SUPERCONDUCTIVITY OF Ni-Sn ALLOY UNDER HIGH PRESSURE

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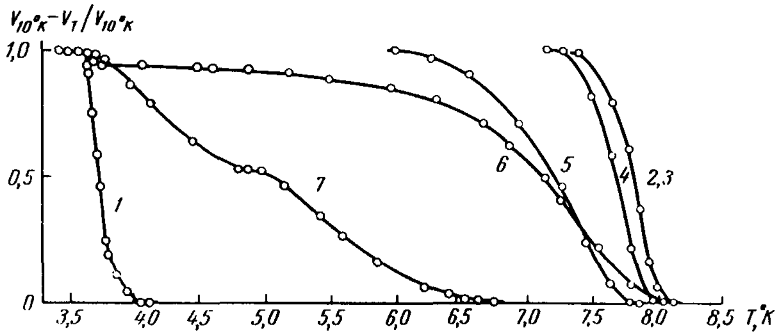
Submitted 14 April 1967
ZhETF Pis'ma 6, No. 1, 471-473 (1 July 1967)

It is known [1-3] that high pressure produces in Bi-Sn alloys a phase (κ) whose structure has not yet been determined. It has been proposed in [2] that the κ-phase is an intermetallide with composition Bi-Sn. It is possible that this phase can be conserved (by deep cooling followed by removal of the pressure) and then investigated at atmospheric pressure. We deemed it of interest to study its superconducting properties, and in particular to determine the temperature T_c of the transition to the superconducting state and the temperature interval in which it is stable.

To this end, we investigated a Bi-Sn alloy (50 at.%) fused from Bi (>99.999%) and Sn (>99.999%). Samples of 8-9 mm diameter and 10 mm height were placed in teflon or prophillite ampoules and then in a specially constructed dismountable high-pressure chamber, where they were subjected to a pressure of 25 katm at 75°C for several hours. The chamber was then cooled to -196°C with liquid N_2, the pressure removed, and the chamber taken apart directly in the liquid N_2. To determine T_c, the sample was rapidly inserted into a cooled instrument. The measuring system consisted of two identical coils connected to buck each other, and placed in a weak alternating (37 Hz) field; the sample was inserted in one of the coils. The onset of superconductivity in the sample upon lowering the temperature produced a change in the inductance of the coil; this change was recorded with the aid of a standard amplifier and a standard synchronous detector. Below 4.2°K, the temperature was determined from the vapor pressure in the liquid He bath; above 4.2°K, a thermocouple prepared by us [(Au + 0.03 at.% Fe) - Cu] and calibrated at VNIIFTRI was used. T_c was taken to be the temperature corresponding to the midpoint of the plot of $V_{10^\circ K} - V_T \cdot V_{10^\circ K} = f(T)$, where $V_{10^\circ K} - V_T/V_{10^\circ K}$ is the relative change of the output signal following the transition. The figure shows the results of the measurements of the superconducting transition of samples in different states:* 1 - sample after melting and prolonged annealing at 100°C; 2 - sample exposed to 250 katm pressure; 3 - the same as in 2, but also heated to -105°C and kept there for 1 hour; 4 - the same as in 3, but also heated to -95°C and kept there for 1 hour; 5 - the same as in 4, but also kept for 1 hr 15 min at -80°C; 6 - the same as in 5, plus 4 hours at -80°C; 7 - the same as in 6 plus 16 hours at 0°C. In the



Relative change of signal vs. temperature in superconducting transition of Bi-Sn alloy in different states (see text).

time intervals between the isothermal exposures and the measurements, the samples were stored in liquid N_2.

It follows from the foregoing data that the curve showing the transition of the sample into state 1 is close to the curve of pure Sn (T_c = 3.72°K); this is to be expected, since the sample comprises then a eutectic of Sn and Bi. The sample in state 2 has T_c = 7.88°K. Keeping the sample at temperatures higher than -95°C decreases T_c and greatly broadens the temperature interval in which the transition takes place, although during the start of the exposure the temperature at which the transition begins changes only slightly. Only after a prolonged exposure to -80°C is a two-step curve observed (the second transition occurs at a value of T close to T_c of Sn enriched with Bi[4]). Finally, exposure to 0°C leads to a considerable change of T_c of the sample.

Thus, the phase obtained by applying high pressure to the alloy has T_c = 7.88°K, which greatly exceeds T_c of pure Sn. This phase is stable up to -105°C. Its decay occurs during the time of isothermal exposures to t > -105°C and proceeds quite slowly. Even prolonged exposure to 0°C does not restore the alloy to the equilibrium state. A Bi-Sn alloy (50 at.%) was transformed in [5] to a homogeneous state (i.e., a solution with β-Sn structure) by abrupt quenching to -196°C. The question whether the structure of the phase studied by us coincides with the structure of the quenched phase remains upon and calls for additional x-ray structure studies.

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*The serial numbers correspond to the numbers on the figure.

THE COTTON-MOUTON EFFECT IN OPTICALLY ORIENTED VAPORS OF ALKALI METALS

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Submitted 17 April 1967
ZhETF Pis'ma 6, No. 1, 473-476 (1 July 1967)

The Cotton-Mouton effect (linear birefringence of light propagating in a medium perpendicular to a magnetic field $H_0 \| OZ$) [1], like the Faraday effect, is brough about by induced anisotropy of the dielectric constant of a medium situated in a magnetic field. Under ordinary conditions, the Cotton-Mouton effect is exceedingly small and has been observed so far only in liquids and a few glasslike solids [2,3], since the degree of polarization of the molecules of the material is very small even in strong magnetic fields. In this paper we describe, apparently for the first time, the Cotton-Mouton effect in a gaseous medium, namely in optically oriented saturated Cs^{133} vapor at 25°C. The possibility of observing magneto-optic phenomena in optically oriented vapor or gas, in spite of the very low pressure of the latter ($\sim 10^{-5}$ mm), is based on the high degree of polarization of the medium in experiments on optical orientation. The degree of polarization is then determined by the intensity of the pump light and is practically independent of the external magnetic field; it can reach ~ 80% in some cases [4].