spectra of MPy(OPrOH)2 porphyrin from 293 to 318 K with a step of 0.5 K. Spectra were recorded by the Fluorolog-3 modular fluorimeter in the wavelengths range of 540–760 nm. Linear partial least squares method (PLS) and nonlinear support vector regression (SVR) are used for fluorescence thermometry. Multivariate calibration models are trained on the randomly selected subset of fluorescence spectra. Comparison of linear and nonlinear models was carried out by values of the root mean square error RMSE of test subset of fluorescence spectra. RMSE = 0.34 K for wideband linear PLS. SVR is optimized for kernel function (linear, polynomial, Gaussian) that is a method used to transform the input data into the required form. For SVR the best value RMSE=0.31 K corresponds to the linear kernel function. Spectral variable selection by searching combination moving window interval PLS gives RMSE=0.13 K and is the most accurate temperature calibration method among those considered.

Multimodal temperature sensors based on Er3+/Tm3+/Yb3+ co-doped NaYF4 microcrystals operating in the first window of biological transparency

Evgeny O. Mityushkin, Artemi G. Shmelev, Andrey V. Leontyev, Larisa A. Nurtdinova, Dmitry K. Zharkov, Victor G. Nikiforov
Federal Research Center «Kazan Scientific Center of Russian Academy of Sciences»

Under near infrared (NIR) excitation upconversion materials doped with rare-earth ions emit infrared, visible and ultraviolet radiation. It is known, that NIR radiation is in the first window of biological transparency (650-1000 nm), which makes upconversion materials promising tools in the field of biology and medicine. One such area is use of upconversion micro/nanoparticles as a probe for non-contact optical thermometry. The non-contact temperature sensor is based on temperature-dependent luminescence properties: excited-state lifetime, position, width, shape and intensity of luminescence peaks, etc. The luminescence intensity ratio (LIR) technique is the simplest and the most accurate. Traditionally, the LIR technique is associated with intensity ratio between two green bands of the emission spectrum of Er3+ ions. However, green light is efficiently absorbed by and has limited penetration depth in biological tissues. Therefore, to create effective temperature sensors for biomedical applications, excitation and emission radiations should be localized in the biological transparency window.

The research discusses the prospects of application NaYF4:Er3+, Tm3+, Yb3+ upconversion microparticles as temperature and bioimaging probes operating in visible and the first biological window ranges. Er3+/Tm3+ doping ions acted as the emitting centers and Yb3+ ions acted as the sensitizers. The hexagonal microrods NaYF4:Er3+,Tm3+,Yb3+ were prepared by means of hydrothermal method using oleic acid as a stabilizing agent. Luminescence (500–900 nm) from Er3+/Tm3+/Yb3+ co-doped NaYF4 phosphors were systemically investigated in the 250-350 K temperature range. High temperature sensitivity was achieved by choosing suitable LIR of emissions located in the first biological window. As a result, it was established that intense 805 nm luminescence band of Tm3+ ions in NaYF4 upconversion microparticles is optimal for temperature probing for bioimaging applications.

The authors are grateful to the Russian Science Foundation (project 23-42-10012), the government assignment for the FRC Kazan Scientific Center of RAS and the Ministry of Education and Science of the Russian Federation (agreements 075-02-2024-1503 dated 02/29/2024 and 075-15-2024-624 dated 12/07/2024) for supporting the research.

Determination of trace amounts of metals in non-metallic matrixes by double-pulse LIBS

K.F. Ermalitskaia, E.S. Voropay
Belarusian State University, Minsk, Belarus

The features of single-pulse and double-pulse laser ablation of porous inhomogeneous nonmetallic matrices have been studied. The influence of the matrix on the propagation and excitation of metal atoms in an ablation plasma excited by single and double laser pulses with microsecond interpulse intervals is assessed. Methods have been developed for qualitative, semi-quantitative and quantitative express analysis of porous non-metallic samples containing trace amounts of metals using laser atomic emission spectroscopy using a double-pulse laser spectrometer developed at the Department of Laser Physics and Spectroscopy, Faculty of Physics, BSU.