Electronic Supplementary Information (ESI)

Mn^{4+} doped fluorotitanate phosphors: synthesis, optical properties and application in LED devices

Qiang Zhou,[a] Huiying Tan,[a] Nan Wang,[a] Qiuhan Zhang,[a] Qianwen Wei,[a] Zhengliang Wang,*[a] Meizhu Rong,[b] and Qin Wang,*[b]

[a] Key Laboratory of Comprehensive Utilization of Mineral Resources in Ethnic Regions, Joint Research Centre for International Cross-border Ethnic Regions Biomass Clean Utilization in Yunnan, School of Chemistry & Environment, Yunnan Minzu University, Kunming, 650500, P. R. China.

[b] College of Chemistry and Chemical Engineering, Yunnan Normal University, Kunming, 650500, P. R. China.

Email: wangzhengliang@foxmail.com

wangqinynnu@163.com.

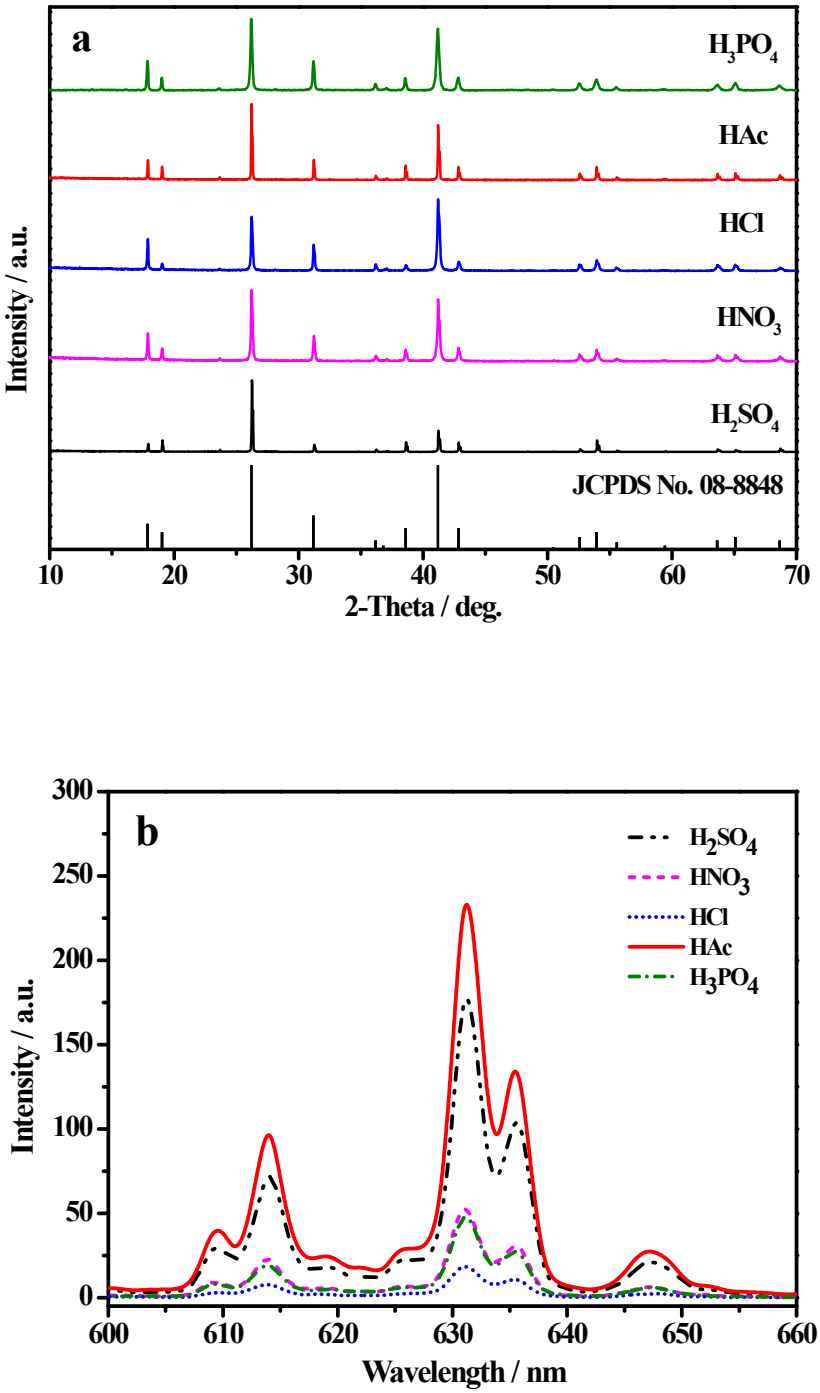

Figure S1. (a) XRD patterns and (b) the corresponding PL spectra of K_2TiF_6:Mn^{4+} red phosphors prepared with different kinds of acids.

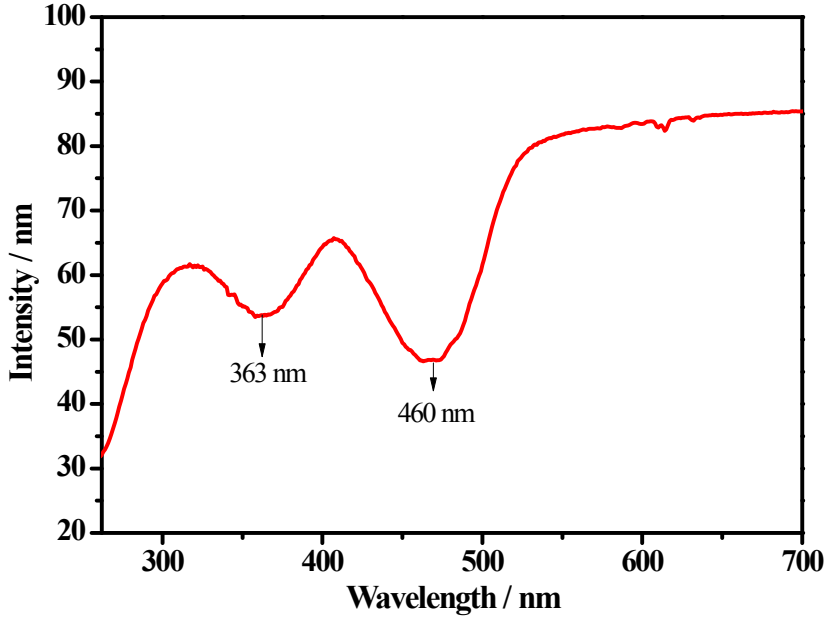

Figure S2. Diffuse reflectance spectra of the $K_2TiF_6:Mn^{4+}$ product examined at 298 K.

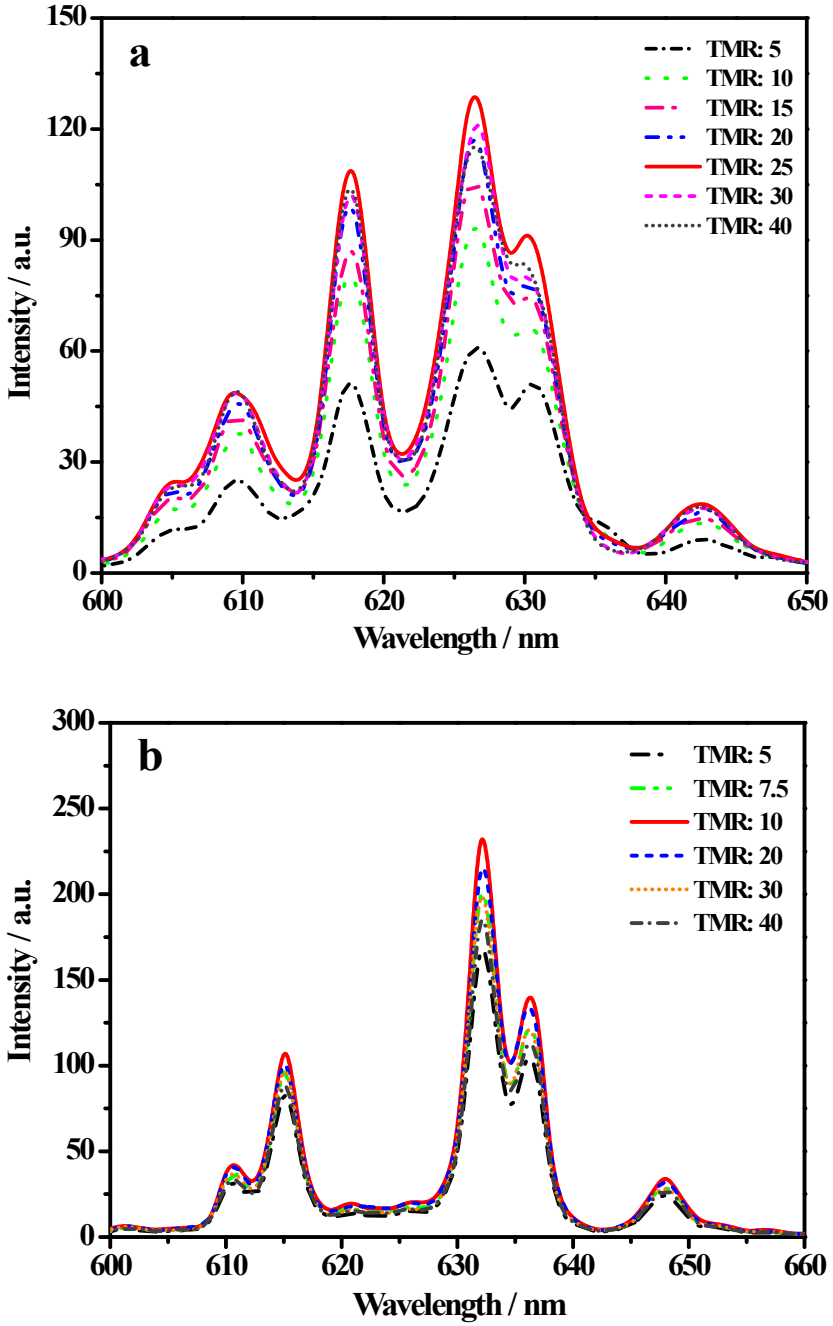

Figure S3. PL spectra of (a) Na_2TiF_6:Mn^{4+} and (b) Cs_2TiF_6:Mn^{4+} red phosphors prepared with different TMRs.

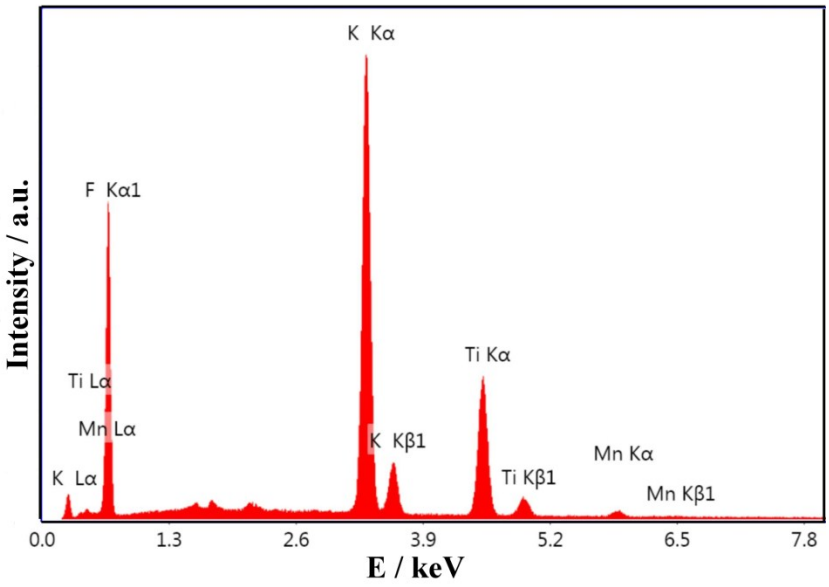

Figure S4. EDS spectrum of the K_2TiF_6:Mn^{4+} red phosphor.

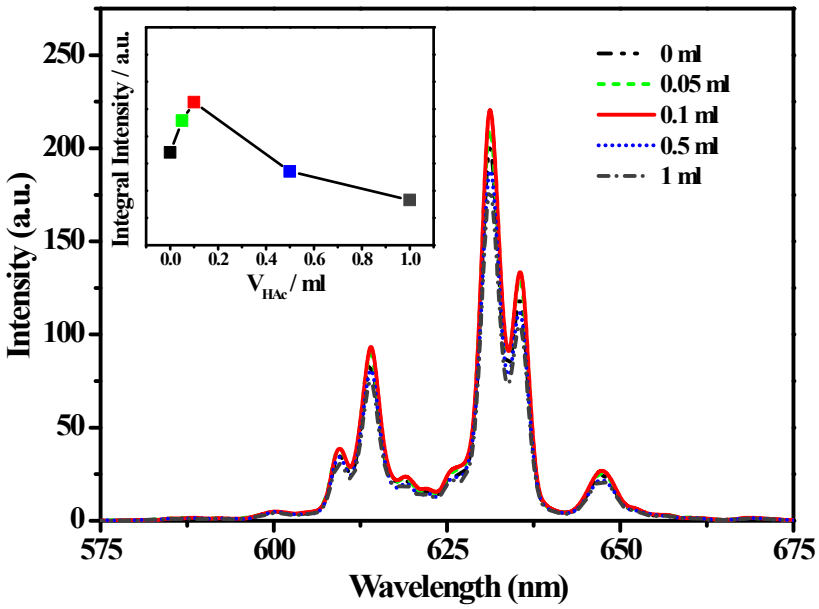

Figure S5. PL spectra for K_2TiF_6:Mn^{4+} products prepared with different glacial acetic acid volume (λ_{ex} = 460 nm). The insert spectrum is the relationship between volume and relative integral emission intensity of K_2TiF_6:Mn^{4+}.

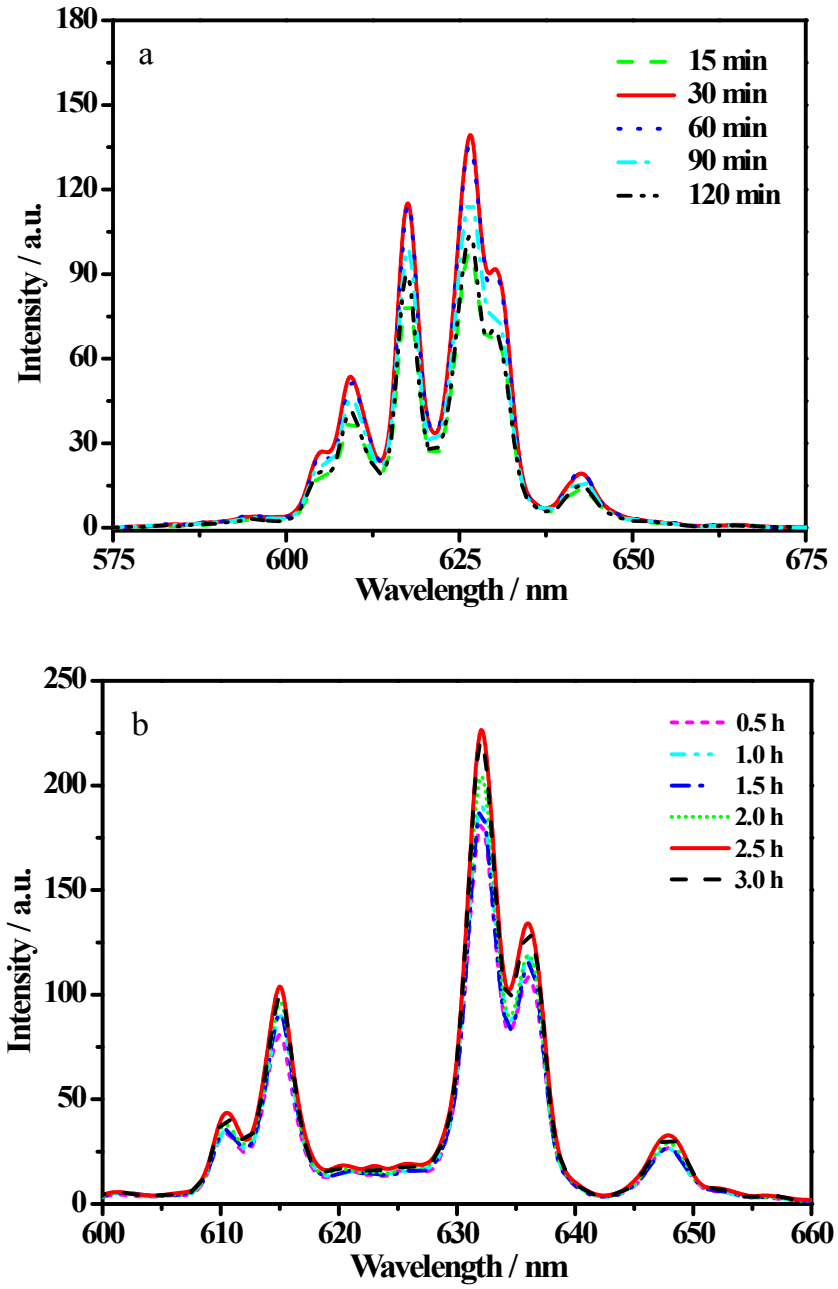

Figure S6. PL spectra for (a) $Na_2TiF_6:Mn^{4+}$ and (b) $Cs_2TiF_6:Mn^{4+}$ products prepared with different reaction time (λ_{ex} = 460 nm).

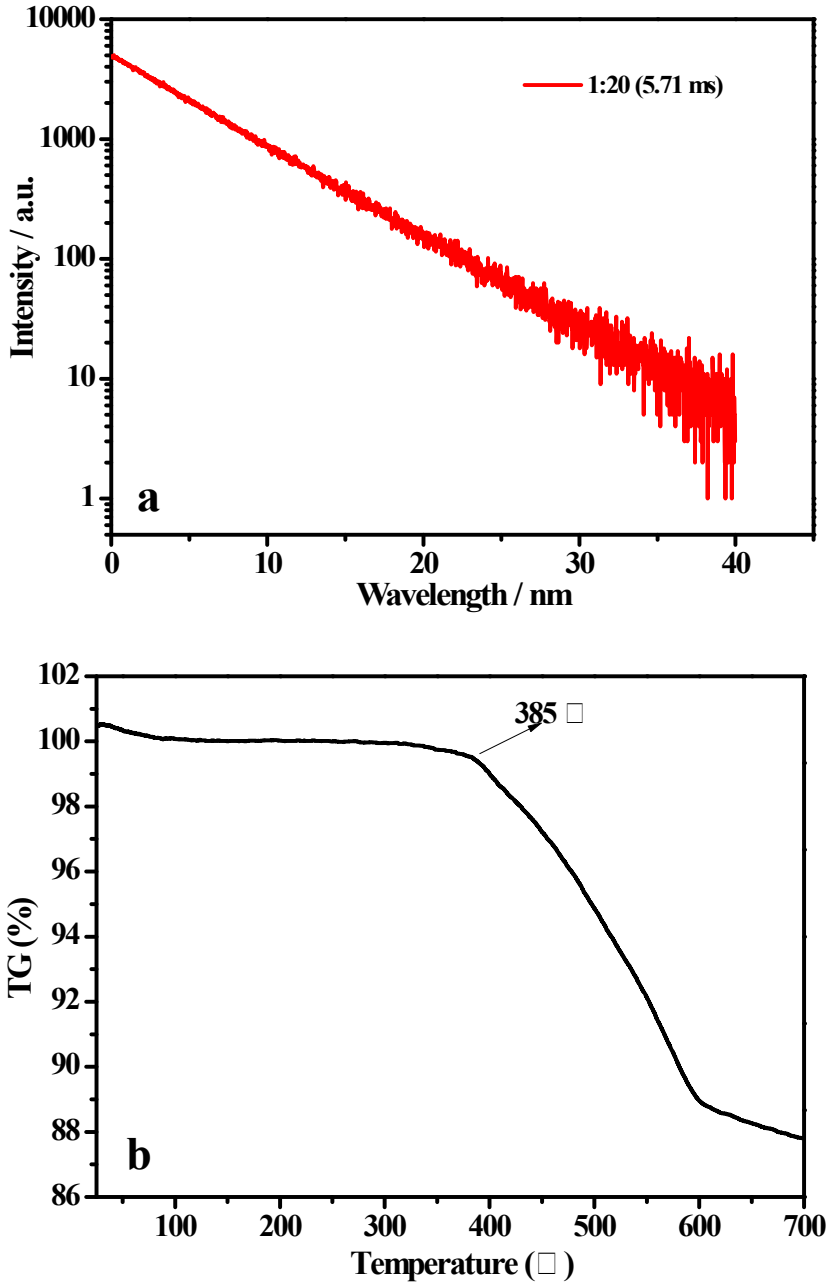

Figure S7. (a) Decay curve and (b) TG curve of the prepared K_2TiF_6:Mn^{4+} product.

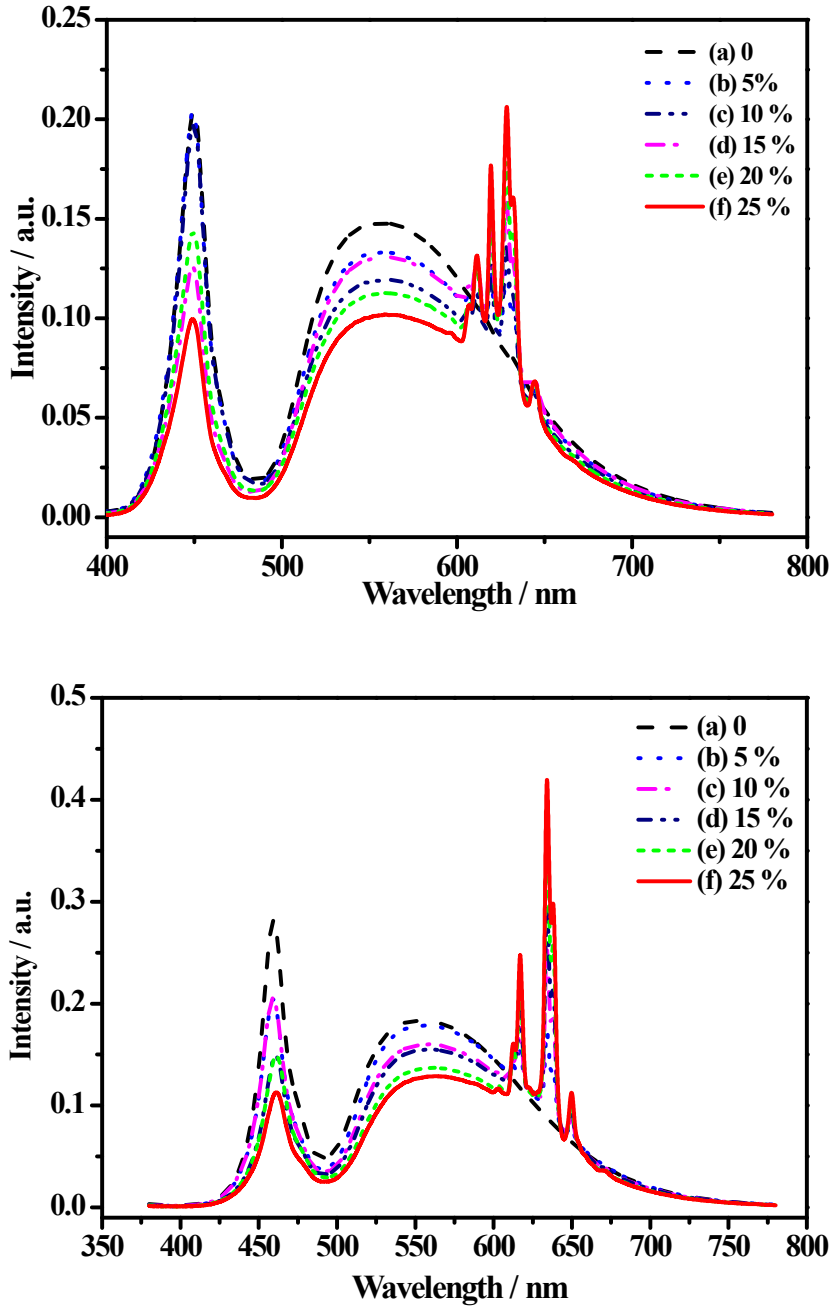

Figure S8. Electroluminescent (EL) spectra of LED devices based on $Na_2TiF_6:Mn^{4+}$ and $Cs_2TiF_6:Mn^{4+}$ phosphors recorded at 20 mA drive current.

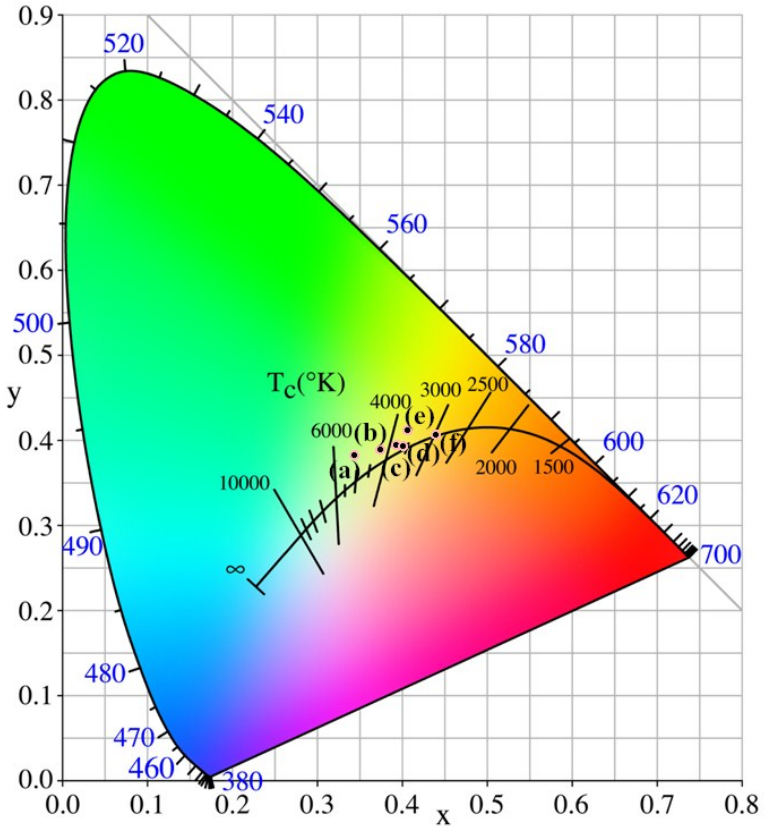

Figure S9. CIE chromaticity diagram for the YAG- $K_2TiF_6:Mn^{4+}$ type WLEDs with different amount of $K_2TiF_6:Mn^{4+}$ in phosphor mixture: (a-f) 0, 5 %, 10 %, 15 %, 20 %, 25 %.

Table S1. Performance of the GaN-based WLEDs fabricated from: (a) YAG, (b-f) YAG-$K_2TiF_6:Mn^{4+}$ at 20 mA forward current.

No. of devices	CIE (x, y)	CCT (K)	CRI (K)	LE (lm/W)
a	0.3437, 0.3828	5139	71.8	180.98
b	0.3741, 0.3892	4304	75.6	199.41
c	0.3940, 0.3951	3794	82.2	188.86
d	0.4018, 0.3939	3627	84.5	177.83
e	0.4071, 0.4122	3582	88.0	173.49
f	0.4403, 0.4072	2969	94.1	156.04

Table S2. Performance of the GaN-based WLEDs fabricated from YAG-$Na_2TiF_6:Mn^{4+}$ LED devices at 20 mA forward current.

No. of devices	CIE (x, y)	CCT (K)	CRI (K)	LE (lm/W)
a	0.3360, 0.3328	5332	70.3	141.28
b	0.3475, 0.3564	4927	71.4	133.58
c	0.3567, 0.3649	4643	73.2	132.59
d	0.3569, 0.3555	4585	74.8	124.05
e	0.3704, 0.3732	4261	75.4	126.76
f	0.3839, 0.3790	3925	78.2	115.90

Table S3. Performance of the GaN-based WLEDs fabricated from YAG-$Cs_2TiF_6:Mn^{4+}$ LED devices at 20 mA forward current.

No. of devices	CIE (x, y)	CCT (K)	CRI (K)	LE (lm/W)
a	0.3437,0.3828	5139	71.8	180.98
b	0.3709,0.4043	4423	73.2	211.78
c	0.3751,0.3893	3794	79.3	193.82
d	0.3975,0.4130	3838	79.5	188.13
e	0.4029,0.3984	3614	85.5	170.41
f	0.4239,0.4080	3262	87.7	162.53