CONCLUSIONS

(1) The electrical resistance of a specimen of magnesium containing 0.043% manganese in solid solution, Mg(Mn), passed through a minimum at 14.5°K and then increased approximately 20% in value as the temperature was lowered to 1.5°K. Within experimental error, the temperature dependence of the thermal resistance was exactly equivalent to that of the electrical resistance.

(2) The electrical resistance of a relatively pure and severely cold-worked specimen of magnesium, Mg(Fe), passed through a minimum at 5°K and then increased about 1.7% in value as the temperature was lowered to 1.5°K. The temperature dependence of the thermal resistance of this specimen was equivalent to that of the electrical resistance at temperatures below 4°K. However, in the temperature range 4°K to 15°K, the thermal resistance showed an additional minimum (with a maximum of 4% at 5°K) which did not correspond to any similar behavior in the electrical resistance. This 4°K to 15°K anomaly in the thermal resistivity is tentatively ascribed to the presence of a small amount of lattice conduction.

ACKNOWLEDGMENTS

The authors are indebted to M. B. Cavanagh and S. H. Cress of the Naval Research Laboratory Metallurgy Division for performing spectrographic analyses and to A. R. Donaldson of the Metallurgy Division for preparing photomicrographs of the specimens. We gratefully acknowledge the generous encouragement, assistance and suggestions received from our colleagues in the Cryogenics Branch.

PHYSICAL REVIEW VOLUME 105, NUMBER 5 MARCH 1, 1957

Resistance Minimum of Magnesium: Electrical Resistivity below 1°K

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(Received August 29, 1956)

Measurements of the electrical resistivity of the two magnesium specimens described by Spohr and Webber in the preceding paper have been extended to temperatures below 1°K. At the lowest temperature at which data were obtained (0.22°K), the electrical resistivities of both specimens were continuing to increase. The ratio $\rho_{0.22^\circ\mathrm{K}}/\rho_{4.22^\circ\mathrm{K}}$ was found to be 1.05 for the purer specimen and 1.24 for the less pure (manganese alloy) specimen.

INTRODUCTION

In the preceding paper,[1] referred to as I, the electrical resistivity of two specimens of magnesium in the temperature range 1.3°K to 25°K is reported. As the temperature was lowered in both specimens, the electrical resistivity passed through a minimum and was still increasing at 1.3°K.

Earlier experiments on the electrical resistance, at very low temperatures, of specimens exhibiting the resistance minimum revealed three types of behavior: (1) Croft *et al.*[2] found in nearly pure gold that the resistance continued to increase monotonically [ρ was linear in $\log(1/T)$] at temperatures as low as 0.007°K, (2) Gerritsen and Linde[3] have reported that in dilute alloys of manganese in the noble metals, the resistance minimum is usually followed at lower temperatures by a resistance maximum, and (3) White[4] has observed in a dilute alloy of tin in copper as the temperature was lowered below that of the resistance minimum (~11°K) that the resistance increased by about 5% and then, over the whole temperature range 0.02°K to 1°K, the resistance remained quite strictly constant.

It was felt to be of interest to extend the resistance measurements on the magnesium specimens used in I to temperatures below 1°K to determine whether their behavior fell into any of the three classes described above.

EXPERIMENTAL DETAILS

The specimens used in the present investigation were the ones with which the thermal and electrical resistivity data reported in I and the magnetoresistance data[5] reported in a later paper of this series were obtained. Details concerning their history and purity can be found in I.

The techniques of cooling the specimen and of determining the resistance were in most respects similar to those previously described by one of us.[6] A noteworthy modification was that thermal contact between the specimen and the salt pill was achieved by cementing (GE Adhesive 7031) one end of the sample into an

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[1] D. A. Spohr and R. T. Webber, preceding paper [Phys. Rev. **105**, 1427 (1957)].

[2] A. J. Croft *et al.*, Phil. Mag. **44**, 289 (1953).

[3] A. N. Gerritsen and J. O. Linde, Physica **17**, 573 (1951); **18**, 877 (1952); **19**, 61 (1953).

[4] G. K. White, Can. J. Phys. **33**, 119 (1955).

[5] R. T. Webber, this issue [Phys. Rev. **105**, 1437 (1957)].

[6] R. A. Hein, Phys. Rev. **106**, 1511 (1956).

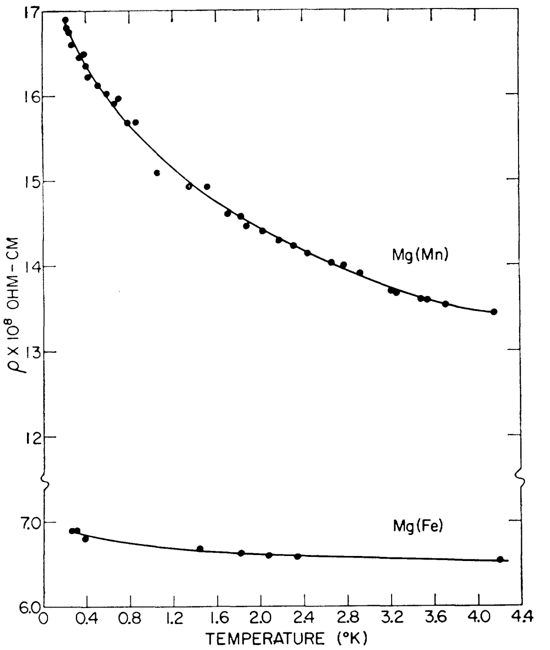

FIG. 1. Electrical resistivity of the two magnesium specimens as a function of temperature.

appropriate hole drilled in the salt pill. Although this type of contact is questionable, it was employed in order to avoid any undue straining of the sample. A carbon-composition thermometer was attached directly to the sample in order to determine its temperature. Data were obtained by first cooling the specimen to ~0.2°K and then periodically measuring its resistance as it warmed up. The warmup time following demagnetization averaged three hours. Errors in temperature measurement due to heating of the specimens by the measuring current were eliminated by use of the carbon-composition thermometer.

RESULTS AND DISCUSSION

The electrical resistivity of the two specimens as a function of temperature is given in Fig. 1. It is evident that the resistance of both specimens continues to increase down to the lowest temperature measured (0.22°K).

In the temperature range 4.2°K to 1.3°K, where these measurements overlap with those in I, the resistivity of the Mg(Fe) specimen agrees with the values reported in I. However, the resistivity values of the Mg(Mn) specimen shown in Fig. 1 are about 4% higher than in I. This additional resistivity may have arisen from strains introduced at some time during the 18-month interval between the measurements in I and the measurements given here.

In I it was emphasized that the electrical resistivity of both magnesium specimens was linear in $\log T$ at liquid helium temperatures. Analysis of the data in Fig. 1 for the Mg(Mn) specimen showed that this $\log T$ dependence continues down to 0.6°K. At temperatures below 0.6°K however, the increase of resistance becomes markedly less rapid, possibly indicating the existence at temperatures below 0.2°K of either a resistance maximum,[3] of a temperature-independent resistance.[4]

ACKNOWLEDGMENT

The authors wish to express their gratitude to the members of the Cryogenics Branch for their helpful suggestions and criticisms.