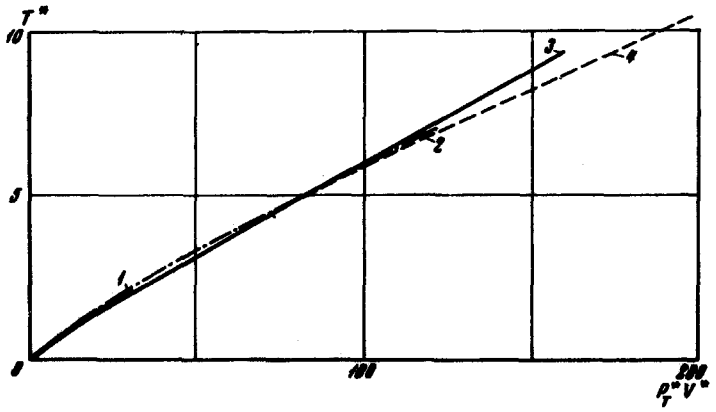

Reduced temperature $T^* = T/T_{cr}$ vs. the reduced product $P_T^*V^* = P_TV/P_{cr}V_{cr}$ for metals in the shock-compression state. P_{cr}, T_{cr}, V_{cr} - pressure, temperature, and specific volume at the critical point. 1 - Li, 2 - Sn, 3 - Na, 4 - K.

under shock compression, bearing in mind that if the reduced products $P^*_TV^* = P_TV/P_{cr}V_{cr}$ are equal for two states, the reduced temperature $T^* = T/T_{cr}$ will also be equal.

Unfortunately, it is impossible to verify the validity of this premise for other metals for which there are no complete sets of data, both with respect to the parameters of the state at the critical point, on the one hand, and with respect to the parameters of the state of shock compression, on the other. It is evidently highly desirable to obtain such data either by calculation or by experiment.

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EMISSION STIMULATED BY EXPLOSION OF HN_3 IN CO_2

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The possibility of obtaining inverted population by transfer of energy from "hot" molecules to cold ones was discussed in [1, 2]. It was noted in [1] that "hot" molecules can be obtained during the course of chemical exothermal reactions. The molecule pair (N_2, CO_2) is one of the best for the realization of this idea, since the effective transfer of excitation from the vibrationally excited N_2 to the CO_2 has been demonstrated by the development of a powerful high-efficiency laser excited by a discharge in an $N_2 + CO_2$ mixture [3]. To obtain "hot" molecules, we used the exothermal reaction of decomposition of the molecule HN_3, in which nitrogen molecules are produced in excited vibrational states [4]. The decomposition (explosion) of HN_3 was effected in an $HN_3 + CO_2$

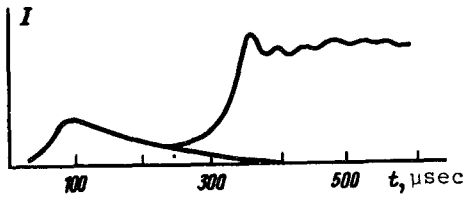

Fig. 1

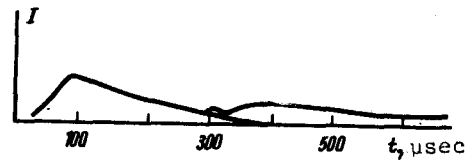

Fig. 2

mixture in a quartz tube of 30 mm diameter and 1.5 m length. The resonator was made up of gold-coated mirrors. The energy was extracted through a 1.5 mm hole in the mirror. The HN_3 was produced directly in the setup, in a special section, from the reaction between sodium azide and sulfuric acid, followed by purification. The emission was recorded by a cooled photoresistor made of germanium doped with zinc. The decomposition of the HN_3 was triggered by light from a xenon lamp. The emission signal, an oscillogram of which is shown in Fig. 1, was registered at a wavelength $\lambda > 7\mu$. The signal disappeared completely when the mirrors were misaligned. As a control experiment, the HN_3 was exploded in the absence of CO_2. The corresponding oscillogram is shown in Fig. 2. The weak glow seen in these experiments 300 μsec after the lamp is turned on is apparently the luminescence of the vibrationally-excited HN radical, which is the intermediate product of the decomposition of HN_3.

According to [4], the decomposition of HN_3 is branched reaction with the following scheme:

1. $HN_3 + h\nu \rightarrow HN + N_2$ (triggering),
2. $HN + HN_3 \rightarrow H_2 + N_2^+$,
3. $N_2^* + \alpha HN_3 \rightarrow N_2 + \alpha HN + \alpha N_2$ (branching).

In the presence of CO_2, the exciting nitrogen transfers its energy to the CO_2 molecule, owing to the quasiresonance between the vibrational levels of the nitrogen and the (00^01) vibrational mode of CO_2.

4. $N_{2*}^* + \beta CO_2 \rightarrow \beta CO_2^{*2}(00^01) + N_2$
5. $CO^*(00^01) + n h\nu_0 \rightarrow (n+1)\, h\nu_0 + CO_2(10^00)$ - generation, n - number of photons at generation frequency ν_0,
6. $CO^*_2 + (00^01) + M \rightarrow CO_2 + M$ - relaxation of excited state,
7. $CO_2(10^00) + M \rightarrow CO_2 + M$ - relaxation of lower working level,
8. Emergence of photons from the resonator.

It is easy to set up and analyze kinetic equations corresponding to processes 1 - 8. The analysis shows that it is impossible to explain the experimentally observed pulsations of the output emission due to the explosion of the mixture of HN_3 and CO_2 without taking into account the stimulated transition (generation). At the same time, introduction of the stimulated transitions (process 5) explains in a natural manner these pulsations, which are a characteristic feature of the transient processes occurring in a laser whose active

medium has a relaxation time shorter than the photon lifetime in the resonator. The absence of a signal when the mirrors are misaligned, as well as the pulsation regime, are sufficiently convincing evidence favoring the generation regime.

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INFLUENCE OF INTERACTION OF HOT ELECTRONS WITH QUASIDISCRETE LEVELS ON THE CURRENT-VOLTAGE CHARACTERISTIC OF A SEMICONDUCTOR

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It was shown in [1] that shallow donor impurities in semiconductors have quasidiscrete levels connected with the higher valleys. These levels were observed experimentally [2, 3]. If the energy of such levels relative to the bottom of the main valley is $\varepsilon_d \gg T_0$ (T_0 is the lattice temperature), then as the conduction electrons become heated by the electric field E, their density is reduced as a result of capture by these levels; this can lead to negative differential resistance (NDR).

The current-voltage characteristic is determined by the well known expression:

$$\vec{j} = e n_e \langle \vec{v} f_{\vec{k}} \rangle , \tag{1}$$

where the symbol $\langle\ \rangle$ denotes summation over all the quasimomenta k. The distribution function $f_{\vec{k}}$ is obtained from the system of kinetic equations[1)]

$$\partial f/\partial t + e\vec{E}\ \partial f/\partial \vec{p} = I_{11}(f) + I_{12}(f, n_d), \tag{2}$$

$$\partial n_d/\partial t = \rho_d \langle f_{\vec{k}} W_{kd} \rangle - n_d \langle W_{kd} \rangle , \tag{3}$$

$$\langle f_{\vec{k}} \rangle + n_d = N_e . \tag{4}$$

Here I_{11} is the collision integral, describing the intravalley scattering, I_{12} describes the interaction of the conduction electrons with the quasidiscrete levels, ρ_d is the density of the quasidiscrete levels, n_d is the density of the electrons on these levels, and W_{kd} and W_{dk} are respectively the probabilities of transition of the electron from the state with quasimomentum $\vec{k}$ to the quasidiscrete level and vice versa. The time ratio $\tau/\tau_{dk} \sim I_{12}/I_{11}$ can be used as the small parameter in the solution of the kinetic equations. In the zeroth approximation in this parameter, in the stationary case, the distribution function is determined from (2) accurate to a constant. We assume that the frequency of the electron-electron collisions is sufficiently high, so that the symmetrical part of

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1) These equations are valid when $\tau \ll \tau_{dk}$ (τ and τ_{dk} are respectively the times of intravalley scattering and of the transition between the quasidiscrete levels and the main valley). Since $\tau \sim 10^{-13} - 10^{-14}$ sec and, according to our calculations, $\tau_{dk} \sim 10^{-11}$ sec, this condition is satisfied.