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On the Exchange Striction of Antiferromagnet Au_2Mn

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Hirone *et al.*¹⁾ once measured the magnetostriction of the intermetallic compound Au_2Mn with helical spin structure.²⁾ The magnetostriction in the present case is considered to originate from several mechanisms. They succeeded in separating the exchange striction part from their experimental data. Since the exchange striction originates from the lattice parameter dependence of the exchange coupling constants, the exchange striction has a close relationship to the pressure change of the transition field from antiferromagnetic to ferromagnetic state of this substance. In the present experiment the pressure dependence of magnetization of the compound Au_2Mn is measured in a magnetic field up to 80 kOe. Based on the results obtained, the lattice parameter dependence of the exchange coupling constants and the exchange striction are discussed.

X-ray analysis for the prepared specimen of Au_2Mn showed that the crystal structure had a bct cell with lattice parameters $a=3.37 \text{ \AA}$ and $c/a=2.60$, which agreed with Smith and Street's³⁾ data for a well ordered phase. Transition fields H_t defined by the break-point A as shown in Fig. 1, are 8320 Oe at

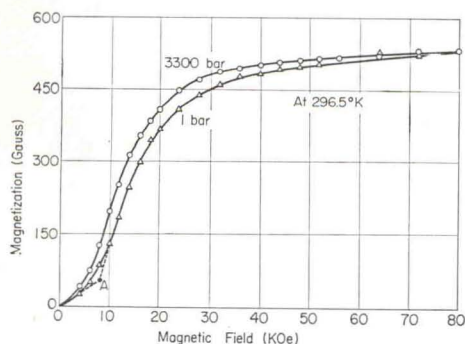


Fig. 1. Magnetization curves at 296.5°K.
curve $\triangle$: at 1 bar
curve $\circ$: at 3300 bar

atmospheric pressure and 6340 Oe at 3300 bar, respectively. Pressure dependence of H_t obtained from the present experiment, $\partial H_t / \partial p = -0.6 \text{ Oe bar}^{-1}$, is in agreement with the results given by Gradzdankina *et al.*⁴⁾ The pressure change of magnetization, $\partial M / \partial p$ in a high magnetic field was smaller than $6 \cdot 10^{-5} \text{ gauss bar}^{-1}$.

On the basis of Lee's theory,⁵⁾ exchange striction constant λ_e is written as follows: $\lambda_e = [(\Delta J_1 / \Delta c) \cos \theta + (\Delta J_2 / \Delta c) \cos 2\theta] \cdot (M_s^2 / E)$, where c is the inter-layer separation, E Young's modulus, M_s the saturation magnetization and θ is a screw angle of helical spin configuration. J_1 is the exchange coupling constant between adjacent pair of c -planes and J_2 is that between next-adjacent pair. The neutron diffraction study⁶⁾ under hydrostatic pressure indicates that the lattice parameter c and the screw angle θ take values as shown in Table I.

Table I

Pressure	θ	c	J_1	J_2
1 bar	$50^\circ 42'$	$8.746 \text{ \AA}$	149.4	-59.1
3300 bar	$47^\circ 51'$	$8.740 \text{ \AA}$	150.5	-56.1

Exchange interaction constants⁵⁾ J_1 and J_2 were calculated by using the values of θ and H_t at each pressures and listed also in Table I, from which it can be deduced:

$$\frac{\Delta J_1}{(\Delta c/c)} = -1569 \text{ and } \frac{\Delta J_2}{(\Delta c/c)} = -4070. \quad (1)$$

Putting $E = 16 \cdot 10^{11} \text{ dyne/cm}^2$, $M_s = 542 \text{ gauss}$ (estimated by using the law of approach to saturation) into the equation of λ_e and using eq. (1), we have

$$\lambda_e = -13 \cdot 10^{-4}. \quad (2)$$

The value of the exchange striction obtained above agrees well with the value $-9.6 \cdot 10^{-4}$ by direct measurement by Hirone *et al.*

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