width of the barrier (Fig. 3). The probability of resonant tunneling is maximal for the levels located at the center of the barrier, and decreases exponentially when they are shifted towards the edges of the barrier [1]. Therefore the main contribution to the tunnel current is made by levels located closer to the center of the barrier. Consequently, at small amounts of uracil, $\Delta V \simeq \Delta E$ and depends little on d_u:

$$\Delta V = \Delta E(1 + d_u / d_0); \quad x = d_0,$$

and with decreasing d_u the period should approximately double

$$\Delta V'(x = L/2) = 2\Delta E,$$

as is indeed observed in the experiment (Fig. 3). The picture is symmetrical with respect to reversal of the voltage, if account is taken of the levels located both above and below the Fermi energy. The most interesting question, namely the origin of such a system of levels, remains open. Generally speaking, these levels may be connected with the energy spectrum of the uracil itself, its complexes with the metal or the oxide, or with the properties of the barrier as a whole. An investigation of the tunnel spectra of uracil in junctions consisting of different metals and oxides, and also the spectra of other bases, will help answer this question.

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LOW-TEMPERATURE QUENCHING OF THE PHOTOMECHANICAL EFFECT IN γ-IRRADIATED NaCl CRYSTALS

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As is well known [1, 2], the mechanical characteristics of alkali-halide crystals with F color centers can change under the influence of light, and previously there were observed the so-called photomechanical effect, i.e., the change of the plastic-flow stress [1], and the photomobility of the dislocations, i.e., the changes of the dynamic properties of the dislocations [2] upon illumination. At the instant of illumination of the deformed crystal by light with wavelength λ_F, corresponding to the maximum optical F-absorption, the electron structure of the F center changes, and this leads to additional slowing down of the moving dislocations, a fact manifest by the growth of the flow stress [1] and a decrease of the dislocation velocity [2]. The equality of the spectral characteristics of the photomechanical effect, the photomobility of the dislocations, of optical absorption, and photoconductivity in colored alkali-halide crystals demonstrates that all these phenomena should be connected with one stage, namely the transition of the F-center electron from the ground to the excited state. It is therefore important to obtain additional information concerning such an excited state, and a feature of the mechanical properties is their selective sensitivity precisely to local changes directly near the dislocation line.
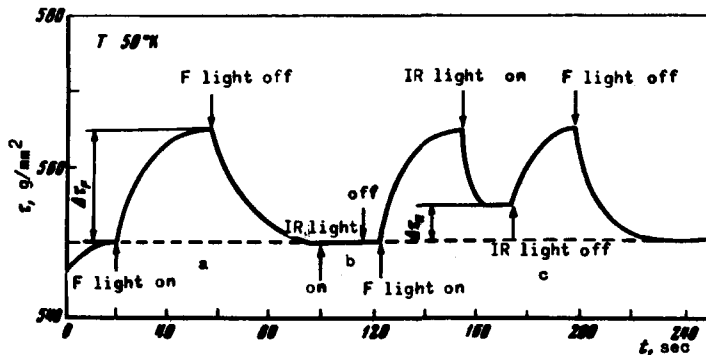
Fig. 1. Diagram of deformation with constant rate, showing a - the action of F-light (photomechanical effect), b - the action of infrared light, c - the joint action of F and infrared light (infrared quenching). The dashed line shows the "dark" deformation diagram.
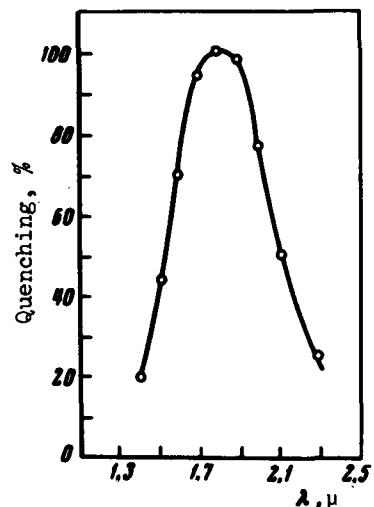
Fig. 2. Spectral characteristic of IRQ, $T = 40°K$.

We present below results that demonstrate the influence exerted on the photomechanical effect by illumination with infrared light at low temperatures ($T < 70°K$).

Samples cleaved from a NaCl crystal colored by γ irradiation, with dimensions $2 \times 3 \times 10$ mm and with F-center concentration of approximately 10^{17} cm^{-3} (these were practically the only color centers) were subjected to uniaxial compression in the <100> direction at a constant deformation rate 10^{-3} cm/min on a TT-SM testing machine with an optical cryostat. During the course of the deformation, the samples could be illuminated by xenon or tungsten lamps with a monochromator (SPM-2) or filters. The strain diagram was recorded by an automatic recorder, the time needed to run through the entire scale being less than 0.25 sec.

After deformation beyond the yield point, conditions were created for the appearance of the photomechanical effect when the sample was illuminated with light with wavelength near λ_F (F-light). The effect is characterized by a reversible change of the reduced shear stress $\Delta\tau_F$ (a in Fig. 1). Light with wavelength different from λ_F (in the range $0.2 - 2.5$ μ) exerts no influence on the strain diagram (b in Fig. 1). When the deformed sample is additionally illuminated with infrared light ($\lambda_i > 0.9$ μ, IR light) the change of the stress due to the F light decreased in reversible fashion to a value $\Delta\tau_i$ (c in Fig. 1). Such a decrease of the stress can be naturally called infrared quenching (IRQ) of the photomechanical effect. The quantity $(\Delta\tau_F - \Delta\tau_I)/\Delta\tau_F$ characterizes the IRQ.

The IRQ phenomenon was observed only at $T < 70°K$ and its magnitude depends on the temperature of the sample (it increases with decreasing T to 30°K), of the wavelength, and of the intensity of the exciting and quenching light. One can choose the intensities of the light fluxes incident on the sample in such a way that $\Delta\tau_i \simeq 0$, i.e., the IRQ reaches 100%. An example of the spectral characteristic of IRQ under these conditions is shown in Fig. 2. We see that the maximum IRQ corresponds to the IR wavelength near 1.8 μ, i.e., to a photon energy 0.7 eV, and the half-width of the IRQ spectrum amounts to about 0.24 eV.

All the characteristic times (of the rise and fall of the voltage when the F and IR light is turned on and off) lie in the range 3 - 15 sec (Fig. 1).

The presented experimental data can be explained on the basis of the following model. Under the influence of the F-light, some of the F centers go from the ground to the excited state ($F^0 \to F^*$ transition). At high temperatures, as follows from data on the photoconductivity of colored NaCl crystals, thermal ionization of the F^* centers is possible, with transition of the electrons to the conduction band. At sufficiently low temperatures (T < 70°K) the thermal ionization practically ceases [3] and an inverse transition $F^* \to F^0$ takes place (via the relaxed state). Such processes occur in the entire volume of the crystal, with the exception of region directly adjacent to the dislocations. It is assumed that the dislocation field of the deformation can give rise to a bound state of the electrons, i.e., the dislocation line can be ascribed a definite energy level (band) [4]. If the dislocation level (band) is appropriately located relative to the F^* level, the electrons can be captured by the dislocations with the F^* centers disposed along them, i.e., the dislocations play the role of "trapping centers." If the dislocations move in this case (plastic deformation), new F^* centers, falling in the region of action of the dislocation field, give up electrons, so that a gradual accumulation of charge on the dislocations takes place during the course of the deformation. Simultaneous drift of the electrons from the dislocations (for example, to an F center with formation of an F^* center), and also the possible displacement of the dislocation level (band) as it becomes filled, lead to a certain stationary value of the charge. Accordingly, a gradual increase by an amount $\Delta\tau_F$ takes place in the deceleration of the moving dislocations due to their additional electrostatic interaction with the encountered defects (principally inclusions [2]).

When the sample is additionally illuminated with infrared light, excitation of the electrons from the dislocation to the conduction band takes place (directly or with the aid of thermal activation), the steady-state dislocation charge becomes smaller, and this leads to the corresponding gradual decrease of this contribution to the deceleration, to the value $\Delta\tau_i$ (Fig. 1). Consequently, the IRQ spectrum (Fig. 2) reflects the parameters of the dislocation level (band), i.e., its approximate distance from the bottom of the conduction band (0.7 eV) and width (0.2 eV). We note that from the results of the deformation luminescence in [5] this distance was recently estimated as being equal to about 2.5 eV. To reconcile these data it is necessary to propose the existence of a whole series of dislocation levels (bands) that manifest themselves in different phenomena.

The proposed model leads to a number of consequences. In particular, in this region of temperatures following IR illumination one should expect the appearance of "dislocation" electron photoconductivity, accompanied by IRQ and dependent on the dislocation density. The nature of the IRQ in colored NaCl crystals, in accordance with this model, differs from the recently observed quenching of photoplasticity in semiconductors [6], which is attributed, like the quenching of photoconductivity, to the existence of sensitization levels in the forbidden band [7].

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INVESTIGATION OF Fe_3BO_6 BY THE NUCLEAR γ RESONANCE METHOD

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The authors of [1] recently established that the compound Fe_3BO_6 is an antiferromagnet with weak ferromagnetism. From measurements of the dependence of the magnetic moment on the temperature they determined the temperature of its transition to the paramagnetic state (508°K) and observed spin reorientation at a temperature 415°K. The crystal structure of this compound is orthorhombic and the space group is P_{nma} [2].

In the present paper we present results of investigation of Fe_3BO_6 by the method of γ resonance spectroscopy in the temperature region 77 - 545°K. The Fe_3BO_6 single crystals were grown by the method of spontaneous crystallization from a solution in the melt in the system $PbO - B_2O_3 - Fe_2O_3$. The single crystals were in the form of plates with dimensions up to 15 × 5 × 0.5 mm.
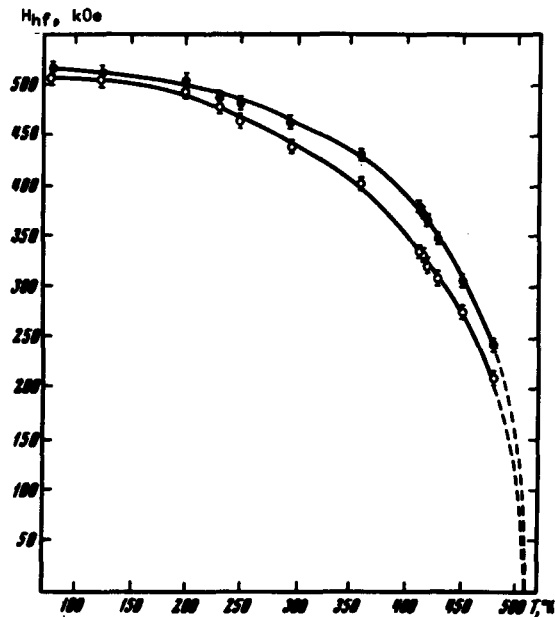

Fig. 1. Temperature dependence of the internal hyperfine magnetic field H_{hf}: o - for the ions Fe(I), o - for the ions Fe(II).

The Fe_3BO_6 crystal lattice is based on hexagonal close packing of the oxygen ions, with iron ions located in the octahedral voids and boron ions in the tetrahedral voids; it presents an alternation of layers of ions of iron and boron and of ions of oxygen along the c axis. Out of the 12 Fe^{3+} ions in the unit cell, four ions, Fe(I), have each eight magnetoactive bonds with the Fe^{3+} ions in the neighboring layers, and the remaining eight ions, Fe(II), have six bonds each.

The authors of [1] have shown, on the basis of magnetic and Mossbauer measurements on single-crystal Fe_3BO_6, that at 4.5°K the spins of the iron ions experience a reorientation from the direction [001] to [100].

The Mossbauer investigations were performed by us in a nuclear γ resonance spectrometer based on the AI-256 multichannel analyzer operating in the time regime. The absorber was powdered single-crystal Fe_3BO_6 with thickness 15 mg/cm^2 in terms of natural