Supplementary Materials

Vapor-deposited cerium-based halide-organic composites for flexible white electroluminescence

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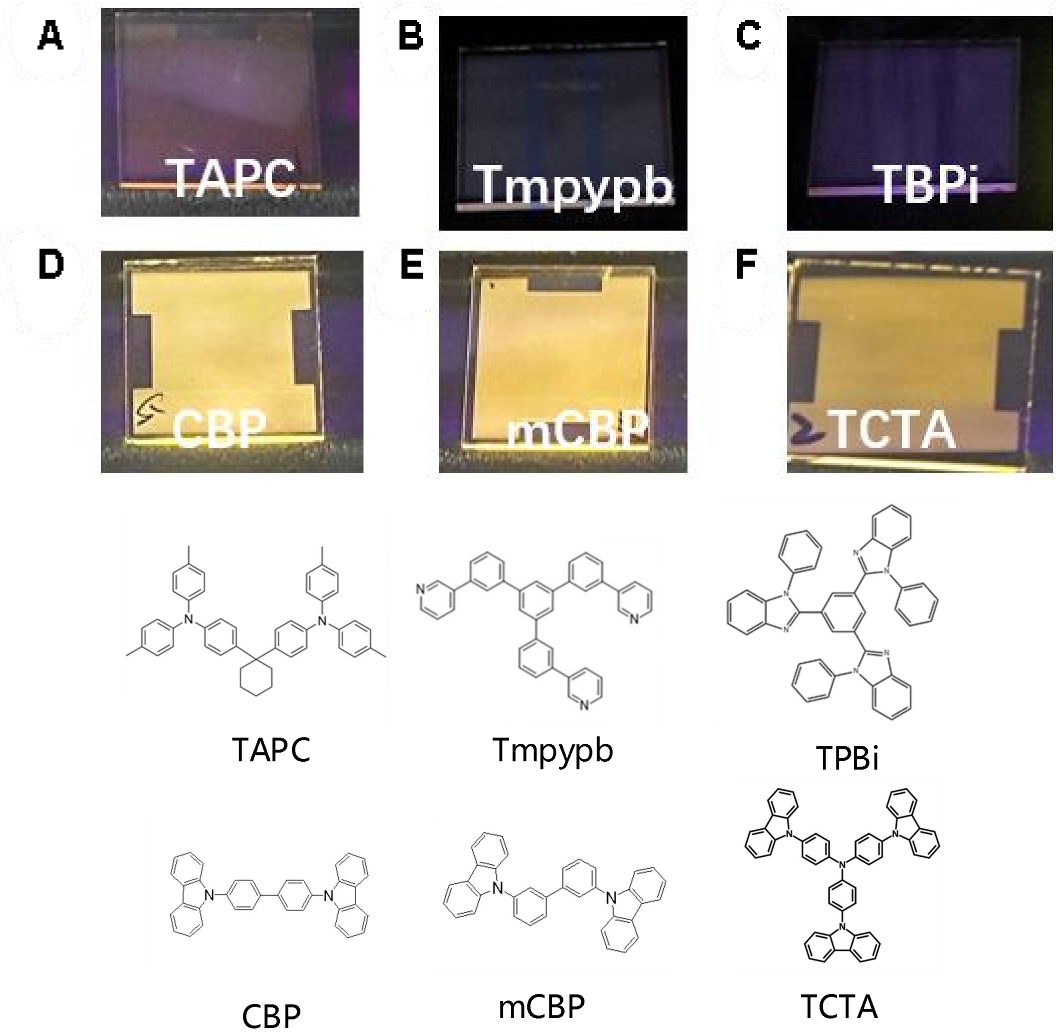
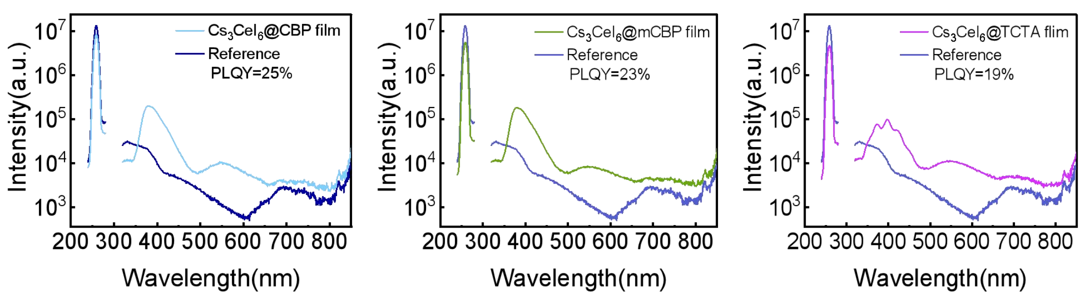


Supplementary Figure 1. Fluorescence of different subjects: (A) TAPC, (B) Tmpypb, (C) TPBi, (D) CBP, (E) mCBP, (F) TCTA. The 2D molecular structure of the individual organics are attached below.

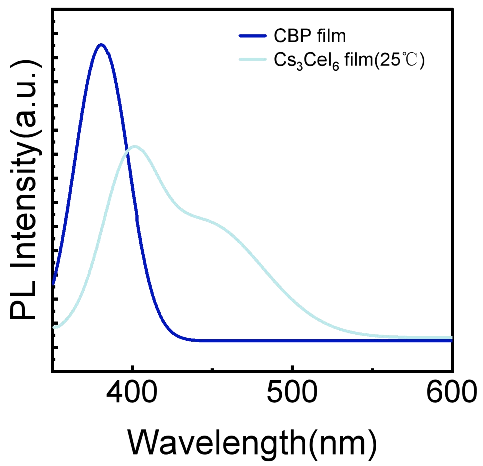


Supplementary Figure 2. Comparison of PLQY of Cs_3CeI_6@CBP, Cs_3CeI_6@mCBP and Cs_3CeI_6@TCTA.

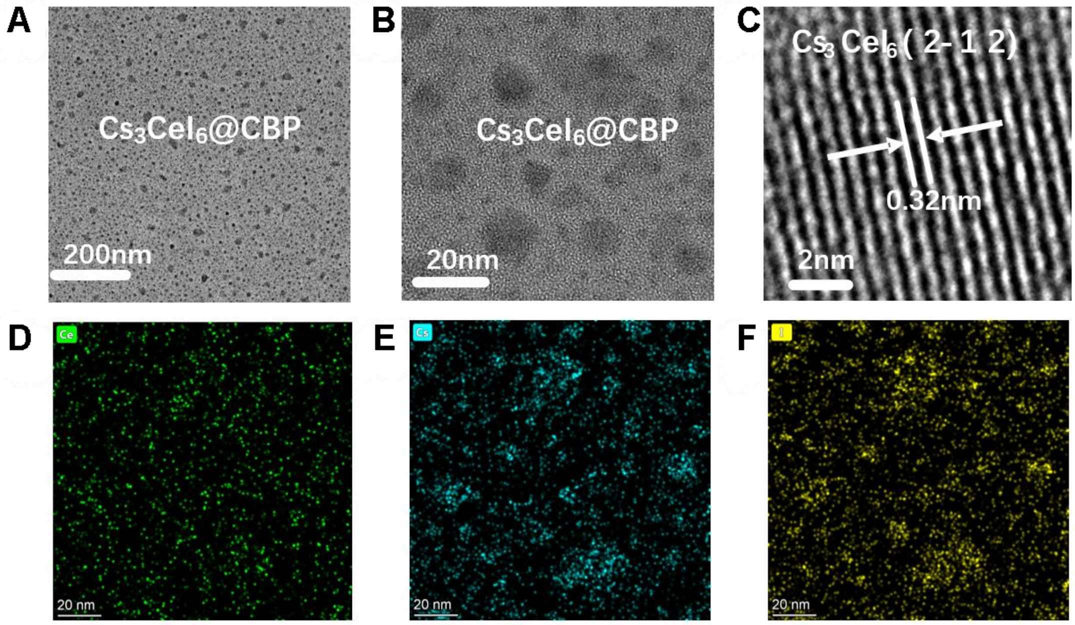
Supplementary Table 1. Comparison of intrinsic properties of organic host materials and PLQY of their co-evaporating films with Cs_3CeI_6

Material	HOMO	LUMO	Charge Carrier Mobility	ΔE_T	PLQY
CBP	6.5 eV	3.0 eV	$6.1*10^{-6}$ $cm^2V^{-1}S^{-1}$	2.5 eV	25%
mCBP	6.1 eV	2.4 eV	$1.2*10^{-6}$ $cm^2V^{-1}S^{-1}$	2.6 eV	23%
TCTA	5.8 eV	2.4 eV	$5.6*10^{-6}$ $cm^2V^{-1}S^{-1}$	3.0 eV	19%
TAPC	5.5 eV	2.0 eV	$1.0*10^{-3}$ $cm^2V^{-1}S^{-1}$	2.8 eV	No
Tmpypb	6.7 eV	2.7 eV	$1.0*10^{-3}$ $cm^2V^{-1}S^{-1}$	2.7 eV	No
TPBi	6.2 eV	2.7 eV	$1.2*10^{-4}$ $cm^2V^{-1}S^{-1}$	2.8 eV	No

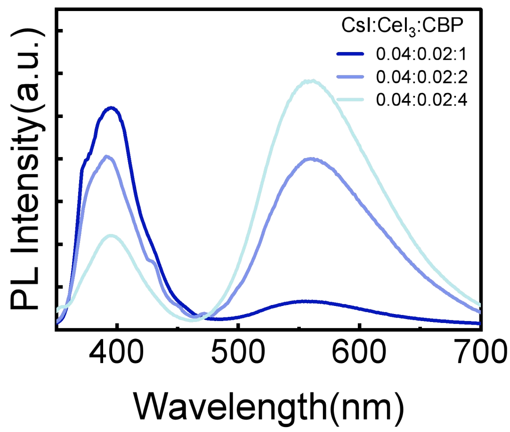
Note: ΔE_T refers to the triplet energy level of organic materials; CBP、mCBP、TCTA and TAPC are hole transport materials, Tmpypb and TPBi are electronic transport materials. The relevant data is sourced from the following website: https://www.sigmaaldrich.cn; https://www.chemicalbook.com.



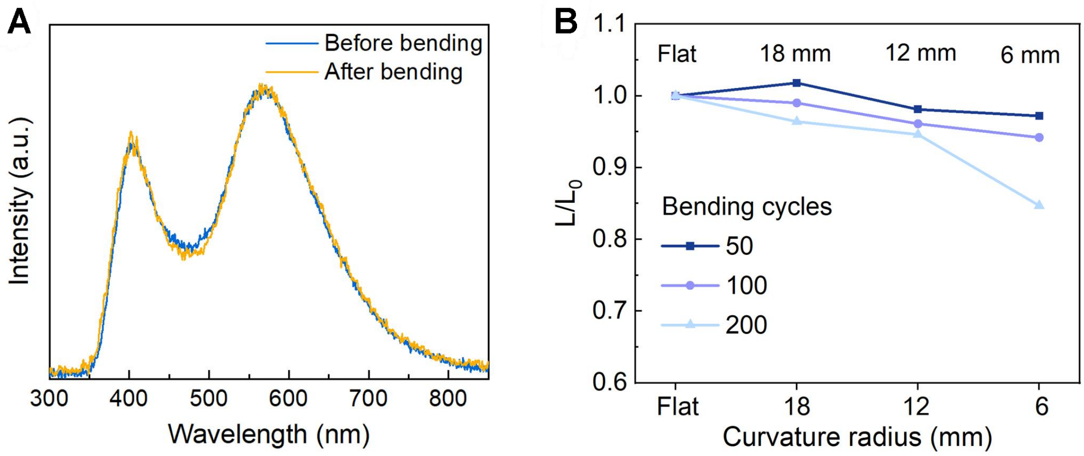
Supplementary Figure 3. PL spectrum of Cs_3CeI_6 and CBP films under 350 nm



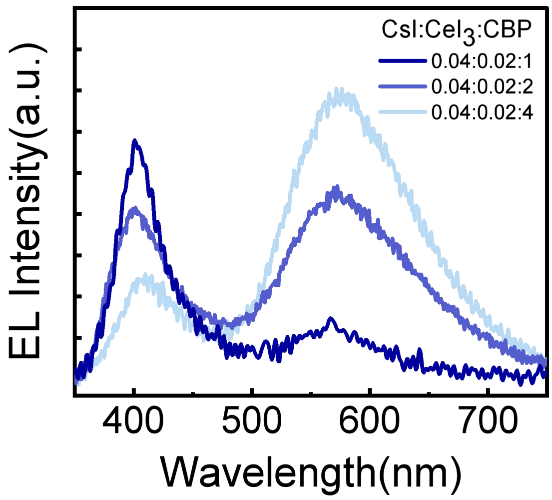
Supplementary Figure 4. (A)-(C) TEM images of the Cs_3CeI_6@CBP film: Low-magnification (left) and aberration-corrected high-resolution TEM images (mid). The crystal plane spacing corresponds to the preferred orientation of the crystal plane as (2, -1, 2) (right); (D)-(F) Mapping images of the Cs_3CeI_6@CBP film: (D) Ce; (E) Cs; (F) I.



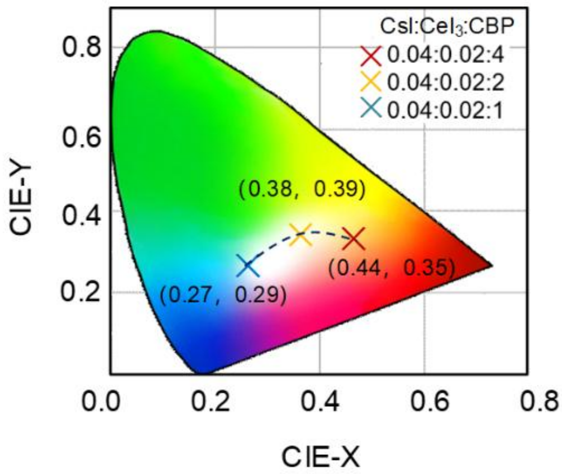
Supplementary Figure 5. PL spectra of Cs_3CeI_6@CBP films with different stoichiometric ratios of precursors.



Supplementary Figure 6. Flexible-device performance of the Cs_3CeI_6@CBP-based warm-white LED. (A) Electroluminescence spectra of the flexible device before and after bending. (B) Normalized luminance (L/L_0) of the flexible device after repeated bending cycles at different bending radii. L_0 corresponds to the initial luminance of the flat device, which was set to approximately 100 cd m^{-2}.



Supplementary Figure 7. EL spectra of Cs_3CeI_6@CBP WLEDs with different stoichiometric ratios of precursors.



Supplementary Figure 8. The CIE of Cs_3CeI_6@CBP WLEDs with different stoichiometric ratios of precursors.

Supplementary Table 2. Comparison of device performance of emissive layers with different deposition rate

Deposition rate (CsI: CeI_3: CBP)	Operating voltage	Luminance	EQE
0.04 Å/s: 0.02 Å/s: 1 Å/s	6.0 V	1944 cd/m²	1.5%
0.04 Å/s: 0.02 Å/s: 2 Å/s	4.0 V	2678 cd/m²	2.1%
0.04 Å/s: 0.02 Å/s: 4 Å/s	5.0V	923 cd/m²	0.9%

Supplementary Table 3. Performance comparison of white LEDs with different emission layers

Emitters	**EQE_{max}**	**CIE coordinate**	**T_{50}**	**Ref**
$CsPbCl_3$: Sm^{3+}	1.2%	(0.32, 0.31)	140 s@6V	[1]
$CsPbCl_3$: Eu^{3+}	5.4%	(0.32, 0.25)	220 s@6V	[2]
$Cs_2Na_{0.4}Ag_{0.6}In_{0.97}Bi_{0.03}Cl_6$: Tb^{3+}	0.76%	(0.38, 0.26)	771 s@ 200 cd·m^{-2}	[3]
$Cs_2Na_{0.4}Ag_{0.6}InCl_6$	＜0.5%	(0.40, 0.45)	10 min@ 50 mA/cm^2	[4]
$Cs_2AgIn_{0.9}Bi_{0.1}Cl_6$@ TPPO NCs	0.08%	(0.32, 0.32)	48.5 min@ 15 mA/cm^2	[5]
$CsCu_2I_3$	0.17%	(0.43, 0.52)	310 min@ 25 ℃	[6]
$CsCu_2I_3$@tween	3.1%	(0.44, 0.53)	NA	[7]
This work	2.1%	(0.38, 0.39)	59.7 min@ 200 cd·m^{-2}	

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