Supporting Information

Full-visible-spectrum lighting enabled by an excellent cyan-emitting garnet phosphor

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Table S1. Atomic data for CYHAO:0.03Ce^{3+}.

Atom	Site	*x*	*y*	*z*	Occu.
Ca	24c	0.25	0.625	0	0.6667
Y	24c	0.25	0.625	0	0.3233
Ce	24c	0.25	0.625	0	0.0100
Hf	16a	0.25	0.75	0.25	1
Al	24d	0.25	0.375	0	1
O	96h	0.3693	0.46516	0.0394	1

Table S2. The values of CIE coordinates of CYHAO:0.03Ce^{3+} phosphors when excited at 408 nm under various temperatures.

Temperature (K)	CIE (x, y)
303	(0.2152, 0.3818)
323	(0.2160, 0.3822)
343	(0.2169, 0.3834)
363	(0.2174, 0.3844)
383	(0.2182, 0.3849)
403	(0.2183, 0.3844)
423	(0.2183, 0.3848)
443	(0.2182, 0.3840)
463	(0.2184, 0.3844)

Table S3. The photoelectric properties of the LED1 device fabricated by using the commercial $CaAlSiN_3:Eu^{2+}$ red phosphors, the commercial $(Ba,Sr)_2SiO_4:Eu^{2+}$ green phosphors, and CYHAO:Ce^{3+} cyan phosphors on a 400 nm LED chip under various driven currents.

Current (mA)	CIE (x, y)	Ra	R12	CCT (K)	Luminous efficacy (lm/W)
20	(0.4081, 0.3953)	90.3	80.1	3479	40.75
40	(0.4071, 0.3951)	90.4	80.6	3500	41.88
60	(0.4064, 0.3950)	90.4	80.8	3513	41.80
80	(0.4061, 0.3949)	90.5	81.1	3519	41.45
100	(0.4058, 0.3951)	90.6	81.5	3527	41.00
120	(0.4057, 0.3953)	90.6	81.7	3531	40.34
180	(0.4047, 0.3953)	90.8	82.5	3552	38.24
240	(0.4040, 0.3954)	91.0	83.3	3569	36.30
300	(0.4032, 0.3954)	91.1	84.0	3585	34.40

Table S4. The photoelectric properties of the LED2 device fabricated by using the commercial BAM:Eu^{2+} blue phosphors, the commercial $CaAlSiN_3$:Eu^{2+} red phosphors, the commercial $(Ba,Sr)_2SiO_4$:Eu^{2+} green phosphors, and CYHAO:Ce^{3+} cyan phosphors on a 400 nm LED chip under various drive currents.

Current (mA)	CIE (x, y)	Ra	R12	CCT (K)	Luminous efficacy (lm/W)
20	(0.3958, 0.3886)	93.4	90.6	3701	35.89
40	(0.3953, 0.3876)	93.5	90.4	3705	37.05
60	(0.3955, 0.3874)	93.5	90.4	3700	37.10
80	(0.3952, 0.3871)	93.4	90.5	3704	36.99
100	(0.3949, 0.3872)	93.4	90.4	3711	36.77
120	(0.3947, 0.3870)	93.4	90.4	3717	36.43
180	(0.3939, 0.3865)	93.4	90.3	3732	35.19
240	(0.3932, 0.3861)	93.3	90.4	3744	33.87
300	(0.3923, 0.3855)	93.3	90.3	3762	32.63

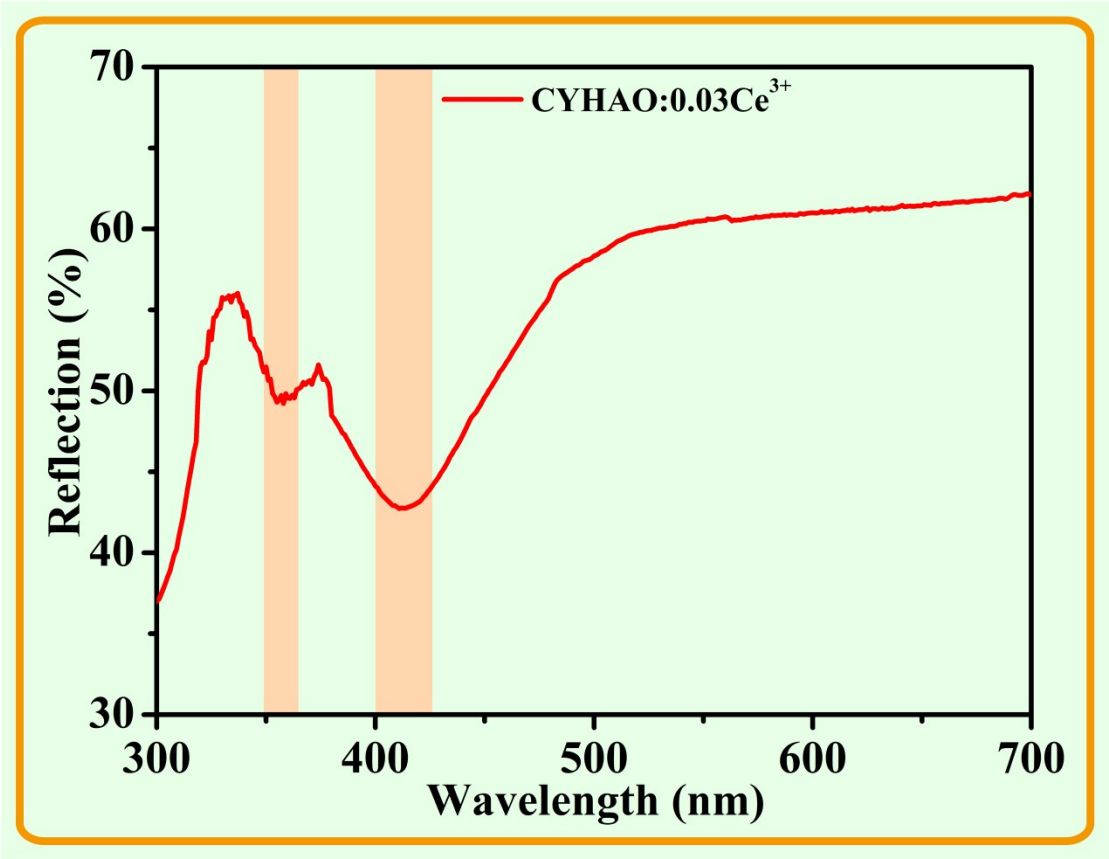

Figure S1. Diffuse reflectance spectrum of CYHAO:0.03Ce^{3+} phosphors.

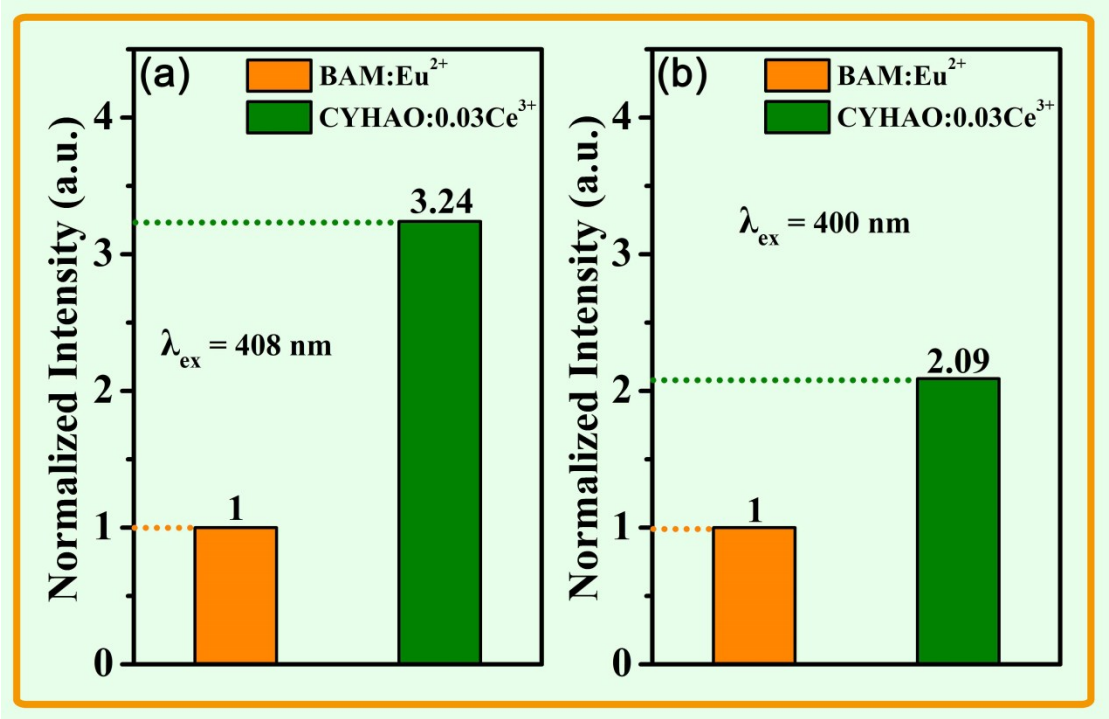

Figure S2. Comparison of normalized integrated emission intensity between CYHAO:0.03Ce^{3+} and the commercial BAM:Eu^{2+} blue phosphors under the NUV excitations of 408 nm (a) or 400 nm (b).

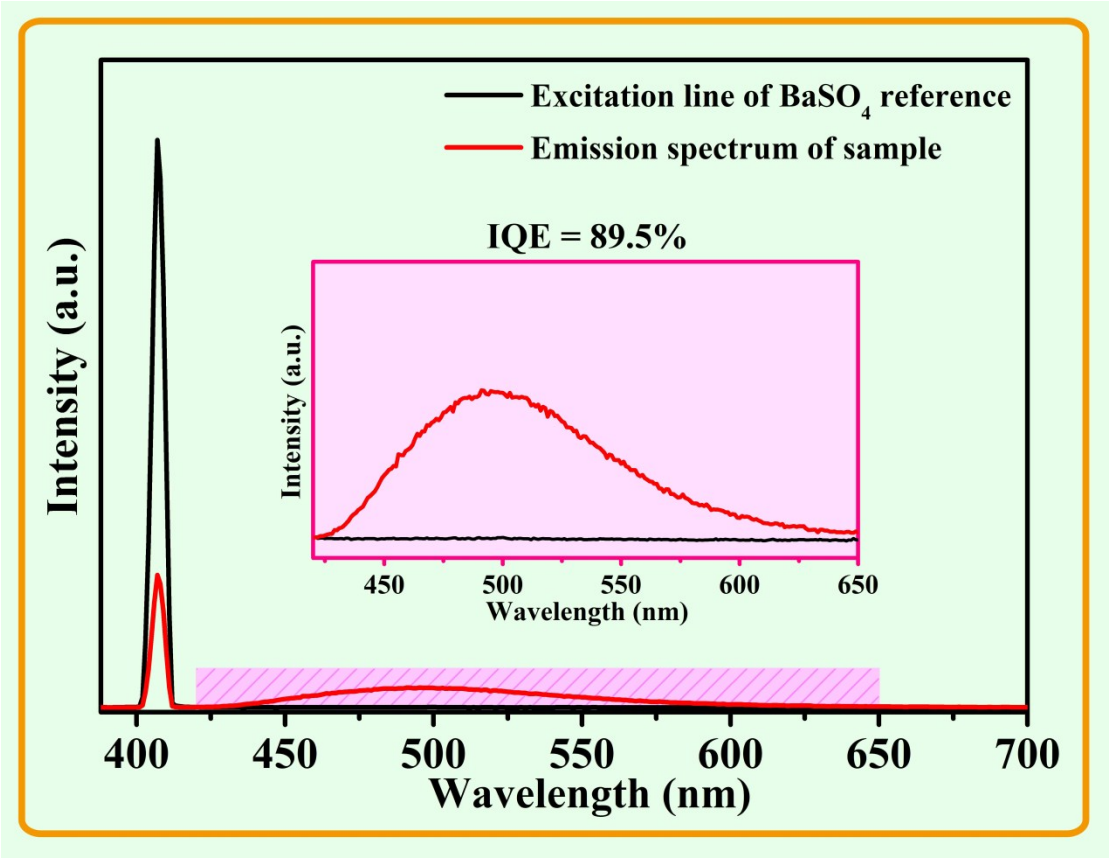

Figure S3. Excitation line of $BaSO_4$ and CYHAO:0.03Ce^{3+}, and the emission spectrum of CYHAO:0.03Ce^{3+} phosphors collected via an integrating sphere. Inset shows a magnification of the emission spectrum of CYHAO:0.03Ce^{3+} in the range of 420-650 nm.

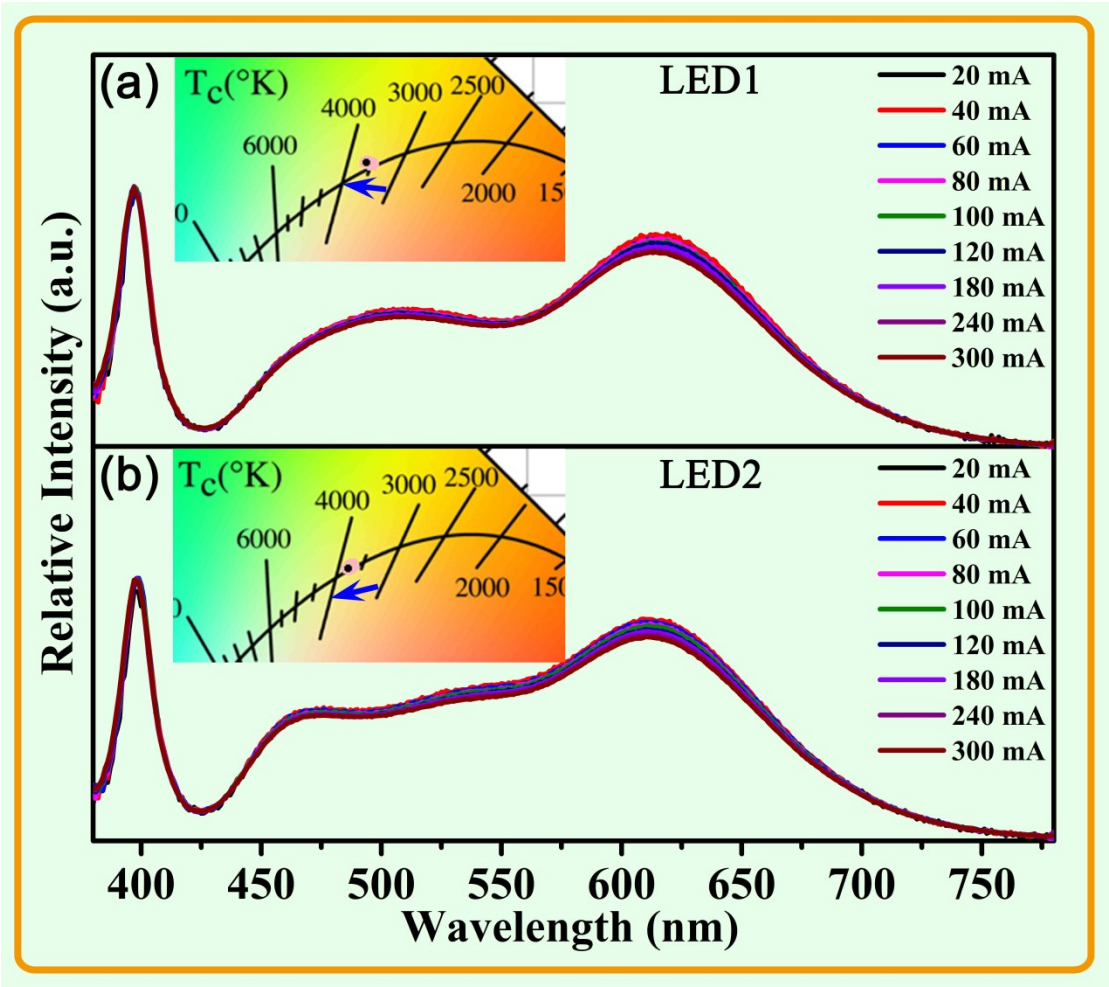

Figure S4. EL spectra of the fabricated LED1 (a) and LED2 (b) under various driven currents. Insets show the current-dependent CIE chromaticity coordinates variation of the two LEDs.