

A clear effect of charge compensation through Na⁺ co-doping on the luminescence spectra and decay kinetics of Nd³⁺ -doped CaAl₄O₇.

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We present a detailed analysis of luminescence behavior of singly Nd³⁺-doped and Nd³⁺, Na⁺-co-doped calcium aluminates powders: Ca_{1-x}Nd_xAl₄O₇ and Ca_{1-2x}Nd_xNa_xAl₄O₇ (x=0.001-0.1). Relatively intense Nd³⁺ luminescence in IR region corresponding to typical ⁴F_{3/2} → ⁴I_J (J=9/2-13/2) transitions with maximum located at about 1079 nm was obtained in all samples on direct excitation into f-f levels. The effect of dopant concentration and charge compensation by co-doping with Na⁺ ions on morphology and optical properties were studied. The results show that both, the Nd³⁺ concentration and the alkali metal co-doping affected the optical properties but had no influence on the powders morphology. The studies of luminescence spectra (298 and 77 K) in a function of dopant concentration showed an increasing distortion of the local symmetry of Nd³⁺ with raising activator content due to certain defects created in the crystal lattice. On the other hand Na⁺ addition led to significant narrowing of absorption and luminescence bands and also a reduction of the number of their components, showing smaller disturbance of Nd³⁺ ions local symmetries. Consequently, charge compensated by Na⁺ co-doping materials showed significantly enhanced Nd³⁺ luminescence. The decrease of emission intensity and luminescence lifetimes with increase of activator concentration was attributed mainly to phonon-assisted cross-relaxation processes between Nd³⁺ ions. Analysis with Inokuti-Hirayama model indicated dipole-dipole mechanism of ion-ion interaction. Na⁺ addition led to much smaller concentration quenching due to smaller clustering of dopant ions in CaAl₄O₇ lattice.

Słowa kluczowe

Calcium aluminate, Enhanced Nd³⁺ luminescence, charge compensation, absorption spectra, decay kinetics

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