STRUCTURE CHARACTERISTICS AND SOME GALVANOMAGNETIC AND MAGNETIC PROPERTIES OF Fe—Ni AND Fe—Ni—Gd THIN FILMS[1])

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We report here upon some preliminary results of the investigations of the microstructure and magnetic domain structures, the Ha[11] effect and hysteresis loop measurements of the thin films $Fe_{19}Ni_{81}$ and $Fe_{17}Ni_{70}Gd_{13}$. The purpose of the present work was to apply transmission electron microscopy predominantly to the investigation of the magnetic domain structure.

I. EXPERIMENTAL PROCEDURES

Thin films of $Fe_{19}Ni_{81}$ and $Fe_{17}Ni_{70}Gd_{13}$ were prepared by the flash-evaporation technique in a vacuum of about 10^{-4} Pa onto glass substrates at room temperature. The initial material was a granulated alloy or a powder. The structure of the films was checked by the electron diffraction method and the transmission electron microscopy (TEM) on additional films evaporated simultaneously onto rock-salt. The thickness of the films was measured by multibeam interference. The films studied were from 30 to 52 nm thick. The coercive field, H_c, of the samples was determined from hysteresis loops, which were traced by the automatic magnetooptic Kerr-effect hysteresisgraph [1]. The Hall-effect curves were measured by the conventional DC current at room temperature.

II. RESULTS AND DISCUSSION

Electron diffraction patterns for films show several Debye rings, typical for the polycrystalline structure of the films. The structure of the films containing a small amount of Gd is fine by crystalline, with diffuse diffraction rings. The magnetic domain structure of the films was examined in the TEM JEM 7 at 100 kV by the Lorentz microscopy. The revealed mixed domain structure con-

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sisted of simple Bloch-type walls, corss-tie walls and magnetization ripple (Fig. 1a and 1b) and in the case of Fe—Ni films of some regions with a stripe-type domain structure (Fig. 1c). All the experimental results were obtained with zero applied magnetic field. Some differences in the domain structure of both films are closely correlated to the differences in the crystalline structures of

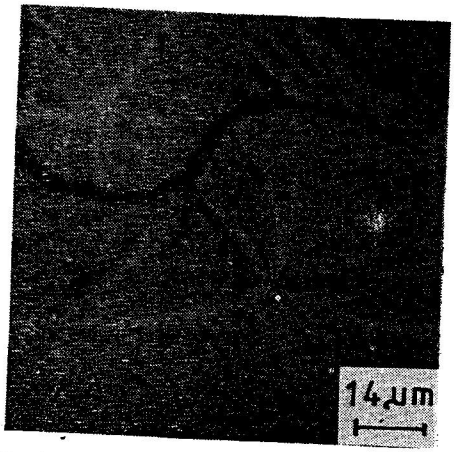

Fig. 1a. Magnetic domain structure with magnetic riple configurations of $Fe_{19}Ni_{81}$ film, 52 nm thick.

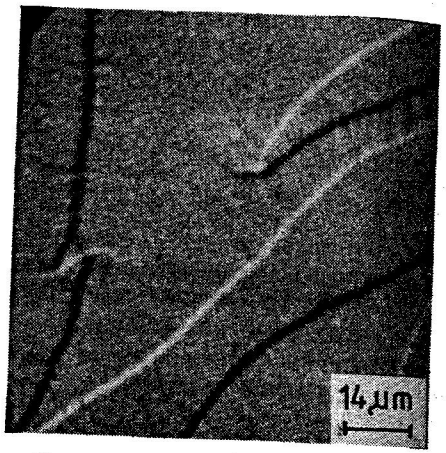

Fig. 1b. Magnetic domain structure of $Fe_{17}Ni_{70}Gd_{13}$ film, 47 nm thick.

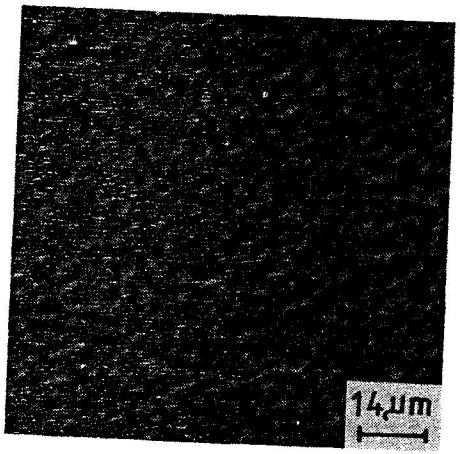

Fig. 1c. Stripe-type magnetic domain structure of the same fil as in Fig. 1a.

the thin films [2, 3, 4]. The results of the studied of the Hall-effect are in Figs 2a and 2b and hysteresis loops are shown in Figs 3a and 3b, which were used to determine the remanent magnetic polarization I_R.

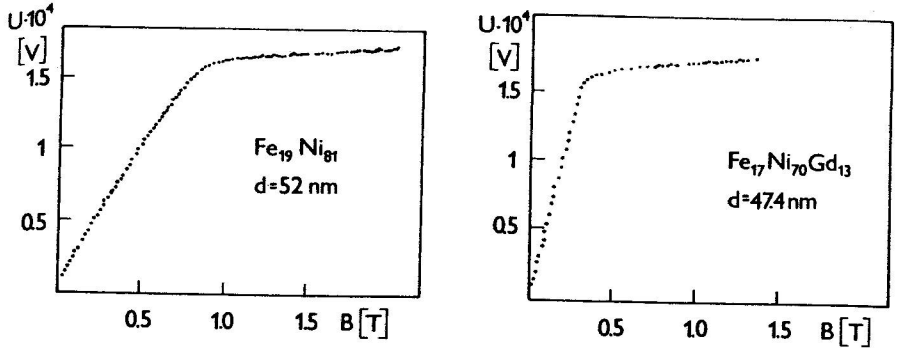

Fig. 2. Magnetic field dependence of the Hall voltage for film: (a) $Fe_{19}Ni_{81}$, (b) $Fe_{17}Ni_{70}Gd_{13}$.

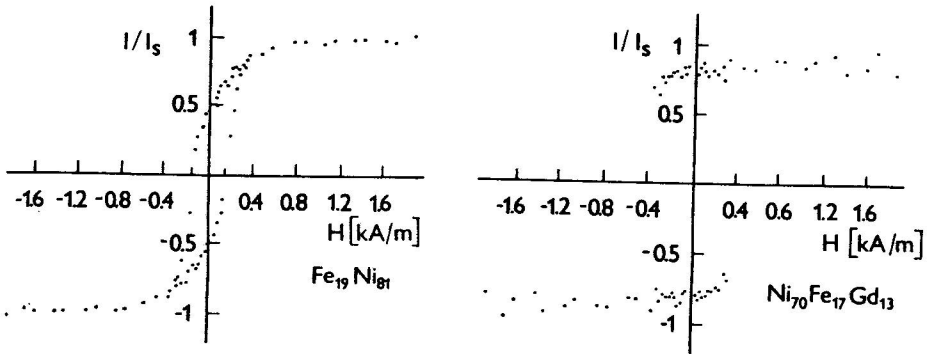

Fig. 3. Hysteresis loops of films: (a) $Fe_{19}Ni_{81}$, (b) $Fe_{17}Ni_{70}Gd_{13}$.

The Hall voltage curves exhibited a well-defined linear dependence on the magnetic field, which allowed to determine spontaneous, R_s, or ordinary, R_0, Hall coefficients, respectively, and saturation magnetic polarization, I_s. All the results derived from Fig. (2a, 2b) and Fig. (3a, 3b) are summarized in the Table 1.

Table 1

Sample	d [nm]	R_0 $\left[10^{-10}\frac{m^3}{As}\right]$	R_s $\left[10^{-9}\frac{m^3}{As}\right]$	I_s [T]	I_R [T]	H_c $\left[\frac{kA}{m}\right]$
$Fe_{19}Ni_{81}$	52	0.756	1.94	0.846	0.414	0.16
$Fe_{17}Ni_{70}Gd_{13}$	47	16.9	82.9	0.324	0.252	0.49

III. CONCLUSION

1) The magnetic domain morphologies are closely related to the crystalline structure; the corresponding magnetic domain configurations show 180° domain walls together with cross-tie walls and the magnetization ripple and a small fraction of the film areas shows the magnetic domains revealing featherlike configurations as well as some white and black dots (stripe-type domain structure in Fig. 1c).
2) The observed coercivities are much larger for the Fe—Ni—Gd than in the Fe—Ni films of the same thickness.

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СТРУКТУРНЫЕ ХАРАКТЕРИСТИКИ И НЕКОТОРЫЕ ГАЛЬВАНОМАГНИТНЫЕ И МАГНИТНЫЕ СВОЙСТВА ТОНКИХ ПЛЕНОК Fe—Ni И Fe—Ni—Gd

В работе излагаются предварительные результаты исследований микроструктуры и структур магнитных домен, эффекта Холла и измерений гистерезисной петли в тонких пленках $Fe_{19}Ni_{81}$ и $Fe_{17}Ni_{70}Gd_{13}$. Целью предлагаемой работы является применение трансмиссионной электронной микроскопии для изучения структуры магнитных домен.