agreement with the theoretical estimates of the over-the-barrier reflection, given in [1].

Generally speaking, the system of layers perpendicular to the current is not static in an uncompensated metal, and moves along the current direction in pure indium [4, 5]. Such a motion, however, should not lead to a change of the sample resistance [4]; indeed, the stopping of the layers on going from T = 2.12° to T = 2.8° does not lead to a change of the transition curves.

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EXPERIMENTAL INVESTIGATION OF THE APPEARANCE OF SCREENING IN LEAD AND ALUMINUM VAPOR

Ya.N. Gnoevoi, A.I. Petrukhin, Yu.E. Pleshanov, and V.A. Sulyaev
O.Yu. Shmidt Earth Physics Institute, USSR Academy of Sciences
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Evaporation of matter under the influence of laser radiation can occur in two essentially different modes. In the first, the vapor has a temperature close to the phase-transition temperature, is weakly ionized, and is practically transparent to the incident radiation (evaporation wave without screening of the evaporating surface [1 - 3]). In the other the vapor is heated to much higher temperatures, it is strongly ionized, and absorbs the incident radiation completely (the surface is screened [4 - 6]). Since the distribution of the parameters in the vapor layer, the laws governing the time variation of these parameters, and the most characteristic values of the parameters (temperature, velocity, etc.) are essentially different in these two modes, it is of interest to determine the conditions for the transition from one mode to the other.

A theoretical analysis of the conditions under which the screening takes place [7] entails considerable difficulties, connected with the nonstationary character of the phenomenon and the lack of detailed information on the optical properties of heated vapor and on the evaporation mechanism. Most experimental investigations were devoted to evaporation without screening [1, 3] or to evaporation with developed screening [5]. There was no detailed investigations of the transition mode.

We have measured certain parameters of the transition mode of evaporation of lead and aluminum under the influence of radiation from a ruby laser. The laser consisted of a Q-switched master generator and an amplifier. To ensure uniform illumination over the entire affected target area, a ground-glass plate was placed ahead of the input face of the amplifier crystal. The output face of the amplifying crystal was projected with the aid of a lens on the surface of the target. Special measurements have shown that the inhomogeneity of the area illumination did not exceed 20%. The radiation pulse from the laser was bell-shaped and its duration at the half-power level was 30 - 40 nsec. The laser pulse energy could be varied in a wide range with the aid of absorbing

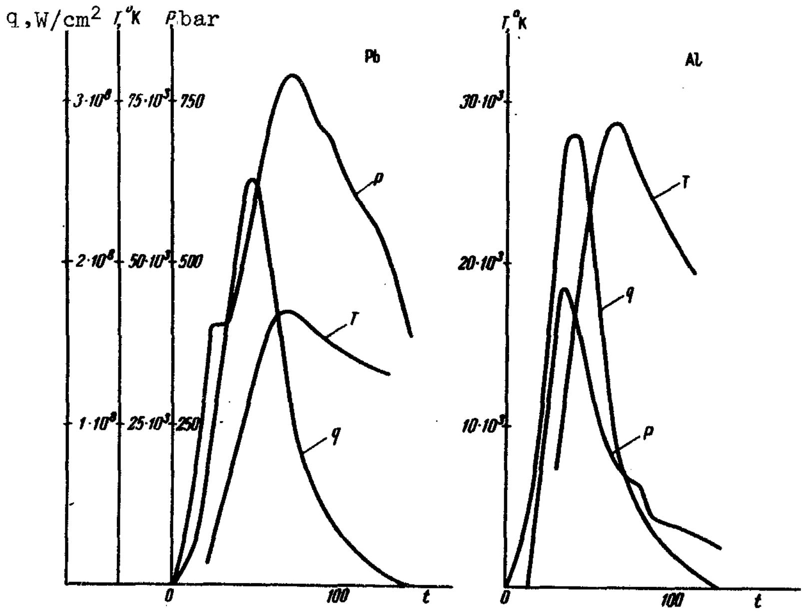

Fig. 1

filters and by varying the pump level of the amplifying crystal. The diameter of the irradiated spot was 10 and 3.5 mm. The maximum surface energy density reached 15 J/cm^2. During the time of action of the laser pulse, the spreading of the evaporation products retained a planar geometry at the employed spot dimensions.

In each experiment, we measured simultaneously the form and the total energy of the laser pulse, the brightness temperature, and the pressure on the surface of the target. The pulse waveform was registered with the aid of a coaxial photocell. The brightness temperature was measured by a photoelectric procedure in the wavelength interval 4000 - 5000 Å. The pressure was measured by determining the entry of the compression wave in a barium-titanate piezoelectric element [8, 9].

Such a method of measuring the pressure ensured a time resolution of 3×10^{-9} sec. The laser pulse waveform and brightness-temperature registration channels had time resolutions on the order of 10^{-9} sec. A special synchronization circuit for the recording oscilloscopes made it possible to align the plots of the laser-pulse waveforms and of the brightness temperature with accuracy $\pm 2 \times 10^{-9}$ sec.

Figure 1 shows the time-aligned oscillograms, recalculated to absolute values, of the laser radiation flux q, the temperature T, and the pressure P, for targets made of lead and aluminum at the maximum laser radiation fluxes attained in these experiments. At lower fluxes, the character of the curves remains approximately the same. The pressure at the initial sections of the curves is proportional to q. For aluminum, this dependence was maintained on the increasing sections of the pressure curves in all the experiments. For lead, the proportionality was maintained up to pressures on the order of 500 bar. With further increase, the pressure curve follows the temperature curve.

The temperature maximum was reached at the end of the laser pulse, upon release of 80 - 90% of the total pulse energy, approximately 6×10^{-8} seconds after the start of the laser pulse. A rapid temperature rise set in after a certain time following the start of the laser pulse, and this delay increased with decreasing pulse energy. If the pulse surface energy density was lower than 1 J/cm^2 for lead and 4 J/cm^2 for aluminum, then the target surface was not heated to the temperature registered by the employed procedure (6000°K).

Figure 2 shows plots of the maxima of the temperature curves for individual experiments, as functions of the surface energy density on the target at the instants when these maxima were reached. The temperature curves ahead of the maxima, obtained in each experiment, agree well with these plots. The dashed lines show the target surface temperature calculated from the heat-conduction equation.

Under the experimental conditions, the surface brightness temperatures reached 46,000°K for lead and 30,000° for aluminum. It is clear that these are the temperatures of the evaporated target material, and to become heated to this degree, the vapor must absorb appreciably the incident laser radiation, i.e., an evaporation regime with screening is observed. The start of the rapid heating lies in the region $\sim$1.5 J/cm^2 for lead and $\sim$4.5 J/cm^2 for aluminum. These values of the surface energy density, at which $T = 10^4$ °K, can apparently be regarded as the limit of occurrence of screening under the conditions of the experiment.

Thus, at medium laser-radiation fluxes $\sim$2.4 mW/cm^2 for lead and $\sim$7.5 mW/cm^2 for aluminum, screening sets in within 6×10^{-8} sec, and even earlier at larger fluxes.

We note that in theoretical estimates of the conditions for the occurrance of screening it is necessary to take into account the time necessary to heat the target surface to the phase-transition temperature, since in our experiments, as shown by estimates based on the heat-conduction equation, it amounts to a large fraction of the delay time.

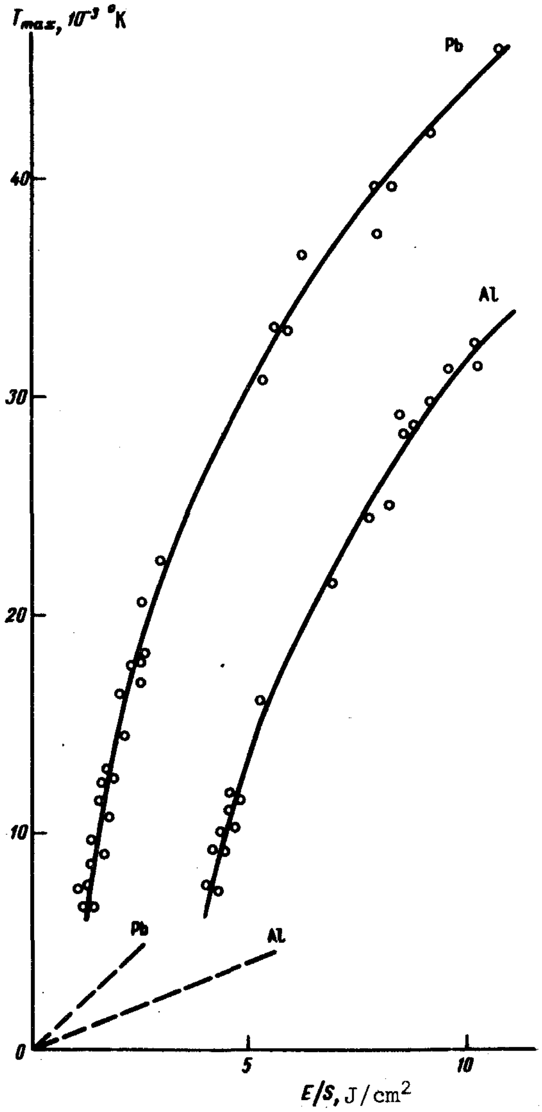

Fig. 2

We are grateful to I.V. Nemchinov for valuable discussion and for providing theoretical estimates of the screening development; these served as the stimulus for our experiments.

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STANDING PATTERN OF SELF-FOCUSING POINTS OF LASER RADIATION IN GLASS

N.I. Lipatov, A.A. Manenkov, and A.M. Prokhorov
P.N. Lebedev Physics Institute, USSR Academy of Sciences
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A large number of theoretical and experimental investigations (see the reviews [1]) have been devoted by now to the phenomenon of self-focusing in various media. The most studies were devoted to self-focusing in liquids, for which interesting results have been obtained recently [2 - 3], leading to definite conclusion concerning the multifocus model [4] of this phenomenon. For solid transparent dielectrics, however, in spite of the large number of investigations, the mechanisms and processes of self-focusing remain unclear.

We have investigated the self-focusing of laser radiation in glasses and observed a fundamentally new picture of the phenomenon, namely a standing pattern of focal points. This was obtained by using in the experiment a rectangular light pulse, making it possible to compare most readily the experimental results with the theoretical self-focusing models. In all the preceding investigations of self-focusing, the experiments were performed with bell-shaped pulses having a smooth time variation of the power, thereby making it difficult to obtain an unambiguous interpretation of the results on the basis of some theoretical model of this phenomenon. Thus, the filamentary faults observed in different transparent dielectrics by various investigators, and induced by laser radiation, were explained as being due either to the waveguide character of the propagation of the high-power radiation in the nonlinear medium [6], or to the motion of the self-focusing region during the course of time variation of the laser-pulse power [7].

The self-focusing regions can have different structures (waveguide, a series of focal points on the beam axis, etc.). This structure can be resolved, and the validity of some particular self-focusing model can thereby be confirmed, by observing the stationary self-focusing pattern at a time-constant power of the radiation incident on the linear medium. These were precisely the conditions realized in our experiments, in which we used rectangular light pulses.

The master generator employed was a single-mode Q-switched ruby laser. A Pockels cell was used to cut from the bell-shaped pulse of this generator a square-wave pulse of 20 nsec duration, with rise and fall times $\sim$2 nsec and with a top flat to $\sim$4%. This square-wave pulse was focused with a lens (F = 12 cm) inside a sample of Tf-105 lead glass 19 cm long.

During the course of the experiment, we registered simultaneously on the oscilloscope the pulses incident on the sample and the pulse passing through it, and also photographed the glass specimen from the side at the instant of passage of the radiation through it.