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Letters to the Editor

THE OCCURRENCE OF NEGATIVE BARKHAUSEN JUMPS IN THE PROCESS OF THE CONSECUTIVE ASYMMETRICAL MAGNETIZATION REVERSAL OF METALLIC FERROMAGNETS

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The magnetization reversal of a ferromagnet between two different values of an external field H_A, H_B, where $H_B \neq -H_A$, is called the asymmetrical magnetization reversal. When such an asymmetrical magnetization reversal between these two values of an external field is successively repeated, a macroscopically measured value of magnetization in the end points of the asymmetrical loop changes with the number of the magnetization cycles. According to Neél [1], [2], the effects of „reptation" and „bascule négativé" are responsible for these changes in magnetization, both effects occurring simultaneously. The experiments show, however, that the effect „bascule négative" is practically negligible after the first few magnetization cycles.

The first experimental information on the microphysical nature of the „reptation" and „bascule négative" effects is given in papers [3], [4], which study the influence of the consecutive asymmetrical magnetization reversal on the domain structure on the surface of the monocrystalline ferromagnets by the method of powder patterns. Since this method can only be used to study magnetization processes on the surface of a ferromagnet — and only on a relatively small part of it — and since it is asumed that the „reptation" and „bacsule négative" effects have primarily a volume character, the possibility of this method to get to the microphysical nature of the above effects is very limited. Yet it was possible to expect from these works that the distribution of critical fields at which the irreversible displacements of domain walls occur, does change in the process of the asymmetrical magnetization reversal in the ferromagnetic sample.

In paper [5] we pointed out a possibility to observe the elementary irreversible magnetization processes taking place during the asymmetrical magnetization reversal of ferromagnets, by the method of Barkhausen jumps (B. j.). This paper is a brief information on the experimental results we obtained during the study of the occurrence of negative B. j. in the process of the consecutive asymmetrical magnetization reversal of metallic ferromagnets. For the measurements an apparatus of a type similar to that described in [6] was used, but with only two channels — one for positive, the other one for negative B. j. The sensitivity was the same for both channels — the apparatus registered all B. j. corresponding to the change in the magnetization larger than 1.4×10^{-6} units cgsm. Measurements were made on annealed polycrystalline Ni and Fe samples in the form of wires. Table 1 contains the characteristic data of the samples.

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Table 1

Sample	Composition	H_c	Length	Diameter
Ni	97.9 % Ni, 2 % Cu	4.3 Oe	17.4 cm	0.1 cm
Fe	98.2 % Fe	5.2 Oe	22.7 cm	0.17 cm

The initial state, from which the process of the asymmetrical magnetization reversal started, was the remanent state obtained by the method shown in Fig. 1. The asymmetrical magnetization reversal was obtained by changing the external magnetic field between the values $H_A = 0$, $H_B = -4.7$ Oe for the Ni sample and between the values $H_A = 0$, $H_B = -9.4$ Oe for the Fe sample. The frequency of the magnetization reversal was 0.016 Hz (the Ni sample) and 0.007 Hz (the Fe sample).

Fig. 2 (the Ni sample) and Fig. 3 (the Fe sample) show the dependences of the ratio N^+/N^- upon the number of magnetization cycles n, where N^+ is the total number of positive B. j. and N^- the total number of negative B. j. registered in the process of the magnetization reversal along one branch of the asymmetrical lopp. The dependences shown correspond to the lower branches of the asymmetrical loops (branch 2 in Fig. 1). For the upper branch (branch 1) the ratioo N^+/N^- was aproximately 30 for the Ni sample and about 60 for the Fe sample and was practically independent from the number of the magnetization cycles. It is evident from these figures that the upper and the lower branches of the asymmetrical loops participate unequally in the number of negative B. j. in the total number of registered B. j. The ratio N^+/N^- is much higher for the upper branches than for the lower ones, thus the occurrence of negative B. j. during the magnetization reversal along the upper branches is substantially lower than during the magnetization reversal along the lower branches. The ratio N^+/N^- in the process of the magnetization reversal along the lower branch of the asymmetrical loop changes with n, its value being in the range from 1 to 10 for both samples. The greatest changes in the ratio N^+/N^-take place during the first 3 (the Ni sample) or 10, resp. (the Fe sample) cycles of the asymmetrical magnetization reversal.

The above mentioned experimental results indicate that the causes leading to the „reptation" and „bascule négative" effects are not equally spaced along the whole asymmetrical loop, but it seems that they localize in only one branch of this loop, where more apparent changes in the realization of the elementary magnetization processes take place. In our case of the consecutive magnetization reversal of the Ni and the Fe samples it was in the lower branch of the asymmetrical loop.

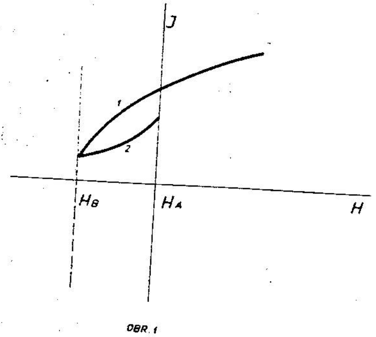

Fig. 1. The diagram of the method adopted for the asymmetrical magnetization reversal.

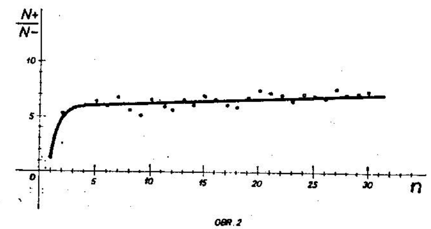

Fig. 2. The dependence of the ratio N^+/N^- upon the number n of the asymmetrical cycles for the Ni sample.

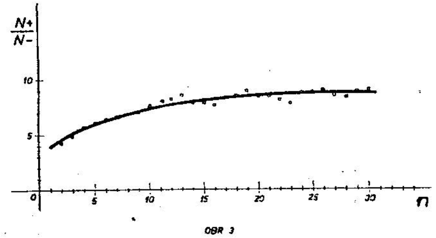

Fig. 3. The dependence of the ratio N^+/N^- upon the number n of the asymmetrical cycles for the Fe sample.

REFERENCES

[1] Neél L., C. R. Acad. Sci. (France) *244* (1957), 2668.
[2] Neél L., C. R. Acad. Sci. (France) *246* (1958), 2313 and 2963.
[3] Gengnagel H., Hajko V., Daniel-Szabó J., Czech. J. Phys. *B 12* (1962), 714.
[4] Kavečanský V., Hajko V., Daniel-Szabó J., Mat. fyz. čas. SAV *13* (1963), 64.
[5] Zentko A., Hajko V., Potocký L., Czech. J. Phys. *B 16* (1966), 939.
[6] Zentko A., Hajko V., Czech J. Phys. *B 18* (1968), 1026.

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