BARKHAUSEN EFFECT IN SOME AMORPHOUS Ni—Fe—B—Si ALLOYS[1]

ЭФФЕКТ БАРКГАУЗЕНА В НЕКОТОРЫХ АМОРФНЫХ СПЛАВАХ Ni—Fe—B—Si

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Barkhausen noise measurements have been performed on amorphous $(Fe, Ni, Co)_{72}M_{28}$ alloys, where M is either B, or a combination of B and Si. The power spectrum of the noise was measured for analysing frequencies ranging between 1.2 and 120 kHz at different temperatures.

We studied the power spectra in amorphous alloys of $Fe_{15}Co_{33}Ni_{24}Si_{10}B_{18}$, $Fe_{29}Co_{19}Ni_{24}B_{18}Si_{10}$, $Fe_{47}Ni_{25}B_{18}Si_{10}$, $Fe_{53}Ni_{27}B_{20}$ and $Co_{46}Fe_{21}B_{21}Si_{10}Al_2$. The used samples were prepared by the single roller technique. The amorphous state was verified by electron diffraction. The length of the used specimens was 100 mm. The power spectra $W(f)$ were measured with the same experimental equipment as that described in [1]. The samples were magnetized along the branch of the hysteresis loop with a frequency of 1.6×10^{-3} Hz. The maximum value of the applied field was 4.5×10^{-3} Am^{-1} for all specimens. The power spectra were always registered with an external field equal to the coercive force of the used sample at room temperature and at liquid nitrogen temperature.

The observed dependences of the power spectra are shown in Fig. 1 (samples) with a content of Fe: 15, 21 and 29 at. %) and in Fig.2 (content of Fe: 47 and 53 at. %). As it is seen the behaviour of the functions $W(f)$ showed in Fig. 1 differs from the behaviour of $W(f)$ in Fig. 2. The functions in Fig. 1 have a linear part which decreases with the frequency $f^{-1.8}$ for the content of Fe 15 and 29 at. % or $f^{-1.3}$ for the content of iron 21 at. % at room temperature. On the other hand in the behaviour of functions $W(f)$ shown in Fig. 2 we cannot find a linear part. The character of this behaviour does not change in liquid nitrogen temperature.

It is very difficult to derive the analytical expression of the power spectral function of the Barkhausen impulses (B.i.), because it is necessary to take into account a very large number of various experimentally observed facts. One of the most important among them is the fact that the elementary B. i. form clusters. Lütgemeier [2] showed that the presence of clusters has a strong influence on the shape of the power spectrum. Mazetti [3, 4] derived the form of the power spectrum of the correlated impulses. He supposed a series of exponential impulses with uniform amplitudes, whose mutual distances were distributed according to the Sawada distribution [5]. Such power spectrum in the region

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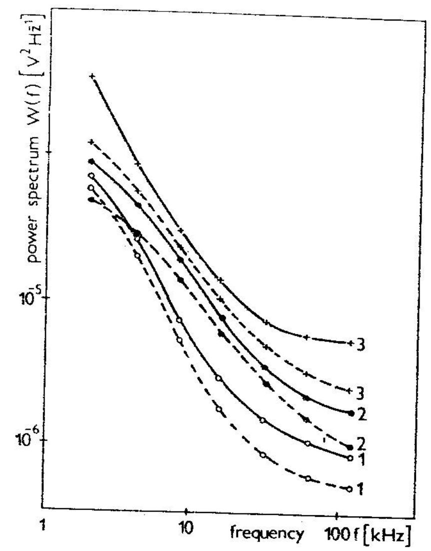

Fig. 1. The course of power spectra $W(f)$. (1 — $Fe_{15}Co_{33}Ni_{24}Si_{10}B_{18}$; 2 — $Co_{46}Fe_{21}B_{21}Si_{10}Al_2$; 3 — $Fe_{29}Co_{19}Ni_{24}B_{18}Si_{10}$; full lines for room temperature, dashed ones for liquid nitrogen temperature).

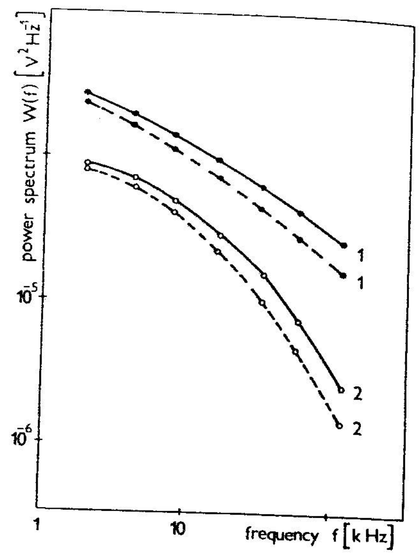

Fig. 2. Behaviour of power spectra $W(f)$. (1 — $Fe_{53}Ni_{27}B_{20}$; 2 — $Fe_{47}Ni_{25}B_{18}Si_{10}$; full lines for room temperature, dashed ones for liquid nitrogen temperature).

of medium frequencies decreases proportionally to f^{-2} and at high frequencies it has a frequency independent part. Even if the power spectrum obtained in [3, 4] agrees well with experiment, it does not inform about the physical essence of correlation between elementary Barkhausen impulses. A more realistic mechanism of correlation is described in [6]. The author of [6] obtained for impulses calculated from the equation of propagation a power spectrum which is not linear in the whole range of frequencies except off the region of low frequencies, for which $W(f)$ has an independent part. In the expression for the power spectrum the electrical conductivity and reversible permeability are represented as parameters, which is very important for the discussion of experimental results. Our results, shown in Figs. 1 and 2 are in very good agreement with the conclusions of the work [6].

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