Electronic Supplementary Information

Bright tunable luminescence of Sb^{3+} doping in zero-dimensional lead-free halide Cs_3ZnCl_5 perovskite crystals

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Table S1. The experimental mole ratio of Cs, Zn and Sb calculated from starting materials and the actual doping concentration in crystals Cs_3ZnCl_5:Sb measured in the sample by using inductive coupled plasma emission spectrometer (ICP).

Experimental mole ratio	Actual contents of Cs	Actual contents of Zn	Actual doping concentration of Sb
$Cs_3Zn_{0.985}Cl_5$:0.015Sb^{3+}	48.14%	13.60%	0.10%
$Cs_3Zn_{0.97}Cl_5$:0.03Sb^{3+}	46.37%	11.67%	0.52%
$Cs_3Zn_{0.95}Cl_5$:0.05Sb^{3+}	46.50%	10.55%	1.22%
$Cs_3Zn_{0.9}Cl_5$:0.1Sb^{3+}	46.08%	9.88%	2.25%
$Cs_3Zn_{0.7}Cl_5$:0.3Sb^{3+}	47.02%	8.88%	4.46%
$Cs_3Zn_{0.5}Cl_5$:0.5Sb^{3+}	45.84%	6.91%	5.67%

Table S2. The lattice parameters of Cs_3ZnCl_5 and Sb^{3+}-doped Cs_3ZnCl_5

Crystal	a (Å)	b (Å)	c (Å)	α (°)	β (°)	γ (°)
Cs_3ZnCl_5 (Exp.)	9.758	9.758	9.758	123.468	123.468	84.091
Cs_3ZnCl_5 (Comput.)	9.931	9.931	9.931	123.498	123.498	84.040
Sb-Cs_3ZnCl_5 (Comput.)	10.448	10.448	10.448	126.985	126.985	78.275

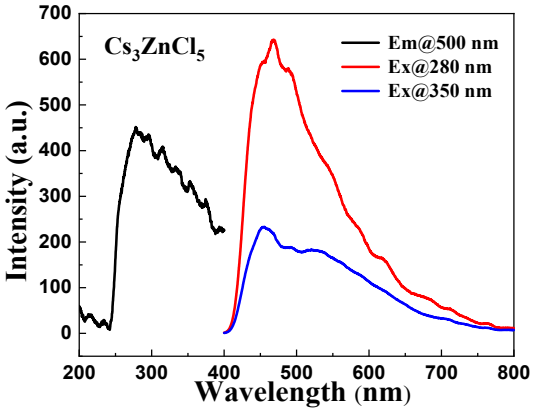

Figure S1. Excitation and emission spectra of undoped Cs_3ZnCl_5 measured at room temperature.

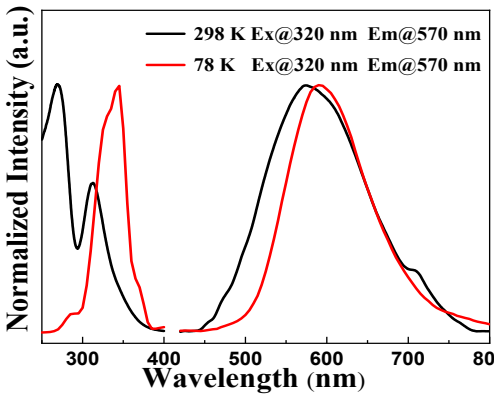

Figure S2. Excitation and emission spectra of $Cs_3Zn_{0.5}Cl_5$:0.5Sb^{3+} measured at 78 K and 298 K, respectively.

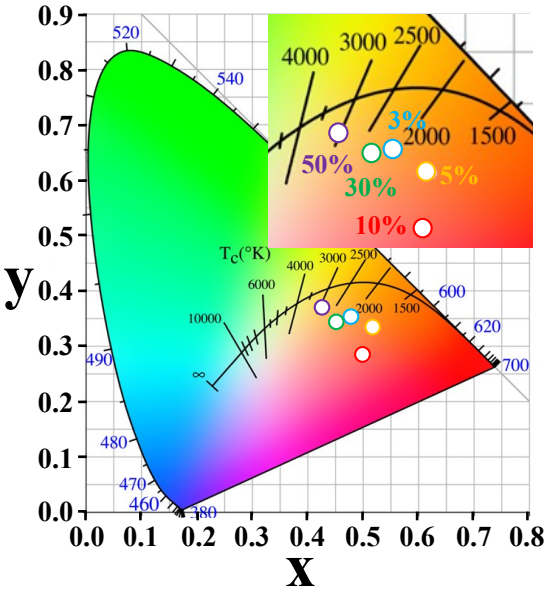

Figure S3. CIE chromaticity coordinates of $Cs3Zn_{1-x}Cl_5$:xSb^{3+} (x = 3-50 mol%) excited at 320 nm.

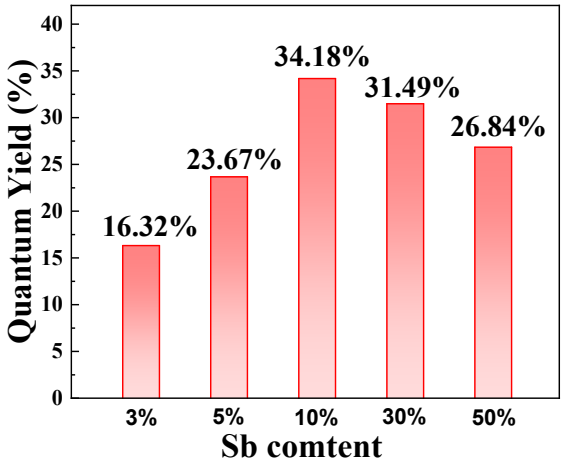

Figure S4. PLQY of $Cs3Zn_{1-x}Cl_5:xSb^{3+}$ (x = 3-50 mol%) excited at 320 nm.

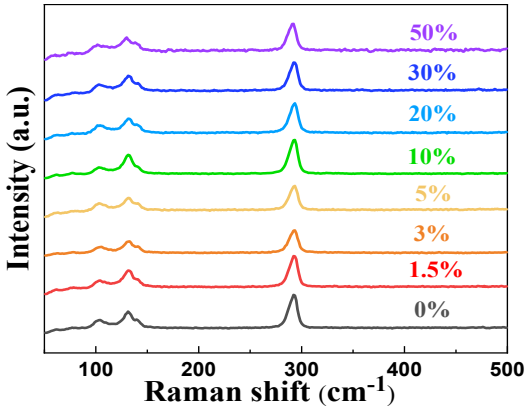

Figure S5. The Raman spectra of Cs_3ZnCl_5 and $Cs_3ZnCl_5:Sb^{3+}$ doped with different concentration of Sb^{3+} (performed using Horiba Jobin Yvon LabRAM HR80 equipped with a microscope and a CCD camera as the detector and a 532 nm diode laserat a power level of 100 mW as the excitation source).

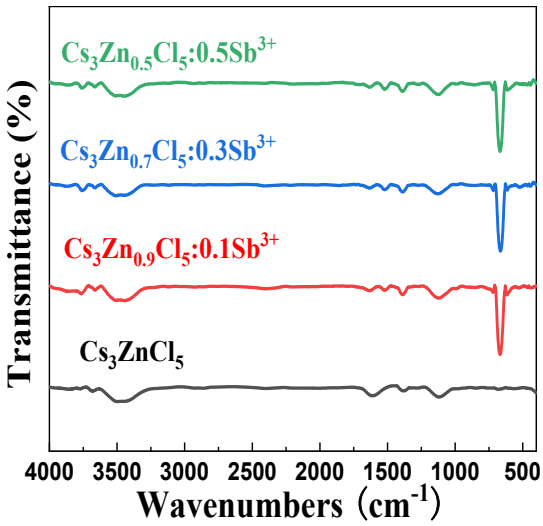

Figure S6. The infrared (IR) spectra of the Cs_3ZnCl_5, $Cs_3Zn_{0.9}Cl_5$:0.1Sb^{3+}, $Cs_3Zn_{0.7}Cl_5$:0.3Sb^{3+}, and $Cs_3Zn_{0.5}Cl_5$:0.5Sb^{3+} performed on Perkin-Elmer 580 B infrared spectrophotometer using the KBr pellet technique.

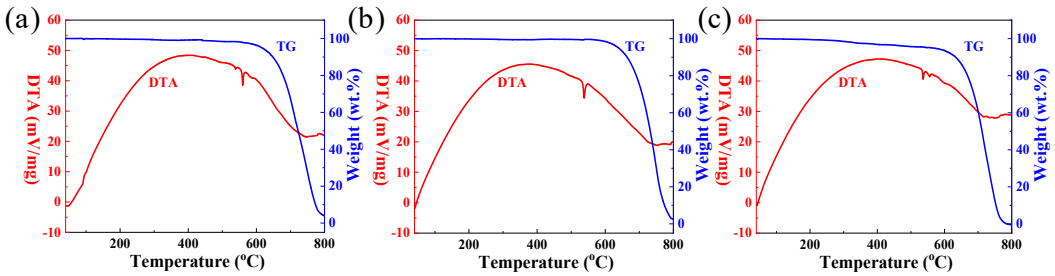

Figure S7. The thermogravimetrics (TG) analysis and differential thermal analysis (DTA) of (a) Cs_3ZnCl_5, (b) $Cs_3Zn_{0.9}Cl_5$:0.1Sb^{3+}, and (c) $Cs_3Zn_{0.5}Cl_5$:0.5Sb^{3+} performed on a PerkinElmer Diamond TG-DTA at 10 °C/min in an argon flow from room temperature to 800 °C under N_2 atmosphere.