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

Supporting Information for

Intense broadband radioluminescence from Mn^{2+}-doped aluminoborate glass scintillator

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Calculation of effective atomic number of glass samples

The Z_{eff} value is estimated by using the well-known empirical equation,[1]

$$Z_{eff} = \sqrt[2.94]{f_1(Z_1)^{2.94} + f_2(Z_2)^{2.94} + f_3(Z_3)^{2.94} + ... + f_i(Z_i)^{2.94}} \quad \text{(S1)}$$

where f_i is fraction of total number of electrons associated with each element, and Z_i is atomic number of each element. The Z_{eff} result of AM0.9 specimen is 48.31.

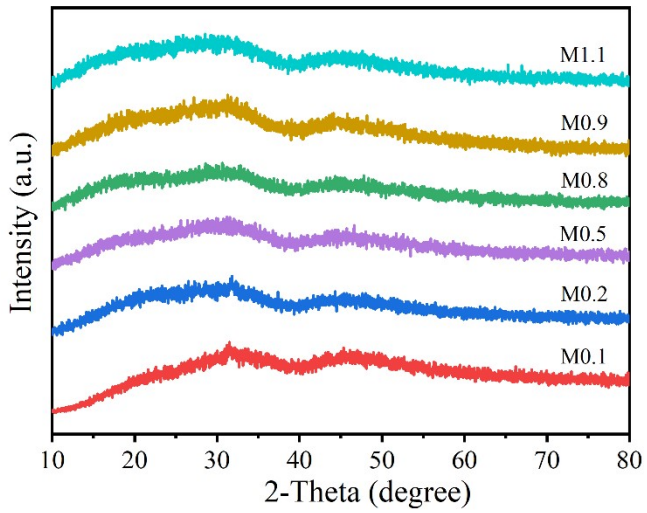

Fig. S1 XRD patterns of all M*x* samples.

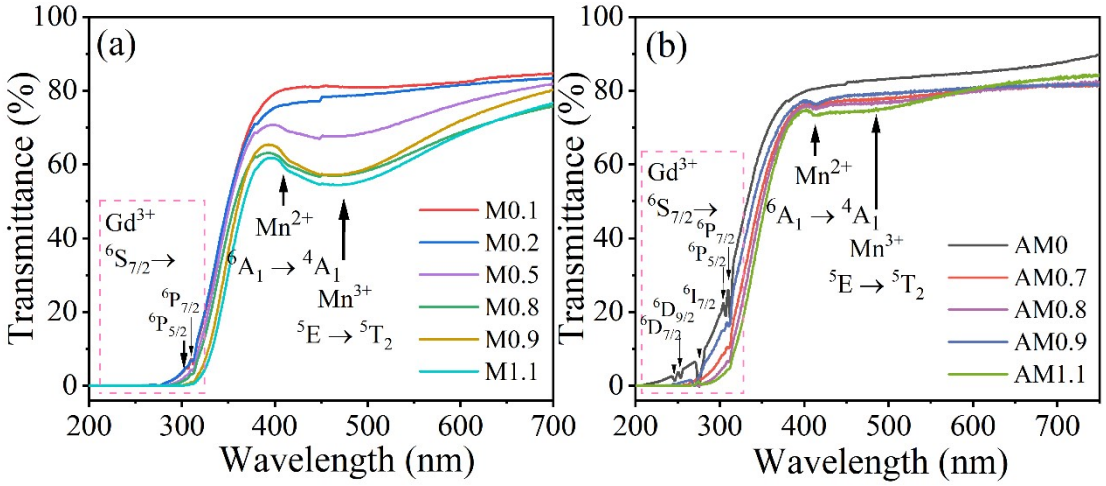

Fig. S2 Transmittance spectra of (a) M*x* samples and (b) AM*x* samples.

The valance variation of Mn^{3+} to Mn^{2+}

The binding energy of Mn^{2+} is around 641.0 eV (green line).[2] The binding energy of Mn^{3+} is around 641.6 eV (magenta line).[2] The content of Mn^{2+} is increased from 25.0 % (in M0.9 sample) to 92.2 % (in AM0.9 sample), which illustrates the splendid reduction of Mn^{3+} to Mn^{2+} with the addition of Al. The detailed area information is listed in Table S1.

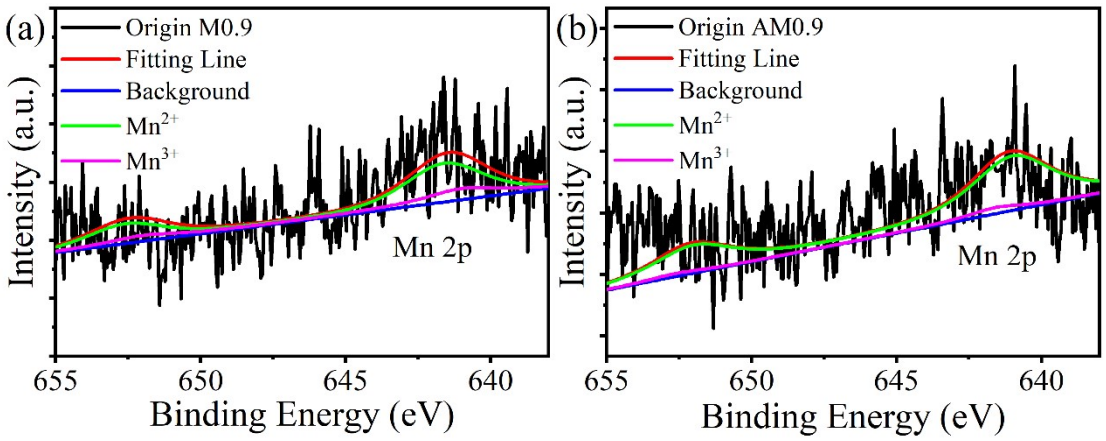

Fig. S3 XPS spectra of Mn 2p level of (a) M0.9 sample, (b) AM0.9 sample.

The complete transformation of Al metal into Al^{3+}

The binding energy of Al^{3+} is around 74.3 eV.[3] And the binding energy of Al metal is around 72 eV.[3] The fitting line can only be fitted by Al^{3+}, indicating all the Al metal is oxidized into Al^{3+}.

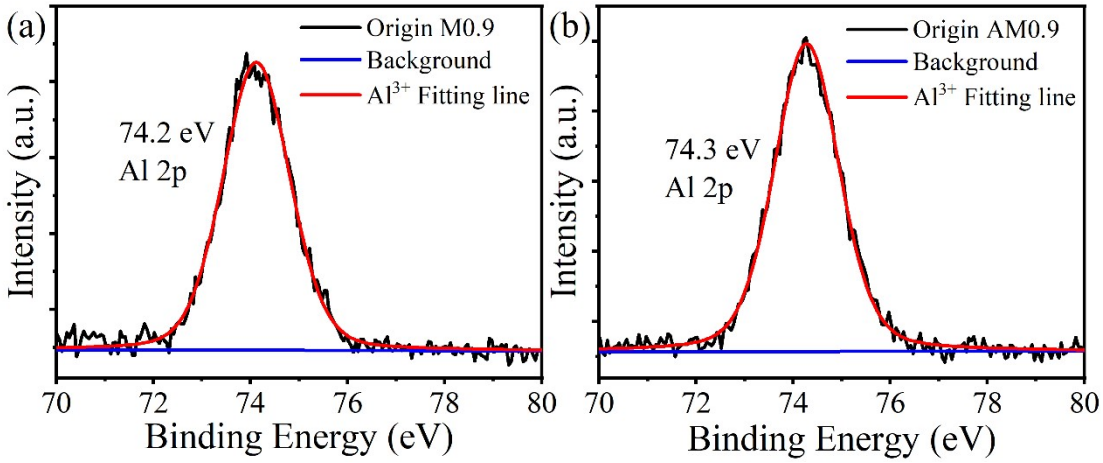

Fig. S4 XPS spectra of Al 2p level of (a) M0.9 sample, (b) AM0.9 sample.

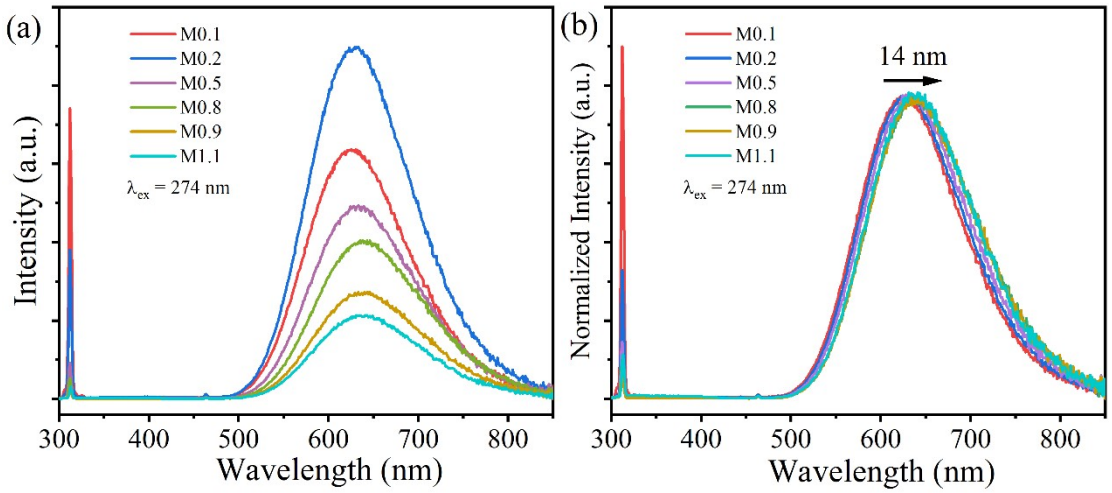

Fig. S5 (a) PL spectra (λ_{ex} = 274 nm), (b) the normalized PL spectra (λ_{ex} = 274 nm) of M*x* specimens.

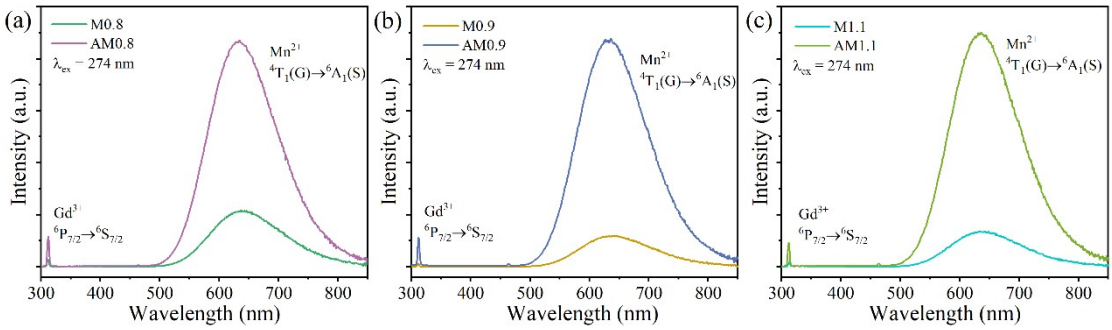

Fig. S6 PLE spectra (λ_{ex} = 274 nm) of (a) M0.8 and AM0.8, (b) M0.9 and AM0.9, (c) M1.1 and AM1.1.

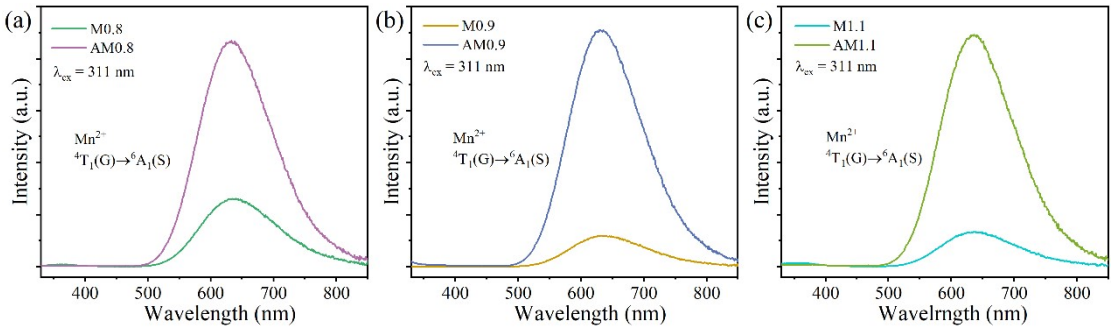

Fig. S7 PLE spectra (λ_{ex} = 311 nm) of (a) M0.8 and AM0.8, (b) M0.9 and AM0.9, (c) M1.1 and AM1.1.

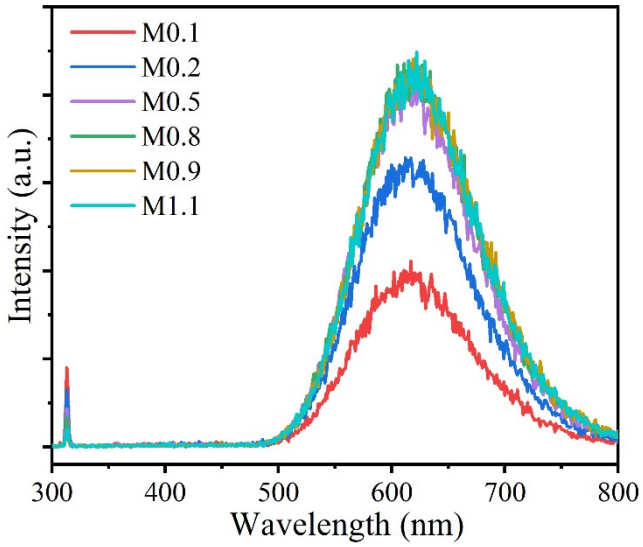

Fig. S8 XEL spectra of all M*x* specimens.

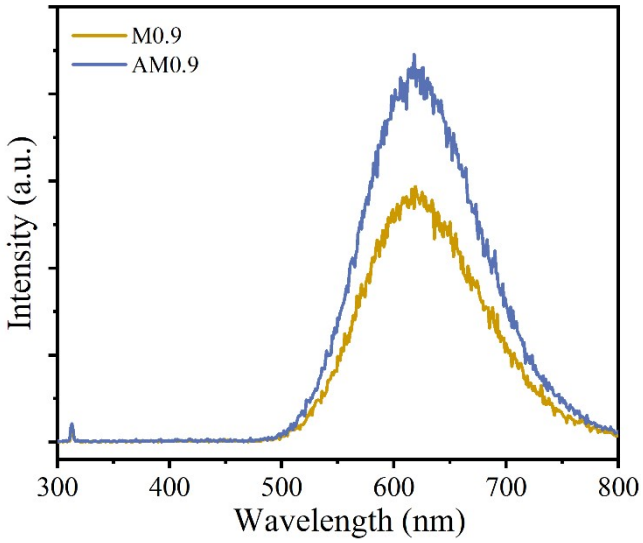

Fig. S9 XEL spectra of AM0.9 and M0.9 specimens.

The radiation tolerance of AM0.9 sample

The optimal AM0.9 specimen was radiated continuously under 7 W X-ray for one hour. The XEL spectra were obtained for every 5 min to show the stability of the specimen.

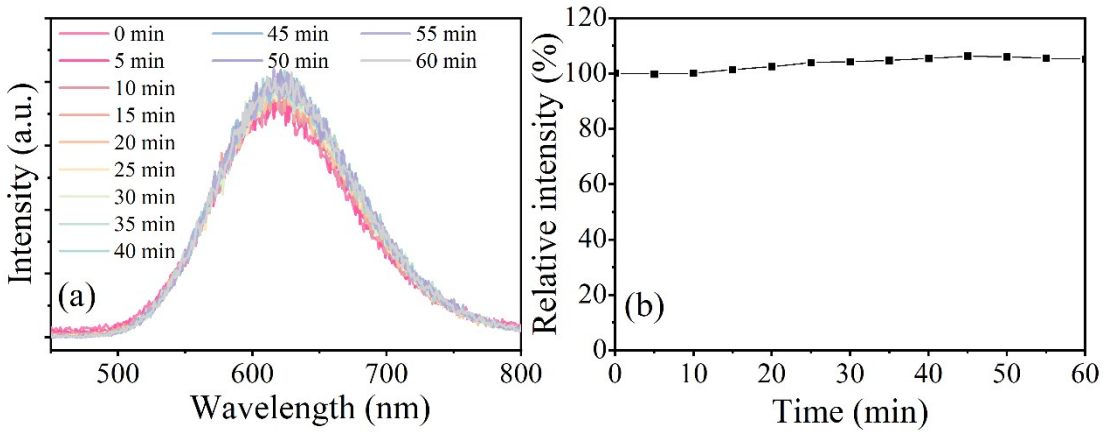

Fig. S10 (a) The XEL spectra measured at different time when the AM0.9 specimen was radiated continuously under 7 W X-ray for one hour; (b) time dependent integrated XEL intensities of AM0.9 specimen.

Table S1 The area of Mn^{2+} and Mn^{3+} from XPS results.

Valance of Mn	Binding Energy (eV)	Area in M0.9 sample/Ratio (%)	Area in AM0.9 sample/Ratio (%)
Mn^{2+}	641.0	106.4576/25.0	496.9508/92.2
Mn^{3+}	641.6	319.3078/75.0	42.1270/7.8

Table S2 IQY values of M*x* specimens excited by 274 nm.

Samples	M0.1	M0.2	M0.5	M0.8	M0.9	M1.1
IQY	18.0 %	18.1 %	14.0 %	6.8 %	3.4 %	0.5 %

Reference:

[1] M. P. Singh, B. S. Sandhh, B. Singh, Nucl. Instrum. Meth. A, 2007, **580**, 50-53.

[2] R. J. Iwanowski, M. H. Heinonen, E. Janik, Chem. Phys. Lett., 2004, **387**, 110-115.

[3] T. Cheng, Z. Wang, S. Jin, F. Wang, Y. Bai, H. Feng, B. You, Y. Li, T. Hayat, Z. Tan, Adv. Opt. Mater., 2017, **5**, 1700035.