

EXCHANGE MAGNETOSTRICTION IN TERBIUM IRON GARNETS

K. P. Belov and D. P. Shlyakhina

Moscow State University

Submitted 3 September 1968

ZhETF Pis. Red. 8, No. 10, 557-559 (20 November 1968)

We investigated the magnetostriction of silicon-substituted terbium iron garnets $\{Tb_{3-x}Ca_x\}(Fe_{3-x}Si_x)[Fe_2]O_{12}$ at $x = 0.3, 0.6, 0.9, 1.2,$ and 1.5 .

It was shown in a number of papers [1,2] that the magnetostriction in terbium iron garnet reaches a tremendous value and is due to the interaction between the orbital momentum of the terbium iron and the electrostatic field of the lattice. This magnetostriction is anisotropic. However, a volume component of the striction, corresponding to the exchange interaction between the rare-earth ions and the iron ions Tb^{3+} and Fe^{3+} , should exist in this ferrite.

When the iron ions in the tetrahedral sublattice are replaced by nonmagnetic silicon ions, the effective field acting on the rare-earth ions (produced by the iron sublattice) becomes weaker, and consequently the para process in the terbium sublattice increases. At the same time, the number of terbium ions decreases, since they are replaced by the nonmagnetic calcium ions, as the result of which the anisotropic striction decreases. Thus, it becomes possible to investigate the exchange magnetostriction accompanying the Tb^{3+} - Fe^{3+} interaction in substituted iron garnets.

The samples were prepared in accordance with the usual ceramic technology. The final sintering was at $1380^\circ C$ for nine hours in air. The purity of the terbium oxide was 99.97%.

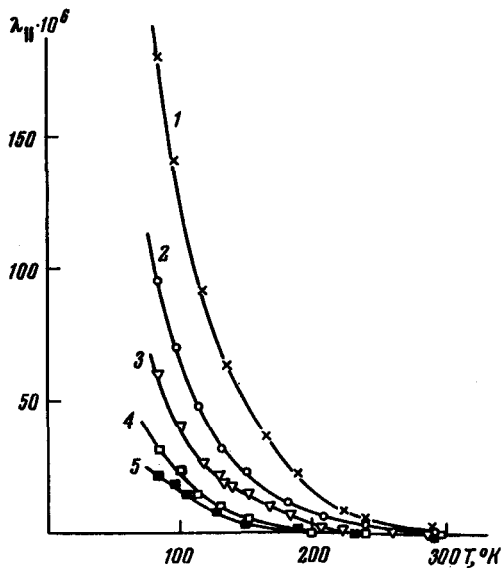


Fig. 1. Temperature dependences of the longitudinal magnetostriction in a 14.5 kOe field for iron garnets of the system $Tb_{3-x}Ca_xFe_{5-x}Si_xO_{12}$: 1) $x = 0.3,$ 2) $x = 0.6,$ 3) $x = 0.9,$ 4) $x = 1.2,$ 5) $x = 1.5$.

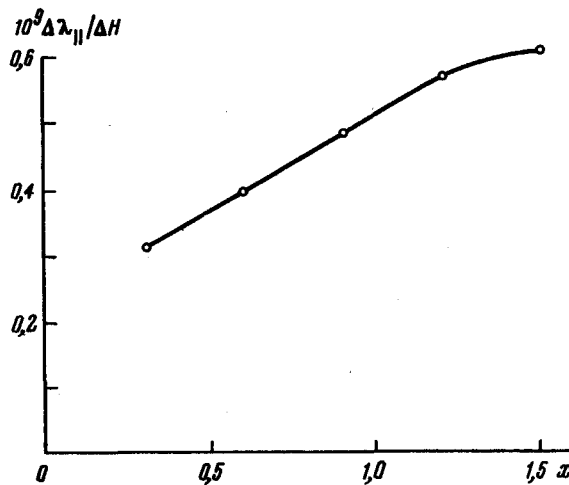


Fig. 2. Dependence of the susceptibility of the para process of magnetostriction (in a field ~ 14 kOe) on the composition, per ion of terbium, at a temperature $T = \theta/4$ (θ - Curie temperature of the given composition) for the system of iron garnets $Tb_{3-x}Ca_xFe_{5-x}Si_xO_{12}$

The remaining oxides in the ferrites had a purity not lower than ch.d.a. (pure for analysis) grade. An x-ray phase analysis (URF-50 IM diffractometer, filtered CoK_{α} radiation) has shown that all the samples are single-phase within $\sim 3\%$.

The magnetostriction was measured with wire-wound pickups in the temperature interval from liquid nitrogen to 300°K in fields up to 14.5 kOe. The magnetostriction measurement accuracy was $\pm 0.4 \times 10^{-6}$.

Figure 1 shows the temperature dependences of the longitudinal magnetostriction in a 14.5 kOe field for all the prepared compositions of the substituted terbium iron garnets.

It is seen that the magnetostriction decreases with increasing number of terbium ions (with increasing x).

In the study of the dependence of the longitudinal and transverse magnetostriction on the field, at all the investigated compositions of the substituted terbium iron garnets, we noticed the presence of a positive volume component of the magnetostriction, which we assumed to accompany the para process in the terbium sublattice and to have an exchange nature. It is due to the exchange interaction between the terbium and iron sublattices.

The susceptibility of the magnetostriction para process for this composition decreases with increasing temperature.

Figure 2 shows the dependence of the susceptibility of the magnetostriction para process (in a field ~ 14 kOe) on the composition, calculated per terbium ion, at a temperature $T = \theta/4$, where θ is the Curie temperature of the given composition. We see that with increasing substitution, the exchange magnetostriction increases, this being due to the decrease of the effective field of the iron sublattices acting on the rare-earth sublattice.

We are grateful to B. V. Mill' for carrying out the x-ray phase analysis of the samples.

- [1] K. P. Belov and V. I. Sokolov, Zh. Eksp. Teor. Fiz. 48, 979 (1965) [Sov. Phys.-JETP 21, 652 (1965)].
- [2] S. Iida, Phys. Lett. 6, 165 (1963).

CONCERNING THE CORRELATION OF γ QUANTA IN THE X-RAY BAND

V. G. Labushkin and E. P. Nikolaev

All-union Research Institute of Physicotechnical and Radiotechnical Measurements

Submitted 6 September 1968

ZhETF Pis. Red. 8, No. 10, 560-562 (20 November 1968)

Questions of coherence and correlation properties of photons of the optical band are considered in detail in a number of papers [1-5]. Interest attaches to the possibility of extending the idea of optics to the x-ray region, where several problems of independent interest also arise, such as a study of interference effects in nuclear physics [6,7], the problem of developing an x-ray laser [8,9], study of interference properties of individual photons [5,10,11], etc. Therefore, interest attaches to the experimentally observed [12] appreciable effect of γ -quantum correlation, wherein photons emitted by the Mossbauer isotope Sn^{119} strike the counter simultaneously. This effect can be due either to induced radiation, or to correlations of the Brown-Twiss type, or to some new uninvestigated phenomenon.