

who introduced us to the field.

*Supported by the U. S. Army European Research Office and by the Comitato Regionale Ricerche Nucleari.

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SPECIFIC HEAT OF METALLIC PALLADIUM BETWEEN 65 AND 105°K

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(Received July 9, 1962)

Hoare and Matthews¹ found that a maximum occurs in the magnetic susceptibility of metallic palladium in the temperature region between 80 and 100°K, and following the work of Lidiard² there has been some speculation as to whether this maximum is associated with an antiferromagnetic Néel temperature. No confirmation of such an antiferromagnetic structure by neutron diffraction experiments has been reported, however.

It seemed profitable to examine carefully the specific heat of palladium at temperatures near the suspected Néel temperature, since this is a property which is sensitive to magnetic ordering but relatively insensitive to the physical state of the specimen. A λ -point type of anomaly is expected to occur at the Néel temperature. Previous measurements by Clusius and Schachinger³ and later by Eichenhauer and Schäfer⁴ were spaced over relatively wide intervals of temperature, and an anomaly as sharp as that reported by Beaumont, Chihara, and Morrison⁵ for chromium might not have been detected. Certainly neither measurement showed any sign of an anomaly in palladium.

Our observations were made on a polycrystalline solid specimen. The palladium was chemically refined to 99.96% purity. Readings of the specific heat were taken at intervals of about $\frac{1}{2}$ °C from 78 to 105°K, and at a few wider intervals below 78°K. The results are shown in Fig. 1.

It is clear that within the limits of the experimental scatter, which is 1 to $1\frac{1}{2}$ %, there is no evidence of any sharp anomaly in the specific heat of palladium. A peak of the same order of size as that previously found in metallic chromi-

um⁵ and also in α -manganese,⁶ both of which are antiferromagnetic, would have been easily detectable. It seems, therefore, that palladium is not an antiferromagnetic having a significant magnetic moment and a Néel temperature in the region of 90°K.

The curve from the previous measurements by Clusius and Schachinger³ is shown in Fig. 1. It lies between $1\frac{1}{4}$ and $2\frac{1}{4}$ % lower than the present measurements. This difference appears to be significant, since our apparatus has been checked by making measurements on pure iron in the same range of temperature and obtaining excellent agreement with the measurements of Kelley.⁷

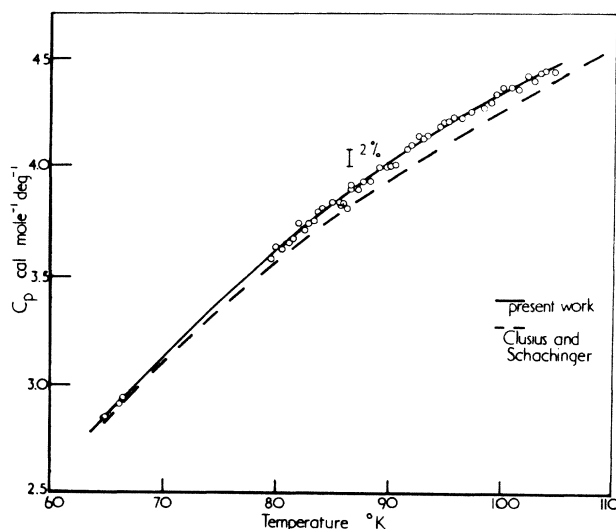


FIG. 1. The specific heat C_p of metallic palladium plotted against temperature.

The values for palladium measured by Eichenhauer and Schäfer⁴ lie between those of reference 3 and ours.

We have also measured the specific heat of a polycrystalline sample of vanadium metal carefully and confirm the result of Clusius, Franzosini, and Piesbergen,⁸ who also made closely spaced measurements, that no appreciable anomaly in specific heat exists in vanadium between 175° and 265°K. Burger and Taylor⁹ reported small anomalies in the magnetic susceptibility and in the electrical resistivity of pure vanadium, which they associated with a possible antiferromagnetic structure.

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CURRENT SATURATION IN PIEZOELECTRIC SEMICONDUCTORS

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(Received June 13, 1962)

The dark current in semiconducting CdS, $\sigma \sim 0.1 (\Omega \cdot \text{cm})^{-1}$, saturates at an applied electric field ~ 1600 volts/cm. The drift velocity of electrons of $\mu \sim 300 \text{ cm}^2/\text{volt sec}$ in this field is $\sim 5 \times 10^5 \text{ cm/sec}$. The current then saturates when the drift velocity of electrons is comparable with the velocity of sound in the crystal. Hutson, McFee, and White¹ recently demonstrated ultrasonic amplification in photoconductive CdS, when the drift velocity of electrons exceeds the velocity of sound in the crystal. We believe that the current saturation reported here arises from the saturation of drift velocity of electrons due to energy transfer from the electron stream to a traveling wave of phonons in the piezoelectric crystal.

Figure 1 shows a typical $V-I$ characteristic for a $0.1 (\Omega \cdot \text{cm})^{-1}$ CdS crystal with the electric field parallel to the c axis. The curve was obtained with voltage pulses $10 \mu\text{sec}$ long. Ohmic contacts of both In and Ga have been used. Saturation is obtained with both vapor-phase-grown platelets and with sections cut from a large boule of CdS. For platelet crystals saturation is direction sensitive as follows:

(a) Stable saturation is always obtained with $E \parallel c$ when $E \sim 1600$ volts/cm.

(b) Saturation can also be obtained with $E \perp c$ and with current flow through the thin section of the crystal when $E \sim 1600$ volts/cm.

(c) The hard saturation shown in Fig. 1 is not

apparent with $E \perp c$ and current flow along the length of crystal. The Ohm's-law current is well behaved below $E \sim 1600$ volts/cm. Above this field there is evidence for incipient saturation, but the current becomes erratic and the higher the voltage is pushed the more likely it is that the crystal will "break down," i.e., become open-circuited and visibly damaged. In any case if saturation can be obtained it is at a field $>1600 \text{ V/cm}$, the current is less stable, and prolonged operation is not possible.²

Saturation is obtained with ease in the c direction of CdS needles, and is also obtained with CdSe at a slightly lower field. We have also

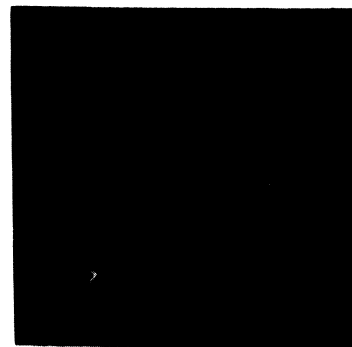


FIG. 1. $V-I$ characteristic for CdS. $L = 0.05 \text{ cm}$, $W = 0.025 \text{ cm}$, $T = 6 \times 10^{-3} \text{ cm}$. $V = 20 \text{ volts/div}$ (horizontal), $I = 5 \text{ mA/div}$ (vertical). $I \parallel c$ axis.