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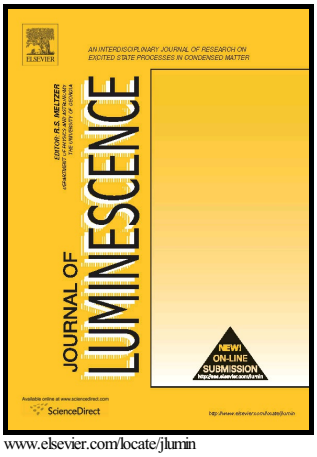

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Doping concentration-independent optical thermometric properties in Stark sublevels-based Er^{3+}-activated $BaGd_2O_4$ luminescent thermometers

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Abstract

We reported a facile strategy to modify the sensor sensitivities of Er^{3+}-doped $BaGd_2O_4$ phosphors by simultaneously modulating the dopant concentration and utilizing the proper Stark sublevels. Under the excitation of 377 nm, visible emissions originating from the Stark sublevels of Er^{3+} ions ($^2H_{11/2(1)}$, $^2H_{11/2(2)}$, $^4S_{3/2(1)}$, $^4S_{3/2(2)}$, $^4F_{9/2(1)}$ and $^4F_{9/2(2)}$) were detected in all the prepared samples. The optimal doping concentration for the Er^{3+} ions in the $BaGd_2O_4$ host lattice was 2 mol% and the electric dipole-dipole interaction can contribute to the concentration quenching mechanism. By utilizing the fluorescence intensity ratio technique, the optical thermometric properties of the obtained phosphors in the temperature range of 288-483 K were studied based on the thermally coupled levels of $^2H_{11/2(1)}/^4S_{3/2(1)}$, $^2H_{11/2(2)}/^4S_{3/2(1)}$, $^2H_{11/2(1)}/^4S_{3/2(2)}$, $^2H_{11/2(2)}/^4S_{3/2(2)}$ and $^2H_{11/2}/^4S_{3/2}$. The maximum relative sensor sensitivities of the resultant compounds based on the Stark levels of $^2H_{11/2(1)}/^4S_{3/2(2)}$ were much higher than that based on the $^2H_{11/2}/^4S_{3/2}$ ordinary thermally coupled levels. Furthermore, the relative sensor sensitivities of the synthesized phosphors were insensitive to the doping concentration and its maximum value was up to 0.0175 K^{-1} at 288 K. These characteristics demonstrated that the Er^{3+}-doped $BaGd_2O_4$ systems were suitable for optical thermometers.

Keywords: Luminescence, Phosphors, Thermometry, Rare-earth

1. Introduction