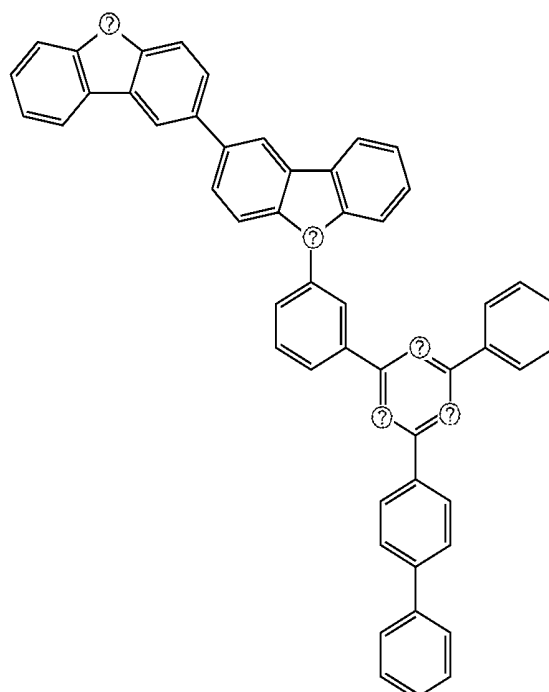
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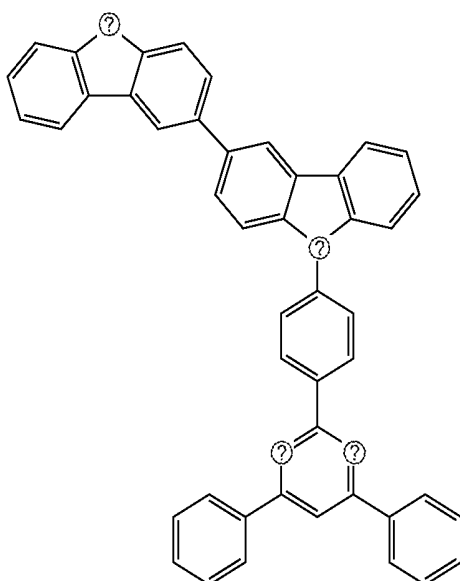
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H2-179

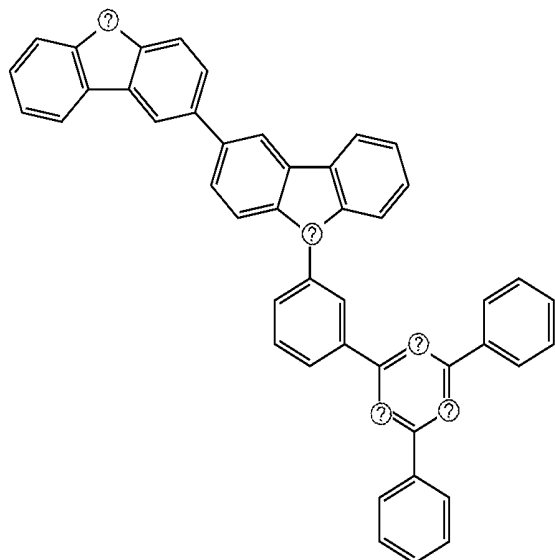


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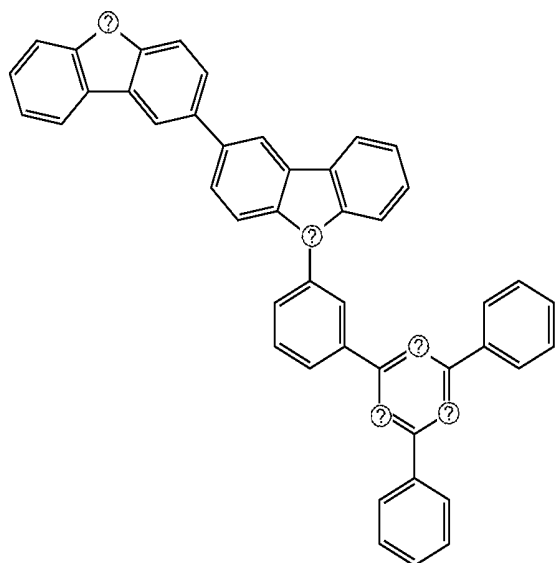


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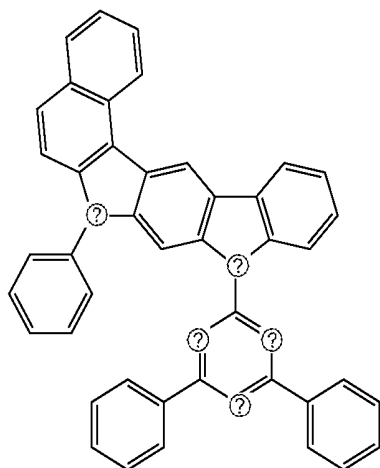
H2-180



H2-181

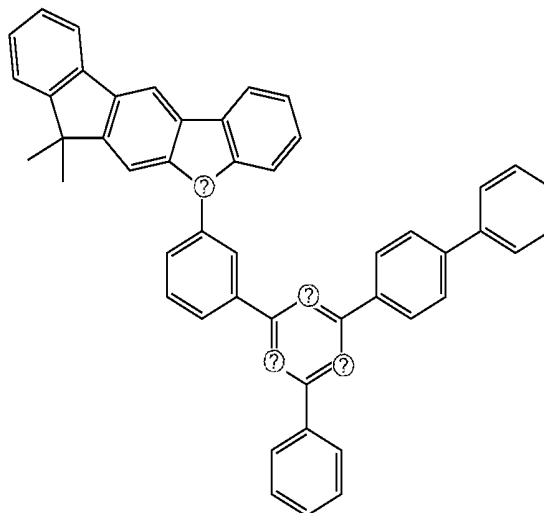


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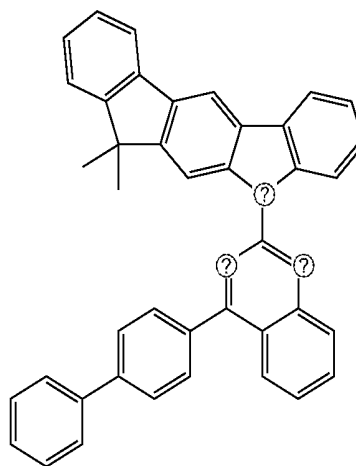


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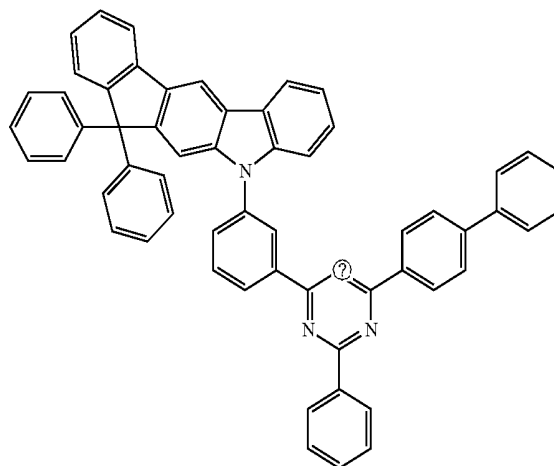
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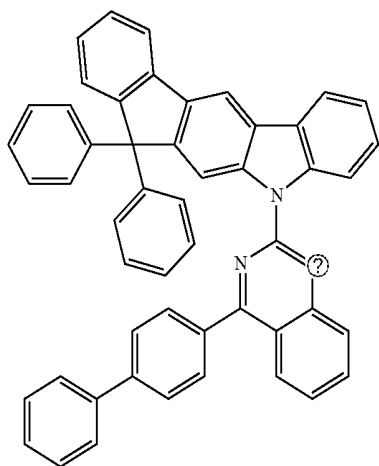
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H2-185

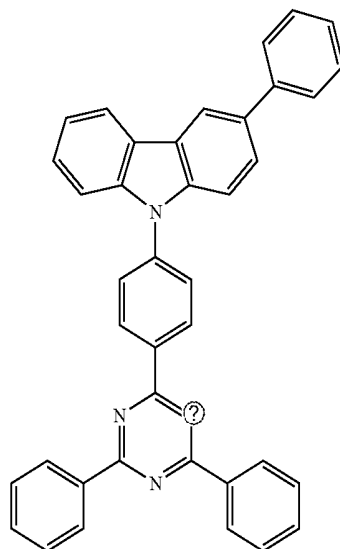


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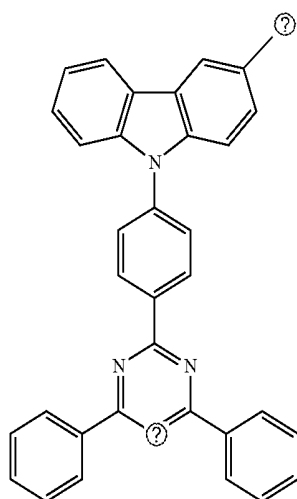
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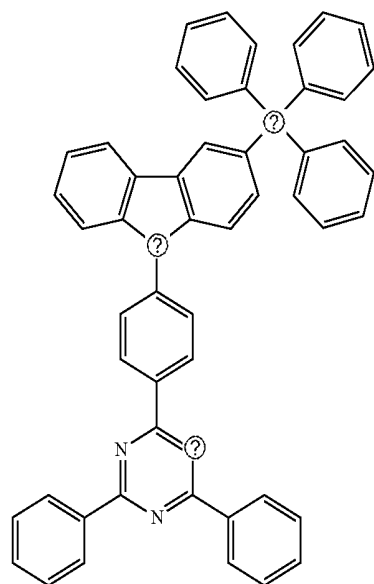


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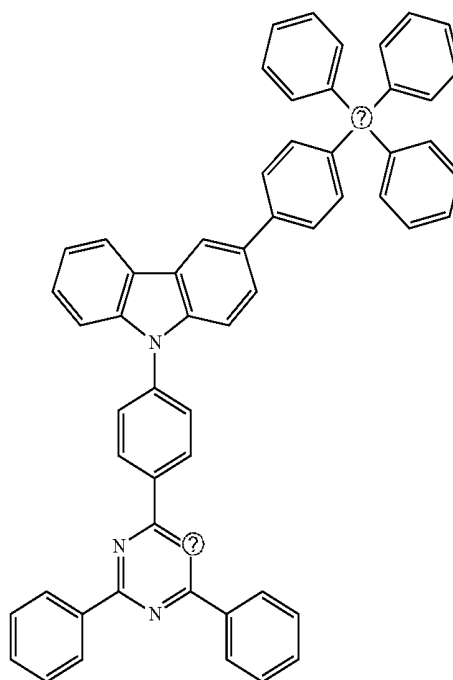
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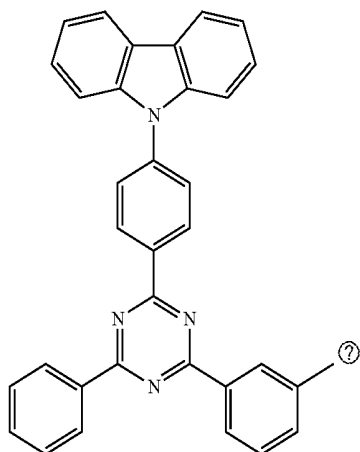
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H2-190

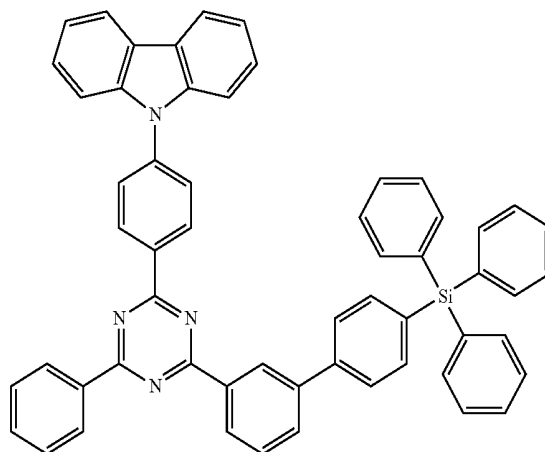


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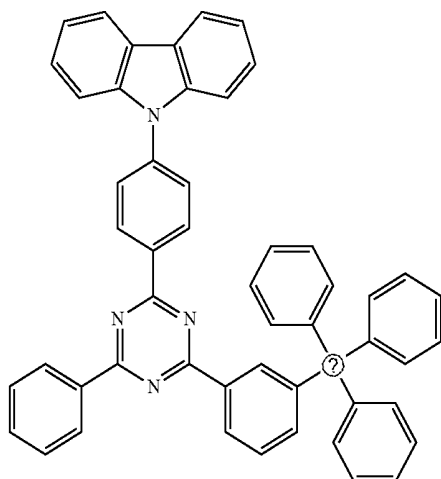
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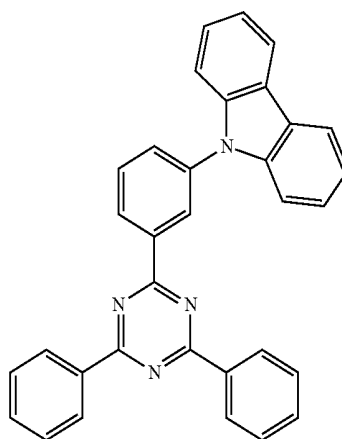
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H2-192

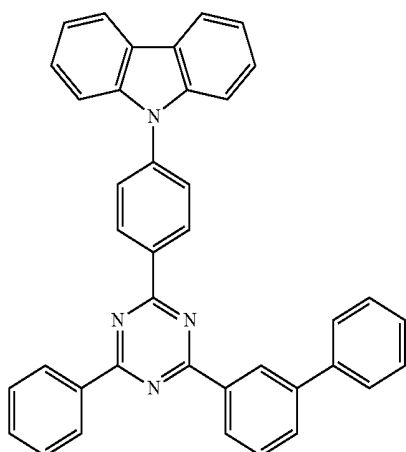


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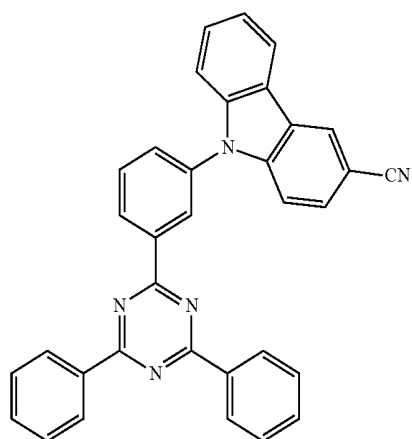
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H2-193

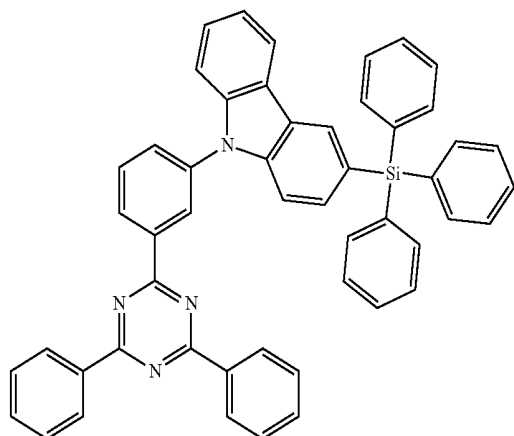


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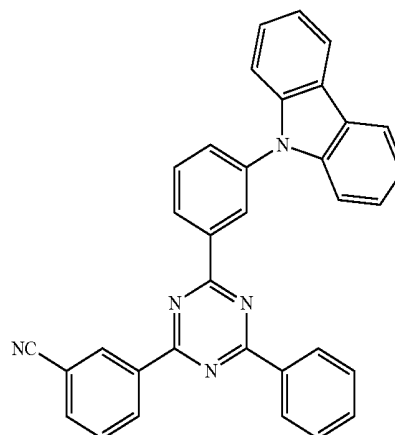
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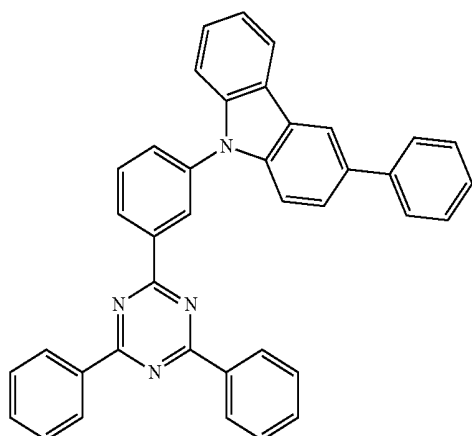


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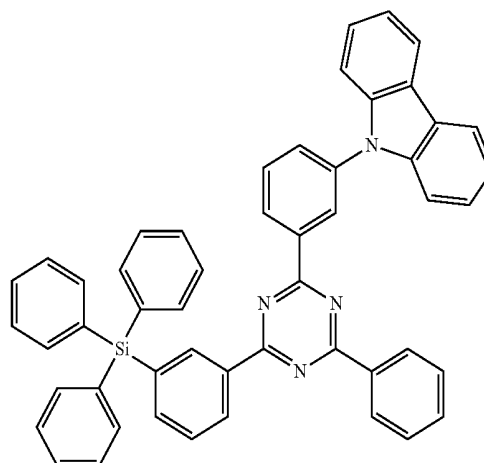
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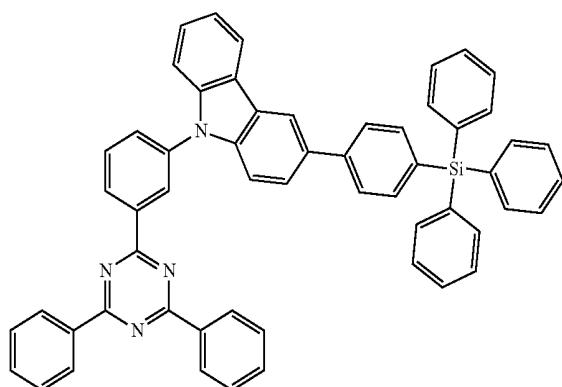
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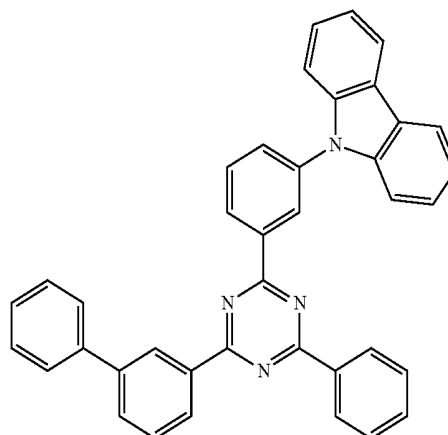
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H2-199

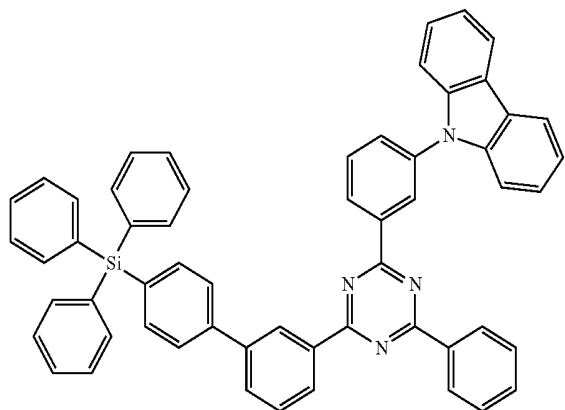


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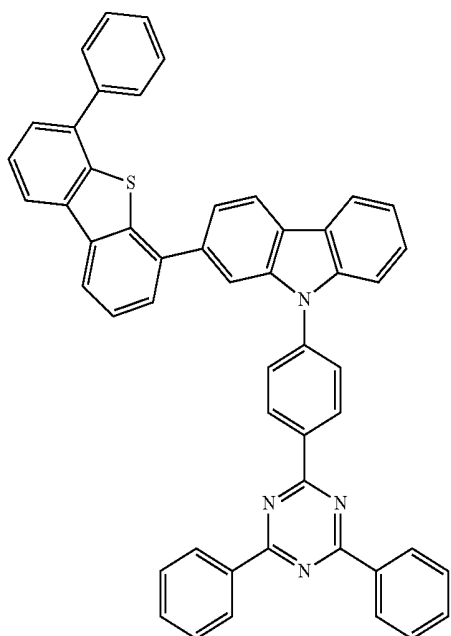


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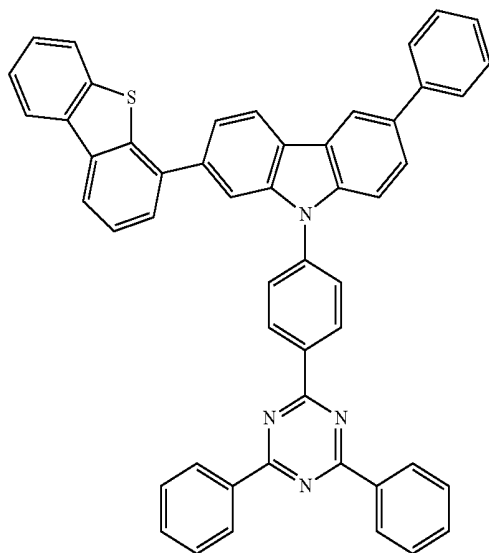
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H2-204

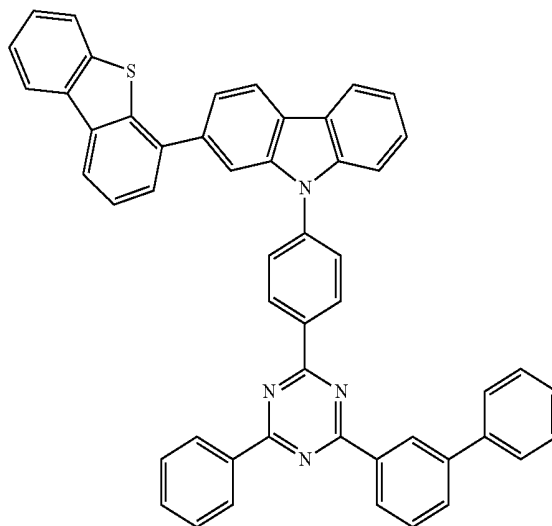


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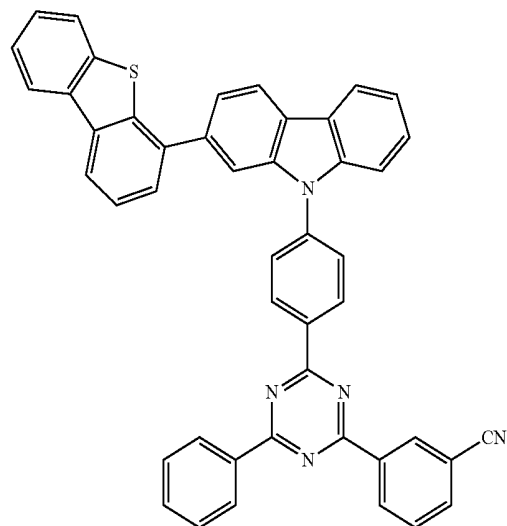


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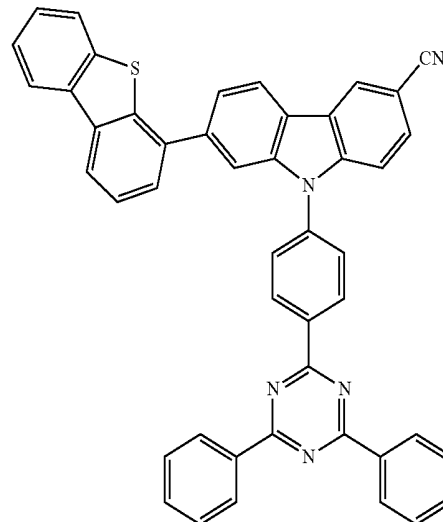
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H2-207

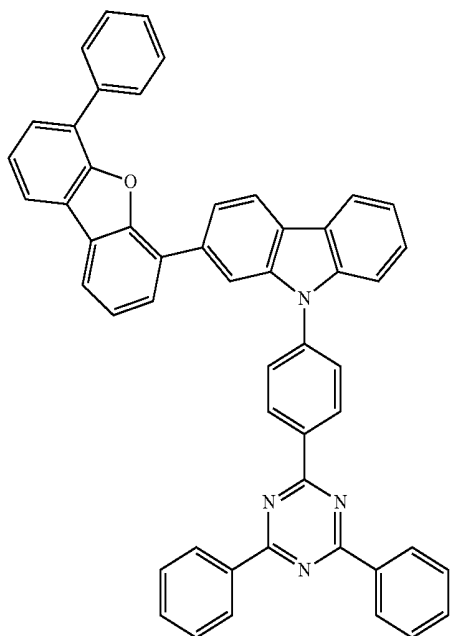


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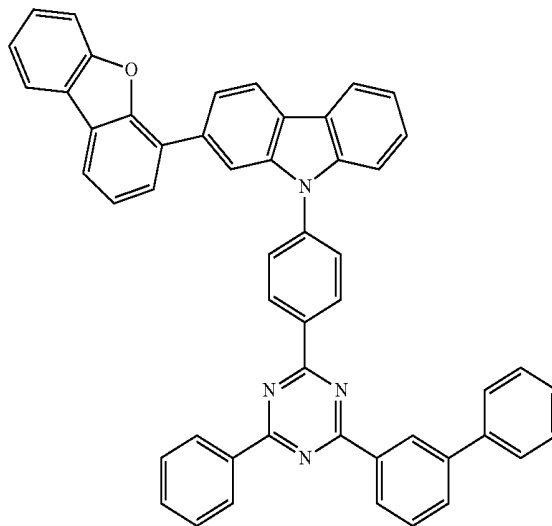
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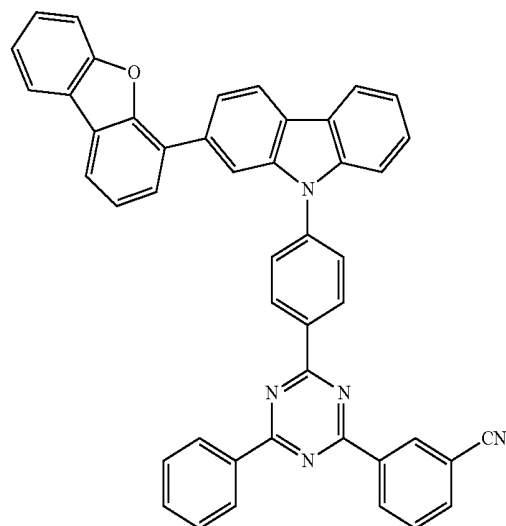


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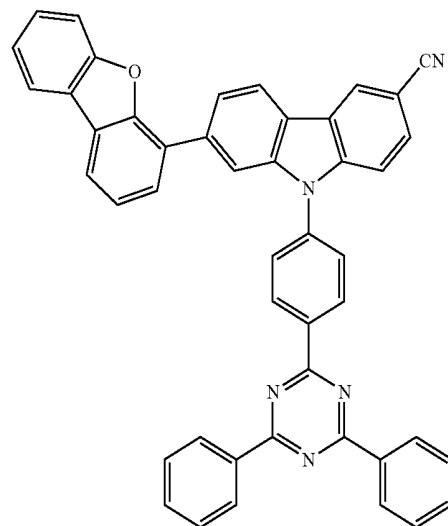
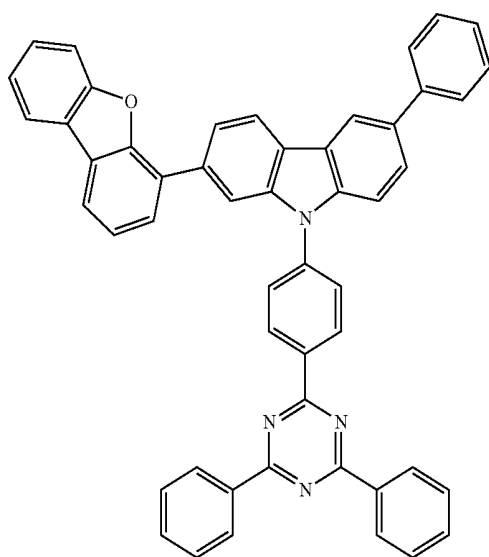


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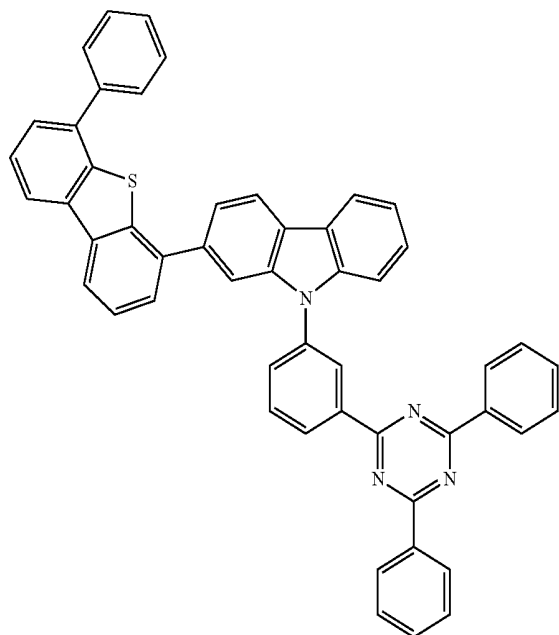
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H2-210



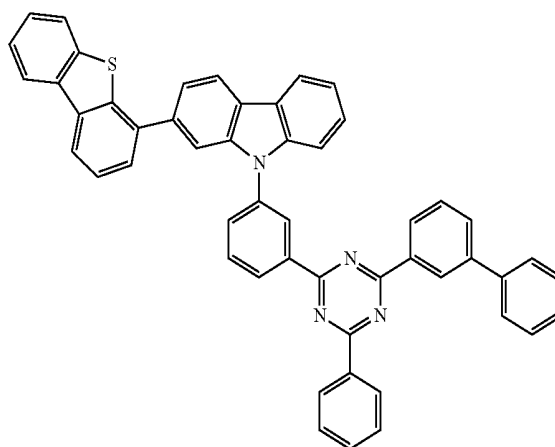
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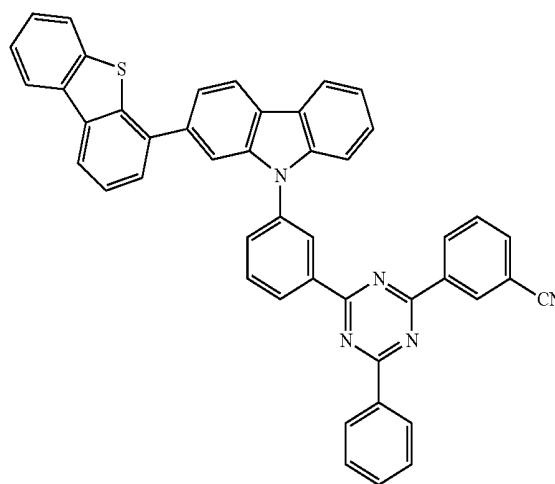


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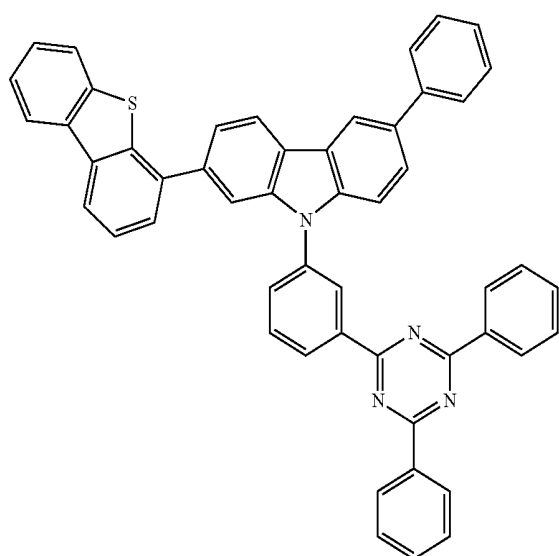
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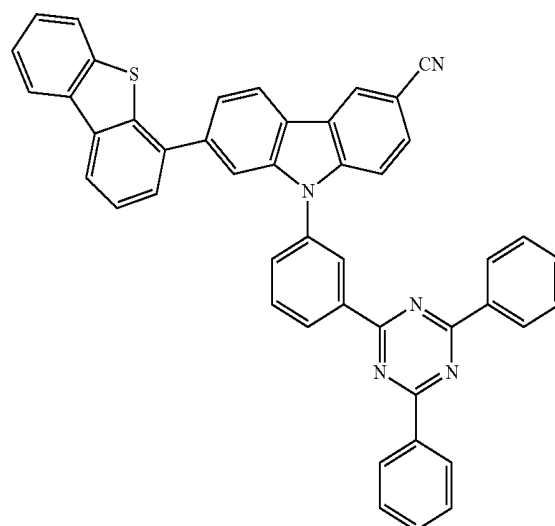
H2-217



H2-215

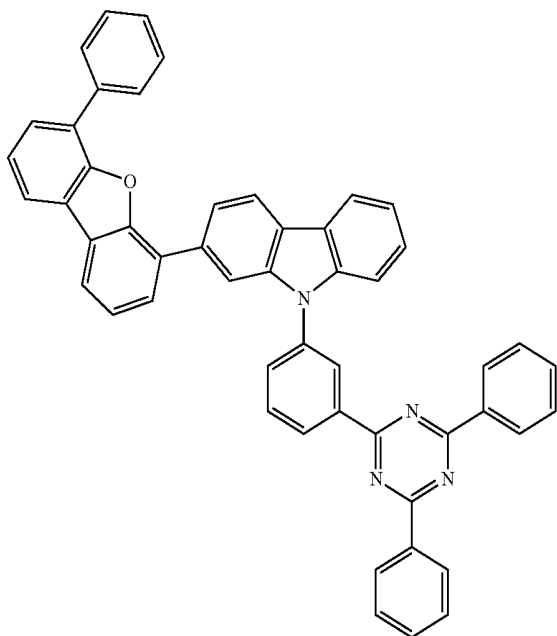


H2-218



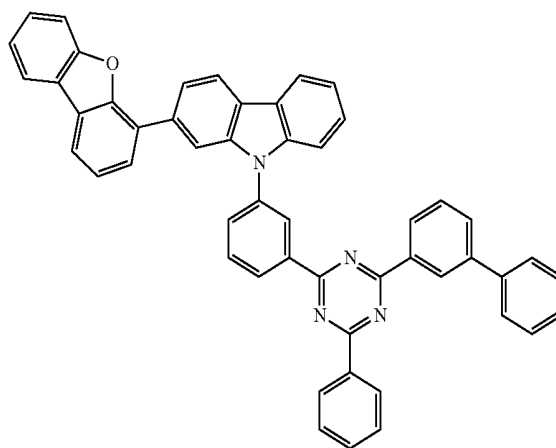
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H2-219

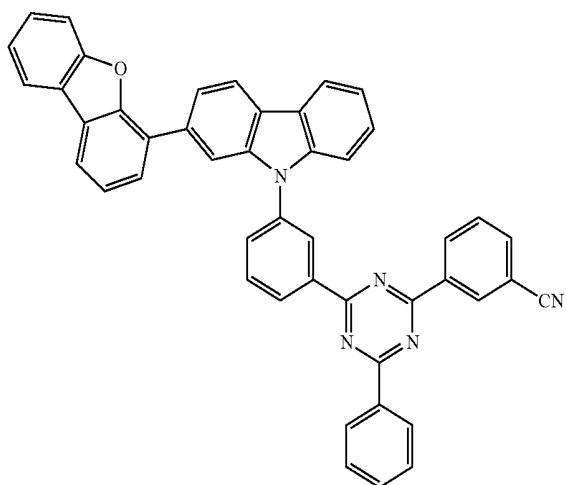


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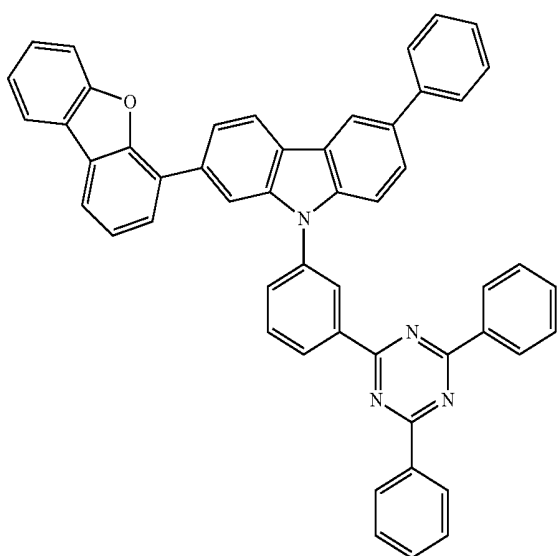
H2-221



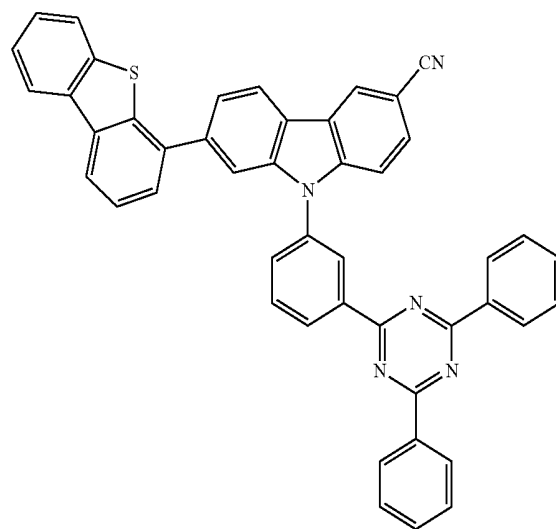
H2-222



H2-220

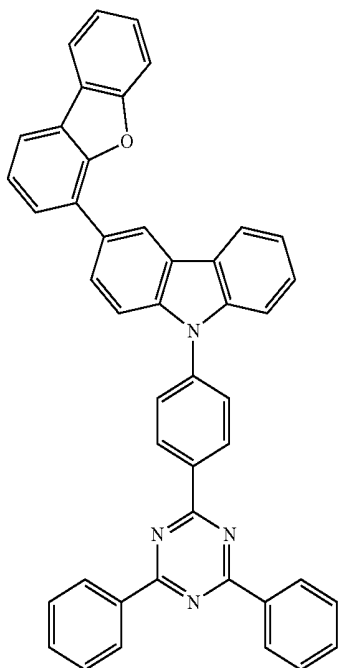


H2-223



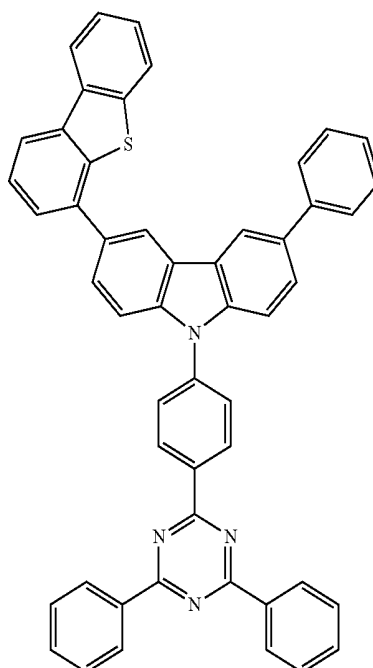
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H2-224

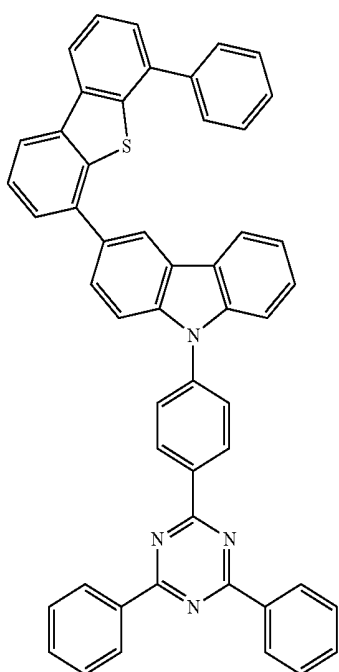


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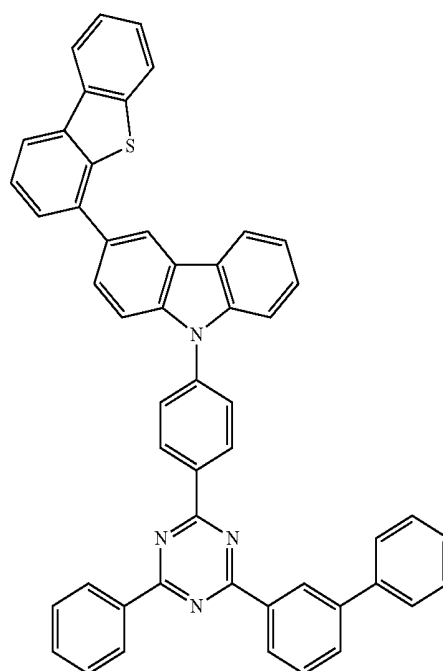
H2-226



H2-225

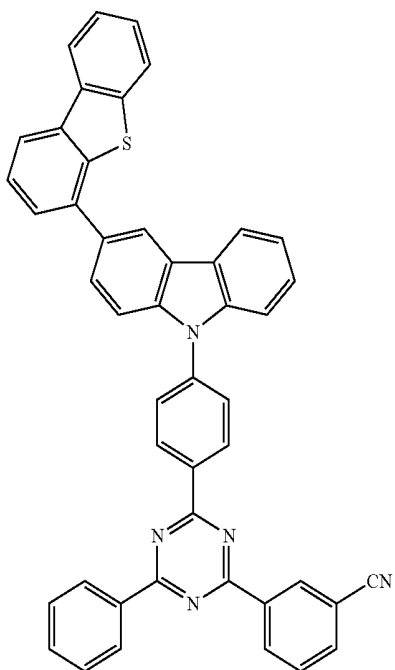


H2-227



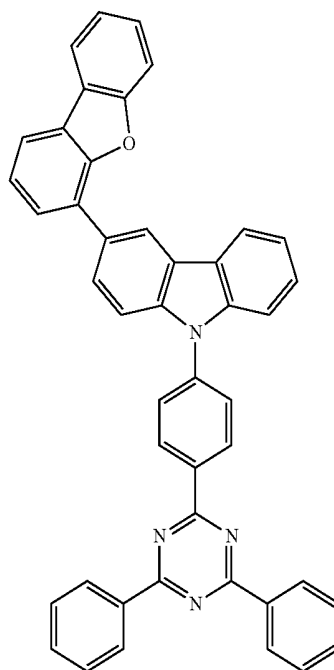
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H2-228

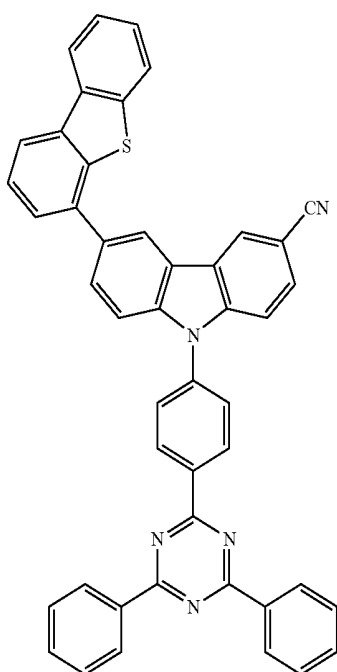


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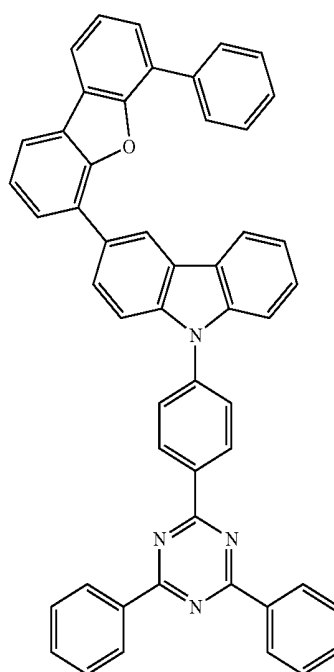
H2-230



H2-229

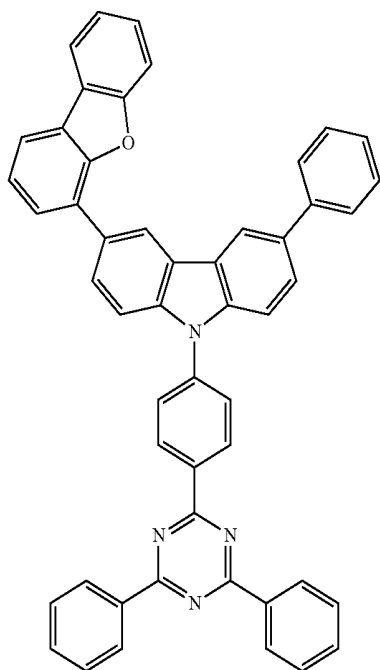


H2-231



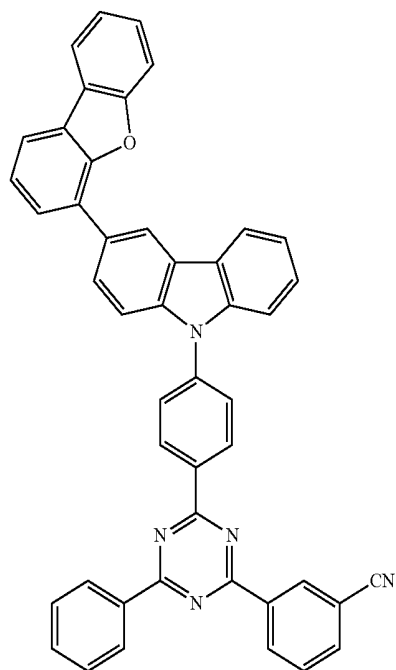
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H2-232

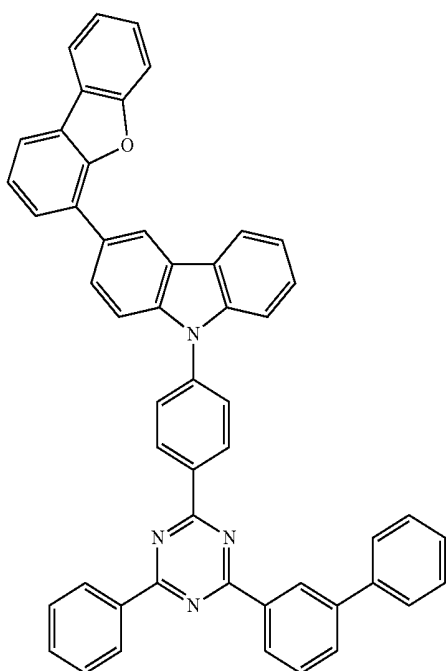


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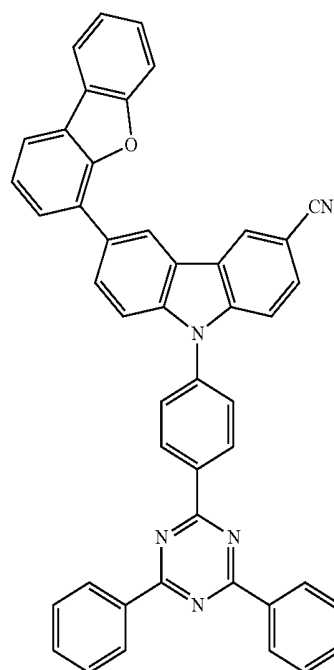
H2-234



H2-233

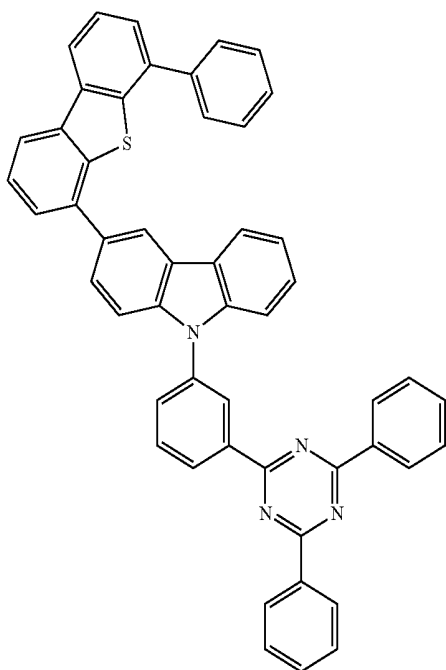


H2-235



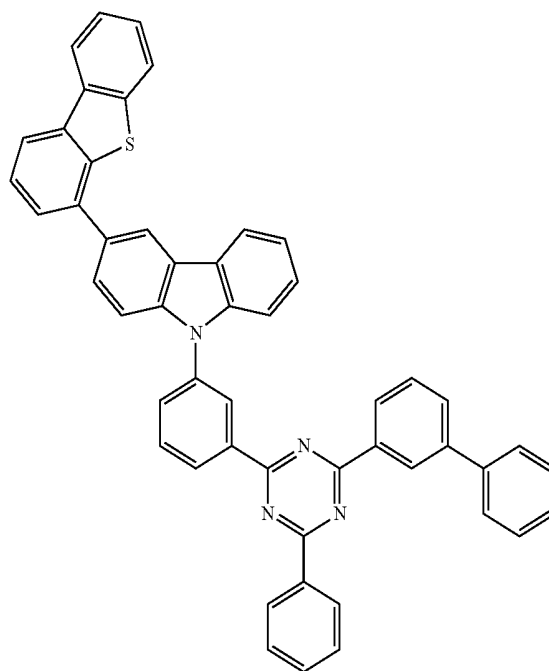
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H2-236

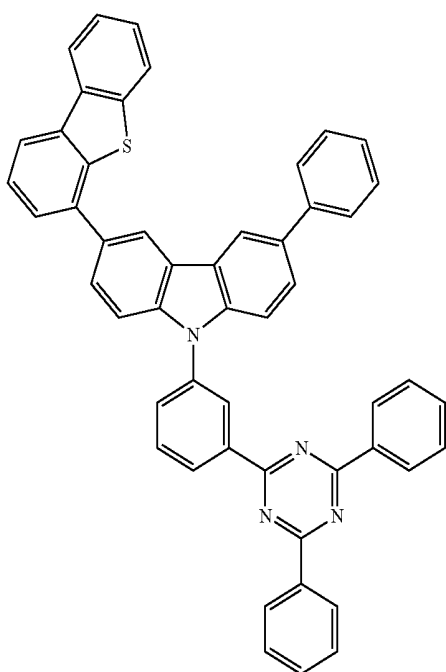


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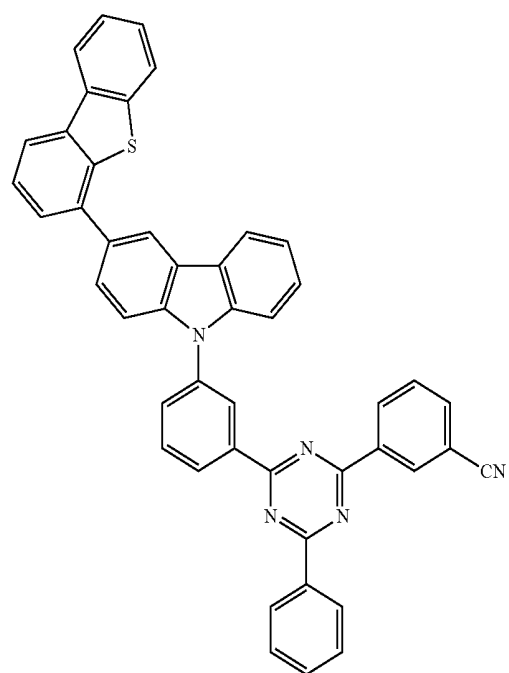
H2-238



H2-237

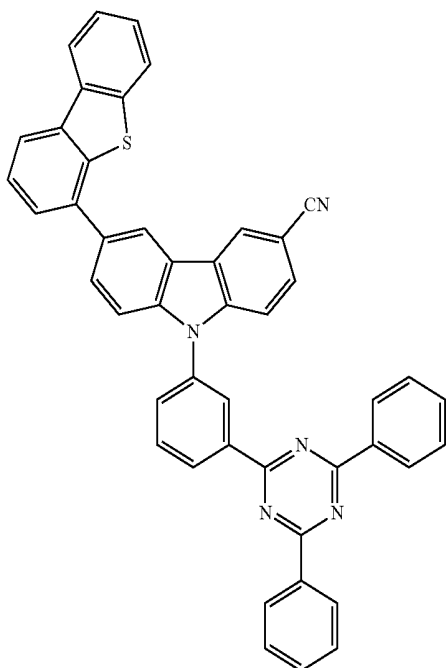


H2-239



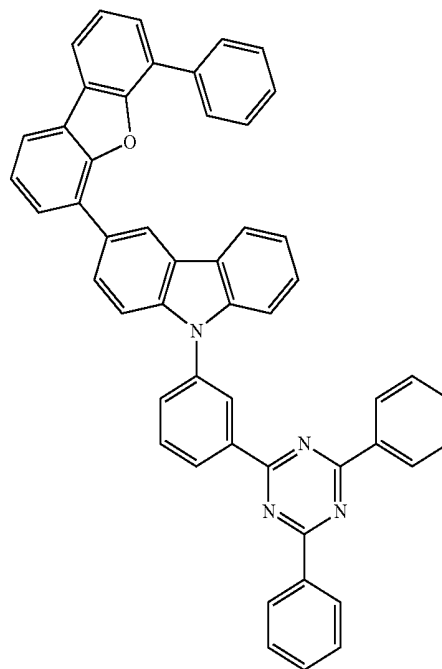
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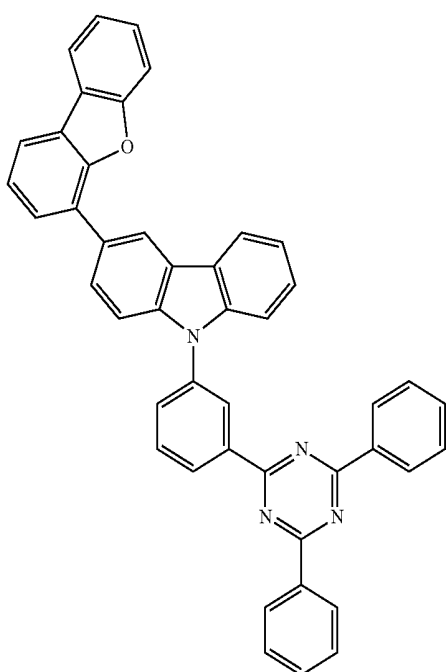


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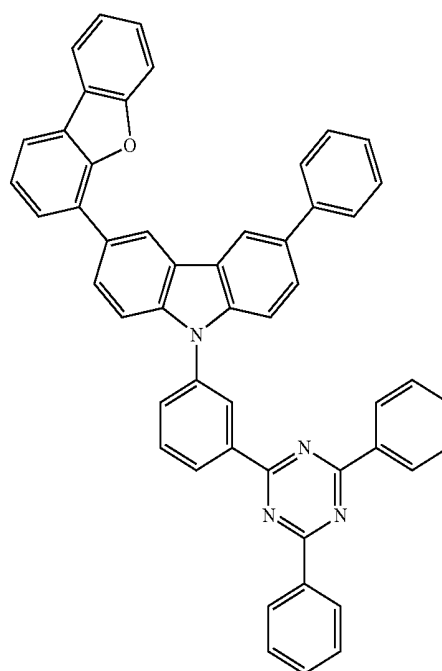
H2-242



H2-241

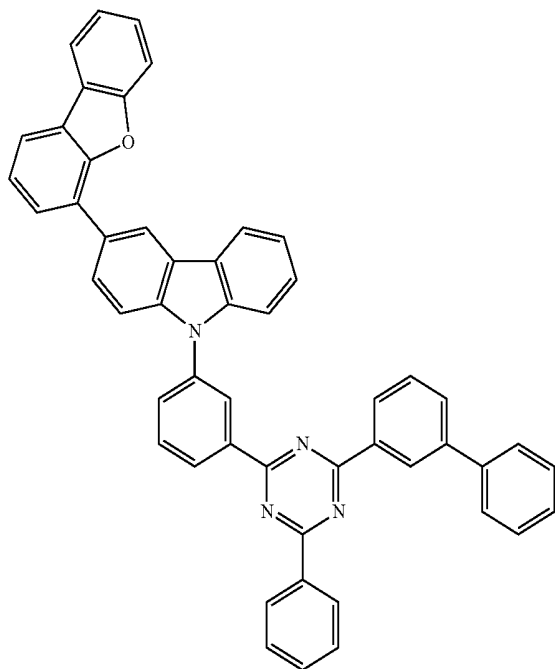


H2-243



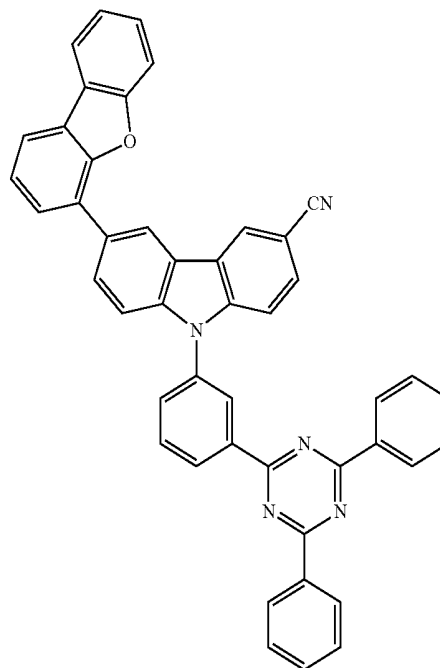
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H2-244

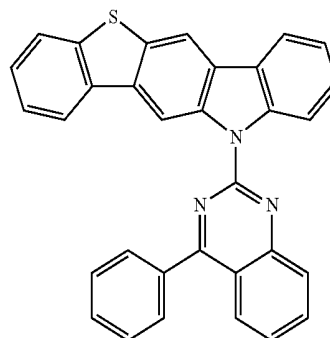


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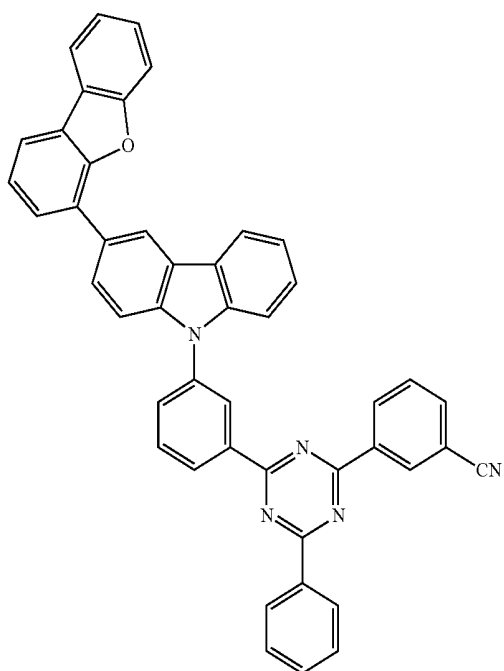
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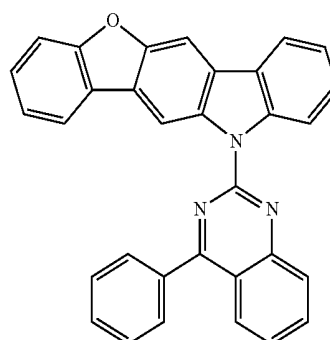
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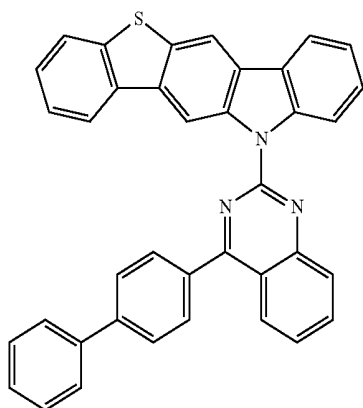
H2-245



H2-248

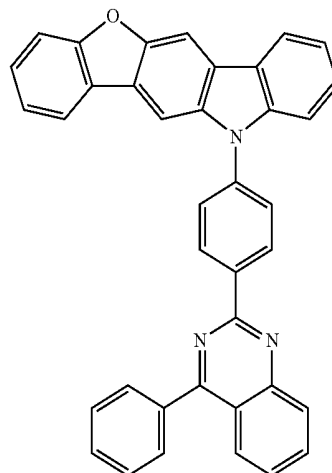


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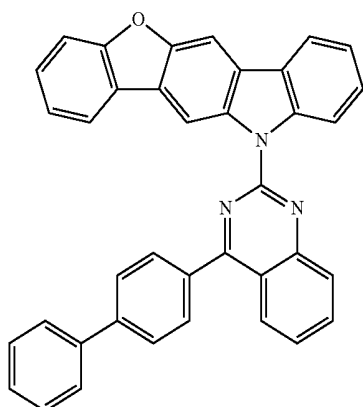


H2-249

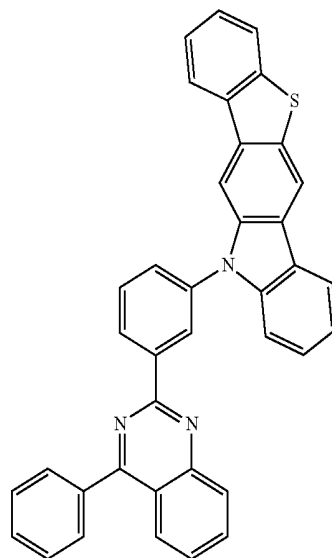
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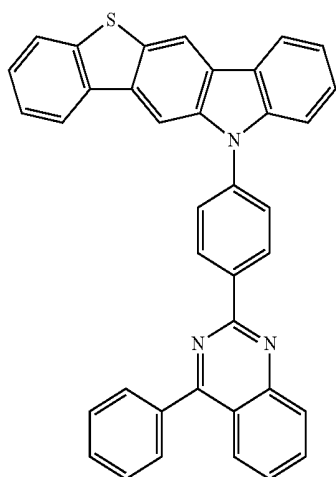
H2-252



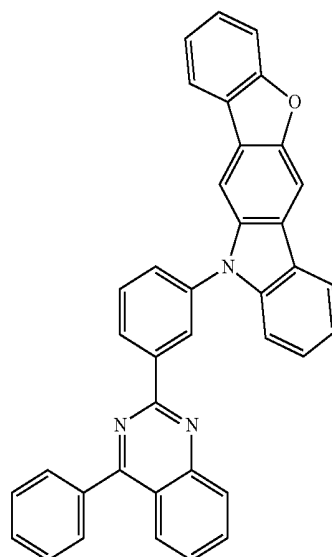
H2-250



H2-253

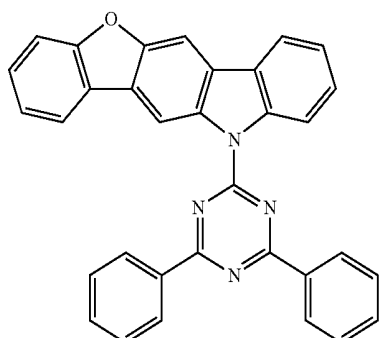


H2-251



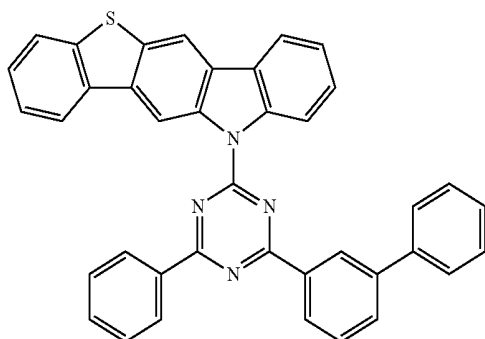
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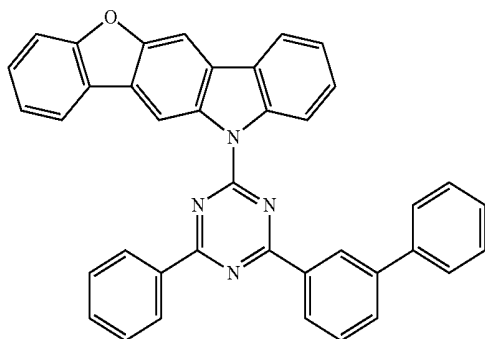


H2-255

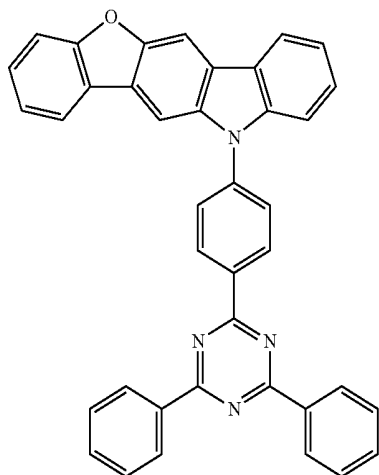
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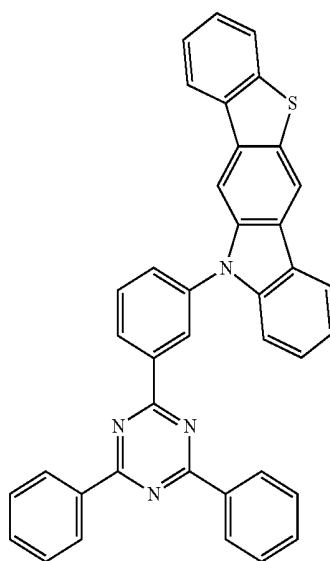
H2-257



H2-258

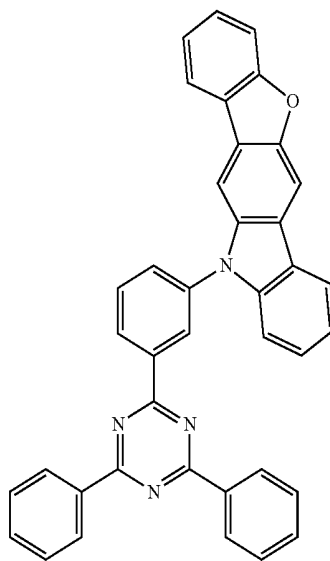


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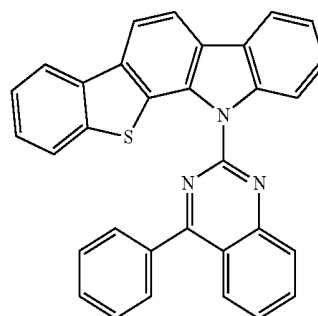


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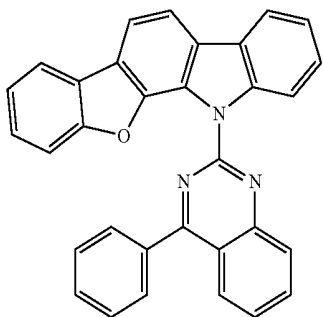
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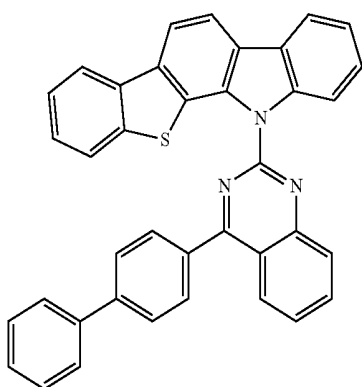
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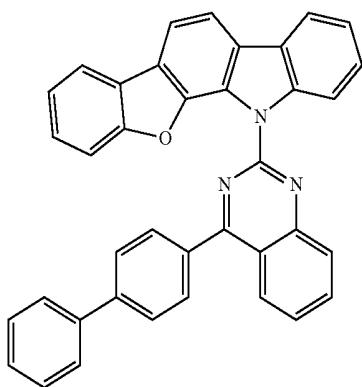
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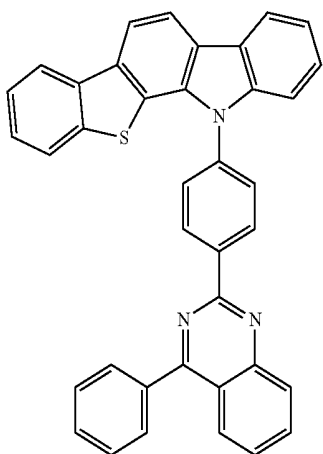
H2-262



H2-263

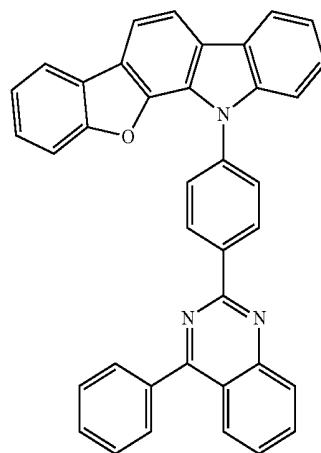


H2-264

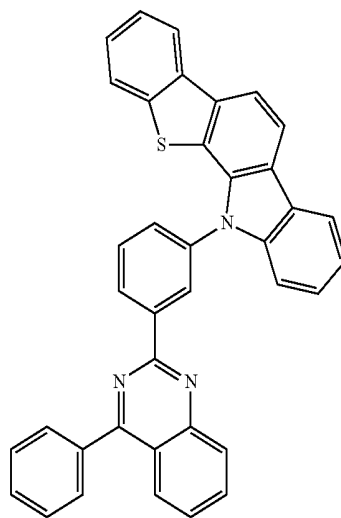


H2-265

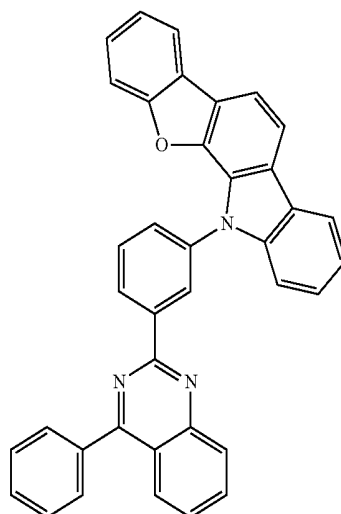
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H2-266

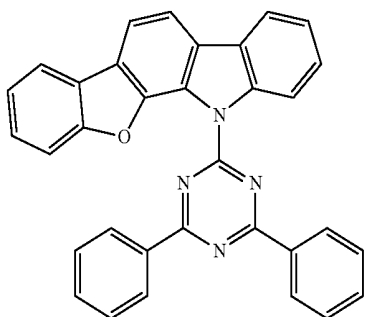


H2-267

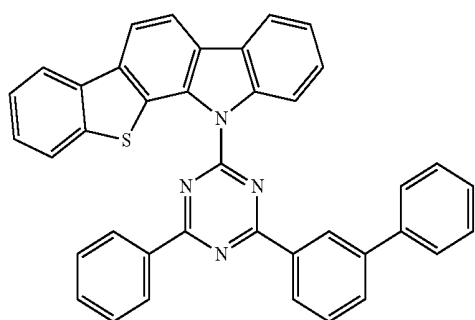


H2-268

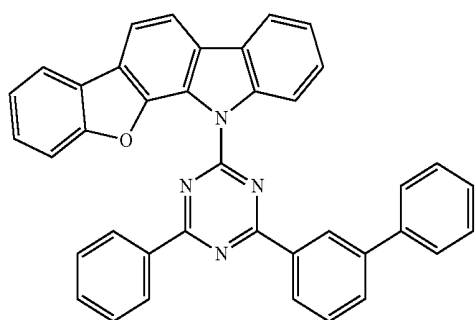
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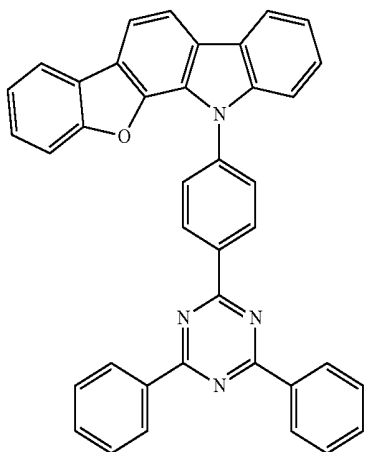
H2-269



H2-270

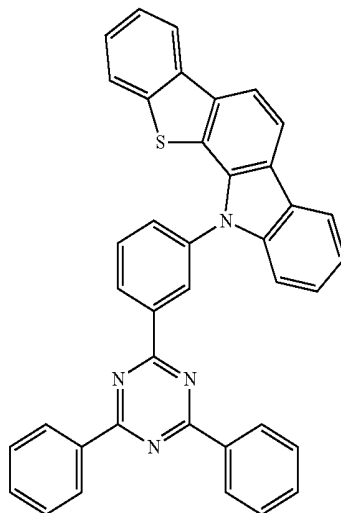


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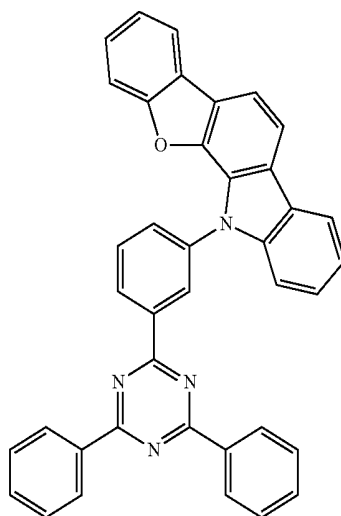


H2-272

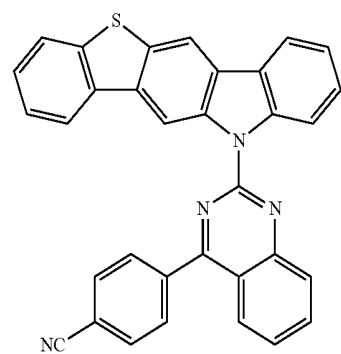
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H2-273

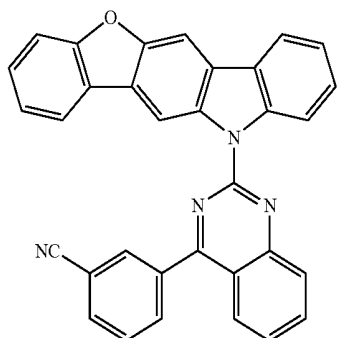


H2-274

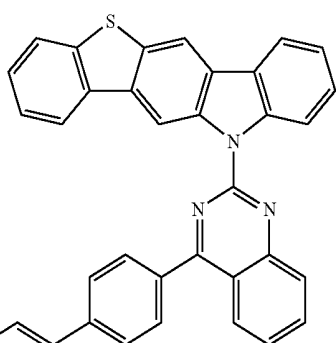


H2-275

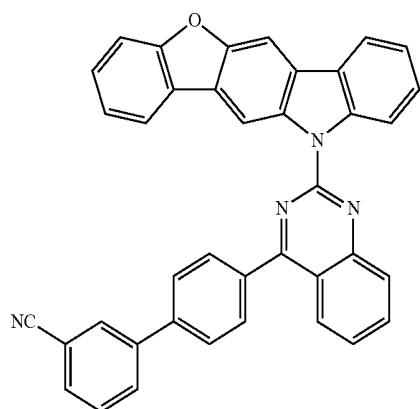
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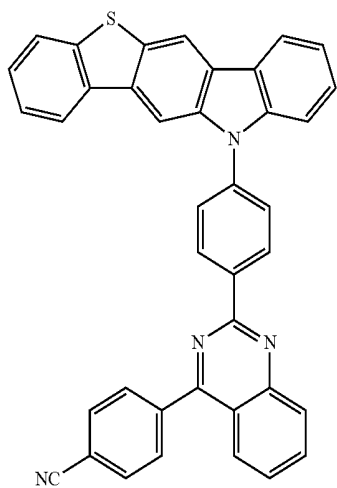
H2-276



H2-277

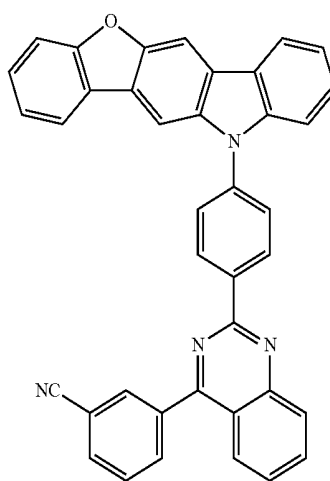


H2-278

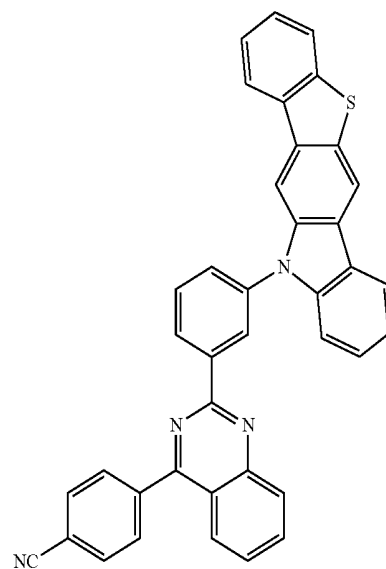


H2-279

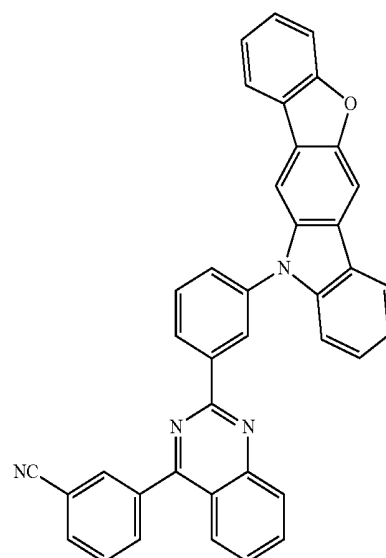
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H2-280



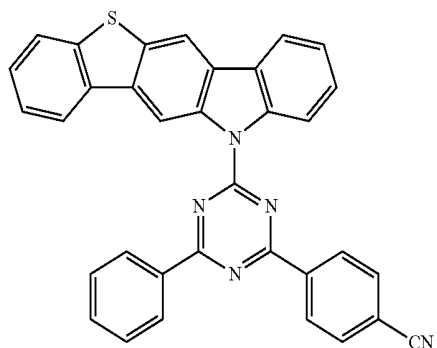
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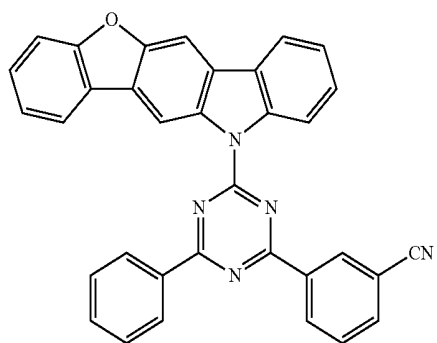
H2-282

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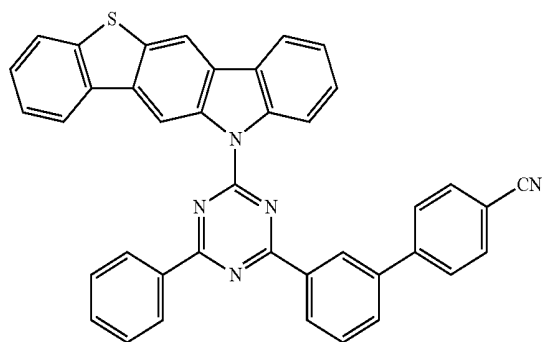
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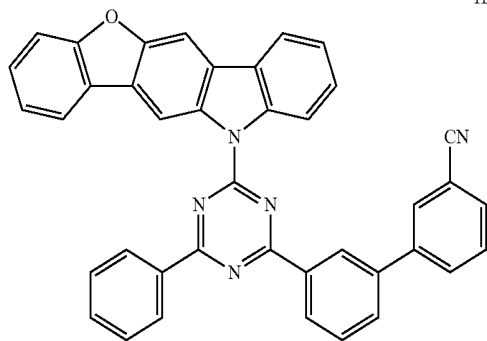
H2-284



H2-285

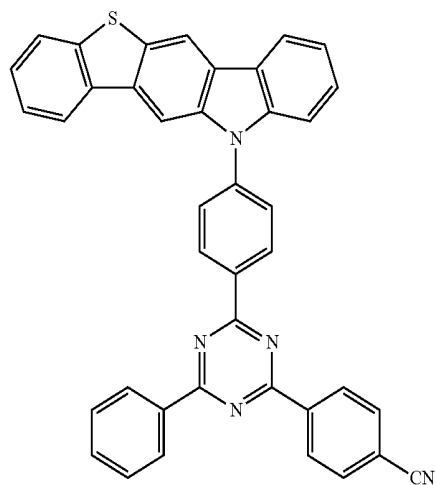


H2-286

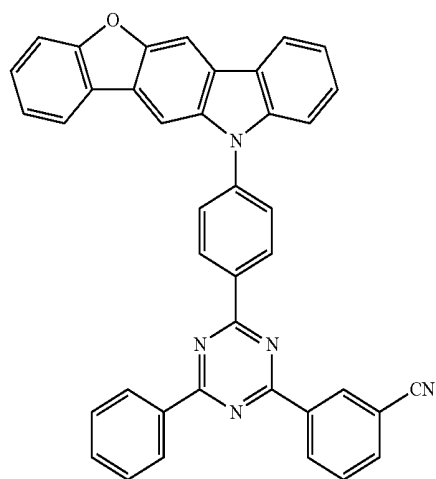


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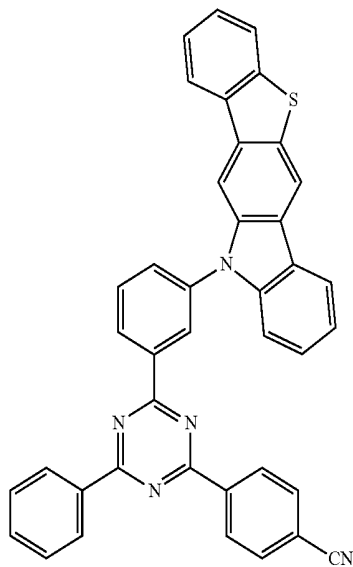
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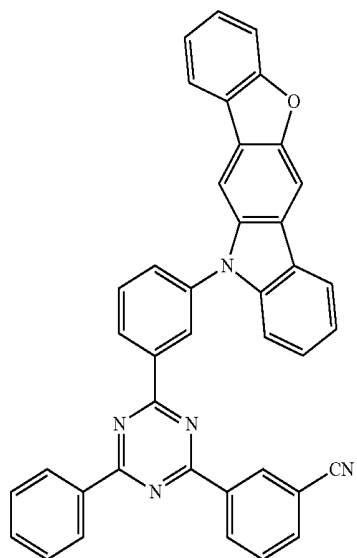
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H2-289

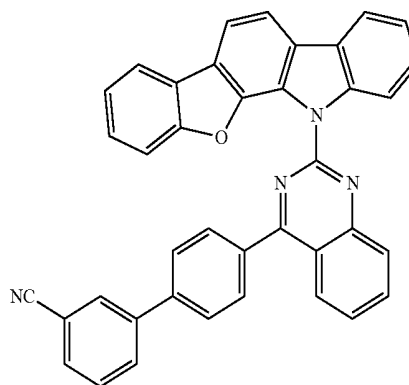


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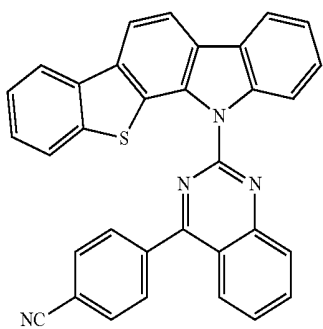


H2-290

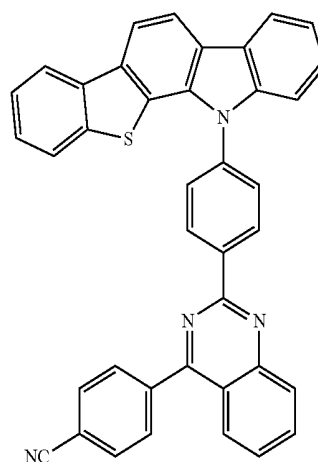
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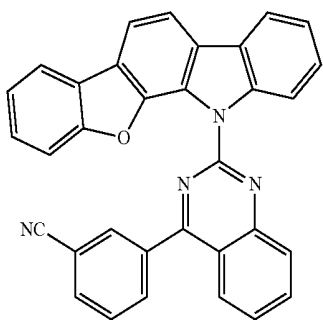
H2-294



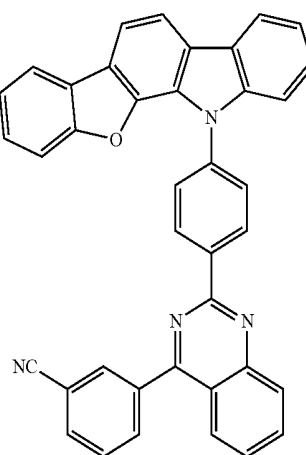
H2-291



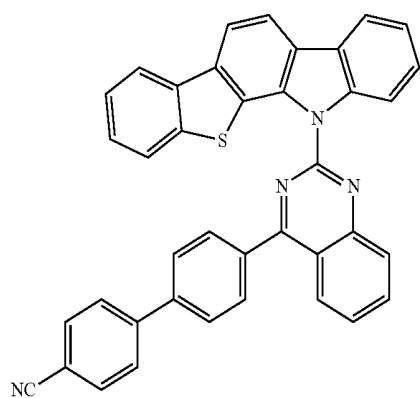
H2-295



H2-292

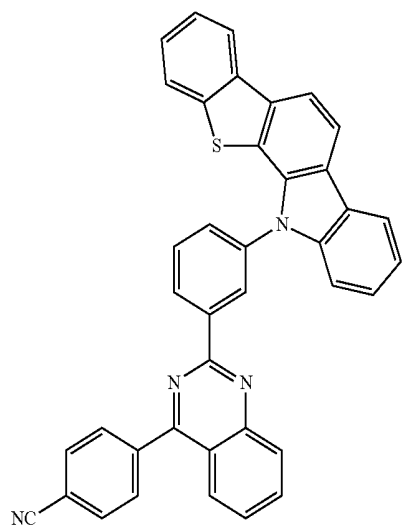


H2-296



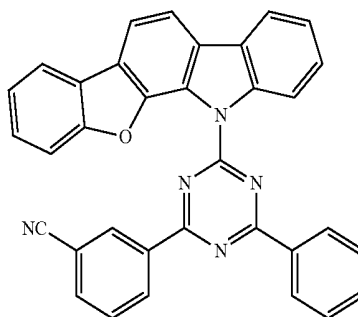
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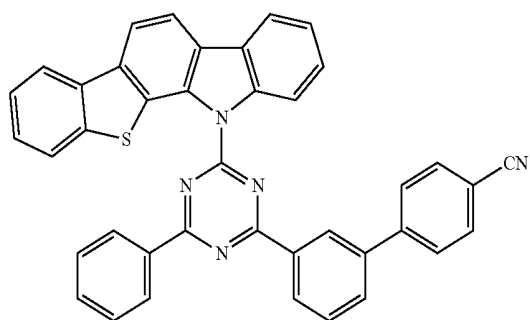
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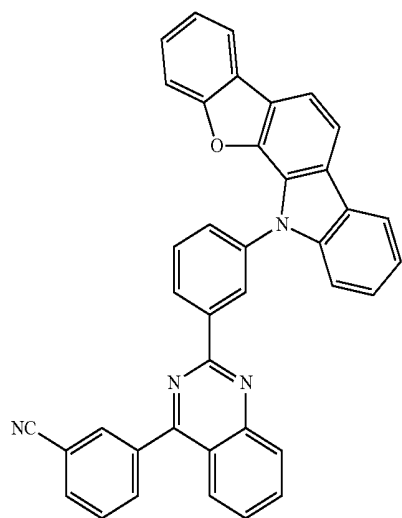


H2-300

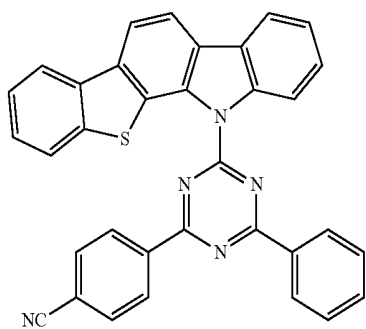
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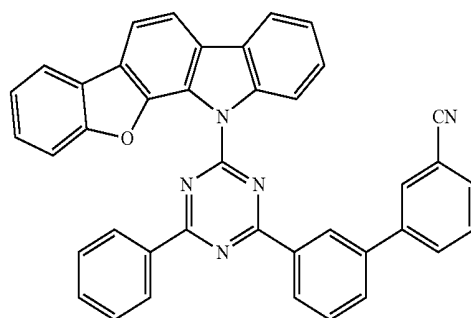
H2-298



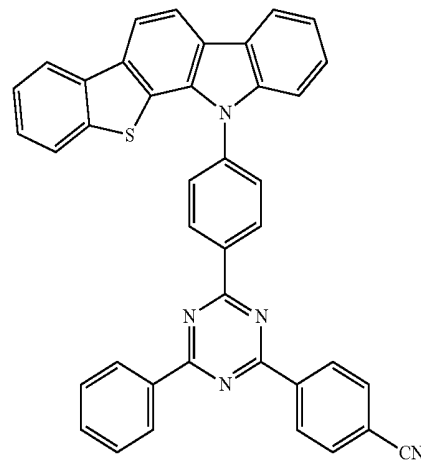
H2-299



H2-302

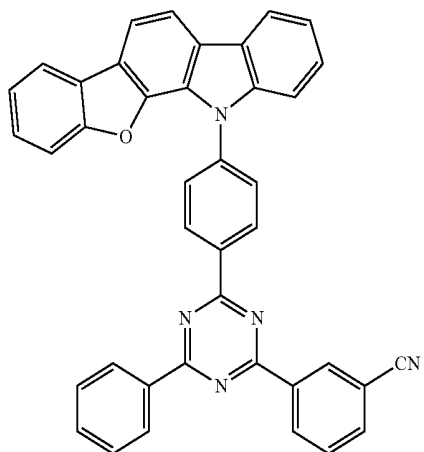


H2-303

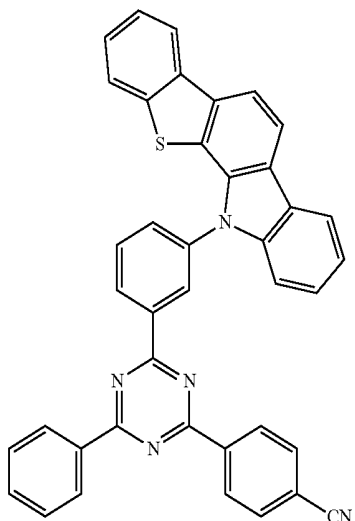


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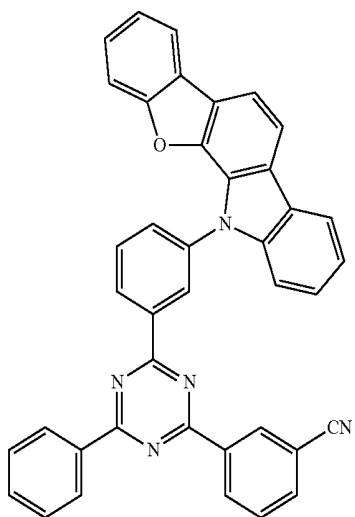
H2-304



H2-305

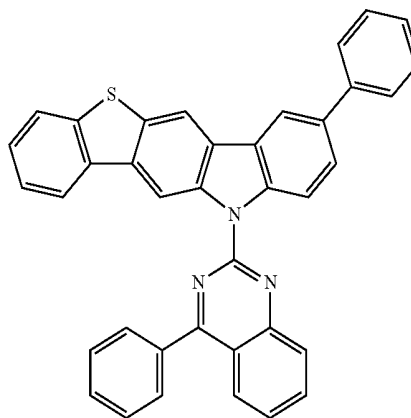


H2-306

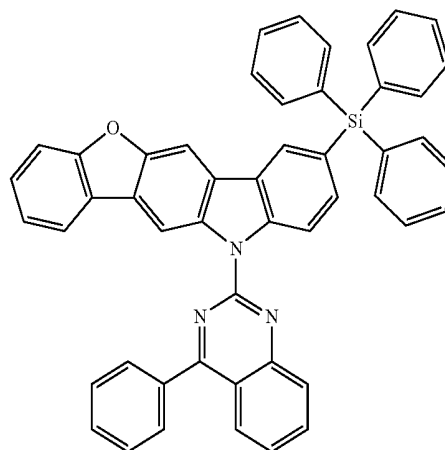


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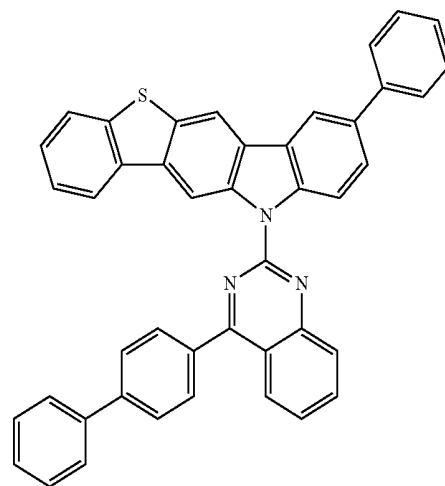
H2-307



H2-308

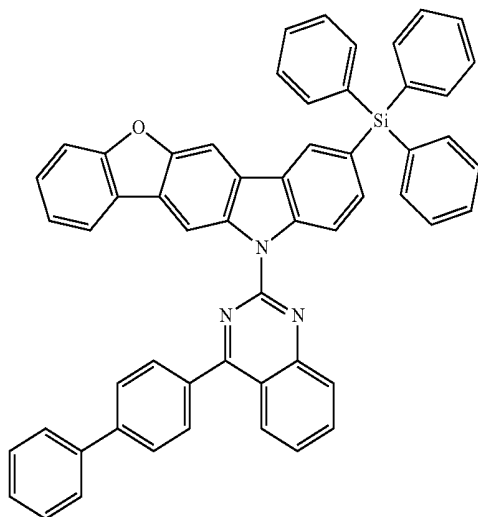


H2-309



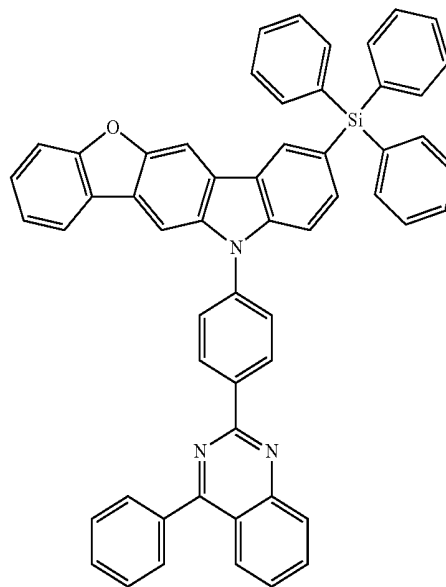
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H2-310

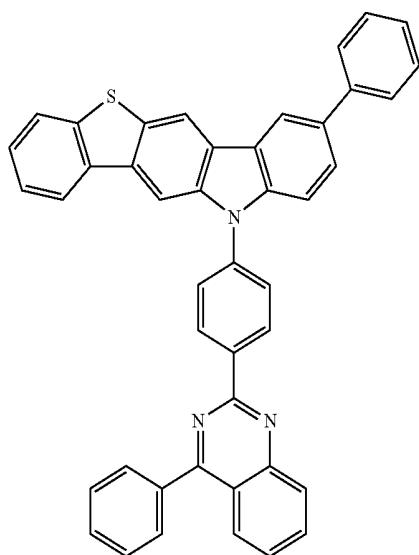


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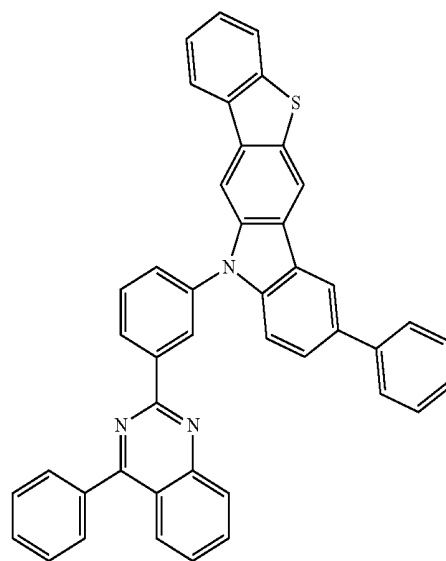
H2-312



H2-311

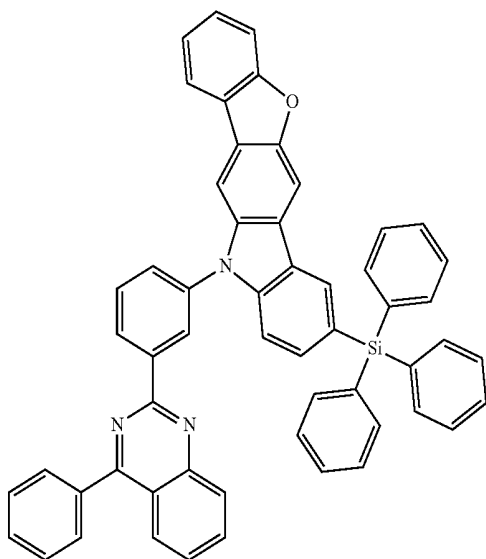


H2-313

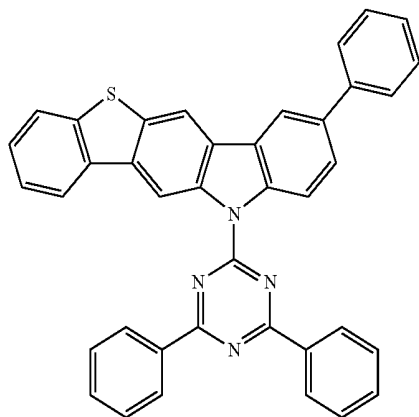


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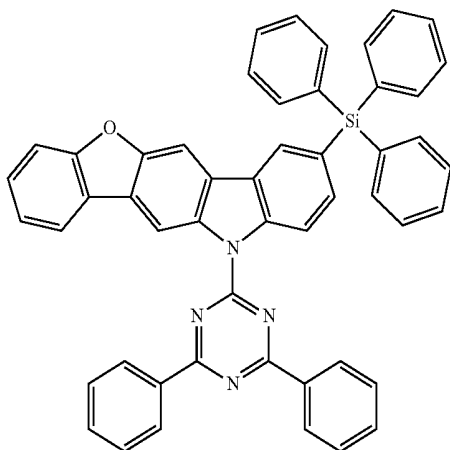
H2-314



H2-315

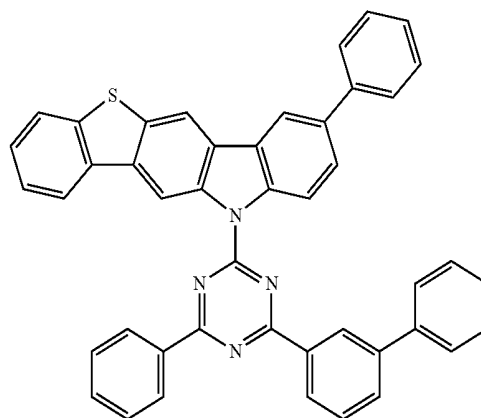


H2-316

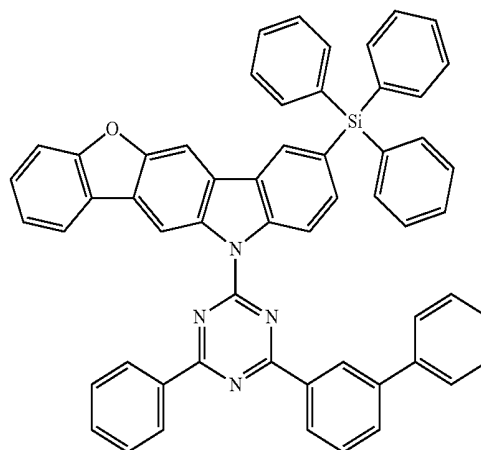


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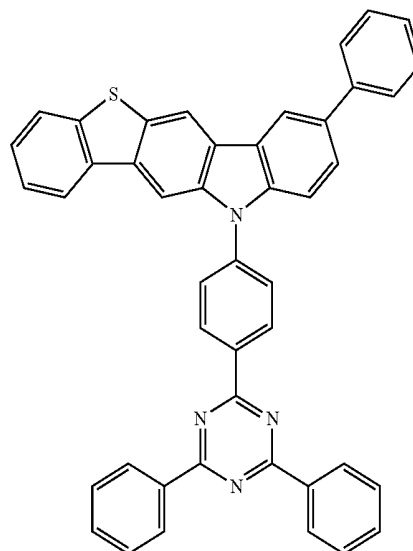
H2-317



H2-318

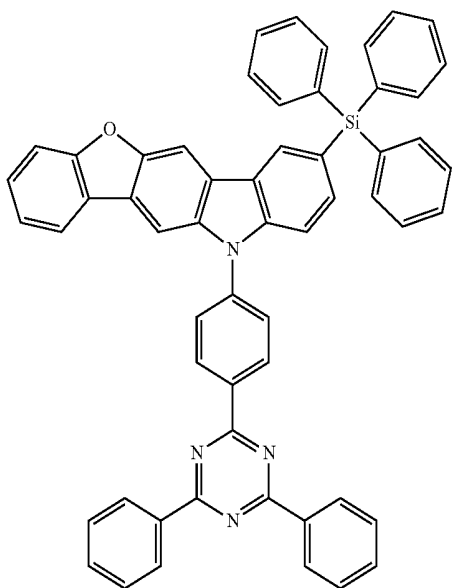


H2-319



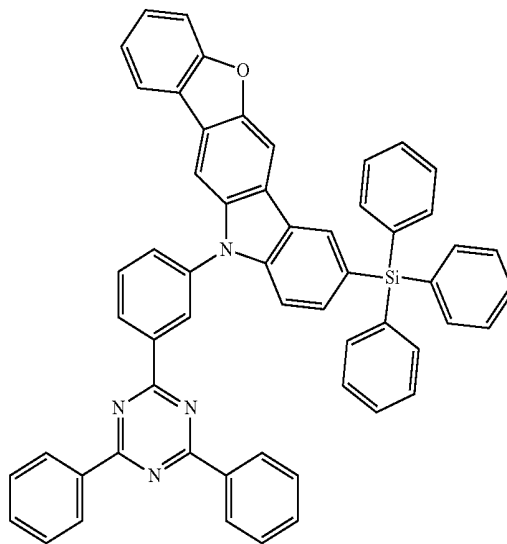
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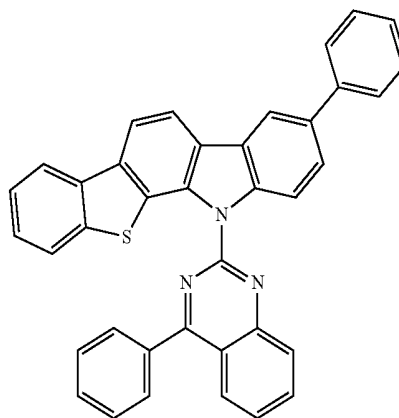


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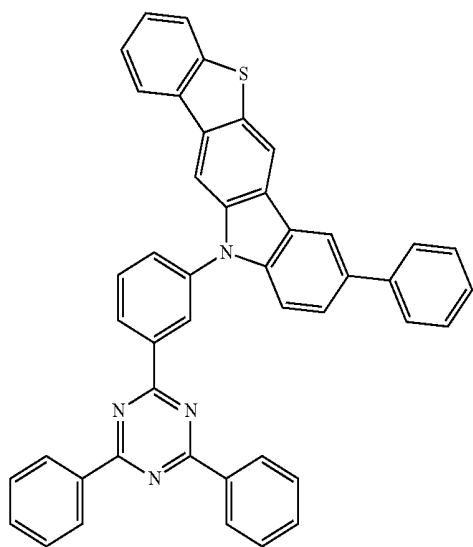
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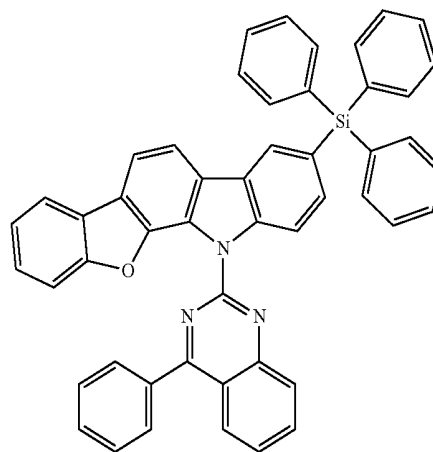
H2-323



H2-321

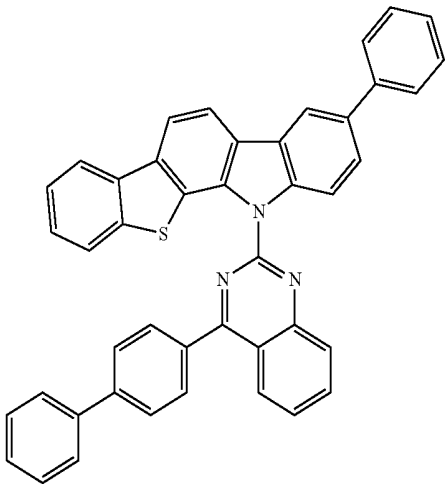


H2-324



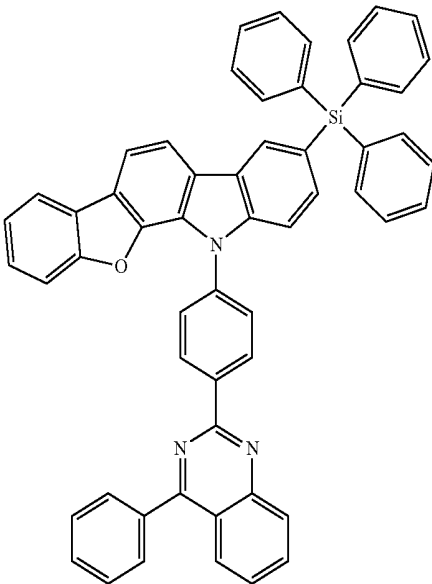
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H2-325



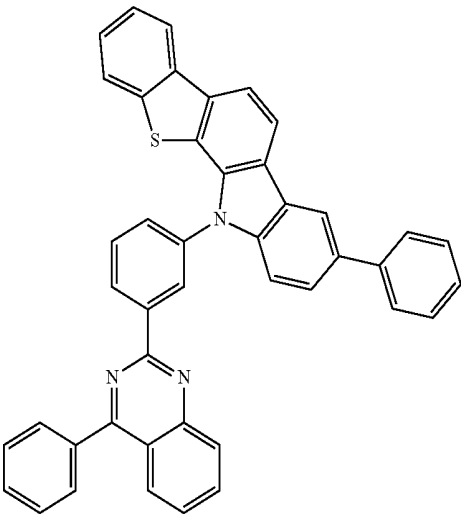
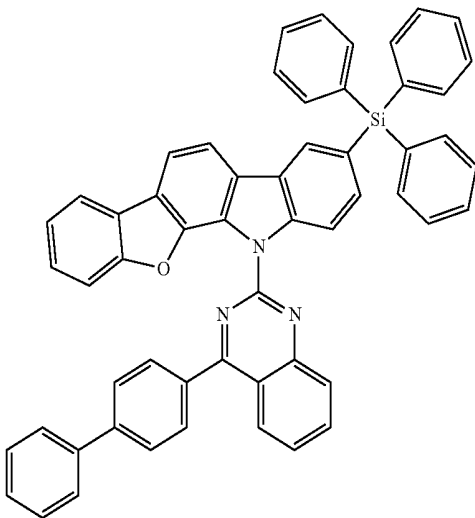
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H2-328



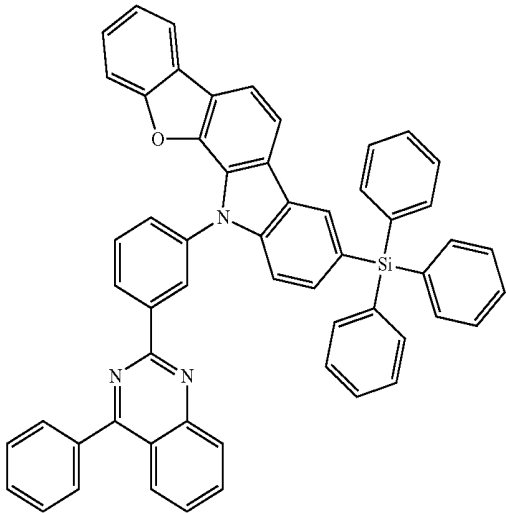
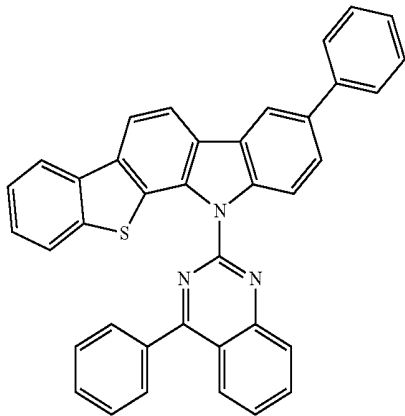
H2-329

H2-326



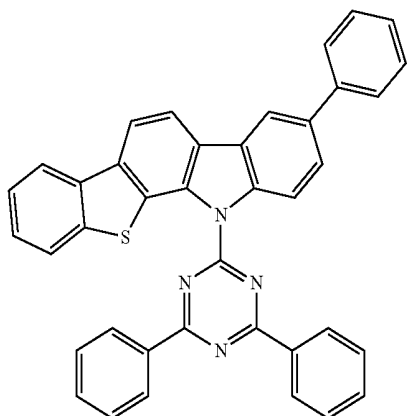
H2-330

H2-327

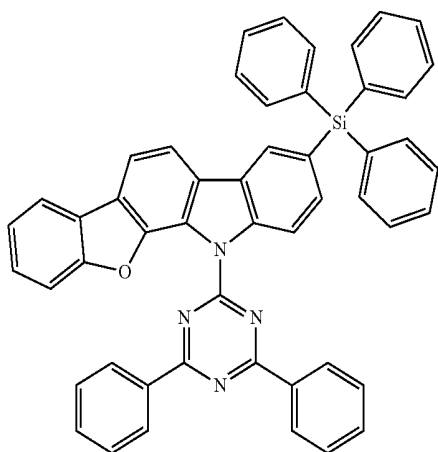


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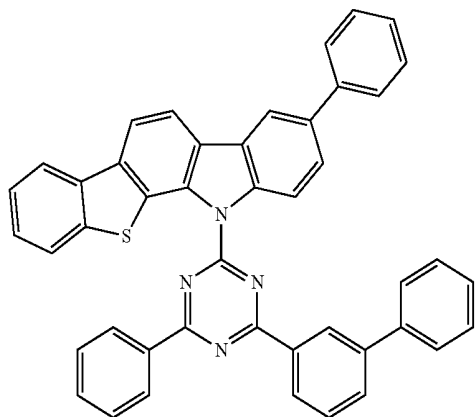
H2-331



H2-332

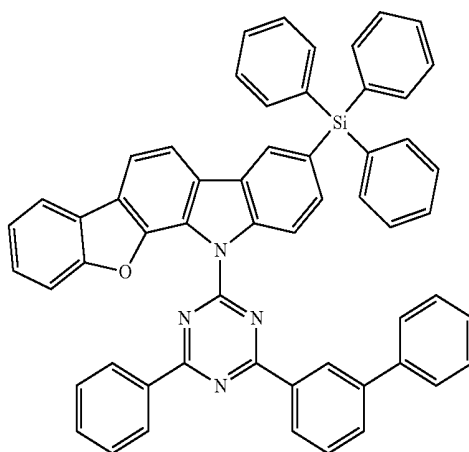


H2-333

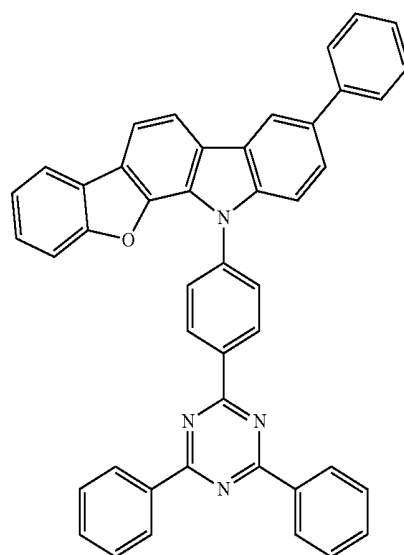


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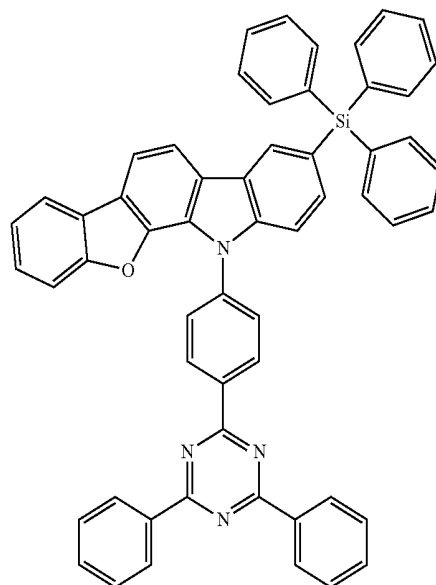
H2-334



H2-335

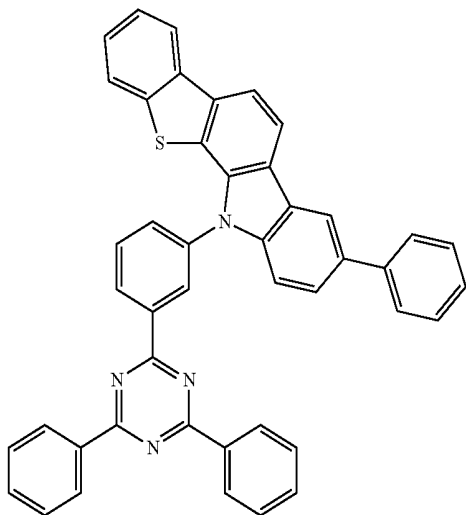


H2-336

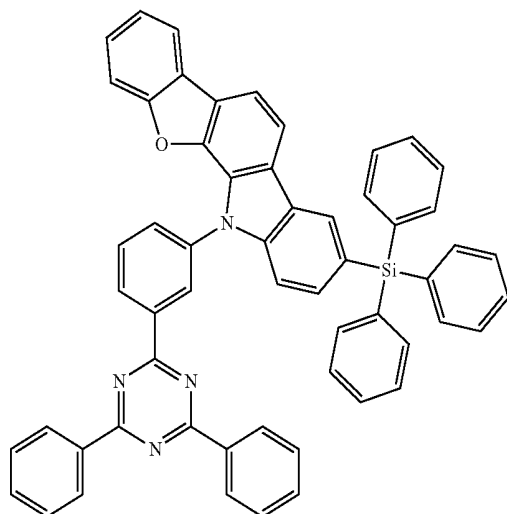


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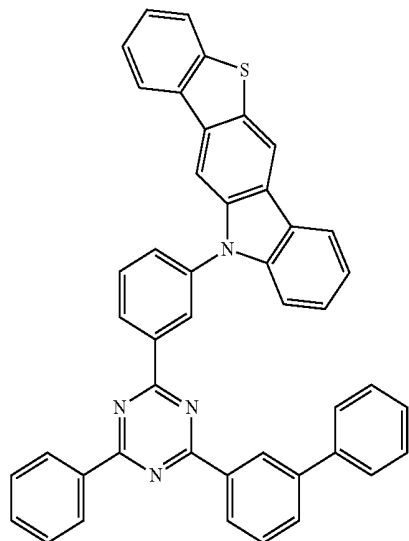
H2-337



H2-338

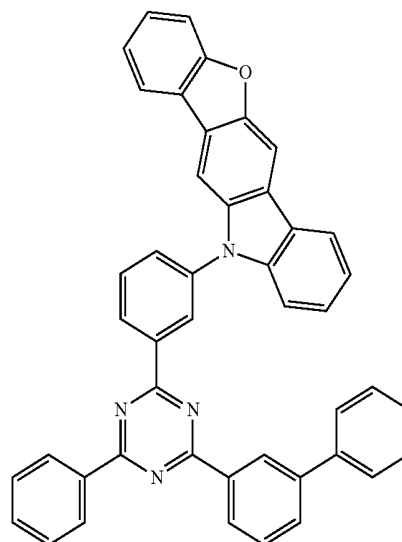


H2-339

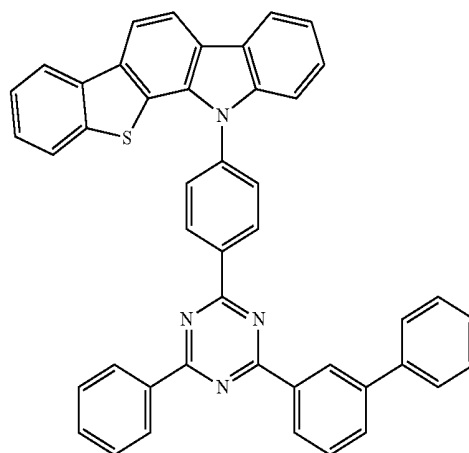


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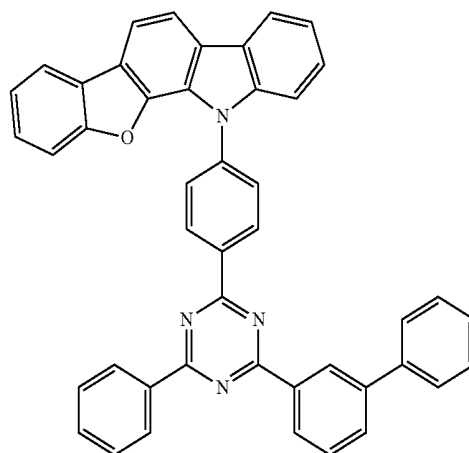
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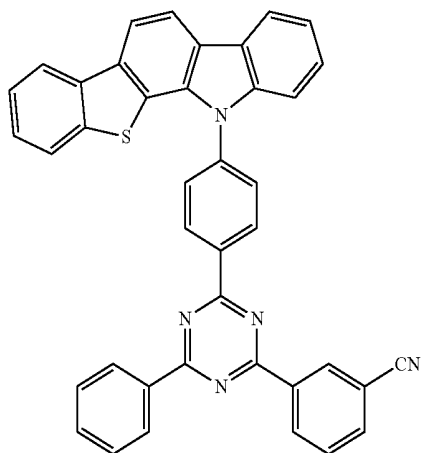
H2-341



H2-342

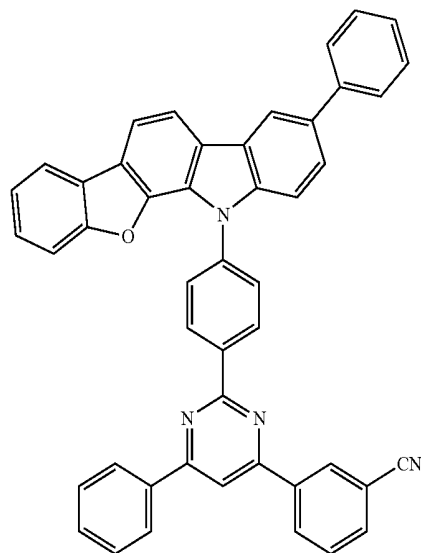


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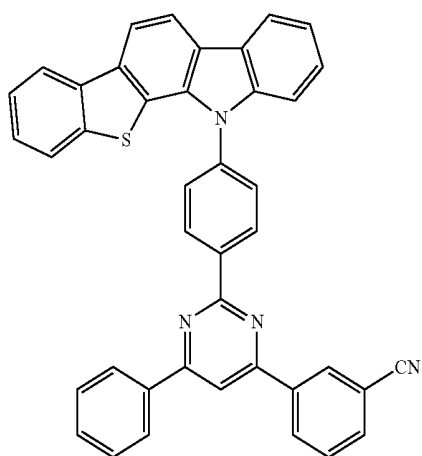


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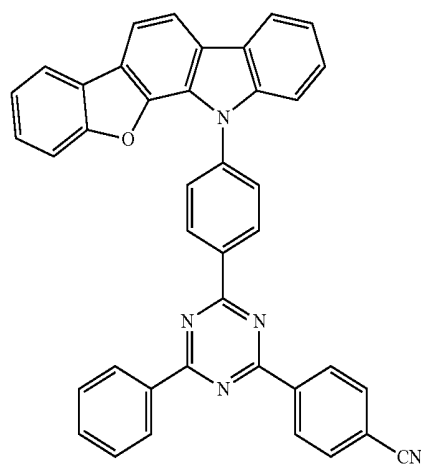
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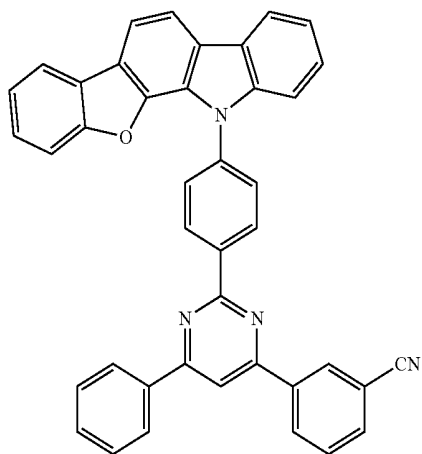
H2-346



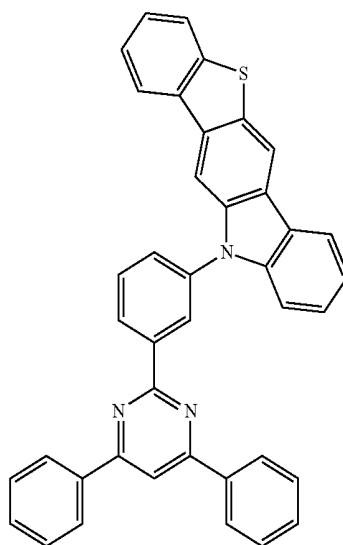
H2-344



H2-347

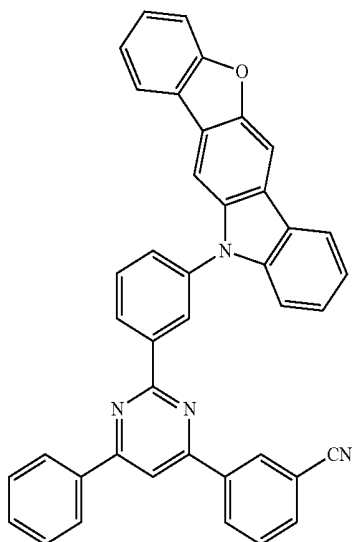


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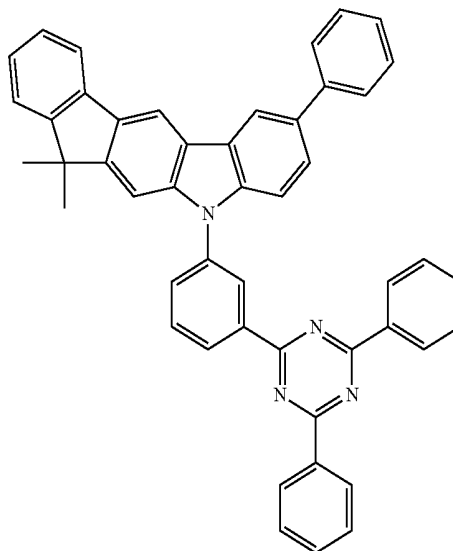
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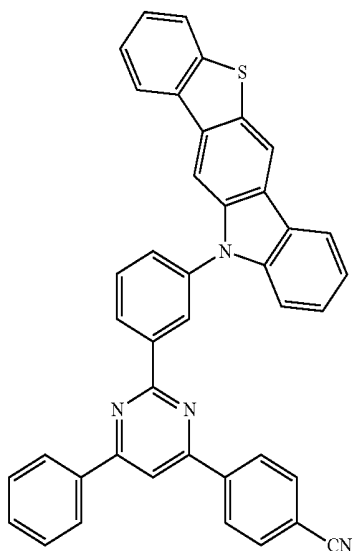
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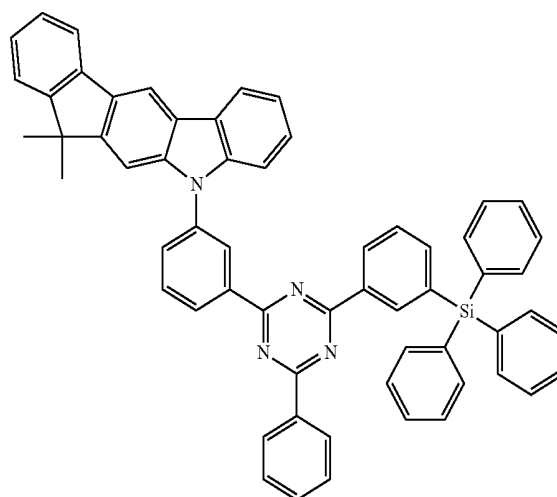


H2-352

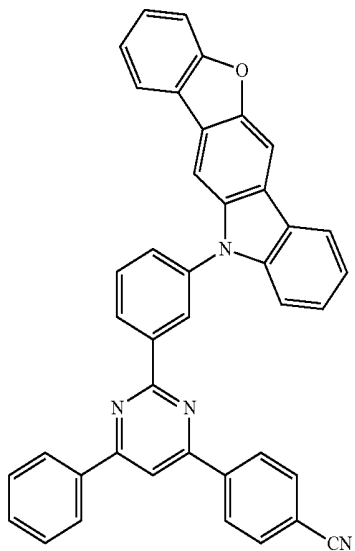
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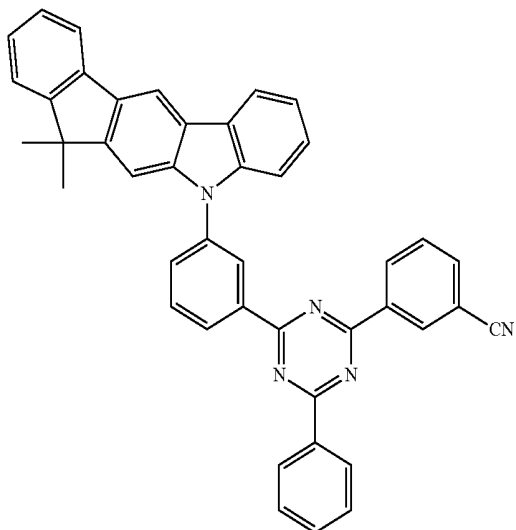
H2-353



H2-351

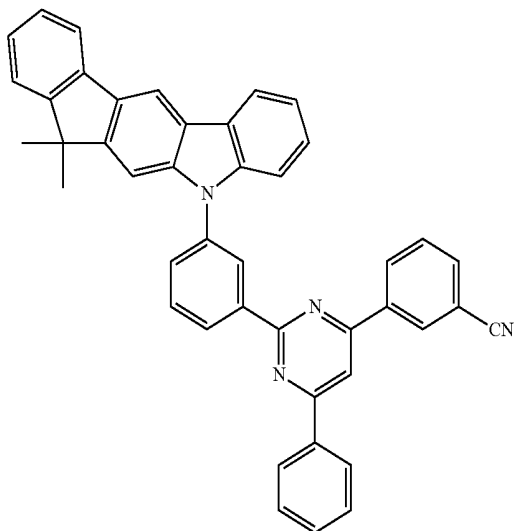


H2-354

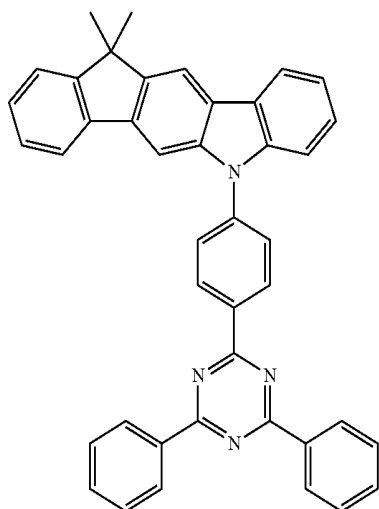


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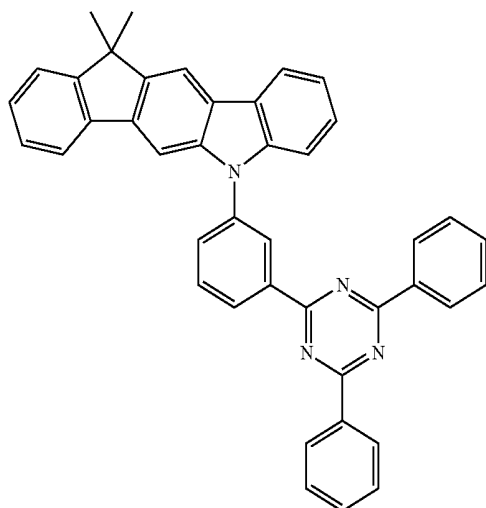
H2-355



H2-356

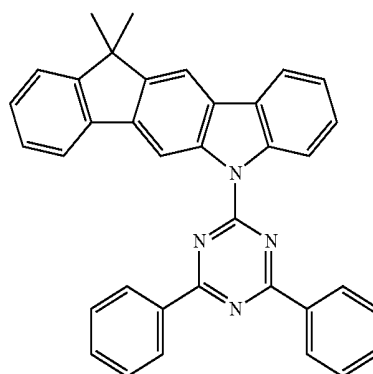


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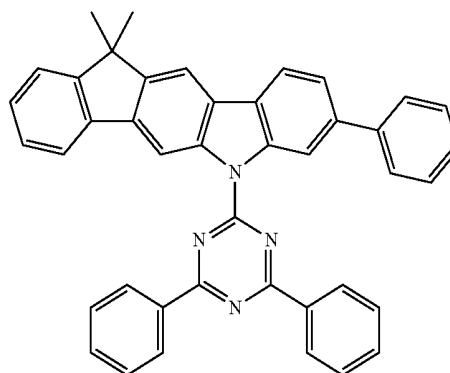


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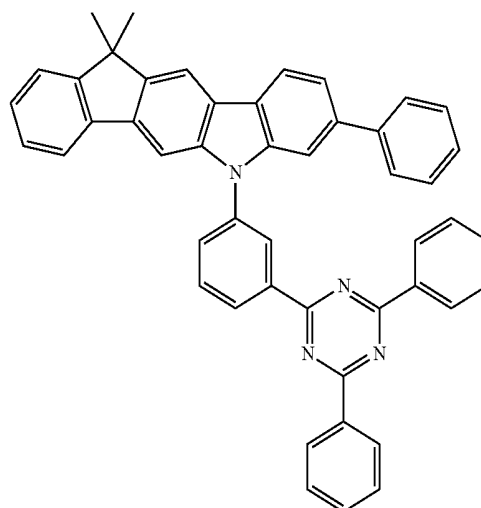
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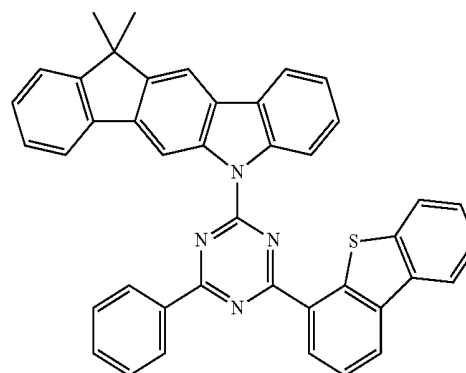
H2-359



H2-360

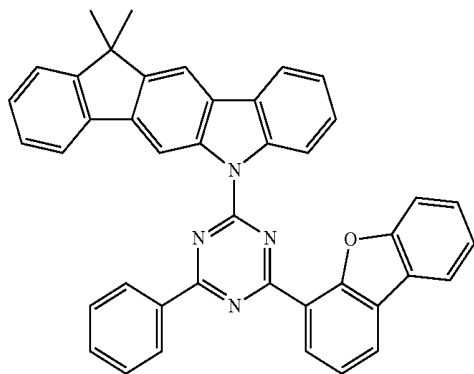


H2-361

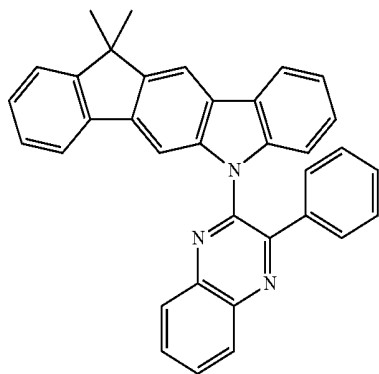


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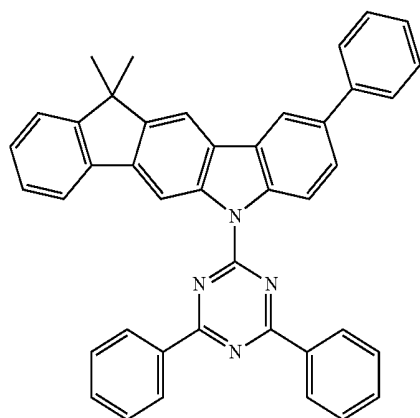
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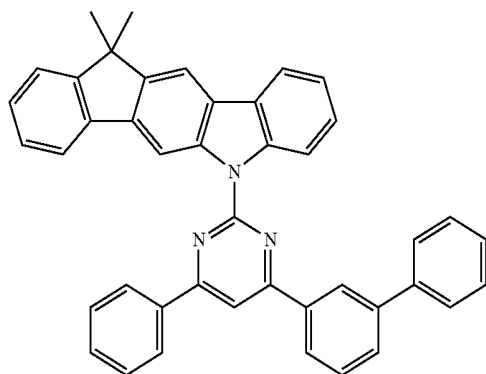
H2-363



H2-364

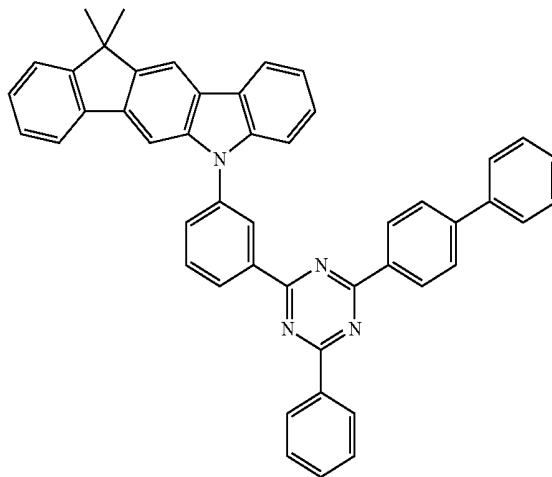


H2-365

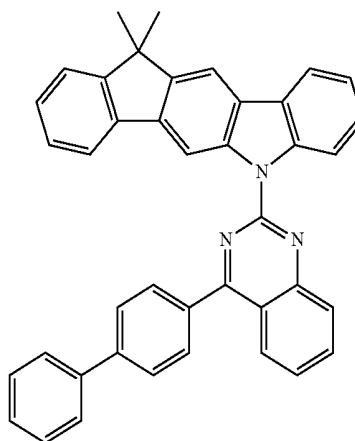


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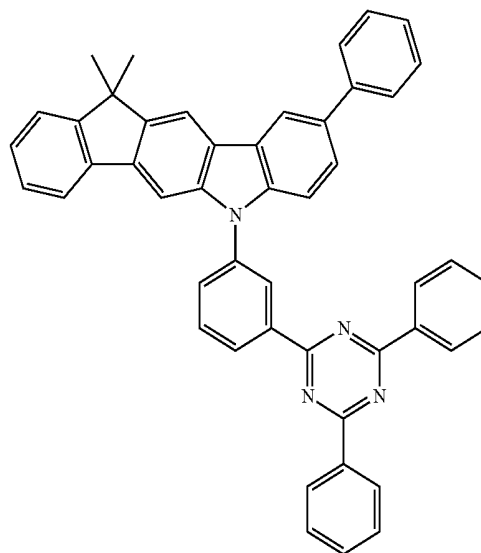
H2-366



H2-367

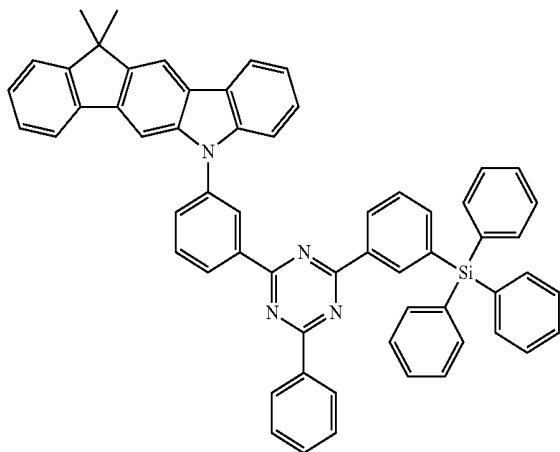


H2-368



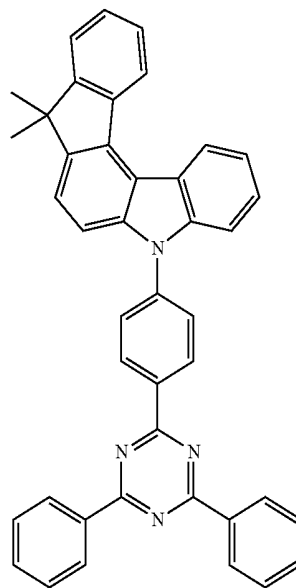
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H2-369

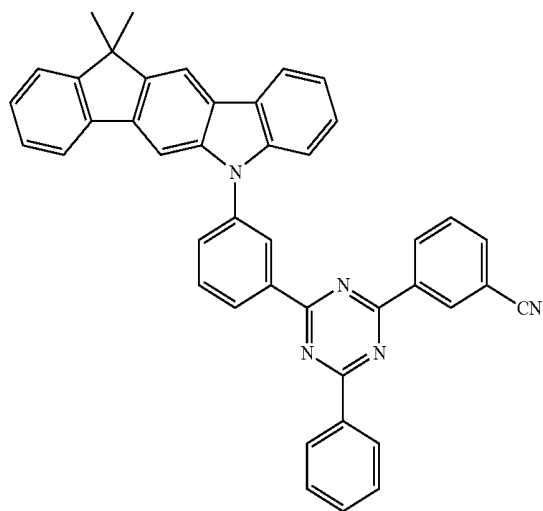


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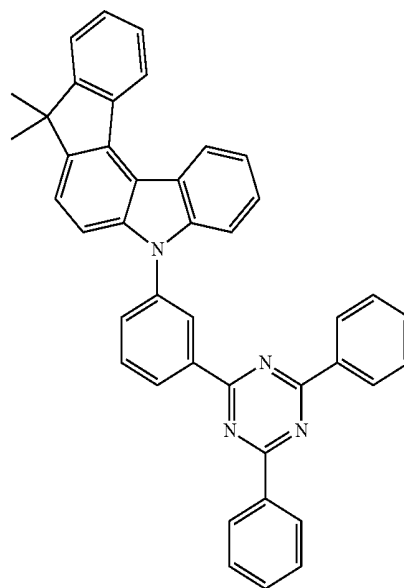
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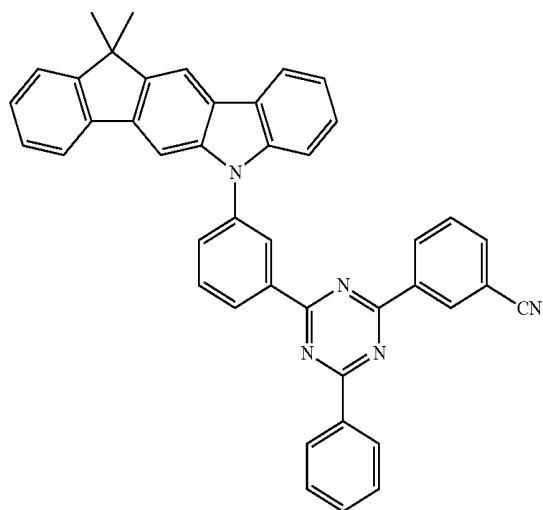
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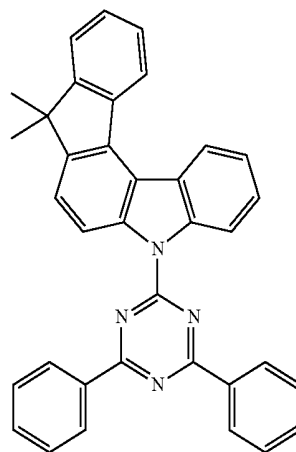
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H2-371

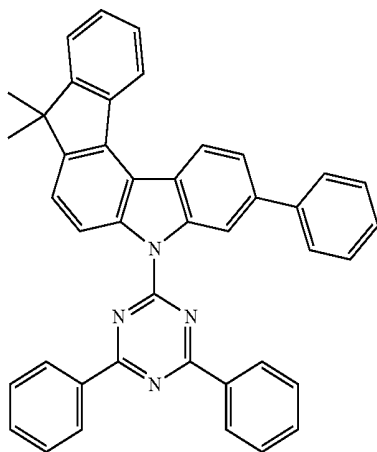


H2-374



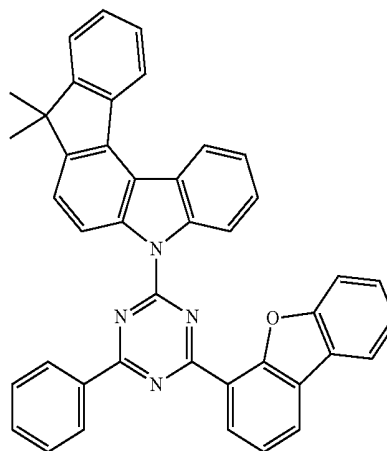
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H2-375

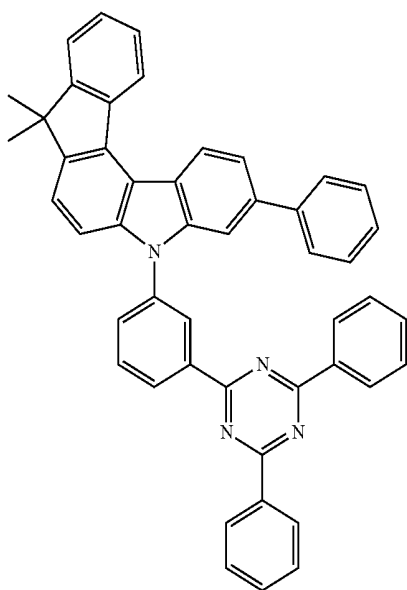


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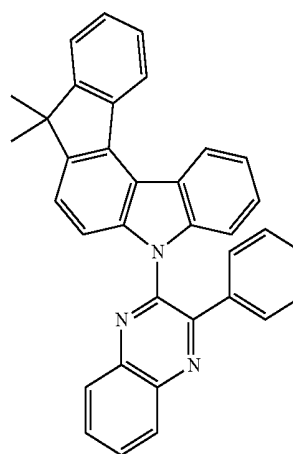
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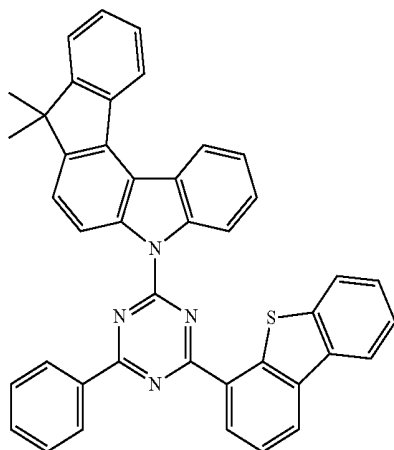
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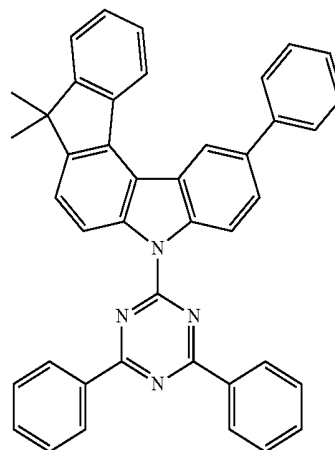
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H2-377

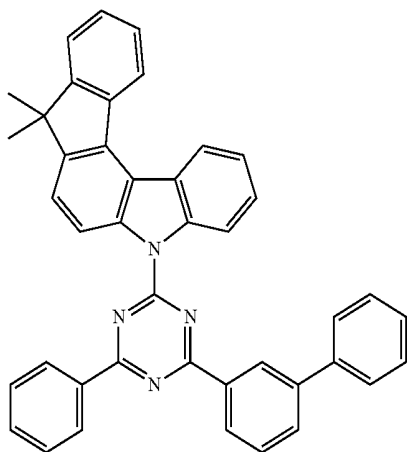


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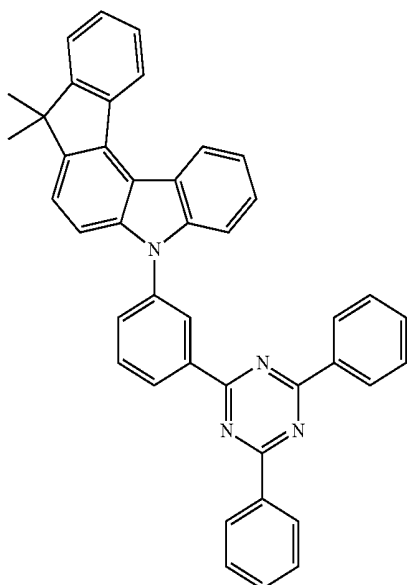


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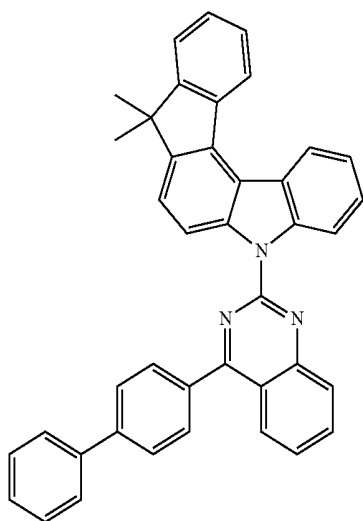
H2-381



H2-382

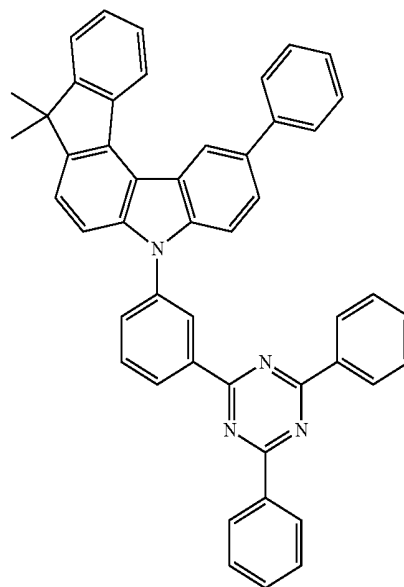


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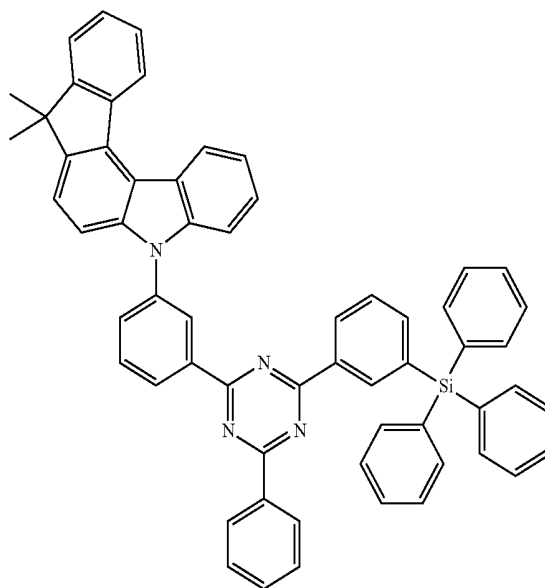


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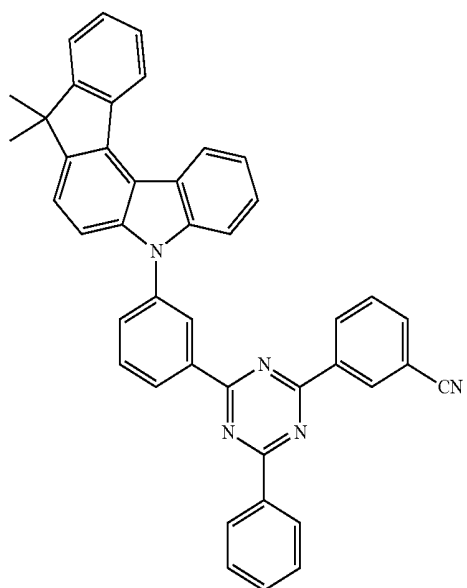


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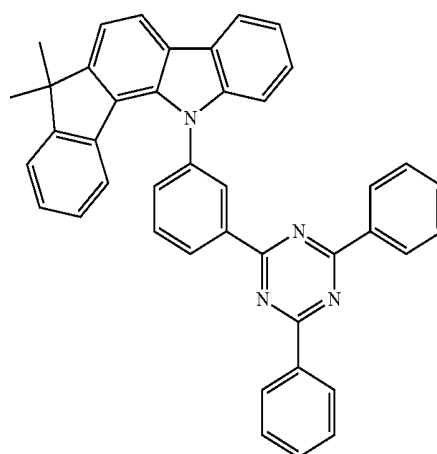
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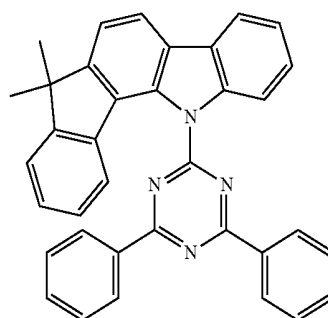


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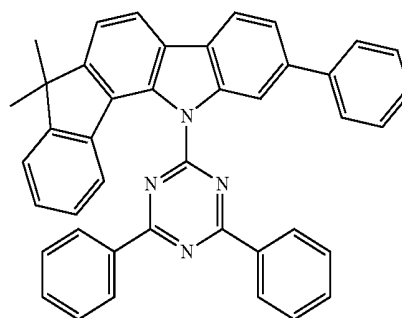
H2-389



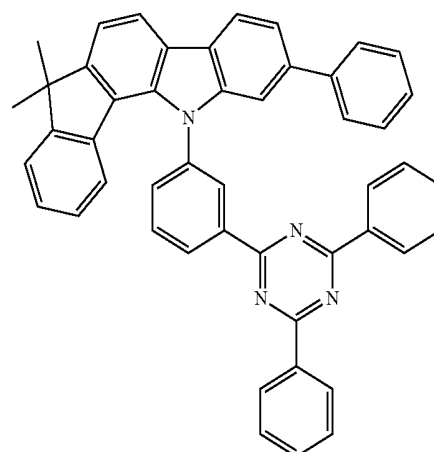
H2-390



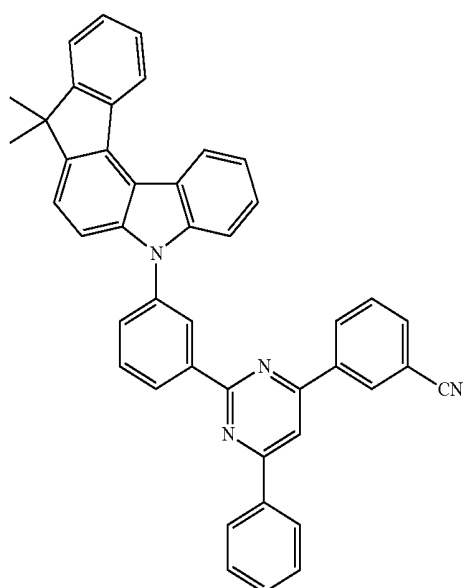
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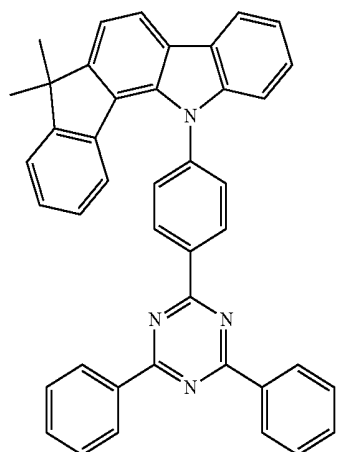
H2-392



H2-387

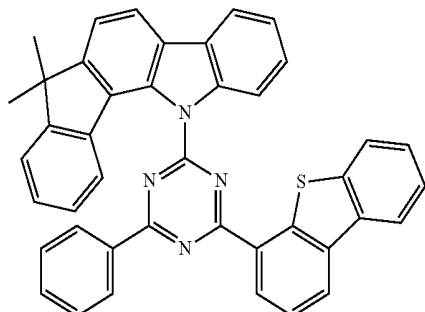


H2-388



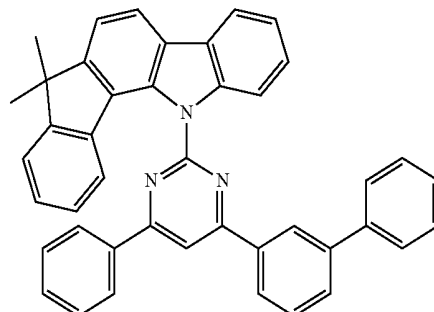
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H2-393

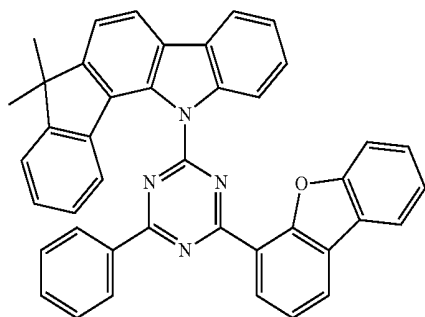


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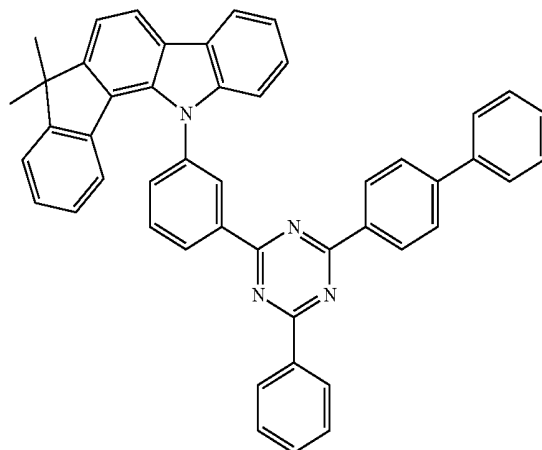
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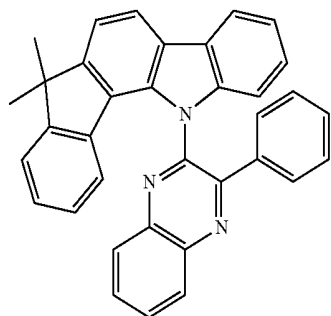
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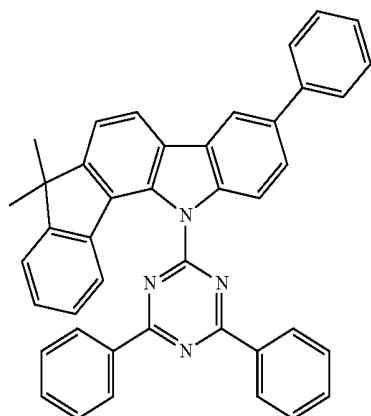
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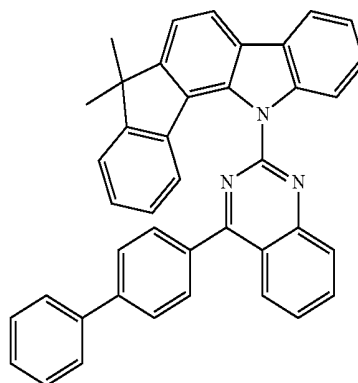
H2-395



H2-396

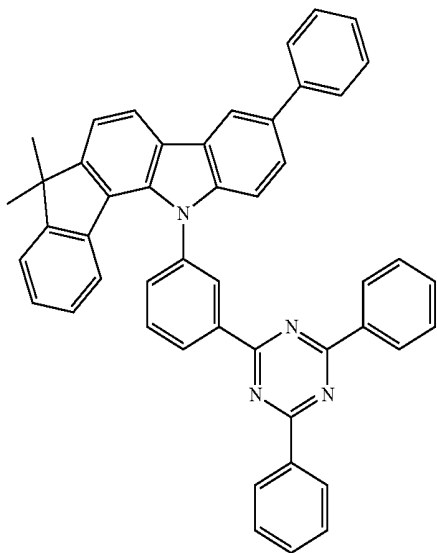


H2-399



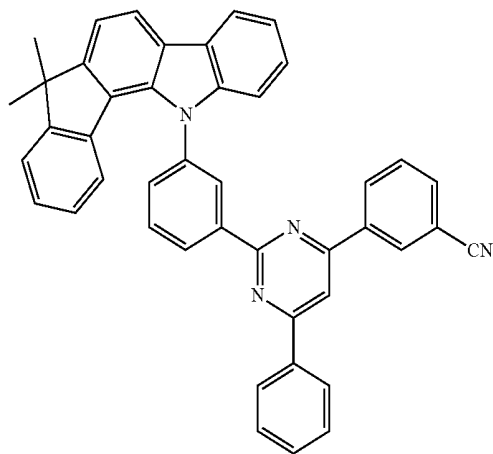
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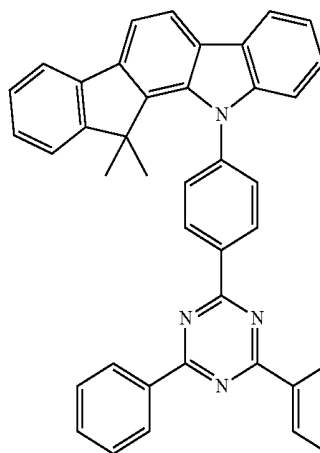


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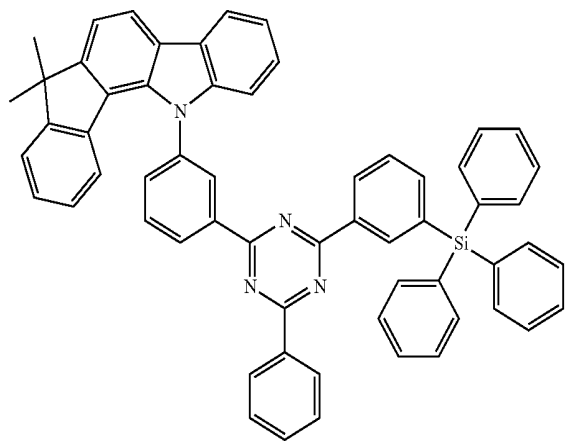
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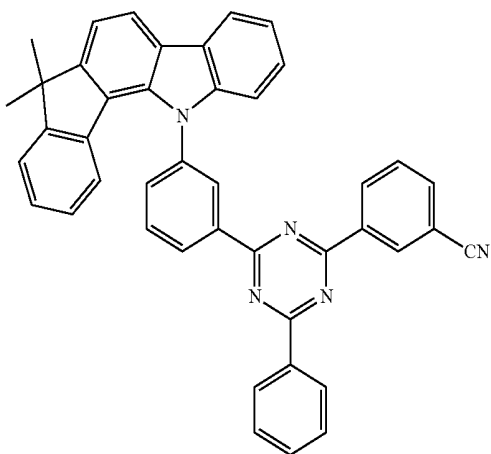
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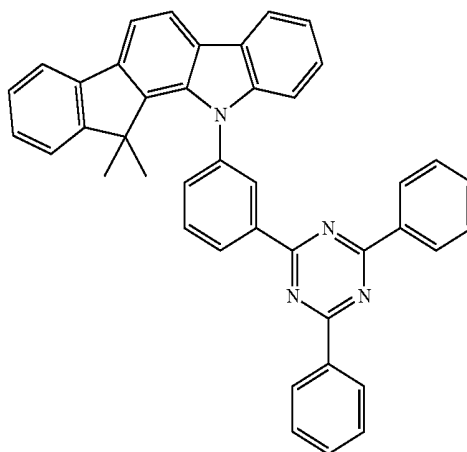
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H2-402

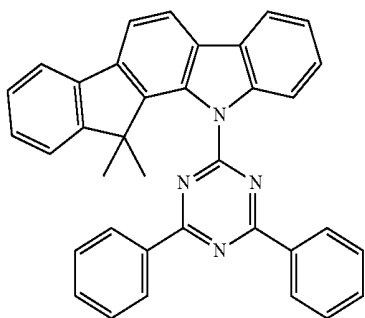


H2-405



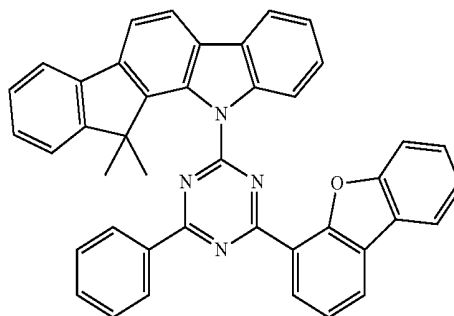
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H2-406

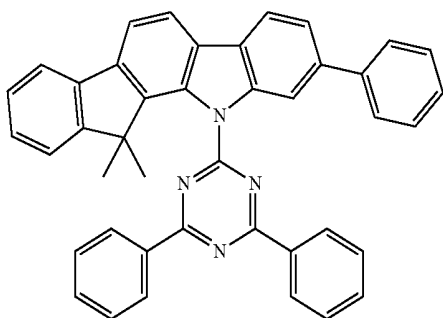


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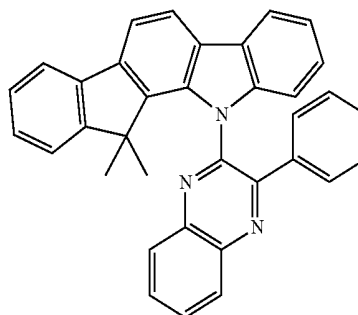
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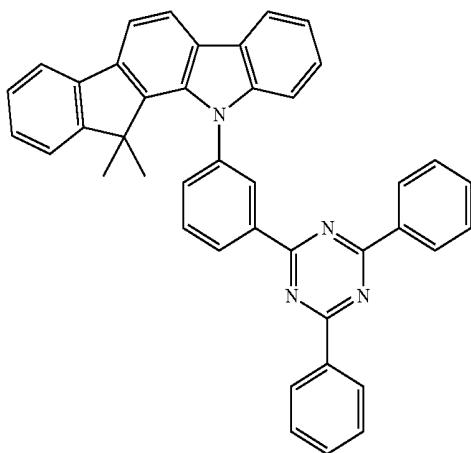
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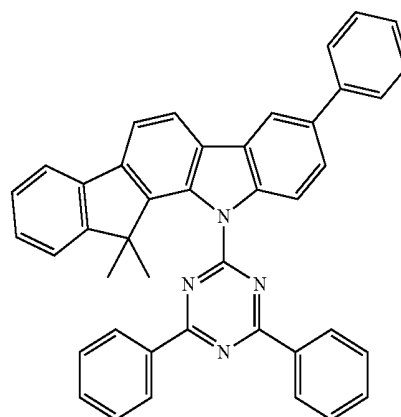
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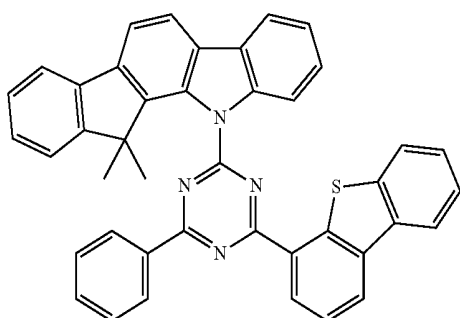
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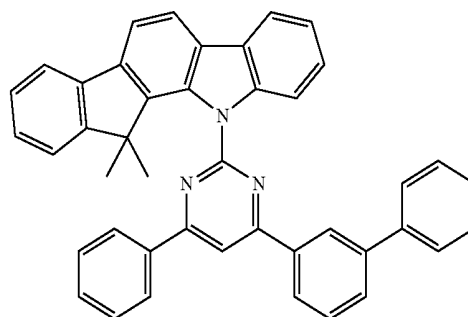
H2-412



H2-409

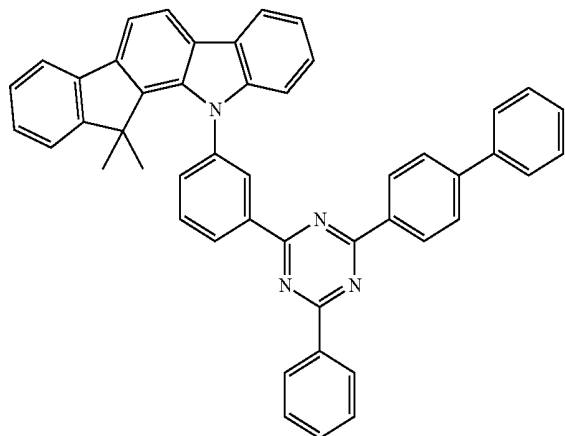


H2-413



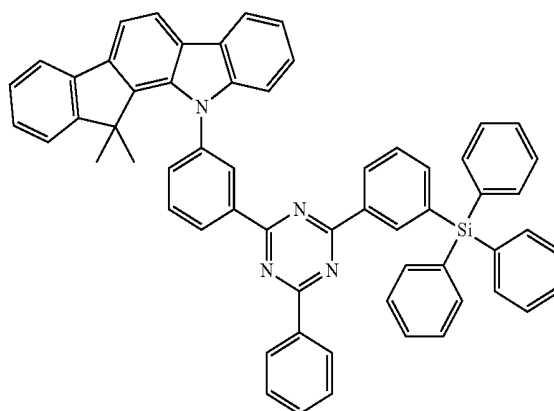
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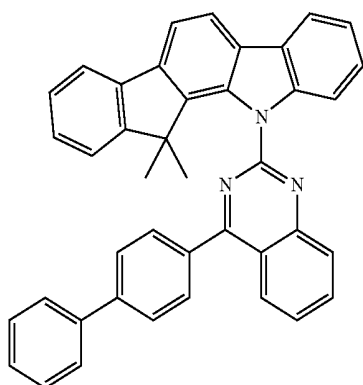


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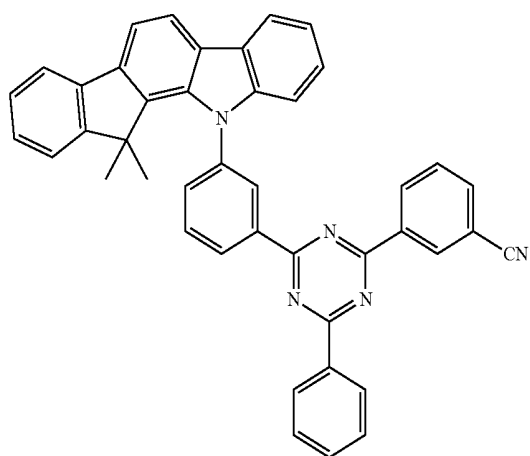
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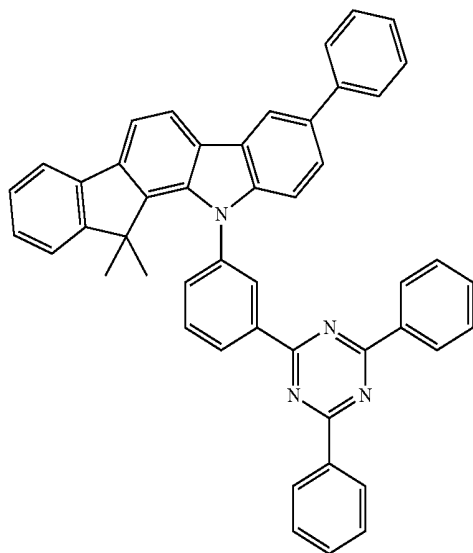
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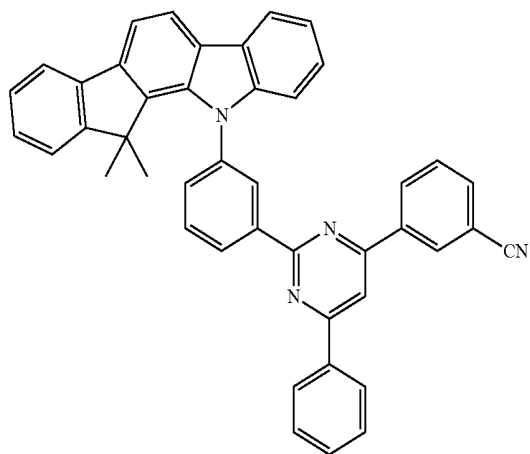
H2-418



H2-416

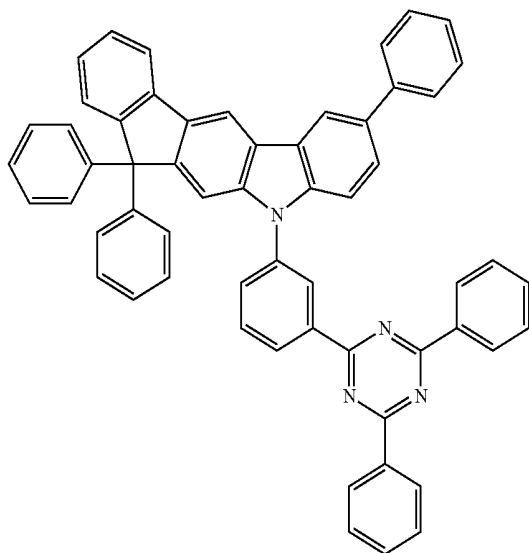


H2-419



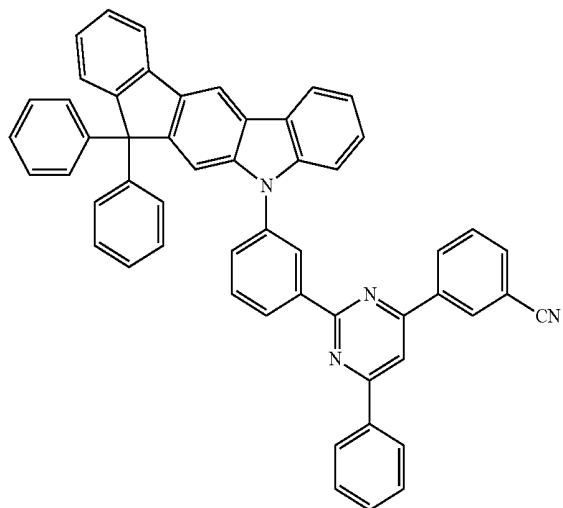
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H2-420

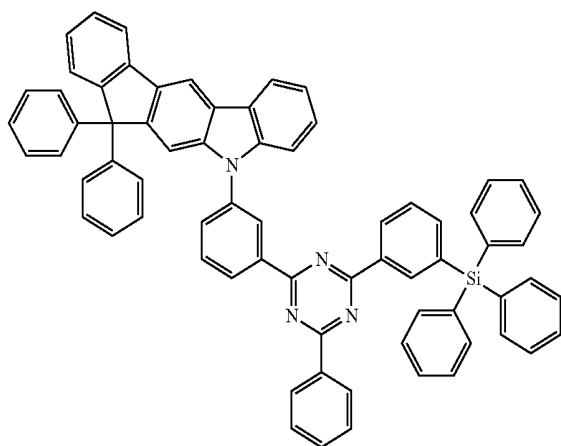


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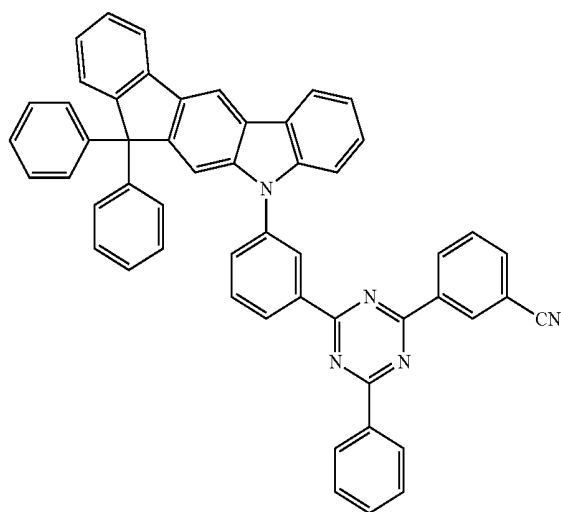
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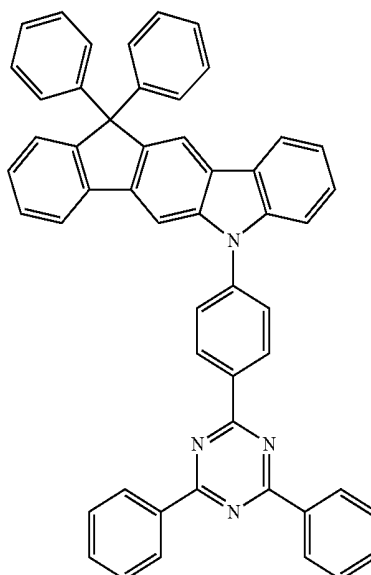
H2-421



H2-422

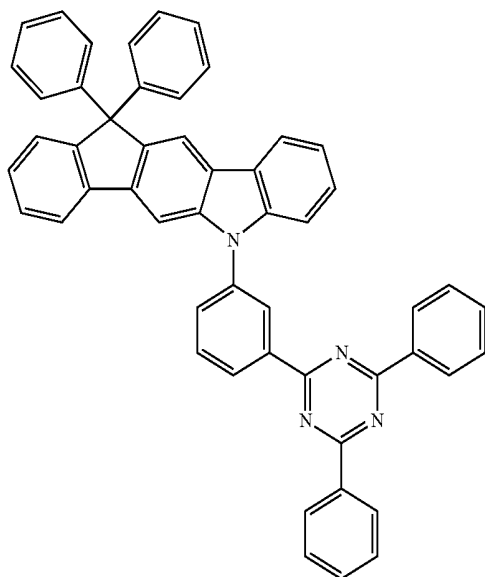


H2-424



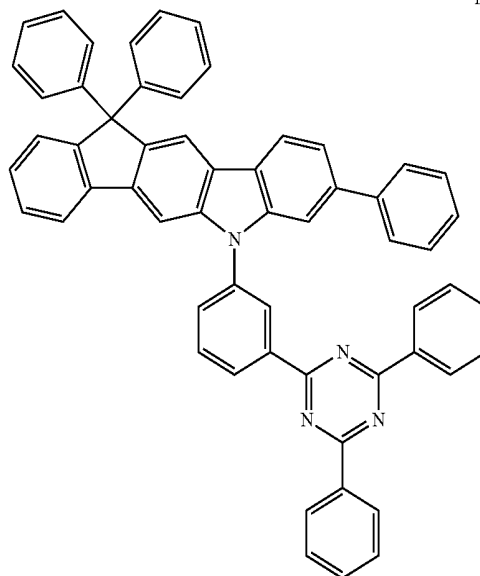
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H2-425

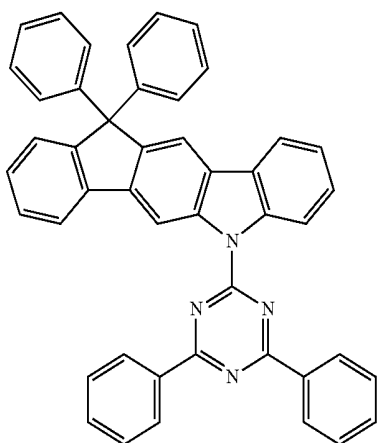


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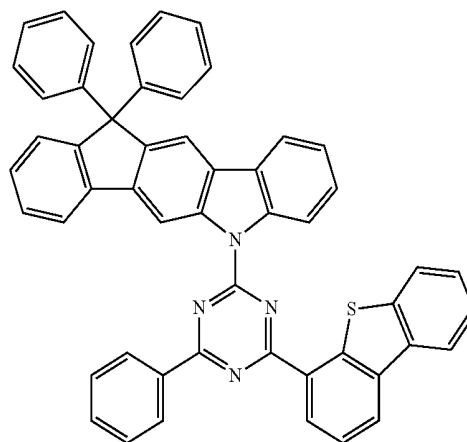
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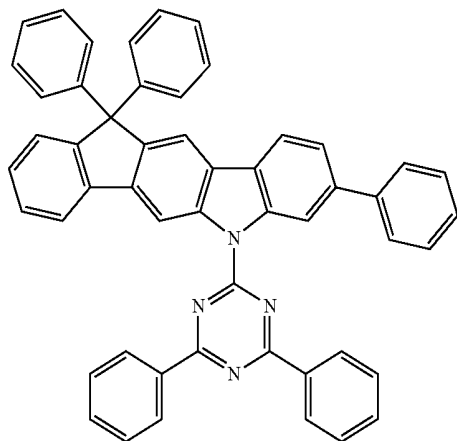
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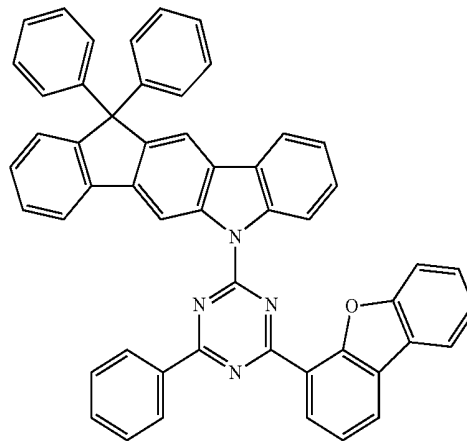
H2-429



H2-427

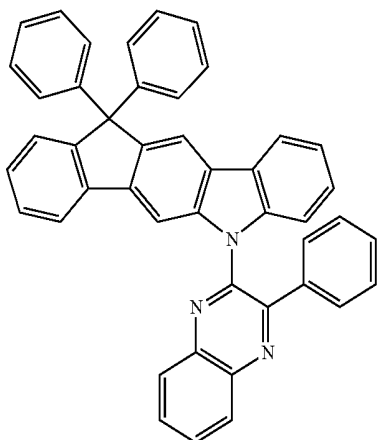


H2-430



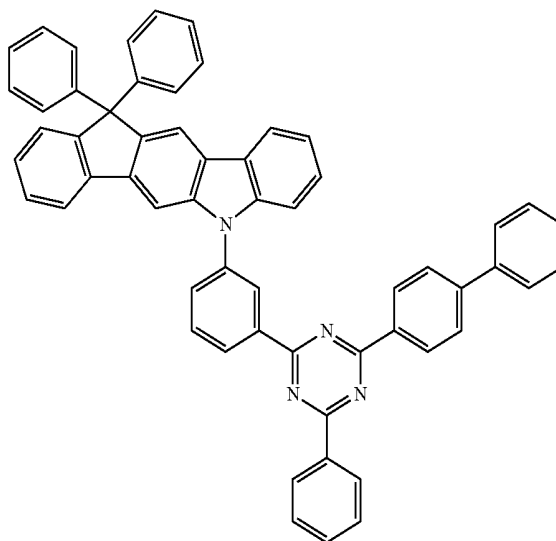
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H2-431

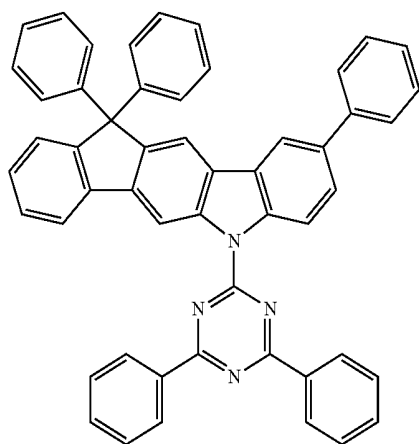


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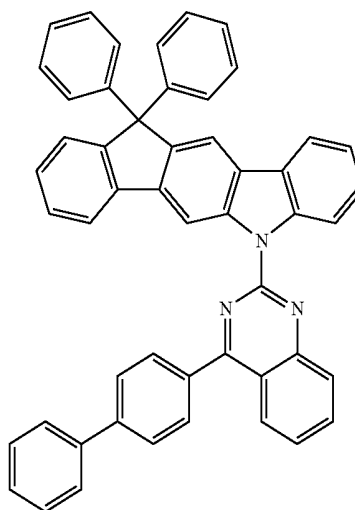
H2-434



H2-432

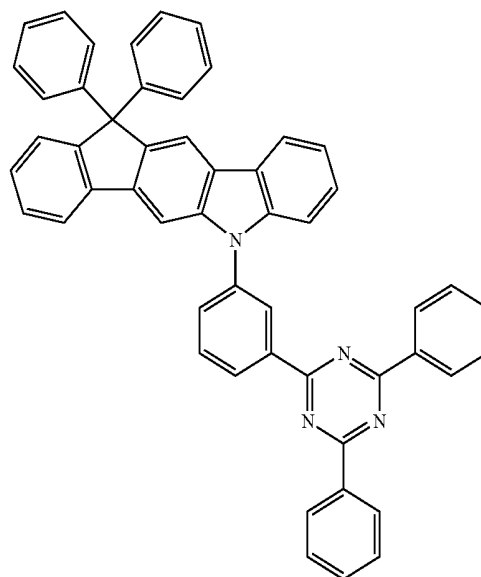
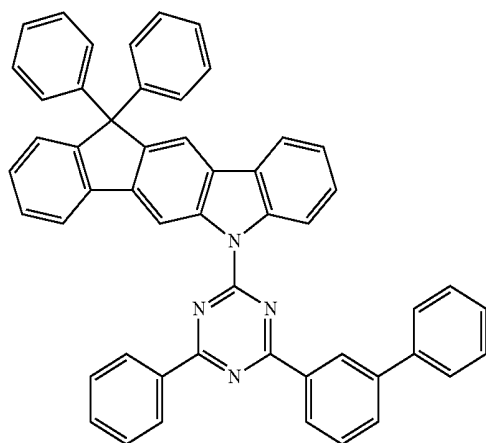


H2-435



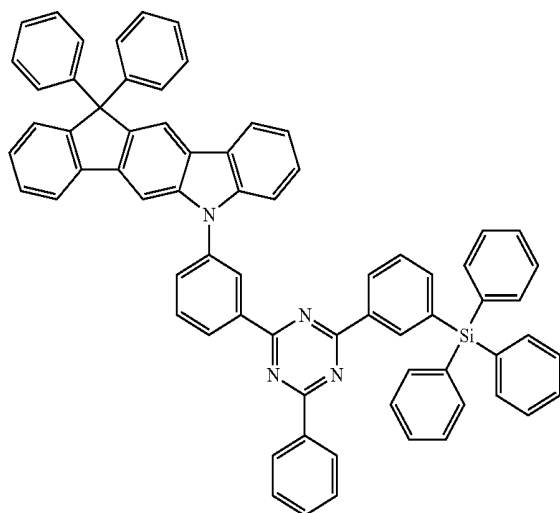
H2-436

H2-433



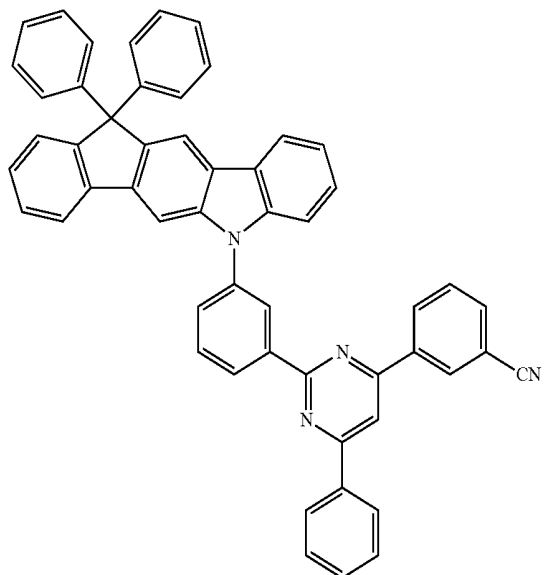
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H2-437

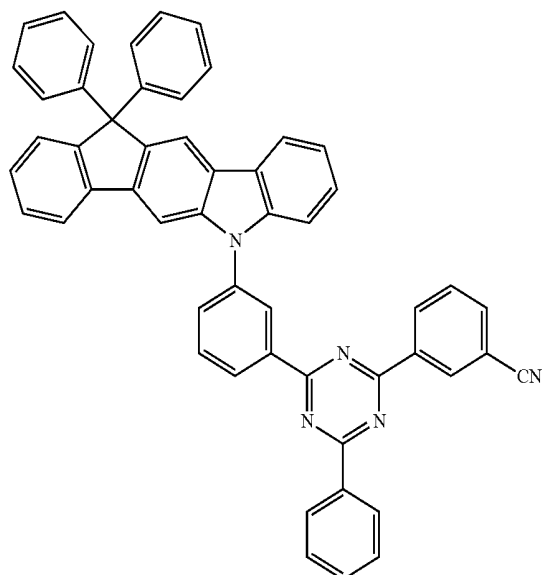


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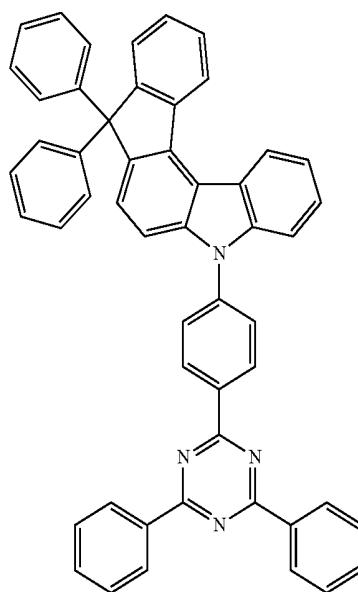
H2-439



H2-438

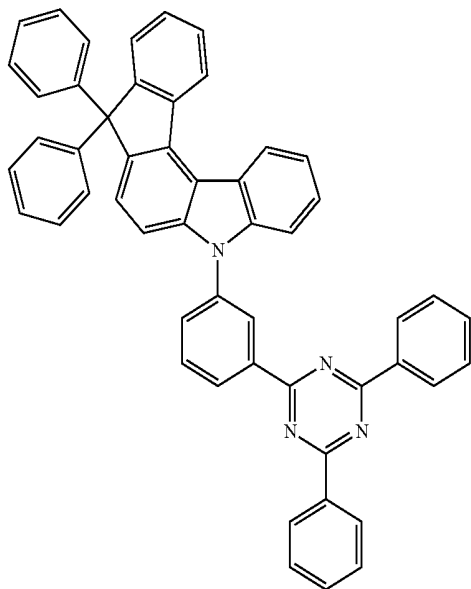


H2-440



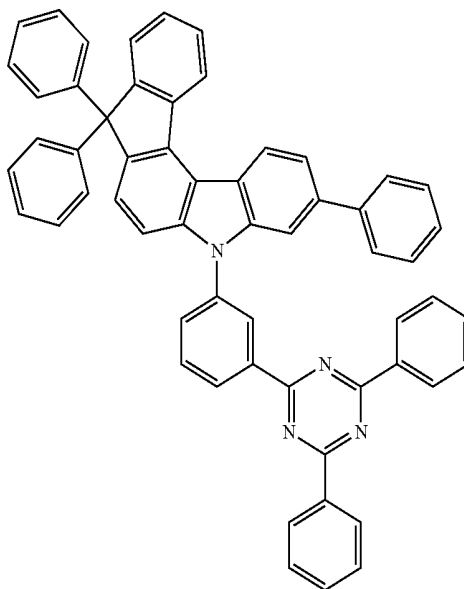
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H2-441

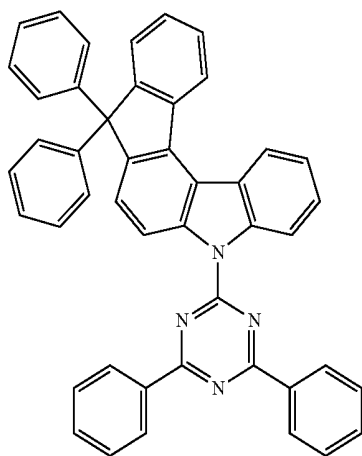


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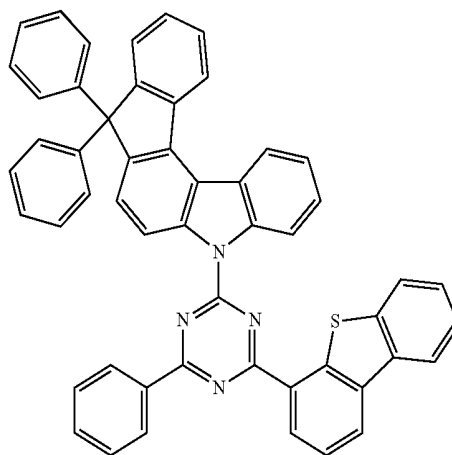
H2-444



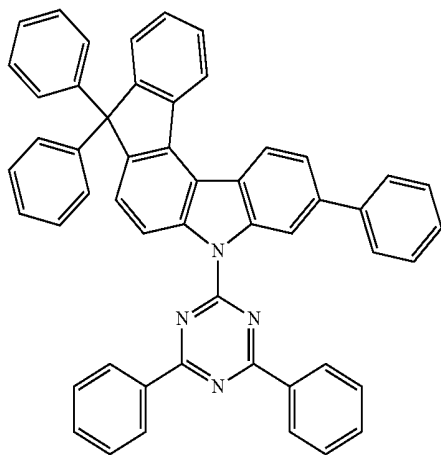
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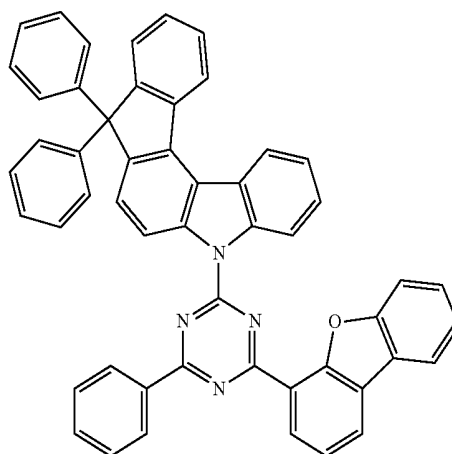
H2-445



H2-443

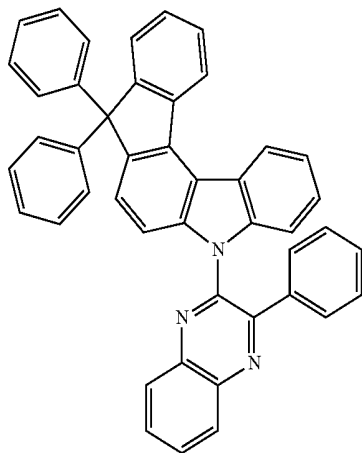


H2-446



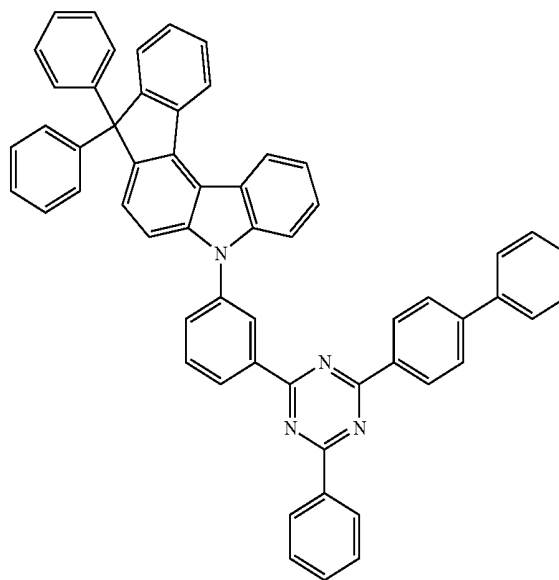
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H2-447

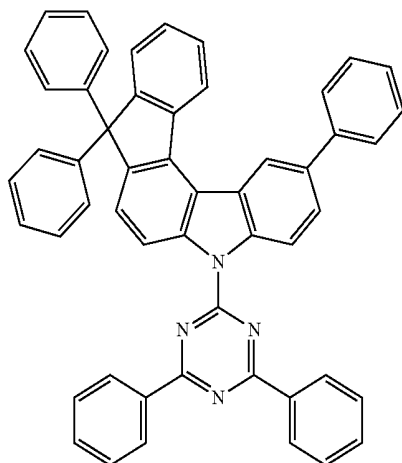


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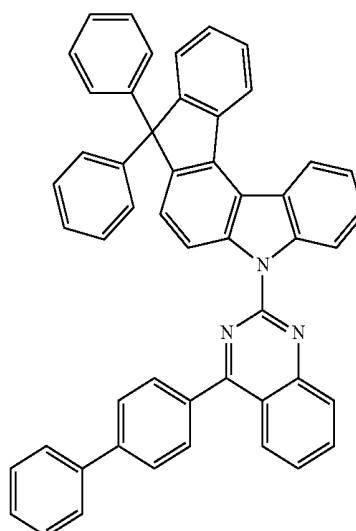
H2-450



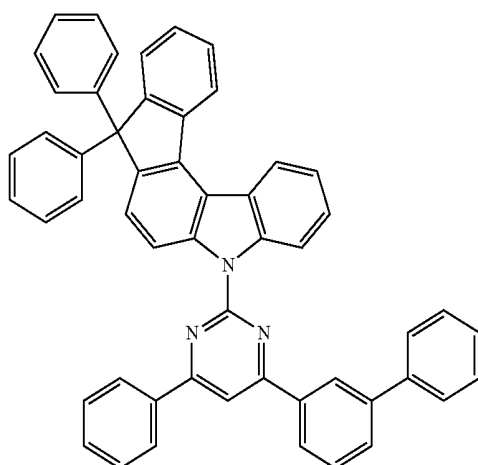
H2-448



H2-451

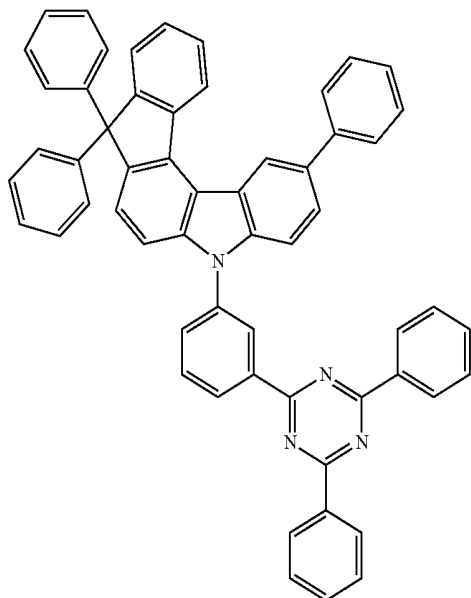


H2-449



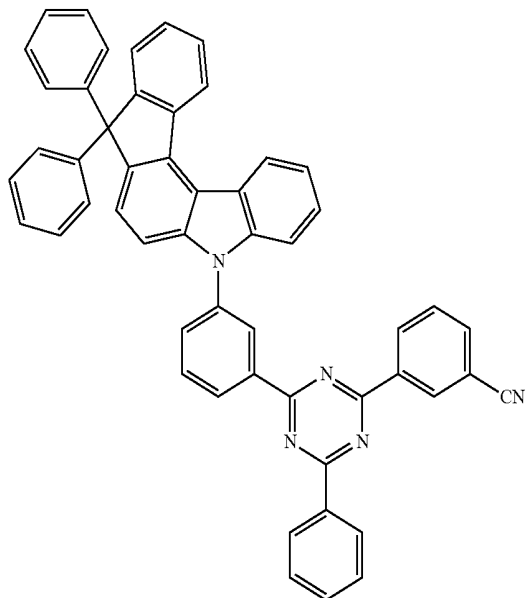
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H2-452

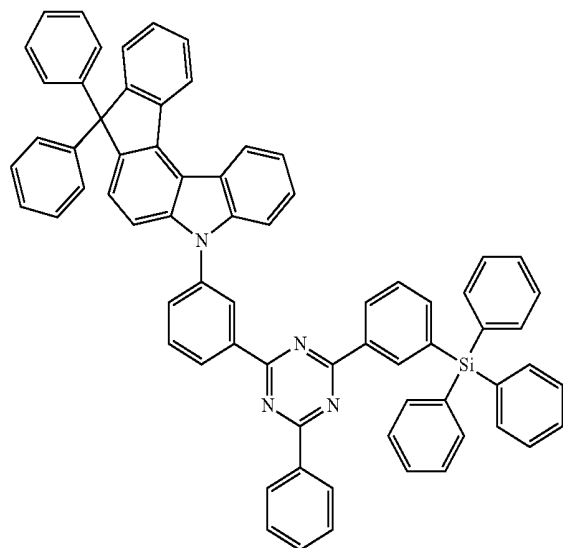


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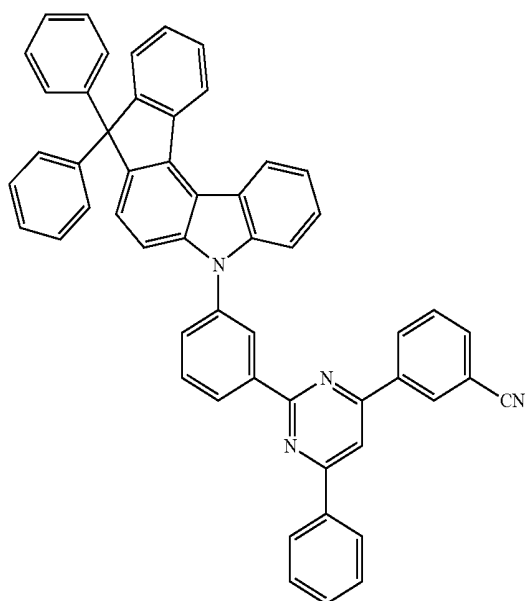
H2-454



H2-453

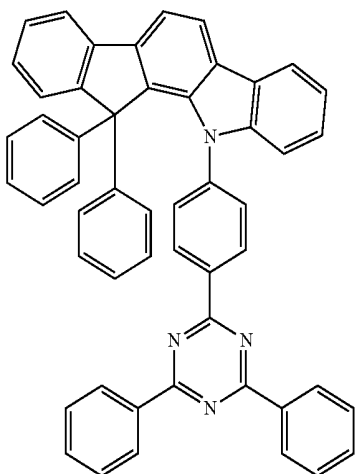


H2-455



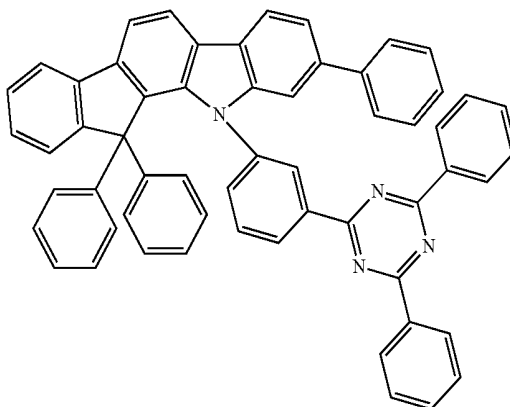
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H2-456

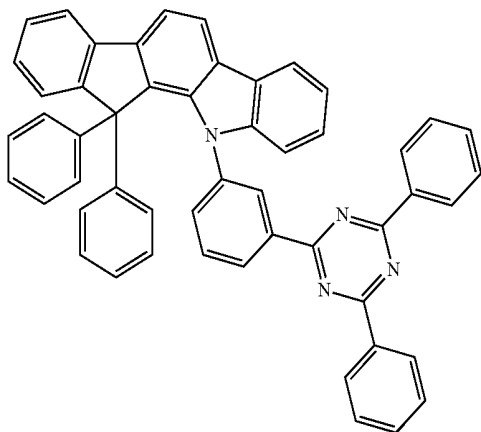


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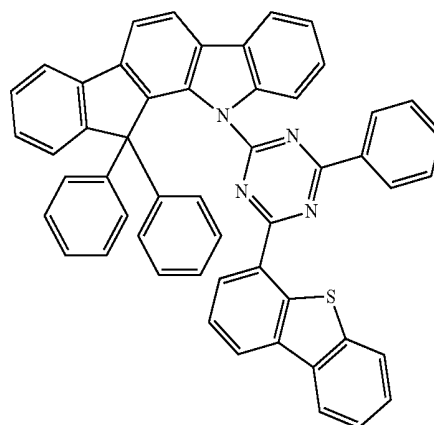
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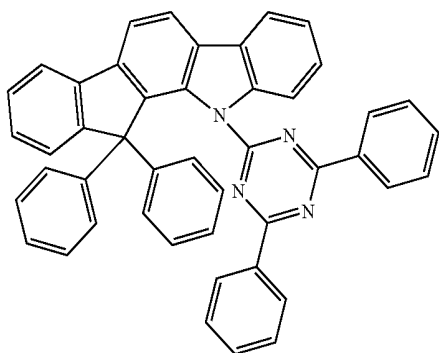
H2-457



H2-461

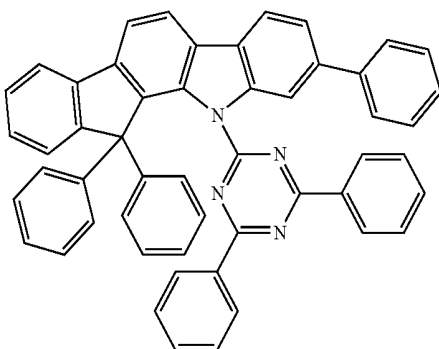
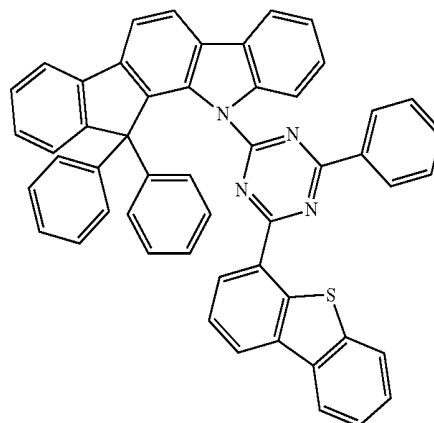


H2-458



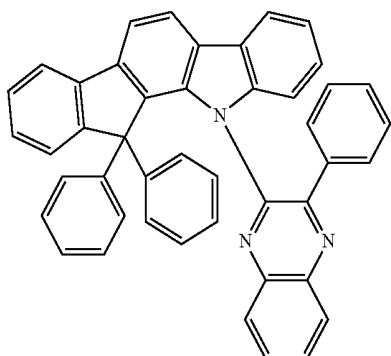
H2-462

H2-459



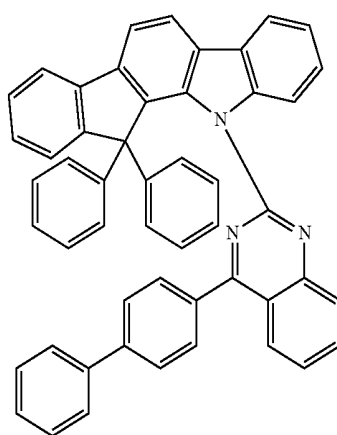
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H2-463

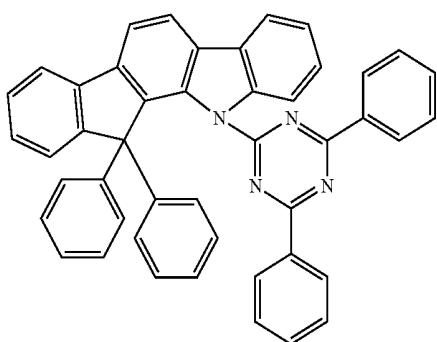


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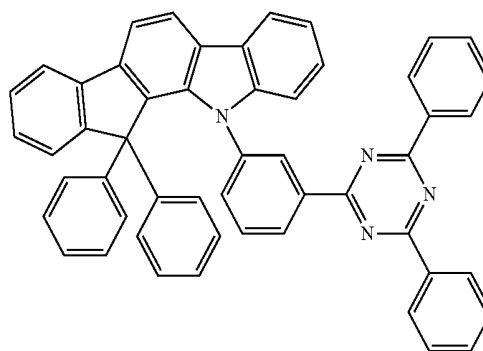
H2-467



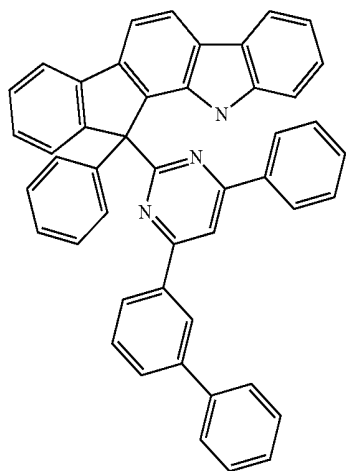
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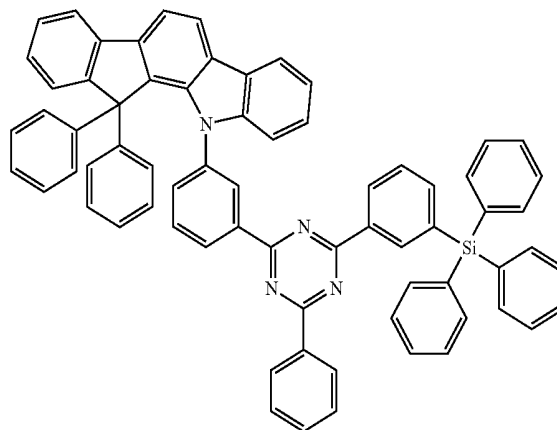
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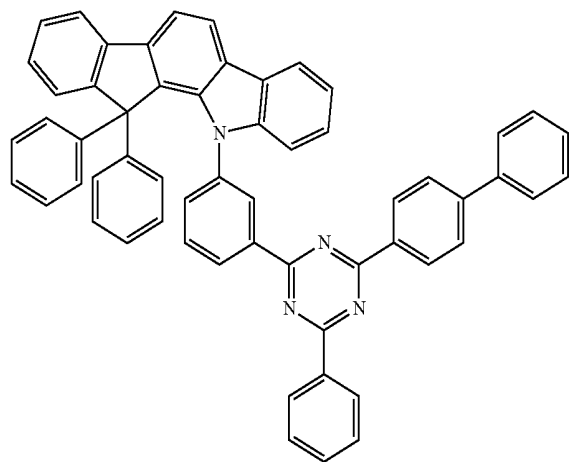
H2-465



H2-469

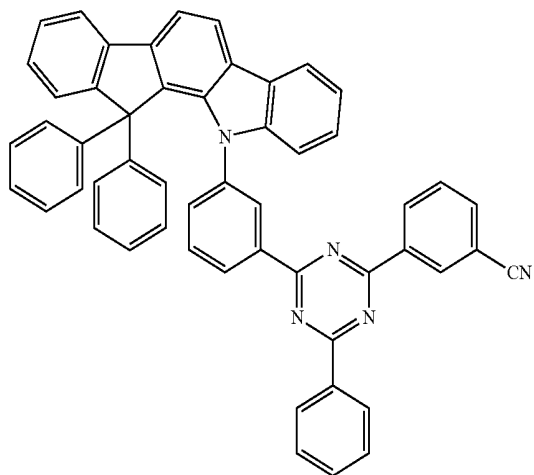


H2-466



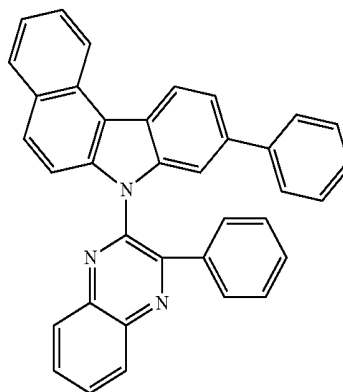
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H2-470



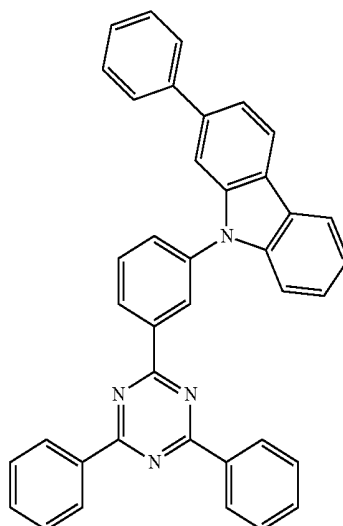
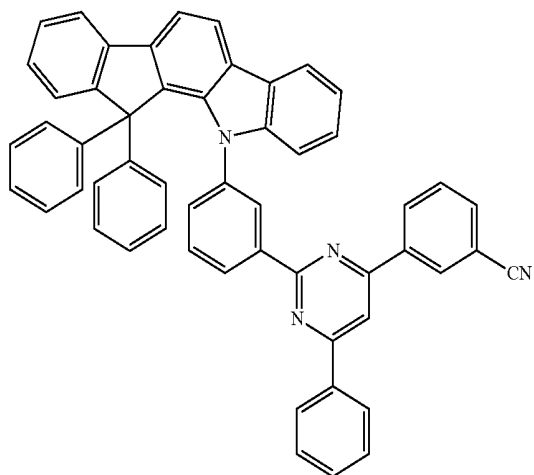
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H2-473



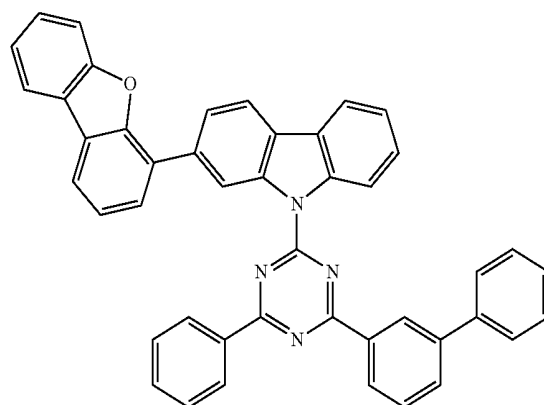
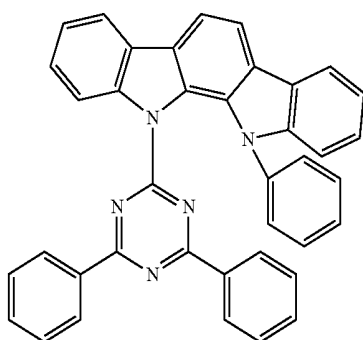
H2-474

H2-471



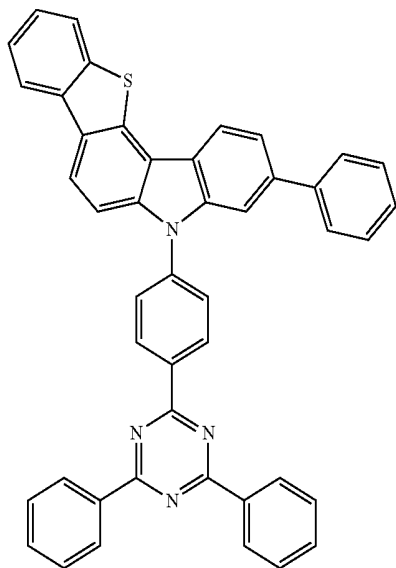
H2-475

H2-472



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H2-476



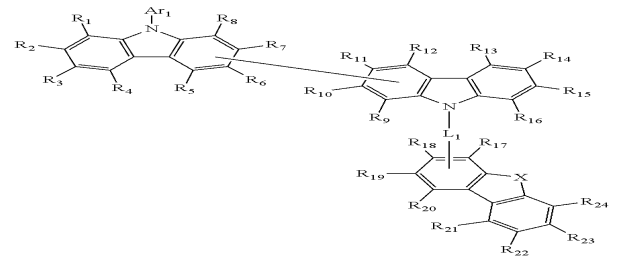
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专利名称(译)	多组分主体材料和包含其的有机电致发光器件		
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[标]申请(专利权)人(译)	罗门哈斯电子材料有限公司		
申请(专利权)人(译)	罗门哈斯电子材料KOREA LTD.		
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摘要(译)

本发明涉及多组分主体材料和包含其的有机电致发光器件。通过包含多组分主体化合物的具体组合，根据本发明的有机电致发光器件可以提供高发光效率和优异的寿命特性。

(1)



(2)

