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DEFECT STRUCTURE FORMED AT DIFFERENT STAGES OF GROWTH PROCESS IN ERBIUM, CALCIUM AND HOLMIUM DOPED YVO_4 CRYSTALS

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Yttrium orthovanadate (YVO_4) is one of the most important laser host materials due to high quantum efficiency and low excitation level when doped with rare earth ions. It is especially useful in micro-laser systems pumped with semiconductor laser diodes. In these applications the crystals should be highly doped with the rare earth elements as erbium or holmium. YVO_4 is of zircon tetragonal structure with space group $I4_1/amd$ and lattice parameter $a = b = 0.712$ nm and $c = 0.629$ nm. The crystallographic structure enables efficient introduction of the required ions. Some recent results concerning growth of YVO_4 are described in Refs. [1-3].

The investigated samples were cut out from different regions of a number of Czochralski grown YVO_4 crystals, doped with erbium, holmium and calcium. The concentrations of the introduced dopants were 0.5 at. %, 5 at. %, and 0.4 at. %, respectively. Some samples were cut out from the regions of the spiral growth, which is one of the most important problems in technology of the crystals. The X-ray topographic methods exploring both conventional and synchrotron X-ray sources were used as the principal methods of characterization. The conventional X-ray Lang topographs were obtained both in transmission and back reflection geometry. The synchrotron investigations were performed in white X-ray beam and included taking the topographs through a fine mesh with a wire spacing of 0.7 mm, enabling precise evaluation of the lattice deformation.

Despite very large concentrations of the dopants the topographs obtained with all used methods did not reveal any segregation fringes. That proves a high homogeneity of chemical composition, corresponding to the segregation coefficient close to the unity. The main defects revealed in the topographs were the numerous subgrain boundaries, which density and character were different in various regions of the crystals. In the examined crystals we observed much lower density ($< 10^4$ cm^{-2}) of weak point-like contrasts (most probably attributed to dislocation outcrops), than in the case of formerly investigated undoped YVO_4 crystal [4].

The values and directions of lattice misorientation connected with the subgrain boundaries were most precisely revealed by the synchrotron back-reflection projection topographs exposed through a mesh, and to some extend by the synchrotron section topographs, and by the Lang conventional topographs as well. The evaluated misorientation values were in the range of 0.1-0.7°.

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