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THE PRESSURE EFFECT ON THE CURIE TEMPERATURE AND EXCHANGE STRICTION OF Cr_2S_3 AND Cr_2Te_3

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The pressure derivative of T_c was found to be 1.0 deg/kbar for Cr_2S_3 and -1.78 deg/kbar for Cr_2Te_3. The volume exchange striction was found to be negative for Cr_2S_3 and positive for Cr_2Te_3. From these results, it was found that the exchange striction was dominant in the a-axis direction.

1. Introduction

The intermetallic compounds Cr_2S_3 and Cr_2Te_3 are known to be ferrimagnetic with a Néel temperature (T_N) of about 130 K and ferromagnetic with a Curie temperature (T_c) of about 180 K. Both compounds have a NiAs structure with ordered arrangement of vacant chromium site. The magnetic moment of the chromium atom is $3\mu_B$, which corresponds to Cr^{3+} ionic state. One of the present authors has investigated the concentration dependence of the Curie temperature and the lattice parameters a and c for pseudobinary compounds $Cr_2S_{3-x}Te_x$ [1]. As seen in fig. 1, the results showed (1) $\partial T_N/\partial x < 0$, $\partial a/\partial x > 0$, $\partial c/\partial x > 0$ and $\partial V/\partial x > 0$ on the Cr_2S_3 side and $\partial T_c/\partial x > 0$, $\partial a/\partial x > 0$ $\partial c/\partial x > 0$ and $\partial V/\partial x > 0$ on the Cr_2Te_3 side. From the above results, we can expect that $\partial T_N/\partial V$ (or $\partial T_N/\partial p$) is negative (or positive) for Cr_2S_3 and $\partial T_c/\partial V$ (or $\partial T_c/\partial p$) is positive (or negative) for Cr_2Te_3. Furthermore, we can also expect negative volume exchange striction for Cr_2S_3 and positive one for Cr_2Te_3 from the standpoint that the strength of exchange interaction depends on the interatomic distance. In this study, the pressure effect on the Curie temperature and the exchange striction for Cr_2S_3 and Cr_2Te_3 are investigated.

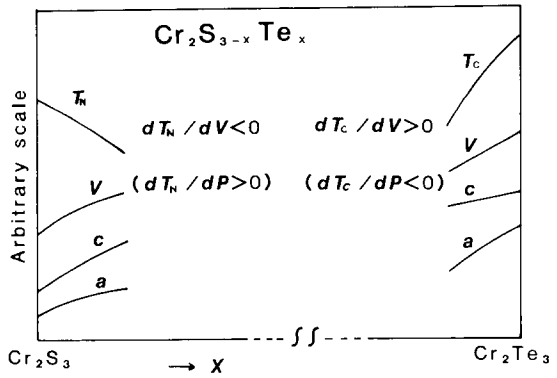

Fig. 1. Magnetic and lattice parameters versus concentration x in $Cr_2S_{3-x}Te_x$.

2. Experimental results and discussion

The pressure change of the Curie temperature was measured at pressures up to 6 kbar. The determination of the Curie temperature was made by measuring the temperature dependence of magnetic permeability. The results are shown in fig. 2. The Curie temperature increases linearly for Cr_2S_3 and decreases linearly for Cr_2Te_3 with applied pressure. The pressure derivative of the Curie temperature was obtained to be 1.0 deg/kbar for Cr_2S_3 and -1.78 deg/kbar for Cr_2Te_3 and their sign is consistent with that expected from the concentration dependence of the Curie temperature and the lattice parameters mentioned above.

The exchange striction for both compounds were measured in the temperature range from 77 to 320 K by X-ray diffraction technique. As shown in figs. 3 and 4, the volume exchange striction was found to be negative for Cr_2S_3 and positive for Cr_2Te_3. These results are also consistent with those expected from the results described above. As seen from figs. 3 and 4, the dominant part of the volume exchange striction, $V(T)$, is one $a(T)$,

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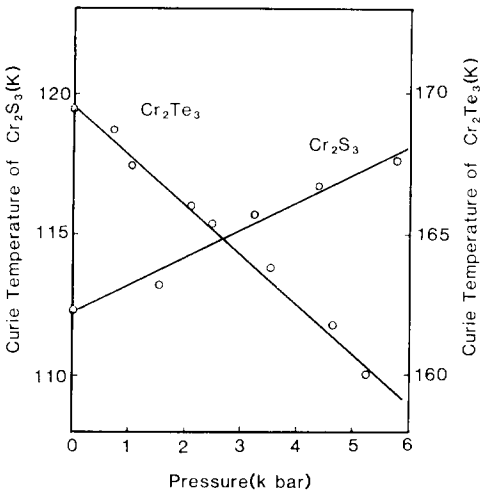

Fig. 2. Pressure dependences of the Curie temperature of Cr_2S_3 and Cr_2Te_3.

along the a-axis. So, we can conclude from all the data mentioned above that the dependency of atomic distance of exchange interaction, J_a, in a-axis direction is dominant in the pressure effect of T_c for Cr_2S_3 and for Cr_2Te_3.

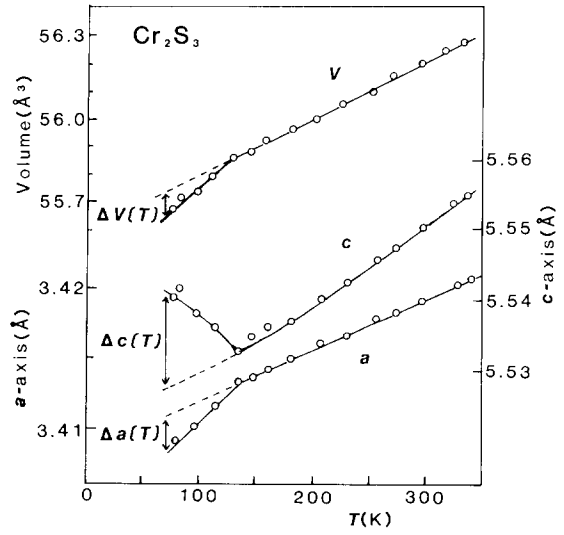

Fig. 3. Lattice parameters versus temperature of Cr_2S_3.

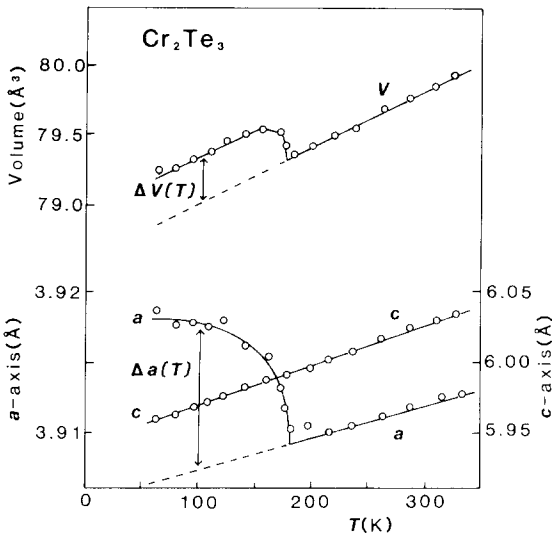

Fig. 4. Lattice parameters versus temperatute of Cr_2Te_3.

From the magnetic structure of both compounds [2,3], J_a is considered to be negative for Cr_2S_3 and positive for Cr_2Te_3. Therefore, the sign of the exchange striction in the a-axis direction is negative for Cr_2S_3 and positive for Cr_2Te_3, but the distance dependence of J_a, dJ_a/da is positive for both compounds. In the compound CrSb with the NiAs structure, the chromium atom is also in the Cr^{3+} ionic state and dJ_a/da is positive [4]. It is considered interesting to examine systematically the atomic dependence of Ja between Cr^{3+} ion in the compounds with a NiAs type structure.

References

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