

Electronic Supplementary Information (ESI)

Mn⁴⁺ nonequivalent doping Al³⁺-based cryolite high-performance warm WLED red phosphors

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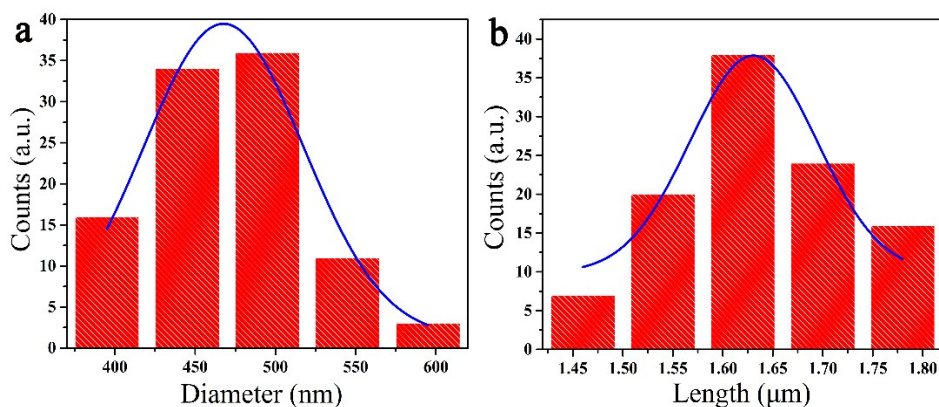


Fig. S1 Histogram of (a) diameter and (b) length of as-prepared Na₃AlF₆:Mn⁴⁺ red phosphor by coprecipitation method

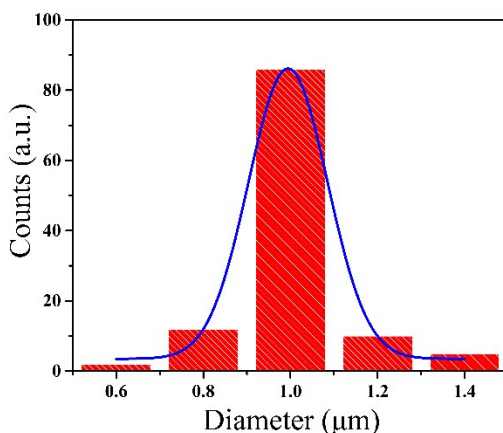


Fig. S2 Histogram of diameter as-prepared of Na₃AlF₆:Mn⁴⁺ red phosphor by hydrothermal method

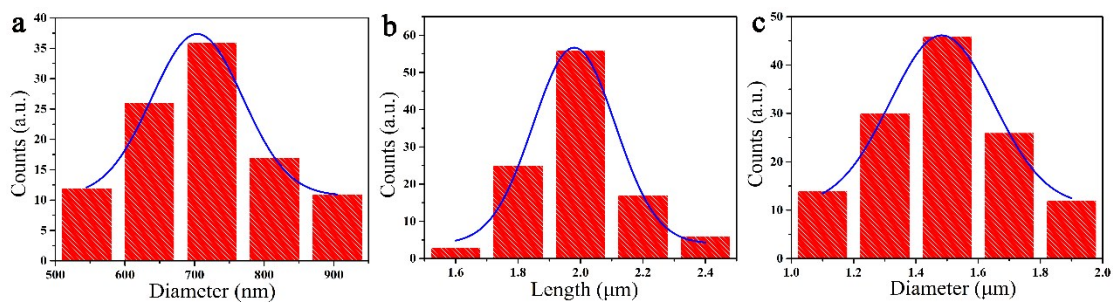


Fig. S3 Histogram of (a) diameter and (b) length of as-prepared $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ rods and histogram of (c) diameter of as-prepared $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ particle at hydrothermal time of 1 h

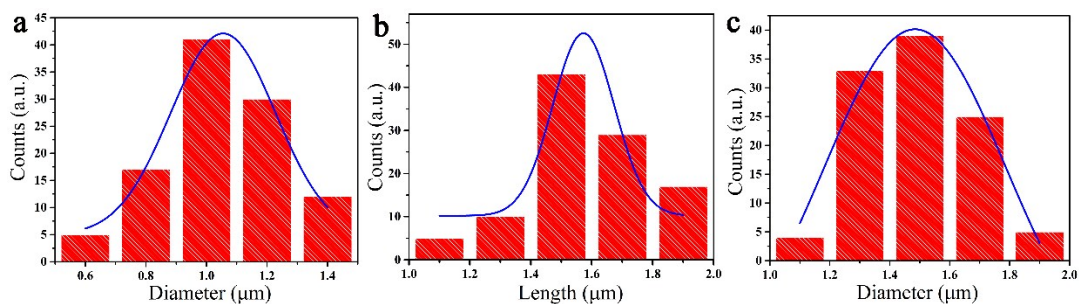


Fig. S4 Histogram of (a) diameter and (b) length of as-prepared $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ rods and histogram of (c) diameter of as-prepared $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ particle at hydrothermal time of 5 h

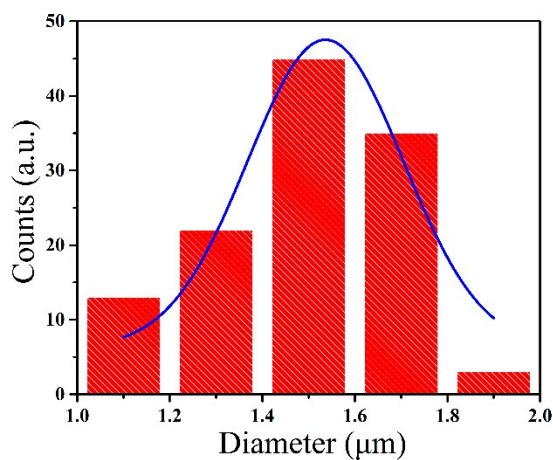


Fig. S5 Histogram of diameter of as-prepared of $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ red phosphor at hydrothermal time of 15 h

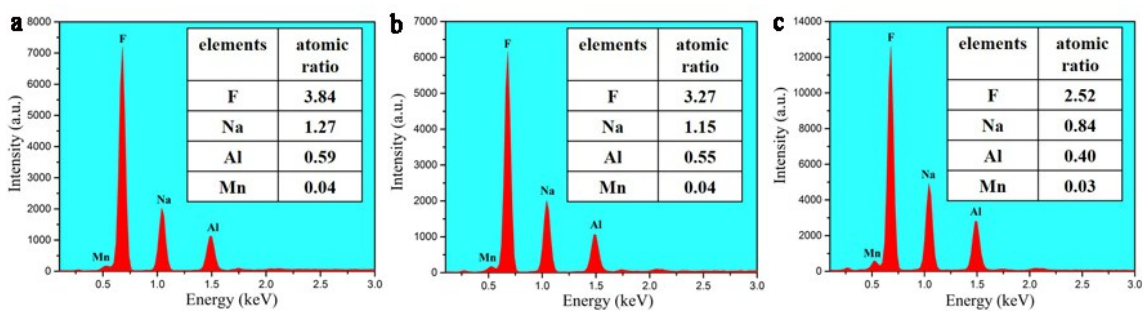


Fig. S6 EDS spectra of as-prepared of $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ red phosphor by different HF concentration
(a: 10 %, b: 30 % and c: 40%)

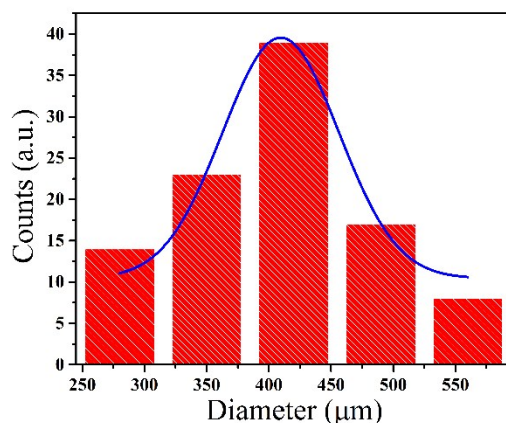


Fig. S7 Histogram of diameter of as-prepared of $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ red phosphor by ethylene glycol as a reaction solvent

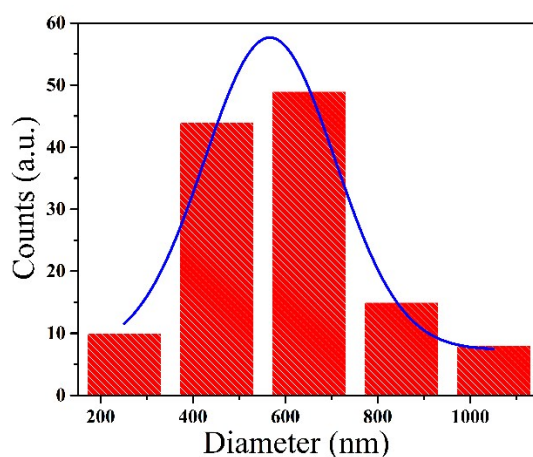


Fig. S8 Histogram of diameter of as-prepared of $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ red phosphor by ethanol as a reaction solvent

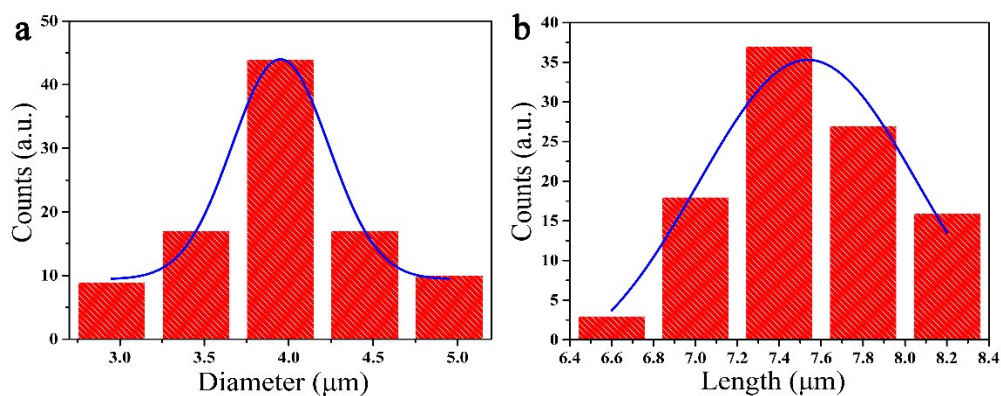


Fig. S9 Histogram of (a) diameter and (b) length of as-prepared $\text{Na}_3\text{AlF}_6:\text{Mn}^{4+}$ red phosphor by cyclohexane as a reaction solvent