The Effect of Uniform Compression on the Superconducting Properties of the α- and β-Modifications of Bi_2Pd

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IT has been pointed out in a previous communication that the compound Bi_2Pd exists in two forms[1], of which the α-modification has a monoclinic lattice and goes over into the superconducting state at T_c = 1.70°K., while the β-modification with a tetragonal lattice, becomes superconducting at T_c = 4.25°K. It seemed of interest to determine the displacement of T_c under uniform compression for both forms of this compound. For this we used our previously-employed method of measuring the mutual inductance at audio frequency.[2]. The pressure was developed in a beryllium bronze bomb by the change in volume of water upon freezing, following the method suggested by Lazarev[3]. The construction of the apparatus was such as to permit placement in the measuring coil, at the time of the experiment of either the specimen in the pressure bomb, or an ebonite ampule in which was placed a similar specimen not subjected to uniform compression. The amount of pressure developed in the bomb was determined from the displacement of the critical temperature for tin. To accomplish this, two completely identical samples of tin were inserted along with the Bi_2Pd samples in both the beryllium bronze bomb and the ebonite ampule; the difference in their respective transition temperatures determined the pressure in the bomb. This was generally ~ 1700 kgm/cm^2. The temperature was determined from the helium vapor pressure. In Fig. 1 are presented the transition curves for compressed

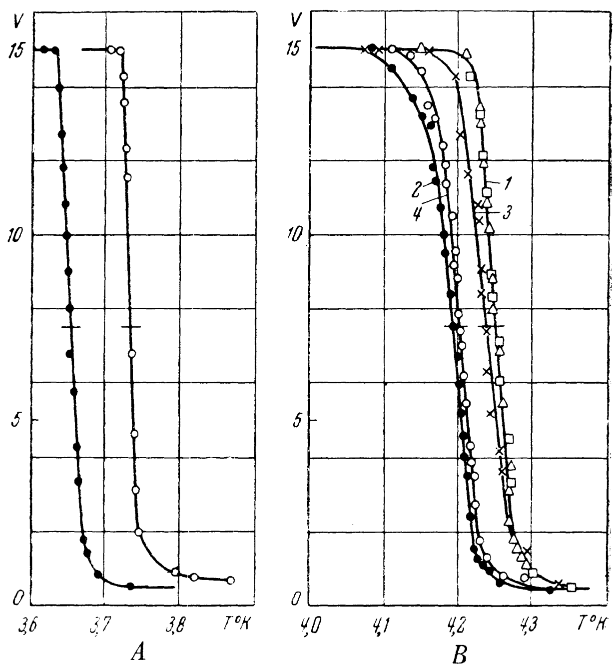

FIG. 1. Transition curves into the superconducting state: *a* — Sn in bomb with β-Bi_2Pd specimen: ○ no pressure in bomb, ● — ice pressure in bomb; *b* — β-Bi_2Pd: sample: △ — in beryllium bronze bomb, no pressure, □ — in ebonite sample, ○ — ice pressure reapplied; β-Bi_2Pd specimen in bomb with Sn sample: ice pressure in bomb, × — pressure removed.

and uncompressed specimens of β-Bi_2Pd and tin (along the vertical axis are given the readings in volts of a cathode voltmeter connected to the output terminals of the mutual induction measurement system[2]). A certain non-reproducibility in the transition curves for β-Bi_2Pd, observed when the pressure was removed and then reapplied, can be explained as due either to a partial decomposition of the β-Bi_2Pd under compression, similar to that occurring for Au_2Bi[4], or to small residual deformations appearing in the sample. In Fig. 2 are given the transition curves for α-Bi_2Pd and for tin,

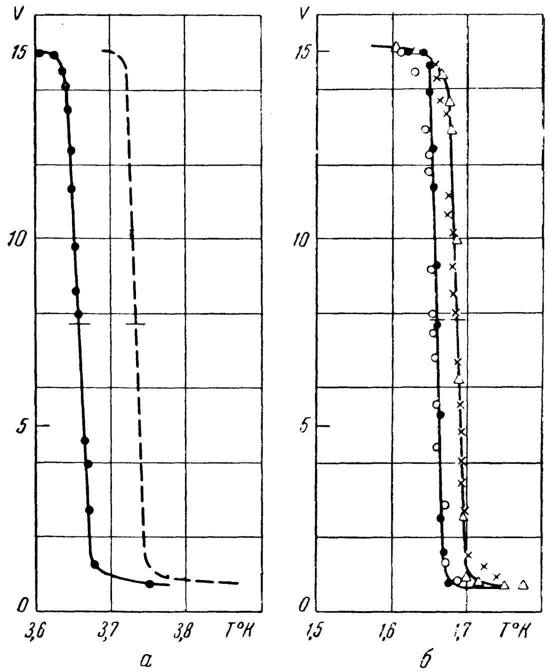

FIG. 2. Transition curves into the superconducting state: *a* – Sn, in bomb with α-Bi_2Pd specimen: ● —ice pressure in bomb; *b*: △— α-Bi_2Pd specimen in beryllium bronze bomb, no pressure in bomb; ● — α-Bi_2Pd specimen in bomb with Sn sample, ice pressure in bomb; × — pressure removed; ○ — α-Bi_2Pd, specimen, ice pressure reapplied.

the latter serving as before to determine the pressure in the bomb. In determining the displacement of the critical temperature for α-Bi_2Pd the temperature was measured with a phosphor bronze resistance thermometer which had a resistance of 11.8 ohms at $T = 4.22$ °K.

In contrast to β-Bi_2Pd, repeated removal and reapplication of the pressure does not lead in the case of α-Bi_2Pd to irreversible displacement of the transition curves. For both β-Bi_2Pd and α-Bi_2Pd, uniform compression leads to a reduction of the critical temperature: for α-Bi_2Pd the value is $\Delta T_c = 2.5 \times 10^{-2}$°K, while for β-Bi_2Pd $\Delta T_c = 5.5 \times 10^{-2}$°K for the first compression (the displacement being determined from curves 1 and 2 of Fig. 1) and $\Delta T_c = 3.5 \times 10^{-2}$°K when the amount of displacement is determined from curves 3 and 4. It may be remarked that the true value for the displacement of T_c is most probably 5.5×10^{-2}°K, for both the internal pressures resulting from decomposition and the small plastic deformation of the compressed specimen would serve only to reduce this quantity.

The values of $\partial T_c/\partial p$ as determined from the values for ΔT_c given above are α-Bi_2Pd, 2.5×10^{-11} °K cm^2/dyne; for β-Bi_2Pd, 5.6×10^{-11}°K cm^2/dyne, with $\Delta T_c = 5{,}5 \cdot 10^{-2}$ °K, or 3.6×10^{-11}°K cm^2/dyne, with $\Delta T_c = 3.5 \cdot 10^{-2}$ °K.

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70