Development of Phosphorescent OLEDs Based on Organometallic Complexes towards Circularly Polarized Light-Emitting Devices

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Recently, an increasing number of organic compounds exhibiting circularly polarized luminescence (CPL) have been developed. The CPL luminophores are attracting much attention in terms of industrial applications, because they are expected to be applied to three-dimensional (3D) displays, bioimaging systems, light sources for plant growth control, and so on. Especially, utilization of self-emitting CPL devices will allow us to produce 3D displays showing stereoscopic images without special glasses on the part of the viewers. In this term, organic light-emitting diode (OLED) is the good candidate as the light source. Towards the practical devices, phosphorescent OLEDs using organometallic phosphors are desirable because of the better luminous efficiencies than those of the fluorescent devices. The device fabrication process is also an important issue for development of OLEDs exhibiting circularly polarized electroluminescence. OLEDs are often fabricated by a vacuum deposition method. For optically active luminophores exhibiting CPL, however, racemization as well as thermal decomposition is concerned during the thermal evaporation process. From this viewpoint, solution processed OLEDs, usually fabricated by a spin-coating method in the laboratory, are more suitable for the CPL emitters. In this presentation, the author talks about his recent studies on phosphorescent OLEDs based on organometallic complexes as emitting materials,[1] looking towards development of circularly polarized electroluminescent devices.

Solution-Processed Double-EML OLEDs using an Organoiridium(III) Complex[2]

Phosphorescent organoiridium(III) complexes bearing six-coordinated octahedral geometry are often used for OLEDs in the form of a racemic mixture of Δ and Λ optical isomers. Although not so many examples have been reported for CPL from optically active organoiridium(III) complexes, they are potentially applicable to circularly polarized light-emitting devices. Recently, we have developed phosphorescent bis- and tris-cyclometalated iridium(III) complexes bearing a 5'-benzoyl substituent in each 2-(4',6'-difluorophenyl)pyridinate cyclometalated ligand (**B-1** and **B-2** in Figure 1), which emit sky blue photoluminescence (PL) with excellent PL quantum yields (Φ_{PL} > 0.8).[2] The solution-processed OLEDs bearing a poly(9-vinylcarbazole) (PVCz)-based single emitting layer (EML) doped with **B-1** (or **B-2**) gave modest device performance (external quantum efficiency η_{ext}; < 2%), whereas fabrication of OLEDs bearing solution-processed p/n double EMLs led to considerable improvement of device performance up to η_{ext} of 8.6%. It was likely that establishment of the p/n interface of EMLs allowed us to improve the hole–electron charge carrier balance in the EML.[2,3] Thus, the double EML device will be effective to develop highly

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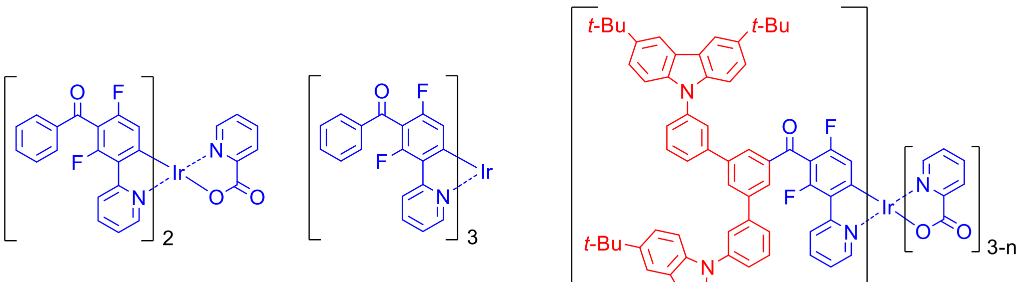
efficient OLEDs using organometallic CPL materials.

Non-Doped Multilayer OLEDs using Dendritic Organoiridium(III) Complexes[4,5]

Attaching carbazole-based dendrons to the benzoyl groups in **B-1** and **B-2**, hole-transporting dendritic organoiridium(III) complexes **D-1** and **D-2** have been developed (Figure 1).[4] With the help of steric hindrance of the dendrons, aggregate-based emission is considerably suppressed even in the film state, and thus these dendritic complexes are applicable to non-doped OLEDs. It is noteworthy that the solubility of the dendritic complexes in an apolar solvent such as cyclohexane as well as the insolubility in an alcoholic solvent such as 2-propanol allowed us to fabricate a non-doped multilayer OLED, where all the organic layers (PEDOT:PSS/PVCz/**D-1** or **D-2**/BPOPB) were fabricated by solution processing employing an orthogonal solvent system. This type of device afforded higher device performance in comparison with conventional solution-processed OLEDs, due to drastic improvement of charge carrier balance. Aimed at further improvement of the charge carrier balance, we were also succeeded in introduction of both hole- and electron-transporting dendrons to obtain an ambipolar dendritic iridium(III) complex.[5] The solution process affording the multilayer OLED will be useful for circularly polarized light-emitting devices: the device performance should be improved by employing the non-doped EML, even in the case of CPL materials with middle-to-high molecular masses.



B-1 **B-2** (*fac*-isomer)

Emitters applied to double EML device

D-1 : n = 2
D-2 : n = 3

Suitable for non-doped multilayer device

Figure 1. Structures of Organoiridium(III) Complexes.

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