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Synthesis and luminescent properties of a novel green-emitting iridium complex

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Abstract. A novel cyclometalated iridium complex bis[(4-(2-(4-Diphenylamino -phenyl)-benzoinidazol-1-ylmethyl)-phenyl)-diphenyl-amine]iridium(acetylacetonate) Ir(DBPA)$_2$(acac) is designed and synthesized, and the thermo-stability and photo-physical properties of iridium complex Ir(DBPA)$_2$(acac) are researched in detail. The complex is functionalized by a bulky non-planarity substituent, thus the phosphorescent concentration quenching in solid state is substantially suppressed, and Ir(DBPA)$_2$(acac) exhibits bright green-emitting in both solution and solid. The maximum emission peak inr pure solid is about 516 nm, which is slightly blue-shifted in comparison with that in solution. Moreover, the complex Ir(DBPA)$_2$(acac) exhibits high photoluminescent efficiency and short excited lifetime, indicating it has potential application in fabricating nodoped electrophosphorescence device.

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Key words: molecule design, iridium complex, photoluminescence

1 Introduction

Nodoped phosphorescent organic light-emitting devices (NPOLEDs) have received an increasing interest because they can simplify the fabrication process and decrease the cost for mass production compared with dopant counterparts [1, 2]. Unfortunately, phosphorescent-based emitters have some intrinsic disadvantages, such as concentration quenching and triplet-triplet (T-T) annihilation, which make them become either weakly emissive or even not emissive at all in solid state [3-5], and several phosphorescent materials are synthesized as neat emitters [6, 7]. A solution to the NPOLEDs, either in materials or devices perspective, is highly needed. Recently, many researchers have turned to explore the possibility of new phosphor materials which can be vacuum-deposited as pure films with

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*Corresponding author. *Email address:* `zhangly0324@163.com` (L. Y. Zhang) highly luminescent efficiency [8-10]. For example, Burn and co-workers have developed a class of phosphorescent dendrons composed of an iridium core, meta-bonded phenylene dendrons, and 2-ethylhexyloxy surface groups. However, the first-generation dendrons are not sufficient enough to prevent the interactions between the emissive cores, and higher-generation dendrons usually cause significant reduction in charge mobility [8, 9]. Huang *et al.* synthesized a new iridium complex containing carbazole functionalized β-diketonate and applied it in NPOLEDs successfully [10]. Moreover, the performances of these recent reported NPOLEDs are comparable with, or better than, the doped OLEDs reported to date. It is thus an important consideration of further obtainng emitters with suppressed self-quenching effect.

In this paper, we attempted to synthesize a green emitting iridium(III) complex bis[(4-(2-(4-Diphenylamino-phenyl)-benzoinidazol-1-ylmethyl)-phenyl)-diphenylamine]iridium (acetylacetonate) [Ir(DBPA)$_2$(acac)] with reduction of concentration quenching effect, which is suitable for NPOLEDs. We designed this molecule to have bulky non-planarity substituent, thus the phosphorescent concentration quenching in solid state can be substantially suppressed, and hole transporting group, triphenylamine, was introduced to the molecule to increase the hole-transporting property. The chemical structure and synthetic route of iridium (III) complex Ir(DBPA)$_2$(acac) are depicted in Fig. 1. Even as our anticipation, the iridium complex Ir(DBPA)$_2$(acac) exhibits highly efficiency phosphorescent emission in solid state, and we discussed its photoluminescent (PL) properties in detail, which indicating that it has potential application in NPOLEDs.

2 Experiments

2.1 Apparatus

^{1}H NMR spectra were recorded on a Bruker AVANVE 300 MHz spectrometer. Element analyses were performed using a Vario Element Analyzer. The UV-visible absorption spectra was obtained on a shi-madzu-UV-3101 scanning spectraphotometer. Steady state PL spectra were measured with a RF-5301Pc spectrofluorophotometer. Thermalgravimetric analyses (TGA) was performed using an SDT 2960 Simultaneous DSC-TGA of TA instruments, and the heating rate was 10°C min^{-1} under nitrogen. The PL decays of the complex in solution and pure solid excited by laser pulse at wavelength 355 nm were measured by a quanta ray DCR-3 pulsed Nd: YAG laser system. The PL quantum yield of the complex was measured in dilute solution by comparing fluorescence intensities (integrated areas) of a standard sample (quinine sulfate) and the unknown sample according to the following equation:

$$\phi_{unk}=\phi_{std}\cdot I_{unk}/A_{unk}\cdot A_{std}/I_{std}\cdot\eta_{unk}^2/\eta_{std}^2 \qquad (1)$$

where ϕ_{unk} is the luminescence quantum yield of the sample; ϕ_{std}=0.546 is the luminescence quantum yield of quinine sulfate [11], I_{unk} and I_{std} are the integrated fluorescence