of the valence band and the anisotropy of the effective mass of the electron. At the increased resolution, we succeeded in observing the doublet structure of the ground-state maxima for transitions with participation of TA and LA phonons (Fig. 3). The splitting was the same in both cases and amounted to 0.8 ± 0.1 meV. The obtained value of the splitting, although smaller than the value 1.1 meV obtained in [1, 2] still exceeds somewhat the theoretical value 0.6 meV [8]. Taking into account the observed splitting, the binding energy of the two components of the ground state of the indirect exciton amounts in accordance with our data to 3.6 ± 0.3 meV and 2.8 ± 0.3 meV. The obtained quantities are in good agreement with the theoretical values 3.5 and 2.9 meV obtained by McLean and London [8] in the effective-mass approximation.

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OBSERVATION OF VECTOR SYNCHRONISM IN GENERATION OF THE SECOND HARMONIC OF A NEODYMIUM LASER WITH SINGLE CRYSTALS OF METANITROANILINE

B.L. Davydov, M.E. Zhabotinskii, V.F. Zolin, L.G. Koreneva, and M.A. Samikhina
Institute of Radio Engineering and Electronics, USSR Academy of Sciences

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We have shown in earlier papers [1, 2] that the efficiency of generating the second harmonic of neodymium-laser radiation in powders of metanitroaniline is not lower than the efficiency for lithium-niobate powders. It was of interest to investigate the second-harmonic generation in single crystals of this compound. The single crystals were obtained by evaporating a saturated solution of metanitroaniline in acetone at room temperature. Under free-surface conditions, the crystals grow mainly in the form of elongated prisms {120}, with average dimensiond 3 × 2 × 10 mm. The dimensions of individual single crystals were of the order of 5 × 10 × 15 mm. As is well known, metanitroaniline crystals belong to rhombic syngony and space group $C_{2v}^5 = P_{ca}2_1$ [3]. The crystals have a (010) cleavage plane. When cleaved along this plane, the crystals could be used without additional polishing, but erosion due to exposure for 2 - 3 days in air made the surface of the crystal dull.

The metanitroaniline crystals are biaxial and their refractive indices n for the sodium D line are [4] $n_x = 1.687$, $n_y = 1.72 - 1.74$, and $n_z > 1.78$. We measured the dispersion of the refractive indices of the obtained crystals in the visible region of the spectrum. The measurements were made by the prism method (n_x and n_y) and by the immersion method (n_z). The accuracy of the measurements by the prism method was 0.0005 for n_x and 0.02 for n_y (owing to the inaccuracy with which the prism was cut) and 0.01 for the immersion method. The values of n for the infrared region of the spectrum were obtained by linear extrapolation of the plot of $(n - 1)\nu^2$ vs. $n - 1$, where ν is the radiation frequency. The extrapolation accuracy is $\sim$0.03. The obtained data are listed in

Refractive indices in metanitroaniline

Wavelength, nm	n_x	n_y	n_z
450	--	–	1.875
546	1,705	1,74	1,87*
590	1.685	1,725	–
656	1,67	1,71	1,86
1060	1,61*	1,65*	1,85*

The asterisks mark refractive indices obtained by extrapolation.

the table. Judging from these data, metanitroaniline can be regarded in first approximation as a negative uniaxial crystal. The condition for collinear synchronism in such a crystal should have the form $2k_e(\nu) = k_0(2\nu)$, where $k_e(\nu)$ and $k_0(2\nu)$ are respectively the wave vectors of the extraordinary ray of the first harmonic and the ordinary ray of the second harmonic. A more detailed analysis of the data in the table with the aid of diagrams [5] leads to the conclusion that collinear synchronism rather than 90° synchronism is critical in this crystal. In addition to collinear synchronism one should observe in metanitroaniline also vector synchronism [6, 7].

Metanitroaniline crystals 0.5 to 5 mm thick were irradiated perpendicular to the cleavage plane by neodymium-laser radiation, polarized along the z axis ($\vec{E}$ vector). The polarizer was an Iceland spar crystal with a diaphragm. The laser radiation power was of the order of 50 MW/cm^2. The second-harmonic generation was observed on a screen placed about 15 cm behind the metanitroaniline crystal. Besides a second-harmonic beam of moderate intensity, coinciding in direction with the laser radiation, a circular cone of second-harmonic radiation was observed, with an approximate apex angle 28°, see Fig. 1. The second-harmonic radiation was polarized perpendicular to z. The agreement between the radiation frequency in the central spot and in the cone was verified with a UM-2 monochromator. The central beam is apparently connected with the presence of conversion in the absence of synchronism, and the cone with vector synchronism. If the incident beam is polarized along x, no cone is observed. If two suitably-polarized laser first-harmonic beams are brought together at an angle ∿28° on a metanitroaniline crystal 3 mm thick with the aid of a prism and two mirrors, see, for example, [7], the picture shown in Fig. 2 is observed.

Fig. 1. Picture observed when a neodymium laser beam is incident on a metanitroaniline crystal perpendicular to the cleavage plane.

The bright spot in the region of intersection of the two weak cones indicates that the condition of vector synchronism is satisfied for the beams brought together at an angle. The coefficient of conversion of the laser radiation reaches several per cent in this case. The vector-synchronism cone in perpendicular

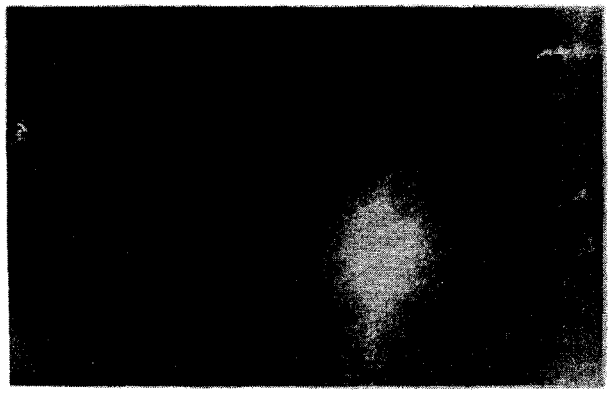

Fig. 2. Picture observed when the vector-synchronism conditions are satisfied.

incidence of the laser radiation on the metanitroaniline crystal is probably due to the presence of scattering in the crystal. No vector synchronism is observed when a plate cut perpendicular to the cleavage plane (parallel to the (001) plane of the crystal) is irradiated. When the laser radiation is focused on the crystal with a short-focus lens, the intensity of of the second-harmonic cone increases sharply, as does also its width. In this case, obviously, the number of combinations of wave vectors satisfying the vector-sychronism condition increases. The cone connected with the vector synchronism remains practically unchanged following small (up to 30°) rotations of the crystal about the x or z axis, and this is probably connected with the relatively small change of the birefringence following such rotations. The vector-synchronism angle changes very little also when the temperature of the crystal is varied from 77 to 350°K. We did not attempt to observe collinear synchronism, since the metanitroaniline crystals are easily split when the plates are cut in directions not coinciding with the cleavage plane.

Obvervations of vector synchronism were quite recently made in [7] with uniaxial ADP crystal. The experiments described by us indicate that metanitroaniline crystals are a much more convenient object for the investigation of vector synchronism.

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PENNING IONIZATION IN COLLISION OF FAST UNEXCITED Rb ATOMS WITH Ar ATOMS

Yu.F. Bydin, V.I. Ogurtsov, and V.S. Sirazetdinov
A.F. Ioffe Physico-technical Institute, USSR Academy of Sciences

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In a study of the energy spectrum of electrons emitted following single collisions of Rb atoms with Ar atoms, performed by a previously described procedure [1, 2], we observed that at an energy T = 200 eV in the laboratory system (relative approach velocity $v \sim 2 \times 10^6$ cm/sec) the spectrum contains, besides the group of slow electrons, also a clearly pronounced group with energy of approximately 7 eV. As seen from the figure, which shows the