THERMOOPTICAL PROPERTIES OF PLZT CERAMICS: COMPUTER SIMULATION AND EXPERIMENT

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The possible observation of self-action of laser beams in the ferroelectric materials is extremely enhanced due to drastic changes of linear and nonlinear optical susceptibilities in the region of the ferroelectric phase transition. Transparent large-graine PLZT ceramics is well known as useful material to demonstrate different effects of such thermal self-action of the laser beams.

We report numerical simulation based detailed analysis of our previous experimental results demonstrating the thermal self-focusing, self-deflection /1/ and self- transparency /2,3/ of laser beams in PLZT ceramics.

Equation of thermal conductivity for the PLZT ceramic plate has been solved numerically by finite differences in cylindric coordinates. Gaussian laser beam serves as heat source in the volume of the sample. In our model, for temperatures above phase transition, light scattering drops from its initial value to 0, but light absorbtion remains constant. Specific heat near the phase transition is assumed to depend on temperature.

Temperature rise profiles vs time in the sample volume were calculated and plotted in Fig.1. As it is seen, the basic features of light-induced transparency are described in terms of a propagating boundary between two states in the bulk of the sample. Sample transmission vs time at the centre of the laser beam is estimated and we find good agreement with results of our previous experimental selftransparency studies in PLZT 8/65/35 showing the characteristic transmittance build-up time in ms range if the intensity at the centre of Ar^+ laser beam amounts 1 kW/cm^2 /2/.

Additional experiments to study temporal and spatial properties of the self action of the visible and near-IR laser beams has been provided by means of optical second harmonic generation (SHG) probe. Continuously pumped actively mode locked and Q-switched Nd:YAG laser (1,06 μm, operating at 1 kHz repetition rate of 100 ps pulse trains) was focused into the transparent region of the sample. Generated SHG signal was monitored in different scattering directions via interference filter by photomultiplier and boxcar averager. Such a nonlinear-optical test with temporal and spatial resolution served as a tool for mapping and imaging of the polar phase in the region of focused laser beam into the bulk of PLZT sample.

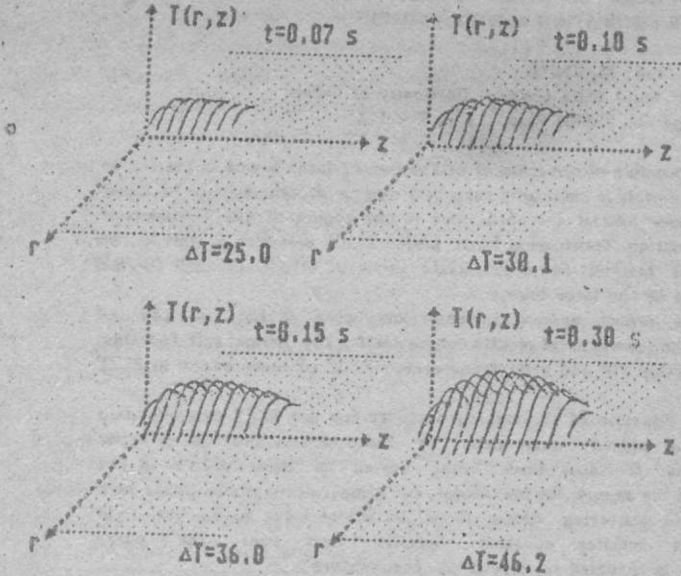

Figure 1. Temporal evolution of temperature rise profiles in the bulk of the PLZT 8/65/35 ceramics. Incident laser beam is directed along Z-axis; t - time after laser onset, ΔT - corresponding maximal temperature rise at the beam centre. Solid lines denotes transparent (nonscattering) state , dotted lines - strongly scattering (opaque) state.

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