:0

and A. SEEGER, phys. stat.

, and O.'BOSER, Mater. Sci.

llphysik, Vol. II, Ed. A. Seeger,

1968)



phys. stat. sol. 30, K107 (1968)

Subject classification: 14.2

Physico-Technical Institute, Ukrainian Academy of Sciences, Donetsk

# Influence of High Pressure on the Energy Gap of Tin[1)]

By

A. A. GALKIN, A. A. DIKII, and V. M. SVISTUNOV

Earlier (1) we reported about a more rapid change of the energy gap of lead with pressure than of the critical temperature. It was assumed that this is determined by the correlation between $\Delta$ and $T_c/\Theta_D$.

Investigation of the phonon spectrum under pressure (2, 3) confirmed this assumption and showed (3) that the change of the gap of lead is satisfactorily explained by the theory of anomalous superconductors (4).

Superconductors with small ratio $T_c/\Theta_D$ are of interest and are well described by microscopic theory (5). In this note we represent experimental results of tunnel measurements of the energy gap of superconducting tin from 1.3 to 4.2 $^{\circ}$K for pressures up to 11 katm on Al-I-Sn and Sn-I-Sn samples.

The aluminium films, the high pressure technique, and the manometer, were the same as in the previous paper (1). The tin films were $\approx$ 1500 Å thick and the starting critical temperature was 3.93 $^{\circ}$K. The energy gap of tin was obtained from I-U and dU/dI-U characteristics of Al-I-Sn and Sn-I-Sn samples.

By using Sn-I-Sn junctions in the experiments the influence of pressure on the energy gap of tin could be clearly demonstrated (Fig. 1), allowing also measurements of the temperature dependence of the gap at 8.2 katm (Fig. 2). Here the gap changed from 1.24 meV (P = 0) to 1.08 meV (P = 8.2), and the critical temperature from 3.93 to 3.53 $^{\circ}$K.

The I-U-characteristics of Al-I-Sn are shown in Fig. 3. The essential influence of pressure on the energy gap is distinctly seen. However, the high temperature in the experiment for Al, $t = T/T_c = 0.77$, did not allow to obtain quantitatively the change $2\Delta/kT_c$ with pressure for this metal.

---

1) Preliminary results up to 6 katm were reported on the assembly of the physical department of the Ukrainian Academy of Sciences on March 27, 1968.

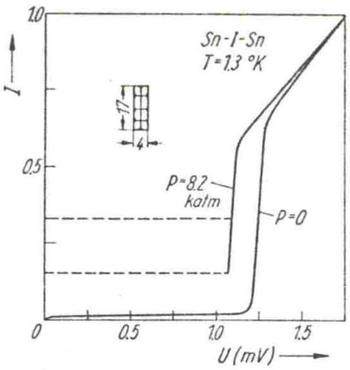


Fig. 1

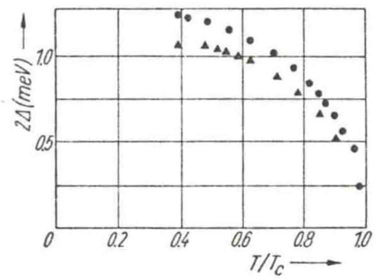


Fig. 2

Fig. 1. I-U characteristics of a Sn-I-Sn junction at P = 0 and P = 8.2 katm. Normalized units are along the I-axis

Fig. 2. Temperature dependence of the energy gap of tin at a pressure of 8.2 katm;

● - P = 0,

▲ - P = 8.2 katm

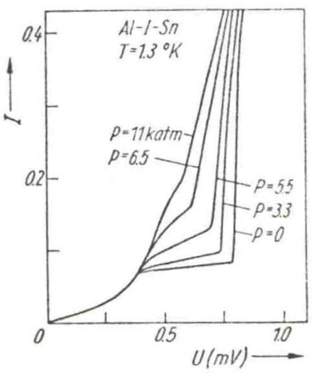


Fig. 3

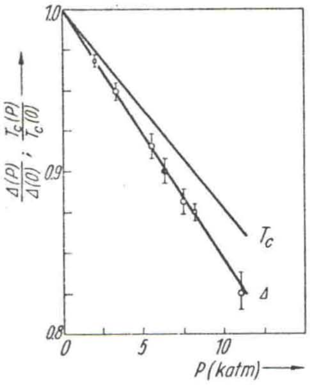


Fig. 4

Fig. 3. I-U characteristics of Al-I-Sn at different pressures. Normalized units are along the I-axis

Fig. 4. Influence of high pressures on the energy gap and critical temperature of tin. The straight line for $T_c$ has a slope of $dT_c/dP = -4.8\times10^{-5}$ °K/atm;

- from Sn-I-Sn,

- from Al-I-Sn,

- pressure break

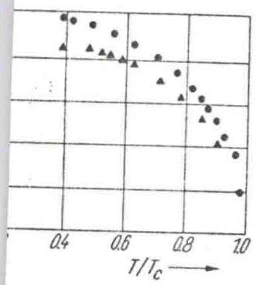


Fig. 2

t P = 0 and ·P = 8. 2 katm.

of tin at a pressure of 8. 2 katm;

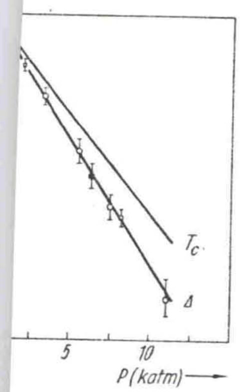


Fig. 4

pressures. Normalized units are

gap and critical temperature of

f $dT_c/dP = -4.8\text{x}10^{-5}$ $^oK/atm$;



The results on the influence of high pressure on the energy gap and critical temperature of tin are represented in Fig. 4.

From experiments the following values are found:

$$\frac{dT_c^{Sn}}{dP} = -(4.8 \pm 0.3)\text{x}10^{-5} \frac{^oK}{atm} \quad ,$$

$$\frac{d2\Delta}{dP} = -(-1.85 \pm 0.1)\text{x}10^{-5} \frac{meV}{atm} \quad .$$

Thus it was shown by means of direct experiment that in the case of tin as for lead $2\Delta/kT_c$ changes with pressure. Analysing the experimental data and the data of (1 to 3) on lead, and estimating the change of $\Theta_D$ with pressure (6, 7) it is interesting to mark that the magnitude of the shift of $2\Delta/kT_c$ with pressure coincides with the change of $T_c/\Theta_D$.

Multi-band effects can possibly cause a gap decrease with pressure. This question is studied now experimentally.

In conclusion we should like to point out the following: Observation of the Josephson dc (8) under pressure (Fig. 1) apparently shows the essential role of fluctuations in superconducting tunnelling.


## Acknowledgements

We are grateful to I. Ivanchenko and L. Zilberman for helpful discussions of the superconducting tunnelling problem, V. I. Makarov for useful remarks and advices, V. V. Shevtsov for constant technical aid, V. P. Raevskii for some innovations in making high pressure cells.


## References


(1) A. A. GALKIN and V. M. SVISTUNOV, phys. stat. sol. 26, K55 (1968).

(2) I. P. FRANCK and W. T. KEELER, Phys. Letters (Netherlands) 25A, 624 (1967).

(3) N. V. ZAVARITSKII, E. S. ITSKEVICH, and A. N. VORONOVSKII, Zh. eksper. teor. Fiz., Pisma 7, 271 (1968).

(4) B. T. GEILIKMAN and V. KRESIN, Fiz. tverd. Tela 7, 3297 (1965).

(5) I. BARDEEN, L. COOPER, and I. SCHRIEFFER, Phys. Rev. 108, 1175 (1957).

(6) J. WITTIG, Z. Phys. 195, 228 (1966).

(7) N.B. BRANDT and N.I. GINZBURG, Uspekhi fiz. Nauk 85, 3 (1965).

(8) B.D. JOSEPHSON, Rev. mod. Phys. 36, 216 (1964).


(Received July 29, 1968)