Getting Long Lifetime, and High efficiencies from the Blues

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Abstract

Perhaps the single most important problem confronting the development of OLED displays and lighting today is how to achieve sufficiently long triplet-controlled emission device lifetime to prevent rapid color change during operation, while achieving 100% internal emission efficiency. In 2008, we showed that bimolecular (e.g. triplet-polaron, triplet-triplet) annihilation provides a source of energy sufficient to destroy the blue triplet chromophore (whether a phosphor or a TADF molecule) or its host. Since that time, several studies have developed a series of structures and strategies to extend blue emission lifetime based on this understanding. Furthermore, various molecular fragments have been identified whose presence leads to the observed luminance loss. Unfortunately, a fully satisfactory solution has not been demonstrated where blue triplet emitter lifetime is sufficient to meet the demands of high performance displays, although white OLED illumination sources may now have adequate lifetime to meet industry standards. In this talk I will review recent advances and understanding of the limitations to extending the lifetime of blue triplet emitters further than are currently achieved.

1. "Intrinsic luminance loss in phosphorescent small-molecule organic light emitting devices due to bimolecular annihilation reactions". N.C. Giebink, B.W. D'Andrade, M.S. Weaver, P.B. Mackenzie, J.J. Brown, M.E. Thompson, and S.R. Forrest, *J. Appl. Phys*., **103**, 044509 (2008).
2. "Ten-Fold Increase in the Lifetime of Blue Phosphorescent Organic Light Emitting Diodes", Y. Zhang, J. Lee, and S. R. Forrest, *Nature Communications*, **5**, 5008, DOI: 10.1038/ncomms6008 (2014).
3. "Effects of charge balance and exciton confinement on the operational lifetime of blue phosphorescent organic light-emitting diodes", C. Coburn and S. R. Forrest, *Phys. Rev. Applied Lett*., **7**, 041002 (2017).
4. "Hot excited state management for long-lived blue phosphorescent organic light-emitting diodes", J. Lee, C. Jeong, T. Batagoda, C. Coburn, M. E. Thompson, S. R. Forrest, *Nature Commun*. **8** (2017).
5. "Understanding molecular fragmentation in blue phosphorescent organic light-emitting devices", C. Jeong, C. Coburn, M. Idris, Y. Li, P. I. Djurovich, M. E. Thompson, and S. R. Forrest, *Org. Electron*., **64** 15 (2019)
6. "*Organic Electronics: Foundations to Applications*", S. R. Forrest, Oxford University Press, Oxford (2020).