PLOTS OF CRITICAL FIELDS OF THE SUPERCONDUCTING MODIFICATION Sn II AT PRESSURES UP TO 270 kbar AND TEMPERATURES (0.1 - 4.2)°K

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At a pressure P ~ 120 kbar and a temperature close to 300°K, white tin goes over into the modification Sn II [1], which has a tetragonal body-centered structure close to the cubic body-centered structure of the A2 type [2]. The crystalline modification Sn II is a superconductor and its temperature T_c of transition into the superconducting state is 5.2 ± 0.1 and 4.85 ± 0.1°K at 125 and 160 kbar respectively [3]. Insofar as we know, there are no other published data on the superconducting properties of Sn II.

We present in this communication preliminary results on the critical-field plots of the modification Sn II at pressures P ≈ 240 and 270 kbar in the temperature region (0.1 - 4.2)°K.

The measurements were made with a setup similar in general construction to that described in [4]. The pressure was produced with the aid of a booster with a modified high-pressure chamber of the Bridgman anvil type [3]. The maximum inhomogeneity of the pressure in the chamber and in the volume of the sample did not exceed ±2%. The superconducting transitions of the sample were revealed by the change of their electric resistance r. The pressure was determined from a calibration curve based on known reference points, with accuracy ±20 kbar.*

The measurements were made on samples prepared from spectrally pure tin.

Figure 1 shows plots of the transition into the superconducting state of two investigated tin samples at different pressures in a zero magnetic field H. For comparison, the same figure shows similar curves for 125 and 160 kbar, obtained in [3]. We see that in our

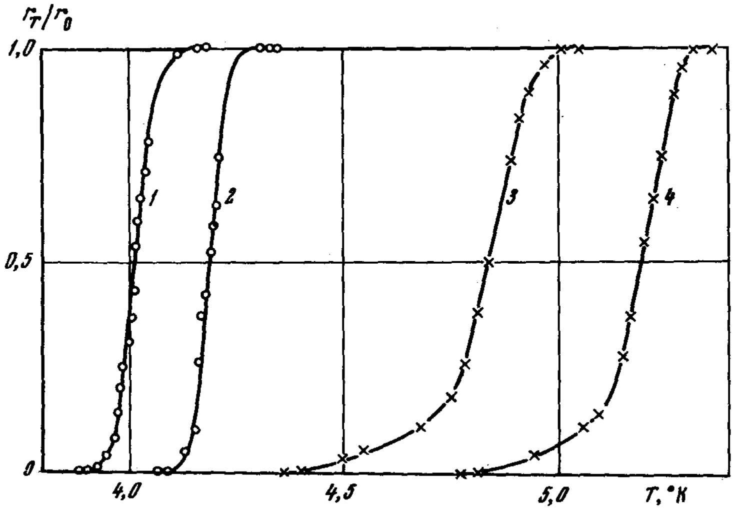


Fig. 1. Plots of relative change of the electric resistance when Sn II goes over into the superconducting state H = 0. 1) P ≈ 270 kbar (sample 1), 2) P ≈ 240 kbar (sample 2), 3) P = 160 kbar [3], 4) P = 125 kbar [3].

Fig. 2. Curves showing the destruction of superconductivity by a magnetic field at the following pressures: $P \approx 270$ kbar: 1) $T = 3.538$°K, 2) $T = 3.160$°K, 3) $T = 2.410$°K, 4) $T = 3.715$°K, 5) $T = 0.3$°K and $P \approx 240$ kbar: 6) $T = 3.788$°K, 7) $T = 2.906$°K, 8) $T = 1.607$°K.

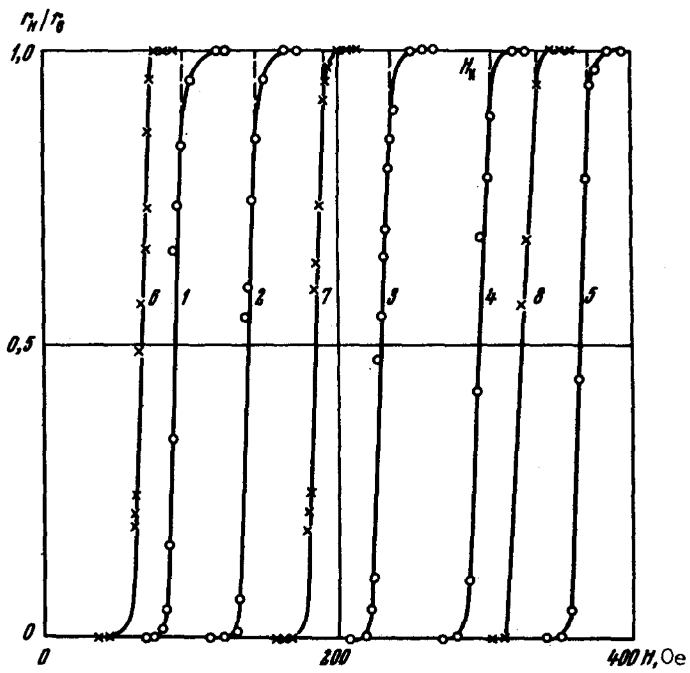
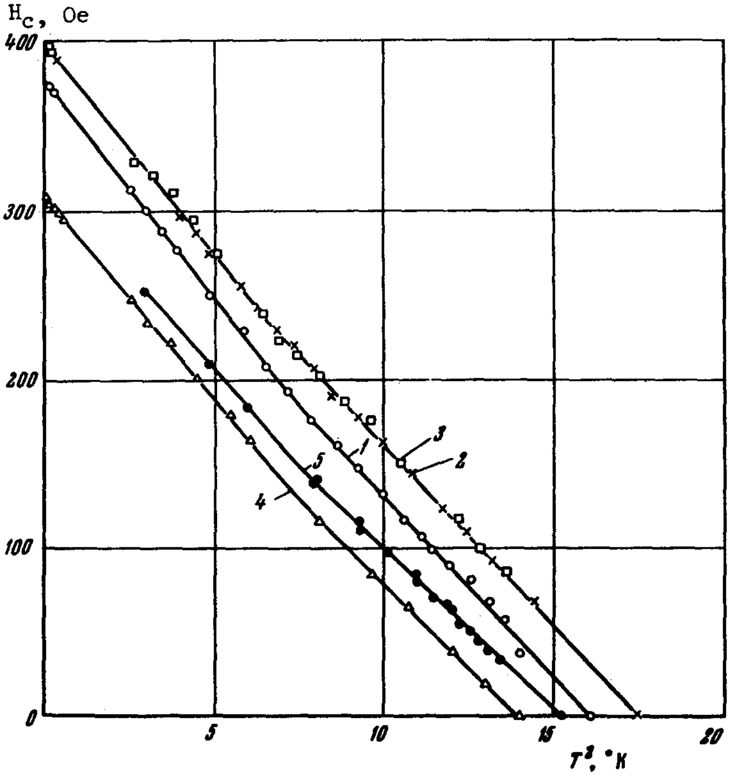


Fig. 3. Plots of critical fields of Sn II: 1) $P \approx 270$ kbar (sample 1), 2) $P \approx 240$ kbar (sample 2), 3) $P \approx 240$ kbar (sample 2, repeated application of pressure), 4) $P = 0$, Sn I, 5) $P = 26.4$ kbar, Bi II [6].



experiments, in spite of the high pressures, the degree of homogeneity of the pressure (if it is characterized by the width of the superconducting-transition curves) greatly exceeds the homogeneity of the pressure attained in [3]. The monotonic decrease of the temperature of the superconducting transition of Sn II, which apparently continues with increasing pressure, can be regarded as an indication that no new modifications of tin, other than Sn II, occur at pressures at leastup to 270 kbar. (The pressure-temperature phase diagram of Sn II was investigated above room temperature only up to 160 kbar [5].) Several curves showing the destruction of superconductivity by a magnetic field are shown in Fig. 2. The values of the critical fields H_c were determined (as indicated in the figure) from the points at which the straight lines extrapolating the linear sections of the curves crossed the horizontal line corresponding to the resistance of the samples in the normal state.

The critical fields are plotted in H_c and T^2 coordinates in Fig. 3. It can be deduced from the character of these curves that Sn II is a superconductor of the first kind whose critical fields at $P \approx 270$ kbar are close to the critical fields of ordinary tin at zero pressure (curve 4) and to the fields of the crystalline modification Bi II [6] at a pressure approximately 26 kbar (curve 5). Just as in the case of Sn I [7], the critical-field curves of Sn II reveal a noticeable negative deviation from parabolicity.

The state density N_0 on the Fermi surface of the Sn II modification, calculated from the formula

$$N_0 = \frac{3}{4\pi^3 K^2} a_2 \frac{H_{0c}^2}{T_c^2}$$

with a coefficient $a_2 = 1.09$, turns out to be higher than that of Sn I at $P = 0$. Unfortunately, it is still impossible to determine accurately the parameter N_0 of Sn II, owing to the possible systematic error in the determination of the magnetic field in the high-pressure chamber. This error should not affect the shape of the critical-field plot, but can cause a slight shift of the curves of Fig. 3 parallel to themselves.

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* A detailed description of the measurement procedure will be published in the near future.