

Exploiting bandgap engineering to finely control dual-mode $\text{Lu}_2(\text{Ge},\text{Si})\text{O}_5:\text{Pr}^{3+}$ luminescence thermometers.

Autorzy

Małgorzata Sójka

Carlos D. S. Brites

Luís D. Carlos

Eugeniusz Zych

Rok wydania

2020

Czasopismo

Journal of Materials

Chemistry C

Numer woluminu

8

Strony

10086-10097

DOI

10.1039/d0tc01958e

Kolekcja

Naukowa

Język

Angielski

Typ publikacji

Artykuł

Streszczenie

It was proved quite recently that luminescence thermometry may benefit from utilizing the $5d \rightarrow 4f/4f \rightarrow 4f$ intensity ratio of Pr^{3+} transitions. This paper presents a comprehensive study of $\text{Lu}_2(\text{Ge}_x\text{Si}_{1-x})\text{O}_5:\text{Pr}$ phosphors in the full range of Ge concentrations ($x = 0-1$) for luminescence thermometry. Silicon substitution by germanium allows effective management of their thermometric properties through bandgap engineering. The Ge/Si ratio controls the range of temperatures within which the $5d \rightarrow 4f$ Pr^{3+} luminescence can be detected. This, in turn, defines the range of temperatures within which the $5d \rightarrow 4f/4f \rightarrow 4f$ emission intensity ratio can be utilized for thermometry. Altogether, the bandgap engineering allows widening the operating range of thermometers (17–700 K), fine-tunes the range of temperatures with the highest relative sensitivity, and reduces the inaccuracy of the measurements. The kinetics of the $5d \rightarrow 4f$ luminescence is also controlled by bandgap engineering and can be also used for luminescence thermometry. The $\text{Lu}_2(\text{Ge}_x\text{Si}_{1-x})\text{O}_5:\text{Pr}$ phosphors were, thus, designed as dual-mode luminescence thermometers exploiting either the inter- and intra-configurational intensity ratios or the $5d \rightarrow 4f$ decay time. The highest relative thermal sensitivity, 3.54% K^{-1} , was found at 17 K for $\text{Lu}_2(\text{Ge}_{0.75}\text{Si}_{0.25})\text{O}_5:\text{Pr}$ and at 350 K for $\text{Lu}_2\text{SiO}_5:\text{Pr}$ and it was combined with a very low (<0.03 K) temperature uncertainty. Herein, we proved that bandgap engineering is a promising and effective approach to developing high-performance luminescence thermometers.

Adres publiczny

<http://dx.doi.org/10.1039/D0TC01958E>

Strona internetowa wydawcy

<https://www.rsc.org/>

