TADF emitters for deep-blue OLEDs

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In the OLED device, the power consumption is mainly determined by the emitter technology. Today's OLED displays typically utilize phosphorescent technology for the red and the green pixel. This technology is very efficient with an internal quantum efficiency (IQE) of ~100%. However, despite years of research, phosphorescence is not applied for the blue pixel due to its very short lifetime [1]. Therefore, panel makers still have to use rather inefficient fluorescent blue emitters with an IQE of ~25% or slightly more. However, a new technology has emerged that is capable to solve this issue: the TADF (thermally activated delayed fluorescence) technology [2].

This technology was introduced in 2010/2011 [3, 4]. Like phosphorescence, it can deliver 100% IQE, but TADF is actually based on fluorescent emission that is fed through a very efficient reverse intersystem crossing (RISC) mechanism (see Fig. 1).

The TADF technology can be used in two different approaches: either as emitter in the self-emitting (or classical TADF) approach, or together with a co-emitter (also called the hyper-approach, see Fig. 1). The classical approach has the advantage to be simple since it includes only a host and the emitter material in the emissive layer. Even though the TADF emission is usually slightly broader than the fluorescent emission, a full-width at half maximum (FWHM) of < 60 nm can be achieved, which is sufficient narrow for the blue pixels in mobile devices [5].

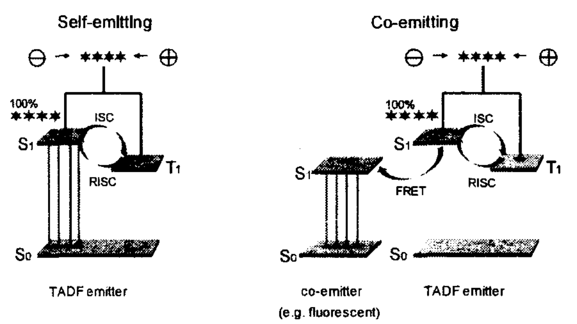

Figure 1: Schematics of the self-emitting (left) and the co-emitting approach (right)

In the case where a very specific emission spectrum is necessary, the co-emitting approach can be used. In this approach, both the charge recombination and the triplet to singlet conversion through RISC occur on the TADF emitter.

Thus, the TADF emitter also guarantees the high efficiency in this approach. But instead of an emission from the TADF material, the singlets are transferred to the co-emitter, which finally emits the light of the OLED device.

At the beginning of 2018, CYNORA was the first company to report deep-blue high-efficiency OLEDs using the classical TADF approach. In the meantime, the company has reached the required color and efficiency for deep-blue OLED pixels in the self-emitting and in the co-emitting approach (see Table 1).

Table 1. Performance of deep-blue TADF OLEDs at CYNORA using the self-emitting and the co-emitting approach

	Self-emitting	Co-emitting
CIEy@1000 cd/m² (1931 CIE)	0.15	0.15
EQE@1000 cd/m² (%)	24	18
LT95@1200 cd/m² (h)	5	10

The numbers given in Table 1 are the best performance that has been shown for deep-blue high-efficiency OLEDs so far. For the blue pixel in OLED display products the peak of the emitter always needs to be around 460 nm and the CIEy coordinate always has to be ≤ 0.15. OLEDs that do not satisfy these two color requirements are not considered deep-blue enough for display applications. Furthermore, the performance of blue pixels can only be compared when their color is also comparable since the three main performance factors (color, efficiency and lifetime) are all connected.

References

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