Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Efficient and stable narrow band Mn^{4+}-activatedfluorotitanate red phosphor$Rb_2TiF_6:Mn^{4+}$ for warm white LED applications

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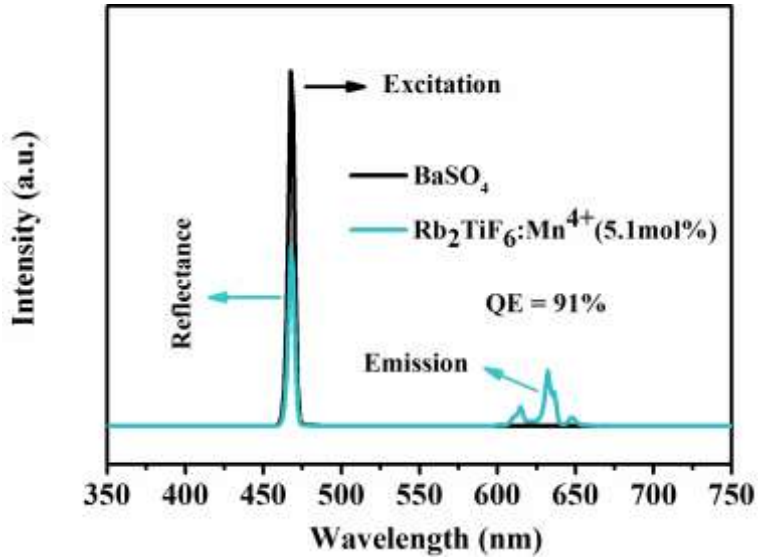

Fig. S1. Excitation spectra of $BaSO_4$,reflectance and emission spectra of $Rb_2TiF_6:Mn^{4+}$ (5.1mol.%).

The quantum efficiency (QE) was calculated as follows:

$$QE = \frac{\int \lambda \cdot P(\lambda) d\lambda}{\int \lambda \{E(\lambda) - R(\lambda)\} d\lambda} \quad (1)$$

where E(λ)/hυ, R(λ)/hυand P(λ)/hυare the number of photons in the spectrum of excitation, reflectance and emissionof the phosphor, respectively. All of spectra were recorded by an optical integrating sphere coupled to the QE-2100 spectrophotometer from Otsuka Photal Electronics at room temperature.

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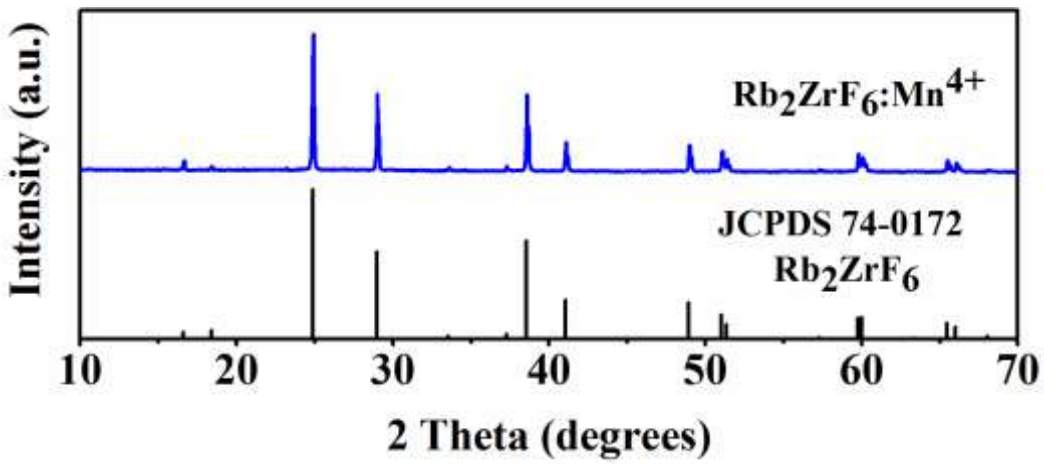

Fig. S2. XRD pattern of red phosphor Rb_2ZrF_6:3.9 mol.%Mn^{4+}

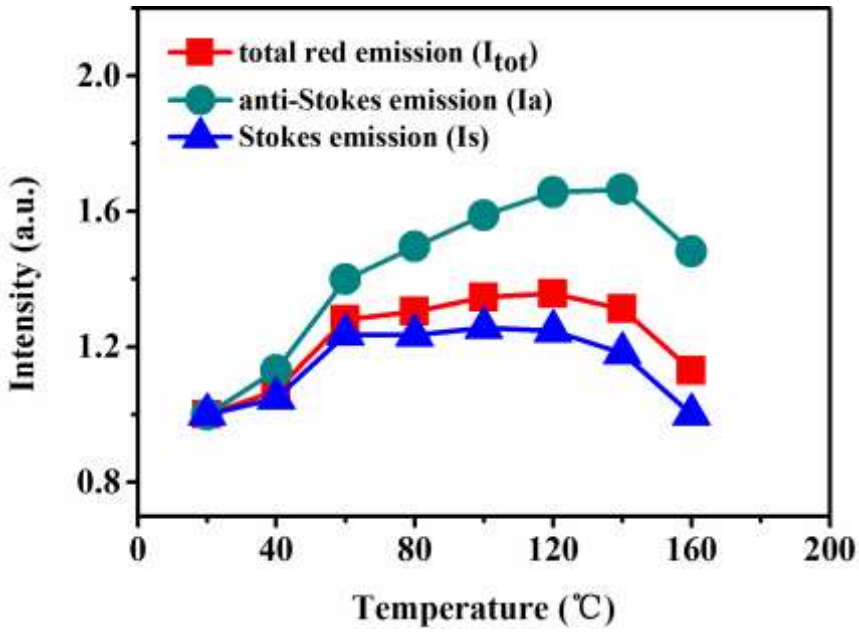

Fig. S3. Temperature-dependent integrated intensity of I_{tot}, I_s and I_a emission of Rb_2TiF_6:Mn^{4+} red phosphor

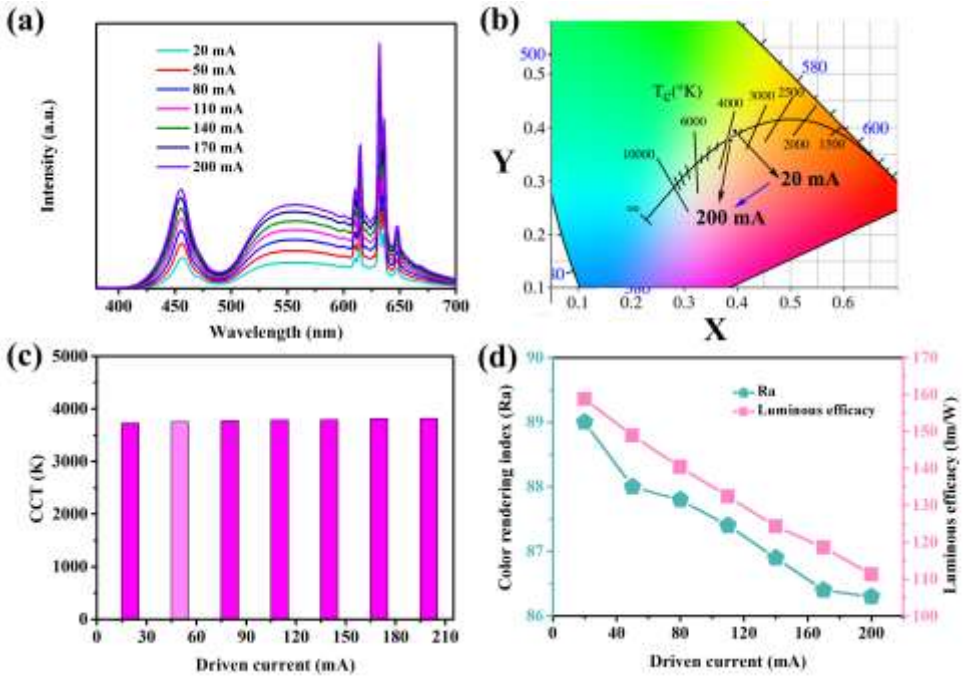

Fig. S4. Current-dependent (a) EL spectra, (b)CIE color coordinates, (c) CCT and (d) Ra and LE of the device featured from Rb_2TiF_6:Mn^{4+}(20% wt.%) at room temperature.

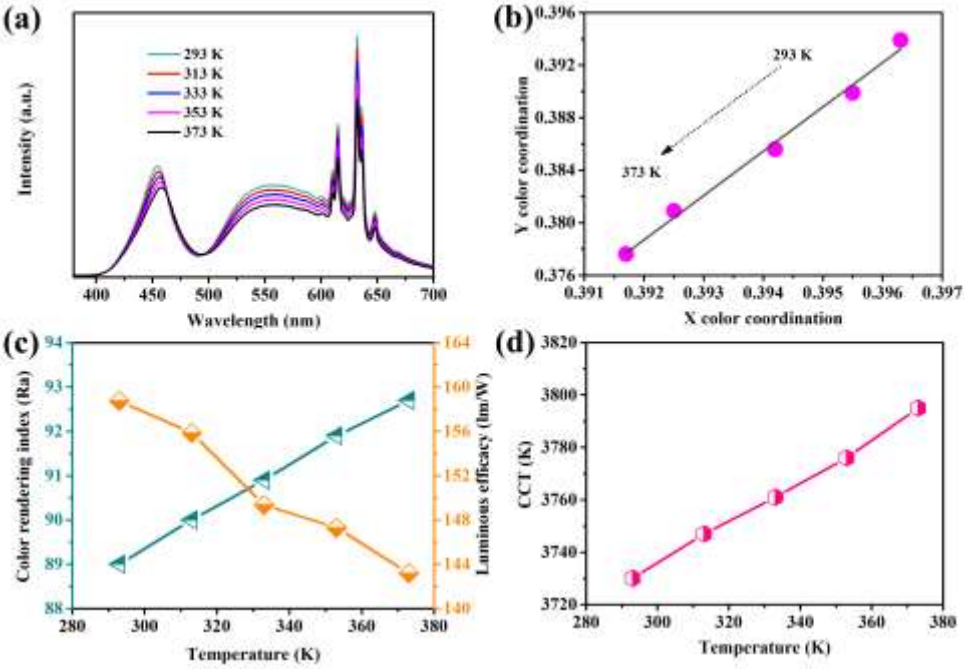

Fig. S5. Temperature-dependent (a)ELspectra, (b)CIE color coordinates,(c) Ra and LE and (d) CCT of the device featured from Rb_2TiF_6:Mn^{4+}(20% wt.%) at 20 mA drive current and 2.7 V drive voltage.

Table. S1. Electro-optical parameters of device (e) featured from $Rb_2TiF_6:Mn^{4+}$(20% wt.%) red phosphor under various drive current.

Drive current (mA)	Drive voltage (V)	Tc (K)	Ra	LE (lm/W)	CIE	
					X	Y
20	2.7	3730	89.0	158.8	0.3963	0.3939
50	2.9	3755	88.0	148.8	0.3942	0.3906
80	3.0	3775	87.8	140.3	0.3924	0.3876
110	3.1	3791	87.4	132.4	0.3907	0.3845
140	3.2	3797	86.9	124.3	0.3894	0.3810
170	3.3	3815	86.4	118.6	0.3882	0.3784
200	3.4	3818	86.3	111.3	0.3870	0.3760

Table. S2. Electro-optical parameters of device (e) featured from $Rb_2TiF_6:Mn^{4+}$(20% wt.%) red phosphor under various different temperature. The driven current and voltage are 20 mA and 2.7 V, respectively.

Temperature (K)	Tc (K)	Ra	LE (lm/W)	CIE	
				X	Y
293	3730	89.0	158.8	0.3963	0.3939
313	3747	90.0	155.9	0.3955	0.3899
333	3761	90.9	149.3	0.3942	0.3856
353	3776	91.9	147.3	0.3925	0.3809
373	3795	92.7	143.2	0.3917	0.3776

Eq.S1

$$\Delta E = \sqrt{(u_t^{'} - u_0^{'})^2 + (v_t^{'} - v_0^{'})^2 + (w_t^{'} - w_0^{'})^2}$$

where u' = 4x/(3 - 2x + 12y), v'= 9y/(3 -2x + 12y), and w'= 1- u'- v'. x and y are the chromaticity coordinates in CIE 1931, 0 and t are the chromaticity shift at 20 °Cand a given temperature, respectively. u' and v' are the chromaticity coordinates in u' v ' uniform color space.