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TOPOGRAPHIC X-RAY CHARACTERIZATION OF GGG HOMOEPITAXIAL LAYERS WITH INTRODUCED DIVALENT IONS OF TRANSITION-METALS

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Optical properties of transition-metal (TM) doped materials have attracted significant attention for application in tunable mid-infrared lasers, for passive Q-switching of lasers operating in the near-infrared region and also as sensitizes for rare-earth ions up-conversion. Among transition metals activators the lasing potential of Cr and Ti ions are most widely used, nevertheless the others, like Co and Ni also exhibit promising optical properties, predestinating them for an application in solid laser systems.

In this paper, we report results of the study on structural perfection of epitaxial films of $Gd_3Ga_5O_{12}$ (GGG) doped with Co^{2+} and Ni^{2+} ions grown by liquid phase epitaxy (LPE). Our previous study on LPE growth of rare earth ions doped garnet waveguide films has indicated that LPE technique is a proper method to fabricate sold state laser structures. We have successfully prepared Cr^{4+} ions doped YAG and GGG layers as saturable absorbers in passively Q-switched epitaxial microchip laser structures [1]. The obtained micro laser performance has stimulated our research on epitaxial growth of Co^{2+}: YAG/YAG structures used as passive Q-switches for 1.54 μm Er: glass laser [2]. As a consequence, the results of Co^{2+}:YAG layers study have focused our attention on the possibility of using Ni^{2+}:GGG and Co^{2+}:GGG layers as passive Q-switches for solid state laser operating in 1.1 – 1.5 μm range. In order to obtain cobalt or nickel ions in the appropriate valence state it was necessary to compensate the electric charge by optically inert ion such as Ge^{4+}.

Epitaxial layers of Ni,Ge: GGG and Co,Ge: GGG films grown on GGG substrates by means of the LPE method have been studied by conventional high resolution X-ray diffraction (HRXRD), synchrotron X-ray topography and optical spectroscopy.

Synchrotron topographic studies were performed using both monochromatic (E2) and white beam (F1) topographic stations at Hasylab. In the case of monochromatic beam topographs were taken at different points of the rocking curve, providing alternative images of defects in the substrate and in the layer.

The most important defects revealed by topographs were the segregation fringes, facetted regions and threading dislocations continued in the epitaxial layers.

High structural perfection and good optical quality of epitaxial Ni,Ge: GGG and Co,Ge: GGG films grown by means of LPE method has been confirmed. The method of controlled incorporation of cobalt and nickel ions in combination with charge compensating germanium ions into garnet layers has been successfully tested, thus, opening good perspectives for its application in the solid state laser technology.

References

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