Supplementary Information

Enhanced upconversion luminescence and optical thermometry in Er^{3+}/Yb^{3+} heavily doped ZrO_2 by stabilizing at the monoclinic phase

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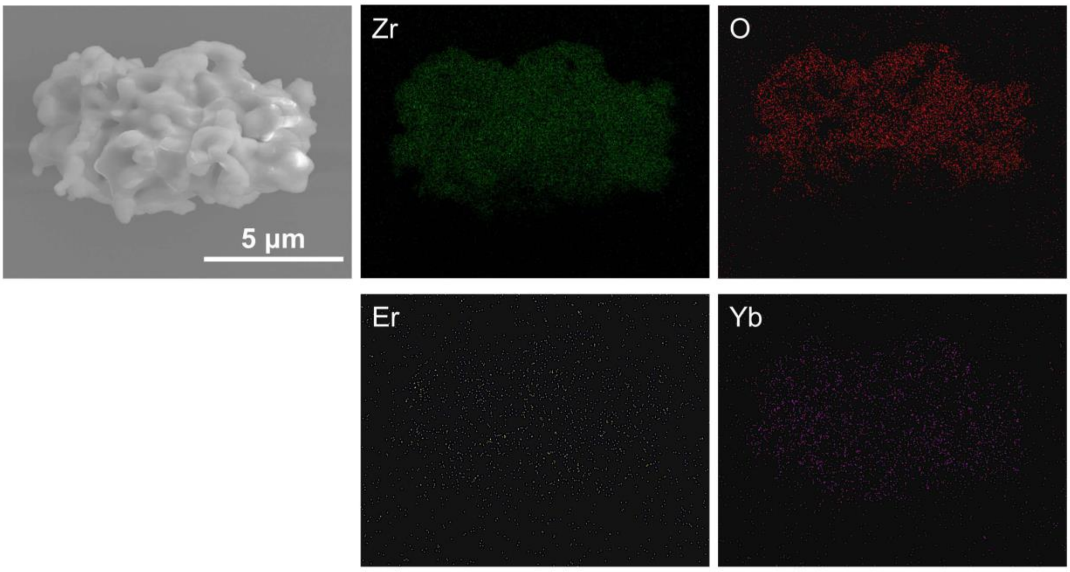

Fig. S1 The SEM image and element mappings of c-ZrO_2:2%Er^{3+}, 14%Yb^{3+}.

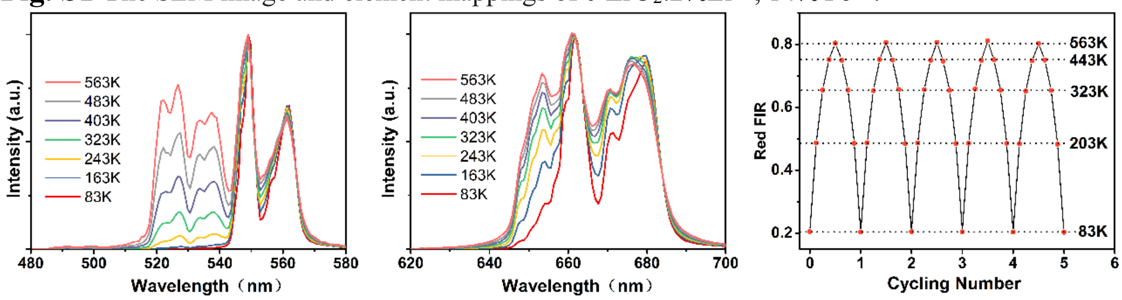

Fig. S2 Temperature-dependent emission spectra of the m-ZrO_2:2%Er^{3+}, 9%Yb^{3+} sample. The emission intensities at 549 and 662 nm are normalized, respectively. The red FIR plotted per cycle step. The dashed lines are the average values.

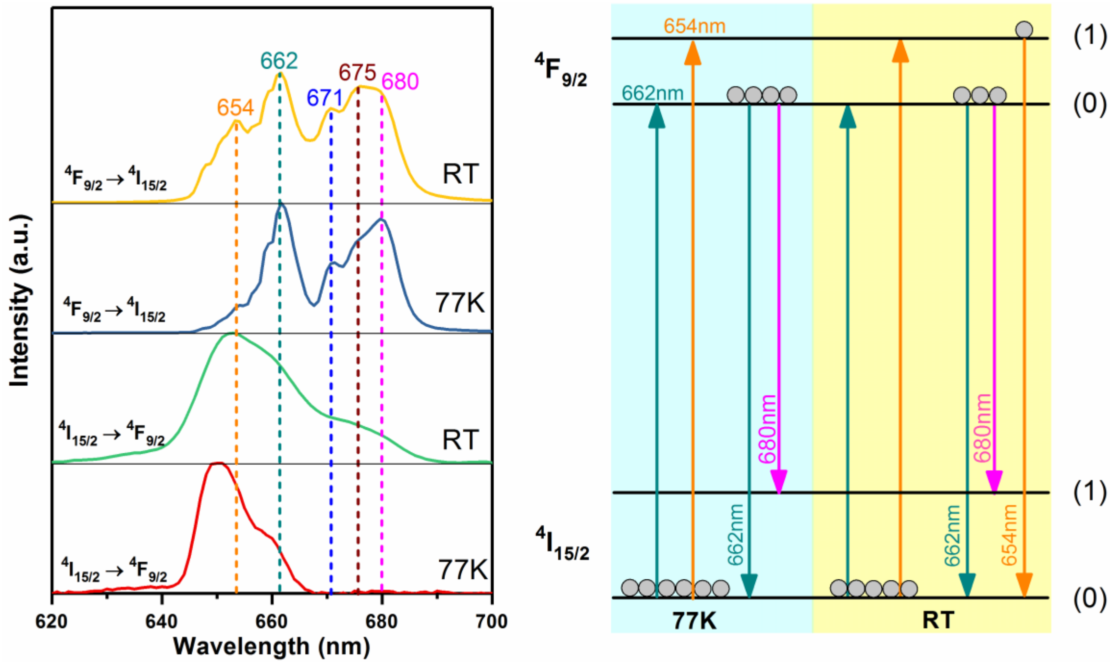

Fig. S3 The excitation and emission spectra at liquid nitrogen temperature (77K) and room temperature (RT). Simplified Stark energy level diagram for the $^4F_{9/2}$ and $^4I_{15/2}$ states.

The temperature resolution δT can be quantified using

$$\delta T = \frac{1}{Sr}\frac{\delta FIR}{FIR} \tag{S1}$$

The estimation of δFIR/FIR can be obtained by [1]:

$$\frac{\delta FIR}{FIR} = \sqrt{\left(\frac{\delta I_1}{I_1}\right)^2 + \left(\frac{\delta I_2}{I_2}\right)^2} \tag{S2}$$

where $\delta I_i/I_i$ *(i=1, 2)* is the single-to-noise ratio value.

(1) Q. Wang, M. Liao, Z. F. Mu, X. Zhang, H. F. Dong, Z. J. Liang, J. C. Luo, Y. Yang and F. G. Wu, Ratiometric Optical Thermometer with High Sensitivity Based on Site-Selective Occupancy of Mn^{2+} Ions in $Li_5Zn_8Al_5Ge_9O_{36}$ under Controllable Synthesis Atmosphere. *J. Phys. Chem. C*, 2020, **124**, 886-895.