Supporting Information

Efficient Ce^{3+}→Tb^{3+} energy transfer pairs toward thermal-stability and internal quantum efficiency close to unity

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Figure S1. X-ray diffraction patterns of typically synthesized CLSO:*x*%Ce^{3+} (*x* = 0.01, 0.03, 0,05, 0.08, 0.10 and 0.15) samples together with the standard data (ICSD No.59293) for comparison.

Figure S2. The ratio of the integral emission energy of Ce^{3+} and Tb^{3+} in the overall emission energy.

Figure S3. The integrated luminescence intensity and PL spectra (a), and XRD patterns (b) evolution of CLSO:8%Ce^{3+}, 60%Tb^{3+} exposed to ambient atmosphere for different times.

Table S1. Rietveld refinement, crystallographic and structure parameters of the representative sample of CLSO:8%Ce^{3+}, 60%Tb^{3+}.

Table S2. Comparison of luminescence properties (λ_{ex} (nm), IQE, EQE, thermal stability (I_{423K}/I_{298K}), LE and color gamut) for the CLSO:8%Ce^{3+}, 60%Tb^{3+} and several other reported green-emitting phosphors

Table S3 RGB CIE chromaticity coordinates of the fabricated pc-WLED device and the NTSC standard.

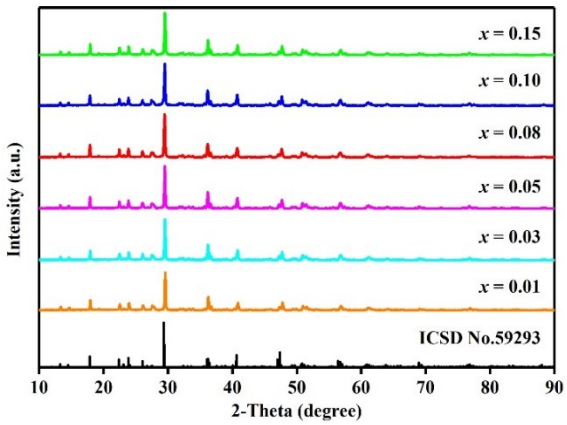

Figure S1

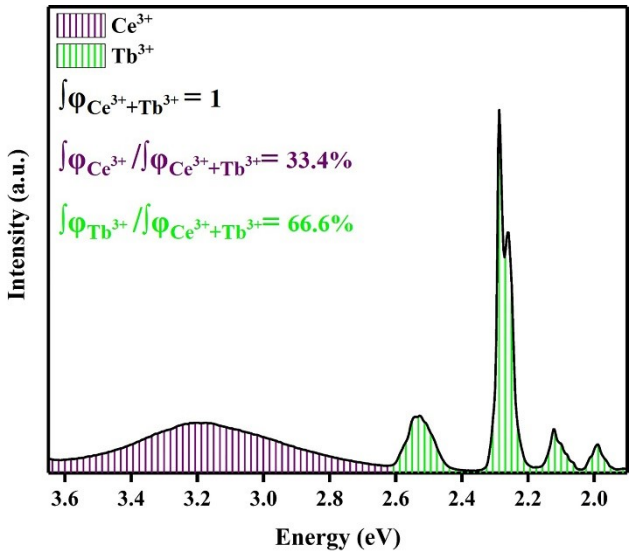

Figure S2

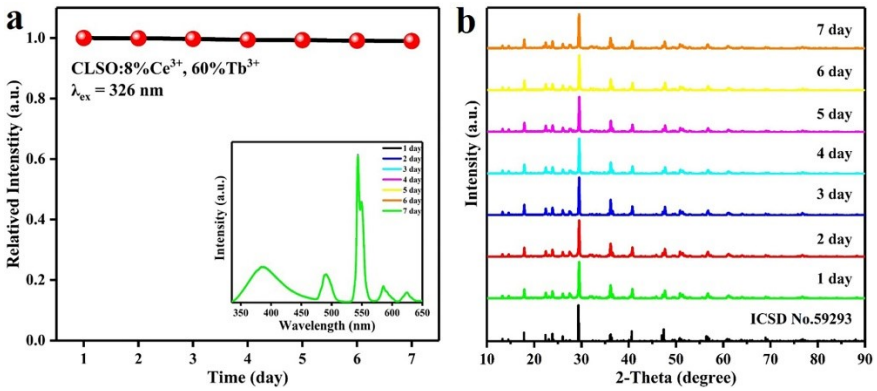

Figure S3

Table S1

formula	$Ca_3Lu_2Si_6O_{18}$:8%Ce^{3+}, 60%Tb^{3+}
crystal system	monoclinic
space group	*C2/c*
$\alpha/\beta/\gamma$ (deg)	$\alpha = \beta = \gamma = 90$
cell parameters	a = 13.3135(9) Å, b = 7.6986(9) Å, c = 14.7229(6) Å, V = 1509.062(2) Å^3, Z = 4
Reliability factors	R_{wp} = 9.52%, R_p = 5.73%, x^2 = 4.22

Table S2

Samples	λ_{ex} (nm)	IQE	EQE	I_{423K}/I_{298K} (%)	LE (lm/W)	Color Gamut (%NTSC)	Ref.
$Ca_2GdHf_2Al_3O_{12}:Ce^{3+}, Tb^{3+}$	408	82.7	60.6	48	27.4		1
$La_3Si_8N_{11}O_4:Ce^{3+}, Tb^{3+}$	360	76.3	46.7	90	4.4		2
$Sr_4Al_{14}O_{25}:Ce^{3+}, Tb^{3+}$	348	47.04		82.21	21.87	85.34	3
$Ca_3Gd_2Si_6O_{18}:Ce^{3+}, Tb^{3+}$	325	95.1	80.5	92	15.73		4
$Ca_2YHf_2Al_3O_{12}:Ce^{3+}, Tb^{3+}$	408	78.5	56	43.3	29.25		5
$Ba_2Y_3(SiO_4)_3F:Ce^{3+}, Tb^{3+}$	355	83.12		82	24.4		6
$La_2Si_2O_7:Ce^{3+}, Tb^{3+}$	332	95.6		89			7
$Sr_3Lu_2(BO_3)_4:Ce^{3+}, Tb^{3+}$	340	77.5	34.8	70			8
$Ca_2TbZr_2Al_3O_{12}:Ce^{3+}$	410	60		55	15.71	61	9
$Ca_2LuHf_2Al_3O_{12}:Ce^{3+}, Tb^{3+}$	408	77.1	55.8	62	29.35		10
$SrB_2O_4:Ce^{3+}, Tb^{3+}$	319	54.7		59.3			11
$Ba_2Lu_5B_5O_{17}:Ce^{3+}, Tb^{3+}$	348	86		90	18.81		12
$Ba_3GdNa(PO_4)_3F:Ce^{3+}, Tb^{3+}$	273	65.5		94			13
$[Mg_{1.25}Si_{1.25}Al_{2.5}]O_3N_3:Ce^{3+}, Tb^{3+}$	335	41.14		65	5.279		14
$Ca2ZrSi4O12:Ce^{3+}, Tb^{3+}$	322	59.2	32.7	72.5			15
$Ca_2LuZr_2(AlO_4)_3:Ce^{3+}, Tb^{3+}$	408	69		48	25		16
$Na_2Ca_3Si_2O_8:Ce^{3+}, Tb^{3+}$	330	85.5		86	6		17
$LaPO_4:Ce^{3+}, Tb^{3+}$	290	96	86				18
$Na_{1.8}Mg_{0.9}Si_{1.1}O_4:Ce^{3+}, Tb^{3+}$	340	82		49.9			19
$Sr_5B_3O_9F:Ce^{3+}, Tb^{3+}$	365	57		32			20
$La_8Ba_2(Si_4P_2O_{22}N_2)O_2:Ce^{3+}, Tb^{3+}$	290	89		91.2			21
$Ca_2LaHf_2Al_3O_{12}:Ce^{3+}, Tb^{3+}$	408	80	59.2	27	17.56		22
$Sr_2MgB_2O_6:Ce^{3+}, Tb^{3+}$	323	66.39	48.92	75.3	6.19	87	23
$Y_5Si_3O_{12}N:Ce^{3+}, Tb^{3+}$	358	85		80			24
$CaAl_4O_7:Ce^{3+}, Tb^{3+}$	350	92.55	71.02	68.5			25

$Ba_3Lu_2B_6O_{15}$:Ce^{3+}, Tb^{3+}	373	51		54			26
[Sr,$BaSiO_4$]:Eu^{2+}	430	78		>50	18.45		27
β-Sialon:Eu^{2+}	450	96.5	71.3		136	96	28
CLSO:Ce^{3+}, Tb^{3+}	326	99.7	76.6	86.8	31.4	90.2	This work

Table S3

Name	**R**	**G**	**B**
NTSC	(0.67, 0.33)	(0.21, 0.71)	(0.14, 0.08)
Fabricated pc-WLEDs	(0.6892, 0.3108)	(0.2936, 0.6655)	(0.1481, 0.0665)

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