Contribution ID: **109** Type: **Poster**

Optical thermometry: fluorescence of rear-earth ions in aluminum nitride thin films

Friday, November 8, 2024 5:22 PM (3 minutes)

Non-contact optical thermometry is based on temperature dependence of fluorescence intensity ratio (FIR) of two spectral lines. Recently, fluorescence of rear-earth ions incorporated in wide-gap materials has been widely used for accurate temperature sensing.
Eu-doped and Sm-doped AlN thin films prepared by radio frequency magnetron sputtering were studied in terms of their applicability as temperature sensors.
In Eu-doped film both trivalent Eu3+ and divalent Eu2+ ions were detected. The film emitted intense red light under UV excitation, where narrow intense lines from the excited level 5D0 of Eu3+ dominated in the spectra. Eu2+ manifested itself as a low-intense fluorescence band at 430–570 nm. The fluorescence excitation spectra allowed to conclude the Eu excitation by nonradiative energy transfer. The temperature dependence of the thermally coupled levels 5D1 and 5D0 of Eu3+ ions was studied in detail from −160 to +250 C. The levels showed an absolute sensitivity up to 0.003 K−1. Approaching a broadband multi-peak detection and the FIR of Eu2+/Eu3+, a much higher sensitivity up to 0.01 K−1 was achieved.
The Sm-doped film emitted a bright orange-red light under UV excitation. The most intense bunches at 580, 621 and 660 nm were identified as due to radiative transitions from the excited Sm3+ level 4G5/2 to the ground ones 6H5/2, 6H7/2 and 6H9/2, respectively. Considering ratios between integral intensities of the Sm3+ line bunches in the mentioned range, the maximum absolute and relative sensitivities of ˜1.3x10-3 and 1.9x10-3 K−1 were obtained, respectively.

Type of presence

Presence online

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Session Classification: Poster Session