energies are practically equal, and to measure accurately the cross sections for the photoionization of the atoms from the excited states. High selectivity can apparently be obtained also by two-step photodissociation of the molecules by laser radiation. Experiments in these directions are presently under way.

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SURFACE CONDUCTIVITY IN TIN IN A STRONG MAGNETIC FIELD

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1. It was shown in [1] that in a strong magnetic field $\vec{H}$ the static conductivity of a metal at the surface and in a region of the depth of the order of the Larmor radius r differs from the conductivity in the interior. The surface impedance with allowance for this fact was subsequently calculated in [2]. It was shown that if the conditions

$$r \ll \delta \ll \ell, \quad H \parallel n \tag{1}$$

are satisfied for pure metals, a skin effect of a new type should occur at frequencies $\omega < \nu$ (δ is the depth of penetration of the electromagnetic field, ν and ℓ are respectively the collision frequency and the mean free path of the conduction electrons, and n is the normal to the surface of the metal). An important feature of the impedance under these conditions is its sensitivity to the character of the scattering of the electrons from the surface. In specular reflection δ is larger than or equal to the depth of penetration of the electromagnetic field calculated from the value of the static conductivity for the normal skin effect (Fig. 1), and in diffuse reflection it is much smaller.

We report in the present paper the results of an investigation of the surface impedance of tin in a magnetic field; these results point to the existence of the skin effect predicted in [2]. We have also observed that in a strong magnetic field ($\omega_c > \nu$ where $\omega_c = eH/m^*c$ is the cyclotron frequency) there exists a region in which the depth of penetration δ decreases with increasing magnetic field. Such a behavior is connected with the distinctive role of diffuse scattering of conduction electrons from the surface of the metal when $\vec{H} \parallel \vec{n}$.

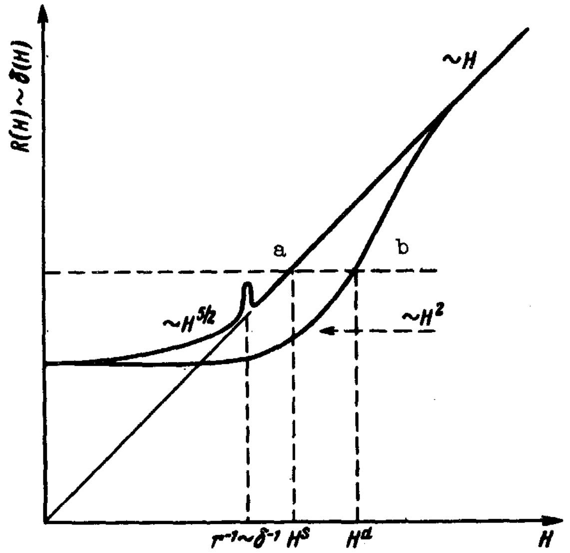

Fig. 1. Depth of penetration δ of the electromagnetic field in a metal at ω = const against the magnetic field, with $\vec{H} \parallel \vec{n}$, in accordance with (2); a - specular reflection of the electrons from the metal surface, b - diffuse reflection; H^d and H^s are the values of the magnetic field for diffuse and specular electron scattering, at which $\delta(H^d) = \delta(H^s)$.

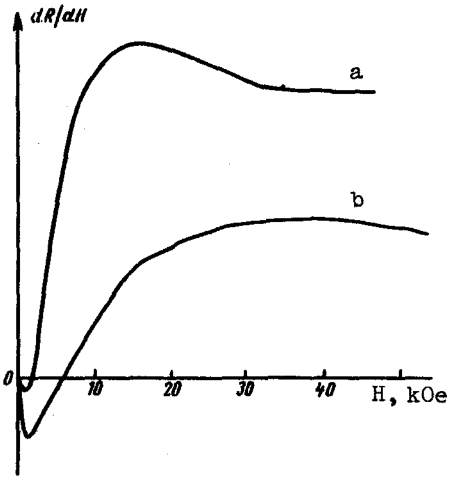

Fig. 2. Experimental plots of the derivative $\partial R/\partial H$ of the real part of the impedance vs. the magnetic field. $\vec{H} \parallel \vec{n}$, $T = 4.2°K$, $\vec{E} \parallel C_2$, a - $f = 1.6$ MHz, b - $f = 12$ MHz.

2. The impedance at the frequencies 1 - 10 MHz was investigated by two methods: 1) by measuring the dependence of the derivative of the real part of the impedance on a magnetic field ($\partial R/\partial H = f(H)$); 2) by directly determining the depth of the skin layer with the aid of sound excited in the sample. The determination of δ with the aid of a sound wave of length λ is based on the fact that when

$$\lambda = \pi\sqrt{2}\,\delta(\omega, H) \tag{2}$$

there should be observed a maximum of the intensity of the standing sound wave [3].

A tin sample with an initial ratio $\rho(300°K)/\rho(4.2°K) \simeq 10^5$ was grown in a dismountable quartz mold and constituted a disc of diameter 18 mm and thickness 1 mm. The surface of the sample was specular. The crystallographic axes C_4 and C_2 were in the plane of the sample. The electron mean free path ℓ in the sample at a temperature 4.2°K was $\sim$1 mm. The sample was inserted in the coil of a high-frequency oscillator and placed in a superconducting solenoid.

Figure 2 shows plots of $(\partial R/\partial H) = f(H)$ at $\vec{H} \parallel \vec{n}$. In the general case, represented by curve a, one can indicate three sections, to each of which there corresponds a characteristic dependence of the high-frequency conductivity on the magnetic field. The section of the curve in the maximal magnetic fields, where $\partial R/\partial H = \text{const}$, corresponds to the normal skin effect, for in this case $\sigma(H) \simeq \sigma(0)(\omega_c\tau)^{-2}$, and

$$R(\omega, H) = \frac{2\sqrt{2}\pi\omega_c r}{c}\sqrt{\frac{\omega}{4\pi\sigma(0)}} \sim H, \tag{3}$$

(τ - relaxation time, $\sigma(0)$ - static conductivity at $H = 0$, c - speed of light). For curve b, this section should lie in the region of even stronger fields H. With decreasing H, and accordingly with decreasing δ, a transition from the normal skin effect to the skin effect of the new type takes place. A characteristic feature in this case is the maximum of the $\partial R/\partial H = f(H)$ curve and the section of the linear growth. This form of $\partial R/\partial H = f(H)$ corresponds to a quadratic $R(H)$ dependence and to a transition to the normal skin effect in accordance with Fig. 1 (curve b). The third type of the impedance dependence, when $\partial R/\partial H < 0$, is observed at still smaller values of H, in which, however, $\omega_c > \nu$ as before. In this region of the magnetic field δ decreases with increasing H, meaning an increase of the high-frequency conductivity $\sigma(\omega H)$. The increase of the conductivity in a strong magnetic field can also be connected only with the diffuse scattering of the electrons. In specular reflection, the conductivity at the surface cannot increase relative to the conductivity in depth, for in this case the electron trajectory does not shift in the direction of the electric field. In this region of the magnetic field, the relation (1), apparently, no longer is satisfied, and another one obtains: $\delta \ll r \ll \ell$. No theoretical analysis of this situation has been carried out as yet.

3. As follows from Fig. 1, in the diffuse scattering of electrons by the surface and under condition (1) δ should be smaller than in the normal skin effect. This premise is confirmed by directly measuring the thickness of the

skin layer with the aid of standing sound wave excited in the sample by the ponderomotive force $F = c^{-1}\vec{j} \times \vec{H}$ ($\vec{j}$ - current density in the skin layer); the frequencies of these waves are determined by the relation

$$f_{\text{res}} = \frac{\omega_{\text{res}}}{2\pi} = \frac{s_t(2n + 1)}{d}$$

(s_t - velocity of transverse sound, d - thickness of plate, 2n + 1 - number of half-waves in the standing wave). A maximum standing sound wave intensity, and consequently satisfaction of the condition (2), was obtained by varying δ with increasing H. The value of the magnetic field H_m at which the thickness of the skin layer was equal to $\delta(f_{\text{res}}H_m) = \lambda/\sqrt{2\pi}$ was determined from the position of the maximum at a fixed frequency f_{res}.

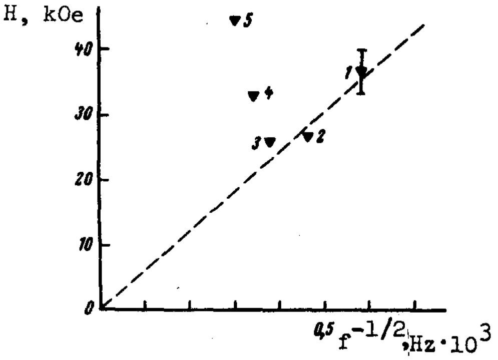

Fig. 3. Dependence of H_m on the frequency. The experimental points correspond to resonances numbered n = 1, 2, 3, 4, 5; $f_{\text{res}} = 0.93(2n + 1)$ MHz; T = 4.2°K.

Figure 3 shows the results of these measurements. In the chosen coordinate system, the straight line drawn from the origin is the line of constant impedance Z, equal to $\sim s_t/c$, under the condition that the normal skin effect is always present (see Fig. 3). The deviation of the experimental points corresponding to the conditions at which $Z \sim s_t/c$ from this straight line thus is connected with the deviation from the static value. The experimental points corresponding to the first numbers of the resonances, n = 1, 2, fit this straight line well, i.e., the skin effect is close to normal. This is natural, for under these conditions the inequality $\delta < \ell$ is not strong ($\delta(H_m) = 0.1$ mm when n = 2). Further increase of the frequency intensifies the inequality $\delta < \ell$ and leads to an increase of H_m relative to the expected values (dashed in Fig. 3). This indicates that $\sigma(\omega, H)$ deviates from the static value, owing to the diffuse scattering of the electrons from the surface (Fig. 1, curve b). In the case of pure specular reflection, H_m should only decrease monotonically.

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[2] M.Ya. Azbel' and S.Ya. Rakhmanov, ibid. 57, 295 (1969) [30, 163 (1970)].
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CERTAIN DISPERSION EFFECTS IN MOLECULAR GASES IN PARALLEL CONSTANT AND ALTERNATING MAGNETIC FIELDS

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In 1967, Scott et al. [1] observed that a heated cylinder in a molecular gas rotates when a magnetic field directed along the axis is turned on (the Scott effect). The authors of [2, 3] have shown that the dependence of the angle of rotation of the cylinder on the ratio H/p (H - field intensity, p - gas pressure) is determined by the kinetic coefficient that connects the