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Effect of Hydrostatic Pressure on the Magnetic Transition Temperature of the System $Cd_{1-x}Zn_xCr_2Se_4$

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It has been reported[1] that the spinel compounds of $Cd_{1-x}Zn_xCr_2Se_4$ are ferromagnetic for $0 \leq x < 0.6$ and antiferromagnetic for $0.6 < x \leq 1$; in the ferromagnetic ones, the Curie temperature decreases linearly with increasing x, and in all the antiferromagnetic ones, the Néel temperature is about 20°K. This paper concerns measurements of the hydrostatic pressure effect on the Curie temperature of ferromagnetic compounds from $x=0$ to 0.4, which may yield information on the magnetic interaction in connection with the magnetic transition.

The specimen used were prepared in powder form by heating stoichiometric mixtures of the elements in evacuated quartz tube at 700~800°C for 120 hours and then pressed into cylindrical rod-shaped lumps, 3.5mm in diameter and 14 mm in length. X-ray analysis proved that all the compounds used are single phase spinel. The lattic parameter, a, decreases linearly with increasing x as shown in Fig. 2. For $x=0$ the value of a is in agreement with that determined by Baltzer *et al.*.[2] The Curie temperature was determined as the temperature corresponding to the inflection point of a weak-field ac mutual inductance, M, versus temperature curve at a constant pressure, in the same way as in the previous study of rare earth metals.[3] The amplitude of applied field is 0.5 Oe and the frequency 500 Hz. The mutual inductance coils were placed inside a pressure bomb made of hardened beryllium-copper alloy. Pressures were generated by a standard Bridgman intensifier and actually applied up to 6 kbar. In Fig. 1 is shown the result of $CdCr_2Se_4$ at various pressures, as an example. For $Cd_{1-x}Zn_xCr_2Se_4$, the values of T_c determined at atmospheric pressure are in agreement with those determined from magnetic measurements using a vibrating sample magnetometer.[1] As the pressure is increased, T_c decreases linearly with pressure as shown in Fig. 1; $\Delta T_c/\Delta p$ is -0.76×10^{-3} deg/bar for $CdCr_2Se_4$, which is nearly equal to -0.82×10^{-3} deg/bar obtained by Srivastava.[4]

In Fig. 2 $\Delta T_c/\Delta p$ is plotted as a function of x for the ferromagnetic compounds $Cd_{1-x}Zn_xCr_2Se_4$ from $x=0$ to 0.4. It is negative in the sign and decreases monotonically with increasing x. According to Baltzer,[2] the negative value of $\Delta T_c/\Delta p$ may be explained by the assumption that the antiferromagnetic interaction K, between the more distant Cr-Cr pairs exceeds the ferromagnetic nearest neighbor Cr-Cr interaction J, in their variations with decreasing atomic spacing. The increase in the magnitude of $\Delta T_c/\Delta p$ with increasing x may be chiefly ascribed to the variation of T_c with K, $\Delta T_c/\Delta K$, which increases in the magnitude with increasing x. Details will be reported elsewhere in the near future.

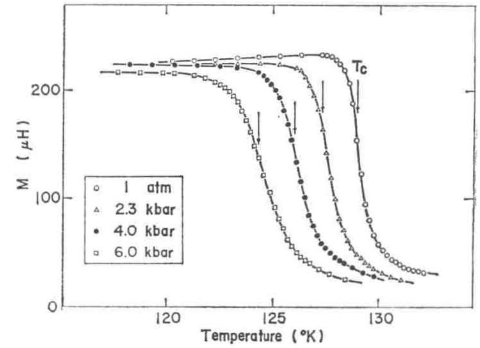

Fig. 1. A plot of M as a function of temperature for $CdCr_2Se_4$ at various pressure.

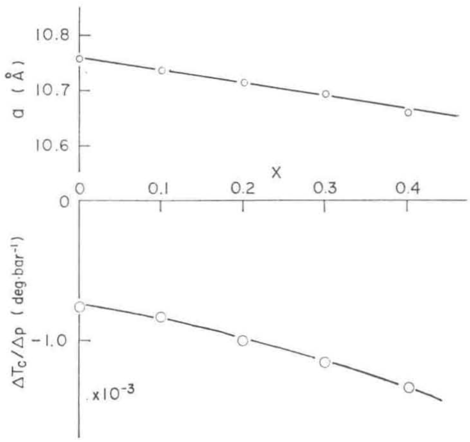

Fig. 2. Lattic parameter, a, and $\Delta T_c/\Delta p$ as a function of x.

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