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No. 82

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UDC 534.26

RADIATION OF SOUND BY COAXIAL CYLINDRICAL SHELLS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 28, No 4, Jul-Aug 82
(manuscript received 12 Dec 80) pp 470-473

VOVK, I. V.

[Abstract] Two thin coaxial cylindrical shells are considered, both infinitely long, separated by a periodic array of acoustically soft annular barriers and a fluid filling the spaces between these barriers. Inside the inner shell is vacuum, outside the outer shell is an ambient fluid with a characteristic impendance different from that of the fluid separating the shells. Radiation of sound by the outer shell vibrating uniformly under uniform external pressure is analyzed on the basis of equivalent series and parallel mechanical impedance circuits. The resonance frequency of the outer shell is found to depend on the inner shell and the fluid between shells, decreasing as the thickness of the inner shell and that of the separating fluid layer are decreased. Figures 3, references 4 Russian.
[238-2415]

UDC 534.222

COHERENT EFFECTS DURING BACKSCATTERING OF SOUND BY BODIES NEAR WAVY SEA SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 28, No 4, Jul-Aug 82
(manuscript received 29 Apr 81) pp 438-440

AKHUNOV, Kh. G., Moscow State Pedagogical Institute imeni V. I. Lenin, and KRAVTSOV, Yu. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Coherent effect are analyzed that accompany backscattering of sound by a particle or bubble under a wavy sea surface and that amplify the scattered signal. With underwater transmitter and receiver at the same

location, there are four paths of sound rays to be considered: transmitter-scatterer-receiver, transmitter-surface-scatterer-receiver, transmitter-scatterer-surface-receiver, and transmitter-surface-scatterer-surface-receiver. The resultant signal intensity measurable at the receiver is calculated taking into account wave motion of the water surface and assuming a unity 100% reflectance. The condition is also established for transition of the two "cross channels" (with reflection of only forward rays and only return rays, respectively, by the surface) from coherent to noncoherent ones, when amplification due to their addition reduces from fourfold to twofold. A numerical example, with transmitter and receiver at same depth as scatterer, illustrates the dependence of path difference and correlation retention time on length and height as well as vertical velocity of the dominant water wave. Figure 1, references 3 Russian.
[238-2415]

UDC 534.21

ATTENUATION OF LOW-FREQUENCY SOUND IN TURBULENT MEDIUM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 28, No 4, Jul-Aug 82
(manuscript received 23 Dec 80) pp 521-522

KUZNETSOV, V. P., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences

[Abstract] Attenuation of sound in a turbulent medium is analyzed, taking into account energy transfer between potential flow mode and vortical flow mode through "vortex-sound" and "sound-sound" as well as "vortex-vortex" interactions. The total velocity field is expressed as the sum of the potential mode and the vortical mode, the corresponding equation of motion is linearized and approximated by omission of insignificant terms, then solved for low values of the Reynolds number. A subsequent Fourier transformation and application of the "mean field" method yield the dispersion equation for the coherent part of the wave field. This equation indicates that in a homogeneous and isotropic medium with small-scale turbulence there occurs additional absorption of sound that does not depend on the frequency of sound. References 2: 1 Russian, 1 Western.
[238-2415]

UDC 621.315.592

ACOUSTOCONCENTRATION EFFECT PRODUCED WITH VOLUME ACOUSTIC WAVES

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 6, Jun 82
(manuscript received 29 Jul 81, final edition received 14 Dec 81) pp 1075-1077

TIMAN, B. L., KOMAR', V. K. and SELEGENEV, Ye. M.

[Abstract] The theoretically predicted acoustoconcentration effect produced in an open semiconductor crystal by passage of an ultrasonic wave has been confirmed experimentally in a CdS crystal. The dependence of this effect, namely of the gradient of electron and hole concentrations (maximum deviation from equilibrium concentrations occurring at the crystal faces), on the resistance of the crystal was determined as well as the dependence of the amplification of surface acoustic waves on the magnitude of this effect. In the experiment a = yayev-Gul-Bluestein wave was excited at the crystal surface and amplified by means of an electric drift field. Transverse acoustic pumping was found to change the SAW gain, decreasing or increasing it depending on the resistance of the surface layer ($2 \cdot 10^3$ ohms and $6 \cdot 10^3$ ohms respectively), as a result of interaction of a propagating acoustic noise pulse with conduction electrons in the crystal (resistivity $\rho \simeq 10^4$ $ohm^{-1} \cdot cm^{-1}$) and consequent redistribution of charge carrier concentrations with an exponential rise in the direction of noise propagation. At the point of maximum SAW gain, corresponding to a surface layer with a resistance of $3.5 \cdot 10^4$ ohms acoustic pumping does not significantly change the SAW gain. The acoustic noise in this experiment covered a wide frequency range, from tens to hundreds of megahertz, so that the acoustoconcentration effect decreased monotonically with increasing crystal resistance. An analogous experiment with coherent sound pumping a quartz transducer with resonance frequency of 32 MHz yielded similar results but a weaker acoustoconcentration effect. Figures 4, references 2: 1 Russian, 1 Western.
[237-2415]

UDC 621.378.9:681.327

EFFECT OF GAMMA RADIATION ON SOME PROPERTIES OF GLASSY CHALCOGENIDE SEMICONDUCTORS

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 3, May-Jun 82 (manuscript received 25 Feb 81) pp 37-39

AZAMATOV, Z. T., GULANYAN, E., KIM, V. M., SADYKOVA, Sh. Z. and KADYROVA, D. R., Order of Labor Red Banner Institute of Cybernetics with Computer Center, UzSSR Academy of Sciences

[Abstract] An experimental study was made to determine irreversible changes caused by γ-radiation in optical properties of thin films of glassy chalocogenide semiconductors used for holographic data recording and storage. The test equipment included an LG 38 helium-neon laser (λ = 0.63 μm), a cubic light splitting prism, two plane mirrors, one semitransparent plate, two diaphragms, two neutal filters, two photoreceivers, three shutters and two potentiometer-type recording instruments. Holograms in the form of diffraction gratings were produced by interference of the two light beams coming from the splitter prism. By opening and closing appropriate shutters, the two potentiometers were made to measure the intensities of both recording light beams, to measure the diffraction efficiency (intensities of incident and diffracted beams), and to measure the transmission coefficient (intensities of incident and transmitted beams) respectively. Specimens of As_7Se_3 and $As_{60}Se_{40}$ films vacuum-deposited on glass and sapphire substrates were held in aluminum capsules and exposed to γ-radiation from a ^{60}Co source in doses up to 10^9R. The results indicate that γ-radiation does not significantly affect the holographic characteristics of chalcogenide films but causes the transmittivity of optical glass and sapphire substrates to decrease very appreciably, from about 0.9 to below 0.1, with opacity saturating at 10^4-10^7 R. Figures 2, reference 1 Russian.
[247-2415]

UDC 621.315.592

SURFACE RECOMBINATION WAVES IN SILICON

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 6, Jun 82 (manuscript received 27 May 81, final edition received 9 Nov 81) pp 1102-1104

GULE, Ye. G. and KLIMOVSKAYA, A. I., Institute of Semiconductors, UkSSR Academy of Sciences, Kiev

[Abstract] Oscillations have been detected in n-type and p-type silicon that depend on film thickness, film temperature, and excitation mode (constant current or constant voltage). A mechanism of this instability has also been proposed that involves not volume but surface recombination waves produced by exchange of charges of surface states and in which the space charge field plays an important role. Experiments were performed with thin silicon films with free charge carrier concentrations within the 10^{15}-10^{16} cm^{-3} range and with the temperature varied from room to 77 K. In these experiments the authors determined the current-voltage characteristics, and the oscillation waveforms depending on the excitation mode, also the dependence of the pulse repetition rate on the pulse amplitude and the excitation current or voltage. The results reveal that the instability depends on the film thickness within the order of magnitude of the Debye shielding length (0.5 μm), ceasing in films thicker than 40 μm, and on the curvature of energy bands at the surface. The oscillation frequencies are comparable with frequencies of exchange of free charge carriers of surface states (100 kHz) and vary linearly with the excitation current or voltage. Figures 2, references 8: 7 Russian, 1 Western.
[237-2415]

UDC 621.315.592

ION IMPLANTATION OF IMPURITIES INTO n-$Hg_{0.8}Cd_{0.2}Te$, PART 2: GROUP-III Al^+, Ga^+ IONS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 6, Jun 82 (manuscript received 20 Apr 81) pp 972-977

VODOP'YANOV, L. K., KOZYREV, S. P. and SPITSYN, A. V., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Experimental studies have revealed that the electrical properties of n-$Hg_{0.8}CD_{0.2}Te$ are changed much more by implanation of group-III ions (Al^+,Ga^+) than by implanation of group-II ions (Mg, Zn^+, Cd^+). Crystals of this material with an electron concentration $n < 10^{16}$ cm^{-3} at 85 K were bombarded with 150 keV Al^+ ions or 300 keV Ga^+ ions. The infrared reflection spectra of this material with various ion implantation layers were measured before and after annealing. The data were then processed by the method of

varying the dispersion parameters in the "damped oscillator" model. The resultant dependence of electron concentrations in the surface layer and in the substrate on the implantation dose follows different trends immediately after implantation and then after annealing, which indicates also atomic diffusion and not only radiative defects plays a substantial role in the process. The authors thank L. V. Keldysh for discussing the results.
Figures 6, table 1, references 7: 3 Russian, 4 Western.
[237-2415]

UDC 621.382

CHANGE IN STRUCTURE AND IN PHYSICAL PROPERTIES OF SEMICONDUCTORS DUE TO PULSING LASER RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1090-1096

KIYAK, S. G., Institute of Application Problems in Mechanics and Mathematics, UkSSR Academy of Sciences

[Abstract] Recrystallization of semiconductors from the liquid phase after local heating and melting of crystals by a pulse laser is examined on the basis of studies that deal with the epitaxial crystallization process. Changes in structure and in electrophysical properties, essentially manifested in redistribution of impurities and intrinsic defects as well as in type of conductivity and in some cases formation of photosensitive n-p junctions, have been established experimentally in $Pb_{1-x}Sn_xTe$, $Pb_{1-y}Sn_ySe$, $Cd\ Hg_{1-z}Te$, InSb, PbSe, CdSb and CdTe. According to results of examination under an electron microscope with resolutions down to 10 Å, melt recrystallization at the anomalously high rates of 3-4 m/s produces layers without line defects but only as far down as the liquid phase has advanced. Full electrical activation of impurities is attainable during laser doping and annealing processes, with the solubility of dopant elements exceeding the equilibrium limit of solubility for impurities in the solid phase by 1-2 orders of magnitude. Laser treatment of semiconductor materials, especially wideband ones, can be intensified and optimized by action of two lasers with different spectral and energy characteristics, either pulsed of CW, inasmuch as the coefficient of light absorption by excess charge carriers is proportional to the wavelength squared, also by proper selection of process temperatures.
Figures 2, table 1, references 41: 28 Russian, 13 Western.
[232-2415]

UDC 621.315.592

FORMATION AND BUILDUP OF STRUCTURAL DEFECTS IN CdS CRYSTALS UNDER LASER RADIATION AND THEIR EFFECT ON OPTICAL AND ELECTRICAL PROPERTIES OF LATTER

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1037-1043

BRODIN, M. S., DAVYDOVA, N. A. and SHABLIY, I. Yu., Institute of Physics, Ukrainian Academy of Sciences

[Abstract] An experimental study was made of defect formation and buildup in crystals under laser radiation, on the basis of analysis of changes in the recombination spectra and for the purpose of determining the effectiveness of this method of analysis. The study objects were high-resistivity CdS crystals with concentration of free electrons of the order of 10^{14} cm^{-3}. They were irradiated at 300 K with pulses of $2 \cdot 10^{-8}$ s duration from a Q-switched multimode ruby laser (λ = 0.69 μm). Emission was focused by a lens and passed through neutal filters for regulation of the power density over the 10-100 MW/cm^2 range. Spectra of recombination radiation were measured at 4.2 K, after irradiation with various doses and after etching off a 1 um surface layer. These spectra reveal the evolution of exciton bands (4850-4900 Å), X-band (4875-4878 Å), Z-band (wide with λ_m = 4878), extreme greem (λ> 5000 A) with increasing concentration of donor centers up to a 10^{18} cm^{-3} excess of donor centers over acceptor centers, and eventual merging of two energy bands (impurity and conduction). Figures 3, table 1, references 13: 8 Russian, 5 Western.
[232-2415]

UDC 621.315.592

KINETICS OF ACCUMULATED RADIATION DAMAGE WITH ION IMPLANTATION IN SILICON

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 8, Aug 82 (manuscript received 24 Jun 81) pp 1390-1395

VAVILOV, V. S., KRASNOPEVTSEV, V. V. and KUDYSHEV, A. N., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The method of radiation conductivity induced by fast electrons is used to study the kinetics of accumulation of radiation damage during ion implantation in silicon. Radiation conductivity is reduced by the formation of radiation defects. Excitation of nonequilibrium charge carriers by electrons can be used to control the depth of the region of electron-hole pair production by changing particle energy. Experiments were done on implantation of He, C, N, Ne, Si, Ar and Kr ions with energy of 30 keV at temperatures of 300 and 100 K. The nonequilibrium carriers were excited by an electron gun producing electrons with energy of 10 keV at current density of 0.1 mA/cm^2. Ion production was done at a current density of 0.4-1 $\mu A/cm^2$, which is far

below the threshold where ion current can affect processes of defect formation and amorphization of silicon. The results are given as curves showing the change in number of radiation defects with ion dose as a function of the mass of the implanted ions and the temperature of the target. It is found that as the temperature of the substrate decreases, there is a reduction in the amorphization dose for all ions, and an increase in the rate of accumulation of radiation defects. For light ions, a simple mechanism of defect accumulation predominates where the number of displaced atoms is proportional to the ion dose. Defect accumulation for heavier ions is characterized by an amorphization mechanism with formation of amorphous regions that repeatedly overlap. Figures 5, references 17: 14 Russian, 3 Western.
[259-6610]

UDC 621.315.592

REDISTRIBUTION OF ION-IMPLANTED PHOSPHORUS IN SILICON WITH ANNEALING UNDER CONDITIONS OF HYDROSTATIC STRESS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 8, Aug 82 (manuscript received 8 Jan 82) pp 1489-1490

OKULICH, V. I., PANTELEYEV, V. A. and VASIN, A. S., Gorkiy Physicotechnical Research Institute, Gorkiy State University imeni N. I. Lobachevskiy

[Abstract] The authors study the possibility of using hydrostatic pressure to control diffusion processes when annealing layers of ion-implanted silicon. A model experiment was done to study diffusion of phosphorus from a layer of ion-implanted silicon in argon at pressures of 100-150 kPa. The specimens were annealed at 870, 905 and 920°C. Phosphorus distribution was determined by a four-probe method with removal of layers by anodic oxidation. The results show that pressure appreciably reduces the depth of dopant penetration. When specimens with surface concentration higher than 10^{20} cm^{-3} are annealed, the pressure increases the concentration of electrically active dopant in the zone of irradiation. Thus it should be possible to use hydrostatic pressure to profile the distribution of dopant atoms in semiconductors, specifically for increasing the coefficient of utilization of implanted ions and making sharp p-n junctions. Figure 1, references 8: 6 Russian, 2 Western.
[259-6610]

UDC 621.315.592

ELECTRONIC ABSORPTION AND AMPLIFICATION OF SOUND IN SEMICONDUCTORS IN ALTERNATING ELECTRIC AND MAGNETIC FIELDS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 8, Aug 82 (manuscript received 24 Aug 81, after revision 2 Mar 82) pp 1517-1519

SMBATYAN, Zh. Ye., GULYAYEV, Yu. V. and BUGAYEV, A. S., Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] Previous research has demonstrated that electronic absorption and amplification of sound in semiconductors are strongly altered in the presence of an electric field alternating at a frequency much less than that of the sound, and that a transverse magnetic field may also have a considerable influence on the magnitude of the electric field that corresponds to optinum amplification of sound. In this paper it is shown that an alternating magnetic field may also have a considerable effect on electronic absorption and amplification of sound. In particular, with appropriate selection of the phase relations between the alternating magnetic and electric fields, volumetric acoustic waves can be amplified even in the absence of a constant electric field. References 5 Russian.
[259-6610]

UDC 536.423.1

METAL VAPORIZATION BY STRONG ELECTRIC CURRENTS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 5, No 8, Aug 82 (manuscript received 3 Oct 80) pp 1647-1652

MIKITIK, G. P., MOTORIN, V. I. and MUSHER, S. L., Novosibirsk State University imeni Lenin Komsomol

[Abstract] The melting stage in the process of electrical explosion of conductors was analyzed in a previous paper [see A. P. Baykov, A. M. Iskol'dskiy, G. P. Mikitik et al, ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI, No 5, 1979]. This paper now continues with the second stage, vaporization. The problem is similar in some ways to that of vaporization of a solid surface by an intense laser beam or relativistic particle beam. Two stages are distinguished in the process of vaporization of a conductor by current flowing through it: "quasiequilibrium" vaporization where the vapor parameters are close to those of the saturated vapor, and "strongly nonequilibrium" vaporization where vapor pressure is much higher than ambient air pressure. The principal equations are derived, and dimensionless times are defined for temperature relaxation, input of energy necessary for vaporizing the conductor, and travel of a sound wave across the solid. The principal modes of vaporization are determined by relations among these characteristic times. The part played by the vaporization stage in the mechanism of distruction of conductors by electrical explosion is determined on the basis of qualitative estimates and numerical calculation of the principal equations. It is shown that the fraction of vaporized material is insignificant until a critical temperature is reached in the center of the specimen. Figures 3, references 13: 11 Russian, 2 Western.
[254-6610]

UDC 621.375.826+662.986

FEASIBILITY OF GAS DYNAMIC CO_2-LASER WITH REGENERATIVE HIGH-TEMPERATURE HEAT EXCHANGER: PART 1

Dushanbe IZVESTIYA AKADEMII NAUK TADZHIKSKOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 4(82), Oct-Dec 81 (manuscript received 25 May 81) pp 14-19

KARPUKHIN, V. T. and CHERNYSHEV, S. M., Institute of High Temperature, USSR Academy of Sciences

[Abstract] The feasibility of producing CW and pulse-periodic gas dynamic lasers on CO_2+ N_2 + H_2O(He) mixtures is examined from both theoretical and practical standpoints. The operating principle of such lasers is based on thermal excitation of vibrational degrees of freedom of molecules in the active medium and subsequent rapid expansion of the medium through a supersonic Laval nozzle. The main performance parameter, namely specific emission power, of such lasers is evaluated on the basis of gas thermodynamic relations and found to increase from 42 J/g at T_0= 1500 K to 210 J/g at T_0= 3000 K. Four methods of heating the gas mixture are available: electrically with resistance heater, by combustion of CO together with nitrogen and water vapor producing additives, by preheating each mixture component in an electric arc (plasmatron), and by heat transfer in surface-type (recuperative) or contact type (regenerative) heat exchangers. All four methods are reviewed comparatively, heat exchangers being of particular interest as devices least developed and yet highly promising for this application. Recuperators are most economical to build, but they are least efficient and not yet optimally designed for high-temperature operation. Regenerators with movable packing are still in the experimental stage of development, regenerators with Cowper packing are reliable but still too large and expensive. Regenerators with ball packing feature a large specific heating surface and combine high reliability with low cost. With spherical Al_2O_3 or ZrO_2 granules used for packing, it is possible to operate at temperatures of 2100 or 2600 K respectively. References 20: 17 Russian, 3 Western.
[248-2415]

UDC 621.375.826

CONTINUOUS-WAVE SELECTIVE HIGH-TEMPERATURE GAS-DYNAMIC CO_2-LASER

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 3, May-Jun 82 (manuscript received 19 May 81) pp 573-579

YEGOROV, V. E., YERMACHENKO, V. P., KUROCHKIN, Yu. V., LAZUTKIN, O. N., PAKHOMOV, N. Yu., PUSTOGAROV, A. V., SHAN'GIN, O. S. and ERNST, V. Ye., Moscow

[Abstract] A test stand has been built for study of CW high-gemperature gas-dynamic lasers with selective thermal excitation, their performance and applications. The equipment includes a CO_2-laser excited during mixing of CO_2+ He with a supersonic N_2 stream (typically 48%mN_2+ 16%mCO_2+ 36%mHe), the latter heated in a d.c. electron-arc plasmatron. It also includes an optical resonator, a nozzle, a supersonic diffuser, a gas ejector, and a subsonic nozzle. Gain and resonator output power are measured with a probing LG-22 laser, modulator, three semitransparent mirrors, three photoreceivers, all mounted separately to ensure interference immunity during strong mechanical vibrations. The gain was found to increase with decreasing static pressure and to decrease with increasing distance from the nozzle throat. Its dependence on the stagnation pressure of nitrogen reveals a peak at approximately 2000 K, which shifts somewhat depending on the expansion ratio. At low temperatures the gain does not depend on the expansion ratio. Helium plays an important role in lowering the translational temperature of the active medium, as indicated by an approximately 33% decrease of gain upon replacement of helium with water. An output power of 45 W was attained with a beam hole $2 \cdot 10^{-3}$ m in diameter in the exit mirror. The authors thank B. A. Tikhonov and B. V. Abakumov for constructive discussion of the results. Figures 6, references 8: 7 Russian, 1 Western.
[230-2415]

UDC 621.378.325

SHAPE OF STABILIZED CRATER FORMING DURING VAPORIZATION OF SOLID SUBSTANCE UNDER LINEARLY POLARIZED LASER RADIATION

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 2 Mar 81, final edition received 18 Aug 81) pp 1139-1140

BARANOV, R. I. and KILL', I.D.

[Abstract] The problem of the shape of a stabilized crater forming in a homogeneous isotropic dielectric material under normally incident linearly polarized laser radiation is treated analytically. The equation of the crater surface is derived with the aid of Fresnel relations for the reflection coefficients, with stabilization of the crater assumed to occur when the energy

absorbed in a unit of time through an arbitrarily small area of the crater surface becomes equal to the energy absorbed in the same time in a region of equal area where the stabilized crater reaches the original surface where only radiation polarized normally to the plane of incidence appears. Stabilization of the crater surface is also assumed to require complete absorption of the reflected wave and use of its entire energy on vaporization. The second-degree first-order partial differential equation in cylindrical coordinates was solved numerically for a laser beam with normal intensity distribution. The results reveal a not nonaxisymmetric crater, with the half-plane at $\theta = 0$ smoothly merging with the original surface and the half-plane at angle $\theta = \frac{1}{2}\pi$ intersecting that surface at some angle (θ- polar angle in a plane perpendicular to the laser beam). Figures 2, references 1 Russian.
[235-2415]

UDC 535.21:541.14

INSTABILITY OF VAPORIZATION AND OF SURFACE OXIDATION UNDER LASER RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1127-1134

TRIBEL'SKIY, M. I.

[Abstract] Interaction of laser radiation and solid material is considered which results in instability of two processes: sublimation (vaporization) and oxidation. The problem is treated as one of a physical system with perturbation and change of symmetry. The model for sublimation is a semi-infinite body (half-space) and laser radiation of constant intensity entering through its surface. The effect of the vaporization front moving depthwise through the temperature field is evaluated in the adiabatic approximation with appropriate boundary conditions. The evolution of evaporation instability is traced through its initial linear stage by analytical methods and through the subsequent nonlinear stage by numerical methods. It has been demonstrated that development of instability slightly above the threshold produces stable two-dimensional stationary structures whose space period depends on the initial conditions and all other parameters remain universal so that from any initial conditions in a continuous class there will always evolve the same stationary structure, a typical example being the spin mode of evaporation. The model for oxidation is an oxide film building on the surface a bulky metal specimen. The effect of incident laser radiation on this process is evaluated on the basis of the homogeneous differential equation of heat conduction and the parabolic law of oxide film kinetics. Results obtained by both analytical and numerical methods reveal that as the film thickness increases slowly, stable and unstable stages of film buildup alternate with instability which is first linear and then nonlinear. Experimental data are available on vaporization of metals and dielectrics such as quartz as well as on oxidation of metals such as copper, a CO_2-laser ($\lambda = 10.6$ μm) having been used in those studies. Figures 6, references 11: 9 Russian, 2 Western.
[232-2415]

UDC 621.375.826

STATISTICS OF BREAKDOWN BY LASER RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1119-1126

DANILEYKO, Yu. K., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Threshold laser radiation causing breakdown of a defective material is defined as the minimum intensity at which irreversible structural changes occur around a defect in the material, through any of various mechanisms such as buildup of thermoelastic stresses or of absorption waves, electron avalanche or bursting due to heat. All breakdown causing processes are random in nature and describable by Poisson statistics. A problem in studying laser-induced breakdown is determining the probability density function, generally of several random variables, which characterizes the probability of breakdown within a unit of time and thus characterizes the material with respect to its destructibility under laser radiation. The problem will be simplified if one considers only macromechanisms of breakdown, and strongly nonlinear processes, with the breakdown threshold laser intensity as the only random variable. Several methods are available for theoretical analysis and for interpretation of experimental data. One may consider an axisymmetric laser beam with some given divergence angle in the material and, depending on the assumed intensity distribution (usually uniform or supergaussian), select the appropriate parameter or coordinate relative to the caustic as the random variable whose probability density function is sought. The analysis is refined by recognition that there are more than one (at least two) groups of defects in a material, each characterized by different concentration and threshold laser radiation intensity, in which case it is best to assume a Gaussian laser beam for determining the probability of breakdown as a function of not only laser radiation intensity but also laser beam focusing. This basic statistical approach, with further refinements such as inclusion of micromechanisms, has been used for interpretation of experimental data. Particularly extensive are experimental data on breakdown of GaAs, NaCl and KCl crystals by radiation from a CO_2-laser (λ =10.6 μm) obtained in a number of studies. Figure 1, references 14: 12 Russian, 2 Western. [232-2415]

UDC 621.378

LASER GENERATION OF STRONG SHOCK WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1081-1089

ANISIMOV, S. I., PROKHOROV, A. M. and FORTOV, V. Ye., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Laser generation of kilojoule-terawatt shock waves, for controlled thermonuclear fusion, has been studied both theoretically and experimentally on the basis of conventional dynamical physics. Here the feasibility of using lasers in high-pressure dynamical physics for producing megabar pressures is reviewed. One important problem is determining the equation of state and other thermodynamic characteristics of superhigh-density plasma theoretically as well as by utilization of available experimental data. Asymptotic models in combination with semiempirical ones, statistical or quasi-statistical methods of calculation, and phase diagrams are considered for determining the properties of various gases, liquids and crystals under high pressure, the physical properties of plasmas being generally characterized by the nonideality parameter. Rough estimates have been made in the one-dimensional approximation with local absorption of light, aided by experiments under conditions of absorption resonance, and various simulation programs have been developed. Criteria and constraints have been established for designing targets and shaping laser pulses. Experiments have been set up and performed for diagnostic purposes, measuring any two of the fundamental five parameters that characterize propagation of steady plane shock discontinuities (phase velocity, group velocity, pressure, density, energy) and then calculating the other three on the basis of conservation laws. The indications are that record high energy concentrations can be attained with modern lasers and that this technique can be very effective in applications requiring extremely high pressures, temperatures, and velocities. Figures 2, references 36: 18 Russian, 18 Western.
[232-2415]

UDC 535.34

THERMOPHYSICAL PROCESSES DURING INTERACTION OF LASER RADIATION AND ABSORBING MEDIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1018-1025

RYKALIN, N. N. and UGLOV, A. A., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences

[Abstract] Thermophysical processes occurring during interaction of laser radiation and an absorbing medium are examined theoretically, with the aid of

some experimental data obtained at the Institute of Metallurgy. First the authors consider the nonlinear problem of a stationary laser heating a thick metal plate, without phase transitions and chemical reactions at the surface. The corresponding equation of heat conduction, with negligible losses due to convection and radiation, is solvable by either numerical or approximate analytical methods, taking into account that the initial temperature changes. Then an examination is made of ablation, through melting and evaporation, and self-oscillations in the vapor stream leaving the body surface and describable by an expression that reduces to a Van der Pol equation. Gas-dynamic processes involved in laser-plasma treatment of materials, including breakdown of dense gas and formation of plasmoids as well as other interdependent short process, are difficult to analyze. Mathematical models have been constructed and solutions obtained by numerical methods, in collaboration with V. I. Mazhukin and B. N. Chetverushkin (Institute of Problems of Mechanics, USSR Academy of Sciences), for optical breakdown of nitrogen. Two other areas of interest are synthesis and reduction of materials from laser plasma. Experiments have been performed and progress made here, typical examples being synthesis of nitrides and carbides and reduction of tungsten oxide to metallic tungsten. Figures 4, references 28: 27 Russian, 1 Western.
[232-2415]

UDC 621.385.6

NEW METHOD OF STIMULATING DIFFRACTION EMISSION OSCILLATOR-FREE ELECTRON LASER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 265, No 2, Jul 82
(manuscript received 25 Nov 81) pp 318-321

YEVDOKIMENKO, Yu. I., LUKIN, K. A., REVIN, I. D., SKRYNNIK, B. K. and SHESTOPALOV, V. P., academician, UkSSR Academy of Sciences, Institute of Radio Physics and Electronics, UkSSR Academy of Sciences, Kharkov

[Abstract] Until recently it had been assumed that diffraction emission oscillator-free electron lasers (DEO-FELs) were typified by one-to-one correspondence between the frequency of stimulated emission and initial electron velocity at fixed parameters of the electrodynamic system (open resonator, diffraction grating, beam hole). It has now been found that oscillations may be observed in the DEO-FEL on the same frequency with excitation of the same open resonator mode for appreciably different initial electron velocities. This effect is due to the peculiarities of a new mechanism of DEO-FEL excitation, and it arises in the case where the phase of the field changes stepwise in the direction of motion of electrons. The electrodynamic system of the DEO-FEL is an open resonator with astigmatic mirrors of rectangular aperture. The electromagnetic energy is coupled out to the load through a beam hole in one of the mirrors. A flat electron beam moves over a diffraction grating fixed in the central part of the other mirror. The high-Q modes of such a cavity differ in frequency and have a complex spatial

field structure approximated by Gauss-Hermite functions. In this paper the authors analyze excitation of the TEM_{01q} mode in the resonator, which is called the first mode of the DEO-FEL open cavity. The spatial structure of this mode is such that there are two spot fields along the direction of electron motion. The oscillations in these spots are 180° out of phase. Analysis of interaction of the electron flux with the field of the first mode of the cavity shows that there are two mode amplification zones where self-oscillations may be excited. These zones are separated by a region of absorption. The efficiency of interaction between the electron flux and the field of the first mode is characterized by the parameter of desychronism $\phi = (\frac{\omega}{v_0} - \frac{\omega}{v_{ph}})w$, where ω is the frequency of stimulated emission, w is the diameter of the spot field of the fundamental mode of the cavity, v_0 is initial electron velocity, and v_{ph} is the phase velocity of the spatial field harmonic that is synchronous with the electron flux when a plane homogeneous wave is normally incident on the diffraction grating. Near the natural frequency of the first mode, there is a change in the frequency of oscillations in both amplification zones. For values of ϕ from the different amplification zones (which is equivalent to different values of the initial electron velocity) the frequency of stimulated emission is the same. Figures 3, references 5: 4 Russian, 1 Western.
[252-6610]

UDC 621.313.12:538.4

OPTIMUM OPERATING CONDITIONS FOR DETONATION MHD-GENERATORS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 3, May-Jun 82 (manuscript received 20 Jun 81) pp 584-586

MINTSEV, V. B. and FORTOV, V. Ye., Moscow

[Abstract] Detonation MHD generators with shock compressed argon, xenon, and air plasma as working substance can produce pulses of 10 MJ energy and 10^{-6}-10^{-3} s, this plasma being generated behind the front of strong shock waves (velocity D in the 5-100 km/s range) formed by detonation of an explosive substance. A performance analysis based on the electrical circuit has yielded the optimum conditions for energy delivery to a resistive load, the determining parameters being $\gamma = L/(R_P + R_L)$ (L- rate of change of inductance, R_P- resistance of plasmoid, R_L- resistance of external load). This parameter depends on the magnetic Reynolds number Re_{mag} thickness of the conducting piston l and effective depth of the current layer in the plasma $\delta \leq 1$, namely $\gamma = (1- k)Re_{mag}\delta/l$ $(k=R_L/R_P+R_L))$. The appropriate circuit and performance equations can be solved analytically for the case of constant D, L, R_P and R_L. Parameters of shock-compression plasma were calculated by simultaneous solution of hydrodynamic and thermodynamic equations, with the aid of tabulated values. The electrical conductivity was calculated in the additive approximation, with the use of cross sections for electron scattering by atoms and with nonideality of plasma due to Coulomb interaction accounted for in the Debye approximation. Performance curves were plotted showing the ratio of energy in the resistive load to energy of the initial magnetic field as a function of the velocity of shock waves at various initial pressures. The authors thank Ye. F. Lebedev and V. Ye. Ostashev for helpful discussions. Figures 2, references 15: 13 Russian, 2 Western. [230-2415]

UDC 621.313.12:538.4

MHD-GENERATORS USING SATURATED VAPORS OF ALKALI METALS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 3, May-Jun 82 (manuscript received 21 May 81) pp 565-572

BIBERMAN, L. M., LIKAL'TER, A. A. and YAKUBOV, I. T., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] The feasibility of an MHD generator with nonideal plasma of alkali metals (K, Cs) as working fluid is analyzed from the standpoint of Rankine cycle thermodynamics and electrical properties. The electrical conductivity is anomalously high, according to the Saha equation for a quasi-neutral plasma of cesium vapor, and moreover proportional to the saturation pressure cubed. With a small fraction of liquid phase throughout the expansion process, the electrical conductivity should remain high. With the channel walls at saturation temperature, there should be no low-conductivity regions near the electrodes. Also the Hall number is low in a magnetic field of realistic intensity. The flow through such an MHD channel can be optimized and the MHD generator designed on the basis of the equations of motion, energy, and thermodynamics with the empirical temperature dependence of saturation pressure $p=\frac{C}{\sqrt{T}} e^{-q_0/RT}$ (q_0= 0.78 eV/atom for cesium and 0.89 eV/atom for potassium). Performance calculations for maximum upper cycle temperature of 1800 K, Mach number 0.5, and magnetic induction of 4 T yield an output power of 400 MW for cesium and 250 MW for potassium at cycle efficiencies of 55 and 50% respectively. The authors thank A. Ye. Sheyndlin and Ye. M. Shelkov for valuable discussions that have stimulated further elaboration of some problems. Figures 5, table 1, references 20: 17 Russian, 3 Western.
[230-2415]

REDUCING ENERGY LOSSES IN CHARGED-PARTICLE BEAM PASSING THROUGH MEDIUM

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 6, Jun 82 (manuscript received 17 Dec 81) pp 1780-1788

NAMIOT, V. A.

[Abstract] Roughly speaking, there are two components of energy loss in a charged-particle beam passing through a material: one due to collisions of beam particles against material particles and a "collective" one due to buildup of oscillations. Although evidently the energy loss can never be smaller than the collision component alone, since "collective" processes in a medium at thermodynamic equilibrium theoretically tend to lower the beam energy, situations can occur where the energy loss is smaller. Such a situation is that of a nearly monochromatic beam with a certain mode of current modulation. This is demonstrated by taking into account periodic pressure fluctuations that occur during collisions and are in some way phase-locked along the entire parth of the beam. While collisions generate heat and the latter builds up a beam wave, these pressure fluctuations can also generate waves. As a result, some of the energy lost may be returned to the beam so that the total energy loss per collision becomes smaller rather than larger for a modulated beam than for an unmodulated one. This self-recuperation mechanism is analyzed here in the linear approximation and assuming constant velocity of beam particles. The equations of kinetics in the velocity and temperature fields are solved first for a boundless plasma of infinitely heavy ions containing an electron beam whose density is a periodic function of one space coordinate only, then for such a plasma containing a modulated beam and placed in a uniform magnetic field parallel to another space coordinate. The self-recuperation coefficient is calculated in each case, also in the practical case of a gaseous target filling an array of acoustic resonator cavities coupled through inductances. The author thanks G. A. Askar'yan and Ye. A. Romanovskiy for helpful discussions. Figure 1, references 10 Russian.
[233-2415]

UDC 621.384.66

USE OF HELICALLY SECTORAL MAGNETS FOR COLLECTING FLAT PARTICLE BEAMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82
(manuscript received 2 Jun 81) pp 1224-1226

DZERGACH, A. I.

[Abstract] Anisotropic focusing of particle beams for particle accumulators, with preferential attraction to the median plane, is possible by means of helically sectoral cyclotron magnets. Focusing a straight flat beam is an extreme application of such a magnet system. Weaker radial focusing allows widening the beam and, with the radial Coulomb forces thus weakened, increasing the number of collectable monoenergetic particles. This number is limited principally by the Coulomb frequency shift of free betatron oscillations, which depends on the charge distribution over the beam section. Calculations based on the potential in a uniformly charged elliptical cylinder, assuming long particle clusters, yield the advantage of magnets producing a flat beam over conventional magnets. Addition of special focusing magnets that produce an oblique periodic field facilitates providing long straight gaps. An analysis of the ballistics of a flat particle beam through such a system involves solution of the Matthieu equation for the region adjacent to the median plane. Typical characteristics of a proton accumulator are: kinetic energy 600 MeV, pulse dispersion 0.15%, mean orbit radius 6 m, intensity of twisting magnetic field 1 T, maximum gradient of magnetic field intensity 10 T/m, betatron frequencies 0.3-0.4 and 3, aperture of vacuum chamber 1.1x0.1 m, weight of magnet 2000 t, magnet supply power 1 MW. The author thanks A. A. Kuz'min and R. A. Meshcherov for support, Ye. L. Burshteyn for helpful discussions, and G. A. Radzin'sh for performing calculation on a computer. References 8 Russian.
[235-2415]

UDC 535.417.1

USE OF HOLOGRAPHIC DIFFRACTION GRATING FOR DEFLECTION OF LASER BEAM

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 53, No 1, Jul 82
(manscript received 17 Nov 80) pp 135-140

KISELEV, N. G.

[Abstract] Characteristics of holographic diffraction gratings as devices for deflecting a laser beam are analyzed on basis of geometrical relations that determine the change of path as a function of the rotation angle. Two special cases of diffraction gratings on plane substrates in air are considered, with the illuminating beam arbitrarily oriented relative to the axis of rotation. In the first case the substrate is arbitarily oriented relative to the axis of rotation but the grating lines are orthogonal to the latter. In the second case the grating lines lie in a plane through the axis of rotation. Both a transmission grating and a reflection grating are examined in each case, the former more difficult to synthesize with conventional optics but yielding a holographic deflectogram with stepwise displacement of the scanning spot, the latter yielding a nonlinear deflection law but suitable for wide deflection angles and high scan frequencies. The performance characteristics of a beam deflector are calculated on this basis and a transmission grating with the substrate orthogonal to the axis of rotation is found to be most promising for this application, combining linearity of the deflection characteristic with near rectilinearity of hologram lines. Figures 4, references 7: 1 Russian, 6 Western.
[239-2415]

UDC 535.818.8

METHOD OF ANALYZING WAVE ABERRATION IN TWO-COMPONENT HOLOGRAPHIC OBJECTIVE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 53, No 1, Jul 82
(manuscript received 23 Dec 80) pp 130-134

SHITOV, V. G., GREYSUKH, G. I., VANIN, V. A. and BUTUSOV, M. M.

[Abstract] A holographic objective converting a divergent wave front to a convergent one is considered which, instead of having an expensive wide

aperture, consists of two parallel oppositely oriented hologram lenses. Holograms are recorded with a spherical wave front from the source and a plane reference wave front, the first hologram restoring an exact copy of the reference wave front and, if that copy is complex conjugate to the reference wave front, it forms an undistorted convergent wave front on the second hologram. The dependence of the wave aberration on the curvature of the reference wave front is calculated by the method of paths, from the fundamental equation of holography for the complex amplitude of wave fronts that can be reconstructed in one of the diffraction orders. On this basis, the image quality indicator is evaluated as a function of reference wave front curvature and also as a function of the distance between lenses. The results, verified by numerical simulation on a computer, reveal that high fidelity requires a reference wave front with large radius of curvature and a point source, if such is used, at a far distance from the objective. Figures 3, references 6: 5 Russian, 1 Western.
[239-2415]

UDC 535.317.1

FILTRATION OF IMAGES NOT SPACE-INVARIANT WITH RESPECT TO ATMOSPHERIC DISTORTIONS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 26 May 81) pp 1076-1079

BAKUT, P. A., SVIRIDOV, K. N. and KHOMICH, N. Yu.

[Abstract] A method is proposed for space filtration of images not space-invariant with respect to atmospheric distortions, namely by dividing such an image into N subimages dimensionally comparable with the isoplanarity region in the atmosphere-telescope system and thus into N independent regions within each of which the system remains space-invariant. The method involves application of the convolution theorem and Fourier transformation, which yield a description of these subimages in the space-frequency domain, followed by further division of each subimage into M fragments corresponding to the number of resolution elements of the system within the isoplanarity region. Restoration of an undistorted diffraction-limited image is then effected by inverse filtration of the space spectra of all subimages and subsequent inverse Fourier transformation. References 7: 3 Russian, 4 Western.
[229-2415]

UDC 621.373:535

WAVEFRONT REVERSAL IN FOUR-WAVE MIXING IN AMPLIFYING MEDIUM OF Ar^+-LASER

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 13 Apr 81) pp 1065-1067

BYKOVA, N. G., LEBEDEVA, V. V. and ODINTSOV, A. I.

[Abstract] Wavefront reversal during degenerate four-wave mixing in the active medium of a CW Ar^+-laser has been found to be theoretically possible at the $4p^2D_{5/3} - 4s^2P_{3/2}$ transition (λ = 488 nm). Optimum conditions for experimental verification have also been established, based on dependence of the reflection coefficient on attenuation, on frequency deviation from resonance and on the ratio of pumping power to saturation power at the center of the resonance line. The equipment consisted of a 1.7 m long resonator with concave spherical mirrors (radii 4 and 5 m, reflection coefficients 99 and 92% respectively) forming a Gaussian TEM_{00}-mode beam with minimum divergence, a quartz prism, and a Trotskiy absorbing film for mode selection. The frequency in one-frequency operation was tuned within the resonance line by means of a piezoceramic corrector and monitored by a Fabry-Perot interferometer. A third mirror (radius 1.5 m) formed a test beam. Phase coupling of the reflected signal at a certain magnitude of attenuation was indicated by its small divergence and by high sensitivity of its intensity to tuning of the system. Figures 2, references 11: 5 Russian, 6 Western.
[229-2415]

UDC 535.317.1+535.42+535.36

DIFFRACTION EFFICIENCY OF HOLOGRAM RECORDED THROUGH TURBID MEDIUM

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 22 Nov 80) pp 1029-1033

PREDKO, K. G. and SINCHENKO, V. G.

[Abstract] An experimental study was made to determine the diffraction efficiency of holograms recorded through a turbid medium with variable optical properties, with the reference beam propagating outside that medium. Both object and reference beams had plane waves, propagated by 16° angle to one another, their intensities were varied by means of neutral filters and holograms were recorded on FN-GV2 film. Milk in various concentrations served as the scattering medium, nigrosine added to ensure absorption of light only. Processing of the holograms yielded the dependence of the degree of coherence on optical thickness of the medium and on photon survival probability as well as the dependence, in turn, of diffraction efficiency on degree of coherence. From these relations it was possible to establish the optimum ratio of object beam to reference beam intensities for maximum diffraction efficiency under various conditions in the turbid medium. Figures 2, references 11:
10 Russian, 1 Western.
[229-2415]

UDC 535.317.1:535.345.6

USE OF DIGITAL HOLOGRAPHIC FILTERS FOR OPTIMIZING METHODS OF COHERENT OPTICAL PATTERN RECOGNITION, PART 2: EXPERIMENTAL RESULTS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 28 Jul 80) pp 1034-1039

GIRNYKH, V. I., KURASHOV, V. N. and NAKHODKIN, N. G.

[Abstract] Feasibility of optimizing coherent optical pattern recognition by synthesis of digital holographic filters in the Fourier plane and the basis of factor analysis was studied experimentally with the aid of a laser light plotter built at Kiev State University. The device consisted of a radiation source (λ = 0.44 μm), acoustico-optic modulator, two lenses and diaphragm between them for trimming and shaping a laser beam with Gaussian intensity distribution, a piezoceramic scanner for controlling the beam in space and an objective for focusing it on the surface of a movable recording medium. For monitoring the beam power, a beam splitter sends part of the output through optics to a photoreceiver with a measuring instrument. Focusing of the beam was controlled from an image of its light spot on a screen. Modulator and deflector were controlled from a computer. With 32 quantization levels and 64x64 hologram elements of 5 um size, holograms were recorded in 4 sec and their dimensions varied from 320-x320 to 1600x1600 μm^2 on Micrat LOI-2 hotographic plates and 6.5 μm thick photothermoplastic film on glass substrates. Effective performance of such filters was observed in terms of binary forrelation responses depending on the light plotter aperture, in recognition of three objects $S_k(r)$,k= 1,2..., K (S_1=1, S_2= 5, S_3= 8) through two different sets of matched filters with pulse responses $U_m(r)$,m= 1,2,...,M M= K= 3 and 3 and M= $\log_2(K+1)$=2). Figures 5, references 4: 2 Russian, 2 Western.
[229-2415]

UDC 535.317.1

PARAMETERS OF CORRELATION RESPONSES IN PROBLEMS OF OPTIMAL IMAGE FILTRATION

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 6 Nov 80) pp 1040-1045

KOROLEV, A. N.

[Abstract] Correlation responses of six algorithms of pattern recognition by optimal image filtration are analyzed comparatively, each algorithm and corresponding filter being optimal under certain conditions and thus for certain applications only (matched filter, inversion filter, inversion filter with regularizer, matched-selective filter of the first kind, plain phase filter, gradient filter). Their frequency characteristics and corresponding weight functions as well as maximum magnitude of the correlation signal according to either are calculated, also half-width of correlation signal and signal-to-noise ratio. Figures 3, tables 1, references 7: 6 Russian, 1 Western.
[229-2415]

UDC 535.211.4

CHARACTERISTICS OF DETECTING INFRARED RADIATION THROUGH ITS INTERACTION WITH INDUCED GRATING IN OPTICAL WAVEGUIDE

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 17 Jul 81) pp 1141-1150

BLACK, T. D., KOMOTSKIY, V. A. and NIKULIN, V. F., University of Peoples' Friendship imeni Patrice Lumumba

[Abstract] The method of detecting infrared radiation with a plane optical waveguide and an interference mask above it is evaluated, a grating being induced on the waveguide film by incident radiation upon passage of the latter through the mask while a surface acoustic wave of wavelength equal to the grating period is excited and propagates transversely over that grating. Upon interaction with both the induced grating and the surface acoustic wave, the incident optical wave becomes space phase modulated before it enters the detector (photoiode in series with a load resistor across d.c. voltage source shunted by a capacitor). Detectability thresholds are determined by noise in the detector circuit (thermal and shot) as well as by amplifier noise and noise bandwidth of the recording channel). The sensitivity of this method depends on the film thickness and temperature. The temperature field in the waveguide is therefore calculated, assuming cosinusoidally distributed density of absorbed infrared power, and sensitivity of the detector is calculated from the thresholds and its response speed is calculated from the pulse rise time and the relaxation time. Numerical values obtained for waveguide film of polymethyl methacrylate on BaF_2 or SrF_2 substrates, or on Si substrate with SiO_2 interlayer, indicate that both power sensitivity ($W/cm^2 \cdot \sqrt{Hz}$) and energy sensitivity ($J/cm^2 \cdot \sqrt{Hz}$) can be improved by optimization of energy absorption and transmission in the system. Figures 6, tables 2, references 4: 2 Russsian, 2 Western.
[235-2415]

UDC 621.378.46

OPTIMUM CONTROL OF WAVE FRONT AND TIME PROFILE OF OPTICAL RADIATION PROPAGATING IN NONLINEAR MEDIUM

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 4, Jul-Aug 82 (manuscript received 19 Oct 80) pp 18-21

KARAMZIN, Yu. N., SUKHORUKOV, A. P. and TROFIMOV, V. A., Department of General Physics and Wave Processes, Moscow State University

[Abstract] When optical beams are used for data transmission, the beams must be shaped so that nonlinear distortions are minimized as they travel through nonlinear media. Conventional methods of optimizing beam parameters generally

require the use of a computer. The required beam parameters can be found most rapidly in the first approximation by using an aberrationless description of the process of optical propagation in a nonlinear medium in which the beam is characterized by only by its dimensionless width. This paper gives an algorithm for realization of the proposed technique in application to media with various mechanisms of nonlinearity for cases of steady and unsteady propagation of optical radiation. Results are given for optimization of pulse shape and wave front for various pulses. The same technique is applicable to analysis of problems of optimizing the slope of the phase front in the case of propagation in a moving medium, as well as pulse shape in the case of unsteady Kerr nonlinearity. Figures 2, references 5 Russian. [253-6610]

UDC 778.4:534-8

WAVE AMPLIFICATION AND PARAMETRIC STIMULATED EMISSION ON PLANE DYNAMIC HOLOGRAMS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 265, No 2, Jul 82 (manuscript received 17 Dec 81) pp 324-327

PILIPETSKIY, N. F., SUDARKIN, A. N. and SHKUNOV, V. V., Institute of Problems in Mechanics, USSR Academy of Sciences, Moscow

[Abstract] Recent research on wavefront reversal by an interface has drawn attention to the problem of light beam and sound beam transformation by dynamic holograms recorded on a reflective surface. The authors discuss problems of dynamic correction and amplification of beams by using holograms of this type, and also analyze the feasibility of using such holograms to develop a parametric device for stimulated emission of highly directional acoustic and optical waves. It is assumed that a strong reference wave and a weak signal wave are incident on a flat reflective surface with amplitude reflectance r'(I) that depends on the intensity of radiation. Upon reflection from the surface with recorded hologram, the reference wave is rescattered in the zero and first diffraction orders. The wave corresponding to the term representing the first diffraction order on the holographic grating propagates in the direction of the signal reflected from the surface for any orientation of the reference wave. It is shown that if amplitude reflectance is a sufficiently sharp function of intensity, the reflected signal may be amplified by energy transfer from the reference wave. A parametric device for stimulated emission of highly directional waves is proposed with pumping by an intense divergent reference wave. This wave generator consists of a cavity containing an angle selector and a nonlinear surface illuminated by the reference wave. Intracavity amplification is provided by a hologram that is recorded on the nonlinear surface by the wave being generated with the reference wave. Acoustic waves are produced by excitation on a liquid surface. Figures 2, references 12: 8 Russian, 4 Western. [252-6610]

UDC 522.2

FIRST RESULTS OF COMPUTERIZED TWO-COORDINATE MACHINING OF OPTICAL SURFACE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 265, No 2, Jul 82
(manuscript received 21 Dec 81) pp 328-330

VITRICHENKO, E. A., GORELIK, V. V., YEVSEYEV, O. A., IRTUGANOV, Sh. Sh., MALYKHIN, V. A., NEKRASOV, V. V., PROKHOROV, A. M., academician, REBROV, A. V., SAVEL'YEV, A. V. and TRUSHIN, Ye. V., Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] The paper gives the results of the first industrial tests of the ZEBRA-2 Soviet system for computer-controlled machining of large optical surfaces with correction of local errors. The testing was done on final lapping of a plate 433 mm in diameter and 40 mm thick made of grade KV fused quartz. The work was done in four stages with a total time of 7 hours and 40 minutes. Interference patterns taken before and after correction show that both flat surfaces were of high quality before final lapping, but the internal inhomogeneities of the material caused deviations from uniformity of the index of refraction. Transmission properties were considerably improved by correction. The rms error of the wavefront transmitted before correction was 0.038 μm, and was 0.028 μm after correction for a wavelength of 0.63 μm, i. e. an improvement from 0.060 to 0.044 wavelength. Figures 3, references 5: 2 Russian, 3 Western.
[252-6610]

UDC 621.397.3

DEVICE FOR OBJECT IDENTIFICATION THROUGH OPTOELECTRONIC PROCESSING OF IMAGES

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 3, May-Jun 82 (manuscript received 17 Jun 81) pp 180-181

MINCHEV, G. G., ILIYEVA, M. G., PEKHLIVANOV, Kh. N., FURNADZHIYEVA, M. V. and BOZHKOV, T. G., Sofia, Bulgaria

[Abstract] A device is proposed for fast and reliable processing of images for object identification. For a typical application, where the input objects are letters and digits of standard print, the device consists of five optical receptors in parallel with a normalizing circuit followed by a logical analyzer. Each receptor has one input and four outputs, the latter corresponding to four relative threshold energy levels of input signals established by preliminary experiment and refined through calibration. Each receptor consists of a photoconverter, an amplifier, and three comparators in parallel determining into which of three preselected ranges a signal falls. The logic analyzer processes the output from all receptors and the normalizing circuit, tests the combination of images, and produces the appropriate symbol in 5-digit 3-range (28 letters of the Russian alphabet) code for display or further computer processing. Figures 2, table 1, references 3: 2 Russian, 1 Bulgarian.
[231-2415]

UDC 535.317.1

A POSTERIORI SPACE FILTRATION OF SHORT-EXPOSURE IMAGE DISTORTED BY ATMOSPHERE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 53, No 1, Jul 82 (manuscript received 8 Jun 81) pp 163-166

BAKUT, P. A., SVIRIDOV, K. N., SIDEL'NIKOV, V. N. and USTINOV, N. D.

[Abstract] A short-exposure image of an object taken by a telescope is distorted by a turbulent atmosphere, as is a long-exposure image, but a posteriori space filtration becomes in this case difficult because of the momentary transfer function of the "atmosphere-telescope" system being a complex random one

not describable by a universal analytical relation. The problem is formulated here as that of finding an approximation of either the random pulse response with the mean optical transfer function known or an approximation of the mean optical transfer function with the random pulse response known. The problem can be solved by statistical processing of spatial spectra of recorded image fragments and in this way reconstructing both modulus and phase of the transfer function and thus also those of the pulse reponse. Calculations are based on invariance of the system with respect to image fragments larger than its resolution elements and are done by an iteration procedure with Fourier and inverse Fourier transformations. A deviation of the initially selected first approximation from the mean transfer function will result in negative intensities in the inverse Fourier transform and these must be reduced to zero. This can be done by first adjusting the modulus with the phase fixed or first adjusting the phase with the modulus fixed and then changing respectively the phase or the modulus from step to step, depending on which has been determined more accurately in the preceding step. References 2 Western. [239-2415]

UDC 537.533.33

EXPERIMENTAL STUDY OF ISOLATED SIMPLE BIPLANAR LENS, PART 2: ABERRATION CHARACTERISTICS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 20 Jul 81) pp 1226-1228

AFANAS'YEV, V. P. and SADYKIN, A. D., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The spherical aberration of an isolated simple biplanar lens in vacuum was measured on an electron-optical bench by a two-grid method. Both screen grid and cathode grid could be moved in two mutually orthogonal directions and rotated about the optical axis of the system without disturbing the vacuum. The two parallel plates of the lens, made of Micarta foil, were square (40 mm) and 20 mm apart, the two inner electrodes were 18 mm wide, the two outer electrodes were 4 mm wide, all electrodes were 29 mm long. With the accelerating potential equal to 2.5 kV, the potential of the inner electrodes was varied in 1-0 or 200 V steps and the potential of the outer electrodes was matched so as to maintain a constant focal length. Linear images of point objects were obtained between lens and screen grid. The aberration coefficient in the focusing plane and in the scattering plane was determined at various focal lengths and various combinations of electrode potentials. The results indicate that this aberration coefficient can, at any given focal length, be controlled electrically over a wide range, also be made negative and reduced to zero. Figure 1, table 1, references 2 Russian. [235-2415]

UDC 537.533.2

EXPERIMENTAL STUDY OF ISOLATED SIMPLE BIPLANAR LENS, PART 1: FOCUSING CHARACTERISTICS

Leningrad ZHURNAL TEKHNICKESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 12 Mar 81) pp 1213-1215

AFANAS'YEV, V. P. and SADYKIN, A. D., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The simplest version of a biplanar lens, an isolated single-section lens, was studied experimentally for determination of its focusing characteristics. The lens consisted of two plates of Micarta foil, with two pairs of electrodes separated from one another and from the remainder of the plates by isolating grooves. Both electrode pairs were energized through a common voltage divider, the inner pair tapped to a point at potential V_1 and the outer pair tapped to a point at potential V_2. The unenergized remainder of the plates was grounded. Such a lens, just as a crossed or quadrupole one, forms a linear image of a point object by collecting a beam of charged particles in one of two orthogonal directions and scattering it in the other. In the experiment the inner electrodes were 18 mm wide and the outer electrodes were 4 mm wide, all electrodes being 29 mm long, the two parallel plates were square (40 mm) and 20 mm apart. The accelerating potential was 3200 V. The potential of the inner electrodes was held constant at various levels while the potential of the outer electrodes was varied. The focal lengths were found to depend on the ratio of each electrode potential to accelerating potential, with either real or virtual images formed. At a certain ratio of potentials V_1 and V_2 the focusing plane and the scattering plane switch locations. The results of measurements indicate that such a lens has twice the optical power of a crossed lens and an only slightly lower optical power than a quadrupole one. The authors thank V. M. Mikhin for assisting with the experiment. Figures 4, references 2 Russian. [235-2415]

UDC 537.533.34

OPTOELECTRONIC SYSTEM BASED ON CYLINDRICAL AND SPHERICAL ELECTROSTATIC MIRRORS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 8, Aug 82 (manuscript received 8 Oct 81) pp 1633-1636

ZASHKVARA, V. V. and ASHIMBAYEVA, B. U., Institute of Nuclear Physics, KaSSR Academy of Sciences, Alma-Ata

[Abstract] A combination optoelectronic system of two electrostatic mirrors of cylindrical type and another of spherical type has been studied in previous research for the case where the charged particle beam penetrates into

the region of the spherical field through the outer spherical electrode (exterior reflection of the beam from the spherical mirror). In this paper, the authors analyze the optoelectronic and time-of-flight characteristics of an analogous system in which the charged particle beam enters the spherical field region through the inner spherical electrode (interior beam reflection from the spherical mirror). The initial equations for the analysis are expressions for the projection of a segment of an arbitrary trajectory from source to image on the axis of symmetry of the system, and for the time of flight of a charged particle along this trajectory. It is found that the system has the following major properties when operating in the mode of zero linear dispersion with respect to energy. 1. A beam of charged particle from a point source is focused on the axis of symmetry with accuracy to the cube of the angle of divergence inclusive. Cubic aberration changes sign near the point of angular focusing of third order. This property permits the system to be used for compensation of both positive and negative cubic aberrations in electrostatic energy analyzers. 2. Considerable angular dispersion. The system could be a high-resolution energy analyzer with low angular divergence of the beam in the axial plane for simultaneous registration of spectra in a finite energy interval by a coordinate detector. The trajectories of a beam of charged particles with the same energy and mass are isochronous in the first approximation with respect to the angle of divergence of the beam. At large values of the ratio of the radius of the inner spherical electrode to that of the inner cylindrical electrode, the dispersion of time of flight with respect to energy is reducible to zero. Thus the proposed system can be used for time-of-flight analysis of charged particle beams. Figures 3, table 1, references 3 Russian.
[254-6610]

UDC 533.951.2

DYNAMICS OF HARMONIC GENERATION IN LASER PLASMA

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 6 Apr 81) pp 600-606

ANDREYEV, N. Ye., SILIN, V. P. and STENCHIKOV, G. L., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Generation of time harmonics of glow discharge in a laser plasma is due to nonlinear processes in the vicinity of critical density at which absorption of the electromagnetic field occurs, especially in the case of obliquely incident p-polarized laser radiation. An analysis of the dynamics of harmonic generation, specifically generation of the second and the third, on the basis of Maxwell field equations with appropriate boundary conditions for reflection yields the coefficients of frequency conversion and their variation in time. Calculations were done for an initial plasma density profile corresponding to a rarefaction wave, in one case of an initially quiescent plasma where the flow of gas near the critical plasma density remains subsonic, and in another case of an initial plasma velocity profile varying linearly in space where the flow of gas near the critical plasma density becomes supersonic. Equations of hydrodynamics were used in the calculation, also experimental data on heating a plasma with a Nd-laser. Figures 4, references 12: 9 Russian, 3 Western.
[236-2415]

UDC 533.932

CHARACTERISTICS OF SPACE-TIME EVOLUTION OF OVERHEATING-IONIZATION INSTABILITY

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 3 Jun 81) pp 561-564

KOROLEVA, I. L., NAPARTOVICH, A. P. and STAROSTIN, A. N., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Filamentation of glow discharge by the universal mechanism of overheating-ionization instability, namely sharp increase of ionization rate and of plasma density at decreasing gas density with attendant heating, is

analyzed on the basis of numerical solution of the coresponding equations of gas dynamics with heat conduction and ambipolar electron diffusion taken into account. The one-dimensional model of ribbon discharge uniform along the current path is considered here, such a discharge being generally used for pulse pumping of laser media. Calculations were made for nitrogen, but assuming a relaxation time for the internal molecular energy much shorter than the filament buildup time, and consequently, no time delay in conversion of all electric energy to heat. The boundary conditions were zero gradients of gas velocity, gas density, energy density, electron concentration at the center and zero gas velocity and electron concentration at the wall. The initial conditions were room temperature (300 K) and atmospheric pressure. The results obtained for various ratios of electric field intensity to gas concentration reveal that, as this parameter increases from $5.5 \cdot 10^{-16}$ to $8.5 \cdot 10^{-16}$ $V \cdot cm^2$ and the filamentation buildup time becomes corespondingly shorter than the sound travel time, this instability shifts from the narrow central region of initial plasma density perturbation toward the peripheral region at the wall. This is evident from the transverse profiles of gas velocity, gas temperature, and electron concentration. Figures 3, tables 1, references 10: 7 Russian, 3 Western.
[236-2415]

UDC 537.525.99

STABILITY OF COMPOUND DISCHARGE MAINTAINED BY CONSTANT AND HIGH-FREQUENCY ELECTRIC FIELDS, PART 1: STRUCTURAL PECULIARITIES OF HIGH-CURRENT HIGH-FREQUENCY CAPACITIVE DISCHARGE

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 3 Nov 80, after correction 20 Apr 81) pp 543-549

MYSHENKOV, V. I. and YATSENKO, N. A., Institute of Problems in Mechanics, USSR Academy of Sciences

[Abstract] A study is made of the stability of discharge simultaneously maintained by a constant electric field and a high-frequency one. The high stability of such a discharge is found to be due to its structural peculiarities. Theoretical analysis of high-current high-frequency capacitive discharge and experimental data on discharge in various gases (air, CO_2, He) reveal high-conductivity zones at the high-frequency electrodes, where the electrical conductivity is much higher than in the plasma column, and also that continuous oscillation of the electric field intensity in the plasma column plays a subordinate role. This is explained by ambipolar diffusion of electrons into the Faraday space and their annihilation during dissociative recombination with molecular ions such as He_2^+, just as in a plain d.c. glow discharge, as well as by a possibly appreciable effect of the electron beam on the structure of the Faraday space under the given conditions. Any differences between compound discharge and plain d.c. glow discharge can also be easily explained on the basis of this model. References 9: 6 Russian, 3 Western.
[236-2415]

UDC 533.922

PLASMA HEATING BY BEAM OF HEAVY IONS

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 13 Jan 81, after correction 28 Oct 81) pp 519-528

BASKO, M. M. and SOKOLOVSKIY, M. V., Institute of Theoretical and Experimental Physics

[Abstract] Heating of a plasma by a heavy-ion beam along its path toward a thermonuclear target is analyzed on the basis of the Coulomb mechanism of ion retardation according to classical energy transfer from individual ions to electrons of the ambient medium. This mechanism is shown to dominate slowdown in an electric field decompensating the electric charge of the beam at the plasma boundary during teardown of electron clouds around ions as well as collective retardation caused by beam instability resulting in plasma oscillations. The retarding force is calculated on the basis of well known kinetics, taking into account electron shells around ions and electron exchange with the ambient medium as well as transition from the "supersonic" ($V \ll \sqrt{T/m_e}$) to "subsonic" ($V \lesssim \sqrt{T/m_e}$) mode, then the rate of Coulomb energy loss is calculated considering three components of the retardation force: stopping at bound electrons of atoms and atomic residues, stopping at free charges of plasma, stopping at unshielded charges of nuclei. Experimental data have been obtained on the proton stopping power and the ion stopping power of various metals (Al, Cu, Ag) and dependence of this power on the proton or ion energy respectively in the range up to 10 MeV/amu. Model calculations were also made for U^{238} ions in cold lead, as starter, yielding the Coulomb range with an error not expected to exceed 15% taking into consideration temperature and ionization profiles in the target at various instants of time. The authors thank N. A. Bobrova, V. S. Imshennik and M. D. Churazov for helpful discussions. Figures 4, tables 1, references 21: 6 Russian, 15 Western.
[236-2415]

UDC 533.95:538.4

MHD-MECHANISM OF METAL ELECTRODE VAPORIZATION IN PLASMA FOCUS

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 23 Feb 81) pp 487-501

GERUSOV, A. V., GINZBURG, S. L. and IMSHENNIK, V. S., Institute of Applied Mathematics, USSR Academy of Sciences

[Abstract] Vaporization of a metal electrode in a plasma with Z-pinch is analyzed in the one-dimensional approximation, based on a model of electron beam and anode surface interaction that includes not only acceleration of electrons and buildup of pressure inside the anode but also generation of x-rays. It also accounts for a predominant role of slow rather than fast

conduction electrons in the process. Heating and motion of liquid metal are described by a plane one-dimensional system of three MHD equations in Lagrange coordinates with initial conditions for metal in the normal state (zero velocity, room temperature, standard density) and boundary conditions at the metal plasma and deuterium plasma interface (constant external pressure $8.28 \cdot 10^9$ dyn/cm^2, zero thermal flux, deuterium temperature 10^7 K, deuterium charge concentration $3 \cdot 10^{18}$ cm^{-3}). The equations of state are formulated to encompass the two extreme states of solid metal and ideal metal vapor plasma. Both ionization energy loss and Joule effect heating are evaluated on this basis, inasmuch as both mechanisms may operate concurrently. Numerical calculations yield the profiles of density, temperature, pressure, velocity, and charge as well as the variation of these quantities and of the characteristic vaporization limits in time. They also reveal diffusion of the magnetic field into the anode, maximum current density at the lower edge of the skin layer, and maximum pressure with possibility of chipping during vaporization at the depth of magnetic field penetration. Secondary physical effects include electric fields in molten metal, sources of fast electrons in deuterium plasma outside molten metal, plasma nonideality and degeneracy, and additional radiation. Vaporization in the x-ray mode is characterized by abrupt separation of the surface layer of metal plasma. For this case the MHD equations and the equations of state should be solved with necessary adjustments and they generally yield lower bound estimates, available experimental data agreeing fairly well with theoretical results and confirming that velocity at the surface and pressure in the bulk are only slightly different for different anode materials (Cu, Al, W). The authors thank N. B. Volkov and V. F. D'yachenko for helpful suggestions with regard to formulation of the problem and method of its solution, also N. V. Filippov and N. N. Kalitkin for helpful discussions of the results. Figures 6, table 1, references 19: 18 Russian, 1 Western.
[236-2415]

UDC 533.9.15:537.52

SLOW IGNITION OF LASER PLASMA

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1141-1149

BUFETOV, I. A., PROKHOROV, A. M., FEDOROV, V. B. and FOMIN, V. K.

[Abstract] Slow ignition of a laser plasma, i.e., maintenance and subsonic propagation of a plasma through a gas in an optical-frequency field has been studied extensively, producing the initial absorption center being the main object of most experiments. A review of studies made by many authors during 1970-80, following the first observations of a laser arc in the slow-ignition mode (in 1969 at the Institute of Physics, USSR Academy of Sciences) is supplemented by a report on the results of studies made by these authors specifically. They studied motion of the gas through the discharge region,

using interaction of two separate optical discharges as means of monitoring the process. They also determined thresholds of discharge propagation through atmospheric air based on measurements of threshold power at zero velocity of the discharge front and of power absorbed for maintenance of discharge. While a CO_2-laser was used in many other studies, an Nd-laser had also been proposed and these authors used it in their studies. Figures 4, references 41: 31 Russian, 10 Western.
[232-2415]

UDC 535.21+621.378.33

PULSE HEATING OF METALS BY LASER PLASMA IN SUBSONIC AIR STREAM

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1058-1064

AGEYEV, V. P., GORBUNOV, A. A., KONOV, V. I., NIKITIN, P. I., SILENOK, A. S. and CHAPLIYEV, N. I., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Pulse heating of metals by laser plasma in a subsonic air stream, with attendant expansion of explosion products to atmospheric pressure and their entrainment by the air shock wave, is analyzed on the basis of the "fire ball" model and experimental data. In the theoretical part the dimension of a "fire ball" is related not to the energy of a laser pulse but to the energy absorbed by the target outside the spot. In the experimental part low-threshold breakdown of air was triggered by irradiation of a disk (3.4 mm diameter) of AMtsM aluminum alloy at the center of a cylinder of thermally insulating material with a pulse-periodic TEA CO_2 laser emitting pulses of 0.1-0.5 J energy and 0.4 μs duration at a repetition rate of 80 Hz. The peak intensity at the center of the spot (0.12 cm radius) was varied from 6.5 to 32 MW/cm^2. Measurements were made with Chromel-Copel thermocouples and a loop oscillograph. The transient energy transfer from "fire ball" to target is evaluated on the basis of the corresponding model of energy distribution, with experimental data on target heating and cooling. The role of radiation is estimated on the basis of empirical relations for emissivity and radiative heat loss as functions of temperature and radius. The role of conduction is estimated in the one-dimensional approximation with a corrective term accounting for convection in the gas-dynamically perturbed state. Shadow photographs illustrate, qualitatively only, evolution of a "fire ball" with vortical or turbulent motion under a downward vertical laser beam and in a horizontal air stream above the target surface. Figures 5, table 1, references 9 Russian.
[232-2415]

UDC 535.21+621.378.33

BREAKDOWN OF AIR NEAR SOLID TARGET BY RADIATION FROM CO_2-LASER

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1044-1051

KONOV, V. I., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] An experimental study was made of plasma formation in air near solid targets irradiated by a CO_2-laser. A pulsed TEA laser was used, first with short emission pulses (strong 200 ns leading peak + weak 2.5 ns tail) and a graphite target for spectroscopic analysis not yet fully interpreted, then with long quasi-triangular emission pulses (energy $E \lesssim 2$ J, duration $\tau \approx 32$ μs) and mainly brass targets for measurement of plasma formation parameters such as plasma glow intensity. The irradiated spots were $\lesssim 1$ mm in diameter in each case. Readings of threshold glow intensity and of intensity changes accompanied by crater formation indicate plasma formation by vapor flare of target material rather than by optical breakdown of air. Data also indicate that moderate evaporation rates suffice for discharge of flares through various surface defects, in air just as in vacuum. The plasma nucleation centers cause optical breakdown of air only above the threshold intensity of 10^7 W/cm^2. This suggests that ionization of air follows breakdown of metal vapor, after the surface layer of target material has evaporated. Further evidence of such a mechanism are thin metal flakes found near the base surface thermally insulated from it. These conclusions are confirmed by quantitative analysis of electron avalanche and diffusion kinetics. Figures 5, references 18: 13 Russian, 5 Western.
[232-2415]

UDC 518.9

EXISTENCE OF EQUILIBRIUM SITUATIONS IN NON-COOPERATIVE DIFFERENTIAL MULTIPLAYER GAMES

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian Vol 13, No 3, Jul 82 (manuscript received 12 Feb 81) pp 40-46

MALAFEYEV, O. A.

[Abstract] A non-cooperative differential game with n players is considered, the dynamics of each player being defined by a generalized dynamic system $D_i(x_i,t)$ in a complete locally compact metric space (X_i,ρ_i) and that generalized dynamic system having been generated, for instance, by a controllable system $x_i = f_i(x_i,u_i)$ in a finite-dimensional Euclidean space R^{mi} which satisfies standard constraints. The duration of the game is $T<\infty$. Each player uses piecewise-programmable strategies, his terminal payoff being defined by a continuous function $\bar{H}_i:X\to R^1$. The existence of equilibrium situations in such a non-cooperative $\Gamma(\cdot)$ game is proved with aid of five lemmas and a theorem pertaining to ε-equilibrium situations in an antagonistic $\Gamma^*(z_0,T)$ game, the set of ε-equilibrium situations of this $\Gamma(\cdot)$ game coinciding with the set of ε-optimum strategies of second player in an antagonistic $\Gamma^*(\cdot)$ game. References 10: 8 Russian, 1 Western. [246-2415]

UDC 519.86

OPTIMAL SYNTHESIS IN PURSUIT GAME PROBLEM WITH SMALL PARAMETER

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 3, May-Jun 82 (manuscript received 26 Jan 81, after completion 2 Dec 81) pp 52-58

KORNEYEV, V. A. and MELIKYAN, A. A., Moscow

[Abstract] The differential game of two players, pursurer and evader, is considered as a problem of control in a conflict situation. Optimum control for each player is sought in dynamics describable by the equations

$\dot{x}_1 = -x_2u + \varepsilon \sin x_3$, $\dot{x}_2 = x_1u - 1 - \varepsilon \cos x_3$, $\dot{x}_3 = -u + \varepsilon\gamma v$ ($|u| \leq 1$, $|v| \leq 1$, $x = (x_1, x_2, x_3)$ vector of phase coordinates, (x_1, x_2)- coordinates of evader in movable system, x_3- angle between velocity vectors of the two players, u- scalar control of pursuer, v- scalar control of evader, ε and γ positive constants). The game is finished when the distance between players becomes smaller than a given $R > 0$ and thus the phase vector falls within the terminal set $M = \{(x_1, x_2, x_3): x_1^2 + x_2^2 \leq R^2, |x_3| \leq \pi\}$. The pursuer strives to minimize the game time and the evader strives to maximize it, the payoff being the functional $J = \int_0^T dt = T$, $x(T) \in M$ (t- time). The pursuer's optimum positional control is determined through synthesis in the initial approximation, the evader's through synthesis in the first approximation. The respective problems are solved for $\varepsilon \to 0$ with aid of corresponding Hamiltonians. Their solutions are analyzed in respective phase planes, of particular interest being the trajectory (pursuer's) and the surface (evader's) where their control changes sign. The results apply qualitatively also to a small interval $0 \leq \varepsilon \leq \varepsilon_0$ and can be extended to a larger one. Figures 3, references 11: 7 Russian, 4 Western.
[231-2415]

CSO: 1862

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