Superconductivity of bulky Nb_3Ge above 22° K

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The obtained bulky Nb_3Ge in which the temperature of the start of the superconducting transition is higher than 22 °K. Transition curves obtained by magnetic and resistive methods are presented.

Recently Gavaler *et al.*[1] reported a new record superconducting transition temperature 22.3 °K (start of the transition), attained in thin Nb_3Ge films (of the order of 1 μ) obtained by cathode sputtering of the initial elements on a hot substrate. The high T_c of these films is attributed by the authors to the fact that the cathode sputtering, in their opinion, ensures the production of an intermetallide with an exact stoichiometric composition, although at the same time they note in their paper that the obtained films were not single-phase.

In the investigation of the superconductivity in the Nb_3Ge system, we measured T_c of bulky samples and obtained in a number of cases T_c higher than 22 °K (start of the transition) at compositions close to Nb_3Ge.

The samples were prepared by melting stock pieces pressed from powders, weighing 10–15 g, in a high-frequency furnace by the "suspended drop" method in a Fogel' inductor[2] and in an atmosphere of argon. When the high-frequency furnace was turned off, the molten "drop" fell on a bulky copper mold and was cooled to room temperature in a fast quenching regime. The time that the drop was kept in the suspended state could be varied in certain limits. Samples of rectangular cross section measuring 15×1.5×1 mm were cut from the casting by an electric-spark method, and were investigated either directly or after heat treatment to determine T_c by a magnetic or resistive method.

The measurements were performed in a helium cryostat for intermediate temperatures, in which the bulky copper block with the sample was placed in the internal Dewar of the helium cryostat. The block was provided with an electric heater, and the heat transferred from it to the liquid helium in the outer vessel could be regulated by adding or pumping off heat-exchange helium from the space between the walls of the internal Dewar.

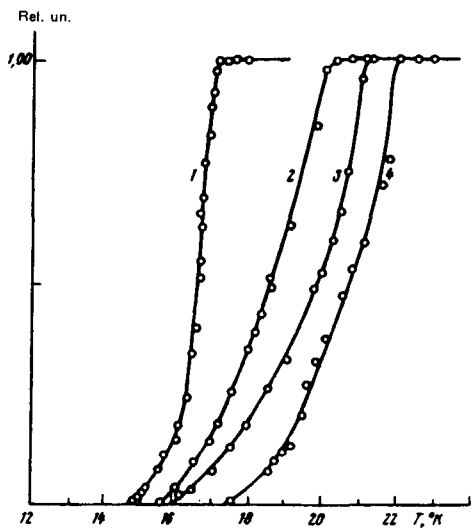

FIG. 1.

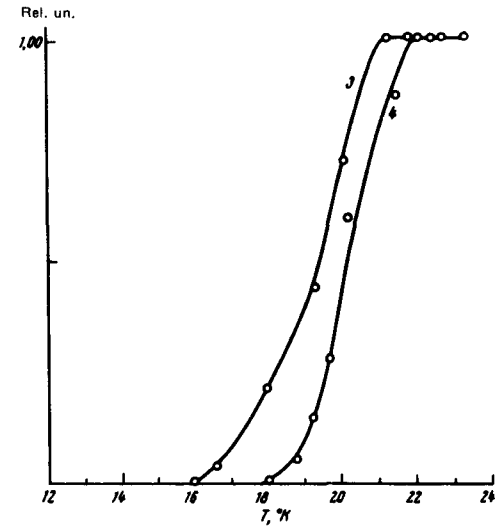

FIG. 2.

The sample temperature was measured with a TSPN-2V platinum reistance thermometer, constructed and calibrated at VNIIFTRI, placed in the immediate vicinity of the sample. When the magnetic method was used, the change of the inductance of the coil as a function of the state of the sample placed in it was measured with an R-571 ac bridge. When the resistive method was used, the resistance of the sample with two pairs of leads deposited on it by means of a silver conducting epoxy paste, was measured with a PPTN R-306 potentiometer. The error in the temperature measurement did not exceed 0.05 °K.

Fig. 1 shows the transition curves plotted by the magnetic method, while Fig. 2 shows the transition curve determined from measuring the resistance of the samples. Curves 1 and 2 pertain to the same sample in the cast state (curve 1) and in the annealed state (curve 2). We see that T_c of the sample (as revealed by the start of the transition) shifted towards higher temperatures, from 17.3 to 20.5 °K, but the transition became more stretched out. Curves 3 and 4 were obtained for cast samples kept during the melting process in the state of a suspended molten drop for two and three minutes respectively. The start of the superconducting transition of these samples occurred at 21.5 and 22.1 °K, respectively, as determined by the magnetic as well as by the resistive method. In the case of the resistive method the transition width is somewhat narrower than in the magnetic method, although the difference is negligible. It should be noted that a number of castings of approximately the same composition the value of T_c was 7 °K,

compound in [3].

The obtained high values of T_c of bulky Nb_3Ge demonstrate that cathode sputtering is not the only way of obtaining a transition temperature higher than 22 °K in this compound, and that in addition to improving the method of obtaining Nb_3Ge films it is necessary to study thoroughly the conditions under which a desirable structure are melted.

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