

$Y_2(Ge,Si)O_5:Pr$ phosphors : multimodal temperature and pressure sensors shaped by bandgap management.

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Luminescence thermometers and manometers are among the most paramount emerging applications of phosphors nowadays, and remote reading is not the only attractive advantage they offer. Presently, truly encouraging examples offering both a wide operating range and appreciating thermal sensitivity are still limited. Double-mode sensors are especially attractive but pose additional problems to design them and control their properties. In this paper, we investigate $Y_2(Ge_x, Si_{1-x})O_5:0.05 \text{ mol\%Pr}$ powder phosphors methodically varying the Ge : Si molar ratio to design their properties both in optical thermometry and manometry. We show that activation energy for thermal quenching of the $5d \rightarrow 4f$ luminescence may be tuned and the mechanism of this process controlled. Consequently, fine-tuning of the luminescent properties important in thermometry may be managed. Specific properties of the $5d \rightarrow 4f$ luminescence allow dual-mode thermometry to be executed using either luminescence intensity ratio or the emission decay kinetics for that purpose. The highest values of the thermometric relative sensitivity depend on the Ge : Si molar ratio and range from ~ 2.5 to $3.5\% \text{ K}^{-1}$. The temperature range of the best performance may also be effectively tuned by adjusting the Ge : Si molar ratio. Controlling the Ge : Si proportion also allows the sensitivity of these phosphors in manometry to be improved. The $Y_2(Ge_{0.10}, Si_{0.90})O_5:0.05\%Pr$ material presents the second-best ever reported sensitivity of 1.28 nm GPa^{-1} . Consequently, the $Y_2(Ge_x, Si_{1-x})O_5:0.05\%Pr$ phosphors are useful for both temperature and pressure monitoring, and their performance in both functionalities may be effectively tuned by means of the Ge : Si molar ratio. Our findings may serve as a guide for researchers searching for novel optical thermometers and manometers.

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