Tunable near-infrared phosphor $LiSc_2SbO_6$:Cr^{3+} by Mg^{2+} substitution and Yb^{3+} co-doping for phosphor-converted light-emitting diodes

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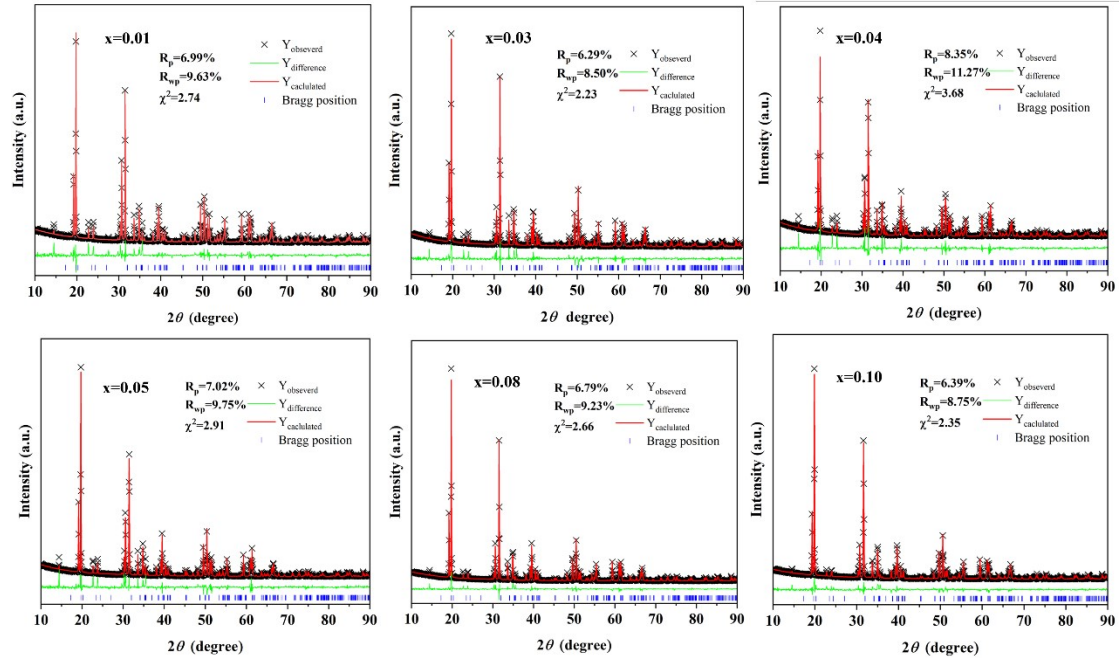E-mail: fhwang@hbu.edu.cn; fenghe_wang@hotmail.com.

Fig.S1. XRD refinement of $LiSc_2SbO_6:Cr^{3+}$ （x = 0.01 - 0.10）

Table.S1. Main parameters of processing and refinement results of $LiSc_2SbO_6:Cr^{3+}$ （x=0-0.10）

Compound	x=0	x=0.01	x=0.02	x=0.03	x=0.04	x=0.05	x=0.08	x=0.10
Space group	Pmn21	Pmn21	Pmn21	Pmn21	Pmn21	Pmn21	Pmn21	Pmn21
a, Å	8.71540	8.70350	8.70180	8.69635	8.68662	8.68376	8.67058	8.66202
b, Å	5.07100	5.06346	5.06290	5.06022	5.05569	5.05519	5.04939	5.04556
c, Å	5.25670	5.24439	5.24430	5.24211	5.23882	5.23869	5.23376	5.22992
V, Å^3	232.324	231.119	231.045	230.681	230.073	229.969	229.140	228.572
α=β=γ, deg	90	90	90	90	90	90	90	90
2θ-interval,deg	10–120	10–120	10–120	10–120	10–120	10–120	10–120	10–120
R$_{wp}$, %		9.63	9.59	8.50	11.27	9.75	9.23	8.75
R$_p$, %		6.99	7.19	6.29	8.35	7.02	6.79	6.39
χ^2		2.74	2.15	2.23	3.68	2.91	2.66	2.35

Fig.S2. EDS of $LiSc_2SbO_6$:$0.02Cr^{3+}$

Table S2 ICP results of LSS:$0.02Cr^{3+}$

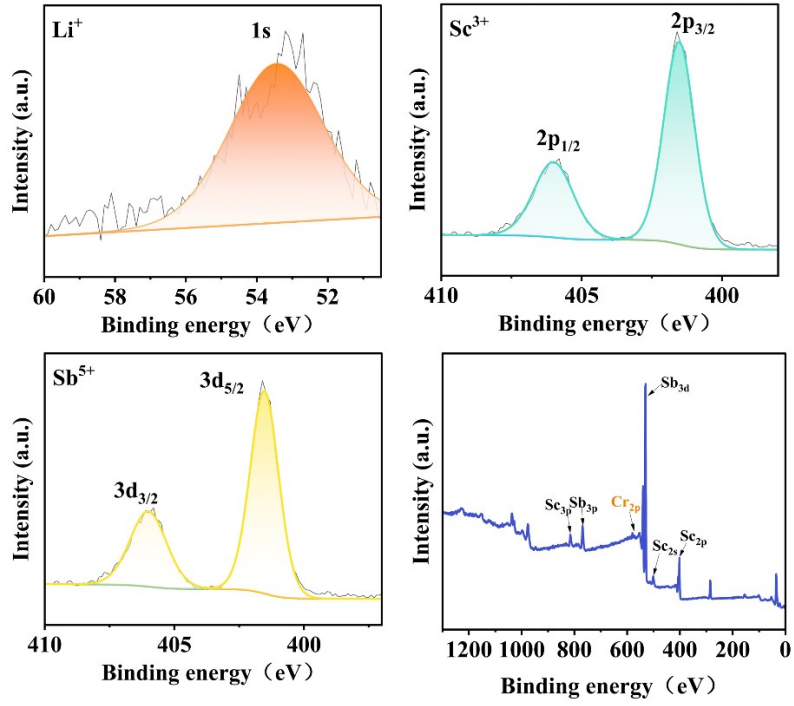| m_0 (g)	V_0 (ml)	element	C_0 (mg/L)	f	C_1 (mg/L)	C_x (mg/kg)	W (%)	Atomic (%)
0.0436	25	Li	1.626	20	32.526	18650.142	1.84%	22.9%
0.0436	25	Sc	4.239	100	423.886	243053.822	24.18%	46.4%
0.0436	25	Cr	1.849	10	18.487	10600.174	1.06%	1.7%
0.0436	25	Sb	6.844	100	684.405	392433.774	39.55%	28%

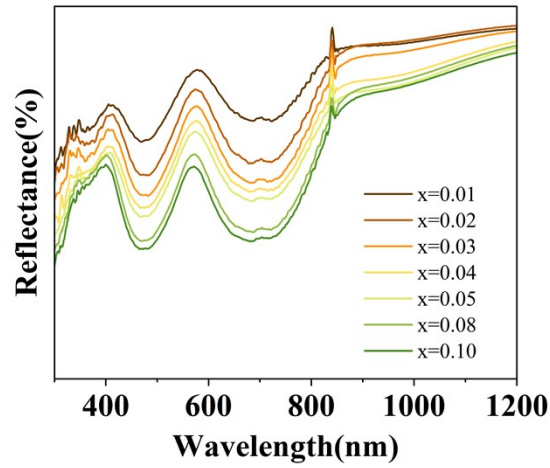**Fig.S3.** XPS of $LiSc_2SbO_6$:$0.02Cr^{3+}$

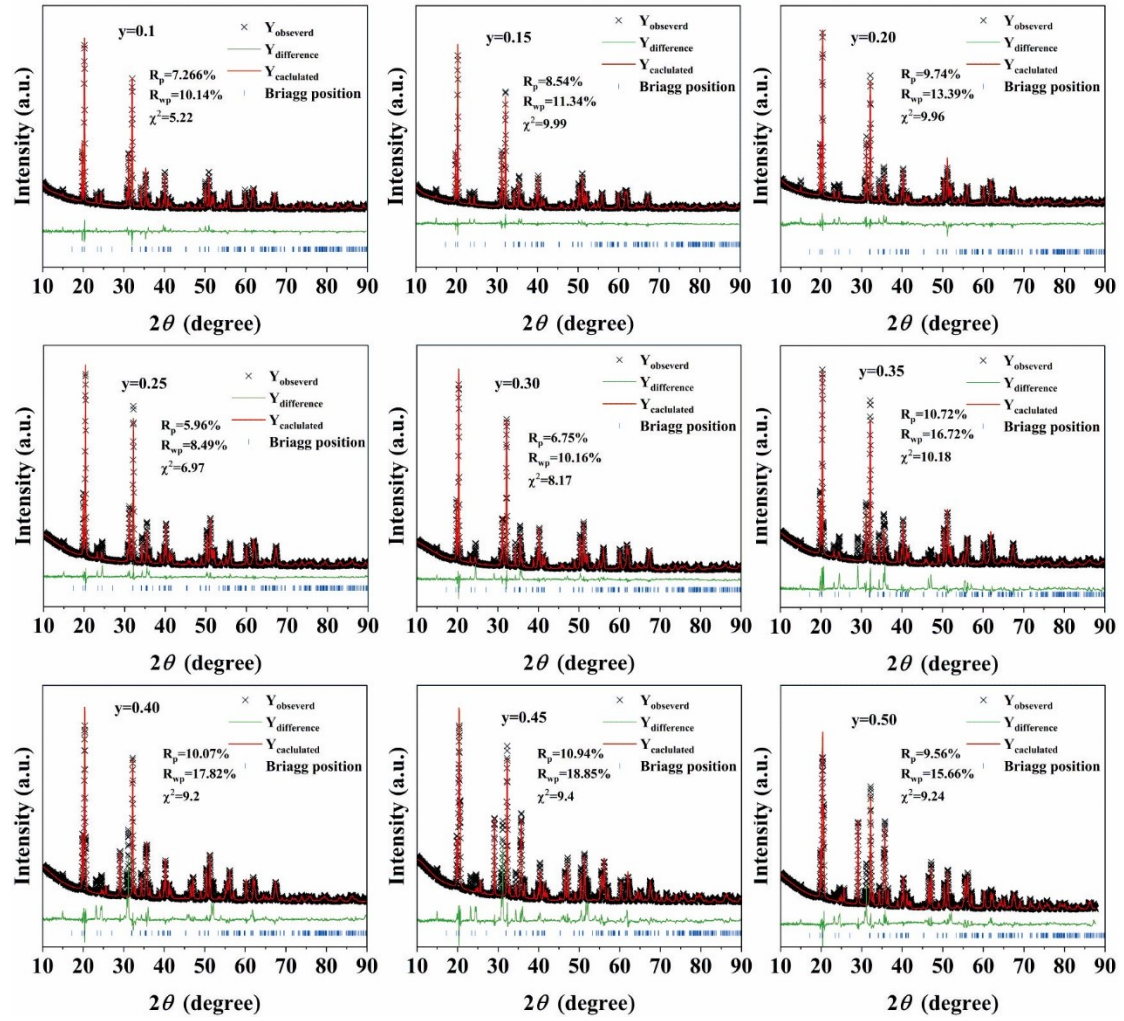**Fig.S4.** Diffuse reflectance spectra of $LiSc_2SbO_6$:xCr^{3+} （x = 0.01 - 0.10）

Fig.S5. XRD refinement of $LMSS{:}Cr^{3+}$ （y = 0.10 - 0.50）
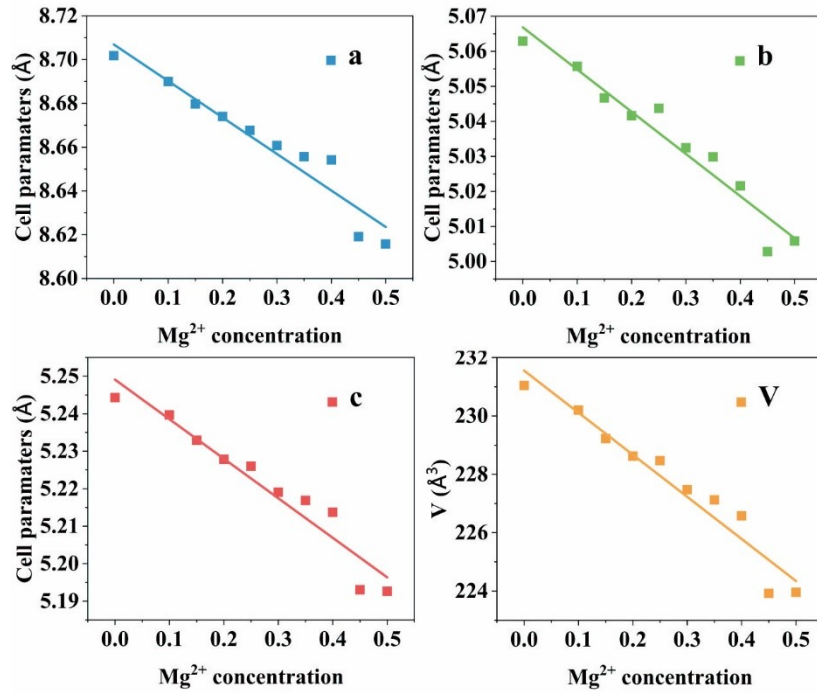
Fig.S6. The lattice parameters of $LiSc_2SbO_6$:$0.02Cr^{3+}$,$0.05Yb^{3+}$ as a function of the doping concentration of Mg^{2+}.
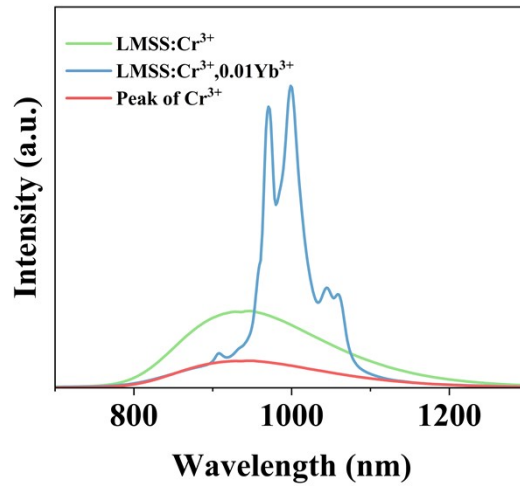

Fig.S7. PL spectra of LMSS:Cr^{3+} and LMSS:Cr^{3+},$0.01Yb^{3+}$

Table.S3. ET efficiency of LMSS:Cr^{3+},zYb^{3+} (z=0.01-0.13)

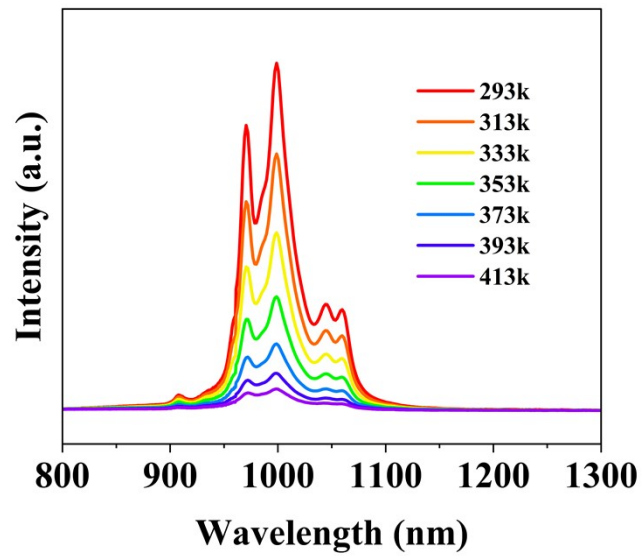| Yb^{3+} concentration	Cr^{3+}integral area in LMSS:Cr^{3+},Yb^{3+}	Cr^{3+}integral area in LMSS: Cr^3	ET (%)
0.01	1125.95	3781.55	70.23%
0.03	701.151	3781.55	81.46%
0.05	664.141	3781.55	82.44%
0.07	599.387	3781.55	84.15%
0.09	512.476	3781.55	86.45%
0.11	462.509	3781.55	87.73%
0.12	439.384	3781.55	88.38%
0.13	409.069	3781.55	89.18%

Fig.S8. Temperature-dependent PL spectra of $LMSS{:}0.02Cr^{3+},0.05Yb^{3+}$