

Novel Phosphorescent Heteroleptic Iridium(III) Complexes for Organic Light Emitting Diodes

新規燐光イリジウム錯体の合成と有機 EL デバイスへの応用

Virendra Kumar Rai, Masayoshi Nishiura, Masanori Takimoto and Zhaomin Hou

Organometallic Chemistry Laboratory, RIKEN Advanced Science Institute

Organic light-emitting devices (OLEDs) using phosphorescent metal complexes as emitting materials have received much current interest, because their emission efficiency is higher than that of the fluorescent counterparts. Since tris(pyridylphenyl)iridium Ir(ppy)₃ (ppy = *ortho*-(2-pyridyl)phenyl) was first reported to show efficient green electrophosphorescence, a large number of tris(cyclometalated) iridium(III) complexes with various C^N chelating ligands have been reported to achieve a wide-range of emission for full color display. Although powerful color tuning was realized by modification of the C^N cyclometalating ligands, unfortunately, the synthesis of the homoleptic complexes with the same cyclometalated ligands is often difficult because of steric and electronic reasons. To improve both synthetic accessibility and EL efficiency, heteroleptic bis(cyclometalated) (C^N) iridium(III) complexes bearing an ancillary monoanionic ligand with a general formula of (C^N)₂Ir(L) have been extensively studied. However, in contrast with plenty of cyclometalating ligands developed for the phosphorescent Ir(III) complexes, the secondary ancillary ligands suitable for such emitting complexes have been much less extensively explored. Recently we found that the use of amidinates, guanidates, and dipyridyl amido groups as new secondary ancillary ligands for the phosphorescent bis-cyclometalated iridium(III) complexes can lead to significant improvement of the emitting properties, such as reduction of self-quenching and insensitivity to doping concentration. This presentation summarizes our recent studies in this area.

1. Amidinate-ligated iridium(III) bis(2-pyridyl)phenyl complex as an excellent phosphorescent material for electroluminescence devices

Amidinate [R'NC(R)NR'] have been widely used as ancillary ligands for various transition metal complexes in coordination chemistry. However, the use of an amidinate ligand for a phosphorescent metal complex has not been reported previously.

Recently we found that the use of a sterically demanding amidinate group as an ancillary ligand for a bis-cyclometalated (C^N) phosphorescent iridium species (Figure 1) can lead to a significant reduction in self-quenching and a dramatic improvement in the electroluminescence properties of the complex, thus enabling the successful fabrication of high efficiency, low driving-voltage phosphorescent OLEDs in a wide range of doping concentrations or even without the requirement of doping the emitter into a host matrix.¹

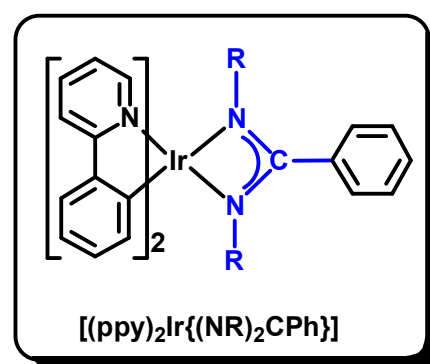


Figure 1.

2. Guanidinate-ligated iridium(III) bis(2-pyridyl)phenyl complexes as an excellent phosphorescent materials for electroluminescence devices

The guanidinate ligand is more electron-donating than amidinate because it has one more amino group on the central carbon atom and can thus serve as an excellent ancillary ligand to stabilize electron-deficient metal centers. Improvement of hole-injection and hole-transportation properties of the resulting complexes can also be expected. However, the utilization of guanidinate as an ancillary ligand for phosphorescent metal complexes has not been reported previously. We found that bis-(pyridylphenyl)iridium(III) complexes with various ancillary guanidinate ligands (Figure 2) can serve as excellent emitting materials for OLEDs, exhibiting both high current efficiency (ca. 116–137 cd/A) and high power efficiency (ca. 33–45 lm/W) under appropriate conditions. The electroluminescence (EL) emission color could be changed in the range of green to yellow by choosing appropriate guanidinate ligands.²

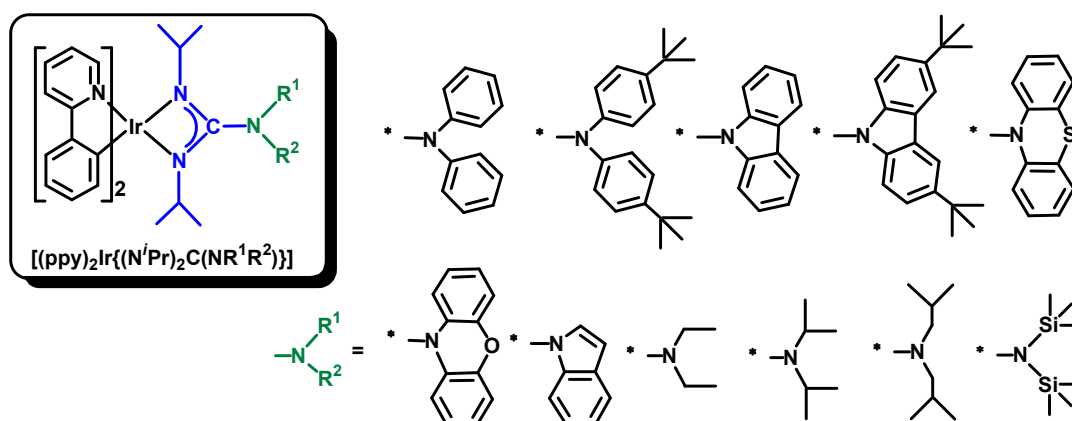


Figure 2.

3. Heteroleptic dipyridylamido/bis(pyridylphenyl) iridium(III) complex for EL devices

2,2'-dipyridylamido (dpa) has been widely used as an ancillary ligand for the synthesis of various metal complexes. However, the related iridium complexes reported so far in the literature were limited solely to a few ion-pair complexes, which are not suitable for OLED applications because of their low vapour pressure, which makes them difficult for vapour deposition. A neutral dpa-coordinated iridium complex has not been reported previously, and the EL property of an iridium complex bearing a dpa ligand has remained unexplored to date. We have succeeded in the synthesis of a neutral 2,2'-dipyridylamido (dpa)-supported bis(cyclometalated) iridium(III) complex $[\text{Ir}(\text{ppy})_2(\text{dpa})]$ (ppy = o-(2-pyridyl)phenyl) (Figure 3), which emits green electroluminescence with high current efficiency (123.5 cd A^{-1}) and high power efficiency (43.2 lm W^{-1}).³

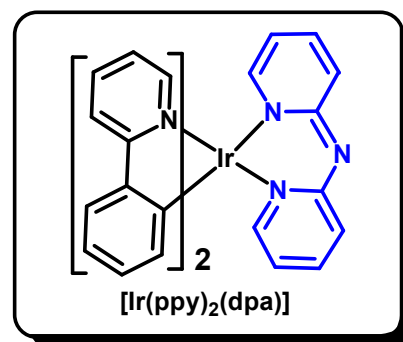


Figure 3

References:

- [1] a) Liu, Y.; Ye, K.; Fan, Y.; Song, W.; Wang, Y.; Hou, Z. *Chem. Commun.* **2009**, 3699. b) Peng, T.; Bi, H.; Liu, Y.; Fan, Y.; Gao, H.; Wang, Y.; Hou, Z. *J. Mater. Chem.* **2009**, *19*, 8072.
- [2] Rai, V. K.; Nishiura, M.; Takimoto, M.; Hou, Z. *Inorg. Chem.* in press.
- [3] Rai, V. K.; Nishiura, M.; Takimoto, M.; Hou, Z. *Chem. Commun.* **2011**, *47*, 5726.