

Supporting Information

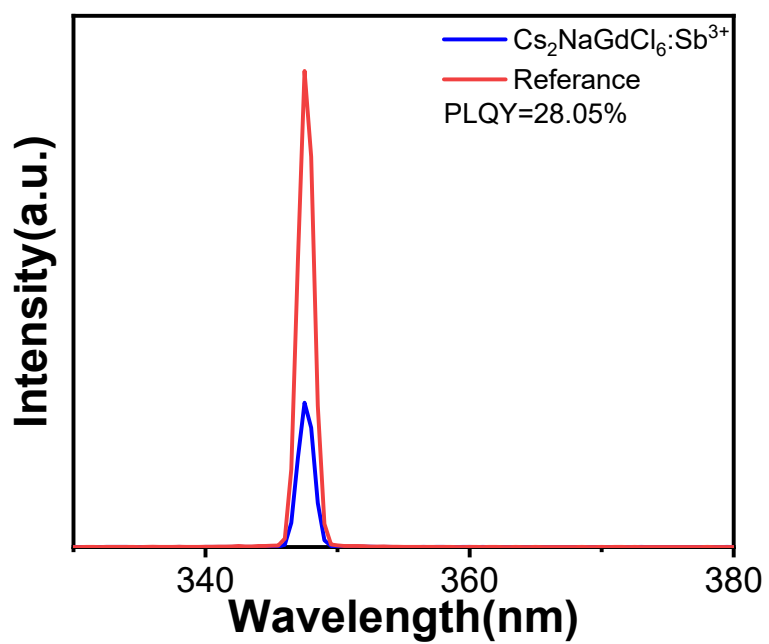


Figure S1. PLQY of $\text{Cs}_2\text{NaGdCl}_6:4\%\text{Sb}^{3+}$.

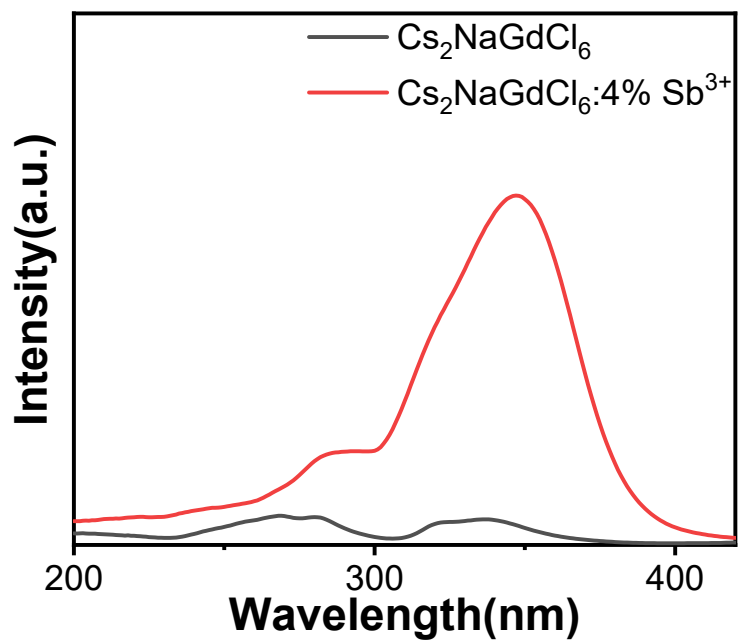


Figure S2. PLE spectra of Cs₂NaGdCl₆ doped Sb³⁺ and undoped Sb³⁺ under 445 nm excitation.

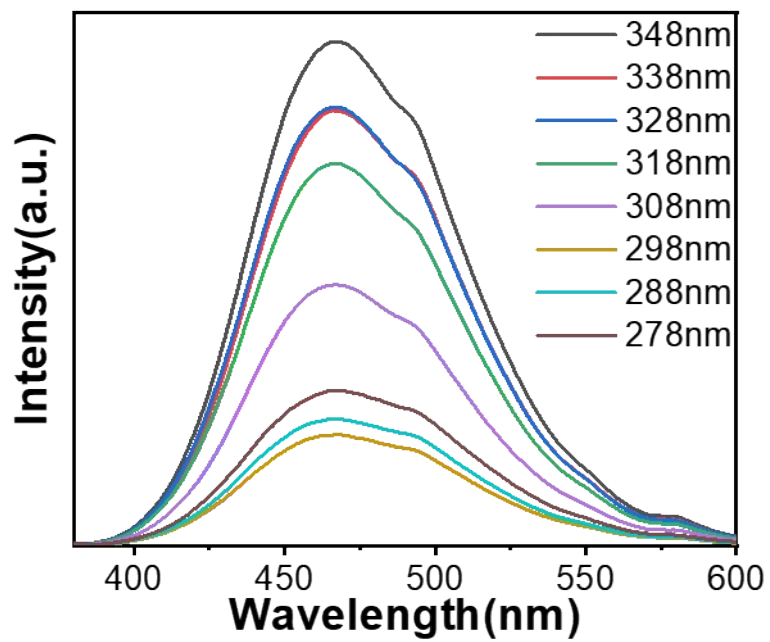


Figure S3. The emission spectra of Cs₂NaGdCl₆: 4%Sb³⁺ at different excitation wavelengths.

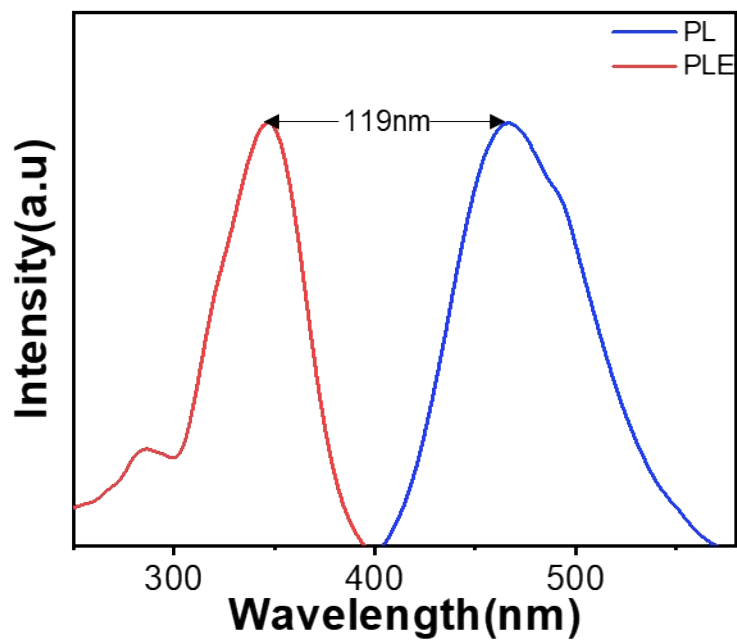


Figure S4. PL and PLE spectra of Cs₂NaGdCl₆: 4%Sb³⁺.

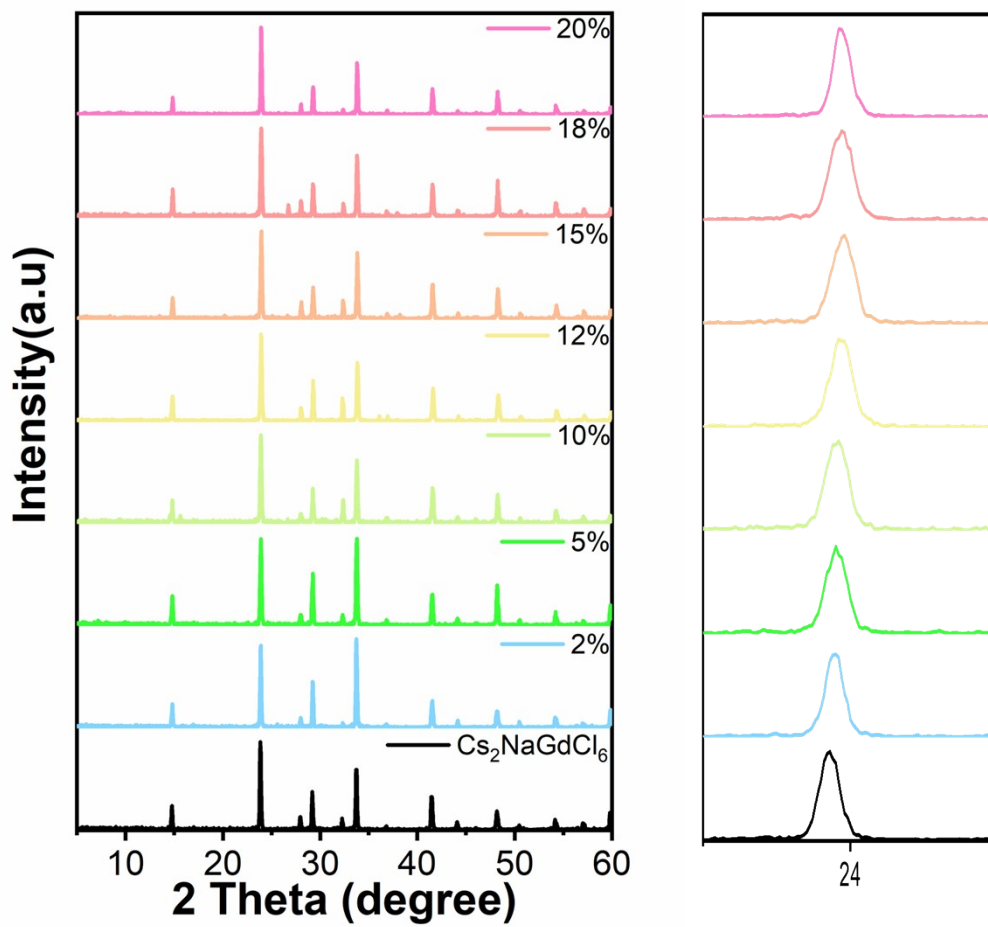


Figure S5. shows the XRD plots of $\text{Cs}_2\text{NaGdCl}_6$ doped with different Tb^{3+} concentrations as well as the strongest XRD peaks of the magnified.

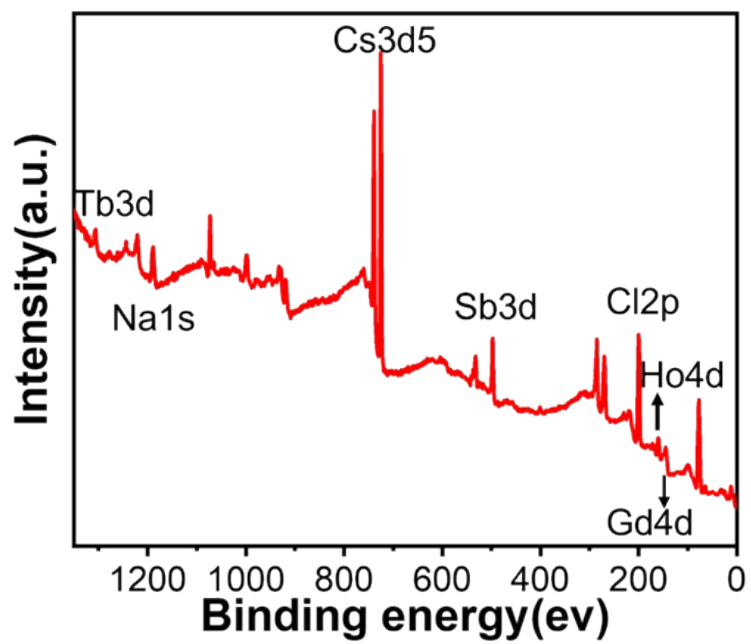


Figure S6. XPS spectra of Cs₂NaGdCl₆: 4%Sb³⁺ 15% Tb³⁺.

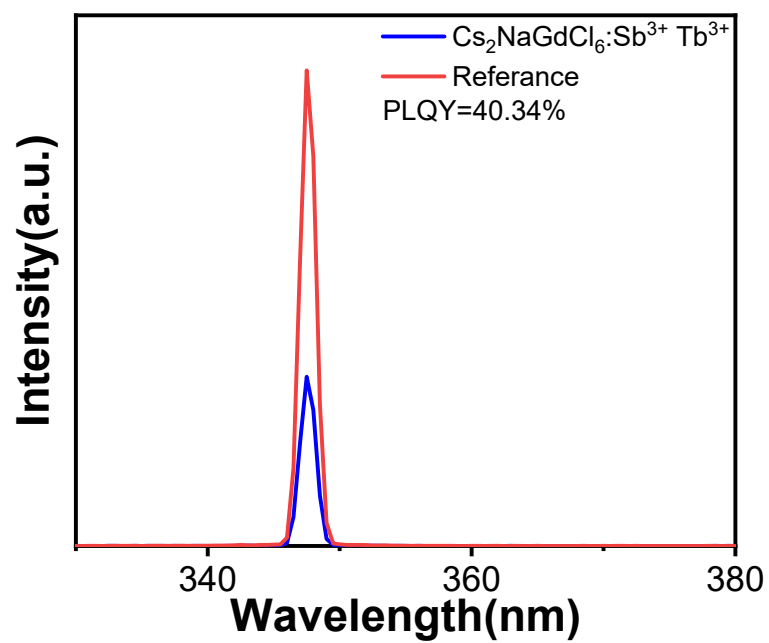


Figure S7. PLQY of $\text{Cs}_2\text{NaGdCl}_6: 4\%\text{Sb}^{3+} 15\%\text{Tb}^{3+}$.

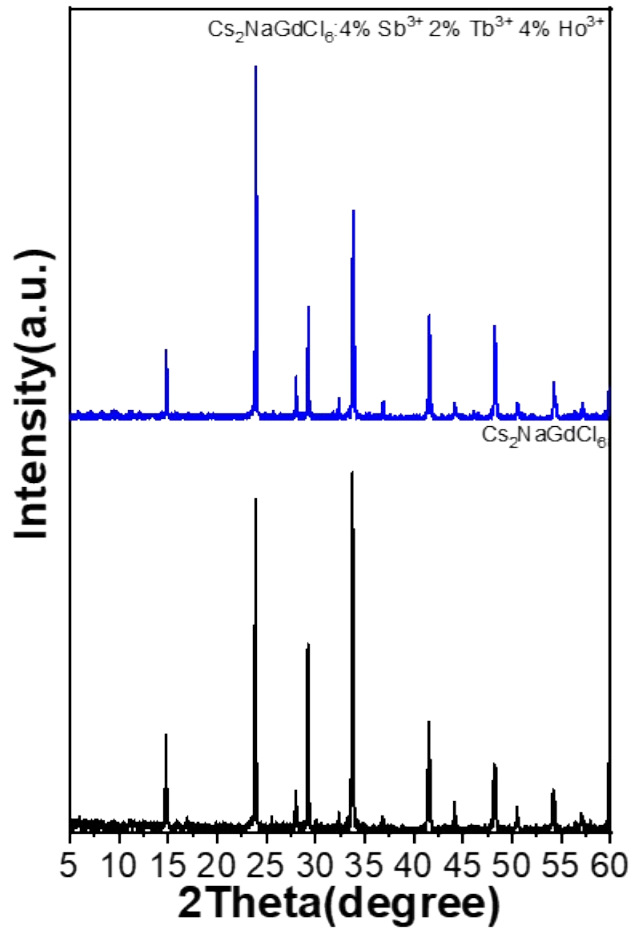


Figure S8. XRD comparison of $\text{Cs}_2\text{NaGdCl}_6: 4\% \text{Sb}^{3+} 2\% \text{Tb}^{3+} 4\% \text{Ho}^{3+}$ and $\text{Cs}_2\text{NaGdCl}_6$.

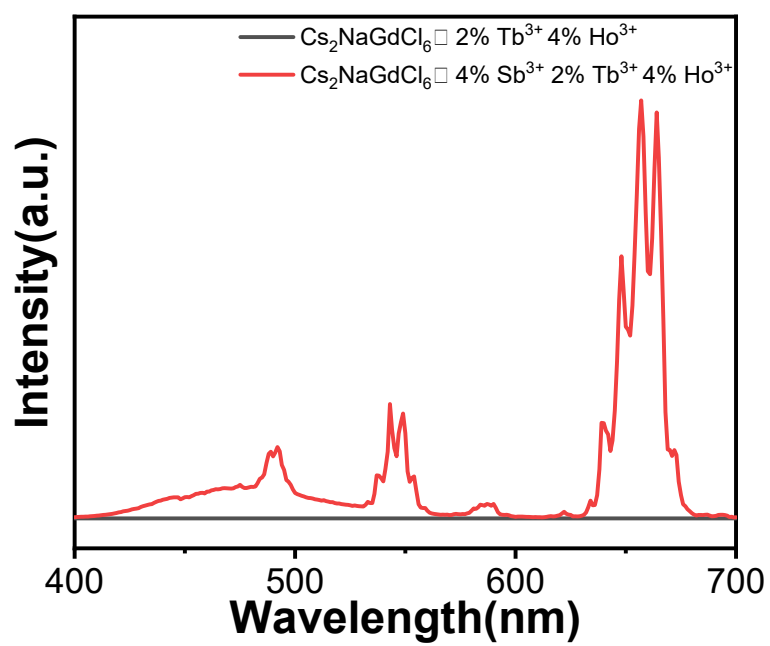


Figure S9. The emission spectra of Cs₂NaGdCl₆: 2%Tb³⁺ 4%Ho³⁺ doped Sb³⁺ and undoped Sb³⁺ under 365 nm excitation.

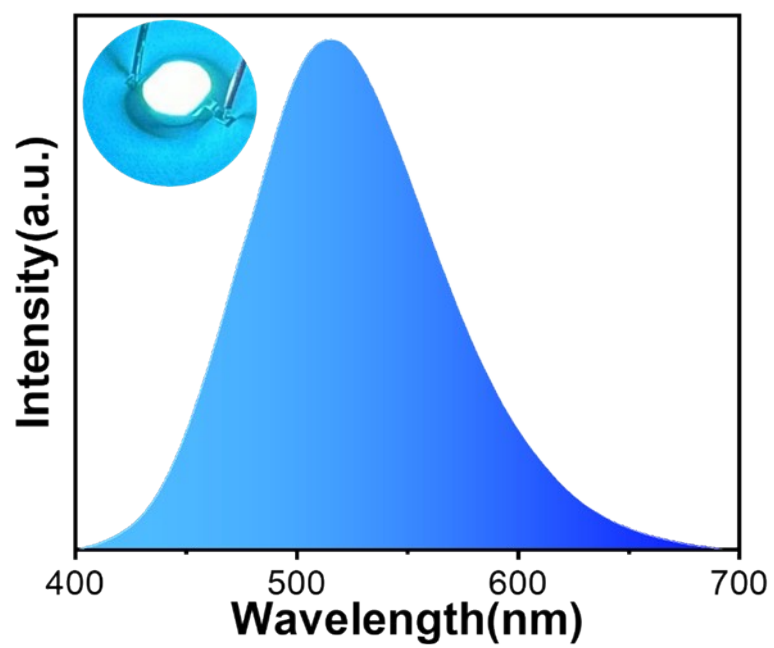


Figure S10. Electroluminescence spectra of Cs₂NaGdCl₆: 4%Sb³⁺.

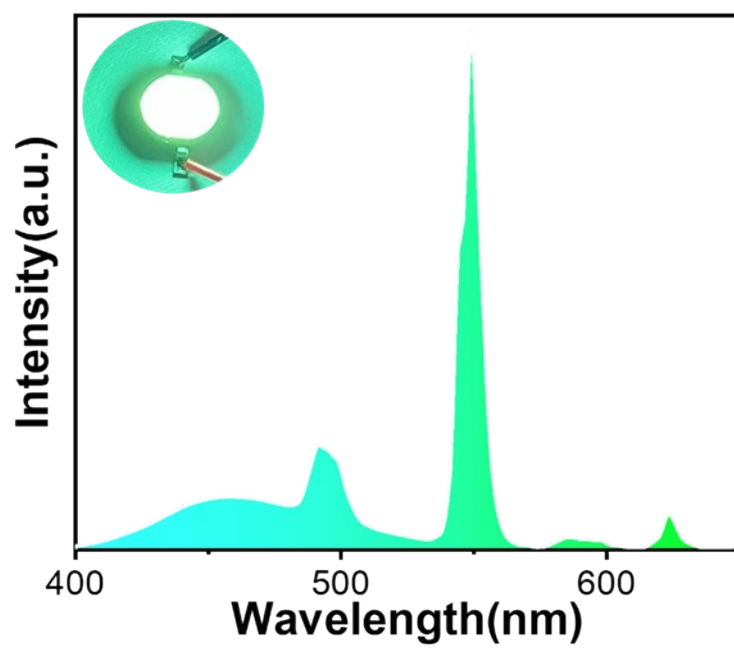


Figure S11. Electroluminescence spectra of Cs₂NaGdCl₆: 4%Sb³⁺ 15%Tb³⁺.

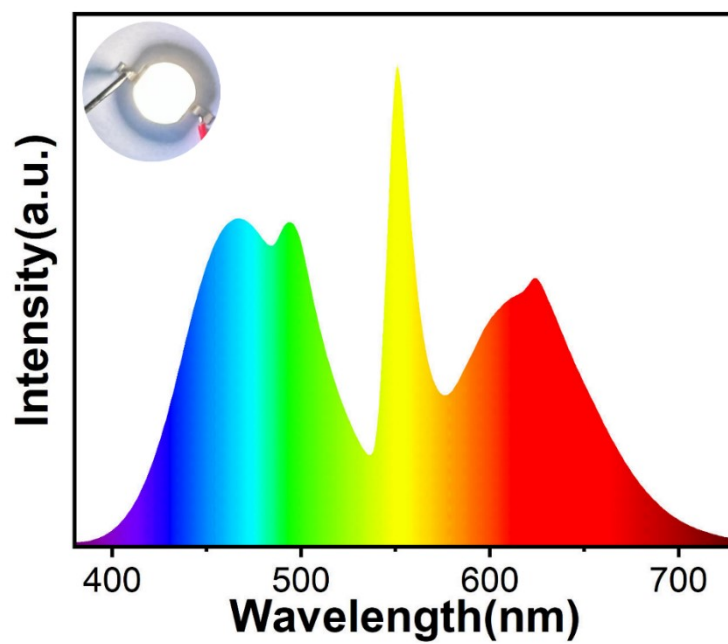


Figure S12. Electroluminescence spectra of $\text{Cs}_2\text{NaGdCl}_6: 4\%\text{Sb}^{3+}$, $\text{Cs}_2\text{NaGdCl}_6: 4\%\text{Sb}^{3+} 15\%\text{Tb}^{3+}$ and commercial red phosphors mixed into white phosphors.

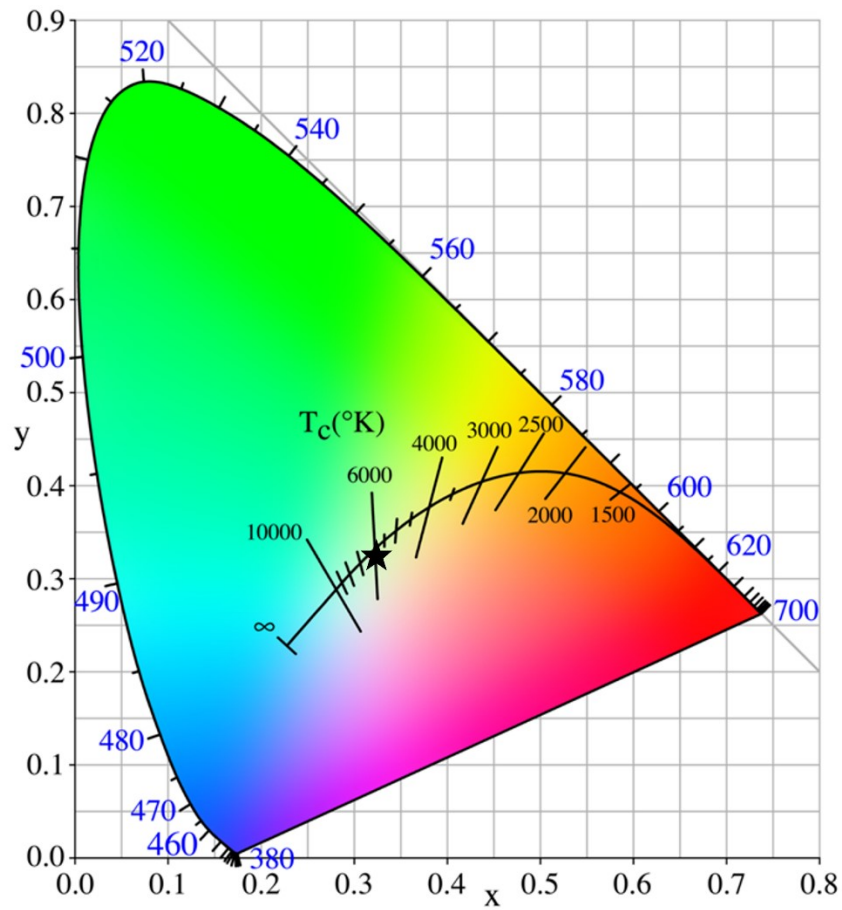


Figure S13. The CIE coordinates of $\text{Cs}_2\text{NaGdCl}_6: 4\%\text{Sb}^{3+}$, $\text{Cs}_2\text{NaGdCl}_6: 4\%\text{Sb}^{3+}$ $15\%\text{Tb}^{3+}$ and commercial red phosphors mixed into white phosphors.

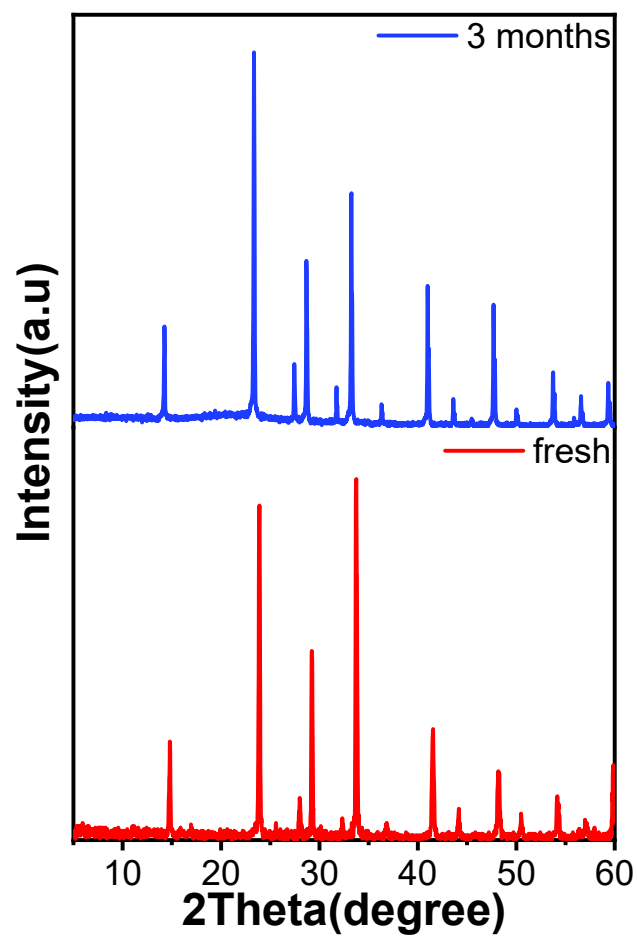


Figure S14. Comparison of initial XRD of $\text{Cs}_2\text{NaGdCl}_6:4\%\text{Sb}^{3+} 2\%\text{Tb}^{3+} 4\%\text{Ho}^{3+}$ and XRD after three months.

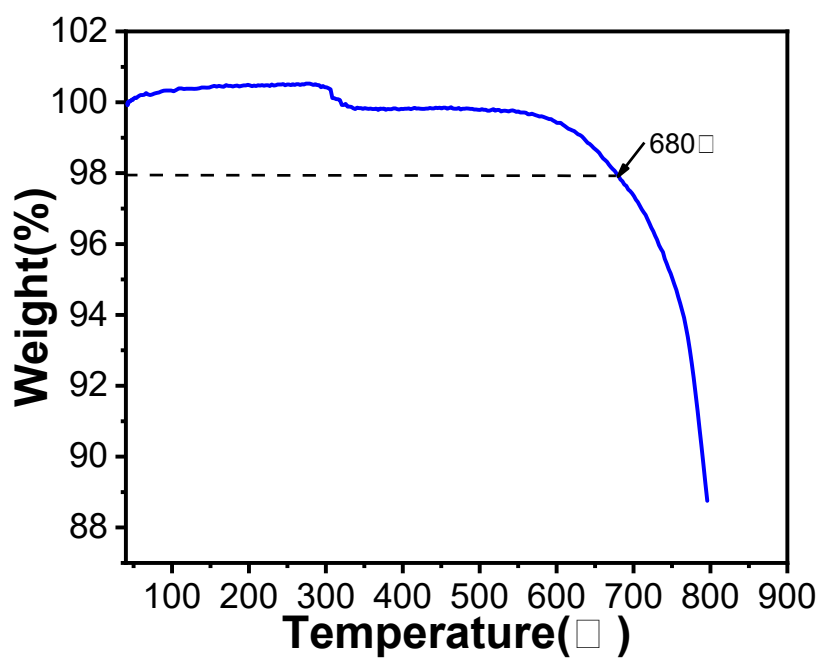


Figure S15. The thermogravimetric curve of $\text{Cs}_2\text{NaGdCl}_6:4\%\text{Sb}^{3+} 2\%\text{Tb}^{3+} 4\%\text{Ho}^{3+}$.

Table S1. Comparison of radius percentage difference (D_r) between the doped Sb ion and matrix cation in the $\text{Cs}_2\text{NaGdCl}_6$ crystal lattice.

Ion type	Ion	Ion radius/ \AA (CN=6)	$D_r/\%$
Doped ion	Sb^{3+}	0.760	--
Matrix cation	Gd^{3+}	0.938	18.0
Matrix cation	Na^+	1.020	25.0

Table S2. Comparison of radius percentage difference (D_r) between the doped Ho ion and matrix cation in the $\text{Cs}_2\text{NaGdCl}_6$ crystal lattice.

Ion type	Ion	Ion radius/ \AA (CN=6)	$D_r/\%$
Doped ion	Ho^{3+}	0.901	--
Matrix cation	Gd^{3+}	0.938	3.9
Matrix cation	Na^+	1.020	11.7

Table S3. Comparison of radius percentage difference (D_r) between the doped Tb ion and matrix cation in the $\text{Cs}_2\text{NaGdCl}_6$ crystal lattice.

Ion type	Ion	Ion radius/ \AA (CN=6)	$D_r/\%$
Doped ion	Tb^{3+}	0.923	--
Matrix cation	Gd^{3+}	0.938	1.6
Matrix cation	Na^+	1.020	9.5