Enhancing Stability of Exciplex-based OLED by Utilizing TADF-Type Acceptor

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Exciplex systems exhibiting thermally activated delayed fluorescence (TADF) hold a great potential to improve organic light-emitting diode (OLED) performances.[1,2] However, the operational lifetime of current exciplex-based devices, unfortunately, falls far behind the requirement for commercialization.

Direct charge recombination on an acceptor molecule serves as a potential degradation mechanism for exciplex-based OLEDs (**Fig. 1**). Under device operation, a high-density accumulation of holes inside an emitting layer would inject holes into the highest-occupied-molecular-orbital (HOMO) of acceptor molecules, leading to an unwanted carrier recombination on the acceptor molecules, damaging the exciplex system. That problem can be addressed by changing the host from a conventional acceptor to a donor (D) -acceptor (A)-type acceptor molecule. Further, since the D unit is responsible for the HOMO in the D-A type acceptor molecule, carefully chosen D moiety would provide TADF-type acceptor. When unwanted carrier recombination happens on the TADF-type acceptor, the electrically generated triplets can convert to the singlet excited state (S_1) through reverse intersystem crossing, and the S_1 of the acceptor molecule then again decays to the exciplex formation (**Fig. 1**). To investigate this hypothesis, a comprehensive study was performed using the exciplex systems containing Tris-PCz (Donor) and a series of TRZ derivatives (Acceptor).

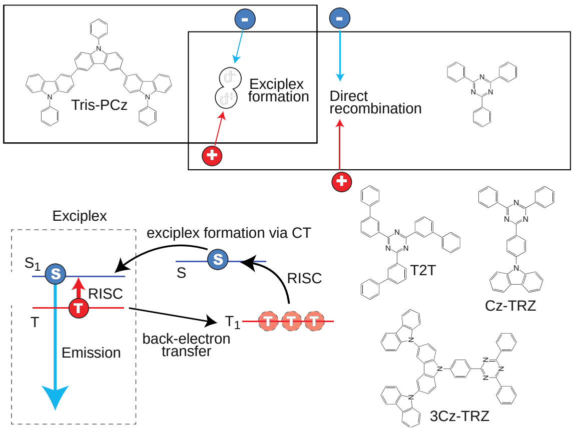

Figure 1. Degradation mechanism of exciplex-based OLED and 'exciton recycling' system in TADF-acceptor exciplex

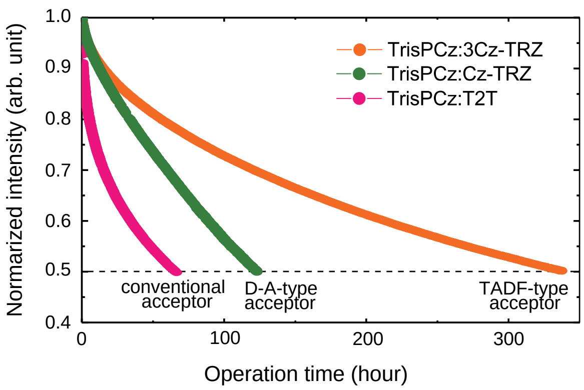

Figure 2. Normalized EL durability of OLEDs at constant current density of 3.3 mA.cm^{-2}. Initial luminance intensities are 830, 920, and 1030 cd・m^{-2} for 3Cz-TRZ, Cz-TRZ, and T2T based exciplex OLEDs, respectively.

Figure 2 clearly emphasizes the importance of D-A-type (no TADF activity) and TADF-type acceptors in term of device stability. Moreover, by employing 'exciton recycling' strategy (**Fig. 1**), a three-fold increased operational lifetime could be achieved with Tris-PCz:3Cz-TRZ systems (**Fig. 2**). This research provides an important step for exciplex-based devices toward the significant improvement of operational stability.[3]

References:

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