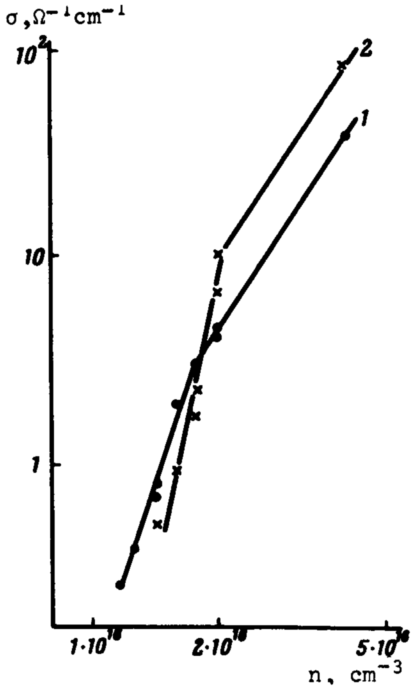
[5] L.D. Landau and N.M. Khalatnikov, Dokl. Akad. Nauk SSSR 96, 469 (1954).
[6] L. Cross, A. Fouskova, and S. Cummins, Phys. Rev. Lett 21, 812 (1968).

DIELECTRIC - METAL TRANSITION IN THE SYSTEM OF EXCITONS IN GERMANIUM

V.M. Asnin and A.A. Rogachev
A.F. Ioffe Physico-technical Institute, USSR Academy of Sciences
Submitted 20 September 1971
ZhETF Pis. Red. 14, No. 9, 494 - 495 (5 November 1971)

The transition of the exciton system from the dielectric state into the metallic state was observed in [1], where a jumplike appearance of conductivity was detected in germanium at an exciton concentration close to $5 - 10^{15}$ cm^{-3}. At somewhat higher excitation levels, the conductivity is described by a relation of the type $\sigma \sim n^3/T^2$, close to that expected for a degenerative electron-hole plasma [1, 2]. However, immediately after the transition to the metallic state, a small region was observed in which the conductivity was independent of the temperature and of the concentration. To explain the nature of such a conductivity, new investigations of the photoconductivity were made. The main results of these investigations are reported in this communication.

The experiments were performed on germanium samples 20 - 40 μ thick, made of germanium single crystals of varying purity. The remaining details of the experiments did not differ from those described in [1]. The measurements have shown that the phenomenon described above, i.e., the independence of the conductivity of the temperature and of the concentration, is observed only in relatively contaminated samples with impurity-center concentration exceeding 10^{14} cm^{-3}. In the purest germanium samples with impurity concentration not higher than 2×10^{12} cm^{-3} this effect was not observed. The dependence of the conductivity of pure germanium on the excitation level is shown in the figure. The appearance of metallic conductivity occurs here at a concentration $(1 - 2) \times 10^{16}$ cm^{-3}, after which the behavior is the same as for the conductivity of degenerate electrons and holes [1, 2].



Conductivity of pure germanium vs. the concentration of the electron-hole pairs, averaged over the sample. 1 - T = 4.2°K, 2 - T = 2.5°K. The curves were obtained with an electric field 40 mV/cm applied to the sample.

The conductivity in the region of the sharp growth near the transition to the metallic state has an unstable character. Even in the case when the intensity of the exciting light pulses was maintained constant within 1%[1]) the observed value of $(\overline{\Delta\sigma^2/\sigma^2})$ was of the order of unity. To the contrary, in the region of high concentrations, the value of $(\overline{\Delta\sigma^2/\sigma^2})$ was determined almost completely by the fluctuations of the intensity of the source of exciting light. Such a

[1]We used for this purpose a registration scheme that operated only when the amplitude of the light pulses deviated from the set value by not more than 1%.

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].

[1] V.M. Asnin and A.A. Rogachev, ZhETF Pis. Red. 7, 464 (1968) [JETP Lett. 7, 360 (1968)].
[2] A.A. Rogachev, Proceedings (Trudy), Ninth Internat. Conf. on Semiconductor Physics, Leningrad, Nauka, 1969, p. 431.
[3] V.M. Asnin and A.A. Rogachev, ZhETF Pis. Red. 9, 415 (1969) [JETP Lett. 9, 248 (1969)].
[4] V.M. Asnin and A.A. Rogachev, Proc. III Int. Conf. on Photoconductivity, 13, Stanford, 1969, Pergamon Press, 1971.
[5] V.M. Asnin, A.A. Rogachev, and N.I. Sablina, ZhETF Pis. Red. 11, 162 (1970) [JETP Lett. 11, 99 (1970)].

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

A.F. Orlov
A.A. Baikov Metallurgy Institute
Submitted 22 September 1971
ZhETF Pis. Red. 14, No. 9, 496 - 498 (5 November 1971)

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-