Transition of xenon into the metallic state at a high pressure. The superconductivity of metallic xenon

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Transition of xenon into the metallic state is observed in a high-pressure chamber consisting of the carbonado-type diamonds. The metallic xenon is shown to be superconducting. The maximum critical temperature is 6.8 ± 0.1 K.

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Transitions of dielectrics into metals under high pressures has been observed in a large number of materials.

Especially interesting in this respect are elements of the zero group which under normal conditions are inert gases. The dielectric-metal transitions in the elements of

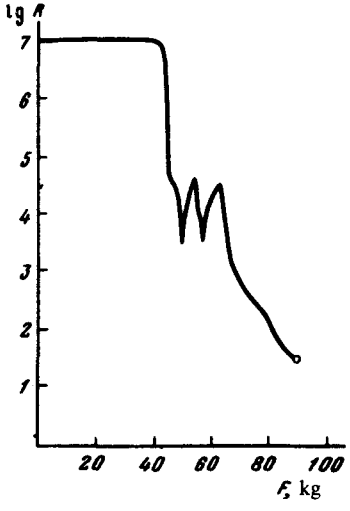

FIG. 1. Dependence of electrical resistance of solid state xenon on the force applied to anvils (anvil insulation resistance $\sim 10^7$ ohm).

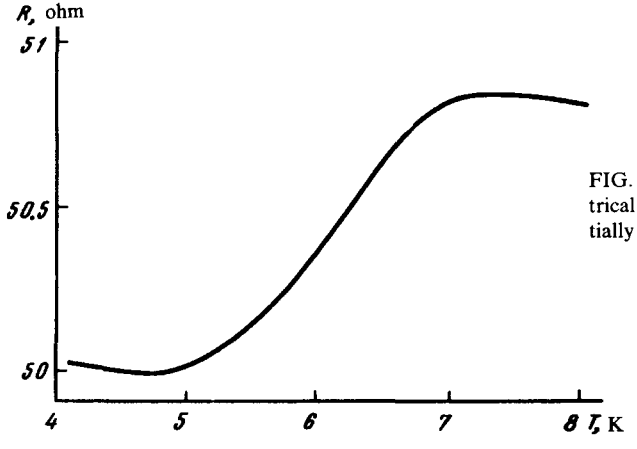

FIG. 2. Temperature dependence of electrical resistance of a specimen with sequentially activated anvils.

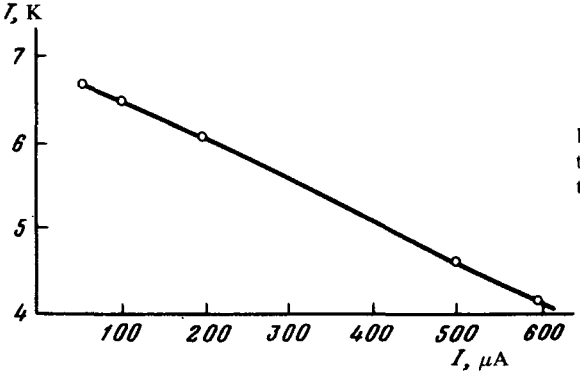

FIG. 3. Dependence of superconducting transition temperature on current through the specimen.

the zero group have been considered theoretically by a number of authors.[1-3] The transition pressure in xenon is in the range from 1 to 5 Mbar.[3]

In Refs. 4–8, xenon was studied under conditions of shock compression. A metal-like state was observed in xenon at a pressure of 500 kbar and temperature of 18,000 K.

The purpose of this work is to obtain a metallic modification of xenon and to study its properties.

The experiments were carried out at the facility used earlier to obtain metallic hydrogen[9] and to study the superconducting properties of the metallic modification of gallium phosphide.[10]

The high-pressure chamber consists of two anvils made of the "carbonado"-type diamonds. One anvil is plane and the other a cone with a rounded-off apex. We used a similar chamber extensively to study the dielectric-metal transitions under the conditions of super-high pressure (see, for example, Ref. 11).

The press and anvils were placed in a cryostat and the anvils were cooled to a temperature below the melting point of xenon (161 K). Subsequently, a heated capillary was used to convey gaseous xenon to the anvil surface, which condensed at the surface in the form of a thin solid layer.

This was followed by loading of the high-pressure chamber and a sharp decrease in the electrical resistance of the specimen was recorded and interpreted as a transition of xenon into the metallic state (Fig. 1).

The chamber containing the specimen was then cooled down to the temperature of liquid helium. The electrical resistance was measured in the process of cooling. A decrease in this parameter characteristic of superconductivity was observed (Fig. 2). The critical temperature decreased with increasing current through the specimen (Fig. 3).

The highest value of T_c which we observed experimentally was 6.8 ± 0.1 K.

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