Supporting Information

Enhanced VIS-NIR Emission of Re^{4+} Doped Cs_2ZrCl_6 for Optical Thermometry and Near-Infrared Illumination Applications

Boya Li[1], Zheng Huang[1], Peiqing Cai[1]*, Yuxin Zhan[1], Xuhui Feng[1], Xipeng Pu[2], Shala Bi[3]*, Guanghua Wang[4], Jie Zhang[4], and Zugang Liu[1]*

[1]College of Optical and Electronic Technology, China Jiliang University, Hangzhou, Zhejiang 310018, China.

[2]School of Materials Science and Engineering, Liaocheng University, Liaocheng, Shandong 252000, China.

[3]Department of Physics and Interdisciplinary Program of Biomedical, Mechanical and Electrical Engineering, Pukyong National University, Busan 608-737, Republic of Korea.

[4]Yunnan Olightek Opto-electronic Technology Co.,Ltd., Kunming 650223, China.

*Author to whom correspondence should be addressed. Email: pqcai@cjlu.edu.cn (Peiqing Cai), BI1425820017@outlook.com (Shala Bi) and zgliu78@cjlu.edu.cn (Zugang Liu).

Table S1 Schemes of different molar ratios of Cs_2ZrCl_6 to Re^{4+} for the synthesis of Cs_2ZrCl_6:Re^{4+} and the actual doping amount of Re^{4+} measured by the ICP-OES

Samples	Zr^{4+} : Re^{4+} (Molar ratio)	Actual ratio of Re^{4+} (mol%)
1	100:0.5	0.29
2	100:1	0.67
3	100:3	2.14
4	100:5	3.95
5	100:7	5.87

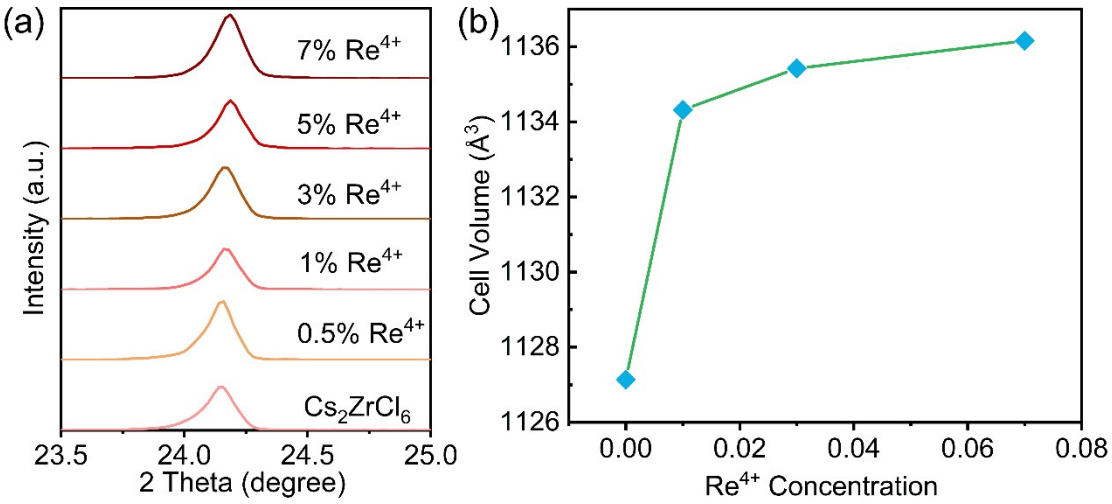

Figure S1. (a) XRD patterns in the range of 23.5-25° of Cs_2ZrCl_6, (b) The experimental cell volumes of $Cs_2Zr_{1-x}Cl_6$: xRe^{4+} as a function of Re^{4+} concentration x.

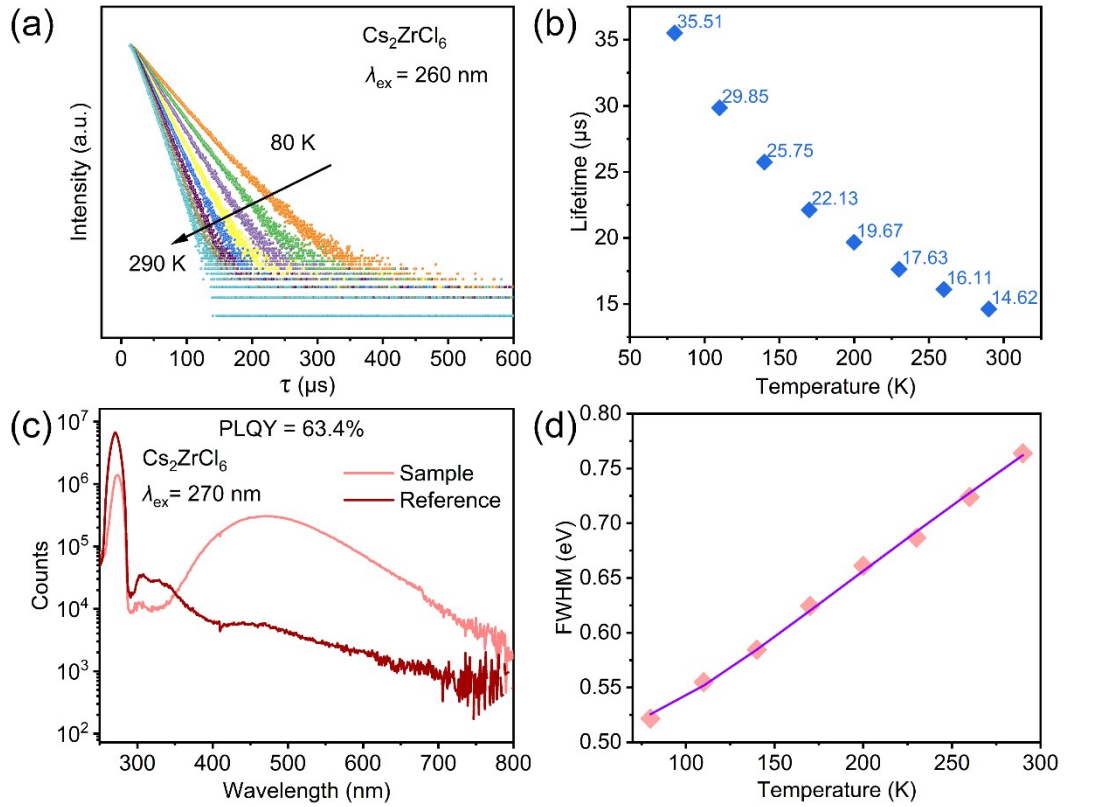

Figure S2. (a) Decay curves and (b) the calculated decay data of pure Cs_2ZrCl_6 at the 80–290 K, (c) PLQY measurement of Cs_2ZrCl_6 under 270 nm excitation. (d) the curve of FWHM vs. temperature and the fitting result of Cs_2ZrCl_6 microcrystals.

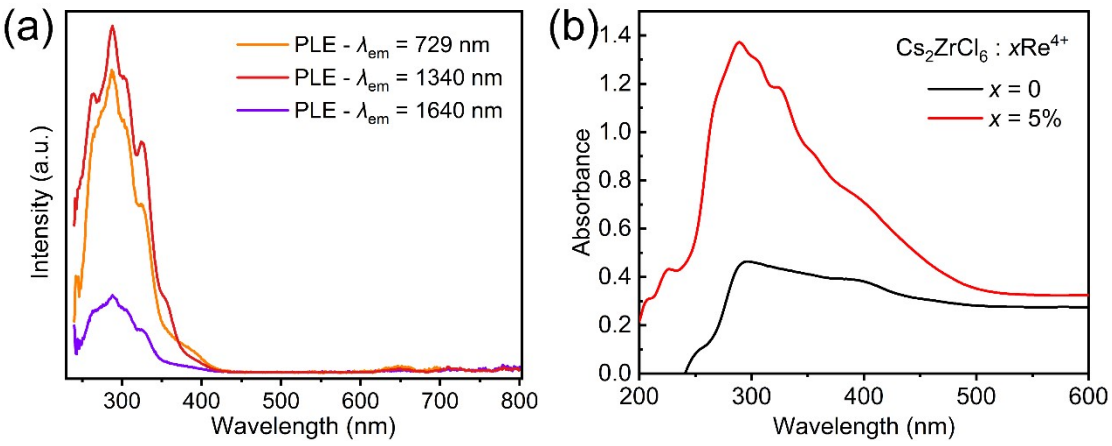

Figure S3. (a) Excitation spectra of Cs_2ZrCl_6: 3%Re^{4+} by monitoring different PL peak emissions, (b) DSR spectra of Cs_2ZrCl_6: x%Re^{4+} at the high-energy range.

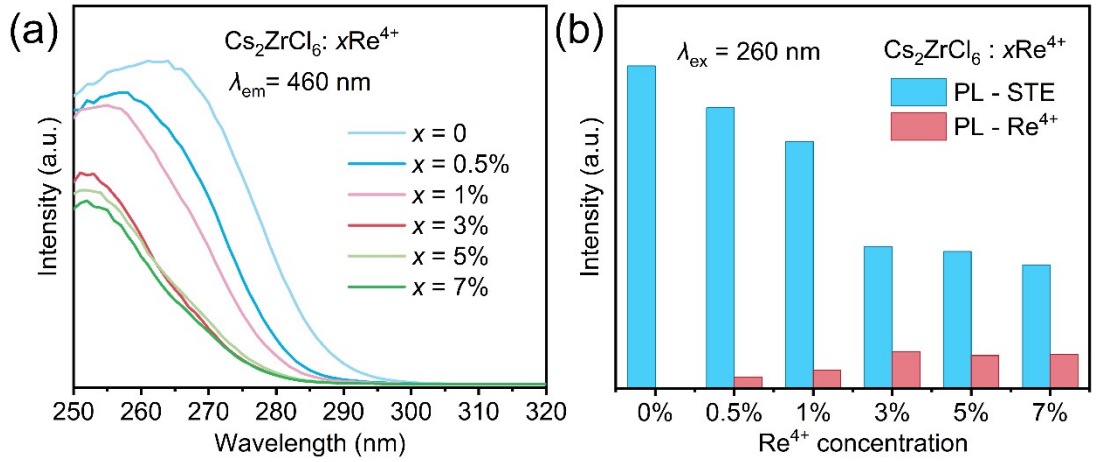

Figure S4. (a) PLE spectra of STE^- luminescence in Cs_2ZrCl_6: x%Re^{4+} as a function of Re^{4+} doping concentration, (b) Comparison of Cs_2ZrCl_6 PL intensity and Re^{4+} PL intensity under 260 nm excitation.

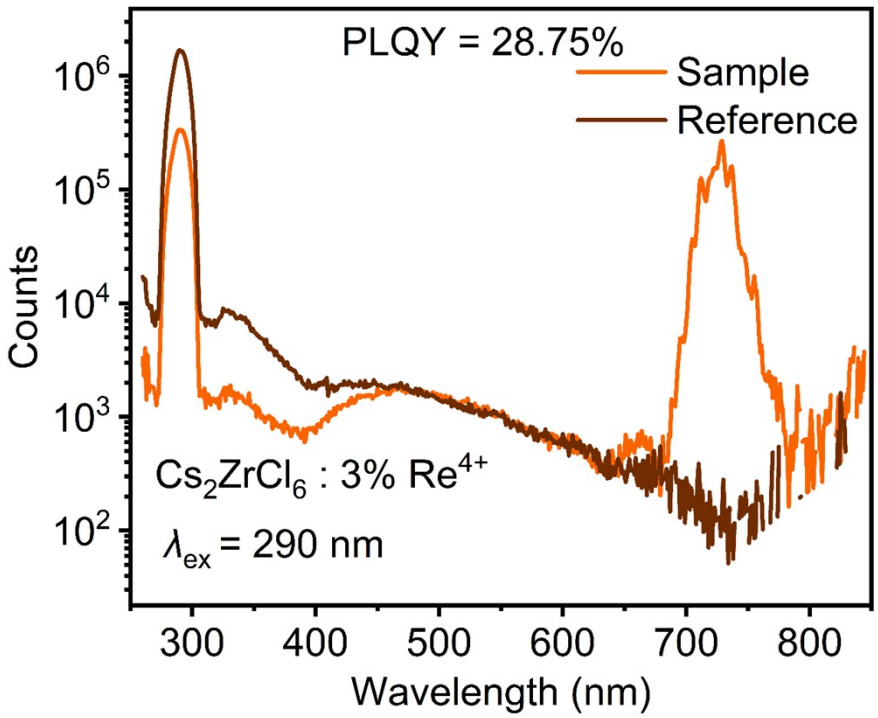

Figure S5. PLQY of the Cs_2ZrCl_6: 3%Re^{4+} powder under 290 nm excitation.

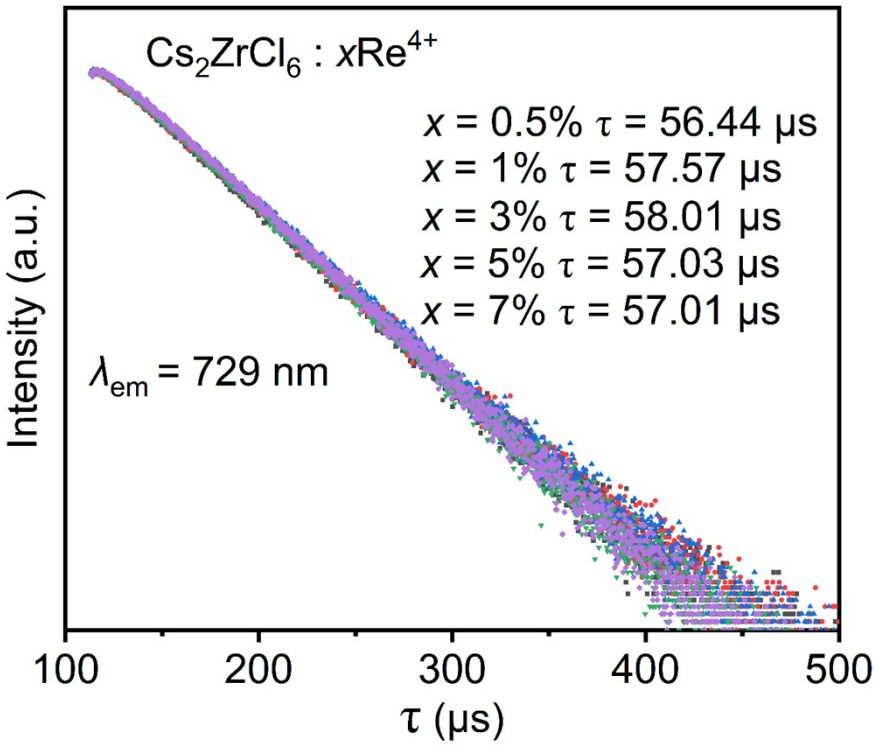

Figure S6. The concentration-dependent decay curves of Cs_2ZrCl_6: $x$$Re^{4+}$ obtained by monitoring the 729 nm emission.

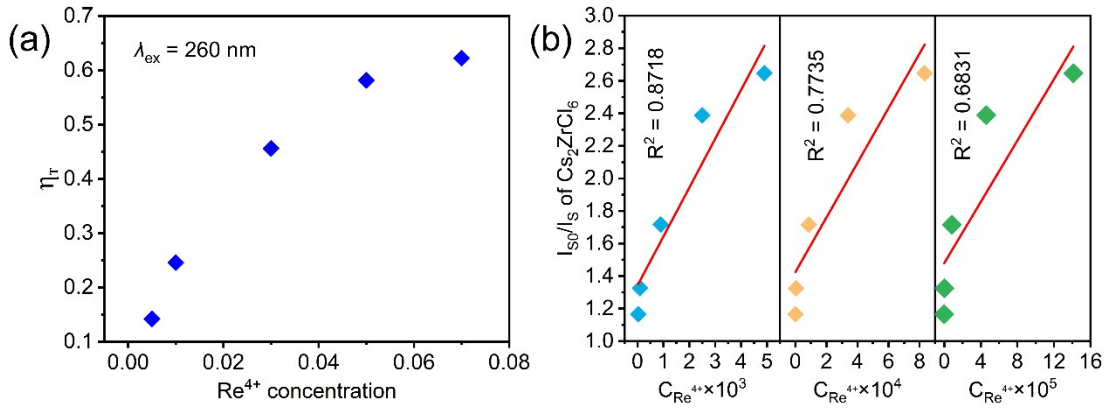

Figure S7. (a) Dependence of energy efficiency η_T on Re^{4+} doping concentration. (b) Dependence of I_{S0}/I_S of Cs_2ZrCl_6 on $C_{Re^{4+}}^{2}$, $C_{Re^{4+}}^{8/3}$ and $C_{Re^{4+}}^{10/3}$.

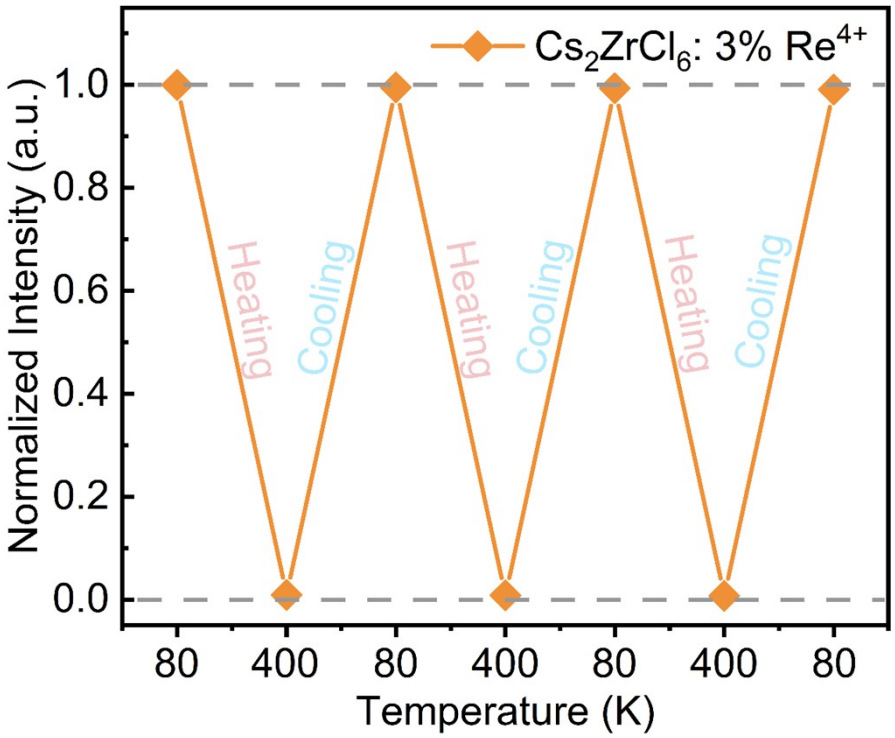

Figure S8. PL intensity variations of Cs_2ZrCl_6: 3%Re^{4+} during the heating-cooling cycles.