# Supporting Information

## $ZnAl_2O_4:Eu^{3+}$ Nanoparticle Phosphors Co-doped with $Li^+$ for Red Light-Emitting Diodes

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**Table S1**: Variation in FWHM of (311) XRD peak and the corresponding change in crystallite size with different doping concentration of $Li^{+}$ co-activator in the $ZnAl_2O_4$:3% $Eu^{3+}$ nanophosphors.

| Sample name | FWHM of (121) peak (degree) | Crystallite size from Scherrer formula (nm) |
|---|---|---|
| $ZnAl_2O_4$:3% $Eu^{3+}$ | 0.251 | 33.39 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 0.5% $Li^{+}$ | 0.246 | 34.00 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 1% $Li^{+}$ | 0.205 | 40.87 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 1.5% $Li^{+}$ | 0.187 | 44.81 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 2% $Li^{+}$ | 0.143 | 58.61 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 2.5% $Li^{+}$ | 0.168 | 49.88 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 3% $Li^{+}$ | 0.228 | 36.74 |

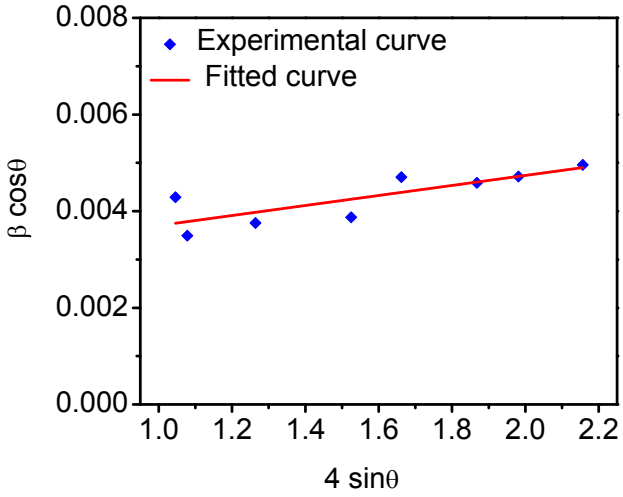


**Figure S1.** Williamson-Hall Plot of $ZnAl_2O_4$:3% $Eu^{3+}$, 2% $Li^{+}$ nanophosphors.

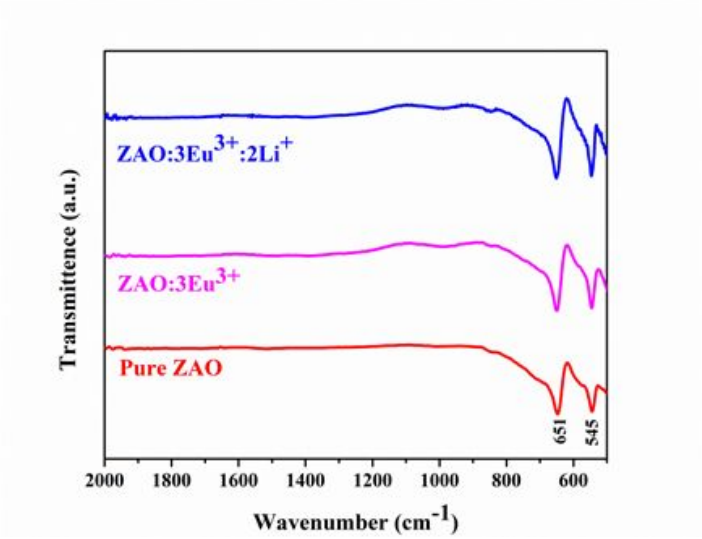


**Figure S2.** FTIR spectra of pure $ZnAl_2O_4$, $ZnAl_2O_4$:3% $Eu^{3+}$ and $ZnAl_2O_4$:3% $Eu^{3+}$, 2% $Li^+$

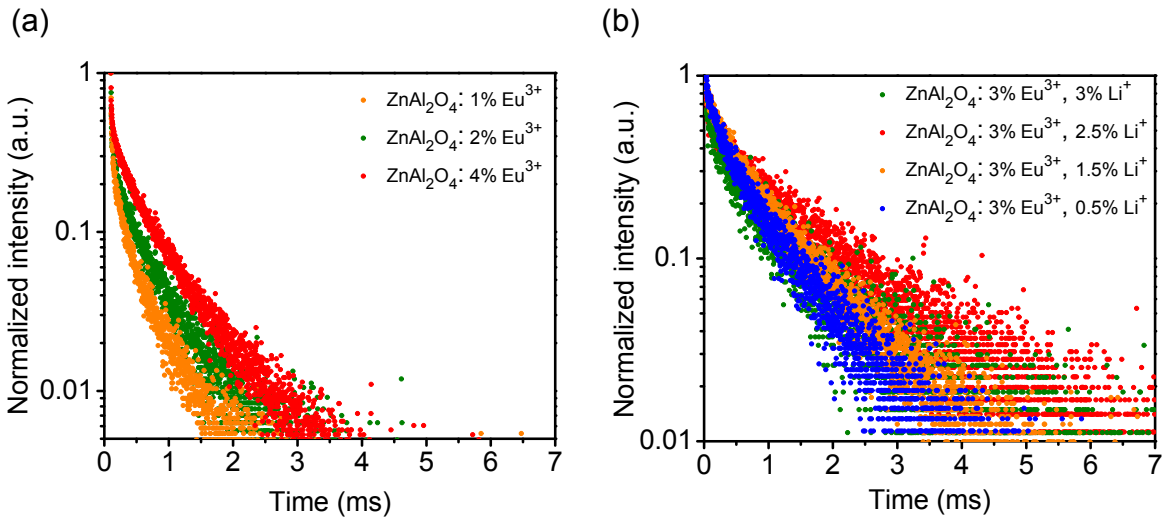


**Figure S3.** Decay curves of (a) $ZnAl_2O_4$: $Eu^{3+}$ and (b) $ZnAl_2O_4$:$Eu^{3+}$, $Li^+$ nanophosphors for various concentration of $Eu^{3+}$ and $Li^+$.

**Table S2.** Fitting parameters for the decay curves of $ZnAl_2O_4$: $Eu^{3+}$ and $ZnAl_2O_4$:$Eu^{3+}$, $Li^+$ nanophosphors.

| Sample name | $\tau_1$ (ms) | $\tau_2$ (ms) | $A_1$ | $A_2$ | $\tau_{avg}$ (ms) |
|---|---|---|---|---|---|
| $ZnAl_2O_4$:1% $Eu^{3+}$ | 0.101 | 0.457 | 404.393 | 222.912 | 0.355 |
| $ZnAl_2O_4$:2% $Eu^{3+}$ | 0.118 | 0.610 | 525.827 | 191.575 | 0.439 |
| $ZnAl_2O_4$:4% $Eu^{3+}$ | 0.215 | 0.605 | 688.266 | 525.374 | 0.481 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 0.5% $Li^+$ | 0.103 | 0.818 | 334.672 | 279.988 | 0.724 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 1.5% $Li^+$ | 0.228 | 1.06 | 328.153 | 305.126 | 0.903 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 2.5% $Li^+$ | 0.125 | 1.032 | 105.445 | 98.891 | 0.928 |
| $ZnAl_2O_4$:3% $Eu^{3+}$, 3% $Li^+$ | 0.268 | 1.08 | 339.172 | 359.806 | 0.926 |

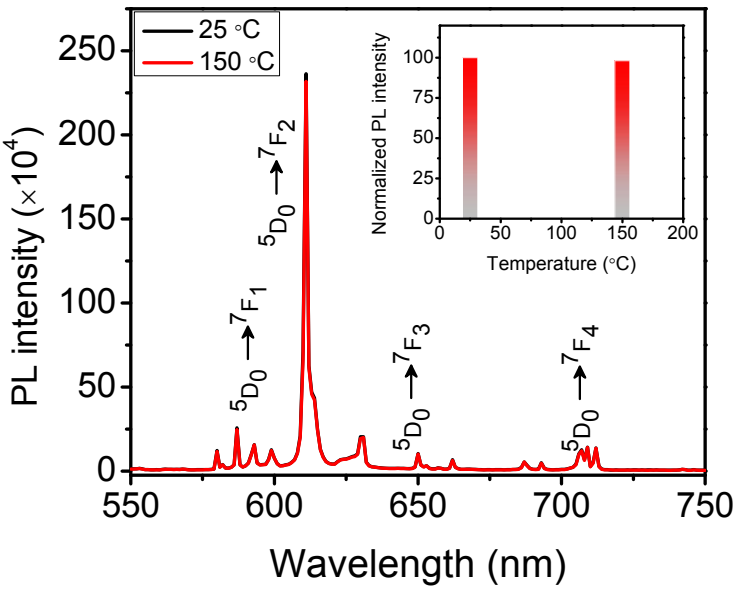


**Figure S4.** Comparison of PL intensity of commercial $Y_2O_3$:0.08 $Eu^{3+}$ phosphor at room temperature and at 150 °C.