Pressure-driven configurational crossover between $4f^7$ and $4f^65d^1$ States – Giant enhancement of narrow Eu^{2+} UV-Emission lines in SrB_4O_7 for luminescence manometry.

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Streszczenie

Accurate, fast, and non-invasive methods for the determination of the local pressure magnitude are crucial for the investigation of the physical and chemical behavior of materials at the extreme conditions of high pressure. A promising method for remote *operando* pressure measurements is luminescence manometry. However, a limiting bottleneck for high-pressure readout is the usually occurring quenching of the emission signal of the luminescent sensor material upon compression. In this work, we reported for the first time the pressure-induced intensity enhancement (by 3 orders of magnitude) of the $4f^7(^6P_{7/2}) \rightarrow 4f^7$ ($^8S_{7/2}$) emission line of Eu^{2+} in the UV range due to pressure-induced configurational crossover between the excited $4f^65d^1$ and $4f^7$ energy levels in SrB_4O_7 host. The peak centroid of the narrow $4f^7 \rightarrow 4f^7$ transition exhibits a significant red-shift (~ -12.84 cm^{-1} GPa^{-1}; 0.17 nm GPa^{-1}) with simultaneous temperature independence of the line position ($4.8 \cdot 10^{-4}$ nm K^{-1}). The pressure sensitivity of the proposed system is competitive to the so far well-established luminescent pressure sensors based on $Al_2O_3:Cr^{3+}$ (ruby) and $SrB_4O_7:Sm^{2+}$ with characteristic narrow line emission in the red range, and offers an alternative spectral range in parallel with an intensity enhancement at higher pressures. This novel pressure gauge may significantly improve the accuracy of the remote pressure measurements and open up new horizons for materials science research at even higher pressures.

Słowa kluczowe

Pressure-enhanced emission, 4f7 → 4f7 emission of Eu2+, Strontium tetraborate, optical pressure gauge, luminescent manometer, pressure-induced crossover

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