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Phosphorescent Organic Light Emitting Diodes with Platinum Complexes

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abstract

Organic light emitting diodes (OLEDs) are a promising approach for display and solid state lighting applications. However, further work is needed in establishing the availability of efficient and stable materials for OLEDs with high external quantum efficiency's (EQE) and high operational lifetimes. Recently, significant improvements in the internal quantum efficiency or ratio of generated photons to injected electrons have been achieved with the advent of phosphorescent complexes with the ability to harvest both singlet and triplet excitons. Since then, a variety of phosphorescent complexes containing heavy metal centers including Os, Ni, Ir, Pd, and Pt have been developed. Thus far, the majority of the work in the field has focused on iridium based complexes. Platinum based complexes, however, have received considerably less attention despite demonstrating efficiency's equal to or better than their iridium analogs. In this study, a series of OLEDs implementing newly developed platinum based complexes were demonstrated with efficiency's or operational lifetimes equal to or better than their iridium analogs for select cases.

In addition to demonstrating excellent device performance in OLEDs, platinum based complexes exhibit unique photophysical properties including the ability to form excimer emission capable of generating broad white light emission from a single emitter and the ability to form narrow band emission from a rigid, tetradentate molecular structure for select cases. These unique photophysical properties were exploited and their optical and electrical properties in a device setting were elucidated.

Utilizing the unique properties of a tridentate Pt complex, Pt-16, a highly efficient white device employing a single emissive layer exhibited a peak EQE of over 20% and high color quality with a CRI of 80 and color coordinates CIE(x=0.33, y=0.33). Furthermore, by employing a rigid, tetradentate platinum complex, PtN1N, with a narrow band emission into a microcavity organic light emitting diode (MOLED), significant enhancement in the external quantum efficiency was achieved. The optimized MOLED structure achieved a light out-coupling enhancement of 1.35 compared to the non-cavity structure with a peak EQE of 34.2%. In addition to demonstrating a high light out-coupling enhancement, the microcavity effect of a narrow band emitter in a MOLED was elucidated.

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