Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting information

White vertical organic permeable-base light-emitting transistors obtained by mixing of blue exciton and orange interface exciplex emissions

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Radiation transition rates of TAPC:CzPm exciplex

To investigate TADF properties of the exciplex forming molecular mixture of CzPm and TAPC, analysis of its radiation transition rates was performed (Table S1). PL decay curves recorded at the different temperatures were fitted. The fitting results are given in Table S1. In addition, the radiation transition rates of the molecular mixture CzPm:TAPC were calculated using the following formula [S1]:

$$k_{PF} = \frac{\eta_{PF}}{\tau_{PF}};$$

$$k_{ISC} = \frac{\eta_{DF}}{\eta_{PF} + \eta_{DF}} k_{PF};$$

$$k_{DF} = \frac{\eta_{DF}}{\tau_{DF}};$$

$$k_{RISC} = \frac{\eta_{DF}}{\eta_{PF}} \cdot \frac{k_{PF} . k_{DF}}{k_{ISC}};$$

where k_{PF}, k_{DF}, k_{ISC}, and k_{RISC} are rate constants of prompt and delayed fluorescence, intersystem crossing (ISC) and RISC processes, respectively; Φ_{PF} and Φ_{DF} are PLQYs prompt and delayed emissions distinguished from the total PLQY (Φ_{N2}) by comparing the integrated intensity of the prompt and delayed components (Table S1).

Table S1. Rate constants of prompt and delayed fluorescence of the molecular mixture of TAPC and C zPm.

T,·K¤	1/T¤	τPF,·ns¤	τDF,·ns¤	ΦN2,· %¤	ΦPF,· %¤	ΦDF,· %¤	kPF,·s⁻¹¤	kDF,·s⁻¹¤	kISC,·s⁻¹¤	kRISC,· s⁻¹¤	ΦISC¤	ΦRISC¤	τPFrad,· ns¤	τPFnrad,· ns¤	kPFrad,· s⁻¹¤	kPFnrad,· s⁻¹¤	kTnrad,· s⁻¹¤
300¤	0.0033¤	190.09¤	3004.58¤	10.66¤	3.21¤	7.45¤	1.69E+05¤	2.48E+04¤	1.18E+05¤	8.25E+04¤	0.97¤	0.72¤	5930.1¤	196.4¤	1.69E+05¤	5.09E+06¤	3.17E+04¤
280¤	0.0036¤	235.12¤	3542.38¤	12.04¤	3.97¤	8.07¤	1.69E+05¤	2.28E+04¤	1.13E+05¤	6.90E+04¤	0.96¤	0.70¤	5918.3¤	244.8¤	1.69E+05¤	4.08E+06¤	2.99E+04¤
240¤	0.0042¤	281.77¤	3935.15¤	13.87¤	5.05¤	8.82¤	1.79E+05¤	2.24E+04¤	1.14E+05¤	6.16E+04¤	0.95¤	0.67¤	5582.1¤	296.7¤	1.79E+05¤	3.37E+06¤	3.04E+04¤
210¤	0.0048¤	314.81¤	3981.37¤	14.79¤	5.74¤	9.05¤	1.82E+05¤	2.27E+04¤	1.12E+05¤	5.85E+04¤	0.94¤	0.65¤	5482.1¤	334.0¤	1.82E+05¤	2.99E+06¤	3.17E+04¤
170¤	0.0059¤	358.24¤	4097.57¤	15.60¤	6.42¤	9.18¤	1.79E+05¤	2.24E+04¤	1.05E+05¤	5.44E+04¤	0.94¤	0.63¤	5580.9¤	382.8¤	1.79E+05¤	2.61E+06¤	3.21E+04¤
140¤	0.0071¤	415.75¤	4323.41¤	16.34¤	7.33¤	9.01¤	1.76E+05¤	2.08E+04¤	9.72E+04¤	4.64E+04¤	0.93¤	0.59¤	5668.7¤	448.7¤	1.76E+05¤	2.23E+06¤	3.16E+04¤
100¤	0.0100¤	406.19¤	3699.25¤	16.54¤	7.12¤	9.43¤	1.75E+05¤	2.55E+04¤	9.98E+04¤	5.92E+04¤	0.93¤	0.61¤	5706.9¤	437.3¤	1.75E+05¤	2.29E+06¤	3.73E+04¤
77¤	0.0130¤	387.10¤	3311.4502¤	16.52¤	7.09¤	9.43¤	1.83E+05¤	2.85E+04¤	1.05E+05¤	6.64E+04¤	0.93¤	0.61¤	5462.2¤	416.6¤	1.83E+05¤	2.40E+06¤	4.16E+04¤

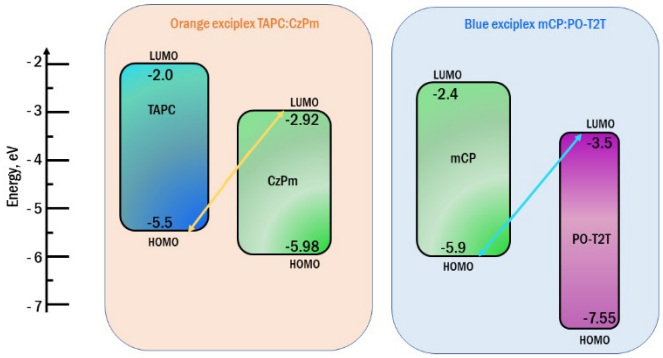

Figure S1. Schematic representation of energy band diagrams of exciplex-forming donors (TAPC and mCP) and acceptor CzPM.

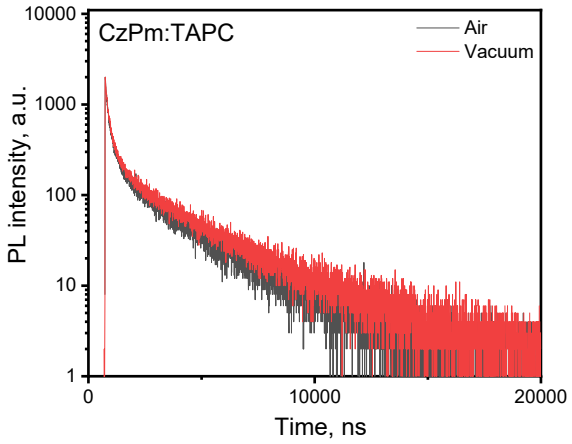

Figure S2. PL decay curves of the film of CzPm:TAPC recorded in air air and in vacuum.

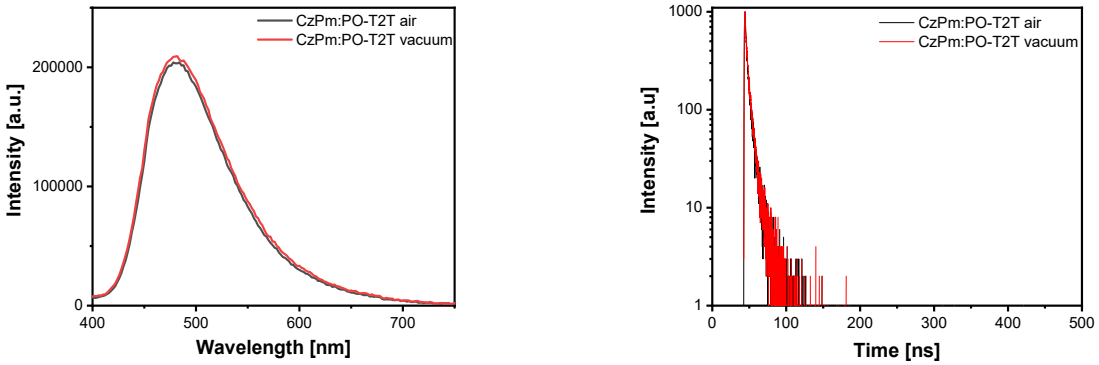

Figure S3. PL spectra (left) and PL decays (right) of CzPm:PO-T2T film.

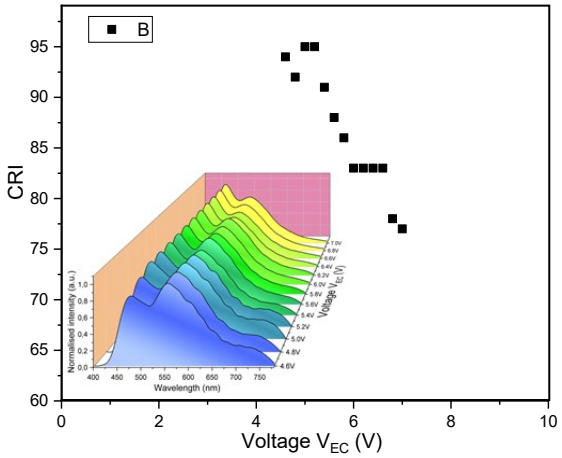

Figure S4. Colour rendering indexes of white OPB-LETs at different voltages. Inset shows the EL spectra of white OPB-LETs.

Table S2. Comparison of characteristics of light-emitting OLETs.

Structure of OLETs	Type of an emitter	[a]V (V)	EQE, %	CIE 1931	Ref.
White OLETs					
planar	Fluorescent/ monomeric	ca.70	-	(0.34, 0.34)	[9, S2]
Quasi-vertical	Fluorescent/ polymer	ca.2.8	-	(0.36, 0.34)	[11, S3]
Vertical with permeable-base	upper level RISC/ TADF exciplex/ monomeric	3.3	2.4	(0.34; 0.36)	this work
Single-colour OLETs					
Vertical with permeable-base	Phosphorescent/ monomeric	ca.2.5	18.9	red	[4, S4]
		ca.2.5	24.3	green	
		ca.2.5	11.7	blue	

[a] turn-on voltages.

References

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[S2] Z. Wu, Y. Liu, E. Guo, G. Darbandy, S.-J. Wang, R. Hübner, A. Kloes, H. Kleemann and K. Leo, Nat. Mater., 2021, 20, 1007–1014.

[S3] T. H. Ke, R. Gehlhaar, C. H. Chen, J. T. Lin, C. C. Wu and C. Adachi, Appl. Phys. Lett., 2009, 95, 063303.

[S4] J. Liu, S. Y. Chou, K. Tong, X. Luan, F. Zhao, Q. Pei and H. Li, J. Phys. Chem. C, 2017, 121, 10112–10118.