Supporting Information

Exciplex host coupled with micro-cavity enabling high efficiency OLEDs with narrow emission profile

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Device Fabrication

In prior to the fabrication of Ex-Te OLEDs, ITO/Ag/ITO anodes were deposited by magnetron sputtering under a vacuum of 10^{-3} Pa. A 10-nm-thick ITO layer was prepared under Ar and O_2 atmosphere on a glass substrate using a DC power and a sputtering pressure of 100 W and 0.5 Pa, respectively. A 100-nm-thick Ag layer was prepared under Ar atmosphere on the bottom ITO layer using a RF power and a sputtering pressure of 200 W and 2 Pa, respectively. The bottom-emitting OLEDs were fabricated on the ITO coated glass substrates. The ITO glasses were ultrasonically cleaned by deionized water and ethanol for 10 minutes subsequently, and then exposed to UV-ozone for 15 minutes. The active area of each device is 9 mm^2. All organic materials and metal layers were deposited by thermal evaporation under a vacuum of 10^{-6} Torr. The deposition rate of HAT-CN and Liq was 0.2 Å/s. The deposition rate of other organic layers was 2-3 Å/s. The deposition rate of Al and Yb:Ag was 5-6 and 2 Å/s, respectively. The doping rate was monitored with a quartz crystal monitor (QCM).

Measurement and characterization

The current density–voltage–luminance (J–V–L) characteristics, electroluminescence spectra and efficiencies of the devices were measured by a Suzhou F-star Scientific Instrument. The photoluminescence spectra were obtained by a Hitachi F-4600 fluorescence spectrophotometer. The surface roughness of the cathode was analyzed by a Veeco MultiMode V atomic force microscopy. The transmittance and reflectance of the electrodes were measured by a Perkin Elmer Lambda 750 spectrophotometer. The sheet resistance of the electrodes was measured by a Suzhou Jingge ST2258A four-point probe tester. The refractive index, extinction coefficient and film thickness of layers were measured by a J.A. Woollam Co., Inc. Alpha-SE ellipsometer with the angle of incidence at 70°.

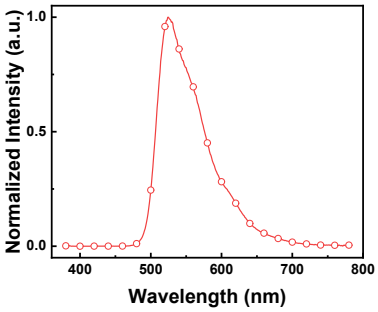


Figure S1. Normalized EL spectrum of the Ref-Be device.

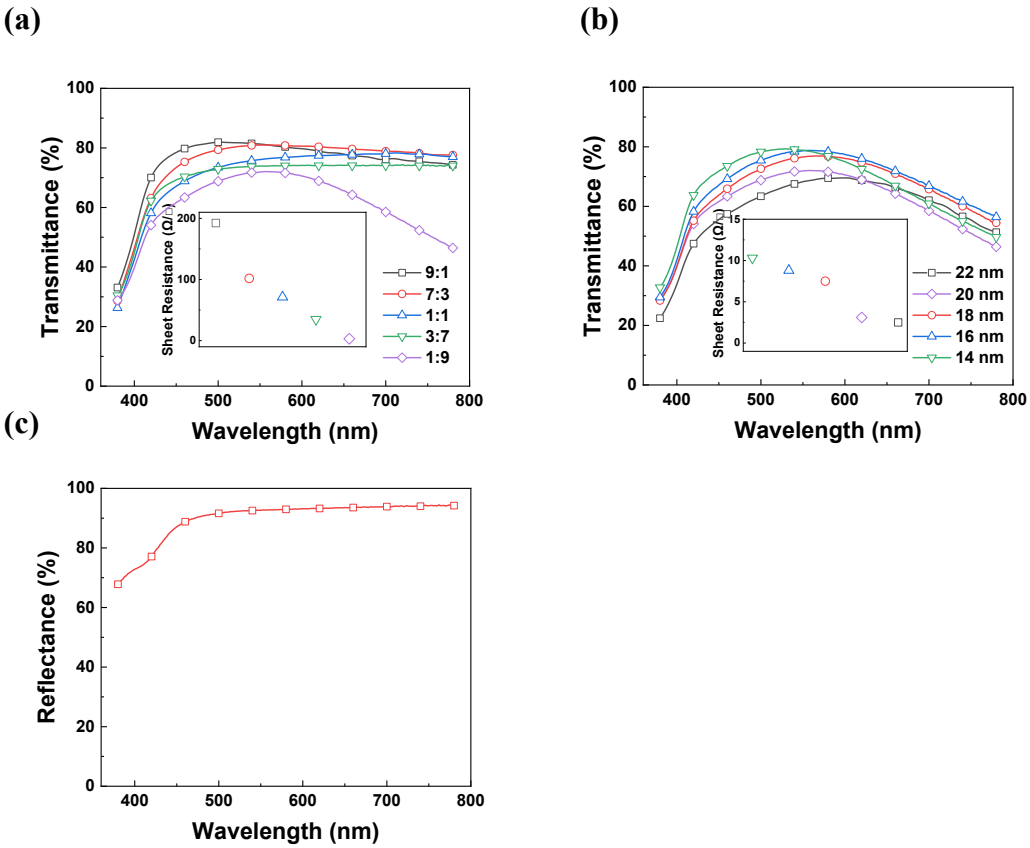


Figure S2. (a) Transmittance and sheet resistance (inset) of co-deposited 20 nm thick Yb:Ag alloy with different volume ratios. **(b)** Transmittance and sheet resistance (inset) of Yb:Ag alloy with different thicknesses at a volume ratio of 1:9. **(c)** Reflectance of ITO/Ag/ITO anode.

Table S1. Summary of the transmittance and sheet resistance of Yb:Ag alloy with different volume ratios and thicknesses.

Ratio	Thickness (nm)	Transmittance $_{@\ 524\ nm}$ (%)	Sheet Resistance (Ω/□)

9:1		81.7	192.4
7:3		80.4	101.8
1:1	**20**	75.0	71.3
3:7		73.6	34.8
1:9		70.9	3.1
	22	66.2	2.7
	20	70.9	3.1
1:9	**18**	75.1	7.5
	16	77.7	8.8
	14	79.2	10.3

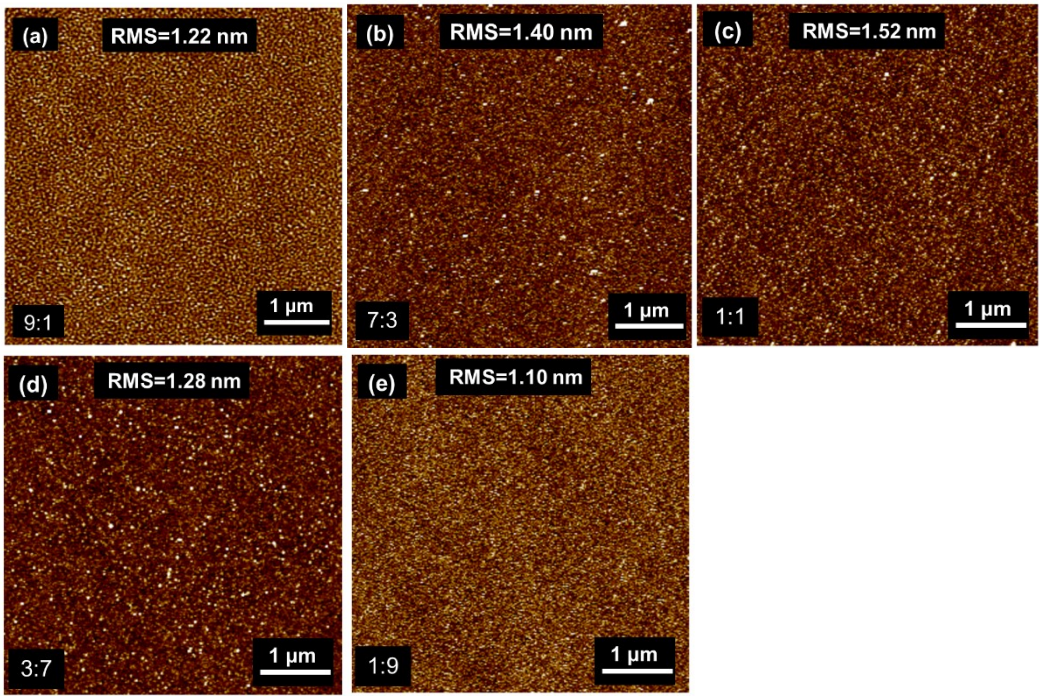
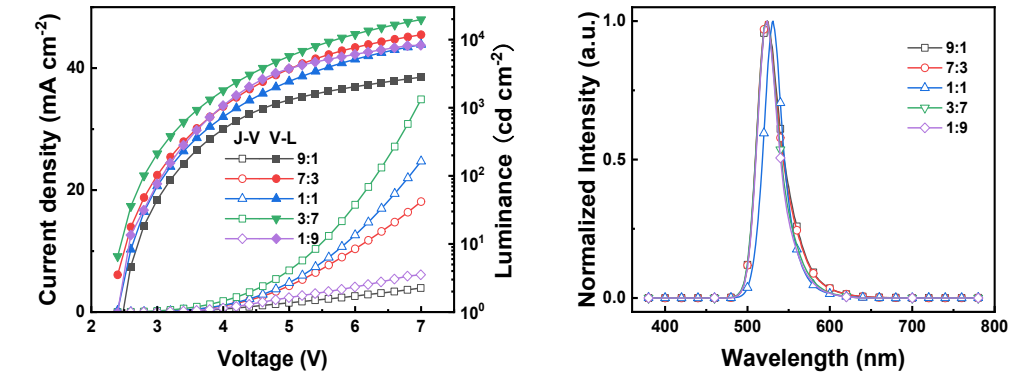


Figure S3. Atomic force microscope (AFM) images of Yb:Ag alloy with different volume ratios.

(a) **(b)**



(c)

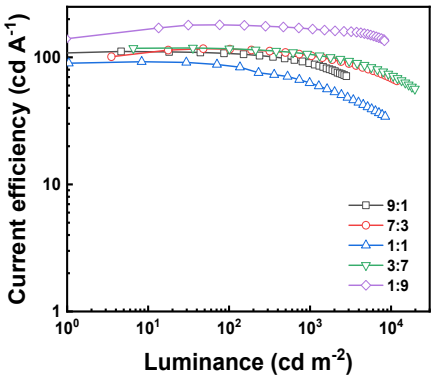


Figure S4. Device performance of the Ex-Te OLEDs based on Yb:Ag cathode with different volume ratios**. (a)** Current density and luminance vs voltage, **(b)** normalized EL spectra and **(c)** current efficiency vs luminance

Table S2. Device characteristics of the fabricated Ex-Te OLEDs based on Yb:Ag cathode with different volume ratios.

Ratio	V_{on} [a)] (V)	Maximum CE (cd/A)	EL Peak (nm)	FWHM (nm)
9:1	2.6	111.3	524	35
7:3	2.4	116.9	524	32
1:1	2.4	92.4	524	32
3:7	2.4	118.6	524	30
1:9	2.4	180.2	531	26

a) The voltage at the luminance of 1 cd m^{-2}.

(a) **(b)**

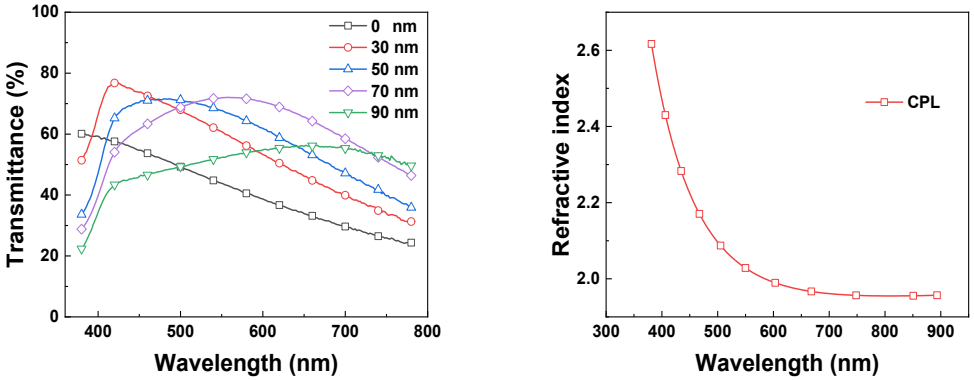


Figure S5. (a) Transmittance of the co-deposited Yb:Ag alloy with different thicknesses of capping layer. **(b)** Refractive index of the CPL layer.

Table S3. Summary showing the transmittance of Yb:Ag alloy with different thicknesses of CPL.

Thickness (nm)	Transmittance $_{@\ 524\ nm}$ (%)
0	46.6
30	64.4
50	69.8
70	70.9
90	50.7

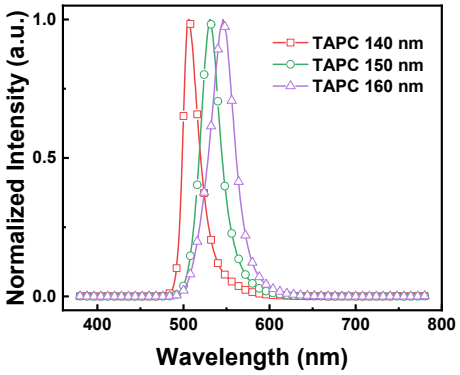


Figure S6. Normalized EL spectra of the Ex-Te devices with TAPC thickness of 140, 150 and 160 nm, from which the emission peak/FWHM are 506/21, 531/26 and 546/33 nm, respectively.