YAKOVLEV, V.A., inzh.

Develop a perfect design of a slip catch. Bezop.truda v prom. 4 no.6:17-18 Je '60. (MIRA 14:3)

1. Trest Khar'kovneftegazrazvedka.
(Pulleys)

YAKOVLEV, V.A.

Quality of No.8 roller bits for full hole drilling. Azerb. neft. khoz. 39 no.10:16-17 O '60. (MIRA 13:11)
(Boring machinery)

YAKOVLEV, V.Ya., inzh.

Automatic switching-out of winches in swabbing wells. Bezop. truda v prom. 4 no.10:33 O '60. (MIRA 13:11)

1. Trest Khar'kovneftegazrazvedka.
(Oil well drilling)

YAKOVLEV, V.A., inzh.

Automatic device for switching off the U2-4-5 draw works in swabbing operations. Neftianik 5 no.6:22 Je '60.
(MIRA 13:7)

1. Trest Khar'koneftegazrazvedka.
(Hoisting machinery)

YAKOVLEV, V.A., inzh.

Prevent open outflow of gassers. Bezop.truda v prom. 5 no.3:31 Mr '61. (MIRA 14:3)

1. Trest Khar'kovneftegazrazvedka.
(Gas well logging--Safety measures)

YAKOVLEV, Vitaliy Arkad'yevich; LATUKHINA, Ye.I., ved. red.; VORONOVA, V.V., tekhn. red.

[Water exclusion in air and gas drilling; drilling practices in foreign countries]Bor'ba s vodoproiavleniemi pri burenii skvazhin s produvkoi zavoia; zarubezhnyi opyt. Moskva, Gostoptekhizdat, 1962. 52 p. (MIRA 16:4)
(Oil well drilling)

BOCHAROV, V.I., kand.tekhn.nauk; RUZIYEV, B.T., inzh.; YAKOVLEV, V.A., inzh.

Automatic device for controlling humidity in cloth. Trudy Frunz. politekh. inst. no. 6:85-88 '62. (MIRA 17:9)

YAKOVLEV, V.A.

Lifetime control of bits with reduced and small diameters at great depths. Izv. vys. ucheb. zav.; neft' i gaz 6 no.10: 25-28 '63. (MIRA 17:3)

1. L'vovskiy politekhnicheskiy institut.

ZUBKOV, Ya.S.; MOSKOVKIN, I.V.; EDERL'MAN, Ya.A.; YAKOVLEV, V.A.

Efficient functioning of bits. Neft. khoz. 41 no. 11:57-59 N '63. (MIRA 17:7)

YAKOVLEV, V.A.

Efficient treatment of bits in the drilling of deep wells of decreased and small diameters. Neft. i gaz. prom. no.3:24-28 Jl-S '64. (MIRA 17:12)

YEREMENKO, T.Ye.; YAKOVLEV, V.A.

Selecting methods for determining the service lifetime of bits.
Izv. vys. ucheb. zav.; neft' i gaz 8 no.3:29-32 '65.
(MIRA 18:5)

1. L'vovskiy politekhnicheskiy institut i institut "UKRNIIGIPRONEFT'".

YAKOVLEV, V. A.

USSR/Engineering - Cable-laying equipment

Card 1/1 : Pub. 133 - 7/19

Authors : Yakovlev, V. A.

Title : Cable-laying plow designed by V. A. Nevizhin and S. M. Stotskiy

Periodical : Vest. svyazi 6, 14-16, June 1955

Abstract : A description of the operation and construction of a cable-laying plow is given. The plow is used for laying inter-city communication lines at the rate of 8 km per day, and at a depth of from 0.8-1 meter. The advantages and disadvantages of the above mentioned equipment, are briefly discussed and pointed out. Drawings; illustration.

Institution : .....

Submitted : .....

PESTOV, Georgiy Nikolayevich; YAKOVLEV, V.A., otvetstvennyy redaktor; DOBRYNINA, A.Ya., redaktor; VEYNTRAUB, A.B., tekhnicheskiy redaktor

[Mechanization of labor-consuming work in the laying of cables without using trenches] Mekhanizatsiia tiazhelykh rabot pri bestransheinom vypolnenii kabel'nykh perekhodov. Moskva, Gos. izd-vo lit-ry po voprosam sviazi i radio, 1956. 60 p. (MLRA 9:9)
(Electric cables)

YAKOVLEV, V.A., inzhener.

Over-all mechanization of underground cable laying. Mekh trud. rab. 10 no.1:33-35 Ja '56. (MLRA 9:5)
(Cables)

PLOKHOTSKIY, M.A., kandidat tekhnicheskikh nauk; YAKOVLEV, V.A., inzhener.

The DM-1 machine for boring horizontal holes. Mekh.trud.rab.10 no.11:32-33 N '56. (MLRA 10:1)
(Boring machinery)

YAKOVLEV, V.A., inzhener.

Mechanizing work on communication and signaling lines. Avtom. elem. i sviaz' no.7:34-37 Jl '57. (MLRA 10:8)
(Building machinery)

YAKOVLEV, V.A., inzh.

Determining the location of casing pipes in cutting blind passages. Transp. stroi. 9 no.4:58 Ap '59. (MIRA 12:6)
(Pipe, Steel)

MAZEL', Solomon Isaakovich; YAKOVLEV, Viktor Alekseyevich; KOKOSOV, Lev Vladimirovich; BERMAN, V.A., inzh., otv.red.; RYAZANTSEVA, M.M., red.; MARKOCH, K.G., tekhn.red.

[Mechanization of line construction of municipal telephone networks] Mekhanizatsiia stroitel'stva lineinykh sooruzhenii gorodskikh telefonnykh setei. Moskva, Gos.izd-vo lit-ry po voprosam sviazi i radio, 1960. 153 p. (MIRA 13:12)
(Telephone lines--Construction)

ACC NR: AP6021780 (A) SOURCE CODE: UR/0413/66/000/012/0045/0045

INVENTORS: Vitkov, G. D.; Kamentsev, V. V.; Seleznev, P. N.; Zaytsev, V. K.; Morozov, P. P.; Yakovlev, V. A.; Tatishchev, P. A.

ORG: none

TITLE: An induction furnace for heating blanks. Class 18, No. 182756

SOURCE: Izobreteniya, promyshlennyye obraztsy, tovarnyye znaki, no. 12, 1966, 45

TOPIC TAGS: furnace, induction furnace, refractory alloy

ABSTRACT: This Author Certificate presents an induction furnace for heating blanks of complex shapes, made of refractory alloys, in a nonoxidizing atmosphere. To save the refractory alloys and to produce proper heating, the furnace is provided with a hermetically closed casing which contains two induction heating elements. The two heating chambers formed are interconnected by transmitting tunnels. A closed rectangle conducts push rods for a self-dumping pan with blanks being heated.

SUB CODE: 13/ SUBM DATE: 11Mar63

Card 1/1 UDC: 621.365.5:621.785.1

YAKOVLEV, V., starshiy mekhanik.

Silencer for supercharged engines. Mor.i rech. flot 13 no.2:31 Je '53.
(MLRA 6:8)
(Engines)

YAKOVLEV,V.A., inzhener

New technology of producing welded crankshafts. Rech. transp. 14 no.4:29 Ap '55. (MLRA 8:6)
(Cranks and crankshafts--Welding)

YAKOVLEV, V.A., inzhener-mekhanik.

Remote control system designed by F.L.Korpachev. Rech.transp.15 no.7:25-26 Jl '56. (MIRA 9:9)
(Motorboats) (Remote control)

YAKOVLEV, V.A., inzh.

Instrument for checking quality of lubricants on ships. Rech. transp. 17 no.11:52 N '58. (MIRA 11:12)
(Ships--Equipment and supplies)
(Lubrication and lubricants)

YAKOVLEV, V.A., inzh.

Vibration cushion for auxiliary equipment. Rech.transp. 18 no.9:3 of cover S '59. (MIRA 13:2)
(Ships--Equipment and supplies)

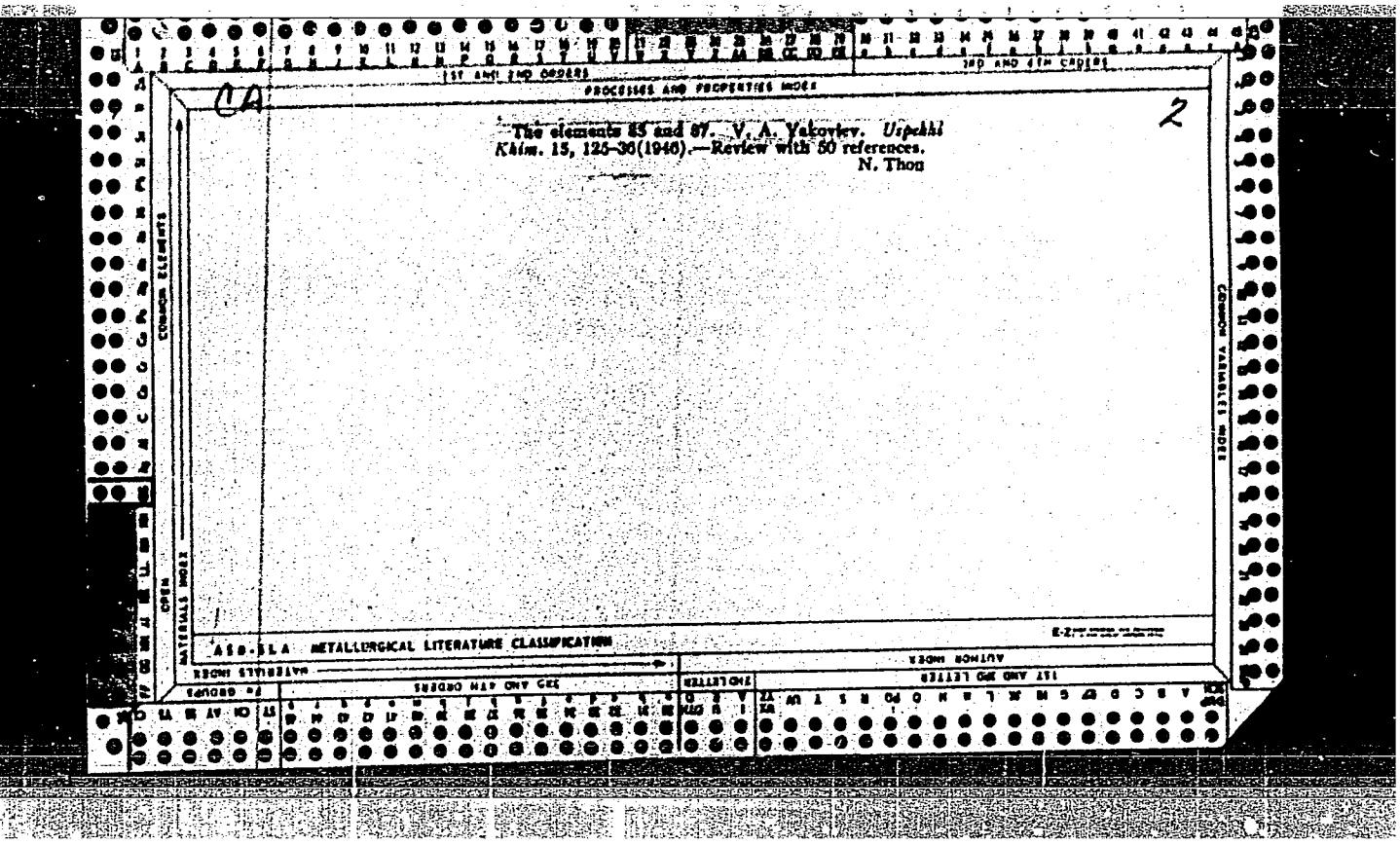
YAKOVLEV, V.A., inzh.

Every inland navitation worker and seaman will read this brochure with interest ("Remote control of main engines on the diesel-propelled ship "Orel"" by B.V. Levitskii, F.V.Filippenko, V.I. Sheleshko. Reviewed by V.A.IAkovlev. Rech.transp. 18 no.11: 55 N '59. (MIRA 13:4)

(Marine engineering) (Remote control)
(Levitskii, B.V.) (Filippenko, F.V.) (Sheleshko, V.I.)

YAKOVLEV, V.A., inzh.

Device for the automatic linking of river and lake vessels.
Sudostroenie 27 no.5:19-23 My '61. (MIRA 14:6)
(Towing)

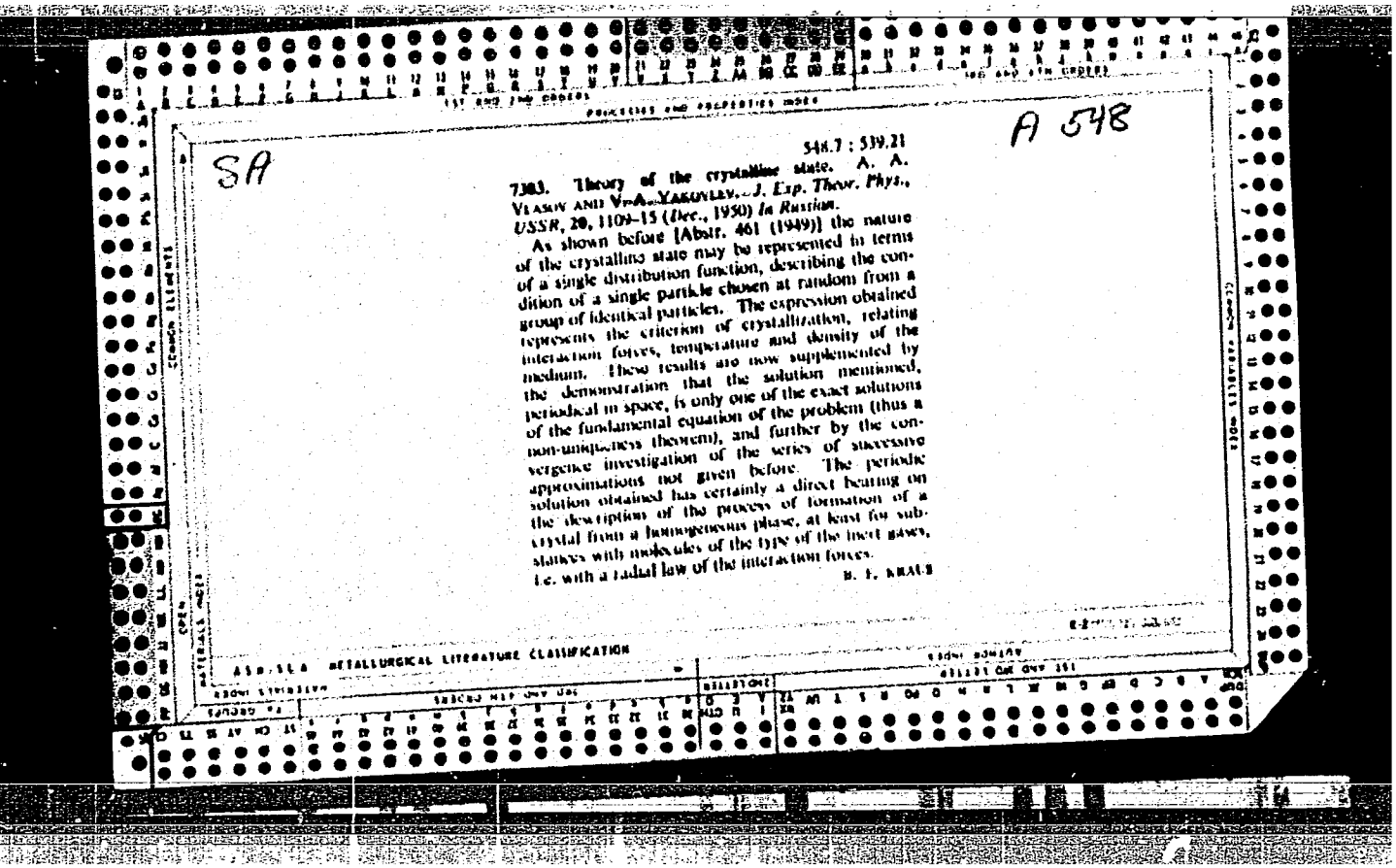


APPROVED FOR RELEASE: 03/14/2001 CIA-RDP86-00513R001961920008-5"

YAKOVLEV, V. A.

"On a New Theory of the Crystal." Thesis for degree of Cand. Physicomathematical Sci. Sub. 15 Jun 49, Moscow Order of Lenin State U imeni M. V. Lomonosov.

[redacted] Summary 82, 18 Dec 52, Dissertations Presented For Degrees in Science and Engineering in Moscow in 1949. From Vechernyaya Moskva, Jan-Dec 1949.



SA

A 548

548.7 : 539.21

7383. Theory of the crystalline state. A. A. VLASOV AND V. A. YAKOVLEV. *J. Exp. Theor. Phys., USSR*, 20, 1109–15 (*Dec.*, 1950) *In Russian.*

As shown before [Abstr. 461 (1949)] the nature of the crystalline state may be represented in terms of a single distribution function, describing the condition of a single particle chosen at random from a group of identical particles. The expression obtained represents the criterion of crystallization, relating interaction forces, temperature and density of the medium. These results are now supplemented by the demonstration that the solution mentioned, periodical in space, is only one of the exact solutions of the fundamental equation of the problem (thus a non-uniqueness theorem), and further by the convergence investigation of the series of successive approximations not given before. The periodic solution obtained has certainly a direct bearing on the description of the process of formation of a crystal from a homogeneous phase, at least for substances with molecules of the type of the inert gases, i.e. with a radial law of the interaction forces.

B. I. KHAIN

A S M / S L A METALLURGICAL LITERATURE CLASSIFICATION

YAKOVLEV, V. A., HANNIK, B. P., KULIKOVA, N. M. and LAZAREVA, L. E.

"The Angular Distribution of Fission Fragments in the Photo Fission of Uranium"
a paper presented at the International Conference on Nuclear Reactions, Amsterdam,
2-7 July 1956.

D551274

120-4-3/35

AUTHORS: Bugorkov, S.S., Malkin, L.Z., Petrzhak, K.A., Yakovlev, V.A. and Yakunin, M.I.

TITLE: Ionisation Chambers for Alpha Particle Counting (Ionizatsionnyye kamery dlya scheta al'fa-chastits)

PERIODICAL: Pribory i Tekhnika Eksperimenta, 1957, No.4, pp. 16 - 19 (USSR)

ABSTRACT: The construction and properties of 5 ionisation chambers for alpha particle counting are described.
No.1: A universal camera for alpha particles emitted within a solid angle of 2π (Fig.1). This camera is used for measurements on alpha-active materials deposited on one or both sides of a thin plate. It can also be used to estimate the degree of alpha-activisation of the inner surfaces of hemispherical platinum cups after various chemical procedures.
No.2: A camera for measurements in a solid angle which is less than, or equal to, 2π (Fig.4).
No.3: A camera for measuring alpha activities of liquids (Fig.5).
No.4: A camera with a solid angle (0.01 - 0.001) x 2π (Fig.6).
No.5: An argon filled camera (Fig.7). This is used to measure intensities of the order of 2×10^5 counts/min and also

Card1/2

Ionisation Chambers for Alpha Particle Counting.

in the measurement of alpha activity on a high beta background. Pressure of the argon is about 1 atm. The mechanical design of the 5 chambers are shown in the figures quoted above. There are 7 figures and 3 references, 1 of which is Slavic

ASSOCIATION: Khlopin Radiation Institute Ac.Sc. USSR: (Radiyevyy institut im. V.G. Khlopina AN SSSR)

SUBMITTED: September 26, 1956.

AVAILABLE: Library of Congress

YAKOVLEV, V. A.

AUTHOR BANNIK, B.P., KULIKOVA, N.M., LAZAREVA, L.Ye., YAKOVLEV, V.A. 56-7-8/66

TITLE Angular Distribution of Photofission Fragments from Uranium. (Uglovoye raspredeleniye oskolkov pri fotodelenii urana - Russian)

PERIODICAL Zhurnal Eksperim. i Teoret.Fiziki, 1957, Vol 33, Nr 7, pp 53-55 (U.S.S.R.)

ABSTRACT With the help of Ilford D-1 plates saturated with uranium the angular distribution of the fission fragments are determined on the occasion of the fissioning of uranium by a γ-bombardment with an energy of 9,4, 12, and 26,5 MeV. The 30 MeV synchrotron of the FIAN served as a γ-source.

Anisotropy increases very considerably with decreasing γ-energy. For the 3 coefficients, a, b, c, of the function of angular distribution the following values were determined:

$E_{\gamma\,max}$	b/a	ratio between the anisotropic and isotropic fission yields 1)
9,4	0,55±0,09	0,55±0,09
12	0,20±0,07	0,13±0,05
26,4	0,07±0,06	0,05±0,04

1) $(\frac{2}{3}\cdot\frac{b}{a} + \frac{2}{15}\cdot\frac{c}{a})$ (2 tables, 1 ill., 3 Slavic references).

ASSOCIATION Physical Institute "P.N.Lebedev" of the Academy of Sciences of the USSR (Fizicheskiy institut im. P.N. Lebedeva Akademii nauk SSSR)

SUBMITTED 7.2.1957

AVAILABLE Library of Congress.

Card 1/1

SOV/48-22-7-10/26

AUTHORS: Aron, P. M., Kalyamin, A. V., Murin, A. N., Yakovlev, V. A.

TITLE: On New Rare Earth Isotopes With Neutron Deficit. Lutetium Isotope With the Mass Number 167 (O novykh neytronodefitsitnykh izotopakh redkikh zemel'. Izotop lyutetsiya s massovym chislom 167)

PERIODICAL: Izvestiya Akademii nauk SSSR, Seriya fizicheskaya, 1958, Vol. 22, Nr 7, pp. 817 - 817 (USSR)

ABSTRACT: When tantalum was bombarded with 660 MeV protons in the synchrocyclotron of the OIYaI rare earth isotopes with a neutron deficit were produced. Some of them have not been known hitherto (Refs 1 - 5). A radioactive nuclide with a half-life of 55 + 3 minutes was discovered in the chromatographic separation of the lutetium fraction. The half-life was obtained from the intensity curve of γ-lines at $\sim$ 100 keV, which was recorded by a γ-scintillation spectrometer. When ytterbium is separated by chromatographic methods 7 hours after the active rare earths had been separated from the lutetium fraction, the

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same line is found. The intensity of this line in the ytterbium fraction dropped with a half-life of 18 minutes. The energies of the γ-quanta and the half-lifes within experimental errors correspond to the tabled data for Yb^{167} ($T_{1/2}$=18 minutes, E_γ = 118 keV). The thulium fraction separated simultaneously with ytterbium from the lutetium fraction emitted the characteristic β^+-spectrum of Tu^{167}. The intensity of the bright β^+-line with an energy of E_β = 2o7 keV decreases with a half-life of ~/1o days. Hence, the existence of the hitherto unknown isotope Lu^{167} is proved:

$$Lu^{167} \xrightarrow{E} Yb^{167} \xrightarrow{E} Tu^{167} \xrightarrow{E} Er^{167}$$

$T_{1/2}$ = 55 min; $T_{1/2}$ = 18 min; $T_{1/2}$=9,6 days (stable)

On New Rare Earth Isotopes With Neutron Deficit. Lutetium Isotope With the Mass Number 167

SOV/48-22-7-1o/26

Apart from the γ-line with an energy of $\sim$1oo keV, also lines with an energy of $\sim$17o keV and $\sim$24o keV were found in the spectrum of the initially separated lutetium fraction. The $\sim$17o keV-line was also observed in the spectrum of the daughter ytterbium. Its half-life is near to that of Yb^{167}. The $\sim$ 24o keV-line was not observed in the spectrum of the daughter ytterbium, as it originates from Lu^{167}. V. P. Dzhelepov, Director of the Laboratory for Nuclear Problems OIYaI, the operational staff of the synchrocyclotron, and B. K. Preobrazhenskiy assisted in the first experiments. There are 5 references, 5 of which are Soviet.

ASSOCIATION: Radiyevyy institut im. V.G. Khlopina Akademii nauk SSSR. (Radium-Institut imeni V.G. Khlopin, AS USSR)

Card 3/4

23(8)

AUTHORS: Kalyamin, A. V., Levenberg, I. Yu., Yakovlev, V. A.

SOV/89-6-5-21/33

TITLE: On New Positron Activities of Neutron-deficient Isotopes of Lutetium, Ytterbium, and Holmium (O novykh pozitronnykh aktivnostyakh neytronno-defitsitnykh izotopov lyutetsiya, itterbiya i gol'miya)

PERIODICAL: Atomnaya energiya, 1959, Vol 6, Nr 5, p 582 (USSR)

ABSTRACT: A tantalum target is irradiated for 10 minutes with 660 Mev in a synchrocyclotron, and after chemical treatment the individual fractions are measured. The following new nuclei were found: 1) Lu^{167}: $T_{1/2}$ = 43 min; $E_{\beta+}$ = 1.7±0.2 Mev; 2) Yb^{161}: $T_{1/2}$ = 82±4 min; $E_{\beta+}$ = 2.90±0.15 Mev; 3) Ho^{155}: $T_{1/2}$ = 50 min; $E_{\beta+}$ = 2.10±0.15 Mev. Positron energies were measured by means of a β-spectrometer constructed by V. N. Mekhedov and M. Ya. Kuznetsova. By means of a γ-scintillation spectrometer the γ-spectrum of a chromatographically separated body was measured, which is identical with the

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On New Positron Activities of Neutron-deficient Isotopes of Lutetium, Ytterbium, and Holmium

SOV/89-6-5-21/33

spectrum of Dy^{155}. Therefore the mass arrangement of Ho^{155} is probably sufficiently certain. Professor A. N. Murin was interested in the investigation, and results were discussed with him. There are 3 references, 2 of which are Soviet.

ASSOCIATION: Laboratoriya yadernykh problem Ob"yedinennogo instituta yadernykh issledovaniya (Laboratory for Nuclear Problems of the Joint Institute of Nuclear Research)

SUBMITTED: December 10, 1958

Card 2/2

BRIK, I.L.; BRESTKIN, A.P.; YAKOVLEV, V.A.

Interaction of esters of the N-methylcarbamic acid with acetylcholinesterases of the brain of white mice and flesh flies. Biokhimiia 29 no.6:1020-1028 N-D '64. (MIRA 18:12)

1. Institut evolyutsionnoy fiziologii i biokhimii imeni I.M. Sechenova AN SSSR, Leningrad. Submitted January 31, 1964.

BUGORKOV, S.S.; MALKIN, L.Z.; PETRZHAK, K.A.; YAKOVLEV, V.A.; YAKUNIN, M.I.

Ionization chambers for α-particle counting. Trudy Radiev.inst. AN SSSR 9:214-228 '59. (MIRA 14:6)
(Ionization chambers) (Alpha rays)

MALKIN, L. Z.; PETRZHAK, K. A.; and YAKOVLEV, V. A.
Study of the Effect of alpha particle reflection on measuring in a chamber with a solid angle - 2π ibid, p. 207

This book represents volume 9 of the Transactions of the Radium Inst. and contains the results of studies conducted at the Institute chiefly from 1955 to 1956. There are a number of articles dealing with the study of nuclear reactions occurring with particles of different energies ranging from several eV up to hundreds of MeV. Others treat different problems of the physics of neutrons.

YAKOVLEV, V.A.

21 (7), 21 (8)

AUTHOR: Rudakov, V. P. SOV/89-7-1-18/26

TITLE: IX All-Union Conference on Nuclear Spectroscopy (IX Vsesoyuznoye soveshchaniye po yadernoy spektroskopii)

PERIODICAL: Atomnaya energiya, 1959, Vol 7, Nr 1, pp 76-79 (USSR)

ABSTRACT: The IX All-Union Conference was held from January 26 to February 2, 1959 at Khar'kov. More than 300 participants heard 100 lectures, the most important of which dealt with the following fields: Nuclear Theory, General problems of β-decay. A. S. Davydov (MGU): Theoretical classification of low-energy excited nuclear states. L. K. Peker: Deformed nuclei. B. L. Birbrair, L. K. Peker, L. A. Sliv (LPTI): Quadrupole oscillations of deformed nuclei. Ye. V. Inopin, V. Yu. Gonchar, S. P. Tsytko (KhFTI): Calculation of the ft-values with matrix elements for β-transitions by means of the generalized nuclear model. S. T. Belyayev (IAE): Consideration of pair-correlation in nuclei. A. B. Migdal (IAE): The application of the superconductivity model to nuclei for the purpose of calculating their moments of inertia. P. E. Nemirovskiy (IAE): Problems of the neutron stability of nuclei. I. S. Shapiro (?): The present stage in the theory of β-decay. V. V. Vladimirskiy,

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V. K. Grigor'yev, V. A. Yergakov, Yu. V. Trebukhovskiy (ITEP): Measurement of the angular correlation between electron and neutrino in the decay of the neutron. V. M. Lobashev, V. A. Nazarenko, L. I. Rusinov (LPTI): Measurement of the correlation between the transversal electron polarization and circular polarization of γ-quanta occurring in the decay of Sc^{46} and Co^{60}. Decay Schemes. γ-radiation of Nuclei. I. F. Anufriyev, A. K. Val'ter, Yu. V. Gonchar, Ye. G. Kopanets, A. N. L'vov, P. M. Tutakin, S. P. Tsytko, P. V. Sorokin, A. S. Deyneko, I. Ya. Malakhov, A. Ya. Taranov (Fiziko-tekhnicheskiy Khar'kovskiy institut (Physico-technical Institute, Khar'kov)): The $Si^{28,29,30}(p,\gamma)$, $Ne^{20}(p,\gamma)$, $S^{32-34}(p,\gamma)$, $Ar^{40}(p,\gamma)$ and $N^{14}(p,\gamma)$ reactions. D. G. Alkhazov, A. P. Grinberg, G. M. Gusinskiy, M. Kh. Lemberg, V. V. Rozhdestvenskiy, E. M. Yaroshina of the Leningradskiy fiziko-tekhnicheskiy institut (Leningrad Physico-technical Institute): Investigation of the Coulomb excitation of the lower levels of some nuclei during their bombardment by multiply charged ions (C, N, O, and Ne). A. V. Kalyamin, A. N. Murin, V. N. Pokrovskiy, V. A. Yakovlev (RIAN): New isotopes

Tu^{161}, Ho^{153}, Ho^{155} and Ho^{157}. B. S. Dzhelepov, I. A. Sergiyenko (LGU): Decay schemes of some neutron-deficient isotopes, set up on the basis of measurements of the coincidence of the internal conversion electrons. Spectroscopy Engineering. B. S. Dzhelepov, N. B. Ivanov, V. G. Nedovesov, V. O. Chumin (RIAN): α-spectrometer with double focusing. S. A. Baranov, V. V. Baruchka, A. G. Zelenkov, A. F. Malov, G. Ya. Shchepkin (IAE): Improved α-spectrometer. A. F. Barchuk, G. V. Belykh, V. I. Golyshkin, V. A. Kovtun (IFAN UkrSSR): Magnetic spectrograph for heavy charged particles. The representatives of the Ministerstvo radiotekhnicheskoy promyshlennosti (Ministry of the Radio-engineering Industry) gave a report about new multipliers. The Conference was closed by B. S. Dzhelepov, who stressed the fact that nuclear tables and reference works ought to be published much more quickly in order to be of real use to the experimenter.

Card 3/3

51

YAKOVLEV, V.A.; LEVCHENKO,L.A.

Localization of dehydrogenases connected with nitrogen fixation in Azotobacter vinelandii. Dokl. AN SSSR 159 no.5:1173-1174 D '64 (MIRA 18:1)

1. Institut khimicheskoy fiziki (filial) AN SSSR. Predstavlenc akademikom V.A. Engel'gardtom.

YAKOVLEV, V.A.; VOROB'YEV, L.V.; LEVCHENKO, L.A.; LINDE, V.R.; SLEPKO, G.I.; SYRTSOVA, L.A.

Study of the biological fixation of molecular notrogen.
Biokhimiia 30 no.6:1167-1178 N-D '65. (MIRA 19:1)

1. Filial Instituta khimicheskoy fiziki AN SSSR, Moskva.
Submitted January 18, 1965.

L 10736-66 EWT(m)/EWP(t) IJP(c) JD/JG

ACC NR: AP6005138 (A) SOURCE CODE: UR/0126/66/021/001/0062/0067

AUTHOR: Smirnov, B. I.; Yakovlev, V. A. 54

ORG: Physico-Technical Institute im. A. F. Ioffe, AN SSSR (Fiziko-tekhnicheskiy institut) B

TITLE: Change in the fine crystalline structure and deformation resistance of tungsten during annealing 44,55,21

SOURCE: Fizika metallov i metallovedeniye, v. 21, no. 1, 1966, 62-67

TOPIC TAGS: crystal structure, crystal lattice dislocation, tungsten, annealing, x ray analysis

ABSTRACT: To clarify the question of whether microdistortions are a cause or an effect of the hardening of metals, the authors investigated the redistribution of microdistortions in individual regions of crystal lattice during the annealing of 99.99% pure W, on using the blurring of X-ray lines as a criterion. W was selected because it facilitates the comparison of the variation in microdistortions and in strength characteristics with increasing temperature. Specimens of W were pre-annealed in vacuum for 90 min at 1600°C and subjected to the following operations: deformation by reduction of 7.5% in area at 20°C, radiography, annealing for 90 min at various temperatures to 2000°C, radiography, and second deformation, with determination of

Card 1/2 UDC: 620.183.48

yield points at a deformation of 0.2% during second loading. The fine crystalline structure of deformed W and its variation during annealing was determined according to the blurring of X-ray lines. The dimensions of microdistortions and blocks were determined both according to line width and by the method of harmonic analysis. It turned out that the "effective" dimensions of blocks in the directions [100] and [110] differ somewhat while the microdistortions are the same. On the other hand, it was established that the variation in the microdistortions and yield points of specimens deformed at 20°C follows the same pattern in both cases. These findings are interpreted as follows: The anisotropy of "effective" block dimensions may be due to the presence of packing errors in the layers {112}. The sameness of microdistortions in the directions [100] and [110] is, from the standpoint of the theory of elastically stressed blocks, attributable to the isotropy of the elastic properties of W. and particularly to the proper ratio between the densities of edge and screw dislocations. Further, both the microdistortions and the deformation resistance of specimens were observed to decrease with increasing temperature. Depending on their nature, microdistortions may either contribute to or reduce the stressed state of the specimen: microdistortions which change in polarity over distances of the order of the "path length" of dislocations will impede the migration of dislocations, i. e. contribute to hardening of the metal, while residual microdistortions, resulting from residual stresses, which reverse polarity over much larger distances, should contribute to local plastic flowage. Orig. art. has: 4 figures.

SUB CODE: 11, 13, 20/ SUBM DATE: 06Jan65/ ORIG REF: 012/ OTH REF: 006

Card 2/2 sm

L 44603-66 EWT(1)/EWT(m)/EEC(k)-2/T/EWP(t)/ETI/EWP(k) IJP(c) WG/JD/JG

ACC NR: AP6030983 SOURCE CODE: UR/0181/66/008/009/2816/2818

AUTHOR: Basov, N. G.; Drozhbin, Yu. A.; Zakharov, Yu. P.; Nikitin, V. V.; Semenov, A. S.; Stepanov, B. M.; Tolmachev, A. M.; Yakovlev, V. A.

ORG: Physics Institute im. P. N. Lebedev, AN SSSR, Moscow (Fizicheskiy institut AN SSSR)

TITLE: The effect of injection current on the temporal characteristics of a GaAs laser

SOURCE: Fizika tverdogo tela, v. 8, no. 9, 1966, 2816-2818

TOPIC TAGS: solid state laser, semiconductor laser, gallium arsenide laser, injection laser, ELECTRIC CURRENT, INJECTION CURRENT

ABSTRACT: In an investigation of the temporal characteristics of a GaAs laser the radiative delay time (τ_g) was determined as a function of the injection current. Ordinary diodes, prepared by means of the diffusion process, were placed in a dewar at the liquid N temperature. The laser was excited by a current oscillator with pulse amplitudes from 4 to 40 amp and a duration of 40 nanosec. Several diodes were investigated at threshold currents from 1.8 to 4 amp. The dependence of τ_g on injection current indicates that the value of τ_g approaches 1.6×10^{-9} sec. This corresponds approximately to the spontaneous radiative lifetimes for electrons and holes calculated theoretically elsewhere (W. P. Dumke, Phys. Rev., 132, 1998, 1963). With a 16-fold

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increase of I_{thr}, τ_g increases to 0.9 nanosec; this is explained by the time increase necessary to achieve population inversion. To eliminate delay due to spontaneous emission and to achieve stimulated emission, the diode was pulsed by currents from an auxilliary oscillator with amplitudes of 1.5 I_{thr} and durations of approximately 200 nanosec. Some 50 nanosec after the onset of the auxilliary pulse, the diode was pulsed by a positive current from the master oscillator. The delay time between the onset of the injection current from the master oscillator and the radiation induced by it was measured, and at 17 I_{thr} was reduced to 6×10^{-11} sec. A furcher decrease in τ_g calls for considerably increased injection currents. The experimental data indicate that GaAs lasers can be used as radiation modulators in the centimeter band and as high-speed (10^{-10}--10^{11} sec) optical switches. Orig. art. has: 1 figure. [YK]

SUB CODE: 20/ SUBM DATE: 13Apr66/ ORIG REF: 001/ OTH REF: 002/ ATD PRESS: 5078

YAKOVLEV, V.A.; MIKHAYLOVSKAYA, A.M.; ARTAMONOV, M.A.; SLAVIN, Yu.T.; STRAKHOV, K.I.; KORNYUSHIN, A.K.

Induction furnace for melting [magnesium] alloys; suggestion by V.A.IAkovlev and others. Prom.energ.11 no.6:28-30 Je '56. (MLRA 9:9)
(Electric furnaces) (Magnesium alloys)

YAKOVLEV, V.A., kandidat tekhnicheskikh nauk.

Commercial frequency crucibles for melting light metals. Lit.proizv. no.6:9-15 Je '57. (MLRA 10:9)
(Crucibles) (Aluminum alloys--Electrometallurgy)

YAKOVLEV, Vasiliy Akimovich, kand. tekhn. nauk; RAGAZINA, M.F., inzh., ved. red.; TRUSOV, L.P., kand.tekhn. nauk, red.; SOROKINA, T.M., tekhn. red.

[Induction heating with a commercial frequency current of aluminum and magnesium alloy ingots]Induktsionnyi nagrev tokom promyshlennoi chastoty slitkov iz aliuminievykh i magnievykh splavov. Moskva, Filial Vses.in-ta nauchn. i tekhn. informatsii, 1958. 21 p. (Peredovoi nauchno-tekhnicheskii i proizvodstvennyi opyt. Tema 3. No.M-58-44/3) (MIRA 16:3)
(Induction heating) (Nonferrous ingots)

YAKOVLEV, V.A.

129-1-10/14

AUTHORS: Yakovlev, V.A., Candidate of Technical Sciences and Ya.I. Spektor, Engineer.

TITLE: Induction Heating of Titanium-base Alloys Prior to Plastic Deformation (Induktsionnyy nagrev splavov na osnove titana pered plasticheskoy deformatsiyey)

PERIODICAL: Metallovedeniye i Obrabotka Metallov, 1958, No.1, pp. 43 - 46 (USSR).

ABSTRACT: The advantage of induction heating of titanium alloy blanks prior to plastic deformation is the considerable reduction in the total heating time, thereby reducing the rate of burning off metal, the depth of the changed layer and the danger of crack formation during plastic deformation. This is of particular importance in the manufacture of thin, aircraft components. The authors of this paper aimed at studying certain relations which accompany induction heating of titanium-base alloys and elaborating recommendations relating to the technology of induction heating of such alloys prior to plastic deformation. The kinetics of induction heating of the alloy BT-2 was studied on specimens of 18 mm dia., 14 mm long. The tested alloy contained: 0.68% C, 2.55% Cr, 2.39% Al, 0.11% Fe, 0.418% O_2 and 0.0391% H_2. The heating current was supplied by

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Induction Heating of Titanium-base Alloys Prior to Plastic Deformation.

a rotary generator of 8 000 c.p.s., 100 kW, which was fitted with a hardening machine (the engineers A.P. Gracheva and V.I. Damaskin participated in the experiments). The temperature recording was by means of a loop oscillograph with thermocouple sensing devices welded on to the specimen. The heating was automatically switched off by a photo-electronic pyrometer with a response time of 45 milliseconds. Curves of induction-heating of specimens of BT-2 alloy for various heating speeds are graphed in Fig.1, p.43. All the curves show a bend in the temperature range 400 to 500 °C. The graph, Fig.2, shows the results of heating of 150 mm dia. specimens made of titanium-base alloys by means of currents of industrial frequency in a three-layer inductor; the total heating time is 20 minutes and the temperature gradient between the surface and the core does not exceed ± 10 °C for a duration of 1 1/2 minutes after switching off the heating current; preliminary heating to 800 °C, followed by rapid heating to 1 050 °C reduced by another 2 to 3 minutes the time during which the temperature of the specimens is within the dangerous range of 800 to 1 050 °C. For heating titanium-base alloys, the authors consider more efficient and economical the use of induction muffle

Induction Heating of Titanium-base Alloys Prior to Plastic Deformation.

furnaces operating at industrial frequency in which a muffle of a heat-resistant alloy is heated by induction current and the blank inside the muffle is heated by induction currents and by radiation; in such furnaces, the sealing of the atmosphere and the use of protective atmospheres is usually solved. The sketch of an experimental, 4-channel, 2-muffle, induction furnace of industrial frequency is shown in Fig.4, p.45; the furnace is well-sealed and an inlet is provided for a protective atmosphere. The blanks inside the muffle are displaced along guides and changeover from one standard dimension to another requires substitution of the respective guide elements; such a changeover can be effected in 3 - 4 hours.
There are 4 figures.

AVAILABLE: Library of Congress
Card 3/3

AUTHORS: Yakovlev, V. A. (Cand.Tech.Sci.), Spektor, Ya. I. (Engineer)

TITLE: Gas Corrosion of Titanium Base Alloys in the Case of Furnace and Induction Heating (Gazovaya korroziya splavov na osnove titana pri pechnom i induktsionnom nagreve)

PERIODICAL: Metallovedeniye i Obrabotka Metallov, 1958, Nr 6, pp 52-56 (USSR)

ABSTRACT: The influence was investigated of the thermal parameters of heating on the kinetics of corrosion and the depth of the change layer in the case of heating in the furnace and induction heating. The kinetics of corrosion of the alloy VT2 was determined by the method of continuous weighing on an instrument designed by Prof. I. Sidorin. The specimens were first ground and washed in alcohol. The kinetics of corrosion was investigated in the temperature range 200-1000°C with temperature steps of 100°C; the weighing at the given temperature was effected over 20 minutes. Dry and humid air was used as the aggressive medium. Fig.1 gives the specific increase in weight of the alloy VT2 as a function of time in various media. Other results are entered in a table, p 54 and in graphs, Figs.2-9. It was established that during furnace heating the corrosion in humid air is more intensive at high temperatures (800-1000°C) than for

Gas Corrosion of Titanium Base Alloys in the Case of Furnace and Induction Heating

dry air. At lower temperatures (about 800°C) the corrosion is less intensive in humid air due to the fact that the degree of dissociation of the water is still small and the vapours which are adsorbed on the surface of the specimen impede the access of oxygen molecules. In the case of furnace heating the corrosion speed in undried air increases sharply at 700°C. In the case of induction heating up to 1000°C, the specific weight increase is about ten times lower than in the case of furnace heating and the duration of the heating is about 200 times shorter. In the case of induction heating to 1200°C with a speed of 10 to 150 c/sec the depth of the changed layer is 5 to 6 times smaller than in the case of furnace heating. It was established that in the case of induction heating, the scale formation processes (temperature of beginning of appearance of an opaque film, temperature of flaking off of the film, etc.) are shifted

Gas Corrosion of Titanium Base Alloys in the Case of Furnace and Induction Heating

upwards by about 200°C due to shortening of the heating times. A. P. Grachev and A. I. Pekarev participated in the experiments. There are 9 figures, 1 table and 4 Soviet references.

1. Titanium alloys - Corrosion 2. Titanium alloys - Induction heating
3. Titanium alloys - Corrosion 4. Gases - Corrosive effects

SOV/94-58-12-9/19

AUTHORS: Strakhov, K.I., Andrianov, S.I., Yakovlev, V.A., Ivanchenko, I.N. and Yakovich, A.I.

TITLE: A Continuously Operating Induction Heater for Heating Hot Stamping Tools (Induktsionnyye nagrevateli nepreryvnogo deystviya dlya nagreva shtampov)

PERIODICAL: Promyshlennaya Energetika, 1958, Nr 12, pp 20-21 (USSR)

ABSTRACT: Hot stamping tools are usually heated by tubular heaters but it takes a long time to heat the tools up in this way. The authors have developed a method of using induction heating for these tools. Insulated conductors are inserted in the tools as shown in the sketch and a 50 kVA transformer is used for supply. Conductor dimensions and current ratings are given. An electronic temperature controller is used. With this method of heating the tools are heated continuously and uniformly, the heating time is cut by a factor of five and is now 1.5 to 2 hours, production is of better quality and the power consumption is much less. This suggestion was

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SOV/94-58-12-9/19

A Continuously Operating Induction Heater for Heating Hot Stamping Tools

awarded a fourth premium in an All-Union Power Economy competition. There is 1 figure.

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YAKOVLEV, V. A.

The second prize (imeni N. A. Minkevich) was awarded to Candidate of Technical Sciences V. A. Yakovlev, Engineers Ya. N. Spektor and K. A. Makashev for the paper "New Heat Treatment Technology for Tubular Components of a Complex Geometrical Shape Using Induction Heating for the Hardening Process".

Results of the 1958 Competition for Obtaining imeni D. K. Chernov and imeni N. A. Minkevich Prizes, Metallovedeniye i termicheskaya obrabotka metallov, 1959, No. 6, pp 62-64

YAKOVLEV, V.A.; KUZ'MIN, S.G.; RYBAKOV, P.A.; KORNYUSHIN, A.K.

Induction furnace using industrial frequency and equpped with a cylindrica cast-iron crucible for smelting aluminum alloys. Prom. energ. 14 no.1:39-40 Ja '59. (MIRA 12:1)
(Electric furnaces)

YAKOVLEV, V.A., inzh.

Installation of TS-1 heat registers. Energetick 8 no.8:19-20 Ag '60. (MIRA 13:10)
(Temperature--Measurement)

85028

S/094/60/000/010/002/002
E073/E335

18.7100 1.2400

AUTHORS: Strakhov, K.I., Kachanov, I.I. and Yakovlev, V.A.

TITLE: High-temperature Induction Furnace of Industrial Frequency for Brazing of Components

PERIODICAL: Promyshlennaya energetika, 1960, No. 10, pp. 15 - 16

TEXT: The authors propose a new design of an induction type furnace operating at the supply frequency with a permanent hermetically closed muffle and not an expendable one. The furnace forms a coreless transformer, the primary winding of which is a multiturn solenoid (inductor) and the secondary winding is the hermetic muffle made of a refractory metal. On connecting the inductor to an AC supply, currents are induced in the muffle and partly also in the components inside it which generate the required brazing heat. The temperature control is effected by means of a potentiometer on the basis of temperature values derived from thermocouples fitted inside the furnace. The furnace consists of the following basic parts: housing - 1; inductor - 2; thermal insulation - 3; hermetic muffle - 4; lid - 5 and the magnetic circuit - 6.

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E073/E335

High-temperature Induction Furnace of Industrial Frequency for Brazing of Components

The housing is made of ordinary "steel 5" and its dimensions are 1 000 x 1 000 mm. To prevent heating of the housing separation gaps are provided. The inductor is a two-layer one and has 78 turns of a 16 x 16 mm hollow aluminium conductor. The outer layer has 5 tappings, enabling selection of the necessary thermal regime of the furnace. The dimensions of the inductor are: external diameter 823 mm; internal diameter 785 mm and height 750 mm. The thermal insulation is made of "ultra-lightweight" material (between the internal layer and the external surface of the muffle) and firebrick. The muffle is made of refractory EI-435 (EI-435) sheet steel, 11 mm thick; the joints are fused by argon arc welding. The cover of the furnace is of nonmagnetic steel, 14 mm thick with a pipe connection for fitting a vacuum pump, introducing a gas flux and thermocouples. On the inside the lid is fitted with thermal insulation. On the outside it is water-cooled. The furnace characteristics are as follows: power 65 kW; voltage 380 V; current consumption 180 A; current intensity

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High-temnerature Induction Furnace of Industrial Frequency for Brazing of Components

in the furnace 700 A; rating of the condenser bank 350 kVAr; temperature 1 200 - 1 250 °C. This furnace has the following advantages: the power consumption is only one-quarter of that of a chamber furnace; the process is much less laborious; a great saving is obtained in expensive refractory metal for manufacturing the muffles. The annual saving in electricity amounts to 600 000 kWh. This proposal was awarded second prize in the Fifteenth All-Union Competition for Saving Energy. There is 1 figure.

Card 3/3

YAKOVLEV, V.A.; DOBRIN, Z.Ye.; KOLDASHOV, S.S.

Building tunnel kilns at the Borovichi Refractories Combine.
Ogneupory 26 no.6:252-255 '61. (MIRA 14:7)

1. Borovichskiy kombinat ogneuporov (for Yakovlev, Dobrin).
2. Stroitel'nyy uchastok - 81 tresta No.43 Upravleniya stroitel'stva Leningradskogo sovnarkhoza (for Koldashov).
(Borovichi--Kilns)

L 17349-63 EWP(k)/EWP(q)/EWT(m)/BDS AFFTC Pf-4 JD/HM
ACCESSION NR: AP3006477 S/0135/63/000/009/0004/0007 64

AUTHOR: Lyubavskiy, K. V. (Dr. of technical sciences, Prof.); Smirnov, A. G. (Engineer); Antonov, Ye. G. (Engineer); Yakovlev, V. A. (Cand. of technical sciences); Dubrovskiy, S. M. (Engineer); Ly*kova, Z. V. (Engineer)

TITLE: Automatic welding of 25KhSNVFA steel with induction post-heating 18 16

SOURCE: Svarochnoye proizvodstvo, no. 9, 1963, 4-7

TOPIC TAGS: high strength pearlitic 25KhSNVFA steel, carbon dioxide shielded automatic welding, automatic submerged arc welding, weld metal ductility, weld metal strength, weld metal notch toughness, weld metal microstructure, induction postheating, postheating effect, combined welding postheating unit, high pressure vessel welding

ABSTRACT: Heat-treated (hardened and tempered) 25KhSNVFA pearlitic high-strength steel [0.23—0.25% C; 0.5—0.8% Mn; 0.9—1.2% each of

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L 17349-63

ACCESSION NR: AP3006477

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Si, Cr, and Ni; 0.5—1.0% W, 0.05—0.15% V] sheets were welded with a carbon dioxide shielded arc and Sv-08G2S electrode wire without backup. Annealed plates 6 mm thick were submerged-arc-welded with 20KhSNVFA electrode wire and AN-15 flux [23.5% SiO_2, 21.0% Al_2O_3, 1.0% Fe_2O_3, 14.0% CaO, 9.3% MgO, 2.7% MnO, 21.3% CaF_2, 0.03% P, 0.03% S] using a copper backup plate. All welds were single-pass square-butt welds. Induction postheating was applied with an induction heater rigidly attached to the welding head at a distance of 350 or 500 mm. This distance was found experimentally and determined the weld temperature at which postheating was applied — 620K, about 20K higher than the M_s point. The heater length, 300 or 450 mm, determined duration of heating, 60 or 90 sec; the postheating temperature was 770—920K for heat-treated steel welds and 970K for annealed steel welds. It was found that in welding hardened or annealed steel, the induction postheating significantly increased the ductility of the weld metal without decreasing the strength of the joint. For example, the tensile strength of the postheated joints of heat-treated 25KhSNVFA steel plates welded with a CO_2 shielded arc varied between 112 and 120 kg/mm^2, the

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ACCESSION NR: AP3006477

bend angle, between 50 and 82°, and the notch toughness, between 5 and 6 mkg/cm^2, compared to 117—121 kg/mm^2, 44—52°, and 3.4—4.2 mkg/cm^2 for welds not postheated. The induction-heated zone adjacent to the weld consisted of martensite, bainite, and pearlite instead of the coarse acicular martensite formed in welds without postheating. This technique has been successfully employed to fabricate industrial high-pressure vessels from 25KhSNVFA steel. The vessels consisted of three cylindrical shells with a wall thickness of 6 mm and two hemispherical end closures formed of 8 mm-thick plate welded to the cylindrical portion. The closures had welded-in central pipe connections. All welds were made with a submerged arc from both sides using 20KhSNVFA filler wire and AN-15 flux. Separate welding units with induction heaters fed by a current at 2500 cps were used for making the longitudinal, circumferential, and circular welds. Orig. art. has: 9 figures and 2 tables.

ASSOCIATION: none

SUBMITTED: 00 DATE ACQ: 30Sep63 ENCL: 00

SUB CODE: MA NO REF SOV: 002 OTHER: 000

Card 3/3

YAKOVLEV, V.A.

USSR/Electricity - Ferromagnetics Mar 52

"Additional Resistance of Ferromagnetic Metals," A. G. Samoylovich, V. A. Yakovlev, Chernovtsy State U

"Zhur Eksper i Teoret Fiz" Vol XXII, No 3, pp 350-355

Considers the influence of spontaneous magnetization of a ferromagnetic crystal upon its elec resistance. Establishes thermal dependence of the addnl resistance in a low temp range. Received 23 Oct 51.

21-5T20

YAKOVLEV, V.A.

ABEL'SKIY, Sh.Sh.; YAKOVLEV, V.A.

Additional resistance of ferromagnets in a magnetic field. AN URSR no.2:143-145 '55. (MLRA 8:11)

1. Chernivets'kiy derzhavniy universitet. Predstaviv diysniy chlen Akademii nauk URSR V.E.Lashkar'ov.
(Ferromagnetism)

SOV/58-59-5-10870

Translation from: Referativnyy Zhurnal Fizika, 1959, Nr 5, p 138 (USSR)

AUTHOR: Yakovlev, V.A.

TITLE: Effect of Electric Field on the State of Electrons in a Solid Body

PERIODICAL: Nauk. zap. Chernivets'k un-t, 1955, Vol 12, pp 147 - 157 (Ukr.; Russ. résumé)

ABSTRACT: The author applies Van'ye (Russ. spell.) functions to the case of a crystal with narrow bands (insulator, semiconductor). He obtains eigenfunctions and the energy spectrum of electrons in the presence of a homogeneous electric field. He calculates the probability of an electron transition from one band to the next. This probability has a form that differs from that known up to the present and points to the existence of an anisotropic dependence of the pre-breakdown current upon the magnitude of the field for the case of a three-dimensional crystal. It is shown that, thanks to this mechanism, the time of passage of significant pre-breakdown current is of an order corresponding to the experimental data.

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The author's résumé

SOV/58-59-5-10953

Translation from: Referativnyy Zhurnal Fizika, 1959, Nr 5, p 149 (USSR)

AUTHORS: Samoylovich, A.G., Yakovlev, V.A.

TITLE: The Kinetics of Semiconductor Photoconductivity

PERIODICAL: Nauk. zap. Chernivets'k. un-t, 1955, Vol 12, pp 167 - 175 (Ukr.; Russ. résumé)

ABSTRACT: The authors studied the character of photocurrent in relation to time as the light which illuminates the semiconductor is switched on and off. The introduction into the kinetic equation of a "statistical term" which takes the thermal interaction of the levels into account makes it possible, in the main, to explain the breaking up of semiconductors that Gurevich and Tolstoy propounded (Gurevich, Tolstoy, Dokl. AS USSR, 1950, Vol 72, p 473); namely, the hyperbolic or exponential character of the variation of the photocurrent is directly caused by the character of steady semiconductor photoconductivity. (Chernivetsk. un-t, USSR).

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The authors' résumé

YAKOVLEV, V. A.

21-5-6/26

AUTHORS: Tarnavskaya, M.V. (Tarnavs'ka, M.V.) and Yakovlev, V.A. (Yakovlyev, V.A.)

TITLE: Excitation Spectrum of a System of Many Particles in a Magnetic Field (Spektr vozbuzhdeniy sistemy mnogikh chastits v magnitnom pole)

PERIODICAL: Dopovidi Akademii Nauk Ukrains'koi RSR, 1957, Nr 5, pp. 448-452 (USSR)

ABSTRACT: The author gives the results of an investigation of excitation spectrum in systems of charged particles of one sign being in a constant homogeneous magnetic field. These results can be applied to an electron plasma. The formula for a "dispersion equation" (formula 6) takes into account all the quantum effects for the case of particles interacting according to any central law. The most complete results are obtained for the particles with the Coulomb interaction law (for "plasma"). The method of density matrix is employed, and the presence of half-integer spin of the particles and correlation due to identity of the particles are taken into consideration. The dispersion equation obtained connects the oscillation frequency with the wave vector. The equation is solved, by means of expansion into series by Bessel functions, for two cases of low temperatures (formula 10) and high temper-

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atures, when the degeneration of the electron gas is left without consideration (formula 12). It can be shown by this method that magnetic field strength does not affect the excitation spectrum of Bose-particle systems at T = 0. The article contains 6 Slavic references.

ASSOCIATION: Chernovtsy University

PRESENTED: By V.Ye.Lashkarev (Lashkar'ov), Member of the AN Ukrainian SSR

SUBMITTED: 20 October 1956

AVAILABLE: Library of Congress

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S/139/60/000/01/002/041
E192/E382

AUTHOR: Yakovlev, V.A.

TITLE: Influence of the Electric Field on the Mobility of Current Carriers in Semiconductors

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Fizika, 1960, pp 12 - 15 (USSR)

ABSTRACT: The general theory of the influence of the electric field on the mobility in pure atomic semiconductors was given in the works of Davydov, Landau and Kompaneyets (Refs 1,2). In practice, however, the semiconductors are used with impurities which can change completely the behaviour of the current carriers. In particular, in a strong electric field, the deviations from the Ohm's law will be determined by the impurities, as can be seen from some experiments carried out on n-type germanium (Ref 3). The theory of this effect (Refs 4, 5) showed that in order to determine the relaxation time it is not possible to employ the perturbation theory for low temperatures. In view of the particular part played by the quantum effects, the relaxation time can have several values. These are given by Eqs (1) for the collision forces. For the resonance

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Influence of the Electric Field on the Mobility of Current Carriers in Semiconductors

scattering conditions, the times are expressed by Eqs (3), while for the scattering corresponding to the Ramsauer effect they are given by Eqs (4), where a is the radius of the impurity potential and N_i is the impurity concentration. These results can be used to determine the distribution function. The function is assumed to be in the form:

$$f(p) = f_o(\varepsilon) + \frac{p}{p} f_1(\varepsilon) \quad .$$

The first component of the function is expressed by Eq (6), where the parameters ζ and w are defined on p 13. The mobility can be expressed by:

$$\mu = \frac{e}{3m}\left(\overline{\frac{1}{v^2}\frac{d}{dv}(\zeta v^2)}\right) \qquad (7)$$

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Influence of the Electric Field on the Mobility of Current Carriers in Semiconductors

where the averaging is effected by employing the function f_o. At high temperatures the mobility can be expressed by either of Eqs (8), where μ_L is the background mobility. At low temperatures, provided the conditions of Eqs (1) and (2) are fulfilled, the mobility is expressed by Eq (9), where $\eta = \beta/(1 + \tau_o/B)$, $B = B_o$ or B_Π and $W_{\mu,\nu}$ is the Whittaker function. At small E the mobility is given by Eq (10), whilst at strong fields it is expressed by Eq (11). On the other hand, the resonance scattering results in a formula for the mobility which is in the form of Eq (12). Consequently, at weak fields, the mobility is given by Eq (13) and at strong fields it is in the form of Eq (14). In the case corresponding to Eqs (4), the mobility is expressed by Eq (15). Consequently, at high concentrations the mobility is given by Eq (16) and at strong fields it is expressed by Eq (17). The results obtained above for comparatively weak fields (Eqs 8, 10, 13 and 16) are analogous to those

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E192/E382

Influence of the Electric Field on the Mobility of Current Carriers in Semiconductors

obtained by M. Sodha (Ref 6). There are 7 references, 5 of which are English and 2 Soviet.

ASSOCIATION: Stalingradskiy podinstitut (Stalingrad Pedagogical Institute)

SUBMITTED: February 6, 1959, initially;
June 11, 1959, after revision.

4

Card 4/4

YAKOVLEV, V.A.

S/181/60/002/007/036/042
B006/B060

AUTHOR: Yakovlev, V. A.

TITLE: Absorption of Infrared Radiation by Electrons in n-Type Silicon

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 7, pp. 1624-1628

TEXT: As is known, a theory of infrared absorption in semiconductors may be developed without making use of equations of motion. This is of special importance for semiconductors with a complex system of electron energy (Si, Ge). As regards germanium there are many more publications available than on silicon. The present paper makes a contribution to this problem. The conduction band structure of n-type silicon in which the absorption by electron scattering can be explained by atomic vibrations and lattice defects, has already been discussed in the paper of Ref. 3 and is therefore assumed to be known. The author gives a theory of infrared absorption due to electron scattering by atomic vibrations. The absorption of a photon by a band electron becomes possible owing to the simultaneous absorption or emission of a photon. The probability of this two-stage process is calculated here by perturbation method in the second approximation.

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Absorption of Infrared Radiation by Electrons in n-Type Silicon

S/181/60/002/007/036/042
B006/B060

For the electrons of the conduction band of n-type Si (whose distribution in the k-space is known) the author first gives an equation for the isoenergetic surface E(k) and one for the matrix element that describes the photon absorption. The Hamiltonian of the interaction with long-wave acoustic oscillations is derived, and an expression (4) is finally given for the probability of photon absorption in which acoustic phonons participate. Next, expressions are derived for the absorption coefficients (first, for the acoustic branch of the atomic vibration spectrum). In the following, the author studies the effect of the optical branch also. The method of the deformation potential, which can be used in the first case, cannot be employed in the second case, so that it is necessary to analyze the matrix elements. A general expression is derived for the absorption coefficient, after which some limiting cases are examined, for which the expressions for the absorption coefficient can be considerably simplified. There are 6 references: 1 Soviet and 5 US.

ASSOCIATION: Stalingradskiy pedagogicheskiy institut (Stalingrad Pedagogical Institute)

SUBMITTED: October 28, 1959

Card 2/2

84618

S/181/60/002/010/047/051
B019/B056

24.2600 (1141 only)
26.2421

AUTHOR: Yakovlev, V. A.

TITLE: The Absorption of Infrared Radiation in n-Type Silicon

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 10, pp. 2639 - 2640

TEXT: In a paper by V. S. Vavilov (Ref.1) a report was given on the anomalous behavior of n-type silicon in the absorption of radiations in the range of 2-7 μ. In this range the absorption coefficient was greater than it ought to have been according to the usual theory. Vavilov suggested the impurities as the cause for this. The present author gives a possible explanation of this anomaly, ascribing the main part played to the absorption of the free carriers, and without taking absorption by impurities into account. Using a result obtained by Yamashita et al. (Ref.5), who put $\hbar\omega_0/kT = 5$, where ω_0 is the frequency of the optical vibrations, the author, on the basis of published results, obtained for the absorption coefficient

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The Absorption of Infrared Radiation in n-Type Silicon

$\mu = 0.62(\lambda^{3/2} + 7.7 \frac{D^2}{C_1^2} \sqrt{\lambda}(1-\lambda/\lambda_0)^{5/2})\,cm^{-1}$ (2), λ is given in μ. By putting $7.7 \frac{D^2}{C^2} = 7$, the absorption curve obtained by Vavilov is well approximated with (2). D and C are coupling constants of electrons with acoustical and optical vibrations, respectively. Thus, the anomalous behavior of absorption may be explained by the effect of the optical branch of the lattice vibrations. There are 7 references: 3 Soviet and 4 US.

ASSOCIATION: Stalingradskiy pedagogicheskiy institut (Stalingrad Pedagogic Institute)

SUBMITTED: March 19, 1960

83178

S/056/60/039/002/015/044
B006/B056

24.2200

AUTHORS: Yakovlev, V. A., Kalyush, A. V.

TITLE: The Excitation Spectrum of a System of Electrons and Ions Located in a Homogeneous Magnetic Field

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 2(8), pp. 308-310

TEXT: The existing mathematical methods of taking collective Coulomb interactions in a multi-particle system into account are being more and more used also in solid-state physics. In the case of a metal, this system is approximated by an isotropic plasma, and in first approximation, the periodicity of ion distribution (in the lattice points) may be ignored when calculating the physical properties of such a plasma, which are, of course, temperature-dependent, the ion motions must be taken into account. V. P. Silin has already investigated the weakly excited states of electrons and ions by means of a quantum equation of motion in a self-consistent field. From an analysis of the dispersion equation it followed

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that in the long-wave range, excitations were essentially of a collective character. By employing a method similar to that used by Silin, the authors of the present paper investigate the influence of a constant homogeneous magnetic field upon the spectrum of the longitudinal excitations of the system investigated. Here, only the long-wave part of the spectrum is investigated, which plays the most important part in many physical phenomena. The authors proceed from a relation for the electron (and ion) distribution function of weakly excited states. The dispersion relations are given, and the authors go over to the Fourier components according to a method developed by L. D. Landau. In the absence of a magnetic field, the dispersion relations (1) furnish (in the case of small k, i.e., long waves) two vibration branches: an acoustic and an electronic one. The thermal motion in a metal excites only acoustic oscillations; for the excitation of electronic oscillations about 10^4 °K would be necessary. The acoustic branch of excitations is further investigated for $T > \theta$ (θ - Debye temperature). Fermi distribution is assumed to hold for the degenerate electron gas, and Maxwell distribution for the ions. The effect of the magnetic field upon this branch is formulated, and several relations

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The Excitation Spectrum of a System of Electrons and Ions Located in a Homogeneous Magnetic Field

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B006/B056

are given. If there is no field, one obtains the same results as Silin. There are 7 references: 6 Soviet and 1 US.

ASSOCIATION: Stalingradskiy pedagogicheskiy institut (Stalingrad Pedagogical Institute).
Chernovitskiy gosudarstvennyy universitet (Chernovtsy State University)

SUBMITTED: December 22, 1959

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YAKOVLEV, V.A.

Concentration of vacancies in solids. Izv.vys.ucheb.zav.; fiz. no.1:143-146 '61. (MIRA 14:7)

1. Stalingradskiy pedagogicheskiy institut.
(Crystals—Defects)

25685

S/181/61/003/007/007/023
B102/B202

24.7700 (1160, 1138, 1035)

AUTHOR: Yakovlev, V. A.

TITLE: Theory of electron conductivity of narrow semiconductor bands in a strong electric field

PERIODICAL: Fizika tverdogo tela, v. 3, no. 7, 1961, 1983 - 1986

TEXT: The author presents a theoretical study of the conductivity caused by the effect of a strong electric field on the state of the electrons in narrow, not filled semiconductor bands. In the calculation of the electrical resistance in solids it is usually assumed that the wave functions and the electron energy spectrum are not influenced by an external magnetic field. (This field causes only a redistribution of the electrons to the levels.) This model applies to metals, but, not to semiconductors where the field strengths may attain 10^6 v/cm. Such a field cannot always be regarded as a disturbance of the periodic field within the crystal; its effect (also in zeroth approximation) on the steady states of the electrons has to be taken into account. I. M. Lifshits and M. I. Kaganov (UFN, LXIX, 419, 1959) discussed the problem of the existence

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Theory of electron ...

of steady states of a crystal electron in a homogeneous electric field. The existence of states corresponding to a finite motion is well substantiated for any law of dispersion and fields not causing band-to-band transitions. In metals, the electron level quantization in an electric field does, however, not cause the observed effect (1). The author studies the possibility of observing the contribution of this effect in semiconductors with narrow bands to their electrical conductivity. He uses the Vannier representation of the single-electron wave function $\Psi(\vec{r}) = \sum_{n,l} \Psi_n(\vec{r}_l) w(\vec{r} - \vec{r}_l)$ (1) where $w_n(\vec{r} - \vec{r}_i)$ are the Vannier functions of the n-th band localized at the point l_x, l_y, l_z. Neglecting the band-to-band transitions (which is justified at 10^5 - 10^6 v/cm) $(E_n(\hat{\vec{p}}) + e(\vec{\mathcal{E}}\vec{r}) - E)\Psi_n(\vec{r}) = 0$ is the equation determining Ψ_n. Here, $\mathcal{E}$ is the field strength of the homogeneous electric field, $E_n(p)$ an operator. In the following the author confines himself to a cubic crystal with narrow conduction band (or narrow impurity band). Here, $E_n(\hbar\vec{k}) = E_n - 2\alpha_n \sum_i \sin^2 \frac{\vec{a}_i\vec{k}}{2}$ (3) holds; $\vec{a}_i$ are the translation vectors.

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Theory of electron ...

Thus, the following solution is obtained for Ψ_n : $\Psi_n(\vec{r})$ $= J_{s_x-l_x}(\alpha_x) J_{s_y-l_y}(\alpha_y) J_{s_z-l_z}(\alpha_z)$ where J are Bessel functions, $\alpha_x = \alpha_n / la\mathcal{E}_x$, s_i integer numbers. Hence, the (normalized) wave function takes on form

$$\Psi_{s_x, s_y, s_z}(\mathbf{r}) = \sum_l J_{s_x-l_x}(\alpha_x) J_{s_y-l_y}(\alpha_y) J_{s_z-l_z}(\alpha_z)\, w(\mathbf{r}-\mathbf{r}_l), \qquad (5)$$

and the energy spectrum is given by $E = E_n - 3\alpha_n + \sum ea\mathcal{E}_i s_i$. The transition between the states $\vec{s} \to \vec{s}'$ is given by the matrix element

$$\left.\begin{aligned} \langle \Psi_s | \delta V | \Psi_{s'} \rangle = A_\sigma \sqrt{\frac{\hbar}{M\omega}} \left\{ \frac{\sqrt{n_\sigma + 1}}{\sqrt{n_\sigma}} \right\} J_{s'_x - s_x}(\beta_x) J_{s'_y - s_y}(\beta_y) J_{s'_z - s_z}(\beta_z) \times \\ \times \exp\left(-i \sum_i (s_i a\sigma_i - (s'_i - s_i)\varphi_i) \right), \\ \beta_i = \frac{2a_n}{ea\mathcal{E}_i} \sin\left(\frac{\sigma_i a}{2}\right); \quad \varphi_i = -\frac{\sigma_i a + \pi}{2}. \end{aligned}\right\} \qquad (11)$$

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Theory of electron ...

this expression is obtained after some transformation; $\delta V = -(\delta\vec{R}\nabla V)$, where $V(\vec{r})$ is the periodic lattice potential, $\delta R = \sum_{\sigma,\lambda} \vec{\varepsilon}_{\sigma\lambda} q_\sigma e^{i\sigma\vec{r}}$, $\vec{\sigma}$ is the phonon wave vector, λ the polarization index. Assuming δV as small,

$$P(s, s') = \frac{2\pi}{\hbar} |\langle \Psi_s | \delta V | \Psi_{s'} \rangle|^2 \delta(E(s) - E(s') \pm \hbar\omega). \qquad (12)$$

is obtained for the transition probability (per sec) ($\pm$ denotes absorption or emission of phonons). Each transition $\vec{s} \to \vec{s}'$ is accompanied by a translation of an electron in the crystal. Such transitions take place if direct and back current differ in magnitude. If $\varepsilon_y \ll \varepsilon_x$, $\varepsilon_z \ll \varepsilon_x$, $j_x = \frac{f_1(\theta) + (\varepsilon_y + \varepsilon_z) f_2(\theta)}{\varepsilon_x}$ (17) is obtained for the current resulting thereof in the narrow impurity bands while $\sigma = \frac{f_1(\theta) + (\varepsilon_y + \varepsilon_z) f_2(0)}{\varepsilon_x^2}$

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Theory of electron ...

$$f_1(\theta)=A_0\int\frac{\sigma^2}{\omega^2}\left(1-e^{-\frac{\hbar\omega}{\theta}}\right)d\sigma,\quad f_2(\theta)=A_0\int\frac{\sigma^2\hbar}{\omega}\left(1-e^{-\frac{\hbar\omega}{\theta}}\right)d\sigma,$$
$$A_0=\frac{2\pi A^2kT_e}{M\hbar a^5}. \qquad (18)$$

is obtained for the conductivity. There are 5 references: 4 Soviet-bloc and 1 non-Soviet-bloc.

ASSOCIATION: Stalingradskiy pedagogicheskiy institut (Stalingrad Pedagogical Institute)

SUBMITTED: January 25, 1960 (initially) and January 30, 1961 (after revision)

Card 5/5

25192
S/056/61/040/006/013/031
B111/B201

247400 (1160, 1395, 1055)

AUTHOR: Yakovlev, V. A.

TITLE: Light absorption by electrons of nonmetallic crystals in an electric field

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 6, 1961, 1695 - 1698

TEXT: The author has studied absorption processes in a regular lattice, in which the electron wave functions are changed markedly and thus disturb the strong periodicity of the lattice field. This disturbance is here assumed to be caused by an outer homogeneous electric field. It is shown that a sufficiently strong field may under given conditions change the electron states in such a way that direct transitions become possible between the levels of the conduction band under absorption or emission of a photon. The following relation holds for the wave function: $\psi(r) = \sum_{n,m} \Phi_n(\vec{r}_m)\, w_n(\vec{r} - \vec{r}_m)$, where $w_n(\vec{r} - \vec{r}_m)$ is Wanne's function of the band with the number n in the lattice point $\vec{m}$ (l_x, l_y, l_z). For the

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Light absorption by electrons ...

coefficients ϕ_n $(E_n^0(\vec{p}) + \vec{r}\vec{F} - E)\phi_n = -\sum_{n' \neq n} \vec{F}\vec{r}_{nn'}\phi_{n'}$ (2) holds, where $\vec{F}/e$ is the electric field strength, $\vec{r}_{nn'}$ the matrix element of the coordinate, $E_n^0(\vec{p})$ the operator obtained from the expression for the energy of the n band. The right-hand side of (2) is neglected in zeroth approximation. To obtain an explicit form for ϕ_n and E_n^0, a calculation is made in strong-coupling approximation (F. Zeyts, Sovremennaya teoriya tverdogo tela, IIL, 1949 (Modern theory of solids)), which, for a simple cubic lattice, yields: $E_n^0 = E_n - 2\alpha_n \sum_{i=1}^{3} \sin^2(\vec{a}_i\vec{k}_i/2)$, where $\vec{a}_i$ are chief translations, $2\alpha_n$ the band width. For ϕ_n,

$$\Phi_n(r) = AJ_{k'}(-\alpha_n/aF_x)\,J_{k''}(-\alpha_n/aF_y)\,J_{k'''}(-\alpha_n/aF_z); \qquad (5)$$

$$k' = C_1/aF_x + x/a, \quad k'' = C_2/aF_y + y/a, \quad k''' = C_3/aF_z + z/a.$$

is found. Because of the finiteness of the wave functions, the Bessel

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Light absorption by electrons ...

functions of 1st order and k', k'', k''' must be finite.
$E = E_n - 3\alpha_n + \sum_i aF_i s_i$, where s_i are finite and equal to c_i/a_iF_i.
Expression

$$\psi_{s_x s_y s_z}(r) = \sum_{l_l} J_{s_x - l_x}\left(\frac{-\alpha_n}{aF_x}\right) J_{s_y - l_y}\left(\frac{-\alpha_n}{aF_y}\right) J_{s_z - l_z}\left(\frac{-\alpha_n}{aF_z}\right) w_n(r - r_m). \quad (7)$$

then holds for the wave function, electron transitions from and into the conduction band being disregarded in the derivation. For quantizing the states it is necessary that the amplitude of the periodic motion be of the order $2\alpha_n/F$ and be smaller than the mean free path. This is not achievable in metals, whereas in a group of semiconductors (Ge, Si) these conditions are easily satisfied. Under the premise that the quantization conditions be satisfied, the absorption coefficient μ is derived. The relation for the interaction of electrons with light reads $\delta v = e\vec{A}\vec{p}/mc$, with $\vec{A} = (\Omega\varepsilon)^{-1/2}\sum_{\sigma,t} q_\sigma \vec{\xi}_{\sigma t} \exp(i\vec{\sigma}\vec{r})$, where $\vec{\sigma}$ is the wave vector of photons, $\vec{\xi}_{\sigma t}$ are unit vectors of polarization, Ω is the crystal volume. The matrix element for a transition from the state s_x, s_y, s_z

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Light absorption by electrons ...

to the state s'_x, s'_y, s'_z has the form

$$\langle \psi_{s'} | \delta V | \psi_s \rangle = \frac{e}{mc\sqrt{\Omega e}} \sum_{\sigma, l, l'} q_\sigma \prod_{l=1}^{3} J_{s_l - l_l}\left(\frac{-\alpha_n}{eF_l}\right) J_{s'_l - l'_l}\left(\frac{-\alpha_n}{aF_l}\right) \times$$

$$\times \int w_n (r - r_l) (\xi_\sigma p) e^{i\alpha r} w_n (r - r_{l'}) \, d\tau. \qquad (11)$$

With denotations

$$A_0 = \int w_n (\rho) \, p_x w_n (\rho \pm a_1) \, d\tau = \int w_n (\rho) \, p_y w_n (\rho \pm a_2) \, d\tau =$$

$$= \int w_n (\rho) \, p_z w_n (\rho \pm a_3) \, d\tau;$$

$$A_1 = \int w_n (\rho) \, p_x w_n (\rho \pm a_2) \, d\tau = \int w_n (\rho) \, p_x w_n (\rho \pm a_3) \, d\tau. \qquad (12)$$

one finds

$$\mu = \bar{P}\sqrt{e}/c, \qquad (13)$$

$$\bar{P} = \frac{2\pi}{\hbar} \sum_{s, s'} |\langle \psi_{s'} | \delta V | \psi_s \rangle|^2 \rho (E_{s'}) f (E_s) \qquad (14)$$

where $\bar{P}$ denotes the total absorption probability referred to 1 sec,

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Light absorption by electrons ...

$f(E_s)$ is the Maxwell-Boltzmann distribution function of the electrons as referred to the total number N, ε is the optical dielectric constant, $\varrho(E)$ is the density of the state numbers in the energy spectrum of the electrons.

$$\mu = \frac{2\pi n e^2 (A_0 + 2A_1)^2}{m^2 c\omega \sqrt{\varepsilon}\, aF} J^2_{\hbar\omega/aF}\left(\frac{\alpha_n}{aF}\sin\frac{\sigma a}{2}\right) \qquad (15)$$

is obtained for μ under the assumption of the nonpolarized radiation being incident along the x-axis and $\hbar\omega \gg |\alpha_n \sin\frac{\sigma\alpha}{2}$, $n = N/\Omega$. If, in addition, $\sigma a \ll 1$ and $\alpha_n \sim 0.1 - 1$ ev, μ may be written in the form of

$$\mu = \frac{ne^2 (A_0 + 2A_1)^2}{m^2 c \sqrt{\varepsilon}\, \hbar\omega^2} (1 - e^{-\hbar\omega/kT}) e^{-F_0(\omega)/F}, \quad F_0(\omega) = \frac{\hbar\omega}{2a} \ln\left(\frac{\hbar\omega}{\alpha_n \sin(\sigma a)}\right). \qquad (16)$$

An absorption decreasing with rising frequency results, as opposed to experiments by V. A. Vasilov and K. I. Britsyn (FTT, 2, 1937, 1960). I. M. Lifshits and M. I. Kaganov are mentioned. There are 10 references: 8 Soviet-bloc and 2 non-Soviet-bloc.

Card 5/6

25192
S/056/61/040/006/013/031
B111/B201

Light absorption by electrons ...

ASSOCIATION: Stalingradskiy pedagogicheskiy institut (Stalingrad Pedagogical Institute)

SUBMITTED: October 2, 1960 (initially)
January 12, 1961 (after revision)

Card 6/6

36888

S/181/62/004/004/032/042
B102/B104

9.4179
26.1512

AUTHOR: Yakovlev, V. A.

TITLE: Low-temperature light absorption by the carriers in certain semiconductors

PERIODICAL: Fizika tverdogo tela, v. 4, no. 4, 1962, 1046-1049

TEXT: The author studies the effect of carrier degeneracy on the temperature and frequency dependences of the light absorption coefficient in semiconductors such as Ge, Si, or InSb. Absorption is assumed to be mainly dependent on scattering from impurities and acoustical phonons; the total absorption coefficient is thus given by $\alpha = \alpha_g + \alpha_a$. The interaction energy between carriers and the impurity center is described by a Coulomb potential $V = e^2 e^{-\delta r}/\varepsilon r$, $\delta = 4\pi n/\varepsilon kT$, n - carrier concentration, ε - dielectric constant. For $\hbar\omega \gg kT$,

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Low-temperature light absorption by ...

$$\alpha_g = \frac{4n_i f_0^2 e^6 kT}{3c\varepsilon^{5/2}\hbar^4 (b-1)\omega^3}\left\{ G(\infty)\left(\frac{\pi^2}{12}+\frac{1}{2}+\frac{1}{2}(\ln 2s)^2\right) - \right.$$
$$\left. - \sum_{i=1}^{2} A_i \left[\mathrm{Ei}^2\left(-\frac{\beta_i z^2}{c_i\Delta}\right) + \frac{c_i\Delta}{z^2\beta_i}\left(1-e^{-\frac{z\beta_i}{\Delta c_i}}\right)\right]\right\}, \qquad (10)$$
$$c_1 = \sqrt{s(1+s)}+s; \quad c_2 = \sqrt{s(1+s)}-s.$$

is obtained with $\Delta = \hbar^2\delta^2/8m_1 kT$, m_1 - transverse, m_2 - longitudinal effective mass, n_i - impurity concentration, μ - chemical potential of the carriers;

$$y(\zeta) = \exp\left(2z - \frac{\mu}{kT} + \zeta + \frac{z^2}{\zeta}\right); \quad z = \frac{\hbar\omega}{4kT}, \quad b = \frac{m_2}{m_1}; \qquad (6a)$$

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$$\ln\left(1+\frac{e^{t^2}-1}{y(\zeta)+1}\right)\simeq\ln(a^2-b^2\zeta^2),$$

$$\xi=\frac{\zeta}{\sqrt{2x}}-\sqrt{\frac{x}{2}};\quad a^2=1+s\quad b^2=\frac{2}{x}s\quad s=\frac{e^{t^2}-1}{e^{\frac{\hbar\omega-\mu}{kT}}+1}. \tag{8}$$

The phonon-scattering component is given by

$$\alpha_a=\frac{32e^2m_1^2m_2(kT)^4}{\pi c\varepsilon^{1/2}\hbar^8m\omega^3}\Phi(b)x^2f(s),$$

$$f(s)=2\sqrt{\frac{1+s}{s}}\ln\left(\sqrt{1+s}+\sqrt{s}\right)-\frac{s+1}{4s}\ln(1+s)-\frac{3}{2} \tag{12}$$

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