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Hyperfluorescence™, a Game Changing Technology of OLED Displays

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Abstract

Hyperfluorescence™ is the OLED emitting technology which combines thermally activated delayed fluorescence (TADF) and fluorescence, enables highly efficient and high color purity emission without using iridium. It provides ultimate solution for OLED displays.

1. Introduction

TADF is a OLED emission technology which enables highly efficient emission without using iridium[1]. One disadvantage of TADF is low color purity if it is applied to displays because of its wide emission spectrum. Hyperfluorescence™ (HF) combines TADF and fluorescence to provide the ultimate solution for OLED display[2]. Fig.1 shows the mechanism of HF. TADF acts as excitons generator and transfers excitons to Fluorescence by Förster energy transfer (FRET).

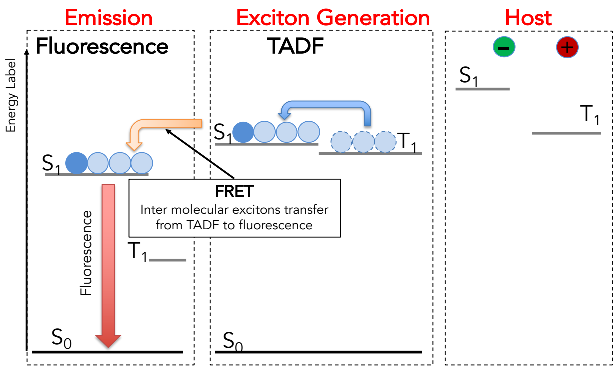

Fig.1 Mechanism of Hyperfluorescence™

Fluorescence molecule receives excitons and emits light as high as 100% internal quantum efficiency which is four times higher efficiency than a conventional fluorescence emitting technology. The demonstration panel shows dramatic enhancement of light intensity of HF compared with fluorescence (Fig.2). Light intensity of HF (the left-hand side of the panel) is more than four times higher than fluorescence (the right-hand side) using the same fluorescence molecule at the same current. HF enables all requirements for a display, full RGB color, nearly 100% internal quantum efficiency (IQE), and a narrow color spectrum.

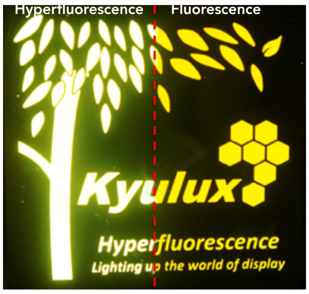

Fig.2 HF vs Fluorescence

2. Color purity enhancement

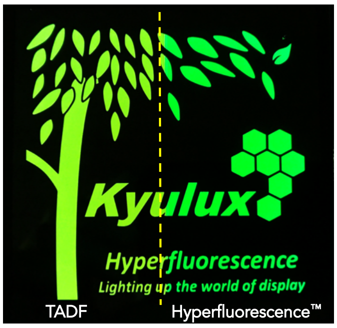

Fig.3 Demonstration of TADF and HF

HF enables narrow spectrum with high efficiency. The benefit of narrow spectrum is to enhance color purity and achieve a wider color space of a display. We fabricated tree OLED devices, TADF with bottom emission (BE), HF with BE and HF with top emission (TE), and evaluated performances. The demonstration panel's emission color comparison of TADF and HF with BE devices is shown in Fig.3. The left-hand side of the demonstration panel is TADF (BE) and the right-hand side is HF (BE). Emission color of TADF looks a bit yellowish green because of its wider spectrum including yellow. On the other hand, Emission color of HF looks purer green than TADF because the spectrum of HF is narrower than TADF. Fig.4 shows comparison of spectrum of the devices. Full width at half maximum (FWHM) of TADF (BE), HF (BE) and HF (TE) are 88nm, 31nm and 20nm respectively. In terms of EL intensity of devices, HF (BE) shows 2.0 times higher light intensity than TADF (BE), and

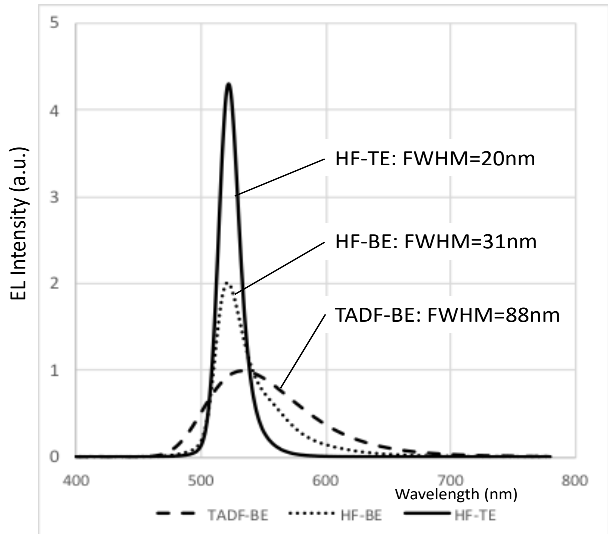

Fig.4 Spectrum comparisons of TADF-BE and HF-BE, TE

HF (TE) shows 4.3 times higher value at 10mA. Fig. 5 shows the CIE 1931 chromaticity diagram and plots of CIE xy coordinates of TADF (BE), HF (BE) and HF (TE). CIE xy coordinates are(0.32, 0.60), (0.27, 0.68) and (0.15, 0.78) respectively. CIE xy of HF (TE) achieves the required green primary color of ITU-R BT.2020. These results show color purity enhancement by using Hyperfluorescence™ and top emission.

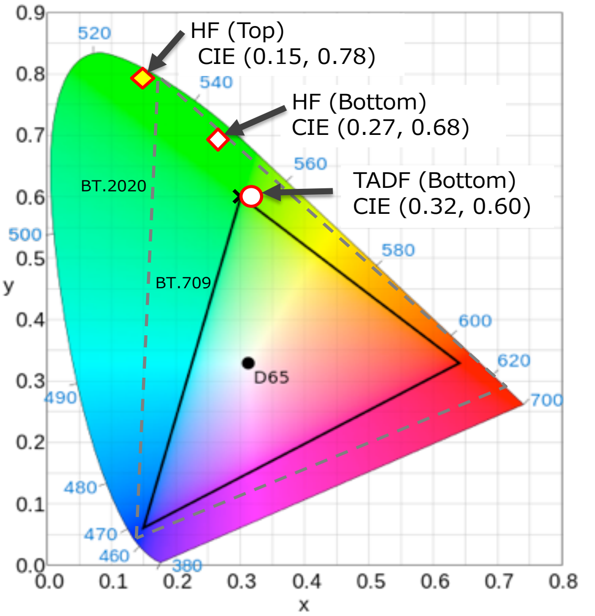

Fig.5 Comparisons of CIE xy of TADF-BE, HF-BE and HF-TE

3. Optical simulation results

Optical simulations of top emission devices were conducted. Device structures are shown in Table 1, and results are shown in Table 2. Peak emission intensity of HF is 2.0 times higher than that of Phosphorescence. Current efficiency of HF is 1.6 times higher than that of Phosphorescence. Color coordinate of HF is CIE (0.139, 0.793). It is close to the experimental result of HF-TE shown in Fig.4. Fig. 5 shows normalized EL intensity of simulation models. HF emission is the narrowest spectrum and highest intensity compared with Phosphorescence and TADF. These results show advantages of HF for display application.

Table 1 Device structures of simulation model

Unit : nm

	APC/ITO	HAT-CN	NPD	Tris-PCz	mCBP	mCBP : Dopant	T2T	Bpy-TP2	LiF	MgAg	NPD
①Phos.	150/10	10	108	15	5	30 (Irppy3)	10	47	0.8	15	104
②TADF	150/10	10	113	15	5	30 (TADF)	10	49	0.8	15	107
③HF	150/10	10	109	15	5	30 (HF)	10	47	0.8	15	105

Table 2 Results of Simulations

	Peak emission intensity	λ (nm)	CIE x	CIE y	Efficiency (cd/A)
①Phos.	0.99	521	0.142	0.765	131.1
②TADF	0.85	535	0.227	0.733	143.7
③HF	**1.97**	**523**	**0.139**	**0.793**	**206.9**

*BT. 2020 CIE (x_G, y_G) = (0.170, 0.797)

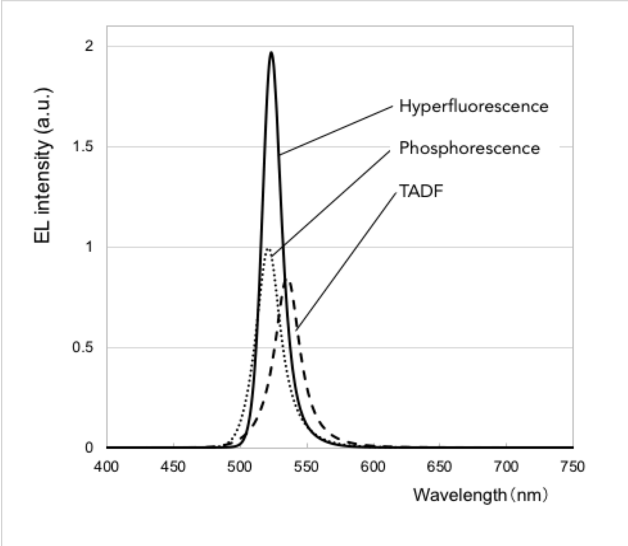

Fig.6 EL Spectrums of Phosphorescence, TADF and HF

4. Conclusions

Hyperfluorescence™ is highly efficient and highly pure color emission technology. It achieved BT.2020 color space requirement in green by the top emission device. Optical simulation results which had quite good agreement with experimental results suggest that Hyperfluorescence™ is the optimum solution for OLED displays.

Acknowledgements

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References

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