formula $n_c = \chi_h T \cdot K / 2\mu_B^2$, taking for $\chi_h T$ the values obtained by extrapolation of the low-temperature exponential into the region of higher temperatures.

Figure 2 shows the temperature dependence of the measured conductivity σ of the single crystals (curve 1) and the mobility μ (curve 2) calculated using the concentration data obtained by the method described above ($n_c = 1.4 \times 10^{20}$ cm^{-3} at T = 300°K). The nearly exponential dependence of μ on 1/T does not demonstrate in this case a jump conductivity mechanism. The conductivity may be connected, for example, with the presence of potential barriers produced by defects in the linear conducting chain. The data at our disposal are not sufficient for a final answer to this question.

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[1] W. A. Little, Phys. Rev. 134A, 1416 (1964).
[2] W. J. Siemons, P. F. Bierstedt, and R. G. Kepler, J. Chem. Phys. 39, 3523 (1963).
[3] E. B. Yagubskii, M. L. Khidekel', I. F. Shchegolev, L. I. Buravov, and R. B. Lyubovskii, ZhOKh (J. of Org. Chem.) 992, 1968.
[4] R. G. Kepler, J. Chem. Phys. 39, 3528 (1963).
[5] L. R. Melby, Can. J. Chem. 43, 1448 (1965).
[6] T. Kondow, K. Siratori, and H. Inokuchi, J. Phys. Soc. Japan 23. 98 (1967).

OPTICAL PROPERTIES AND STIMULATED EMISSION OF Nd^{3+} IN FLUOR-APATITE

Z. M. Bruk, Yu. K. Voron'ko, G. V. Maksimova, V. V. Osiko, A. M. Prokhorov, K. F. Shpilov, and I. A. Shcherbakov
P. N. Lebedev Physics Institute, USSR Academy of Sciences
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The optical properties and the stimulated emission of the ion Nd^{3+} were investigated in a large number of crystals of simple and complex fluorides and oxides. Fluor-apatite (FA) $Ca_5(PO_4)_3F:Nd^{3+}$ is a new fluoride-oxide system containing both fluorine ions and oxygen ions. Information on the properties of FA crystals and their laser characteristics, which in certain respects are unique, are given in [1].

Crystals of this compound were recently synthesized and investigated in the Oscillation Laboratory of our institute. FA crystals, both pure and doped with Nd^{3+}, were grown from the melt by the Czochralski method from a platinum-rhodium crucible (30% Rh, 70% Pt). The initial substances where calcium orthophosphate and calcium fluoride. The crystals were grown in an atmosphere that prevented the reduction of the phosphorus or the loss of the fluorine. The linear growth rate was 9 mm/hr. We investigated the absorption and luminescence spectra of the grown crystals at 300, 77, and 4.2°K, and also the radiative lifetime τ_{rad} of the $^4F_{3/2}$ level at 300 and 77°K. The spectral measurements on the crystal with Nd^{3+} concentration 0.5% yielded the scheme of the crystalline splitting of the levels $^4I_{9/2}$, $^4F_{3/1}$, $^4F_{5/2}$, $^2H_{9/2}$, and $^4F_{7/2}$, $^4S_{3/2}$, as shown in Fig. 1. The level positions correspond to T = 77°K. The scheme constructed in accordance with our data differs somewhat from the scheme constructed in [1]. The $^4I_{9/2}$ level splits into five components, in agreement with the theory, making it unnecessary to interpret a number of levels in [1] as due to the

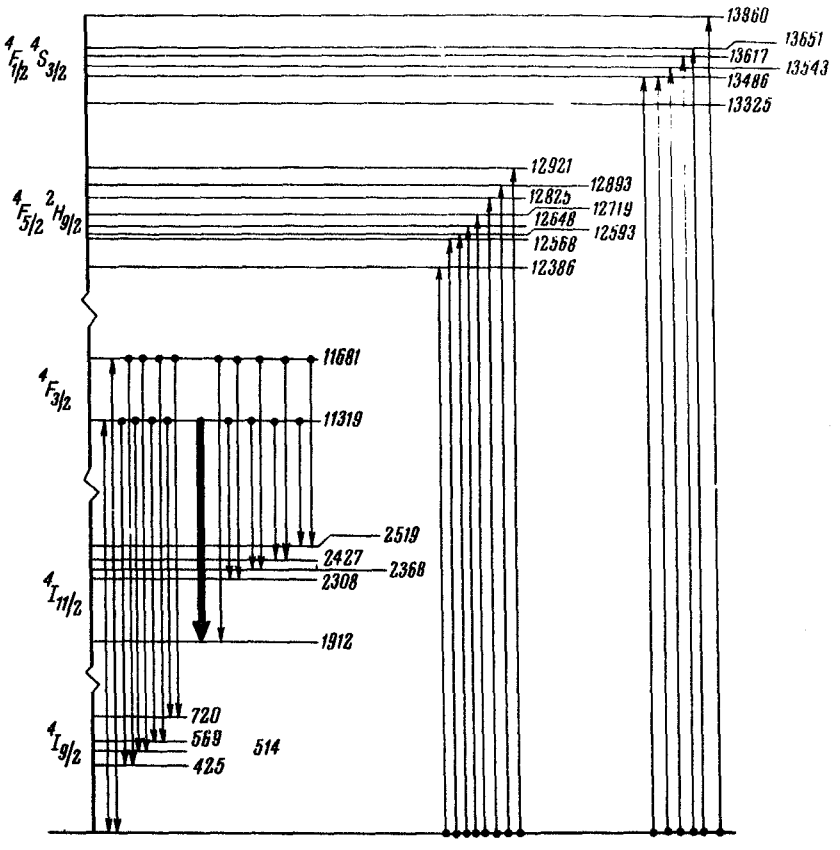

Fig. 1. Level splitting scheme in crystal FA with 0.5% Nd^{3+} (77°K)

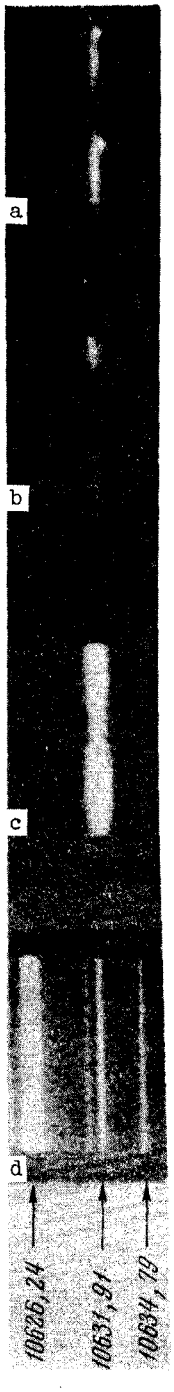

Fig. 2. Photograph of generation spectrum of FA:0.5% Nd^{3+} (300°K)

interaction of the electronic transitions with the crystal lattice. We were able to observe in the group corresponding to the $^4F_{3/2} \rightarrow {}^4I_{11/2}$ transitions only five lines instead of the six predicted by the theory. The splittings obtained by us agree in the main with the results of [1], but the absolute values of the Stark-component frequencies are somewhat higher; this can be attributed in part to the lower Nd^{3+} concentration in our crystals. Many lines of the absorption and luminescence spectra are not elementary, and are split into two closely lying components. This fact offers evidence that the Nd^{3+} is distributed among at least two center types. Measurement of the radiative lifetime of the $^4F_{3/2}$ level of the FA:0.5%Nd^{3+} yielded $\tau_{rad} \sim$ 230 msec at 300°K and 200 msec at 77°K.

Stimulated emission at 300°K in the pulsed mode was observed in the first experiments in an FA:0.5% Nd^{3+} sample 15 mm long and 3 mm in diameter, with plane-parallel faces (within

2"). The resonator consisted of external confocal dielectric mirrors (R = 500 mm) with 0.6% transmission. The generation was excited by a xenon flash lamp (IFP-800) in an elliptical cylindrical illuminator (semiaxes L_1 = 16 mm and L_2 = 14 mm). The stimulated emission was recorded with an FEU-28 photomultiplier with a silicon input filter. The signal from the photomultiplier was fed to an S-1-17 oscilloscope. The generation threshold was 5.6 J without allowance for the inequality of the lengths of the luminous column of the lamp and of the sample. With allowance for this inequality, the threshold was approximately 1 J. Under similar conditions, the threshold of a calcium tungstate crystal of comparable dimensions and optical quality was 2.4 J.

Figure 2 shows a photograph of the generation spectrum, obtained with a PGS-2 diffraction spectrograph. The reference was the set of an iron-arc lines in third order. The generation wavelength was 10631 Å and the generation line width 0.2 Å. Thus, FA:Nd^{3+} crystals have optical properties (narrow and intense luminescence line and exceptionally large level splitting) and generation parameters (low threshold and high gain) making it a promising material for continuous and pulsed lasers, and also for the investigation of the magnetic properties of the Nd^{3+} ion.

[1] R. C. Ohlman, K. B. Stenbruegge, and R. Mazelsky, J. Appl. Optics 7, 905 (1968).

MICROTRON WITH PLASMA INJECTOR

Yu. E. Kreindel', L. P. Ponomareva, M. T. Shivyrtalov, and P. M. Shchanin
Tomsk Institute of Electronics and Electronic Technology
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In modern strong-current microtrons, the injection is by means of a scheme proposed by S. P. Kapitza, wherein the electron emitter is a thermionic cathode installed near the injection aperture of the resonator [1]. A number of limitations imposed by the thermionic cathode on the capabilities of the microtron can be eliminated in principle by using a plasma injector, which ensures large density of the currents extracted from the plasma surface, is free of incandescent parts, and has little sensitivity to the gas atmosphere in the vacuum chamber.

We started up a microtron in which the electrons were injected into the accelerating resonator from the plasma of a low-pressure gas discharge localized near the injection aperture. The injection scheme, shown in the figure, is similar to that developed earlier [1], but the thermionic cathode was replaced by a Penning discharge produced in the microtron magnetic field. The electrody system of the discharge chamber consists of two cold aluminum cathodes 1 and 2, and a copper anode made up of part 3, mounted on the cover of the resonator, and the part of the cover having the injection aperture (2.8 mm diameter). To improve the discharge-chamber characteristics, the gas (air) was admitted through