Electrophosphorescent Organic Light Emitting Devices: High Efficiency, White Light and Spin

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Abstract

Electrophosphorescence, that is the emission of light from the triplet state of an organic molecule, has been shown to be the most efficient means for generating light in an organic light emitting device, simply due to the fact that 100% of the molecular excited states are emissive[1]. Indeed, nearly 100% internal emission efficiency, corresponding to ~20% external efficiency, can be obtained using electrophosphorescent OLEDs[2,3]. Our work has centered on the use of metalorganic compounds containing the heavy metal, Ir or Pt, to effect strong spin orbit coupling of the singlet and triplet emissive manifolds in the ligand, thereby converting electrically generated singlet states to triplets via intersystem crossing, and substantially reducing the triplet radiative transition rate formally forbidden in electric dipole transitions. In this paper, we discuss recent results in ultrahigh efficiency electrophosphorescent organic light emitting devices. In particular, we consider electrophosphorescent devices emitting in the red, green and blue and white spectral regions, and the relationship between efficiency and energy transfer. Both small molecular weight and polymer OLEDs are discussed.

Furthermore, very high brightness, white emitting electrophosphorescent OLEDs employing triplet excimer states will be described. That is, we have found that triplet excimers can be very efficient emitting centers, leading to a new architecture for realizing very high white light efficiencies using only a single dopant[4]. These triplet excimer emitters open new possibilities for OLEDs being used in solid state lighting applications. Additional significant enhancements in efficiency have also been demonstrated by employing conductivity doping of the hole and electron transport layers in white and green electrophosphorescent OLEDs. Very high luminous power efficiencies are demonstrated in low voltage, doped small molecular weight electrophosphorescent OLEDs. The details of these experiments will also be discussed in this paper.

Finally, we will discuss the singlet-triplet exciton formation ratio in both polymer and small molecular weight OLEDs. Measurements to determine this ratio, that is central to the understanding of the physics of OLEDs, will be described.

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