Supporting Information

Achieving Extreme Utilization of Excitons by an Efficient Sandwich-Type Emissive Layer Architecture for Reduced Efficiency Roll-Off and Improved Operational Stability in Organic Light-Emitting Diodes

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Deducing process about the k_{TT} and k_{TP}

Under device operating conditions, the exciton population becomes:[1,2]

$$\frac{\mathrm{dn}_{ex}}{\mathrm{dt}} = -\frac{\mathrm{n}_{ex}}{\tau} - \frac{1}{2}k_{TT}\mathrm{n}_{ex}{}^{2} - k_{TP}\rho\mathrm{n}_{ex} + \frac{J}{eW} \qquad (1)$$

where $\frac{J}{eW}$ represents electrical generation of excitons,[3] e is the elementary charge, W is the width of the exciton formation zone. n_{ex} is the exciton density, τ is exciton lifetime, ρ is the polaron density, k_{TT} and k_{TP} are the rate coefficient of TTA and TPQ.

A steady-state solution $(\mathrm{dn_{ex}}/\mathrm{dt} = 0)$ to Equation (1) can be found which describes the photon output per electron input, which is equivalent to the external quantum efficiency η_{EQE} That solution is:[1]

$$\frac{\eta_{\mathrm{EQE}}}{\eta_0} = \Theta\left(\sqrt{\frac{\Delta^2 + \Gamma \mathrm{k_{TT}}}{\mathrm{k_{TT}}{}^{2}}} - \frac{\Delta}{\mathrm{k_{TT}}}\right) \qquad (2)$$

$$\Theta = \frac{eW}{\tau J} \qquad (3)$$

$$\Delta = \left(\frac{1}{\tau} + \mathrm{k_{TP}}CJ^{1/l+1}\right) \qquad (4)$$

$$\Gamma = \frac{2J}{eW} \qquad (5)$$

where a relationship between the current density and polaron in a full device is assumed, $\rho = CJ^{1/l+1}$, C is a constant which describes the electronic properties of the device, e.g., the mobility, dielectric constant-which can only be estimated, and l is taken to be unity, according to the simple Mott-Gurney relation.[1]

The Equation S2 (the same as the Equation 4) is used to fit the obtained device's EQEs. It can be seen that the behavior is determined by four parameters: τ, W, k_{TT}, k_{TP}. Here, we assume the exciton lifetime τ of $Ir(ppy)_2(acac)$ is 1.5 μs,[4] the exciton recombination zone width W is between 2-8 nm. Thus, by the Equation S2 we can obtain the k_{TT}, and k_{TP} values.

References:

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