Supplementary materials for

Novel Eu^{3+}-activated $Ca_3Ga_2Ge_4O_{14}$ red-emitting phosphors with high quantum efficiency for plant growth lighting and white LEDs

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Tab. S1. The lattice parameters of $Ca_3Ga_2Ge_4O_{14}$: $x$$Eu^{3+}$.

$(Ca_{1-x}Eu_x)_3Ga_2Ge_4O_{14}$	a = b(Å)	c (Å)	V(Å^3)	α, β, γ
0	8.06877	4.97158	280.31	α = β = 90°, γ = 120°
0.01	8.05892	4.93866	277.78	α = β = 90°, γ = 120°
0.03	8.03490	4.95230	276.88	α = β = 90°, γ = 120°
0.05	8.05927	4.92006	276.75	α = β = 90°, γ = 120°
0.07	8.03526	4.94375	276.43	α = β = 90°, γ = 120°
0.09	8.07939	4.88786	276.32	α = β = 90°, γ = 120°
0.12	8.05359	4.91803	276.25	α = β = 90°, γ = 120°
0.15	8.06559	4.87423	274.61	α = β = 90°, γ = 120°
0.20	8.05740	4.87776	274.25	α = β = 90°, γ = 120°

Tab. S2. The chromaticity coordinates, CCT and color purity at different Eu^{3+} doping concentrations of CGG.

NO.	$(Ca_{1-x}Eu_x)_3Ga_2Ge_4O_{14}$	CIE (x, y)	CCT(K)	Color purity (%)
1	0.01	(0.5936, 0.4015)	1628	91.34%
2	0.03	(0.6063, 0.3888)	1629	94.08%

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3	0.05	(0.6155, 0.3816)	1668	96.35%
4	0.07	(0.6202, 0.3767)	1709	96.47%
5	0.09	(0.6178, 0.3785)	1690	96.86%
6	0.12	(0.6217, 0.3761)	1719	97.89%
7	0.15	(0.6211, 0.3756)	1720	97.68%
8	0.20	(0.6289, 0.3690)	1811	96.68%

Tab. S3. Some reported red emitting phosphors for w-LEDs.

Activator	Compound	λ_{ex} (nm)	λ_{em} (nm)	Color purity (%)	QY	Ref.
12% Eu^{3+}	$Ca_3Ga_2Ge_4O_{14}$	394	618	97.89	94.26	This work
5% Eu^{3+}	$Na_2Tb_{0.5}(MoO_4)(PO_4)$	394	614	95.30	43.60	[1]
6% Eu^{3+}	Y_2SiWO_8	395	619	96.61	14.80	[2]
2.5% Eu^{3+}	$Na_5W_3O_9F_5$	466	607	97.44	29.10	[3]
40% Eu^{3+}	Ca_2GdTaO_6	396	615	96.00	83.00	[4]
50% Eu^{3+}	Ca_2GdSbO_6	396	612	94.90	73.00	[5]

References

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Tab. S4. CCT, CRI and color coordinates of prepared white-LEDs as a function of currents.

Current	CCT	CRI	CIE *x*	CIE y
20 mA	4808 K	91.64	0.3514	0.3604
40 mA	4921 K	90.78	0.3479	0.3571
60 mA	5008 K	90.44	0.3453	0.3550
80 mA	5058 K	90.19	0.3439	0.3537
100 mA	5096 K	90.00	0.3428	0.3527

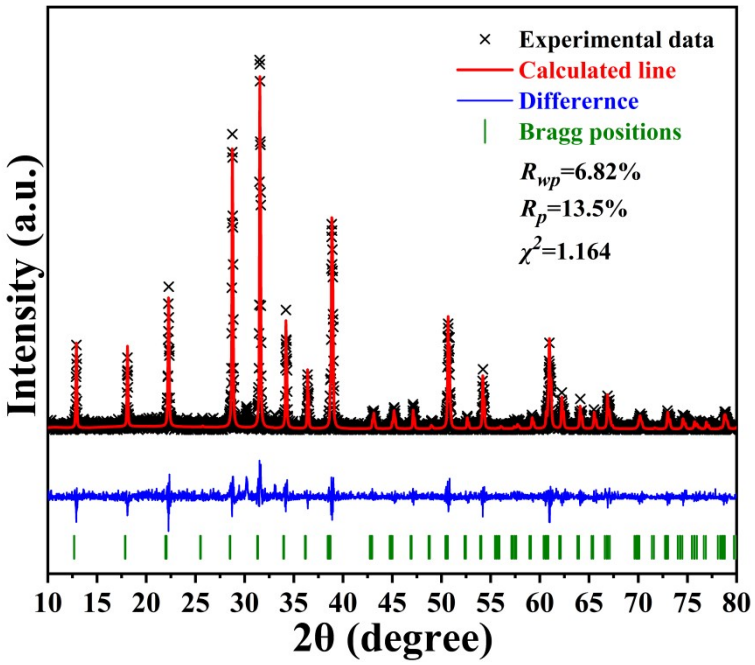

Fig. S1 XRD Rietveld refinement patterns of CGG: 12%Eu^{3+}.

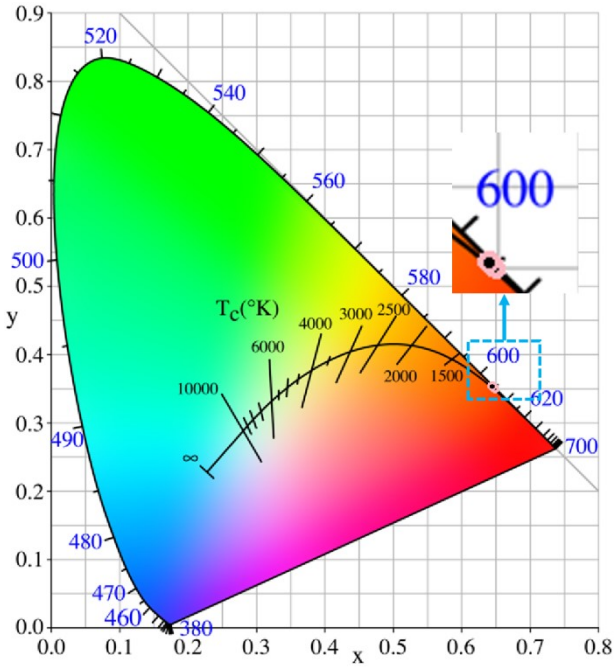

Fig. S2 The CIE coordinates at different temperatures from 303 K to 483 K.

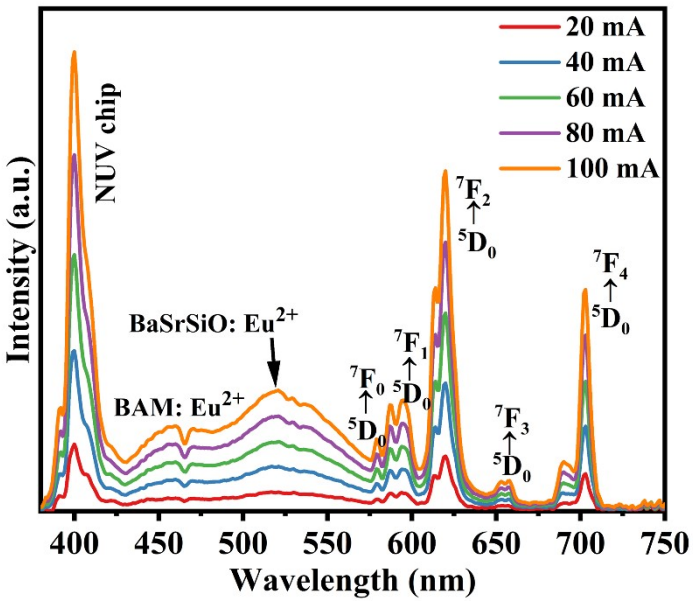

Fig. S3 The EL emission spectra of the developed w-LEDs under 20-100 mA injected current.

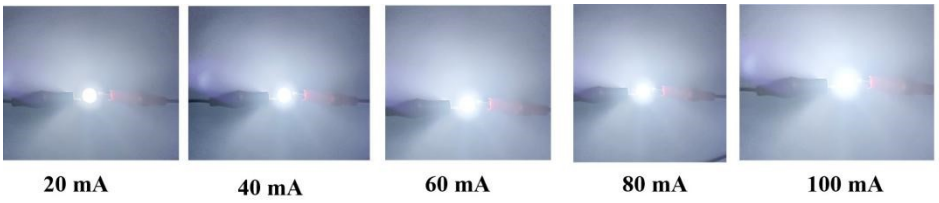

Fig. S4 The photos of the developed w-LEDs under 20-100 mA injected current.