SUPERCONDUCITIVITY OF Tl-Sn AND Pb-Sn ALLOYS SUBJECTED TO HIGH PRESSURES

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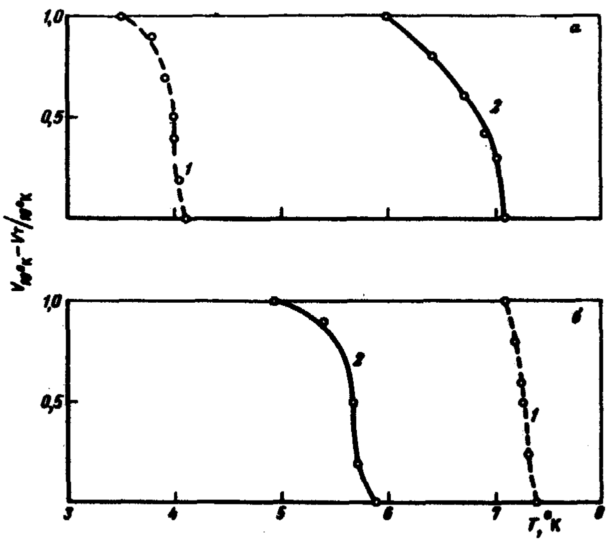
One of the authors has recently observed the existence of high-pressure phases in Sn-Tl and Pb-Sn alloys [1]. The alloys of the Pb-Sn system have at atmospheric pressure a diagram of state of the eutectic type with limited mutual solubility of the components [2]. A new intermediate phase (X phase) is produced under a pressure of 11.5 kbar in the Sn concentration range 90 - 82 at.%. The Sn-Tl diagram of state [3] has at atmospheric pressure the same form as Pb-Sn at pressures above 11.5 kbar. On the Sn-Tl diagram at 1 atm, the intermediate X' phase is stable in the region of equal-atom composition in an interval of 19°. The region of stability of the X' phase of Sn-Tl greatly broadens under the influence of pressure. Thus, for example, at 15 kbar its stability temperature interval is 170 - 305°C.

We have determined T_c and H_{c_2} of alloys synthesized at P and T values corresponding on the P-T-C diagrams to new single-phase states with X and X' phases (the initial states, as is well known, are eutectic mixtures: Pb + Sn and γ-Tl + Sn). The synthesis was carried out in a specially constructed readily dismountable chamber in which pressures up to 40 kbar (using a solid pressure-transmitting medium) and a temperature 700 - 800° could be produced. The chamber construction made it possible to quench the samples from specified values of P and T to -196°C with high speed, while maintaining the pressure constant.

After keeping the samples at the specified values of P and T (see below), the temperature was dropped abruptly to -196°C. The pressure was then reduced to 1 atm. The samples were taken out of the chamber and inserted into the instruments used to determine T_c and H_{c_2} directly in liquid N_2 (see [4, 5] concerning the method of determining these quantities).

The figure shows plots of the transition into the superconducting state of the following samples: a) alloy of Sn and 35 at.% Tl in the initial state after annealing for 170 hours at 70 - 80° (curve 1) and after synthesis at P = 30 kbar, and t = 280 ± 20°C for one hour (curve 2); b) alloy of Sn with 15 at.% Pb in the initial state after annealing for 120 hours at 100° (curve 1) and after synthesis at P = 30 kbar, t = 280 ± 20°C, for one hour (curve 2). As seen from these data, the new structures produced after application of high pressures and temperatures can be conserved in Tl-Sn and Pb-Sn alloys to temperatures $\leq$ 77°K in a metastable steady state at atmospheric pressures. In the cases of the Tl-Sn alloys these structures have much higher values of T_c. The values of H_{c_2} of the alloy of Sn with 34 at.% Tl, determined at 4.2°K, amounts to 3.46 kOe. As seen from Fig. a, this alloy is not superconducting prior to pressure treatment at 4.2°K.

In the Pb-Sn alloy, T_c decreases from 7.2°K to ∼ 5.6°K. In both alloys, the pressures at which the triple points Liq ⇄ Pb + Sn ⇄ X phase and Liq ⇄ Sn + Tl ⇄ X' phase are produced on the T-P diagrams tend to the value of the pressure of the triple point Liq ⇄ β-Sn ⇄ Sn II



Curves showing transitions of Tl-Sn (a) and Pb-Sn (b) alloys into the superconducting state after various treatments.

[1]. After pressure treatment, as already noted, T_c increases for the Tl-Sn alloys and decreases for Pb-Sn, assuming in both cases (particularly Tl-Sn) a value close to the $T_c \approx 6.4^\circ K$ that Sn II should have at P = 0, as would follow from a linear extrapolation of the data of [6, 7] on the pressure dependence of the critical temperature T_c of Sn II.

These facts give grounds for drawing the preliminary conclusion that the intermediate phases produced under pressure in these alloys are solid solutions based on the high-pressure modification of Sn II. Of course, to confirm this conclusion it is necessary to determine the structures under pressure by x-ray diffraction.

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ANTIFERROMAGNETIC RESONANCE IN COPPER CHLORIDE DIHYDRIDE AT LOW FREQUENCIES FOLLOWING TURNING OF THE SUBLATTICE MAGNETIC MOMENTS

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The dependence of the antiferromagnetic-resonance (AFMR) frequencies on the external magnetic field was investigated by many workers, and the experimental data are in good agreement with the theory [1]. However, some data [2] concerning the AFMR frequencies near the field H_t at which the magnetic moments are turned have not yet been explained. The purpose of this paper is to investigate AFMR at low frequencies. Particular attention is paid to the magnetic-field region close to the field H_t.

The dependence of the AFMR frequencies at $|H - H_t| \ll H_t$ on the magnetic field H (which is parallel to the easy axis) is determined by the character of the phase transition in which the antiferromagnetism vector $\vec{l}$ is rotated by $\pi/2$. If the transition from the phase $l_\parallel$ in which $\vec{l}$ is parallel to the easy axis to the phase $l_\perp$ where $\vec{l}$ is perpendicular to the easy axis