Efficient NIR emission in SiO_2-LaF_3:Nd^{3+} sol-gel nano-glass-ceramics

Joanna Śmiarowska[1#], Natalia Pawlik[1], Tomasz Goryczka[2], Wojciech A. Pisarski[1]

[1] University of Silesia, Institute of Chemistry, Szkolna 9 Street, 40-007 Katowice, Poland
[2] University of Silesia, Institute of Materials Science, 75. Pułku Piechoty 1A Street, 41-500 Chorzów, Poland

Optical properties of Nd^{3+} ions have been widely investigated due to the efficient emission in the near-infrared spectral range. Indeed, the NIR emissions (~1.06 μm and ~1.3 μm) have proved to be used in solid-state lasers or O-band amplifiers. However, the luminescent performance of the Nd^{3+} ions is strongly dependent on the type of host material; therefore, it is crucial to find a suitable matrix to enhance the resultant luminescence. Among many host systems, oxyfluoride sol-gel nano-glass-ceramics (nGCs) present unique advantages due to the combination of the high chemical and mechanical stability of the oxide host with the low phonon energy of the fluoride framework. Efficient incorporation of the dopant ions into low-phonon energy fluoride crystal lattice may significantly reduce the probability of multiphonon relaxation and consequently enhance their luminescence [1,2].

In this work, the series of sol-gel materials doped with Nd^{3+} ions were synthesized and further transformed into nano-glass-ceramics containing LaF_3:Nd^{3+} nanocrystals via controlled heat treatment, carried out at 700^0C and 900^0C. The structural characterization of obtained materials was performed using X-ray diffraction (XRD), revealing the crystallization of the fluoride nanophase. The examination of luminescent properties included analysis of PLE (λ_{em}=1063 nm) as well as the PL spectra recorded using different excitation wavelengths (λ_{exc}=521 nm, 579 nm, and 793 nm). Furthermore, the luminescence decay curves of the $^4F_{3/2}$ excited state of Nd^{3+} were registered. Additionally, the influence of the temperature of controlled heat treatment on the luminescence of Nd^{3+} ions was studied. The characteristic emissions of Nd^{3+} ions were observed in all fabricated samples. The results indicate the obtained materials are promising candidates for the NIR luminescence applications.

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corresponding author: joanna.smiarowska@us.edu.pl