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THE THERMOELECTRIC POWER OF LIQUID MERCURY AT ELEVATED TEMPERATURES AND PRESSURES

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The thermoelectric power of liquid mercury is measured at pressures up to 1000 bar and temperatures to 1000°C and values are given for the variation of absolute thermoelectric power with temperature, pressure and volume.

The absolute thermoelectric power of liquid mercury has been measured and discussed several times [1-3]. At or near zero pressure it is given by [1]

$$S_{p=0} = 2.00 - 23.3 \times 10^{-3} T \; \mu\mathrm{V}/^{\circ}\mathrm{K}$$

The temperature coefficient is an order of magnitude larger than for other metals.

Possibly the pseudopotential theory of electron transport in liquid metals [4] is adequate to account for this property of mercury if the model were to include the temperature and volume dependence of the structure factor, and the volume and energy dependence of the pseudopotential. But these are still difficult to incorporate numerically into a calculation. However it is also possible that the theory is inadequate to cover the case of mercury because the electron ion interaction is too strong and the Fermi surface is smeared out in consequence [5].

Pending clarification of these theoretical points we have made two further experimental investigations which extend the temperature range over which S is known and find its volume dependence.

The experiments were performed up to 1000 bar inside the pressure vessel described by Postill et al. [6]. The specimen was a column of mercury inside an open ended silica tube. The latter was inside a thin tantalum or steel sheath closed at the hot end. Contact between the mercury and the thermocouple and counter electrode was through the sheath. The effect of pressure on the thermoelectricity of copper is given up to 100°C by Bridgman [7] and if copper behaves like gold up to 1000°C [8] we are justified in assuming that up to 1000 bar the effect of pressure on the counter electrode is negligible for our purposes. More technical details will be published elsewhere.

At low pressures and up to 300°C there was good agreement with eq. (1), but at 500 bar or greater, the mercury could be taken to 1000° without boiling and it was observed that at higher temperatures and lower densities, $(\partial S/\partial T)_p$ became more and more negative. At 500 bar and up to 1000°C,

$$S_{p=500} = -(1.90 + 5.48 \times 10^{-3} T + 1.86 \times 10^{-5} T^2) \pm 0.1 \; \mu\mathrm{V}/^{\circ}\mathrm{K}$$

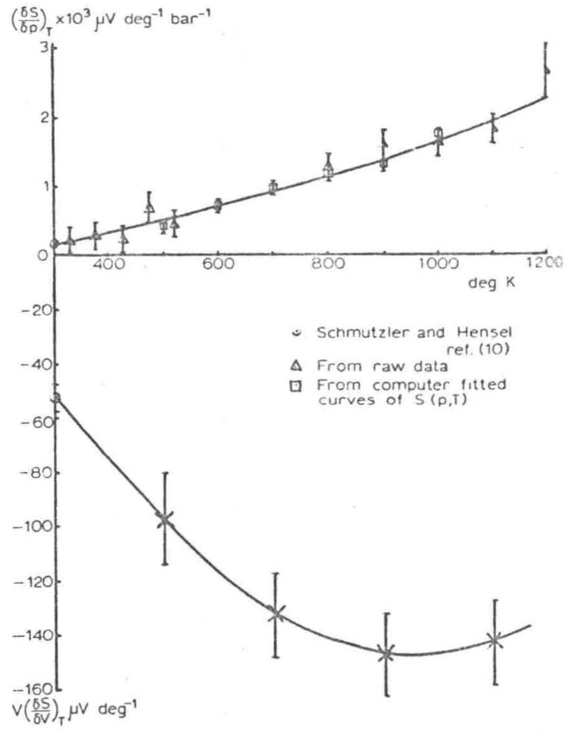

Fig. 1. Pressure and volume dependence of the absolute thermoelectric power of liquid mercury.

with T in $^{\circ}$K. The error does not include any contribution from S_{Cu} which was taken to be $0.05 + (5.45 \times 10^{-3})T\ \mu\mathrm{V}/^{\circ}\mathrm{K}$.

This result is the mean of several runs of different specimens in steel and tantalum sheaths. Agreement between the runs at a given pressure was very satisfactory but the differences between them, though small, were not small compared with the effect of 1000 bar. However, the effect of pressure on any one specimen was always of the same sign and magnitude and by measuring $S(p, T)$ at various pressures, values of $(\partial S/\partial p)_T$ could be found. This quantity is positive, i.e. S becomes less negative when mercury is compressed. $V(\partial S/\partial V)_T$, which can be found by combining $(\partial S/\partial p)_T$ with the compressibilities found by Postill et al. [9], is therefore negative and gets more so as the density decreases, at least for low temperatures.

The errors in measuring $(\partial S/\partial V)_T$ are considerable especially at low temperatures where the compressibility is least, but there the more accurate method of Schmutzler and Hensel [10] is available and the agreement between the two experiments is satisfactory. The results and an estimate of error are shown in fig. 1.

The negative sign of $(\partial S/\partial V)_T$ is in agreement with Animalu's theoretical result [11] but the latter was derived from a formula which cannot get the right sign for S itself.

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ACTION OF DISLOCATIONS ON PINNING IN A SUPERCONDUCTING SINGLE CRYSTAL

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The influence of dislocations on the pinning of Abrikosov's flux lines in a $\mathrm{Ta}_{70}\mathrm{Nb}_{30}$ single crystal is studied. It has turned out that at small deformations ($\Delta l/l = 4\%$), when compared with a non-deformed crystal, the coupling energy of the flux lines with the lattice imperfections increases, while at large deformations ($\Delta l/l = 42\%$) the pinning vanishes completely within the accuracy provided by our equipment.

We have studied the dissipative processes and pinning in type II superconductors by current-free methods [1-5] and it has turned out that these effects depend greatly on the strength of the magnetic field, on temperature and on the state of the specimen.

We have now investigated the pinning phenomenon of Abrikosov's flux lines on surface imperfections of a $\mathrm{Ta}_{70}\mathrm{Nb}_{30}$ crystal, and the present note deals with the pinning on line imperfections existing in the volume of the crystal lattice. These dislocations were generated by compres-