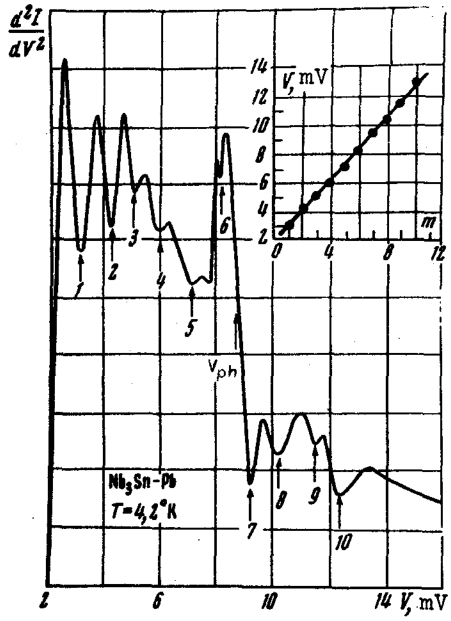

Fig. 2. Plot of d^2I/dV^2 vs. V for an Nb_3Sn-Pb junction at a voltage $V > (\Delta_{eff} + \Delta_{Pb})$. The numbers are those of the harmonics of Δ_{eff}. $V_{ph} = \Delta_{ph} + \Delta_{eff} + \Delta_{Pb}$. The insert shows the dependence of the positions of the minima of d^2I/dV^2 on the number of the harmonic.

Besides the indicated jump of d^2I/dV^2, detailed investigations of many junctions suggest the presence of a second small jump of d^2I/dV^2 in the region $\Delta'_{ph} \approx 3.5$ meV. Its amplitude is much smaller and it appears distinctly only in those cases when the amplitude of the gap harmonics is small. We assume that this second jump of d^2I/dV^2 is also connected with the maximum of the phonon density of states in Nb_3Sn.

4. At voltages $V > 2\Delta$, harmonics $V_m = m\Delta_{eff}$ were observed in some cases for Nb_3Sn-Pb junctions. These harmonics are marked by arrows on Fig. 2. We have observed these harmonics up to m = 10. All the minima on the d^2I/dV^2 curve agree well with the foregoing linear dependence. It is possible that they are connected with the inelastic interaction of a pair of tunneling electrons with the superconducting pairs.

In conclusion, we consider it our pleasant duty to thank V.L. Ginzburg, I.O. Kulik, E.G. Maksimov, and D.I. Khomskii for a discussion of the present results and I.S. Levchenko for preparing the Nb_3Sn films.

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EFFECTIVENESS OF EXCITATION OF LASING IN AN $F_2 + H_2$ MIXTURE BY A BEAM OF RELATIVISTIC ELECTRONS

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To obtain the maximum parameters of a pulsed chemical laser using an $F_2 + H_2$ mixture it is necessary to increase considerably the volume and pressure of the working medium. The method whereby the reaction is initiated in this case should ensure a considerable energy input to the active volume within a time approximately equal to the vibrational relaxation time (τ_{rel}) of the excited HF molecules. At p ∿ 1 atm we have

$$\tau_{rel}HF \sim 10^{-7} sec /1/.$$

We describe below the results of an investigation of the integral energy characteristics of an $F_2 + H_2$ laser excited by a beam of relativistic electrons.

Figure 1 shows the schematic diagram of the experimental setup. A beam of relativistic electrons from the RIUS-5 accelerator (electron energy E = 2 MeV, beam current 4 kA, pulse duration t ∿ 5 × 10^{-8} sec) was introduced into the laser cavity (1) perpendicular to its axis through two titanium foils (7) 5 μ thick. The length of the active part of the cell was 5 cm and the cross section 1.5 × 1.5 cm. The cell was made of copper. The internal chamber was cooled with liquid nitrogen to 150 - 100°K and insulated from the ambient by a vacuum jacket to protect the fluorite windows (11) of the cell against condensation of atmospheric moisture. At a temperature 150 > T > 100°K the mixture of fluorine with hydrogen remained stable up to 600 Torr pressure. The fluorine and hydrogen were cooled beforehand to the same temperature and admitted at a rate dictated by the construction of the gas system, which did not exceed 10 Torr/sec.

The optical resonator consisted of a spherical (R ∿ 2 m) total-reflection mirror coated with gold (3) and a germanium plate (3').

The bulk of the laser radiation was registered with an IEK-1 calorimeter (4). A plane-parallel quartz plate (9) diverted part of the radiation to a GeAu detector (6) shielded against parasitic γ radiation by a lead housing. The signal from the detector was registered with an S-1-29 oscilloscope. The time constant of the measuring system was 10^{-6} sec.

The optical system was adjusted with an LG-126 laser at two wavelengths (λ_1 = 0.63 μ, λ_2 = 3.39 μ). The generation pulse duration was ∿20 × 10^{-6} sec.

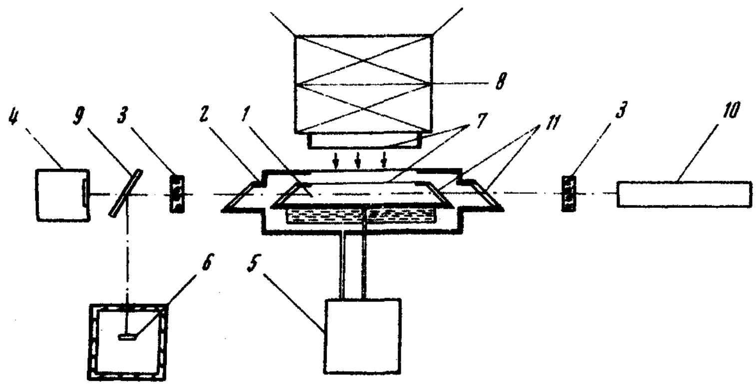

Fig. 1. Diagram of setup: 1 - laser cavity, 2 - outside chamber, 3 - germanium plate, 3' - total reflection mirror, 4 - IEK-1 calorimeter, 5 - system for the admission and evacuation of the gas mixture, 6 - GeAu detector, 7 - titanium foil, 8 - magnetic lens of accelerator, 9 - plane-parallel quartz plate, 10 - adjusting laser (LG-126), 11 - CaF_2 windows.

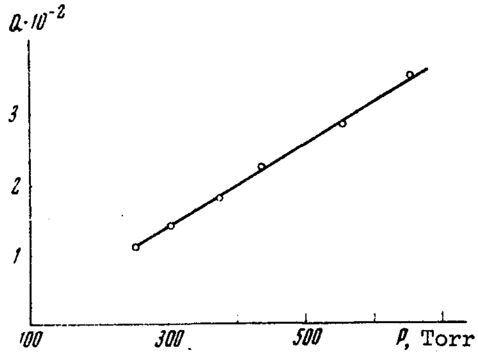

Fig. 2. Generation energy at different pressure of the $F_2 + H_2$ mixture.

The generation threshold was reached at a mixture pressure ∿150 - 200 Torr. The generation pulse parameter were unstable near the threshold and were sensitive to fluctuations of the electron-beam parameters. In those cases when the mixture pressures exceeded the threshold value, the reproducibility from pulse to pulse was good.

Figure 2 shows the dependence of the laser-radiation energy on the pressure of the initial mixture. The linear character of this dependence indicates that the energy of the laser radiation is directly proportional to the beam energy absorbed in the mixture.

It was impossible to raise the pressure above 600 Torr. The passivization of the cell walls apparently gets worse following electron bombardment. This leads to random explosions of the mixture (neither the calorimeter nor the GeAu detector registers laser radiation). In such cases, the cell windows become covered with a deposit that is opaque to visible and infrared radiation.

The electron-beam energy loss in the titanium foils that decouple the reaction volume from the ambient were determined experimentally. To this end, the chamber was replaced by a thick sheet of duraluminum in which a window covered on both sides with titanium foils was cut, with full geometrical similarity maintained. It turned out that about 30% of the total beam energy reached the reaction volume.

The amount of energy absorbed in the active medium was calculated from the known density of the mixture and from the known electron energy. The ratio of the laser-radiation energy (Q_{las}) to the beam energy absorbed in the active medium (Q_{abs}) was 1.5 - 1.8.

It should be noted that the energy efficiency Q_{las}/Q_{abs} remained constant in the investigated range of pressures (200 - 600 Torr). The absolute value we obtained for the efficiency is apparently not the maximum, since no measures whatever were taken to optimize the resonator.

The experiments indicate that the use of electron beams to initiate chemical reactions in laser media is promising. An investigation of the concrete mechanisms of the reactions leading to the dissociation of the fluorine will apparently make it possible to create conditions improving the effectiveness of beam energy utilization.

In conclusion, the authors thank G.G. Dolgov-Savel'ev for suggesting the problem and S.B. Vasserman for the opportunity to work with the RIUS-5 accelerator.

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