Simple-Structured High-Performance Narrow-Band Responsive PM-OPDs Enabled by Deep Trap Charge Capturing

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Materials

Copper (II) 1,2,3,4,8,9,10,11,15,16,17,18,22,23,24,25-Hexadecafluorophthalocyanine (F16CuPc) was purchased from Macklin. 1,4,5,8,9,11-Hexaazatriphenylene hexacarbonitrile (HAT-CN) and 2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP) were purchased from Jilin OLED Material Tech Co., Ltd. All the materials were used as received without further purification.

Device Fabrication

For the device fabrication, the glass substrate was ultrasonically cleaned in a washing solution for 90 minutes, then rinsed with deionized water and dried with high-purity nitrogen gas. Subsequently, it was placed in a real oven at 120 ℃ for 30 minutes. Subsequently, the glass substrate was treated with oxygen plasma for 4 minutes to further remove the residual impurities on the glass surface, and then the substrate was transferred into the vacuum evaporation system. All subsequent materials were deposited via thermal evaporation under high vacuum conditions of 10^{-5} Pa, with an effective area of 0.09 cm^2 for each device. A quartz crystal monitor was employed to control the evaporation rates, layer thicknesses, and mixing ratios. All measurements were carried out in an air environment. The absorption spectra of the film were measured using a UV-Visible dual-beam spectrophotometer (TU-1900, PG Instrument Co., Ltd.).

OPD characterization

For the external quantum efficiency (*EQE*) measurements, an incident light from halogen lamp (250 W) was passed through a monochromator, which was chopped at 35 Hz, and focused onto the device active region. The photocurrent signal was amplified

using a low-noise current preamplifier (SR570, Stanford Research Systems) and detected by a lock-in amplifier (SR830, Stanford Research Systems). The reverse bias voltage was applied by using a Keithley 236 Source-Measure Unit. Prior to measurements, a crystalline silicon photodiode (S1337-1010BQ, Hamamatsu), which was calibrated by National Institute of Metrology of China, was used as a reference. For the dark current measurements, the current-voltage characteristics were recorded with a Keithley 2636B source measurement unit.

Table S1. The key parameters of representative PM-OPD based on phthalocyanine-based materials over the past ten years

Device structure	Response range[nm]	J_d[A cm^{-2}]	EQE[%]	[Ref.]
ITO/HAT$(CN)_6$ (10 nm)/C_{60} (30 nm)/ZnPc:C_{60} (30 wt%, 100 nm)/HATNA-Cl_6 (10 nm)/HATNA-Cl_6:$W_2(hpp)_4$ (10 nm)/Al	300-900	~10^{-4} @-8V	1290 @(650nm,-8V)	[1]
Au/p-TPD/Y-TiOPc:ZnS/ITO	365-940	-	2985.5 @(365nm,-18V)	[2]
ITO/TAPC(30 nm)/PbPc(50 nm)/SubPc:C_{70}(30 wt%, 75 nm)/C_{70}(50 nm)/C_{70}:10 wt% MoO3(10 nm)/BCP(10 nm) /Al	300-1000	~10^{-4} @-8V	6000% @(890nm,-8V)	[3]
ITO/TAPC(30 nm)/PbPc(80 nm)/HATCN(10 nm)/BCP(10 nm) /Al	300-1000	~10^{-2} @-6V	~5675 @(755nm,-6V)	[4]
ITO/ZnPc:C_{60} (3 wt%, 400 nm)/HATCN-Cl_6(10 nm)/Al	300-900	~10^{-3} @-10V	~1000@(760nm,-10V)	[5]
P-Si/PTCDA :CuPc : PbPc (2 : 1 : 1.5) /Cathode	400-850	~10^{-1} @-15V	~5500@(655nm,-15V)	[6]
Au/Y-TiOPc(2μm)/Au	400-900	-	356 @(830nm,-5V)	[7]
ITO/NTCDA/C_{60}/CuPc:C_{60}(1:2)/BCP/Al	300-800	~10^{-4} @-3V	~700 @(300nm,-3V)	[8]
ITO/F16CuPc:HATCN/BCP/Al	300-800	~10^{-3} @-8V	5579 @(640nm,-8V)	This work

Notes and references

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