Influence of Thermal Deformation Processes on Temperature Parameters of Nonlinear Optical Frequency Conversion in LBO Crystal

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Abstract—High values and high anisotropy of thermal expansion coefficients proved to be the properties of lithium triborate (LiB₃O₅, LBO) crystal. The aim of this work was to measure how crystal working face varies with temperature. Our results show that the working face inclination leads to a greater change in the direction of laser radiation propagation if compared with angular phase-matching bandwidth.

High values and high anisotropy of thermal expansion coefficients proved to be the properties of lithium triborate (LiB₃O₅, LBO) crystal. These coefficients are as follows: \( \alpha_x \approx 120 \cdot 10^{-6} \, ^\circ C^{-1} \), \( \alpha_y \approx -95 \cdot 10^{-6} \, ^\circ C^{-1} \), \( \alpha_z \approx 35 \cdot 10^{-6} \, ^\circ C^{-1} \). They do not affect all the frequency conversion processes for cuts along principle crystallographic axes. As for the general crystal cuts, thermal expansion coefficients have no direct influence on phase-matching conditions. However, in this case, one can observe thermal deformation processes leading to crystal form deformation. At that, depending on method of crystal fixation, i.e. fixation by working face or by side face, the front face can have different orientations relative to the axis of input laser radiation. So, input radiation can have different angles of refraction.

The aim of this work was to measure how crystal working face varies with temperature. Our results show that the working face inclination leads to a greater change in the direction of laser radiation propagation if compared with angular phase-matching bandwidth. The sign of this change depends on the method of crystal fixation.

Experimental investigation of frequency conversion was performed for third harmonic generation (THG) of laser radiation (see Fig.1). Different types of crystal fixation (Fig.1: curve 1 – by working face, curve 2 – by side face, curve 3 – by upper face) gave different temperature bandwidths.

Brief overview of the above properties was published in [1,2]. This work gives more detailed theoretical and experimental data.