Growth and Investigation of Colorless Lithium Tantalate Single Crystals for Optoelectronics

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Lithium tantalate ($LiTaO_3$, LT) ferroelectric single crystal is isostructural to lithium niobate ($LiNbO_3$, LN) crystal and has properties similar to it. Despite a number of advantages compared with LN (higher temperature stability of properties, higher electro-optical coefficients values, etc.) usage of LT is not so extensive as LN. This occurs particularly due to the higher melting temperature (T_m = 1650 ^oC) and significantly lower Curie temperature (T_C ~ 660 ^oC).

Because of the relatively high T_m the growth of LT crystals is carried out usually in the Pt-Rh crucible. But Rh, entering into the crystal causes formation of color centers which result in LT becomes dark brown. For use in acoustoelectronic color of LT does not a matter but for use in acoustooptics or electrooptics elements made of crystal must have high transparency in the visible range of the spectrum. This problem can be solved if the LT growth process occurs in the Ir crucible. The paper presents results of experiments on growing $LiTaO_3$ from iridium crucibles and further study of obtained crystals.

High purity powder raw materials were used for the $LiTaO_3$ growing. Powder was pressed in tablets before loading into the crucible. Growth was carried out by the Czochralski method on Physiterm (France) fasilities. Special thermal unit was designed to provide the necessary temperature distribution field and as well as its gradient. The growth was carried out on oriented seed in X, Y and Z crystal directions. Optimal crystal pulling and rotation rates during crystal growth were determined.

As a result, single crystals with diameter of 60 mm and 60 mm length were obtained. Grown crystals were annealed in air at 1200 °C for 24 hours. The procedure monodomainization of the single crystal was performed in an external electrical field at temperature about 700 °C using platinum electrodes. Single domain state checking was carried out by optical methods.

Active element for acousto-optical, electro-optical and acoustoelectronic devices were made from single domain crystal. Crystal machining modes and characteristics of the treated surfaces are established. Their optical homogeneity was investigated. Optical absorption spectra of crystals were registrated including OH groups region. Antireflection coating structures on certain wavelengths for LT optical elements were calculated. It was concluded that $LiTaO_3$ grown crystals are quite suitable for manufacturing optoelectronic components.

This work performed in the frames of State Order of Ukraine and partially supported by DB/EMSh project of Ukrainian Ministry of Education and Science.