For the "collision" stage of breakdown development, we can propose an appreciable influence of the photoionization of the atoms and molecules excited by electron impact, namely, the larger the radiation frequency, the more substantial its influence [8].

Further experimental and theoretical research is necessary to explain the nonmonotonic frequency dependence of the threshold breakdown in gases.

It can be assumed that to obtain more exact relative and absolute data on the frequency dependence of the threshold breakdown in gases it is necessary to perform experiments with single-spatial-mode radiation, so as to avoid the influence of the irregularity of the radiation structure of a multimode laser.

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PLASTICITY OF REACTOR-IRRADIATED LiF CRYSTALS

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We examined the possibility of simultaneously improving the strength and plastic characteristics of LiF crystals by the joint action of irradiation, mechanical loading, and cooling.

We investigated the stress-strain diagram of LiF crystals exposed to radiation and mechanical action. The samples, cleaved from one single-crystal ingot, were in the form of parallelepipeds measuring 28 × 3 × 3 mm. The samples were annealed for 8 hours at 650°C and then cooled at a rate of 0.5 deg/min (the dislocation density after annealing was 2×10^5 cm^{-2}).

The crystals were irradiated in a reactor with a dose 5×10^{14} neutron/cm^2 (in terms of thermal neutrons). The irradiation was effected at the reactor temperature and at 120°K. When irradiated in the reactor, some of the crystals were subjected to transverse compression [1] (stress 250 g/mm^2 in the plastic deformation region). The compression was by means of a spring, the elastic properties of which remained unchanged under irradiation in the employed dose interval. The mechanical load remained applied for two months (the time of decrease of activity).

The stress-strain diagram was registered with a DRP two-coordinate potentiometer.

LiF	Control crystals		Crystals irradiated in reactor, 5×10^{14} neut/cm^2			
			at reactor temperature		at 120°K	
	1	2	3	4	5	6
	Mechanical load, g/mm^2					
	0	250	0	250	0	250
Ultimate strength, g/mm^2	460 ± 15	490 ± 15	1900±210	900 ± 100	2100±40	1000±110
Deformation limit, %	0,37±0,04	0,60±0.05	0,20 ±0,09	1.20±0,30	0,37±0,02	1.20±0,15

1. As seen from the table (which lists data obtained by averaging the measurement results for 6 - 10 samples), irradiation of crystals in the reactor, both at the reactor temperature and at low temperatures, greatly strengthened the crystal (by approximately four times) (table, columns 3 and 5). The crystal fails without reaching the plastic region (Fig. 1, curve 3). This fact can be easily explained: The point defects resulting from the irradiation pin the dislocations so strongly that the applied stress is insufficient to move it.

This conclusion is confirmed by our measurements of the electric resistance R. As seen from Fig. 2, R of the non-irradiated crystal decreases in the elastic deformation region. We propose the following mechanism to explain this effect: with increasing elastic deformation, the dislocations bend relative to the cloud of point defects surrounding the dislocation. This disturbs the equilibrium between the cloud and the dislocation, as a result of which some of the vacancies are released from the cloud under the influence of the applied electric field and participate in the conductivity. The more the dislocation is bent, the larger the fraction of released vacancies. In other words, the larger the strain, the larger the decrease of the resistance.

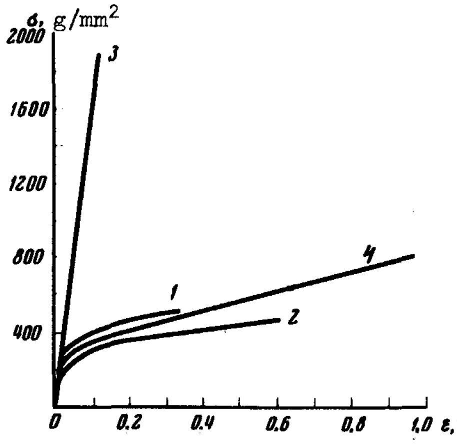

Fig. 1. Stress-strain diagrams of LiF crystals: 1 - control sample; 2 - loaded four months (250 g/mm^2); 3 - irradiated in reactor (5×10^{14} neutron/cm^2); 4 - irradiated in reactor (5×10^{14} neutron/cm^2) in a mechanically loaded state (250 g/mm^2). Kept under load two months after the irradiation.

The electric resistance R of a similar crystal but not irradiated in the reactor remains constant during the course of the deformation, up to the failure of the crystal (Fig. 3). This indicates that after the irradiation the dislocations are so strongly pinned that they are incapable not only of moving in the crystal (there is no plastic deformation region), but also of bending in the cloud of point defects.

Whereas irradiation in the free, unloaded state ensures a strengthening by a factor of 4, irradiation (only several minutes at a differential flux 3.2×10^{12} neutron/cm^{2}sec) of a crystal stressed in the plastic region is strengthened

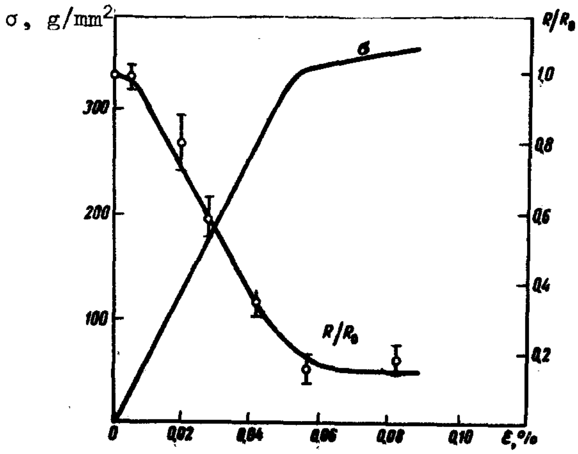

Fig. 2

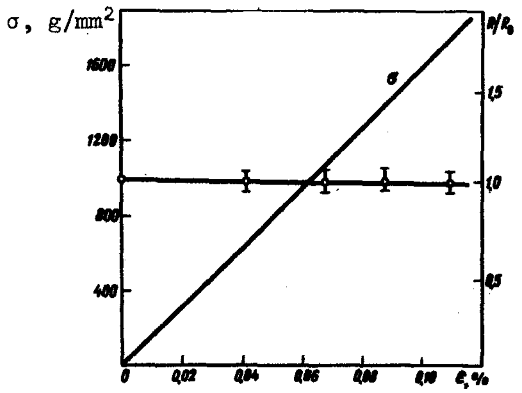

Fig. 3

Fig. 2. Stress-strain diagram (σ) and dependence of the electric resistivity (R/R_0) on the deformation of the LiF crystal.

Fig. 3. Stress-strain diagram (σ) and dependence of the electric resistivity (R/R_0) on the deformation of an irradiated (5×10^{14} neutron/cm^2) LiF crystal.

only by a factor of 2 compared with the non-irradiated crystal (table, columns 4 and 6).

2. J. Gilman and W. Johnston [2] have shown that LiF crystals pre-stressed in the plastic region have a larger yield point than crystals not subjected to stress. Our measurements confirm this conclusion, but with a stipulation. Prior mechanical loading actually leads to an increase in the yield point, but only if the sample is under load for a short time (say, one-half hour). If the sample is kept under load for a long time (four months), the yield point decreases and the limiting strain increases (Fig. 1, curves 1 and 2).

Thus, the duration of the preliminary mechanical loading in the plastic region is of great importance when it comes to changing the strength and plasticity of crystals. The crystal becomes stronger following a relatively brief loading, but prolonged loading makes the crystal more plastic.

3. As shown above, a prolonged stress on the crystal in the plastic region leads to an improvement of its plastic properties. One could expect irradiation of stressed crystals to enhance this effect (it is known that irradiation of such fissioning material as U accelerates the creep [3]).

Actually, the experiments have shown that a combination of mechanical loading and irradiation leads to a stronger growth of the limiting strain than in the case when only mechanical loading is applied. Mechanical loading alone (several months) increases the limiting strain by 60% (table, columns 1 and 2). Reactor irradiation of the crystals alone leads to worse plastic properties (Fig. 1, curves 1 and 3). Joint action of mechanical loading and irradiation (for only several minutes) increases the limiting strain by three times and the ultimate strength by two times (table, columns 4 and 6).

Thus, the joint action of radiation and mechanical loading strengthens crystal and at the same time greatly improves their plastic characteristics.

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RESONATORLESS PARAMETRIC LIGHT GENERATOR USING AN α-HIO₃ CRYSTAL

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We obtained generation in a resonatorless parametric light generator. The coefficient of conversion of the pump radiation energy into parametric waves that are smoothly adjustable in frequency in the range 1 - 1.10 μ was 57%. We measured the dynamics of the generation development. The width of the output radiation spectrum was 0.2 cm^{-1}.

Until recently, parametric generation of light was realized in schemes using a resonator for at least one of the parametric waves. In [1], an attempt was made to observe parametric generation in accordance with the traveling-wave scheme, but the gain turned out to be insufficient to obtain generation in the strictly-traveling-wave regime. Interest in resonatorless schemes of parametric light generation (PLG) is due mainly to the fact that in such generators the frequency variation is smooth, whereas in parametric generation of light with resonators it occurs jumpwise, owing to the mode character of the resonator radiation. Besides the traveling-wave PLG considered in [1], a resonatorless scheme of PLG can be realized by using feedback [2], and also by means of the scheme proposed in [3]. In resonatorless PLG the parametric frequencies are determined only by the resonant properties of the parametric gain lines. This makes it possible to obtain narrow emission lines coupled to the center of the gain line, regardless of the stability of the geometric dimensions of the system. The latter is of interest in connection with the fact that the frequency stability of PLG can be higher than the stability of the pump frequency [4].

A distinguishing feature of resonatorless PLG is the high threshold pump power, so that experimental realization calls for the use of highly efficient nonlinear crystals [5]. In our experiment we used an α-HIO₃ crystal with length $\ell = 2.3$ cm, cut for an $e_p - e_s o_i$ interaction (the subscripts p, s, and i pertain to the pump, signal, and idle waves, respectively). Such an interaction has enabled us to use collinear propagation of the parametrically coupled waves, for which the threshold pump powers are minimal, unlike the vector interaction considered in [3]. The experimental setup is shown in Fig. 1. The resonator-

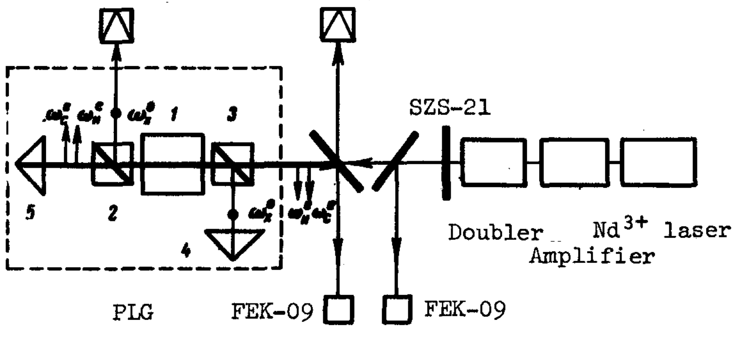

Fig. 1. Block diagram of resonatorless PLG: 1 - α-HIO₃ crystal 2.3 cm long; 2, 3 - Glan prism; 4, 5 - glass prisms.