GROWTH OF THICK EPITAXIAL YAG:Cr^{4+} FILMS FOR PASSIVE Q-SWITCHING OF MICROCHIP LASERS

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Yttrium-aluminium garnet (YAG) crystals doped with Cr^{4+} ions are used as a saturable absorption Q-switches of Nd:YAG lasers at 1.064 μm. As an alternative to bulk crystals the YAG:Cr^{4+} epitaxial films grown on Nd:YAG wafers are used for monolith passively Q-switched microchip lasers fabrication [1]. To perform Q-switching they must have enough concentration of phototropic centers Cr^{4+} in tetrahedral sites of the garnet lattice and to be thick enough without any inhomogeneities. The present work is devoted to study how the epitaxial growth conditions influence on the crystalization mechanism and the surface morphology and final concentration of phototropic centers as well as how the high-temperature after-growth annealing in air can improve the saturable absorption ability.

Epitaxial films of YAG:Cr^{4+} were grown on the (100)-oriented YAG:Nd substrate by routine isothermal LPE method from supercooled melt based on PbO-B_2O_3 solvent. The MgO was introduced into the melt to force the 4+ states for the Cr ions. The Cr^{4+} concentration in films was estimated by optical absorption coefficient α at λ = 1064 nm measured using spectrophotometer Shimadzu UV-3600. The effect of high-temperature after-growth annealing in air was studied at 800, 1000 and 1300°C on the films having mirror like surface.

Surface morphology of thick (more than 30 μm) epitaxial films was different depending from supercooling and film thickness and can be conditionally divided in three types. The mirror like surface take place under pure tangential growth mechanism at supercooling degree ΔT < 20°C for all films at any thickness up to 150 μm. Opposite case of dominant kinetic growth with hillocks throughout the film's surface occurs at supercooling ΔT > 30°C for thick films above some critical thickness. The moderate supercooling between 20 and 30°C results in mixed growth mechanism and arising of isolated hillocks in area extent of the film's surface.

Optical absorption study demonstrated that the increase of molar ratio Cr_2O_3/MgO in the melt decreases α_{1064} and decrease of Cr_2O_3/Al_2O_3 increases α_{1064}. The influence of high-temperature after-growth annealing in air on the Cr absorption structure may be qualitatively different at different temperatures and depends from melt composition and from growth conditions. The change of growth mechanism and influence of the melt composition and after-growth annealing on phototropic centers formation are discussed in comparison with known results of previous investigations.

References

[1] I. Izhnin, M. Vakiv, A. Izhnin, I. Syvorotka, S. Ubizskii, I. Syvorotka Jr. *Proc. SPIE, Lasers and Applications*, **5958** (2006) 595823.