Thermal effects of Er^{3+} / Yb^{3+} doped $NaYF_4$ phosphor induced by 980 nm laser diode irradiation

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1. Introduction

Upconversion luminescence (UCL) is an anti-stokes luminescence that plays an important role in biological fluorescence labels, silicon solar cells, 3D displays, and anti-counterfeit fields[1-4]. Most academic studies focused on their luminescence properties but disregard the photothermal conversion process. In fact, UCL process is accompanied by the generation of thermal effects. The light-heat conversion has a competitive relationship with the light-light conversion when the same amount of absorption energy can be absorbed.In this work, the thermal effects of Er / Yb doped $NaYF_4$ phosphor induced by 980 nm laser diode irradiation were intuitively and contrastively investigated using an infrared thermal imaging technology with real-time online monitoring. The Yb^{3+} / Er^{3+} codoped materials have strong thermal effects and high temperature elevation under 980 nm irradiation. However, the severe thermal effects of materials with higher Er^{3+} ion doping concentration is remarkably attributed to the cross relaxation between the Er^{3+} ions under 980 nm irradiation. The temperature rising rate and elevation ΔT value of samples depend on the ion doping concentration and power density of the laser diode excitation. The internal temperature of the samples exhibits deep temperature gradient under 980 nm laser diode irradiation. By comparing the two kinds of thermometry methods, the temperature value calculated by fluorescence intensity ratio is almost similar to that obtained through infrared thermal imaging technology under higher excitation power pumping.

2. Results and discussion

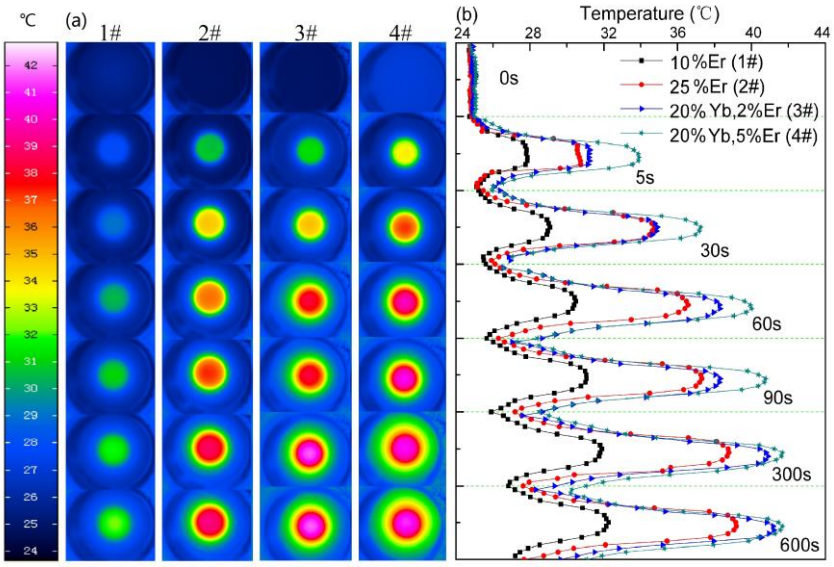

Fig. 1 Temperature images at different irradiation times (a) and the corresponding temperature curves (b), temperature elevation ΔT of $NaYF_4$: xEr (x = 10, 25 mol%) and $NaYF_4$: 20%Yb, yEr (y = 2, 5 mol%) samples (c) under irradiation of 980 nm LD.

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4. References

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