CONCERNING THE MEASUREMENT OF THE SURFACE TENSION BETWEEN SUPERCONDUCTING AND NORMAL PHASES

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The regular structure of the intermediate state in a cylindrical sample located in a transverse magnetic field was used to determine the surface tension at the boundary between the superconduting and normal phases in tin.

THE intermediate state of a cylinder in a transverse magnetic field is characterized according to Landau[1,2] by a structure consisting of alternating layers of normal and superconducting phases. As shown by Sharvin,[3] the period of this structure is

$$a = \sqrt{2R\Delta/\varphi(C_n)}, \quad \Delta = \sigma_{ns}\,(8\pi/H_{\rm cr}^2), \tag{1}$$

where R —radius of cylinder, $\varphi(C_n)$ —Landau function, the numerical values of which are given in [4] (C_n —concentration of normal phase; for a cylinder in a transverse field $C_n = 2\eta - 1$, where $\eta = H/H_{cr}$; for a plate in a transverse field $C_n = \eta$, and therefore (the simple notation $\varphi(\eta)$ is used in [4]), σ_{ns} —surface tension on the n-s boundary, H_{cr} —critical field.

Shal'nikov[5] observed a regular structure of the intermediate state on the surface of a cylindrical specimen, using the ferromagnetic powder method. According to Shal'nikov's observations this structure was particularly clearly pronounced if the transverse magnetic field was supplemented by direct current of value not more than 15% of critical flowing through the specimen. One of us (Mis'kevich) repeated Shal'nikov's experiment using bismuth microdetectors to observe the structure of the magnetic field. Figure 1 shows a curve characterizing the structure of the magnetic field on the surface of a tin cylinder 8 mm in diameter and 55 mm long.

In the present work the field structure was investigated by both methods using three single crystals of 99.998% pure tin: SnI (diameter 8 mm, length 55 mm), Sn II (diameter 8 mm, length 53 mm) and SnIII (diameter 11 mm, length 120 mm); the last two were cut along the major diameter by electro-erosion. The intermediate state was reached in all the experiments by lowering the temperature and then increasing the transverse magnetic field to $0.9\,H_{cr}$. The measurements

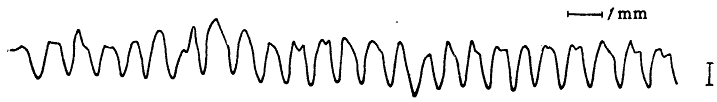

FIG. 1. The magnetic field on the surface of a cylindrical sample. $T = 3.42°K$, $H = 0.59\ H_{cr}$, $I = 0.095\ I_{cr}$.

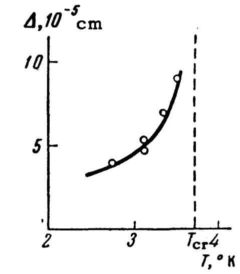

FIG. 2. The temperature dependence of Δ for sample III.

were made by the ferromagnetic powder method and with bismuth microdetectors, both on the specimen surface and inside a slot 100 μ wide. Passage of an insignificant amount of current through the specimen makes the pictures sharper and more regular in character. By measuring the period of the structure obtained with the microdetector at different temperatures, and by using relation (1), we calculated the value of Δ, the temperature dependence of which (see Fig. 2) is in satisfactory agreement with Sharvin's observations.[6]

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