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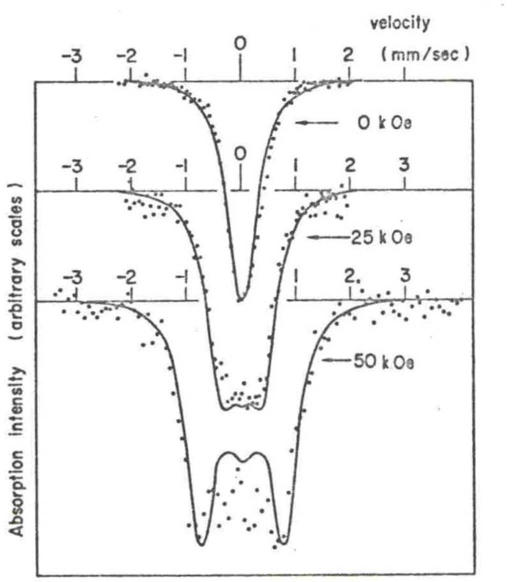

Fig. 2. Absorption spectra of Mössbauer effect of $(Mn_{0.99}Fe_{0.01})_{0.95}Cu_{0.05}$ alloy. Closed circles are observed values and solid curves are calculated. (See text.) Numbers attached are values of applied magnetic field.

transformation is quite remarkable. The discontinuous change of the electric resistivity at the transition temperature almost disappeared by addition of 1 at. % iron to $Mn_{0.95}Cu_{0.05}$ alloys. The iron impurities also affected the susceptibility in such a way as to broaden the sharp kink observed at the transition temperature. These results are quite contrasted with the effect of copper impurities on the transition. The alloys containing 5 at. % copper still show a sharp transition.

Thanks are due to Dr. H. Nagasawa for the measurement of the electric resistance at low temperatures.

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NONLINEAR PRESSURE EFFECT ON THE ELECTRONIC DENSITY OF STATES OF INDIUM*

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The pressure dependence of γ of In was determined directly from low temperature measurements of the changes of the critical field under pressure. The observed change of H_c under hydrostatic pressure does not follow the predictions of the similarity principle.

The normal electronic density of states may be deduced from the critical field of a superconductor, $H_c(T)$, at temperatures approaching 0°K [1]. This article describes measurements of $H_c(T)$ for In of sufficient sensitivity to observe the pressure effect on the Sommerfeld constant, γ, directly and which shows the deviations from the so-called "similarity principle" which occur under pressure. H_c of In from T_c to 0.3°K was measured under pressures up to 1000 atm using solid He. γ was calculated from the slope of $H_c^2(T,p)$ versus T^2 using:

$$H_c^2 = H_0^2 - (4\pi\gamma/V)T^2 . \tag{1}$$

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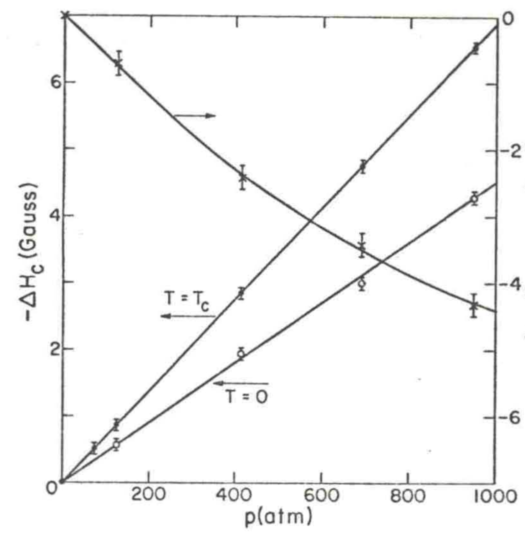

Fig. 1. Pressure dependence of $\Delta\gamma^*$ and ΔH_c. The curve through the $\Delta\gamma^*$ values represents a parabolic fit. The relative error in pressure was about 1%.

The critical field was determined from measurements of specimen magnetization versus applied field using an improved vibrating coil magnetometer [2]. The apparatus permitted isothermal comparison of two In specimens, one at $p = 0$ and one mounted in a pressure cell†. The relative accuracy in γ is about 2×10^{-4}.

In fig. 1 ΔH_c at $T = T_c$ and $T = 0$ and $\Delta\gamma^*$ ($\gamma^* = \gamma/V$) are plotted against pressure. A linear least square fit of the $\Delta\gamma^*$ values does not describe the observed behavior within the experimental errors. An excellent fit is obtained by a parabolic dependence of $\Delta\gamma^*$ versus p. Using the pressure dependent compressibility [4] one obtains:

$$\gamma(p) = 1.6720 - 1.4 \times 10^{-5} p + 34 \times 10^{-10} p^2 \qquad (2)$$

where p is in atm and γ in mJ/mole°K [2]††.

From fig. 1 $\partial H_c/\partial p$ was calculated. $(\partial H_c/\partial p)_{T_c} = -6.87 \pm 0.05$ G/10^3 atm and $(\partial H_c/\partial p)_{T=0} = -4.52 \pm 0.05$ G/10^3 atm are both higher than those of Collins et al. [6] which were derived from the change in length which occurs at the transition from the normal to the superconducting state in a magnetic field.

In recent years several values of $d\ln\gamma/d\ln V$ have been reported: 1.0 ± 0.5 by Rohrer [7], 2.9 ± 0.8 by Collins et al. [6], and 1.5 ± 0.3 by Berman et al. [8]. From eq. (2) we get $d\ln\gamma/d\ln V = 3.40 \pm 0.1$ for $p = 0$ and 1.80 ± 0.05 for $p = 1000$ atm [5]. Our value for $p = 0$ agrees fairly well with that of Collins. Berman et al. [8] extrapolated high pressure γ-values with relatively large errors. Although some of their main assumptions concerning the shape of the critical field curve for calculating γ are not valid, the difference in $d\ln\gamma/d\ln V$ can be explained by considering the nonlinear decrease of γ below 1000 atm.

The pressure dependence of K, a characteristic superconducting constant,

$$K = 2\pi\gamma T_c^2/VH_0^2 = 2\pi\gamma^* T_c^2/H_0^2 \qquad (3)$$

can be investigated since $(\partial H_c/\partial p)_{T\to 0}$, $\partial T_c/\partial p$, and $\partial\gamma^*/\partial p$ were measured independently. For $p \to 0$ one finds $dK/dp = (-0.25 \pm 0.5) \times 10^{-6}$ atm^{-1}. Going to higher pressures K increases due to the nonlinearity of $\gamma^*(p)$. At 1000 atm dK/dp is about 3.4×10^{-6} atm^{-1}. A consequence of this is that the shape of the reduced critical field curve also changes under pressure. This was directly confirmed by temperature dependent measurements of $\partial H/\partial p$.

The author would like to thank Professor D. E. Mapother for his hospitality during this work and for helpful discussions.

† Measurements of Gubser [3] give the following values for In: $\gamma = 1.672$ mJ/mole°K^2 and $H_0 = 281.53$ gauss. These values were used to define the temperature scale in the range below 1°K.

†† The compressibility of 2.2×10^{-6} atm^{-1}, deduced from elastic constants by Chandarasekhar and Rayne [5] slightly modifies eq. (2). The revised values are: $d\ln\gamma/d\ln V = 3.7$ for $p = 0$ and 1.9 for $p = 1000$ atm.

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