OBSERVATION OF THE MARTENSITIC TRANSFORMATION IN SUPERCONDUCTING V_3Si BY TRANSMISSION ELECTRON MICROSCOPY

M. J. Goringe and U. Valdrè*

Cavendish Laboratory, Cambridge, England

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Evidence for a martensitic phase transformation in superconducting alloys of the β-W structure has been reported by Batterman and Barrett,[1] who used x-ray techniques. There seems to be some doubt as to whether further evidence for the existence of the transformation is given by resistivity anomalies.

We wish to report that we have confirmed the existence of this phase transformation in V_3Si by transmission electron microscopy in the temperature range 20-30°K. Observations have been made both on polycrystalline and single-crystal material using a liquid-helium-cooled specimen holder described elsewhere.[2] The diffraction contrast effects found agree with the predictions of the theory of Gevers et al.[3,4] for coherent twin boundaries, assuming the previously reported value for c/a of 1.0025.[1] Some of the main features of the transformed material are shown in Fig. 1 and the related stereogram of Fig. 2. At a and b in Fig. 1 one can see fringes caused by inclined boundaries between twin-related tetragonal regions, the boundaries being on (101) and (011) [or ($\bar{1}$01) and (0$\bar{1}$1)] planes. In the region c of Fig. 1 the transformation has taken place such that the twin planes are perpendicular to the foil (which had [001] normal), i.e., on interlocking (110) and ($\bar{1}$10) planes, giving rise to contrast which is most visible close to the dark extinction contours as fine dark lines on one side of the contour and fine bright lines on the other. It has been found that these twin-related lamellae occur fairly regularly over large regions of the specimen with an average periodicity of about 250 Å. On raising the temperature through the transformation temperature the twin boundaries disappear, the specimen returning to its original single-crystal orientation. The same region of specimen cooled on different occasions shows a similar, but not identical, arrangement of twin boundaries.

A fuller account of this work will be published in due course.

We wish to thank Dr. B. W. Batterman of Bell Telephone Laboratories for supplying the samples of V_3Si used in the experiments.

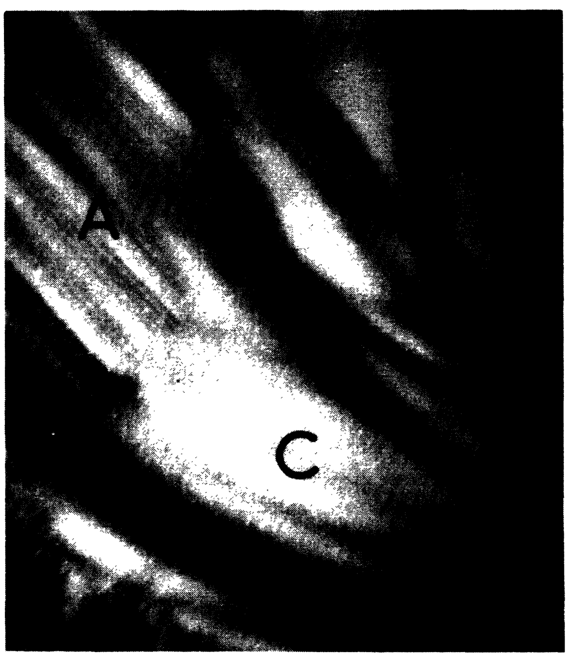

FIG. 1. Transmission electron micrograph of V_3Si at a temperature of approximately 20°K, showing contrast due to twin boundaries. Foil normal [001]. Magnification 27 000×.

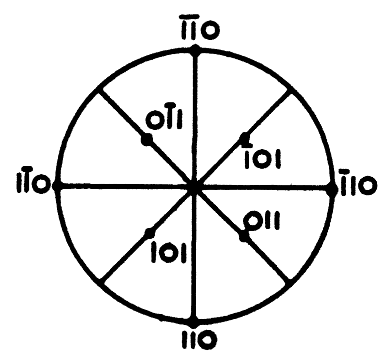

FIG. 2. Stereogram showing geometry of twin planes in Fig. 1.

*On leave from Istituto di Fisica dell'Università di Bologna, Bologna, Italy.

[1]B. W. Batterman and C. S. Barrett, Phys. Rev. Let-

ters 13, 390 (1964).
[2]U. Valdrè and M. J. Goringe, J. Sci. Instr. 42, 268 (1965).
[3]R. Gevers, P. Delavignette, H. Blank, and S. Amelinckx, Phys. Status Solidi (Germany) 4, 383 (1964).
[4]R. Gevers, P. Delavignette, H. Blank, J. Van Landuyt, and S. Amelinckx, Phys. Status Solidi (Germany), 5, 595 (1964).

TUNNELING IN LEAD SALT p-n JUNCTIONS

Robert M. Williams*
RCA Laboratories, Princeton, New Jersey
and
John Shewchun†
Brown University, Providence, Rhode Island
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Hall[1] has observed structure near zero bias in the conductance-voltage curves of tunnel p-n junctions at 4.2°K in 11 different semiconductors. More recently, two of these materials (Ge and Si) have been studied near 1°K,[2] and similar effects have been observed in metal-oxide-metal diodes.[3] In spite of these observations, a clear theoretical explanation for them is still not available. For this reason, we have made extensive experimental measurements on three semiconductors (PbS, PbTe, PbSe) to temperatures near 1°K. We have observed two striking effects not previously reported, and have studied their temperature and magnetic field dependence.

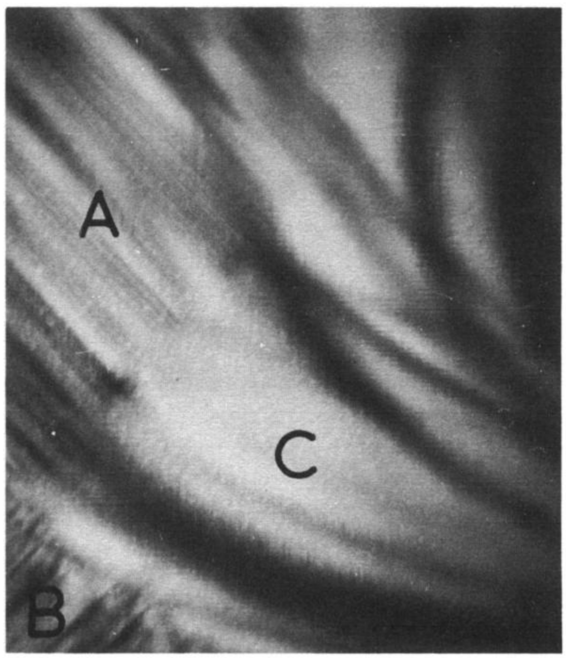
The p-n junctions were made by alloying dots into the host crystal. Indium dots were used on p-type PbS and PbTe while a (Sn-In) dot was used on PbSe.[4] These junctions were immersed in liquid helium which could be pumped to near 1°K. The current I, resistance dV/dI, and second derivative of voltage d^2V/dI^2 were directly plotted as functions of voltage with an X-Y recorder. The differentiator used has been described previously.[5] The ac sensing signal in the differentiator was adjusted so that even the data at the lowest temperature were not distorted by the sensing signal. A typical peak-to-peak sensing voltage was 100 μV.

In Fig. 1, the resistance, dV/dI, of three lead salt diodes is plotted against voltage (directly from recorder traces) for different temperatures. The normalizing resistance of the background, R_b, is the resistance at zero bias at the lowest temperature, T_b, at which structure is not observed. The main features of Fig. 1 can be summarized as follows: At T_b, the resistance is a smooth function of the voltage for all three samples. As the temperature is decreased below T_b, the resistance near zero bias increases markedly. The increase in resistance is symmetric about zero bias when the resistance at T_b is also symmetric about zero bias. The common feature of the data is that all three diodes exhibit a strongly temperature-dependent resistance near zero bias. Consider now the differences in the data.

In Fig. 1(a) (PbS), there is a bell-shaped resistance at 4.2°K. This is termed a Λ curve. The broken line is the 4.75°K curve shifted to coincide at large bias with the 4.2°K curve. It shows that the bell is just superimposed on the smooth background. The 4.2°K curve is similar to those observed previously near 1°K.[2,3] However, the 1.36°K curve shows a symmetric dip (undershoot) below the shifted 4.75°K curve. Correspondingly, this is called a W curve. Recently, this type of undershoot has also been observed in InSb.[6] The maximum effect is a resistance increase of about 30%.

In Fig. 1(b) (PbSe), there is a much larger undershoot and also some additional structure in the curve. Notice that the position of the structure shifts with temperature. The undershoot is plainly visible at 4.2°K, and the maximum resistance increase is about 70%.

Finally, in Fig. 1(c) (PbSe) at 4.2°K, spikes (marked with arrows) are observed. They are symmetrically located about zero bias. The original data at this temperature are reminiscent of the 1.37°K data in Fig. 1(b) in that both show similar spikes. On decreasing the tem-



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