

Tm²⁺ activated SrB₄O₇ bifunctional sensor of temperature and pressure : highly sensitive, multi-parameter luminescence thermometry and manometry.

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Streszczenie

Noninvasive sensing of temperature and pressure offers new and exciting opportunities to investigate and monitor the variation of physicochemical and spectroscopic properties of materials under extreme conditions. In this work, Tm²⁺-doped SrB₄O₇ phosphor material—a novel, contactless bifunctional, and multimodal optical sensor for pressure and temperature is reported. A series of SrB₄O₇: xTm²⁺ samples are synthesized via a high-temperature solid-state method in air. The impact of high pressure (up to ≈13 GPa) and temperature (from 10 to 400 K) on spectroscopic properties of SrB₄O₇:Tm²⁺ is investigated. The emission band of Tm²⁺ demonstrates a significant spectral shift and a band broadening as a function of both pressure and temperature. Such a result is a consequence of a significant change of vibronic components of the Tm²⁺ 4f¹²5d ↔ 4f¹³ zero-phonon line. The emission bandwidth and its spectral position exhibit excellent sensitivities to pressure, that is, ≈23.17 and ≈−11.85 cm^{−1} GPa^{−1}, respectively. Furthermore, for the first time, it is shown that temperature sensing can be realized via four different pathways in a single material: i) bandwidth, ii) band shift, iii) band intensity ratio, and iv) luminescence lifetime, with maximal sensitivities of ≈3.85 cm^{−1} K^{−1}, 1.44 cm^{−1} K^{−1}, 1.48% K^{−1} and 4.16% K^{−1}, respectively.

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