Table II

λ, nm	Liquid laser eff. %	Liq. laser energy, J	Sec. harm. UV energy, J	η', % in energy	Emission power, MW
559,6	34.4	0.172	0.0036	2,1	0,180
565,0	43.0	0.215	0.0060	2.8	0,300
570,5	48,8	0.240	0,0074	3,1	0,370
574,0	51,0	0.255	0,0084	3,3	0,420
576,3	47,6	0,238	0,0072	3,0	0,360
582,0	36,7	0,1815	0,0042	2,3	0,210
588,5	29.5	0,1465	0,0028	1,3	0,140
595,0	28,1	0,1405	0,0026	1,8	0,130

Note: Neodymium-laser second-harmonic energy 0.5 J.
Liquid-laser emission duration ∿25 nsec.
Liquid-laser second-harmonic duration ∿20 nsec.

emission-spectrum variation of various dyes is illustrated by the spectrograms in the figure. The maximum efficiency of conversion into the second harmonic amounted to 0.53% in this case, the second-harmonic emission duration was ∿20 nsec, and the power was 0.09 MW.

To increase the UV radiation power, the spectrum of the liquid laser was decreased to 0.1 nm with the generation efficiency kept high by introducing a dispersion prism into the dye-laser resonator, in analogy with [5]. The characteristics of the lasing of rhodamine-6G and of its second harmonic, obtained in this case, are listed in Table II. The maximum dye generation efficiency occurred at λ = 574 nm and amounted to 51%, the energy efficiency of second-harmonic conversion (λ = 287 nm) was 3.3%, and the peak emission power at this wavelength was 0.42 MW.

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CONDUCTIVITY OF DOPED GERMANIUM AT INFRALOW TEMPERATURES

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Submitted 24 November 1971
ZhETF Pis. Red. 15, No. 1, 30 - 33 (5 January 1972)

As is well known, the conductivity of doped germanium at low (helium) temperatures is determined by the "impurity conduction" mechanism [1]. At low impurity concentrations this is the so-called "jump" conductivity, while at

larger concentration the impurity conduction mechanism has not been fully explained. In either case, however, the experimental plot of the logarithm of the resistivity against the reciprocal temperature, measured in the interval 4.2 - 1.3°K, is well approximated by a straight line, i.e., a constant activation energy ε is observed. This energy reflects the difference between the energies of the Fermi level and those impurity states that make the largest contribution to the conductivity. At lower temperatures, however, one can expect the largest contribution to the conductivity to be made by states lying closer to the Fermi level, i.e., the conduction activation energy should decrease continuously with decreasing temperature. In the case of the jump conductivity, Mott has shown that $\varepsilon \sim T^{3/4}$ or $\log \rho \sim T^{-1/4}$ [2]. A conductivity of this type was observed in amorphous germanium.

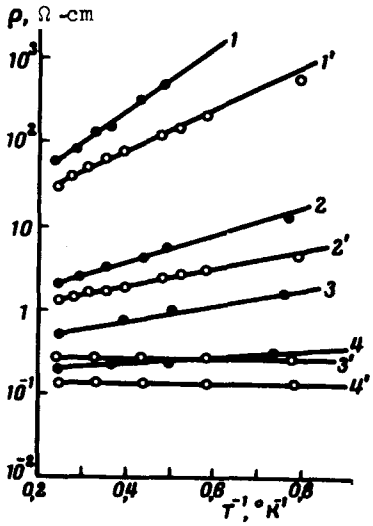

Fig. 1. Resistivity vs. T^{-1} in the usual temperature inverval (4.2 - 1.3°K), obtained by two different methods (explanation in text). The numbers at the curves correspond to the numbers of the samples with the following values of N_{Ga} (in cm^{-3}): 1 - 3.5×10^{16}, 2 - 8.2×10^{16}, 3 - 1.3×10^{17}, 4 - 2.0×10^{17}. $K = N_D/N_A = 0.40$ for all samples.

The purpose of the present study was to observe conductivity over states that come closer and closer to the Fermi level in the case of impurity conductivity. To this end, it was necessary to extend appreciably the temperature interval in which this conductivity was measured, into the region below 1°K. Special requirements were imposed also with respect to the homogeneity of the impurity distribution in the samples, to prevent the decrease of ε from being caused by the shunting of the sample by regions having higher impurity concentrations. We therefore chose for the investigation p-Ge samples in which shallow impurities were introduced into the "pure" material via nuclear transmutations produced by slow-neutron bombardment of the samples in an atomic reactor. The resultant p-type samples had different impurity concentrations, depending on the irradiation dose, but a constant compensation, K = 0.40 [3]. Special experiments have revealed that the distribution of the doping impurities is highly homogeneous in such samples.

An infralow temperature was obtained by adiabatic demagnetization of paramagnetic potassium chrome alum $CrK(SO_4)_2 \cdot 12H_2O$. The temperature was determined by measuring the magnetic susceptibility of the salt. Two methods were used to produce thermal contact between the sample and the block of paramagnetic salt. In the first, the salt block was made in the form of a cylinder with an axial hole. The sample was placed freely, without stress, inside the cylinder, and the current and potential leads, made of copper foil, were glued to the salt, thus ensuring good thermal contact at $T \geq 0.1$°K. In the second case, the sample was placed in a container with a water-glycerine solution of the alum. The solution solidified when cooled, causing hydrostatic compression of the sample. The thermal contact between the salt and the sample was in this case sufficiently reliable already at $T \geq 0.07$°K. The dependence of the resistivity ρ on T^{-1} for the four investigated samples, plotted in the interval 4.2 - 1.3°K by both methods, is shown in Fig. 1. It is seen from the figure that hydrostatic compression (the dark circles in the figures) increased ε, and also made it possible to transform two samples from the

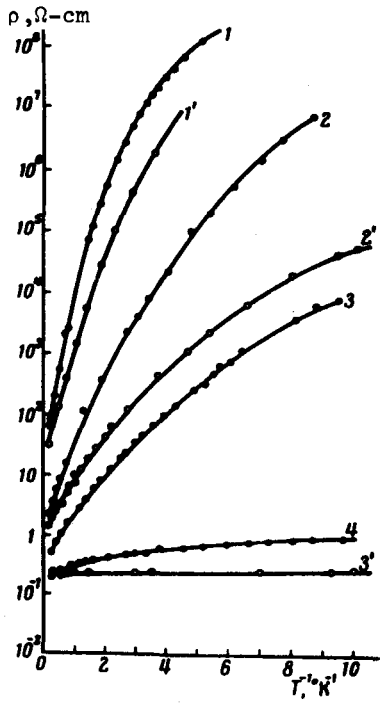

Fig. 2. The same plots as in Fig. 1 in a wider temperature range (down to 0.1°K).

metallic state into a state with $\varepsilon \neq 0$. Thus, the use of the second method resulted in a larger assortment of curves with the available samples.

Figure 2 shows the same plots of ρ against T^{-1} down to 0.1°K. It is seen from this figure that the activation energy of the impurity conductivity does not remain constant, but decreases continuously with decreasing temperature. For the weakly doped sample 1, the plot of the resistivity against the reciprocal temperature agrees well with the formula $\log \rho \sim T^{-1/4}$. With increasing concentration, the exponent increases, namely, $\log \rho \sim T^{-0.5}$ for sample 2 and $\log \rho \sim T^{-0.75}$ for sample 3. The fact that not all samples obeyed the $T^{-1/4}$ law predicted by Mott is not unexpected, since the conductivity of these samples is not described by the usual jump mechanism. It should be noted that the curves have a smooth form, starting with 4.2°K, so that the apparent linearity in the 4.2 - 1.3°K interval is due only to the narrowness of the temperature interval.

The investigation has thus shown that the impurity conductivity in doped germanium does not have a constant activation energy, and with decreasing temperature it is effected via states that come ever closer to the Fermi level.

The authors thank Professor S.M. Ryvkin, B.P. Zakharchenya, and B.I. Shklovskii for useful discussions of the results.

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EXPERIMENTAL INVESTIGATION OF TURBULENT PLASMA HEATING BY STRAIGHT-DISCHARGE SKIN CURRENT

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Submitted 25 November 1971
ZhETF Pis. Red. 15, No. 1, 33 - 36 (5 January 1972)

The experiments were performed with the TN-5 Probkotron mirror machine [1, 2] under conditions when the plasma-heating current was strongly concentrated in the skin layer. In the experiments, the radius of the plasma column was 10 cm (the measured thickness of the skin layer was ∿3 cm, see below), and the length of the plasma column was 300 cm. The amplitude of the straight discharge current was 20 kA, with a period of 7.5 μsec and an initial voltage 40 kV. The containing magnetic field of the Probkotron was 5 kOe (8 kOe in the mirrors). The preliminary plasma density was $n_0 \geq 7 \times 10^{13}$ cm^{-3}, and the initial energy content was $n_0 T_0 \leq 2 \times 10^{14}$ eV-cm^{-3}.

The total discharge current was measured with a Rogowski loop placed outside the plasma. The current density distribution over the cross section of the plasma column was measured with a set of seven single-turn magnetic probes