SUPERCONDUCTIVITY OF Te AT HIGH PRESSURES

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Bridgman has established, from measurements of the bulk compressibility [1 - 4], that Te has two polymorphic transitions at room temperature in the region from 0 to 100 kbar. The pressures of these transitions were found by Bridgman to be 39 - 40 kbar for the Te I → Te II transition and 69 kbar for the Te II → Te III transition.

By studying the behavior of the electric resistivity of Te at high pressures and at room temperatures, Bridgman [5] observed a drop in the resistivity, by several orders of magnitude, at a pressure P ∿ 29 - 40 kbar and proposed that the Te I → Te II transition is a semiconductor-metal transition. With further increase of pressure, no anomalies were found on the plots of the pressure dependence of the resistivity at room temperature, up to 100 kbar, by neither Bridgman [6] nor Vereshchagin and co-workers [6]. Later, Matthias [7] observed superconductivity of the Te II modification at P ∿ 56 kbar; the critical temperature of the superconducting transition was found by him to be T_c = 3.3°K.

We carried out investigations in the pressure range from 40 to 100 kbar, for the purpose of studying the superconductivity of the Te modifications that

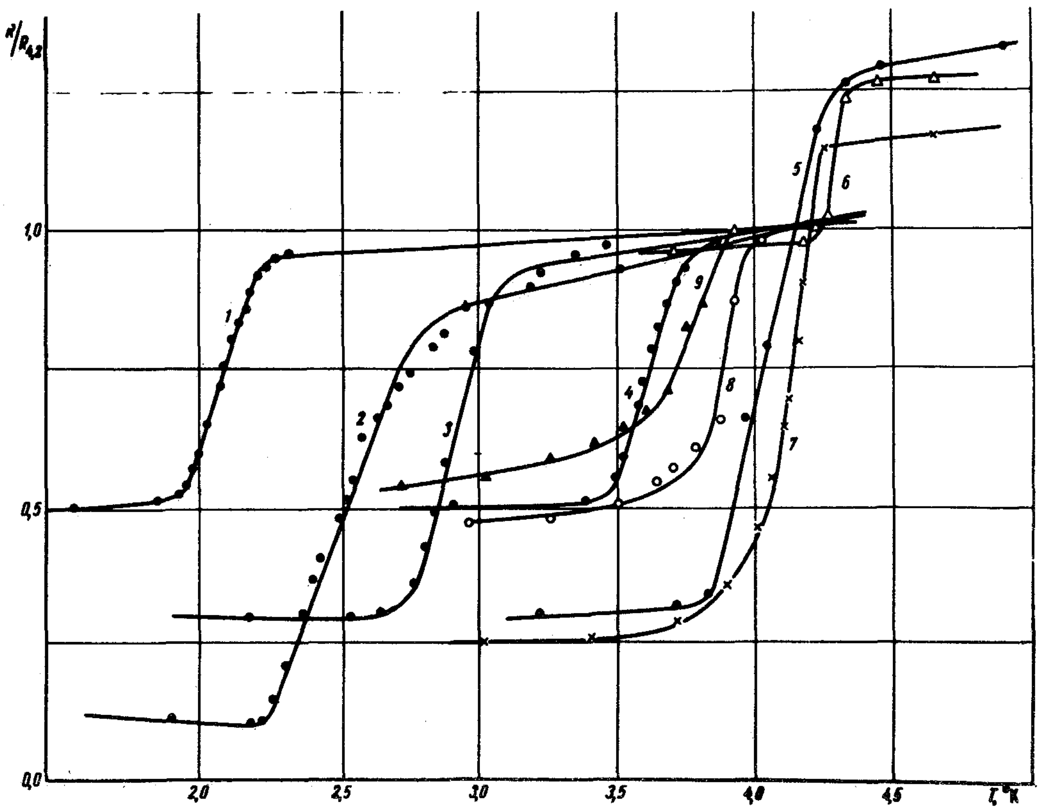

Fig. 1. Change of electric resistivity of tellurium samples going over into the superconducting state in the pressure range 40 - 100 kbar. Te II: 1 - 43, 2 - 48, 3 - 53, 4 - 61, 5 - 66 kbar. Te IV: 6 - 84, 7 - 88, 8 - 96, 9 - 100 kbar.

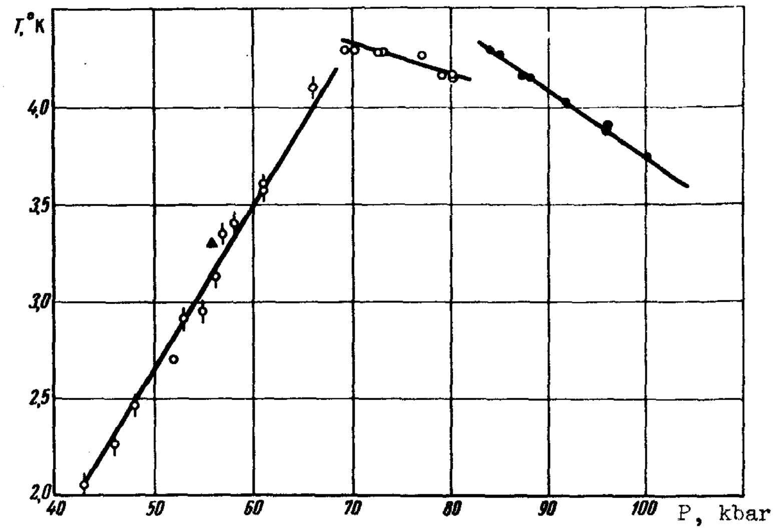

Fig. 2. Temperature of superconducting transition vs. pressure, for various modifications of Te, Δ - point from [7].

exist in this pressure interval. The measurements were made with a fixed-pressure setup similar to that described in [8]. The samples were cut from a single-crystal Te block with a hole density $p = (1 - 4) \times 10^{18}$ cm^{-3}. The transition to the superconducting state was determined from the drop of the electric resistivity. Temperatures of 4.2°K and above were obtained by heating a cold booster [8] over the surface of liquid helium in a Dewar, and were determined with the aid of a thermocouple of copper with a gold-iron alloy.

Figure 1 shows some of the temperature dependences obtained for the relative resistance $R/R_{4.2}$ of Te samples at different pressures.

Figure 2 shows the dependence of the temperature T_c of the superconducting transition on the pressure P in the entire investigated pressure interval. It is seen from Fig. 2 that in the case of Te the plot of T_c against P breaks up into three parts.

In the pressure interval from 40 to 70 kbar, Te exists in the modification Te II, which is superconducting both in accord with our data and in accord with the data of [7], with a superconducting transition temperature T_c = 2.05°K at 43 kbar and $dT_c/dP = (8.5 \pm 0.5) \times 10^{-5}$ deg/bar. The critical temperature of the Te superconducting transition, obtained in [7], fits well the plot of T_c against P obtained by us for this modification

In the pressure region ∿68 - 70 kbar, the plot of the critical superconducting temperature T_c vs. P changes its slope abruptly, thus confirming the existence of the polymorphic Te transition, first observed by Bridgman [3] in this pressure range. A new modification Te III is produced, which is also superconducting with T_c = 4.28°K at P = 70 kbar and $dT_c/dP = -(1.7 \pm 0.5) \times 10^{-5}$ deg/bar.

At a pressure 82 kbar, the plot of T_c vs. P becomes discontinuous, the critical temperature of the superconducting transition is T_c = 4.3°K at 84 kbar and $dT_c/dP = -(3.4 \pm 0.5) \times 10^{-5}$ deg/bar in the entire succeeding pressure interval up to 100 kbar.

We have thus confirmed the results of [7] concerning the superconductivity of the modification Te II, and established that the modification Te III is also superconducting. In addition, as already noted by us earlier [9], the study of the superconductivity has made it possible to detect the presence of a new modification, Te IV, which occurs at ∿80 kbar.

In conclusion, the authors thank Academician L.F. Vereshchagin for support and interest in the work, and N.V. Baryshev for taking part in the experiment.

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POLARIZATION OF Li^8 FRAGMENTS IN NUCLEAR REACTIONS PRODUCED BY SLOW π^- MESONS

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Splitting (one per ∿300 stopped π^- mesons) accompanied by formation of Li^8 fragments was observed following capture of slow π^- mesons by emulsion nuclei. The Li^8 tracks in the emulsion are reliably identified by the "lithium hammers" produced by β decay of Li^8

$$Li^8 \xrightarrow{\beta^-} Be^8 \to 2\alpha .$$

With the aid of NIKFI-R emulsions irradiated with slow π^- mesons, we measured the angular distribution of the electrons of the β decay of the Li^8 fragments relative to the direction of its momentum (by the direction of the Li^8 fragment momentum is means the direction of the start of its track). The result of measurements for 957 cases is shown in Fig. 1 as a function of the excitation energy of the Be^8 nucleus. The parameter η characterizing the distribution of the electrons is taken to be the ratio

$$\eta = \frac{N_f - N_b}{N_f + N_b} ,$$

where N_f and N_b are the numbers of the electrons emitted in the

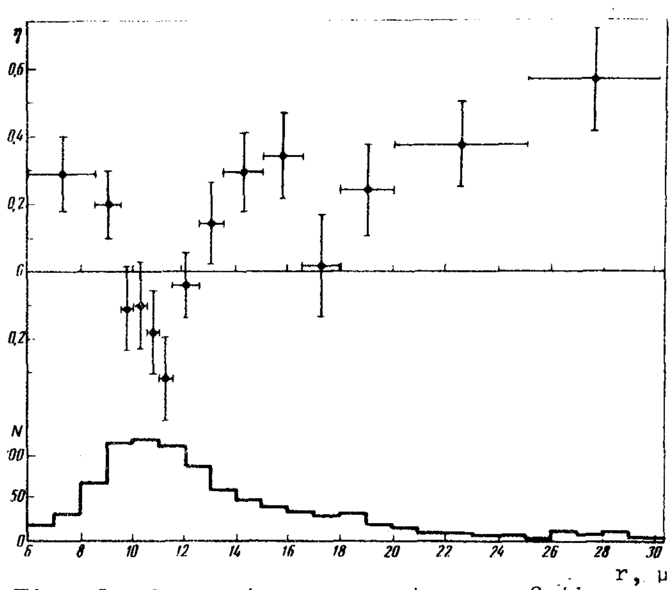

Fig. 1. Asymmetry parameter η of the emission of the electrons from the β decay of Li^8 vs. the summary length, R, of the tracks of the two α particles of the decay of Be^8. The histogram shows the distribution of the reaction yield N as a function of R.