Superconductivity of gallium phosphide at high pressure

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A superconducting transition has been observed in the metallic modification of gallium phosphide. The superconducting transition temperature is $T_c = 6.6 \pm 0.1$ K and decreases with increasing pressure.

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Compounds of elements of the third and fifth groups of the periodic system (III-V), which are superconductors or dielectrics under normal conditions, become metallic under high pressure.[1,2] Studies of the properties of the metallic phases of these compounds have revealed in some substances transitions to the superconducting state. For example, the superconducting transition temperature of the metallic modification of gallium arsenide (GaAs) is 4.8 K,[3] while that of AlSb is 2.8 K.[4]

Observation of a dielectric—metal transition in gallium phosphide was reported in[5]. According to the data of[6] the transition pressure is 220 kbar, which is the limit attainable in modern high-pressure installations. The superconductivity at such high pressure has not been investigated.

Our experiments on the superconductivity of gallium phosphide were made with a high-pressure setup previously employed for the study of insulator—metal transition in the megabar pressure range[7,8] and at low temperatures. The setup is based on anvils made of Carbonado diamonds. The resistivity was measured in the course of cooling by a standard potentiometer procedure.

Since the sample was very small, the experimentally measured resistance included the anvil resistances in addition to the sample resistance. The sample resistance jump at the superconducting transition was recorded against the

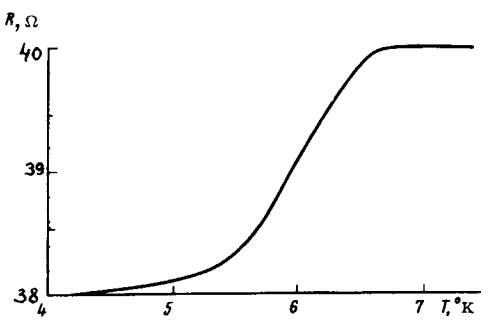

FIG. 1. Superconducting transition in gallium phosphide.

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background of the anvil resistances, which added up usually to several dozen ohm.

We used this apparatus to investigate the electric properties of the metallic modifications of germanium and silicon. Superconducting transitions were observed at low temperatures.

The superconducting transition temperature of silicon was 6.7 ± 0.1 K and was independent of the applied force. T_c of germanium decreased with increasing load. The maximum T_c observed by us in germanium was 5.3 ± 0.1 K. In all the samples, T_c decreased with increasing current through the sample, and the superconductivity of all samples was destroyed at liquid-helium temperature at a certain current value.

Experiments were performed with different samples and different anvils. The results of all experiments agreed with those of Wittig.[9]

In the experiments on the superconductivity of gallium phosphide, a thin layer of GaP was deposited on the surface of the flat anvil, in accord with the procedure employed in[7]. At room temperature, the pressure on the anvil was increased to the value at which the phase transition of GaP to the metallic state took place. This transition was revealed by a decrease of the sample resistance.

The high-pressure chamber with the GaP sample in the metallic state was placed in a cryostat and cooled to liquid-helium temperature.

Figure 1 shows a plot of the resistance of the sample + anvils system against temperature. It is seen that the superconducting transition temperature is 6.6 ± 0.1 K. The superconducting-transition temperature was observed to decrease with increasing load on the anvils.

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