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EFFECT OF PRESSURE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF THE ALLOYS Nb_3Sn *AND* Nb−Zr

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The effect of isotropic compression upon the temperature of the transition to the superconducting state has been investigated for the alloys Nb_3Sn and Nb−Zr. For Nb_3Sn, beginning at a pressure p ∼ 3000 atm, the curve relating ΔT_c and p is quadratic in form. For Nb−Zr an increase in the superconducting transition temperature was observed under pressure.

We have investigated the effect of isotropic compression upon the temperature of the transition to the superconducting state for the alloys Nb_3Sn and Nb−Zr.

The hydrostatic pressure was generated in a fixed-pressure bomb, following the procedure described previously [1]. Temperatures were measured with a platinum resistance thermometer, calibrated at the Institute for Physico-technical Measurements with the aid of a set of standards for the region 10–90°K [2]. The thermometer was fitted tightly into a thick-walled copper tube which was in mechanical thermal contact with the body of the bomb. Coarse temperature control was achieved through the pressure of the vapor over the liquid hydrogen. One sample was placed within the bomb, while a second, connected in series with the first, was attached to the outside of the bomb. The transition to the superconducting state was detected as a sharp drop in the electrical resistance. With each application of pressure we obtained two superconducting transition curves—one under pressure and one without.

The resistance measurements on the samples were made after the system had reached thermal equilibrium.

A. The Nb_3Sn samples were prepared via the method described by Alekseevskiĭ and Mikhaĭlov [3]. The specimens were in the form of short sections of wire; we endeavored not to subject them to deformation. Figure 1 shows the curve obtained for the dependence of $\Delta T_c = T_{c,p} - T_{c,0}$ upon p^2. All of the points fall closely along a straight line, which, however, does not pass through the origin. It can be asserted that, beginning at a pressure p ∼ 3000 atm, the curve relating T_c to p is quadratic in character, and may be described by the relation $\Delta T_c = -(0.0019p^2 + 0.02)$°K, where p is the pressure in kiloatm.

Lazarev et al, using a freezing technique, observed a reduction in the transition temperature for Nb_3Sn of 0.045°K, under a pressure of 1730 atm [4]. Their point is shown in the diagram; it lies somewhat above our data.

B. The Nb−Zr samples took the form of a wire drawn from an ingot (75% Nb + 25% Zr) alloyed in a vacuum arc furnace from zirconium iodide and a niobium rod.

Under pressure, the superconducting transition temperature of the Nb−Zr alloy was raised, and this to a progressively greater extent with each succeeding cycle of application of pressure (Fig. 2). Removal of the pressure restored the initial value

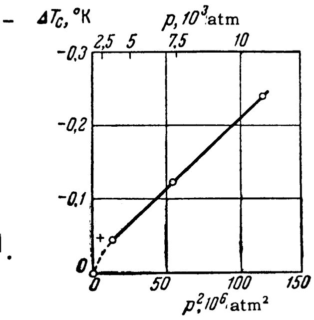

FIG. 1

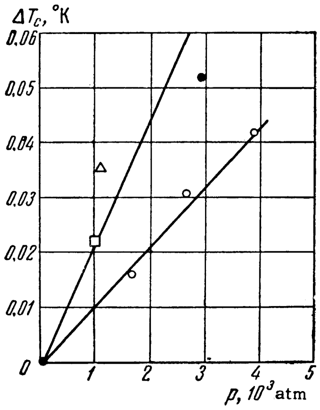

FIG. 2

FIG. 1. Displacement of the superconducting transition temperature for Nb_3Sn under hydrostatic pressure: ○ – our data, + – data of Lazarev, et al.

FIG. 2. Effect of pressure on the superconducting transition temperature for Nb – Zr. Sample no. 1: ○ – first application of pressure, □ – second application of pressure, △ – third application of pressure; ● – sample no. 2.

of T_c. One specimen, cut from the same piece of wire as sample no. 1, showed a decrease in T_c upon application of a small pressure (by 0.066°K for p = 1500 atm), and then an increase in T_c (for pressures from 3000 to 11000 atm, $\Delta T_c/\Delta p = 0.006 \times 10^{-3}$ deg/atm). Unfortunately, we were unable to measure T_c for this sample after the pressure was removed.

We do not know of any practical reason for this behavior in the niobium-zirconium alloy under pressure. Nevertheless, we find the most satisfactory value for $\Delta T_c/\Delta p$ to be 0.022×10^{-3} deg/atm.

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[1] E. S. Itskevich, PTÉ **4**, 148 (1963).

[2] Borovik-Romanov, Orlova, and Strel'kov, Shkala nizkikh temperatur mezhdu 90° i 10°K, (The low temperature scale between 90° and 10°K), Main Bureau of Measures and Measuring Apparatus, 1954.

[3] N. E. Alekseevskiĭ and N. N. Mikhaĭlov, JETP **41**, 1809 (1961), Soviet Phys. JETP **14**, 1287 (1962).

[4] Lazarev, Lazareva, Ovcharenko, and Matsakov, JETP **43**, 2309 (1962), Soviet Phys. JETP **16**, 1630 (1963).

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