J. Phys. Soc. Japan 36 (1974) 909

Effect of Hydrostatic Pressure on the Magnetocrystalline Anisotropy Constant K_1 of Ni-Pd Alloys

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(Received November 9, 1973)

In a previous work, the magnetocrystalline anisotropy constants of Ni-Pd alloys have been determined from 4.2 K to their Curie temperatures by one of the present authors (H. F.) *et al.*, and the dependence of K_1 on Pd content at 0 K has been reported.[1] In the present work, the effect of hydrostatic pressure on K_1 has been measured under pressures up to about 6 kb at 77 K for Ni, 20, 30, and 40 at % Pd.

Specimens employed were those used in the previous work; i.e., spherical crystals, 4 to 7 mm in diameter. The pressure was applied in the micro-pressure bomb made of Be-Cu, the details of which have been described also by one of the present authors (H. K. *et al.*).[2]

The pressure coefficients $(1/K_1)(\partial K_1/\partial p)$ obtained from the change in the amplitude of the torque curve with pressure under the magnetic field in the (001) plane are plotted against the concentration of Pd in Fig. 1. No dependence of the coefficient on the magnetic field has been found up to 25 kOe, and the measurements have been made at this strength of the field enough to saturate the magnetization.

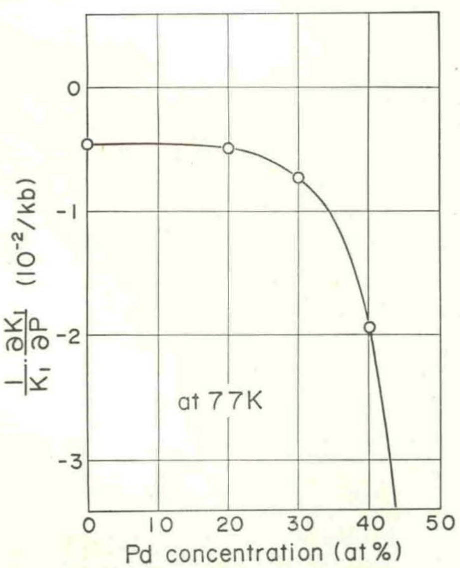

Fig. 1. A plot of pressure coefficient of K_1 $(1/K_1)(\partial K_1/\partial p)$ at 77 K as a function of Pd concentration in at %.

The values of $(1/K_1)(\partial K_1/\partial p)$ hitherto obtained for Ni at 77 K are, for example, -1.11, -0.48 and -0.20 (10^{-2}/kb) by Kadomatsu *et al.*,[2] Kawai *et al.*[3] and Franse,[4] respectively. The present value is -0.46×10^{-2}/kb and the agreement is rather satisfactory, considering the difficulty of this kind of measurement.

The results obtained from Fig. 1 are briefly summarized, together with the unpublished data on K_1 at normal pressure, as follows. (i) The sign of the pressure coefficient of K_1 is negative. Since the sign of K_1 at normal pressure has been found to be negative, the sign of $\partial K_1/\partial p$ is positive. (ii) The magnitude of the coefficient is almost independent of Pd content in Ni-rich side, where K_1 also has the same behavior, but varies rapidly above 30 at % Pd, where the absolute value of K_1 decreases rapidly accompanying with the change in sign at about 45 at % Pd. As the result, $\partial K_1/\partial p$ increases not rapidly but gradually with Pd above 30 at % Pd.

Assuming that a formal relation $K_1=K_1(M_s[T, H, p])$ is valid for the pure metals, where M_s is the saturation magnetization, Veerman *et al.*[5] have discussed a linearity between the pressure coefficient of K_1 and of M_s from so-called n-th power law. Their estimations are likely to explain the experimental results in their own light but unlikely to explain the present results, since the pressure coefficient of M_s at 77 K for Ni-Pd alloys previously obtained[6] has a finite value at 45 at % Pd, for example, where the coefficient of K_1 diverges. However, if $K_1(T)$ for Ni-Pd alloys employed in the present paper, for which K_1 changes the sign in the preliminary data obtained, will be expressed by such a formula as

$$\frac{K_1(T)}{K_1(0)}=\left(1-\alpha\frac{T}{T_c}\right)\left[\frac{M_s(T)}{M_s(0)}\right]^{(\beta+T/T_c)}, \qquad (1)$$

the discussions on the similar basis to Veerman *et al.*'s is likely to be made. For Ni, the formula (1) has been obtained[2] where the constants α and β are 1.73 and 25, respectively.

A full description including the results at 273 K will be presented after a paper on K_1 at normal pressure is fully presented.

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