Some Transport Properties in Martensitic Iron-Nickel Alloys (*).

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(ricevuto l'1 Agosto 1983)

Summary. — Resistivity, Hall effect and magnetoresistivity measurements in Fe-Ni alloy specimens with Ni content ranging from 29 to 32 wt. % and subjected to martensitic transformation have been performed. The results have been interpreted by considering both the mechanisms of the martensitic transformation, different in 29 and 30 wt. % Ni alloys from that in 31 and 32 wt. % Ni ones, and the theories of Smit and Berger on the Hall effect in dilute ferromagnetic alloys, which have been applied to the above-described alloys. The Hall data, analysed by means of Kohler plots, have allowed us to identify the charge carrier scattering mechanisms prevailing in the different alloys, i.e. the skew scattering in 29 and 30 wt. % Ni alloys and the side jump scattering in 31 and 32 wt. % Ni ones.

PACS. 72.15. — Electronic conduction in metals and alloys.

1. — Introduction.

In a previous paper (1) we studied the mechanisms of the martensitic transformation vs. cooling temperature of iron-nickel alloys, containing 29, 30, 31 and 32 wt. % Ni, by performing resistive and magnetic measurements during the transformation of the samples. The obtained results suggested that the

(*) To speed up publication, the authors of this paper have agreed to not receive the proofs for correction.

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"burst" mechanism of the martensitic transformation of 31 and 32 wt. % Ni alloys probably is due to the organization of embryos into groups. On the contrary, the activation of single embryos controls the smooth behaviour of the martensitic transformation of 29 and 30 wt. % Ni alloys.

JELLINGHAUS et al. (2) performed measurements of the Hall effect and electrical resistivity on iron-nickel alloys with a content of Ni in Fe ranging from zero to 100 %. They plotted the experimental data taking as parameters the nickel concentration and the alloy structure. Their curves of the extraordinary Hall coefficient and electrical resistivity present an unclear behaviour at the concentration of 30 % Ni, because the transition from the magnetically not saturated state of the sample to the saturated one could not be well determined. The authors explained this anomalous behaviour assuming that the simultaneous presence of the α and γ phases renders the lattice of the examined samples inhomogeneous.

The aim of the present work is to test the martensitic-transformation mechanisms suggested in our previous paper and to evaluate their contribution to the transport properties in iron-nickel alloys just in the range in which the Jellinghaus-De Andrés curves are not well definite. Thus we have performed measurements of Hall effect, electrical resistivity and magnetoresistivity as a function of cooling temperature. Moreover, applying to our experimental results the scattering model of Smit (3) and Berger (4,5) for transport properties of ferromagnetic dilute alloys, we can suggest that a correlation occurs between the martensitic transformation and the transport properties in the studied iron-nickel system.

2. - Experimental.

2/1. Preliminary considerations. - The Hall resistivity $\rho_H$ of the studied iron-nickel alloys behaves like that of a ferromagnetic material. Then we may write

$$\rho_H = \frac{E_y}{j_x} = R_0 B_z + R_s M_z,$$

where the electric-current density $j$, the electric field $E$ and the magnetic induction $B$ point in the $x$, $y$, $z$ directions, respectively. The term $R_0 B_z$ (where $R_0$ is the "ordinary" Hall constant) has its origin in the Lorentz force acting on the electrons and it is present in nonmagnetic materials as well. The term