

High quality white light emission from Sb^{3+} , Tb^{3+} and Mn^{2+} co-doped

$\text{Cs}_2\text{NaScCl}_6$ double perovskite

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☆**Foundation item:** Project supported by the National Natural Science Foundation of China (52262020)

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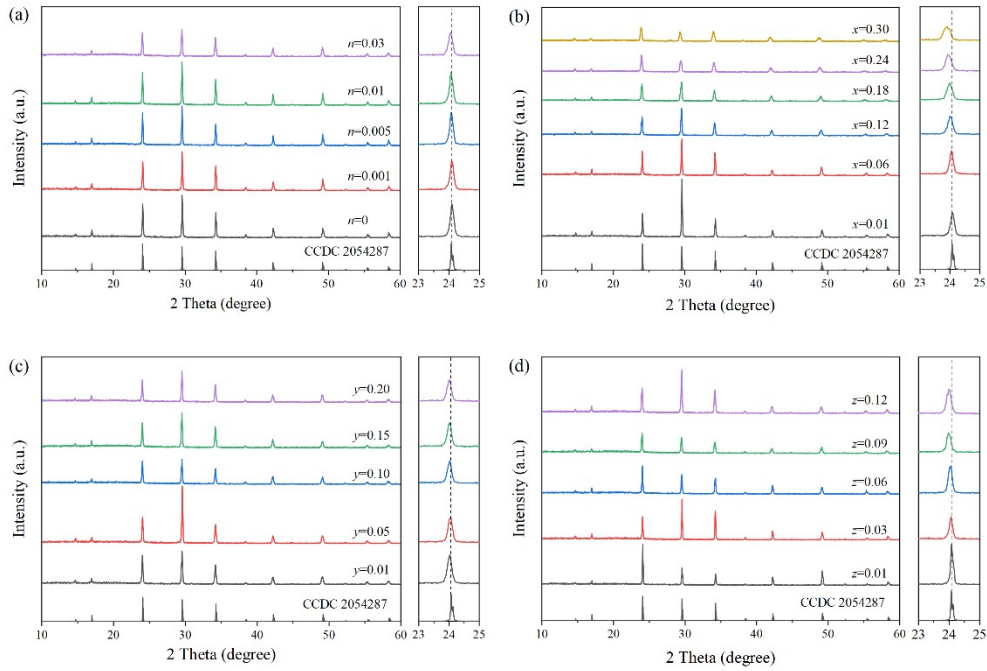


Fig. S1 (a) XRD patterns of CNSC: $n\text{Sb}^{3+}$, (b) XRD patterns of CNSC: 0.01Sb^{3+} , $x\text{Tb}^{3+}$, (c) XRD patterns of CNSC: 0.01Sb^{3+} , $y\text{Mn}^{2+}$, (d) XRD patterns of CNSC: 0.01Sb^{3+} , $z\text{Tb}^{3+}$, 0.07Mn^{2+} .

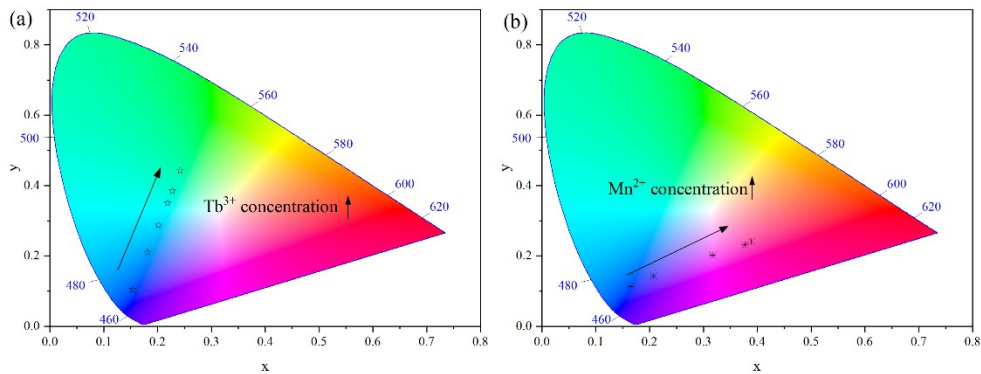


Fig. S2 (a) CIE chromaticity diagram of CNSC: 0.01Sb^{3+} , $x\text{Tb}^{3+}$ ($x = 0.01, 0.06, 0.12, 0.18, 0.24, 0.3$), and (b) CIE chromaticity diagram of CNSC: 0.01Sb^{3+} , $y\text{Mn}^{2+}$ ($y = 0.01, 0.05, 0.1, 0.15, 0.2$).

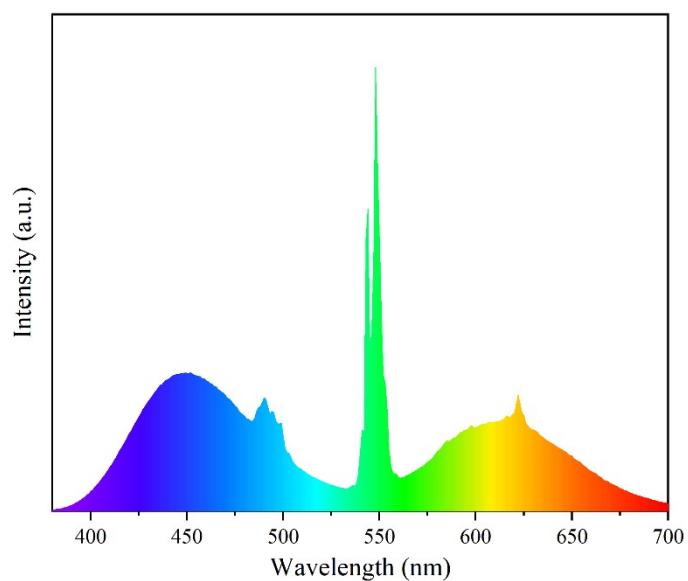


Fig. S3 PL spectra of CNSC: Sb^{3+} , Tb^{3+} , Mn^{2+} under the excitation of 336 nm.

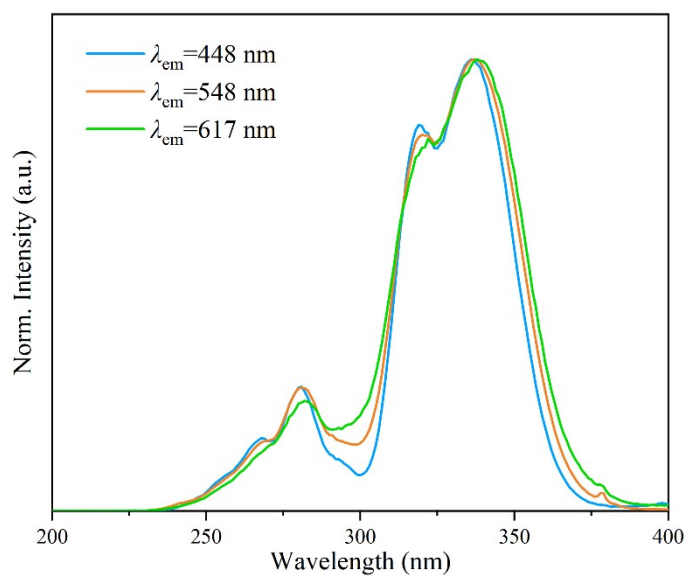


Fig. S4 PLE spectra of CNSC: 0.01Sb^{3+} , 0.12Tb^{3+} , 0.07Mn^{2+} were monitored at 448, 548 and 617 nm.

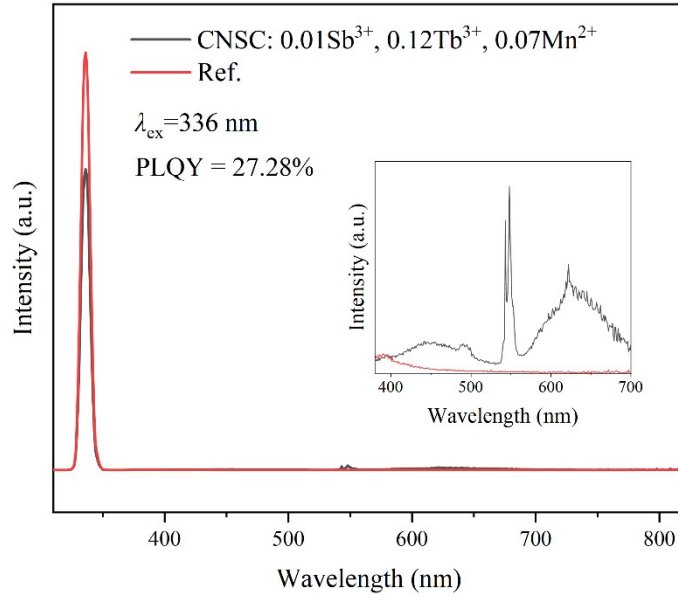


Fig. S5 PLQY of CNSC: 0.01Sb³⁺, 0.12Tb³⁺, 0.07Mn²⁺ with white emission.

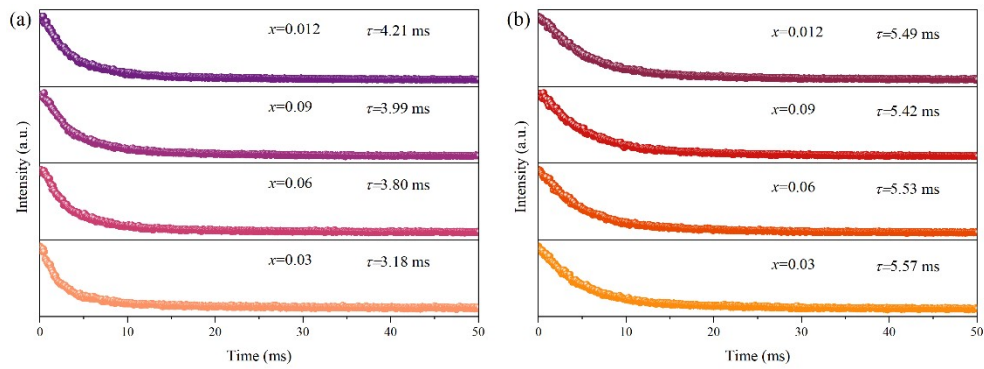


Fig. S6 (a) fluorescence lifetime decay curves of CNSC: 0.01Sb³⁺, x Tb³⁺, 0.07Mn²⁺ monitored at 548 nm, and (b) fluorescence lifetime decay curves of CNSC: 0.01Sb³⁺, x Tb³⁺, 0.07Mn²⁺ monitored at 617 nm.

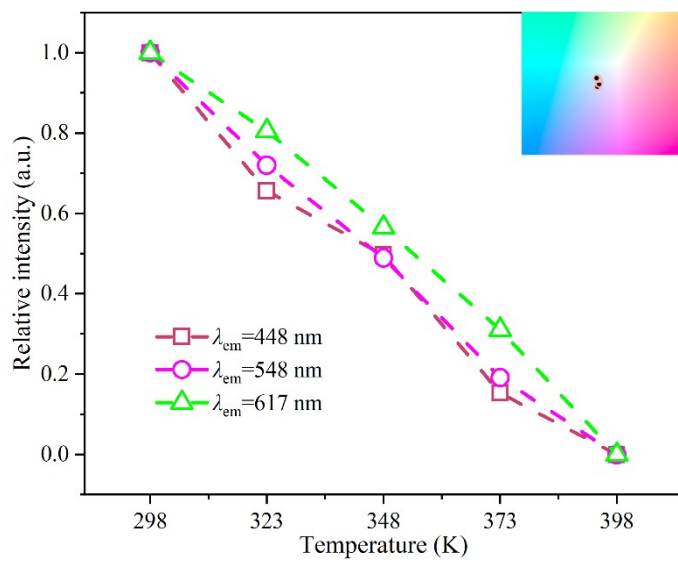


Fig. S7 Dependences of the relative intensities of Sb^{3+} (at 448 nm), Tb^{3+} (548 nm), and Mn^{2+} (at 617 nm) on temperature (inset is the trend of CIE coordinates varying with temperature).

Table S1 The ICP-MS results of CNSC:0.01 Sb^{3+} , 0.07 Mn^{2+} (sample 1) and CNSC:0.01 Sb^{3+} , 0.12 Tb^{3+} , 0.07 Mn^{2+} (sample 2). (Fr represents the feed ratio, and A represents the ratio of actual doped ions in all samples)

Samples	Fr	Sc (mg/kg)	Sb (mg/kg)	Mn (mg/kg)	Tb (mg/kg)	A
1	92:1:7	72659.2	3600.7	2762.8	0	95.3:1.7:3
2	80:1:7:12	50766.3	2401	3588.5	27833.3	81.3:1.4:4.7:12.6

Table S2 The decay lifetimes of STE emission in CNSC: 0.01 Sb^{3+} , $x\text{Tb}^{3+}$, 0.07 Mn^{2+} monitored at 448 nm

x	A_1	τ_1 (μs)	A_2	τ_2 (μs)	τ_{ave} (μs)	η_{ET} (%)
0	0.6641	0.00801	0.2358	0.7618	0.74	0
0.03	0.7234	0.00515	0.1937	0.5007	0.4824	34.8
0.06	0.8322	0.00579	0.0933	0.5047	0.4584	38.1
0.09	0.6612	0.00694	0.2283	0.3860	0.3673	50.4
0.12	0.805	0.00294	0.1457	0.2194	0.2044	72.4

Table S3 the fabricated WLED device under different operating times. (LF represents luminous flux)

Time (min)	CIE (x, y)	CRI	CCT (K)	LF (lm)
0	(0.3363, 0.3389)	91.3	5330	1.76
10	(0.3368, 0.3354)	91.4	5310	1.71
20	(0.3368, 0.3407)	92.2	5301	1.41
30	(0.3404, 0.3416)	93.1	5159	1.28
40	(0.3425, 0.3435)	93.6	5078	1.08

Table S4 the fabricated WLED device under different driving currents. (LF represents luminous flux)

Current (mA)	CIE (x, y)	CRI	CCT (K)	LF (lm)
350	(0.3531, 0.3569)	95.2	4726	1.43
300	(0.3549, 0.3601)	95.4	4681	1.39
250	(0.3586, 0.3638)	95.7	4572	1.31
200	(0.362, 0.3685)	95.8	4488	1.24
150	(0.3663, 0.3748)	95.9	4395	1.08
100	(0.3715, 0.3778)	96.1	4257	1.05