Supporting Information

High-performance dual-mode self-calibrating optical thermometry for Er^{3+}, Li^{+} co-doped oxides

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Structure and characteristics

The unit cell structure of the yttrium oxide (Y_2O_3) is visualized based on the #155173 of the ICSD (Inorganic Crystal Structure Database)[1]. As presented in Figure S1(a), Y_2O_3 crystallized in cubic structure (α=β=γ=90) with the Ia-3 space group, with the lattice parameters of a= 10.6039 (1) Å, b = 10.6039 (1) Å, c = 10.6039 (1) Å, and V= 1192.33 Å^3. The Y^{3+} atoms at two different Wyckoff position form octahedral coordination with each of the six oxygen atoms. Here, 24 identical Y_dO_6 octahedrons have Y-O bond lengths ranging from 2.256 to 2.34 Å, while the Y-O bond lengths of Y_bO_6 octahedrons at 8 different positions are all 2.29 Å. Besides, the close ionic radii of Er^{3+} (~0.89 Å)[2] as compared with Yb^{3+} (~0.9 Å)[3] facilitates the replacement of Y^{3+} upon doping with Er^{3+}. While the Li^+ (~0.59 Å)[3] ions with a smaller radius are more likely to enter into interstitial sites (Figure S1(b)).

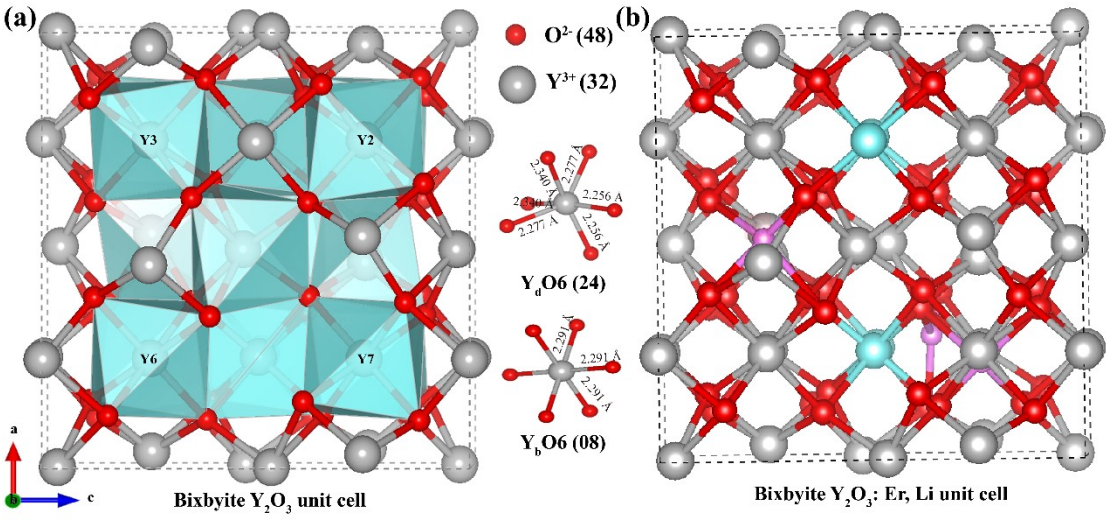

Figure S1. a) Crystal structure of the Y_2O_3 (red and gray-white spheres are oxygen and yttrium atoms, respectively). b) Possible crystal structure of Er, Li co-doped Y_2O_3。

The normalized XRD patterns of Y_2O_3: Er^{3+} 10%, Li^+ *y* (*y*=0, 1, 3, 5, 7, 10 and 15 mol%) phosphor powders are shown in Figure S2(a). All the XRD peaks agree well with the data of the standard pattern (JCPDS NO.79-1257), indicating that the synthesized sample has a pure phase structure without any secondary phase. In addition, all the diffraction peaks are significantly enhanced with the increase of Li^+ doping concentration, implying a remarkable improvement in crystallinity. In addition, as shown in Figure S2(b), the main diffraction peak is slightly shifted to the left based on Y_2O_3: Er^{3+} 10%, which is due to lattice expansion caused by interstitial doping of the Li^+ ions. However, the right shift phenomenon at Li^+ 15% should be the replacement of the Y^{3+} ions by Li^+ after interstitial doping saturation.

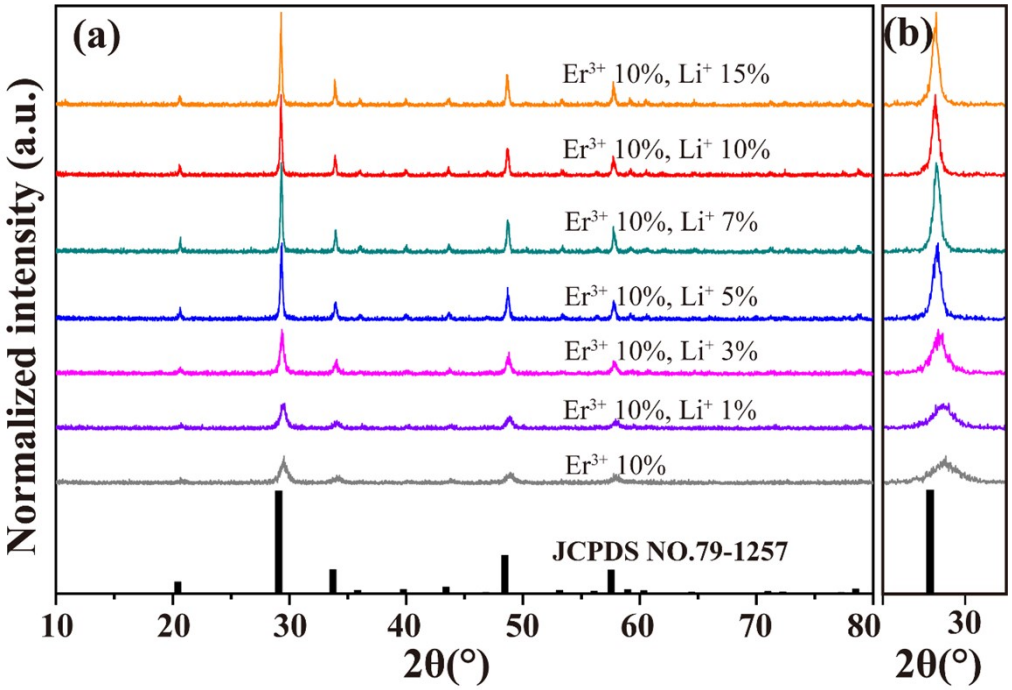

Figure S2. a) Normalized XRD patterns of Y_2O_3: Er^{3+} 10%, Li^+ *y* (*y*=0, 1, 3, 5, 7, 10 and 15 mol%) samples and standard pattern of the Y_2O_3 (JCPDS NO.79-1257) (The

amplified XRD pattern is shown in Figure S2(b)).

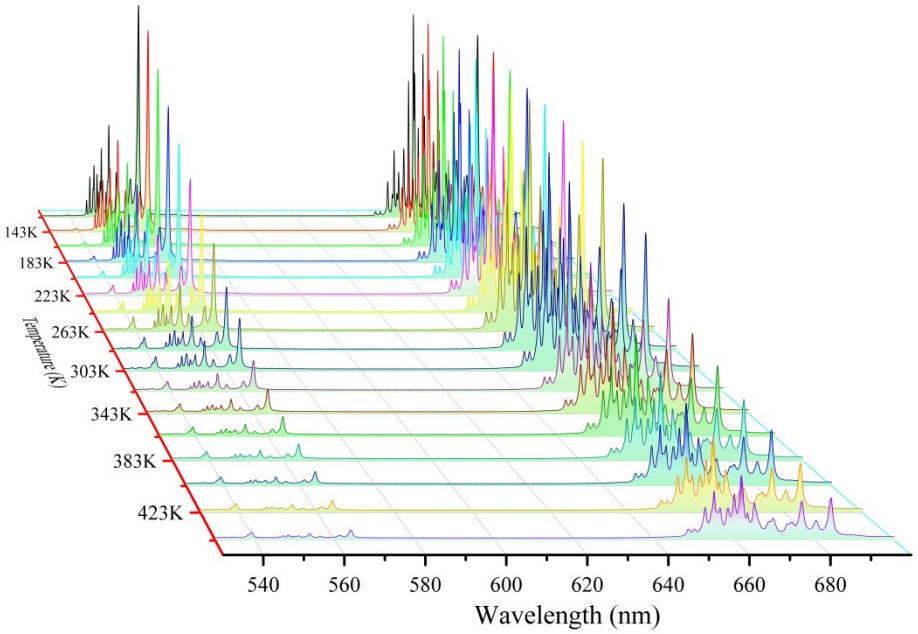

Figure S3. UC spectra of Y_2O_3: 10%Er^{3+}, 10%Li^{+} phosphors at different temperatures (123-443 K).

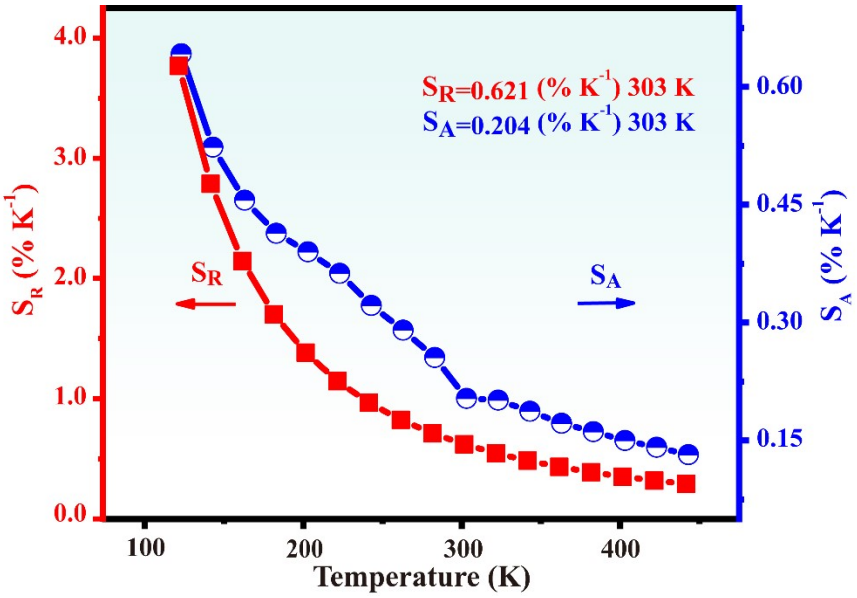

Figure S4. Relative sensitivity (S_R) and absolute sensitivity (S_A) values of Y_2O_3: 10%Er^{3+}, phosphor in the temperature range of 303-443 K.

Reference

[1] F. F. Ferreira, E. Granado, W. Carvalho, Jr., S. W. Kycia, D. Bruno and R. Droppa, Jr., *J Synchrotron Radiat*, 2006, **13**, 46-53.

[2] J. Singh, C. Singh, D. Kaur, S. Bindra Narang, R. Jotania and R. Joshi, *J. Alloys Compd*, 2017, **695**, 792-798.

[2] B. R. D. Shannon, *Acta Crystallogr. A*, 1976, **32**, 751-767.