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Relating charge transport and performance in single-layer graded-composition organic light-emitting devices

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Organic light-emitting devices (OLEDs) continue to receive interest for application in displays and as solid-state lighting sources. While OLEDs can exhibit high external quantum and luminous power efficiencies, high performance often requires the use of complex, multilayer architectures. Consequently, there has been interest in the development of OLED architectures containing fewer device active layers or perhaps, a single active layer. Here, we describe an approach to realize efficient electroluminescence from a single active layer through the use of engineered composition gradients. Graded-emissive layer (G-EML) devices contain a single layer consisting of nearly 100% hole-transporting material (HTM) at the anode and nearly 100% electron-transport material (ETM) at the cathode, and having a continuously varying HTM:ETM composition across the active layer. Electroluminescence originates from a phosphorescent guest that is uniformly doped throughout the G-EML. For red-, green-, and blue-emitting phosphors, efficiencies are realized that rival those of more complex, multilayer structures. The G-EML balances electron and hole injection and transport leading to effective charge carrier confinement and exciton formation. This talk will examine how charge confinement in the G-EML is realized through a spatial variation in the carrier mobility across the active layer. In addition, separate measurements of the G-EML exciton recombination zone show that it is substantially broader than that of conventional, abrupt heterojunction OLEDs, a feature which may help to reduce bimolecular exciton quenching in these structures.