behavior is apparently the consequence of the fact that the metal - dielectric transition in the system of excitons in germanium is a first-order phase transition at helium temperatures [3 - 5].

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SUPERCONDUCTING TRANSITION TEMPERATURE OF A METASTABLE MIXTURE BASED ON NON-TRANSITION METALS

A.F. Orlov
A.A. Baikov Metallurgy Institute
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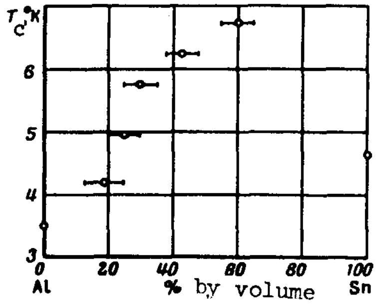
It is known that the temperature T_c of the transition into the superconducting state rises when superconductors with polarizable organic molecules [1, 2] or with semiconductors [3] are simultaneously condensed on a cold substrate. It is shown in [2] that in the case of condensation of a superconductor with organic additives the rise of T_c can be due to size quantization of the electrons in the minute crystals of the superconducting phase. The change of T_c of Al, In, and Sn alloyed with nonmagnetic additives in the region of dilute solid solutions was also investigated earlier [4, 5]. The change of T_c with increasing impurity concentration x was approximated by the relation [5] $\delta T_c = k_1 x + k_2 x \ln x$, where k_1 and k_2 are constants for the corresponding pair of materials. The validity of this relation was confirmed [6] by an analysis performed on the basis of the BCS theory.

We have investigated the possibility of increasing T_c by strongly alloying nontransition superconductors with nonmagnetic additives, i.e., in solid solutions that do not exist under equilibrium conditions and are produced [7] by low-temperature simultaneous condensation of the components. We wish to demonstrate at the same time that to explain the results of [3], just as in the case of [1, 2], there is no need to make use of non-phonon superconductivity mechanisms.

We investigated the change of T_c in metastable solid solutions with varying compositions, of the systems Al-Ag, Al-Sn, and In-Bi, obtained by simultaneous condensation of the components on a substrate cooled with liquid helium. The limiting solubilities at room temperature of the second component in these systems are 0.18, 0.005, and 4.9 at.%, respectively [8]. In accordance with the conclusions of [4, 6], one should expect a decrease of T_c in the Al-Ag system with increasing Ag content, and when the second component in the Al-Sn system is increased T_c should increase, in analogy with its increase in the Al-Ge system, as observed in [3]. In our case, however, there is no possibility of additional interaction connected with the excitons of the semi-



Superconducting transition temperature of Al-Sn films obtained by low-temperature condensation.

conductor. When In is alloyed with Bi one should expect, in accordance with [5], a considerable rise in T_c compared with pure In.

The condensation was produced in a sealed ampoule that differed little from that used in [9]. T_c was determined with the aid of a low-inertia pickup [10] at the point where the electric resistance of the film decreased to half the normal value. The proposed composition of the films was set by the regime of the evaporators. During one experiment, several films with different composition were condensed on the substrate, with a total thickness of several hundred Angstrom.

The figure shows the results of an investigation of T_c of films of the Al-Sn system with metastable single-phase structure. After annealing to room temperature, the T_c of a multilayer film dropped from 6.72 to 3.77°K, corresponding to complete decay of the solid solution. The residual resistance of the film decreased at the same time by a factor 3.8. The value of T_c of a condensed film of a mixture of Al with 30% Ag by volume was 2.48°K, i.e., lower than that of pure Al. The maximum value of T_c observed by us in condensed In-Bi films with different composition was 7.95°K. This exceeds the values of T_c observed both in films of pure In and Bi obtained at low temperatures (4.15 and 6.0°K, respectively [9]) and in the crystalline modification BiIII, which exists at high pressures (7.25°K) [11].

The sign of the observed change of T_c, in all three systems, agrees with the conclusions of [6, 12]. However, an extrapolation of the data obtained with dilute solid solutions of Bi in In has made it possible to propose the possible existence in this system of metastable mixtures with higher values of T_c than observed by us. This disparity is due apparently to the large error resulting when the existing theory is applied to concentrated alloys. A value T_c = 6.45°K was observed in [3] for a film of Al with 10% Ge, condensed on a cold substrate. Extrapolation of the data of [5] for an alloy of this composition, without allowance for the rise of T_c due to the change of the phonon spectrum in low-temperature condensation [9], gives a value T_c = 5.80°K, which can be regarded as in good agreement.

The rise of the superconducting transition temperature was observed by us also in the case of layer-by-layer condensation of thin Sn films on the surface of thicker films of the mixture Al-Sn, or for condensation of Bi on the surface of an In film. When a thin film ∿30 Å thick was deposited on a film of aluminum mixed with 20% tin and ∿250 Å thick, T_c rose from 4.20 to 4.90°K. With increasing thickness of the second film, the rise of T_c decreased. The magnitude of this effect in all cases greatly exceeded the change of T_c observed in [13] for Ge condensed on the surface of Tl and Sn films. This may be connected, first, with the greater purity of the surface of the films in our experiments. The results of these observations can also be explained from the point of view of [6], if it is assumed that the rise of T_c occurs in a thin layer near the phase interface. To resolve this problem it is necessary to investigate the temperature dependence of the critical current in such systems.

It should be noted that, as in the case of application of an electrostatic charge [12], in the Al-Sn system simultaneously with an increase of T_c there was observed upon condensation of Sn on films of a mixture an anomalous rise in the electric resistance of a multiple-layer film. The effect was observed at Sn film thickness not higher than 30 - 40 Å, and its value was up to 14% of the resistance of the initial layer, and remained unchanged when the films were annealed to 40°K, whereas the film resistance connected with the crystal structure defects were greatly decreased in this temperature interval.

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ANTIFERROMAGNETISM OF INVAR ALLOYS

V.L. Sedov
Moscow State University
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Kondorskii and the author [1, 2] have reached the conclusion that the anomalies of the physical properties of invar alloys are connected with the antiferromagnetism of the γ phase of iron [3 - 5] (cubic face-centered modification of iron). This point of view was subsequently used in a number of papers [6]. However, the concrete mechanism of the origin of the invar anomalies is still under discussion in the literature. Interest in this question has recently increased in connection with neutron-diffraction investigations of invar alloys [7 - 9]. It follows from these investigations that an invar alloy constitutes a magnetically-inhomogeneous medium in which, according to [8, 10], there can exist in addition to the ferromagnetic regions also regions that are antiferromagnetic at low temperatures.

If such regions actually exist, then one should expect the character of the temperature dependence of the susceptibility of the para-process and of the galvanomagnetic properties of the invar alloys should reflect the transition of these regions.into the antiferromagnetic state. The present article presents therefore experimental data on those invar-alloy properties which point to the existence of an antiferromagnetic transformation. These experimental data were published in part in [11], but no interpretation was offered for them.