Supporting Information

Energy Transfer and Charge Compensation of $Ba_2ZnGe_2O_7:Tb^{3+}$, Eu^{3+} Phosphors for White LEDs

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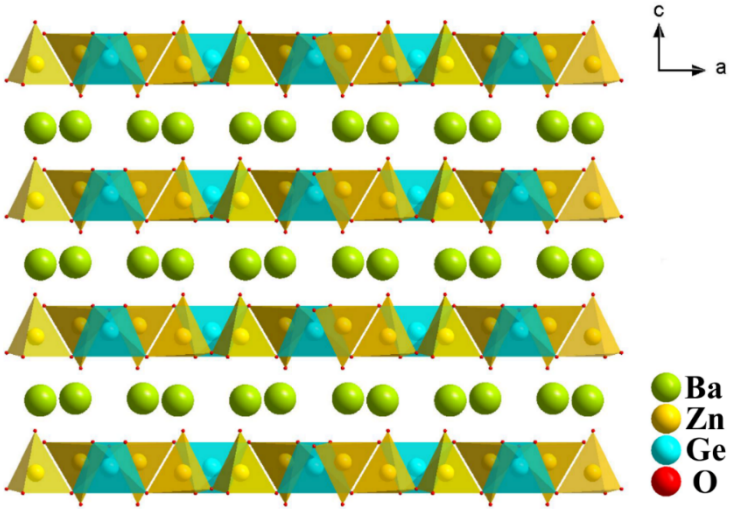

Figure S1 Schematic illustration of the crystal structure of $Ba_2ZnGe_2O_7$ view along axis *b*.

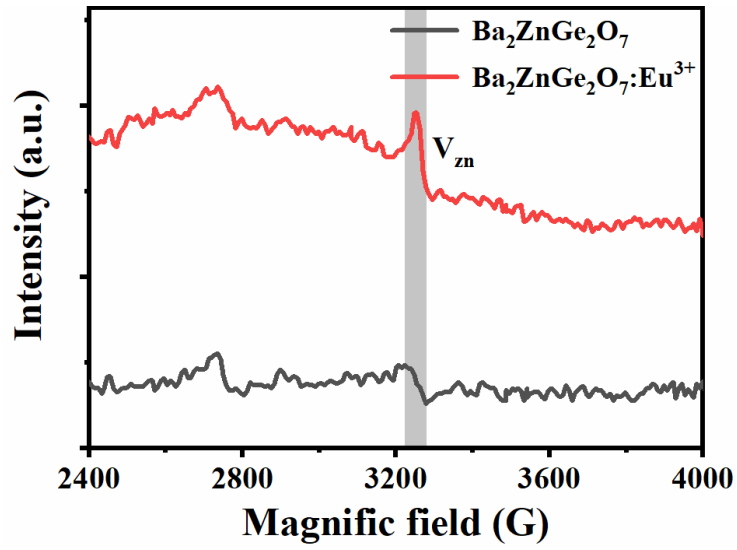

Figure S2 EPR spectra for $Ba_2ZnGe_2O_7$ and $Ba_2ZnGe_2O_7:Eu^{3+}$.

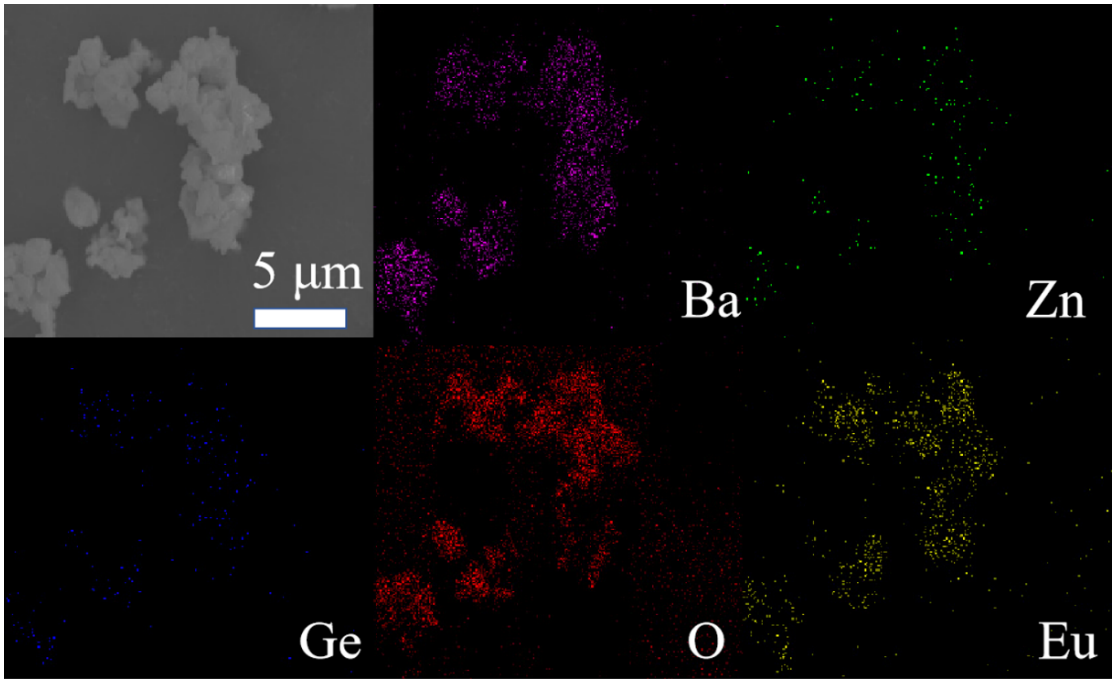

Figure S3 SEM image and elemental mapping images of $Ba_2ZnGe_2O_7$:0.4Eu^{3+} phosphors.

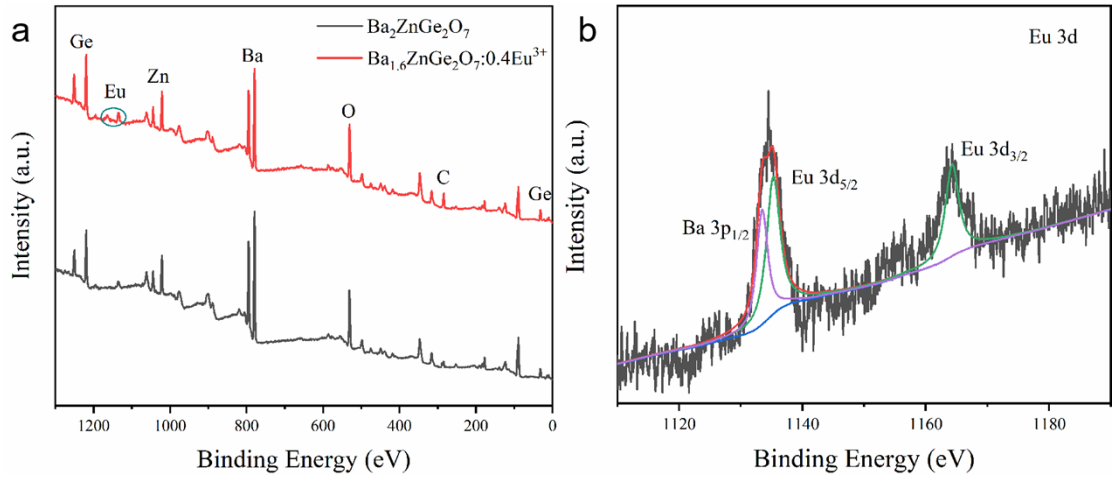

Figure S4 (a) XPS survey spectra of $Ba_2ZnGe_2O_7$ and $Ba_2ZnGe_2O_7$:0.4Eu^{3+}; (b) high-resolution XPS spectrum of Eu in $Ba_2ZnGe_2O_7$:0.4Eu^{3+}.

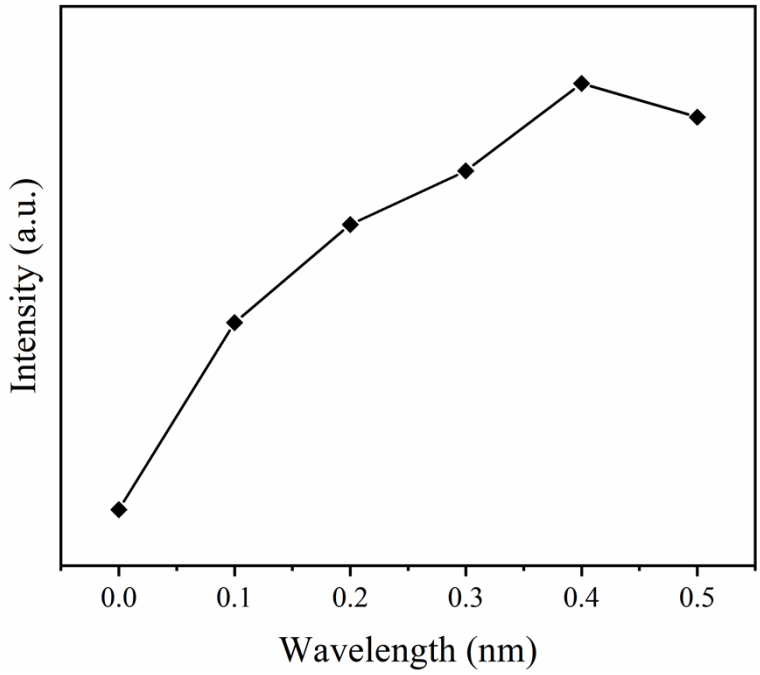

Figure S5 Emission peak intensity of $Ba_{2-x}ZnGe_2O_7:xEu^{3+}$ (x=0-0.5) phosphors.

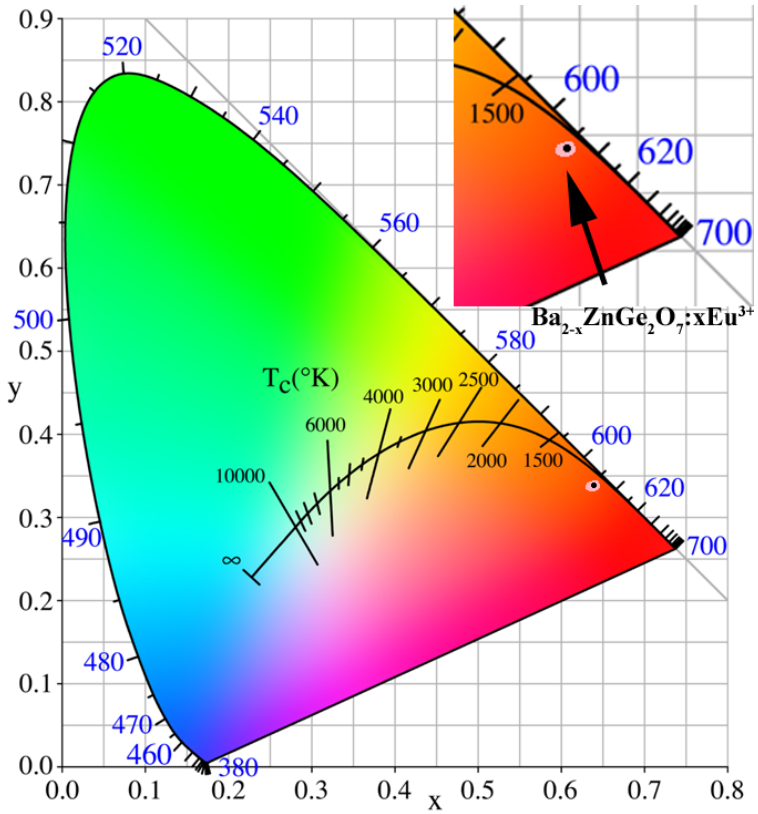

Figure S6 CIE chromaticity coordinate diagram of $Ba_{2-x}ZnGe_2O_7:xEu^{3+}$ (x=0-0.5) phosphors.

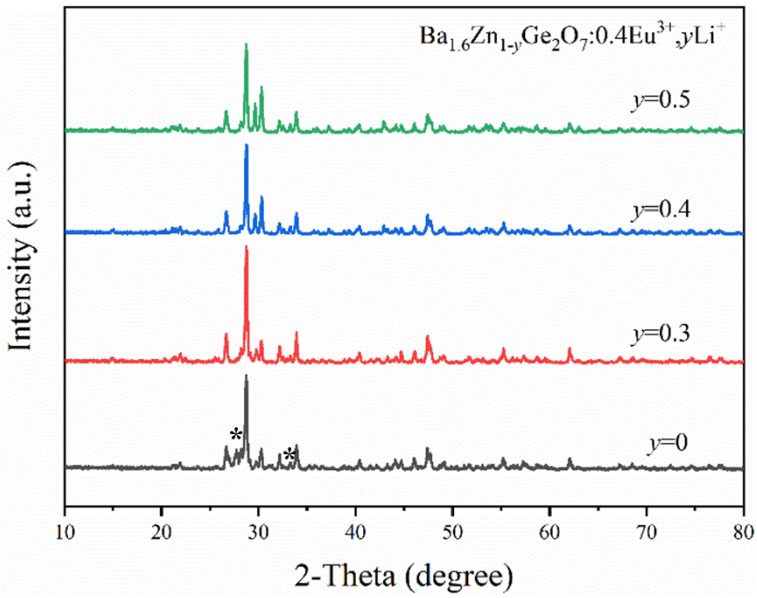

Figure S7 XRD patterns of $Ba_2Zn_{1-y}Ge_2O_7:0.4Eu^{3+}$, yLi^+ (y= 0-0.5) phosphors.

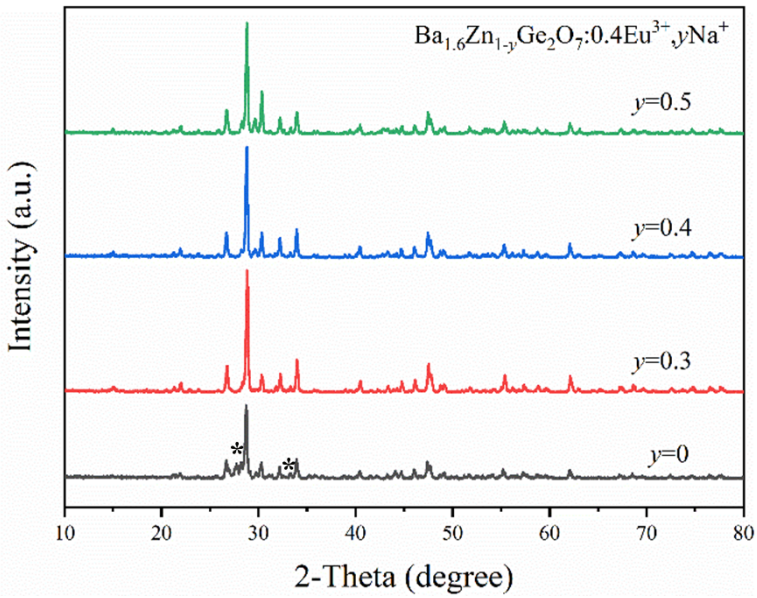

Figure S8 XRD patterns of $Ba_2Zn_{1-y}Ge_2O_7:0.4Eu^{3+}$, yNa^+ (y= 0-0.5) phosphors.

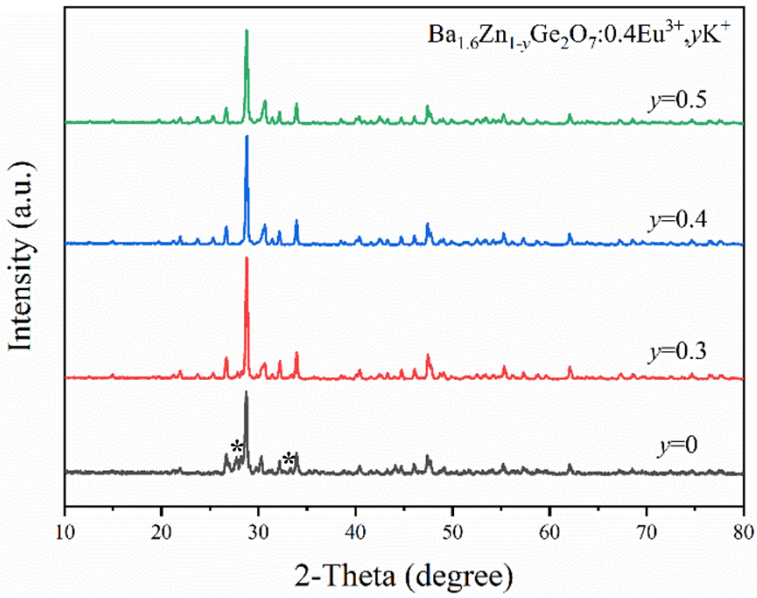

Figure S9 XRD patterns of $Ba_2Zn_{1-y}Ge_2O_7$:0.4Eu^{3+}, yK^+ (y= 0-0.5) phosphors.

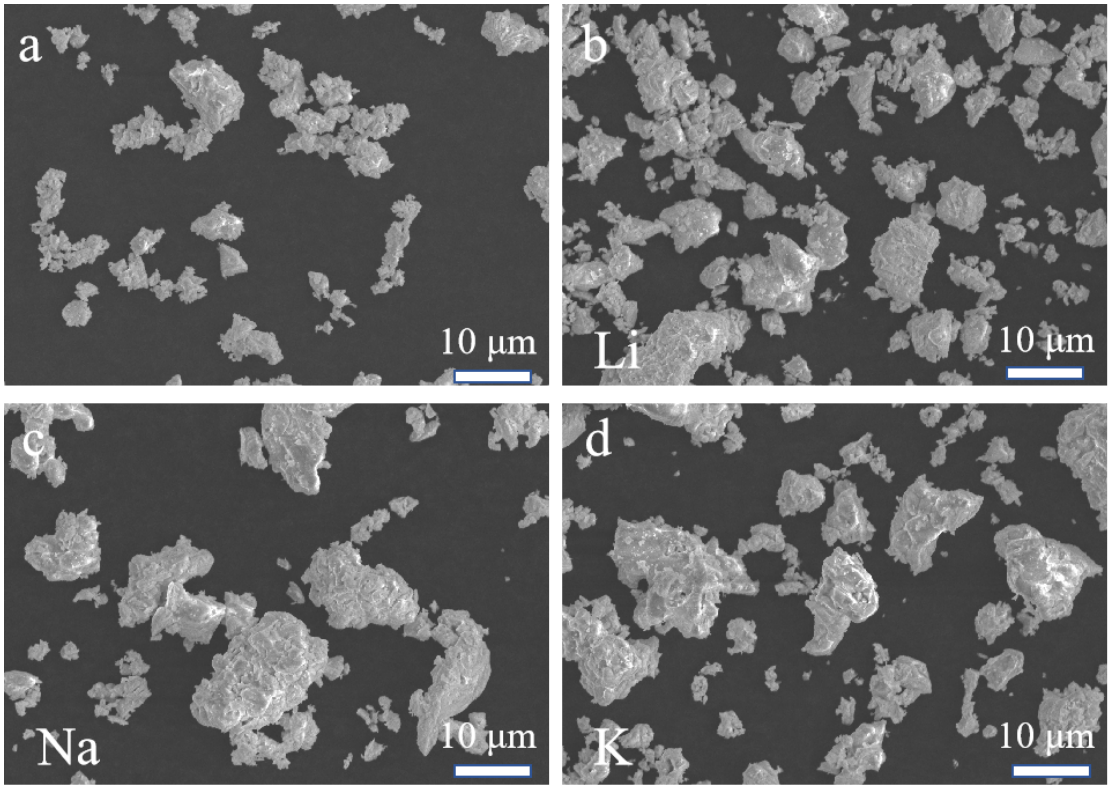

Figure S10 SEM image of (a) $Ba_2ZnGe_2O_7$:0.4Eu^{3+}, (b) $Ba_2Zn_{0.6}Ge_2O_7$:0.4Eu^{3+}, 0.4Li^+, (c) $Ba_2Zn_{0.6}Ge_2O_7$:0.4Eu^{3+}, 0.4Na^+, and (d) $Ba_2Zn_{0.6}Ge_2O_7$:0.4Eu^{3+}, 0.4K^+ phosphors.

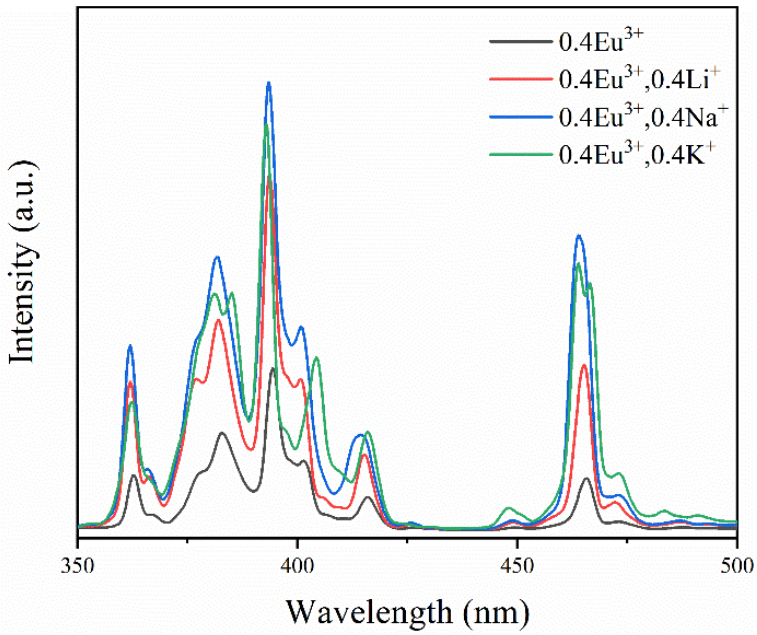

Figure S11 PLE spectra of $Ba_2Zn_{1-y}Ge_2O_7$:0.4Eu^{3+}, 0.4M^+ (M= Li^+, Na^+, K^+) phosphors.

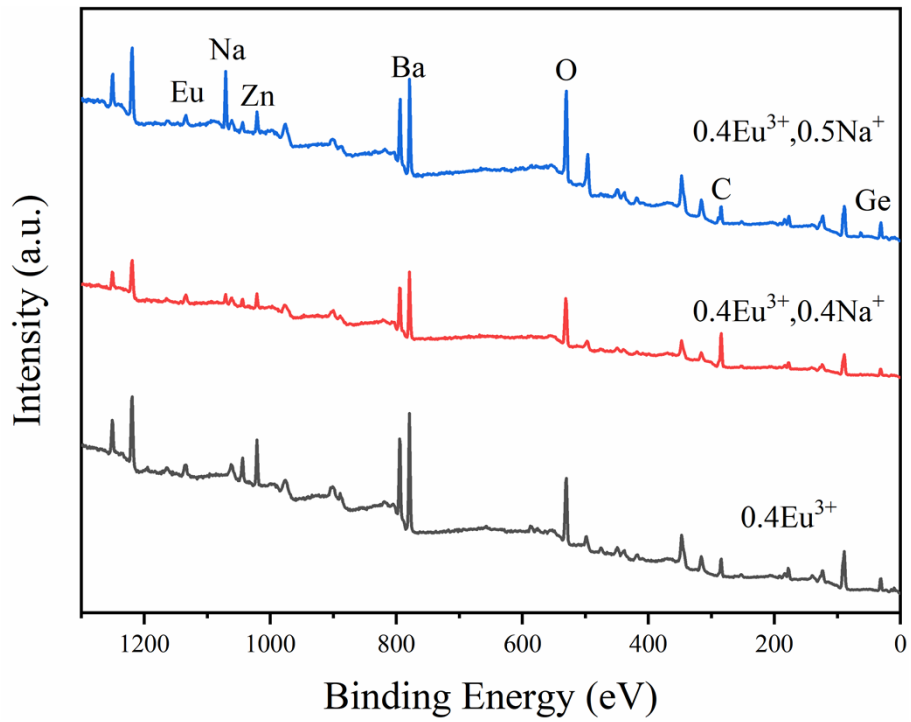

Figure S12 XPS survey spectra of $Ba_2Zn_{1-y}Ge_2O_7$:0.4Eu^{3+}, $y$$Na^+$ (y=0, 0.4, 0.5) phosphors.

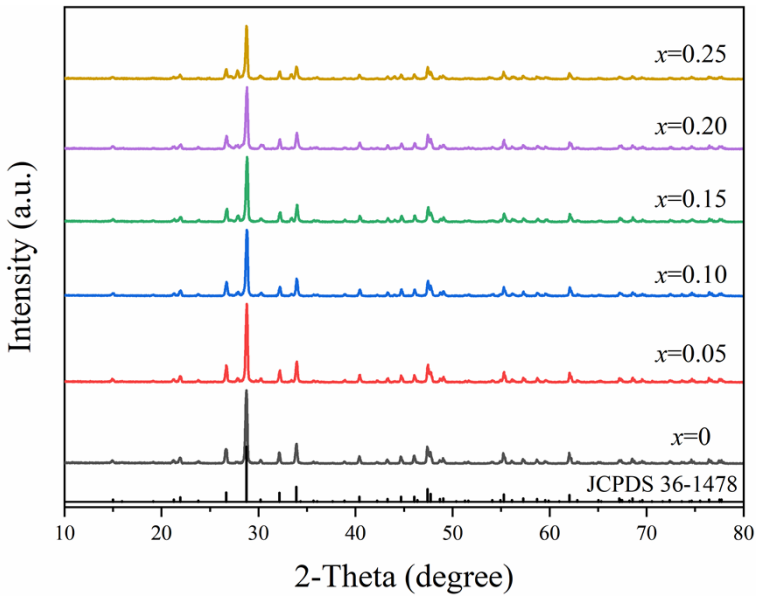

Figure S13 XRD pattern of $Ba_{2-x}ZnGe_2O_7$:xTb^{3+} (x=0-0.25) phosphor.

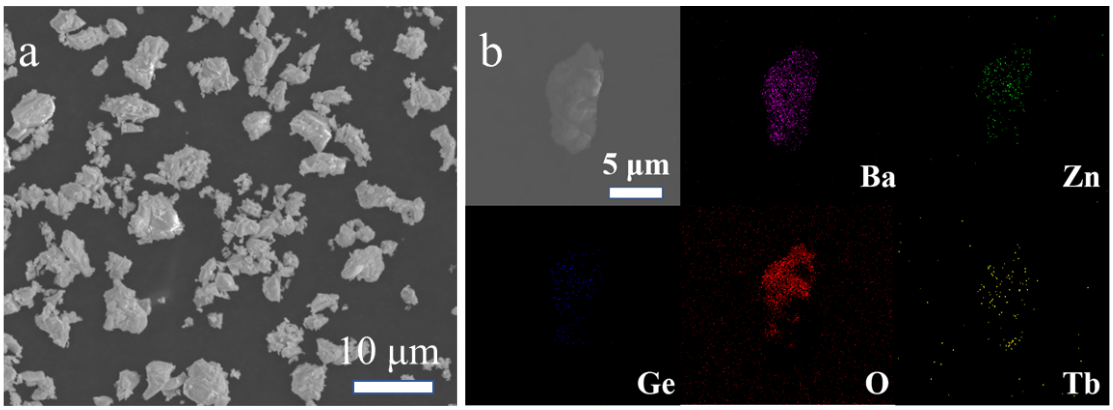

Figure S14 (a) SEM image and (b) EDS mapping image of $Ba_2ZnGe_2O_7$:$0.2Tb^{3+}$ phosphor.

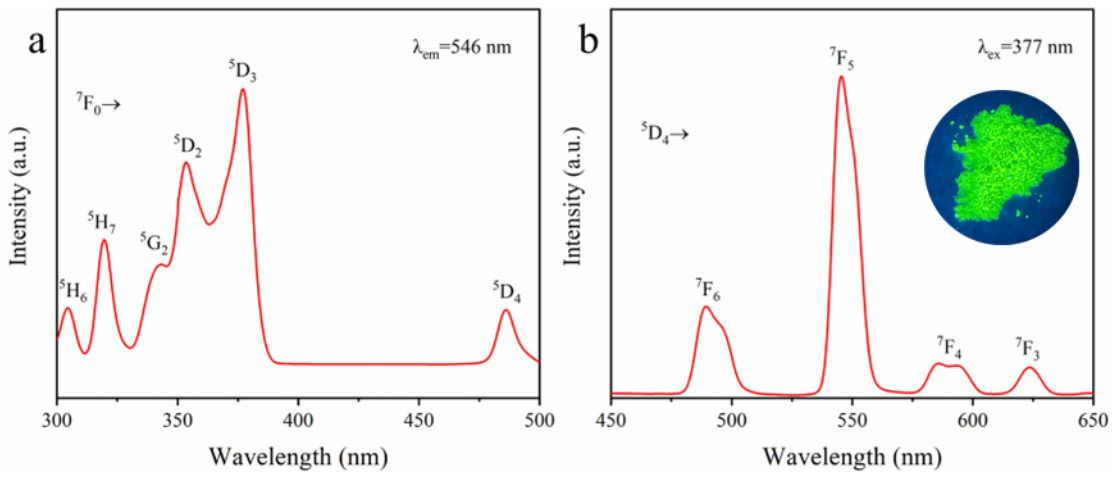

Figure S15 (a) PLE spectrum and (b) PL spectrum of $Ba_2ZnGe_2O_7$:Tb^{3+} phosphor.

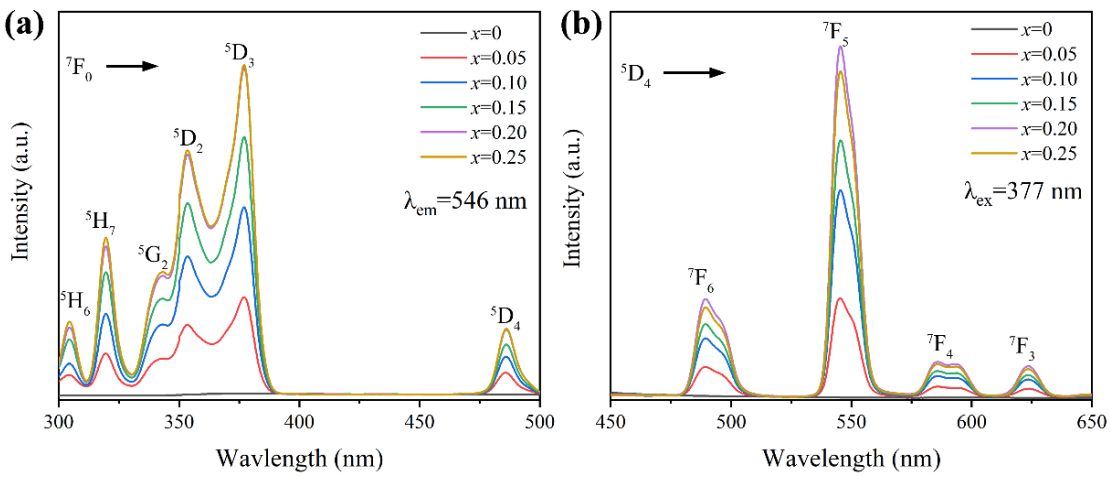

Figure S16 (a) PLE spectra and (b) PL spectra of $Ba_{2-x}ZnGe_2O_7$:xTb^{3+}(x=0-0.25) phosphors.

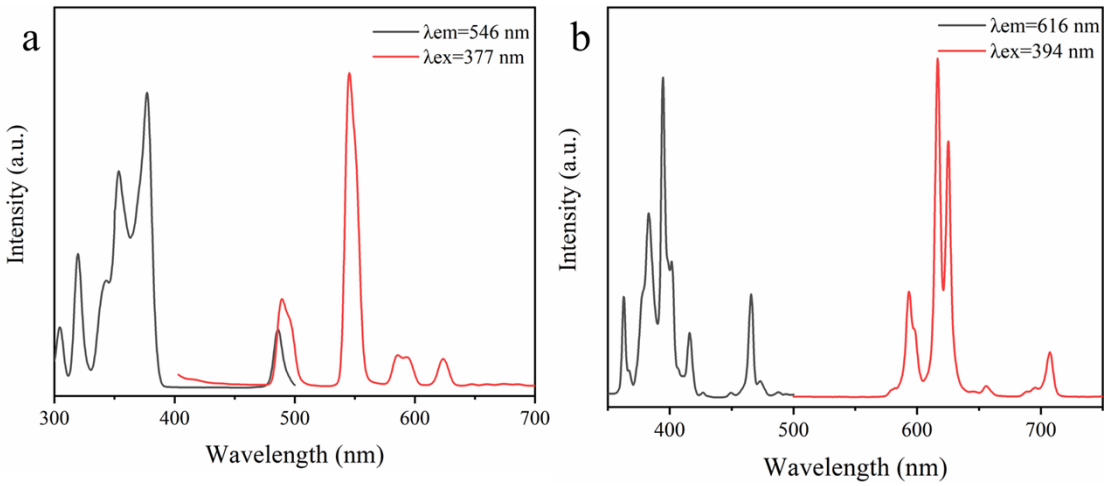

Figure S17 PLE spectrum and PL spectrum of (a)$Ba_2ZnGe_2O_7$:Tb^{3+}, (b) $Ba_2ZnGe_2O_7$:Eu^{3+} phosphors.

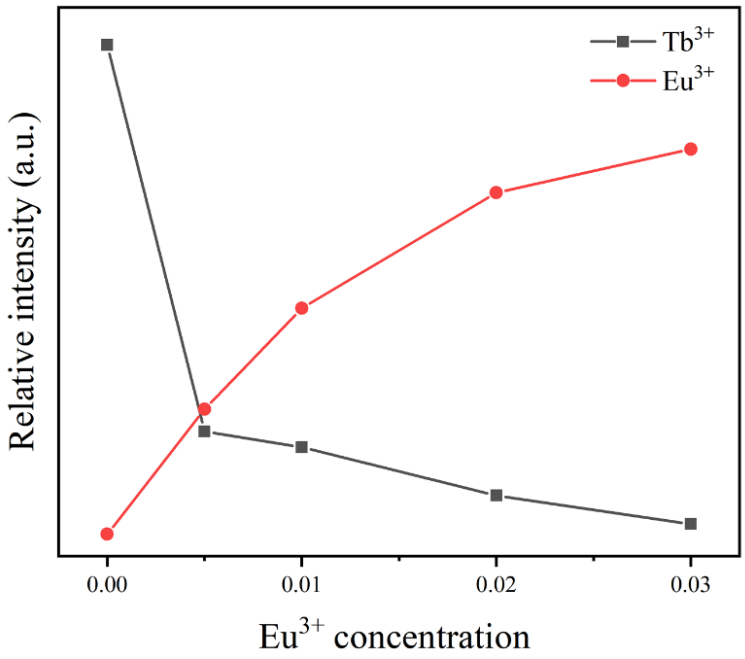

Figure S18 Relative intensity changes of Tb^{3+} and Eu^{3+} emission in $Ba_2ZnGe_2O_7$:0.2Tb^{3+}, *y*Eu^{3+} phosphor.

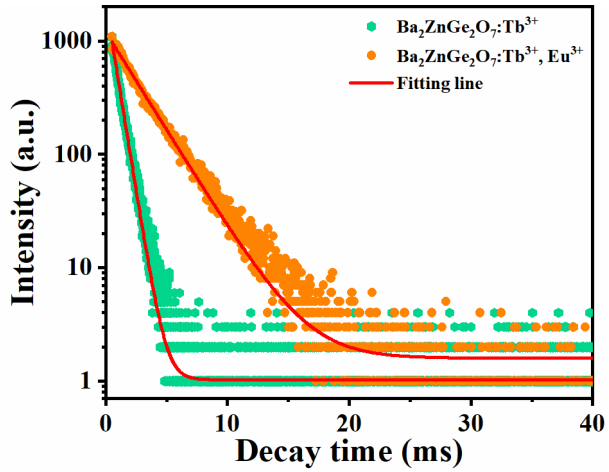

Figure S19 PL decay curves of $Ba_2ZnGe_2O_7$:0.2Tb^{3+} and $Ba_2ZnGe_2O_7$:0.2Tb^{3+}, 0.4Eu^{3+} phosphors.