CRITICAL FIELDS OF THE CRYSTALLINE MODIFICATIONS Bi II *AND* Bi III

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The critical fields of the modifications Bi II and Bi III were investigated. It was found that Bi II is a "soft" superconductor with a critical-field curve similar to that of tin, and Bi III is a "hard" superconductor with $(\partial H_c/\partial T)_{T=T_c} \approx 2600$ Oe/deg.

As reported earlier, [1,2] the crystalline modifications of bismuth, Bi II and Bi III, which are formed at room temperature at pressures P greate than 25 000 kg/cm^2, exhibit superconductivity with superconducting transition temperatures $T_c = 3.916°$K at P = 25 000 kg/cm^2 and $T_c \approx 7°$K in the range 27 000 < P < 30 000 kg/cm^2.

In the present paper we report the results of a study of the critical fields H_c of these two modifications. To obtain Bi II and Bi III a pressure booster with a piston of cemented tungsten carbide VK-3 was employed. The samples were prepared from bismuth 9f 99.999% purity. The measurements were carried out by the ac induction method [3] with the external magnetic field oriented at right angles or parallel to the longitudinal axis of the booster. A transverse magnetic field of up to 400 Oe intensity was produced by a Helmholtz system. A longitudinal field of up to 1000 Oe intensity was produced by a solenoid cooled in liquid nitrogen

Below 4.2° K the temperature was determined from the vapor pressure of liquid helium. To obtain temperatures above 4.2° K the booster piston was raised over the liquid helium level and the temperature was measured with a carbon thermometer.

Figures 1a and 1b show some of the curves representing the destruction of the superconductivity in Bi II and Bi III. The curves for Bi II were recorded at constant temperature with increasing transverse magnetic field.

Similar curves for Bi III were recorded in a constant magnetic field with the temperature increasing slowly. The critical field was determined from the end-point of the superconducting transition by extrapolating the rectilinear portion of the transition curve (cf. Fig. 1). The critical fields determined in this way for transverse and longitudinal magnetic fields agree with one another within the limits of the experimental error.

Figure 2 shows the critical-field curve of Bi II obtained at 26 400 kg/cm^2. As a check we repeated the experiment without the tin manometer. It follows from Fig. 2 that Bi II is a "soft" superconductor with a critical-field curve similar to that of tin (dashed curve).

Figure 3 shows the critical fields for various samples of Bi III near T_c. The results indicate that Bi III is obviously a "hard" superconductor with $(\partial H_c/\partial T)_{T=T_c} \approx 2600$ Oe/deg.

It is worth noting that the value of $(\partial H_c/\partial T)_{T=T_c}$ of Bi III is practically independent of the pressure

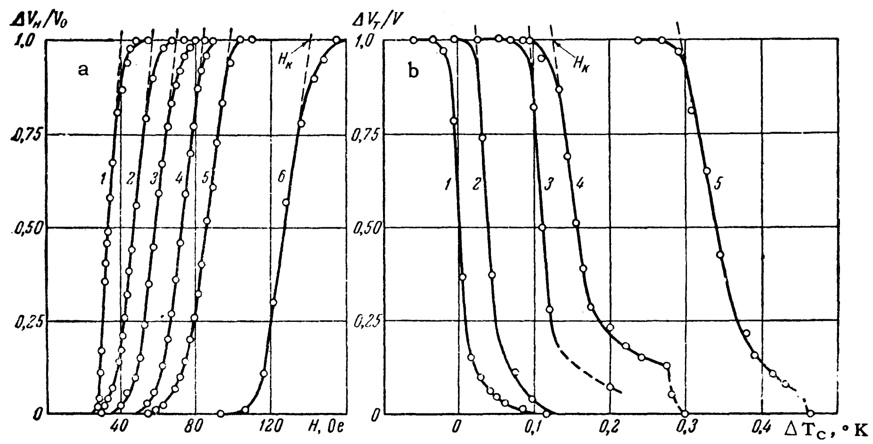

FIG. 1. Superconducting transitions of the crystalline modifications of bismuth. a) Dependence of the relative change in the signal during the superconducting transition in Bi III as a function of the transverse magnetic field intensity: 1) T = 3.637° K; 2) T = 3.522° K; 3) T = 3.452° K; 4) T = 3.312° K; 5) T = 3.191° K; 6) T = 2.837° K. b) Dependence of the relative change in the signal during the superconducting transition in Bi III as a function of $\Delta T_c = T_c(0) - T_c(H)$ in a constant magnetic field: 1) H = 0; 2) H = 58 Oe; 3) H = 245 Oe; 4) H = 367 Oe (transverse field); 5) H = 800 Oe (longitudinal field).

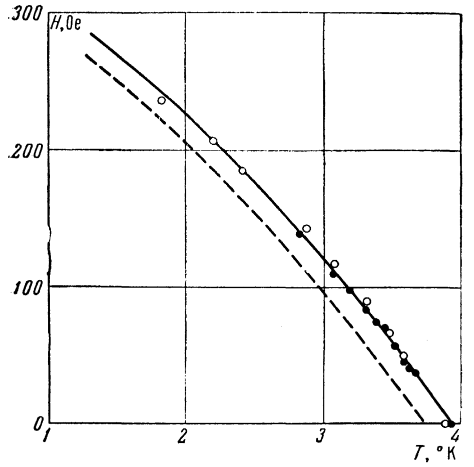

FIG. 2. Critical fields for Bi II: o – P = 26 400 kg/cm²; • – test without tin manometer.

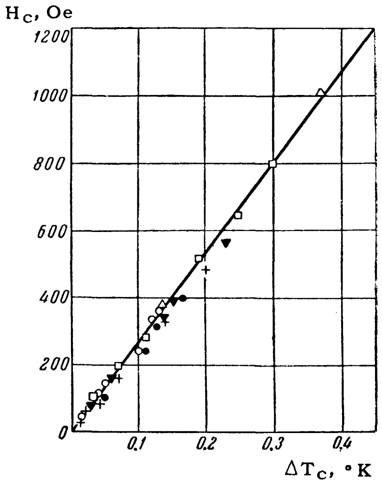

FIG. 3. Critical fields for Bi III at pressures of: △, □ – 30 000 kg/cm²; ▲ – 28 000 kg/cm²; + – 30 500 kg/cm²; • – 28 000 kg/cm²; o – 30 000 kg/cm².

in the 28 000–30 500 kg/cm² range and is also the same for samples containing a small amount of the Bi II phase (the scatter of the experimental points in Fig. 3 is the consequence of the inaccuracy of temperature measurement). The clearly defined nature of the superconducting transition curves of Bi III in magnetic fields, retained on repeated compression cycling of the same sample which unavoidably makes the sample structure more defective, also indicates that the high value of $(\partial H_c/\partial T)_{T=T_c}$ of Bi III is not related to singularities of the crystal structure.

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81