FLUORESCENCE OF Nd^{3+} OPTICAL CENTERS CLOSE TO CUBIC SYMMETRY IN A CALCIUM FLUORIDE CRYSTAL CO-DOPED WITH Na^{+}

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It was shown by the EPR method that at a very low concentration of the Nd^{3+} ion in the Nd^{3+}: CaF_2 crystal, highly symmetric cubic centers with the O_h symmetry are formed [1, 2]. In the present study, the optical centers of the Nd^{3+} ion with an anomalously long radiative lifetime τ_R = 13.6 ms of the $^4F_{3/2}(1)$ crystal-field (CF) level in the Nd^{3+} (0.05 at.%): Na^+ (0.2 at.%): CaF_2 single crystal at T = 7 K were detected for the first time by the method of time-resolved site-selective fluorescence laser spectroscopy. New optical centers exhibit inhomogeneous splitting and can be attributed to nearly cubic sites with symmetry close to O_h.

Also numerous new Nd^{3+} optical sites in the Nd^{3+} (0.03 at.%): CaF_2 and Nd^{3+} (0.05 at.%): Na^+ (0.2 at.%): CaF_2 crystals at T = 7 K with τ_R = 240 μs – 8.5 ms of the $^4F_{3/2}(1)$ CF level of Nd^{3+} were detected in a shorter wavelength spectral range compared to the nearly cubic sites. We found that the optical sites with τ_R = 8.5 ms in the Nd^{3+} (0.05 at.%): Na^+ (0.2 at.%): CaF_2 crystals have C_{2v} symmetry, when the Na^+ ion compensates for the excess of the charge. Since optical sites with C_{4v} symmetry have τ_R = 1.4 ms, it means, that for optical sites without a center of inversion, the radiative lifetime of the excited state at sites with higher symmetry can be almost an order of magnitude shorter than at sites with lower symmetry. This result was explained with the Judd-Ofelt approach by the different distance between the Nd^{3+} ion and the Na^+ ion.

References

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