EFFECT OF PRESSURE ON MAGNETIC BREAKDOWN IN BERYLLIUM

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The influence of hydrostatic compression on magnetic breakdown in beryllium is investigated. It is shown that the breakdown field decreases with pressure.

We have performed preliminary investigations of the influence of hydrostatic pressure on magnetic breakdown in beryllium. The investigations were performed at 4.2°K in a bomb made of beryllium bronze[1]. The pressure was measured with a manganin manometer whose calibration was additionally verified against the T_c shift of tin. A horizontal magnetic field up to 50 kOe was produced with a superconducting magnet with permendur concentrators. The use of a horizontal magnetic field has made it possible to change slightly the orientation of the sample relative to the direction of the magnetic field.

It was shown earlier [1] that the magnetoresistance of a binary sample in a field parallel to the hexagonal axis first increases quadratically, followed at 30 - 40 kOe by a kink due to magnetic breakdown, after which saturation sets in. In the same fields, giant oscillations of the resistance set in, with frequency corresponding to the intersection of the electronic part of the beryllium Fermi surface ("cigar") [2].

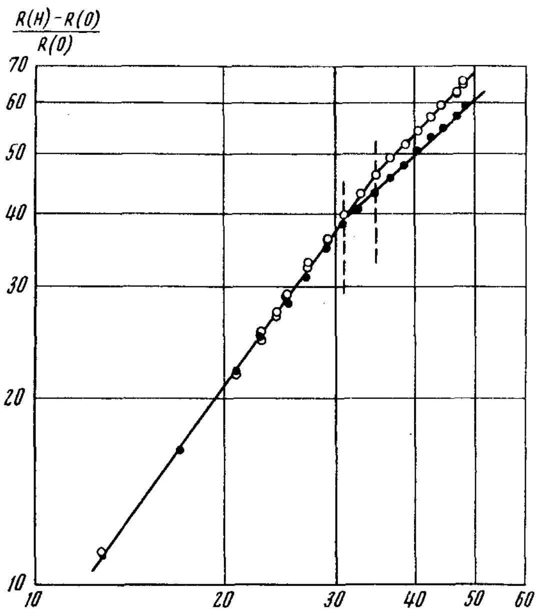

Fig. 1. Monotonic part of magnetoresistance of Be-21($R_{300°K}/R_{4.2°K}$ ≈ 150) vs. the magnetic field. Temperature 4.2°K: o - p = 0, • - p = 1.6 kbar.

Figure 1 shows plots of the monotonic part of the magnetoresistance against the field, obtained without pressure and at the relatively low pressure 1.6 kbar. With increasing pressure, the magnetic field at which a kink is observed in the magnetoresistance decreases, meaning a decrease in the breakdown field H_0. From the results of our measurements, which were performed at pressures up to 3.5 kbar, it follows that $dH_0/dp = -2 \pm 0.4$ Oe/bar.

The amplitude of magnetoresistance oscillations decreases with increasing pressure (Fig. 2), and the corresponding Dingle temperature increases. It is shown in [3] that the oscillatory phenomena are very sensitive to the homogeneity of the sample, so that the growth of the Dingle temperature may be connected with an insufficiently homogeneous compression of the sample. The same inhomogeneity leads apparently to a 3% decrease in the resistance ratio $R_{300°K}/R_{4.2°K}$ at 2 kbar.

[1]The high-pressure beryllium-bronze bomb was prepared at the Institute of Inorganic Chemistry (Novosibirsk), for which the authors thank D.S. Mirinskii.

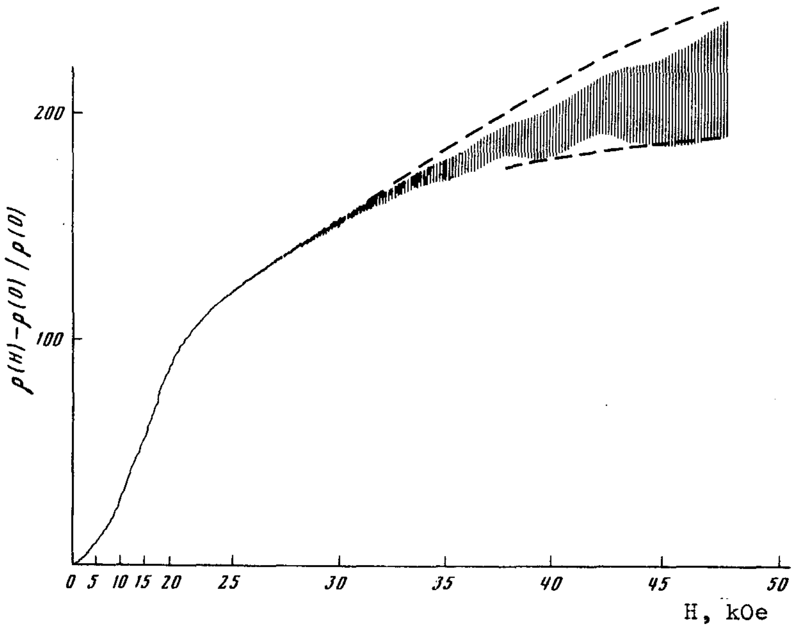

Fig. 2. Resistance of the Be-30 sample ($R_{300°K}/R_{4.2°K}$ ≈ 400) vs. the magnetic field. Pressure p = 3.3 kbar. Temperature 4.2°K. Measuring current I || [1010], field H || [0001]. Dashed line - envelope of the oscillations at p = 0.

At pressures up to 3.5 kbar, the oscillation period changes by not more than 0.5%. The results of an investigation of the influence of the pressure on the beryllium magnetic-susceptibility oscillations were published in [4]. The changes of the period of the oscillations with pressure, obtained in the present paper, are also quite small.

Thus, the results offer evidence that hydrostatic compression of beryllium leads to a noticeable increase of the breakdown probability, and this may be due to the decrease of the distance between the electronic and hole parts of the Fermi surface. If it is assumed that this decrease is proportional to the applied pressure, then tangency of the electronic and the hole parts of the beryllium Fermi surface will occur at a pressure ∿60 kbar. It is interesting to note that it is precisely in this pressure range that a singularity is observed in the pressure dependence of the electric resistance [5], and this singularity is not connected with a first-order phase transition [6].

The influence of the pressure on the Fermi surface of beryllium was considered theoretically in [7], but the accuracy of the calculations of [7] is insufficient to predict unambiguously the variation of the Fermi surface with pressure.

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