LETTER TO THE EDITOR

COMPLEX SCREENING COEFFICIENT OF SELECTED FERROMAGNETIC MATERIALS[1])

P. VOJTANÍK[2]), J. FILIPENSKÝ[3]), O. DUŠA[2]), Košice

КОМПЛЕКСНЫЙ КОЭФФИЦИЕНТ ЭКРАНИРОВАНИЯ ДЛЯ ВЫБРАННЫХ ФЕРРОМАГНИТНЫХ МАТЕРИАЛОВ

In the development of applications of amorphous soft magnetic materials (ASMM) to the screening of complicated laboratory instruments and devices against spurious time variable electromagnetic fields it is essential to investigate the complex screening coefficient of screening shields at various intensities and frequencies of those fields. The complex screening coefficient $\bar{S}$ is in its linear approximation defined as [1]:

$$\bar{S} = \frac{H_1 \exp [j\,(\omega t + \varphi_1)]}{H_2 \exp [j\,(\omega t + \varphi_2)]} = S \exp (j\,\varphi)$$

where H_1 and φ_1 are the intensity and the phase angle of the original external homogeneous magnetic field, respectively, H_2 and φ_2 are the magnetic field intensity and its phase inside the screening shield sample, $S = H_1/H_2$ and $\varphi = \varphi_1 - \varphi_2$ are the amplitude and phase of $\bar{S}$, ω is the angular frequency and t is time.

The paper presents some results of complex screening coefficient investigations realized on selected crystalline and amorphous ferromagnetic shields.

Measurements were carried out on samples of cylindrical screening shields with a length of 150 mm, a diameter of 30 mm and a wall thickness of 0.3 mm. Their preparation and associated basic magnetic measurements have been described in detail in [2]. Both the amplitude S and the phase φ have been measured by means of a synchronous voltmeter. The designation of our samples corresponds to the sample designation given in Table 1, p. 438 [2] as follows:

1) our crystalline samples No. 1 and 2 were originally designated as samples No. 2 and 3,
2) our amorphous samples No. 3 and 4 were originally designated as samples No. 7 and 9.

The results of the measurements are shown in Figs. 1 and 2. There is a striking difference in the course of the field intensity and frequency dependences of both S and φ in crystalline and amorphous samples. The screening coefficient S in amorphous alloys No. 3 and 4 reaches much higher values than in crystalline samples for the measured range of field intensities. The phase φ is constant at fields above about 500 Am^{-1} (Fig. 1b). In general, the phase φ of the complex screening coefficient S can reach positive and negative values due to the competition of different screening mechanism (eddy currents, domain wall motion, magnetostatic, etc.). It can be seen from Fig. 2 that the amorphous samples No. 3 and 4 have extremely high values of the screening coefficient S above all in static applications as well as in the low frequency region (below 100 Hz). A further advantage of the amorphous samples No. 3 and 4 is the very small frequency dependence of both amplitude and phase of the complex screening coefficient. On the contrary, in the crystalline samples No. 1 and 2 higher values of S than those for the

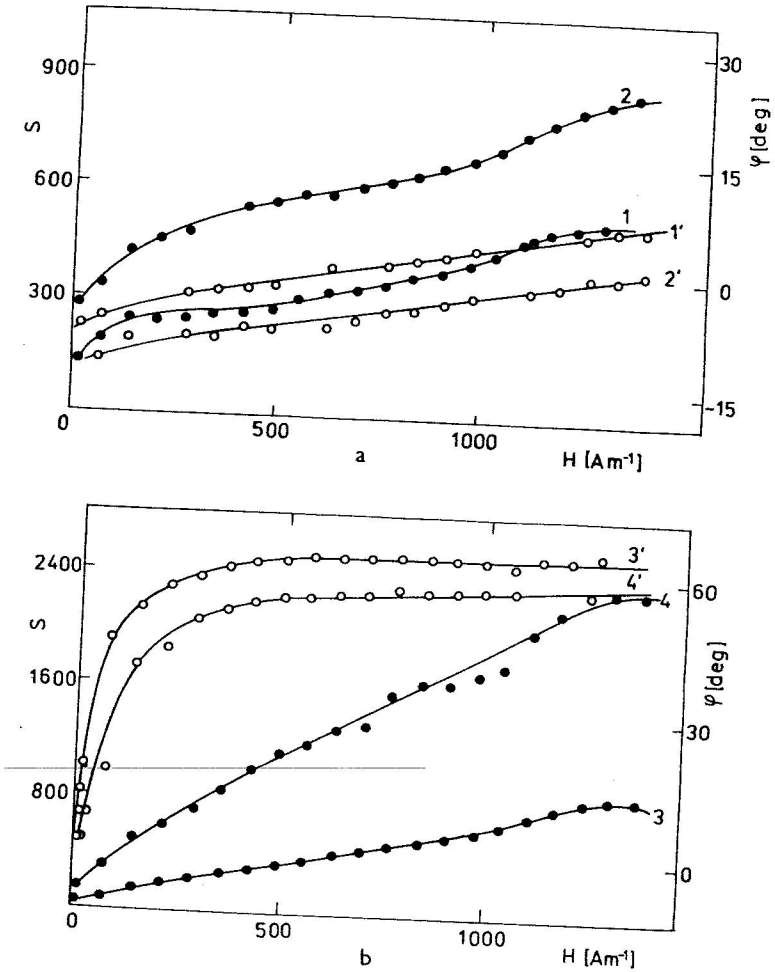

Fig. 1. Dependences of the amplitude S (...) and the phase φ (ooo) of the complex screening coefficient $\bar{S}$ on the alternating magnetic field intensity H (frequency $f = 80$ Hz) for a) crystalline samples No. 1 and 2, b) amorphous samples No. 3 and 4.

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[2]) Faculty of Science, P. J. Šafárik University, Dept. of Experimental Physics, nám. Febr. víťazstva 9, 041 54 KOŠICE, Czechoslovakia.
[3]) TESLA Brno, Purkyňova 99, 612 45 BRNO, Czechoslovakia.

amorphous samples No. 3 and 4 can be attained, especially in the high frequency region (100—10000 Hz) but of course at the expense of non-linear frequency dependencies for both amplitude and phase of $\bar{S}$.

Even though our results are in good agreement with the findings published in [2, 3, 4, 5], this complex of problems will require further detailed studies (above all with regard to the complicated interaction of the electromagnetic field with ferromagnetic materials of samples). It is also clear that the properties of

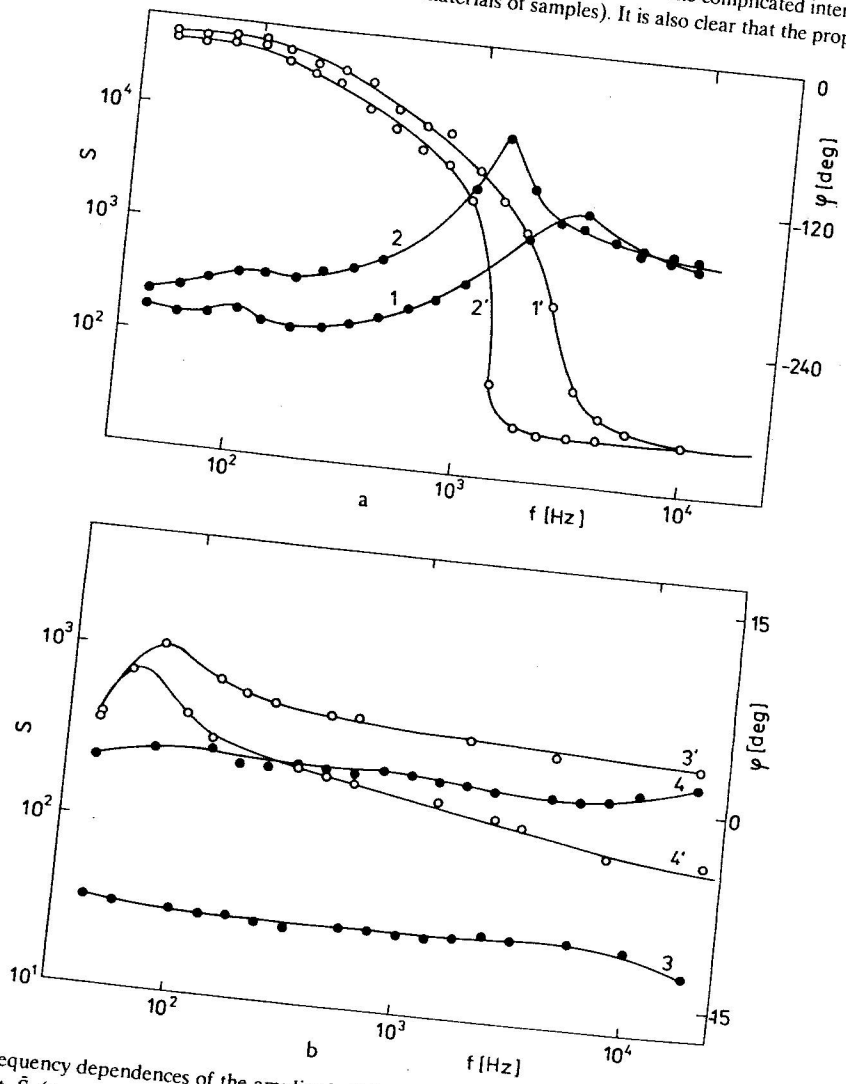

Fig. 2. Frequency dependences of the amplitude S (...) and the phase φ (ooo) of the complex screening coefficient $\bar{S}$ (magnetic field intensity $H = 10.6\ \mathrm{Am}^{-1}$) for a) crystalline samples No. 1 and 2, b) amorphous samples No. 3 and 4.

crystalline and amorphous samples supplement each other. Thus the screening shields which link the positive properties of both sample types could be prepared by their suitable combination.

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