Growth and Characterization of Titanium Doped Spinel Crystals

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Recently there appear the interest for growth and investigation of properties of titanium doped magnesium aluminates spinel (Ti:MAS) crystals for possible laser application [1-3]. It was turned out that the optical properties of grown crystals are depended on the growth conditions. Grown by Verneuil method Ti:MAS crystals demonstrates absorption bands at 790, 490 nm and strong absorption in UV range. In absorption spectra of crystals grown by micro-pulling-down method Ti:MAS of different titanium concentration also three bands were observed [2]. But crystals grown using the floating zone method under oxidizing atmosphere have no absorption bands except UV-range [3]. The luminescence properties of grown crystals are also different. In this paper we have grown Ti:MAS crystals doped with titanium at concentration 0.1 – 0.5 mass% using Verneuil method which were non-uniformly colored in bluish and investigated optical properties.

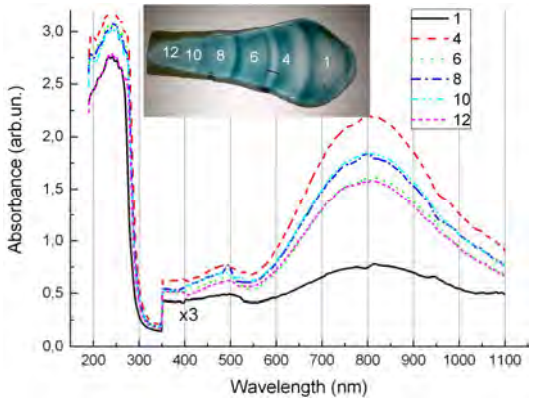

Fig. 1. Cross section view of Ti:MAS crystals doped with titanium 0.2 mass%

The crystals sizes of 30-40 mm in length and about 20 mm in width were obtained at growth rate about 20 mm per hour. The measured lattice parameter a= 0.7996±0.0004 nm which corresponds to crystal lattice of non-stoichiometric spinel $MgO{\cdot}2.5Al_2O_3$. No variation in spinel composition across the boule was registered. Optical absorption spectra and radio luminescence of Ti:MAS crystals have been investigated in order to find out the nature of bluish coloration in obtained crystal. The absorption spectra of spinel crystals doped with titanium contains strong and wide band of maximum at 800 nm, low intensity asymmetrical band at 480 nm. In the UV range a strong absorption edge arising from 300 nm is observed and red shift of this edge increases with growth of titanium concentration. There was registered the correlation of the red shift with intensity of optical absorption band at 800 nm. No variation of titanium atoms concentration measured by X-ray fluorescent analysis along the crystal growth direction was observed, Also, the variation of optical absorption band at 800 nm is correlated to content of iron atoms. The measurement of absorption spectra of Ti:MAS crystals intentionally irradiated with X-rays and/or UV light allow us to distinguish several absorption bands in UV-range related to presence of titanium ions.

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