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THE ANISOTROPY OF THE POWER SPECTRUM OF THE BARKHAUSEN NOISE IN THE UGa_2 SINGLE CRYSTAL*

ANTON ZENTKO**, ŠTEFAN FILKA***, Košice,
A. V. DERYAGIN****, A. V. ANDREYEV****, Sverdlovsk

The behaviour of the power spectrum of Barkhausen impulses in a UGa_2 single crystal was investigated. It was shown that the observed power spectra reveal an apparent anisotropy.

АНИЗОТРОПИЯ ЭНЕРГЕТИЧЕСКОГО СПЕКТРА ШУМА, ВЫЗВАННОГО ЕФФЕКТОМ БАРКГАУЗЕНА, В МОНОКРИСТАЛЛЕ UGa_2

В работе исследовано поведение энергетического спектра баркгаузеновских импульсов в монокристалле UGa_2. Показано, что наблюдаемые энергетические спектры обладают заметной анизотропией.

I. INTRODUCTION

The electrical and magnetic properties of the intermetallic compound UGa_2 have been studied by several authors [1, 2, 3]. UGa_2 belongs to the group of the hexagonal uranium compounds with an AlB_2 type structure. According to magnetic and neutron diffraction investigations this compound possesses ferromagnetic properties below the Curie temperature T_c = 126 K (2, 3], or T_c = 133 K [4]. The subject of the present paper is the study of the Barkhausen effect in a UGa_2 single crystal.

II. EXPERIMENTAL

The UGa_2 single crystal was cut from the grain of a polycrystalline compound. After being ground to a spherical shape and after crystallographic orientation the

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** Inst. of Experimental Physics, Slov. Acad. Sci., CS-041 54 KOŠICE.
*** Dept. of Experimental Physics, Faculty of Science, P. J. Šafárik University, CS-041 54 KOŠICE.
**** Ural State University, 620 083 SVERDLOVSK, USSR.

sample was placed into a pick-up coil and magnetized with a frequency of 2×10^{-2} Hz at liquid nitrogen temperature. The maximum value of the external magnetic field was 480 kA/m ($\sim$6 kOe). For the measurement of the Barkhausen effect the same apparatus as that described in papers [6, 7] was used.

III. RESULTS AND DISCUSSION

The angular variation of the power spectra of the Barkhausen noise, when the magnetic field H is applied in the (001) plane (where 3 easy directions lie) is shown

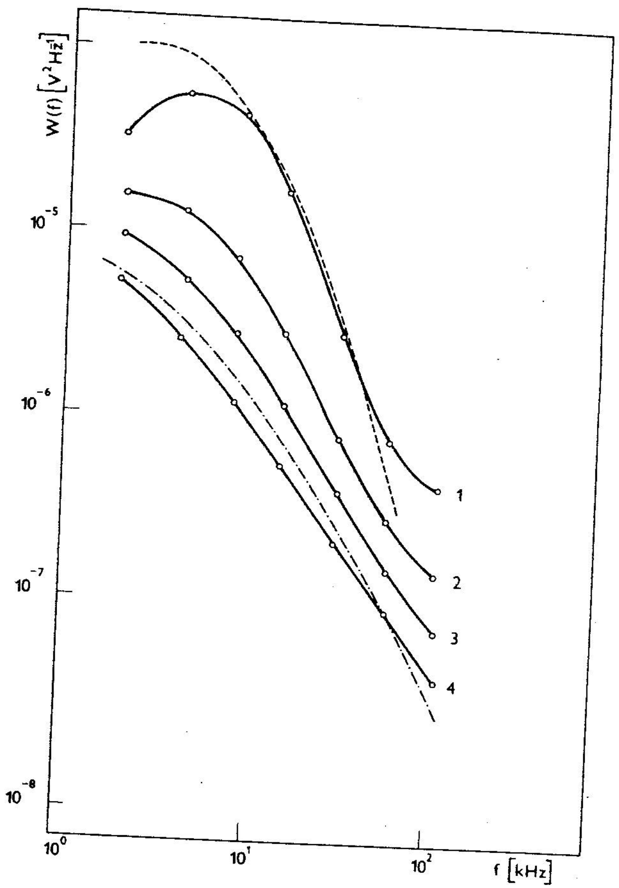

Fig. 1. The power spectra of the Barkhausen noise for different orientation of UGa_2 single crystal (curve 1 — easy direction, curve 2 — deviation from easy axis $\varphi=10^{\circ}$, curve 3 — $\varphi=20^{\circ}$, curve 4 — $\varphi=30^{\circ}$). The full lines are experimental and broken lines theoretical, based on equation (1). (The dashed line corresponds $\alpha=2\times10^{-4}$ s, dot-dashed line is for $\alpha=5\times10^{-5}$ s.

in Figure 1. It is seen that the registered power spectra for the individual deviations of the magnetic field H from the easy axis differ from each other by their intensity and also by their shape. The differences in the spectrum intensity are caused by the different total number of the registered Barkausen impulses for the individual orientation of the magnetic field. The dependence of total number of the registered Barkhausen impulses upon the external field is shown in Fig. 2. The power spectrum for an easy direction ($\varphi=0$) has a maximum in the region of low frequencies. The occurrence of such a maximum can be explained as a result of the correlation between elementary Barkhausen impulses. The rate of the spectrum

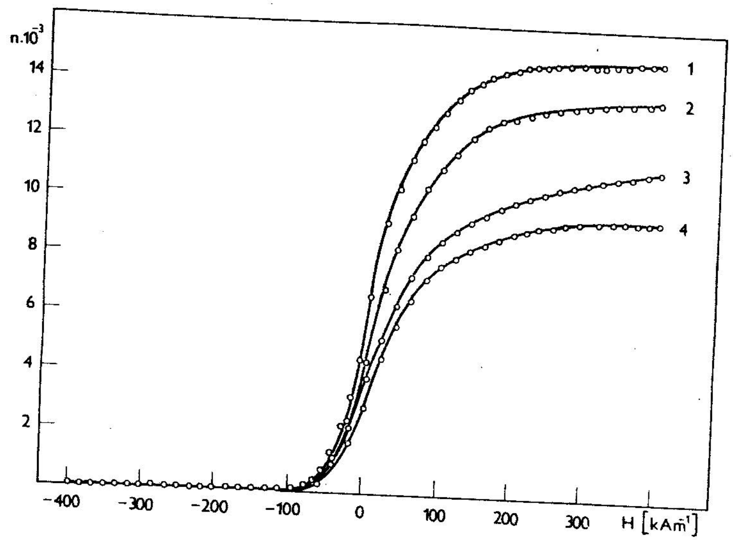

Fig. 2. The dependence of the number of registered Barkhausen impulses upon the external field. (Curve 1 is for easy direction, curve 2 for $\varphi=10^{\circ}$, curve 3 for $\varphi=20^{\circ}$ and curve 4 for $\varphi=30^{\circ}$).

decrease in the central part is influenced by the electrical and magnetic properties of the sample. As shown in [5] we can write for the power spectrum

$$\Phi(\omega)=nC^2(M,\alpha)/2|\sqrt{4i\alpha\omega}\,K_1(\sqrt{4i\alpha\omega})|^2, \qquad (1)$$

where n is the average number of impulses per unit time, (M, α) is the amplitude of the elementary impulses, K_1 is the Mac Donald function, $\alpha\sim\mu\sigma$, μ is the reversible permeability and σ is the electrical conductivity of the sample. We now examine the experimentally observed spectra. If the value of the time constant α is assumed to be 5×10^{-5} s and 2×10^{-4} s, for the easy axis and the 30° deviation, respectively, a good agreement between the theoretical curves and the experimental ones is obtained (see Fig. 1). Since the change of the time constant α is caused by the changes of μ and σ, we can conclude that the reversible permeability of the UGa_2 single crystal shows an apparent anisotropy.

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