[3] A.I. Akhiezer, M.I. Kaganov, and G.Ya. Lyubarskii, Zh. Eksp. Teor. Fiz. 32, 837 (1957) [Sov. Phys.-JETP 5, 685 (1957)].
[4] A.I. Akhiezer, ibid. 8, 1318, 1330 (1938).
[5] M.I. Kaganov and A.I. Semenenko, ibid. 50, 630 (1966) [23, 419 (1966)].
[6] A.B. Migdal, ibid. 34, 1438 (1958) [7, 996 (1958)]; W. Kohn, Phys. Rev. Lett. 3, 393 (1959).

INVESTIGATION OF MAGNETIC TRANSITION IN MANGANESE ARSENIDE UNDER THE INFLUENCE OF LIGHT PULSES

G.A. Govor and N.N. Sirota
Institute of Solid State Physics and Semiconductors, Belorussian Academy of Sciences
Submitted 30 March 1972; resubmitted 23 June 1972
ZhETF Pis. Red. 16, No. 3, 137 - 140 (5 August 1972)

Investigations of magnetic phase transitions in manganese arsenide as functions of the temperature and pressure [1, 2] have established that a transition takes place from the α-ferromagnetic state into the β-paramagnetic state when the sample is heated above 318°K, as well as, say, at room temperature and a pressure of 2.2 kbar. As shown by x-ray [3] and neutron-diffraction [4] investigations, the α → β transition is accompanied by an orthorhombic distortion of the nickel arsenide structure of manganese arsenide (transition into a structure of the MnP type). The displacements from the equilibrium positions in the crystal lattice, which the ions experience as a result of the α → β transition, are apparently connected with an electronic transition of the Jahn-Teller type. When the temperature increases, the degree of distortion of the crystal lattice decreases, and above 400°K the distortions are eliminated completely [5]. It is known also that the β → α transition takes place when a strong magnetic field is applied [6, 7]. An analysis of the singularities of the α → β transition has given grounds for assuming that this transformation can be observed under the influence of sufficiently strong electromagnetic fields, and in particular under the influence of light pulses in the visible band.

We have investigated experimentally the changes occurring in the magnetization of manganese arsenide under the influence of light pulses. The experimental setup is shown in Fig. 1. In the experiment, the sample was placed between the poles of an electromagnet. A measuring coil was wound directly on the sample or else was placed on the central part of the electromagnet core. Light pulses of 3.5 msec duration were produced by an IFK-500 photographic flash lamp with pulse energy ∿500 J. The sample was prepared in the form of a plate measuring 20 × 10 × 1 mm by pressing powdered manganese arsenide and subsequent annealing in vacuum at 600°C for 1 hr. The remaining details of the setup can be seen in Fig. 1. The sample was placed in an electromagnetic field of intensity ∿100 Oe.

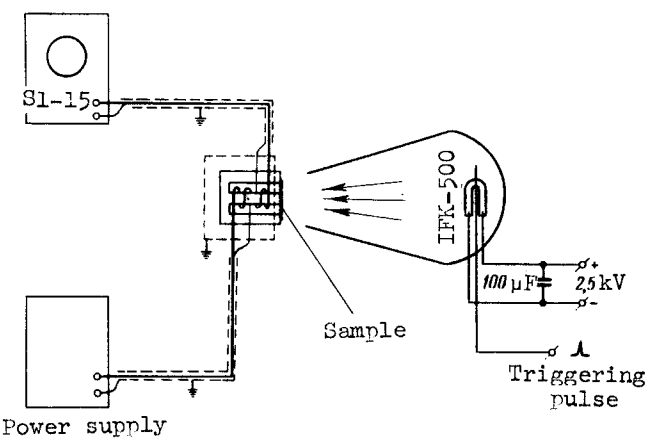

Fig. 1. Experimental setup.

Figure 2 shows the time variation of the light intensity in the pulse (a) and the corresponding change of the emf induced in the measuring coil (b) as a result of the magnetic transition.

Figure 3 shows the change of the area of the voltage pulses, which are induced in the measuring coil and are

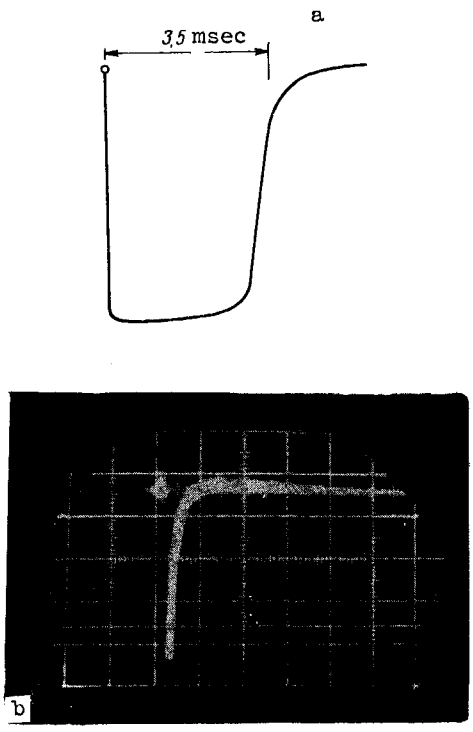

Fig. 2

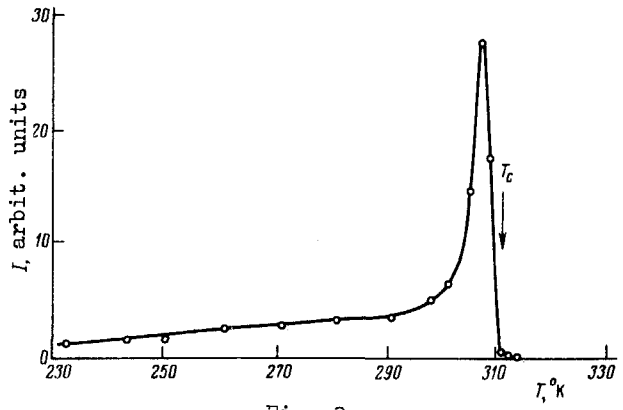

Fig. 3

Fig. 2. a) Waveform of light pulses, b) waveform of emf pulse in the measuring coil at 298°K.

Fig. 3. Change of sample magnetization upon illumination as a function of the temperature.

proportional to the change of the magnetic flux, as a function of the temperature. As seen from the figure, the greatest change in the sample magnetization is observed near the magnetic transition temperature.

Specially organized experiments with the use of thermal filters, with cooling the sample surface with liquid-nitrogen vapor, etc., as well as calculations, have shown that the $\alpha \rightarrow \beta$ magnetic transition under the influence of light pulses is not connected with superheating and is nonthermal in nature. According to our estimates, the change of the temperature of the sample surface as a result of pulsed illumination for 3.5 msec does not exceed 0.01°C when the radiation energy incident on the sample is 0.1 - 0.01 J/cm^2.

The thickness of the layer in which the magnetic transition takes place was estimated from the signal produced in the measuring coil by the change of the magnetization of the investigated sample, and was found to equal 0.1 mm at room temperature. The magnetization pulse was observed for 0.5 msec at a light-flash duration 3.5 msec. The inverse transition at this temperature occurs at 10 msec after the removal of the illumination. On the other hand, the relaxation time in the case of a thermal transition should amount to several minutes.

The effect of nonthermal change of the magnetic state of a ferromagnet by means of light pulses, observed here for the first time, is of considerable interest in connection with the study of the mechanism of similar transformations and its possible utilization in various magneto-optical devices.

[1] F. Guilland and J. Phys. Rad. 12, 223 (1951).
[2] N.N. Sirota, E.A. Vasilev, and G.A. Govor, J. de Physique 32, Suppl. 2-3, c1-987 (1971).
[3] R.H. Wilson and J.S. Kasper, Acta cryst., 17, 95 (1964).

[4] N.N. Sirota, E.A. Vasilev, and G.A. Govor, Phys. Stat. Sol. (a) 5, 43 (1971).
[5] N. Menyuk, J.A. Kafalas, et al., Phys. Rev. 177, 942 (1969).
[6] C.P. Bean and D.S. Rodbell, Phys. Rev. 126, 104 (1962).
[7] N.P. Grazhdankina, E.A. Zavadskii, and I.G. Fakidov, Fiz. Tverd. Tela 11, 2327 (1969) [Sov. Phys.-Solid State 11, 1879 (1970)].

SUPERLUMINESCENCE IN ANTHRACENE CRYSTALS

M.D. Galanin, Sh.D. Khan-Magometova, and Z.A. Chizhikova
P.N. Lebedev Physics Institute, USSR Academy of Sciences
Submitted 23 June 1972
ZhETF Pis. Red. 16, No. 3, 141 - 144 (5 August 1972)

When anthracene crystals were intensely excited with a nitrogen laser (λ = 337 nm) at 4.2°K, a strong increase of the luminescence line and of the vibronic transition to the 1400 cm^{-1} vibrational level was observed. This increase is due to the unique superluminescence which occurs in a thin ($\sim\lambda$) excited layer near the surface of the crystal.

The luminescence spectrum of an anthracene crystal at helium temperature consists of narrow ($\sim$5 - 10 cm^{-1}) bands corresponding to vibronic transitions from the exciton state, and a background apparently connected with superposition of the phonon wings [1, 2]. One observes also a number of narrow lines belonging to uncontrollable impurities [1]. The exciton density attainable by intense excitation is strongly limited by "nonlinear" quenching which is due (in the case of short exciting pulses) to dipole-dipole energy transfer in the interaction of singlet excitons [3]. As noted by us in [4], at an exciting flux of $\sim 10^{23}$ photons-$cm^{-2}sec^{-1}$ the electron density reaches 2×10^{18} cm^{-3}, i.e., about 5×10^{-4} of all the molecules are excited. An increase in the excitation intensity by several more times already damages the crystal.

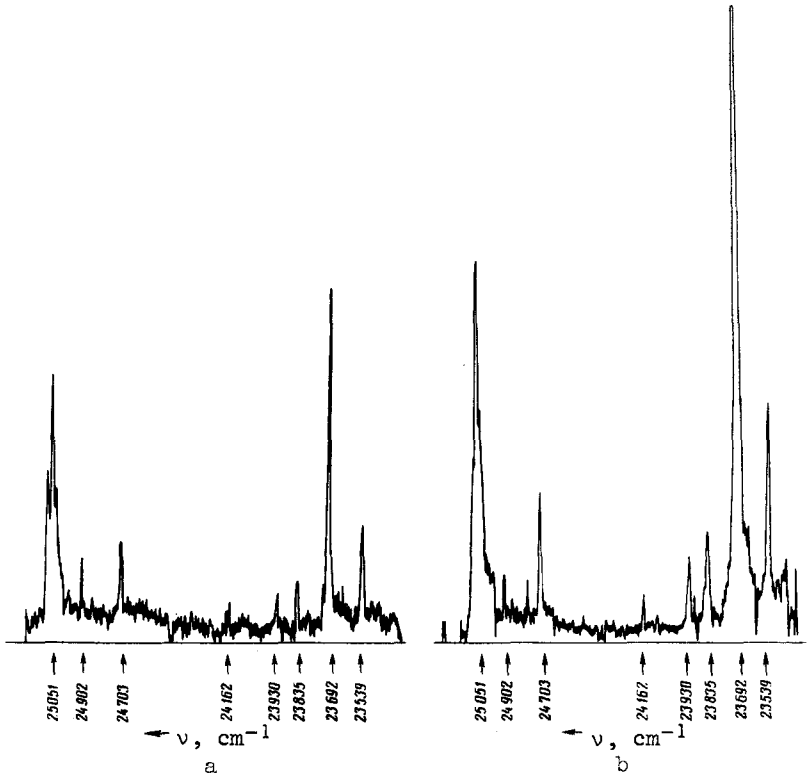

Fig. 1. Luminescence spectrum of anthracene crystal at 4.2°K at excitation intensities 1.4×10^{22} (a) and 1×10^{23} (b) photon-$cm^{-2}sec^{-1}$.