

**TEMPERATURE
DEPENDENCE OF THE
FIRST MAGNETIC
ANISOTROPY
CONSTANT OF SINGLE
FERRITE CRYSTALS
WITH SPINEL
STRUCTURE AS A
FUNCTION OF
SATURATION
MAGNETIZATION**

PHYSICS

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Fig. 1. Graphs of the dependence $n(T)$ for single crystals of certain ferrites with spinel structure: 1—experimental, 2—calculated curves. *I*— $\text{Mg}_{0.5}\text{Mn}_{0.5}\text{Fe}_2\text{O}_4$; *II*— MnFe_2O_4 ; *III*— $\text{Co}_{0.94}\text{Fe}_{0.12}^{2+}\text{Fe}_{1.96}^{3+}\text{O}_4$; *IV*— $\text{Li}_2\text{O}(\text{Fe}_2\text{O}_3)_5$; *V*— $\text{Ni}_{0.71}\text{Co}_{0.03}\text{Fe}_{0.20}^{2+}\text{Fe}_{0.24}^{3+}\text{O}_4$.

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Abstract

Full Text

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PHYSICS

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TEMPERATURE DEPENDENCE OF THE FIRST MAGNETIC ANISOTROPY CONSTANT OF SINGLE FERRITE CRYSTALS WITH SPINEL STRUCTURE AS A FUNCTION OF SATURATION MAGNETIZATION

(Presented by Academician A. V. Shubnikov on 2 VII 1966)

Classical calculations (~ 1 , ~ 2) and quantum-mechanical calculations based on the application of the spin-wave method to dipole and quadrupole models lead, for cubic single crystals, to the “tenth-power law,” i.e., they show that the first constant of magnetic anisotropy in the

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low-temperature region should vary with temperature as the tenth power of the saturation magnetization. However, experiments show that this dependence is not satisfied not only for such classical ferromagnets as iron and nickel, but also for ferrites. For iron, the constant

the magnetic anisotropy changes to a lesser degree [3], for nickel—to a considerably greater degree [4], and for ferros spinels—to a lesser degree. Theories leading

to this law probably do not take into account the full variety of factors determining the relation between spontaneous magnetization and the magnetic anisotropy constant. For medium and high temperatures there are no such calculations at all.

Experimental measurements of the magnetic anisotropy constants of single-crystal ferrite spheres with the spinel structure by the torque method, and of the spontaneous magnetization at different temperatures, showed that there is a definite relation between the temperature dependences of these parameters over a wide temperature interval. If the ratio is denoted by n :

$$n = \frac{\lg K_1(T) - \lg K_1(0)}{\lg M_s(T) - \lg M_s(0)}, \quad (1)$$

where $K_s(T)$ and $K_1(0)$ are the values of the first magnetic anisotropy constant, respectively at temperature T and at 0°K , and $M_s(T)$ and $M_s(0)$ are the value of the spontaneous magnetization at temperature T and at 0°K , then the dependence $n(T)$ can be expressed by the empirical formula

$$n = aT^b e^{cT}. \quad (2)$$

Here a , b , and c are constants depending on the ferrite composition. Calculations performed on the Ural-2 electronic computer on the basis of experimental data showed satisfactory agreement with formula (2) for many ferrites with the spinel structure. As an example, Fig. 1 gives experimental and calculated data for the dependences $n(T)$ for several simple and complex single crystals with the spinel structure. The values of the coefficients a , b , and c are as follows:

	a	b	c
I	$0.1059 \cdot 10^{-6}$	4.319	$-0.126 \cdot 10^{-1}$
II	$0.1204 \cdot 10^{-3}$	2.359	$-0.8975 \cdot 10^{-2}$
III	$0.128 \cdot 10^{-4}$	2.597	$-0.6053 \cdot 10^{-2}$
IV	$0.1647 \cdot 10^{-3}$	2.082	$-0.5083 \cdot 10^{-2}$
V	$0.445 \cdot 10^{-9}$	4.89	$-0.124 \cdot 10^{-1}$

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