

Fluorene-based π -conjugated polymers for OLEDs: advances, opportunities, and challenges

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Table S1. Red and orange emitting PLEDs.

PLED	EML	V _{on} (V)	λ_{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)
ITO/PEDOT (40 nm)/EML (80 nm)/CsF (1.5 nm)/Al (100 nm)	PFO-Cz-TPATST1 ⁴	7.0	558	0.63	749
	PFO-Cz-TPATST5 ⁴	7.4	590	0.97	581
ITO/PEDOT (40 nm)/EML (80 nm)/TPBI (30 nm)/CsF (1.5 nm)/Al (100 nm)	PFO-Cz-TPATST1 ⁴	9.0	616	0.64	516
	PFO-Cz-TPATST10 ⁴	9.2	652	0.61	223
ITO/PEDOT/EML(180)/PFPO(140) / LiF/Al	P3 ⁵	9.8	~600	0.89	727
	P4 ⁵	10.5	~610	0.80	639
ITO/PEDOT:PSS (40 nm)/EML (60~70 nm) /TPBI (40 nm)/LiF (0.6 nm)/Al (80 nm)	PPFOH-H ⁶	6.0	594	0.93	420

Table S2. Green emitting PLEDs.

PLED	EML	V _{on} (V)	λ_{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)
ITO/PEDOT:PSS (60 nm)/EML (60 nm)/TPBi (40 nm)/LiF (1.2 nm)/Al (80 nm)	[4]CF ⁷	5.38	508	0.83	878
ITO/(PEDOT:PSS)/EL/CsF/Al	PF-DHTSO5 ⁸	3.8	~500	5.2	11926
	PF-DHTSO10 ⁸	2.8	~540	6.0	13175
	PF-DHTSO15 ⁸	3.0	~540	10.8	17148
	PF-DHTSO20 ⁸	2.8	~540	7.7	12858
ITO/PEDOT:PSS/EML/Ca/Al	SF5 ⁹	7.5		1.20	3165
		13.5		2.00	2246
	SF6 ⁹	8.2		1.28	5272
		14.4		4.42	3774

ITO/PEDOT:PSS/EML/Ba/Al	PPF-SO15-BT1 ¹⁰	3.0	~525	13.76	74796
ITO/PEDOT:PSS/PVK/EML/Ba/Al		3.6	~525	20.94	74220
ITO/PEDOT:PSS/PFO-TF/EML/Ba/Al		3.2	~525	22.27	91020
ITO/PEDOT: PSS (40 nm)/EML (60~80 nm) /TPBI (40 nm)/LiF (0.6 nm)/Al (80 nm)	PFPOH-co-DF8 ¹¹	n/p	548	1.06	1266
ITO/PEDOT: PSS (40 nm)/EML (60~70 nm) /TPBI (40 nm)/LiF (0.6 nm)/Al (80 nm)	PPFOH-H ⁶	6.6	536	1.10	1303
ITO/PEDOT:PSS/EML/Ca/Al	PFC16BT-Xy-2MA ¹²	2.2	538	n/p	3705
ITO/PEDOT:PSS/PVK:EML (25 wt%)/Ca/Al	PFABT ¹³	11.62	~535	206	0.09
ITO/PEDOT:PSS (35 nm)/p-TPD (30 nm)/PVK (5 nm)/EML (70–75 nm)/PF-PO (20 nm)/LiF (1 nm)/Al (80 nm)	PFCN1 ¹⁴	5.1	520	4880	1.48

Table S3. Blue emitting PLEDs.

PLED	EML	V _{on} (V)	λ _{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)	EQE _{max} , %
ITO/PEDOT:PSS (40 nm)/EML:MATS/Al(100 nm)	PF2DSO ¹⁵	6.8	434	1.60	878	
ITO/PEDOT:PSS/EML/CsF/Al	PFSO15 ¹⁶	3.5	~450	2.96	9064	3.21
	PFSO-Cz5 ¹⁶	3.2	~450	4.00	11051	4.00
	PFSO-T5 ¹⁶	2.8	~450	7.04	15097	6.34
	PF-FSO5 ¹⁷	3.8	~430	0.74	3911	
	PF-FSO15 ¹⁷	4.8	~430	1.17	2002	1.10
	PF-CzSO5 ¹⁷	4.2	~450	0.54	2837	
	PF-CzSO20 ¹⁷	4.1	~430	0.68	2075	0.71
	PF-CzBTO10 ¹⁸	3.6	~450	0.6	1495	0.7
	PPF-FSO10 ¹⁹	3.2	~430-445	2.38	4125	2.38
	PPF-SOF15 ¹⁹	3.0	~430-445	2.00	4094	3.76
ITO/PEDOT:PSS/EML(60 nm)/Ba/Al	PNFSO5 ²⁰	4.0	432	1.96	5481	
ITO/PEDOT:PSS/PFO-TF/EML/Ba/Al	PPF-SOF15 ¹⁰	3.0	~430-445	4.07	19098	
ITO/PEDOT:PSS/EML/CsF/Al	PF-BTOF30 ²¹	3.0	~480	3.50	10085	3.50
	PCz-BTOF20 ²¹	3.2	~460	3.10	19662	2.55
	PFSO5-Cz20 ²²	3.1	~450	1.6	8256	1.6
	PFSO15-Cz10 ²²	3.1	~460	5.2	11372	4.8
	37SOF8 ²³	3.2	~450	2.75	8530	2.84

	28SOF8 ²³	3.4	~430	1.89	7236	2.29
ITO/PEDOT:PSS/ EML (80 nm)/CsF (1.5 nm)/Al(80 nm)	PF-27SO20 ²⁴	3.2	~425	1.30	3735	2.73
	PF-36SO10 ²⁴	3.2	~425	1.56	5733	2.24
ITO/PEDOT: PSS/EML/CsF/Al	PF-BTOCz30 ²⁵	3.0	~470	6.36	16719	5.03
ITO/PEDOT: PSS/PVK/EML/CsF/Al	PPF-NS5 ²⁶	3.2		8.35	8582	
	PPFNSO10 ²⁶	3.0		9.15	11245	
ITO/PEDOT:PSS(50 nm)/EML(50-60 nm)/Ca(50 nm)/Al(100 nm)	P6 ²⁷			0.50	2830	
ITO/PEDOT:PSS/EML/CsF/Al	C8T-PsF ²⁸	2.7	428, 447	0.67	3484	
	C8T-alt-mO-PsF ²⁸	3.1	426, 592	0.65	3375	
	T-alt-mO-PsF ²⁸	3.2	430, 450	0.81	3302	
ITO/PEDOT:PSS/EML/CsF/Al	mO-PsF ²⁸	3.3	430, 447	1.10	2487	
ITO/PEDOT:PSS/EML/TPBi/LiF/Al	PG-C8 ²⁹	5.1		0.85	1212	
ITO/PEDOT:PSS/EML/CsF/Al	PPF-F ³⁰	4.2		3.73	8938	
	PPF-IF ³⁰	4.9		1.54	3871	
	PPF-NIF ³⁰	5.2		1.05	4006	
ITO/PEDOT:PSS/EML/Ca/Al	PFQ10 ³¹	9.8			~2500	
ITO/PEDOT: PSS (80 nm)/EML (30–50 nm)/TPBi (23 nm)/LiF (1.0 nm)/Al (100 nm)	P7-9DPF ³²	5.6	450, 475, 512	1.17	3467	
ITO/PEDOT:PSS (40 nm)/EML (40 nm)/TPBi (20 nm)/LiF (1 nm)/Al (100 nm)	PF-MC4 ³³	4.9	438, 460		2949	

Table S4. Yellow emitting PLEDs

PLED	EML	V _{on} (V)	λ _{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)
ITO/PEDOT:PSS/EML (~40 nm)/Ca(15 nm)/Al (120 nm)	SF4 ³⁴	6.3	540	1.54	5241
ITO/PEDOT:PSS (30 nm)/EML (40 nm)/TmPyPB (50 nm)/LiF(1 nm)/Al (100 nm)	P2 ³⁵	4.0	564	15.7	33539
ITO/PEDOT:PSS (35 nm)/p-TPD (30 nm)/PVK (5 nm)/EML (70–75 nm)/PF-PO(20 nm)/LiF (1 nm)/Al (80 nm)	FFCN1 ¹⁴	6.0	562	1.63	5750

Table S5. White emitting PLEDs

PLED	EML	V_{on} (V)	λ_{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)	EQE_{max} , %
ITO/PEDOT:PSS(40 nm)/EML(80 nm)/TPBI(30 nm)/LiF(1 nm)/Al(80 nm)	TM-R3G4 ³⁶	4.8	430, 450, 512, 600	2.09	2170	1.08
ITO/PEDOT:PSS (25 nm)/EML/TPBI(40 nm)/LiF (1 nm)/Al (120 nm)	LPF-TM03 ³⁷	7.5	424, 546	5.17	2375	2.35
	SPF-PM02 ³⁷	5.8		10.30	9244	5.1
ITO/PEDOT:PSS (40 nm)/EML (~70 nm)/TPBI (30 nm) /LiF (1 nm)/Al (100 nm)	WDP-1 ³⁸	4.47	432, 462, 554	7.82	9753	
	WDT-1 ³⁸	4.14	424, 446, 578	4.57	7436	
ITO/PEDOT: PSS (50 nm) / EML (50–60 nm) /Ca (50 nm) /Al (100 nm)	P5 ³⁹	7.0		1.86	3278	
ITO/PEDOT:PSS/EML/TPBI/LiF/Al	DC-TPA03 ⁴⁰	5.0	428, 452, ~ 560	10.7	6848	3.91
	DC-SBF03 ⁴⁰	5.2	428, 452, ~ 560	17.4	10083	6.17
ITO/PEDOT : PSS(35 nm)/EML(80 nm)/PF-EP(20 nm)/LiF(1 nm)/Al(80 nm)	FCP-I ⁴¹			1.98	2650	
	FCP-II ⁴¹			6.04	40900	
ITO/PEDOT:PSS (35 nm)/PTPD (20 nm)/PVK (5 nm)/EML (60-87 nm)/PF-EP (20 nm)/LiF/Al	P6 ⁴²	5.0		2.15	4130	
	P9 ⁴²	5.0		1.40	2020	
	P14 ⁴²	4.7		1.33	5110	

Table S6. Red and orange emitting PLEDs based on the second generation emitters.

PLED	EML	V_{on} (V)	λ_{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)	EQE_{max} , %
ITO/PEDOT:PSS/EML/TPBI/LiF(1 nm)/Al(120 nm)	PFCzIr(PhStz)5.0 ⁵¹	6		6.24	1568	
	PFOIr(PhStz)5.0 ⁵¹	6		2.41	663	
ITO/PEDOT:PSS (40 nm)/emission layer, EML (40 nm)/TPBI(40 nm)/LiF (1 nm)/Al (100 nm)	P-R-3 ⁵²	18.9	~640	8.31	5402	16.07
ITO/PEDOT : PSS (50 nm)/EML (45 nm)/LiF (0.5 nm)/Al (150 nm)	PFPPhIrpqi1 ⁵³	8.3–8.6	~420, 616	0.80	43	0.58

ITO/PEDOT:PSS/PVK/EML/CsF/A 1	PFTiqIr2 ⁵⁴	7.7	~625	3.52	1188	
	PFCzTiqlr3 ⁵⁴	5.9	~625	5.33	2204	
ITO/PEDOT:PSS/EML/Ca/Al	PF2/6-PF-Pt(salen) ⁵⁵		~640	~6		
ITO/PEDOT:PSS /PVK/EML/Ba/Al	PFO-PtTPP1 ⁵⁶	18.4	676		18.5	0.43

Table S7. Green emitting PLEDs based on the second generation emitters.

PLED	EML	V _{on} (V)	λ _{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)
ITO/PEDOT/EML/					
TPBI/LiF/Al	PF(BipyPr) ₆ ⁵⁷	6	492	1.5335	705.3
n/p	I ⁵⁸	20	531		320
	II ⁵⁸	20	538		190

Table S8. Blue emitting PLEDs based on the second generation emitters.

PLED	EML	V _{on} (V)	λ _{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)	EQE _{max} , %
n/p	III ⁵⁸	20	482		280	
ITO/PEDOT:PSS (40 nm)/EML (60 nm)/TPBI (40 nm)/LiF (1 nm)/Al (100 nm)	LPF-Ir5 ⁵⁹	7.5		1.69	5343	1.18

Table S9. White emitting PLEDs based on the second generation emitters.

PLED	EML	V _{on} (V)	λ _{max} (nm)	Luminance efficiency (cd/A)	Maximum brightness (cd/m ²)	EQE _{max} , %
ITO/PEDOT:PSS (40 nm)/EML (60 nm)/TPBI (40 nm)/LiF (1 nm)/Al (100 nm)	PF-Ir(piq) ₃ 100 ⁶⁰	7.3	430, 452, 488, 636	1.97	824	
ITO/PEDOT:PSS (40 nm)/EML (60 nm)/TPBI (40 nm)/LiF (1 nm)/Al (100 nm)	HPF-Ir10 ⁵⁹	7.2	430, 454, 484, 518, 626	1.73	2469	1.30
	LPF-Ir10 ⁵⁹	8.2	433, 459, 491, 524, 619	1.78	3863	1.26

			434, 460, 493, 523, 594	2.58	2036	1.48
	ELPF-Ir5 ⁵⁹	6.7				
ITO/PEDOT: PSS (40 nm)/EML (80 nm)/Ba (4 nm)/Al (150 nm)	PFQ-IrFppy + PBD (30 wt%) ⁶¹	4.3	425, 550	7.20	6409	3.60
	PFQ-IrFsn + PBD (30 wt%) ⁶¹	4.3	425, 568	6.48	5680	3.24
	PFQ-IrFpq + PBD (30 wt%) ⁶¹	4.9	425, 574	2.84	4333	1.42
ITO/PEDOT:PSS (50 nm)/EML (80 nm)/TPBI (40 nm)/LiF (1 nm)/Al (100 nm)	PF-BT250-Ir(piq)₃ ⁶²	16	432, 460, 528, 632	1.60	3267	
ITO/PEDOT:PSS (40 nm)/EML (50 nm)/TPBI (35 nm)/LiF (1 nm)/Al (150 nm)	PFSDF-Ir4 ⁶³	7.05	425, 548	4.0	6777.3	
ITO/PEDOT:PSS (40 nm)/EML (50 nm)/TPBI (45 nm)/LiF (1 nm)/Al (150 nm)	PFCzSDF10Ir8 ⁶⁴	6.10		4.65	6210	
	PFCzSDF10Ir9 ⁶⁴	6.10		6.30	4024.5	
ITO/PEDOT:PSS (40 nm)/EML (50 nm)/TPBi (35 nm)/LiF (1 nm)/Al (150 nm)	PFCzSDF10R8G32 ⁶⁵	4.50	420, 520	2.58	9054	
ITO/PEDOT:PSS (50 nm)/EML (80 nm)/BCP (15 nm)/Alq ₃ (30 nm)/LiF (1 nm)/Al (100 nm)	PAF(OF)₂APt (1 wt%)-PVKPBD ⁶⁶	10	486, 555	0.58	480	0.15

The numbering of references corresponds to the list of references in the article.