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Low temperature microwave impedance of aluminum in orthogonal magnetic field

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The real part of surface impedance of aluminum in the range of decimeter wave length have been investigated by the method of registration the Q-factor of coaxial resonator. The resonating system was situated in the magnetic field of helium cryostat. It has been observed that surface impedance is non-monotonic function of magnetic field. On the picture of weak total increase of resistance with magnetic field growth there takes place local negativity of surface magnetoresistance in the region of 2 T. The surface impedance negativity belongs to quasi-resonant movement of electrons situated beyond of central section of Fermi surface. There are two characteristic groups of electrons taking place in charge transfer. Central section electrons have small drift velocity through the skin layer but don't enlarge high frequency conductivity in the region of high magnetic field. They drift in normal direction to electric field and the displacement along electric field direction decreases for these electrons with the magnetic field growth. Second group electrons belong to non-central sections. The part of these electrons being in the skin-layer for the time of the order of Larmor period get electric field energy efficiently. These electrons also drift in transverse direction however these electron groups is able to enlarge surface conductivity because their displacement along field direction is of the order of Larmor radius. For the microwave range the next relations between the basic parameters having the frequency dimension are $\omega \ll \Omega \ll \tau^{-1}$ for high magnetic field and $\Omega \ll \omega \ll \tau^{-1}$ for weak magnetic field. Here ω is the microwave frequency, Ω is Larmor frequency, τ^{-1} is the frequency under interaction with the structure defects. At this process the static conductivity tensor in magnetic field $\sigma = \sigma_o / \left[1 + (\Omega\tau)^2\right]$ is modified due to skinning phenomena. The most include to surface conductivity is ensured with first electron group being in skin-layer δ for the time of τ due to small normal component of Fermi velocity v and the second electron group being in skin-layer for the Larmor period. As a result the conductivity can be represented as

$$\sigma_{ef} = \sigma_0 \left(\frac{\delta}{T_\Omega} + \frac{\delta}{\tau} \right) \frac{1}{v} \frac{1}{1 + (\Omega\tau)^2}$$

This expression shows the behaviour of conductivity in all range of magnetic field. For the limit case of weak magnetic fields the conductivity speeds to the expression being valid under anomalous skin-effect. Under another limit case the conductivity speeds to zero. Under the intermediate conditions there must take place a weak maximum which have been observed at surface impedance as a quasi-resonance energy absorption on non-central electrons.