

**Tuning multicolor emission of $\text{Zn}_2\text{GeO}_4\text{:Mn}$ phosphors by Li^+ doping for
information encryption and anti-counterfeiting applications**

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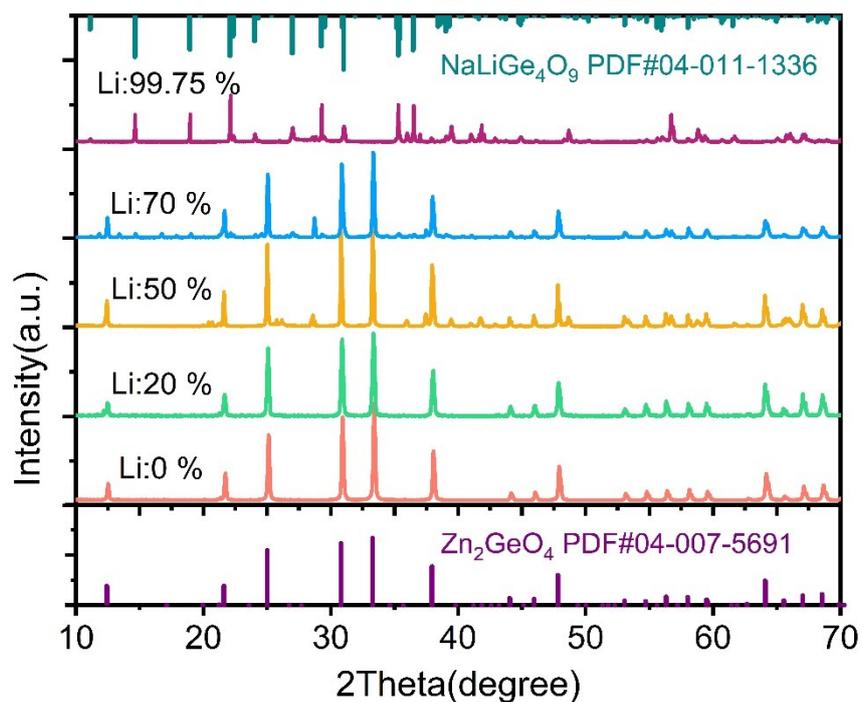


Fig. S1 XRD patterns of Zn₂GeO₄:Mn,*x*%Li (*x*=0 and 20), Zn₂GeO₄-NaLiGe₄O₉:Mn, *x*%Li (*x*=50 and 70) and NaLiGe₄O₉:Mn phosphors calcined at 900 °C. Note that the bottom of the panel is standard data for hexagonal Zn₂GeO₄ (purple, PDF# 04-007-5691), and the top of the panel is orthorhombic NaLiGe₄O₉:0.25%Mn (green, PDF# 04-011-1336).

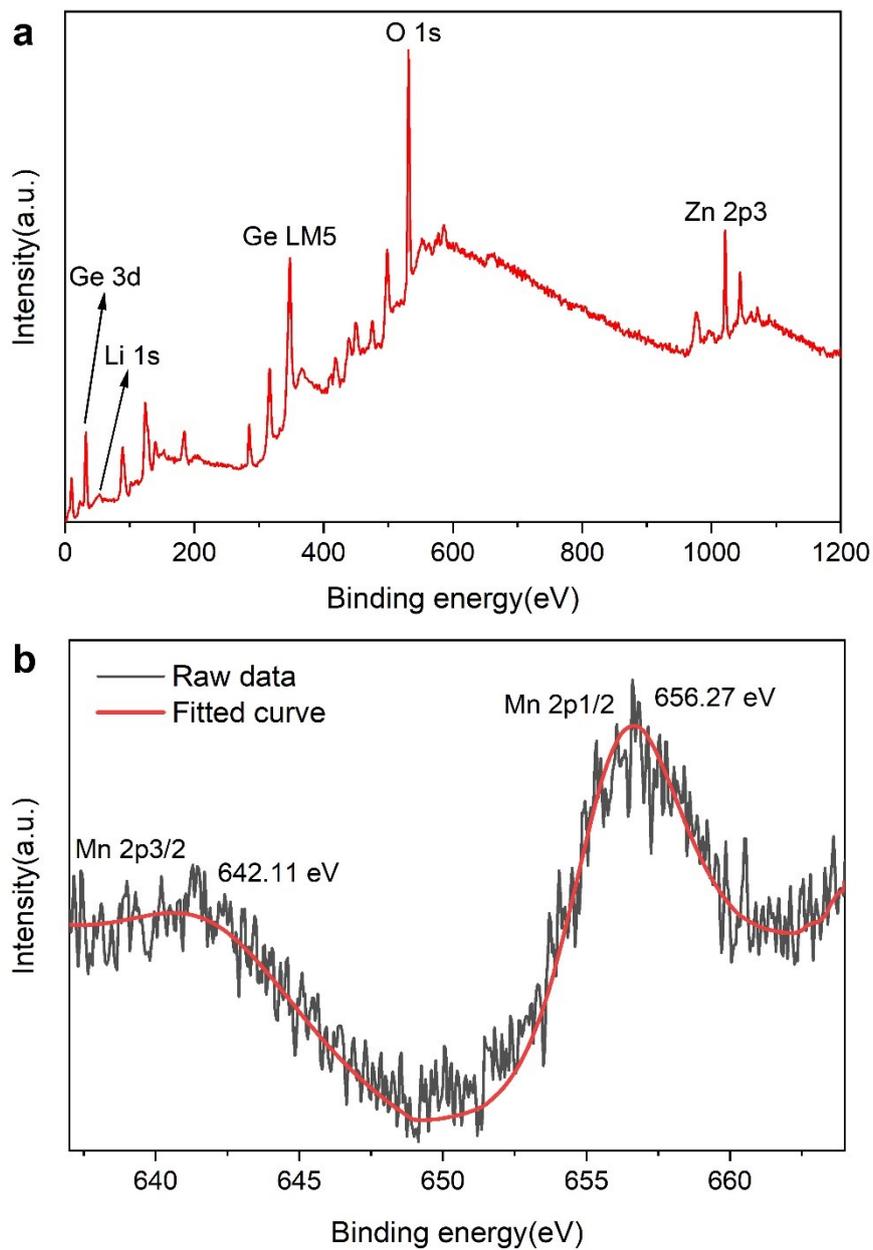


Fig. S2 XPS survey scan spectrum (a) and high-resolution XPS spectrum of Mn 2p (b) in $\text{Zn}_2\text{GeO}_4\text{-NaLiGe}_4\text{O}_9\text{:Mn}$, 70%Li sample.

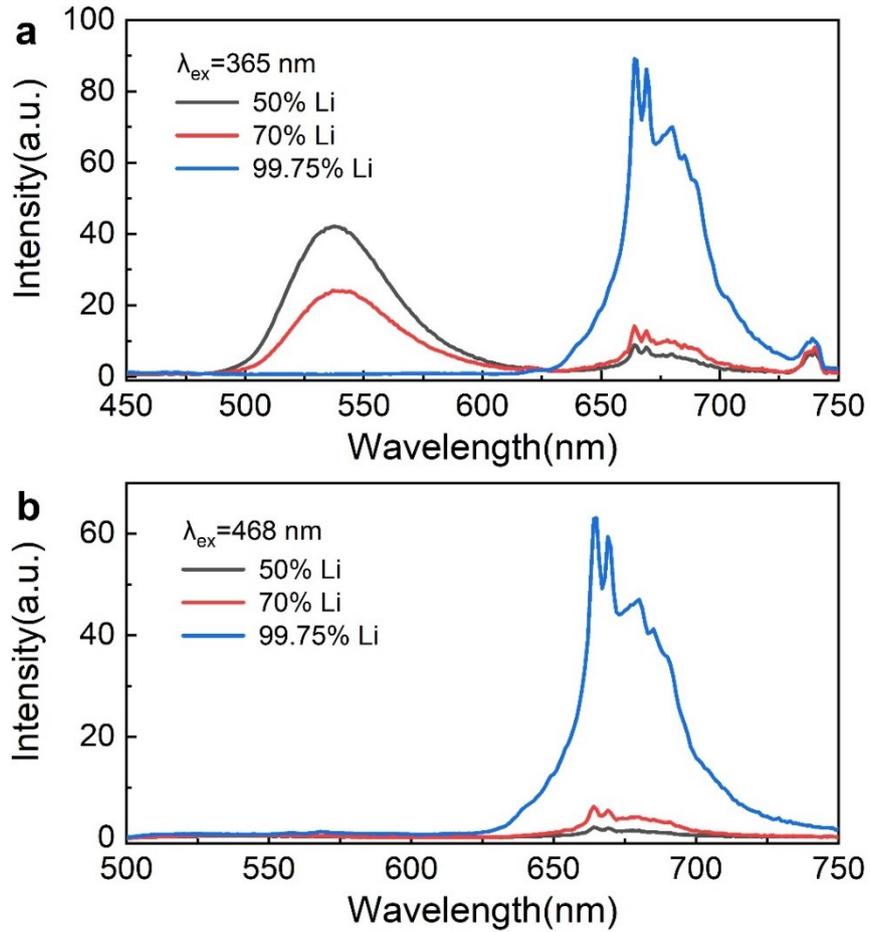


Fig. S3 Li⁺ doping concentration dependent PL spectra of Zn₂GeO₄-NaLiGe₄O₉:Mn, x%Li (x=50 and 70) and NaLiGe₄O₉:Mn phosphors under selective excitation with (a) 365 nm and (b) 468 nm, respectively. With the increase of Li⁺ ion doping concentrations and excitation wavelengths, the red luminescence increases.

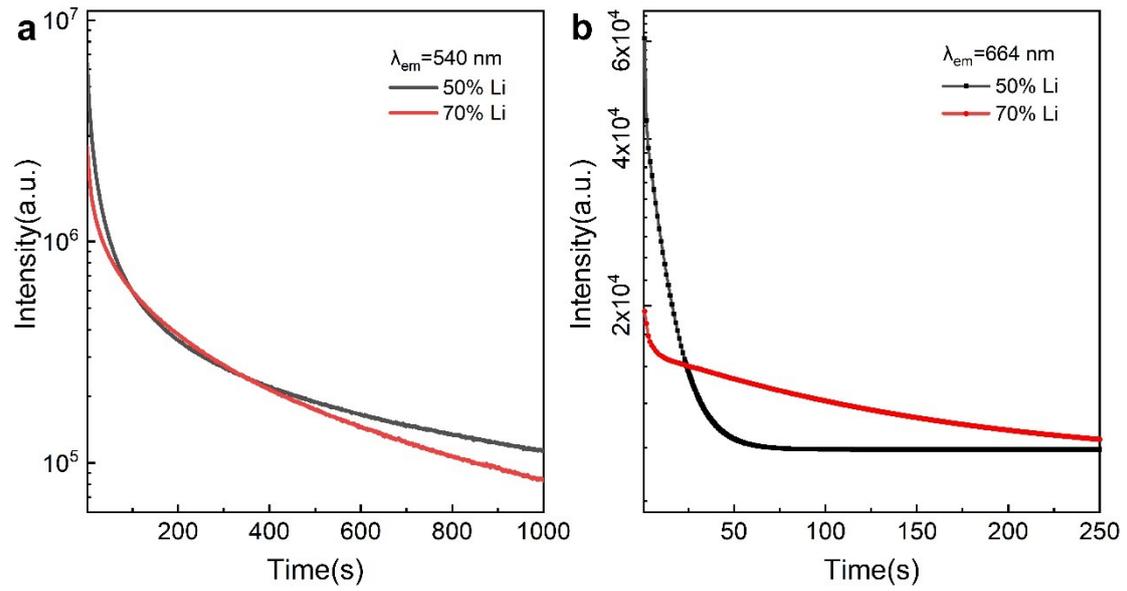


Fig. S4 Li^+ doping concentration dependent PersL decay curves of $\text{Zn}_2\text{GeO}_4\text{-NaLiGe}_4\text{O}_9\text{:Mn}$, $x\%\text{Li}$ phosphors ($x=50$ and 70) phosphors monitored at 540 nm (a) and 664 nm (b) after irradiated by a 365 nm lamp for 5 min.

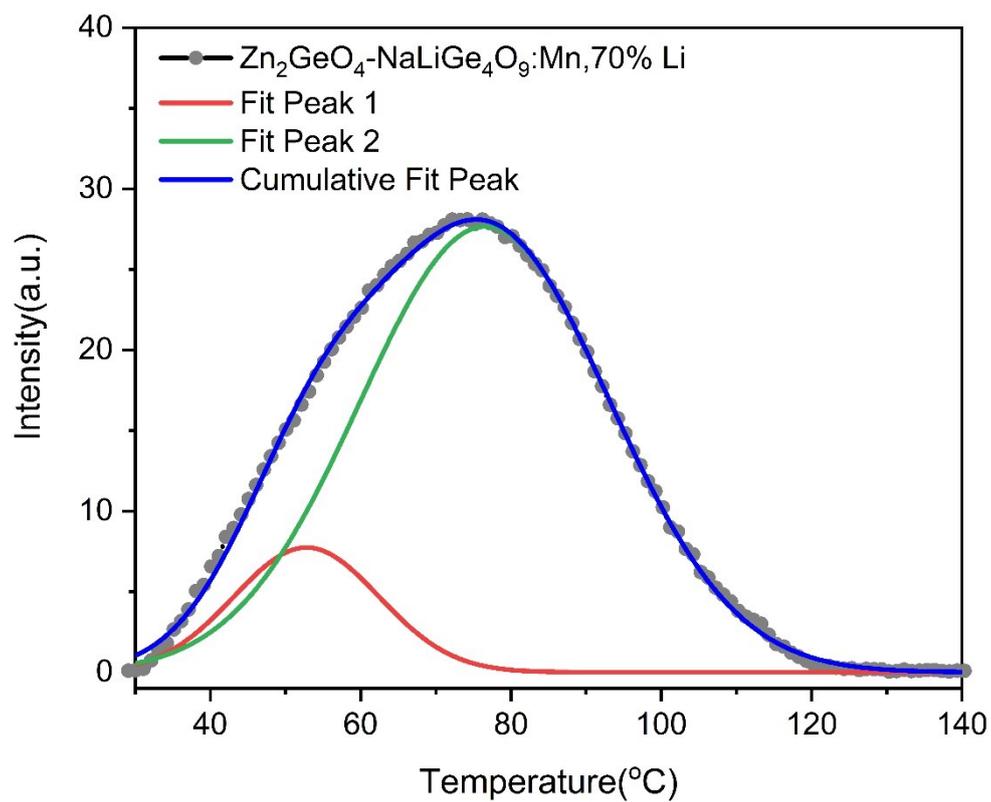


Fig. S5 TL curves of $\text{Zn}_2\text{GeO}_4\text{-NaLiGe}_4\text{O}_9\text{:Mn,70\%Li}$ phosphor monitored at 540 nm emission over 30–140 °C. The sample has been pre-irradiated by 365 nm UV light for 8 min.

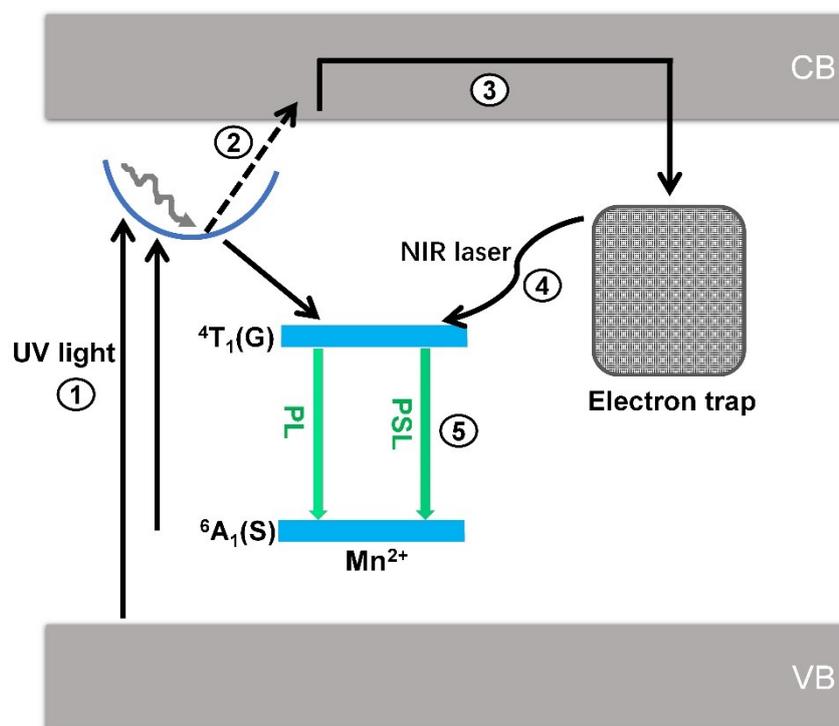


Fig. S6 The proposed PL, PersL and PSL schematic diagram for green and red emissions of Mn²⁺/Mn⁴⁺ in the Zn₂GeO₄-NaLiGe₄O₉:Mn phosphors. Therein, ① UV light excitation, ② energy (or electron) transfer processes, ③ trapping, ④ release and ⑤ recombination. The straight-line arrows and curved line arrows represent optical transitions and energy (or electron) transfer processes, respectively.