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ANISOTROPY OF THE ELECTRICAL RESISTANCE OF Mg *AND* Pt *SINGLE CRYSTALS IN A MAGNETIC FIELD AT 4.2°K*

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The anisotropy of the electrical resistance of Mg and Pt single crystals located in a magnetic field is investigated. The dependences found are characteristic of metals with open Fermi surfaces.

IT has been reported previously[1,2] that the galvanomagnetic properties of single crystals of a number of metals are extremely anisotropic. As is well known,[3,4] strong anisotropy of the galvanomagnetic properties should be observed in metals with open Fermi surfaces.

In connection with the fact that the electric resistance of polycrystalline specimens of Mg and Pt located in a magnetic field increases without limit,[5,6] it could be assumed that the Fermi surfaces of these metals were either closed with $n_1 = n_2$ (n_1 and n_2 are the number of electrons and holes, respectively) or open. The resistance in large magnetic fields should be practically isotropic in the first case, and strongly anisotropic in the second.

Inasmuch as the galvanomagnetic properties of Mg and Pt were investigated only in polycrystalline specimens, there was interest in carrying out measurements on single crystals of these metals also. For this purpose we grew single crystals of Mg and Pt with different orientations. The ratio of resistance at room temperature and temperature of 4.2°K ranged from 230 to 610 for the Mg samples and from 1900 to 2400 for Pt.

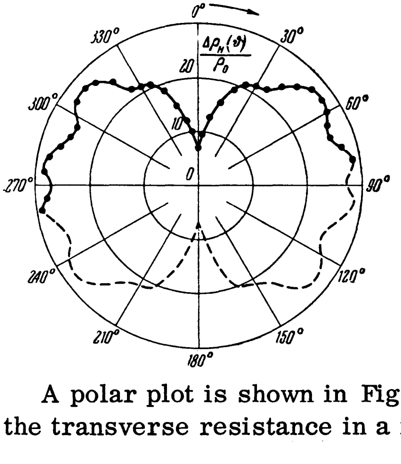

FIG. 1. Polar plot of the resistance of an Mg sample; $\rho_{300°K}/\rho_{4.2°K} = 230$, H = 23500 oe.

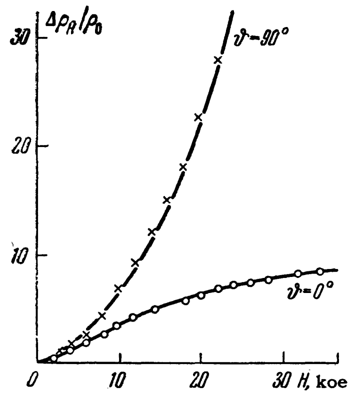

FIG. 2. Dependence of the resistance on the magnetic field for an Mg specimen (see Fig. 1).

A polar plot is shown in Fig. 1 of the change of the transverse resistance in a magnetic field $\Delta\rho_H(\vartheta)/\rho_0 = \rho_H(\vartheta)/\rho_{H=0} - 1$ for a single crystal of Mg, the axis of which formed an angle of 65° with the [0001] axis. For this specimen, as for the other specimens, the minimum resistance in the diagram is observed for a magnetic field direction coinciding with the direction of the projection of the [0001] axis on the plane of rotation of the magnetic field.

For investigation of the dependence of the resistance on the magnetic field in the direction of the maxima of the polar diagrams, an unlimited increase was observed, according to a law that was nearly quadratic. (Fig. 2).

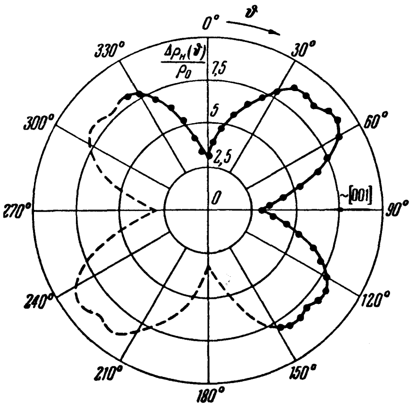

FIG. 3. Polar plot of the resistance of of a Pt specimen; $\rho_{300°K}/\rho_{4.2°K} = 1900$. H = 23500 oe.

For specimens whose axis was parallel to the [0001] direction, the anisotropy of the resistance is practically nonexistent; in this case, the resistance increases without limit for an arbitrary direction of the magnetic direction of the magnetic field according to a square law. It is known that the other metals of hexagonal structure (Zn and Cd) behave in similar fashion.[7]

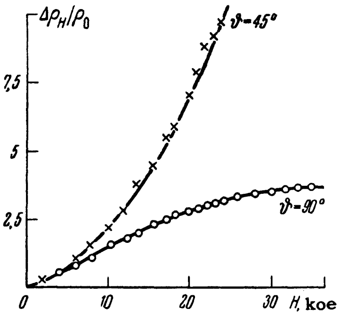

FIG. 4. Dependence of the resistance on the magnetic field for a Pt specimen (see Fig. 3).

Investigation of single crystals of Pt has shown that the latter also posesses a strong anisotropy of electrical resistance in a magnetic field. The results of measurements for one of the Pt samples are shown in Figs. 3 and 4. The axis of the sample departs from the [001] axis by about 10°. It is seen from the drawings that the behavior of the resistance of Pt in a magnetic field is similar to the behavior of the other metals previously studied with a strong anisotropy in the resistance.[1,2] Measurements carried out on some specimens showed that the minimum in the polar diagrams in the direction of a fourth order axis is observed for any orientation of the current relative to the axes of the crystal.

Saturation and unlimited growth of resistance, observed for different crystalline directions, give grounds for assuming that magnesium and platinum have Fermi surfaces of the open type.

If we attempt to represent the form of the Fermi surface, then, just as we noted for Tl,[1] such a surface could be a "corrugated plane." However, for such a type of Fermi surface, for a specimen of Mg with axis parallel to the direction [0001], one should have expected saturation of the resistance in the magnetic field, and not a quadratic increase observed experimentally. The results we obtained for platinum are very similar to the results for the non-transition metals (for example, for Pb[1]). Borovik and Volotskaya, carrying out measurements on polycrystalline platinum,[6] came to very similar conclusions.

At best, the experimental results for platinum describe a Fermi surface of the "spatial grid of cylinders" type, with cylinder directed along the fourfold axes order of the platinum reciprocal lattice.

In conclusion, we consider it our pleasant duty to thank Academician P. L. Kapitza for his great attention to the present work. We also thank G. É. Karstens for help in the determination of the orientation of the specimens.

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