the laser-pulse energy E consumed in the production of the shock wave

$$E = \rho(\frac{5}{2} D_{cr})^3 t_{cr}^3,$$

where ρ is the initial gas density.

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ABSORPTION OF ULTRASOUND IN A KDP CRYSTAL NEAR ITS PHASE TRANSITION TEMPERATURE

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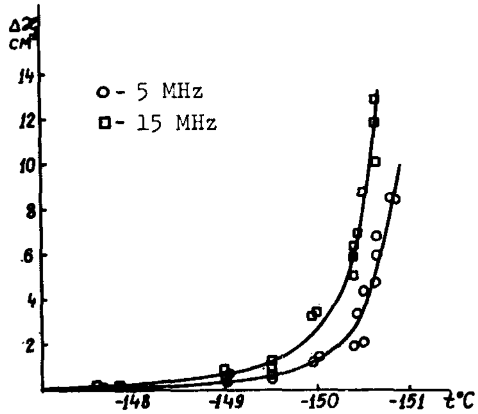
Among the many singularities that take place in second order phase transitions in crystals, interest attaches to the intensification of the relaxation absorption of sound. This phenomenon, which is due, as is well known [1], to the sharp increase in the relaxation time of the thermodynamic non-equilibrium states of the medium as the latter approaches the phase-transition temperature, has already been investigated in many crystals [2-8]. We chose as the object of our investigation potassium dihydrophosphate, which experiences at t = -150°C a phase transition close to the critical Curie point [9].

An analysis of the thermodynamic potential of this crystal, with allowance for its concrete piezoelectric properties and symmetry, and also of the experimental data on the anomalous behavior of the piezoelectric modulus d_{36} in the direct vicinity of the transtion point [9], has made it possible to propose that a sharp increase in the absorption of an acoustic shear wave of definite polarization (y_x) should occur when the crystal temperature approaches its phase transition temperature. This should be a relaxation process, since it is connected with loss of energy of the acoustic wave to the relaxing piezoelectric polarization of the crystal.

To confirm this assumption, we set up an experiment whose scheme consisted of the following: A KDP crystal ~3 mm thick was placed in a special cryostat, which made it possible to obtain and stabilize the required temperature. Shear-wave pulses of frequency 5 and 15 MHz, duration 2 μsec, and off-duty cycle 1 msec, propagating along the x axis and polarized along the y axis of the crystal, were radiated by a quartz transmitter. After passing once through the crystal, the acoustic pulse was received by a second quartz crystal, fed to an amplifier, and recorded with an oscilloscope. During the course of the experiment, we measured the relative change of the amplitude of the sound signal passing through the crystal.

The figure shows the temperature dependence of the difference $\Delta\kappa$ of the amplitude absorption coefficient κ near the phase-transition temperature, and of the absorption coefficient at a temperature remote from the Curie point, at the frequencies 5 and 15 MHz.



As seen from the figure, at both frequencies an increase was observed in the sound absorption coefficient on approaching the phase-transition point. The absorption in the ferroelectric low-temperature phase is apparently connected with the formation of a finely-dispersed domain structure in the crystal, hindering the passage of the acoustic signal through the domain boundaries, or else with hysteresis losses accompanying the polarization.

A control experiment was performed with the z_x wave. Neither a peak of the absorption coefficient nor an increase of the coefficient in the low-temperature ferroelectric phase of the crystal was observed during the course of the control experiment.

Experiments on the absorption of longitudinal acoustic waves revealed a peak of the absorption coefficient near the transition point, as expected in accordance with [5]. Details of the latter effect, which was observed by us also in Rochelle salt, will be described by us elsewhere.

Since we do not have at present experimental data on the temperature dependence of the elastic constant C_{66} for KDP [9], and since we did not perform measurements with crystals differing appreciably in thickness, we disregard for the time being the changes of the reflection coefficient of the acoustic waves from the crystal boundaries near its phase transition point.

In conclusion, the authors are grateful to T. S. Velichkina and I. A. Yakovlev for continuous interest in the work and a discussion of the results, and also to V. M. El'shin for help with the experiment.

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