US012389791B2

(12) **United States Patent**
Boudreault et al.

(10) **Patent No.: US 12,389,791 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ORGANIC ELECTROLUMINESCENT MATERIALS AND DEVICES**

(71) Applicant: **Universal Display Corporation**, Ewing, NJ (US)

(72) Inventors: **Pierre-Luc T. Boudreault**, Ewing, NJ (US); **Hsiao-Fan Chen**, Ewing, NJ (US); **Scott Joseph**, Ewing, NJ (US); **Jason Brooks**, Ewing, NJ (US); **Bert Alleyne**, Ewing, NJ (US); **Daniel W. Silverstein**, Ewing, NJ (US)

(73) Assignee: **Universal Display Corporation**, Ewing, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1173 days.

(21) Appl. No.: **16/131,266**

(22) Filed: **Sep. 14, 2018**

(65) **Prior Publication Data**

US 2019/0123288 A1 Apr. 25, 2019

Related U.S. Application Data

(60) Provisional application No. 62/561,281, filed on Sep. 21, 2017.

(51) **Int. Cl.**
H10K 85/30 (2023.01)
C07F 15/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H10K 85/346*** (2023.02); ***C07F 15/0086*** (2013.01); ***C09K 11/06*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01L 51/0087; H01L 51/009; H01L 51/5016; C07F 15/0086; C09K 2211/185;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,769,292 A 9/1988 Tang
5,061,569 A 10/1991 Vanslyke
(Continued)

FOREIGN PATENT DOCUMENTS

EP 0650955 5/1995
EP 1238981 9/2002
(Continued)

OTHER PUBLICATIONS

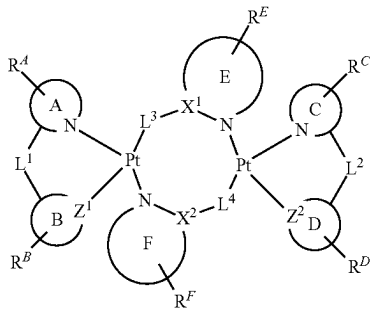
English translation of JP 2007294720 A obtained from Global Dossier (Year: 2007).*
(Continued)

Primary Examiner — Elizabeth M. Dahlburg
Assistant Examiner — Braelyn R Watson
(74) *Attorney, Agent, or Firm* — Riverside Law LLP

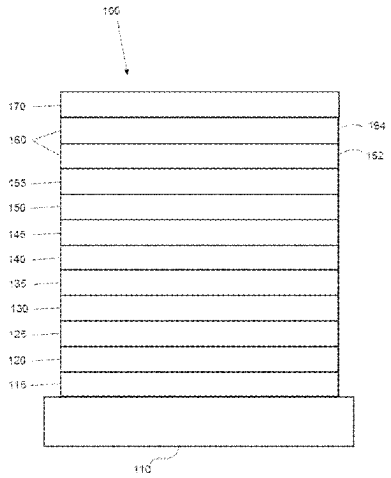
(57) **ABSTRACT**

A compound of Formula (I)

Formula I



Ring A, ring C, ring E and ring F are independently a 5-membered or 6-membered heterocyclic ring; ring B and ring D are independently a 5-membered, or
(Continued)



6-membered, carbocyclic or heterocyclic ring; and Z^1 and Z^2 are independently an anionic coordinating atom selected from the group consisting of C and N.

19 Claims, 2 Drawing Sheets

(51) **Int. Cl.**
C09K 11/06 (2006.01)
H10K 50/11 (2023.01)
H10K 101/10 (2023.01)

(52) **U.S. Cl.**
CPC *C09K 2211/1044* (2013.01); *C09K 2211/185* (2013.01); *H10K 50/11* (2023.02); *H10K 2101/10* (2023.02)

(58) **Field of Classification Search**
CPC C09K 11/06; C09K 2211/1044; H10K 85/346; H10K 50/11; H10K 2101/10; H10K 85/361; H10K 85/40; H10K 85/615; H10K 85/622; H10K 85/626; H10K 85/654; H10K 85/6572; H10K 85/6576
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,247,190	A	9/1993	Friend	
5,703,436	A	12/1997	Forrest	
5,707,745	A	1/1998	Forrest	
5,834,893	A	11/1998	Bulovic	
5,844,363	A	12/1998	Gu	
6,013,982	A	1/2000	Thompson	
6,087,196	A	7/2000	Sturm	
6,091,195	A	7/2000	Forrest	
6,097,147	A	8/2000	Baldo	
6,294,398	B1	9/2001	Kim	
6,303,238	B1	10/2001	Thompson	
6,337,102	B1	1/2002	Forrest	
6,468,819	B1	10/2002	Kim	
6,528,187	B1	3/2003	Okada	
6,687,266	B1	2/2004	Ma	
6,835,469	B2	12/2004	Kwong	
6,921,915	B2	7/2005	Takiguchi	
7,087,321	B2	8/2006	Kwong	
7,090,928	B2 *	8/2006	Thompson	H01L 51/0087 257/102
7,154,114	B2	12/2006	Brooks	
7,250,226	B2	7/2007	Tokito	
7,279,704	B2	10/2007	Walters	
7,332,232	B2	2/2008	Ma	
7,338,722	B2	3/2008	Thompson	
7,393,599	B2	7/2008	Thompson	
7,396,598	B2	7/2008	Takeuchi	
7,431,968	B1	10/2008	Shtein	
7,445,855	B2	11/2008	Mackenzie	
7,534,505	B2	5/2009	Lin	
7,968,146	B2	6/2011	Wagner	
8,367,850	B2 *	2/2013	Ma	C07D 409/04 549/460
8,409,729	B2	4/2013	Zeng	
9,108,998	B2	8/2015	Molt	
2002/0034656	A1	3/2002	Thompson	
2002/0134984	A1	9/2002	Igarashi	
2002/0158242	A1	10/2002	Son	
2003/0017361	A1 *	1/2003	Thompson	H01L 51/0087 428/690
2003/0138657	A1	7/2003	Li	
2003/0152802	A1	8/2003	Tsuboyama	
2003/0162053	A1	8/2003	Marks	
2003/0175553	A1	9/2003	Thompson	
2003/0230980	A1	12/2003	Forrest	
2004/0036077	A1	2/2004	Ise	
2004/0137267	A1	7/2004	Igarashi	
2004/0137268	A1	7/2004	Igarashi	
2004/0174116	A1	9/2004	Lu	
2004/0197600	A1 *	10/2004	Thompson	H01L 51/0087 428/690
2005/0025993	A1	2/2005	Thompson	
2005/0112407	A1	5/2005	Ogasawara	
2005/0142381	A1 *	6/2005	Lyu	C07F 15/0033 546/10
2005/0238919	A1	10/2005	Ogasawara	
2005/0244673	A1	11/2005	Satoh	
2005/0260441	A1	11/2005	Thompson	
2005/0260449	A1	11/2005	Walters	
2006/0008670	A1	1/2006	Lin	
2006/0202194	A1	9/2006	Jeong	
2006/0240279	A1	10/2006	Adamovich	
2006/0251923	A1	11/2006	Lin	
2006/0263635	A1	11/2006	Ise	
2006/0280965	A1	12/2006	Kwong	
2007/0190359	A1	8/2007	Knowles	
2007/0278938	A1	12/2007	Yabunouchi	
2008/0015355	A1	1/2008	Schafer	
2008/0018221	A1	1/2008	Egen	
2008/0106190	A1	5/2008	Yabunouchi	
2008/0124572	A1	5/2008	Mizuki	
2008/0220265	A1	9/2008	Xia	
2008/0297033	A1	12/2008	Knowles	
2009/0008605	A1	1/2009	Kawamura	
2009/0009065	A1	1/2009	Nishimura	
2009/0017330	A1	1/2009	Iwakuma	
2009/0030202	A1	1/2009	Iwakuma	
2009/0039776	A1	2/2009	Yamada	
2009/0045730	A1	2/2009	Nishimura	
2009/0045731	A1	2/2009	Nishimura	
2009/0101870	A1	4/2009	Prakash	
2009/0108737	A1	4/2009	Kwong	
2009/0115316	A1	5/2009	Zheng	
2009/0165846	A1	7/2009	Johannes	
2009/0167162	A1	7/2009	Lin	
2009/0179554	A1	7/2009	Kuma	
2010/0320449	A1 *	12/2010	Schmid	C09K 11/06 257/E51.026
2013/0026452	A1	1/2013	Kottas	
2013/0119354	A1	5/2013	Ma	
2014/0054564	A1	2/2014	Kim	
2014/0117318	A1 *	5/2014	Choi	C09K 11/06 257/40
2014/0326960	A1 *	11/2014	Kim	H01L 51/0072 257/40
2015/0318487	A1	11/2015	Ito	
2017/0229670	A1 *	8/2017	Laitar	C09K 11/06

FOREIGN PATENT DOCUMENTS

EP	1725079		11/2006
EP	2034538		3/2009
EP	2551932		1/2013
EP	2977378		1/2016
JP	200511610		1/2005
JP	2005259377	A *	9/2005
JP	2006060198	A *	3/2006
JP	2007123392		5/2007
JP	2007254297		10/2007
JP	2007294720	A *	11/2007
JP	2008074939	A	4/2008
JP	2009215277	A *	9/2009
JP	2010135467		6/2010
JP	2014024750	A *	2/2014
WO	0139234		5/2001
WO	0202714		1/2002
WO	0215645		2/2002
WO	03040257		5/2003
WO	03060956		7/2003
WO	2004093207		10/2004
WO	2004107822		12/2004
WO	2004111066		12/2004

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO	2005014551	2/2005	
WO	2005019373	3/2005	
WO	2005030900	4/2005	
WO	2005089025	9/2005	
WO	2005123873	12/2005	
WO	2006009024	1/2006	
WO	2006056418	6/2006	
WO	2006072002	7/2006	
WO	2006082742	8/2006	
WO	2006098120	9/2006	
WO	2006100298	9/2006	
WO	2006103874	10/2006	
WO	2006114966	11/2006	
WO	2006132173	12/2006	
WO	2007002683	1/2007	
WO	2007004380	1/2007	
WO	2007063754	6/2007	
WO	2007063796	6/2007	
WO	2008044723	4/2008	
WO	2008056746	5/2008	
WO	2008057394	5/2008	
WO	2008101842	8/2008	
WO	2008132085	11/2008	
WO	2008141637	11/2008	
WO	2009000673	12/2008	
WO	2009003898	1/2009	
WO	2009008311	1/2009	
WO	2009018009	2/2009	
WO	2009021126 A2	2/2009	
WO	2009050290	4/2009	
WO	2009062578	5/2009	
WO	2009063833	5/2009	
WO	2009066778	5/2009	
WO	2009066779	5/2009	
WO	2009086028	7/2009	
WO	2009100991	8/2009	
WO	2010011390	1/2010	
WO	2010111175	9/2010	
WO	2010126234	11/2010	
WO	2013027569	2/2013	
WO	WO-2014024750 A1 *	2/2014	..... C07D 251/24
WO	WO-2014202675 A1 *	12/2014	..... C07F 9/5045

OTHER PUBLICATIONS

Babudri, Francesco, et al. "Fluorinated organic materials for electronic and optoelectronic applications: the role of the fluorine atom." Chemical Communications 10 (2007): 1003-1022. (Year: 2007).*

Yang, Xiaolong, et al. "Pyrimidine-based mononuclear and dinuclear iridium (III) complexes for high performance organic light-emitting diodes." ACS applied materials & interfaces 8.49 (2016): 33874-33887. (Year: 2016).*

CBP, ChemSpider, Royal Society of Chemistry (Year: 2021).*

Saito, Ken, et al. "Theoretical study of excited states of pyrazolate- and pyridinethiolate-bridged dinuclear platinum (II) complexes: relationship between geometries of excited states and phosphorescence spectra." Inorganic chemistry 49.19 (2010): 8977-8985 (Year: 2010).*

English translation of JP 2006060198 A obtained from Global Dossier (Year: 2006).*

English translation of JPWO 2014024750 A obtained from Global Dossier (Year: 2014).*

Ma, Biwu, et al. "Platinum Binuclear Complexes as Phosphorescent Dopants for Monochromatic and White Organic Light-Emitting Diodes." Advanced Functional Materials 16.18 (2006): 2438-2446. (Year: 2006).*

Chakraborty, Arnab, et al. "Charge-transfer and ligand-localized photophysics in luminescent cyclometalated pyrazolate-bridged dinuclear platinum (II) complexes." Organometallics 32.14 (2013): 3819-3829. (Year: 2013).*

English translation of JP 2005259377 A obtained from Espacenet (Year: 2005).*

English translation of JP 2005259377 A obtained from Global Dossier (Year: 2005).*

English translation of WO 2014202675 obtained from Global Dossier (Year: 2014).*

Mizota, Mina, and Ken Sakai. "Di-μ-2-aminopyridinato-bis [(2, 2'-bipyridine) platinum (II)] dinitrate tetrahydrate as a head-to-tail isomer." Acta Crystallographica Section E: Structure Reports Online 60.4 (2004): m473-m476.) (Year: 2004).*

Zhu, Yulin, et al. "Binuclear platinum (II) complexes based on 2-mercaptobenzothiazole 2-mercaptobenzimidazole and 2-hydroxpyridine as brigding ligands: Red and near-infrared luminescence originated from MMLCT transition." Dyes and Pigments 145 (2017): 144-151. (Year: 2017).*

Summers, David Alexander. Synthesis and characterization of oligometallic and polymetallic transition metal azolates. Diss. University of British Columbia, 1996. (Year: 1996).*

Wong, Wai-Yeung, "Multifunctional Iridium Complexes Based on Carbazole Modules as Highly Efficient Electrophosphors," Angew. Chem. Int. Ed., 45:7800-7803 (2006).

Ma, Yuguang et al., "Triplet Luminescent Dinuclear-Gold(I) Complex-Based Light-Emitting Diodes with Low Turn-On voltage," Appl. Phys. Lett., 74(10):1361-1363 (1999).

Mi, Bao-Xiu et al., "Thermally Stable Hole-Transporting Material for Organic Light-Emitting Diode: an Isoindole Derivative," Chem. Mater., 15(16):3148-3151 (2003).

Okumoto, Kenji et al., "Green Fluorescent Organic Light-Emitting Device with External Quantum Efficiency of Nearly 10%," Appl. Phys. Lett., 89:063504-1-063504-3 (2006).

Paulose, Betty Marie Jennifer S, et al., "First Examples of Alkenyl Pyridines as Organic Ligands for Phosphorescent Iridium Complexes," Adv. Mater., 16(22):2003-2007 (2004).

Tang, C.W. and VanSlyke, S.A., "Organic Electroluminescent Diodes," Appl. Phys. Lett., 51(12):913-915 (1987).

T. Ostergard et al., "Langmuir-Blodgett Light-Emitting Diodes of Poly(3-Hexylthiophene): Electro-Optical Characteristics Related to Structure," Synthetic Metals, 87:171-177 (1997).

Tung, Yung-Liang et al., "Organic Light-Emitting Diodes Based on Charge-Neutral Ru II PHosphorescent Emitters," Adv. Mater., 17(8):1059-1064 (2005).

Van Slyke, S. A. et al., "Organic Electroluminescent Devices with Improved Stability," Appl. Phys. Lett, 69(15):2160-2162 (1996).

Wong, Keith Man-Chung et al., "A Novel Class of Phosphorescent Gold(III) Alkynyl-Based Organic Light-Emitting Devices with Tunable Colour," Chem. Commun., 2906-2908 (2005).

Adachi, Chihaya et al., "Organic Electroluminescent Device Having a Hole Conductor as an Emitting Layer," Appl. Phys. Lett., 55(15):1489-1491 (1989).

Gao, Zhiqiang et al., "Bright-Blue Electroluminescence From a Silyl-Substituted ter-(phenylene-vinylene) derivative," Appl. Phys. Lett., 74(6):865-867 (1999).

Lee, Chang-Lyoul et al., "Polymer Phosphorescent Light-Emitting Devices Doped with Tris(2-phenylpyridine) Iridium as a Triplet Emitter," Appl. Phys. Lett., 77(15):2280-2282 (2000).

Wang, Y. et al., "Highly Efficient Electroluminescent Materials Based on Fluorinated Organometallic Iridium Compounds," Appl. Phys. Lett., 79(4):449-451 (2001).

Kwong, Raymond C. et al., "High Operational Stability of Electrophosphorescent Devices," Appl. Phys. Lett., 81(1):162-164 (2002).

Holmes, R.J. et al., "Blue Organic Electrophosphorescence Using Exothermic Host-Guest Energy Transfer," Appl. Phys. Lett., 82(15):2422-2424 (2003).

Sotoyama, Wataru et al., "Efficient Organic Light-Emitting Diodes with Phosphorescent Platinum Complexes Containing NCN-Coordinating Tridentate Ligand," Appl. Phys. Lett., 86:153505-1-153505-3 (2005).

Kanno, Hiroshi et al., "Highly Efficient and Stable Red Phosphorescent Organic Light-Emitting Device Using bis[2-(2-benzothiazoyl)phenolato]zinc(II) as host material," Appl. Phys. Lett., 90:123509-1-123509-3 (2007).

(56) **References Cited**

OTHER PUBLICATIONS

Sun, Yiru and Forrest, Stephen R., "High-Efficiency White Organic Light Emitting Devices with Three Separate Phosphorescent Emission Layers," Appl. Phys. Lett., 91:263503-1-263503-3 (2007).
Adachi, Chihaya et al., "High-Efficiency Red Electrophosphorescence Devices," Appl. Phys. Lett., 78(11):1622-1624 (2001).
Hamada, Yuji et al., "High Luminance in Organic Electroluminescent Devices with Bis(10-hydroxybenzo[h]quinolinato)beryllium as an Emitter," Chem. Lett., 905-906 (1993).
Nishida, Jun-ichi et al., "Preparation, Characterization, and Electroluminescence Characteristics of a-Diimine-type Platinum(II) Complexes with Perfluorinated Phenyl Groups as Ligands," Chem. Lett., 34(4):592-593 (2005).
Baldo et al., "Very high-efficiency green organic light-emitting devices based on electrophosphorescence," Appl. Phys. Lett., vol. 75, No. 3, 4-6 (1999).
Huang, Wei-Sheng et al., "Highly Phosphorescent Bis-Cyclometalated Iridium Complexes Containing Benzoimidazole-Based Ligands," Chem. Mater., 16(12):2480-2488 (2004).
Niu, Yu-Hua et al., "Highly Efficient Electrophosphorescent Devices with Saturated Red Emission from a Neutral Osmium Complex," Chem. Mater., 17(13):3532-3536 (2005).
Lo, Shih-Chun et al., "Blue Phosphorescence from Iridium(III) Complexes at Room Temperature," Chem. Mater., 18(21):5119-5129 (2006).
Takizawa, Shin-ya et al., "Phosphorescent Iridium Complexes Based on 2-Phenylimidazo[1,2-a]pyridine Ligands: Tuning of Emission Color toward the Blue Region and Application to Polymer Light-Emitting Devices," Inorg. Chem., 46(10):4308-4319 (2007).
Lamansky, Sergey et al., "Synthesis and Characterization of Phosphorescent Cyclometalated Iridium Complexes," Inorg. Chem., 40(7):1704-1711 (2001).
Ranjan, Sudhir et al., "Realizing Green Phosphorescent Light-Emitting Materials from Rhenium(I) Pyrazolato Diimine Complexes," Inorg. Chem., 42(4):1248-1255 (2003).
Noda, Tetsuya and Shirota, Yasuhiko, "5,6-Bis(dinnesitylboryl)-2,2'-bithiophene and 5,5"-Bis(dimesitylbory1)-2,2':5',2"-terthiophene as a Novel Family of Electron-Transporting Amorphous Molecular Materials," J. Am. Chem. Soc., 120 (37):9714-9715 (1998).
Sakamoto, Youichi et al., "Synthesis, Characterization, and Electron-Transport Property of Perfluorinated Phenylene Dendrimers," J. Am. Chem. Soc., 122(8):1832-1833 (2000).
Adachi, Chihaya et al., "Nearly 100% Internal Phosphorescence Efficiency in an Organic Light Emitting Device," J. Appl. Phys., 90(10):5048-5051 (2001).
Shirota, Yasuhiko et al., "Starburst Molecules Based on p-Electron Systems as Materials for Organic Electroluminescent Devices," Journal of Luminescence, 72-74:985-991 (1997).
Inada, Hiroshi and Shirota, Yasuhiko, "1,3,5-Tris[4-(diphenylamino)phenyl]benzene and its Methylsubstituted Derivatives as a Novel Class of Amorphous Molecular Materials," J. Mater. Chem., 3(3):319-320 (1993).
Kido, Junji et al., "1,2,4-Triazole Derivative as an Electron Transport Layer in Organic Electroluminescent Devices," Jpn. J. Appl. Phys., 32:L917-L920 (1993).
Guo, Tzung-Fang et al., "Highly Efficient Electrophosphorescent Polymer Light-Emitting Devices," Organic Electronics, 1:15-20 (2000).
Palilis, Leonidas C., "High Efficiency Molecular Organic Light-Emitting Diodes Based on Silole Derivatives and Their Exciplexes," Organic Electronics, 4:113-121 (2003).
Ikeda, Hisao et al., "P-185: Low-Drive-Voltage OLEDs with a Buffer Layer Having Molybdenum Oxide," SID Symposium Digest, 37:923-926 (2006).
Hu, Nan-Xing et al., "Novel High Tg Hole-Transport Molecules Based on Indolo[3,2-b]carbazoles for Organic Light-Emitting Devices," Synthetic Metals, 111-112:421-424 (2000).
Salbeck, J. et al., "Low Molecular Organic Glasses for Blue Electroluminescence," Synthetic Metals, 91:209-215 (1997).
Kuwabara, Yoshiyuki et al., "Thermally Stable Multilayered Organic Electroluminescent Devices Using Novel Starburst Molecules, 4,4',4"-Tri(N-carbazolyl)triphenylamine (TCTA) and 4,4',4"-Tris(3-methylphenylphenyl-amino)triphenylamine (m-MTDATA), as Hole-Transport Materials," Adv. Mater., 6(9):677-679 (1994).
Huang, Jinsong et al., "Highly Efficient Red-Emission Polymer Phosphorescent Light-Emitting Diodes Based on Two Novel Tris(1-phenylisoquinolinato-C2,N)iridium(III) Derivatives," Adv. Mater., 19:739-743 (2007).
Aonuma, Masaki et al., "Material Design of Hole Transport Materials Capable of Thick-Film Formation in Organic Light Emitting Diodes," Appl. Phys. Lett., 90, Apr. 30, 2007, 183503-1-183503-3.
Hung, L.S. et al., "Anode Modification in Organic Light-Emitting Diodes by Low-Frequency Plasma Polymerization of CHF3,"Appl. Phys. Lett., 78(5):673-675 (2001).
Ikai, Masamichi and Tokito, Shizuo, "Highly Efficient Phosphorescence From Organic Light-Emitting Devices with an Exciton-Block Layer," Appl. Phys. Lett., 79(2):156-158 (2001).
Baldo et al., "Highly Efficient Phosphorescent Emission from Organic Electroluminescent Devices," Nature, vol. 395,151-154, (1998).
Brown-Xu et al., 2016, "Tunable Excited-State Properties and Dynamics as a Function of Pt-Pt Distance in Pyrazolate-Bridged Pt(II) Dimers," J. Phys. Chem. A 120:543-550.
Chakraborty et al., 2013, "Charge-Transfer and Ligand-Localized Photophysics in Luminescent Cyclometalated Pyrazolate-Bridged Dinuclear Platinum(II) Complexes," Organometallics 32:3819-3829.
Culham et al., 2013, "Highly Luminescent Dinuclear Platinum(II) Complexes Incorporating Bis-Cyclometallating Pyrazine-Based Ligands: A Versatile Approach to Efficient Red Phosphors," Inorg. Chem. 52:10992-11003.
Han et al., 2014, "A Phosphorescent Molecular "Butterfly" that undergoes a Photoinduced Structural Change allowing Temperature Sensing and White Emission," Angew. Chem. Int. Ed. 53:10908-10912.
Huang et al., 2015, "A theoretical investigation on the metal-metal interaction in a series of pyrazolate bridged platinum(II) complexes," Synthetic Metals 205, 222-227.
Ivanova et al., 2009, "Spectral and Luminescent Properties of Mono- and Binuclear Cyclometalated Complexes of Pd(II) and Pt(II) Based on 4,6-Diphenylpyrimidine with Ethylenediamine and Orthophenanthroline," Optics and Spectroscopy 106:359-364.
Lai et al., 1999, "Synthesis of Organoplatinum Oligomers by Employing N-Donor Bridges with Predesigned Geometry: Structural and Photophysical Properties of Luminescent Cyclometalated Platinum(II) Macrocycles," Organometallics 18:3991-3997.
Leopold et al., 2016, "Binuclear CÔC* Cyclometalated Platinum(II) NHC Complexes with Bridging Amidinate Ligands," Angew. Chem. Int. Ed. 55:1-5.
Lockard et al., 2010, "Triplet Excited State Distortions in a Pyrazolate Bridged Platinum Dimer Measured by X-ray Transient Absorption Spectroscopy," J Phys Chem A 114:12780-12787.
Ma et al., 2005, "Synthetic Control of Pt . . . Pt Separation and Photophysics of Binuclear Platinum Complexes," J. Am. Chem. Soc. 127:28-29.
Ma et al., 2006, "Platinum Binuclear Complexes as Phosphorescent Dopants for Monochromatic and White Organic Light-Emitting Diodes," Adv. Funct. Mater. 16:2438-2446.
Rachford and Castellano, 2009, "Thermochromic Absorption and Photoluminescence in [Pt(ppy)(μ-Ph2pz)]2," Inorg. Chem. 48:10865-10867.
Su et al., 2017, "Near-infrared emission from binuclear platinum (II) complexes containing pyrenylpyridine and pyridylthiolate units: Synthesis, photo-physical and electroluminescent properties," Dyes and Pigments 138:162-168.
Zhou et al., 2015, "Precise Design of Phosphorescent Molecular Butterflies with Tunable Photoinduced Structural Change and Dual Emission," Angew. Chem. Int. Ed. 54:9591-9595.

* cited by examiner

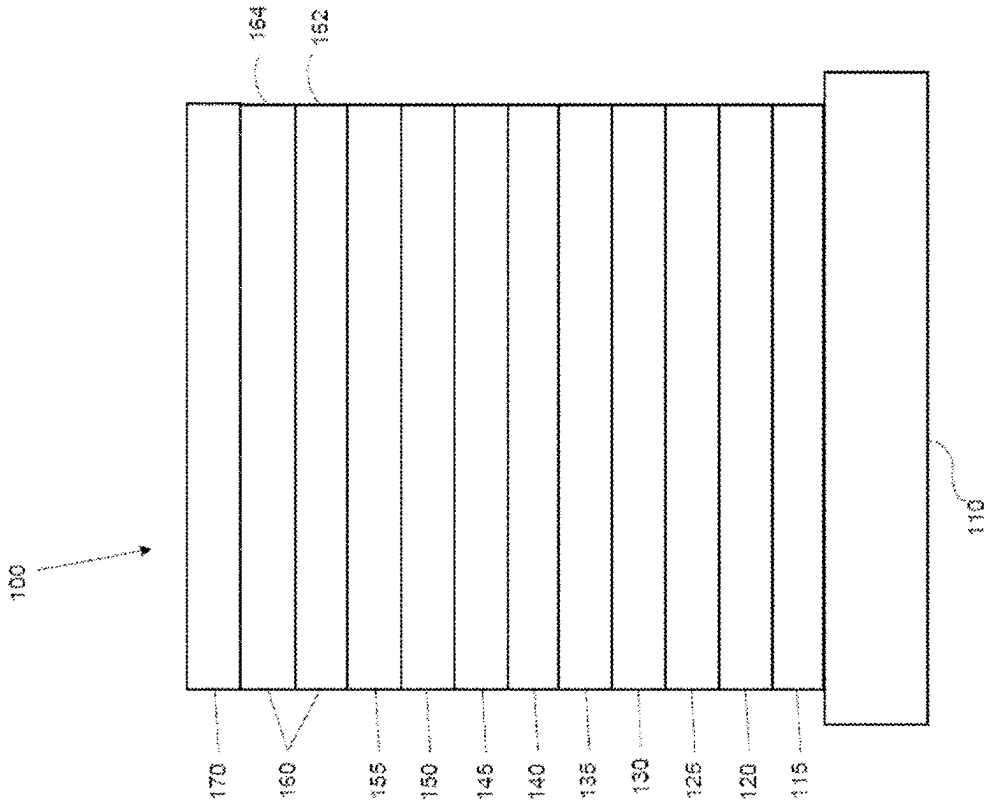


Figure 1

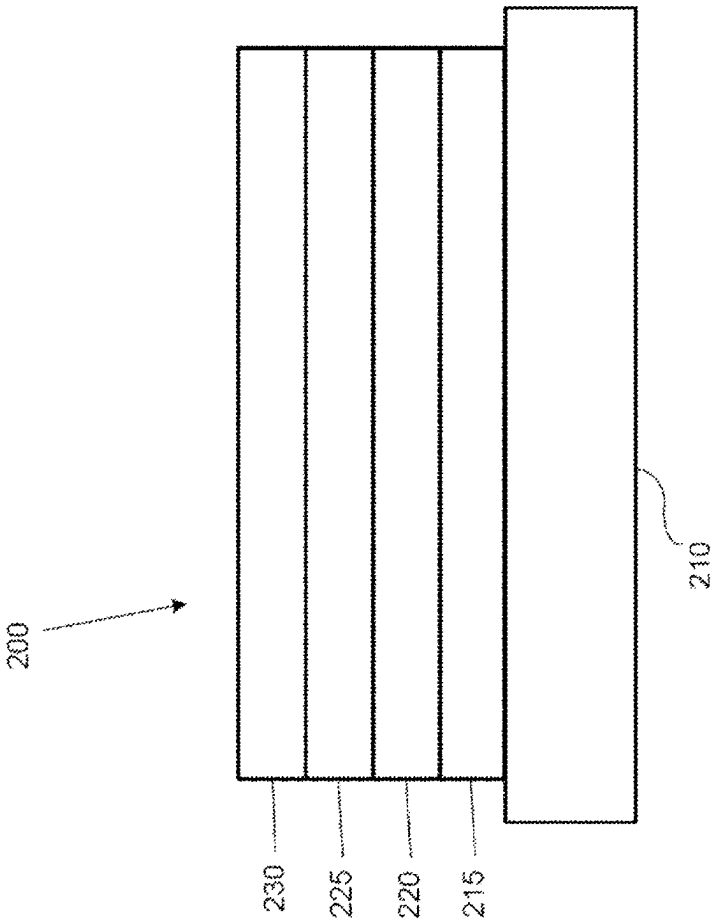


Figure 2

ORGANIC ELECTROLUMINESCENT MATERIALS AND DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Application No. 62/561,281, filed Sep. 21, 2017, the entire contents of which are incorporated herein by reference.

FIELD

The present invention relates to compounds for use as emitters, and devices, such as organic light emitting diodes, including the same.

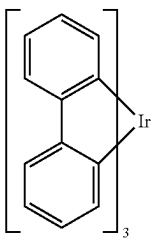
BACKGROUND

Opto-electronic devices that make use of organic materials are becoming increasingly desirable for a number of reasons. Many of the materials used to make such devices are relatively inexpensive, so organic opto-electronic devices have the potential for cost advantages over inorganic devices. In addition, the inherent properties of organic materials, such as their flexibility, may make them well suited for particular applications such as fabrication on a flexible substrate. Examples of organic opto-electronic devices include organic light emitting diodes/devices (OLEDs), organic phototransistors, organic photovoltaic cells, and organic photodetectors. For OLEDs, the organic materials may have performance advantages over conventional materials. For example, the wavelength at which an organic emissive layer emits light may generally be readily tuned with appropriate dopants.

OLEDs make use of thin organic films that emit light when voltage is applied across the device. OLEDs are becoming an increasingly interesting technology for use in applications such as flat panel displays, illumination, and backlighting. Several OLED materials and configurations are described in U.S. Pat. Nos. 5,844,363, 6,303,238, and 5,707,745, which are incorporated herein by reference in their entirety.

One application for phosphorescent emissive molecules is a full color display. Industry standards for such a display call for pixels adapted to emit particular colors, referred to as "saturated" colors. In particular, these standards call for saturated red, green, and blue pixels. Alternatively the OLED can be designed to emit white light. In conventional liquid crystal displays emission from a white backlight is filtered using absorption filters to produce red, green and blue emission. The same technique can also be used with OLEDs. The white OLED can be either a single EML device or a stack structure. Color may be measured using CIE coordinates, which are well known to the art.

One example of a green emissive molecule is tris(2-phenylpyridine) iridium, denoted $Ir(ppy)_3$, which has the following structure:



In this, and later figures herein, we depict the dative bond from nitrogen to metal (here, Ir) as a straight line.

As used herein, the term "organic" includes polymeric materials as well as small molecule organic materials that may be used to fabricate organic opto-electronic devices. "Small molecule" refers to any organic material that is not a polymer, and "small molecules" may actually be quite large. Small molecules may include repeat units in some circumstances. For example, using a long chain alkyl group as a substituent does not remove a molecule from the "small molecule" class. Small molecules may also be incorporated into polymers, for example as a pendent group on a polymer backbone or as a part of the backbone. Small molecules may also serve as the core moiety of a dendrimer, which consists of a series of chemical shells built on the core moiety. The core moiety of a dendrimer may be a fluorescent or phosphorescent small molecule emitter. A dendrimer may be a "small molecule," and it is believed that all dendrimers currently used in the field of OLEDs are small molecules.

As used herein, "top" means furthest away from the substrate, while "bottom" means closest to the substrate. Where a first layer is described as "disposed over" a second layer, the first layer is disposed further away from substrate. There may be other layers between the first and second layer, unless it is specified that the first layer is "in contact with" the second layer. For example, a cathode may be described as "disposed over" an anode, even though there are various organic layers in between.

As used herein, "solution processible" means capable of being dissolved, dispersed, or transported in and/or deposited from a liquid medium, either in solution or suspension form.

A ligand may be referred to as "photoactive" when it is believed that the ligand directly contributes to the photoactive properties of an emissive material. A ligand may be referred to as "ancillary" when it is believed that the ligand does not contribute to the photoactive properties of an emissive material, although an ancillary ligand may alter the properties of a photoactive ligand.

As used herein, and as would be generally understood by one skilled in the art, a first "Highest Occupied Molecular Orbital" (HOMO) or "Lowest Unoccupied Molecular Orbital" (LUMO) energy level is "greater than" or "higher than" a second HOMO or LUMO energy level if the first energy level is closer to the vacuum energy level. Since ionization potentials (IP) are measured as a negative energy relative to a vacuum level, a higher HOMO energy level corresponds to an IP having a smaller absolute value (an IP that is less negative). Similarly, a higher LUMO energy level corresponds to an electron affinity (EA) having a smaller absolute value (an EA that is less negative). On a conventional energy level diagram, with the vacuum level at the top, the LUMO energy level of a material is higher than the HOMO energy level of the same material. A "higher" HOMO or LUMO energy level appears closer to the top of such a diagram than a "lower" HOMO or LUMO energy level.

As used herein, and as would be generally understood by one skilled in the art, a first work function is "greater than" or "higher than" a second work function if the first work function has a higher absolute value. Because work functions are generally measured as negative numbers relative to vacuum level, this means that a "higher" work function is more negative. On a conventional energy level diagram, with the vacuum level at the top, a "higher" work function is illustrated as further away from the vacuum level in the

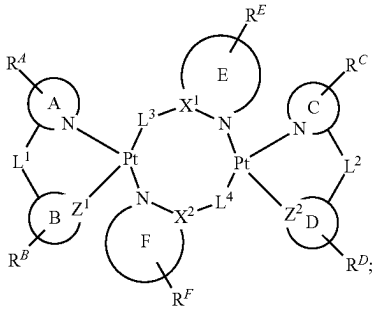
downward direction. Thus, the definitions of HOMO and LUMO energy levels follow a different convention than work functions.

More details on OLEDs, and the definitions described above, can be found in U.S. Pat. No. 7,279,704, which is incorporated herein by reference in its entirety.

SUMMARY

A compound of Formula (I)

Formula I



wherein

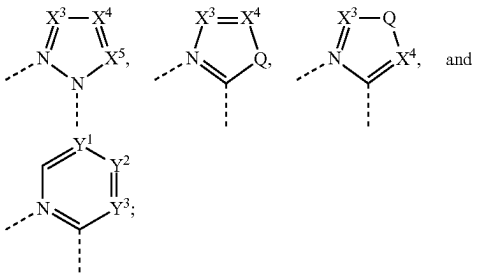
ring A, ring C, ring E and ring F are independently a 5-membered or 6-membered heterocyclic ring;

ring B and ring D are independently a 5-membered, or 6-membered, carbocyclic or heterocyclic ring;

Z^1 and Z^2 are independently an anionic coordinating atom selected from the group consisting of C and N;

R^A, R^B, R^C, R^D, R^E, and R^F independently represent no substitution to the maximum allowable number of substituents; and

L^1, L^2, L^3, and L^4 are independently selected from the group consisting of a direct bond, CRR', SiRR', NR', O, and S. The ring A and the ring C are independently selected from the group consisting of



wherein X^1, X^2, X^3, X^4, and X^5 are independently selected from the group consisting of CR^A and N;

Q is selected from the group consisting of CRR', SiRR', NR, O, and S;

Y^1, Y^2, and Y^3 are each independently selected from the group consisting of CR^A and N; wherein at least one of Y^1, Y^2, and Y^3 is N; and the dash lines represent N-coordination to Pt, and a connection to L^1 or L^2 of ring B or ring D, respectively, or if L^1 and/or L^2 is a direct bond, then to ring B or ring D, respectively;

each R^A, R^B, R^C, R^D, R^E, and R^F are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; or optionally, any two adjacent R^A, R^B, R^C, R^D, R^E, and R^F can join to form a ring; and

R and R' are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, aryl, heteroaryl, and combinations thereof; or optionally, any two adjacent R and R'can join to forma ring.

An organic light emitting device (OLED) including an anode, a cathode, and an organic layer disposed between the anode and the cathode, the organic layer comprising a compound of formula (I) above.

A consumer product comprising an OLED that includes an anode, a cathode, and an organic layer disposed between the anode and the cathode, the organic layer comprising a compound of formula (I) above.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows an organic light emitting device.

FIG. **2** shows an inverted organic light emitting device that does not have a separate electron transport layer.

DETAILED DESCRIPTION

Generally, an OLED comprises at least one organic layer disposed between and electrically connected to an anode and a cathode. When a current is applied, the anode injects holes and the cathode injects electrons into the organic layer(s). The injected holes and electrons each migrate toward the oppositely charged electrode. When an electron and hole localize on the same molecule, an "exciton," which is a localized electron-hole pair having an excited energy state, is formed. Light is emitted when the exciton relaxes via a photoemissive mechanism. In some cases, the exciton may be localized on an excimer or an exciplex. Non-radiative mechanisms, such as thermal relaxation, may also occur, but are generally considered undesirable.

The initial OLEDs used emissive molecules that emitted light from their singlet states ("fluorescence") as disclosed, for example, in U.S. Pat. No. 4,769,292, which is incorporated by reference in its entirety. Fluorescent emission generally occurs in a time frame of less than 10 nanoseconds.

More recently, OLEDs having emissive materials that emit light from triplet states ("phosphorescence") have been demonstrated. Baldo et al., "Highly Efficient Phosphorescent Emission from Organic Electroluminescent Devices," Nature, vol. 395, 151-154, 1998; ("Baldo-I") and Baldo et al., "Very high-efficiency green organic light-emitting devices based on electrophosphorescence," Appl. Phys. Lett., vol. 75, No. 3, 4-6 (1999) ("Baldo-II"), are incorporated by reference in their entireties. Phosphorescence is described in more detail in U.S. Pat. No. 7,279,704 at cols. 5-6, which are incorporated by reference.

FIG. **1** shows an organic light emitting device **100**. The figures are not necessarily drawn to scale. Device **100** may include a substrate **110**, an anode **115**, a hole injection layer **120**, a hole transport layer **125**, an electron blocking layer **130**, an emissive layer **135**, a hole blocking layer **140**, an electron transport layer **145**, an electron injection layer **150**, a protective layer **155**, a cathode **160**, and a barrier layer **170**. Cathode **160** is a compound cathode having a first conductive layer **162** and a second conductive layer **164**. Device

100 may be fabricated by depositing the layers described, in order. The properties and functions of these various layers, as well as example materials, are described in more detail in U.S. Pat. No. 7,279,704 at cols. 6-10, which are incorporated by reference.

More examples for each of these layers are available. For example, a flexible and transparent substrate-anode combination is disclosed in U.S. Pat. No. 5,844,363, which is incorporated by reference in its entirety. An example of a p-doped hole transport layer is m-MTDATA doped with F_4-TCNQ at a molar ratio of 50:1, as disclosed in U.S. Patent Application Publication No. 2003/0230980, which is incorporated by reference in its entirety. Examples of emissive and host materials are disclosed in U.S. Pat. No. 6,303,238 to Thompson et al., which is incorporated by reference in its entirety. An example of an n-doped electron transport layer is BPhen doped with Li at a molar ratio of 1:1, as disclosed in U.S. Patent Application Publication No. 2003/0230980, which is incorporated by reference in its entirety. U.S. Pat. Nos. 5,703,436 and 5,707,745, which are incorporated by reference in their entireties, disclose examples of cathodes including compound cathodes having a thin layer of metal such as Mg:Ag with an overlying transparent, electrically-conductive, sputter-deposited ITO layer. The theory and use of blocking layers is described in more detail in U.S. Pat. No. 6,097,147 and U.S. Patent Application Publication No. 2003/0230980, which are incorporated by reference in their entireties. Examples of injection layers are provided in U.S. Patent Application Publication No. 2004/0174116, which is incorporated by reference in its entirety. A description of protective layers may be found in U.S. Patent Application Publication No. 2004/0174116, which is incorporated by reference in its entirety.

FIG. 2 shows an inverted OLED 200. The device includes a substrate 210, a cathode 215, an emissive layer 220, a hole transport layer 225, and an anode 230. Device 200 may be fabricated by depositing the layers described, in order. Because the most common OLED configuration has a cathode disposed over the anode, and device 200 has cathode 215 disposed under anode 230, device 200 may be referred to as an "inverted" OLED. Materials similar to those described with respect to device 100 may be used in the corresponding layers of device 200. FIG. 2 provides one example of how some layers may be omitted from the structure of device 100.

The simple layered structure illustrated in FIGS. 1 and 2 is provided by way of non-limiting example, and it is understood that embodiments of the invention may be used in connection with a wide variety of other structures. The specific materials and structures described are exemplary in nature, and other materials and structures may be used. Functional OLEDs may be achieved by combining the various layers described in different ways, or layers may be omitted entirely, based on design, performance, and cost factors. Other layers not specifically described may also be included. Materials other than those specifically described may be used. Although many of the examples provided herein describe various layers as comprising a single material, it is understood that combinations of materials, such as a mixture of host and dopant, or more generally a mixture, may be used. Also, the layers may have various sublayers. The names given to the various layers herein are not intended to be strictly limiting. For example, in device 200, hole transport layer 225 transports holes and injects holes into emissive layer 220, and may be described as a hole transport layer or a hole injection layer. In one embodiment, an OLED may be described as having an "organic layer" disposed between a cathode and an anode. This organic layer may comprise a single layer, or may further comprise multiple layers of different organic materials as described, for example, with respect to FIGS. 1 and 2.

Structures and materials not specifically described may also be used, such as OLEDs comprised of polymeric materials (PLEDs) such as disclosed in U.S. Pat. No. 5,247,190 to Friend et al., which is incorporated by reference in its entirety. By way of further example, OLEDs having a single organic layer may be used. OLEDs may be stacked, for example as described in U.S. Pat. No. 5,707,745 to Forrest et al, which is incorporated by reference in its entirety. The OLED structure may deviate from the simple layered structure illustrated in FIGS. 1 and 2. For example, the substrate may include an angled reflective surface to improve out-coupling, such as a mesa structure as described in U.S. Pat. No. 6,091,195 to Forrest et al., and/or a pit structure as described in U.S. Pat. No. 5,834,893 to Bulovic et al., which are incorporated by reference in their entireties.

Unless otherwise specified, any of the layers of the various embodiments may be deposited by any suitable method. For the organic layers, preferred methods include thermal evaporation, ink-jet, such as described in U.S. Pat. Nos. 6,013,982 and 6,087,196, which are incorporated by reference in their entireties, organic vapor phase deposition (OVPD), such as described in U.S. Pat. No. 6,337,102 to Forrest et al., which is incorporated by reference in its entirety, and deposition by organic vapor jet printing (OVJP), such as described in U.S. Pat. No. 7,431,968, which is incorporated by reference in its entirety. Other suitable deposition methods include spin coating and other solution based processes. Solution based processes are preferably carried out in nitrogen or an inert atmosphere. For the other layers, preferred methods include thermal evaporation. Preferred patterning methods include deposition through a mask, cold welding such as described in U.S. Pat. Nos. 6,294,398 and 6,468,819, which are incorporated by reference in their entireties, and patterning associated with some of the deposition methods such as ink jet and organic vapor jet printing (OVJP). Other methods may also be used. The materials to be deposited may be modified to make them compatible with a particular deposition method. For example, substituents such as alkyl and aryl groups, branched or unbranched, and preferably containing at least 3 carbons, may be used in small molecules to enhance their ability to undergo solution processing. Substituents having 20 carbons or more may be used, and 3-20 carbons is a preferred range. Materials with asymmetric structures may have better solution processibility than those having symmetric structures, because asymmetric materials may have a lower tendency to recrystallize. Dendrimer substituents may be used to enhance the ability of small molecules to undergo solution processing.

Devices fabricated in accordance with embodiments of the present invention may further optionally comprise a barrier layer. One purpose of the barrier layer is to protect the electrodes and organic layers from damaging exposure to harmful species in the environment including moisture, vapor and/or gases, etc. The barrier layer may be deposited over, under or next to a substrate, an electrode, or over any other parts of a device including an edge. The barrier layer may comprise a single layer, or multiple layers. The barrier layer may be formed by various known chemical vapor deposition techniques and may include compositions having a single phase as well as compositions having multiple phases. Any suitable material or combination of materials may be used for the barrier layer. The barrier layer may

incorporate an inorganic or an organic compound or both. The preferred barrier layer comprises a mixture of a polymeric material and a non-polymeric material as described in U.S. Pat. No. 7,968,146, PCT Pat. Application Nos. PCT/US2007/023098 and PCT/US2009/042829, which are herein incorporated by reference in their entireties. To be considered a "mixture", the aforesaid polymeric and non-polymeric materials comprising the barrier layer should be deposited under the same reaction conditions and/or at the same time. The weight ratio of polymeric to non-polymeric material may be in the range of 95:5 to 5:95. The polymeric material and the non-polymeric material may be created from the same precursor material. In one example, the mixture of a polymeric material and a non-polymeric material consists essentially of polymeric silicon and inorganic silicon.

Devices fabricated in accordance with embodiments of the invention can be incorporated into a wide variety of electronic component modules (or units) that can be incorporated into a variety of electronic products or intermediate components. Examples of such electronic products or intermediate components include display screens, lighting devices such as discrete light source devices or lighting panels, etc. that can be utilized by the end-user product manufacturers. Such electronic component modules can optionally include the driving electronics and/or power source(s). Devices fabricated in accordance with embodiments of the invention can be incorporated into a wide variety of consumer products that have one or more of the electronic component modules (or units) incorporated therein. A consumer product comprising an OLED that includes the compound of the present disclosure in the organic layer in the OLED is disclosed. Such consumer products would include any kind of products that include one or more light source(s) and/or one or more of some type of visual displays. Some examples of such consumer products include flat panel displays, curved displays, computer monitors, medical monitors, televisions, billboards, lights for interior or exterior illumination and/or signaling, heads-up displays, fully or partially transparent displays, flexible displays, rollable displays, foldable displays, stretchable displays, laser printers, telephones, mobile phones, tablets, phablets, personal digital assistants (PDAs), wearable devices, laptop computers, digital cameras, camcorders, viewfinders, micro-displays (displays that are less than 2 inches diagonal), 3-D displays, virtual reality or augmented reality displays, vehicles, video walls comprising multiple displays tiled together, theater or stadium screen, a light therapy device, and a sign. Various control mechanisms may be used to control devices fabricated in accordance with the present invention, including passive matrix and active matrix. Many of the devices are intended for use in a temperature range comfortable to humans, such as 18 degrees C. to 30 degrees C., and more preferably at room temperature (20-25 degrees C.), but could be used outside this temperature range, for example, from −40 degree C. to +80 degree C.

The materials and structures described herein may have applications in devices other than OLEDs. For example, other optoelectronic devices such as organic solar cells and organic photodetectors may employ the materials and structures. More generally, organic devices, such as organic transistors, may employ the materials and structures.

The terms "halo," "halogen," and "halide" are used interchangeably and refer to fluorine, chlorine, bromine, and iodine.

The term "acyl" refers to a substituted carbonyl radical (C(O)—R_s).

The term "ester" refers to a substituted oxycarbonyl (—O—C(O)—R_s or —C(O)—O—R_s) radical.

The term "ether" refers to an —OR_s radical.

The terms "sulfanyl" or "thio-ether" are used interchangeably and refer to a —SR_s radical.

The term "sulfinyl" refers to a —S(O)—R_s radical.

The term "sulfonyl" refers to a —SO_2—R_s radical.

The term "phosphino" refers to a —$P(R_s)_3$ radical, wherein each R_s can be same or different.

The term "silyl" refers to a —$Si(R_s)_3$ radical, wherein each R_s can be same or different.

In each of the above, R_s can be hydrogen or a substituent selected from the group consisting of deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, heterocycloalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, and combination thereof. Preferred R_s is selected from the group consisting of alkyl, cycloalkyl, aryl, heteroaryl, and combination thereof.

The term "alkyl" refers to and includes both straight and branched chain alkyl radicals. Preferred alkyl groups are those containing from one to fifteen carbon atoms and includes methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 2,2-dimethylpropyl, and the like. Additionally, the alkyl group is optionally substituted.

The term "cycloalkyl" refers to and includes monocyclic, polycyclic, and spiro alkyl radicals. Preferred cycloalkyl groups are those containing 3 to 12 ring carbon atoms and includes cyclopropyl, cyclopentyl, cyclohexyl, bicyclo [3.1.1]heptyl, spiro[4.5]decyl, spiro[5.5]undecyl, adamantyl, and the like. Additionally, the cycloalkyl group is optionally substituted.

The terms "heteroalkyl" or "heterocycloalkyl" refer to an alkyl or a cycloalkyl radical, respectively, having at least one carbon atom replaced by a heteroatom. Optionally the at least one heteroatom is selected from O, S, N, P, B, Si and Se, preferably, 0, S or N. Additionally, the heteroalkyl or heterocycloalkyl group is optionally substituted.

The term "alkenyl" refers to and includes both straight and branched chain alkene radicals. Alkenyl groups are essentially alkyl groups that include at least one carbon-carbon double bond in the alkyl chain. Cycloalkenyl groups are essentially cycloalkyl groups that include at least one carbon-carbon double bond in the cycloalkyl ring. The term "heteroalkenyl" as used herein refers to an alkenyl radical having at least one carbon atom replaced by a heteroatom. Optionally the at least one heteroatom is selected from O, S, N, P, B, Si, and Se, preferably, O, S, or N. Preferred alkenyl, cycloalkenyl, or heteroalkenyl groups are those containing two to fifteen carbon atoms. Additionally, the alkenyl, cycloalkenyl, or heteroalkenyl group is optionally substituted.

The term "alkynyl" refers to and includes both straight and branched chain alkyne radicals. Preferred alkynyl groups are those containing two to fifteen carbon atoms. Additionally, the alkynyl group is optionally substituted.

The terms "aralkyl" or "arylalkyl" are used interchangeably and refer to an alkyl group that is substituted with an aryl group. Additionally, the aralkyl group is optionally substituted.

The term "heterocyclic group" refers to and includes aromatic and non-aromatic cyclic radicals containing at least one heteroatom. Optionally the at least one heteroatom is selected from O, S, N, P, B, Si, and Se, preferably, O, S, or

N. Hetero-aromatic cyclic radicals may be used interchangeably with heteroaryl. Preferred hetero-non-aromatic cyclic groups are those containing 3 to 7 ring atoms which includes at least one hetero atom, and includes cyclic amines such as morpholino, piperidino, pyrrolidino, and the like, and cyclic ethers/thio-ethers, such as tetrahydrofuran, tetrahydropyran, tetrahydrothiophene, and the like. Additionally, the heterocyclic group may be optionally substituted.

The term "aryl" refers to and includes both single-ring aromatic hydrocarbyl groups and polycyclic aromatic ring systems. The polycyclic rings may have two or more rings in which two carbons are common to two adjoining rings (the rings are "fused") wherein at least one of the rings is an aromatic hydrocarbyl group, e.g., the other rings can be cycloalkyls, cycloalkenyls, aryl, heterocycles, and/or heteroaryls. Preferred aryl groups are those containing six to thirty carbon atoms, preferably six to twenty carbon atoms, more preferably six to twelve carbon atoms. Especially preferred is an aryl group having six carbons, ten carbons or twelve carbons. Suitable aryl groups include phenyl, biphenyl, triphenyl, triphenylene, tetraphenylene, naphthalene, anthracene, phenalene, phenanthrene, fluorene, pyrene, chrysene, perylene, and azulene, preferably phenyl, biphenyl, triphenyl, triphenylene, fluorene, and naphthalene. Additionally, the aryl group is optionally substituted.

The term "heteroaryl" refers to and includes both single-ring aromatic groups and polycyclic aromatic ring systems that include at least one heteroatom. The heteroatoms include, but are not limited to O, S, N, P, B, Si, and Se. In many instances, O, S, or N are the preferred heteroatoms. Hetero-single ring aromatic systems are preferably single rings with 5 or 6 ring atoms, and the ring can have from one to six heteroatoms. The hetero-polycyclic ring systems can have two or more rings in which two atoms are common to two adjoining rings (the rings are "fused") wherein at least one of the rings is a heteroaryl, e.g., the other rings can be cycloalkyls, cycloalkenyls, aryl, heterocycles, and/or heteroaryls. The hetero-polycyclic aromatic ring systems can have from one to six heteroatoms per ring of the polycyclic aromatic ring system. Preferred heteroaryl groups are those containing three to thirty carbon atoms, preferably three to twenty carbon atoms, more preferably three to twelve carbon atoms. Suitable heteroaryl groups include dibenzothiophene, dibenzofuran, dibenzoselenophene, furan, thiophene, benzofuran, benzothiophene, benzoselenophene, carbazole, indolocathazole, pyridylindole, pyrrolodipyridine, pyrazole, imidazole, triazole, oxazole, thiazole, oxadiazole, oxatriazole, dioxazole, thiadiazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine, oxazine, oxathiazine, oxadiazine, indole, benzimidazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinnoline, quinazoline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuropyridine, furodipyridine, benzothienopyridine, thienodipyridine, benzoselenophenopyridine, and selenophenodipyridine, preferably dibenzothiophene, dibenzofuran, dibenzoselenophene, carbazole, indolocathazole, imidazole, pyridine, triazine, benzimidazole, 1,2-azaborine, 1,3-azaborine, 1,4-azaborine, borazine, and aza-analogs thereof. Additionally, the heteroaryl group is optionally substituted.

Of the aryl and heteroaryl groups listed above, the groups of triphenylene, naphthalene, anthracene, dibenzothiophene, dibenzofuran, dibenzoselenophene, carbazole, indolocarbazole, imidazole, pyridine, pyrazine, pyrimidine, triazine, and benzimidazole, and the respective aza-analogs of each thereof are of particular interest.

The terms alkyl, cycloalkyl, heteroalkyl, heterocycloalkyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aralkyl, heterocyclic group, aryl, and heteroaryl, as used herein, are independently unsubstituted, or independently substituted, with one or more general substituents.

In many instances, the general substituents are selected from the group consisting of deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, heterocycloalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carboxylic acid, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

In some instances, the preferred general substituents are selected from the group consisting of deuterium, fluorine, alkyl, cycloalkyl, heteroalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, aryl, heteroaryl, nitrile, isonitrile, sulfanyl, and combinations thereof.

In some instances, the preferred general substituents are selected from the group consisting of deuterium, fluorine, alkyl, cycloalkyl, alkoxy, aryloxy, amino, silyl, aryl, heteroaryl, sulfanyl, and combinations thereof.

In yet other instances, the more preferred general substituents are selected from the group consisting of deuterium, fluorine, alkyl, cycloalkyl, aryl, heteroaryl, and combinations thereof.

The terms "substituted" and "substitution" refer to a substituent other than H that is bonded to the relevant position, e.g., a carbon or nitrogen. For example, when R^1 represents mono-substitution, then one R^1 must be other than H (i.e., a substitution). Similarly, when R^1 represents di-substitution, then two of R^1 must be other than H. Similarly, when R^1 represents no substitution, R', for example, can be a hydrogen for available valencies of ring atoms, as in carbon atoms for benzene and the nitrogen atom in pyrrole, or simply represents nothing for ring atoms with fully filled valencies, e.g., the nitrogen atom in pyridine. The maximum number of substitutions possible in a ring structure will depend on the total number of available valencies in the ring atoms.

As used herein, "combinations thereof" indicates that one or more members of the applicable list are combined to form a known or chemically stable arrangement that one of ordinary skill in the art can envision from the applicable list. For example, an alkyl and deuterium can be combined to form a partial or fully deuterated alkyl group; a halogen and alkyl can be combined to form a halogenated alkyl substituent; and a halogen, alkyl, and aryl can be combined to form a halogenated arylalkyl. In one instance, the term substitution includes a combination of two to four of the listed groups. In another instance, the term substitution includes a combination of two to three groups. In yet another instance, the term substitution includes a combination of two groups. Preferred combinations of substituent groups are those that contain up to fifty atoms that are not hydrogen or deuterium, or those which include up to forty atoms that are not hydrogen or deuterium, or those that include up to thirty atoms that are not hydrogen or deuterium. In many instances, a preferred combination of substituent groups will include up to twenty atoms that are not hydrogen or deuterium.

The "aza" designation in the fragments described herein, i.e. aza-dibenzofuran, aza-dibenzothiophene, etc. means that one or more of the C—H groups in the respective fragment can be replaced by a nitrogen atom, for example, and without any limitation, azatriphenylene encompasses both dibenzo[f,h]quinoxaline and dibenzo[f,h]quinoline. One of ordinary skill in the art can readily envision other nitrogen

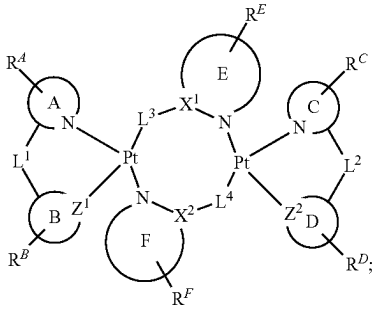
analogs of the aza-derivatives described above, and all such analogs are intended to be encompassed by the terms as set forth herein.

As used herein, "deuterium" refers to an isotope of hydrogen. Deuterated compounds can be readily prepared using methods known in the art. For example, U.S. Pat. No. 8,557,400, Patent Pub. No. WO 2006/095951, and U.S. Pat. Application Pub. No. US 2011/0037057, which are hereby incorporated by reference in their entireties, describe the making of deuterium-substituted organometallic complexes. Further reference is made to Ming Yan, et al., *Tetrahedron* 2015, 71, 1425-30 and Atzrodt et al., *Angew. Chem. Int. Ed.* (*Reviews*) 2007, 46, 7744-65, which are incorporated by reference in their entireties, describe the deuteration of the methylene hydrogens in benzyl amines and efficient pathways to replace aromatic ring hydrogens with deuterium, respectively.

It is to be understood that when a molecular fragment is described as being a substituent or otherwise attached to another moiety, its name may be written as if it were a fragment (e.g. phenyl, phenylene, naphthyl, dibenzofuryl) or as if it were the whole molecule (e.g. benzene, naphthalene, dibenzofuran). As used herein, these different ways of designating a substituent or attached fragment are considered to be equivalent.

In one instance, the invention is direct to compound of Formula I

Formula I



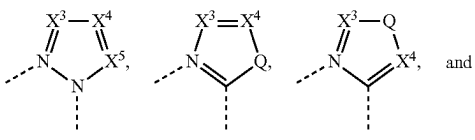
wherein

ring A, ring C, ring E and ring F are independently a 5-membered or 6-membered heterocyclic ring; and ring B and ring D are independently a 5-membered, or 6-membered, cathocyclic or heterocyclic ring;

Z^1 and Z^2 are independently an anionic coordinating atom selected from the group consisting of C and N; and

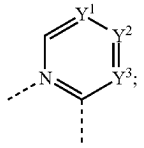
R^A, R^B, R^C, R^D, R^E, and R^F independently represent no substitution to the maximum allowable number of substituents; and L^1, L^2, L^3, and L^4 are independently selected from the group consisting of a direct bond, CRR', SiRR', NR', O, and S.

Ring A and the ring C are independently selected from the group consisting of



and

-continued



wherein

X^1, X^2, X^3, X^4, and X^5 are independently selected from the group consisting of CR^A and N; Q is selected from the group consisting of CRR', SiRR', NR, O, and S; and Y^1, Y^2, and Y^3 are each independently selected from the group consisting of CR^A and N; wherein at least one of Y^1, Y^2, and Y^3 is N; and the dash lines represent N-coordination to Pt, and a connection to L^1 or L^2 of ring B or ring D, respectively, or if L^1 and/or L^2 is a direct bond, then to ring B or ring D, respectively.

In addition, each R^A, R^B, R^C, R^D, R^E, and R^F are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; or optionally, any two adjacent R^A, R^B, R^C, R^D, R^E, and R^E can join to form a ring; and R and R' are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, aryl, heteroaryl, and combinations thereof; or optionally, any two adjacent R and R^1 can join to form a ring.

In one embodiment, ring A is a 5-membered heterocyclic ring. In another embodiment, ring A is a 6-membered heterocyclic ring.

In one embodiment ring B is a 5-membered carbocyclic or heterocyclic ring. In another embodiment ring B is a 6-membered carbocyclic or heterocyclic ring.

In one embodiment ring C is a 5-membered heterocyclic ring. In another embodiment ring C is a 6-membered heterocyclic ring.

In one embodiment ring D is a 5-membered carbocyclic or heterocyclic ring. In another embodiment ring D is a 6-membered carbocyclic or heterocyclic ring.

In one embodiment ring E is a 5-membered heterocyclic ring. In another embodiment ring E is a 6-membered heterocyclic ring.

In one embodiment ring F is a 5-membered heterocyclic ring. In another embodiment ring F is a 6-membered heterocyclic ring.

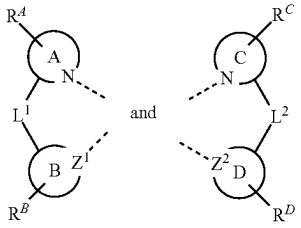
In one embodiment, the ring A and the ring C is a 5-membered heterocyclic ring, or in another embodiment, the ring A and the ring C is a 6-membered heterocyclic ring.

In one embodiment, the ring B and the ring D is a 5-membered carbocyclic or heterocyclic ring, or in another embodiment, the ring B and the ring D is a 6-membered carbocyclic or heterocyclic ring. In yet another embodiment, the ring B and the ring D is benzene.

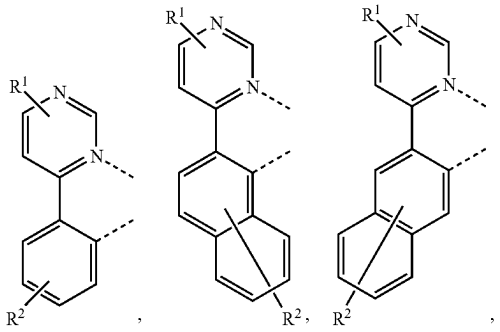
In one embodiment, the ring E and the ring F is a 5-membered heterocyclic ring, or in another embodiment, the ring E and the ring F is a 6-membered heterocyclic ring.

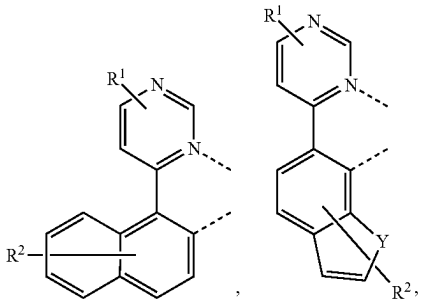
In one embodiment, the compounds of Formula I will have at least one of Z^1 or Z^2 is an sp^2 carbon atom selected from an aromatic ring group consisting of benzene, pyridine, furan, thiophene, and pyrrole. Alternatively, the compounds of Formula I will have at least one of Z' or Z^2 is a coordinating nitrogen of a N-heterocyclic ring selected from the group consisting of imidazole, benzoimidazole, pyrazole, and triazole.

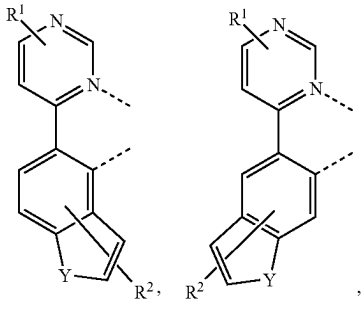
Compounds of Formula I of interest will include the ligands component sets below, wherein the ring A and ring B ligand component, and the ring C and ring D ligand component, of the compounds of Formula I as indicated below. Moreover, as stated, the two ligand component set, i.e., rings A-B and rings C-D, can be the same or different. Accordingly,



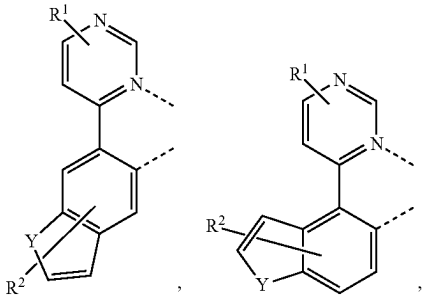
are each independently selected from the group consisting of:

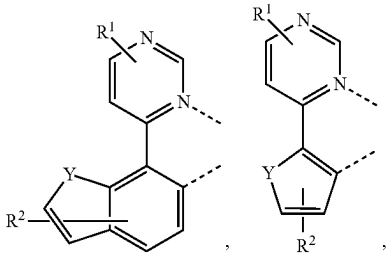


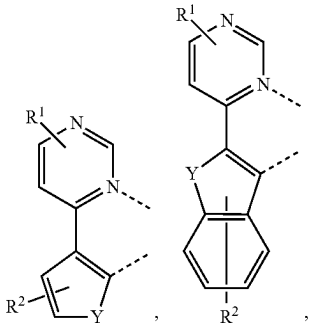


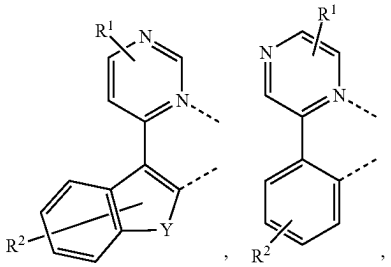


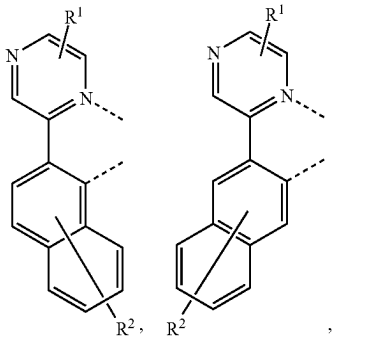
-continued



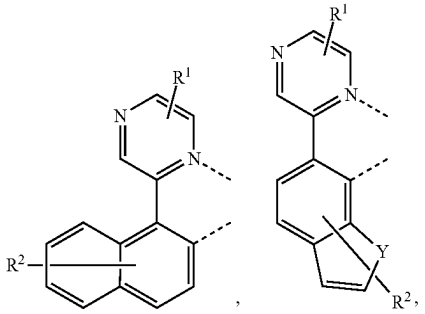


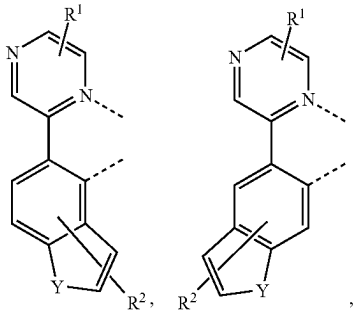


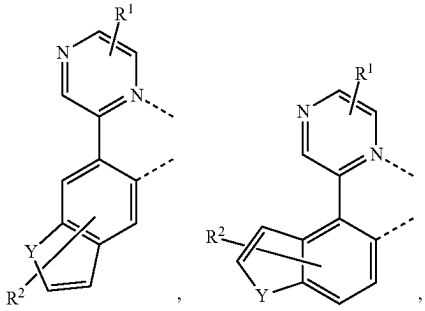


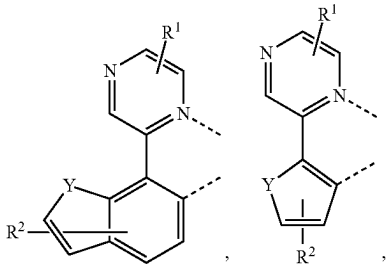


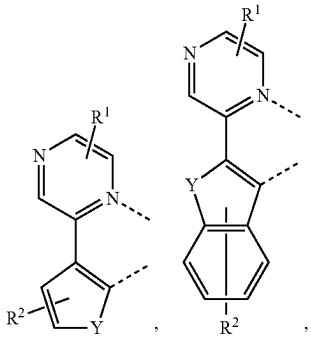
-continued



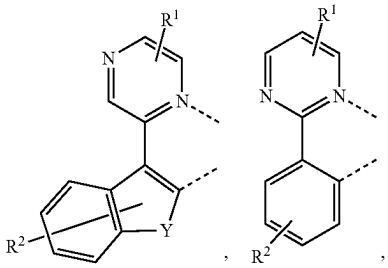


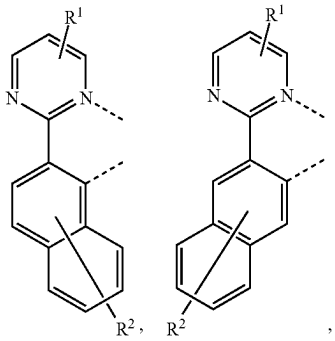


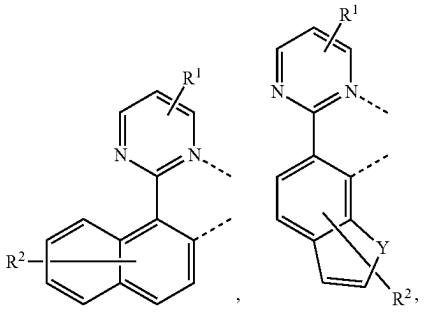


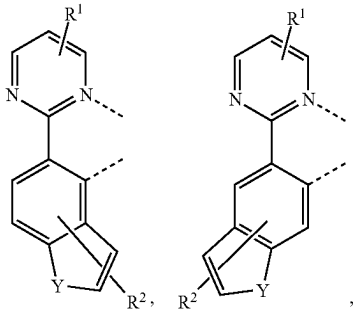


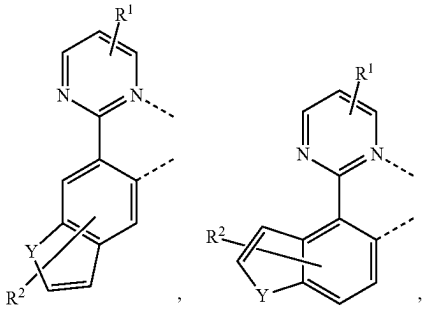
-continued



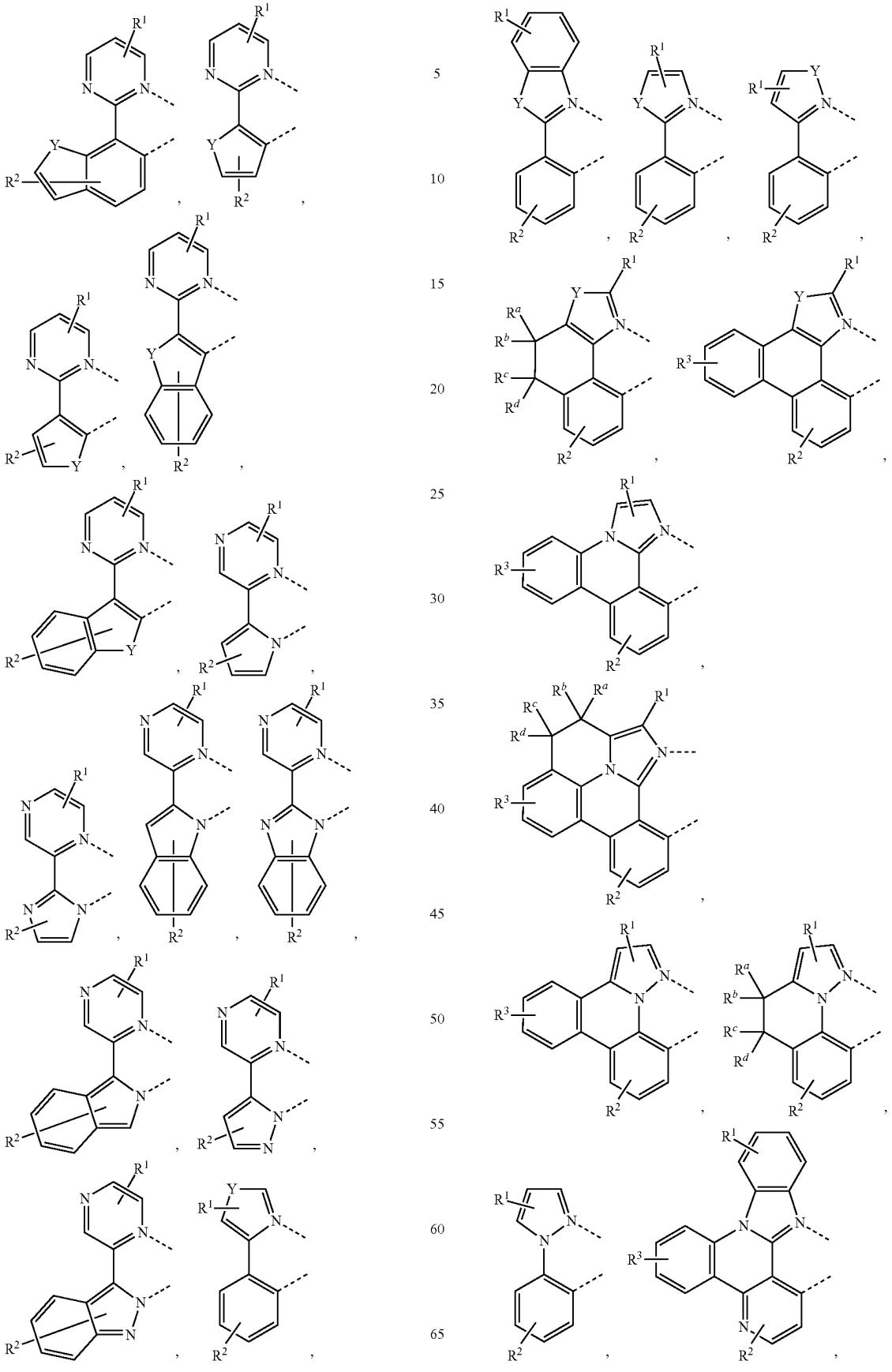




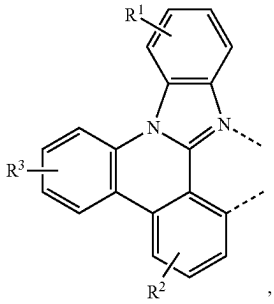


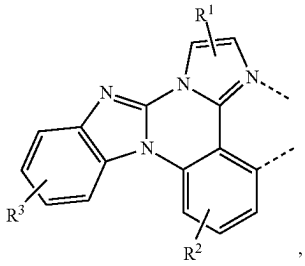


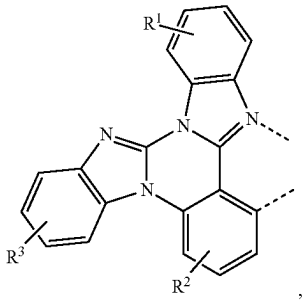
-continued

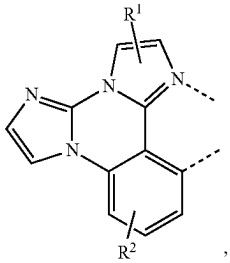


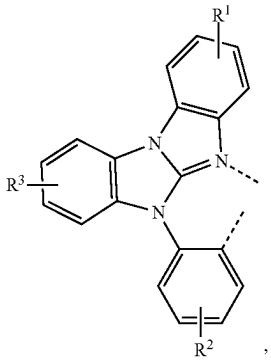
-continued



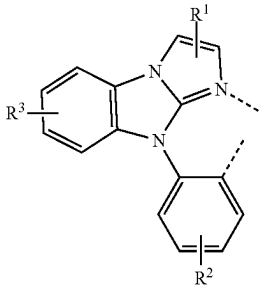


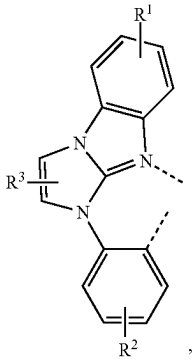


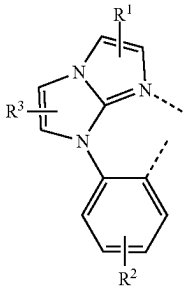




-continued







and

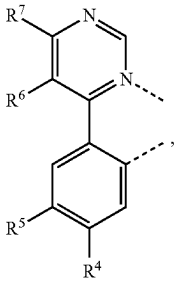
wherein

Y is selected from the group consisting of S, O, Se, CRR', SiRR', BR', and NR';

R^1, R^2, R^3 independently represent none to the maximum allowable number of substituents;

each R^a, R^b, R^c, and R^d, and each R^1, R^2, and R^3, are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; or optionally any two adjacent substitutions in R^a, R^b, R^c, R^d, R^1, R^2, and R^3 can join to form a ring.

Compounds of Formula I of particular interest will include the two ligand component sets, i.e., component rings A-B and rings C-D below. Again, the two ligand component sets can be the same or different. In one embodiment, the component ligand set is selected from the group consisting of: L_{A1} through L_{A306}, which is based on a ligand component set with a structure of Formula X,



in which R^4, R^5, R^6, and R^7 are defined in Table 1.

TABLE 1

	R^4	R^5	R^6	R^7
L_{A1}	H	H	H	H
L_{A2}	H	H	R^{B1}	H
L_{A3}	H	H	R^{B3}	H
L_{A4}	H	H	R^{B4}	H
L_{A5}	H	H	R^{B7}	H
L_{A6}	H	H	R^{B12}	H
L_{A7}	H	H	R^{B18}	H
L_{A8}	H	H	R^{A3}	H
L_{A9}	H	H	R^{A34}	H
L_{A10}	R^{B1}	H	H	H
L_{A11}	R^{B1}	H	R^{B1}	H
L_{A12}	R^{B1}	H	R^{B3}	H
L_{A13}	R^{B1}	H	R^{B4}	H
L_{A14}	R^{B1}	H	R^{B7}	H
L_{A15}	R^{B1}	H	R^{B12}	H
L_{A16}	R^{B1}	H	R^{B18}	H
L_{A17}	R^{B1}	H	R^{A3}	H
L_{A18}	R^{B1}	H	R^{A34}	H
L_{A19}	R^{B2}	H	H	H
L_{A20}	R^{B2}	H	R^{B1}	H
L_{A21}	R^{B2}	H	R^{B3}	H
L_{A22}	R^{B2}	H	R^{B4}	H
L_{A23}	R^{B2}	H	R^{B7}	H
L_{A24}	R^{B2}	H	R^{B12}	H
L_{A25}	R^{B2}	H	R^{B18}	H
L_{A26}	R^{B2}	H	R^{A3}	H
L_{A27}	R^{B2}	H	R^{A34}	H
L_{A28}	R^{B3}	H	H	H
L_{A29}	R^{B3}	H	R^{B1}	H
L_{A30}	R^{B3}	H	R^{B3}	H
L_{A31}	R^{B3}	H	R^{B4}	H
L_{A32}	R^{B3}	H	R^{B7}	H
L_{A33}	R^{B3}	H	R^{B12}	H
L_{A34}	R^{B3}	H	R^{B18}	H
L_{A35}	R^{B3}	H	R^{A3}	H
L_{A36}	R^{B3}	H	R^{A34}	H
L_{A37}	H	R^{B1}	H	H
L_{A38}	H	R^{B1}	R^{B1}	H
L_{A39}	H	R^{B1}	R^{B3}	H
L_{A40}	H	R^{B1}	R^{B4}	H
L_{A41}	H	R^{B1}	R^{B7}	H
L_{A42}	H	R^{B1}	R^{B12}	H
L_{A43}	H	R^{B1}	R^{B18}	H
L_{A44}	H	R^{B1}	R^{A3}	H
L_{A45}	H	R^{B1}	R^{A34}	H
L_{A46}	H	R^{B2}	H	H
L_{A47}	H	R^{B2}	R^{B1}	H
L_{A48}	H	R^{B2}	R^{B3}	H
L_{A49}	H	R^{B2}	R^{B4}	H
L_{A50}	H	R^{B2}	R^{B7}	H
L_{A51}	H	R^{B2}	R^{B12}	H
L_{A52}	H	R^{B2}	R^{B18}	H
L_{A53}	H	R^{B2}	R^{A3}	H
L_{A54}	H	R^{B2}	R^{A34}	H
L_{A55}	H	R^{B3}	H	H
L_{A56}	H	R^{B3}	R^{B1}	H
L_{A57}	H	R^{B3}	R^{B3}	H
L_{A58}	H	R^{B3}	R^{B4}	H
L_{A59}	H	R^{B3}	R^{B7}	H
L_{A60}	H	R^{B3}	R^{B12}	H
L_{A61}	H	R^{B3}	R^{B18}	H
L_{A62}	H	R^{B3}	R^{A3}	H
L_{A63}	H	R^{B3}	R^{A34}	H
L_{A64}	R^{B1}	R^{B1}	H	H
L_{A65}	R^{B1}	R^{B1}	R^{B1}	H
L_{A66}	R^{B1}	R^{B1}	R^{B3}	H
L_{A67}	R^{B1}	R^{B1}	R^{B4}	H
L_{A68}	R^{B1}	R^{B1}	R^{B7}	H
L_{A69}	R^{B1}	R^{B1}	R^{B12}	H
L_{A70}	R^{B1}	R^{B1}	R^{B18}	H
L_{A71}	R^{B1}	R^{B1}	R^{A3}	H
L_{A72}	R^{B1}	R^{B1}	R^{A34}	H
L_{A73}	R^{B2}	R^{B2}	H	H
L_{A74}	R^{B2}	R^{B2}	R^{B1}	H
L_{A75}	R^{B2}	R^{B2}	R^{B3}	H
L_{A76}	R^{B2}	R^{B2}	R^{B4}	H
L_{A77}	R^{B2}	R^{B2}	R^{B7}	H
L_{A78}	R^{B2}	R^{B2}	R^{B12}	H

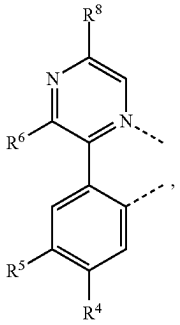
TABLE 1-continued

	R^4	R^5	R^6	R^7
L_{A79}	R^{B2}	R^{B2}	R^{B18}	H
L_{A80}	R^{B2}	R^{B2}	R^{A3}	H
L_{A81}	R^{B2}	R^{B2}	R^{A34}	H
L_{A82}	R^{B3}	R^{B3}	H	H
L_{A83}	R^{B3}	R^{B3}	R^{B1}	H
L_{A84}	R^{B3}	R^{B3}	R^{B3}	H
L_{A85}	R^{B3}	R^{B3}	R^{B4}	H
L_{A86}	R^{B3}	R^{B3}	R^{B7}	H
L_{A87}	R^{B3}	R^{B3}	R^{B12}	H
L_{A88}	R^{B3}	R^{B3}	R^{B18}	H
L_{A89}	R^{B3}	R^{B3}	R^{A3}	H
L_{A90}	R^{B3}	R^{B3}	R^{A34}	H
L_{A91}	H	H	H	R^{B1}
L_{A92}	H	H	H	R^{B3}
L_{A93}	H	H	H	R^{B4}
L_{A94}	H	H	H	R^{B7}
L_{A95}	H	H	H	R^{B12}
L_{A96}	H	H	H	R^{B18}
L_{A97}	H	H	H	R^{A3}
L_{A98}	H	H	H	R^{A34}
L_{A99}	R^{B1}	H	H	R^{B1}
L_{A100}	R^{B1}	H	H	R^{B3}
L_{A101}	R^{B1}	H	H	R^{B4}
L_{A102}	R^{B1}	H	H	R^{B7}
L_{A103}	R^{B1}	H	H	R^{B12}
L_{A104}	R^{B1}	H	H	R^{B18}
L_{A105}	R^{B1}	H	H	R^{A3}
L_{A106}	R^{B1}	H	H	R^{A34}
L_{A107}	R^{B2}	H	H	R^{B1}
L_{A108}	R^{B2}	H	H	R^{B3}
L_{A109}	R^{B2}	H	H	R^{B4}
L_{A110}	R^{B2}	H	H	R^{B7}
L_{A111}	R^{B2}	H	H	R^{B12}
L_{A112}	R^{B2}	H	H	R^{B18}
L_{A113}	R^{B2}	H	H	R^{A3}
L_{A114}	R^{B2}	H	H	R^{A34}
L_{A115}	R^{B3}	H	H	R^{B1}
L_{A116}	R^{B3}	H	H	R^{B3}
L_{A117}	R^{B3}	H	H	R^{B4}
L_{A118}	R^{B3}	H	H	R^{B7}
L_{A119}	R^{B3}	H	H	R^{B12}
L_{A120}	R^{B3}	H	H	R^{B18}
L_{A121}	R^{B3}	H	H	R^{A3}
L_{A122}	R^{B3}	H	H	R^{A34}
L_{A123}	H	R^{B1}	H	R^{B1}
L_{A124}	H	R^{B1}	H	R^{B3}
L_{A125}	H	R^{B1}	H	R^{B4}
L_{A126}	H	R^{B1}	H	R^{B7}
L_{A127}	H	R^{B1}	H	R^{B12}
L_{A128}	H	R^{B1}	H	R^{B18}
L_{A129}	H	R^{B1}	H	R^{A3}
L_{A130}	H	R^{B1}	H	R^{A34}
L_{A131}	H	R^{B2}	H	R^{B1}
L_{A132}	H	R^{B2}	H	R^{B3}
L_{A133}	H	R^{B2}	H	R^{B4}
L_{A134}	H	R^{B2}	H	R^{B7}
L_{A135}	H	R^{B2}	H	R^{B12}
L_{A136}	H	R^{B2}	H	R^{B18}
L_{A137}	H	R^{B2}	H	R^{A3}
L_{A138}	H	R^{B2}	H	R^{A34}
L_{A139}	H	R^{B3}	H	R^{B1}
L_{A140}	H	R^{B3}	H	R^{B3}
L_{A141}	H	R^{B3}	H	R^{B4}
L_{A142}	H	R^{B3}	H	R^{B7}
L_{A143}	H	R^{B3}	H	R^{B12}
L_{A144}	H	R^{B3}	H	R^{B18}
L_{A145}	H	R^{B3}	H	R^{A3}
L_{A146}	H	R^{B3}	H	R^{A34}
L_{A147}	R^{B1}	R^{B1}	H	R^{B1}
L_{A148}	R^{B1}	R^{B1}	H	R^{B3}
L_{A149}	R^{B1}	R^{B1}	H	R^{B4}
L_{A150}	R^{B1}	R^{B1}	H	R^{B7}
L_{A151}	R^{B1}	R^{B1}	H	R^{B12}
L_{A152}	R^{B1}	R^{B1}	H	R^{B18}
L_{A153}	R^{B1}	R^{B1}	H	R^{A3}
L_{A154}	R^{B1}	R^{B1}	H	R^{A34}
L_{A155}	R^{B2}	R^{B2}	H	R^{B1}
L_{A156}	R^{B2}	R^{B2}	H	R^{B3}

TABLE 1-continued

	R^4	R^5	R^6	R^7
L_{A157}	R^{B2}	R^{B2}	H	R^{B4}
L_{A158}	R^{B2}	R^{B2}	H	R^{B7}
L_{A159}	R^{B2}	R^{B2}	H	R^{B12}
L_{A160}	R^{B2}	R^{B2}	H	R^{B18}
L_{A161}	R^{B2}	R^{B2}	H	R^{A3}
L_{A162}	R^{B2}	R^{B2}	H	R^{A34}
L_{A163}	R^{B3}	R^{B3}	H	R^{B1}
L_{A164}	R^{B3}	R^{B3}	H	R^{B3}
L_{A165}	R^{B3}	R^{B3}	H	R^{B4}
L_{A166}	R^{B3}	R^{B3}	H	R^{B7}
L_{A167}	R^{B3}	R^{B3}	H	R^{B12}
L_{A168}	R^{B3}	R^{B3}	H	R^{B18}
L_{A169}	R^{B3}	R^{B3}	H	R^{A3}
L_{A170}	R^{B3}	R^{B3}	H	R^{A34}

In one embodiment, the component ligand set is selected from the group consisting of: L_{A171} through L_{A380}, which is based on a structure of Formula XI,



in which R^4, R^5, R^6, and R^8 are defined in Table 2.

TABLE 2

	R^4	R^5	R^6	R^8
L_{A171}	H	H	H	H
L_{A172}	H	H	R^{B1}	H
L_{A173}	H	H	R^{B3}	H
L_{A174}	H	H	R^{B4}	H
L_{A175}	H	H	R^{B7}	H
L_{A176}	H	H	R^{B12}	H
L_{A177}	H	H	R^{B18}	H
L_{A178}	H	H	R^{A3}	H
L_{A179}	H	H	R^{A34}	H
L_{A180}	R^{B1}	H	H	H
L_{A181}	R^{B1}	H	R^{B1}	H
L_{A182}	R^{B1}	H	R^{B3}	H
L_{A183}	R^{B1}	H	R^{B4}	H
L_{A184}	R^{B1}	H	R^{B7}	H
L_{A185}	R^{B1}	H	R^{B12}	H
L_{A186}	R^{B1}	H	R^{B18}	H
L_{A187}	R^{B1}	H	R^{A3}	H
L_{A188}	R^{B1}	H	R^{A34}	H
L_{A189}	R^{B2}	H	H	H
L_{A190}	R^{B2}	H	R^{B1}	H
L_{A191}	R^{B2}	H	R^{B3}	H
L_{A192}	R^{B2}	H	R^{B4}	H
L_{A193}	R^{B2}	H	R^{B7}	H
L_{A194}	R^{B2}	H	R^{B12}	H
L_{A195}	R^{B2}	H	R^{B18}	H
L_{A196}	R^{B2}	H	R^{A3}	H
L_{A197}	R^{B2}	H	R^{A34}	H
L_{A198}	R^{B3}	H	H	H
L_{A199}	R^{B3}	H	R^{B1}	H
L_{A200}	R^{B3}	H	R^{B3}	H
L_{A201}	R^{B3}	H	R^{B4}	H
L_{A202}	R^{B3}	H	R^{B7}	H

TABLE 2-continued

	R^4	R^5	R^6	R^8
L_{A203}	R^{B3}	H	R^{B12}	H
L_{A204}	R^{B3}	H	R^{B18}	H
L_{A205}	R^{B3}	H	R^{A3}	H
L_{A206}	R^{B3}	H	R^{A34}	H
L_{A207}	H	R^{B1}	H	H
L_{A208}	H	R^{B1}	R^{B1}	H
L_{A209}	H	R^{B1}	R^{B3}	H
L_{A210}	H	R^{B1}	R^{B4}	H
L_{A211}	H	R^{B1}	R^{B7}	H
L_{A212}	H	R^{B1}	R^{B12}	H
L_{A213}	H	R^{B1}	R^{B18}	H
L_{A214}	H	R^{B1}	R^{A3}	H
L_{A215}	H	R^{B1}	R^{A34}	H
L_{A216}	H	R^{B2}	H	H
L_{A217}	H	R^{B2}	R^{B1}	H
L_{A218}	H	R^{B2}	R^{B3}	H
L_{A219}	H	R^{B2}	R^{B4}	H
L_{A220}	H	R^{B2}	R^{B7}	H
L_{A221}	H	R^{B2}	R^{B12}	H
L_{A222}	H	R^{B2}	R^{B18}	H
L_{A223}	H	R^{B2}	R^{A3}	H
L_{A224}	H	R^{B2}	R^{A34}	H
L_{A225}	H	R^{B3}	H	H
L_{A226}	H	R^{B3}	R^{B1}	H
L_{A227}	H	R^{B3}	R^{B3}	H
L_{A228}	H	R^{B3}	R^{B4}	H
L_{A229}	H	R^{B3}	R^{B7}	H
L_{A230}	H	R^{B3}	R^{B12}	H
L_{A231}	H	R^{B3}	R^{B18}	H
L_{A232}	H	R^{B3}	R^{A3}	H
L_{A233}	H	R^{B3}	R^{A34}	H
L_{A234}	R^{B1}	R^{B1}	H	H
L_{A235}	R^{B1}	R^{B1}	R^{B1}	H
L_{A236}	R^{B1}	R^{B1}	R^{B3}	H
L_{A237}	R^{B1}	R^{B1}	R^{B4}	H
L_{A238}	R^{B1}	R^{B1}	R^{B7}	H
L_{A239}	R^{B1}	R^{B1}	R^{B12}	H
L_{A240}	R^{B1}	R^{B1}	R^{B18}	H
L_{A241}	R^{B1}	R^{B1}	R^{A3}	H
L_{A242}	R^{B1}	R^{B1}	R^{A34}	H
L_{A243}	R^{B2}	R^{B2}	H	H
L_{A244}	R^{B2}	R^{B2}	R^{B1}	H
L_{A245}	R^{B2}	R^{B2}	R^{B3}	H
L_{A246}	R^{B2}	R^{B2}	R^{B4}	H
L_{A247}	R^{B2}	R^{B2}	R^{B7}	H
L_{A248}	R^{B2}	R^{B2}	R^{B12}	H
L_{A249}	R^{B2}	R^{B2}	R^{B18}	H
L_{A250}	R^{B2}	R^{B2}	R^{A3}	H
L_{A251}	R^{B2}	R^{B2}	R^{A34}	H
L_{A252}	R^{B3}	R^{B3}	H	H
L_{A253}	R^{B3}	R^{B3}	R^{B1}	H
L_{A254}	R^{B3}	R^{B3}	R^{B3}	H
L_{A255}	R^{B3}	R^{B3}	R^{B4}	H
L_{A256}	R^{B3}	R^{B3}	R^{B7}	H
L_{A257}	R^{B3}	R^{B3}	R^{B12}	H
L_{A258}	R^{B3}	R^{B3}	R^{B18}	H
L_{A259}	R^{B3}	R^{B3}	R^{A3}	H
L_{A260}	R^{B3}	R^{B3}	R^{A34}	H
L_{A261}	H	H	H	R^{B1}
L_{A262}	H	H	H	R^{B3}
L_{A263}	H	H	H	R^{B4}
L_{A264}	H	H	H	R^{B7}
L_{A265}	H	H	H	R^{B12}
L_{A266}	H	H	H	R^{B18}
L_{A267}	H	H	H	R^{A3}
L_{A268}	H	H	H	R^{A34}
L_{A269}	R^{B1}	H	H	R^{B1}
L_{A270}	R^{B1}	H	H	R^{B3}
L_{A271}	R^{B1}	H	H	R^{B4}
L_{A272}	R^{B1}	H	H	R^{B7}
L_{A273}	R^{B1}	H	H	R^{B12}
L_{A274}	R^{B1}	H	H	R^{B18}
L_{A275}	R^{B1}	H	H	R^{A3}
L_{A276}	R^{B1}	H	H	R^{A34}
L_{A277}	R^{B2}	H	H	R^{B1}
L_{A278}	R^{B2}	H	H	R^{B3}
L_{A279}	R^{B2}	H	H	R^{B4}
L_{A280}	R^{B2}	H	H	R^{B7}

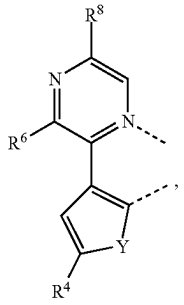
TABLE 2-continued

	R^4	R^5	R^6	R^8
L_{A281}	R^{B2}	H	H	R^{B12}
L_{A282}	R^{B2}	H	H	R^{B18}
L_{A283}	R^{B2}	H	H	R^{A3}
L_{A284}	R^{B2}	H	H	R^{A34}
L_{A285}	R^{B3}	H	H	R^{B1}
L_{A286}	R^{B3}	H	H	R^{B3}
L_{A287}	R^{B3}	H	H	R^{B4}
L_{A288}	R^{B3}	H	H	R^{B7}
L_{A289}	R^{B3}	H	H	R^{B12}
L_{A290}	R^{B3}	H	H	R^{B18}
L_{A291}	R^{B3}	H	H	R^{A3}
L_{A292}	R^{B3}	H	H	R^{A34}
L_{A293}	H	R^{B1}	H	R^{B1}
L_{A294}	H	R^{B1}	H	R^{B3}
L_{A295}	H	R^{B1}	H	R^{B4}
L_{A296}	H	R^{B1}	H	R^{B7}
L_{A297}	H	R^{B1}	H	R^{B12}
L_{A298}	H	R^{B1}	H	R^{B18}
L_{A299}	H	R^{B1}	H	R^{A3}
L_{A300}	H	R^{B1}	H	R^{A34}
L_{A301}	H	R^{B2}	H	R^{B1}
L_{A302}	H	R^{B2}	H	R^{B3}
L_{A303}	H	R^{B2}	H	R^{B4}
L_{A304}	H	R^{B2}	H	R^{B7}
L_{A305}	H	R^{B2}	H	R^{B12}
L_{A306}	H	R^{B2}	H	R^{B18}
L_{A307}	H	R^{B2}	H	R^{A3}
L_{A308}	H	R^{B2}	H	R^{A34}
L_{A309}	H	R^{B3}	H	R^{B1}
L_{A310}	H	R^{B3}	H	R^{B3}
L_{A311}	H	R^{B3}	H	R^{B4}
L_{A312}	H	R^{B3}	H	R^{B7}
L_{A313}	H	R^{B3}	H	R^{B12}
L_{A314}	H	R^{B3}	H	R^{B18}
L_{A315}	H	R^{B3}	H	R^{A3}
L_{A316}	H	R^{B3}	H	R^{A34}
L_{A317}	R^{B1}	R^{B1}	H	R^{B1}
L_{A318}	R^{B1}	R^{B1}	H	R^{B3}
L_{A319}	R^{B1}	R^{B1}	H	R^{B4}
L_{A320}	R^{B1}	R^{B1}	H	R^{B7}
L_{A321}	R^{B1}	R^{B1}	H	R^{B12}
L_{A322}	R^{B1}	R^{B1}	H	R^{B18}
L_{A323}	R^{B1}	R^{B1}	H	R^{A3}
L_{A324}	R^{B1}	R^{B1}	H	R^{A34}
L_{A325}	R^{B2}	R^{B2}	H	R^{B1}
L_{A326}	R^{B2}	R^{B2}	H	R^{B3}
L_{A327}	R^{B2}	R^{B2}	H	R^{B4}
L_{A328}	R^{B2}	R^{B2}	H	R^{B7}
L_{A329}	R^{B2}	R^{B2}	H	R^{B12}
L_{A330}	R^{B2}	R^{B2}	H	R^{B18}
L_{A331}	R^{B2}	R^{B2}	H	R^{A3}
L_{A332}	R^{B2}	R^{B2}	H	R^{A34}
L_{A333}	R^{B3}	R^{B3}	H	R^{B1}
L_{A334}	R^{B3}	R^{B3}	H	R^{B3}
L_{A335}	R^{B3}	R^{B3}	H	R^{B4}
L_{A336}	R^{B3}	R^{B3}	H	R^{B7}
L_{A337}	R^{B3}	R^{B3}	H	R^{B12}
L_{A338}	R^{B3}	R^{B3}	H	R^{B18}
L_{A339}	R^{B3}	R^{B3}	H	R^{A3}
L_{A340}	R^{B3}	R^{B3}	H	R^{A34}
L_{A341}	H	H	R^{B1}	R^{B1}
L_{A342}	H	H	R^{B3}	R^{B3}
L_{A343}	H	H	R^{B4}	R^{B4}
L_{A344}	H	H	R^{B7}	R^{B7}
L_{A345}	H	H	R^{B12}	R^{B12}
L_{A346}	H	H	R^{B18}	R^{B18}
L_{A347}	H	H	R^{A3}	R^{A3}
L_{A348}	H	H	R^{A34}	R^{A34}
L_{A349}	R^{B1}	H	R^{B1}	R^{B1}
L_{A350}	R^{B1}	H	R^{B3}	R^{B3}
L_{A351}	R^{B1}	H	R^{B4}	R^{B4}
L_{A352}	R^{B1}	H	R^{B7}	R^{B7}
L_{A353}	R^{B1}	H	R^{B12}	R^{B12}
L_{A354}	R^{B1}	H	R^{B18}	R^{B18}
L_{A355}	R^{B1}	H	R^{A3}	R^{A3}
L_{A356}	R^{B1}	H	R^{A34}	R^{A34}
L_{A357}	R^{B2}	H	R^{B1}	R^{B1}
L_{A358}	R^{B2}	H	R^{B3}	R^{B3}

TABLE 2-continued

	R^4	R^5	R^6	R^8
L_{A359}	R^{B2}	H	R^{B4}	R^{B4}
L_{A360}	R^{B2}	H	R^{B7}	R^{B7}
L_{A361}	R^{B2}	H	R^{B12}	R^{B12}
L_{A362}	R^{B2}	H	R^{B18}	R^{B18}
L_{A363}	R^{B2}	H	R^{A3}	R^{A3}
L_{A364}	R^{B2}	H	R^{A34}	R^{A34}
L_{A365}	H	R^{B1}	R^{B1}	R^{B1}
L_{A366}	H	R^{B1}	R^{B3}	R^{B3}
L_{A367}	H	R^{B1}	R^{B4}	R^{B4}
L_{A368}	H	R^{B1}	R^{B7}	R^{B7}
L_{A369}	H	R^{B1}	R^{B12}	R^{B12}
L_{A370}	H	R^{B1}	R^{B18}	R^{B18}
L_{A371}	H	R^{B1}	R^{A3}	R^{A3}
L_{A372}	H	R^{B1}	R^{A34}	R^{A34}
L_{A373}	H	R^{B2}	R^{B1}	R^{B1}
L_{A374}	H	R^{B2}	R^{B3}	R^{B3}
L_{A375}	H	R^{B2}	R^{B4}	R^{B4}
L_{A376}	H	R^{B2}	R^{B7}	R^{B7}
L_{A377}	H	R^{B2}	R^{B12}	R^{B12}
L_{A378}	H	R^{B2}	R^{B18}	R^{B18}
L_{A379}	H	R^{B2}	R^{A3}	R^{A3}
L_{A380}	H	R^{B2}	R^{A34}	R^{A34}

In one embodiment, the component ligand set is selected from the group consisting of: L_{A381} through L_{A608}, which is based on a structure of Formula XII,



in which R^4, R^6, R^8, and Y are defined in Table 3.

TABLE 3

	R^4	R^6	R^8	Y
L_{A381}	H	H	H	S
L_{A382}	H	R^{B1}	H	S
L_{A383}	H	R^{B3}	H	S
L_{A384}	H	R^{B4}	H	S
L_{A385}	H	R^{B7}	H	S
L_{A386}	H	R^{B12}	H	S
L_{A387}	H	R^{B18}	H	S
L_{A388}	H	R^{A3}	H	S
L_{A389}	H	R^{A34}	H	S
L_{A390}	R^{B1}	H	H	S
L_{A391}	R^{B1}	R^{B1}	H	S
L_{A392}	R^{B1}	R^{B3}	H	S
L_{A393}	R^{B1}	R^{B4}	H	S
L_{A394}	R^{B1}	R^{B7}	H	S
L_{A395}	R^{B1}	R^{B12}	H	S
L_{A396}	R^{B1}	R^{B18}	H	S
L_{A397}	R^{B1}	R^{A3}	H	S
L_{A398}	R^{B1}	R^{A34}	H	S
L_{A399}	R^{B2}	H	H	S
L_{A400}	R^{B2}	R^{B1}	H	S
L_{A401}	R^{B2}	R^{B3}	H	S
L_{A402}	R^{B2}	R^{B4}	H	S
L_{A403}	R^{B2}	R^{B7}	H	S
L_{A404}	R^{B2}	R^{B12}	H	S
L_{A405}	R^{B2}	R^{B18}	H	S

TABLE 3-continued

	R^4	R^6	R^8	Y
L_{A406}	R^{B2}	R^{A3}	H	S
L_{A407}	R^{B2}	R^{A34}	H	S
L_{A408}	R^{B3}	H	H	S
L_{A409}	R^{B3}	R^{B1}	H	S
L_{A410}	R^{B3}	R^{B3}	H	S
L_{A411}	R^{B3}	R^{B4}	H	S
L_{A412}	R^{B3}	R^{B7}	H	S
L_{A413}	R^{B3}	R^{B12}	H	S
L_{A414}	R^{B3}	R^{B18}	H	S
L_{A415}	R^{B3}	R^{A3}	H	S
L_{A416}	R^{B3}	R^{A34}	H	S
L_{A417}	H	H	H	S
L_{A418}	H	R^{B1}	H	S
L_{A419}	H	R^{B3}	H	S
L_{A420}	H	R^{B4}	H	S
L_{A421}	H	R^{B7}	H	S
L_{A422}	H	R^{B12}	H	S
L_{A423}	H	R^{B18}	H	S
L_{A424}	H	R^{A3}	H	S
L_{A425}	H	R^{A34}	H	S
L_{A426}	H	H	H	S
L_{A427}	H	R^{B1}	H	S
L_{A428}	H	R^{B3}	H	S
L_{A429}	H	R^{B4}	H	S
L_{A430}	H	R^{B7}	H	S
L_{A431}	H	R^{B12}	H	S
L_{A432}	H	R^{B18}	H	S
L_{A433}	H	R^{A3}	H	S
L_{A434}	H	R^{A34}	H	S
L_{A435}	H	H	H	S
L_{A436}	H	R^{B1}	H	S
L_{A437}	H	R^{B3}	H	S
L_{A438}	H	R^{B4}	H	S
L_{A439}	H	R^{B7}	H	S
L_{A440}	H	R^{B12}	H	S
L_{A441}	H	R^{B18}	H	S
L_{A442}	H	R^{A3}	H	S
L_{A443}	H	R^{A34}	H	S
L_{A444}	R^{B1}	H	H	S
L_{A445}	R^{B1}	R^{B1}	H	S
L_{A446}	R^{B1}	R^{B3}	H	S
L_{A447}	R^{B1}	R^{B4}	H	S
L_{A448}	R^{B1}	R^{B7}	H	S
L_{A449}	R^{B1}	R^{B12}	H	S
L_{A450}	R^{B1}	R^{B18}	H	S
L_{A451}	R^{B1}	R^{A3}	H	S
L_{A452}	R^{B1}	R^{A34}	H	S
L_{A453}	R^{B2}	H	H	S
L_{A454}	R^{B2}	R^{B1}	H	S
L_{A455}	R^{B2}	R^{B3}	H	S
L_{A456}	R^{B2}	R^{B4}	H	S
L_{A457}	R^{B2}	R^{B7}	H	S
L_{A458}	R^{B2}	R^{B12}	H	S
L_{A459}	R^{B2}	R^{B18}	H	S
L_{A460}	R^{B2}	R^{A3}	H	S
L_{A461}	R^{B2}	R^{A34}	H	S
L_{A462}	R^{B3}	H	H	S
L_{A463}	R^{B3}	R^{B1}	H	S
L_{A464}	R^{B3}	R^{B3}	H	S
L_{A465}	R^{B3}	R^{B4}	H	S
L_{A466}	R^{B3}	R^{B7}	H	S
L_{A467}	R^{B3}	R^{B12}	H	S
L_{A468}	R^{B3}	R^{B18}	H	S
L_{A469}	R^{B3}	R^{A3}	H	S
L_{A470}	R^{B3}	R^{A34}	H	S
L_{A471}	H	R^{B1}	R^{B1}	S
L_{A472}	H	R^{B3}	R^{B3}	S
L_{A473}	H	R^{B4}	R^{B4}	S
L_{A474}	H	R^{B7}	R^{B7}	S
L_{A475}	H	R^{B12}	R^{B12}	S
L_{A476}	H	R^{B18}	R^{B18}	S
L_{A477}	H	R^{A3}	R^{A3}	S
L_{A478}	H	R^{A34}	R^{A34}	S
L_{A479}	R^{B1}	R^{B1}	R^{B1}	S
L_{A480}	R^{B1}	R^{B3}	R^{B3}	S
L_{A481}	R^{B1}	R^{B4}	R^{B4}	S
L_{A482}	R^{B1}	R^{B7}	R^{B7}	S
L_{A483}	R^{B1}	R^{B12}	R^{B12}	S

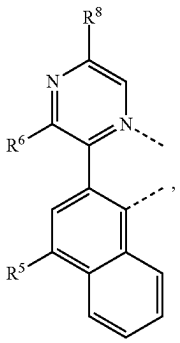
TABLE 3-continued

	R^4	R^6	R^8	Y
L_{A484}	R^{B1}	R^{B18}	R^{B18}	S
L_{A485}	R^{B1}	R^{A3}	R^{A3}	S
L_{A486}	R^{B1}	R^{A34}	R^{A34}	S
L_{A487}	R^{B2}	R^{B1}	R^{B1}	S
L_{A488}	R^{B2}	R^{B3}	R^{B3}	S
L_{A489}	R^{B2}	R^{B4}	R^{B4}	S
L_{A490}	R^{B2}	R^{B7}	R^{B7}	S
L_{A491}	R^{B2}	R^{B12}	R^{B12}	S
L_{A492}	R^{B2}	R^{B18}	R^{B18}	S
L_{A493}	R^{B2}	R^{A3}	R^{A3}	S
L_{A494}	R^{B2}	R^{A34}	R^{A34}	S
L_{A495}	H	H	H	O
L_{A496}	H	R^{B1}	H	O
L_{A497}	H	R^{B3}	H	O
L_{A498}	H	R^{B4}	H	O
L_{A499}	H	R^{B7}	H	O
L_{A500}	H	R^{B12}	H	O
L_{A501}	H	R^{B18}	H	O
L_{A502}	H	R^{A3}	H	O
L_{A503}	H	R^{A34}	H	O
L_{A504}	R^{B1}	H	H	O
L_{A505}	R^{B1}	R^{B1}	H	O
L_{A506}	R^{B1}	R^{B3}	H	O
L_{A507}	R^{B1}	R^{B4}	H	O
L_{A508}	R^{B1}	R^{B7}	H	O
L_{A509}	R^{B1}	R^{B12}	H	O
L_{A510}	R^{B1}	R^{B18}	H	O
L_{A511}	R^{B1}	R^{A3}	H	O
L_{A512}	R^{B1}	R^{A34}	H	O
L_{A513}	R^{B2}	H	H	O
L_{A514}	R^{B2}	R^{B1}	H	O
L_{A515}	R^{B2}	R^{B3}	H	O
L_{A516}	R^{B2}	R^{B4}	H	O
L_{A517}	R^{B2}	R^{B7}	H	O
L_{A518}	R^{B2}	R^{B12}	H	O
L_{A519}	R^{B2}	R^{B18}	H	O
L_{A520}	R^{B2}	R^{A3}	H	O
L_{A521}	R^{B2}	R^{A34}	H	O
L_{A522}	R^{B3}	H	H	O
L_{A523}	R^{B3}	R^{B1}	H	O
L_{A524}	R^{B3}	R^{B3}	H	O
L_{A525}	R^{B3}	R^{B4}	H	O
L_{A526}	R^{B3}	R^{B7}	H	O
L_{A527}	R^{B3}	R^{B12}	H	O
L_{A528}	R^{B3}	R^{B18}	H	O
L_{A529}	R^{B3}	R^{A3}	H	O
L_{A530}	R^{B3}	R^{A34}	H	O
L_{A531}	H	H	H	O
L_{A532}	H	R^{B1}	H	O
L_{A533}	H	R^{B3}	H	O
L_{A534}	H	R^{B4}	H	O
L_{A535}	H	R^{B7}	H	O
L_{A536}	H	R^{B12}	H	O
L_{A537}	H	R^{B18}	H	O
L_{A538}	H	R^{A3}	H	O
L_{A539}	H	R^{A34}	H	O
L_{A540}	H	H	H	O
L_{A541}	H	R^{B1}	H	O
L_{A542}	H	R^{B3}	H	O
L_{A543}	H	R^{B4}	H	O
L_{A544}	H	R^{B7}	H	O
L_{A545}	H	R^{B12}	H	O
L_{A546}	H	R^{B18}	H	O
L_{A547}	H	R^{A3}	H	O
L_{A548}	H	R^{A34}	H	O
L_{A549}	H	H	H	O
L_{A550}	H	R^{B1}	H	O
L_{A551}	H	R^{B3}	H	O
L_{A552}	H	R^{B4}	H	O
L_{A553}	H	R^{B7}	H	O
L_{A554}	H	R^{B12}	H	O
L_{A555}	H	R^{B18}	H	O
L_{A556}	H	R^{A3}	H	O
L_{A557}	H	R^{A34}	H	O
L_{A558}	R^{B1}	H	H	O
L_{A559}	R^{B1}	R^{B1}	H	O
L_{A560}	R^{B1}	R^{B3}	H	O
L_{A561}	R^{B1}	R^{B4}	H	O

TABLE 3-continued

	R^4	R^6	R^8	Y
L_{A562}	R^{B1}	R^{B7}	H	O
L_{A563}	R^{B1}	R^{B12}	H	O
L_{A564}	R^{B1}	R^{B18}	H	O
L_{A565}	R^{B1}	R^{A3}	H	O
L_{A566}	R^{B1}	R^{A34}	H	O
L_{A567}	R^{B2}	H	H	O
L_{A568}	R^{B2}	R^{B1}	H	O
L_{A569}	R^{B2}	R^{B3}	H	O
L_{A570}	R^{B2}	R^{B4}	H	O
L_{A571}	R^{B2}	R^{B7}	H	O
L_{A572}	R^{B2}	R^{B12}	H	O
L_{A573}	R^{B2}	R^{B18}	H	O
L_{A574}	R^{B2}	R^{A3}	H	O
L_{A575}	R^{B2}	R^{A34}	H	O
L_{A576}	R^{B3}	H	H	O
L_{A577}	R^{B3}	R^{B1}	H	O
L_{A578}	R^{B3}	R^{B3}	H	O
L_{A579}	R^{B3}	R^{B4}	H	O
L_{A580}	R^{B3}	R^{B7}	H	O
L_{A581}	R^{B3}	R^{B12}	H	O
L_{A582}	R^{B3}	R^{B18}	H	O
L_{A583}	R^{B3}	R^{A3}	H	O
L_{A584}	R^{B3}	R^{A34}	H	O
L_{A585}	H	R^{B1}	R^{B1}	O
L_{A586}	H	R^{B3}	R^{B3}	O
L_{A587}	H	R^{B4}	R^{B4}	O
L_{A588}	H	R^{B7}	R^{B7}	O
L_{A589}	H	R^{B12}	R^{B12}	O
L_{A590}	H	R^{B18}	R^{B18}	O
L_{A591}	H	R^{A3}	R^{A3}	O
L_{A592}	H	R^{A34}	R^{A34}	O
L_{A593}	R^{B1}	R^{B1}	R^{B1}	O
L_{A594}	R^{B1}	R^{B3}	R^{B3}	O
L_{A595}	R^{B1}	R^{B4}	R^{B4}	O
L_{A596}	R^{B1}	R^{B7}	R^{B7}	O
L_{A597}	R^{B1}	R^{B12}	R^{B12}	O
L_{A598}	R^{B1}	R^{B18}	R^{B18}	O
L_{A599}	R^{B1}	R^{A3}	R^{A3}	O
L_{A600}	R^{B1}	R^{A34}	R^{A34}	O
L_{A601}	R^{B2}	R^{B1}	R^{B1}	O
L_{A602}	R^{B2}	R^{B3}	R^{B3}	O
L_{A603}	R^{B2}	R^{B4}	R^{B4}	O
L_{A604}	R^{B2}	R^{B7}	R^{B7}	O
L_{A605}	R^{B2}	R^{B12}	R^{B12}	O
L_{A606}	R^{B2}	R^{B18}	R^{B18}	O
L_{A607}	R^{B2}	R^{A3}	R^{A3}	O
L_{A608}	R^{B2}	R^{A34}	R^{A34}	O

In one embodiment, the component ligand set is selected from the group consisting of: L_{A609} through L_{A858}, which is based on a structure of Formula XIII,



in which R^5, R^6, and R^8 are defined in Table 4.

TABLE 4

	R^5	R^6	R^8
L_{A609}	H	H	H
L_{A610}	H	R^{B1}	H
L_{A611}	H	R^{B3}	H
L_{A612}	H	R^{B4}	H
L_{A613}	H	R^{B7}	H
L_{A614}	H	R^{B12}	H
L_{A615}	H	R^{B18}	H
L_{A616}	H	R^{A3}	H
L_{A617}	H	R^{A34}	H
L_{A618}	R^{B1}	H	H
L_{A619}	R^{B1}	R^{B1}	H
L_{A620}	R^{B1}	R^{B3}	H
L_{A621}	R^{B1}	R^{B4}	H
L_{A622}	R^{B1}	R^{B7}	H
L_{A623}	R^{B1}	R^{B12}	H
L_{A624}	R^{B1}	R^{B18}	H
L_{A625}	R^{B1}	R^{A3}	H
L_{A626}	R^{B1}	R^{A34}	H
L_{A627}	R^{B2}	H	H
L_{A628}	R^{B2}	R^{B1}	H
L_{A629}	R^{B2}	R^{B3}	H
L_{A630}	R^{B2}	R^{B4}	H
L_{A631}	R^{B2}	R^{B7}	H
L_{A632}	R^{B2}	R^{B12}	H
L_{A633}	R^{B2}	R^{B18}	H
L_{A634}	R^{B2}	R^{A3}	H
L_{A635}	R^{B2}	R^{A34}	H
L_{A636}	R^{B3}	H	H
L_{A637}	R^{B3}	R^{B1}	H
L_{A638}	R^{B3}	R^{B3}	H
L_{A639}	R^{B3}	R^{B4}	H
L_{A640}	R^{B3}	R^{B7}	H
L_{A641}	R^{B3}	R^{B12}	H
L_{A642}	R^{B3}	R^{B18}	H
L_{A643}	R^{B3}	R^{A3}	H
L_{A644}	R^{B3}	R^{A34}	H
L_{A645}	R^{B5}	H	H
L_{A646}	R^{B5}	R^{B1}	H
L_{A647}	R^{B5}	R^{B3}	H
L_{A648}	R^{B5}	R^{B4}	H
L_{A649}	R^{B5}	R^{B7}	H
L_{A650}	R^{B5}	R^{B12}	H
L_{A651}	R^{B5}	R^{B18}	H
L_{A652}	R^{B5}	R^{A3}	H
L_{A653}	R^{B5}	R^{A34}	H
L_{A654}	R^{B6}	H	H
L_{A655}	R^{B6}	R^{B1}	H
L_{A656}	R^{B6}	R^{B3}	H
L_{A657}	R^{B6}	R^{B4}	H
L_{A658}	R^{B6}	R^{B7}	H
L_{A659}	R^{B6}	R^{B12}	H
L_{A660}	R^{B6}	R^{B18}	H
L_{A661}	R^{B6}	R^{A3}	H
L_{A662}	R^{B6}	R^{A34}	H
L_{A663}	R^{B16}	H	H
L_{A664}	R^{B16}	R^{B1}	H
L_{A665}	R^{B16}	R^{B3}	H
L_{A666}	R^{B16}	R^{B4}	H
L_{A667}	R^{B16}	R^{B7}	H
L_{A668}	R^{B16}	R^{B12}	H
L_{A669}	R^{B16}	R^{B18}	H
L_{A670}	R^{B16}	R^{A3}	H
L_{A671}	R^{B16}	R^{A34}	H
L_{A672}	R^{B20}	H	H
L_{A673}	R^{B20}	R^{B1}	H
L_{A674}	R^{B20}	R^{B3}	H
L_{A675}	R^{B20}	R^{B4}	H
L_{A676}	R^{B20}	R^{B7}	H
L_{A677}	R^{B20}	R^{B12}	H
L_{A678}	R^{B20}	R^{B18}	H
L_{A679}	R^{B20}	R^{A3}	H
L_{A680}	R^{B20}	R^{A34}	H
L_{A681}	R^{B44}	H	H
L_{A682}	R^{B44}	R^{B1}	H
L_{A683}	R^{B44}	R^{B3}	H
L_{A684}	R^{B44}	R^{B4}	H
L_{A685}	R^{B44}	R^{B7}	H
L_{A686}	R^{B44}	R^{B12}	H

TABLE 4-continued

	R^5	R^6	R^8
L_{A4687}	R^{B44}	R^{B18}	H
L_{A4688}	R^{B44}	R^{A3}	H
L_{A4689}	R^{B44}	R^{A434}	H
L_{A4690}	R^{A434}	H	H
L_{A4691}	R^{A434}	R^{B1}	H
L_{A4692}	R^{A434}	R^{B3}	H
L_{A4693}	R^{A434}	R^{B4}	H
L_{A4694}	R^{A434}	R^{B7}	H
L_{A4695}	R^{A434}	R^{B12}	H
L_{A4696}	R^{A434}	R^{B18}	H
L_{A4697}	R^{A434}	R^{A3}	H
L_{A4698}	R^{A434}	R^{A434}	H
L_{A4699}	H	H	R^{B1}
L_{A4700}	H	H	R^{B3}
L_{A4701}	H	H	R^{B4}
L_{A4702}	H	H	R^{B7}
L_{A4703}	H	H	R^{B12}
L_{A4704}	H	H	R^{B18}
L_{A4705}	H	H	R^{A3}
L_{A4706}	H	H	R^{A434}
L_{A4707}	R^{B1}	H	R^{B1}
L_{A4708}	R^{B1}	H	R^{B3}
L_{A4709}	R^{B1}	H	R^{B4}
L_{A4710}	R^{B1}	H	R^{B7}
L_{A4711}	R^{B1}	H	R^{B12}
L_{A4712}	R^{B1}	H	R^{B18}
L_{A4713}	R^{B1}	H	R^{A3}
L_{A4714}	R^{B1}	H	R^{A434}
L_{A4715}	R^{B2}	H	R^{B1}
L_{A4716}	R^{B2}	H	R^{B3}
L_{A4717}	R^{B2}	H	R^{B4}
L_{A4718}	R^{B2}	H	R^{B7}
L_{A4719}	R^{B2}	H	R^{B12}
L_{A4720}	R^{B2}	H	R^{B18}
L_{A4721}	R^{B2}	H	R^{A3}
L_{A4722}	R^{B2}	H	R^{A434}
L_{A4723}	R^{B3}	H	R^{B1}
L_{A4724}	R^{B3}	H	R^{B3}
L_{A4725}	R^{B3}	H	R^{B4}
L_{A4726}	R^{B3}	H	R^{B7}
L_{A4727}	R^{B3}	H	R^{B12}
L_{A4728}	R^{B3}	H	R^{B18}
L_{A4729}	R^{B3}	H	R^{A3}
L_{A4730}	R^{B3}	H	R^{A434}
L_{A4731}	R^{B5}	H	R^{B1}
L_{A4732}	R^{B5}	H	R^{B3}
L_{A4733}	R^{B5}	H	R^{B4}
L_{A4734}	R^{B5}	H	R^{B7}
L_{A4735}	R^{B5}	H	R^{B12}
L_{A4736}	R^{B5}	H	R^{B18}
L_{A4737}	R^{B5}	H	R^{A3}
L_{A4738}	R^{B5}	H	R^{A434}
L_{A4739}	R^{B6}	H	R^{B1}
L_{A4740}	R^{B6}	H	R^{B3}
L_{A4741}	R^{B6}	H	R^{B4}
L_{A4742}	R^{B6}	H	R^{B7}
L_{A4743}	R^{B6}	H	R^{B12}
L_{A4744}	R^{B6}	H	R^{B18}
L_{A4745}	R^{B6}	H	R^{A3}
L_{A4746}	R^{B6}	H	R^{A434}
L_{A4747}	R^{B16}	H	R^{B1}
L_{A4748}	R^{B16}	H	R^{B3}
L_{A4749}	R^{B16}	H	R^{B4}
L_{A4750}	R^{B16}	H	R^{B7}
L_{A4751}	R^{B16}	H	R^{B12}
L_{A4752}	R^{B16}	H	R^{B18}
L_{A4753}	R^{B16}	H	R^{A3}
L_{A4754}	R^{B16}	H	R^{A434}
L_{A4755}	R^{B20}	H	R^{B1}
L_{A4756}	R^{B20}	H	R^{B3}
L_{A4757}	R^{B20}	H	R^{B4}
L_{A4758}	R^{B20}	H	R^{B7}
L_{A4759}	R^{B20}	H	R^{B12}
L_{A4760}	R^{B20}	H	R^{B18}
L_{A4761}	R^{B20}	H	R^{A3}
L_{A4762}	R^{B20}	H	R^{A434}
L_{A4763}	R^{B44}	H	R^{B1}
L_{A4764}	R^{B44}	H	R^{B3}

TABLE 4-continued

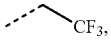
	R^5	R^6	R^8
L_{A4765}	R^{B44}	H	R^{B4}
L_{A4766}	R^{B44}	H	R^{B7}
L_{A4767}	R^{B44}	H	R^{B12}
L_{A4768}	R^{B44}	H	R^{B18}
L_{A4769}	R^{B44}	H	R^{A3}
L_{A4770}	R^{B44}	H	R^{A434}
L_{A4771}	R^{A434}	H	R^{B1}
L_{A4772}	R^{A434}	H	R^{B3}
L_{A4773}	R^{A434}	H	R^{B4}
L_{A4774}	R^{A434}	H	R^{B7}
L_{A4775}	R^{A434}	H	R^{B12}
L_{A4776}	R^{A434}	H	R^{B18}
L_{A4777}	R^{A434}	H	R^{A3}
L_{A4778}	R^{A434}	H	R^{A434}
L_{A4779}	H	R^{B1}	R^{B1}
L_{A4780}	H	R^{B3}	R^{B3}
L_{A4781}	H	R^{B4}	R^{B4}
L_{A4782}	H	R^{B7}	R^{B7}
L_{A4783}	H	R^{B12}	R^{B12}
L_{A4784}	H	R^{B18}	R^{B18}
L_{A4785}	H	R^{A3}	R^{A3}
L_{A4786}	H	R^{A434}	R^{A434}
L_{A4787}	R^{B1}	R^{B1}	R^{B1}
L_{A4788}	R^{B1}	R^{B3}	R^{B3}
L_{A4789}	R^{B1}	R^{B4}	R^{B4}
L_{A4790}	R^{B1}	R^{B7}	R^{B7}
L_{A4791}	R^{B1}	R^{B12}	R^{B12}
L_{A4792}	R^{B1}	R^{B18}	R^{B18}
L_{A4793}	R^{B1}	R^{A3}	R^{A3}
L_{A4794}	R^{B1}	R^{A434}	R^{A434}
L_{A4795}	R^{B2}	R^{B1}	R^{B1}
L_{A4796}	R^{B2}	R^{B3}	R^{B3}
L_{A4797}	R^{B2}	R^{B4}	R^{B4}
L_{A4798}	R^{B2}	R^{B7}	R^{B7}
L_{A4799}	R^{B2}	R^{B12}	R^{B12}
L_{A4800}	R^{B2}	R^{B18}	R^{B18}
L_{A4801}	R^{B2}	R^{A3}	R^{A3}
L_{A4802}	R^{B2}	R^{A434}	R^{A434}
L_{A4803}	R^{B3}	R^{B1}	R^{B1}
L_{A4804}	R^{B3}	R^{B3}	R^{B3}
L_{A4805}	R^{B3}	R^{B4}	R^{B4}
L_{A4806}	R^{B3}	R^{B7}	R^{B7}
L_{A4807}	R^{B3}	R^{B12}	R^{B12}
L_{A4808}	R^{B3}	R^{B18}	R^{B18}
L_{A4809}	R^{B3}	R^{A3}	R^{A3}
L_{A4810}	R^{B3}	R^{A434}	R^{A434}
L_{A4811}	R^{B5}	R^{B1}	R^{B1}
L_{A4812}	R^{B5}	R^{B3}	R^{B3}
L_{A4813}	R^{B5}	R^{B4}	R^{B4}
L_{A4814}	R^{B5}	R^{B7}	R^{B7}
L_{A4815}	R^{B5}	R^{B12}	R^{B12}
L_{A4816}	R^{B5}	R^{B18}	R^{B18}
L_{A4817}	R^{B5}	R^{A3}	R^{A3}
L_{A4818}	R^{B5}	R^{A434}	R^{A434}
L_{A4819}	R^{B6}	R^{B1}	R^{B1}
L_{A4820}	R^{B6}	R^{B3}	R^{B3}
L_{A4821}	R^{B6}	R^{B4}	R^{B4}
L_{A4822}	R^{B6}	R^{B7}	R^{B7}
L_{A4823}	R^{B6}	R^{B12}	R^{B12}
L_{A4824}	R^{B6}	R^{B18}	R^{B18}
L_{A4825}	R^{B6}	R^{A3}	R^{A3}
L_{A4826}	R^{B6}	R^{A434}	R^{A434}
L_{A4827}	R^{B16}	R^{B1}	R^{B1}
L_{A4828}	R^{B16}	R^{B3}	R^{B3}
L_{A4829}	R^{B16}	R^{B4}	R^{B4}
L_{A4830}	R^{B16}	R^{B7}	R^{B7}
L_{A4831}	R^{B16}	R^{B12}	R^{B12}
L_{A4832}	R^{B16}	R^{B18}	R^{B18}
L_{A4833}	R^{B16}	R^{A3}	R^{A3}
L_{A4834}	R^{B16}	R^{A434}	R^{A434}
L_{A4835}	R^{B20}	R^{B1}	R^{B1}
L_{A4836}	R^{B20}	R^{B3}	R^{B3}
L_{A4837}	R^{B20}	R^{B4}	R^{B4}
L_{A4838}	R^{B20}	R^{B7}	R^{B7}
L_{A4839}	R^{B20}	R^{B12}	R^{B12}
L_{A4840}	R^{B20}	R^{B18}	R^{B18}
L_{A4841}	R^{B20}	R^{A3}	R^{A3}
L_{A4842}	R^{B20}	R^{A434}	R^{A434}

TABLE 4-continued

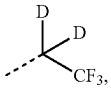
	R^5	R^6	R^8
L_{A4843}	R^{B44}	R^{B1}	R^{B1}
L_{A4844}	R^{B44}	R^{B3}	R^{B3}
L_{A4845}	R^{B44}	R^{B4}	R^{B4}
L_{A4846}	R^{B44}	R^{B7}	R^{B7}
L_{A4847}	R^{B44}	R^{B12}	R^{B12}
L_{A4848}	R^{B44}	R^{B18}	R^{B18}
L_{A4849}	R^{B44}	R^{A3}	R^{A3}
L_{A4850}	R^{B44}	R^{A34}	R^{A34}
L_{A4851}	R^{A34}	R^{B1}	R^{B1}
L_{A4852}	R^{A34}	R^{B3}	R^{B3}
L_{A4853}	R^{A34}	R^{B4}	R^{B4}
L_{A4854}	R^{A34}	R^{B7}	R^{B7}
L_{A4855}	R^{A34}	R^{B12}	R^{B12}
L_{A4856}	R^{A34}	R^{B18}	R^{B18}
L_{A4857}	R^{A34}	R^{A3}	R^{A3}
L_{A4858}	R^{A34}	R^{A34}	R^{A34}

wherein R^{A1} to R^{A51} have the following structures:

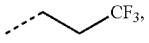
R^{A1}



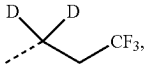
R^{A2}



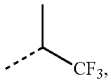
R^{A3}



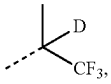
R^{A4}



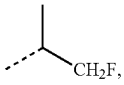
R^{A5}



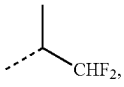
R^{A6}



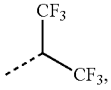
R^{A7}



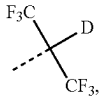
R^{A8}



R^{A9}

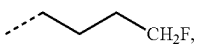


R^{A10}

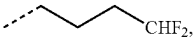


R^{A11}

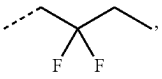
R^{A12}



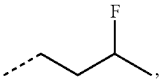
R^{A13}



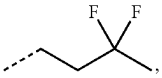
R^{A14}



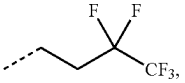
R^{A15}



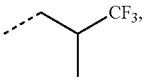
R^{A16}



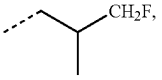
R^{A17}



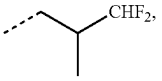
R^{A18}



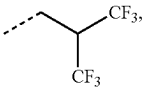
R^{A19}



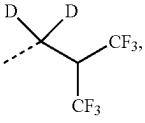
R^{A20}



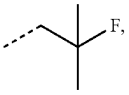
R^{A21}



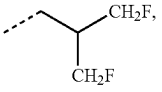
R^{A22}



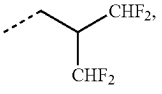
R^{A23}



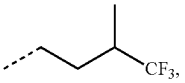
R^{A24}



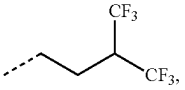
R^{A25}



R^{A26}

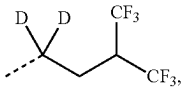


R^{A27}

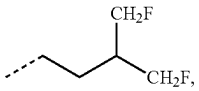


-continued

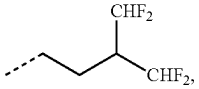
R^{A28}



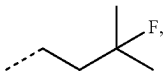
R^{A29}



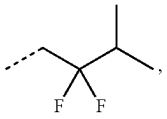
R^{A30}



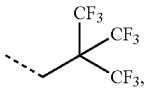
R^{A31}



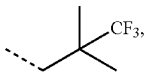
R^{A32}



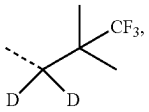
R^{A33}



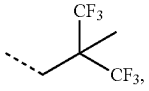
R^{A34}



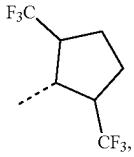
R^{A35}



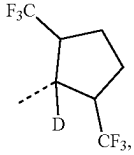
R^{A36}



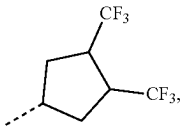
R^{A37}



R^{A38}

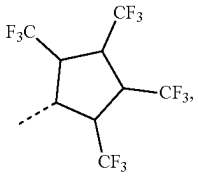


R^{A39}

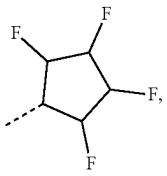


-continued

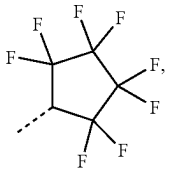
R^{A40}



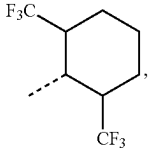
R^{A41}



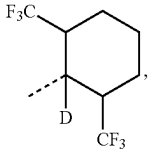
R^{A42}



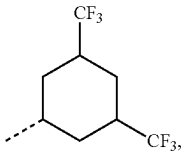
R^{A43}



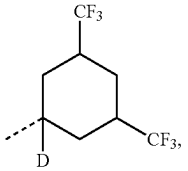
R^{A44}



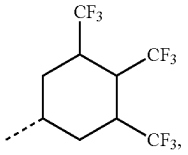
R^{A45}



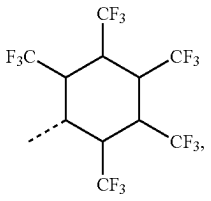
R^{A46}



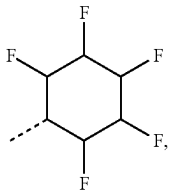
R^{A47}

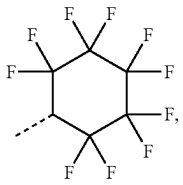


R^{A48}

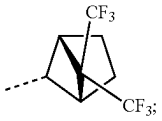


-continued





and

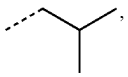


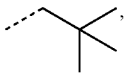
wherein R^{B1} to R^{B21} have the following structures

R^{B1} 

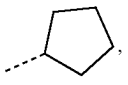
R^{B2} 

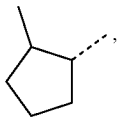
R^{B3} 

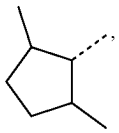
R^{B4} 

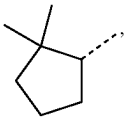
R^{B5} 

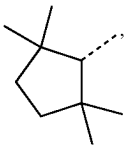
R^{B6} 

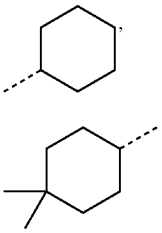
R^{B7} 

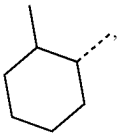
R^{B8} 

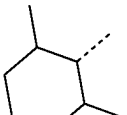
R^{B9} 

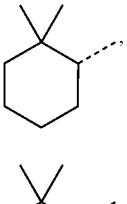
R^{A49} 

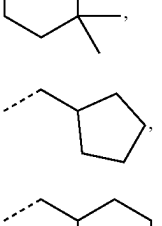
R^{A50} 

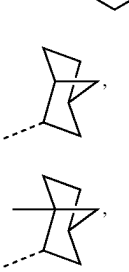
R^{A51} 

R^{B10} 

R^{B11} 

R^{B12} 

R^{B13} 

R^{B14} 

R^{B15}

R^{B16}

R^{B17}

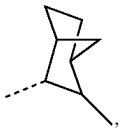
R^{B18}

R^{B19}

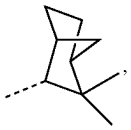
R^{B20}

R^{B21}

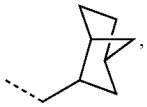
-continued



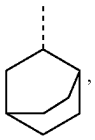
R^{B22}



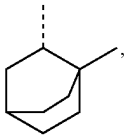
R^{B23}



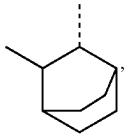
R^{B24}



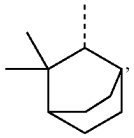
R^{B25}



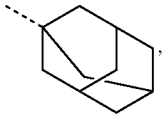
R^{B26}



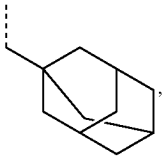
R^{B27}



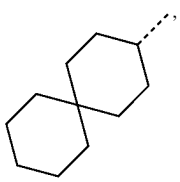
R^{B28}



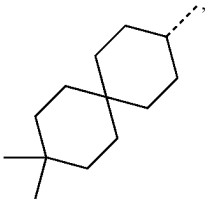
R^{B29}



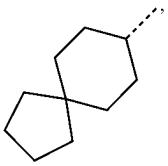
R^{B30}



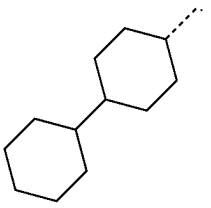
R^{B31}



R^{B32}

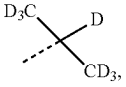


R^{B33}

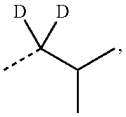


R^{B34}

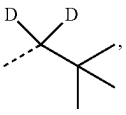
R^{B35}



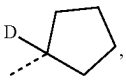
R^{B36}



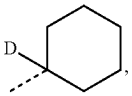
R^{B37}



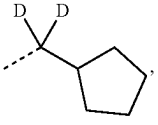
R^{B38}



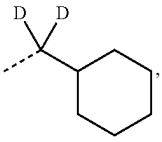
R^{B39}



R^{B40}

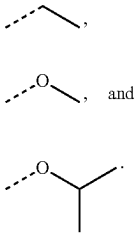


R^{B41}



R^{B42}

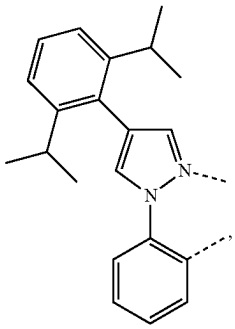
-continued



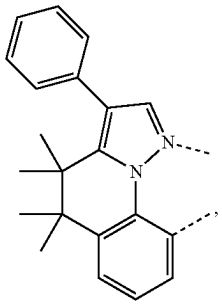
and

In one embodiment, the component ligand set is selected from the group consisting of L_{A859} to L_{A902}.

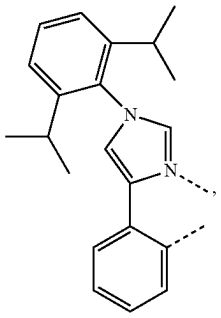
L_{A859}



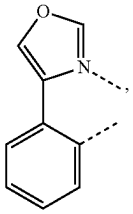
L_{A860}



L_{A861}

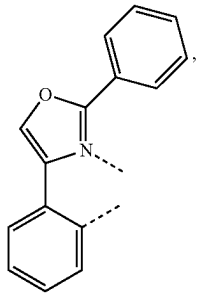


L_{A862}

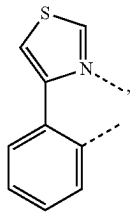


-continued

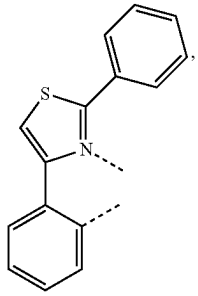
L_{A863}



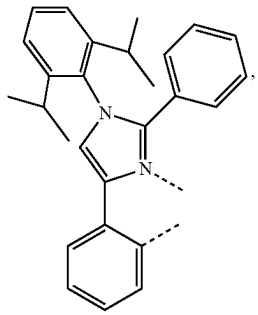
L_{A864}



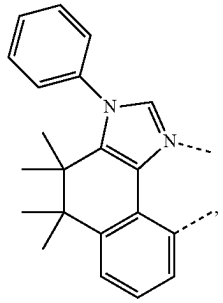
L_{A865}



L_{A866}

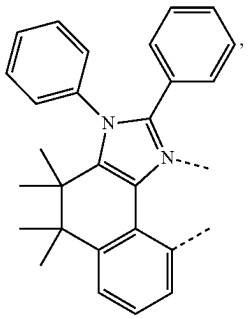


L_{A867}

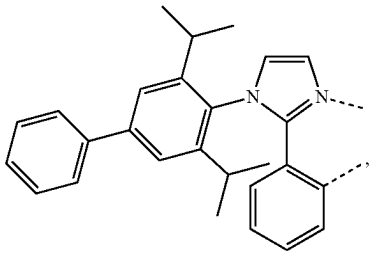


-continued

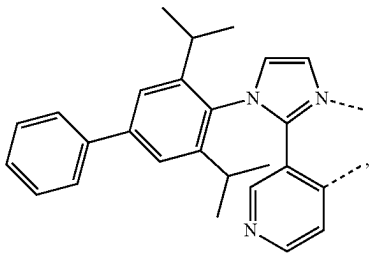
L_{A868}



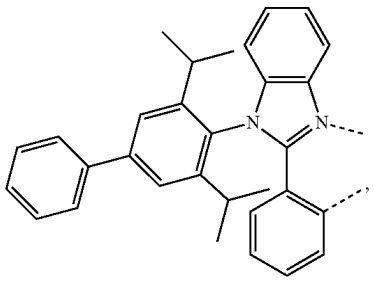
L_{A869}



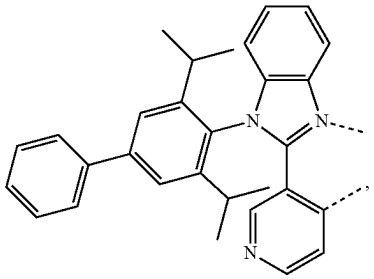
L_{A870}



L_{A871}

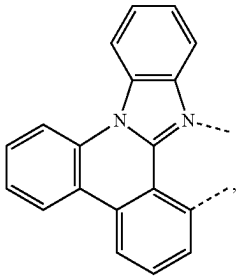


L_{A872}

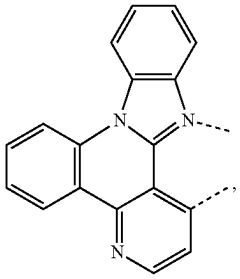


-continued

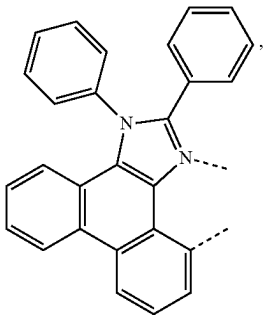
L_{A873}



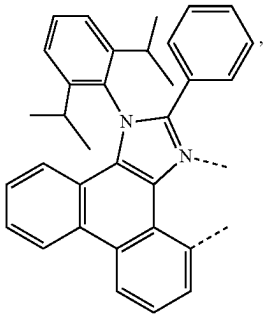
L_{A874}



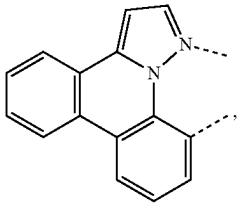
L_{A875}



L_{A876}

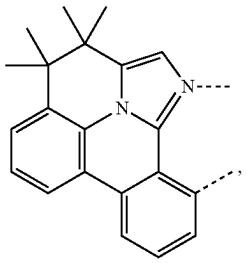


L_{A877}

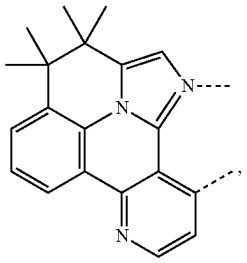


-continued

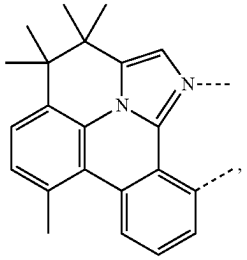
L_{A878}



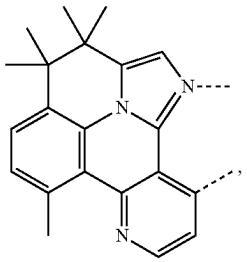
L_{A879}



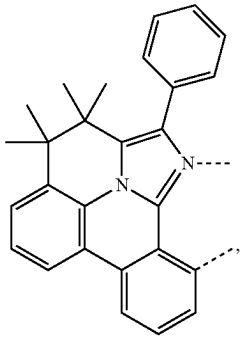
L_{A880}



L_{A881}

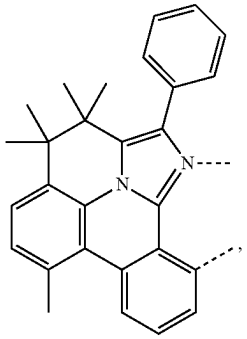


L_{A882}

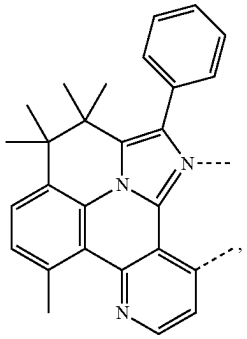


-continued

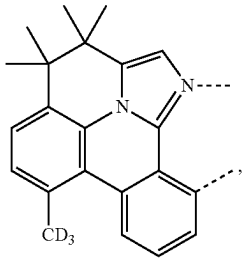
L_{A883}



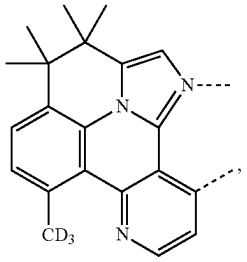
L_{A884}



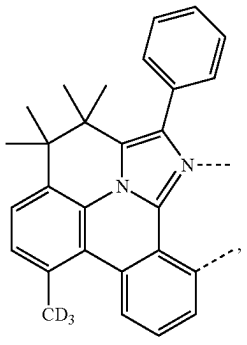
L_{A885}



L_{A886}

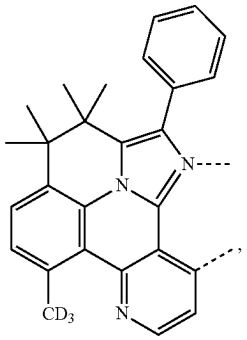


L_{A887}

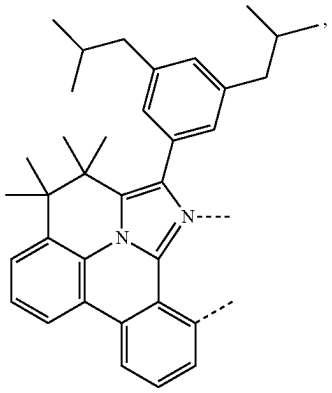


-continued

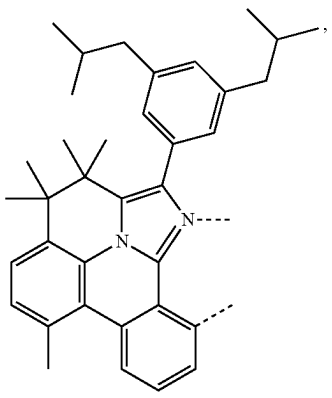
L_{A888}



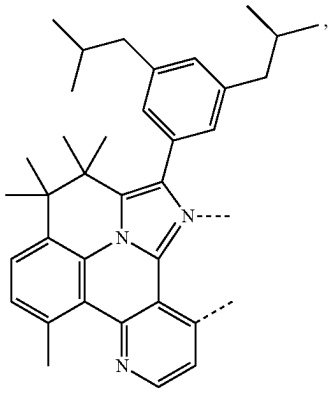
L_{A889}



L_{A890}

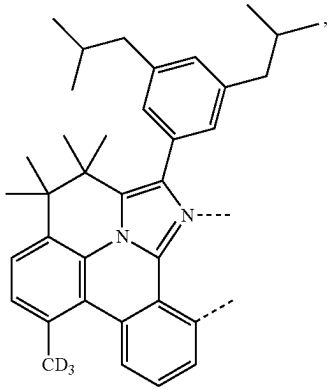


L_{A891}

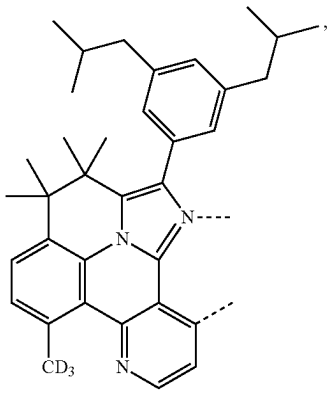


-continued

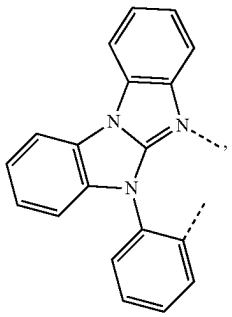
L_{A892}



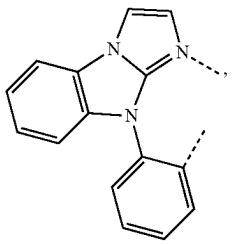
L_{A893}



L_{A894}

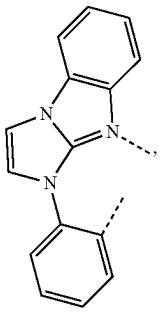


L_{A895}

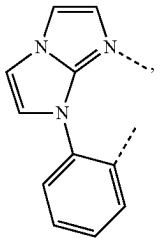


-continued

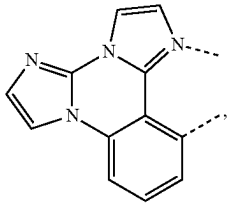
L_{A896}



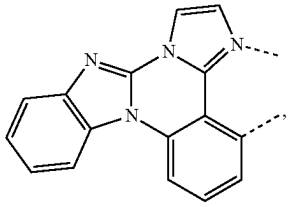
L_{A897}



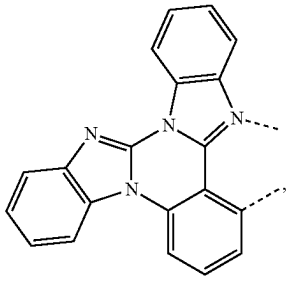
L_{A898}



L_{A899}

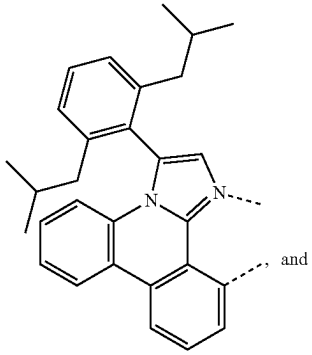


L_{A900}



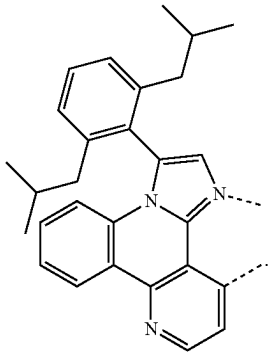
-continued

L_{A901}



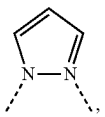
and

L_{A902}

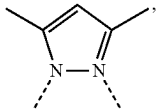


In one embodiment, the ligand component ring A-B and ring C-D, which are the same or different, together with bridge ring E and bridge ring F, which are the same or different, form the dinuclear platinum compounds of Formula I. In this regard, bridge ligands L_{Cj} are independently selected from the group consisting of:

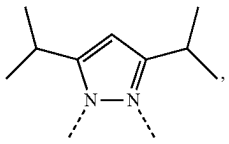
L_{C1}



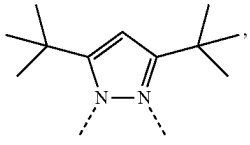
L_{C2}



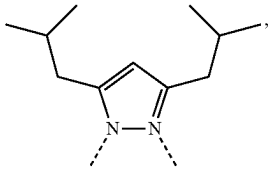
L_{C3}



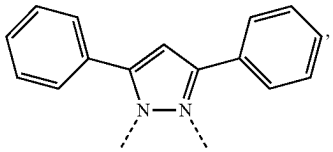
L_{C4}



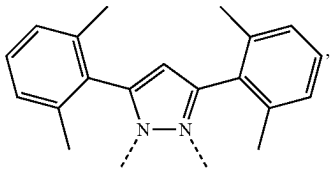
-continued



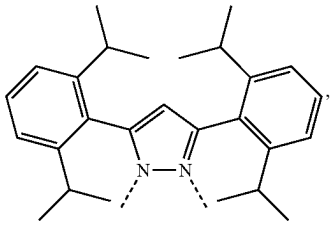
L_{C5}



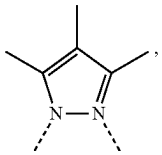
L_{C6}



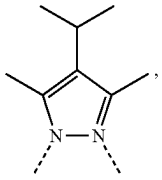
L_{C7}



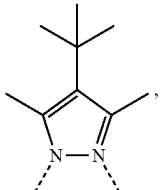
L_{C8}



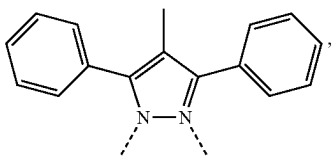
L_{C9}



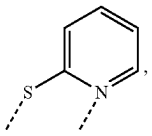
L_{C10}



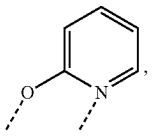
L_{C11}



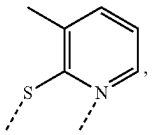
L_{C12}



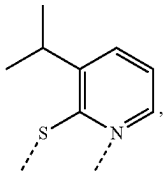
L_{C13}



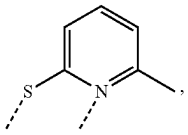
L_{C14}



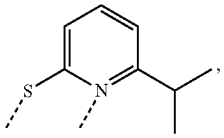
L_{C15}



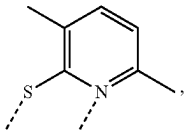
L_{C16}



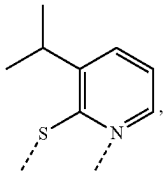
L_{C17}



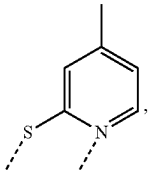
L_{C18}



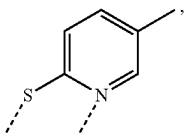
L_{C19}



L_{C20}

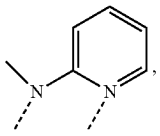


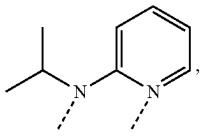
L_{C21}

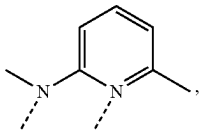


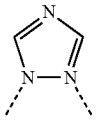
L_{C22}

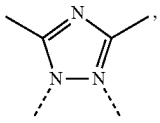
-continued

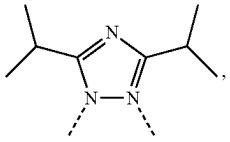


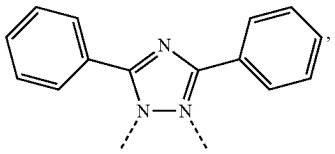


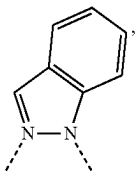


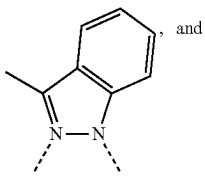


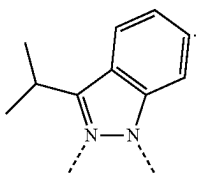








 , and

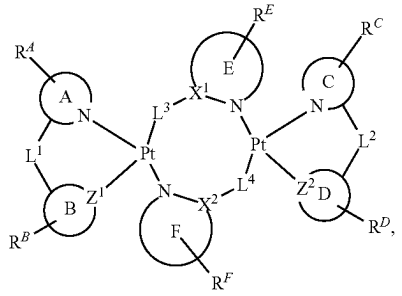


In another embodiment, the combination with two of the same ligand components L_{A1} to L_{A902}, with two of the same ligand bridge components, L_{C1} to L_{C31}, provide a select list of compounds of Formula I, Moreover, any one of these compounds is defined as a specific Compound x defined by the equation below, and has a general formula of $(L_{Ai})Pt(L_{Cj})_2Pt(L_{Ai})$.

Compound x=31i+j−31; i is an integer from 1 to 902, and j is an integer from 1 to 31.

The invention is also directed to an organic light emitting device (OLED) including an anode, a cathode, and an organic layer disposed between the anode and the cathode, the organic layer comprising a compound of Formula I

Formula I



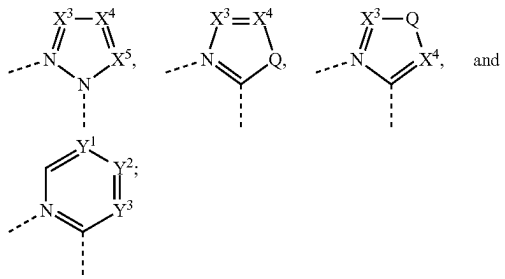
wherein

ring A, ring C, ring E and ring F are independently a 5-membered or 6-membered heterocyclic ring; and ring B and ring D are independently a 5-membered, or 6-membered, cathocyclic or heterocyclic ring;

Z^1 and Z^2 are independently an anionic coordinating atom selected from the group consisting of C and N; and

R^A, R^B, R^C, R^D, R^E, and R^F independently represent no substitution to the maximum allowable number of substituents; and L^1, L^2, L^3, and L^4 are independently selected from the group consisting of a direct bond, CRR', SiRR', NR', O, and S.

Ring A and the ring C are independently selected from the group consisting of



and

wherein

X^1, X^2, X^3, X^4, and X^5 are independently selected from the group consisting of CR^A and N; Q is selected from the group consisting of CRR', SiRR', NR, O, and S; and Y^1, Y^2, and Y^3 are each independently selected from the group consisting of CR^A and N; wherein at least one of Y^1, Y^2, and Y^3 is N; and the dash lines represent N-coordination to Pt, and a connection to L^1 or L^2 of ring B or ring D, respectively, or if L^1 and/or L^2 is a direct bond, then to ring B or ring D, respectively.

In addition, each R^A, R^B, R^C, R^D, R^E, and R^F are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; or optionally, any two adjacent R^A, R^B, R^C, R^D, R^E, and R^F can join to form a ring; and R and R' are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, aryl, heteroaryl, and combinations thereof; or optionally, any two adjacent R and R' can join to form a ring.

In another embodiment, the invention is directed to an organic light emitting device (OLED) including an anode, a cathode, and an organic layer disposed between the anode and the cathode, the organic layer comprising a Compound x as defined above. Again for reference, Compound x is defined below, and has a general formula of $(L_{Ai})Pt(L_{Cj})_2Pt(L_{Ai})$.

Compound x=31i+j−31; i is an integer from 1 to 902, and j is an integer from 1 to 31.

OLEDs prepared with an organic emitting layer that includes one or more compounds of Formula I emit in the yellow-orange or amber range of the visible spectrum. The OLEDs emit in a range from 550 nm to 620 nm. Of general interest are OLEDs that emit in a range from 570 nm to 610 nm.

In some embodiments, the OLED has one or more characteristics selected from the group consisting of being flexible, being rollable, being foldable, being stretchable, and being curved. In some embodiments, the OLED is transparent or semi-transparent. In some embodiments, the OLED further comprises a layer comprising carbon nanotubes.

In some embodiments, the OLED further comprises a layer comprising a delayed fluorescent emitter. In some embodiments, the OLED comprises a RGB pixel arrangement or white plus color filter pixel arrangement. In some embodiments, the OLED is a mobile device, a hand held device, or a wearable device. In some embodiments, the OLED is a display panel having less than 10 inch diagonal or 50 square inch area. In some embodiments, the OLED is a display panel having at least 10 inch diagonal or 50 square inch area. In some embodiments, the OLED is a lighting panel.

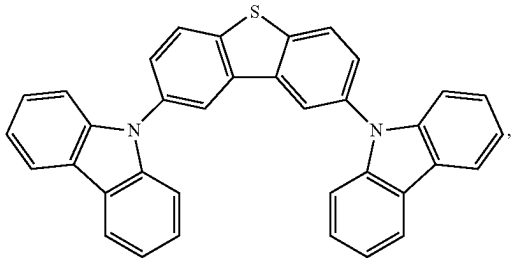
In some embodiments, the compound can be an emissive dopant. In some embodiments, the compound can produce emissions via phosphorescence, fluorescence, thermally activated delayed fluorescence, i.e., TADF (also referred to as E-type delayed fluorescence; see, e.g., U.S. application Ser. No. 15/700,352, which is hereby incorporated by reference in its entirety), triplet-triplet annihilation, or combinations of these processes.

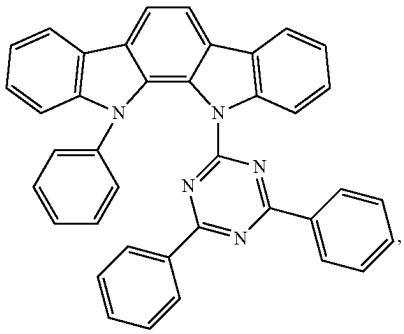
According to another aspect, a formulation comprising the compound described herein is also disclosed.

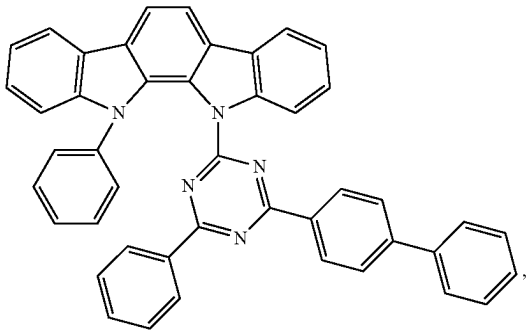
The OLED disclosed herein can be incorporated into one or more of a consumer product, an electronic component module, and a lighting panel. The organic layer can be an emissive layer and the compound can be an emissive dopant in some embodiments, while the compound can be a non-emissive dopant in other embodiments.

The organic layer can also include a host. In some embodiments, two or more hosts are preferred. In some embodiments, the hosts used may be a) bipolar, b) electron transporting, c) hole transporting or d) wide band gap materials that play little role in charge transport. In some embodiments, the host can include a metal complex. The host can be a triphenylene containing benzo-fused thiophene or benzo-fused furan. Any substituent in the host can be an unfused substituent independently selected from the group consisting of C_nH_{2n+1}, OC_nH_{n2+1}, OAr_1, $N(C_nH_{2n+1})_2$, $N(Ar_1)(Ar_2)$, $CH{=}CH{-}C_nH_{2n+1}$, $C{\equiv}C{-}C_nH_{2n+1}$, Ar_1, $Ar_1{-}Ar_2$, and $C_nH_{2n}{-}Ar_1$, or the host has no substitutions. In the preceding substituents n can range from 1 to 10; and Ar_1 and Ar_2 can be independently selected from the group consisting of benzene, biphenyl, naphthalene, triphenylene, carbazole, and heteroaromatic analogs thereof. The host can be an inorganic compound. For example a Zn containing inorganic material e.g. ZnS.

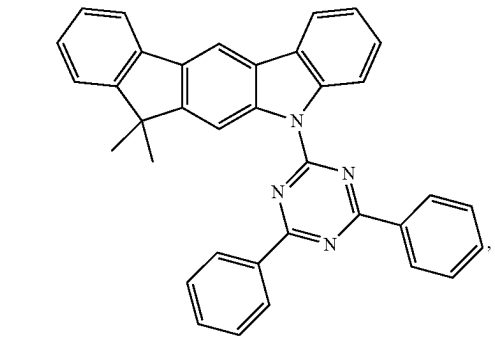
The host can be a compound comprising at least one chemical group selected from the group consisting of triphenylene, carbazole, dibenzothiophene, dibenzofuran, dibenzoselenophene, azatriphenylene, azacarbazole, aza-dibenzothiophene, aza-dibenzofuran, and aza-dibenzoselenophene. The host can include a metal complex. The host can be, but is not limited to, a specific compound selected from the group consisting of:

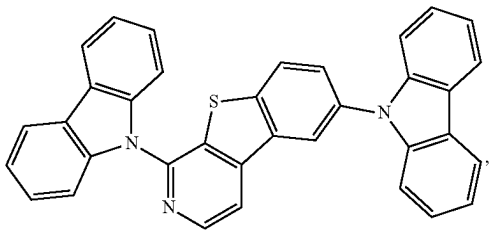


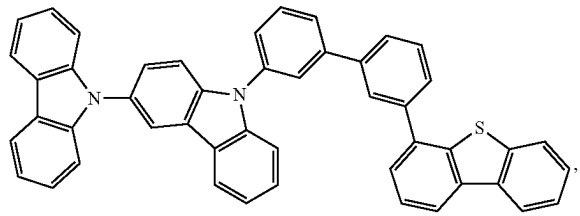


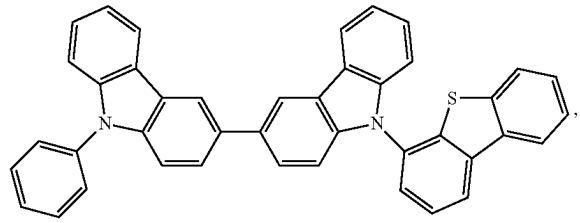


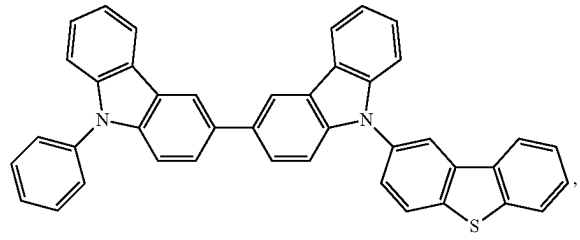
-continued

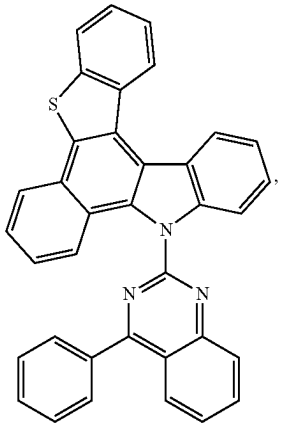




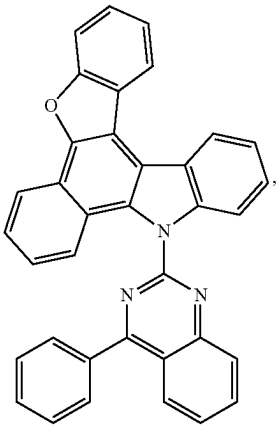


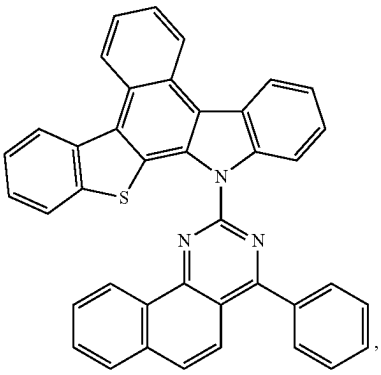


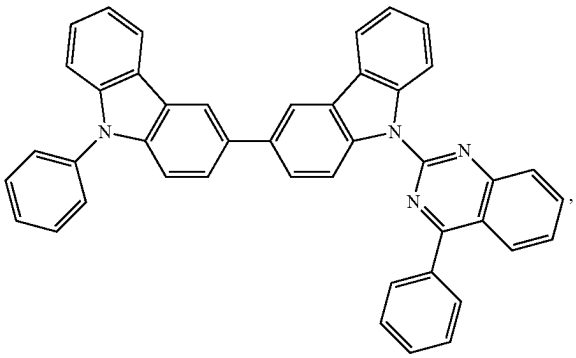


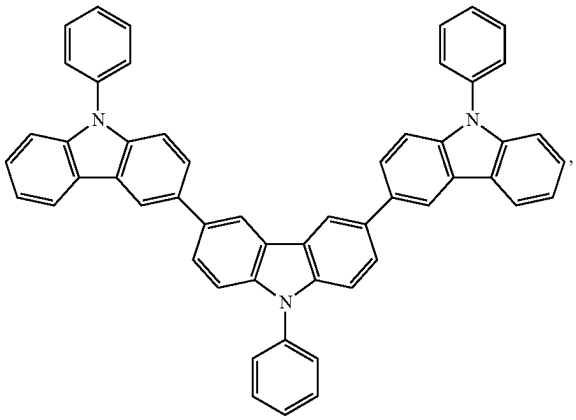


-continued

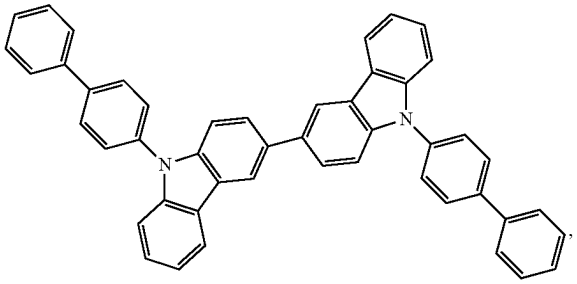


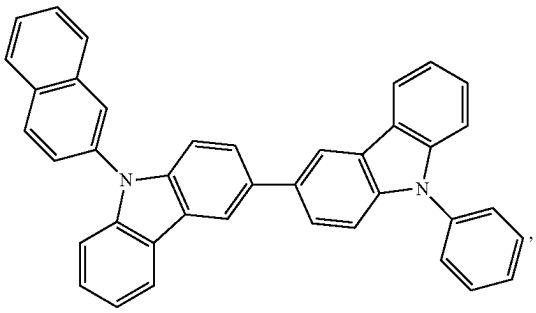


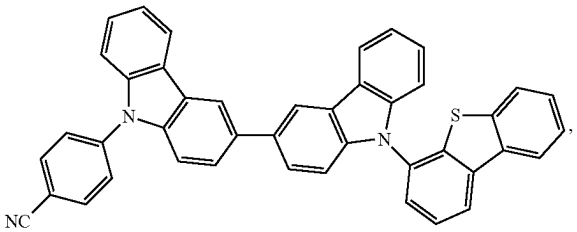


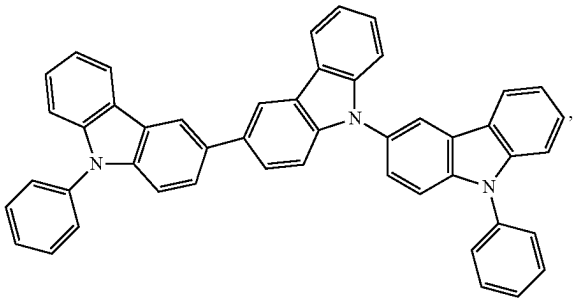


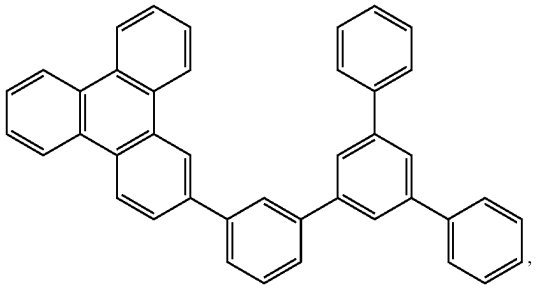
-continued

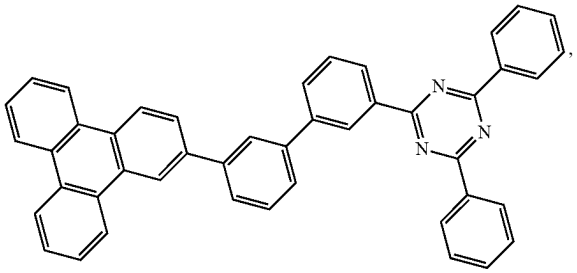




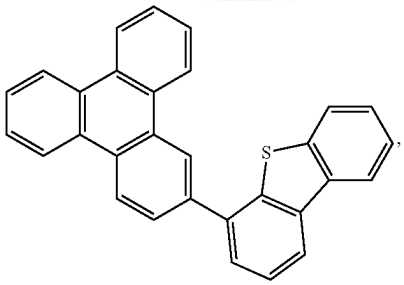


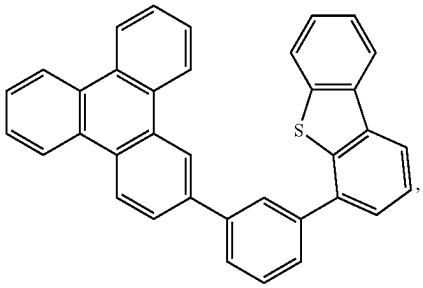


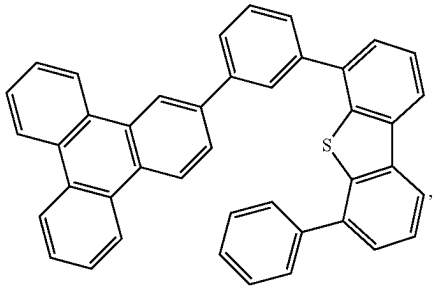


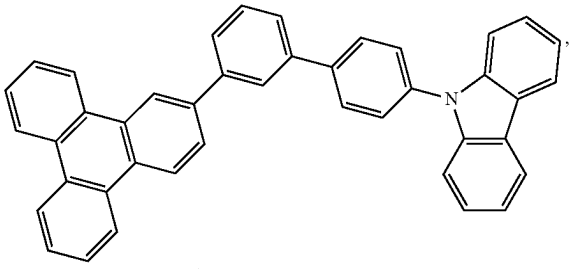


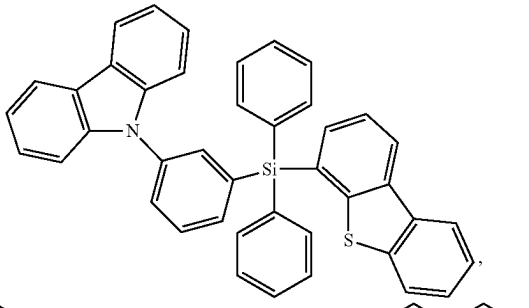
-continued

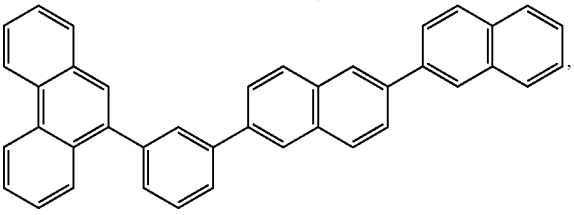












and combinations thereof.

Additional information on possible hosts is provided below.

In yet another aspect of the present disclosure, a formulation that comprises the novel compound disclosed herein is described. The formulation can include one or more components selected from the group consisting of a solvent, a host, a hole injection material, hole transport material, electron blocking material, hole blocking material, and an electron transport material, disclosed herein.

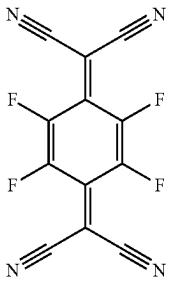
Combination with Other Materials

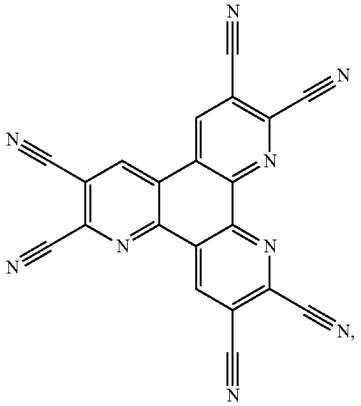
The materials described herein as useful for a particular layer in an organic light emitting device may be used in combination with a wide variety of other materials present in the device. For example, emissive dopants disclosed herein may be used in conjunction with a wide variety of hosts, transport layers, blocking layers, injection layers, electrodes and other layers that may be present. The materials described or referred to below are non-limiting examples of materials that may be useful in combination with the compounds disclosed herein, and one of skill in the art can readily consult the literature to identify other materials that may be useful in combination.

Conductivity Dopants:

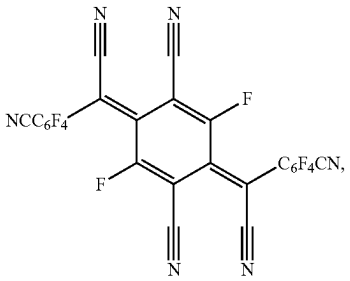
A charge transport layer can be doped with conductivity dopants to substantially alter its density of charge carriers, which will in turn alter its conductivity. The conductivity is increased by generating charge carriers in the matrix material, and depending on the type of dopant, a change in the Fermi level of the semiconductor may also be achieved. Hole-transporting layer can be doped by p-type conductivity dopants and n-type conductivity dopants are used in the electron-transporting layer.

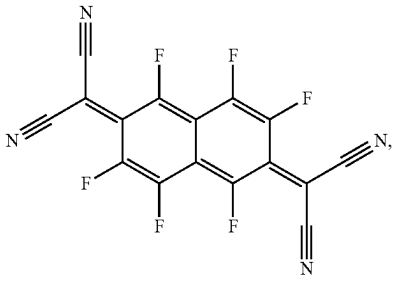
Non-limiting examples of the conductivity dopants that may be used in an OLED in combination with materials disclosed herein are exemplified below together with references that disclose those materials: EP01617493, EP01968131, EP2020694, EP2684932, US20050139810, US20070160905, US20090167167, US2010288362, WO06081780, WO2009003455, WO2009008277, WO2009011327, WO2014009310, US2007252140, US2015060804, US20150123047, and US2012146012.

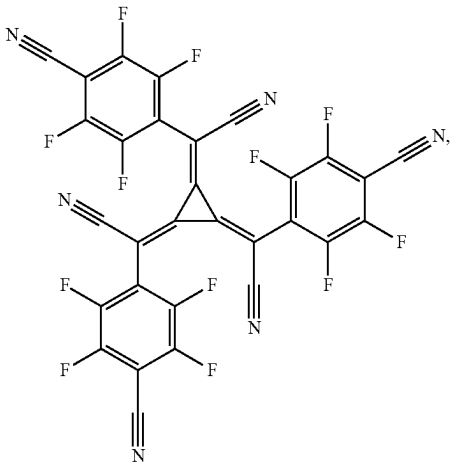


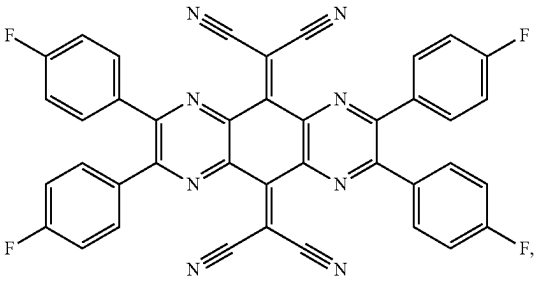


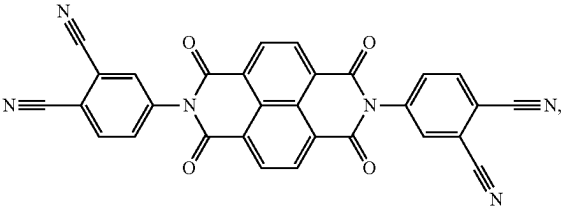
-continued



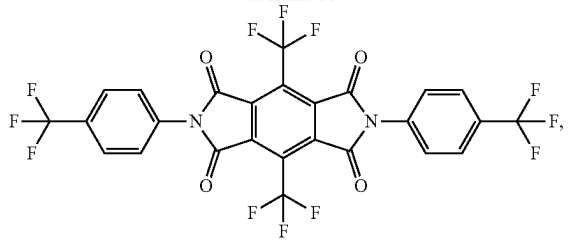


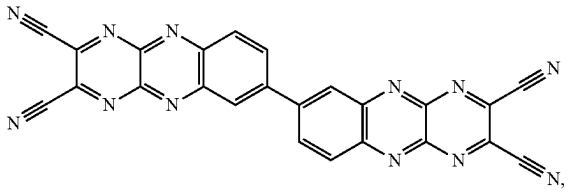


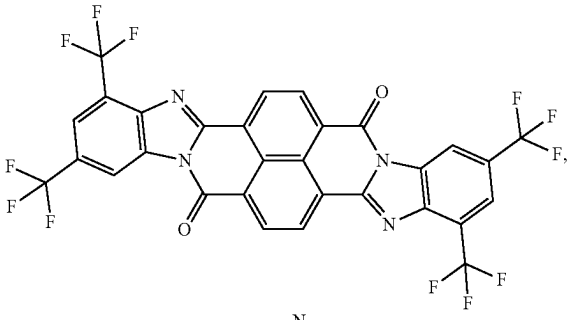


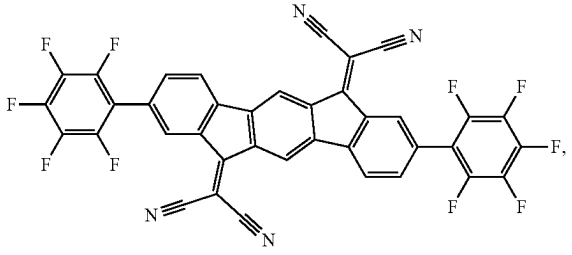


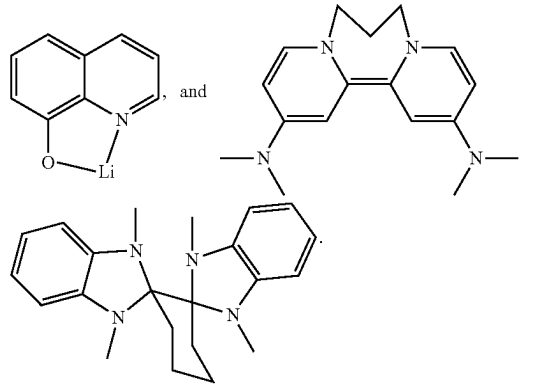
-continued







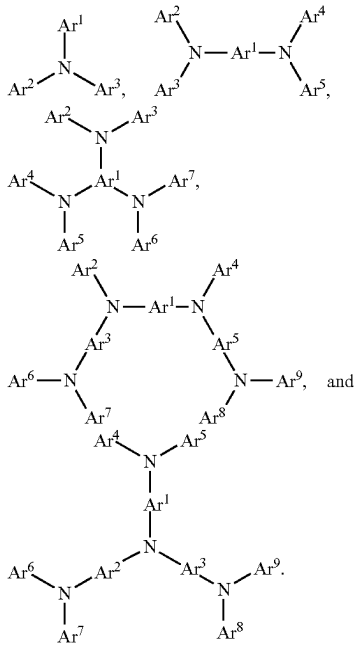




HIL/HTL:

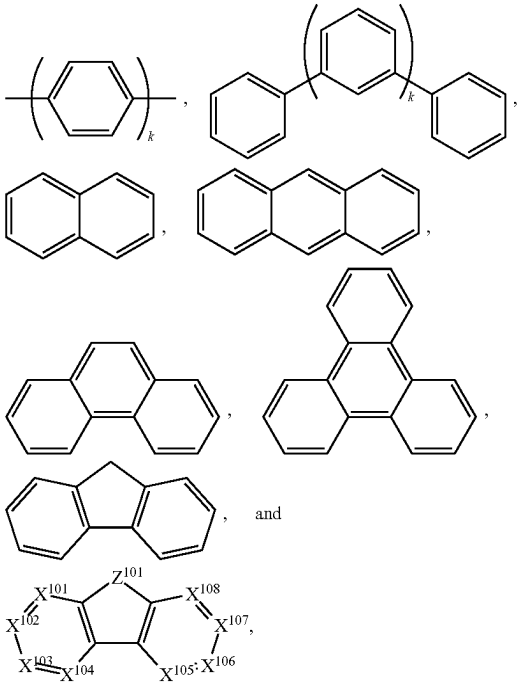
A hole injecting/transporting material to be used in the present invention is not particularly limited, and any compound may be used as long as the compound is typically used as a hole injecting/transporting material. Examples of the material include, but are not limited to: a phthalocyanine or porphyrin derivative; an aromatic amine derivative; an indolocarbazole derivative; a polymer containing fluorohydrocarbon; a polymer with conductivity dopants; a conducting polymer, such as PEDOT/PSS; a self-assembly monomer derived from compounds such as phosphoric acid and silane derivatives; a metal oxide derivative, such as MoO_x; a p-type semiconducting organic compound, such as 1,4,5,8,9,12-Hexaazatriphenylenehexacarbonitrile; a metal complex, and a cross-linkable compounds.

Examples of aromatic amine derivatives used in HIL or HTL include, but not limit to the following general structures:



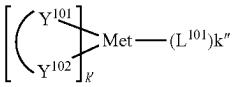
Each of Ar^1 to Ar^9 is selected from the group consisting of aromatic hydrocarbon cyclic compounds such as benzene, biphenyl, triphenyl, triphenylene, naphthalene, anthracene, phenalene, phenanthrene, fluorene, pyrene, chrysene, perylene, and azulene; the group consisting of aromatic heterocyclic compounds such as dibenzothiophene, dibenzofuran, dibenzoselenophene, furan, thiophene, benzofuran, benzothiophene, benzoselenophene, carbazole, indolocarbazole, pyridylindole, pyrrolodipyridine, pyrazole, imidazole, triazole, oxazole, thiazole, oxadiazole, oxatriazole, dioxazole, thiadiazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine, oxazine, oxathiazine, oxadiazine, indole, benzimidazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinnoline, quinazoline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuropyridine, furodipyridine, benzothienopyridine, thienodipyridine, benzoselenophenopyridine, and selenophenodipyridine; and the group consisting of 2 to 10 cyclic structural units which are groups of the same type or different types selected from the aromatic hydrocarbon cyclic group and the aromatic heterocyclic group and are bonded to each other directly or via at least one of oxygen atom, nitrogen atom, sulfur atom, silicon atom, phosphorus atom, boron atom, chain structural unit and the aliphatic cyclic group. Each Ar may be unsubstituted or may be substituted by a substituent selected from the group consisting of deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, heterocycloalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carboxylic acids, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

In one aspect, Ar^1 to Ar^9 is independently selected from the group consisting of:



wherein k is an integer from 1 to 20;) X^{101} to X^{108} is C (including CH) or N; Z^{101} is NAr^1, O, or S; Ar^1 has the same group defined above.

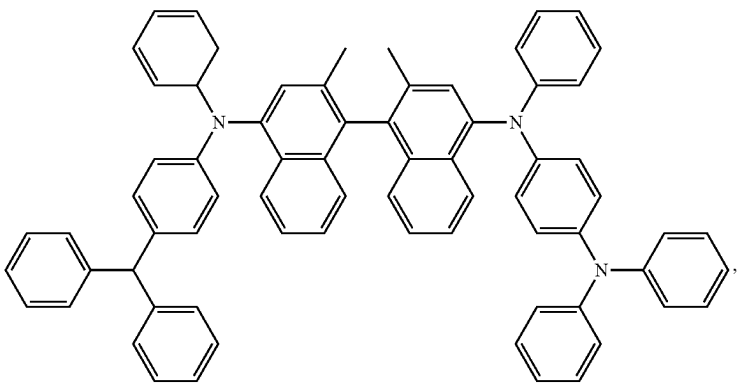
Examples of metal complexes used in HIL or HTL include, but are not limited to the following general formula:



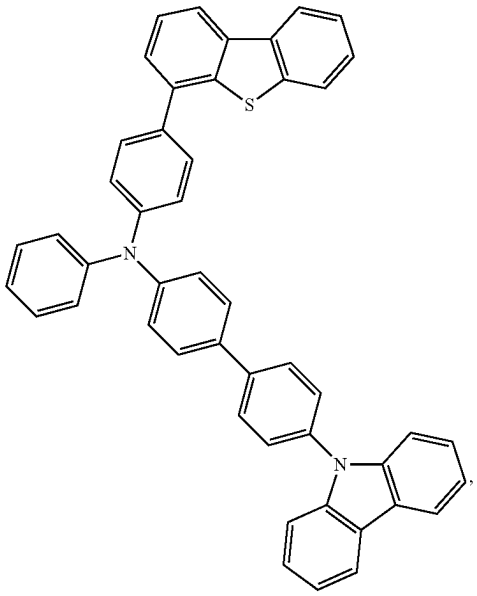
wherein Met is a metal, which can have an atomic weight greater than 40; (Y^{101}-Y^{102}) is a bidentate ligand, Y^{101} and Y^{102} are independently selected from C, N, O, P, and S; L^{101} is an ancillary ligand; k' is an integer value from 1 to the maximum number of ligands that may be attached to the metal; and k'+k" is the maximum number of ligands that may be attached to the metal.

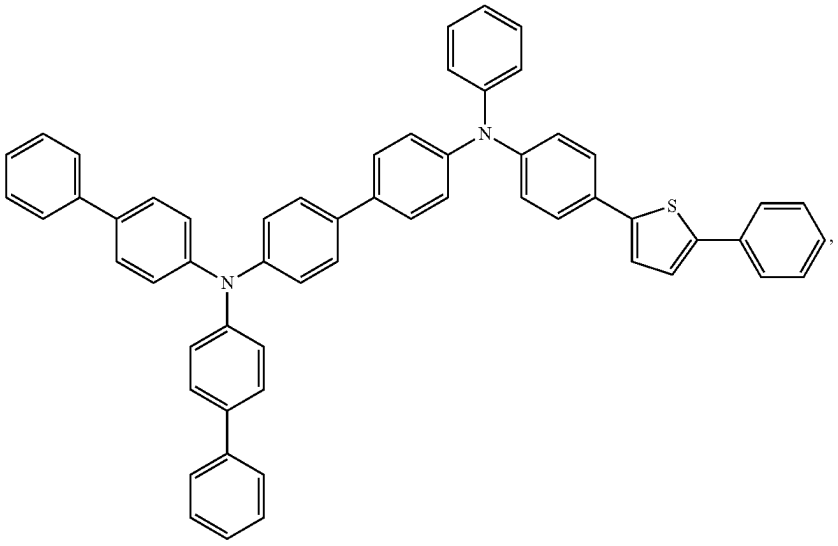
In one aspect, (Y^{101}-Y^{102}) is a 2-phenylpyridine derivative. In another aspect, (Y^{101}-Y^{102}) is a carbene ligand. In another aspect, Met is selected from Ir, Pt, Os, and Zn. In a further aspect, the metal complex has a smallest oxidation potential in solution vs. Fc^+/Fc couple less than about 0.6 V.

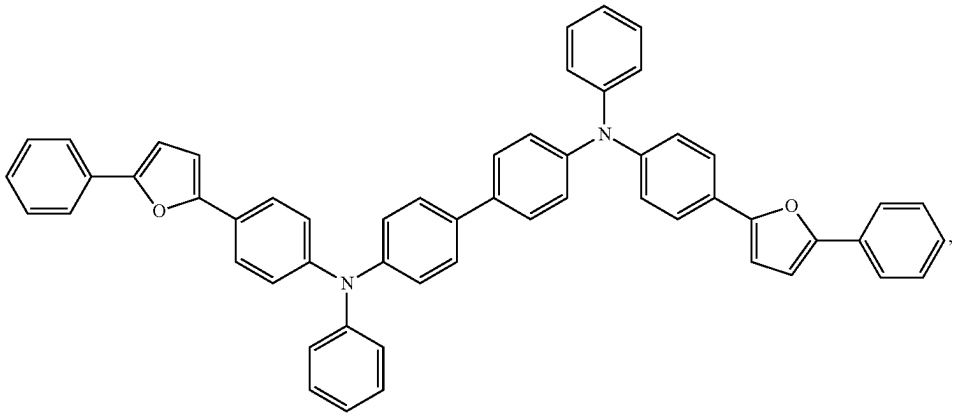
Non-limiting examples of the HIL and HTL materials that may be used in an OLED in combination with materials disclosed herein are exemplified below together with references that disclose those materials: CN102702075, DE102012005215, EP01624500, EP01698613, EP01806334, EP01930964, EP01972613, EP01997799, EP02011790, EP02055700, EP02055701, EP1725079, EP2085382, EP2660300, EP650955, JP07-073529, JP2005112765, JP2007091719, JP2008021687, JP2014-009196, KR20110088898, KR20130077473, TW201139402, U.S. Ser. No. 06/517,957, US20020158242, US20030162053, US20050123751, US20060182993, US20060240279, US20070145888, US20070181874, US20070278938, US20080014464, US20080091025, US20080106190, US20080124572, US20080145707, US20080220265, US20080233434, US20080303417, US2008107919, US20090115320, US20090167161, US2009066235, US2011007385, US20110163302, US2011240968, US2011278551, US2012205642, US2013241401, US20140117329, US2014183517, U.S. Pat. Nos. 5,061,569, 5,639,914, WO05075451, WO07125714, WO08023550, WO08023759, WO2009145016, WO2010061824, WO2011075644, WO2012177006, WO2013018530, WO2013039073, WO2013087142, WO2013118812, WO2013120577, WO2013157367, WO2013175747, WO2014002873, WO2014015935, WO2014015937, WO2014030872, WO2014030921, WO2014034791, WO2014104514, WO2014157018.



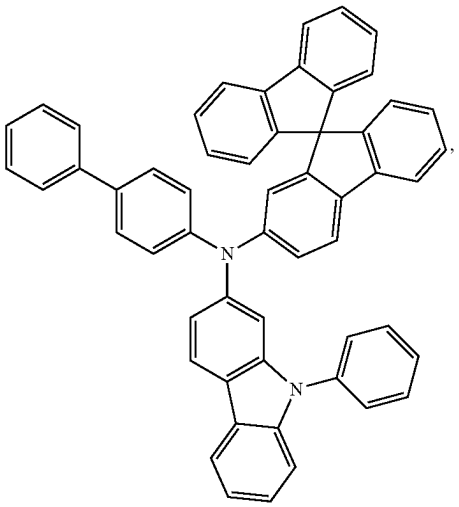
-continued

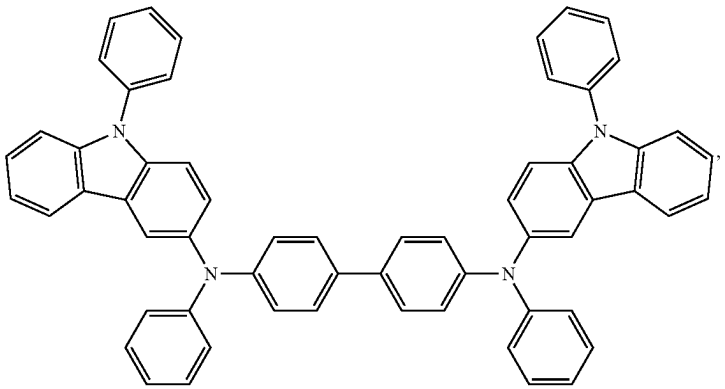


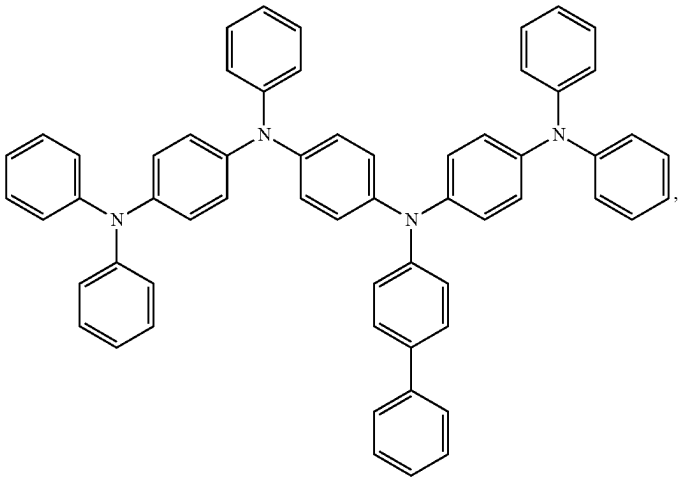




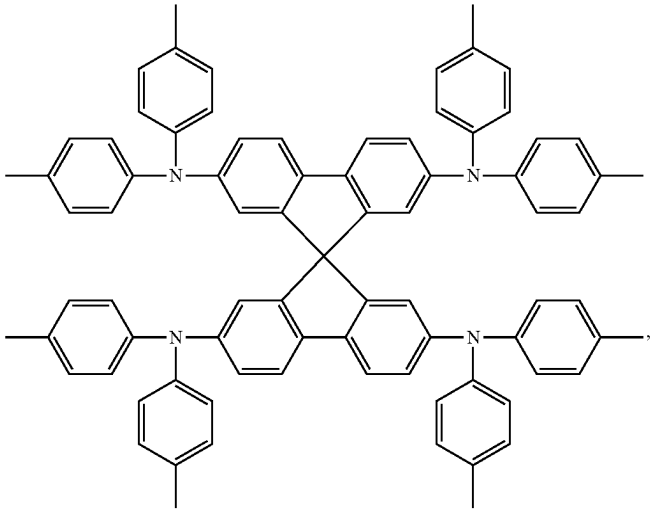
-continued

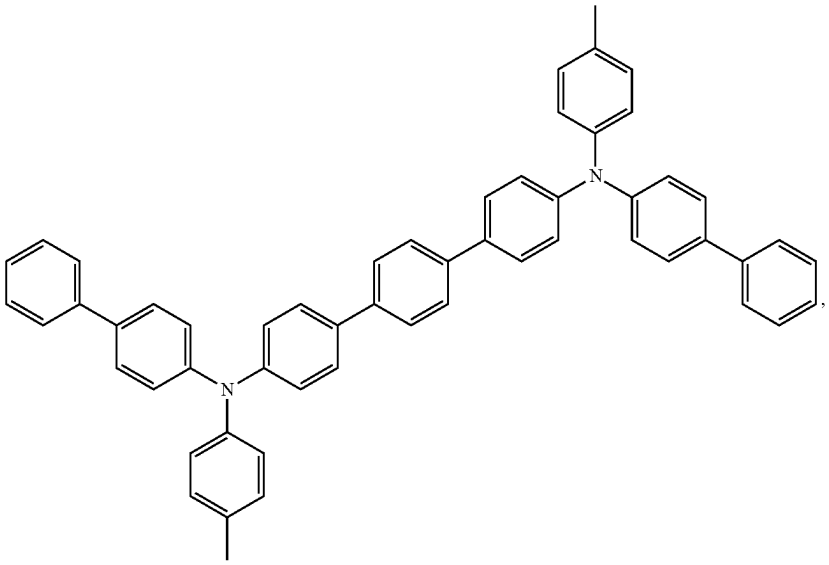


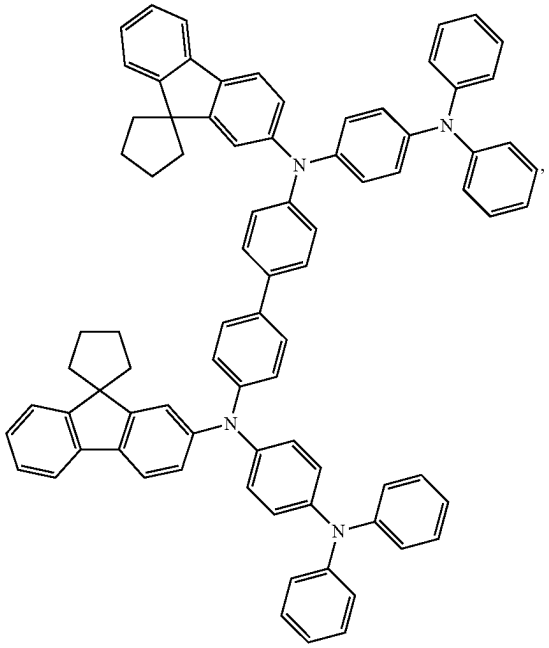




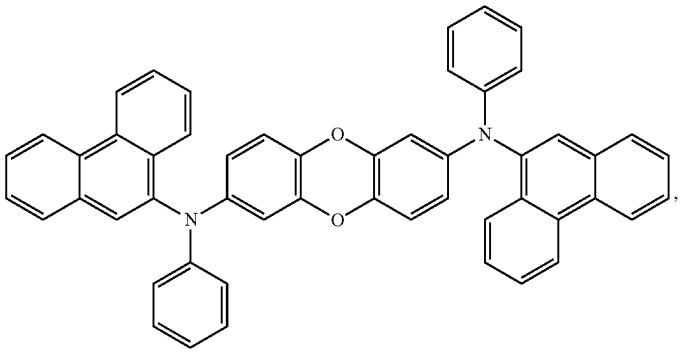
-continued

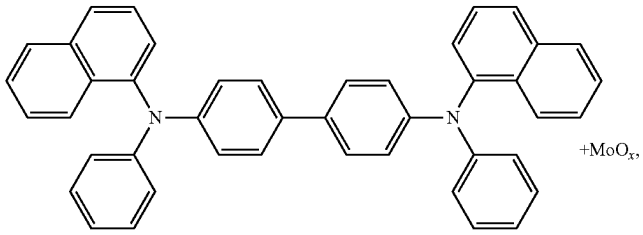


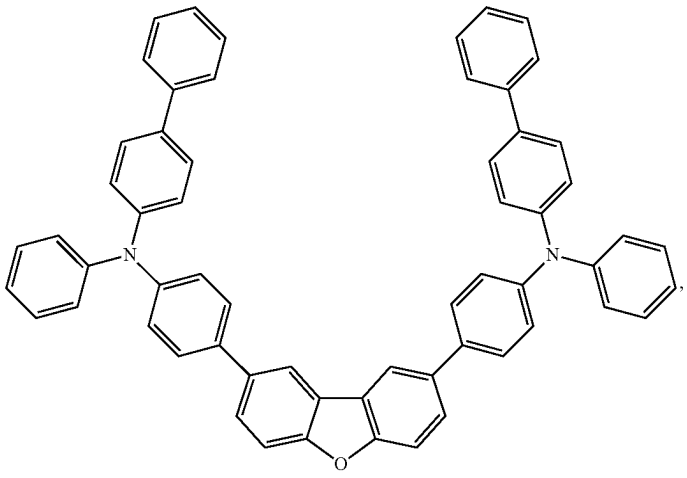


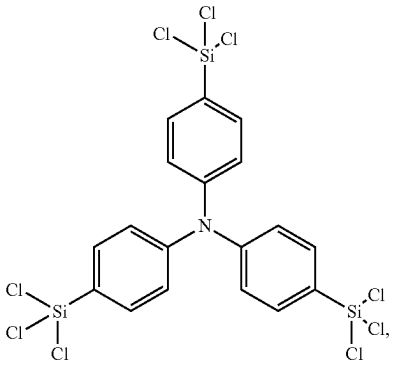


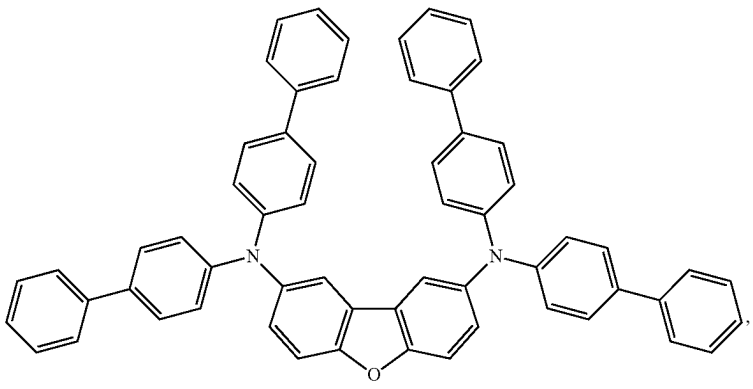
-continued

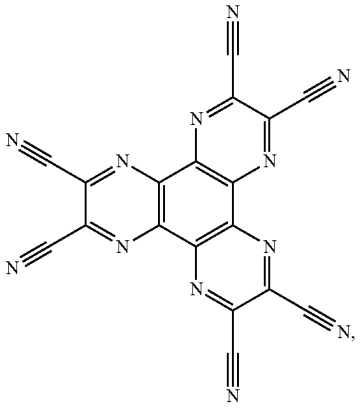




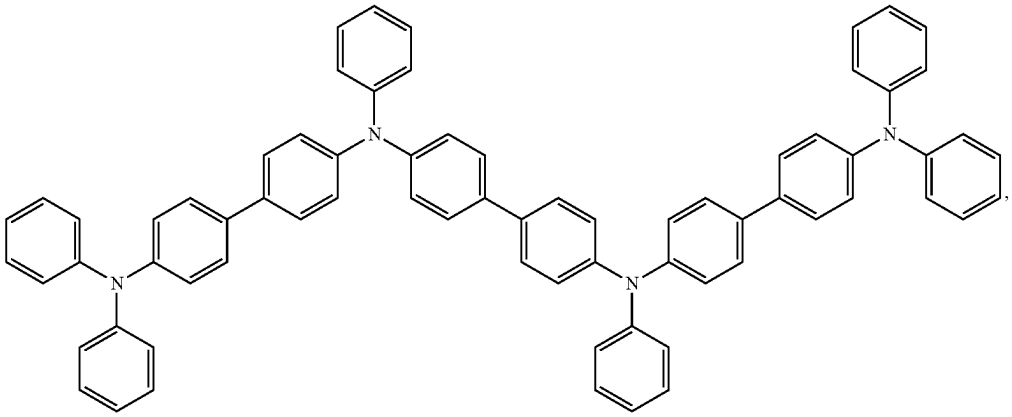


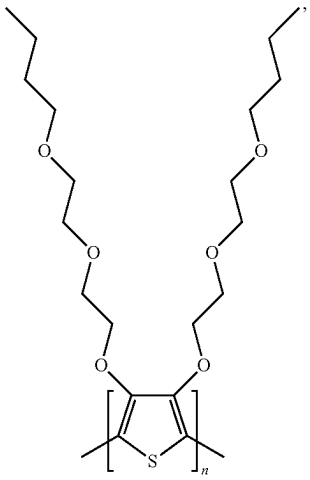


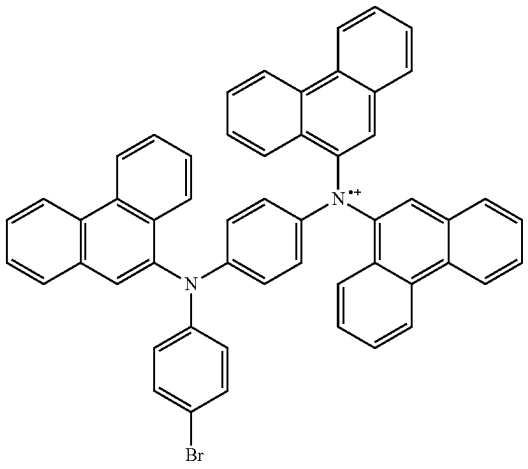


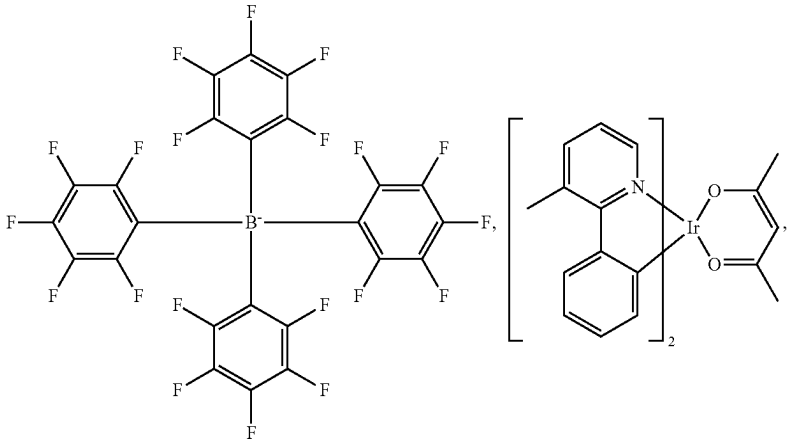


-continued

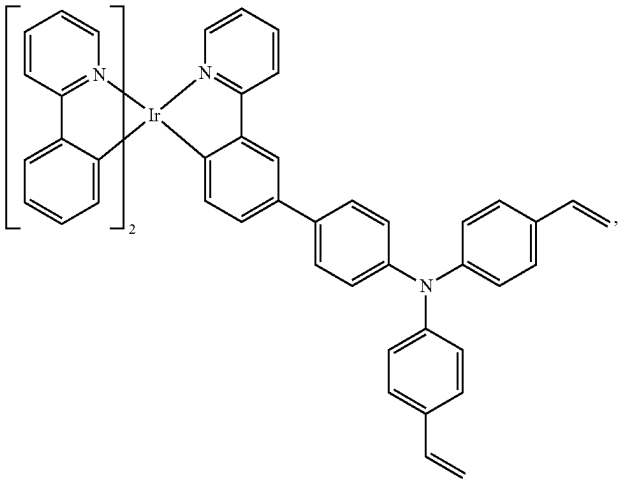


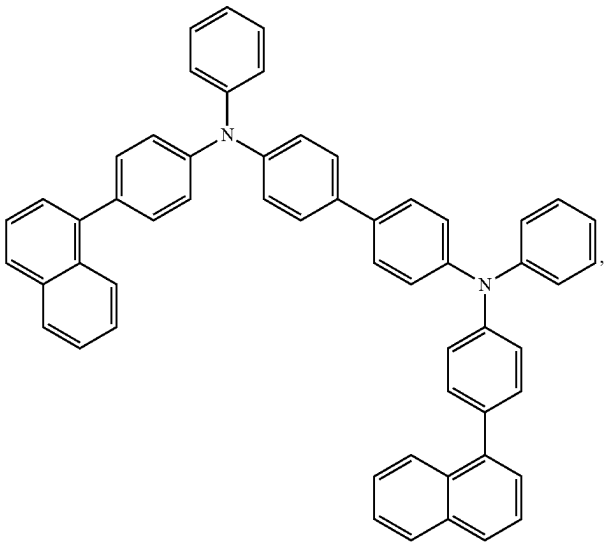


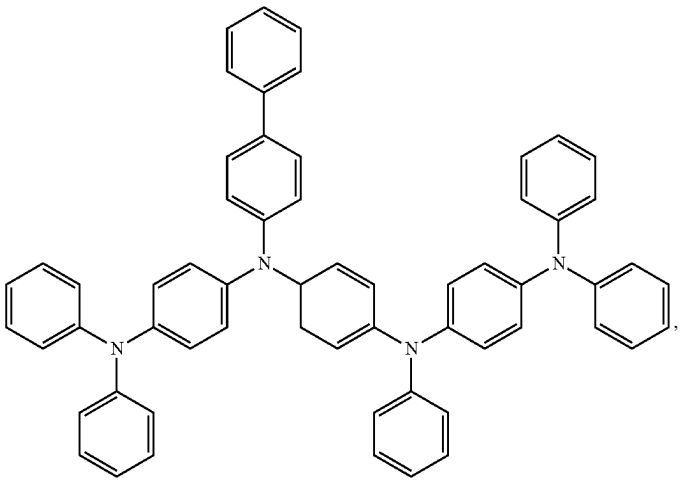




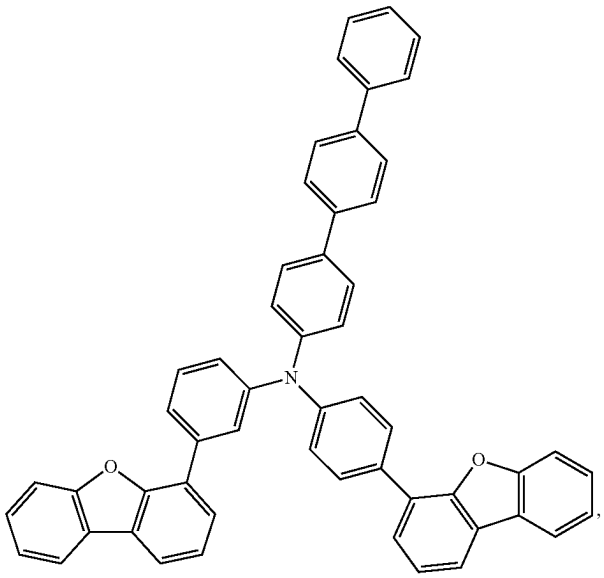
-continued

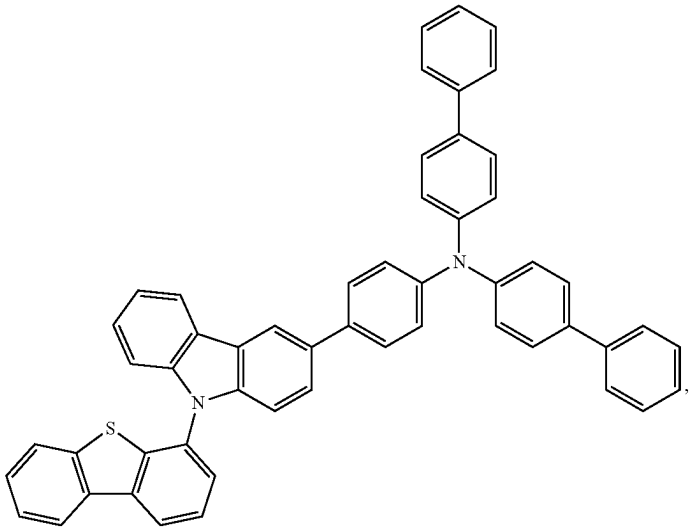


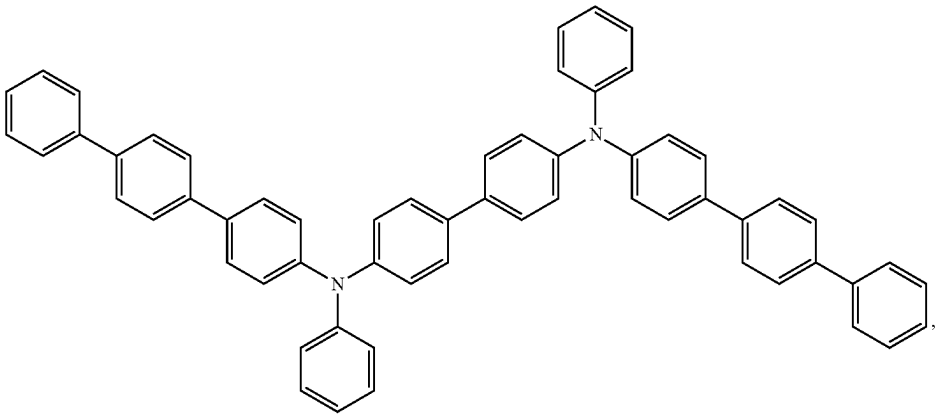




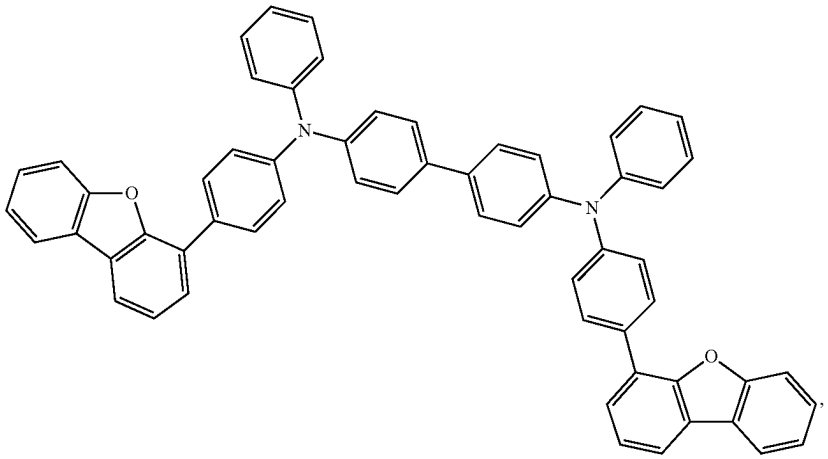
-continued

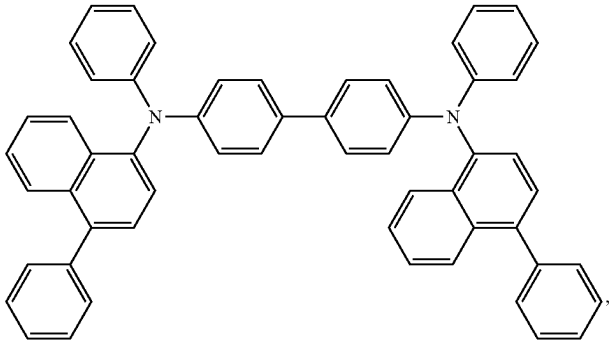


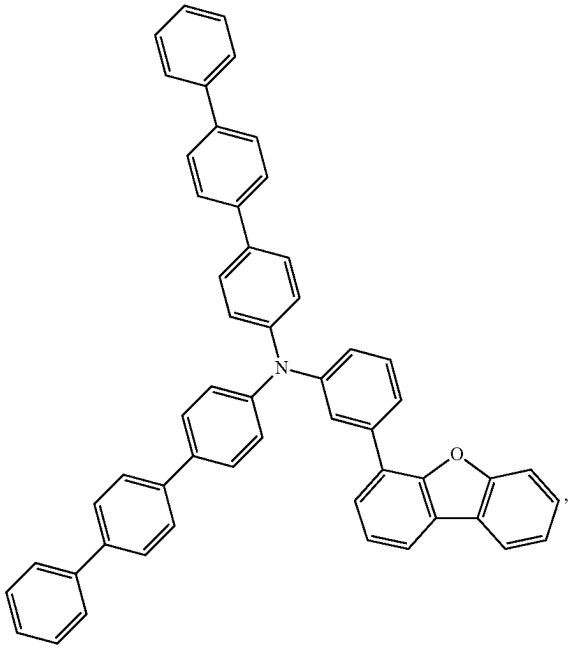


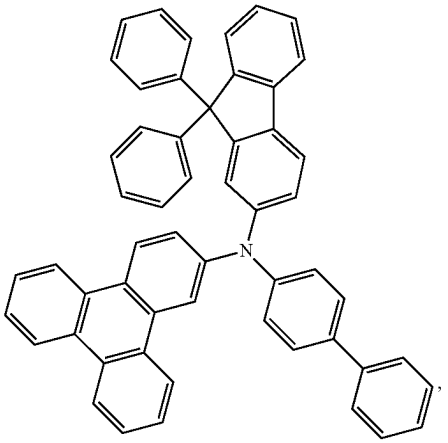


-continued

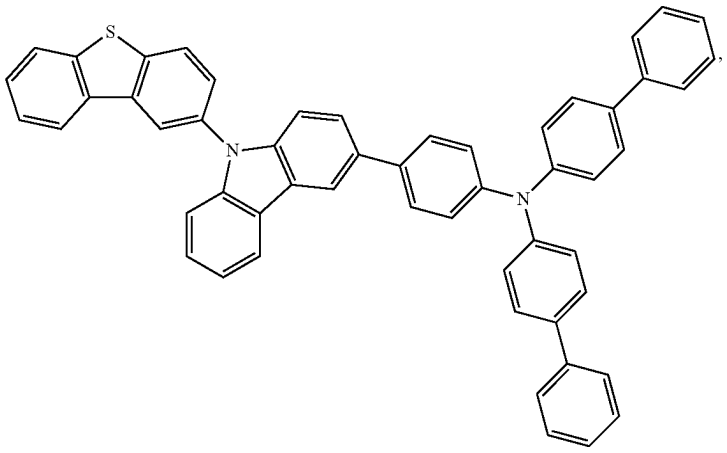


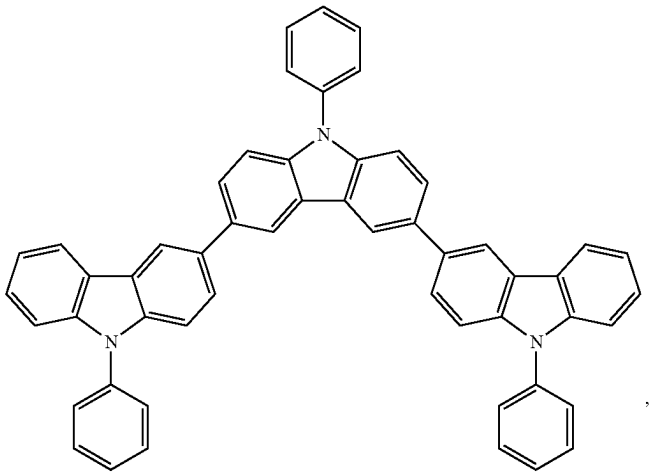


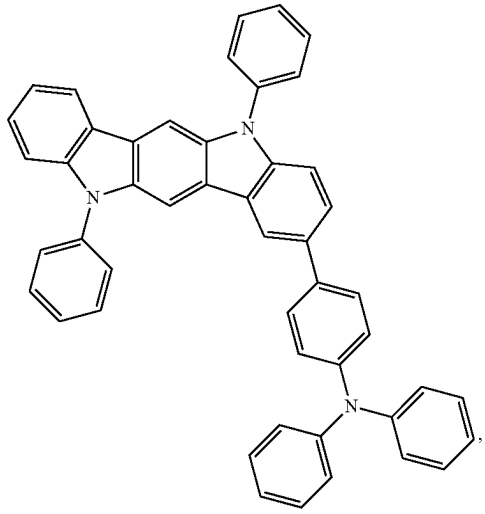


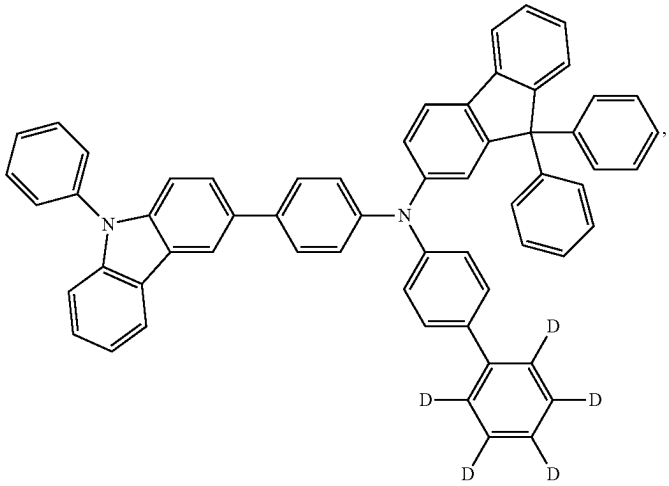


-continued

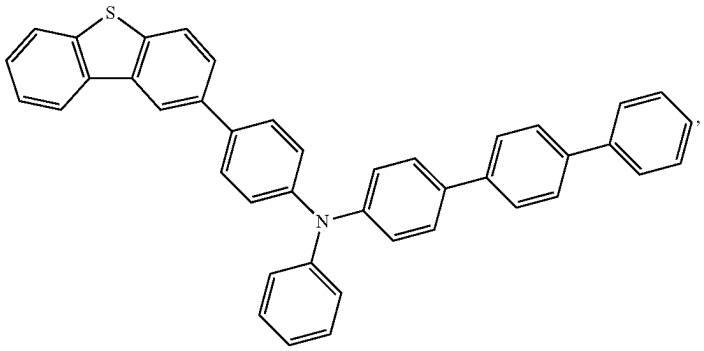


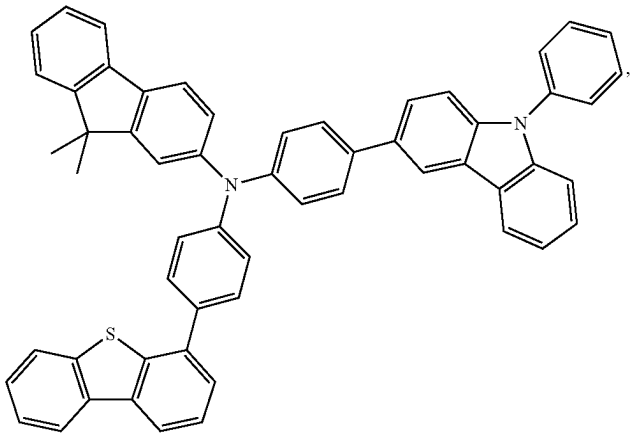


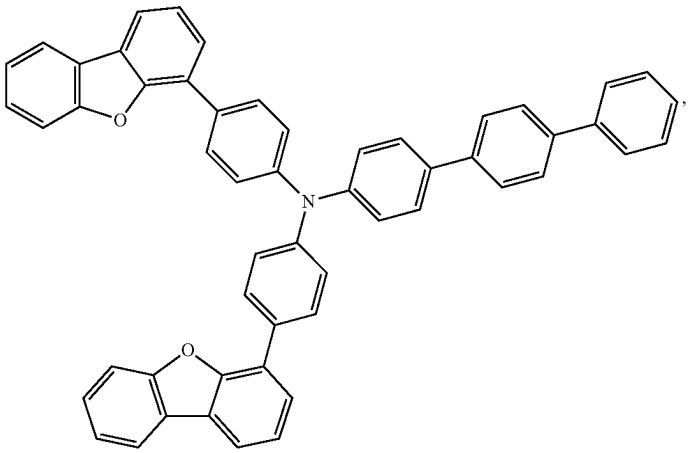




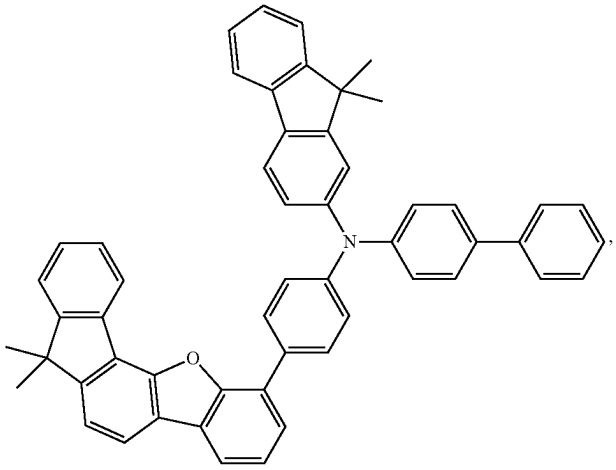
-continued

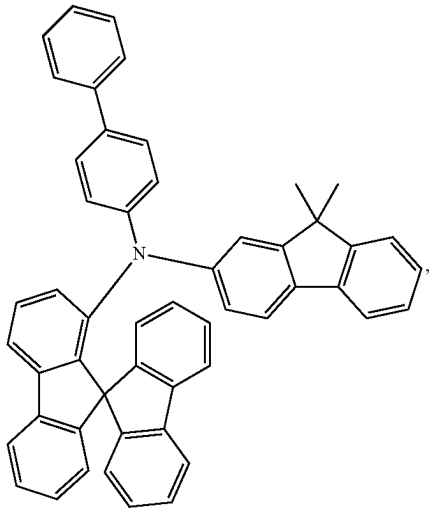


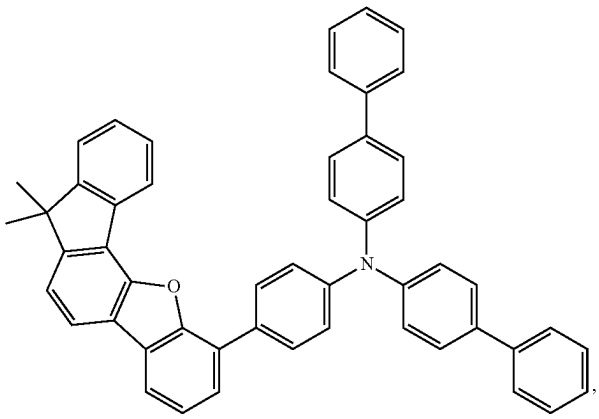


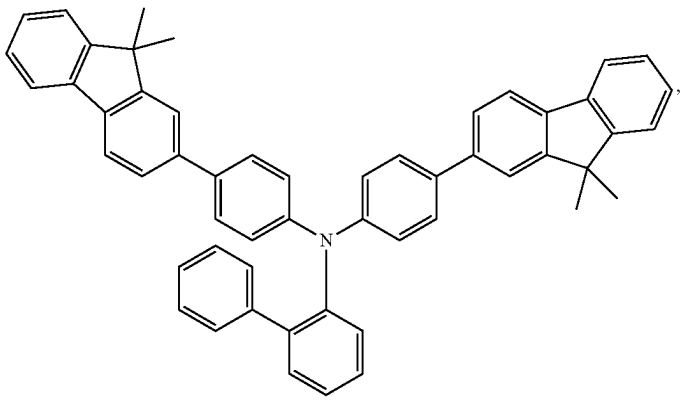


-continued

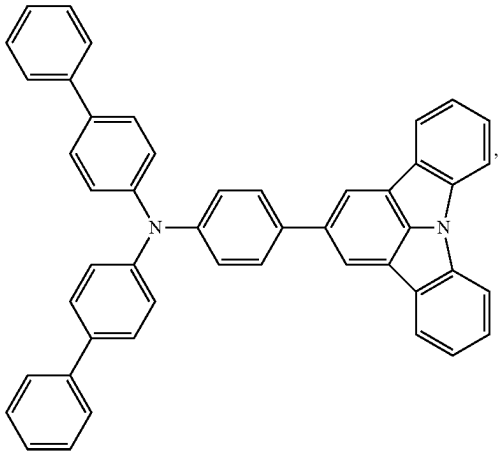


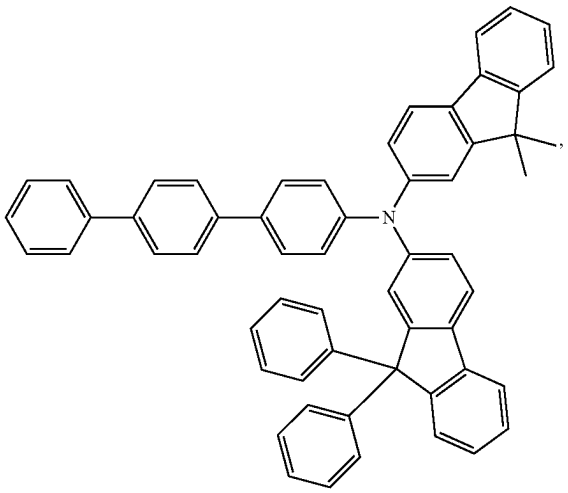


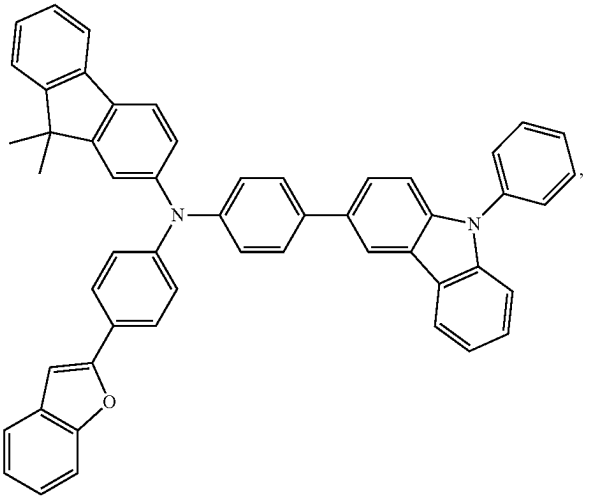


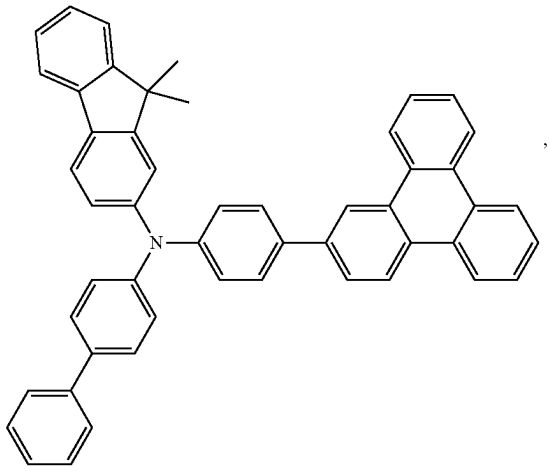


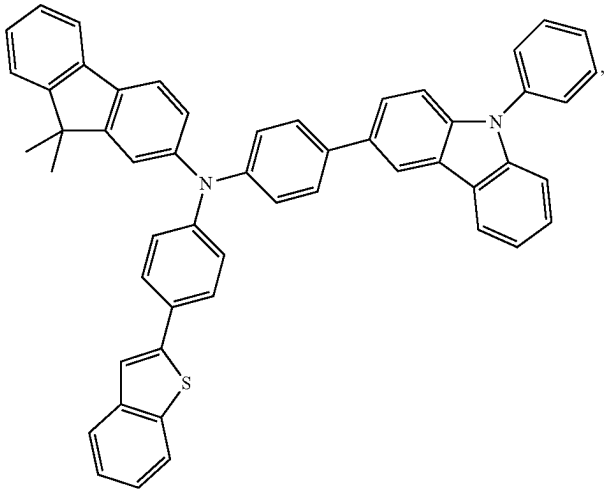
-continued



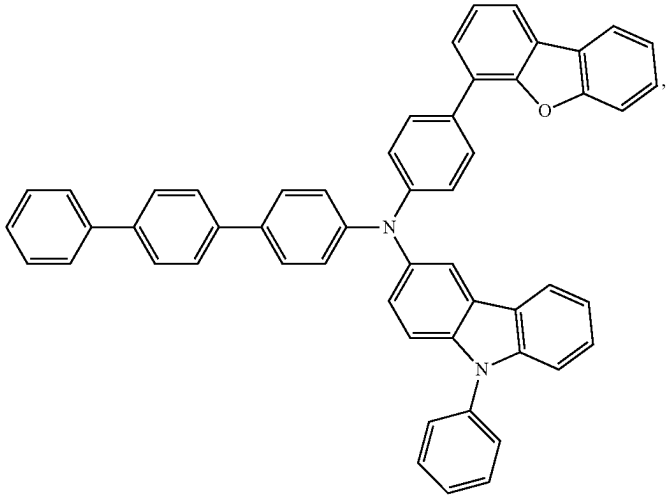


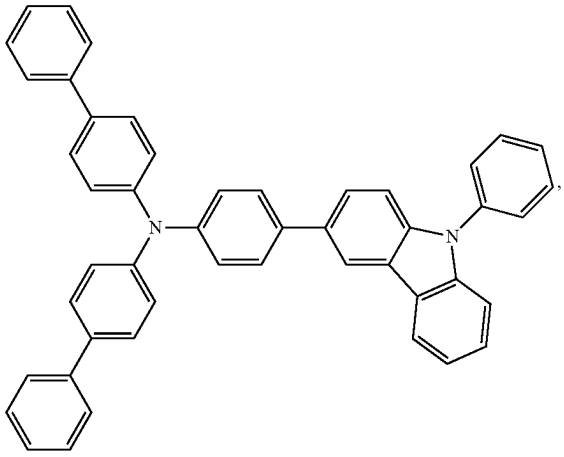


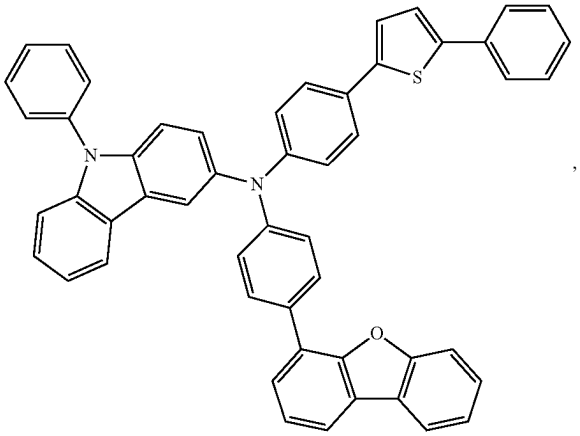


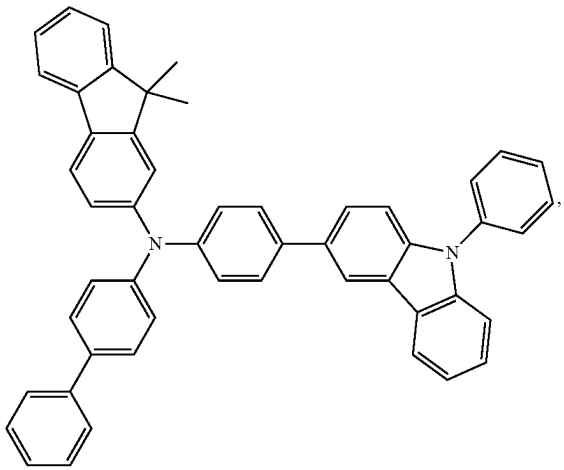


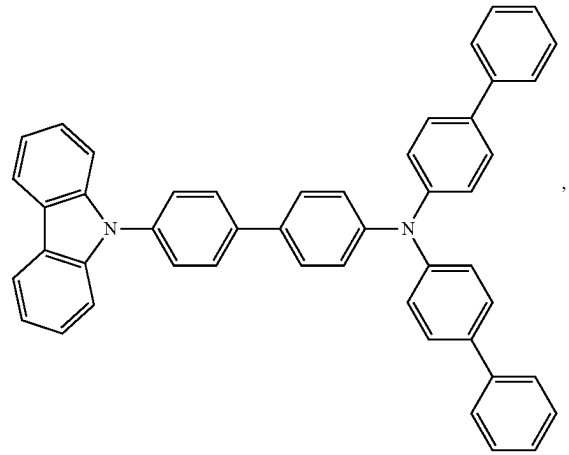
-continued



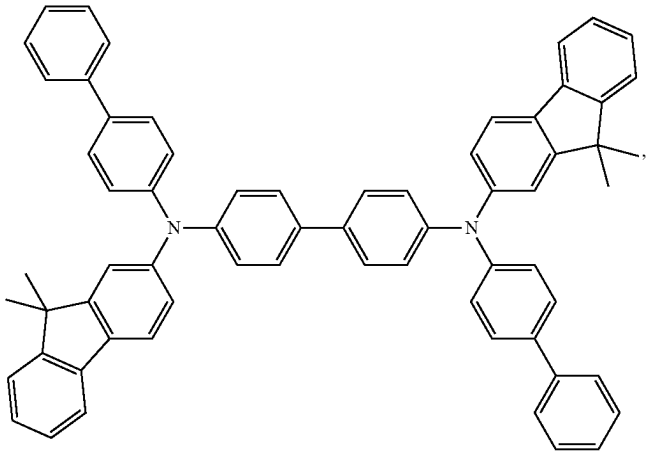


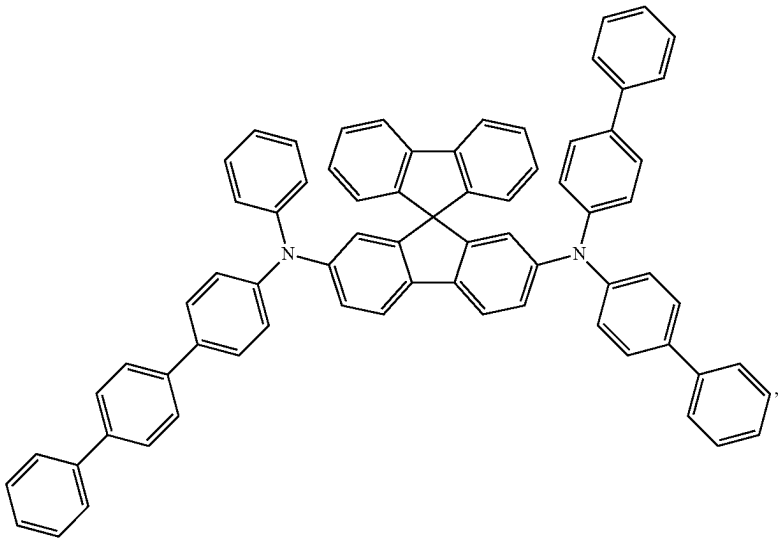


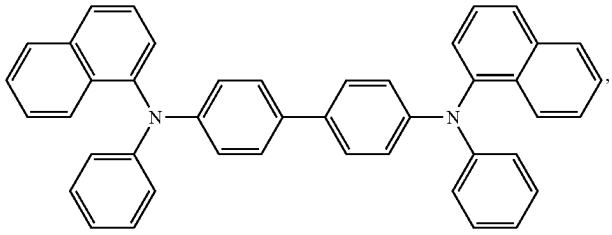


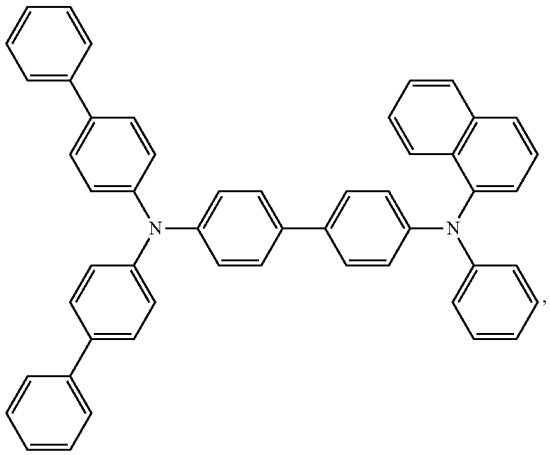


-continued

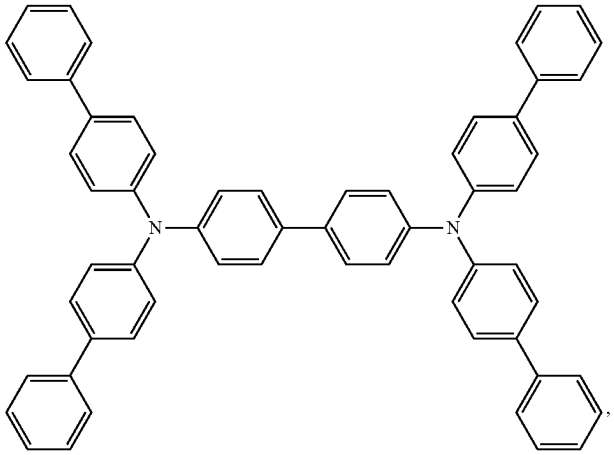


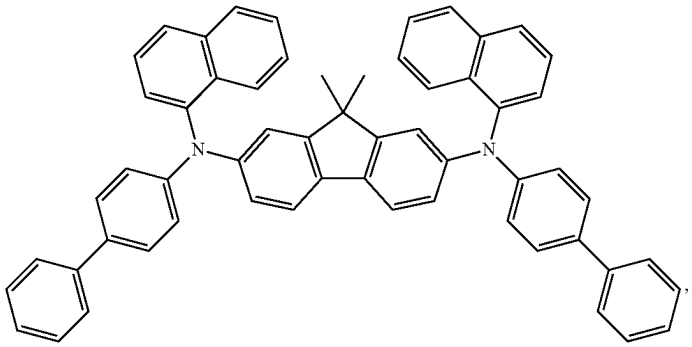


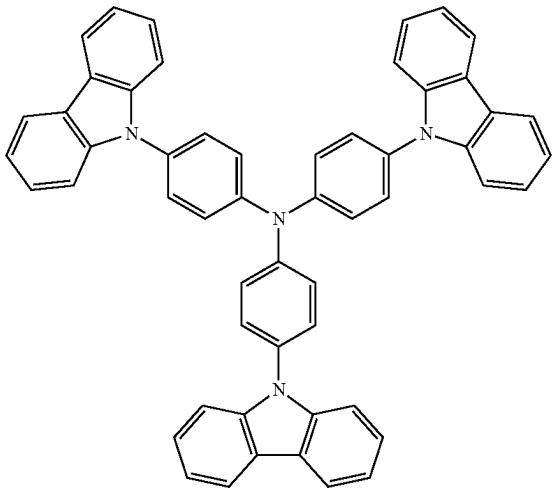


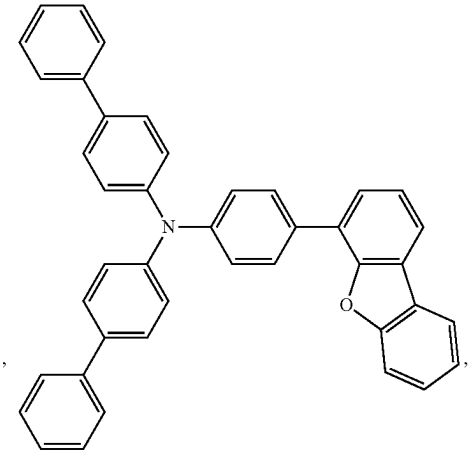


-continued

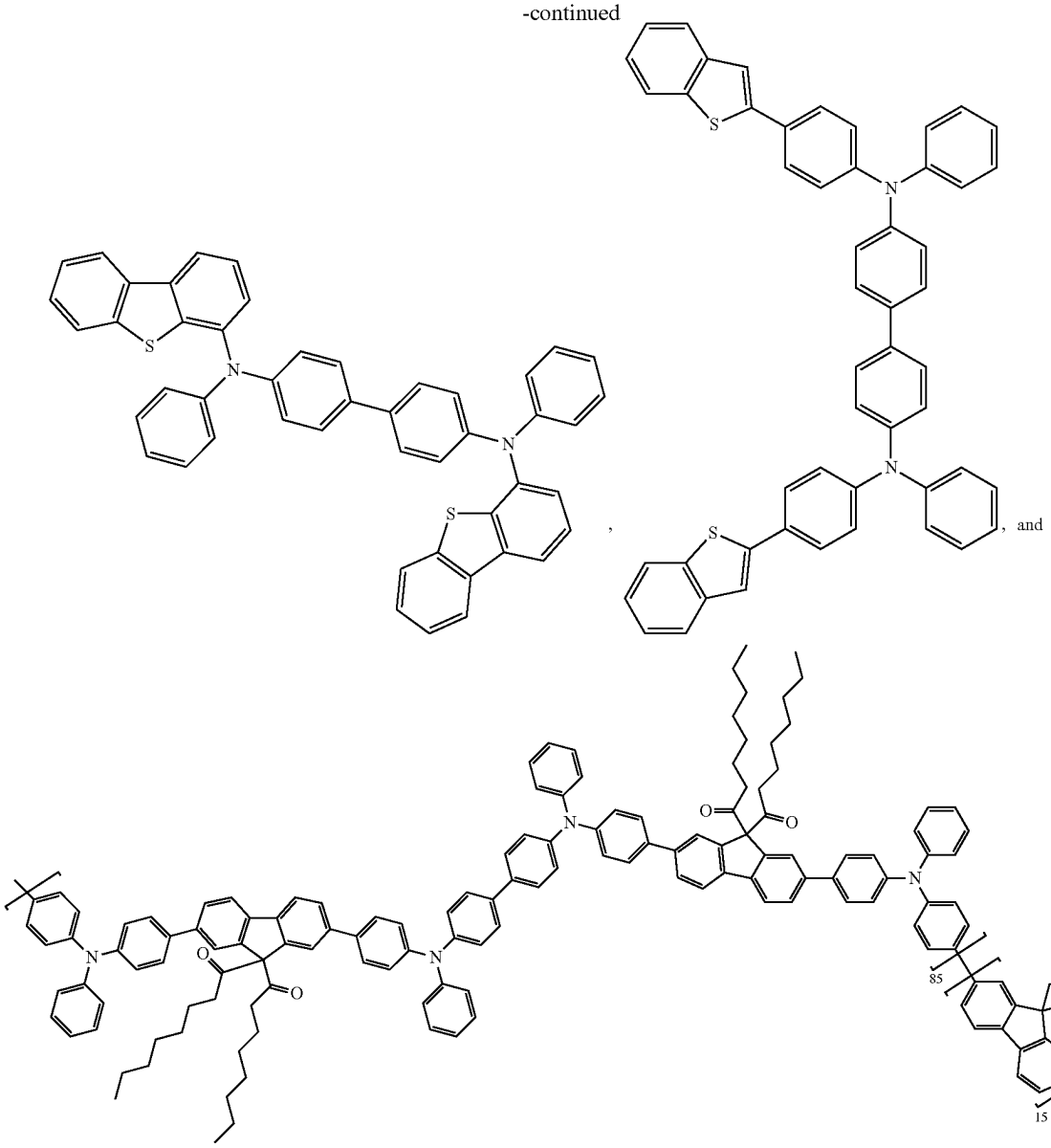








-continued



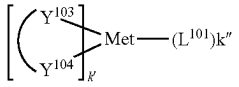
EBL:

An electron blocking layer (EBL) may be used to reduce the number of electrons and/or excitons that leave the emissive layer. The presence of such a blocking layer in a device may result in substantially higher efficiencies, and/or longer lifetime, as compared to a similar device lacking a blocking layer. Also, a blocking layer may be used to confine emission to a desired region of an OLED. In some embodiments, the EBL material has a higher LUMO (closer to the vacuum level) and/or higher triplet energy than the emitter closest to the EBL interface. In some embodiments, the EBL material has a higher LUMO (closer to the vacuum level) and/or higher triplet energy than one or more of the hosts closest to the EBL interface. In one aspect, the compound used in EBL contains the same molecule or the same functional groups used as one of the hosts described below.

Host:

The light emitting layer of the organic EL device of the present invention preferably contains at least a metal complex as light emitting material, and may contain a host material using the metal complex as a dopant material. Examples of the host material are not particularly limited, and any metal complexes or organic compounds may be used as long as the triplet energy of the host is larger than that of the dopant. Any host material may be used with any dopant so long as the triplet criteria is satisfied.

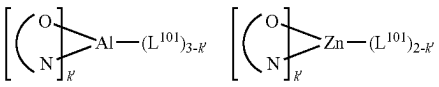
Examples of metal complexes used as host are preferred to have the following general formula:



wherein Met is a metal; (Y^{103}-Y^{104}) is a bidentate ligand, Y^{103} and Y^{104} are independently selected from C, N, O, P, and S; L^{101} is an another ligand; k' is an integer value from 1 to the maximum number of ligands that may be

attached to the metal; and k'+k" is the maximum number of ligands that may be attached to the metal.

In one aspect, the metal complexes are:

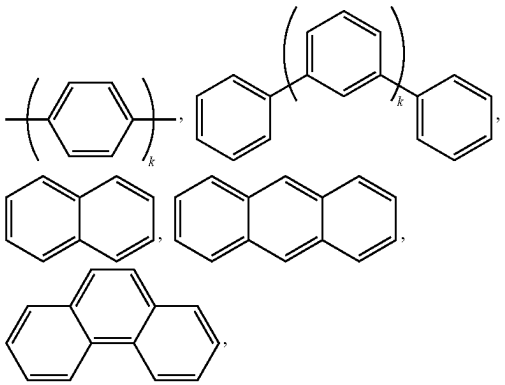


wherein (O—N) is a bidentate ligand, having metal coordinated to atoms 0 and N.

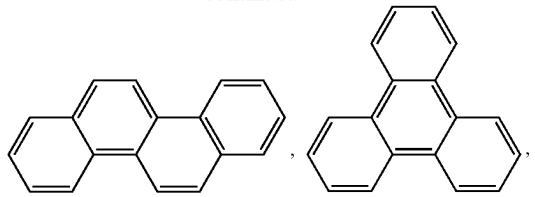
In another aspect, Met is selected from Ir and Pt. In a further aspect, (Y^{103}-Y^{104}) is a carbene ligand.

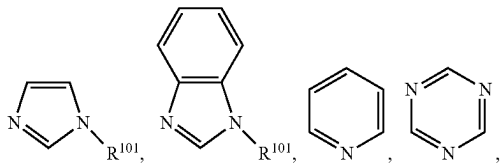
Examples of other organic compounds used as host are selected from the group consisting of aromatic hydrocarbon cyclic compounds such as benzene, biphenyl, triphenyl, triphenylene, tetraphenylene, naphthalene, anthracene, phenalene, phenanthrene, fluorene, pyrene, chrysene, perylene, and azulene; the group consisting of aromatic heterocyclic compounds such as dibenzothiophene, dibenzofuran, dibenzoselenophene, furan, thiophene, benzofuran, benzothiophene, benzoselenophene, carbazole, indolocarbazole, pyridylindole, pyrrolodipyridine, pyrazole, imidazole, triazole, oxazole, thiazole, oxadiazole, oxatriazole, dioxazole, thiadiazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine, oxazine, oxathiazine, oxadiazine, indole, benzimidazole, indazole, indoxazine, benzoxazole, benzisoxazole, benzothiazole, quinoline, isoquinoline, cinnoline, quinazoline, quinoxaline, naphthyridine, phthalazine, pteridine, xanthene, acridine, phenazine, phenothiazine, phenoxazine, benzofuropyridine, furodipyridine, benzothienopyridine, thienodipyridine, benzoselenophenopyridine, and selenophenodipyridine; and the group consisting of 2 to 10 cyclic structural units which are groups of the same type or different types selected from the aromatic hydrocarbon cyclic group and the aromatic heterocyclic group and are bonded to each other directly or via at least one of oxygen atom, nitrogen atom, sulfur atom, silicon atom, phosphorus atom, boron atom, chain structural unit and the aliphatic cyclic group. Each option within each group may be unsubstituted or may be substituted by a substituent selected from the group consisting of deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, heterocycloalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carboxylic acids, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof.

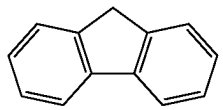
In one aspect, the host compound contains at least one of the following groups in the molecule:

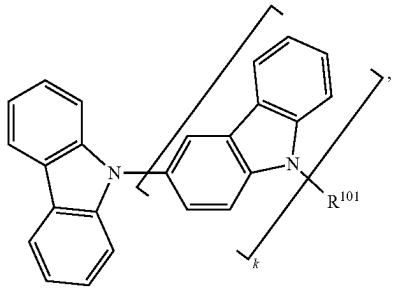


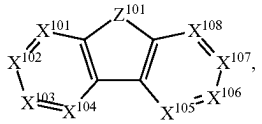
-continued

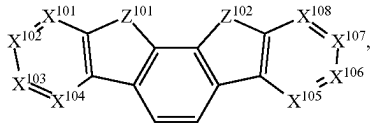


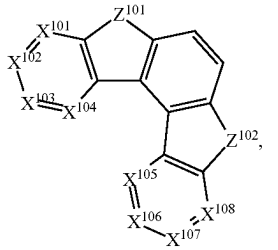


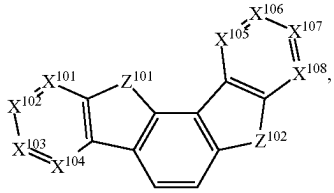


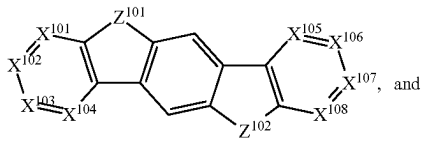




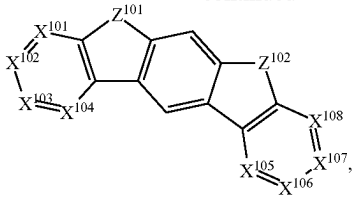






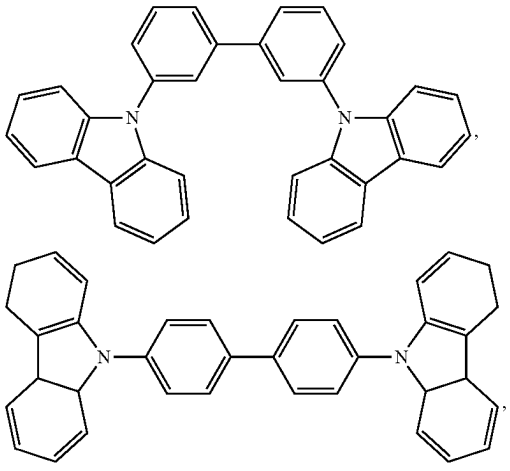


-continued

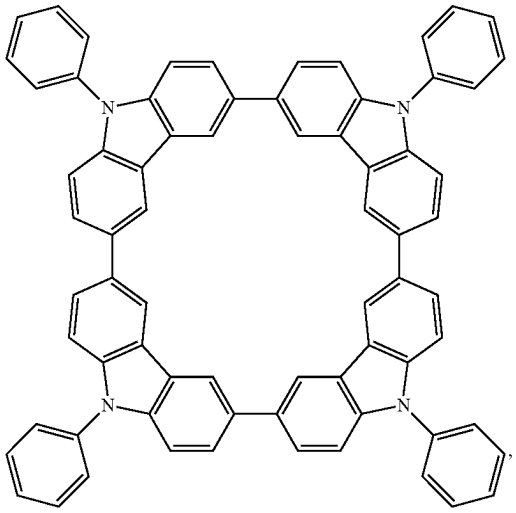


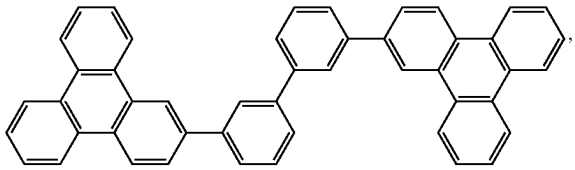
wherein R^{101} is selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, heterocycloalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carboxylic acids, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof, and when it is aryl or heteroaryl, it has the similar definition as Ar's mentioned above. k is an integer from 0 to 20 or 1 to 20. X^{101} to X^{108} are independently selected from C (including CH) or N. Z^{101} and Z^{102} are independently selected from NR^{101}, O, or S.

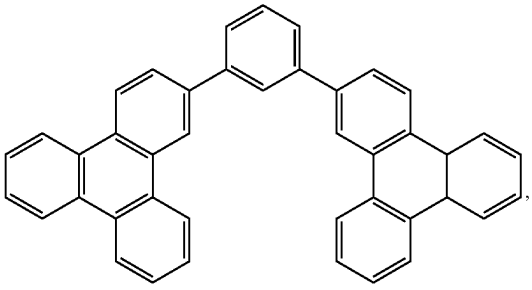
Non-limiting examples of the host materials that may be used in an OLED in combination with materials disclosed herein are exemplified below together with references that disclose those materials: EP2034538, EP2034538A, EP2757608, JP2007254297, KR20100079458, KR20120088644, KR20120129733, KR20130115564, TW201329200, US20030175553, US20050238919, US20060280965, US20090017330, US20090030202, US20090167162, US20090302743, US20090309488, US20100012931, US20100084966, US20100187984, US2010187984, US2012075273, US2012126221, US2013009543, US2013105787, US2013175519, US2014001446, US20140183503, US20140225088, US2014034914, U.S. Pat. No. 7,154,114, WO2001039234, WO2004093207, WO2005014551, WO2005089025, WO2006072002, WO2006114966, WO2007063754, WO2008056746, WO2009003898, WO2009021126, WO2009063833, WO2009066778, WO2009066779, WO2009086028, WO2010056066, WO2010107244, WO2011081423, WO2011081431, WO2011086863, WO2012128298, WO2012133644, WO2012133649, WO2013024872, WO2013035275, WO2013081315, WO2013191404, WO2014142472, US20170263869, US20160163995, U.S. Pat. No. 9,466,803,

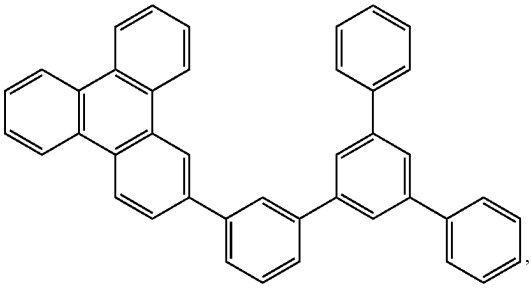


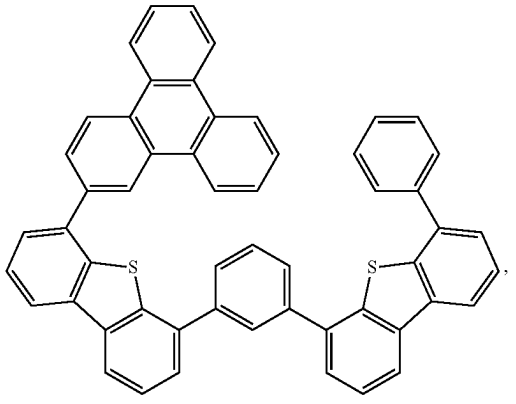
-continued



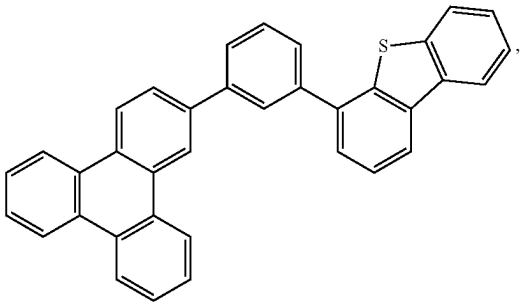


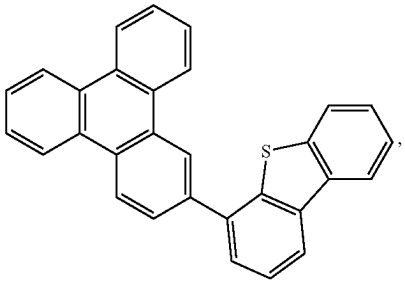


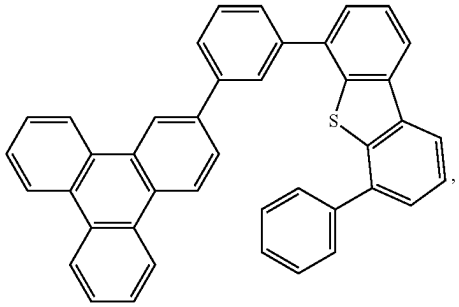


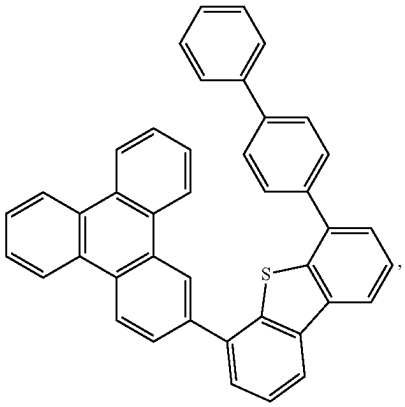


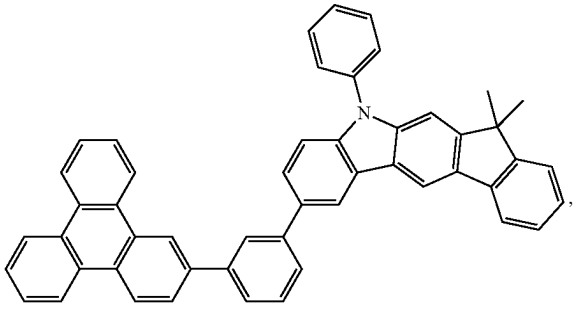
-continued



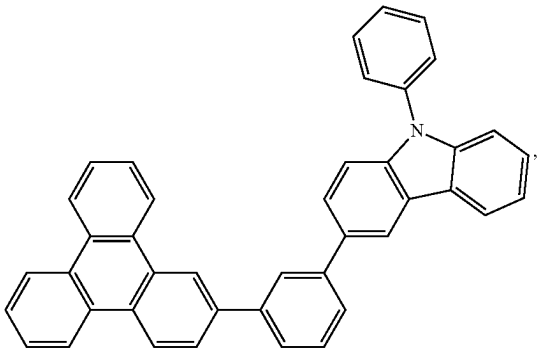


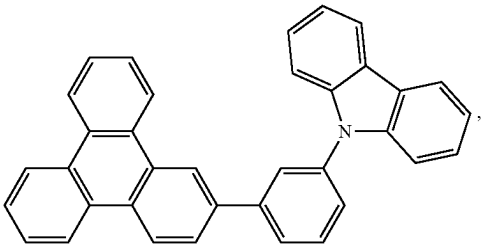


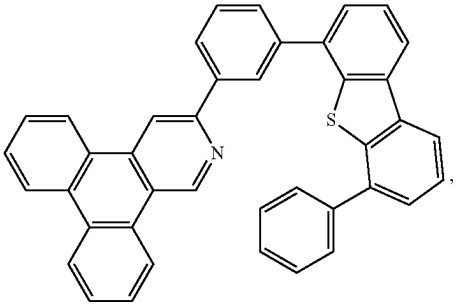


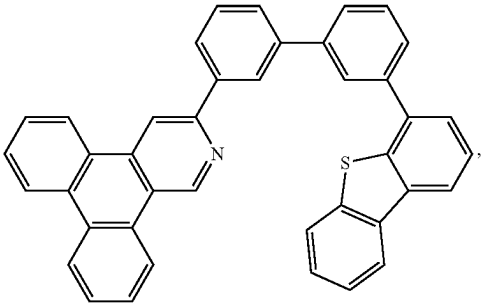


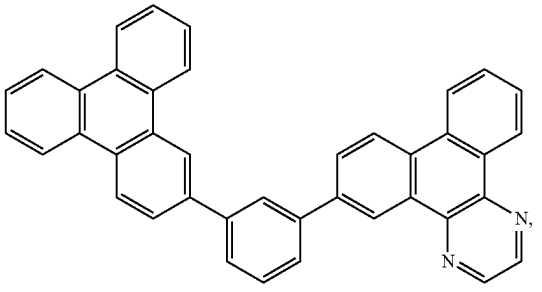
-continued



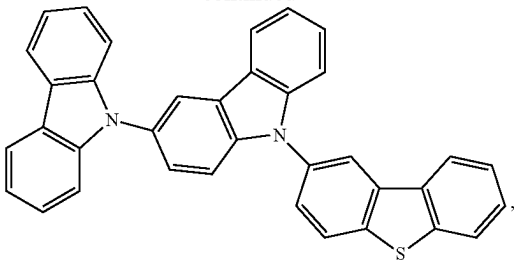


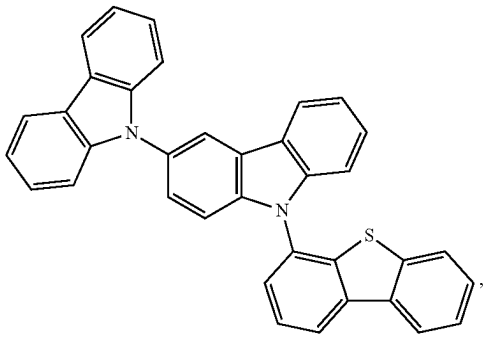


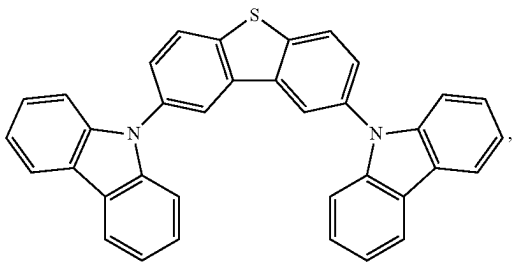


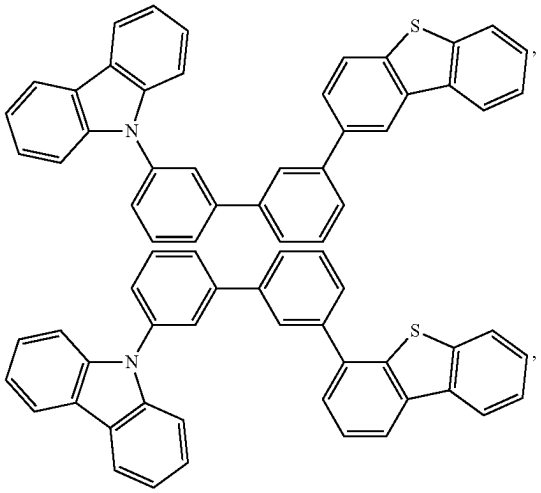


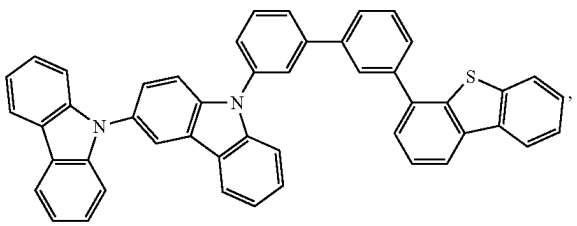
-continued



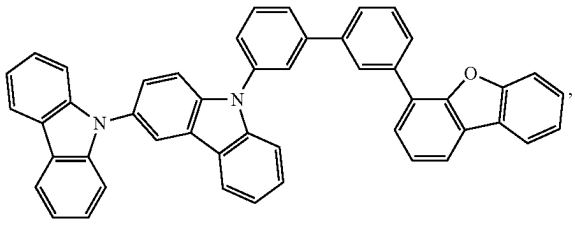


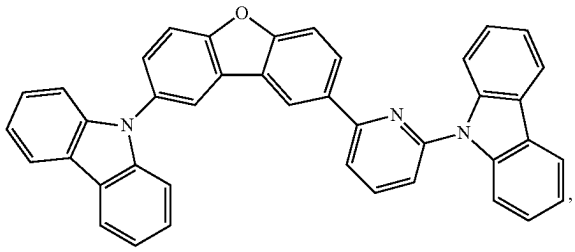


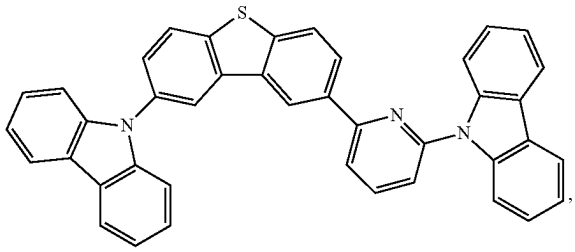


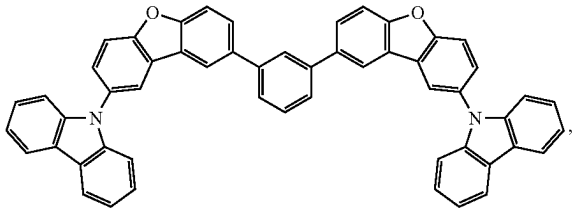


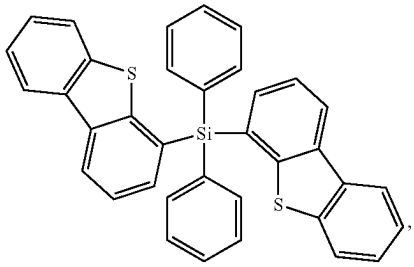
-continued

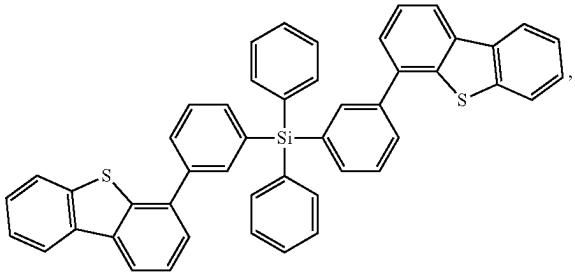




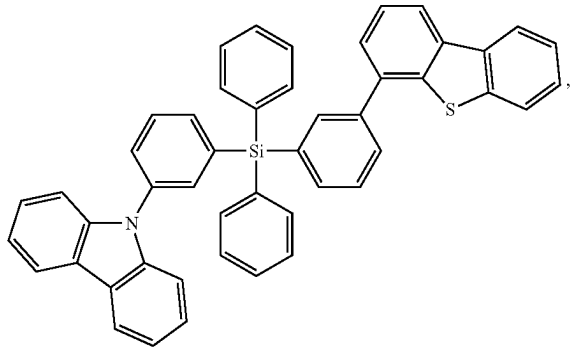


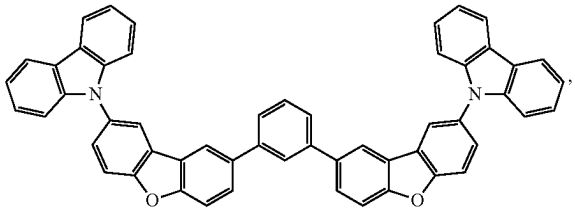


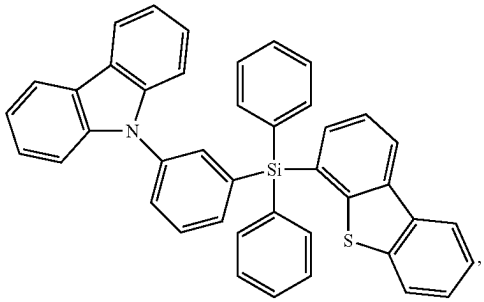


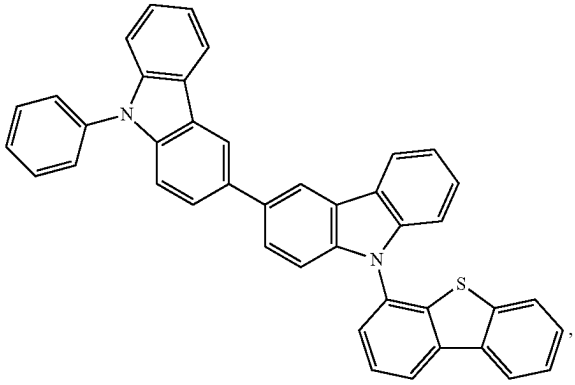


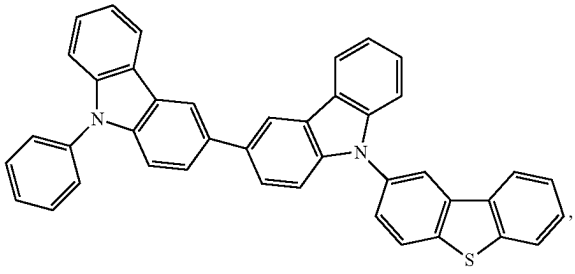
-continued



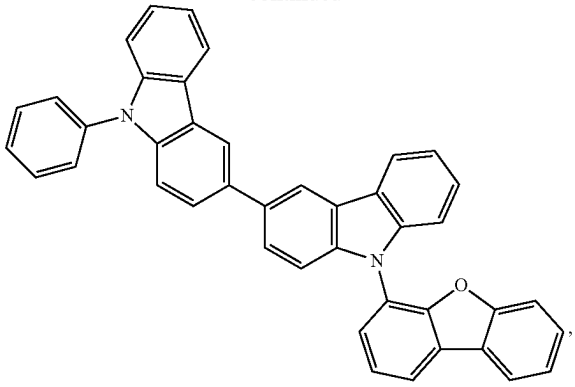


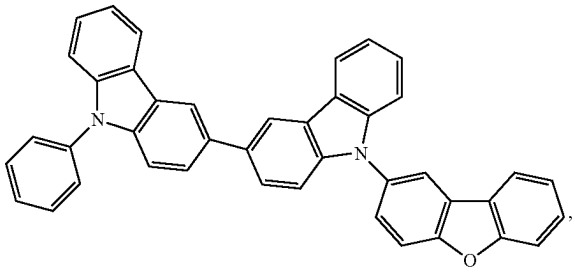


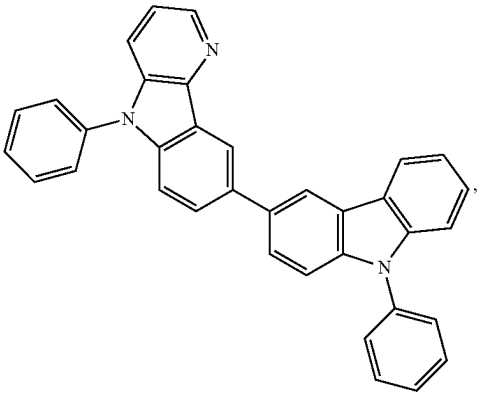


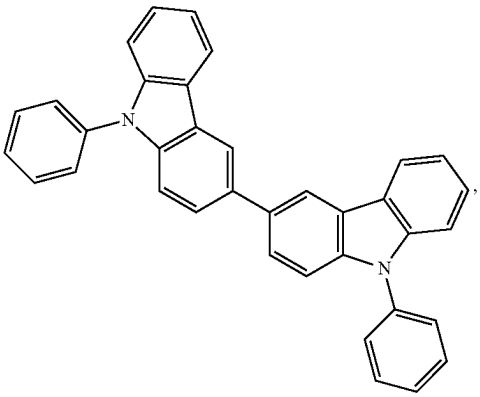


-continued

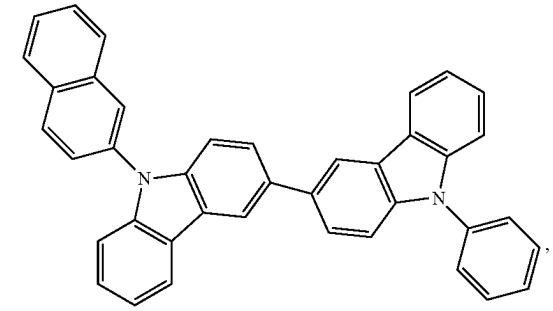


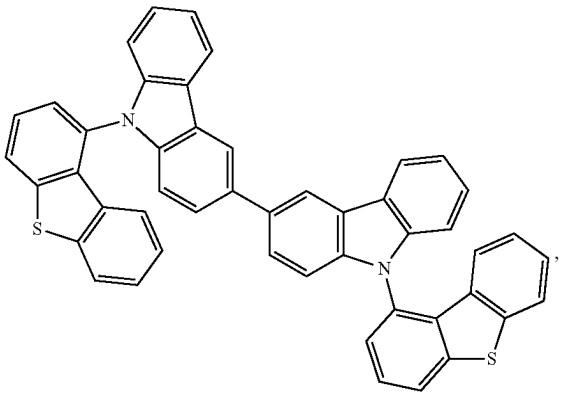


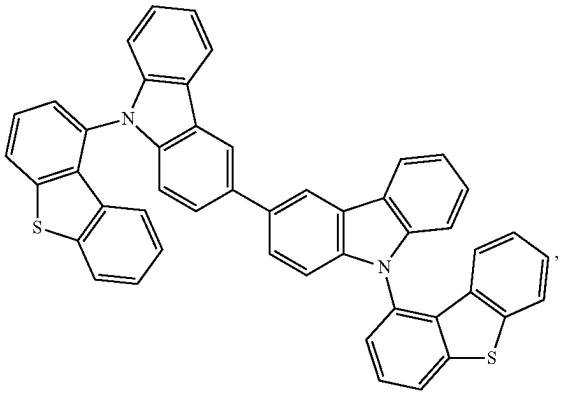


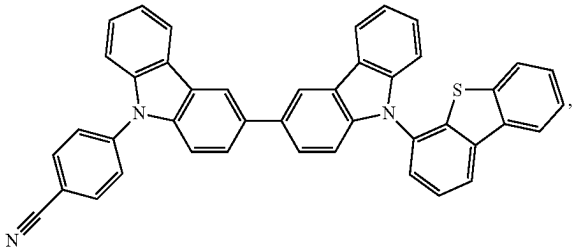


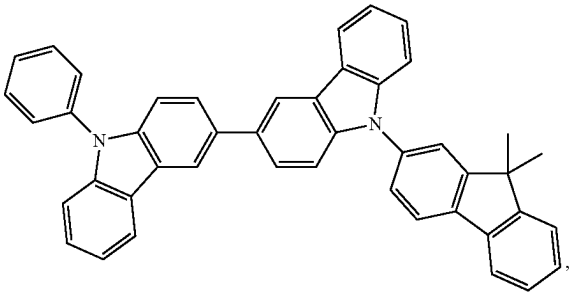
-continued



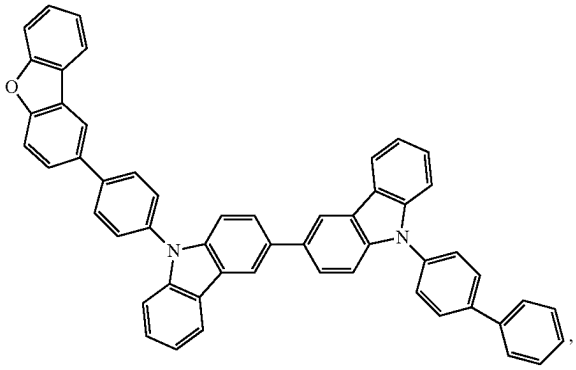


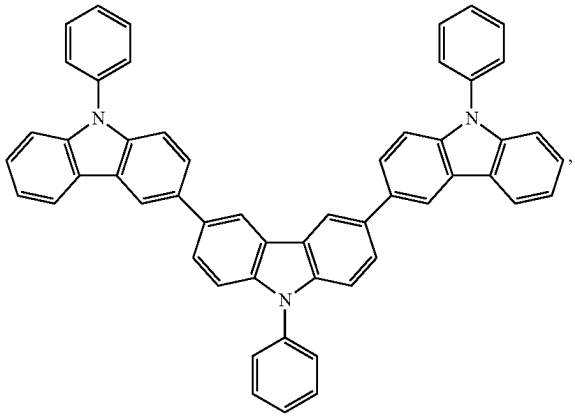


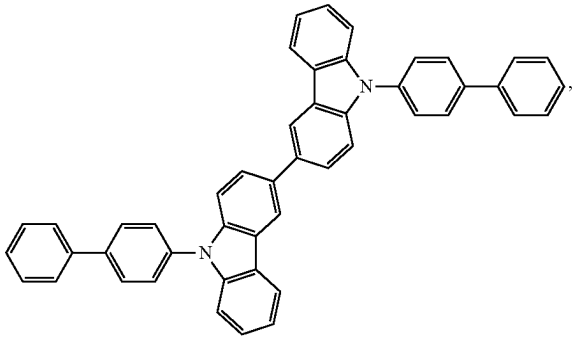


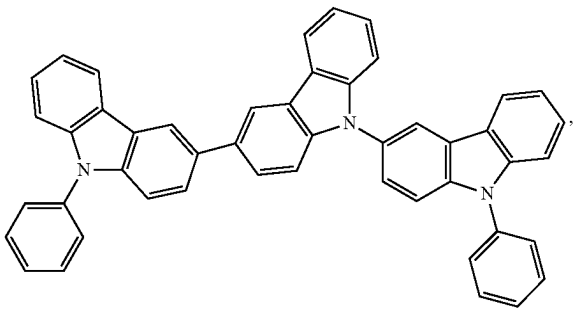


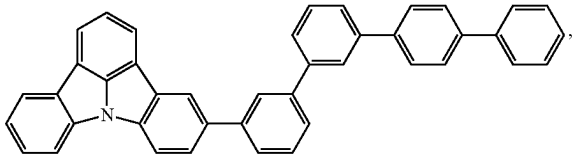
-continued



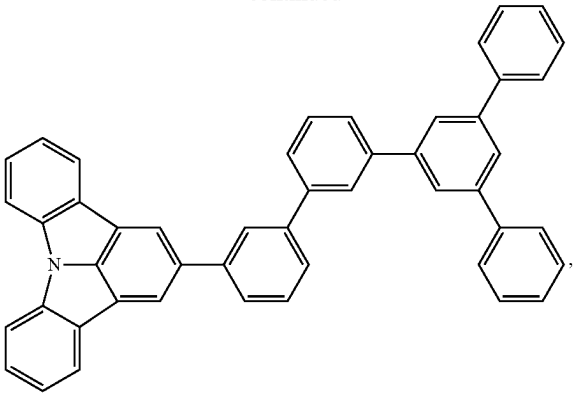


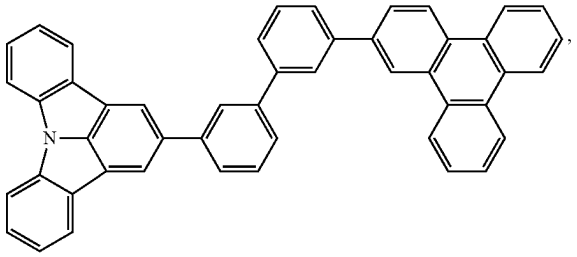


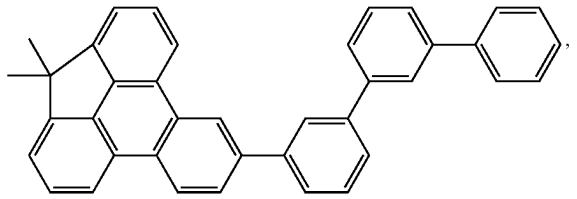


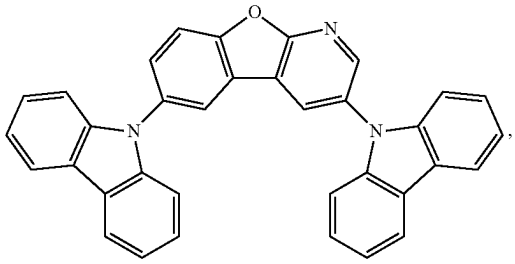


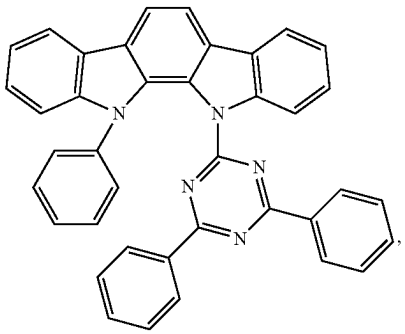
-continued



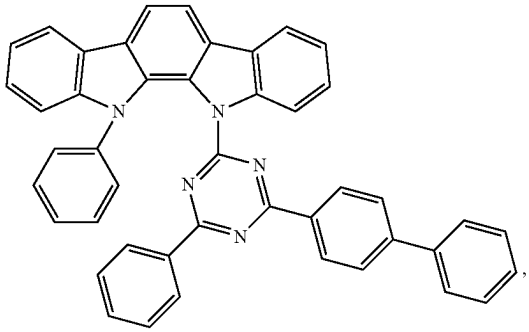


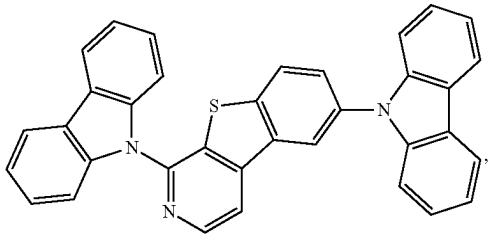


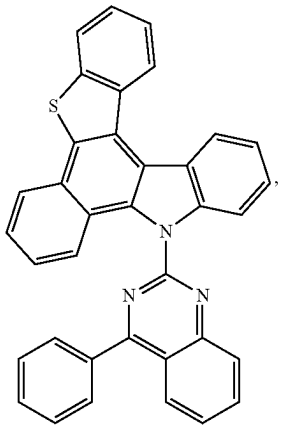


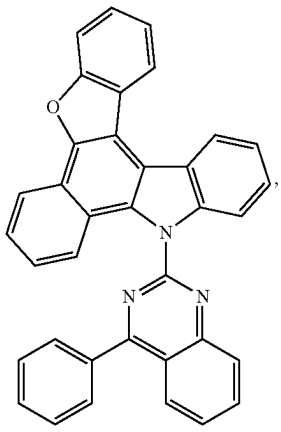


-continued

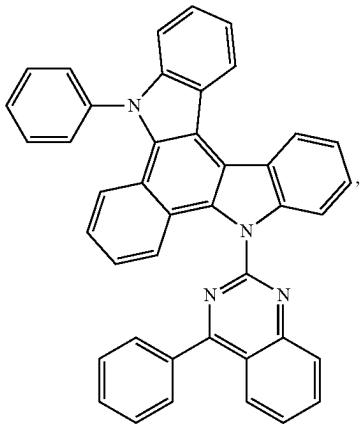


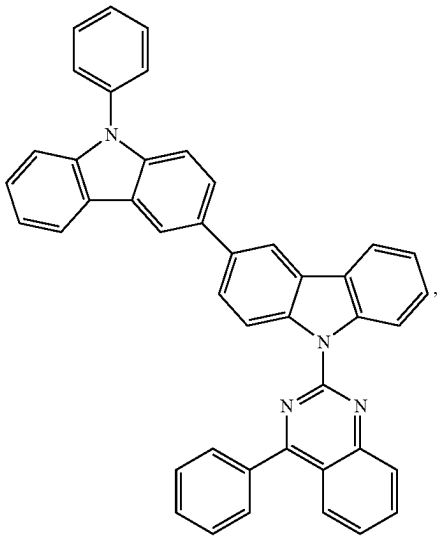


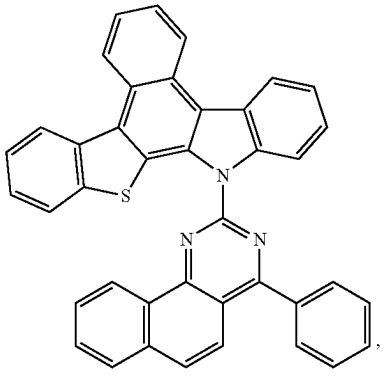


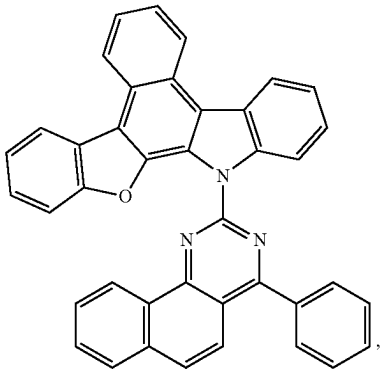


-continued

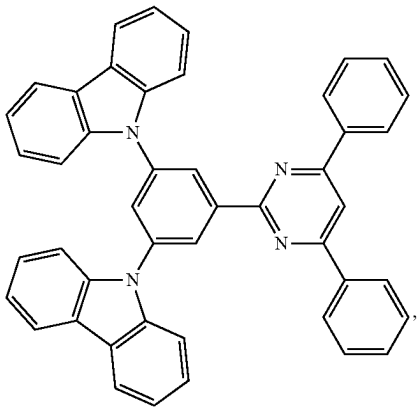


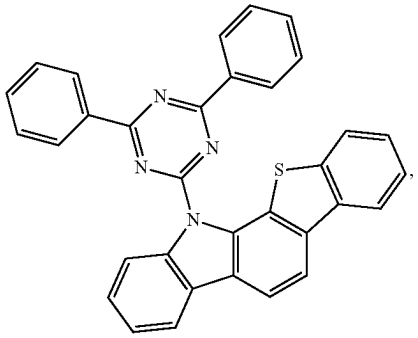


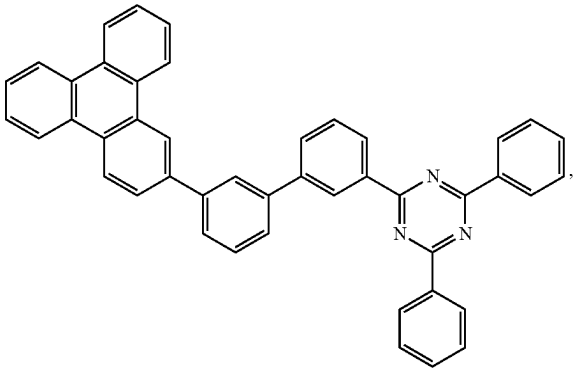


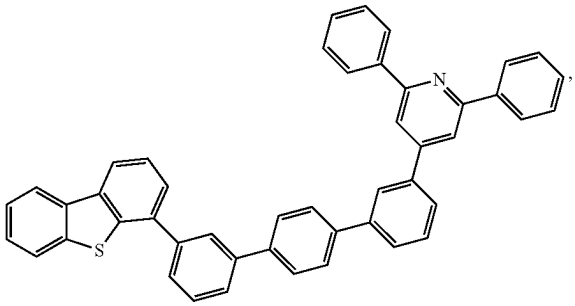


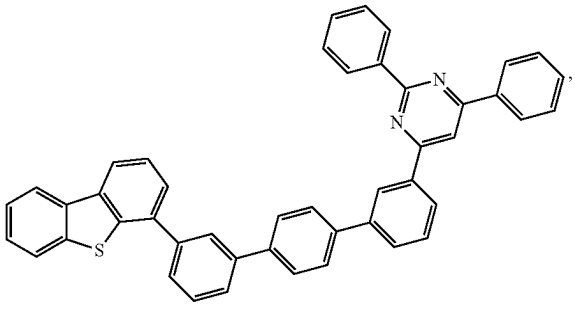
-continued



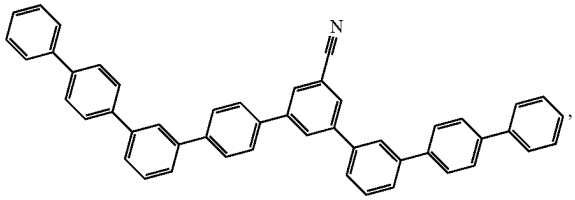


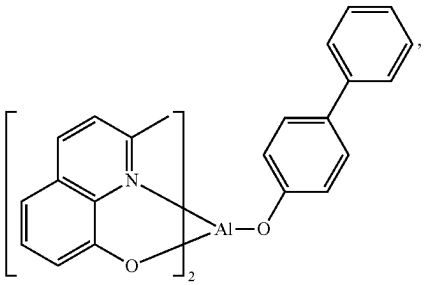


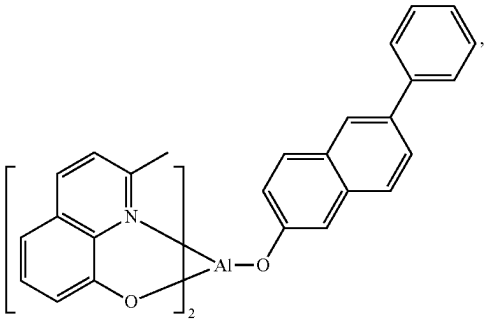


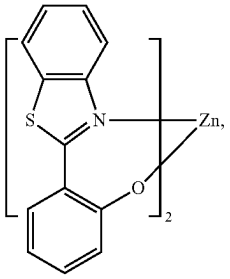


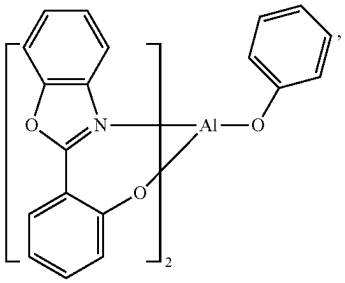
-continued

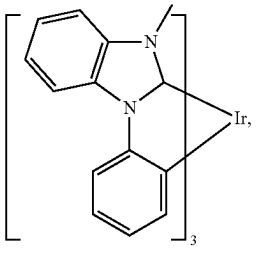




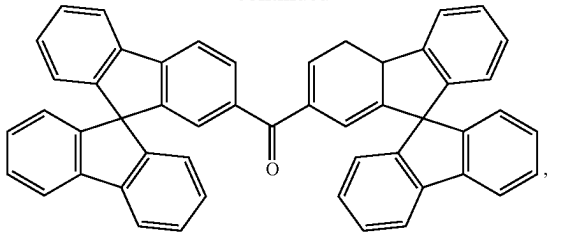


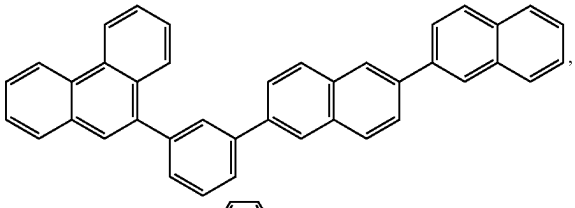


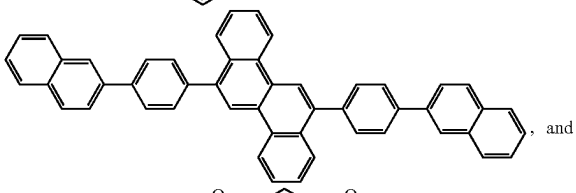




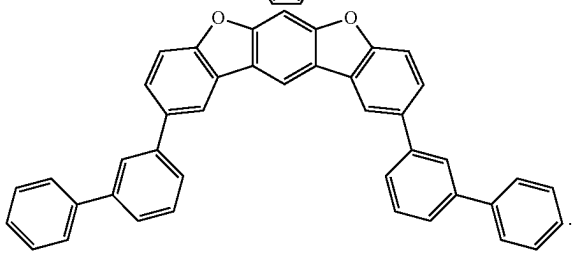
-continued







and

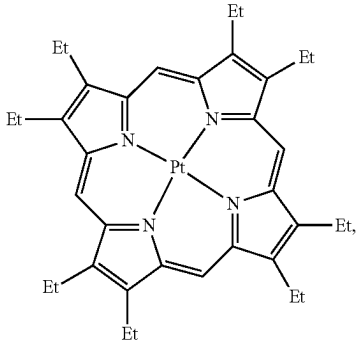


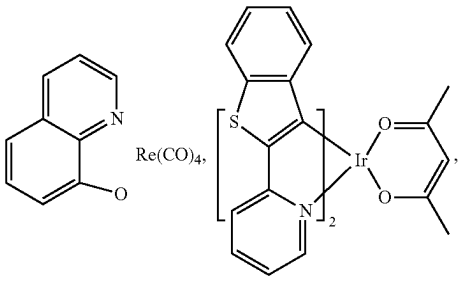
Additional Emitters:

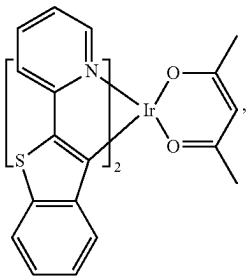
One or more additional emitter dopants may be used in conjunction with the compound of the present disclosure. Examples of the additional emitter dopants are not particularly limited, and any compounds may be used as long as the compounds are typically used as emitter materials. Examples of suitable emitter materials include, but are not limited to, compounds which can produce emissions via phosphorescence, fluorescence, thermally activated delayed fluorescence, i.e., TADF (also referred to as E-type delayed fluorescence), triplet-triplet annihilation, or combinations of these processes.

Non-limiting examples of the emitter materials that may be used in an OLED in combination with materials disclosed herein are exemplified below together with references that disclose those materials: CN103694277, CN1696137, EB01238981, EP01239526, EP01961743, EP1239526, EP1244155, EP1642951, EP1647554, EP1841834, EP1841834B, EP2062907, EP2730583, JP2012074444, JP2013110263, JP4478555, KR1020090133652, KR20120032054, KR20130043460, TW201332980, U.S. Ser. No. 06/699,599, U.S. Ser. No. 06/916,554, US20010019782, US20020034656, US20030068526, US20030072964, US20030138657, US20050123788, US20050244673, US2005123791, US2005260449, US20060008670, US20060065890, US20060127696, US20060134459, US20060134462, US20060202194, US20060251923, US20070034863, US20070087321, US20070103060, US20070111026, US20070190359, US20070231600, US2007034863, US2007104979, US2007104980, US2007138437, US2007224450, US2007278936, US20080020237, US20080233410,

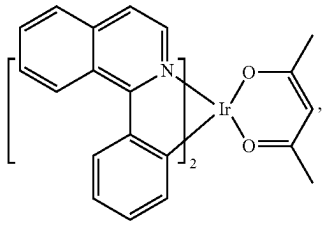
US20080261076, US20080297033, US200805851, US2008161567, US2008210930, US20090039776, US20090108737, US20090115322, US20090179555, US2009085476, US2009104472, US20100090591, US20100148663, US20100244004, US20100295032, US2010102716, US2010105902, US2010244004, US2010270916, US20110057559, US20110108822, US20110204333, US2011215710, US2011227049, US2011285275, US2012292601, US20130146848, US2013033172, US2013165653, US2013181190, US2013334521, US20140246656, US2014103305, U.S. Pat. Nos. 6,303,238, 6,413,656, 6,653,654, 6,670,645, 6,687,266, 6,835,469, 6,921,915, 7,279,704, 7,332,232, 7,378,162, 7,534,505, 7,675,228, 7,728,137, 7,740,957, 7,759,489, 7,951,947, 8,067,099, 8,592,586, 8,871,361, WO06081973, WO06121811, WO07018067, WO07108362, WO07115970, WO07115981, WO08035571, WO2002015645, WO2003040257, WO2005019373, WO2006056418, WO2008054584, WO2008078800, WO2008096609, WO2008101842, WO2009000673, WO2009050281, WO2009100991, WO2010028151, WO2010054731, WO2010086089, WO2010118029, WO2011044988, WO2011051404, WO2011107491, WO2012020327, WO2012163471, WO2013094620, WO2013107487, WO2013174471, WO2014007565, WO2014008982, WO2014023377, WO2014024131, WO2014031977, WO2014038456, WO2014112450.

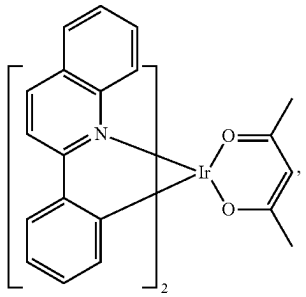


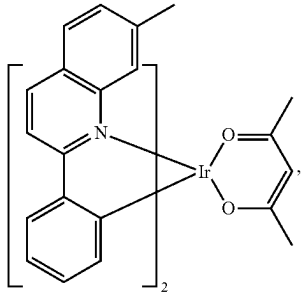


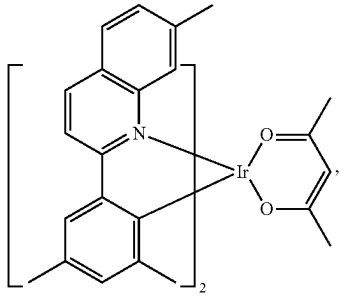


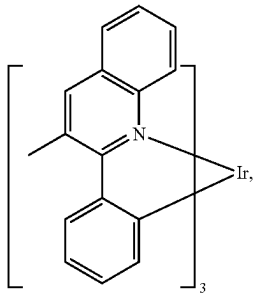
-continued

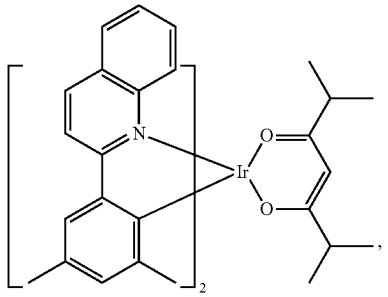




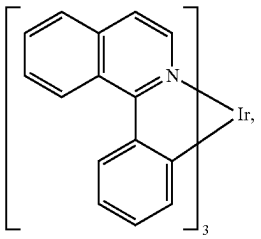


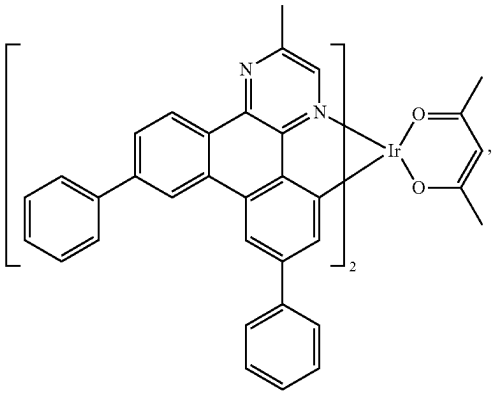


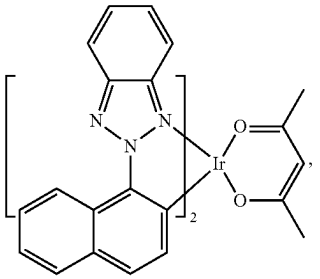


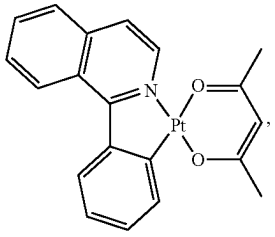


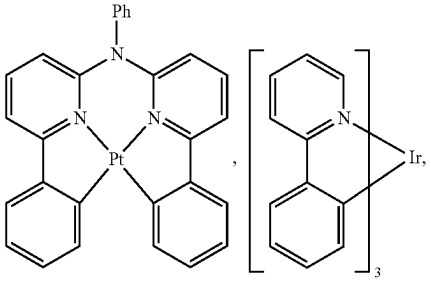
-continued



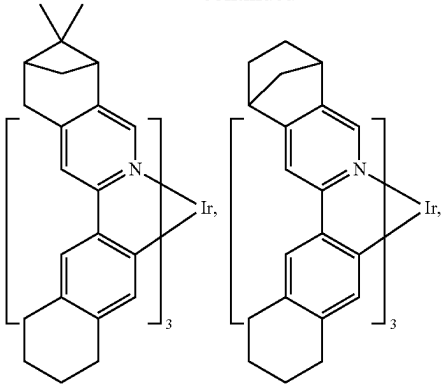


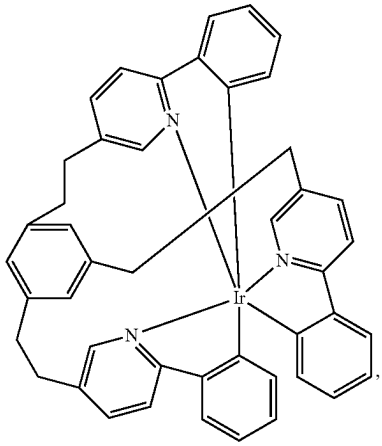


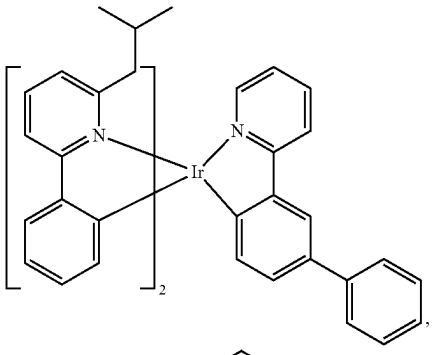


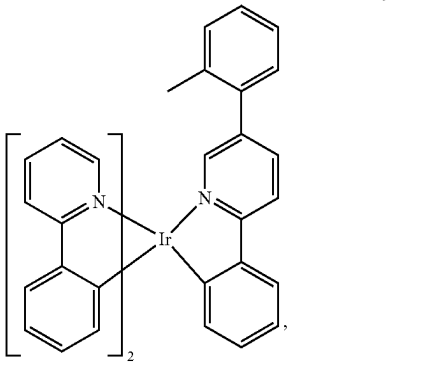


-continued

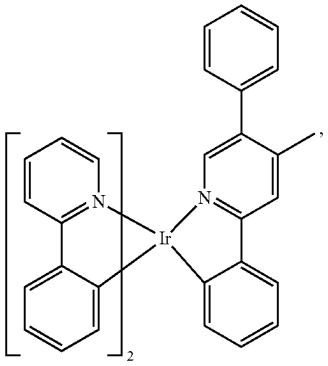


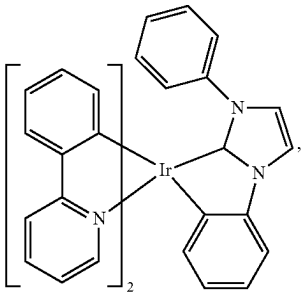


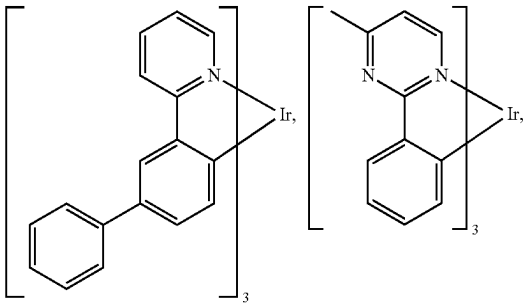


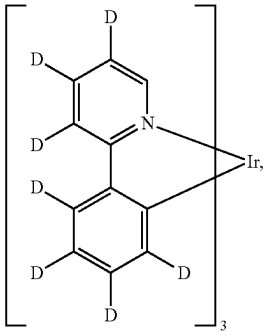


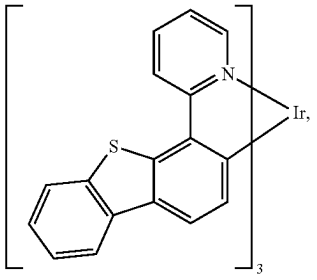
-continued



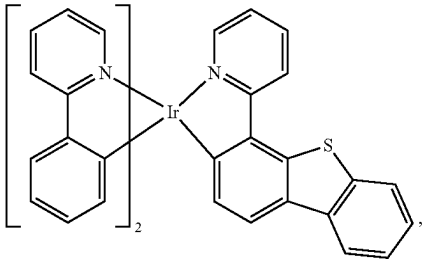


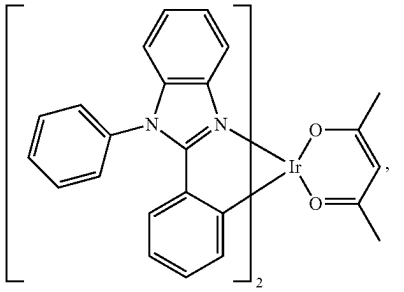


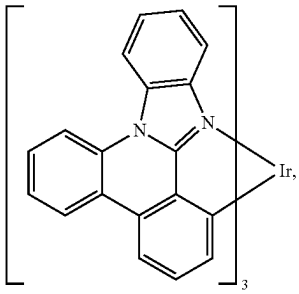


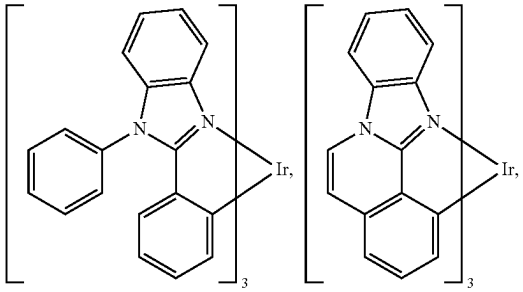


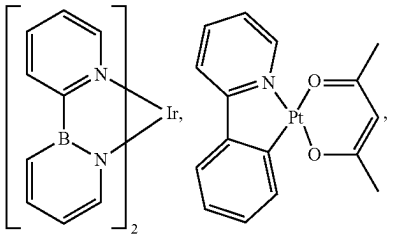
-continued

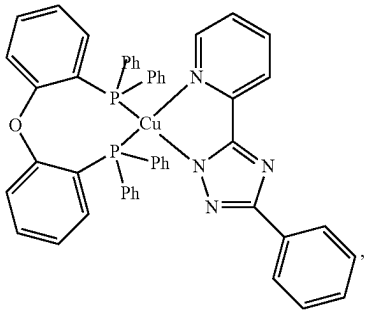




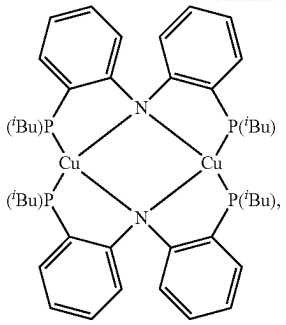


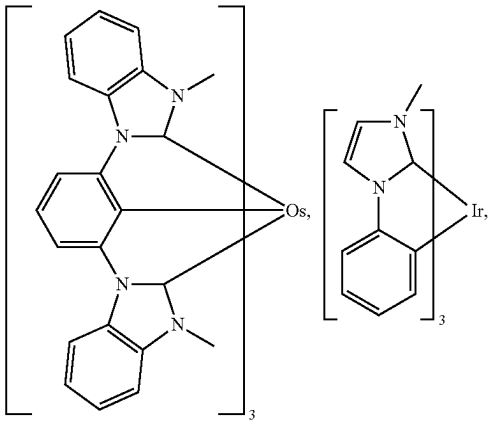


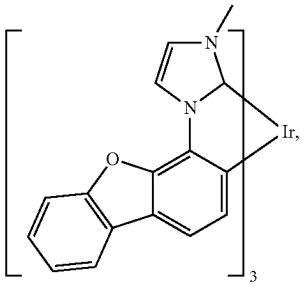


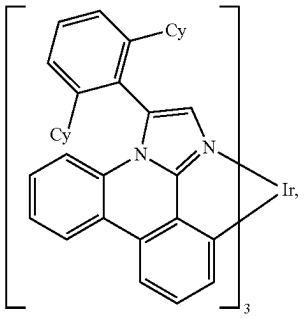


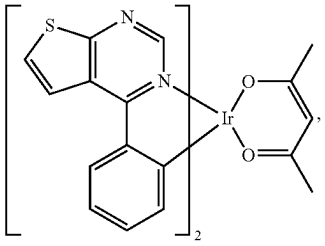
-continued



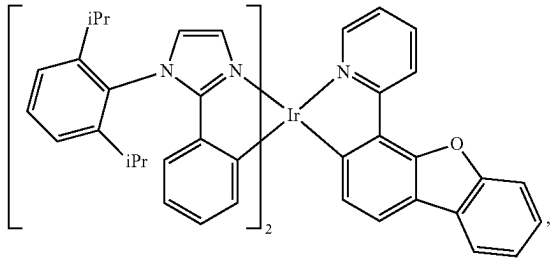


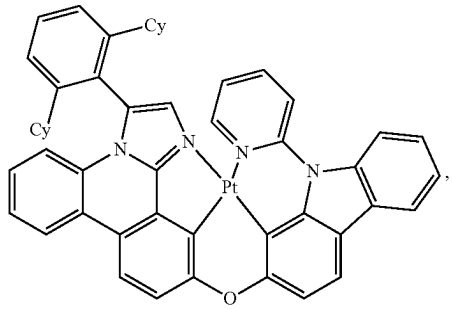


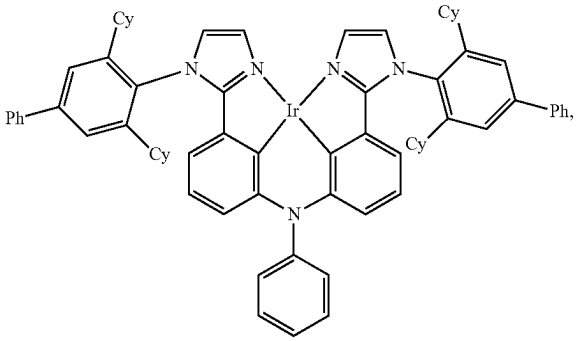


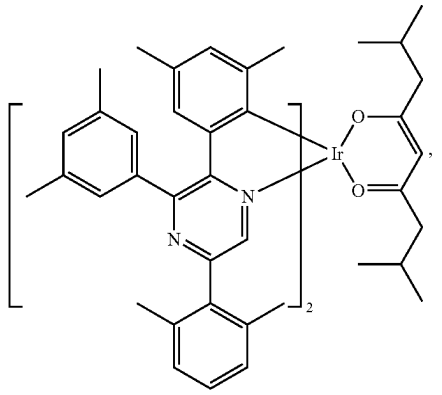


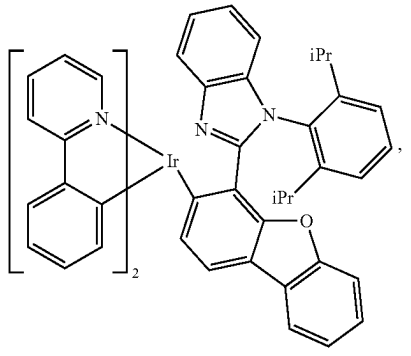
-continued



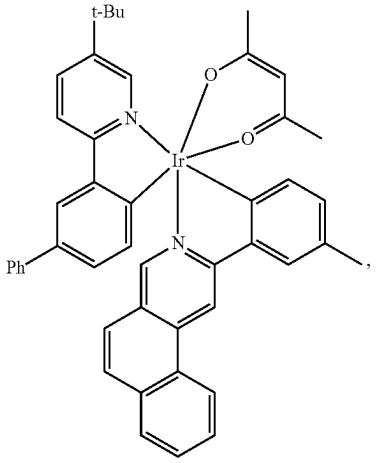


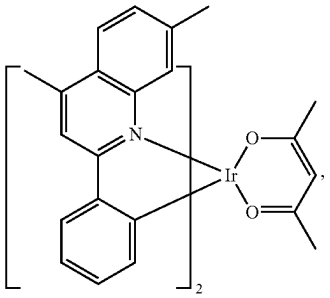


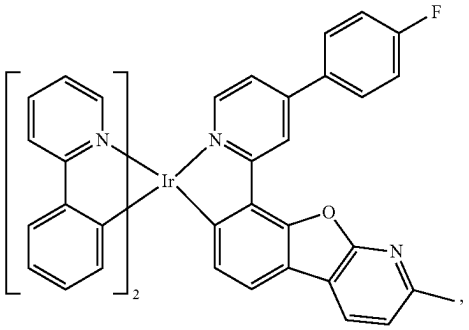


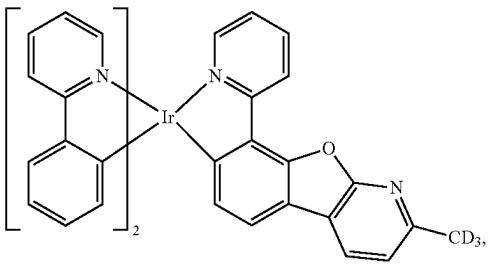


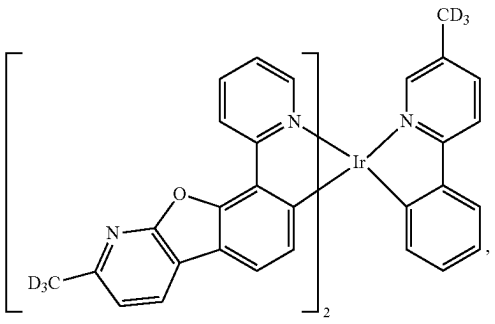
-continued



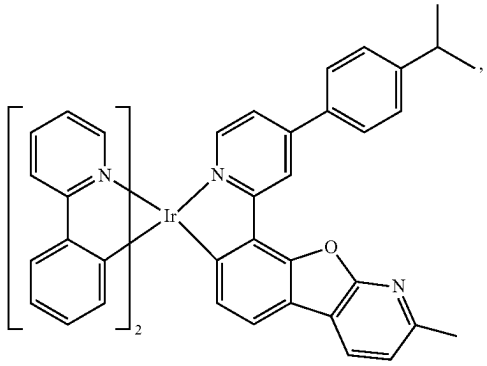


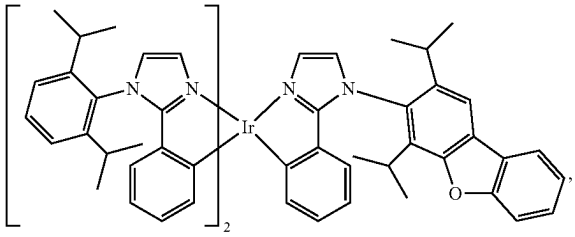


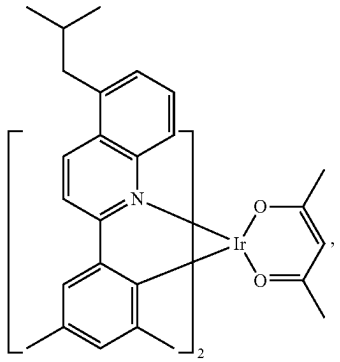


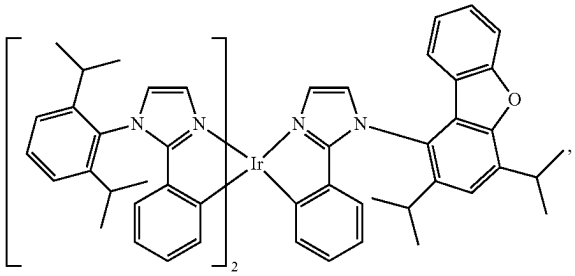


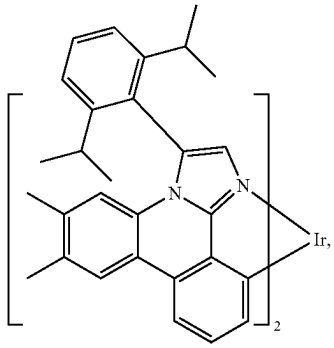
-continued



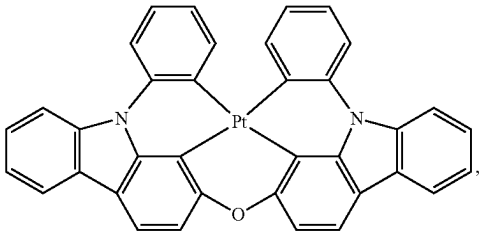


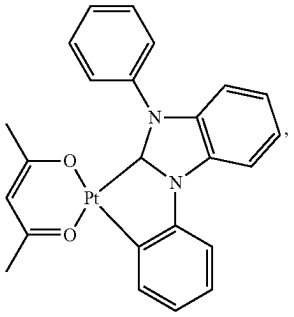


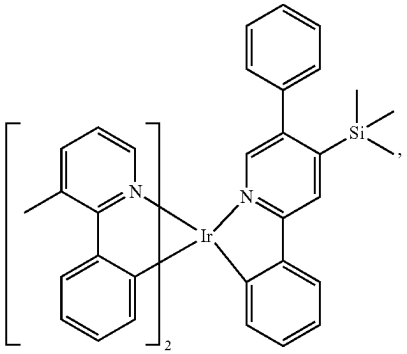


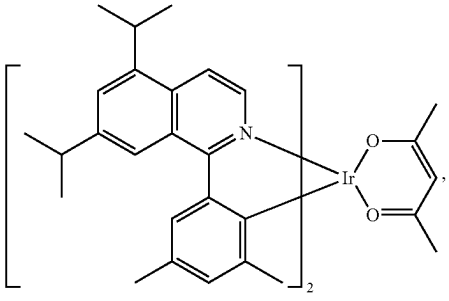


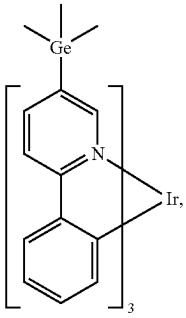
-continued



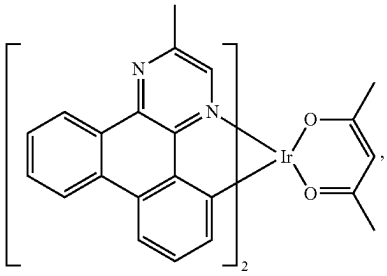


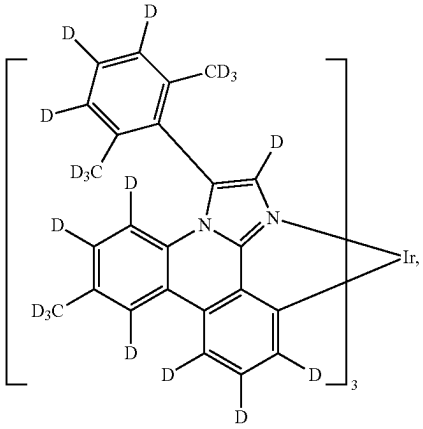


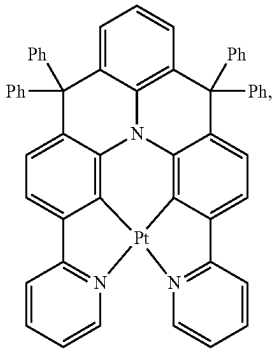


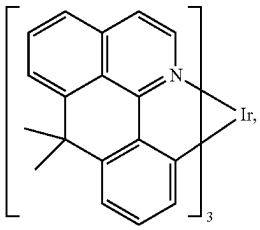


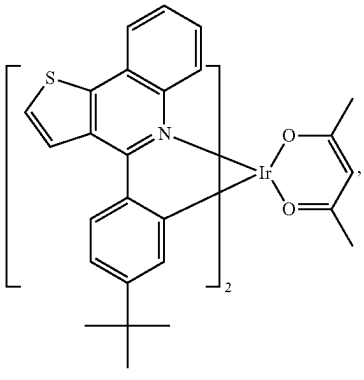
-continued



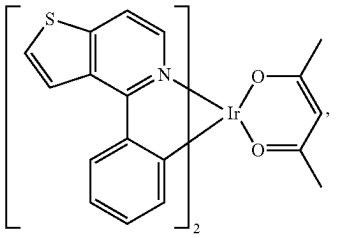


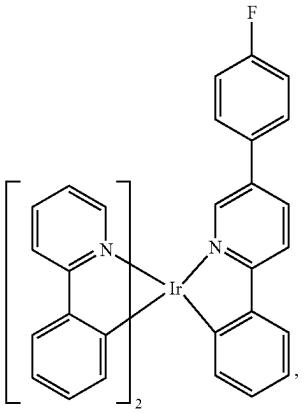


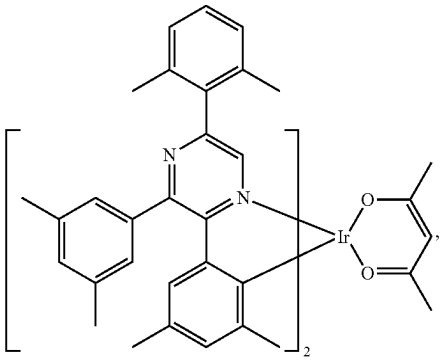


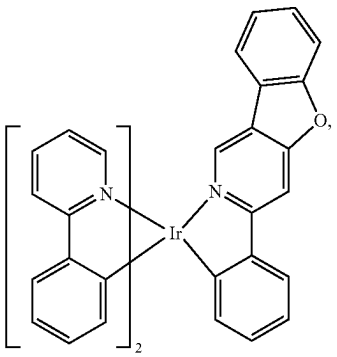


-continued

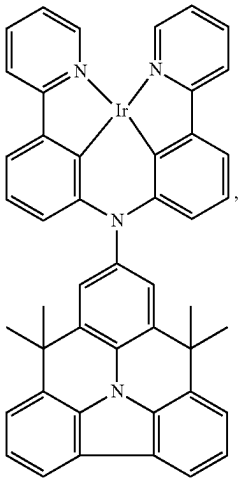


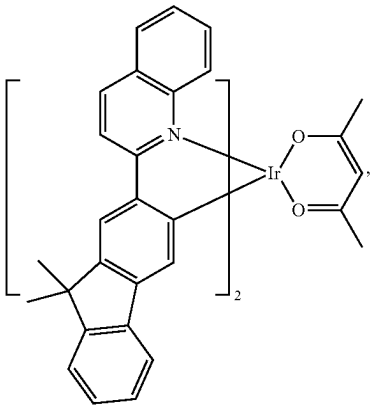


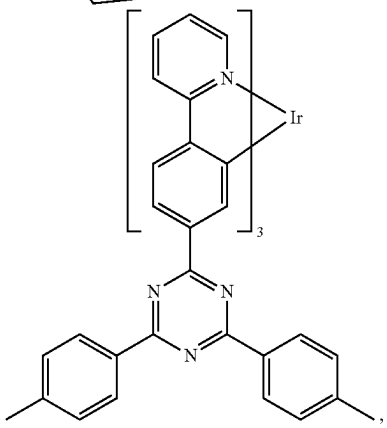


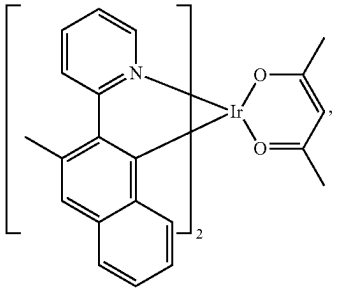


-continued

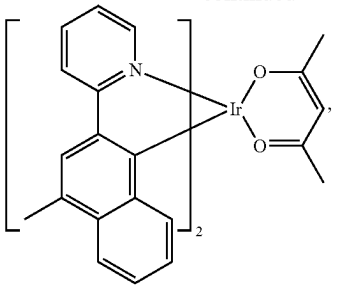


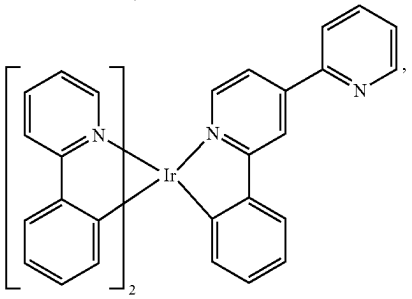


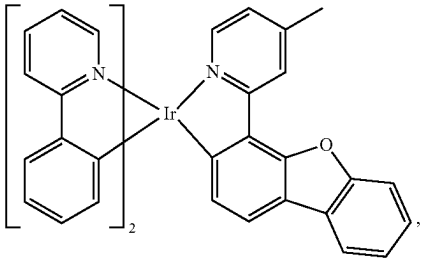


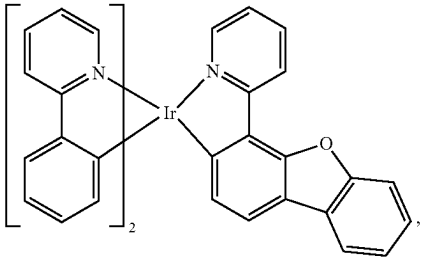


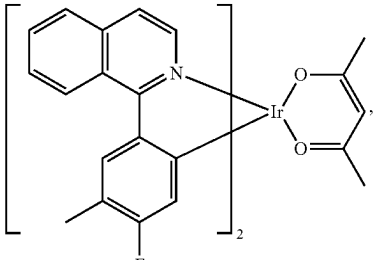
-continued

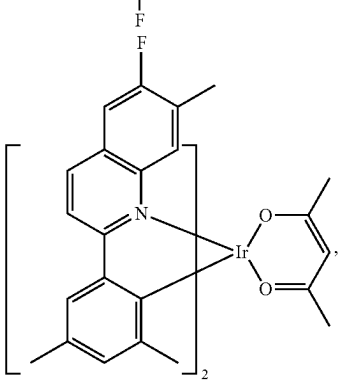




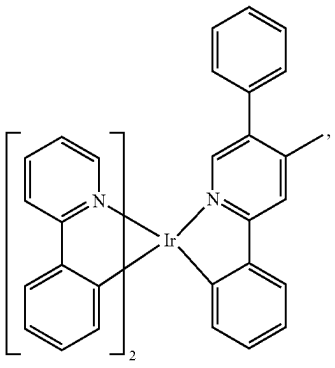


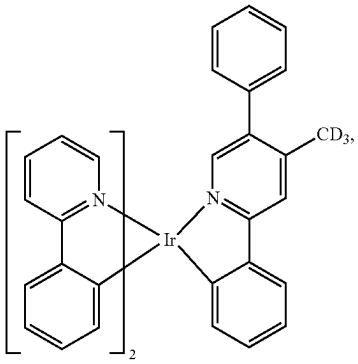


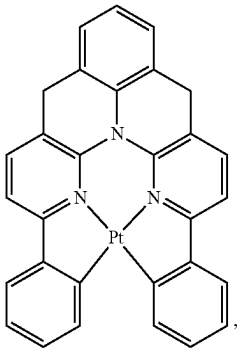


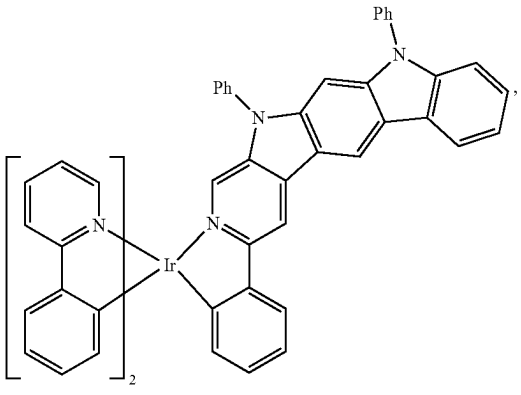


-continued

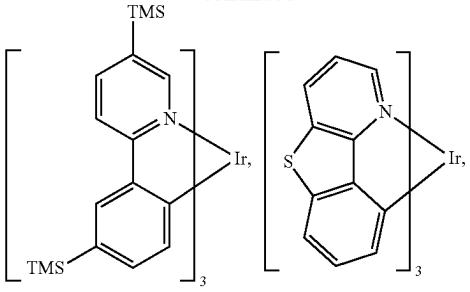


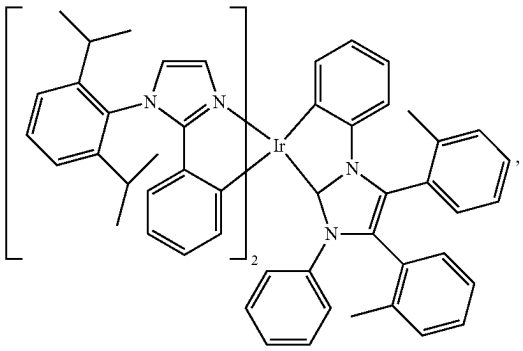


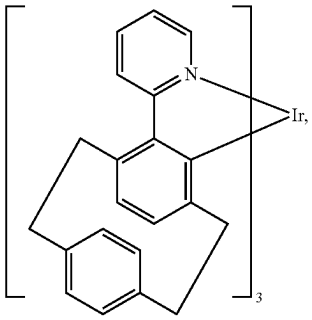


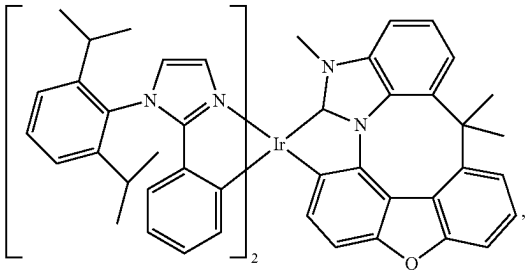


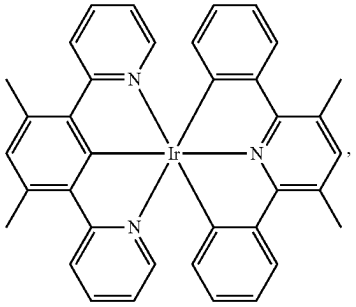
-continued



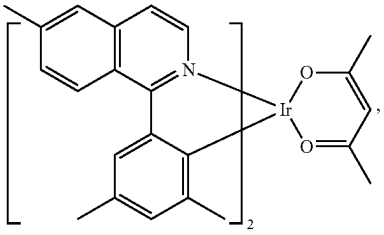


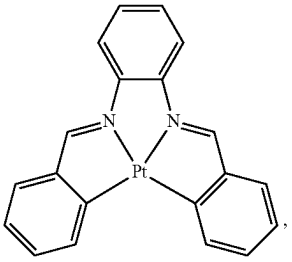


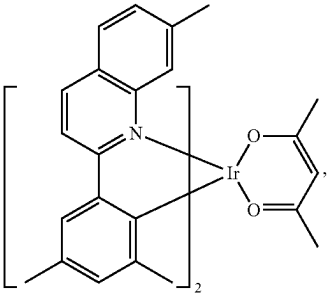


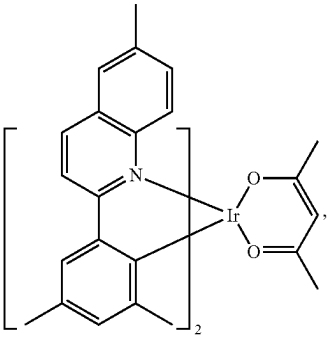


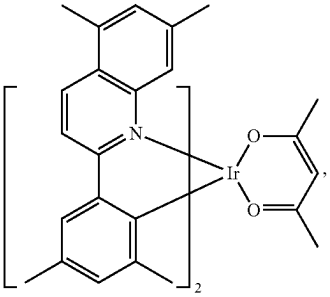
-continued

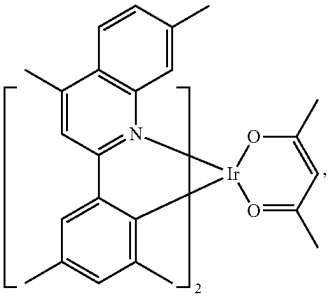




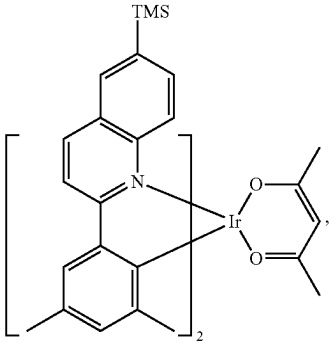


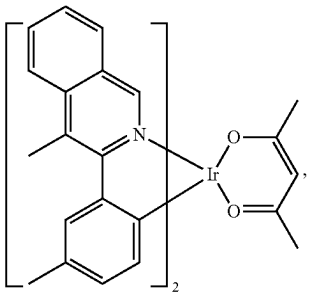


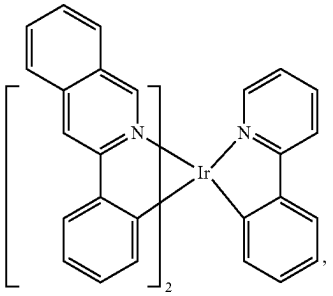


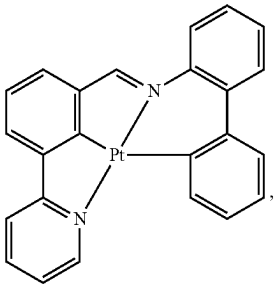


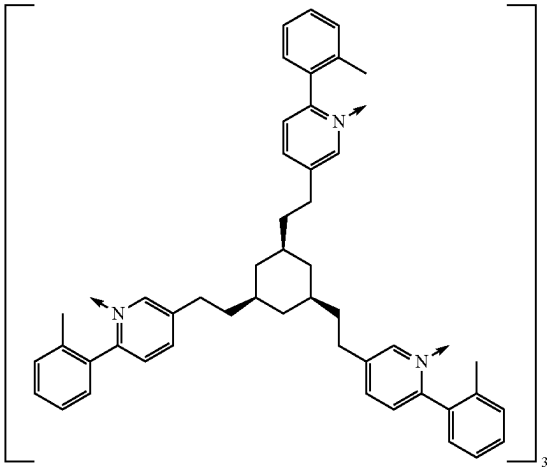
-continued



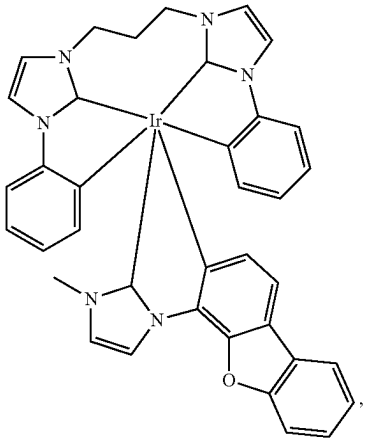


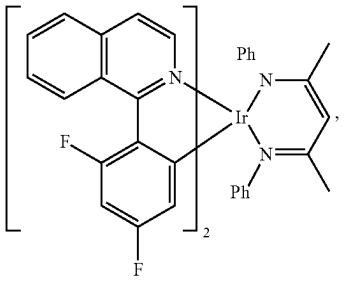


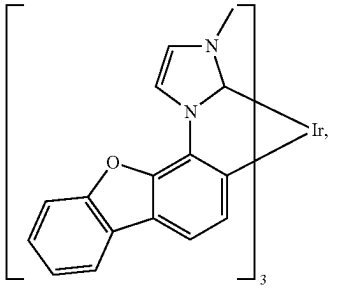


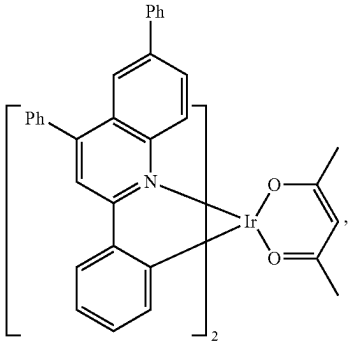


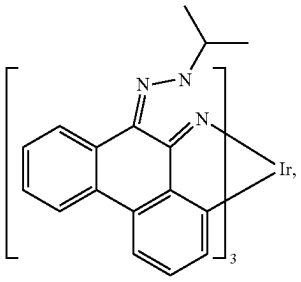
-continued



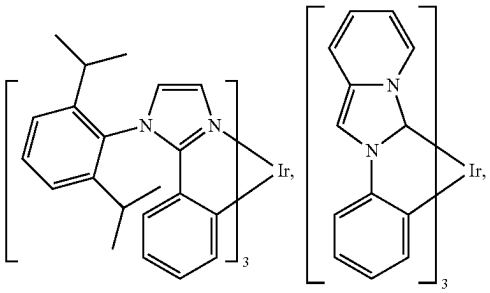


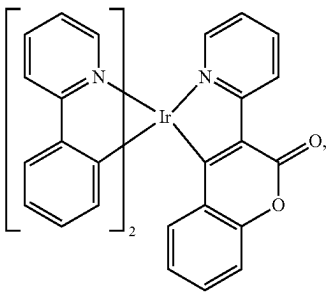


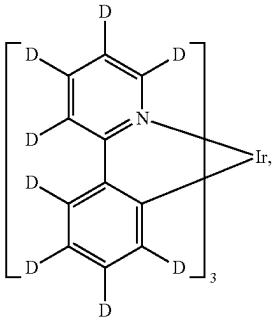


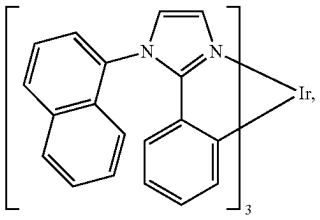


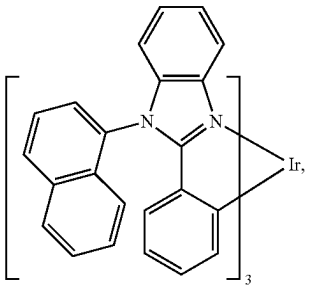
-continued

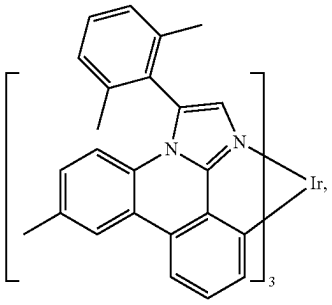




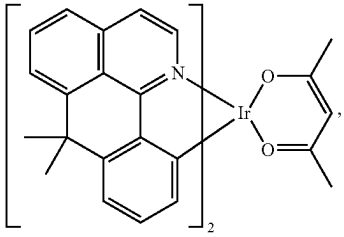


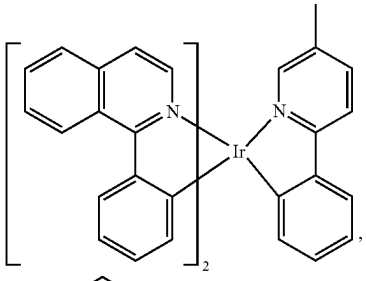


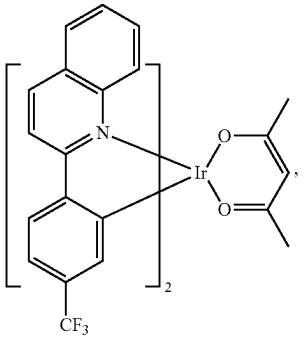


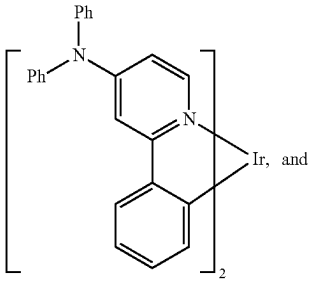


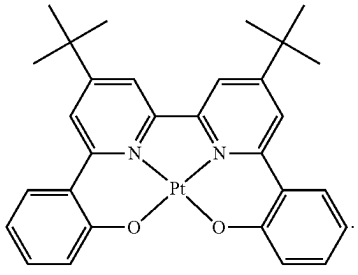
-continued











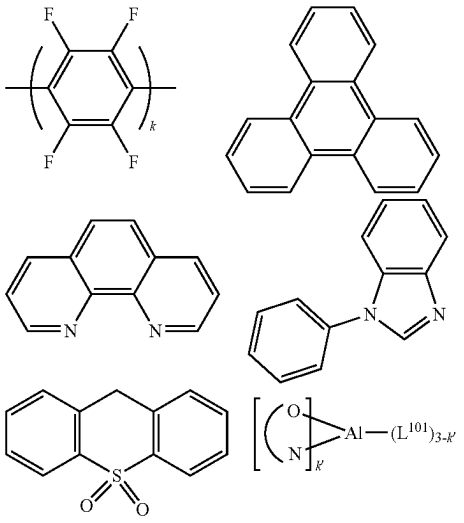
HBL:

A hole blocking layer (HBL) may be used to reduce the number of holes and/or excitons that leave the emissive layer. The presence of such a blocking layer in a device may result in substantially higher efficiencies and/or longer lifetime as compared to a similar device lacking a blocking layer. Also, a blocking layer may be used to confine emission to a desired region of an OLED. In some embodiments, the HBL material has a lower HOMO (further from the vacuum level) and/or higher triplet energy than the emitter closest to the HBL interface. In some embodiments, the HBL material

has a lower HOMO (further from the vacuum level) and/or higher triplet energy than one or more of the hosts closest to the HBL interface.

In one aspect, compound used in HBL contains the same molecule or the same functional groups used as host described above.

In another aspect, compound used in HBL contains at least one of the following groups in the molecule:

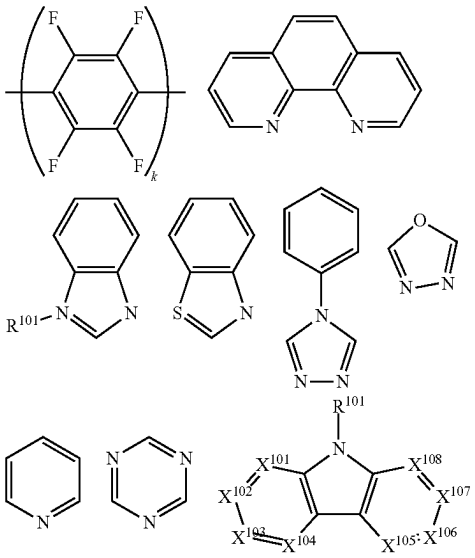


wherein k is an integer from 1 to 20; L^{101} is an another ligand, k' is an integer from 1 to 3.

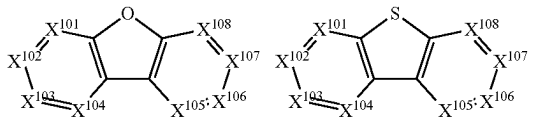
ETL:

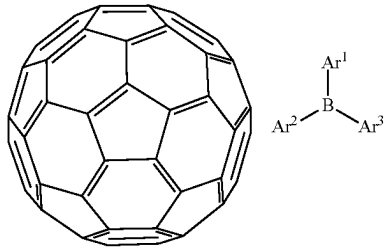
Electron transport layer (ETL) may include a material capable of transporting electrons. Electron transport layer may be intrinsic (undoped), or doped. Doping may be used to enhance conductivity. Examples of the ETL material are not particularly limited, and any metal complexes or organic compounds may be used as long as they are typically used to transport electrons.

In one aspect, compound used in ETL contains at least one of the following groups in the molecule:



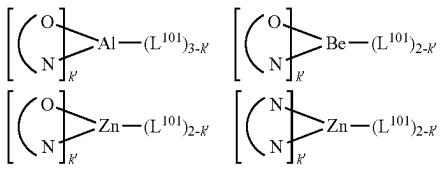
-continued





wherein R^{101} is selected from the group consisting of hydrogen, deuterium, halogen, alkyl, cycloalkyl, heteroalkyl, heterocycloalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carboxylic acids, ether, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof, when it is aryl or heteroaryl, it has the similar definition as Ar's mentioned above. Ar^1 to Ar^3 has the similar definition as Ar's mentioned above. k is an integer from 1 to 20. X^{101} to X^{108} is selected from C (including CH) or N.

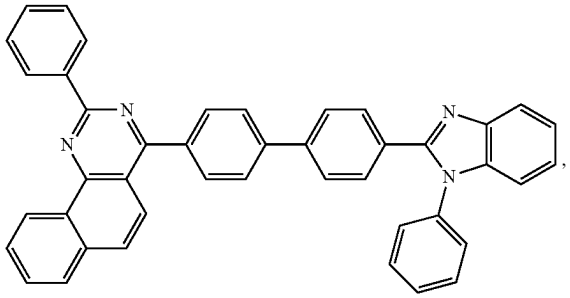
In another aspect, the metal complexes used in ETL contains, but not limit to the following general formula:

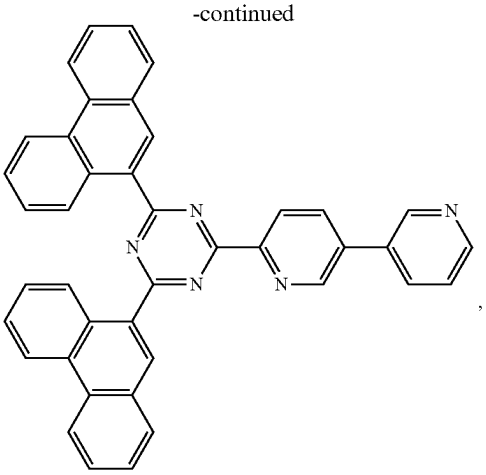


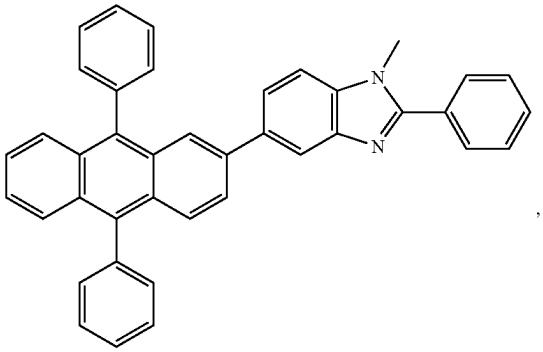
wherein (O—N) or (N—N) is a bidentate ligand, having metal coordinated to atoms O, N or N, N; L^{101} is another ligand; k' is an integer value from 1 to the maximum number of ligands that may be attached to the metal.

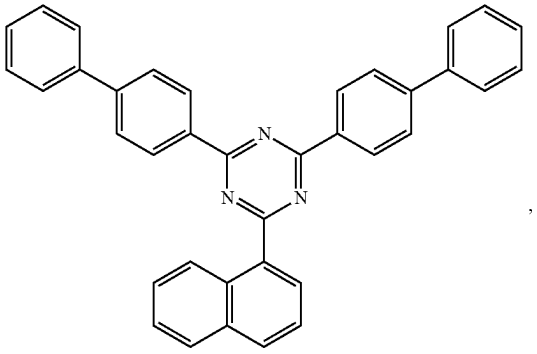
Non-limiting examples of the ETL materials that may be used in an OLED in combination with materials disclosed herein are exemplified below together with references that disclose those materials: CN103508940, EP01602648, EP01734038, EP01956007, JP2004-022334, JP2005149918, JP2005-268199, KR0117693, KR20130108183, US20040036077, US20070104977, US2007018155, US20090101870, US20090115316, US20090140637, US20090179554, US2009218940, US2010108990, US2011156017, US2011210320, US2012193612, US2012214993, US2014014925, US2014014927, US20140284580, U.S. Pat. Nos. 6,656,612, 8,415,031, WO2003060956, WO2007111263, WO2009148269, WO2010067894, WO2010072300, WO2011074770, WO2011105373, WO2013079217, WO2013145667, WO2013180376, WO2014104499, WO2014104535,

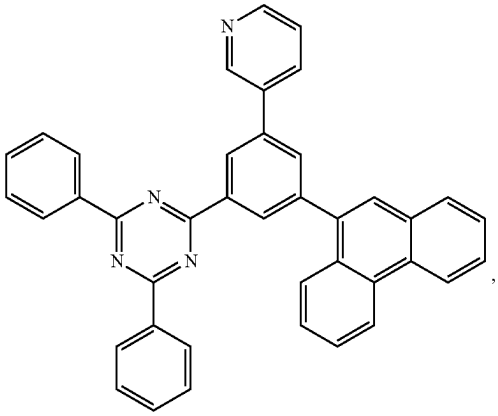
-continued

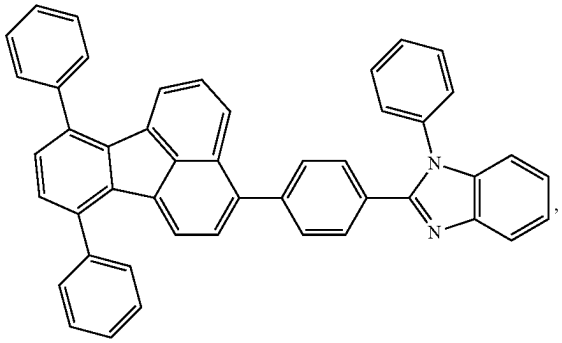


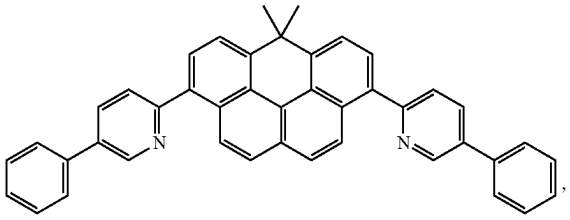


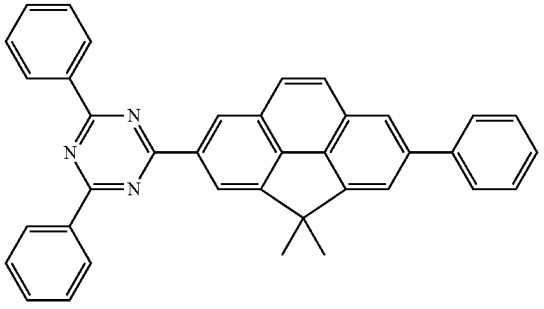




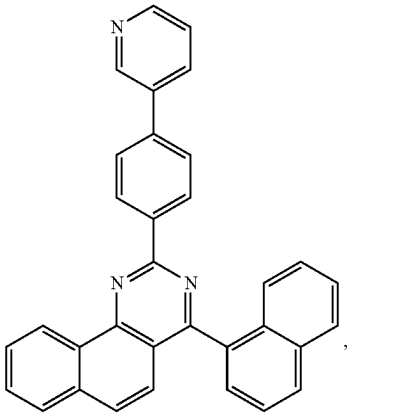


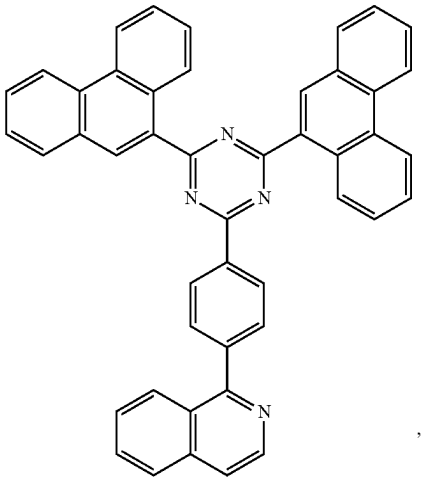


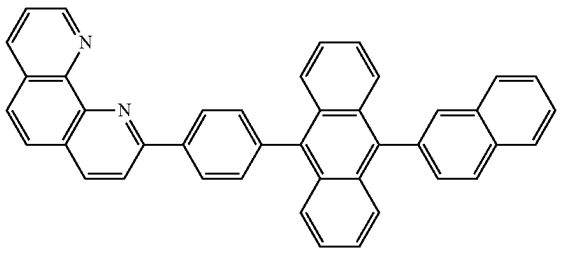


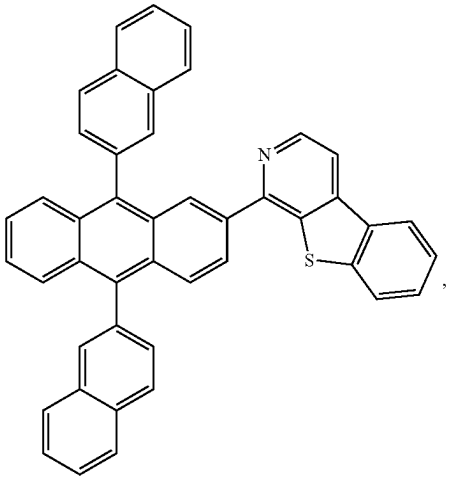


-continued

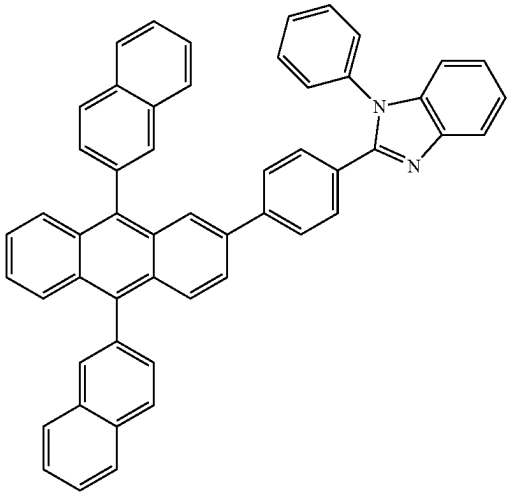


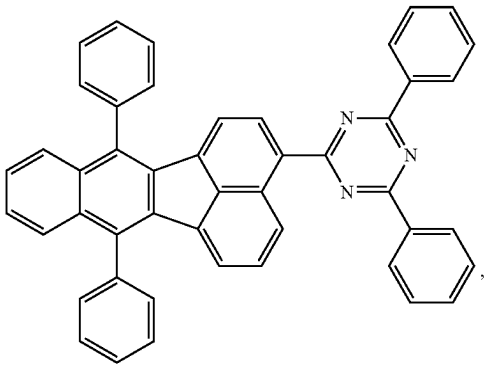


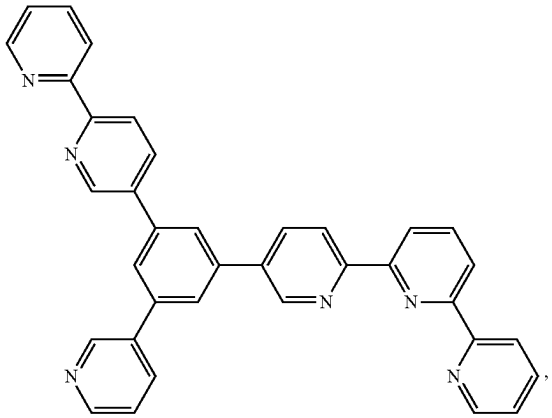




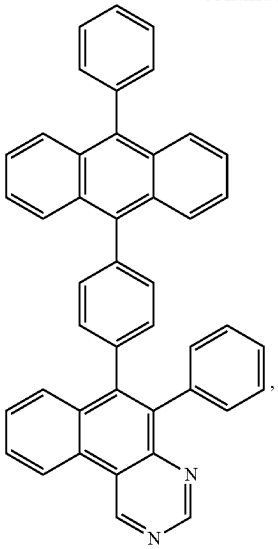
-continued



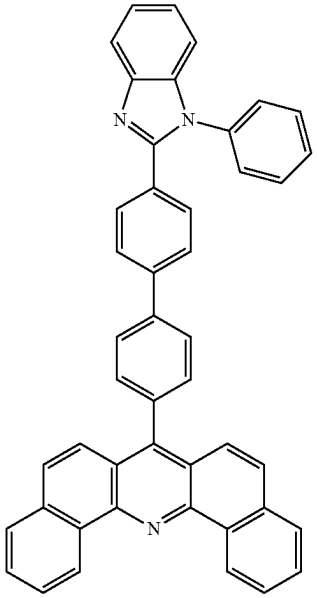


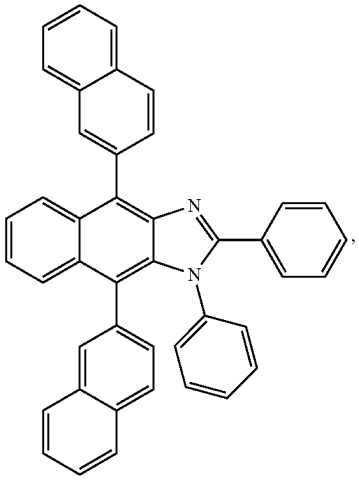


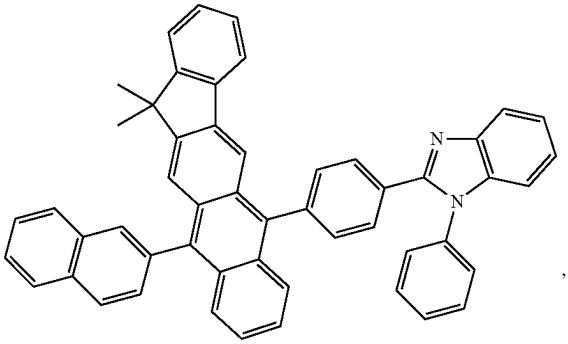
-continued

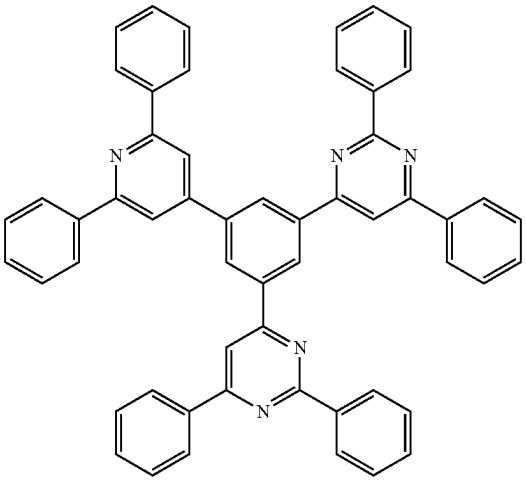


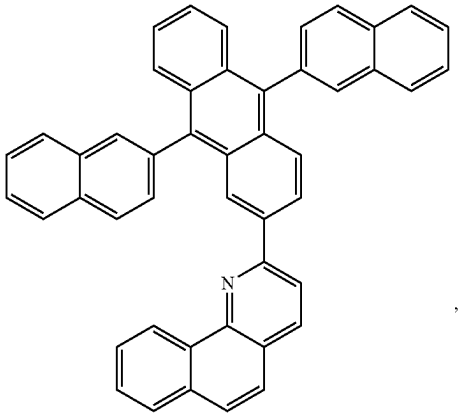
-continued

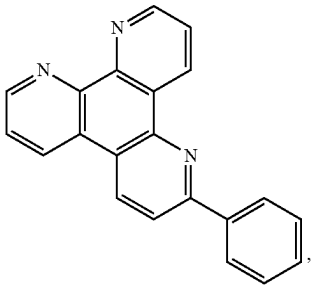




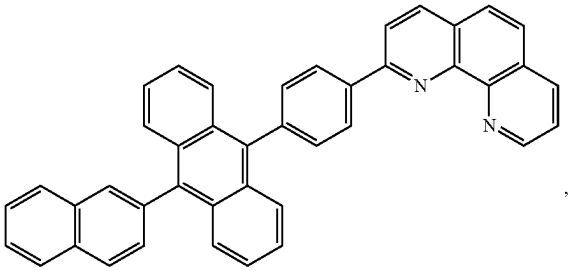


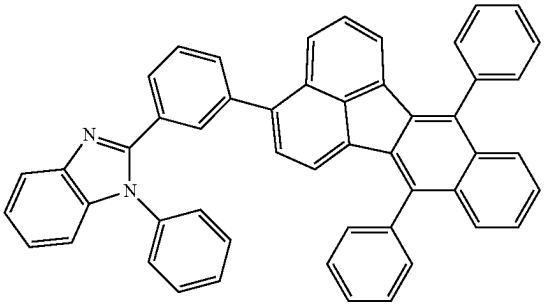


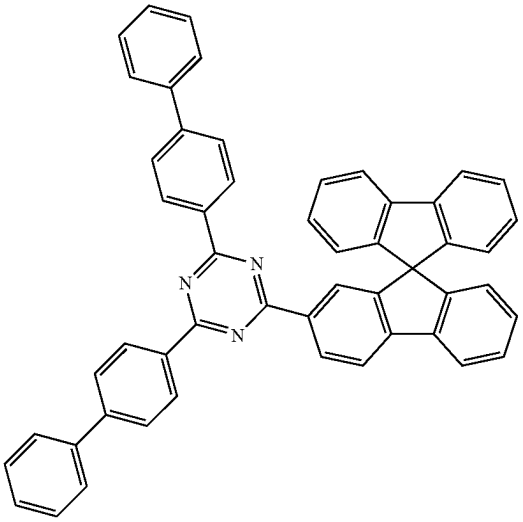


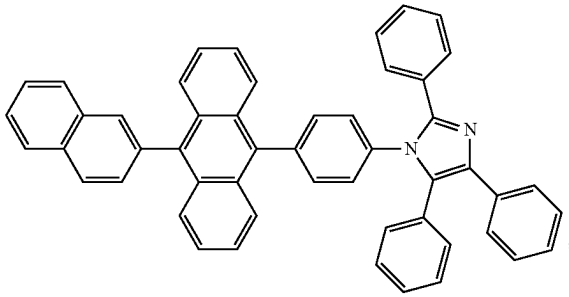


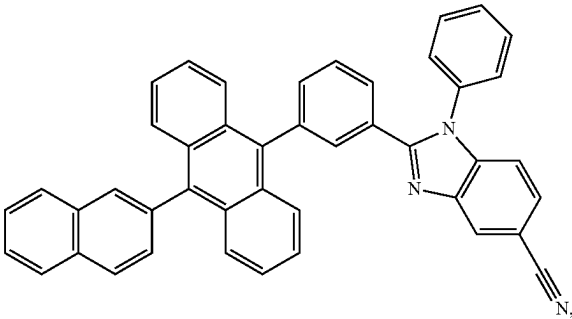
-continued



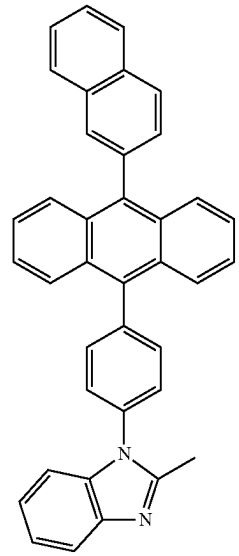


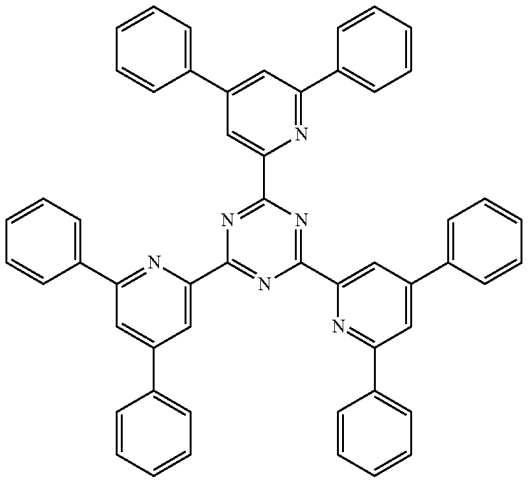


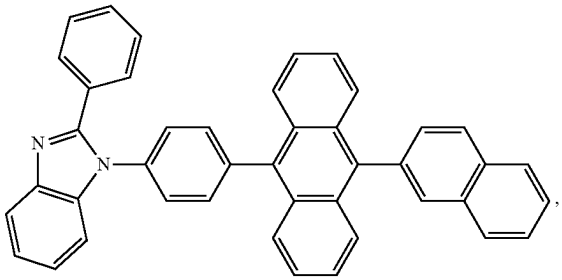


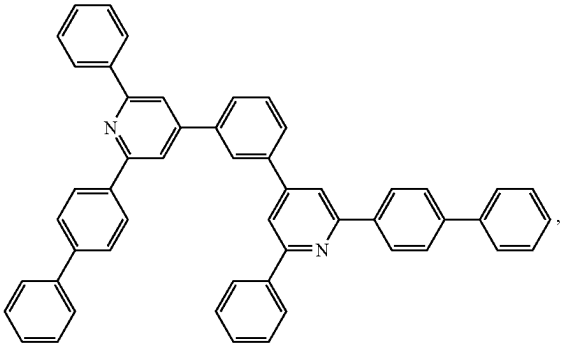


-continued

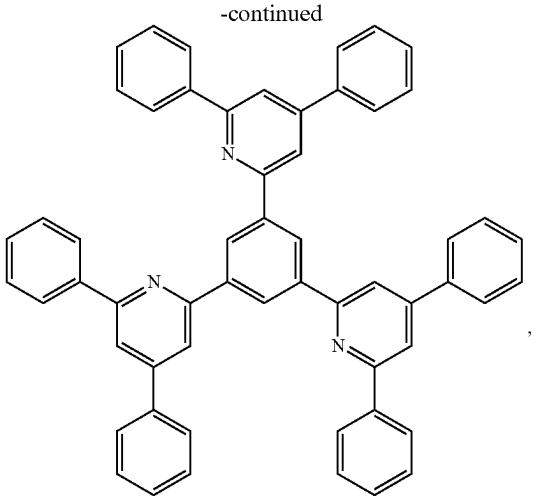




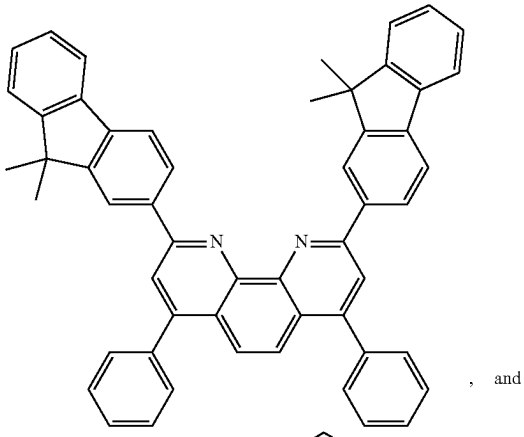




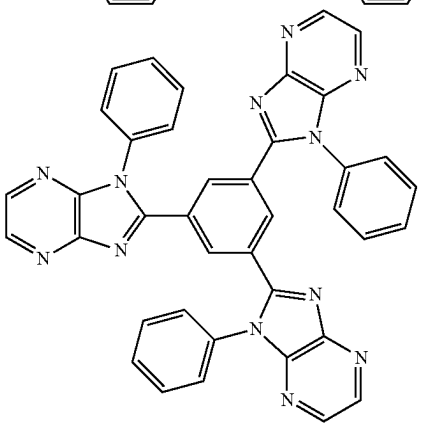
-continued



,



, and



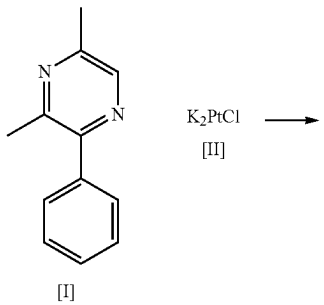
.

Charge Generation Layer (CGL)

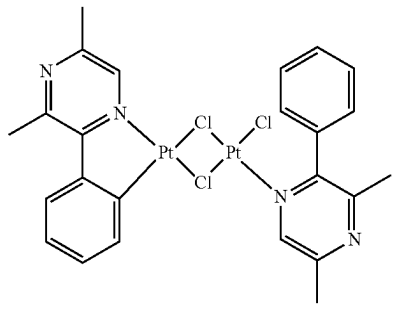
In tandem or stacked OLEDs, the CGL plays an essential role in the performance, which is composed of an n-doped layer and a p-doped layer for injection of electrons and holes, respectively. Electrons and holes are supplied from the CGL and electrodes. The consumed electrons and holes in the CGL are refilled by the electrons and holes injected from the cathode and anode, respectively; then, the bipolar currents reach a steady state gradually. Typical CGL materials include n and p conductivity dopants used in the transport layers.

In any above-mentioned compounds used in each layer of the OLED device, the hydrogen atoms can be partially or fully deuterated. Thus, any specifically listed substituent, such as, without limitation, methyl, phenyl, pyridyl, etc. may be undeuterated, partially deuterated, and fully deuterated versions thereof. Similarly, classes of substituents such as, without limitation, alkyl, aryl, cycloalkyl, heteroaryl, etc. also may be undeuterated, partially deuterated, and fully deuterated versions thereof.

EXPERIMENTAL



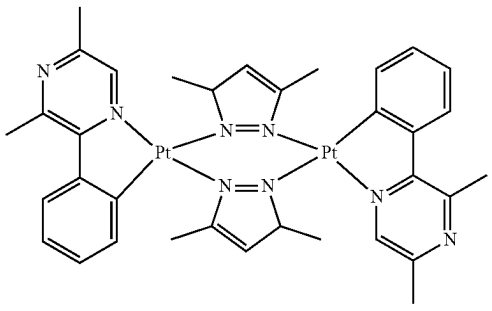
[I]



[III]

A 250 mL RBF was charged with 2-EtOEtOH (120 ml), Water (40.2 ml), 3,5-dimethyl-2-phenylpyrazine (1.953 g, 10.60 mmol) and potassium tetrachloroplatinate (2 g, 4.82 mmol). The reaction was degassed with nitrogen and heated at 80 C overnight. Reaction solution is clear, amber in color. After 16 hrs the reaction is a light yellow, cloudy suspension. Cooled to room temp and filtered, washed with water and MeOH, and dried in vacuo

Preparation of Example Compound 1

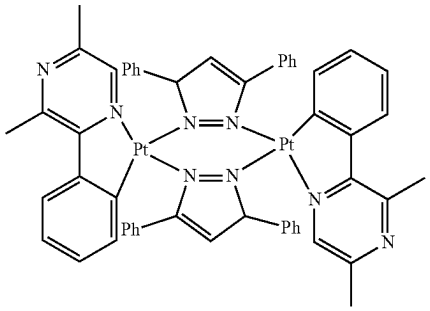


Example Compound 1

A 250 mL RBF was charged with the bis-Pt compound [III] (1.25 g, 1.447 mmol), 3,5-dimethyl-1H-pyrazole (0.278 g, 2.89 mmol), DCM (145 ml) and degassed with nitrogen.

Sodium methanolate (0.195 g, 3.62 mmol) was added and the reaction was heated to reflux overnight at 55 C. The reaction solution gradually changes from yellow to orange. The solvent was removed in vacuo, orange residue dissolved in a minimal amount of DCM and passed through a plug of silica with ~10% EtOAc/DCM. Concentrated to orange solids. Purified by column chromatography in 0-5% EtOAc, 25-50% DCM/heptanes. Pure fractions combined and concentrated to orange solids.

Reparation of Example Compound 2

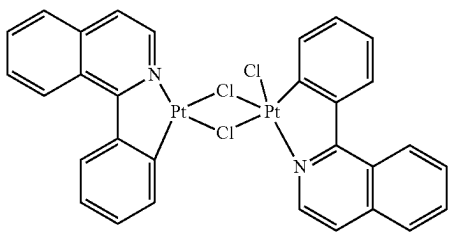


Example Compound 2

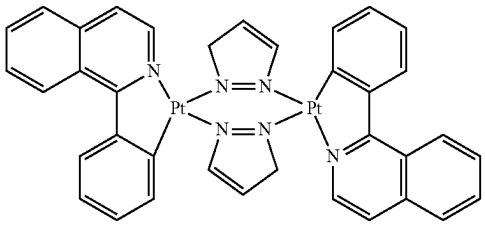
A 250 mL RBF was charged with bis-Pt compound [III] (1.1 g, 1.273 mmol), 3,5-diphenyl-1H-pyrazole (0.561 g, 2.55 mmol), DCM (127 ml) and degassed with nitrogen. Sodium methanolate (0.172 g, 3.18 mmol) was added and the reaction was heated to reflux overnight at 55 C. The reaction solution gradually changes from yellow to red. Solvent removed in vacuo, red residue dissolved in a minimal amount of DCM and passed through a plug of silica with ~10% EtOAc/DCM. Concentrated to orange solids. Purified by column chromatography in 25-50% DCM/heptanes, then 0-5% EtOAc/50% DCM/heptanes. Pure fractions combined and concentrated to ~0.5 g orange solids. Purified by column chromatography on 2 untreated columns as in Example 1. Fractions analyzed by HPLC.

Preparation of Bis-Pt Phenyl-Quinoline, Tris-Chloride [IV}

The similar procedure as the bis-Pt Compound [III] was used to prepare bis-Pt_phenyl-quinoline [IV].



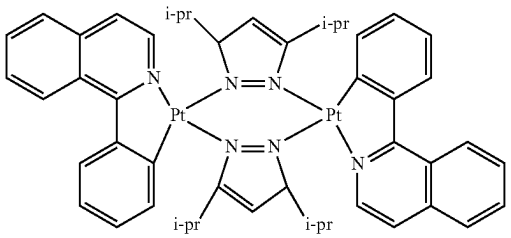
Preparation of Example Compound 3



Example Compound 3

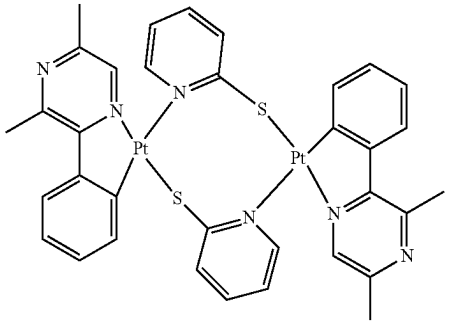
A 100 mL RBF was charged with the bis-Pt compound [IV] (1.5 g, 1.656 mmol), 1H-pyrazole (0.225 g, 3.31 mmol), DCM (166 ml) and degassed with nitrogen. Sodium methanolate (0.224 g, 4.14 mmol) was added and the reaction was heated to reflux overnight at 55 C. Continued reflux for 1 more day. Cooled to room temp. The product was filtered through an untreated plug of silica with DCM and concentrated to 1.4 g orange/red solids. The solids are ~99% pure (mixture of 2 isomers). Recombined filtrate and solids, loaded on celite and purified by column chromatography in 50% DCM/heptanes on untreated columns.

Preparation of Example Compound 4



Example Compound 4. A 500 mL RBF was charged with "dimer" (1.2 g, 1.324 mmol), 3,5-diisopropyl-1H-pyrazole (0.403 g, 2.65 mmol), DCM (132 ml) and degassed with nitrogen. sodium methanolate (0.179 g, 3.31 mmol) was added and the reaction was heated to reflux for 48 hrs at 55 C. Cooled to room temp, loaded on Celite and purified by column chromatography in 25-50% DCM/heptanes on untreated columns Most intense fractions combined and concentrated to ~0.5 g red solids. HPLC indicates 99.2% pure.

Preparation of Example Compound 5



Example Compound 5

A 25 mL RBF was charged with "dimer" (1.5 g, 2.508 mmol), pyridine-2-thiol (0.418 g, 3.76 mmol), Methanol (84 ml) and degassed with nitrogen. Bright yellow suspension. potassium carbonate (0.381 g, 2.76 mmol) was added causing an immediate color change to red. The reaction solution was degassed by swing purging with nitrogen 3× and heated to reflux at 65 C. Cooled to room temp and filtered through filter paper with MeOH. Red filtrate discarded. The brown solids were extracted with DCM, a brown/red filtrate concentrated to ~1.5 g dark solids. Loaded on celite and purified by column chroamtography in 50% DCM/heptanes—5% MeOH 50% DCM 45% heptanes.

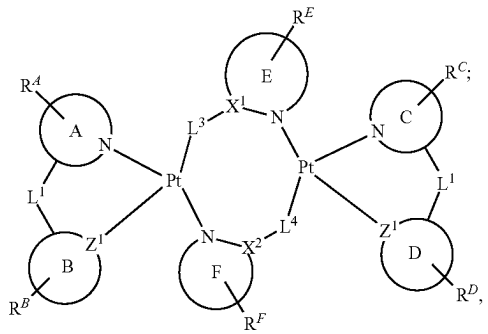
An OLED was made using general materials and methods well known in the OLED art. The OLED emitted light with a peak wavelength of about 590 nm.

It is understood that the various embodiments described herein are by way of example only, and are not intended to limit the scope of the invention. For example, many of the materials and structures described herein may be substituted with other materials and structures without deviating from the spirit of the invention. The present invention as claimed may therefore include variations from the particular examples and preferred embodiments described herein, as will be apparent to one of skill in the art. It is understood that various theories as to why the invention works are not intended to be limiting.

We claim:

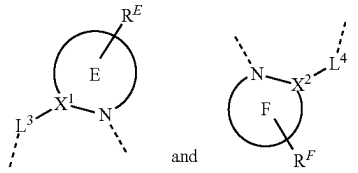
1. A compound of formula (I):

Formula I



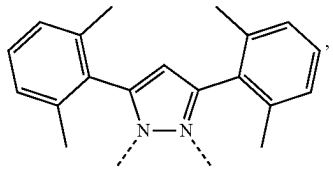
wherein

ring B and ring D are independently a 5-membered, or 6-membered, carbocyclic or heterocyclic ring;

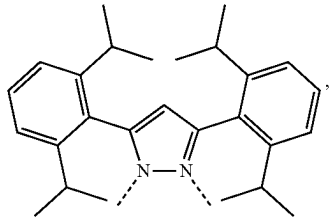


are independently selected from the group consisting of:

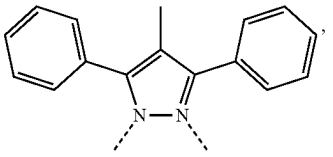
L_{C7}



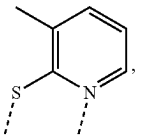
L_{C8}



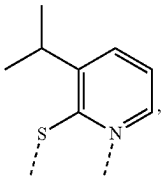
L_{C12}



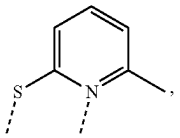
L_{C15}



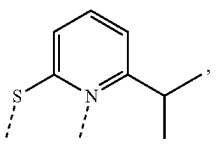
L_{C16}



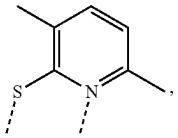
L_{C17}



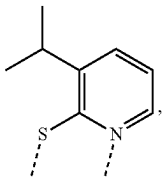
L_{C18}



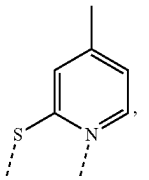
-continued



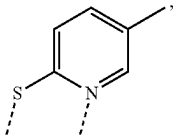
L_{C19}



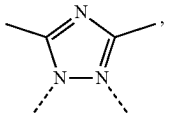
L_{C20}



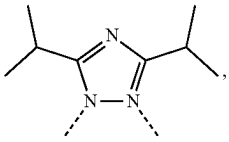
L_{C21}



L_{C22}

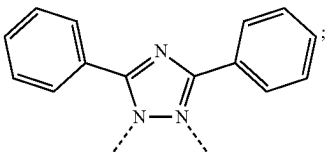


L_{C27}



and

L_{C28}



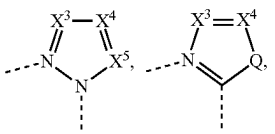
L_{C29}

Z^1 and Z^2 are independently an anionic coordinating atom selected from the group consisting of C and N;

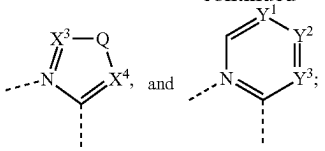
R^A, R^B, R^C, and R^D independently represent no substitution to the maximum allowable number of substituents;

L^1 and L^2 are independently selected from the group consisting of a direct bond, CRR', SiRR', NR', O, and S;

wherein the ring A and the ring C are independently selected from the group consisting of



-continued



and

wherein

X^3, X^4, and X^5 are independently selected from the group consisting of CR^A and N;

Q is selected from the group consisting of CRR', SiRR', NR, O, and S;

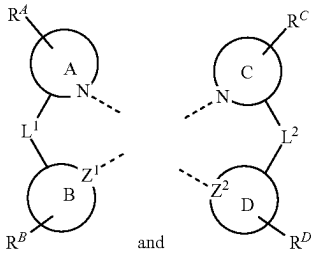
Y^1, Y^2, and Y^3 are each independently selected from the group consisting of CR^A and N; wherein at least one of Y^1, Y^2, and Y^3 is N; and the dash lines represent N-coordination to Pt, and a connection to L^1 or L^2 of ring B or ring D, respectively, or if L^1 and/or L^2 is a direct bond, then to ring B or ring D, respectively;

each R^A, R^B, R^C, and R^D are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; or optionally, any two adjacent R^A, R^B, R^C, and R^D can join to form a ring; and

R and R' are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, aryl, heteroaryl, and combinations thereof; or optionally, any two adjacent R and R' can join to form a ring.

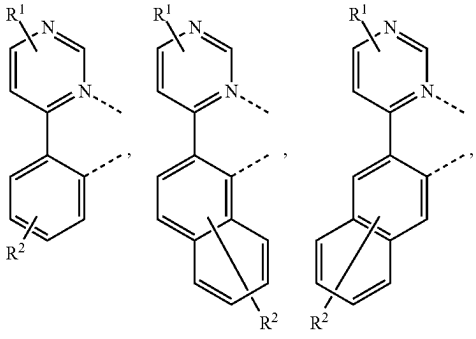
2. The compound of claim **1**, wherein the ring B and the ring D are each a 6-membered carbocyclic or heterocyclic ring.

3. The compound of claim **1**, wherein the ligands

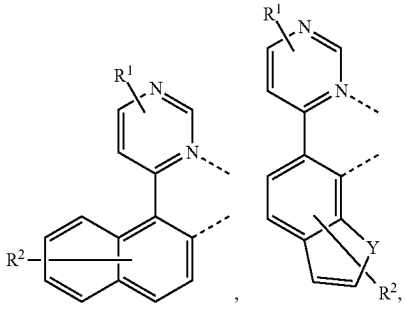


and

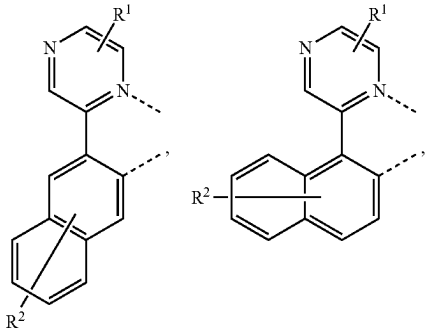
are each independently selected from the group consisting of:

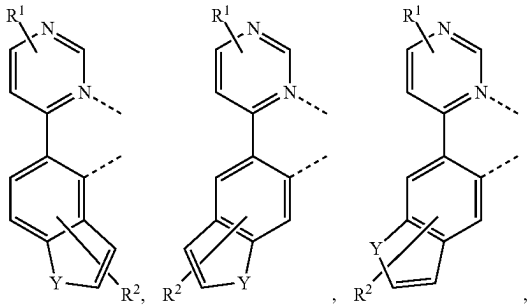


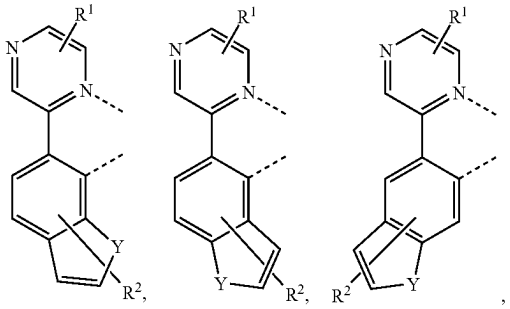
-continued

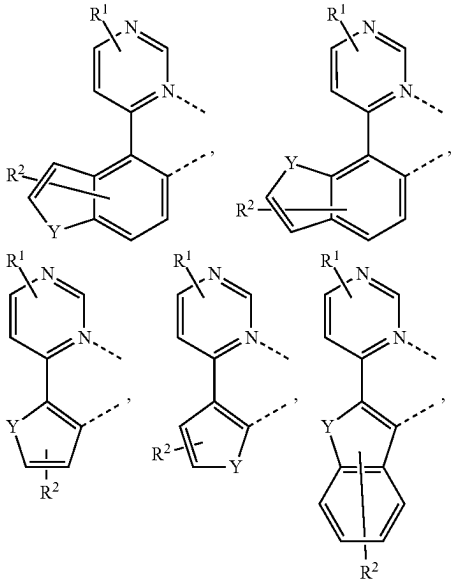


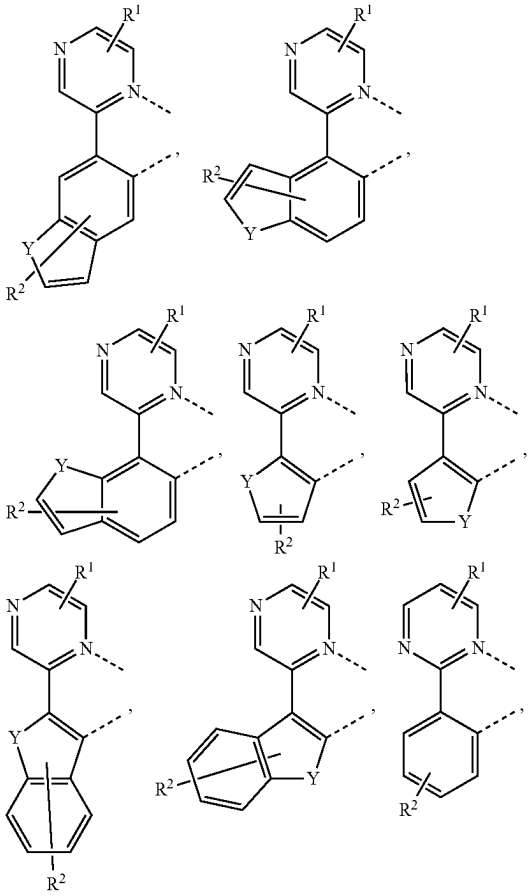
-continued



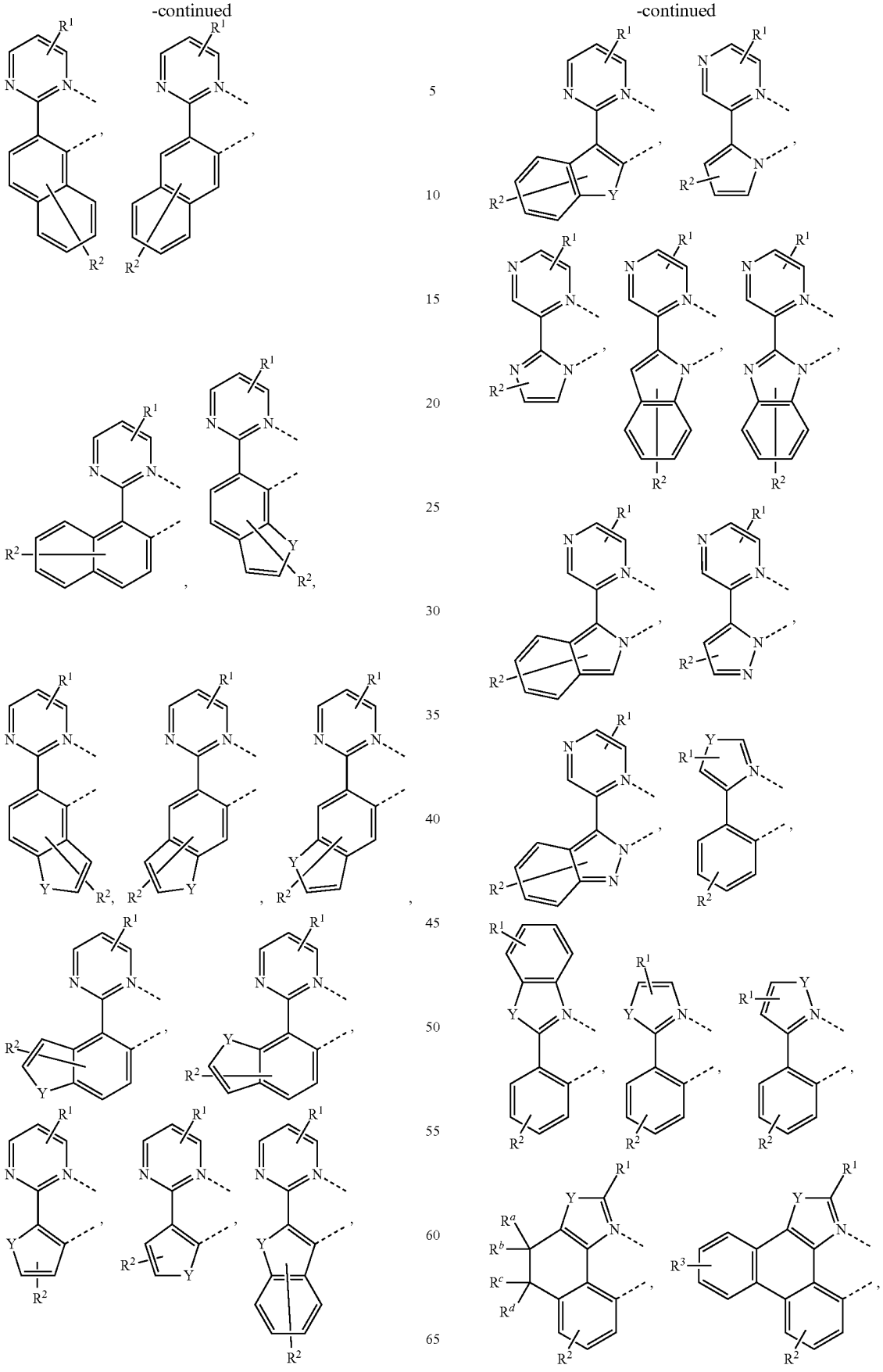




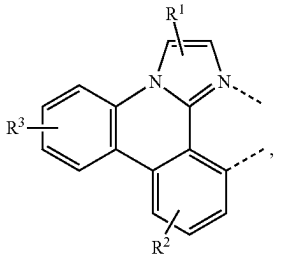


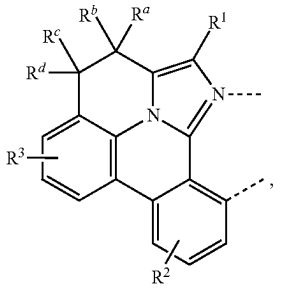


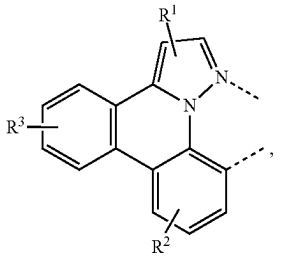
-continued

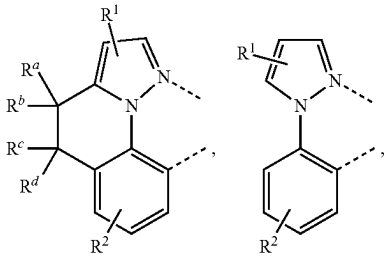


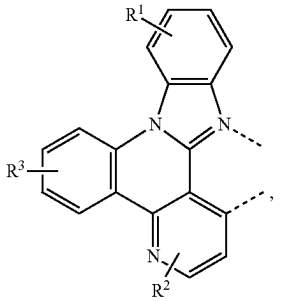
-continued

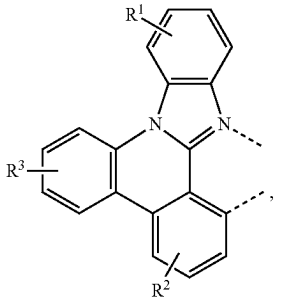




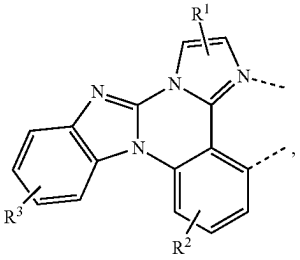


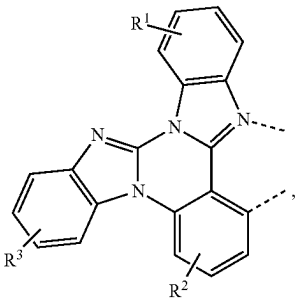


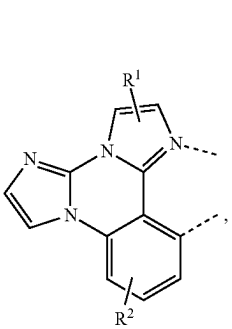


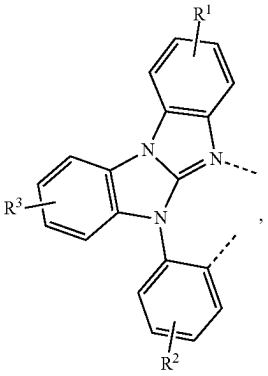


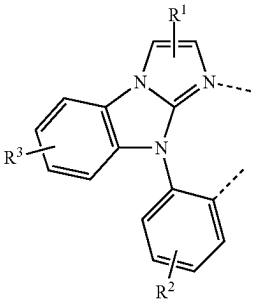
-continued

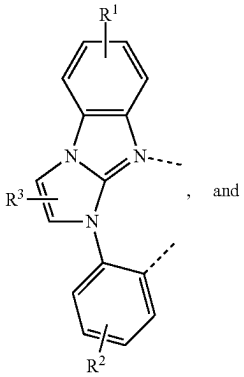




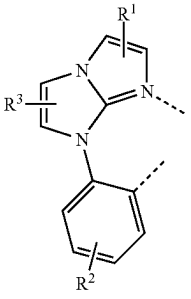








and



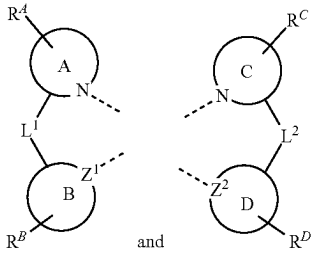
wherein

Y is selected from the group consisting of S, O, Se, CRR', SiRR', BR', and NR';

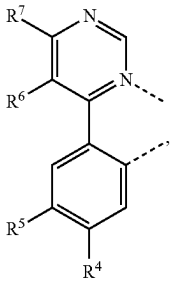
R^1, R^2, R^3 independently represent none to the maximum allowable number of substituents;

each R^a, R^b, R^c and R^d, and each R^1, R^2, and R^3, are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; or optionally any two adjacent substitutions in R^a, R^b, R^c, R^d, R^1, R^2, and R^3 can join to form a ring.

4. The compound of claim **1**, wherein the ligands



are the same or different, and are independently selected from the group consisting of: L_{A1} through L_{A306} based on a structure of Formula X,



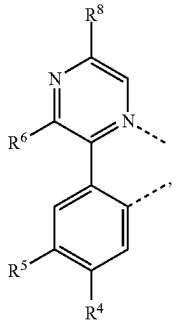
in which R^4, R^5, R^6, and R^7 are defined as:

	R^4	R^5	R^6	R^7
L_{A1}	H	H	H	H
L_{A2}	H	H	R^{B1}	H
L_{A3}	H	H	R^{B3}	H
L_{A4}	H	H	R^{B4}	H
L_{A5}	H	H	R^{B7}	H
L_{A6}	H	H	R^{B12}	H
L_{A7}	H	H	R^{B18}	H
L_{A8}	H	H	R^{A3}	H
L_{A9}	H	H	R^{A34}	H
L_{A10}	R^{B1}	H	H	H
L_{A11}	R^{B1}	H	R^{B1}	H
L_{A12}	R^{B1}	H	R^{B3}	H
L_{A13}	R^{B1}	H	R^{B4}	H
L_{A14}	R^{B1}	H	R^{B7}	H
L_{A15}	R^{B1}	H	R^{B12}	H
L_{A16}	R^{B1}	H	R^{B18}	H
L_{A17}	R^{B1}	H	R^{A3}	H
L_{A18}	R^{B1}	H	R^{A34}	H
L_{A19}	R^{B2}	H	H	H
L_{A20}	R^{B2}	H	R^{B1}	H
L_{A21}	R^{B2}	H	R^{B3}	H
L_{A22}	R^{B2}	H	R^{B4}	H
L_{A23}	R^{B2}	H	R^{B7}	H
L_{A24}	R^{B2}	H	R^{B12}	H
L_{A25}	R^{B2}	H	R^{B18}	H
L_{A26}	R^{B2}	H	R^{A3}	H
L_{A27}	R^{B2}	H	R^{A34}	H
L_{A28}	R^{B3}	H	H	H
L_{A29}	R^{B3}	H	R^{B1}	H
L_{A30}	R^{B3}	H	R^{B3}	H
L_{A31}	R^{B3}	H	R^{B4}	H
L_{A32}	R^{B3}	H	R^{B7}	H
L_{A33}	R^{B3}	H	R^{B12}	H
L_{A34}	R^{B3}	H	R^{B18}	H
L_{A35}	R^{B3}	H	R^{A3}	H
L_{A36}	R^{B3}	H	R^{A34}	H
L_{A37}	H	R^{B1}	H	H
L_{A38}	H	R^{B1}	R^{B1}	H
L_{A39}	H	R^{B1}	R^{B3}	H
L_{A40}	H	R^{B1}	R^{B4}	H
L_{A41}	H	R^{B1}	R^{B7}	H
L_{A42}	H	R^{B1}	R^{B12}	H
L_{A43}	H	R^{B1}	R^{B18}	H
L_{A44}	H	R^{B1}	R^{A3}	H
L_{A45}	H	R^{B1}	R^{A34}	H
L_{A46}	H	R^{B2}	H	H
L_{A47}	H	R^{B2}	R^{B1}	H
L_{A48}	H	R^{B2}	R^{B3}	H
L_{A49}	H	R^{B2}	R^{B4}	H
L_{A50}	H	R^{B2}	R^{B7}	H
L_{A51}	H	R^{B2}	R^{B12}	H
L_{A52}	H	R^{B2}	R^{B18}	H
L_{A53}	H	R^{B2}	R^{A3}	H
L_{A54}	H	R^{B2}	R^{A34}	H
L_{A55}	H	R^{B3}	H	H
L_{A56}	H	R^{B3}	R^{B1}	H
L_{A57}	H	R^{B3}	R^{B3}	H
L_{A58}	H	R^{B3}	R^{B4}	H
L_{A59}	H	R^{B3}	R^{B7}	H
L_{A60}	H	R^{B3}	R^{B12}	H
L_{A61}	H	R^{B3}	R^{B18}	H
L_{A62}	H	R^{B3}	R^{A3}	H
L_{A63}	H	R^{B3}	R^{A34}	H
L_{A64}	R^{B1}	R^{B1}	H	H
L_{A65}	R^{B1}	R^{B1}	R^{B1}	H
L_{A66}	R^{B1}	R^{B1}	R^{B3}	H
L_{A67}	R^{B1}	R^{B1}	R^{B4}	H
L_{A68}	R^{B1}	R^{B1}	R^{B7}	H
L_{A69}	R^{B1}	R^{B1}	R^{B12}	H
L_{A70}	R^{B1}	R^{B1}	R^{B18}	H
L_{A71}	R^{B1}	R^{B1}	R^{A3}	H
L_{A72}	R^{B1}	R^{B1}	R^{A34}	H
L_{A73}	R^{B2}	R^{B2}	H	H
L_{A74}	R^{B2}	R^{B2}	R^{B1}	H
L_{A75}	R^{B2}	R^{B2}	R^{B3}	H
L_{A76}	R^{B2}	R^{B2}	R^{B4}	H
L_{A77}	R^{B2}	R^{B2}	R^{B7}	H
L_{A78}	R^{B2}	R^{B2}	R^{B12}	H
L_{A79}	R^{B2}	R^{B2}	R^{B18}	H
L_{A80}	R^{B2}	R^{B2}	R^{A3}	H
L_{A81}	R^{B2}	R^{B2}	R^{A34}	H
L_{A82}	R^{B3}	R^{B3}	H	H
L_{A83}	R^{B3}	R^{B3}	R^{B1}	H
L_{A84}	R^{B3}	R^{B3}	R^{B3}	H
L_{A85}	R^{B3}	R^{B3}	R^{B4}	H
L_{A86}	R^{B3}	R^{B3}	R^{B7}	H
L_{A87}	R^{B3}	R^{B3}	R^{B12}	H
L_{A88}	R^{B3}	R^{B3}	R^{B18}	H
L_{A89}	R^{B3}	R^{B3}	R^{A3}	H
L_{A90}	R^{B3}	R^{B3}	R^{A34}	H
L_{A91}	H	H	H	R^{B1}
L_{A92}	H	H	H	R^{B3}
L_{A93}	H	H	H	R^{B4}
L_{A94}	H	H	H	R^{B7}
L_{A95}	H	H	H	R^{B12}
L_{A96}	H	H	H	R^{B18}
L_{A97}	H	H	H	R^{A3}
L_{A98}	H	H	H	R^{A34}
L_{A99}	R^{B1}	H	H	R^{B1}
L_{A100}	R^{B1}	H	H	R^{B3}

-continued

	R^4	R^5	R^6	R^7
L_{A101}	R^{B1}	H	H	R^{B4}
L_{A102}	R^{B1}	H	H	R^{B7}
L_{A103}	R^{B1}	H	H	R^{B12}
L_{A104}	R^{B1}	H	H	R^{B18}
L_{A105}	R^{B1}	H	H	R^{A3}
L_{A106}	R^{B1}	H	H	R^{A34}
L_{A107}	R^{B2}	H	H	R^{B1}
L_{A108}	R^{B2}	H	H	R^{B3}
L_{A109}	R^{B2}	H	H	R^{B4}
L_{A110}	R^{B2}	H	H	R^{B7}
L_{A111}	R^{B2}	H	H	R^{B12}
L_{A112}	R^{B2}	H	H	R^{B18}
L_{A113}	R^{B2}	H	H	R^{A3}
L_{A114}	R^{B2}	H	H	R^{A34}
L_{A115}	R^{B3}	H	H	R^{B1}
L_{A116}	R^{B3}	H	H	R^{B3}
L_{A117}	R^{B3}	H	H	R^{B4}
L_{A118}	R^{B3}	H	H	R^{B7}
L_{A119}	R^{B3}	H	H	R^{B12}
L_{A120}	R^{B3}	H	H	R^{B18}
L_{A121}	R^{B3}	H	H	R^{A3}
L_{A122}	R^{B3}	H	H	R^{A34}
L_{A123}	H	R^{B1}	H	R^{B1}
L_{A124}	H	R^{B1}	H	R^{B3}
L_{A125}	H	R^{B1}	H	R^{B4}
L_{A126}	H	R^{B1}	H	R^{B7}
L_{A127}	H	R^{B1}	H	R^{B12}
L_{A128}	H	R^{B1}	H	R^{B18}
L_{A129}	H	R^{B1}	H	R^{A3}
L_{A130}	H	R^{B1}	H	R^{A34}
L_{A131}	H	R^{B2}	H	R^{B1}
L_{A132}	H	R^{B2}	H	R^{B3}
L_{A133}	H	R^{B2}	H	R^{B4}
L_{A134}	H	R^{B2}	H	R^{B7}
L_{A135}	H	R^{B2}	H	R^{B12}
L_{A136}	H	R^{B2}	H	R^{B18}
L_{A137}	H	R^{B2}	H	R^{A3}
L_{A138}	H	R^{B2}	H	R^{A34}
L_{A139}	H	R^{B3}	H	R^{B1}
L_{A140}	H	R^{B3}	H	R^{B3}
L_{A141}	H	R^{B3}	H	R^{B4}
L_{A142}	H	R^{B3}	H	R^{B7}
L_{A143}	H	R^{B3}	H	R^{B12}
L_{A144}	H	R^{B3}	H	R^{B18}
L_{A145}	H	R^{B3}	H	R^{A3}
L_{A146}	H	R^{B3}	H	R^{A34}
L_{A147}	R^{B1}	R^{B1}	H	R^{B1}
L_{A148}	R^{B1}	R^{B1}	H	R^{B3}
L_{A149}	R^{B1}	R^{B1}	H	R^{B4}
L_{A150}	R^{B1}	R^{B1}	H	R^{B7}
L_{A151}	R^{B1}	R^{B1}	H	R^{B12}
L_{A152}	R^{B1}	R^{B1}	H	R^{B18}
L_{A153}	R^{B1}	R^{B1}	H	R^{A3}
L_{A154}	R^{B1}	R^{B1}	H	R^{A34}
L_{A155}	R^{B2}	R^{B2}	H	R^{B1}
L_{A156}	R^{B2}	R^{B2}	H	R^{B3}
L_{A157}	R^{B2}	R^{B2}	H	R^{B4}
L_{A158}	R^{B2}	R^{B2}	H	R^{B7}
L_{A159}	R^{B2}	R^{B2}	H	R^{B12}
L_{A160}	R^{B2}	R^{B2}	H	R^{B18}
L_{A161}	R^{B2}	R^{B2}	H	R^{A3}
L_{A162}	R^{B2}	R^{B2}	H	R^{A34}
L_{A163}	R^{B3}	R^{B3}	H	R^{B1}
L_{A164}	R^{B3}	R^{B3}	H	R^{B3}
L_{A165}	R^{B3}	R^{B3}	H	R^{B4}
L_{A166}	R^{B3}	R^{B3}	H	R^{B7}
L_{A167}	R^{B3}	R^{B3}	H	R^{B12}
L_{A168}	R^{B3}	R^{B3}	H	R^{B18}
L_{A169}	R^{B3}	R^{B3}	H	R^{A3}
L_{A170}	R^{B3}	R^{B3}	H	R^{A34}

or the ligands L_{A171} through L_{A380}, which are based on a structure of Formula XI,



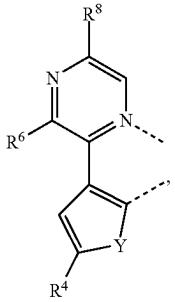
in which R^4, R^5, R^6, and R^8 are defined as:

	R^4	R^5	R^6	R^8
L_{A171}	H	H	H	H
L_{A172}	H	H	R^{B1}	H
L_{A173}	H	H	R^{B3}	H
L_{A174}	H	H	R^{B4}	H
L_{A175}	H	H	R^{B7}	H
L_{A176}	H	H	R^{B12}	H
L_{A177}	H	H	R^{B18}	H
L_{A178}	H	H	R^{A3}	H
L_{A179}	H	H	R^{A34}	H
L_{A180}	R^{B1}	H	H	H
L_{A181}	R^{B1}	H	R^{B1}	H
L_{A182}	R^{B1}	H	R^{B3}	H
L_{A183}	R^{B1}	H	R^{B4}	H
L_{A184}	R^{B1}	H	R^{B7}	H
L_{A185}	R^{B1}	H	R^{B12}	H
L_{A186}	R^{B1}	H	R^{B18}	H
L_{A187}	R^{B1}	H	R^{A3}	H
L_{A188}	R^{B1}	H	R^{A34}	H
L_{A189}	R^{B2}	H	H	H
L_{A190}	R^{B2}	H	R^{B1}	H
L_{A191}	R^{B2}	H	R^{B3}	H
L_{A192}	R^{B2}	H	R^{B4}	H
L_{A193}	R^{B2}	H	R^{B7}	H
L_{A194}	R^{B2}	H	R^{B12}	H
L_{A195}	R^{B2}	H	R^{B18}	H
L_{A196}	R^{B2}	H	R^{A3}	H
L_{A197}	R^{B2}	H	R^{A34}	H
L_{A198}	R^{B3}	H	H	H
L_{A199}	R^{B3}	H	R^{B1}	H
L_{A200}	R^{B3}	H	R^{B3}	H
L_{A201}	R^{B3}	H	R^{B4}	H
L_{A202}	R^{B3}	H	R^{B7}	H
L_{A203}	R^{B3}	H	R^{B12}	H
L_{A204}	R^{B3}	H	R^{B18}	H
L_{A205}	R^{B3}	H	R^{A3}	H
L_{A206}	R^{B3}	H	R^{A34}	H
L_{A207}	H	R^{B1}	H	H
L_{A208}	H	R^{B1}	R^{B1}	H
L_{A209}	H	R^{B1}	R^{B3}	H
L_{A210}	H	R^{B1}	R^{B4}	H
L_{A211}	H	R^{B1}	R^{B7}	H
L_{A212}	H	R^{B1}	R^{B12}	H
L_{A213}	H	R^{B1}	R^{B18}	H
L_{A214}	H	R^{B1}	R^{A3}	H
L_{A215}	H	R^{B1}	R^{A34}	H
L_{A216}	H	R^{B2}	H	H
L_{A217}	H	R^{B2}	R^{B1}	H
L_{A218}	H	R^{B2}	R^{B3}	H
L_{A219}	H	R^{B2}	R^{B4}	H
L_{A220}	H	R^{B2}	R^{B7}	H
L_{A221}	H	R^{B2}	R^{B12}	H
L_{A222}	H	R^{B2}	R^{B18}	H
L_{A223}	H	R^{B2}	R^{A3}	H
L_{A224}	H	R^{B2}	R^{A34}	H
L_{A225}	H	R^{B3}	H	H
L_{A226}	H	R^{B3}	R^{B1}	H
L_{A227}	H	R^{B3}	R^{B3}	H
L_{A228}	H	R^{B3}	R^{B4}	H

-continued

	R^4	R^5	R^6	R^8
L_{A229}	H	R^{B3}	R^{B7}	H
L_{A230}	H	R^{B3}	R^{B12}	H
L_{A231}	H	R^{B3}	R^{B18}	H
L_{A232}	H	R^{B3}	R^{A3}	H
L_{A233}	H	R^{B3}	R^{A34}	H
L_{A234}	R^{B1}	R^{B1}	H	H
L_{A235}	R^{B1}	R^{B1}	R^{B1}	H
L_{A236}	R^{B1}	R^{B1}	R^{B3}	H
L_{A237}	R^{B1}	R^{B1}	R^{B4}	H
L_{A238}	R^{B1}	R^{B1}	R^{B7}	H
L_{A239}	R^{B1}	R^{B1}	R^{B12}	H
L_{A240}	R^{B1}	R^{B1}	R^{B18}	H
L_{A241}	R^{B1}	R^{B1}	R^{A3}	H
L_{A242}	R^{B1}	R^{B1}	R^{A34}	H
L_{A243}	R^{B2}	R^{B2}	H	H
L_{A244}	R^{B2}	R^{B2}	R^{B1}	H
L_{A245}	R^{B2}	R^{B2}	R^{B3}	H
L_{A246}	R^{B2}	R^{B2}	R^{B4}	H
L_{A247}	R^{B2}	R^{B2}	R^{B7}	H
L_{A248}	R^{B2}	R^{B2}	R^{B12}	H
L_{A249}	R^{B2}	R^{B2}	R^{B18}	H
L_{A250}	R^{B2}	R^{B2}	R^{A3}	H
L_{A251}	R^{B2}	R^{B2}	R^{A34}	H
L_{A252}	R^{B3}	R^{B3}	H	H
L_{A253}	R^{B3}	R^{B3}	R^{B1}	H
L_{A254}	R^{B3}	R^{B3}	R^{B3}	H
L_{A255}	R^{B3}	R^{B3}	R^{B4}	H
L_{A256}	R^{B3}	R^{B3}	R^{B7}	H
L_{A257}	R^{B3}	R^{B3}	R^{B12}	H
L_{A258}	R^{B3}	R^{B3}	R^{B18}	H
L_{A259}	R^{B3}	R^{B3}	R^{A3}	H
L_{A260}	R^{B3}	R^{B3}	R^{A34}	H
L_{A261}	H	H	H	R^{B1}
L_{A262}	H	H	H	R^{B3}
L_{A263}	H	H	H	R^{B4}
L_{A264}	H	H	H	R^{B7}
L_{A265}	H	H	H	R^{B12}
L_{A266}	H	H	H	R^{B18}
L_{A267}	H	H	H	R^{A3}
L_{A268}	H	H	H	R^{A34}
L_{A269}	R^{B1}	H	H	R^{B1}
L_{A270}	R^{B1}	H	H	R^{B3}
L_{A271}	R^{B1}	H	H	R^{B4}
L_{A272}	R^{B1}	H	H	R^{B7}
L_{A273}	R^{B1}	H	H	R^{B12}
L_{A274}	R^{B1}	H	H	R^{B18}
L_{A275}	R^{B1}	H	H	R^{A3}
L_{A276}	R^{B1}	H	H	R^{A34}
L_{A277}	R^{B2}	H	H	R^{B1}
L_{A278}	R^{B2}	H	H	R^{B3}
L_{A279}	R^{B2}	H	H	R^{B4}
L_{A280}	R^{B2}	H	H	R^{B7}
L_{A281}	R^{B2}	H	H	R^{B12}
L_{A282}	R^{B2}	H	H	R^{B18}
L_{A283}	R^{B2}	H	H	R^{A3}
L_{A284}	R^{B2}	H	H	R^{A34}
L_{A285}	R^{B3}	H	H	R^{B1}
L_{A286}	R^{B3}	H	H	R^{B3}
L_{A287}	R^{B3}	H	H	R^{B4}
L_{A288}	R^{B3}	H	H	R^{B7}
L_{A289}	R^{B3}	H	H	R^{B12}
L_{A290}	R^{B3}	H	H	R^{B18}
L_{A291}	R^{B3}	H	H	R^{A3}
L_{A292}	R^{B3}	H	H	R^{A34}
L_{A293}	H	R^{B1}	H	R^{B1}
L_{A294}	H	R^{B1}	H	R^{B3}
L_{A295}	H	R^{B1}	H	R^{B4}
L_{A296}	H	R^{B1}	H	R^{B7}
L_{A297}	H	R^{B1}	H	R^{B12}
L_{A298}	H	R^{B1}	H	R^{B18}
L_{A299}	H	R^{B1}	H	R^{A3}
L_{A300}	H	R^{B1}	H	R^{A34}
L_{A301}	H	R^{B2}	H	R^{B1}
L_{A302}	H	R^{B2}	H	R^{B3}
L_{A303}	H	R^{B2}	H	R^{B4}
L_{A304}	H	R^{B2}	H	R^{B7}
L_{A305}	H	R^{B2}	H	R^{B12}
L_{A306}	H	R^{B2}	H	R^{B18}
L_{A307}	H	R^{B2}	H	R^{A3}
L_{A308}	H	R^{B2}	H	R^{A34}
L_{A309}	H	R^{B3}	H	R^{B1}
L_{A310}	H	R^{B3}	H	R^{B3}
L_{A311}	H	R^{B3}	H	R^{B4}
L_{A312}	H	R^{B3}	H	R^{B7}
L_{A313}	H	R^{B3}	H	R^{B12}
L_{A314}	H	R^{B3}	H	R^{B18}
L_{A315}	H	R^{B3}	H	R^{A3}
L_{A316}	H	R^{B3}	H	R^{A34}
L_{A317}	R^{B1}	R^{B1}	H	R^{B1}
L_{A318}	R^{B1}	R^{B1}	H	R^{B3}
L_{A319}	R^{B1}	R^{B1}	H	R^{B4}
L_{A320}	R^{B1}	R^{B1}	H	R^{B7}
L_{A321}	R^{B1}	R^{B1}	H	R^{B12}
L_{A322}	R^{B1}	R^{B1}	H	R^{B18}
L_{A323}	R^{B1}	R^{B1}	H	R^{A3}
L_{A324}	R^{B1}	R^{B1}	H	R^{A34}
L_{A325}	R^{B2}	R^{B2}	H	R^{B1}
L_{A326}	R^{B2}	R^{B2}	H	R^{B3}
L_{A327}	R^{B2}	R^{B2}	H	R^{B4}
L_{A328}	R^{B2}	R^{B2}	H	R^{B7}
L_{A329}	R^{B2}	R^{B2}	H	R^{B12}
L_{A330}	R^{B2}	R^{B2}	H	R^{B18}
L_{A331}	R^{B2}	R^{B2}	H	R^{A3}
L_{A332}	R^{B2}	R^{B2}	H	R^{A34}
L_{A333}	R^{B3}	R^{B3}	H	R^{B1}
L_{A334}	R^{B3}	R^{B3}	H	R^{B3}
L_{A335}	R^{B3}	R^{B3}	H	R^{B4}
L_{A336}	R^{B3}	R^{B3}	H	R^{B7}
L_{A337}	R^{B3}	R^{B3}	H	R^{B12}
L_{A338}	R^{B3}	R^{B3}	H	R^{B18}
L_{A339}	R^{B3}	R^{B3}	H	R^{A3}
L_{A340}	R^{B3}	R^{B3}	H	R^{A34}
L_{A341}	H	H	R^{B1}	R^{B1}
L_{A342}	H	H	R^{B3}	R^{B3}
L_{A343}	H	H	R^{B4}	R^{B4}
L_{A344}	H	H	R^{B7}	R^{B7}
L_{A345}	H	H	R^{B12}	R^{B12}
L_{A346}	H	H	R^{B18}	R^{B18}
L_{A347}	H	H	R^{A3}	R^{A3}
L_{A348}	H	H	R^{A34}	R^{A34}
L_{A349}	R^{B1}	H	R^{B1}	R^{B1}
L_{A350}	R^{B1}	H	R^{B3}	R^{B3}
L_{A351}	R^{B1}	H	R^{B4}	R^{B4}
L_{A352}	R^{B1}	H	R^{B7}	R^{B7}
L_{A353}	R^{B1}	H	R^{B12}	R^{B12}
L_{A354}	R^{B1}	H	R^{B18}	R^{B18}
L_{A355}	R^{B1}	H	R^{A3}	R^{A3}
L_{A356}	R^{B1}	H	R^{A34}	R^{A34}
L_{A357}	R^{B2}	H	R^{B1}	R^{B1}
L_{A358}	R^{B2}	H	R^{B3}	R^{B3}
L_{A359}	R^{B2}	H	R^{B4}	R^{B4}
L_{A360}	R^{B2}	H	R^{B7}	R^{B7}
L_{A361}	R^{B2}	H	R^{B12}	R^{B12}
L_{A362}	R^{B2}	H	R^{B18}	R^{B18}
L_{A363}	R^{B2}	H	R^{A3}	R^{A3}
L_{A364}	R^{B2}	H	R^{A34}	R^{A34}
L_{A365}	H	R^{B1}	R^{B1}	R^{B1}
L_{A366}	H	R^{B1}	R^{B3}	R^{B3}
L_{A367}	H	R^{B1}	R^{B4}	R^{B4}
L_{A368}	H	R^{B1}	R^{B7}	R^{B7}
L_{A369}	H	R^{B1}	R^{B12}	R^{B12}
L_{A370}	H	R^{B1}	R^{B18}	R^{B18}
L_{A371}	H	R^{B1}	R^{A3}	R^{A3}
L_{A372}	H	R^{B1}	R^{A34}	R^{A34}
L_{A373}	H	R^{B2}	R^{B1}	R^{B1}
L_{A374}	H	R^{B2}	R^{B3}	R^{B3}
L_{A375}	H	R^{B2}	R^{B4}	R^{B4}
L_{A376}	H	R^{B2}	R^{B7}	R^{B7}
L_{A377}	H	R^{B2}	R^{B12}	R^{B12}
L_{A378}	H	R^{B2}	R^{B18}	R^{B18}
L_{A379}	H	R^{B2}	R^{A3}	R^{A3}
L_{A380}	H	R^{B2}	R^{A34}	R^{A34}

or the ligand L_{A381} through L_{A608}, which are based on a structure of Formula XII,



in which R^4, R^6, R^8, and Y are defined as:

	R^4	R^6	R^8	Y
L_{A381}	H	H	H	S
L_{A382}	H	R^{B1}	H	S
L_{A383}	H	R^{B3}	H	S
L_{A384}	H	R^{B4}	H	S
L_{A385}	H	R^{B7}	H	S
L_{A386}	H	R^{B12}	H	S
L_{A387}	H	R^{B18}	H	S
L_{A388}	H	R^{A3}	H	S
L_{A389}	H	R^{A34}	H	S
L_{A390}	R^{B1}	H	H	S
L_{A391}	R^{B1}	R^{B1}	H	S
L_{A392}	R^{B1}	R^{B3}	H	S
L_{A393}	R^{B1}	R^{B4}	H	S
L_{A394}	R^{B1}	R^{B7}	H	S
L_{A395}	R^{B1}	R^{B12}	H	S
L_{A396}	R^{B1}	R^{B18}	H	S
L_{A397}	R^{B1}	R^{A3}	H	S
L_{A398}	R^{B1}	R^{A34}	H	S
L_{A399}	R^{B2}	H	H	S
L_{A400}	R^{B2}	R^{B1}	H	S
L_{A401}	R^{B2}	R^{B3}	H	S
L_{A402}	R^{B2}	R^{B4}	H	S
L_{A403}	R^{B2}	R^{B7}	H	S
L_{A404}	R^{B2}	R^{B12}	H	S
L_{A405}	R^{B2}	R^{B18}	H	S
L_{A406}	R^{B2}	R^{A3}	H	S
L_{A407}	R^{B2}	R^{A34}	H	S
L_{A408}	R^{B3}	H	H	S
L_{A409}	R^{B3}	R^{B1}	H	S
L_{A410}	R^{B3}	R^{B3}	H	S
L_{A411}	R^{B3}	R^{B4}	H	S
L_{A412}	R^{B3}	R^{B7}	H	S
L_{A413}	R^{B3}	R^{B12}	H	S
L_{A414}	R^{B3}	R^{B18}	H	S
L_{A415}	R^{B3}	R^{A3}	H	S
L_{A416}	R^{B3}	R^{A34}	H	S
L_{A417}	H	H	H	S
L_{A418}	H	R^{B1}	H	S
L_{A419}	H	R^{B3}	H	S
L_{A420}	H	R^{B4}	H	S
L_{A421}	H	R^{B7}	H	S
L_{A422}	H	R^{B12}	H	S
L_{A423}	H	R^{B18}	H	S
L_{A424}	H	R^{A3}	H	S
L_{A425}	H	R^{A34}	H	S
L_{A426}	H	H	H	S
L_{A427}	H	R^{B1}	H	S
L_{A428}	H	R^{B3}	H	S
L_{A429}	H	R^{B4}	H	S
L_{A430}	H	R^{B7}	H	S
L_{A431}	H	R^{B12}	H	S
L_{A432}	H	R^{B18}	H	S
L_{A433}	H	R^{A3}	H	S
L_{A434}	H	R^{A34}	H	S
L_{A435}	H	H	H	S
L_{A436}	H	R^{B1}	H	S
L_{A437}	H	R^{B3}	H	S
L_{A438}	H	R^{B4}	H	S
L_{A439}	H	R^{B7}	H	S

-continued

	R^4	R^6	R^8	Y
L_{A440}	H	R^{B12}	H	S
L_{A441}	H	R^{B18}	H	S
L_{A442}	H	R^{A3}	H	S
L_{A443}	H	R^{A34}	H	S
L_{A444}	R^{B1}	H	H	S
L_{A445}	R^{B1}	R^{B1}	H	S
L_{A446}	R^{B1}	R^{B3}	H	S
L_{A447}	R^{B1}	R^{B4}	H	S
L_{A448}	R^{B1}	R^{B7}	H	S
L_{A449}	R^{B1}	R^{B12}	H	S
L_{A450}	R^{B1}	R^{B18}	H	S
L_{A451}	R^{B1}	R^{A3}	H	S
L_{A452}	R^{B1}	R^{A34}	H	S
L_{A453}	R^{B2}	H	H	S
L_{A454}	R^{B2}	R^{B1}	H	S
L_{A455}	R^{B2}	R^{B3}	H	S
L_{A456}	R^{B2}	R^{B4}	H	S
L_{A457}	R^{B2}	R^{B7}	H	S
L_{A458}	R^{B2}	R^{B12}	H	S
L_{A459}	R^{B2}	R^{B18}	H	S
L_{A460}	R^{B2}	R^{A3}	H	S
L_{A461}	R^{B2}	R^{A34}	H	S
L_{A462}	R^{B3}	H	H	S
L_{A463}	R^{B3}	R^{B1}	H	S
L_{A464}	R^{B3}	R^{B3}	H	S
L_{A465}	R^{B3}	R^{B4}	H	S
L_{A466}	R^{B3}	R^{B7}	H	S
L_{A467}	R^{B3}	R^{B12}	H	S
L_{A468}	R^{B3}	R^{B18}	H	S
L_{A469}	R^{B3}	R^{A3}	H	S
L_{A470}	R^{B3}	R^{A34}	H	S
L_{A471}	H	R^{B1}	R^{B1}	S
L_{A472}	H	R^{B3}	R^{B3}	S
L_{A473}	H	R^{B4}	R^{B4}	S
L_{A474}	H	R^{B7}	R^{B7}	S
L_{A475}	H	R^{B12}	R^{B12}	S
L_{A476}	H	R^{B18}	R^{B18}	S
L_{A477}	H	R^{A3}	R^{A3}	S
L_{A478}	H	R^{A34}	R^{A34}	S
L_{A479}	R^{B1}	R^{B1}	R^{B1}	S
L_{A480}	R^{B1}	R^{B3}	R^{B3}	S
L_{A481}	R^{B1}	R^{B4}	R^{B4}	S
L_{A482}	R^{B1}	R^{B7}	R^{B7}	S
L_{A483}	R^{B1}	R^{B12}	R^{B12}	S
L_{A484}	R^{B1}	R^{B18}	R^{B18}	S
L_{A485}	R^{B1}	R^{A3}	R^{A3}	S
L_{A486}	R^{B1}	R^{A34}	R^{A34}	S
L_{A487}	R^{B2}	R^{B1}	R^{B1}	S
L_{A488}	R^{B2}	R^{B3}	R^{B3}	S
L_{A489}	R^{B2}	R^{B4}	R^{B4}	S
L_{A490}	R^{B2}	R^{B7}	R^{B7}	S
L_{A491}	R^{B2}	R^{B12}	R^{B12}	S
L_{A492}	R^{B2}	R^{B18}	R^{B18}	S
L_{A493}	R^{B2}	R^{A3}	R^{A3}	S
L_{A494}	R^{B2}	R^{A34}	R^{A34}	S
L_{A495}	H	H	H	O
L_{A496}	H	R^{B1}	H	O
L_{A497}	H	R^{B3}	H	O
L_{A498}	H	R^{B4}	H	O
L_{A499}	H	R^{B7}	H	O
L_{A500}	H	R^{B12}	H	O
L_{A501}	H	R^{B18}	H	O
L_{A502}	H	R^{A3}	H	O
L_{A503}	H	R^{A34}	H	O
L_{A504}	R^{B1}	H	H	O
L_{A505}	R^{B1}	R^{B1}	H	O
L_{A506}	R^{B1}	R^{B3}	H	O
L_{A507}	R^{B1}	R^{B4}	H	O
L_{A508}	R^{B1}	R^{B7}	H	O
L_{A509}	R^{B1}	R^{B12}	H	O
L_{A510}	R^{B1}	R^{B18}	H	O
L_{A511}	R^{B1}	R^{A3}	H	O
L_{A512}	R^{B1}	R^{A34}	H	O
L_{A513}	R^{B2}	H	H	O
L_{A514}	R^{B2}	R^{B1}	H	O
L_{A515}	R^{B2}	R^{B3}	H	O
L_{A516}	R^{B2}	R^{B4}	H	O

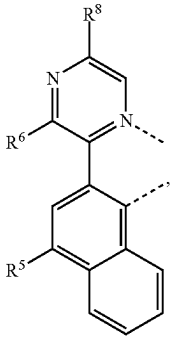
-continued

	R^4	R^6	R^8	Y
L_{A517}	R^{B2}	R^{B7}	H	O
L_{A518}	R^{B2}	R^{B12}	H	O
L_{A519}	R^{B2}	R^{B18}	H	O
L_{A520}	R^{B2}	R^{A3}	H	O
L_{A521}	R^{B2}	R^{A34}	H	O
L_{A522}	R^{B3}	H	H	O
L_{A523}	R^{B3}	R^{B1}	H	O
L_{A524}	R^{B3}	R^{B3}	H	O
L_{A525}	R^{B3}	R^{B4}	H	O
L_{A526}	R^{B3}	R^{B7}	H	O
L_{A527}	R^{B3}	R^{B12}	H	O
L_{A528}	R^{B3}	R^{B18}	H	O
L_{A529}	R^{B3}	R^{A3}	H	O
L_{A530}	R^{B3}	R^{A34}	H	O
L_{A531}	H	H	H	O
L_{A532}	H	R^{B1}	H	O
L_{A533}	H	R^{B3}	H	O
L_{A534}	H	R^{B4}	H	O
L_{A535}	H	R^{B7}	H	O
L_{A536}	H	R^{B12}	H	O
L_{A537}	H	R^{B18}	H	O
L_{A538}	H	R^{A3}	H	O
L_{A539}	H	R^{A34}	H	O
L_{A540}	H	H	H	O
L_{A541}	H	R^{B1}	H	O
L_{A542}	H	R^{B3}	H	O
L_{A543}	H	R^{B4}	H	O
L_{A544}	H	R^{B7}	H	O
L_{A545}	H	R^{B12}	H	O
L_{A546}	H	R^{B18}	H	O
L_{A547}	H	R^{A3}	H	O
L_{A548}	H	R^{A34}	H	O
L_{A549}	H	H	H	O
L_{A550}	H	R^{B1}	H	O
L_{A551}	H	R^{B3}	H	O
L_{A552}	H	R^{B4}	H	O
L_{A553}	H	R^{B7}	H	O
L_{A554}	H	R^{B12}	H	O
L_{A555}	H	R^{B18}	H	O
L_{A556}	H	R^{A3}	H	O
L_{A557}	H	R^{A34}	H	O
L_{A558}	R^{B1}	H	H	O
L_{A559}	R^{B1}	R^{B1}	H	O
L_{A560}	R^{B1}	R^{B3}	H	O
L_{A561}	R^{B1}	R^{B4}	H	O
L_{A562}	R^{B1}	R^{B7}	H	O
L_{A563}	R^{B1}	R^{B12}	H	O
L_{A564}	R^{B1}	R^{B18}	H	O
L_{A565}	R^{B1}	R^{A3}	H	O
L_{A566}	R^{B1}	R^{A34}	H	O
L_{A567}	R^{B2}	H	H	O
L_{A568}	R^{B2}	R^{B1}	H	O
L_{A569}	R^{B2}	R^{B3}	H	O
L_{A570}	R^{B2}	R^{B4}	H	O
L_{A571}	R^{B2}	R^{B7}	H	O
L_{A572}	R^{B2}	R^{B12}	H	O
L_{A573}	R^{B2}	R^{B18}	H	O
L_{A574}	R^{B2}	R^{A3}	H	O
L_{A575}	R^{B2}	R^{A34}	H	O
L_{A576}	R^{B3}	H	H	O
L_{A577}	R^{B3}	R^{B1}	H	O
L_{A578}	R^{B3}	R^{B3}	H	O
L_{A579}	R^{B3}	R^{B4}	H	O
L_{A580}	R^{B3}	R^{B7}	H	O
L_{A581}	R^{B3}	R^{B12}	H	O
L_{A582}	R^{B3}	R^{B18}	H	O
L_{A583}	R^{B3}	R^{A3}	H	O
L_{A584}	R^{B3}	R^{A34}	H	O
L_{A585}	H	R^{B1}	R^{B1}	O
L_{A586}	H	R^{B3}	R^{B3}	O
L_{A587}	H	R^{B4}	R^{B4}	O
L_{A588}	H	R^{B7}	R^{B7}	O
L_{A589}	H	R^{B12}	R^{B12}	O
L_{A590}	H	R^{B18}	R^{B18}	O
L_{A591}	H	R^{A3}	R^{A3}	O
L_{A592}	H	R^{A34}	R^{A34}	O
L_{A593}	R^{B1}	R^{B1}	R^{B1}	O

-continued

	R^4	R^6	R^8	Y
L_{A594}	R^{B1}	R^{B3}	R^{B3}	O
L_{A595}	R^{B1}	R^{B4}	R^{B4}	O
L_{A596}	R^{B1}	R^{B7}	R^{B7}	O
L_{A597}	R^{B1}	R^{B12}	R^{B12}	O
L_{A598}	R^{B1}	R^{B18}	R^{B18}	O
L_{A599}	R^{B1}	R^{A3}	R^{A3}	O
L_{A600}	R^{B1}	R^{A34}	R^{A34}	O
L_{A601}	R^{B2}	R^{B1}	R^{B1}	O
L_{A602}	R^{B2}	R^{B3}	R^{B3}	O
L_{A603}	R^{B2}	R^{B4}	R^{B4}	O
L_{A604}	R^{B2}	R^{B7}	R^{B7}	O
L_{A605}	R^{B2}	R^{B12}	R^{B12}	O
L_{A606}	R^{B2}	R^{B18}	R^{B18}	O
L_{A607}	R^{B2}	R^{A3}	R^{A3}	O
L_{A608}	R^{B2}	R^{A34}	R^{A34}	O

or the ligands L_{A609} through L_{A858}, which are based on a structure of Formula XIII,



in which R^5, R^6, and R^8 are defined as:

	R^5	R^6	R^8
L_{A609}	H	H	H
L_{A610}	H	R^{B1}	H
L_{A611}	H	R^{B3}	H
L_{A612}	H	R^{B4}	H
L_{A613}	H	R^{B7}	H
L_{A614}	H	R^{B12}	H
L_{A615}	H	R^{B18}	H
L_{A616}	H	R^{A3}	H
L_{A617}	H	R^{A34}	H
L_{A618}	R^{B1}	H	H
L_{A619}	R^{B1}	R^{B1}	H
L_{A620}	R^{B1}	R^{B3}	H
L_{A621}	R^{B1}	R^{B4}	H
L_{A622}	R^{B1}	R^{B7}	H
L_{A623}	R^{B1}	R^{B12}	H
L_{A624}	R^{B1}	R^{B18}	H
L_{A625}	R^{B1}	R^{A3}	H
L_{A626}	R^{B1}	R^{A34}	H
L_{A627}	R^{B2}	H	H
L_{A628}	R^{B2}	R^{B1}	H
L_{A629}	R^{B2}	R^{B3}	H
L_{A630}	R^{B2}	R^{B4}	H
L_{A631}	R^{B2}	R^{B7}	H
L_{A632}	R^{B2}	R^{B12}	H
L_{A633}	R^{B2}	R^{B18}	H
L_{A634}	R^{B2}	R^{A3}	H
L_{A635}	R^{B2}	R^{A34}	H
L_{A636}	R^{B3}	H	H
L_{A637}	R^{B3}	R^{B1}	H
L_{A638}	R^{B3}	R^{B3}	H
L_{A639}	R^{B3}	R^{B4}	H
L_{A640}	R^{B3}	R^{B7}	H

-continued

	R^5	R^6	R^8
L_{A4641}	R^{B3}	R^{B12}	H
L_{A4642}	R^{B3}	R^{B18}	H
L_{A4643}	R^{B3}	R^{A3}	H
L_{A4644}	R^{B3}	R^{A34}	H
L_{A4645}	R^{B5}	H	H
L_{A4646}	R^{B5}	R^{B1}	H
L_{A4647}	R^{B5}	R^{B3}	H
L_{A4648}	R^{B5}	R^{B4}	H
L_{A4649}	R^{B5}	R^{B7}	H
L_{A4650}	R^{B5}	R^{B12}	H
L_{A4651}	R^{B5}	R^{B18}	H
L_{A4652}	R^{B5}	R^{A3}	H
L_{A4653}	R^{B5}	R^{A34}	H
L_{A4654}	R^{B6}	H	H
L_{A4655}	R^{B6}	R^{B1}	H
L_{A4656}	R^{B6}	R^{B3}	H
L_{A4657}	R^{B6}	R^{B4}	H
L_{A4658}	R^{B6}	R^{B7}	H
L_{A4659}	R^{B6}	R^{B12}	H
L_{A4660}	R^{B6}	R^{B18}	H
L_{A4661}	R^{B6}	R^{A3}	H
L_{A4662}	R^{B6}	R^{A34}	H
L_{A4663}	R^{B16}	H	H
L_{A4664}	R^{B16}	R^{B1}	H
L_{A4665}	R^{B16}	R^{B3}	H
L_{A4666}	R^{B16}	R^{B4}	H
L_{A4667}	R^{B16}	R^{B7}	H
L_{A4668}	R^{B16}	R^{B12}	H
L_{A4669}	R^{B16}	R^{B18}	H
L_{A4670}	R^{B16}	R^{A3}	H
L_{A4671}	R^{B16}	R^{A34}	H
L_{A4672}	R^{B20}	H	H
L_{A4673}	R^{B20}	R^{B1}	H
L_{A4674}	R^{B20}	R^{B3}	H
L_{A4675}	R^{B20}	R^{B4}	H
L_{A4676}	R^{B20}	R^{B7}	H
L_{A4677}	R^{B20}	R^{B12}	H
L_{A4678}	R^{B20}	R^{B18}	H
L_{A4679}	R^{B20}	R^{A3}	H
L_{A4680}	R^{B20}	R^{A34}	H
L_{A4681}	R^{B44}	H	H
L_{A4682}	R^{B44}	R^{B1}	H
L_{A4683}	R^{B44}	R^{B3}	H
L_{A4684}	R^{B44}	R^{B4}	H
L_{A4685}	R^{B44}	R^{B7}	H
L_{A4686}	R^{B44}	R^{B12}	H
L_{A4687}	R^{B44}	R^{B18}	H
L_{A4688}	R^{B44}	R^{A3}	H
L_{A4689}	R^{B44}	R^{A34}	H
L_{A4690}	R^{A34}	H	H
L_{A4691}	R^{A34}	R^{B1}	H
L_{A4692}	R^{A34}	R^{B3}	H
L_{A4693}	R^{A34}	R^{B4}	H
L_{A4694}	R^{A34}	R^{B7}	H
L_{A4695}	R^{A34}	R^{B12}	H
L_{A4696}	R^{A34}	R^{B18}	H
L_{A4697}	R^{A34}	R^{A3}	H
L_{A4698}	R^{A34}	R^{A34}	H
L_{A4699}	H	H	R^{B1}
L_{A4700}	H	H	R^{B3}
L_{A4701}	H	H	R^{B4}
L_{A4702}	H	H	R^{B7}
L_{A4703}	H	H	R^{B12}
L_{A4704}	H	H	R^{B18}
L_{A4705}	H	H	R^{A3}
L_{A4706}	H	H	R^{A34}
L_{A4707}	R^{B1}	H	R^{B1}
L_{A4708}	R^{B1}	H	R^{B3}
L_{A4709}	R^{B1}	H	R^{B4}
L_{A4710}	R^{B1}	H	R^{B7}
L_{A4711}	R^{B1}	H	R^{B12}
L_{A4712}	R^{B1}	H	R^{B18}
L_{A4713}	R^{B1}	H	R^{A3}
L_{A4714}	R^{B1}	H	R^{A34}
L_{A4715}	R^{B2}	H	R^{B1}
L_{A4716}	R^{B2}	H	R^{B3}
L_{A4717}	R^{B2}	H	R^{B4}

-continued

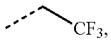
	R^5	R^6	R^8
L_{A4718}	R^{B2}	H	R^{B7}
L_{A4719}	R^{B2}	H	R^{B12}
L_{A4720}	R^{B2}	H	R^{B18}
L_{A4721}	R^{B2}	H	R^{A3}
L_{A4722}	R^{B2}	H	R^{A34}
L_{A4723}	R^{B3}	H	R^{B1}
L_{A4724}	R^{B3}	H	R^{B3}
L_{A4725}	R^{B3}	H	R^{B4}
L_{A4726}	R^{B3}	H	R^{B7}
L_{A4727}	R^{B3}	H	R^{B12}
L_{A4728}	R^{B3}	H	R^{B18}
L_{A4729}	R^{B3}	H	R^{A3}
L_{A4730}	R^{B3}	H	R^{A34}
L_{A4731}	R^{B5}	H	R^{B1}
L_{A4732}	R^{B5}	H	R^{B3}
L_{A4733}	R^{B5}	H	R^{B4}
L_{A4734}	R^{B5}	H	R^{B7}
L_{A4735}	R^{B5}	H	R^{B12}
L_{A4736}	R^{B5}	H	R^{B18}
L_{A4737}	R^{B5}	H	R^{A3}
L_{A4738}	R^{B5}	H	R^{A34}
L_{A4739}	R^{B6}	H	R^{B1}
L_{A4740}	R^{B6}	H	R^{B3}
L_{A4741}	R^{B6}	H	R^{B4}
L_{A4742}	R^{B6}	H	R^{B7}
L_{A4743}	R^{B6}	H	R^{B12}
L_{A4744}	R^{B6}	H	R^{B18}
L_{A4745}	R^{B6}	H	R^{A3}
L_{A4746}	R^{B6}	H	R^{A34}
L_{A4747}	R^{B16}	H	R^{B1}
L_{A4748}	R^{B16}	H	R^{B3}
L_{A4749}	R^{B16}	H	R^{B4}
L_{A4750}	R^{B16}	H	R^{B7}
L_{A4751}	R^{B16}	H	R^{B12}
L_{A4752}	R^{B16}	H	R^{B18}
L_{A4753}	R^{B16}	H	R^{A3}
L_{A4754}	R^{B16}	H	R^{A34}
L_{A4755}	R^{B20}	H	R^{B1}
L_{A4756}	R^{B20}	H	R^{B3}
L_{A4757}	R^{B20}	H	R^{B4}
L_{A4758}	R^{B20}	H	R^{B7}
L_{A4759}	R^{B20}	H	R^{B12}
L_{A4760}	R^{B20}	H	R^{B18}
L_{A4761}	R^{B20}	H	R^{A3}
L_{A4762}	R^{B20}	H	R^{A34}
L_{A4763}	R^{B44}	H	R^{B1}
L_{A4764}	R^{B44}	H	R^{B3}
L_{A4765}	R^{B44}	H	R^{B4}
L_{A4766}	R^{B44}	H	R^{B7}
L_{A4767}	R^{B44}	H	R^{B12}
L_{A4768}	R^{B44}	H	R^{B18}
L_{A4769}	R^{B44}	H	R^{A3}
L_{A4770}	R^{B44}	H	R^{A34}
L_{A4771}	R^{A34}	H	R^{B1}
L_{A4772}	R^{A34}	H	R^{B3}
L_{A4773}	R^{A34}	H	R^{B4}
L_{A4774}	R^{A34}	H	R^{B7}
L_{A4775}	R^{A34}	H	R^{B12}
L_{A4776}	R^{A34}	H	R^{B18}
L_{A4777}	R^{A34}	H	R^{A3}
L_{A4778}	R^{A34}	H	R^{A34}
L_{A4779}	H	R^{B1}	R^{B1}
L_{A4780}	H	R^{B3}	R^{B3}
L_{A4781}	H	R^{B4}	R^{B4}
L_{A4782}	H	R^{B7}	R^{B7}
L_{A4783}	H	R^{B12}	R^{B12}
L_{A4784}	H	R^{B18}	R^{B18}
L_{A4785}	H	R^{A3}	R^{A3}
L_{A4786}	H	R^{A34}	R^{A34}
L_{A4787}	R^{B1}	R^{B1}	R^{B1}
L_{A4788}	R^{B1}	R^{B3}	R^{B3}
L_{A4789}	R^{B1}	R^{B4}	R^{B4}
L_{A4790}	R^{B1}	R^{B7}	R^{B7}
L_{A4791}	R^{B1}	R^{B12}	R^{B12}
L_{A4792}	R^{B1}	R^{B18}	R^{B18}
L_{A4793}	R^{B1}	R^{A3}	R^{A3}
L_{A4794}	R^{B1}	R^{A34}	R^{A34}

-continued

	R^5	R^6	R^8
L_{A4795}	R^{B2}	R^{B1}	R^{B1}
L_{A4796}	R^{B2}	R^{B3}	R^{B3}
L_{A4797}	R^{B2}	R^{B4}	R^{B4}
L_{A4798}	R^{B2}	R^{B7}	R^{B7}
L_{A4799}	R^{B2}	R^{B12}	R^{B12}
L_{A4800}	R^{B2}	R^{B18}	R^{B18}
L_{A4801}	R^{B2}	R^{A3}	R^{A3}
L_{A4802}	R^{B2}	R^{A34}	R^{A34}
L_{A4803}	R^{B3}	R^{B1}	R^{B1}
L_{A4804}	R^{B3}	R^{B3}	R^{B3}
L_{A4805}	R^{B3}	R^{B4}	R^{B4}
L_{A4806}	R^{B3}	R^{B7}	R^{B7}
L_{A4807}	R^{B3}	R^{B12}	R^{B12}
L_{A4808}	R^{B3}	R^{B18}	R^{B18}
L_{A4809}	R^{B3}	R^{A3}	R^{A3}
L_{A4810}	R^{B3}	R^{A34}	R^{A34}
L_{A4811}	R^{B5}	R^{B1}	R^{B1}
L_{A4812}	R^{B5}	R^{B3}	R^{B3}
L_{A4813}	R^{B5}	R^{B4}	R^{B4}
L_{A4814}	R^{B5}	R^{B7}	R^{B7}
L_{A4815}	R^{B5}	R^{B12}	R^{B12}
L_{A4816}	R^{B5}	R^{B18}	R^{B18}
L_{A4817}	R^{B5}	R^{A3}	R^{A3}
L_{A4818}	R^{B5}	R^{A34}	R^{A34}
L_{A4819}	R^{B6}	R^{B1}	R^{B1}
L_{A4820}	R^{B6}	R^{B3}	R^{B3}
L_{A4821}	R^{B6}	R^{B4}	R^{B4}
L_{A4822}	R^{B6}	R^{B7}	R^{B7}
L_{A4823}	R^{B6}	R^{B12}	R^{B12}
L_{A4824}	R^{B6}	R^{B18}	R^{B18}
L_{A4825}	R^{B6}	R^{A3}	R^{A3}
L_{A4826}	R^{B6}	R^{A34}	R^{A34}
L_{A4827}	R^{B16}	R^{B1}	R^{B1}
L_{A4828}	R^{B16}	R^{B3}	R^{B3}
L_{A4829}	R^{B16}	R^{B4}	R^{B4}
L_{A4830}	R^{B16}	R^{B7}	R^{B7}
L_{A4831}	R^{B16}	R^{B12}	R^{B12}
L_{A4832}	R^{B16}	R^{B18}	R^{B18}
L_{A4833}	R^{B16}	R^{A3}	R^{A3}
L_{A4834}	R^{B16}	R^{A34}	R^{A34}
L_{A4835}	R^{B20}	R^{B1}	R^{B1}
L_{A4836}	R^{B20}	R^{B3}	R^{B3}
L_{A4837}	R^{B20}	R^{B4}	R^{B4}
L_{A4838}	R^{B20}	R^{B7}	R^{B7}
L_{A4839}	R^{B20}	R^{B12}	R^{B12}
L_{A4840}	R^{B20}	R^{B18}	R^{B18}
L_{A4841}	R^{B20}	R^{A3}	R^{A3}
L_{A4842}	R^{B20}	R^{A34}	R^{A34}
L_{A4843}	R^{B44}	R^{B1}	R^{B1}
L_{A4844}	R^{B44}	R^{B3}	R^{B3}
L_{A4845}	R^{B44}	R^{B4}	R^{B4}
L_{A4846}	R^{B44}	R^{B7}	R^{B7}
L_{A4847}	R^{B44}	R^{B12}	R^{B12}
L_{A4848}	R^{B44}	R^{B18}	R^{B18}
L_{A4849}	R^{B44}	R^{A3}	R^{A3}
L_{A4850}	R^{B44}	R^{A34}	R^{A34}
L_{A4851}	R^{A34}	R^{B1}	R^{B1}
L_{A4852}	R^{A34}	R^{B3}	R^{B3}
L_{A4853}	R^{A34}	R^{B4}	R^{B4}
L_{A4854}	R^{A34}	R^{B7}	R^{B7}
L_{A4855}	R^{A34}	R^{B12}	R^{B12}
L_{A4856}	R^{A34}	R^{B18}	R^{B18}
L_{A4857}	R^{A34}	R^{A3}	R^{A3}
L_{A4858}	R^{A34}	R^{A34}	R^{A34}

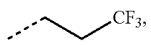
wherein R^{A1} to R^{A51} have the following structures

R^{A1}

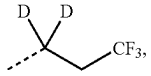


R^{A2}

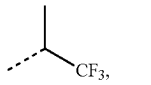
R^{A3}



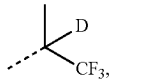
R^{A4}



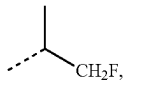
R^{A5}



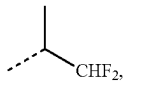
R^{A6}



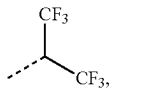
R^{A7}



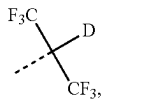
R^{A8}



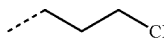
R^{A9}



R^{A10}



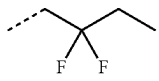
R^{A11}



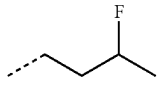
R^{A12}

R^{A13}

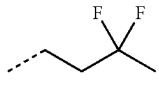
R^{A14}



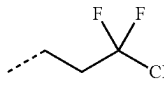
R^{A15}



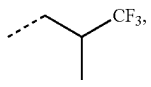
R^{A16}



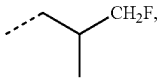
R^{A17}



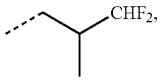
R^{A18}



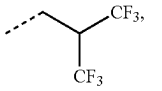
-continued



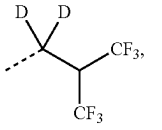
R^{A19}



R^{A20}

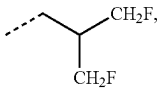


R^{A21}

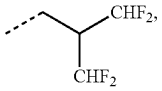


R^{A22}

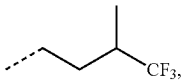
R^{A23}



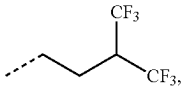
R^{A24}



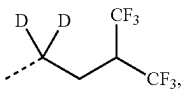
R^{A25}



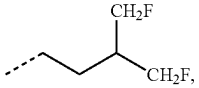
R^{A26}



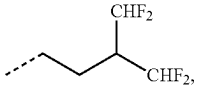
R^{A27}



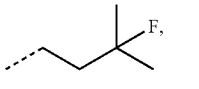
R^{A28}



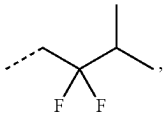
R^{A29}



R^{A30}

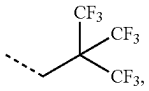


R^{A31}

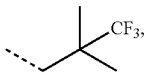


R^{A32}

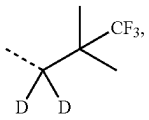
R^{A33}



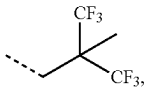
R^{A34}



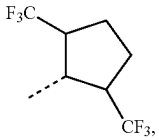
R^{A35}



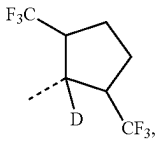
R^{A36}



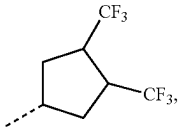
R^{A37}



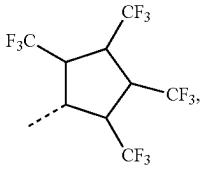
R^{A38}



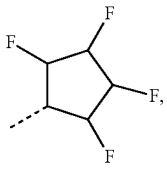
R^{A39}



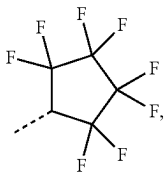
R^{A40}



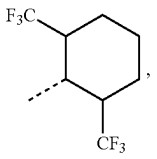
R^{A41}



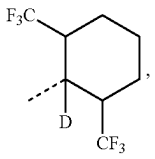
R^{A42}

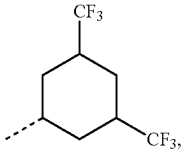


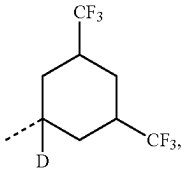
R^{A43}

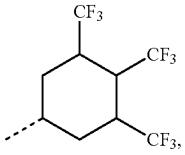


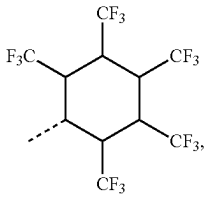
-continued

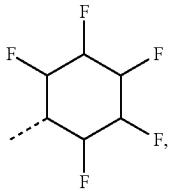


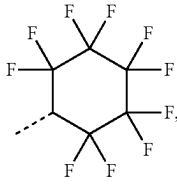




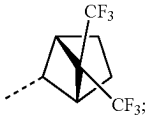








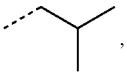
and



and R^{B1} to R^{B21} have the following structures:

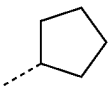
R^{A44}

R^{A45}

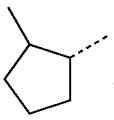


R^{A46}

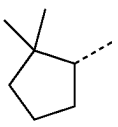
R^{A47}



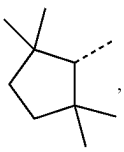
R^{A48}



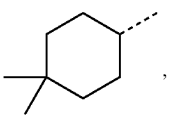
R^{A49}



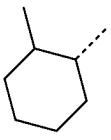
R^{A50}



R^{A51}



R^{B1}

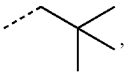


R^{B2}

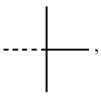
R^{B3}

R^{B4}

R^{B5}



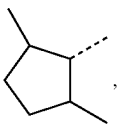
R^{B6}



R^{B7}

R^{B8}

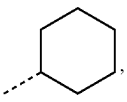
R^{B9}



R^{B10}

R^{B11}

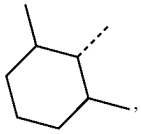
R^{B12}

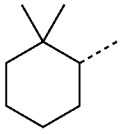


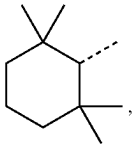
R^{B13}

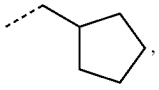
R^{B14}

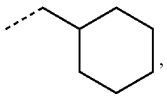
-continued

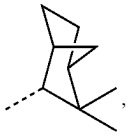


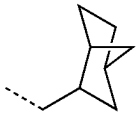


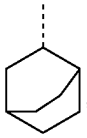




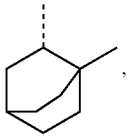




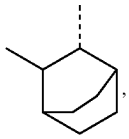




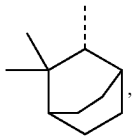
R^{B15}



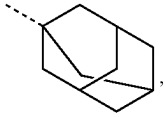
R^{B16}



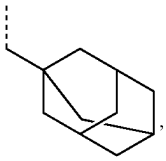
R^{B17}



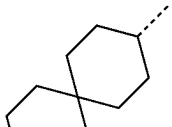
R^{B18}



R^{B19}

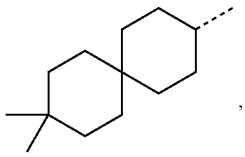


R^{B20}

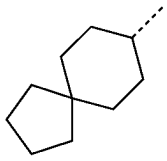


R^{B21}

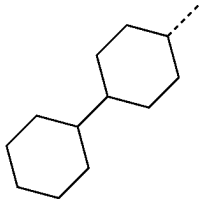
R^{B22}



R^{B23}



R^{B24}



R^{B25}

R^{B26}

R^{B27}

R^{B28}

R^{B29}

R^{B30}

R^{B31}

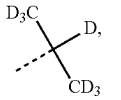
R^{B32}

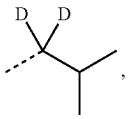
R^{B33}

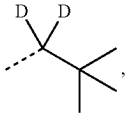
R^{B34}

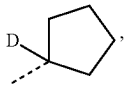
R^{B35}

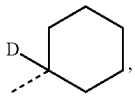
-continued

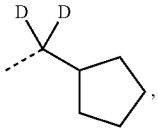


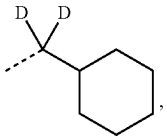


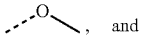




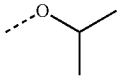








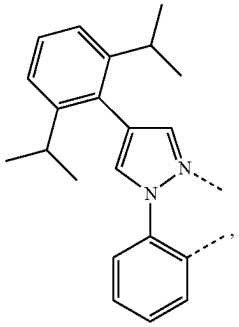
and



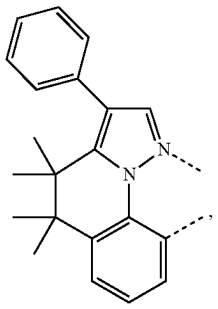
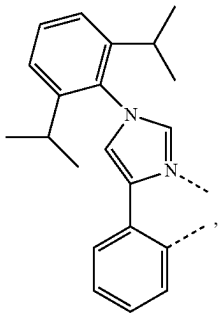
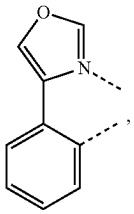
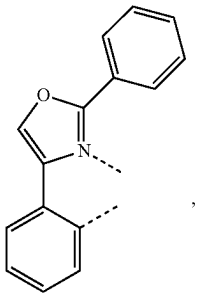
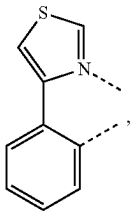
;

or the ligands are independently selected from the group consisting of L_{A859} to L_{A902};

L_{A859}

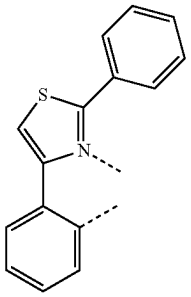


-continued

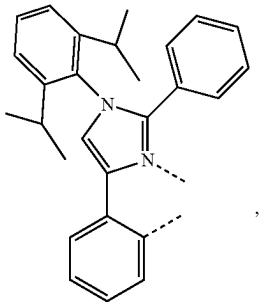
R^{B36}	L_{A860} 
R^{B37}	
R^{B38}	L_{A861} 
R^{B39}	
R^{B40}	L_{A862} 
R^{B41}	
R^{B42}	L_{A863} 
R^{B43}	
R^{B44}	L_{A864} 
R^{B44}	

-continued

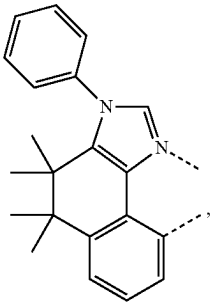
L_{A865}



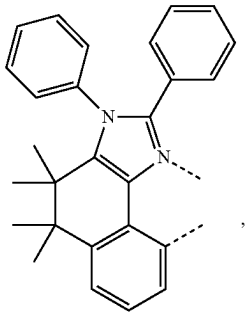
L_{A866}



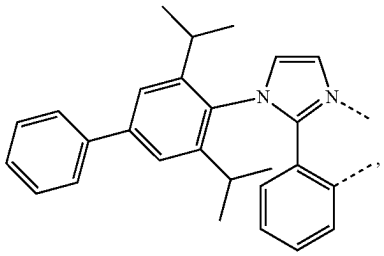
L_{A867}



L_{A868}

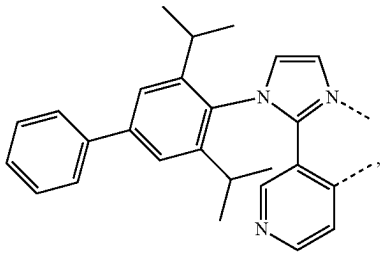


L_{A869}

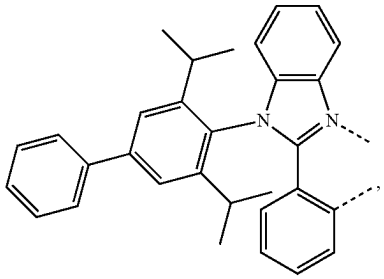


-continued

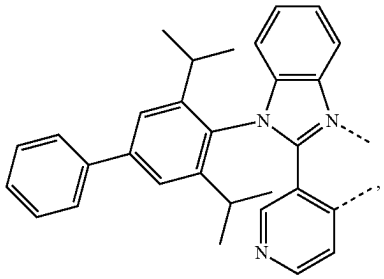
L_{A870}



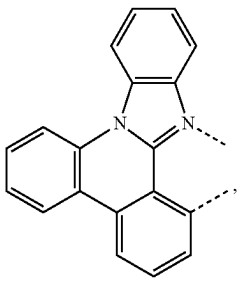
L_{A871}



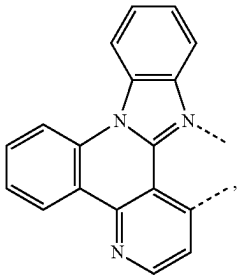
L_{A872}



L_{A873}

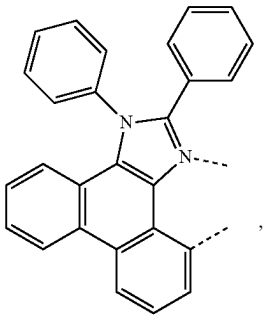


L_{A874}

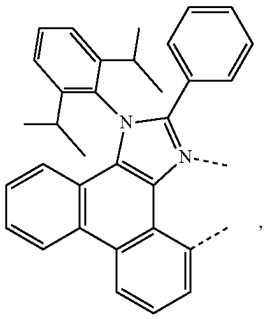


-continued

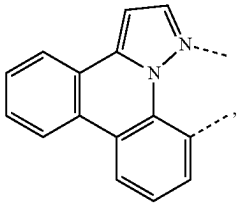
L_{A875}



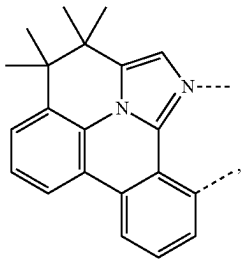
L_{A876}



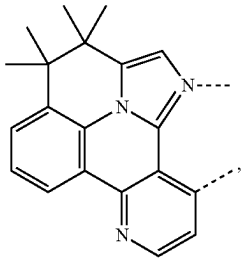
L_{A877}



L_{A878}

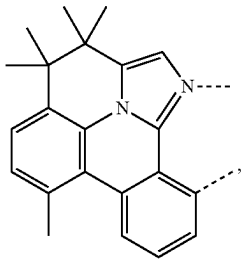


L_{A879}

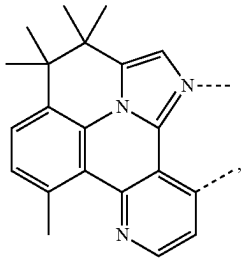


-continued

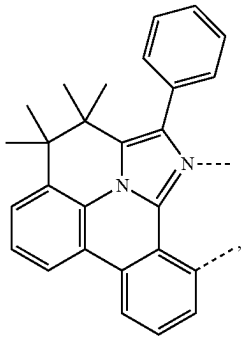
L_{A880}



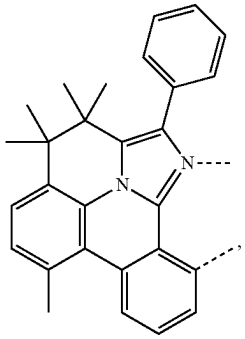
L_{A881}



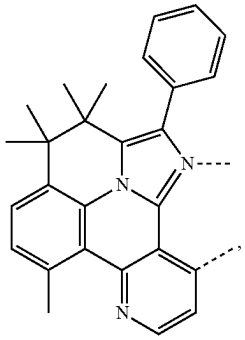
L_{A882}



L_{A883}

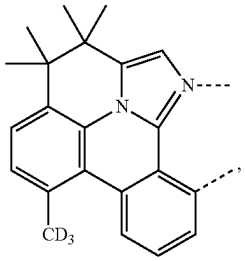


L_{A884}

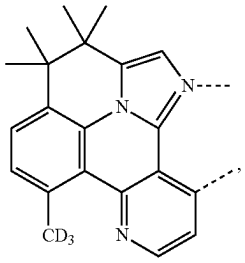


-continued

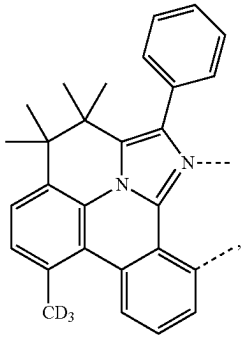
L_{A885}



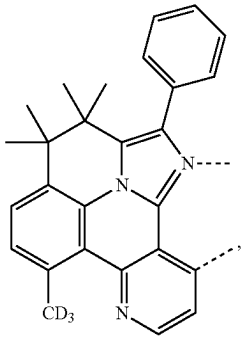
L_{A886}



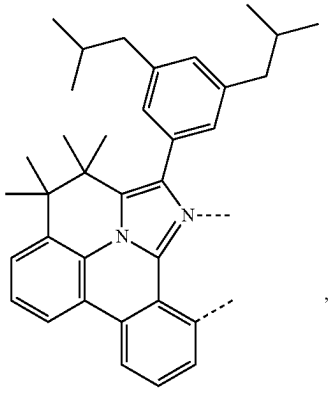
L_{A887}



L_{A888}

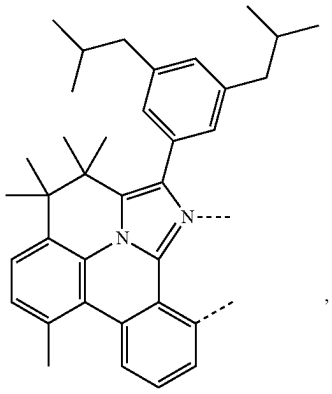


L_{A889}

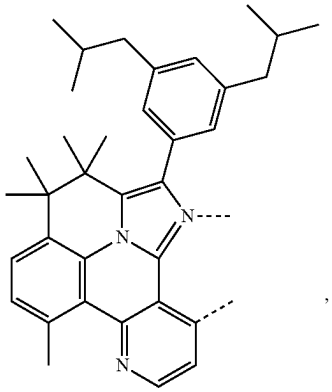


-continued

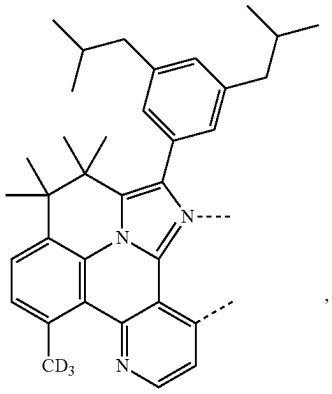
L_{A890}



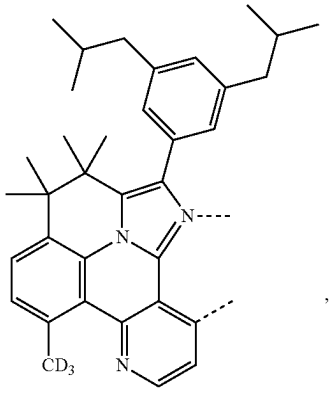
L_{A891}



L_{A892}

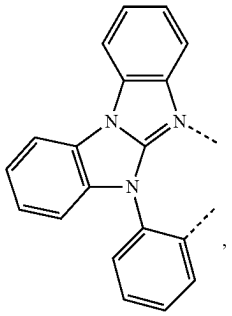


L_{A893}

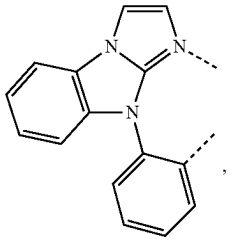


-continued

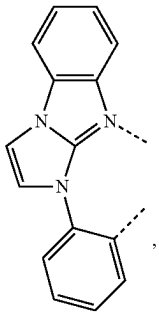
L_{A894}



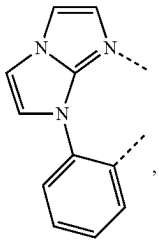
L_{A895}



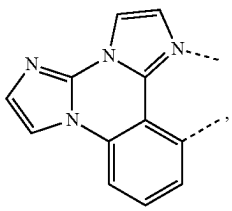
L_{A896}



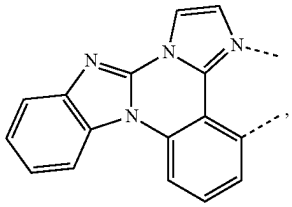
L_{A897}



L_{A898}

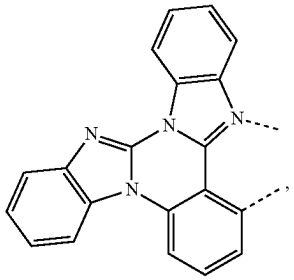


L_{A899}

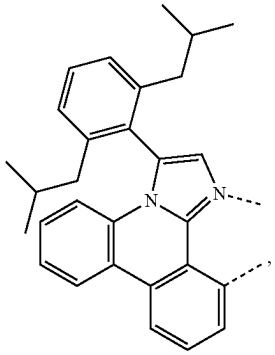


-continued

L_{A900}

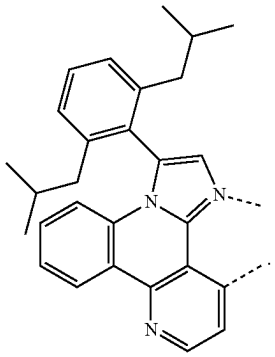


L_{A901}



and

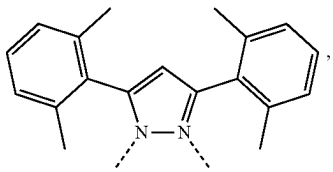
L_{A902}



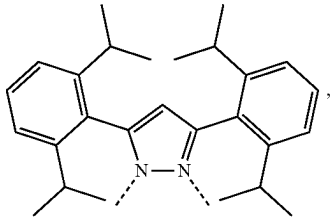
5. The compound of claim **4**, wherein the compound is the Compound x having the formula $(L_{Ai})Pt(L_{cj})_2Pt(L_{Ai})$;

wherein x=31i+j−31; i is an integer from 1 to 902, and j is an integer from 1 to 31; and ligands L_{Cj} are independently selected from the group consisting of:

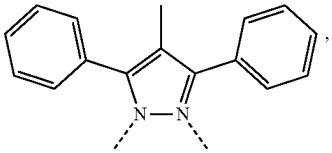
L_{C7}

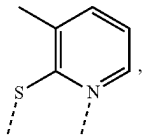


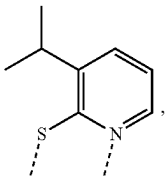
L_{C8}

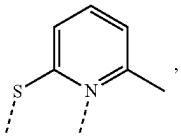


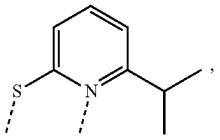
-continued

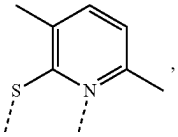


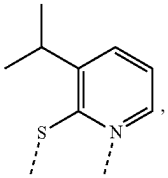


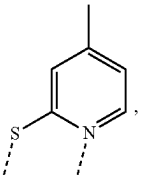


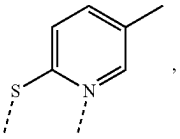


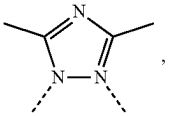












L_{C12}

L_{C15}

L_{C16}

L_{C17}

L_{C18}

L_{C19}

L_{C20}

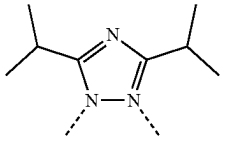
L_{C21}

L_{C22}

L_{C27}

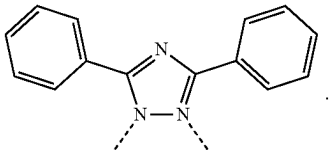
-continued

L_{C28}



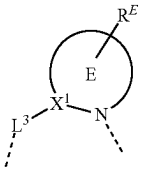
and

L_{C29}

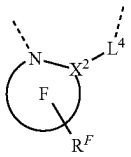


6. An organic light emitting device (OLED) including an anode, a cathode, and an organic layer disposed between the anode and the cathode, the organic layer comprising a compound of claim **5**.

7. The compound of claim **1**, wherein

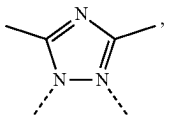


and

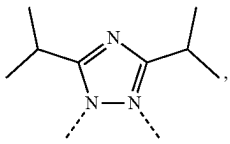


are independently selected from the group consisting of:

L_{C27}

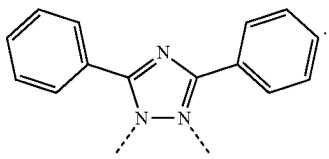


L_{C28}

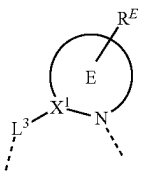


and

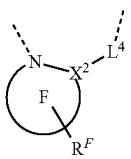
L_{C29}



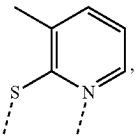
8. The compound of claim **1**, wherein

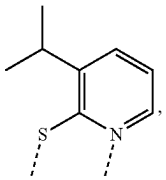


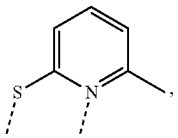
and

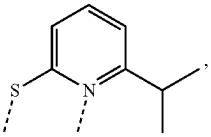


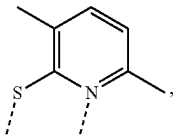
are independently selected from the group consisting of

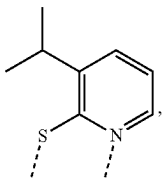
L_{C15} 

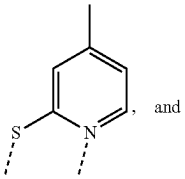
L_{C16} 

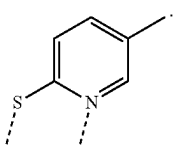
L_{C17} 

L_{C18} 

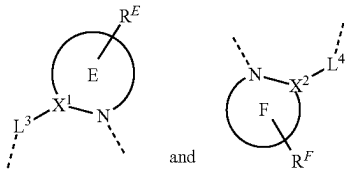
L_{C19} 

L_{C20} 

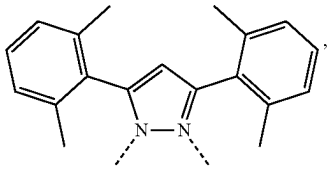
L_{C21}  , and

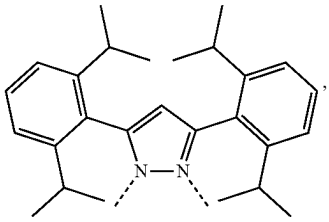
L_{C22} 

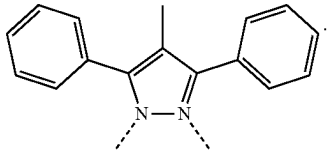
9. The compound of claim **1**, wherein

 , and

are independently selected from the group consisting of

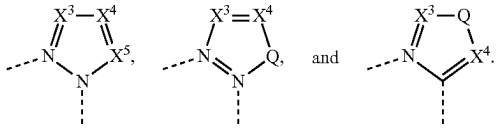
L_{C7} 

L_{C8}  , and

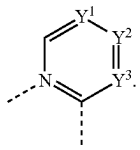
L_{C12} 

10. The compound of claim **1**, wherein R^A, R^B, R^C, and R^D are each independently selected from the group consisting of deuterium, fluorine, alkyl, cycloalkyl, alkoxy, aryloxy, amino, silyl, aryl, heteroaryl, sulfanyl, and combinations thereof.

11. The compound of claim **1**, wherein the ring A and the ring C are each independently selected from the group consisting of



12. The compound of claim **1**, wherein the ring A and the ring C are independently



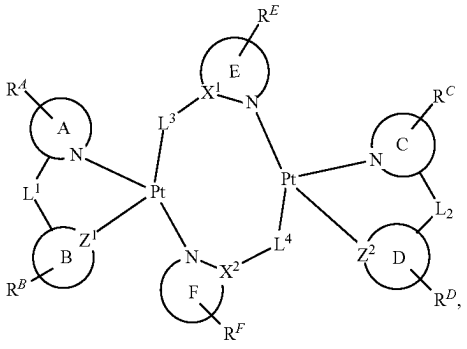
13. The compound of claim **1**, wherein the ring B and the ring D are each independently a 5-membered carbocyclic or heterocyclic ring.

14. The compound of claim 1, wherein the ring B and the ring D are each benzene.

15. An organic light emitting device (OLED) including an anode, a cathode, and

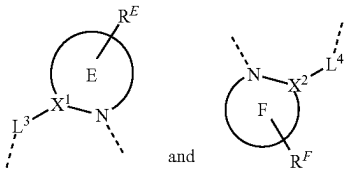
an organic layer disposed between the anode and the cathode, the organic layer comprising a compound of Formula I

Formula I;



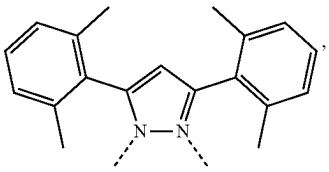
wherein

ring Band ring D are independently a 5-membered, or 6-membered, carbocyclic or heterocyclic ring;

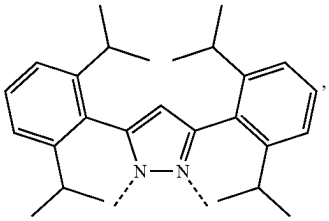


are independently selected from the group consisting of:

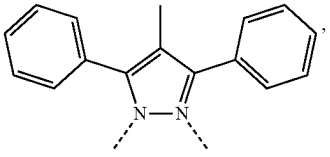
L_{C7}



L_{C8}

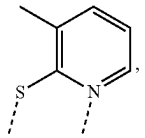


L_{C12}

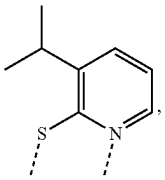


-continued

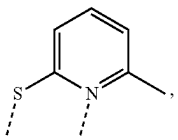
L_{C15}



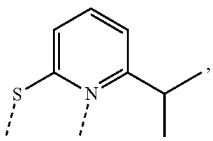
L_{C16}



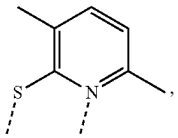
L_{C17}



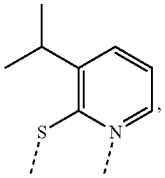
L_{C18}



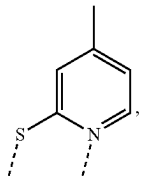
L_{C19}



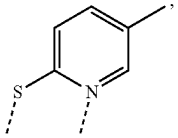
L_{C20}



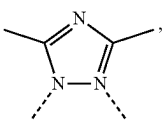
L_{C21}



L_{C22}

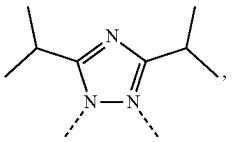


L_{C27}



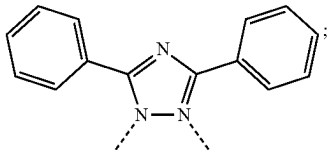
-continued

L_{C28}



and

L_{C29}

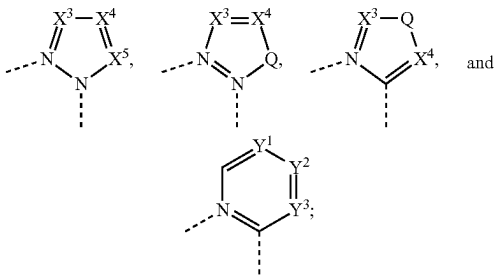


Z^1 and Z^2 are independently an anionic coordinating atom selected from the group consisting of C and N;

R^A, R^B, R^C, and R^D independently represent no substitution to the maximum allowable number of substituents;

L^1 and L^2 are independently selected from the group consisting of a direct bond, CRR', SiRR', NR', O, and S;

wherein the ring A and the ring C are independently selected from the group consisting of



and

wherein

X^3, X^4, and X^5 are independently selected from the group consisting of CR^A and N;

Q is selected from the group consisting of CRR', SiRR', NR, O, and S;

Y^1, Y^2, and Y^3 are each independently selected from the group consisting of CR^A and N; wherein at least one of Y^1, Y^2, and Y^3 is N; and the dash lines represent N-coordination to Pt, and a connection to L^1 or L^2 of ring B or ring D, respectively, or if L^1 and/or L^2 is a direct bond, then to ring B or ring D, respectively;

each R^A, R^B, R^C, and R^D are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, arylalkyl, alkoxy, aryloxy, amino, silyl, alkenyl, cycloalkenyl, heteroalkenyl, alkynyl, aryl, heteroaryl, acyl, carbonyl, carboxylic acids, ester, nitrile, isonitrile, sulfanyl, sulfinyl, sulfonyl, phosphino, and combinations thereof; or optionally, any two adjacent R^A, R^B, R^C, and R^D can join to form a ring; and

R and R' are independently selected from the group consisting of hydrogen, deuterium, halide, alkyl, cycloalkyl, heteroalkyl, aryl, heteroaryl, and combinations thereof; or optionally, any two adjacent R and R' can join to form a ring.

16. The OLED of claim **15**, wherein the organic layer further comprises a host, wherein the host comprises a triphenylene containing benzo-fused thiophene or benzo-fused furan;

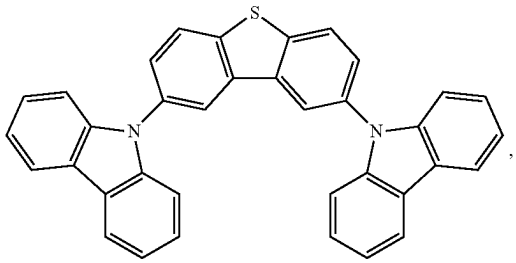
wherein any substituent in the host is an unfused substituent independently selected from the group consisting of C_nH_{2n+1}, OC_nH_{2n+1}, OAr_1, $N(C_nH_{2n+1})_2$, $N(Ar_1)(Ar_2)$, $CH{=}CH{-}C_nH_{2n+1}$, $C{\equiv}CC_nH_{2n+1}$, Ar, Ar_1-Ar_2, $C_nH_{2n-}Ar_1$, or no substitution;

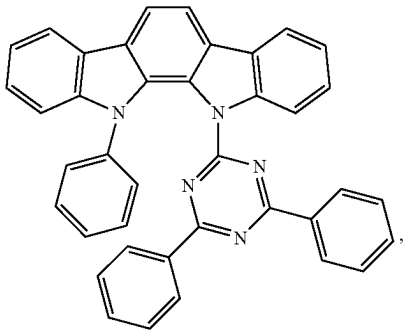
n is from 1 to 10; and

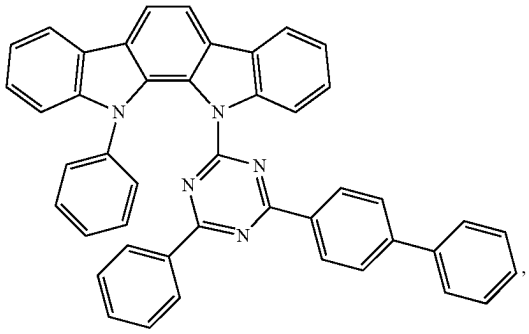
Ar_1 and Ar_2 are independently selected from the group consisting of benzene, biphenyl, naphthalene, triphenylene, carbazole, and heteroaromatic analogs thereof; or

the host comprises at least one chemical group selected from the group consisting of carbazole, dibenzothiophene, dibenzofuran, dibenzoselenophene, azatriphenylene, azacarbazole, aza-dibenzothiophene, aza-dibenzofuran, and aza-dibenzoselenophene.

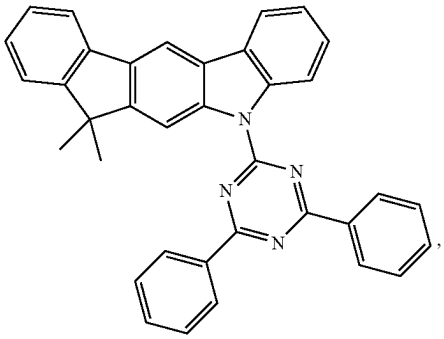
17. The OLED of claim **15**, wherein the organic layer further comprises a host, wherein the host is selected from the group consisting of:

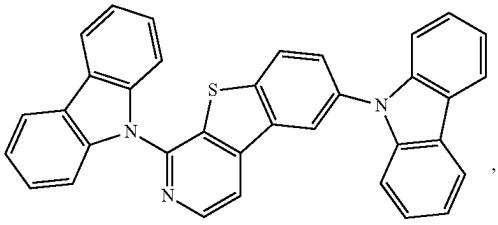


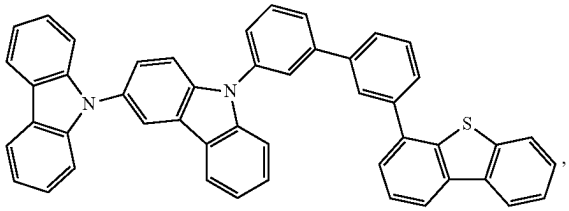


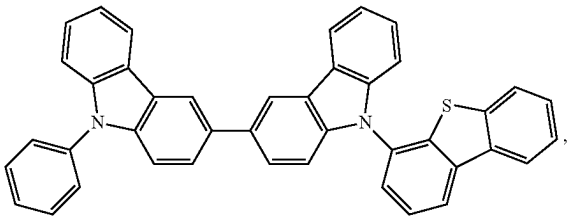


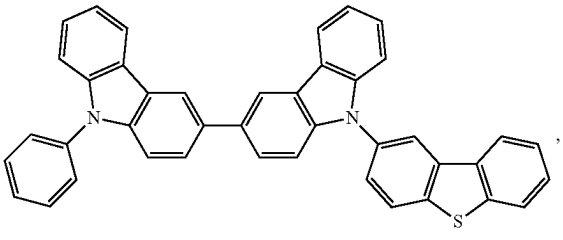
-continued

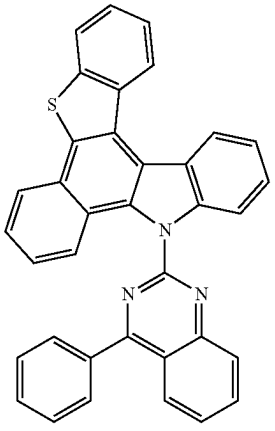




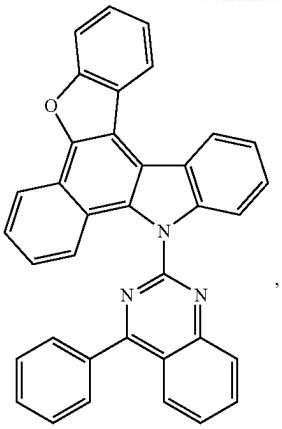


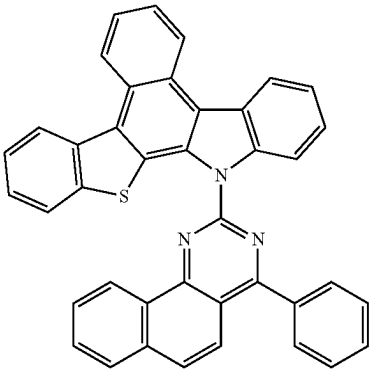


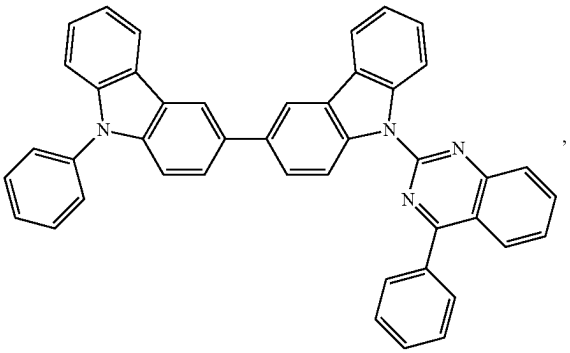


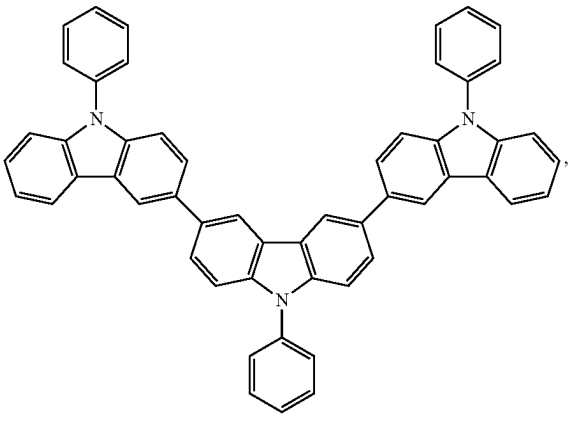


-continued

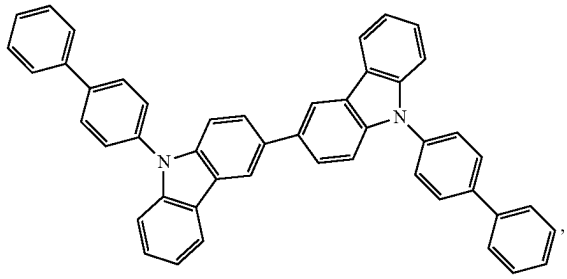


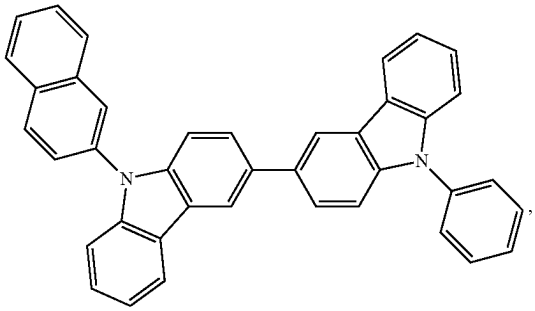


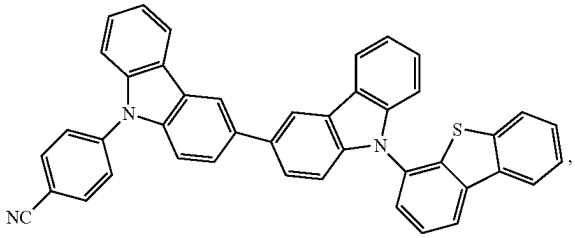


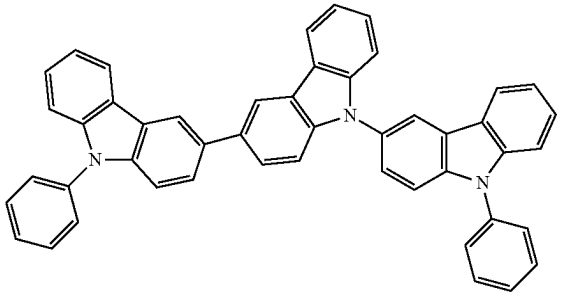


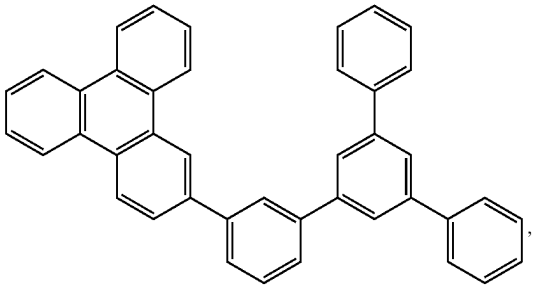
-continued

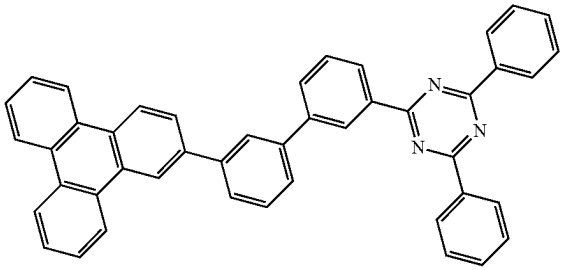




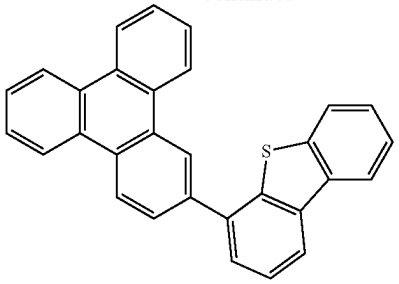


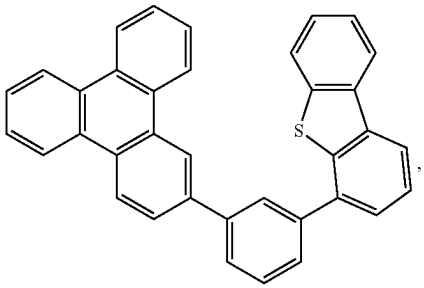


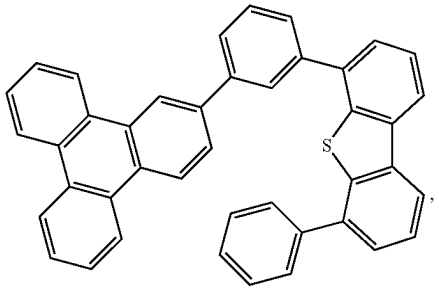


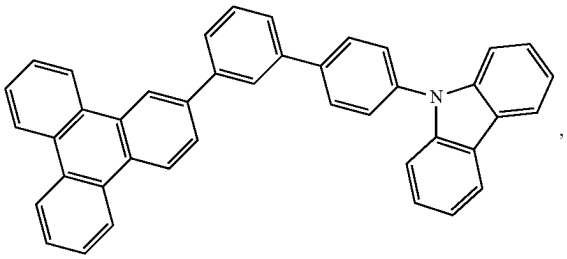


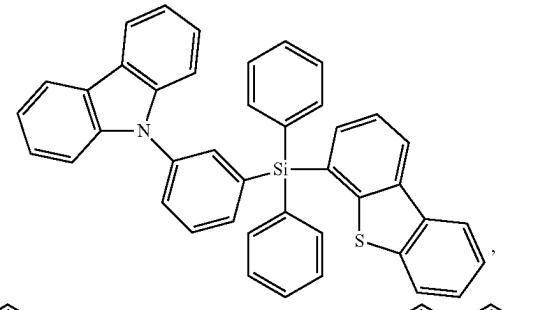
-continued

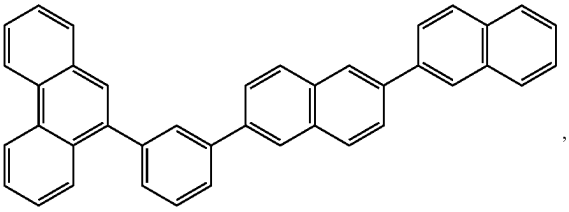












and combinations thereof.

18. A consumer product comprising the OLED of claim **15**, wherein the consumer product is selected from the group

consisting of a flat panel display, a curved display, a computer monitor, a medical monitor, a television, a billboard, a light for interior or exterior illumination and/or signaling, a heads-up display, a fully or partially transparent display, a flexible display, a rollable display, a foldable display, a stretchable display, a laser printer, a telephone, a mobile phone, a tablet, a phablet, a personal digital assistant (PDA), a wearable device, a laptop computer, a digital camera, a camcorder, a viewfinder, a micro-display, a 3-D display, a virtual reality or augmented reality display, a vehicle, a video wall comprising multiple displays tiled together, a theater or stadium screen, a light therapy device, and a sign.

19. The OLED of claim **15**, wherein the organic layer further comprises a host, wherein the host comprises at least one chemical group selected from the group consisting of triphenylene, carbazole, dibenzothiophene, dibenzofuran, dibenzoselenophene, azatriphenylene, azacarbazole, aza-dibenzothiophene, aza-dibenzofuran, and aza-dibenzoselenophene.

* * * * *