**Supporting Information**

# Highly Efficient Deep-Blue Electroluminescence from a A-π-D-π-A Structure Based Fluoresence Material with Exciton Utilizing Efficiency above 25%

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## 1. Introduction

**Table S1. Recent research process of deep-blue fluorescence materials**

| | Device performance | | | | | Ref. |
|---|---|---|---|---|---|---|
| | $\lambda_{EL}$[a] (nm) | Color index (x,y) | FWHM[b] (nm) | $EQE_{max}$ (%) | $\eta_s$[c] (%) | |
| **CzPAF-TFMP** | **436** | **0.155, 0.066** | **47** | **5.4** | **73.4** | **this work** |
| PyINA | 432 | 0.156, 0.060 | 59 | 5.05 | 59 | [1] |
| **8** | | 0.148, 0.084 | | 5.1 | | [2] |
| BD3 | 423 | 0.15, 0.06 | 45 | 12 | | [3] |
| DSFX-TFB | 433 | 0.15, 0.07 | 65 | 3.7 | | [4] |
| PMSO | 445 | 0.152, 0.077 | | 6.8 | 55 | [5] |
| PCAN | 447 | 0.151, 0.084 | 54 | 4.61 | | [6] |
| Ph-BPA-BPI | 448 | 0.15, 0.08 | | 4.56 | 36.2 | [7] |
| 3a | 443 | 0.15, 0.08 | 53 | 7.1 | 94 | [8] |
| PITO | 444 | 0.15, 0.08 | | 4.67 | | [9] |
| TPA-BPI | 448 | 0.15, 0.09 | 71 | 3.08 | | [10] |
| OF(3)-NPh | 428-432 | 0.152,0.083 | | 4.1 | | [11] |
| TPA-PPI | 434 | 0.15, 0.11 | | 5.02 | 28 | [12] |
| Isopro-BTPE | 451 | 0.15, 0.11 | | 1.7 | | [13] |
| TTP-TPI | 424 | 0.16, 0.05 | | 5.02 | | [14] |
| DPT-TPI | 432 | 0.16, 0.07 | | 5.25 | | [14] |
| m-BBTPI | 428 | 0.16,0.06 | | 3.63 | | [15] |

[a]The main EL emission peak of the devices; [b]full width at half maximum of the devices; [c]exciton utilizing efficiency.

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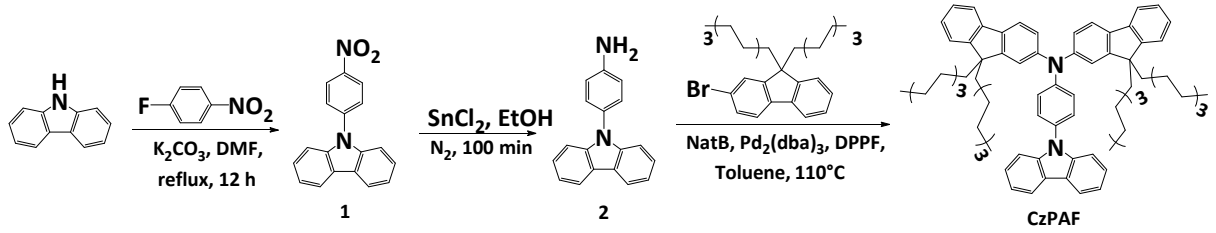
## 2. Synthesis of CzPAF




**Scheme S1.** Synthetic route of CzPAF.

**N-(4-(9H-carbazol-9-yl)phenyl)-N-(9,9-dioctyl-fluoren-2-yl)-9,9-dioctyl-fluoren-2-amine (CzPAF)**. The synthesis procedure of CzPAF is similar to the synthesis of CzPAF-Br but using 9,9-dioctyl-2-bromofluorene instead of 9,9-dioctyl-2,7-dibromofluorene. Compound 2 (0.26 g, 1 mmol), 9,9-dioctyl-2-bromofluorene (0.94 g, 2 mmol), and sodium tertiary butoxide (0.96 g, 10 mmol) were added to dry toluene (12 mL) and stirred under $N_2$ for 10 min. And then $Pd_2(dba)_3$ (9.16 mg, 0.01 mmol) and 1,1′-bis(diphenylphosphino)ferrocene (DPPF) (44.00 mg, 0.08 mmol) were added to the mixture. Finally the mixture was degassed with $N_2$ and stirred at 110 °C under

$N_2$ atmosphere for 18 h. After completing reaction, the resulting mixture was poured into water and extracted with ether. The collected organic layer was dried over anhydrous $MgSO_4$ and the solvent was concentrated under reduced pressure. Finally, the residue was purified by column chromatography on silica gel eluted with dichloromethane/petroleum ether (1:50) to afford CzPAF as viscous liquid (0.62 g, 60%). $^1$H NMR (600 MHz, $CDCl_3$) δ 8.15 (d, J = 7.7 Hz, 2H), 7.66-7.60 (m, 4H), 7.48 (d, J = 8.1 Hz, 2H), 7.43 (dd, J = 16.9, 8.5 Hz, 4H), 7.35-7.26 (m, 12H), 7.15 (s, 2H), 1.99-1.85 (m, 8H), 1.21-1.04 (m, 40H), 0.81-0.63 (m, 20H). $^{13}$C NMR (151 MHz, $CDCl_3$) δ 155.20, 153.56, 149.66, 144.00, 143.75, 139.78, 134.03, 130.59, 129.74, 129.39, 128.76, 126.64, 126.23, 125.69, 123.43, 123.20, 122.67, 122.38, 122.12, 112.73, 58.04, 56.29, 43.25, 34.72, 33.01, 32.73, 32.40, 32.29, 32.17, 29.15, 26.89, 25.52, 16.94. Elemental analysis: Found: C, 88.42; H, 9.125; N, 2.26. Calc. for CzPAF: C, 88.15; H, 9.15; N, 2.71.

**3. Measurement Section**

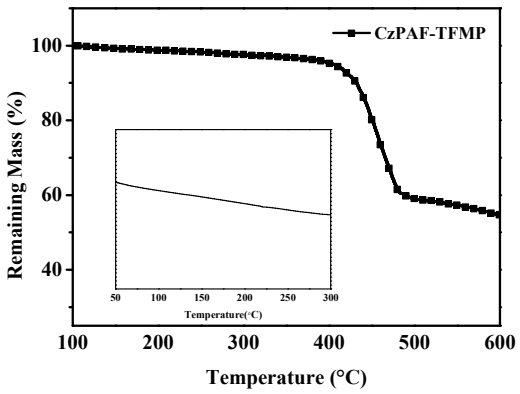



**Figure S1.**The TGA curve and DSC curve of CzPAF-TFMP.

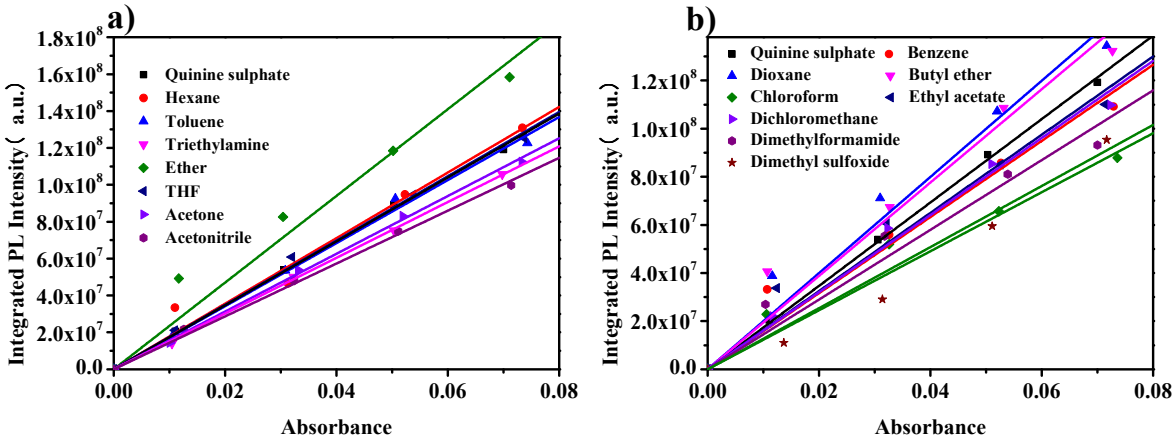



**Figure S2.**Quantum yield (vs quinine sulphate) measurements of CzPAF-TFMP in different polar solvents.

**Table S2.** Photophysical and electrochemical data of CzPAF

| Compound | $\lambda_{em}$[a] [nm] | $\lambda_{ab}$[a] [nm] | HOMO/LUMO[b] [eV] |
|---|---|---|---|
| CzPAF | 397/417 | 354 | -5.32/-2.25 |

[a]Measured in neat film. [b]Measured by an Ionization Energy Measurement System, LUMO (eV) = $E_g$ + HOMO.

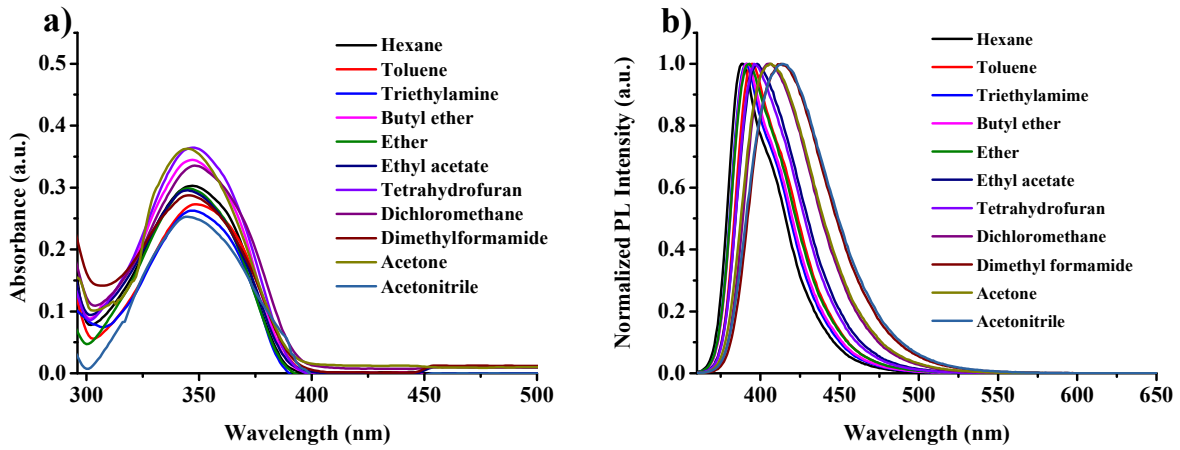



**Figure S3.**Photophysical properties of CzPAF with concentration of 1.0 × $10^{-5}$ mol/L in different solvents: a) UV-vis absorption spectra; b) PL spectra.

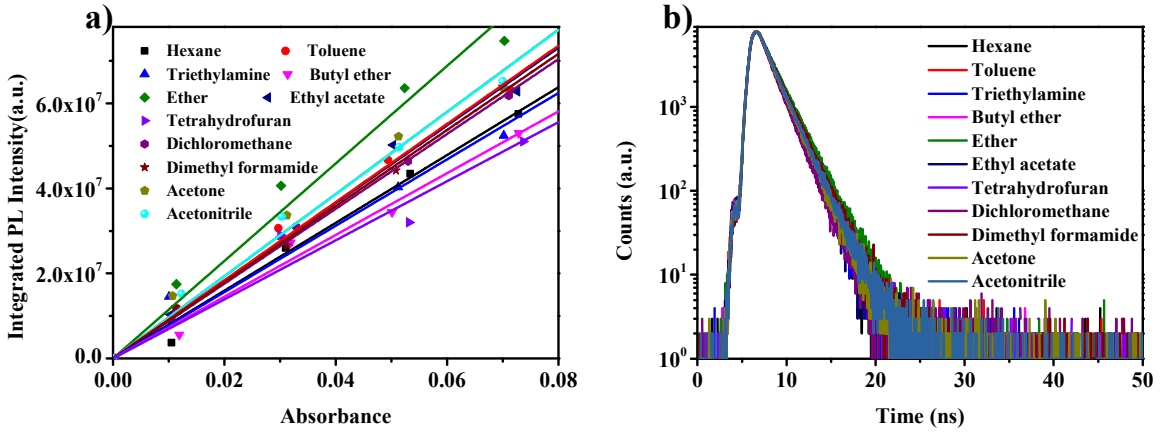



**Figure S4.** a) Quantum yield (vs quinine sulphate) measurements and b) transient PL decay spectra of CzPAF in different polar solvents.

**Table S3.** Photophysical properties of CzPAF in different solvents

| Solvents | $f(\varepsilon, n)$ | CzPAF | | | | | |
|---|---|---|---|---|---|---|---|
| | | $\nu_a$[a] [nm] | $\nu_f$[b] [nm] | $\nu_a$-$\nu_f$[c] [cm$^{-1}$] | FWHM[d] [nm] | $\eta_{pl}$[e] [%] | Lifetime[f] [ns] |
| Hexane | 0.0012 | 347 | 389 | 3112 | 37 | 27 | 1.68 |
| Toluene | 0.012 | 348 | 395 | 3419 | 39 | 36 | 1.75 |
| Triethylamime | 0.048 | 347 | 391 | 3243 | 38 | 27 | 1.69 |
| Butyl ether | 0.096 | 347 | 392 | 3308 | 39 | 25 | 1.78 |
| Ether | 0.167 | 345 | 393 | 3733 | 41 | 37 | 1.97 |
| Ethyl acetate | 0.2 | 345 | 398 | 3860 | 45 | 30 | 1.66 |
| Tetrahydrofuran | 0.21 | 347 | 396 | 3566 | 44 | 24 | 1.80 |
| Dichloromethane | 0.217 | 348 | 406 | 4355 | 50 | 30 | 1.62 |
| Dimethylformamide | 0.276 | 345 | 414 | 4831 | 50 | 32 | 1.87 |
| Acetone | 0.28 | 345 | 406 | 4351 | 52 | 31 | 1.75 |
| Acetonitrile | 0.305 | 345 | 414 | 4831 | 58 | 31 | 1.80 |

[a]Absorption peak. [b]Emission peak. [c]Stokes shift in different solvents. [d]The full width at half maximum. [e]Fluorescence quantum yield estimated versus quinine sulphate. [f]Measured at the peak wavelengths in different solvents.

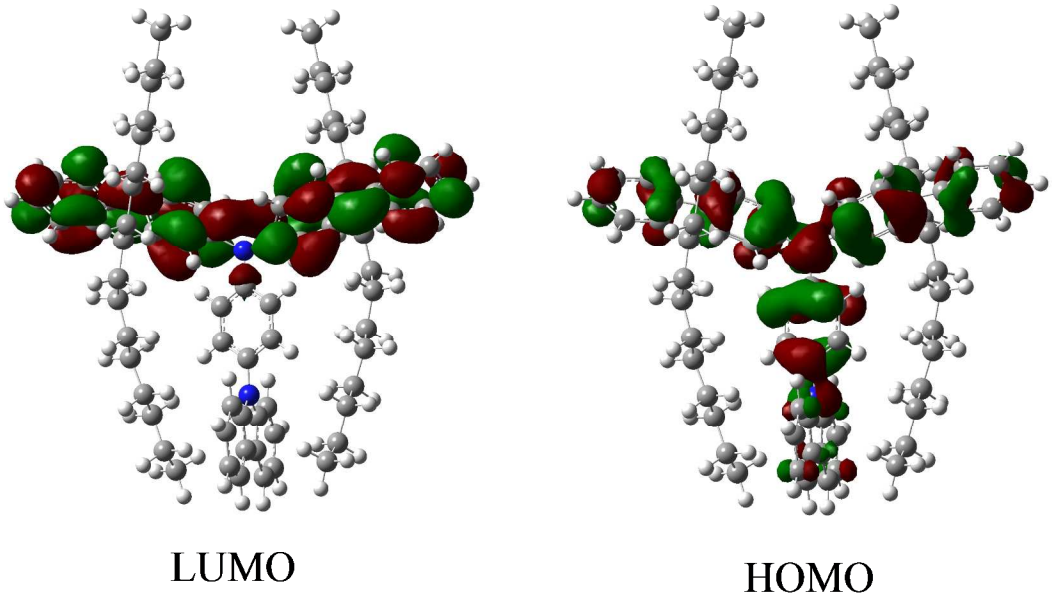



**Figure S5.**The calculated HOMO/LUMO spatial distributions of CzPAF.

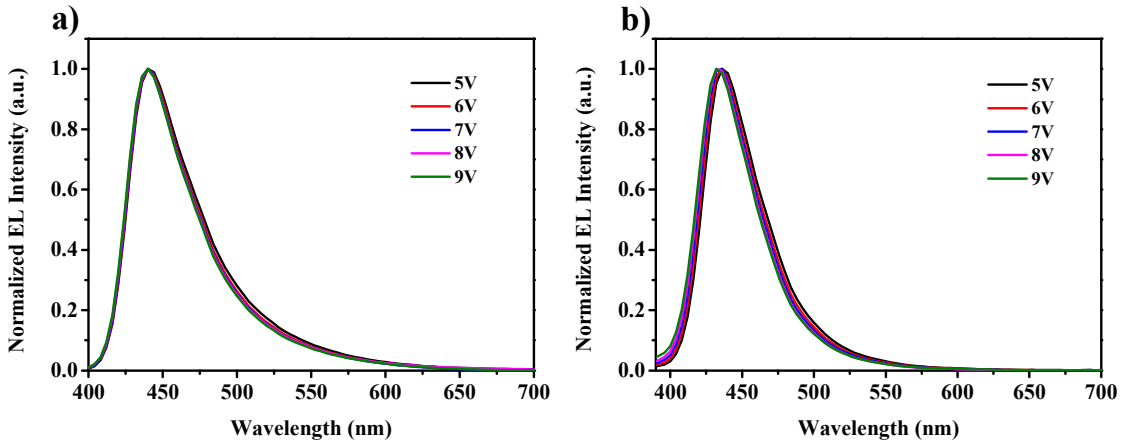



**Figure S6.**EL spectra at different voltage: a) Device I; b) Device II.

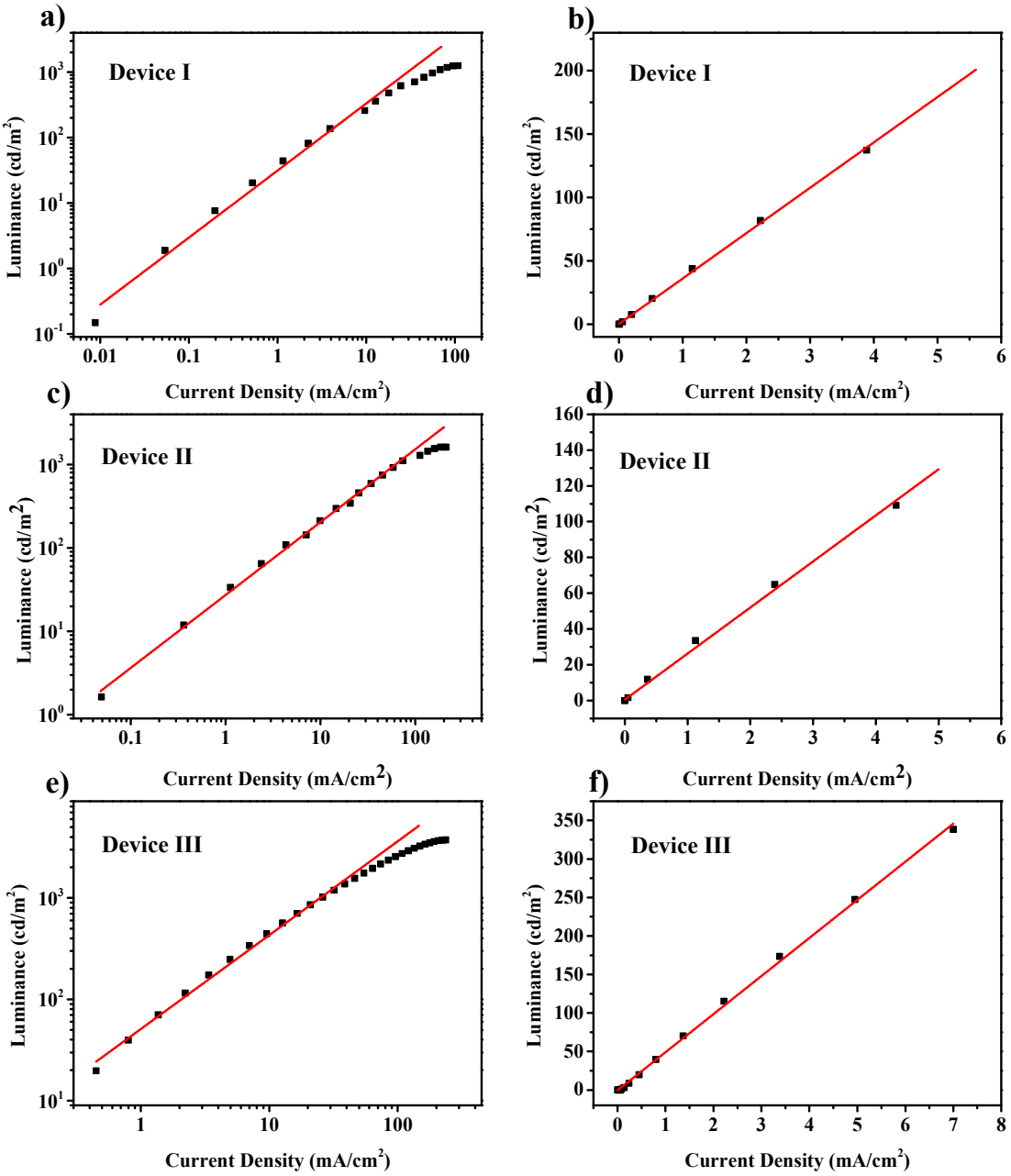



**Figure S7.** Dependence of the luminance of Device I, Device II and Device III on the current density: (a), (c) and (e) High injection current density; (b), (d) and (f) Low injection current density.

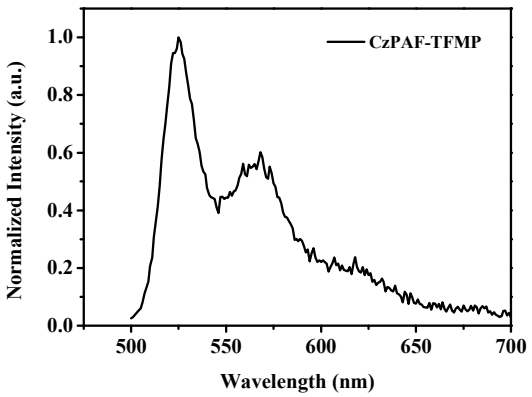



**Figure S8.**Phosphorescent spectrum of CzPAF-TFMP with concentration of $1.0 \times 10^{-5}$ mol/L in toluene at 77K.