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OPTICAL CHARACTERIZATION OF Er^{3+}-Yb^{3+} CO-DOPED FLUOROPHOSPHATE GLASSES FOR OPTICAL TEMPERATURE SENSORS

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Er^{3+}/Yb^{3+} co-doped fluorophosphate glasses have been examined for up-conversion luminescence temperature sensors. Absolute temperature sensitivity were found to be strongly affected by phosphate content changes, while the effect of ErF_3 and YbF_3 concentrations was found to be insignificant.

Introduction. Phosphates are often added into fluoride glasses to improve their stabilities, and avoid the crystallization of the glass, so fluorophosphate glasses are expected to have the stability that representing a compromise between pure fluoride and oxide glasses with flexible optical properties. Among trivalent rare earth ions, temperature sensor based on the Er^{3+} green up-converted luminescence is the most popular, because two states $^2H_{11/2}$ and $^4S_{3/2}$ are thermally coupled levels, whose populations meet the Boltzmann distribution law. The temperature can be obtained by processing the fluorescence intensity ratio (FIR) technique.

Main part. Glasses under study have chemical composition of: $xBa(PO_3)_2$–$(100\text{-}x\text{-}y\text{-}z)(AlF_3 – CaF_2 – MgF_2 – BaF_2 – SrF_2)$–$yErF_3$–$zYbF_3$, where x=5, 10, 15, 20 while y=0.3, 1.0 and z=0, 5, 10 (mol. %). In order to calculate the absolute temperature sensitivity using Judd-Ofelt (JO) theory, the absorption spectra at room temperature were recorded in the range of 300-1700 nm. The upconversion luminescence spectra for sensing parameters calculation have been excited with diode laser at 980 nm and measured in the range 500–600 nm. The upconversion luminescence measurements were carried out in thermo-cell in temperature range from 300 up to 703 K. The fluorescence intensity ratio technique, also known as FIR,was used in this work to calibrate the temperature sensor. The intensities of the emission bands of two closely spaced, thermalized energy levels are recorded as a function of the temperature of the host matrix and, if the laser power is low enough, the ratio R of these intensities is proportional to the relative populations of the thermalized levels involved. The effects of phosphate, ErF_3 and YbF_3 concentrations on temperature sensitivity of studied glass samples have been examined.

Conclusion. The fluorescence intensity ratio (FIR) and temperature sensitivity of Er^{3+}/Yb^{3+} co-doped fluorophosphate glasses were experimentally determined and compared with calculated values according to the JO theory, the maximum absolute sensitivities were found to be $55–65\times10^{-4}$ K^{-1} in the temperature range of 300–703 K. Sensitivity values were found to be strongly affected by changes phosphate content, while the effect of ErF_3 and YbF_3 concentrations was found to be insignificant. The high values of S_{max} compared to other host materials, suggest that Er^{3+}/Yb^{3+} co-doped fluorophosphate glasses under study are promising for optical temperature sensors.

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