

Unusual emission from $^2F_{5/2}$ two lowest excited levels of Yb^{3+} -doped $LuPO_4$ nano/micro-crystalline materials

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Yb^{3+} -doped inorganic materials are constantly in demand due to a strong interest in fundamental and applied research. The simplicity of the $4f^{13}$ electronic structure minimizes de-excitation processes and enables a quasi-three-level laser emission scheme at 1 μm employed for IR laser devices.

In this work, we present an unusual simultaneous emission from two of the lowest levels of the $^2F_{5/2}$ excited state observed at 77 K, measured for the first time and confirmed by the barycenter law for Yb^{3+} -doped tetragonal $LuPO_4$ revealing the lowest crystal field among Yb^{3+} ion-activated oxide crystals.

Three series of tetragonal lutetium orthophosphate powders, containing various concentrations of Yb^{3+} ions (0.5–5 mol %), were analyzed in nano and micro-crystalline forms. The ionic liquid-assisted (IL) hydrothermal (HT) method was used for the nano-powders' preparation. This route enabled the fabrication of fine nano-powders with particle sizes of 15 nm in an ethylene glycol (GE) reaction medium and 30 nm in a water (W) medium, each exhibiting the desired well-crystallized single-phase phosphate. For comparative studies, the micro-crystalline samples were synthesized *via* reaction in the solid phase at a relatively high temperature.

The Yb^{3+} ion also served as a structural probe, its spectroscopy *i.e.*, absorption at 4.2 K, selectively excited luminescence at 77 K, and fluorescence decays were used to assign Yb^{3+} energy levels in only one D_{2d} center precisely. This assignment was based on exceptional features due to the unique emissions observed from the two lowest levels of the $^2F_{5/2}$ excited state, split only by 27 cm^{-1} , confirmed by calculation of the crystal field parameters from Zeeman spectra.

Słowa kluczowe

Nano/micro-powders, Ionic liquid-assisted hydrothermal methods, Unusual Yb³⁺ emission, D²d center, LuPO₄

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