

## Supplementary materials

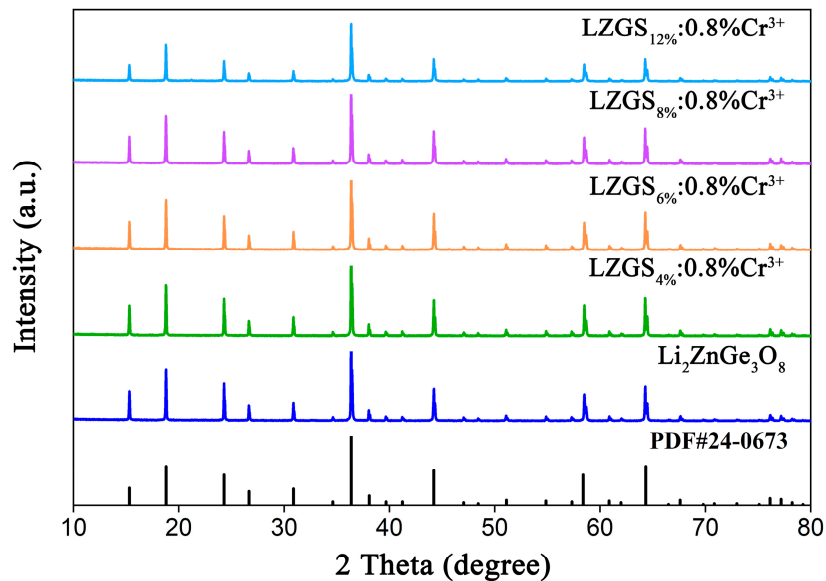


Figure S1. The XRD of LZGS<sub>x</sub>O:0.8%Cr<sup>3+</sup> ( $x = 0-12\%$ ).

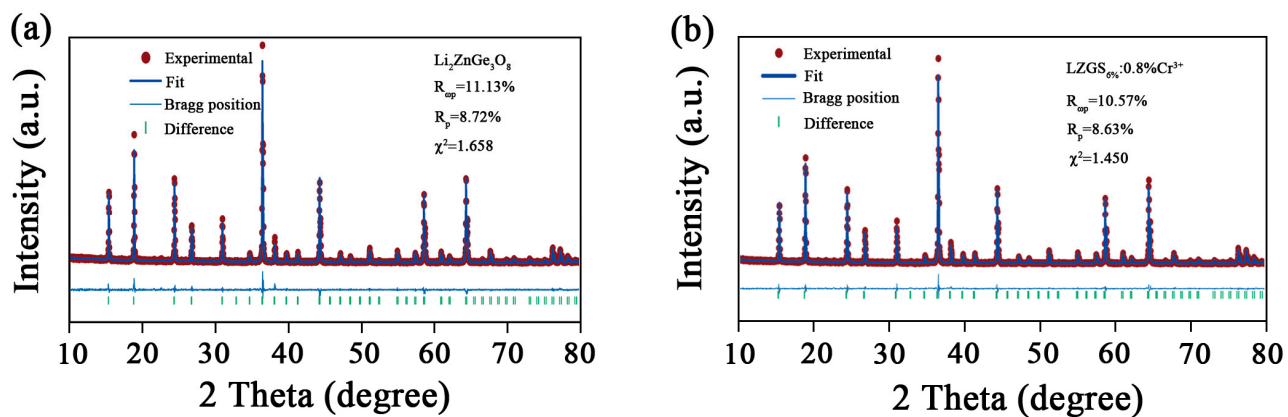
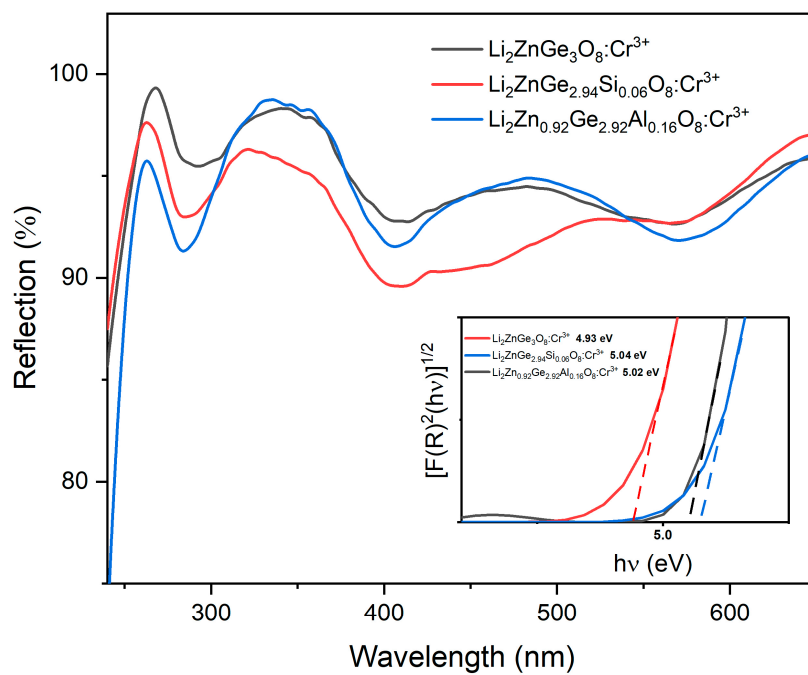
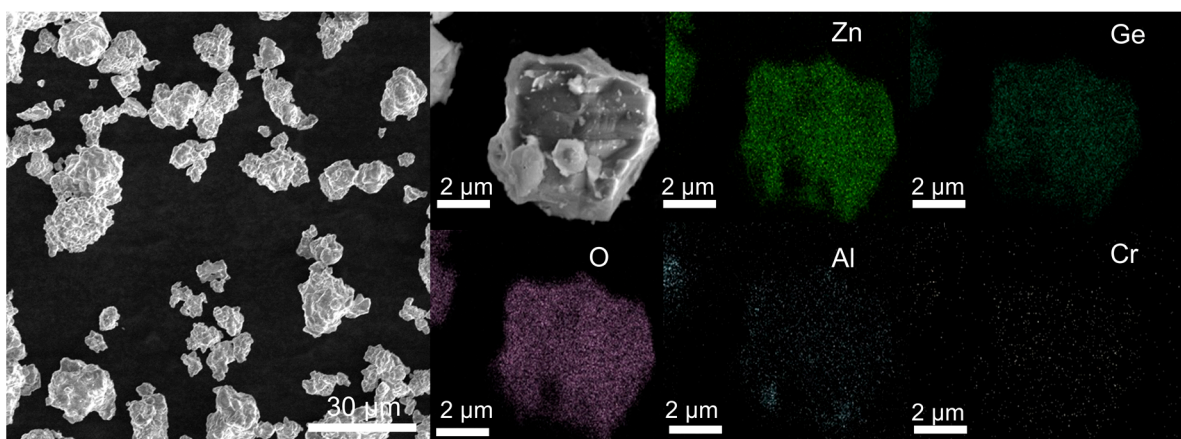


Figure S2. The Rietveld refinement results of (a) LZGO and (b) LZGS<sub>6%</sub>O:0.8%Cr<sup>3+</sup>.



**Figure S3.** The DRs of LZGA: Cr, LZGS: Cr and LZGO: Cr. Inset: the bandgap width of LZGA: Cr, LZGS: Cr and LZGO: Cr.



**Figure S4.** Elemental mapping analysis and SEM of LZGAO:0.8%Cr<sup>3+</sup>.

**Table S1.** Refined crystallographic data of LZGS: Cr (y = 0-12%)

<b>y</b>	<b>0%</b>	<b>2%</b>	<b>6%</b>	<b>8%</b>	<b>12%</b>
Crystal System	Cubic				
a(Å)=b(Å)=c(Å)	P4332 (Allows Chirality)				
Cell Volume (Å <sup>3</sup> )	550.414	550.300	550.259	550.287	550.317
R <sub>wp</sub> (%)	12.6	12.2	10.57	13.2	14.5
R <sub>p</sub> (%)	9.0	8.69	8.63	9.38	9.96
$\chi^2$	1.311	1.236	1.450	1.419	1.702

**Table S2.** Refined crystallographic data of LZGA: Cr (y = 0-12%)

<b>z</b>	<b>0%</b>	<b>0.5%</b>	<b>2%</b>	<b>6%</b>	<b>10%</b>
Crystal System	Cubic				
a(Å)=b(Å)=c(Å)	P4332 (Allows Chirality)				
Cell Volume (Å <sup>3</sup> )	550.414	550.403	550.327	550.330	550.351
R <sub>wp</sub> (%)	12.6	11.9	12.0	12.4	12.7
R <sub>p</sub> (%)	9.0	8.64	8.73	8.69	9.11
$\chi^2$	1.311	1.286	1.297	1.381	1.455