Role of a charge-transfer interface in blue TTU-OLEDs

九大 OPERA[1], WPI・I[2]-CNER[2] °(D)Nguyen Ba Thanh[1], 中野谷 一 [1,2], 安達 千波矢 [1,2]

OPERA, Kyushu Univ. [1], I2-CNER, Kyushu Univ.[2], ○Thanh Ba Nguyen[1], Hajime Nakanotani[1,2], Chihaya Adachi[1,2]

E-mail: nbthanh@opera.kyushu-u.ac.jp

Two low-energy triplets can convert to one singlet via triplet-triplet upconversion (TTU), resulting in an exciton production yield in fluorescence organic light-emitting diodes (OLEDs) beyond the theoretical limit. However, TTU's underlying mechanism still remains debated with varied viewpoints. Especially, although interfacial charge-transfer (CT) interaction has been shown to sensitize TTU before, it was claimed as a reason for external quantum efficiency (EQE) loss for blue TTU OLEDs. [1-3]

Herein, such interaction at the electron-blocking / emissive-layer interface is reported as an "overlooked" pathway to enhance TTU yields in OLEDs significantly. **Figure 1** depicts the contribution of interfacial exciplex to the TTU process. A small offset of the highest occupied molecular orbital (HOMO) level at the interface enables the formation of a high-energy CT exciton between Tris-PCz and NaNaP-A. The CT energy is sufficiently high to overcome exciton loss, allowing the Tris-PCz/NaNaP-A based OLEDs to reach the maximum EQE of ~6% (**Fig. 2**). Moreover, the generated triplet CT (^{3}CT) non-radiatively decays to the localized excited triplet state (^{3}LE) of NaNaP-A. The exceedingly dense ^{3}LE excitons, then, trigger efficient TTU at the interface. Conversely, replacing Tris-PCz with mCBP decreased EQE substantially. As the

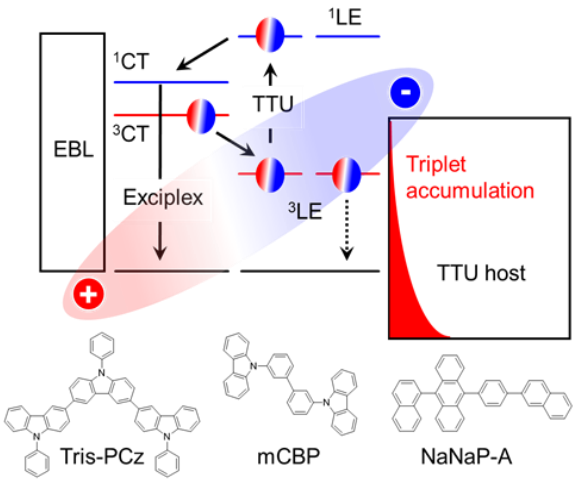

Figure 1. Charge-transfer interaction at the interface between electron-blocking and emitting layer.

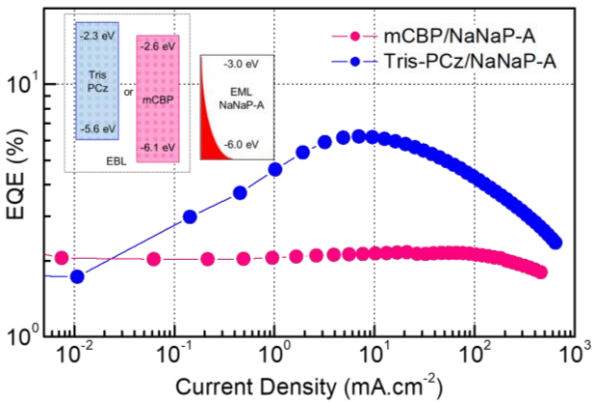

Figure 2. EQE-Current density characteristics of tested OLEDs. Inset: Band-gap diagram of Tris-PCz, mCBP and NaNaP-A.

HOMO level of both NaNaP-A and mCBP are similar, the CT interface is absent (**Fig. 2**).

This research, therefore, underlines an important role of the CT interface to exploit the full potential of TTU in the pure-blue OLEDs.

Reference:

[1] B.-Y. Lin. et al, *ACS Appl. Mater. Inter.* **2017**, 9, 10970.
[2] T. Sato. et al, *Org. Elec.* **2019**, 74, 118.
[3] T. Suzuki. et al, *Jpn. J. Appl. Phys.* **2014**, 53, 052102.