# Growth and Characterization of $Ca_3Y_2(BO_3)_4$:Er,Yb Laser Crystal

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1.5 μm lasers are of great interest for several industrial applications: laser range-finding, environmental sensing, telecommunication due to eye-safety, high transparency in atmosphere, low losses and minimal value of the group velocity dispersion in fused-silica waveguides. Binary borate $REAl_3(BO_3)_4$:Er,Yb (RE=Y, Gd, Lu) crystals are promising materials for the gain media. Efficient continuous-wave and Q-switched lasing operations were demonstrated [1]. But these compounds have incongruent melting and can be grown only by TSSG technique [2]. This peculiarity significantly limits the application of the crystals. Thus the search for the 1.5 μm gain media which could be produced by direct crystallization from melts is actual task. This report is devoted to the crystal growth by the Czochralski technique and characterization of pure and Er,Yb-doped $Ca_3Re_2(BO_3)_4$ single crystals.

Pure and Er,Yb-doped $Ca_3Y_2(BO_3)_4$ single crystals were grown by the Czochralski method using an automated and equipped with a weight control system “Kristall 3M” puller. The growth processes was carried out in argon from Ir crucible. The crystal and defect structure were characterized. Volumetric chemical methods without prior separation of the components were developed and applied for the determination of the dependence of chemical compositions of the crystals on the growth conditions. Powder XRD technique was used for the study of crystal structure and characterization of defects in the crystals.

Polarized spectroscopic properties of the doped crystal were studied at room temperature. Polarized absorption spectra manifested a weak anisotropy of absorption properties. A strong absorption band corresponding to $^2F_{7/2} \rightarrow {}^2F_{5/2}$ transition of $Yb^{3+}$ ions in $Ca_3Y_2(BO_3)_4$:Er,Yb crystal was centered at 976 nm, with the maximal absorption coefficient of 6.8 $cm^{-1}$ for light polarization E//*b*. The luminescence decay time of $^4I_{13/2}$ erbium level was measured to be of 580 μs. The measured lifetime was significantly shorter than that calculated from the Judd–Offelt analysis (2.41 ms [3]). The luminescence quantum yield for the $^4I_{13/2}$ manifold of $Ca_3Y_2(BO_3)_4$:Er,Yb crystal was estimated about 24%. Thus $Ca_3Y_2(BO_3)_4$:Er,Yb crystal are expected to be suitable for application as gain medium for diode pumped 1.5 μm lasers.

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[3] B. Wei et al, *Materials Research Innovations* **11(**3) (2007) 154.