registered coincidences in the correlation investigation did not exceed 10^3.

[1] V. V. Avrosimov, Yu. S. Gordeev, M. N. Panov, and N. V. Fedorenko, ZhTF 34, 1624 (1964), Soviet Phys. Tech. Phys. 9, 1256 (1965).
[2] E. Everhart and Q. C. Kessel, Phys. Rev. Lett. 14, 247 (1965).
[3] U. Fano and W. Lichten, Phys. Rev. Lett. 14, 627 (1965).
[4] M. Ya. Amusia, Phys. Lett. 14, 36 (1965).
[5] M. Ya. Amus'ya, ZhTF 36, 1409 (1966), Soviet Phys. Tech. Phys. 11, 1053 (1967).
[6] V. V. Afrosimov, Yu. S. Gordeev, M. N. Panov, and N. V. Fedorenko, ZhTF 36, 123 (1966), Soviet Phys. Tech. Phys. 11, 89 (1966).
[7] Q. C. Kessel, A. Russek, and E. Everhart, Phys. Rev. Lett. 14, 484 (1965).
[8] Q. C. Kessel and E. Everhart, Phys.Rev. 146, 16 (1966).

OBSERVATION OF ELECTRIC "DOMAINS" IN HIGH-RESISTANCE GaAs WITH THE AID OF THE ELECTROOPTIC EFFECT

V. S. Bogachev, Yu. N. Berozashvili, and B. M. Vul
P. N. Lebedev Physics Institute, USSR Academy of Sciences
Submitted 12 April 1967
ZhETF Pis'ma 6, No. 1, 464-467 (1 July 1967)

We investigated the inhomogeneities of the distribution and the oscillations of the electric field in an n-type GaAs crystal at T = 80°K. As is well known, electric instability was observed experimentally in Ge [1,2], in CdS [3], and in the semiconducting GaAs [4-6].

In this investigation we measured the local electric field intensity with an optical probe, using the Pockels electrooptic effect [7].

The measurements were made on single-crystal semple of semiconducting GaAs doped with iron. Their resistivity at 80°K was of the order of 10^{10} ohm-cm. The samples were parallelepipeds measuring 6 x 3 x 3 mm. The electrodes were of indium and deposited on the [111] plane. The distance between the electrodes was 3 mm. The remaining four sides, on which there were no electrodes, were subjected to thorough optical polishing.

The sample was placed between two crossed polaroids and illuminated with plane-polarized monochromatic light of quantum energy smaller than the forbidden-band width and with the $\vec{e}$ vector at an angle of 45° to the direction of the electrostatic field.

The anisotropy introduced by the electric field gives rise to birefringence in the crystal. For the GaAs crystal, whose symmetry class is $\bar{4}3m$, the phase difference between the two rays depends on the electric field intensity (the Pockels effect) and its value in degrees is in our case

$$\delta^\circ = \frac{\sqrt{3}\,\pi}{\lambda} n_0^3 r_{41} EL , \tag{1}$$

where λ is the wavelength of the light, n_0 the refractive index of the crystal in the absence of an electric field, E the electric field intensity, L the length of the crystal in the light propagation direction, and r_{41} the electrooptic coefficient, which is equal to $\sim 3 \times 10^{-10}$ cm/V for $\lambda = 0.9\ \mu$.

The intensity I of the light passing through the sample and the two crossed polaroids is

$$I \sim \sin^2 \frac{\delta^\circ}{2} . \tag{2}$$

Thus, the phase difference δ becomes noticeable in GaAs even at small values of E and crystal lengths L [8]. By determining δ from measurements of the transmission of light through different regions of the crystal in crossed polaroids it is possible to determine with sufficiently high accuracy the local values of the electric field intensity.

Measurements have shown that the investigated samples have N-shaped current-voltage characteristics. A sharp decrease of the current was observed when a certain field value E_{cr} was reached, together with a simultaneous appearance of current oscillations and loss of homogeneity of the electric field distribution in the sample.

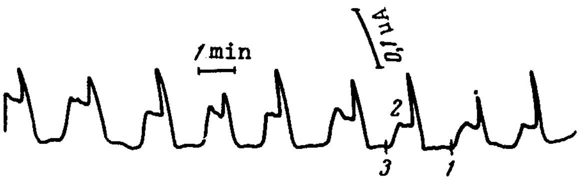

Fig. 1. Oscillations of current flowing through sample to which 1000 V is applied.

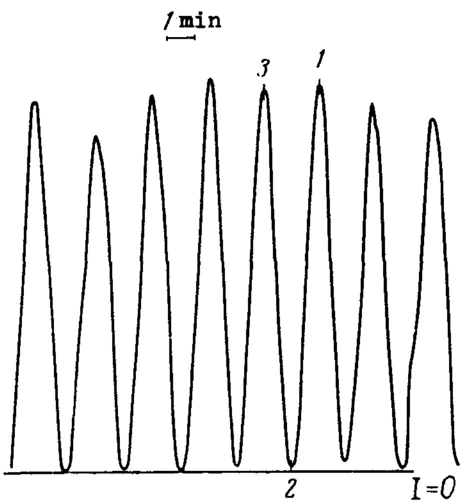

Fig. 2. Change of intensity of light going through 1 mm wide region of GaAs crystal near its center, between crossed polaroids. These light-intensity changes were recorded simultaneously with the current oscillogram (Fig. 1). Equally marked points in the two figures are synchronous.

Figure 1 shows a current oscillogram and Fig. 2 shows the change in the intensity of the light passing through the sample, in a region 1 mm wide near its center, at a voltage 1000 V applied to the sample.

A diaphragm used during the light-transmission measurement limited the dimensions of light beam passing through the sample. Displacement of the diaphragm made it possible to scan the sample.

A region with increased electric-field intensity ("domain") was produced first at the cathode and then moved towards the anode. On reaching the anode, the "domain" disappeared and a new one was produced at the cathode. In our case, with 1 kV applied to the sample, the speed of the "domain" was $\sim 2\times 10^{-3}$ cm/sec and increased with increasing illumination level and with the applied voltage. The increase of "domain" speed due to the increase of the illumination level was nonlinear and much steeper than the increase due to due to the change in field.

It was noted in the measurements that a certain role is played in the formation of the electric "domain" by the state of the surface. The surface state affected strongly the parameters of the oscillations and the very possibility of their occurrence.

The low-frequency oscillations and the N-shaped current-voltage characteristics are obviously due to recombination instability connected with an increase in the coefficient of electron capture by local levels in the electric field [9,10].

[1] B. K. Ridley and R. G. Pratt, Phys. Lett. 4, 300 (1963).
[2] S. G. Kalashnikov and I. A. Kurova, FTT 5, 3224 (1963), Soviet Phys. Solid State 5,2359 (1964).

[3] K. W. Boer, Phys.Chem. Solids 22,123 (1961).
[4] A. Barraud, Compt. rend. 256, 3632 (1963).
[5] D. C. Northrop, P. R. Thornton, and K. E. Tretise, Solid State Electr. 7, 17 (1964).
[6] A. W. Smith, ibid. 8, 833 (1965).
[7] F. Pockels, Lehrbuch der Kristalloptik, Teubner, Leipzig, 1906.
[8] V. S. Bagaev, Yu. N. Berozashvili, and L. V. Keldysh, JETP Letters 4,364 (1966), transl. p. 246.
[9] B. K. Ridley and J. B. Watkins, J. Phys. Chem. Sol. 22, 155 (1961).
[10] V. L. Bonch-Bruevich and S. G. Kalashnikov, FTT 7, 750 (1965), Soviet Phys. Solid State 7, 599 (1965).

NEW TYPE OF ANTIFERROMAGNETIC RESONANCE IN α-Fe_2O_3

V. I. Ozhogin and V. G. Shapiro
Submitted 12 April 1967
ZhETF Pis'ma 6, No. 1, 467-471 (1 July 1967)

The antiferromagnetic α-Fe_2O_3 has been investigated very thoroughly, but interest in it does not subside. Thus, under discussion presently is the question of the anomalies of the magnetization curve $m_x(H_x)$ in a direction perpendicular to the threefold C_3 axis in strong fields and for $T < T_M$, when the magnetizations $\vec{M}_1$ and $\vec{M}_2$ of the sublattices are aligned along C_3 at zero field [1-4]. It is therefore of interest to study experimentally the dynamics of the sublattices in this region of fields and temperatures.

Having in mind α-Fe_2O_3 at $T < T_M$, let us consider the influence of a transverse field on a very simple antiferromagnet with "easy axis" anisotropy and with nonzero Dzyaloshinskii interaction. We direct the z axis along the easy axis and the x axis along the field $\vec{H}$, which is perpendicular to z. The system energy is written in the form

$$H = \frac{B}{2} M^2 + \frac{a}{2}(L_x^2 + L_y^2) - \beta(M_x L_y - M_y L_x) - \mathbf{MH}, \tag{1}$$

where

$$\mathbf{M} \equiv \mathbf{M}_1 + \mathbf{M}_2;\ \ \mathbf{L} \equiv \mathbf{M}_1 - \mathbf{M}_2;\ \ |\mathbf{M}_1|^2 = |\mathbf{M}_2|^2 \equiv M_0^2 .$$

Analyzing then the equations of motion for the vectors $\vec{M}$ and $\vec{L}$ $([\vec{M}\vec{H}] \equiv \vec{M}\times\vec{H})$

$$\frac{1}{\gamma}\dot{\mathbf{M}} = [\mathbf{MH}_M] + [\mathbf{LH}_L];\qquad \frac{1}{\gamma}\dot{\mathbf{L}} = [\mathbf{MH}_L] + [\mathbf{LH}_M], \tag{2}$$

where

$$\mathbf{H}_M \equiv -\partial H/\partial \mathbf{M};\ \ \mathbf{H}_L \equiv -\partial H/\partial \mathbf{L},$$

we obtain the equilibrium values of $\vec{M}$ and $\vec{L}$.

$$H_x < H_{c\perp}:\ \ m_x = \frac{H_A H_x}{2H_A H_E - H_D^2};\ \ \ell_y = \frac{H_D H_x}{2H_A H_E - H_D^2};\ \ \ell_z = \left(1 - \frac{H_x^2}{H_{c\perp}^2}\right)^{1/2}, \tag{3}$$

$$H_x > H_{c\perp}:\ \ell_z = 0;\ \ \ell_y = \sqrt{1 - m_x^2};\ \ (B - a)m_x - \beta\frac{1 - 2m_x^2}{\sqrt{1 - m_x^2}} = \frac{H_x}{2M_0}, \tag{4}$$

where

$$\mathbf{m} \equiv \mathbf{M}/2M_0;\ \ \boldsymbol{\ell} = \mathbf{L}/2M_0;\ \ H_E \equiv BM_0;\ \ H_A \equiv 2aM_0;\ \ H_D \equiv 2\beta M_0 .$$

The components M_y, M_z, and L_x vanish for all H_x. The critical field $H_{c\perp}$ is defined as the field at which L_z first vanishes. The expression for it is