atures a few degrees below the Curie point, absorption of sound is weakly dependent on the external field. Specifically, a field of intensity ≈ 600 v/cm changes the sound absorption by only several percent. This is apparently due to the fact that the external field intensities away from the Curie point become small compared with the molecular field of the spontaneous polarization inside the crystal.

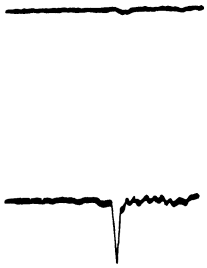

FIG. 1

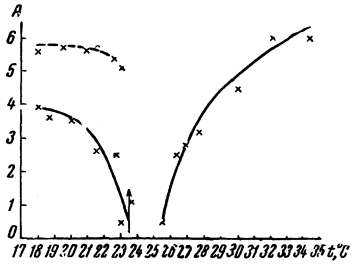

FIG. 2

However, at temperatures 0.1° to 0.2° below the Curie point, the influence of the electrostatic field on the absorption of sound in the Rochelle salt is very large. At these temperatures placing the crystal in an external field of the intensity indicated increases the amplitude of the sound wave passing through this crystal by a factor of several times ten. Figure 1 shows two oscillograms of sound pulses passing through a Rochelle salt crystal at a temperature $T - \Theta_c \approx 0.2°$. The upper oscillogram corresponds to the passage of sound through an unpolarized crystal. It shows only the zero sweep line of the oscillograph, washed out by the noise. The sound signal is not noticeable at this temperature, owing to the strong absorption of sound at this temperature. The lower photograph shows an oscillogram of a sound pulse under the same conditions, but after passing through a crystal polarized by an external field. The amplitude of the pulse is increased by approximately 50 times.

The polarization of the crystal by an external field also affects substantially the temperature dependence of sound absorption below the Curie point. In the absence of an external field, in the temperature range from 23° to 19° C, the absorption of sound diminishes monotonically with cooling of the crystal, while in a crystal polarized by an external field near the Curie point, the absorption of sound becomes practically independent of the temperature. With this, the amplitude of the sound signal passing through the polarized crystal depends on the temperature at which the external field was applied to the crystal. Figure 2 shows typical plots of the temperature dependence of the amplitude of the signal passing through the Rochelle salt. The solid and dotted curves pertain to the unpolarized and polarized crystal respectively. The high temperature branches of both curves are identical. The arrow on the diagram shows the jump in intensity of sound signal as a result of the superposition of an external electrostatic on the crystal.

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CYCLOTRON RESONANCE IN TIN AT 9300 Mcs

P. A. BEZUGLYI and A. A. GALKIN

Institute for Technical Physics, Academy of Sciences, Ukrainian S.S.R.

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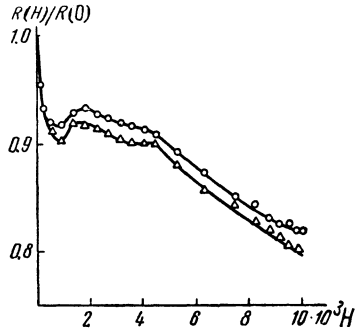
AZBEL' and Kaner[1,2] showed that cyclotron resonance should take place in a magnetic field parallel to the surface of a metal provided that $\delta \ll r \ll \ell$ (δ is the skin-depth, r the radius of curvature of the electron orbit in the magnetic field, and ℓ the mean free path of the electrons). In contradistinction to diamagnetic resonance in semiconductors,[3] cyclotron resonance in metals takes place not only when the frequency of the external high frequency field ω coincides with the Larmor frequency Ω but also at

higher harmonics. In addition, one can only observe cyclotron resonance in fields that are strictly parallel to the metal surface.

To observe this phenomenon experimentally we undertook a measurement of the dependence of the active part of the surface resistance of tin on the strength of the constant magnetic field at 9300 Mcs. The sample we used was an electropolished single crystal of tin with a diameter of 0.8 mm; within 5° the tetragonal axis coincided with the axis of the sample. The specimen was arranged along the axis of a coaxial copper resonator operating in the fundamental TEM mode. The surface hf current in it was parallel to the axis of the specimen. The electrical connection of the resonator with the high frequency power generator was through the central conductor of the coaxial line leading out of the cap of the apparatus. The resonator with the specimen was placed in the electromagnetic field in such a way that the constant magnetic field H was approximately parallel to the specimen axis. The final adjustment of the position of the specimen parallel to the field was obtained by turning it in the horizontal and vertical planes at temperatures $T < T_c$ in a magnetic field lying between $\frac{1}{2}H_c$ and H_c, until the current in the detector output was maximum. The current through the detector decreases when the specimen is no longer parallel to the field because the superconducting specimen goes over into the intermediate state. An estimate of the change of the surface resistance was obtained from the magnitude of the deflection of the pointer of a dc galvanometer connected in the detector circuit. The measurement was carried out when the generator was working continuously.



In the figure we give the results of the measurements R(H)/R(0) [R(H) and R(0) are, respectively, the surface resistance of the specimen in the field and in zero field] at a temperature of 4.2° K (upper curve) and at 2° K (lower curve) in the case where the hf current is parallel to the constant field and to the tetragonal axis of the specimen and $\omega t_0 = 6$. This value of ωt_0 (ω is the angular frequency of the electromagnetic field and t_0 is the relaxation time of the electrons) refers to a temperature of 4.2° K and was determined from the residual resistance. It can be seen that there are two resonance minima on the curves, which increase in sharpness with decreasing temperature. For fields exceeding 4000 oersted the resistance decreases monotonically in agreement with theory. The position of the resonance minimum at H = 900 oersted and also the monotonic decrease of the resistance in strong fields is also in agreement with the experimental results of Fawcett[4] which were obtained with tin at 24,000 Mcs.

If we assume that the resonance minimum at H = 3600 oersted corresponds to the condition $\omega = eH/m^*c$ and hence gives us an estimate for the effective mass m^* of the electrons, it turns out that $m^* \approx m_0$, where m_0 is the mass of a free electron. It is interesting to note that an estimate of the effective mass of the electrons from the conductivity of tin obtained from experiments on galvanomagnetic phenomena[5] leads to approximately the same value.

The fact that there are only two resonance minima on the experimental curve, one of which is only a weak minimum, is apparently connected with the small value of ωt_0. This point of view is confirmed by the experiments at 2° K. Indeed, at this temperature the resonance sharpens appreciably with a blending of the minimum on the side of large fields, in accordance with theory. It is also possible that the resonance minima at $H_1 = 3600$ and at $H_2 = 900$ oersted are caused by electrons of different effective mass ($m_1 \approx m_0$ and $m_2 \approx 0.25\, m_0$). Finally, the resonance effect is possibly suppressed by the fact that the field is not strictly parallel to the surface of the specimen.

Turning the specimen over 90° relative to the constant field confirms roughly this picture of the phenomenon, as it produces a decrease in the depth of the minimum and a blending of the minimum at smaller fields. The cause of the decrease in sharpness of the resonance is apparently the decrease of the effective surface of the specimen parallel to the field and the blending of the minimum in the region of smaller fields is caused by the anisotropy of the effective mass of the electrons.

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