curves are in comparison with the curves for $3Y_2O_3 \cdot 5Fe_2O_3$. Probably the Al^{3+} and Cr^{3+} ions are distributed nonuniformly in the ferrite-garnet lattice, as a result of which there occur fluctuations of the exchange interactions through the volume of the specimen; these in turn lead to a "washing out" of the curves of ΔH and σ_s vs temperature. According to the theory of Clogston, Suhl, et al.,[2] the value of ΔH in ferrites should be proportional to $\sqrt{\sigma_s}$. As can be seen from Fig. 2, this

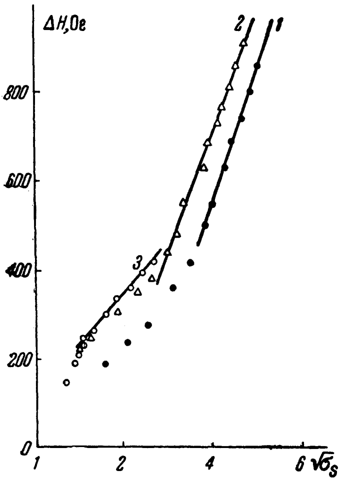

FIG. 2. Dependence of ΔH on $\sqrt{\sigma_s}$ for ferrite-garnets, calculated from the curves of Fig. 1 (same materials and same notation for them).

relation is satisfied qualitiatively in a certain temperature interval (far from the Curie point).

Figure 3 shows the temperature dependence of

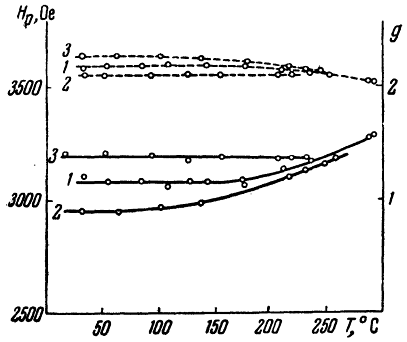

FIG. 3. Temperature dependence of resonance field H_p (solid curves) and of g-factor (dashed curves) for the same materials as in Fig. 1.

the resonance field H_p and of the g-factor on temperature. It is interesting to note that in the stoichiometric ferrite $3Y_2O_3 \cdot 5Fe_2O_3$ and in $3Y_2O_3 \cdot 4.5Fe_2O_3 \cdot 0.5Cr_2O_3$, H_p increases on approach to the Curie point, whereas the g-factor decreases slightly.

This work was performed under the direction of K. P. Belov.

[1] Belov, Bol'shova, and Elkina, Izv. Akad. Nauk SSSR, Ser. Fiz., **21**, 1047 (1957), Columbia Tech. Transl. p. 1051.

[2] Clogston, Suhl, Walker, and Anderson, Phys. Chem. Solids **1**, 129 (1956).

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MAGNETIC AND RESONANCE PROPERTIES OF YTTRIUM FERRITE-GARNETS WITH REPLACEMENT OF Fe^{3+} *IONS BY* Cr^{3+} *AND* Al^{3+} *IONS*

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RECENTLY there has been great interest in the investigation of ferromagnetic resonance in new magnetic materials, ferrite-garnets of the rare-earth elements and of yttrium.[1,2] In the present communication we give the results of our experiments on the effect of replacement of Fe^{3+} ions by Al^{3+} and Cr^{3+} ions, in the stoichiometric yttrium ferrite-garnet $3Y_2O_3 \cdot 5Fe_2O_3$, upon the magnetic and resonance properties of this ferrite. Upon replacement of a corresponding quantity of Fe^{3+} ions by Al^{3+} and Cr^{3+}, the formulas for the ferrites studied will have the form:

$$3Y_2O_3 \cdot (5-a)\, Fe_2O_3 \cdot a\, Al_2O_3;\ 3Y_2O_3 \cdot (5-a)\, Fe_2O_3 \cdot aCr_2O_3.$$

Here a is the content of Al^{3+} or Cr^{3+} ions per mole. The measurements of magnetic and resonance characteristics were carried out on polycrystalline specimens, prepared in accordance with standard ceramic technology (sintering at 1300°C in air for four hours). The density of the specimens was no greater than 2.75 g/cm^3; this led to a pronounced broadening of the ferromagnetic resonance absorption line. In our experiments this was an advantage, since it permitted a clear exhibition of the effect of the introduction of Al^{3+} and Cr^{3+} ions into the ferrite upon the absorption line width. For all the specimens, isotherms of the magnetization were taken by a ballistic method at helium temperatures; from these the saturation magnetization σ_0 was found, in Bohr magnetons per mole.

Replacement of Fe^{3+} ions by Al^{3+} ions (which have no magnetic moment) causes a decrease in the value of σ_0 (Fig. 1), whereas replacement by Cr^{3+} ions at first leads to an increase of σ_0; but

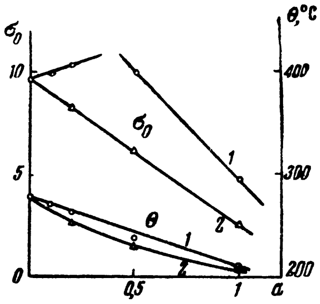

FIG. 1. Dependence of the magnetization σ_0 at 4.3°K (in Bohr magnetons) and the Curie point Θ on content a of Cr^{3+} and Al^{3+} ions in yttrium ferrite-garnet: 1) Cr^{3+}; 2) Al^{3+}.

at contents $a > 0.5$ the value of σ_0 decreases. The Curie point decreases in all cases, both on replacement by Al^{3+} and on replacement by Cr^{3+} (Fig. 1). These results are in agreement with the data of Pauthenet.[3]

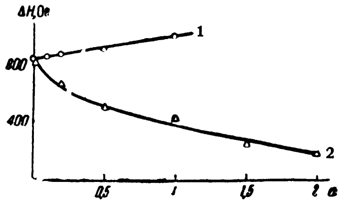

FIG. 2. Dependence of the width of the absorption line on content of Cr^{3+} and Al^{3+} ions in yttrium ferrite-garnet: 1) Cr^{3+}; 2) Al^{3+}.

Figure 2 gives the results of the measurements of ΔH, the width of the absorption line. The value of ΔH increases with increase of Cr^{3+} content, whereas it decreases with increase of Al^{3+} content. Since the magnetic anisotropy is very small in yttrium ferrite-garnet, it is possible to calculate the value of the g-factor with satisfactory accuracy. With increase of Cr^{3+} content, the g-factor rises from a value 2.150 ± 0.005 (for $3Y_2O_3 \cdot 5Fe_2O_3$) to 2.200 ± 0.005 (for $3Y_2O_3 \cdot 4Fe_2O_3 \cdot Cr_2O_3$), while upon increase of Al^{3+} content the g-factor drops to a value 2.030 ± 0.005 (for $3Y_2O_3 \cdot 4Fe_2O_3 \cdot Al_2O_3$). Comparison of the curves for ΔH, σ_0, and Θ (Figs. 1 and 2) shows that the value of ΔH is directly related to the values of σ_0 and Θ (in the case of replacement by Al^{3+}): the smaller σ_0 and Θ, the smaller ΔH. This is qualitatively in agreement with the deductions of the theory,[4] according to which ΔH in ferrites should be proportional to the values of σ_0 and of Θ. In the case of replacement by Cr^{3+} ions, as Figs. 1 and 2 show, the experimental data on the change of the values of ΔH, σ_0, and Θ are in contradiction to the theory mentioned.

[1] M. Sirvetz and J. Zneimer, J. Appl. Phys. **29**, 431 (1958).

[2] R. Vautier and A. Berteaud, Compt. Rend. **247**, 1322 (1958).

[3] R. Pauthenet, Compt. rend. **243**, 1499 and 1737 (1956).

[4] Clogston, Suhl, Walker, and Anderson, Phys. Chem. Solids **1**, 129 (1956).

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ELECTRIC FIELD IN A MICROWAVE PLASMA AS A FUNCTION OF TIME

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It is of considerable interest to study the formation of a pulsed ultrahigh frequency (UHF) discharge from the onset of breakdown to the time at which the electron density, electric field, and other plasma parameters assume their steady-state values.

We have investigated the time dependence of the electric field during the transient period in a pulsed UHF discharge at 9400 Mcs. The field strength was measured optically by noting the Stark effect of the Balmer lines in the external oscillating field.[1,2] The microwave plasma was generated in a narrow capillary approximately 2 mm in diameter which was placed in a waveguide with cross section 23×10 mm^2.

An analysis was made of the transverse radiation with respect to the direction of the electric field. The spectral analysis apparatus was a DFS-2 diffraction grating (theoretical resolving power of 80,000). The analysis of the spectrum and the determination of the parameters of the H_β line used for the experiment were made by means of a photo-electric scanning attachment on a FEU-19 photomultiplier. To make it possible to examine the line shapes corresponding to various stages of the UHF pulses ($\tau = 2\,\mu$sec) a time-selection system was used to examine the signal from the FEU.

The triggering pulses were approximately 0.1 μsec long and could be shifted in steps of 0.1 μsec. It is assumed that the quantity being measured was essentially constant over a 0.1 μsec period. Since the repetition frequency was about 400 cps and the scanning was carried out rather slowly the results of the measurements represent averages over several thousand illumination pulses.

The measurements were carried out in deuterium at a pressure of several millimeters of mercury. In the figure is shown the time dependence of the electric field inside the plasma during a uhf pulse. In the same figure is shown the UHF pulse in the waveguide in which the capillary was located and an oscillogram of the intensity of the H_β line in relative units (same time scale for all quantities).

During the entire UHF pulse the amplitude of