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Pressure Effect on the Antiferromagnetism of Chromium-Vanadium-Manganese Alloys

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The antiferromagnetic properties of Cr and its alloys are sensitively dependent upon the characteristics of the electronic structure.[1–4] The pressure effect[5–8] on magnetic properties of Cr is very sensitive.

In this note we report on the pressure dependence of the Néel temperature T_N and electrical resistivity anomaly $\Delta\rho$ of Cr-V-Mn alloys. Samples were supplied from Dr. Komura of Japan Atomic Energy Research Institute and were in the form of a bar, 0.7 mm by 20 mm. The electrical resistivity was measured with 0.05% reproducibility by the standard d.c. potentiometric method. The hydrostatic pressure system was similar to that used in the previous work.[5] Temperature was controlled within ± 0.2°C.

Figure 1 shows the relative resistivity versus temperature near T_N for Cr- 0.59 at% V- 1.18 at% Mn alloy under pressure. The Néel temperature for this alloy was determined from the temperature associated with the inflection point of the ρ vs T curve, and this value is 433 ± 10°K at atmospheric pressure, in agreement with the result of Komura *et al.*.[4] The pressure derivative of T_N, $-(1/T_N)(dT_N/dp)_{p\to 0}$, is almost constant with respect to variation in effective electron

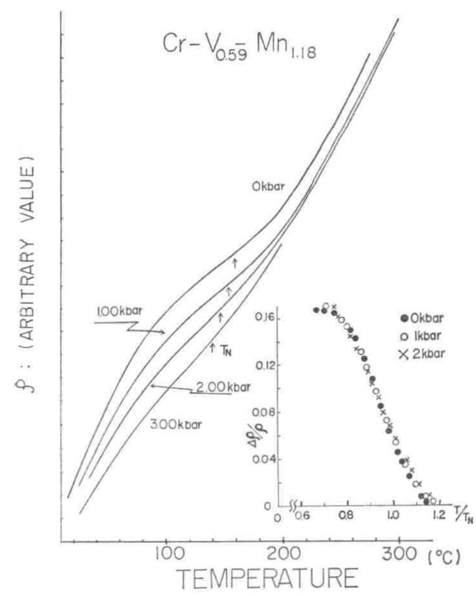

Fig. 1. The relative resistivity of Cr- 0.59 at% V- 1.18 at% Mn alloy as a function of temperature and pressure. The inset gives $\Delta\rho/\rho = (\rho_a - \rho_p)/\rho_a$ vs T.

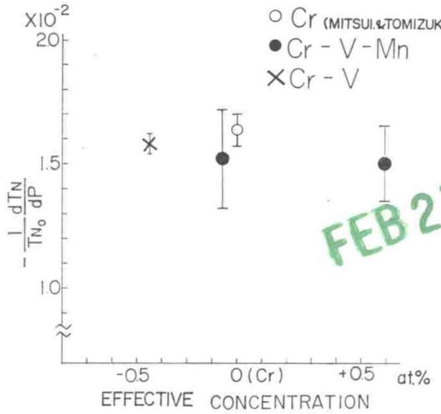

Fig. 2. A plot of $-(1/T_N)(dT_N/dp)_{p\to 0}$ as a function of effective concentration.

concentration, *i.e.* Mn concentration subtracted by V concentration in units of atomic percent, as shown in Fig. 2. On the other hand, Trego *et al.*[2] have shown that $\ln T_N$ changes almost linearly with electron concentration in Cr-V and Cr-Mn alloys. Namely these rapid changes of T_N with pressure and electron concentration are explained by $T_N = T_B \exp(-1/\lambda)$,[6,9] where $\lambda = N(0)\bar{V}$, $N(0)$ is the density of states, $\bar{V}$ the average Coulomb attraction and kT_B is of the order of a band energy. This means that it is reasonable to ascribe the change in λ to a change in the area of the magnetic part of the Fermi surface. This assumption seems to be fairly good in understanding the pressure effect on these alloys if the change of T_N with pressure corresponds to that of T_N with the electron concentration due to the addition of V and Mn, and the amount of 1 at% V equivalent to the application of the pressure 18.0 ± 1.0 kbar.

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