Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.

Structural confinement-induced highly efficient deep-red emission and negative thermal quenching performances in Mn^{4+}-activated $Ca_7Mg_2Ga_{6-y}Al_yO_{18}:Mn^{4+}$ phosphors

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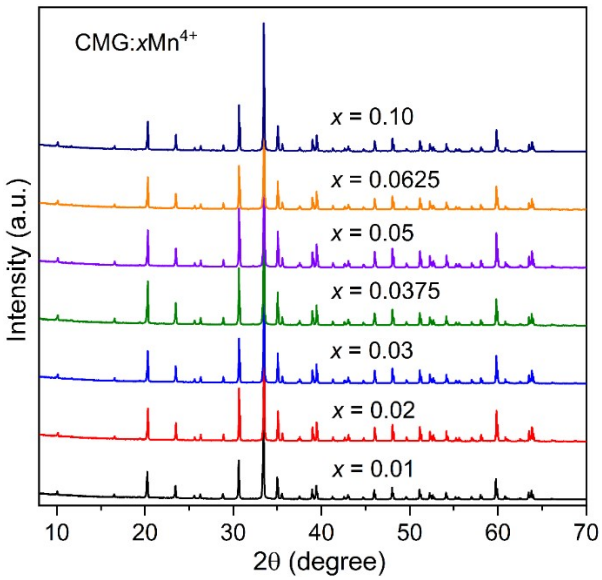

Fig. S1 XPRD patterns for CMGO: xMn^{4+} (x = 0.01, 0.02, 0.03, 0.0375, 0.05, 0.0625, and 0.10).

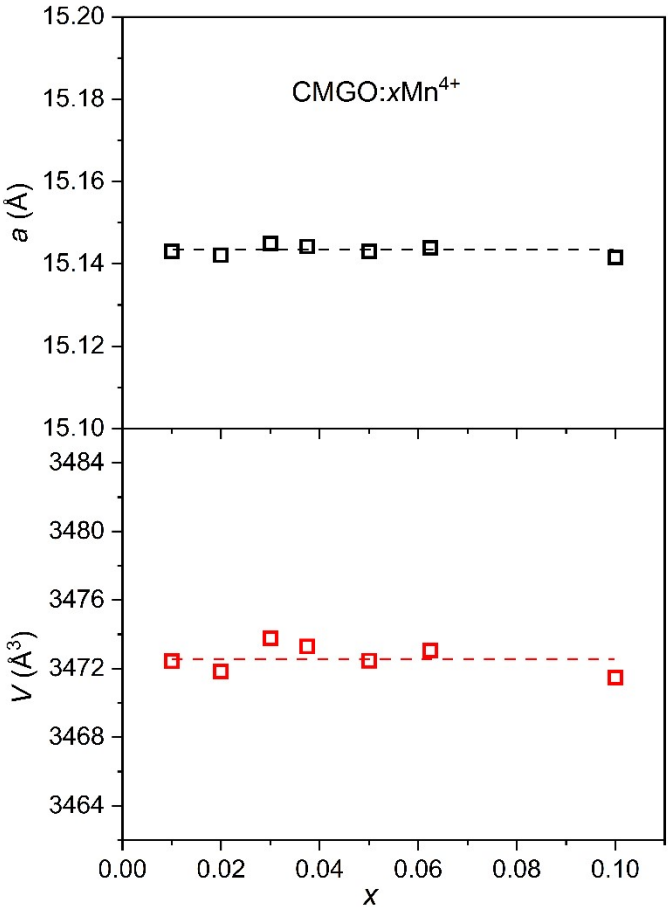

Fig. S2 Plots of lattice parameters along with Mn^{4+}-content (x) in CMGO: xMn^{4+}.

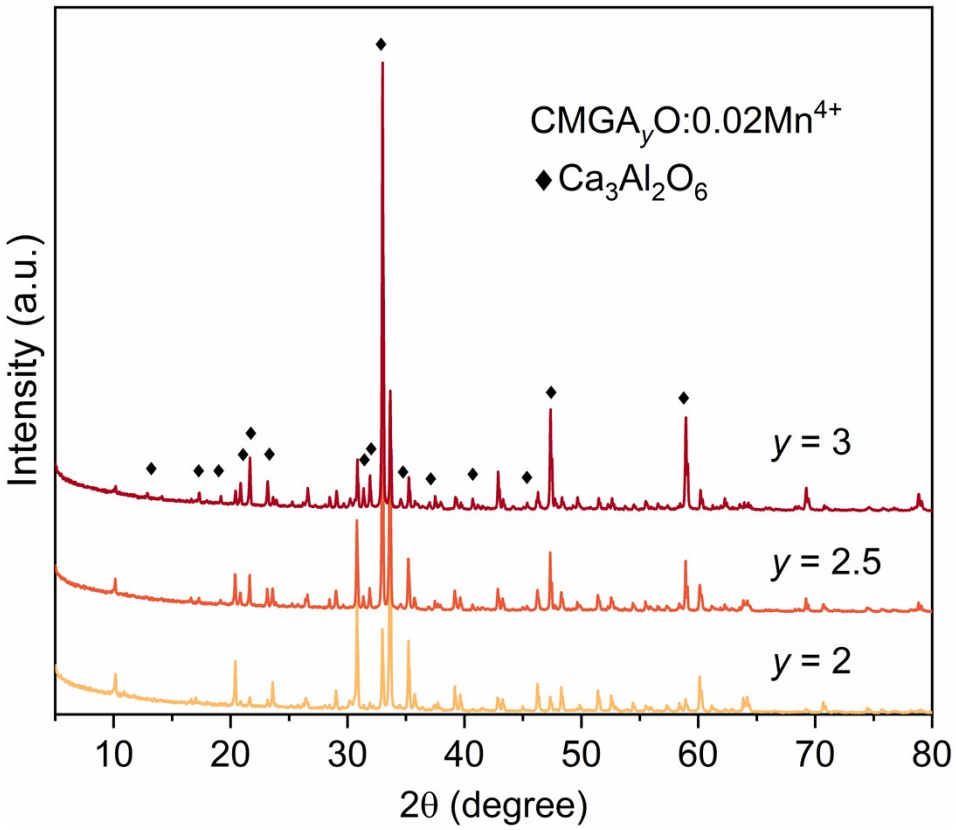

Fig. S3 PXRD patterns for CMGA$_y$O:0.02Mn^{4+} with y = 2, 2.5, and 3. The black diamonds represent the diffraction peaks corresponding to the impurity phase $Ca_3Al_2O_6$.

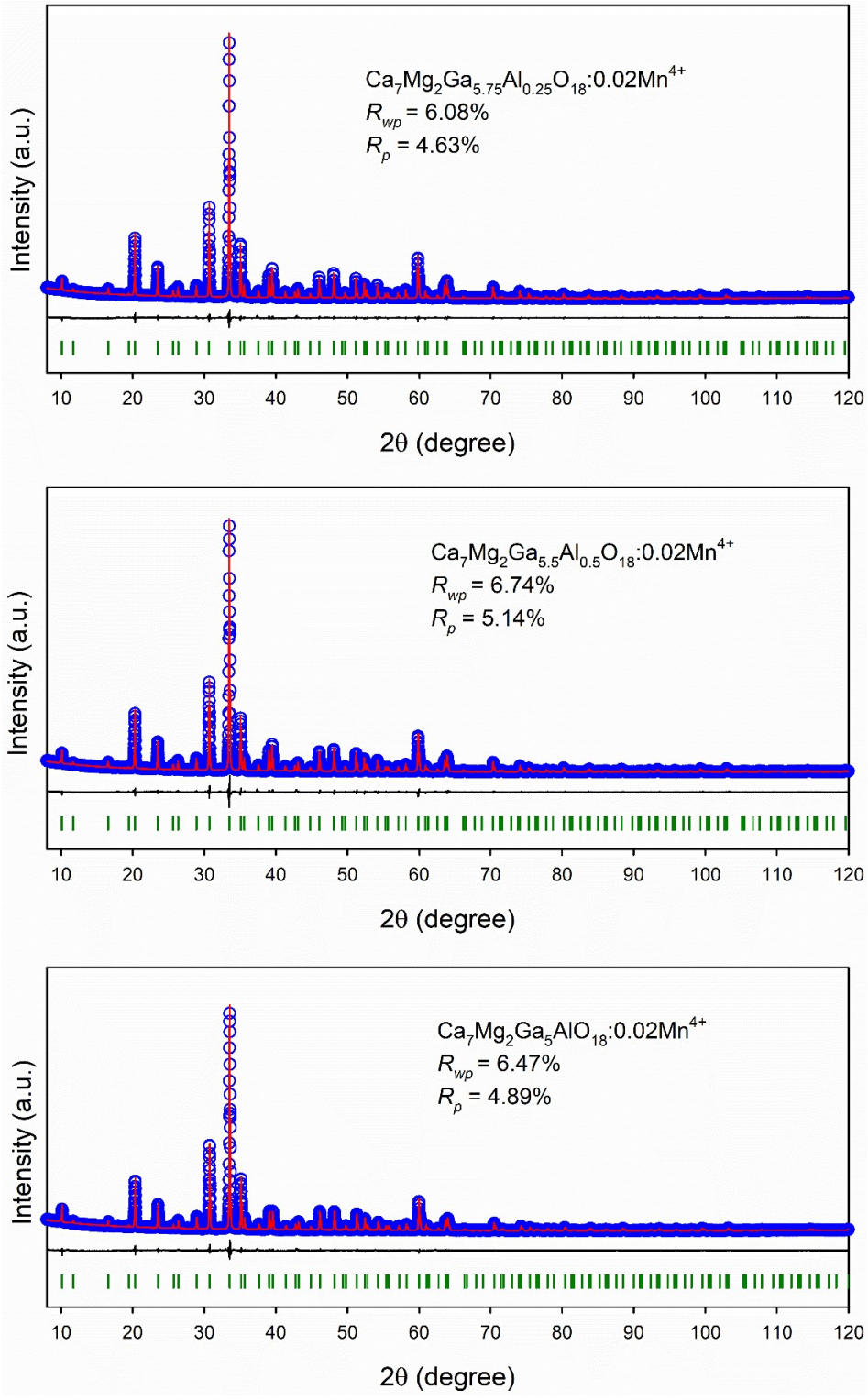

Fig. S4 Rietveld refinement plots of XPRD data for $CMGA_yO:Mn^{4+}$ (y = 0.25, 0.5, and 1).

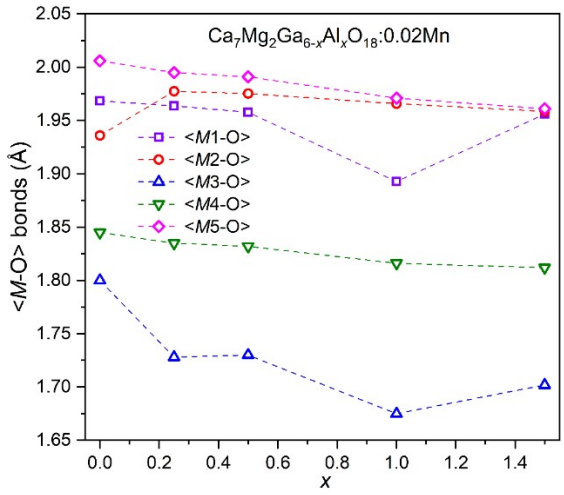

Fig. S5 Plots of the average metal-oxygen (*M*-O) bond lengths along with Al-content (*y*) in $CMGA_yO:Mn^{4+}$ (*y* = 0, 0.25, 0.5, 1, and 1.5).

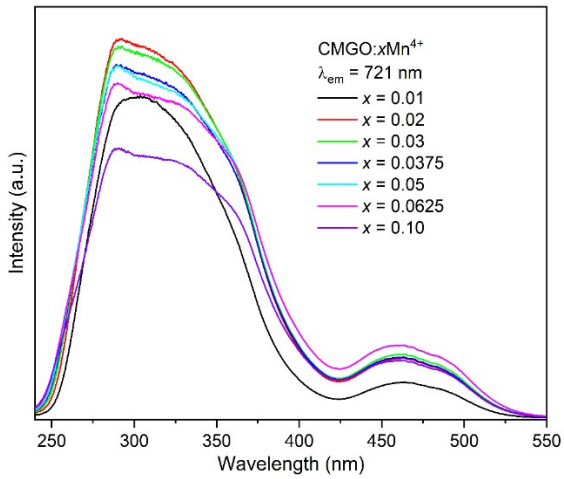

Fig. S6 The PLE spectra of $CMGO:xMn^{4+}$ (*x* = 0.01, 0.02, 0.03, 0.0375, 0.05, 0.0625, and 0.10).

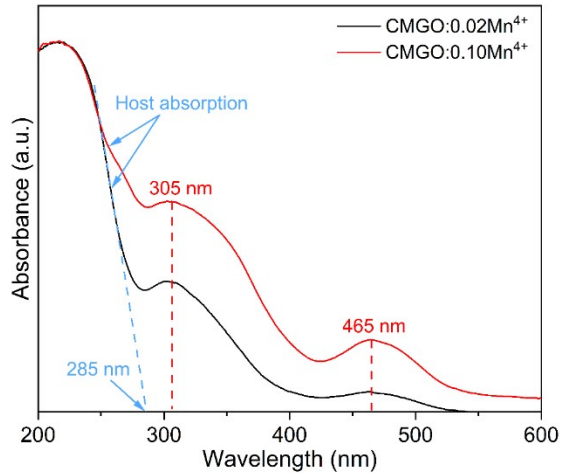

Fig. S7 The UV-visible light diffuse reflectance spectra for $CMGO:xMn^{4+}$ (*x* = 0.02 and 0.10).

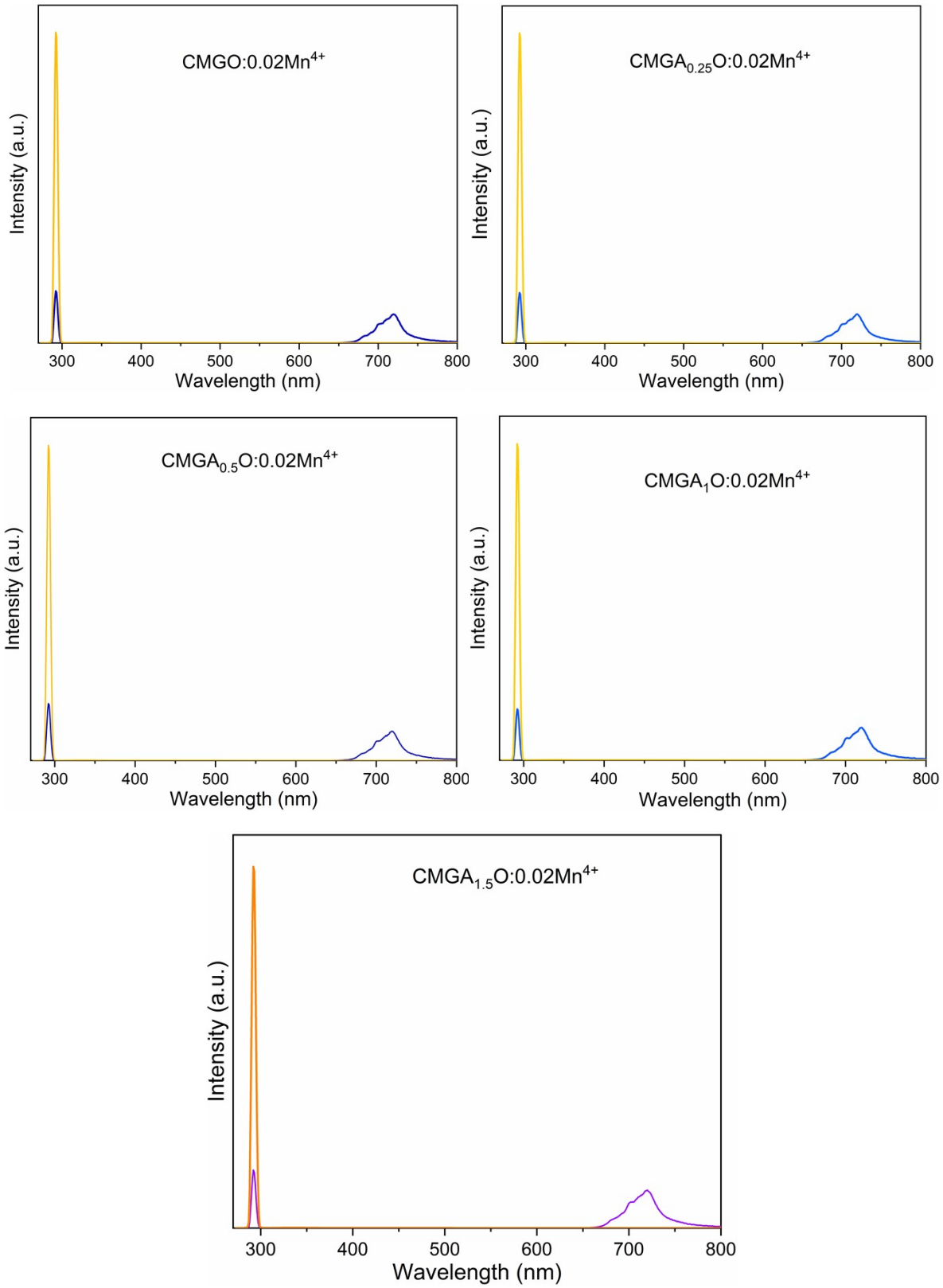

Fig. S8 The optical spectra of $CMGA_yO:0.02Mn^{4+}$ phosphors recorded by the quantum efficiency system under the excitation wavelength of 293 nm. The yellow lines in the figures represent the reflectance of the $BaSO_4$ standard.

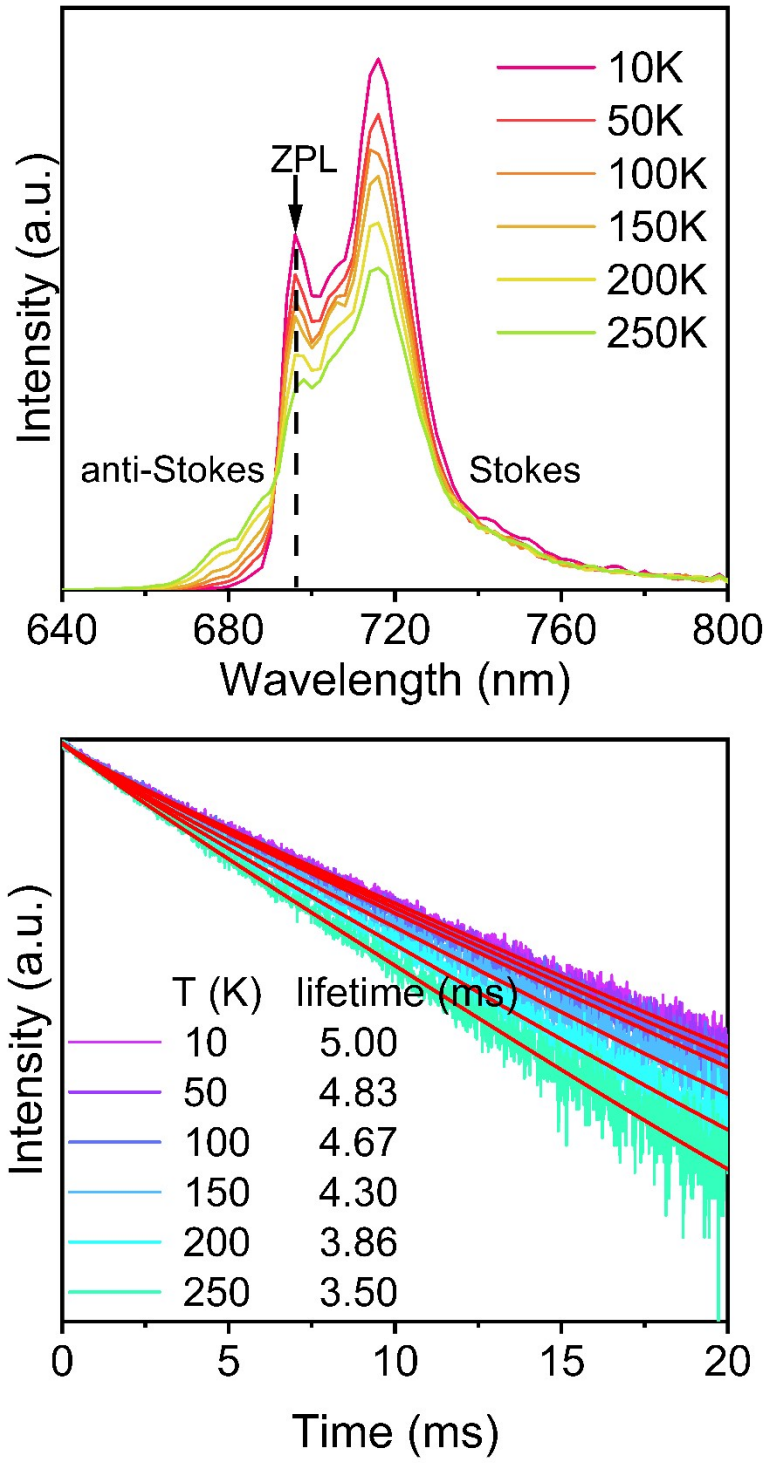

Fig. S9 Temperature-dependent PL spectra (up panel) and decay curves (down panel) of CMGO:0.02Mn^{4+} recorded at 10, 50, 100, 150, 200, and 250 K.

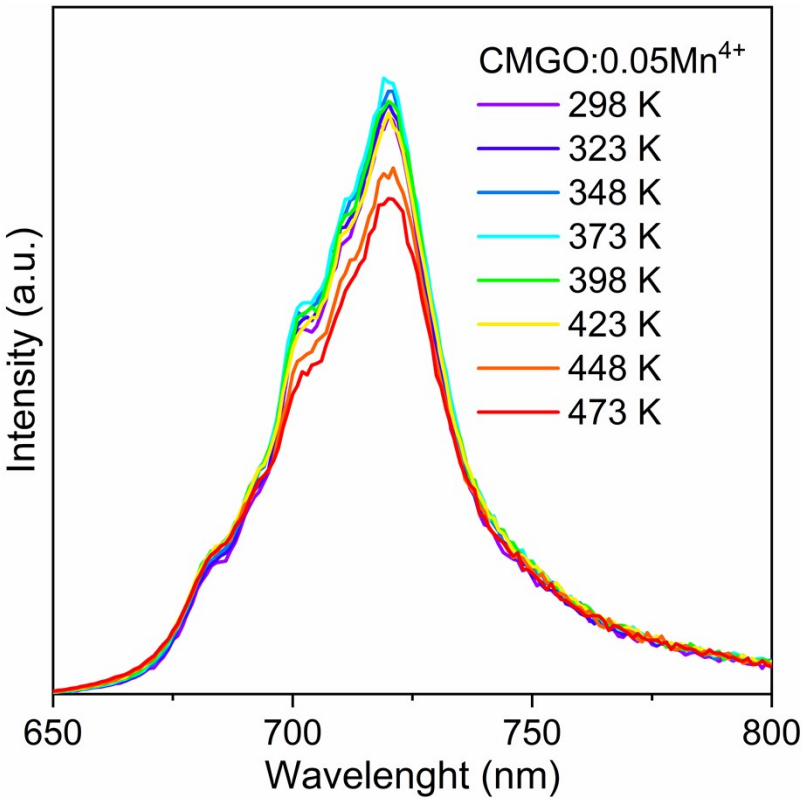

Fig. S10 Temperature-dependent PL spectra of CMGO:0.05Mn^{4+}.

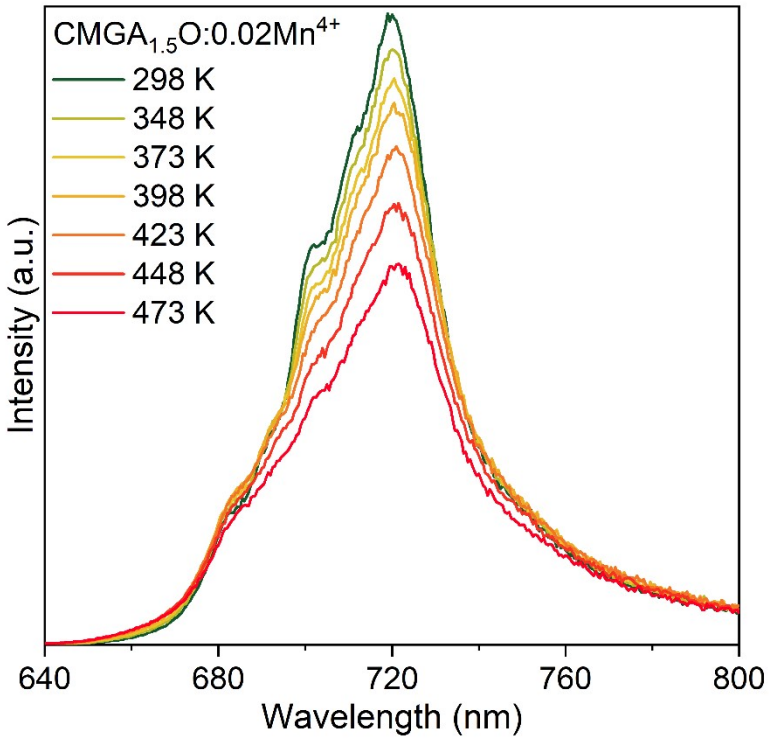

Fig. S11 Temperature-dependent PL spectra of $CMGA_{1.5}O$:0.02Mn^{4+}.

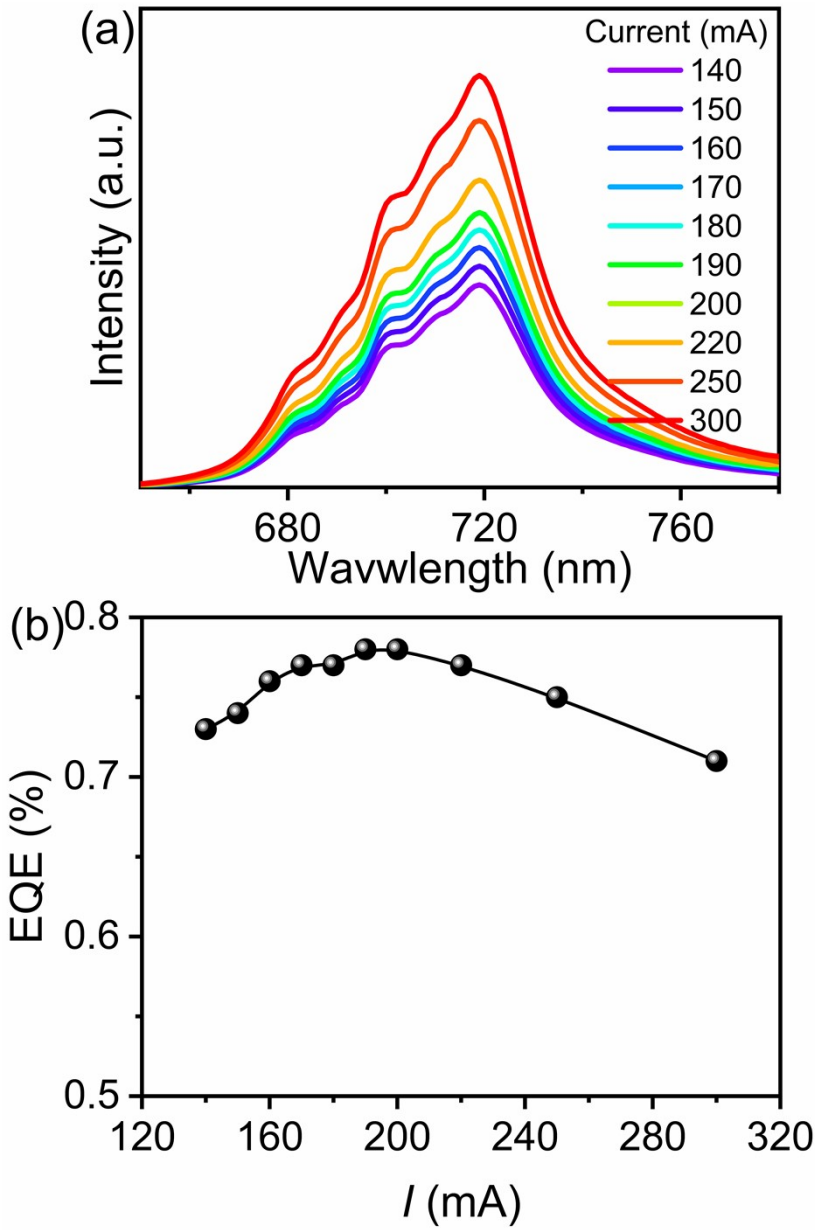

Fig. S12 Electroluminescence spectra (a) and measured EQE values (b) for the pc-LED fabricated by the combination of a 310 nm UV-chip and deep-red emitting phosphor $CMGA_{1.5}O:Mn^{4+}$ under various driven currents.

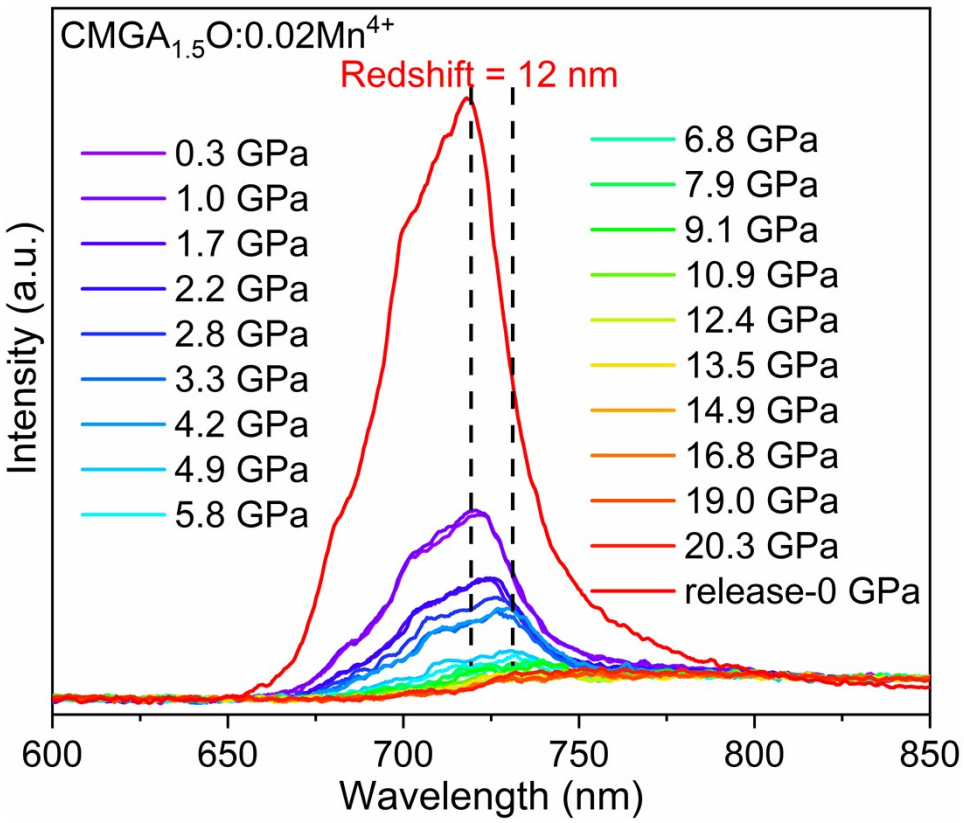

Fig. S13 The emission spectra (λ_{ex} = 375 nm) of $CMGA_{1.5}O:0.02Mn^{4+}$ at different pressures.

Table S1 Fitted values for hv_s, a_1, ΔE_1, a_2, and ΔE_2.

Phosphors	hv_s (meV)	a_1	ΔE_1 (meV)	a_2	ΔE_2 (eV)
$CMGO:0.02Mn^{4+}$	73.5	3.83	92.7	1.20×10^6	0.66
$CMGO:0.05Mn^{4+}$	73.8	1.59	72.3	1.20×10^6	0.63
$CMA_{0.5}GO:Mn^{4+}$	73.8	2.07	73.8	—[#]	—[#]
$CMA_{1.5}GO:Mn^{4+}$	73.6	3.82	88.1	1.14×10^6	0.59

[#] The "—" signs indicate these exponents are unnecessary in the mathematical fitting.