current [1, 4, 5]. With the argon pressure in the cold part of the system approximately 0.4 mm Hg, the discharge current in each tube was 390 A. The output power was 500 W at an efficiency relative to the discharge (including the voltage drop at the electrodes) exceeding 0.2%. The generation power was measured by a calorimetric method with accuracy ±10%. In addition to the stronger generation lines with λ = 5145 Å and λ = 4880 Å, the emission spectrum contained also lines of wavelength 5017, 4965, 4765, and 4579 Å.

4. With repeated switching, the laser operated a total of 140 hours before the cathode failed. The working lifetime can undoubtedly be increased by improving the cathode. Although the field power in the resonator was high (5 kW), no output-power decrease due to any changes in the resonator mirrors was observed. This is a particularly important fact, and clearly illustrates the advantages of the principles employed here to obtain high-power discharges for gas lasers, since usually the damage suffered by the discharge tubes and by the electrodes in high-power ionic lasers is quite appreciable, soils the optical-resonator elements, and prevents normal operation of the resonator. According to published data [6], the actual service life of the most powerful argon lasers with 100 W output power amounts therefore to several minutes, an obstacle to the scientific and practical utilization of high-power argon lasers.

We note in conclusion that in addition to good output characteristics and relatively long service life, the laser described here is comparatively easy to construct and can be used for a variety of scientific and practical applications in which high-intensity stationary light fluxes are needed.

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LIGHT SCATTERING IN A KH_2PO_4 CRYSTAL UNDERGOING A HIGH-TEMPERATURE PHASE TRANSITION

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We investigated light scattering in a KH_2PO_4 crystal undergoing a phase transition at ±175°C. We show that the total intensity of the scattered light decreases near the transition point. An investigation of the fine structure of the scattered-light line has made it possible to determine the temperature dependence of the hypersonic-wave velocity.

A phase transition at a temperature near 175°C was observed in KH_2PO_4 crystals [1], as revealed by the strong temperature dependence of the dielectric constants of the crystal. Blinc and co-workers [2] have investigated this phase transition by proton magnetic resonance, by x-ray scattering, by cold-neutron scattering, and by determining the infrared absorption spectra. The temperature dependence of the dielectric constants of the crystal and of the infrared reflection spectra near the phase-transition point was investigated in [3]. It was established that below the phase-transition point the H_2PO_4 groups rotate about one axis, and this calls for overcoming the potential barrier of two hydrogen bonds. Above the transition temperature, hindered rotation of the H_2PO_4 groups about all three axes sets in, and this involves overcoming hindrances exerted by all four bonds. The change of the crystal enthalpy, $\int_{171}^{200} \Delta C_p \Delta T$ = 1.1 kcal/mole, indicates that a first-order phase transition takes place in the crystal.

We have investigated the high-temperature transition of the KH_2PO_4 crystal by the light-

scattering method. We measured both the integrand intensity of the scattered light and its spectral composition. The single crystals were cut in the form of blocks ∿ 3 cm^3 in size and were placed in an accurately temperature-controlled oven with a small spatial temperature gradient. Recognizing that the studied phase transition is very close to the crystal decomposition temperature, we paid particular attention to the temperature conditions of the experiment. Near the transition temperature, the rate of heating of the samples was 0.7 deg/h. At such a heating rate we were able to go through the transition without causing the crystal faces to become dull. The sample weight remained constant within 0.01% during the course of the experiment. The light source was an He-Ne gas laser. To measure the integrated intensity of the scattered light we used crystal blocks differently oriented relative to the crystal axes. The directions of the exciting and scattered light beams were varied relative to the crystal axes. The scattered light was registered at 90° to the incident light. The results obtained in all cases were close. Figure 1 shows typical temperature dependences of the integrated intensity of the scattered light. The ordinates represent the ratio of the intensity of the scattered light at the temperature of the experiment and at 170°C. Each experiment was performed with a new sample that had not undergone a phase transition, since the intensity of the scattered light remained the same as before the transition after the crystal was cooled to room temperature, and no change of the intensity of the scattered light was observed when the experiment was repeated. It is seen from the plots that the phase-transition temperature changes somewhat from experiment to experiment, apparently as a result of overheating the crystal.

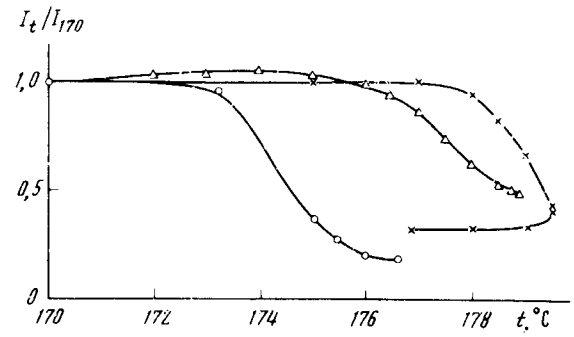

Fig. 1

In addition to measuring the integrated intensity of the scattered light, we investigated the fine structure of the spectral line of the scattered line. The spectral resolution was effected with a Fabry-Perot interferometer. The crystal was cut in such a way that the primary light beam propagated normally to the crystal x axis, which in turn was in the plane of the exit face of the crystal, perpendicular to the scattering plane. The crystal y and z axes, which were in the horizontal scattering plane, were inclined 45° to the exciting and the scattered light beams. Thus, the Mandel'shtam-Brillouin spectral line components were due to longitudinal Debye elastic waves propagating along the z axis of the crystal.

The velocity of these elastic waves is determined by only one elastic modulus C_{33}, namely $v = \sqrt{C_{33}/\rho}$, where ρ is the density of the crystal. Consequently, measurement of the spectral shifts of the Mandel'shtam-Brillouin components has made it possible to determine the temperature dependence of the elastic modulus C_{33} at the hypersonic frequency in the vicinity of the phase-transition point.

Investigation of the fine structure has shown that the decrease in the integrated intensity of the scattered light in the region of the phase transition is due mainly to the change in the intensity of the central unshifted component of the spectral line. The phase transition therefore increases the optical homogeneity of the crystal.

Figure 2 shows the temperature dependence of the shift of the Mandel'shtam-Brillouin components (in Å - solid curve) and the temperature dependence of the elastic modulus C_{33} (dashed curve); the changes of the top quantities are fully reversible.

It follows from these data that near the phase-transition point the velocity of the hypersonic wave decreases in accord with the decrease of the modulus C_{33}.

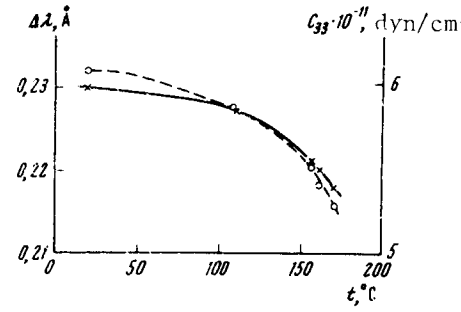

Fig. 2

We are grateful to A. S. Sonin for supplying an optically perfect KH_2PO_4 single crystal, and to B. A. Reznikov for help in preparing the samples.

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STIMULATED EMISSION OF NEODYMIUM IONS IN QUARTZ GLASS

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Stimulated emission from neodymium-doped quartz glass having a coefficient of thermal expansion 6×10^{-7} deg^{-1} is reported for the first time. It is found that this material is not inferior in its spectral and luminescence characteristics to commercial silicate glass with neodymium.

In the few papers describing attempts to introduce rare-earth ions in quartz glass for the purpose of obtaining an effective luminescenct material with high thermal endurance, it is noted that the activator, particularly Nd^{3+}, is not uniformly distributed in the matrix, and experiences in this case a strong concentration quenching [1, 2].

The maximum activator concentration that could be obtained in quartz glass without visible stratification was quite negligible (tenths of a per cent by weight), but the luminescence quantum yield was much lower ($\sim$ 1%) than at the same concentration in commercial silicate glasses (20 - 30%). Nonetheless, the practical need for lasing material with high thermal endurance have induced us to continue the search in this direction.

We report here the first attained lasing of Nd^{3+} in quartz glass with a thermal-expansion coefficient 6×10^{-7} deg^{-1}. The use of a new technique of introducing the activator into the quartz-glass matrix, in conjunction with addition of a buffer component, has made it possible to obtain samples without stratification (without opalescence and dulling), with activator concentrations up to 1 mol.% Nd_2O_3. The investigation of the absorption and luminescence spectra, of the lifetime and of the quantum yield, and of the oscillator strengths and of the stimulated-transition cross section, have shown that when it comes to these parameters the quartz glass is not inferior to commercial multicomponent silicate glasses with neodymium (Fig. 1, table).

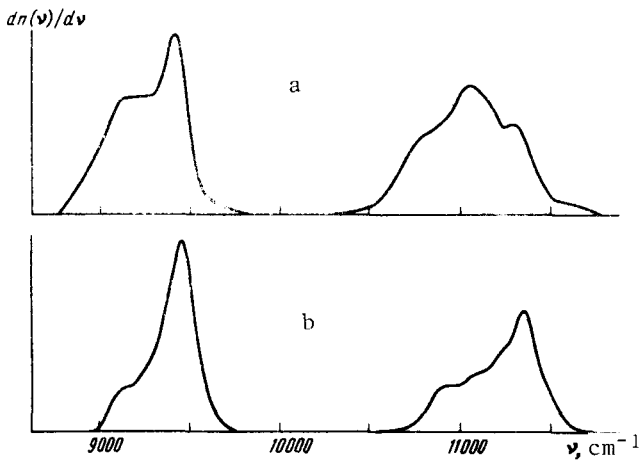

Fig. 1. Luminescence spectrum near 0.9 and 1.06 μ: a) quartz glass with neodymium, b) commercial glass (GLS-2) at 300°K. The spectra are corrected for the spectral sensitivity of the receiver.

We have performed lasing experiments on samples of 10 mm diam and 100 mm length, with Nd_2O_3 concentration 1.3 wt.%. In a nearly-confocal resonator, with mirrors of 500 mm radius, we obtained the spectrum and time variation shown in Figs. 2a and 2b. The transmission of the output mirror was 5%. The generation threshold was reached at 330 J of electric pump energy. The UV component of the pumping light was not filtered out. The center of the lasing spectrum corresponds to 1062 nm, which coincides with the maximum of the luminescence band (Fig. 1). Attention is called to the appreciable width of the spectrum even at slight excesses above threshold. At a fourfold excess above threshold, the width of the spectrum is approximately 100 Å. This is due primarily to the appreciable inhomogeneous broadening of the $^4F_{3/2} \rightarrow {}^4I_{11/2}$ band of Nd^{3+} in the quartz glass. The relatively high generation spectrum is due, besides to non-optimal test conditions, also to the appreciable inactive absorption in the samples at the generation wavelength. The use