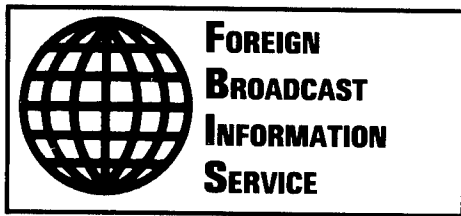


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24 AUGUST 1988



# ***JPRS Report***

# **Soviet Union**

***USSR: Materials Science***

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# Science & Technology

## USSR: Materials

JPRS-UMS-88-014

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UDC 541.65

**Influence of Phase Structure Transformations on Optical, Magneto-optical Characteristics of Fe-Ni Alloys**

18420239a Moscow FIZIKA METALLOV I  
METALLOVEDENIYE in Russian  
Vol 65 No 3, Mar 88 (manuscript received  
7 May 86) pp 505-511

[Article by Ye.A. Ganshina, D.N. Dzhurayev, A.G. Ilchuk, V.V. Litvintsev, and T.L. Tomas, Moscow State University imeni M.V. Lomonosov]

[Abstract] A change in order in alloys results in reconstruction of the electronic energy spectrum, which causes changes in optical and magneto-optical spectra. Tracing these changes in a single specimen with structural transformations such as order-disorder transitions and transition into the amorphous state is accordingly of interest. Results are presented of a study of optical and magneto-optical spectra in the energy region of 0.5 to 3.5 eV in films of  $Fe_{1-x}Ni_x$  alloys in the amorphous and crystalline states with 0.42 less than or equal to  $x$  less than or equal to 0.69. The films were prepared by high-frequency magnetron sputtering, using the ion-plasma method described elsewhere. The films were kept within the thickness range of 80 to 100 nm in order to lessen the influence of the surface on the ordering mechanism. Films of all compositions were amorphous directly after deposition. Films of a crystalline and ordered phase were formed after annealing at 500 K, and for 6 h at 590 K under vacuum at a pressure of  $1.10^{-3}$  Pa, respectively. Examination with an electron microscope showed that regions with a short-range order similar to that characteristic of the  $L1_0$  phase form as the result of annealing. Subsequent annealing at 650 K and quenching on a cold metal plate completely destroy the  $L1_0$  superstructure. Optical constants  $n$  and  $k$  were measured with 2- to 4-percent accuracy using (Bitti's) polarimetric method and automated equipment. Magneto-optical spectra were determined by measuring the equatorial Kerr effect with light striking at angles of 70 and 80 degrees. The diagonal and nondiagonal components of the permittivity tensor were calculated. Changes associated with an order-disorder transition and transition from the amorphous phase to the crystalline state were found in the spectra. The optical and magneto-optical spectra of Fe-Ni alloys are sensitive to the alloys' structural state. It is established that an ordered  $L1_0$  phase forms in Fe-Ni alloys and the distinctive features of the spectra are associated with the origin of antiferromagnetic interaction of iron atoms information of the superstructure and the formation of an Fe impurity level in a subband with spin directed according to magnetization. References 21: 14 Russian, 7 Western.

8831/12223

UDC 669.794'24:539.213:(538.214+537.311.31)

**Electrical, Magnetic Properties of  $Y_{66.5}Ni_{33.5}$  Metallic Glass Alloy**

18420239b Moscow FIZIKA METALLOV I  
METALLOVEDENIYE in Russian  
Vol 65, No 3, Mar 88 (manuscript received  
16 Dec 86) pp 512-518

[Article by S.V. Yartsev, A.F. Prekul, V.A. Rassokhin, and E.V. Galoshina, Metal Physics Institute, Urals Department (UrO), USSR Academy of Sciences]

[Abstract] A metallic glass alloy having the composition  $Y_{66.5}Ni_{33.5}$  was produced for the first time and studies were made of its magnetic and electrical properties. Vacuum-distilled yttrium and electrolytic nickel after annealing under a high vacuum in order to remove dissolved gases were used in the experiments. The alloy's composition was produced by arc melting on a water-cooled bottom in an atmosphere of purified argon. The specimen was divided into small portions weighing about 1.5 g which were remelted separately five times each and fused together; the entire ingot was then remelted and inverted five more times for the purpose of homogenization. Melting was performed without a crucible. Specimens were produced by quenching the alloy from the liquid phase on the inside surface of a copper cylinder rotating at 120 m/s in an inert vacuum. X-ray examination showed the total absence of crystal reflectants. Magnetic susceptibility was measured by the Faraday method in fields of up to 1.5 T in the temperature range of 10 to 300 K. Low specific susceptibility values of  $1.6 \times 10^{-6}$  cm<sup>3</sup>/g and the negative value of  $\delta X/\delta T$  at high temperatures show that the metallic glass alloy is a Pauli paramagnetic with the Fermi level at the minimum of the density of states curve. The strong temperature dependence of  $X$  at low temperatures attests to the presence of localized magnetic moments. The negative Curie temperature indicates antiferromagnetic interaction. The temperature dependence of electrical resistance was studied in the 1.75 to 300 K range on a specimen measuring 12 x 2 x 0.02 mm using the standard 4-contact technique and iridium clamped contacts.  $Y_{66.5}Ni_{33.5}$  has a negative temperature coefficient of resistance (TKS) over the entire temperature range studied. There is an increase in the TKS at low temperatures and it is shown that this is not associated with Kondo scattering. Evidence points in favor of the negative TKS's being of an activation nature both in the low- and high-temperature regions. The total conduction represents the sum of conduction of the metallic and jump types.  $Y_{66.5}Ni_{33.5}$  can be a convenient subject of study for explaining the reasons for the manifestation of activation conduction in disordered alloys whose components are only metals. References 11: 4 Russian, 7 Western.

8831/12223

UDC 546.(48.22+81.22):537.311.3

**Electrophysical Properties of  $(\text{SnS})_{1-x}(\text{CdS})_x$  Solid Solutions**

18420241d Moscow NEORGANICHESKIYE  
MATERIALY in Russian Vol 24 No 3, Mar 88  
(manuscript received 4 Jun 86) pp 498-499

[Article by Sh.B. Aliyeva, Ya.N. Sharifov, M.R. Alazov, D.A. Asadov and A.A. Movsum-zade, Special Engineering Design Bureau for Complex Mineral Raw Material Processing with Experimental Production Unit, AzSSR Academy of Sciences]

[Abstract] A study is presented of the influence of cadmium sulfide on the electrophysical properties of tin sulfide. Specimens of the solid solutions  $(\text{SnS})_{1-x}(\text{CdS})_x$ , where  $x$  is not over 0.04, were obtained from very pure elements in evacuated quartz ampules. Conductivity was measured by a compensation method at 300-800 K with an accuracy of up to 2%, thermo-emf with an accuracy of up to 3%. A figure shows the temperature variation of conductivity of the alloy. The studies indicated p-type conductivity throughout the temperature interval studied. The conductivity is of semiconductor type. The activation energy was found to increase with increasing CdS concentration in the solid solutions. Thermo-emf decreases with increasing temperature in proportion to  $1/T$ , but retains its positive sign. References 5: 3 Russian, 2 Western.

6508

UDC 546.181'77'48.299.68

**Thermoelectric Properties of TIPSe**

18420241b Moscow NEORGANICHESKIYE  
MATERIALY in Russian Vol 24, No 3, Mar 88  
(manuscript received 4 Apr 86) pp 493-495

[Article by S.K. Karimov, S.S. Sitamov and A. Umarov, Kulyab State Pedagogical Institute]

[Abstract] A study was made of the thermoelectric properties of TIPSe over a broad temperature range, including the liquid state. The compound was synthesized by melting the elements in the stoichiometric ratio in sealed graphitized quartz ampules evacuated to 0.0013 Pa. The thermo-emf was measured in a horizontal boat with 40-50 K temperature drop along the length of the specimen. As temperature increased, the conductivity first increased monotonically, then sharply decreased at the melting point, and then continued increasing monotonically, indicating semiconductor-semiconductor melting. The specimens had n-type conductivity throughout the 77-1030 K temperature range studied. The mobility of the electrons increases as  $\mu=BT^{3/2}$  in the low temperature range and as  $\mu=BT^{-3/2}$  in the higher temperature range, indicating that the electrons are scattered basically on

ionized centers in the low temperature area and primarily on the atoms of the lattice in the higher temperature area. References 13: 12 Russian, 1 Western.

6508

UDC 620.179.14

**Influence of Eddy Currents on Location of Surface Defects by Magnetic Defectoscopy**

18420256a Sverdlovsk DEFEKTOSKOPIYA in Russian  
No 4, Apr 88 (manuscript received 31 Dec 86; in final form 9 Jul 87) pp 3-10

[Article by A.I. Pashagin, V.Ye. Shcherbinin and N.P. Benklevskaya, Metal Physics Institute, Urals Department, USSR Academy of Sciences]

[Abstract] An analytic solution is sought for the field of a heterogeneously polarized defect magnetized by a variable magnetic field, in order to allow a more complete analysis of the solution and to consider the influence of eddy currents which curve in the area of the defect on the field of the defect. It is found that the surface effect decreases the field of magnetic charges in comparison to homogeneous magnetization with a constant magnetic field, the decrease being greater, the less the value of  $a$  and the greater the value of  $h$ . Polarization heterogeneity of the defect has the greatest influence on its field where  $y$  is much greater than  $h$ . Where  $y$  is much less than  $h$  and  $a$  is at least  $h$ , the polarization of the defect can be considered homogeneous. In the range of penetration depths studied where  $a=0.1-0.2$  mm, the magnitude of the defect field resulting from eddy current is one to two orders of magnitude less than the field of the magnetic charges and its contribution to the total defect field is very slight. Changing the depth of penetration influences  $H_x$  and  $H_{xe}$  differently: The magnetic charge field increases with increasing  $a$ , whereas the field resulting from the eddy current decreases. References 8: 7 Russian, 1 Western.

6508

UDC 620.179.152; 621.386

**Estimating Defect Radiation Image Parameters**

18420256c Sverdlovsk DEFEKTOSKOPIYA in Russian  
No 4, Apr 88 (manuscript received 13 Jan 86) pp 40-44

[Article by F.R. Sosnin, Introscopy Scientific Research Institute, Moscow]

[Abstract] Statistical and phenomenological theory are used to generate a quantitative estimate of the contrast and signal/noise ratio of radiation images produced by transmission of bremsstrahlung radiation through tested objects by representing the spectrum of the radiation in a scale of linear multiple-energy radiation attenuation coefficients using the gamma distribution. The model of the bremsstrahlung radiation spectrum derived allows

quantitative description of the characteristics of defect radiation images and can serve as a basis for further, more realistic approximations. References 6: 3 Russian, 3 Western (1 in Russian translation).

6508

UDC 537.222.2

**Electrostatic Induction Testing of Dielectric Films**  
*18420256b Sverdlovsk DEFEKTOSKOPIYA in Russian No 4, Apr 88 (manuscript received 27 Nov 86) pp 22-26*

[Article by A.V. Sokolov and V.K. Fedotov, Khimavtomatika Scientific-Production Association, Barnaul Special Design Bureau for Automation]

[Abstract] A method of automatic testing of dielectric films is suggested, based on finding disruptions in the structure of the material at the molecular level by detecting charge relaxation, a physical parameter which is functionally related to the structure of the material. The method is based on measurement of nonuniformity in the charge distribution on a preliminarily charged specimen. The charge is applied during the manufacturing process by friction between the film and the coiling drums. The charge and the potential on the surface of the film are redistributed as functions of conductivity. A three-electrode sensor is used to monitor the film passing over it by the method of electrostatic induction, using a differential system to suppress the influence of external electrostatic fields. An analog divider is used to eliminate error resulting from any change in the speed of the material passing over the sensors by computing the relative charge difference. References 8: all Russian.

6508

UDC 620.179.16

**Possibility of Ultrasonic Location of Root Cracks in Steam Turbine Rotor Welded Joints**  
*18420256d Sverdlovsk DEFEKTOSKOPIYA in Russian No 4, Apr 88 (manuscript received 13 Apr 87) pp 45-50*

[Article by A.Kh. Vopilkin, V.A. Voronkov, I.N. Yermolov and V.N. Danilov, Scientific-Production Association, Central Scientific Research Institute of Machine-Building Technology, Moscow; Moscow Mining Institute]

[Abstract] Analysis of defects in rotors rejected in ultrasonic testing revealed the possibility of vertically oriented cracks in the root zone of a welded joint, reaching

the bottom surface. Incomplete root penetration was also possible, creating a strong echo signal. This article presents an analysis of the acoustical path of the direct converter used for ultrasonic testing upon reflection from a corner reflector, and on that basis analyzes the possibility of differentiating echo signals from cracks and incomplete root penetration. With the existing design of rotors, it is possible to locate root cracks by testing welded joints on the disk side. The calculation model developed in the article generally correctly reflects the situation occurring with inclined incidence of ultrasonic longitudinal waves at a crack which reaches a free surface, and can therefore be used to develop rotor testing methods. References 3: 1 Russian, 2 Western (1 in Russian translation).

6508

UDC 539.1.04;25

**Influence of Irradiation and Deformation on Zirconium Hydride Fine Structure**  
*18420253b Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 88 (manuscript received 11 Mar 87) pp 10-14*

[Article by G.V. Berezhkova, A.G. Lanin, A.A. Malinin, P.P. Perstnev, V.R. Regel and V.N. Turchin, Moscow]

[Abstract] Results are presented from a study of Zr  $\epsilon$ -hydride in the initial and deformed states and the influence of bombardment with argon ions at 5 keV and electrons at 1 MeV on the initial structure. Studies were performed on  $\epsilon$ -ZrH<sub>1.92</sub> foils deformed by compression at 575 K and extrusion at 1175 K. The electron-microscope studies showed that bombardment with Ar<sup>+</sup> ions and focused electron beams produced radiation damage. Since ion polishing causes radiation damage, the evaluation of the fine structure of Zr hydride during deformation should be performed on foils prepared by chemical thinning. Low-temperature deformation is accompanied by an increase in dislocation density and lamella substructure breakdown. The substructure of extruded Zr hydride results from superpositioning of the dislocation cell structure formed in high-temperature deformation with the microtwin structure formed in  $\delta$  to  $\epsilon$  conversion upon cooling. References 11: 4 Russian, 7 Western (2 in Russian translation).

6508



UDC 621.785.3:669. 14.018.58

**Improving Technology of Producing Electric Insulating Coating on Anisotropic Electrical-Sheet Steel**

18420255f Moscow *STAL* in Russian  
No 5, May 88 pp 67-70

[Article by Ye.A. Samsikov, V.V. Bulankova, V.I. Lavrov, B.G. Borisenko and L.A. Shvartsman, Novolipetsk Metallurgical Combine; Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] A study is made of the influence of metallurgical production factors on the quality of the base layer and insulating coating on electrical-sheet steel. The influence of chemical composition of the steel, decarburizing annealing, high-temperature annealing and magnesium suspension preparation conditions is studied. The quality of the coating on anisotropic electrical-sheet steel is found to be determined by the chemical composition of the steel, temperature and gas conditions during annealing, preparation and use of the magnesium suspension which produces a heat-insulating base coating, physical and chemical characteristics of the magnesium oxide used. The best quality coating is achieved when the mass share of manganese in the steel is about 0.25 percent, residual carbon in annealed strips is not over 0.004 percent, with an area of internal oxidation about 2.5  $\mu\text{m}$  thick on the metal prepared for high-temperature annealing, with magnesium suspensions prepared in cold water and limited contact time between magnesium oxide and water. References 5: 3 Russian, 2 Western.

6508

**Use of Electrolytic Heating for Heat Treatment of Composite Electrochemical Coatings**

18420258e Kishinev *ELEKTRONNAYA OBRABOTKA MATERIALOV* in Russian No 2, Mar-Apr 88  
(manuscript received 12 Nov 85) pp 37-39

[Article by L.M. Yagodkina, V.I. Andryushechkin, I.Z. Yasnogorodskiy and G.V. Khaldeyev, Perm]

[Abstract] A new method is suggested for producing boride composite coatings by coprecipitation of electrolytic nickel with dispersed particles of amorphous boron or boron carbide and subsequent heat treatment in an electrolytic plasma. The coatings are produced using a sulfate nickelizing electrolyte with suspended amorphous boron or boron carbide microscopic powder. Diffusion annealing of coatings is performed in 15 percent sodium carbonate at 773-1150 K, holding time 1-300 seconds. The primary strengthening phase produced under all conditions is  $\text{Ni}_3\text{B}$ , and the short heating time avoids alteration of the strength properties of the material being coated. The more rapid diffusion formation of the hardening phase by plasma treatment results from the retention of high dislocation density in the

nickel matrix due to the great heating rate (50-500°C/s), and also possibly due to initial defects initiated by the spark discharge. References 2: both Russian.

6508

**Influence of Absorbing Coating on Laser Hardening**

18420258g Kishinev *ELEKTRONNAYA OBRABOTKA MATERIALOV* in Russian  
No 2, Mar-Apr 88 (manuscript received 14 Sep 85) pp 80-82

[Article by V.S. Kovalenko, L.F. Golovko, V.I. Oreshnik, N.I. Zakharova and E.Ye. Taganova, Kiev]

[Abstract] A study is presented of the influence of an absorbing coating and its thickness on the depth and hardness of the surface layer produced by laser hardening. Studies were performed on 40Kh steel with phosphate coatings 4.5-7.5  $\mu\text{m}$  applied to the surface by a galvanic method, with oxide coatings produced by 30-60 minutes oxidation, and with coatings based on ZnO and aluminum-chromium phosphate 10-30  $\mu\text{m}$  thick. The coated specimens were irradiated by a high power  $\text{CO}_2$  laser, power density  $2.7\text{-}4\cdot 10^3$  W/cm<sup>2</sup> moving at 0.4-0.8 m/min. After irradiation, the topography of the surface was studied and sections used to determine the change in hardness and depth of the hardened layer. The effectiveness of the coatings was found to be in the following sequence: Oxides, phosphates, ZnO-based coatings, aluminum-chromium phosphates. Oxide absorbing coatings should be used for laser hardening in which the surface is not melted, while phosphate coatings are better if the surface will be melted. The maximum hardness and hardening depth with oxide coatings was achieved by holding the specimen in the bath for 40-50 minutes, the best results with phosphate coatings were achieved with 35-40 minutes for low intensity radiation, 30-35 minutes for higher intensity radiation.

6508

UDC 535.21:537.534.9:535.683

**Change in Optical Properties of Thermoregulating Coatings Upon Simultaneous Exposure to Different Radiations**

18420253e Moscow *FIZIKA I KHIMIYA OBRABOTKI MATERIALOV* in Russian No 2, Mar-Apr 88  
(manuscript received 16 Jul 87) pp 85-87

[Article by A.P. Grashchenko and G.G. Solovyev, Moscow]

[Abstract] A method is suggested for computation of the results of simultaneous exposure of the thermoregulating coatings used on spacecraft to several different types of radiation, in order to determine the changes in the coefficient of reflection of these coatings on the basis of experimental data on the influence of the individual types of radiation. The method is based on the fact that

the change in concentration of centers of optical absorption upon exposure to radiation can be calculated by a known equation including the concentration of defects upon which the centers are created and the rate constants of formation and destruction of the centers. The method is based on summation of these rate constants for the various types of ionizing radiation present and can be used to determine changes in the optical properties of

diffusely reflecting media exposed to several types of radiation simultaneously. The method can be used to predict changes in the coefficient of reflection of thermoregulating coatings on spacecraft under space conditions based on experimental data obtained under laboratory conditions. References 2: both Russian.

6508

UDC 669-494:669.778;669.784

**Computation of Thickness of Barrier Coating  
Needed for Interaction of Metal Melt With  
Carbon Fiber**

18420253f Moscow *FIZIKA I KHIMIYA OBRABOTKI  
MATERIALOV* in Russian No 2, Mar-Apr 88  
(manuscript received 27 Apr 87) pp 88-92

[Article by T.A. Chernyshova, N.L. Bolotov, L.I. Kobeleva, M.P. Arsenyeva and K.P. Gurov, Moscow]

[Abstract] An attempt is made to calculate the coating thickness required to protect a fiber from interaction with a metal melt during the period required to produce a fiber composite by a liquid-phase method. Computations were based on a specimen produced by saturating a bundle of 40  $\mu\text{m}$ -diameter carbon monofilaments in a

titanium melt. The fibers were preliminarily coated with carbonyl chromium, molybdenum and tungsten by a gas-phase method, the coatings dissolving in the matrix during saturation. The calculations assumed that: the rate of dissolution was limited by diffusion of the coating material atoms in the melt; the fiber material did not participate in the diffusion; the fiber was placed regularly in the matrix and each fiber was cylindrical; the process was isothermic; the melting point of the fiber and coating were higher than the temperature of the melt; and at the initial moment the concentration of coating atoms in the matrix was equal to zero. The model can be used for estimation of the interaction kinetics between the fiber and its coating and the melt in the manufacture of composites. References 9: 6 Russian, 3 Western (1 in Russian translation).

6508

UDC 669.18.046

**Increasing Quality of Bearing Steel by Vacuum Refining**

*18420255b Moscow STAL in Russian  
No 5, May 88 pp 29-32*

[Article by Ye.F. Mazurov, A.R. Kamalov, V.V. Shakhnovich, A.K. Krupichev and Yu.M. Nerovnyy, Central Scientific Research Institute of Ferrous Metallurgy; Donetsk Metallurgical Plant]

[Abstract] A study is made of the influence of liquid metal manufacturing technology and subsequent vacuum treatment on bearing steel quality. Pure bearing steel can be produced only by combining optimal deoxidation and vacuum treatment, which has been found to reduce the content of nonmetallic inclusions in type ShKh15 steel significantly. The statistical mean durability of vacuum-treated steel bearings was 50-100 percent greater than that of untreated bearings. The technology for vacuum treatment outside the furnace includes removal of sulfur in the ladle by the use of desulfurating slag, degassing of the metal in a vacuum, treatment to remove sulfur and oxygen, formation of a nonmetallic phase by creation of extensive argon-metal and vacuum-metal separation surfaces. The process is implemented by adding aluminum to the metal, followed by evacuation and introduction of a high-speed jet of argon with reduced pressure above the metal. The process significantly reduces the content of nonmetallic inclusions in the steel. References 5: all Russian.

6508

UDC 669.18.046

**Increasing Quality of Bearing Steel**

*18420255a Moscow STAL in Russian  
No 5, May 88 pp 26-29*

[Article by V.A. Sinelnikov and A.F. Kablukovskiy, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] The quality of bearing steel can be improved by improving production technology, particularly by equipping electric steel-melting shops for processing the metal with gases, slag, vacuum and powdered materials outside the furnace; by introducing standardized technological modules consisting of a high-capacity arc furnace, combined processing unit and continuous casting equipment; by improving the quality of the metal charge used in arc furnaces and converters; by lining ladles and other equipment with high-quality refractories; and by assuring reliable protection of liquid metal from oxidation during pouring. Positive results achieved by these methods are described. Selection of a process for refining metal outside the furnace must be based on plant capacity, the practicality of redesign and placement of the

necessary equipment, availability of capital for investment and amortization of the costs involved, the quality of rolled metal products produced, as well as possible reductions in cost of the steel and improvement in working conditions. References 9: all Russian.

6508

UDC 669.14.018.24

**Mastering Making and Pouring of ShKh15 Bearing Steel at Orsk-Khalilovo Metallurgical Combine**

*18420255c Moscow STAL in Russian  
No 5, May 88 pp 34-35*

[Article by V.V. Kulakov, T.N. Ryakhov, V.V. Anishchenko, V.V. Kulikov and V.I. Savchukov, Orsk-Khalilovo Metallurgical Combine; Ukrainian Scientific Research Institute of Special Steels]

[Abstract] The combine and institute have studied the making of bearing steel in high-capacity furnaces by a single-slag method with the metal tapped from the furnace beneath an oxidizing slag, with adjustment of the chemical composition and desulfuration during tapping by a solid slag-forming mixture of lime, fluorspar and aluminum. Deoxidation during tapping and blowing of argon through the metal significantly reduced the oxygen content of the slag. The major macrostructure defect was central porosity, influenced by the vacuum treatment of the metal, residual aluminum content, pouring temperature and other factors. Nonmetallic inclusions increased at pouring temperatures below 1510-1530°C. Other process factors and chemical composition were found not to influence acceptance testing characteristics. Addition of ferrochrome to the ladle rather than the furnace decreased oxide contamination of the steel.

6508

669.586.6+669.718.65-621.793

**Interaction of Steel Strip With Aluminum-Zinc Melt During Application of Coatings**

*Moscow STAL in Russian No 5, May 88 pp 50-52*

[Article by A.A. Tarasova and V.A. Trifonova, Urals Scientific Research Institute of Ferrous Metallurgy]

[Abstract] The transition of iron from steel into a melt used to coat steel strips and the iron content in the coating as functions of the basic parameters of the process were determined by means of a multifactor experiment. The experimental data were computer processed to derive equations describing the iron loss and iron content in the coating as functions of silicon content, temperature, time and pressure. An algorithm was

developed for selection of optimal aluminum-zinc coating parameters for which the quantity of iron dissolved from the strip is equal to the quantity of iron extracted from the melt. This decreases the total quantity of

drossformed and thus decreases the quantity of melt consumed in coating the strip.

6508

UDC 546.861.7

**Heavy Rare Earth Element Diantimonides**

18420241c Moscow NEORGANICHESKIYE  
MATERIALY in Russian Vol 24, No 3, Mar 88  
(manuscript received 22 Apr 86) pp 495-498

[Article by M.N. Abdusalyamova, O.R. Burnashev,  
K.Ye. Mironov, O.I. Rakhmatov and N.D. Fazlyyeva,  
Chemistry Institute imeni V.I. Nikitin, Tajik Academy  
of Sciences]

[Abstract] Studies of the phase diagrams of Gd-Sb, Tb-Sb, Dy-Sb, Ho-Sb, Er-Sb and Tm-Sb by differential thermal analysis revealed thermal effects, the maximum number of which occurred at a composition of about 66.6 at.% Sb, i.e., the diantimonide. Studies were performed in crucibles of molybdenum, tantalum and oxides of aluminum and zirconium. The incongruent melting temperature of heavy rare earth element diantimonides differs significantly from that of the light rare earth element diantimonides. It is suggested that the rare earth element diantimonides, beginning with gadolinium, have a unique crystalline lattice. References 10: 2 Russian, 8 Western.

6508

UDC 669.017-911.61+669.316

**Amorphous Cu-Ni-Ti, Cu-Ti-Sn and Cu-Ni-Zr Alloys**

18420260g Moscow NEORGANICHESKIYE  
MATERIALY in Russian Vol 24, No 5, May 88  
(manuscript received 1 Jul 86) pp 760-764

[Article by V.V. Vavilova, Yu.K. Kovneristyy, V.L. Lyubimov and L.N. Galkin, Metallurgy Institute imeni A.A. Baykov, USSR Academy of Sciences]

[Abstract] A search was conducted for materials containing titanium or zirconium as the "active" component and with a tendency to amorphization in order to increase the plasticity of foils used as solders to join products of ceramics and other nonmetallic materials following application of titanium powder paste to the surface of the products to be joined. Compositions of ternary alloys on the cross sections between the compositions of the binary eutectics or between the binary eutectic and pure component were selected. Hardening of specimens in the Cu-Ti-Ni and Cu-Ti-Sn systems at  $10^5$ - $10^6$  degrees per second yielded copper-based alloys in the form of flexible tapes 35-50  $\mu$ m thick containing titanium as the active component, with melting points of 910 and 832°C. Alloys on the cross section between compositions  $e_1$  and  $e_2$  of binary eutectics and in the initial crystalline state, mixtures of two or three intermetallic compounds, had a tendency to amorphization in the system Cu-Ti-Ni. Alloys in the system Cu-Ti-Sn are less likely to become amorphous. References 8: 4 Russian, 4 Western.

6508

UDC 669.27:539.1.043

**Development of Radiation Damage in Neutron-Bombarded Tungsten**

18420253a Moscow FIZIKA I KHIMIYA OBRABOTKI  
MATERIALOV in Russian No 2, Mar-Apr 88  
(manuscript received 8 Jun 87) pp 6-9

[Article by V.I. Shcherbak, Moscow]

[Abstract] Neutron bombardment of tungsten at high temperatures causes dislocation loops and vacancy pores. In this article, dislocation loops in bombarded tungsten are identified and the variation of their mean diameter and concentration with dose is studied in polycrystalline tungsten foils 0.1 mm thick bombarded at 400-500°C with fluxes of  $0.9 \cdot 10^{24}$ - $3.6 \cdot 10^{26}$  neutrons per square meter with energies of over 0.1 MeV following annealing at 1100°C for two hours. Electron-microscope observation of microstructures of the bombarded specimens showed that bombardment resulted in the formation of pores and dislocation loops, the dimensions and concentration of which depended on neutron flux. At small doses, dislocation structures are formed as a result of generation of new dislocation loops, the concentration of which increases linearly with dose. As the doses increased, the formation of new dislocation loops is reduced and at high dose levels the concentration and mean diameter of loops depend little on dose, indicating that the loops are formed as a result of annealing of displacement peaks. Interstitial dislocation loops serve as point defect sinks, leading to slight supersaturation of the material with interstitial atoms and vacancies and a slight excess flow of interstitial atoms to vacancy dislocation loops. References 5: 3 Russian, 2 Western.

6508

UDC669.24'295 : 620.181

**Structural Changes in TiNi Alloy with Shape Memory Effect During Deformation**

18420239d Moscow FIZIKA METALLOV I  
METALLOVEDENIYE in Russian  
Vol 65, No 3, Mar 88 (manuscript received 29 Sep 86,  
in final version 17 Dec 86) pp 564-569

[Article by S.G. Fedotov, L.A. Matlakhova, Yu.K. Kovneristyy and N.F. Zhebyneva, Metallurgy Institute imeni A.A. Baykov, USSR Academy of Sciences]

[Abstract] The results are presented of a study of the change in the structure and properties of TiNi during tensile deformation at temperatures below  $M_k = 38^\circ\text{C}$ . A TiNi alloy having 54 percent nickel by weight was studied, having, after annealing at 500°C for 1 h, a B19' martensitic structure with the following temperature transformations:  $M_n = 53^\circ\text{C}$ ,  $M_k = 38^\circ\text{C}$ ,  $A_n = 55^\circ\text{C}$  and  $A_k = 95^\circ\text{C}$ . Specimens with a working section diameter of

7 mm were deformed in an Instron machine at 20°C at a rate of  $3.5 \cdot 10^{-4} \text{ s}^{-1}$  to a level of the plastic component of  $\epsilon_0 = 2$  to 30 percent. Specimens were cut from the working section by electron discharge machining for x-ray diffraction analysis, measurement of resistivity and dilatometric and differential thermal analysis (DTA). Diffraction patterns were recorded at room temperature on a DRON-2 unit, and during heating and cooling in the low-temperature attachment of a KRN-190 unit furnished with a heater utilizing copper  $K_\alpha$  radiation. The specimens were electropolished before testing to eliminate saturation with hydrogen and transformation of the high-temperature phase into martensite in the near-surface layers. The tensile test diagram is of a form characteristic of alloys based on TiNi with a martensitic structure. The test results make it possible to conclude that the growth in resistivity observed and the unusual change in the modulus of elasticity, E, during tensile deformation to  $\epsilon_0 = 7$  percent, according to x-ray diffraction analysis, are associated with an increase in distortion of the martensite lattice within the limits of its

stability to the appearance of a transitional R-phase. An increase in the shape memory effect (SME) was observed in other studies in a deformed specimen with this structure to a maximum value of 5 percent with  $\epsilon_0 = 7$  percent with a negligible level of the dislocation component. The R-phase is regarded in the present study as a state with a maximum distorted martensite lattice with which the maximum value of the SME is associated. According to DTA, x-ray diffraction analysis and the temperature dependence of E, with heating the R-phase undergoes a transformation into the B2-phase, i.e., behaves as a martensitic phase. The plastic component and residual stresses along with it increase the stability of the R-phase formed and expand the range of forward and reverse martensitic transformations. The plastic component inhibits the phase reconstruction process with heating and cooling and broadens the temperature range of this process. References 16: 10 Russian, 6 Western (1 in Russian translation).

8821/12223

UDC 621.315.592

**Interaction Between Defects in Double Doping of Germanium by Gallium and Antimony**

18420260b Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 5, May 88 (manuscript received 20 Jun 86) pp 715-718

[Article by R.A. Akopyan, E.T. Mamedova and N.I. Titova, Moscow Electronic Engineering Institute]

[Abstract] A study is made of the interaction between the donor and acceptor doping elements in germanium-based solid solutions in the germanium-gallium-antimony system by constructing composition-property diagrams for the solid solution. Melts were prepared with constant total dopant concentration in sealed quartz ampules evacuated to  $10^{-2}$  Pa. The basic parameters used in the study were the microhardness and Hall effect. The composition-property diagrams show singular points corresponding to the equiatomic ratio between donor and acceptor atoms. The picture is explained by the formation of  $(\text{GaSb})^0$  associates. Electron-hole interactions may also influence the concentration of charge carriers. References 8: 7 Russian, 1 Western (in Russian translation).

6508

UDC 546.28'289

**Silicon Single Crystals Doped With Germanium**

18420260a Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 5, May 88 (manuscript received 11 Jun 86) pp 709-714

[Article by Ye.S. Levshin, N.I. Puzanov, I.S. Sukhareva and A.M. Eydenzon, Podolsk Chemical-Metallurgical Plant]

[Abstract] The purpose of this work was to grow large dislocation-free silicon crystals doped with Ge at about  $10^{20}\text{cm}^{-3}$  and to study their electrophysical and structural properties. Single crystals 80 mm in diameter with phosphorus content  $2 \cdot 10^{14}\text{cm}^{-3}$  and 100 mm in diameter with phosphorus content  $1 \cdot 15\text{cm}^{-3}$  were grown by the Czochralski method from 6 and 16 kg charges. Dislocation-free crystals were obtained with Ge concentration up to  $10^{20}\text{cm}^{-3}$ . Further increases in Ge content damaged the crystals. Under steady growth conditions, no signs of concentration supercooling of the melt were observed at  $1.9\text{-}2.5 \cdot 10^{20}\text{cm}^{-3}$  Ge. Resistivity measurements showed that the contribution of thermodonors to resistivity was great at the germanium concentrations studied. Doping with germanium did not influence the concentration of thermodonors formed as the large single crystals were grown. The same types of microscopic defects were observed as in crystals containing no Ge. The life of secondary charge carriers in the crystals containing Ge was approximately double that observed in crystals containing no Ge. Following stabilizing heat

treatment, the life of these carriers was approximately the same as for crystals of the same type without Ge. A study of swirl defects indicated that they did not vary with Ge concentration. The A-type microdefect distribution period in longitudinal cross sections was the same as the period of Ge layers, while that of A'-defects generally did not coincide. Ge was found to change the dislocation structure of the crystal, with accumulation of dislocations parallel to the crystallization front in the dislocation portion. References 11: 7 Russian, 4 Western.

6508

UDC 546.289.24+546.819'24

**Structure and Properties of  $\text{Bi}_{2+/-x}\text{Te}_3$ ,  $\text{Bi}_{2+/-x}(\text{Te}_{0.9}\text{Se}_{0.1})_3$  and  $\text{Bi}_{2+/-x}(\text{Te}_{0.8}\text{Se}_{0.2})_3$  (Where x is Between -0.2 and 0.2)**

18420260e Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 5, May 88 (manuscript received 20 May 86) pp 727-729

[Article by A.D. Bigvava, V.K. Korobov, E.D. Kunchuliya and R.R. Shvangiradze, Sukhumi Physical Technical Institute]

[Abstract] Specimens of the compositions mentioned in the title were studied by x-ray phase, electron-probe and metallographic analysis, as well as by measurement of the electrophysical properties. A correlation was observed between structural and electrophysical parameters. A maximum was found on the curve of matrix phase unit cell volume as a function of bismuth content at the point where the sign of conductivity reversed. References 10: 7 Russian, 3 Western.

6508

UDC 546.26—162

**Minimum Diamond Synthesis Temperature in Metal-Carbon Systems**

18420260f Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 5, May 88 (manuscript received 24 Jun 86) pp 743-746

[Article by V.M. Sonin, A.I. Chepurov, I.I. Fedorov and I.Yu. Malinovskiy, Geology and Geophysics Institute imeni the 60th Anniversary of the USSR, Siberian Department, USSR Academy of Sciences]

[Abstract] An experimental study of diamond synthesis conditions in low-melting-point metal systems is continued. The experiments were performed in a high-pressure apparatus, with specimens assembled by layers of metal alloy and graphite with each layer 1 mm thick and graphite tablets on either side of the specimen to assure reliable isolation of the different parts. The reaction products were studied under microscopes in transmitted and reflected light. Addition of Cu, Mg, Pb and Zn to transition metal melts did not succeed in reducing the



synthesis temperature already achieved in the system  $Mn_{0.6}Ni_{0.4}$ —C. Introduction of Mg, Pb and Zn even increased the p-T parameters of diamond synthesis. The results confirm the conclusion drawn earlier that there is a lower temperature boundary of diamond synthesis in metal-carbon systems. References 13: 11 Russian, 2 Western.

6508

UDC 666.11.01 : 541.183.5

**Transparency and Reflectivity of Lead-Borosilicate Glasses with Ytterbium and Gadolinium Tellurite Additives**

18420260h Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 5, May 88 (manuscript received 25 Jun 86) pp 878-880

[Article by L.A. Ivanchenko, N.N. Plemyannikov, V.M. Frankfurt, N.V. Kononko and L.S. Sarapina, Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] This article presents some characteristics of lead-borosilicate glass containing gadolinium and ytterbium tellurites. Glass specimens containing these additives were obtained by normal glass manufacturing methods. Optical transparency and reflectivity spectra were measured at 0.2-25  $\mu$  wavelength in standard dual-beam spectrophotometers. Addition of ytterbium and gadolinium tellurites caused almost no changes in optical transparency at the edge of absorption up to 16 mass percent. Four main bands are observed in the IR reflection spectra near 440, 700, 900 and 1200  $cm^{-1}$ , which may result from oscillations of the Si-O, Pb-O, Te-O and B-O bonds. No significant differences were found in the properties of the glasses as a function of type of rare-earth element contained. References 4: all Russian.

6508

UDC 548.736.3,548.1;621.315.592

**Growth of Single Crystals, Structure and Photoelectric Properties of New  $GaInS_3$  Polymorphous Modifications**

18420260d Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 5, May 88 (manuscript received 25 Jun 86) pp 723-726

[Article by I.R. Amiraslanov, T.Kh. Azizov, G.G. Guseynov, A.S. Kuliyeu and G.M. Niftiyev, Physics Institute, AzSSR Academy of Sciences]

[Abstract] This work is dedicated to the growth of single crystals and structural and electrophysical studies of new  $GaInS_3$  modifications obtained under various conditions by chemical transport reactions. Rhombic and hexagonal crystals were produced and the crystalline structures determined on an autodiffractometer and

refined by the least squares method. Projections of the crystalline structures are presented. The rhombic crystals are photoconductive. The spectral distribution of photoconductivity, photoluminescence spectra and absorption spectra are used to determine the forbidden zone widths, energy position of r-recombination centers, donor levels and the mechanism of photoluminescence and photoconductivity. References 2: both Russian.

6508

UDC 666.3/.7(075.8)

**Gas-Dynamic Peculiarities of Matrix Removal During Heat Treatment of Ceramic Materials**

18420253g Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 88 (manuscript received 6 May 87) pp 98-102

[Article by B.D. Anchipalovskiy, N.N. Ostroukhov, V.M. Marusev, G.A. Fomina and D.A. Ivanov, Moscow]

[Abstract] A study is presented of the influence of mutual placement of a product being worked and structural elements in the process of deformation of thin ceramic plates during their heat treatment, considering the influence of nonuniformity of removal of the matrix, in order to develop heat treatment methods decreasing such deformation. The process of removing matrix decomposition products from the plate being heat treated is studied, with and without the influence of structural elements of the equipment. A method is developed for removing the matrix from thin ceramic plates which decreases their deformation by decreasing the gap through which matrix decomposition products flow, while simultaneously increasing the number of sources of decomposition products, for example by making the frame of the same raw material as the plate. Experiments confirmed the positive influence of increasing the partial pressure of matrix decomposition products on the rate of its removal. Slowing the rate of removal of the matrix from the peripheral area of the plate by this method causes reduced deformation of thin ceramic plates. References 5: 3 Russian, 2 Western (in Russian translation).

6508

**Influence of Processing Modes on Laser Cutting of Ceramics**

18420258a Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 2, Mar-Apr 88 (manuscript received 27 Oct 86) pp 8-12

[Article by V.S. Kovalenko, A.V. Lavrinovich and V.P. Skoropisov, Kiev]

[Abstract] One promising method of working structural ceramics is periodic-pulse laser working with a high repetition rate of very short pulses, which eliminates the danger of cracking. The method is capable of precise dimensional working of complex shaped products with

good accuracy. An installation based on two LTI-502 lasers allows circular scanning of the laser beam along with scanning of the product being cut to achieve the optimal processing mode. With this combined scanning the overlap factor depends on the radius of the circular scan of the laser beam and the scanning frequency. Even relatively low-power lasers can achieve greater productivity, in terms of material removed per unit time, than diamond disk working. Combined-scanning laser devices can remove up to 7.2 mm<sup>3</sup>/min when cutting hot-pressed silicon nitride ceramic. References 5: 1 Russian, 4 Western.

6508

UDC 621.74.045:669.295

**Increasing Strength and Reducing Chemical Activity of Ceramic Molds**

*18420251c Moscow LITEYNOYE PROIZVODSTVO in Russian No 4, Apr 88 pp 19-20*

[Article by V.M. Aleksandrov, doctor of technical sciences, B.A. Kulakov, candidate of technical sciences, and A.A. Solodyankin, engineer]

[Abstract] Finely dispersed aluminum powder is suggested as a strengthening additive for synthetic corundum molds using low-silicon ethyl silicate binder with 4-10 percent SiO<sub>2</sub>. In order to select the best type of aluminum powder, the physical-chemical processes of oxidation and sintering of pure highly dispersed aluminum powders were studied for several powders with different manufacturing methods, chemical purity, shape and size of particles. A technology was developed for manufacture of synthetic corundum forms with good chemical resistance to titanium alloys. The inner layers were made using a suspension consisting of low-silicon

ethyl silicate binder and synthetic corundum filler with aluminum powder added. The oxidation of the aluminum powder was encouraged by introducing 0.1-1 percent potassium perchlorate to the suspension. Traditional methods were used to manufacture the outer layers of the product. The new product had 30-60 percent greater strength, 20-30 percent greater thermal stability and required fewer coating layers, while achieving good quality of centrifugal casting. References 4: all Russian.

6508

UDC 621.315.592

**Influence of External Electric Field on Photoelectric Properties of GaSe Single Crystals**

*18420241e Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 3, Mar 88 (manuscript received 8 Apr 86) pp 499-501*

[Article by S.N. Mustafayeva and M.M. Asadov, Special Design-Technological Bureau for Complex Mineral Raw Material Processing With Experimental Production Unit, AzSSR Academy of Sciences]

[Abstract] Results are presented from a study of the influence of an external constant electric field on the photocurrent spectra in GaSe single crystals. The crystals were doped during growth from a melt with 0.3 at.% metallic tin. The crystals had p-type conductivity and dark resistivity at room temperature on the order of 10<sup>9</sup>ohm·cm. The studies indicated that the photocurrent spectra spread by approximately 90 nm under the influence of an external electric field of 1.7·10<sup>2</sup>-1.6·10<sup>4</sup>V/cm, significantly increasing the spectral band of sensitivity. References 3: all Russian.

6508

UDC 546.684,654,281

**Optical Quality and Structural Perfection of  $\text{La}_3\text{Ga}_5\text{SiO}_{14}$  Single Crystals Grown by the Czochralski Method**

18420241f Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 3, Mar 88 (manuscript received 7 Feb 86) pp 517-519

[Article by M.F. Dubovik, G.M. Ivanova, S.A. Lebedev, B.P. Nazarenko and V.F. Tkachenko]

[Abstract] Large langasite single crystals up to 50 mm in diameter and 600 g in mass were grown in an automatically controlled installation. It was found that the major heterogeneities were a defect in the central, axial portion of the single crystal regardless of the crystallographic orientation, as well as bubble and microscopic crack inclusions, transverse growth stratification and the presence of separate structural blocks. The defect is an accumulation primarily of bubbles and microscopic cracks with a circular cross section. The transverse growth stratification primarily repeated the shape of the melt-crystal interface. The formation of structural blocks and bubbles indicated that the melt has a strong tendency toward supercooling. The optical quality of the single crystals was estimated from the anomalous birefringence. Structural homogeneity was verified by x-ray studies in a two-crystal spectrometer. Blocks were found with disorientation of up to 5'. References 7: 6 Russian, 1 Western.

6508

UDC 621.74.042.669.295

**Modeling Flow of Titanium Alloys in Centrifugal Casting Gating Systems**

18420251b Moscow LITEYNOYE PROIZVODSTVO in Russian No 4, Apr 88 pp 16-18

[Article by Candidate of Technical Sciences I.D. Golovanov]

[Abstract] A study is made of the flow of titanium alloy in a metal receiver and cylindrical channel with sharp entry edges. Studies were performed on a special gating system model to determine the flow of fluid from the gating system under steady conditions with constant metal receiver filling level. Motion picture photography showed that the flow completely filled the channel, forming an area of reduced pressure as rotation began in the channel, the bubble indicating low pressure increasing in width and reducing the cross section of the channel as rotating speed increased. At slightly over 82 rpm, atmospheric pressure from the outlet aperture reached the rarefaction zone and the flow rate dropped significantly. Further increases in rotating speed caused no change in the nature of fluid movement, increasing only its speed. The results of the study were used to design gating systems for the production of complex thin wall

castings of titanium alloys by centrifugal casting. A metal receiver with ribs was suggested which permits decreasing inertial slippage, increasing the flow factor and improving the quality of castings. References 4: all Russian.

6508

UDC 621.9.048.7

**Drilling of Circular Apertures With Elliptical Electron Beam**

18420253c Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 88 (manuscript received 16 Mar 87) pp 21-23

[Article by Ye.V. Armenskiy, V.V. Savvateyev and A.V. Rozhankovskiy, Moscow]

[Abstract] Electron-beam ellipticity causes elliptical apertures in thin foils. However, if the electron beam is switched off immediately after a penetrating aperture is made in the foil, the liquid bath is drawn to a circular shape by surface tension forces, resulting in a true circular aperture under certain conditions. A model is constructed to explain the process. The calculations indicate that the toroidal volume of liquid oscillates around an equilibrium position, then the oscillations are damped by the viscosity of the liquid. If cooling is slow enough, the resulting aperture in the solid phase is very nearly circular. Even rapid cooling can yield a circular aperture if it occurs at the moment when the oscillating liquid passes through the equilibrium position. High-speed photomicrographs illustrate the oscillation of a ring of liquid around an aperture in a thin foil. References 3: all Russian.

6508

UDC 621.74.042

**Economic Effectiveness of Producing Bimetallic Products by Centrifugal Method**

18420251a Moscow LITEYNOYE PROIZVODSTVO in Russian No 4, Apr 88 pp 15-16

[Article by Engineer V.F. Smolyanskaya and Doctor of Technical Sciences A.I. Shevchenko]

[Abstract] The sleeves of foreign drying machines for artificial rubber, made of cobalt-based wear-resistant steel, have an operating life 2-2.5 times greater than that of sleeves manufactured in the Soviet Union. A new technology has now been developed for centrifugal casting of bimetallic sleeve blanks under flux, involving successive pouring into a rotating mold of the outer layer, Kh17N13M3T steel, and the inner layer, cobalt-based wear-resistant alloy. By avoiding purchasing of imported sleeves, and significantly reducing the labor consumption in the manufacture of bimetallic sleeves, the new technology has achieved an economic effect of

730,000 rubles per year. Centrifugal casting of bimetallic drill pump cylinder sleeves of 50L steel plus high-chromium cast iron has tripled their operating life. The economic effect of centrifugally cast bimetallic cylinder sleeves in marine engines was about 3.8 million rubles in one factory alone. These examples indicate the great economic effectiveness and desirability of broad industrial mastery of centrifugal casting of bimetallic pipes and sleeves.

6508

UDC 621.778.1-427.4

### Development of Spiral Type PK Cable for Sprinklers

18420255e Moscow *STAL* in Russian  
No 5, May 88 pp 59-60

[Article by M.F. Glushko, deceased, V.K. Skalatskiy and L.D. Solomkin, Odessa Scientific Research Department of Steel Cable, All-Union Scientific Research Institute of Metal Products]

[Abstract] The "Fregat" sprinkler initially used LK-R wire cable, as did its foreign prototype. The authors' institute has now developed a basically new type of spirally-wound 1 x 31(1+6+12+12) wire cable which is easier to manufacture and has superior mechanical parameters. Testing has indicated that bending rigidity is not a sufficient criterion for selection of the optimal wire cable type for sprinklers. Contact stresses, significantly less in spirally-wound cable, are apparently of decisive significance under the operating conditions of sprinklers. Six years of use in the field have indicated the superiority of type PK cable. The low residual elongation of the cable increases the rigidity and reliability of sprinkler arms. Several different diameters of the cable have been produced for use in various parts of the machines. Standardization on one cable type could significantly simplify manufacturing technology. The 6.0 mm diameter cable with layout 1 x 19(1+6+12) and 37.7 kN tensile strength is recommended, and should improve reliability of the entire sprinkler installation by 9 percent, while generating an economic effect of 300,000 rubles. References 3: all Russian.

6508

UDC 546.682'18:66.046.516

### Doping of InP with Bismuth

18420241a Moscow *NEORGANICHESKIYE MATERIALY* in Russian Vol 24, No 3, Mar 88  
(manuscript received 1 Apr 86) pp 492-493

[Article by Ye.V. Vavilov, V.G. Yelsakov, L.F. Zakhar'kov, V.V. Makarov and S.B. Mikhrin, Leningrad Polytechnical Institute imeni M.I. Kalinin]

[Abstract] A study is presented of the influence of bismuth as an isovalent dopant on the electrophysical and structural characteristics of indium phosphide crystals. Bismuth was introduced to a melt used to produce

indium phosphide single crystals by the Czochralski method at 0.01-1.5 mass percent. At over 0.3 mass percent, second phase inclusions were found in the end of the ingots. Bismuth doping did not change microhardness or reduce dislocation density significantly. All specimens had n-type conductivity; doping did not result in the appearance of donor or acceptor centers, indicating that bismuth replaced phosphorus, with little bismuth in the interstices manifesting electrical activity. The behavior of the bismuth is thus similar to that of other isovalent dopants in A<sup>III</sup>B<sup>V</sup> semiconductor compounds, except for its anomalously low solubility. References 4: 3 Russian, 1 Western.

6508

UDC 669.15-194:621.791.011

### Development of Low-Alloy Steel Compositions for Cast Welded Structures

18420238c Moscow *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA* in Russian No 3, Mar 88  
(manuscript received 10 Oct 86) pp 87-91

[Article by Yu.M. Lebedev, V.A. Repin, and A.G. Tsimbalistyy, Nikolayev Ship Building Institute]

[Abstract] A search was made for the optimal composition of low-alloy steel for cast welded structures to be used in air at temperatures of up to 400 C. The influence of carbon, manganese, chromium, nickel, molybdenum, vanadium and zirconium was studied. Experimental melts were made in an induction furnace. The microstructure of the steel was studied in the cast state, as were properties after double normalization and tempering at 630 C. All of the alloying elements were found to strengthen the low-carbon steels after double normalization and high tempering, while decreasing ductility. Only molybdenum had a positive influence on impact toughness. Studies were continued to find the composition with the best combination of mechanical properties which could be welded without preliminary heating, based on testing of welded joints for delayed fracture and metallographic analysis of the heat-affected zone. The low-carbon alloy produced is designated type 12KhGNMFTsL, containing 0.11% C, 0.32% Si, 0.76% Mn, 0.65% Cr, 0.60% Ni, 0.25% Mo, 0.17% V and 0.12% Zr. It has bainite structure with segregation of structurally free hypoeutectoid ferrite grains. Its hardness is HV255. Double normalization results in full homogeneity of composition and structure and much smaller grain size, with hardness decreasing to HV237. Subsequent tempering at 630 C and holding for 1 hour increases hardness to HV245 and increases etching of grain boundaries. After double normalization and tempering it has tensile strength 770 MPa, yield point 625 MPa, delta=19%, psi=540, KCU=106J/cm<sup>2</sup>. References 11: 10 Russian, 1 Western.

6508/12223

UDC 669.15'25'26:669.017.3

**Phase, Structural Transformations in High-Coercivity Alloy Kh25K15YuB**

18420238b Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; CHERNAYA METALLURGIYA in Russian No 3, Mar 88 (manuscript received 20 Apr 87) pp 78-81

[Article by B.A. Maksimov, B.A. Samarin, and V.S. Shubakov; Plant-VTUZ attached to ZIL; Moscow Steel and Alloys Institute]

[Abstract] Thermomagnetic and calorimetric analysis methods were used to study phase transitions in an alloy of iron with 25% Cr, 15% Co, 1% Nb, 1% Al and 0.5% Si. Calorimetric analysis was performed on a differential scanning microcalorimeter. Electron microscope studies

were performed on a TESLA-BS-540 electron microscope. Calorimetric analysis revealed three temperature areas corresponding to three successively occurring transformations in specimens hardened to alpha-solid solution and tempered at 620 and 600 C. Comparison of thermomagnetic and calorimetric data indicate that these specimens differ from other specimens additionally tempered at 580 and 560 C in the temperature variation of saturation magnetism. The results indicate that the breakdown within the  $\alpha_1$  and  $\alpha_2$  phases is replaced by reverse transformation upon heating, causing a thermal effect at 600-640 C. Further heating results in dissolution of the  $\alpha_1$  and  $\alpha_2$  phases, achieving a single-phase state. The phase and structural transitions occurring throughout the entire temperature interval generally used in heat treatment are reversible. Reference 6: 4 Russian, 2 Western.

6508/12223

UDC 669:621.373.83

**Laser-Plasma Target Surface Instability**

18420253d Moscow *FIZIKA I KHIMIYA OBRABOTKI MATERIALOV* in Russian  
No 2, Mar-Apr 88 (manuscript received  
13 Oct 86) pp 24-27

[Article by A.A. Uglov, S.S. Pryakhin and A.D. Fomin, Moscow]

[Abstract] Oscillations occurring in nitrogen at the surface of titanium plates as they move in the focal point of a continuous laser beam are described. The morphology of the surface thus treated is studied. These processes, occurring in an atmosphere of nitrogen on the surface of titanium plates exposed to continuous laser radiation, were studied on an installation allowing continuous focusing of the beams of both continuous and pulsed lasers at a single spot in a high-pressure chamber. The radiation of a continuous 120 W laser was focused on a 0.2 mm spot. The laser beam was modulated at 100 Hz by about 5 percent. A 35 J 1 ms pulse was focused on a spot about 0.6 mm in diameter. The studies showed that the surface combustion of the titanium in nitrogen caused by the continuous laser radiation was periodic in nature and spatially unstable. The surface of the irradiated specimens showed a complex periodic nonaxisymmetrical relief. References 4: all Russian.

6508

**Charging and Orientation of Threadlike Crystals in Electric Field**

18420258d Kishinev *ELEKTRONNAYA OBRABOTKA MATERIALOV* in Russian No 2, Mar-Apr 88  
(manuscript received 12 Nov 85) pp 28-31

[Article by M.I. Glazov and A.A. Pimoshin, Moscow]

[Abstract] The initial charge of threadlike crystals and the charge acquired by the crystals in an electric field and the speed of movement of the crystals and their orientation time are determined using untreated and hydrated AlN crystals initially charged by contact and friction processes. The hydrated crystals, with higher conductivity, had no significant initial charge, but acquired a charge in the electric field. The mean movement speed of the crystals in a field of 2-4.5 kV/cm was 0.2-1 m/s, allowing them to be oriented in an electrostatic field in a time of not over  $10^{-2}$ s. The orientation studies were performed in a field produced by two horizontal flat 500x500 mm electrodes 100 mm apart as the crystals fell through a 10x100 mm slot from a vibration feeder. The method is promising for orientation of crystals to be used in the manufacture of composites. References 6: all Russian.

6508

**Laser Hardening of Titanium Alloys**

18420258c Kishinev *ELEKTRONNAYA OBRABOTKA MATERIALOV* in Russian No 2, Mar-Apr 88  
(manuscript received 8 Apr 86) pp 20-23

[Article by S.V. Bushik, Minsk]

[Abstract] Laser methods have significant unrealized potential for improving the physical and mechanical properties of titanium alloy surface layers. This article studies the phase and structural transformations in ( $\alpha$  plus  $\beta$ )-titanium alloys during laser heat and chemical-heat treatment, as well as the difference between these processes and the processes occurring during traditional heat treatment and chemical-heat treatment of the same type VT9 and VT3-1 alloys. Laser treatment was performed using a pulsed neodymium laser operating at power densities  $8 \cdot 10^3 - 2 \cdot 10^5 \text{ W/cm}^2$ , pulse length 6 ms. Pulsed heat treatment with slow repetition rates and laser boriding using coatings of amorphous boron were performed. Boriding formed a  $\text{TiB}_2$  phase with high hardness and a solid solution of boron in the  $\alpha'$  phase of titanium. Increasing laser radiation intensity decreased the concentration of boron due to the increase in the size of the borided zone and the increase in loss of the boron coating with the plasma flame. The microhardness was distributed approximately uniformly throughout the entire melted zone. The increase in hardness due to laser hardening in air results from oxidation, which was greater when the surface was repeatedly exposed to laser pulses. When the surface did not melt, the depth of the altered layer was about 10-20  $\mu\text{m}$ , though its microhardness did not differ from that of the base metal. Laser boriding was more effective in producing hard surface layers. References 8: 7 Russian, 1 Western.

6508

**Influence of Carbon Additive to VK Hard Alloy on Surface Layer Formation in Electric-Spark Alloying**

18420258b Kishinev *ELEKTRONNAYA OBRABOTKA MATERIALOV* in Russian No 2, Mar-Apr 88  
(manuscript received 1 Jul 85; after revision  
7 Apr 87) pp 13-18

[Article by A.D. Verkhoturov, A.I. Mikhaylyuk, I.M. Mukha, N.S. Stolyarova, S.V. Gnedova, A.Ye. Gitlevich and I.A. Podchernyayeva, Kiev, Kishinev]

[Abstract] A study is made of the influence of the addition of carbon to hard-alloy electrode materials on electric-spark coating characteristics and mass transfer parameters. The kinetics of the process are studied, including the time variation of total and specific anode erosion and cathode gain, hardness, thickness and phase composition of coatings produced upon electric-spark alloying of type 45 steel with VK20 hard alloy containing 0, 0.5, 1, 2 and 4 vol. percent carbon. The results of the experiments indicate that addition of carbon to VK20 alloy significantly influences both mass-transfer parameters and coating properties. As carbon content increases, formation of secondary structure on the anode

surface becomes decisive in the formation of the alloy layer. The content of the more plastic WC phase increases. Effectiveness of the process increases with increasing carbon content. The influence of spark-discharge parameters causes difference in the concentration variation of mass-transfer parameters and phase line intensities in the coating, causing the corresponding changes in alloyed-layer microhardness. The maximum microhardness corresponds to the maximum content of WC and  $W_2C$  phases. Coating quality depends on alloy composition and alloying mode. Coating thickness and continuity increase with increasing carbon content. References 5: all Russian.

6508

UDC 546.681.191.7

**Gallium Arsenide Plasma Chemical Etching Rate in  $CCl_4$  and  $C_2F_3Cl_3$ -Based Medium**

18420260c Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 24, No 5, May 88 (manuscript received 16 Jun 86) pp 719-722

[Article by G.D. Kuznetsov, E.M. Novikova and A.V. Zhuravlev, Moscow Steel and Alloys Institute]

[Abstract] A study is made of the change in plasma chemical etching rate of GaAs as a function of substrate temperature in  $CCl_4$  and  $C_2F_3Cl_3$ -based media and oxygen concentration in a  $CCl_4+O_2$ -based medium. The variation in contact wetting angle with oxygen content in the initial gas mixture indicates that when 3-9 vol. percent oxygen is added to carbon tetrachloride, the surface layer of the substrate is not enriched with impurity products of the interaction at the heterogeneous interface. The studies demonstrate the possibility of plasma chemical etching of gallium arsenide in a medium based on trichlorofluoroethane; it is found that with otherwise equal parameters, the rate of removal of the gallium arsenide surface layer in trichlorofluoroethane is higher than in carbon tetrachloride. It is found that the plasma chemical etching rate of gallium arsenide in trichlorofluoroethane at 250-350°C increases in comparison to the rate at 180-250°C by a factor of almost eight. This results from the additional participation of fluorine in the etching process. It is found that the addition of oxygen at up to 10 vol. percent to a carbon tetrachloride-based mixture helps to increase the rate of the process by an order of magnitude. References 15: 7 Russian, 8 Western (1 in Russian translation).

6508

UDC 669.15'71'782:539.213:538.213

**Cross Relaxation of Permeability in FeSiAl Alloy**

18410239c Moscow FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 65, No 3, Mar 88 (manuscript received 3 Sep 86) pp 606-607

[Article by Ye.A. Dorofeyeva, V.V. Sosnin, and V.L. Stolotniy, Precision Alloys Institute, Central Scientific Research Institute of Ferrous Metallurgy imeni I.P. Bardin]

[Abstract] The rapidly quenched microcrystalline alloy FeSiAl is known for a combination of good soft-magnetic and mechanical properties. It is shown that this alloy has a number of previously unknown distinctive features of the temperature-time behavior of its initial permeability. Magnetic deaccommodation (DA) curves are presented, expressing  $\Delta\mu_0/\mu_0$  versus time, obtained for toroidal specimens, for a quenched alloy at -15, 25 and 100°C, and for an alloy annealed at 400°C for 30 min, at 25, 35, 45, 65 and 75°C. The curves are distinguished by the fact that DA has a nonmonotonic time dependence; there is a qualitative change in the kind of DA curve with a rise in temperature, with the minimum disappearing and a maximum appearing; and DA depends strongly on the temperature, T. The maximum value of DA is observed in the room temperature range and the minimum at temperatures greater than 100°C. The nonmonotonic nature of DA is maintained after isothermal aging at 400°C for 30 min, but a change in the type of curve takes place at temperatures approximately greater than 25°C, with the maximum value of DA, of about 11 percent, reached at 45°C. DA is reduced considerably, to less than one percent, after annealing at 800°C for 30 min. It is suggested that the coincidence of two relaxation processes occurs in the rapidly quenched FeSiAl alloy: the ordinary stabilization of domain boundaries after demagnetization, and relaxation with a change in T. That is to say, the nonmonotonicity of the time dependence of DA is due to cross relaxation. Deaccommodation is apparently due to particular features of the rapidly quenched alloy's structure, i.e., the high volume density of prismatic dislocation loops appearing as the result of the relaxation of quenching vacancies. The cross relaxation is probably due to the presence of various types of dislocation structures in the FeSiAl alloy having a wide range of relaxation times. References 2: 1 Russian, 1 Western.

8831/12223

UDC 621.735.32

**Degrees of Deformation upon Repeated Forging with Change in Axis**

18420238f Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 88 (manuscript received 10 Mar 87) pp 140-141

[Article by V.A. Petrov, A.V. Kotelkin, and S.A. Mashenkov, Moscow Steel and Alloys Institute]

[Abstract] Optimal compression achieved by repeated upsetting with a change in axis can increase the quality and decrease the labor cost of the manufacture of non-ferrous metal forgings. Experiments on forging were performed using lead specimens to optimize the ratio of square height at the end of a forging after compression to square height in the central portion of the forging. Optimal results were achieved when the ratio remained equal to one. It was found that the process should be performed in conical hammer blocks with compressions determined by the two equations presented in the article.

6508/12223

UDC 669.041.067.33.101.24

**Change in Hydraulic Resistance of Filter Cloth  
Under Influence of Pulsed Spark Discharge**

18420238d Moscow *IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: CHERNAYA  
METALLURGIYA* in Russian No 3, Mar 88  
(manuscript received 8 Jul 87) pp 110-113

[Article by L.A. Miroshkina, N.N. Kozlova, and S.B. Stark, Moscow Steel and Alloys Institute]

[Abstract] A study is presented of the decrease in the hydraulic resistance of cloth under the influence of electric field alone and the parameters of the optimal

reduction are determined. Studies were performed on an installation consisting of a powder source, a filter element and a high voltage rectifier. It was found that a pulse spark discharge decreases the hydraulic resistance of materials of varying conductivity, the decrease in resistance occurring only at the moment of the discharge and depending on the voltage applied, which corresponds to the shock wave theory. A mode was selected in which a discharge occurred each 2 minutes, in which case the resistance of the filter varied but slightly, remaining rather high, and good filtering properties were maintained. References 7: 6 Russian, 1 Western.

6508/12223



**Anodic Electrochemical Etching of Molybdenum Before Soldering With Glass and Ceramic**  
18420258f Kishinev ELEKTRONNAYA OBRABOTKA  
MATERIALOV in Russian No 2, Mar-Apr 88  
(manuscript received 6 Jul 85) pp 78-79

[Article by N.I. Kisilenko, V.N. Parusnikov and A.V. Kaptanovskiy, Moscow]

[Abstract] Results are presented from experiments on producing a rough grainy surface on molybdenum wire by anodic electrochemical etching. The experiments determined that anodic dissolution of molybdenum and the quality of the metal surface produced were influenced by the composition, concentration and temperature of the electrolyte, the anodic current density and processing time. The grainy surface was probably produced due to liberation of carbon dioxide gas at the anode, which broke up the oxide layer. The lower oxides of molybdenum were then removed from the surface by annealing in hydrogen at 900-1000°C for 5-10 minutes. References 7: 3 Russian, 2 Czech (in Russian translation), 2 Western (in Russian translation).

6508

UDC 621.791.947.55.002:669.14.018.295

**Thermal and Technological Specifics of Plasma-Arc Cutting of Thin Sheet Metal**  
18420252f Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 88 (manuscript received 5 Aug 86; in final form 26 Oct 87) pp 52-55

[Article by V.M. Yampolskiy, doctor of technical sciences, V.V. Ship, candidate of technical sciences, Moscow Higher Technical School imeni M.E. Bauman, S.V. Tebenchuk, candidate of technical sciences, Rostov Scientific Research Institute of Machine-Building Technology]

[Abstract] A model of the plasma-arc cutting process is suggested in order to consider the stage in which the metal is melted and carried away from the cut cavity. The method is used to study the influence of arc power and cutting speed on the width of the slot and extent of the thermally affected zone. It is found that as arc power increases at constant cutting speed, the slot width and extent of thermally affected zone increase significantly. The extent of the thermally affected zone varies little with metal thickness at constant power, though slot width increases with decreasing metal thickness. When metal 2-8 mm thick is cut, optimal slot widths and thermally affected zones can be achieved by the use of air-plasma arcs with 5-14 kW effective power rather than the 40-60 kW generally used today. This can be done by reducing the current to 30-100 A. References 7: all Russian.

6508

UDC 621.791.754'293.011:669.15-194

**Weldability of Nitrogen-Containing Austenitic Steels**  
18420252b Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 88 (manuscript received 26 Sep 86) pp 6-10

[Article by K.A. Yushchenko, doctor of technical sciences, A.M. Solokha, candidate of technical sciences, N.P. Kazennov, engineer, Electric Welding Institute imeni Ye.O. Paton, Ukrainian Academy of Sciences]

[Abstract] A study is presented of the weldability of high-nitrogen steel with nitrogen content above equilibrium and a technology is developed for welding these steels. Studies were performed on high-nitrogen steels produced by processing under gas counter pressure. Specimens were austenitized at 1100°C, forged at 1050°C to 850-900°C and rolled at 1150°C, homogenized at 1050-1150°C and cooled in water. Weldability was studied using mechanized argon-arc welding with a tungsten electrode with and without a 1.6 mm type ChS-39 wire. Weldability was found to be limited, with seam porosity influenced not only by the absolute concentration of nitrogen, but also by welding bath volume and shape, speed and metal crystallization conditions and superheating temperature. Good quality welded joints can be made in steels containing up to 1 percent nitrogen by limited-power argon-arc welding. Arc spot welding decreases the superheating of the metal in the welded bath due to the periodic reduction in welding current. References 14: 11 Russian, 3 Western.

6508

UDC 621.791.947.5(204.1)

**Underwater Arc Cutting with Powder Wire**  
18420252h Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 88 (manuscript received 29 Sep 86) pp 59-61

[Article by M.Ye. Danchenko and I.M. Savich, candidates of technical sciences, and Yu.N. Nefedov, engineer, Electric Welding Institute imeni Ye.O. Paton, Ukrainian Academy of Sciences]

[Abstract] The authors' institute has developed a method of electric-arc cutting with powder wire for use underwater. In contrast to previous methods, the new method does not require additional feeding of gas or water into the arc zone. The essence of the method is continuous feeding of a special powder wire, the core of which contains gas-forming and stabilizing components. The thermochemically highly active gas-flame jet thus formed melts, oxidizes and removes the melted metal from the cutting zone. The electrode wire extends 5-15 mm during cutting, with its tip making an angle of 60-70

degrees with the cut surface, bevel forward. The cut width at the upper edge is 4-6 mm, at the lower edge 7-9 mm. The cutting speed of low-carbon and low-alloy steels is practically the same; austenitic steels can be cut 10-15 percent faster due to the lower heat conductivity of the metal. Significantly lower arc voltage is required, and the increase in required voltage with increasing depth is also less. References 4: 3 Russian, 1 Western.

6508

UDC 621.791.754'293:[669.14+669.71]:532.6.001.24

### Wetting and Spreading During Arc Welding of Dissimilar Metals

18420252e Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 88 (manuscript received 5 Dec 86) pp 28-31

[Article by V.R. Ryabov, doctor of technical sciences, I.S. Dykhno, engineer, Electric Welding Institute imeni Ye.O. Paton, Ukrainian Academy of Sciences, B.M. Berezovskiy, candidate of technical sciences, A.G. Kramarenko, engineer, Chelyabinsk Polytechnical Institute, and G.F. Deyev, candidate of technical sciences, Lipetsk Polytechnical Institute]

[Abstract] Nonisothermal spreading and wetting processes occurring during welding and soldering have been little studied, hindering the selection of optimal conditions for joining dissimilar or composite materials. This article calculates the surface shape of spreading liquid metal, considering the force of gravity, surface tension and arc pressure. The influence of arc pressure on the spreading process is found to be more effective than the influence of drop mass, which is decisively influenced by the mechanism by which the drop surface is cleansed of its oxide film, which is the limiting factor in nonisothermal wetting and spreading of aluminum over steel. Spreading can be controlled by changing the arc pressure through changing the welding current and electrode diameter. References 9: all Russian.

6508

UDC 621.791.002:629.1-43:65.011.56

### Continuous Line for Assembly and Welding of Semitrailer Platform Bases

18420252g Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 88 (manuscript received 3 Jul 86; in final form 20 Apr 87) pp 56-58, 61

[Article by V.I. Tereshchenko, candidate of technical sciences, A.N. Sharovolskiy and K.A. Sidorenko, engineers, Electric Welding Institute imeni Ye.O. Paton, Ukrainian Academy of Sciences, and V.V. Shurinov, engineer, Krasnoryarsk Trailer Plant]

[Abstract] The Krasnoryarsk Trailer Plant has created a highly mechanized, continuous flow production line for assembly and welding of type OdAZ-9370 semitrailer

platform bases with two longitudinal beams of rolled steel consisting of 400 mm I beams, two longitudinal and two transverse channel sections with flat bed toe rails welded to them, transverse rigidity ribs of various channel sections, supporting sheet sections, cross braces, two longitudinal corrugated sheets 2 mm thick and a number of small accessory parts. The new line raises the technical level of platform base manufacture by the use of highly productive processes and equipment, and also by separating the design of the base into independently manufactured welded units and subunits. The new line increases labor productivity by a factor of 3.3, allowing 78 workers to be released at the current production volume of 22,500 units per year. Automation of welding operations is increased to 31.1 percent, production per square meter of factory floor is increased by 62.3 percent, cost is reduced by 41.5 percent, yielding an annual economic effect of 375,600 rubles. References 2: both Russian.

6508

UDC [621.791:72:669.15-194.2]:621.039.5

### Electron-Beam Facing of Edges Solves Problem of Welding Structural Steels

18420252a Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 88 (manuscript received 15 Jan 87; in final form 9 Jun 87) pp 1-5

[Article by Academician B.Ye. Paton, S.N. Kovbasenko, candidate of technical sciences, O.K. Nazarenko, doctor of technical sciences, Yu.V. Orsa, engineer, Electric Welding Institute imeni Ye.O. Paton, Ukrainian Academy of Sciences]

[Abstract] The authors' institute has suggested and developed a method of electron-beam facing (surfacing) of edges to be welded together allowing subsequent single-pass electron-beam welding of metal over 100 mm thick. The same electron gun and product feed mechanism are used as for ordinary electron-beam welding. The speed of surfacing depends on the gas content and purity of the metal being surfaced and the surfacing metal, diameter of the surfacing wire and geometry of the arrangement, but productivities of 3-12 kg/hr are typical. The strength of joints produced by the new method is usually greater than that of the base metal. The process was effectively used in the manufacture of rolled structures 1600 mm in diameter with 100 mm wall thickness. Strength characteristics produced were 30 percent greater than with arc welding under flux. References 5: 3 Russian, 2 Western.

6508

UDC 621.791.72:621.373.826

**Dynamics, Structure of Stream of Information on Laser Welding, Related Processes**  
18420240h Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 88, pp 45-46

[Article by Candidate of Technical Sciences V.G. Krutikhovskiy and Engineer V.V. Tikhomirova]

[Abstract] Results are presented from a study of the dynamics and structure of the stream of information published on laser welding and related processes, based on analysis of article abstracts published in 1981-1985 in several Soviet abstract journals covering the Soviet and Western literature in the areas of metallurgy, electronics, welding and machine building. Graphs illustrate the rate of growth of the number of abstracts on laser working of metals and related processes, indicating an exponential growth rate in the number of articles. The greatest share of the information was on the subject of welding, followed by cutting, surfacing, atomization and brazing/soldering. The scattering of articles among many abstract journals and sections in the abstract journal hinders the free flow of information, resulting in terminological instability and information loss. It is suggested that all abstracts on laser welding and related processes be concentrated in the abstract journal SVARKA in a special section and in the abstract journal RADIO-TEKHNIKA in the quantum electronics section. References 7: 4 Russian, 3 Western.

6508/12223

UDC 621.791.09:621.785:669.296

**Eddy-Current Method of Determining Depth of Strain Hardened Layer on Surface of Zirconium Alloy Welded Joints**  
18420240f Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 88, pp 28-29

[Article by Engineer V.N. Tyurin, Engineer V.A. Komarov, Candidate of Technical Sciences, M.I. Plyshevskiy, Engineer N.S. Rassoshkina and Engineer I.I. Akimov]

[Abstract] An eddy-current method based on the change in resistance of metal as a function of degree of strain hardening was used to perform nondestructive testing of welded joints in an alloy of zirconium with 2.5% niobium. Studies were performed on welded connections of pipes measuring 88x4mm with joints made by electron beam welding and hardened by rolling at 1-4 kN. A transformer-type sensor was used to determine resistance. The measurements revealed characteristic changes in resistivity in various zones of the welded joints. The results of metallographic investigations and hardness measurement in the surface layers of the rolled pipes showed good correlation with the eddy-current studies. References 4: all Russian.

6508/12223

UDC 621.791.052:620.18

**Properties, Structure of Joints Produced by Induction Brazing of Steel**  
18420240d Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 88, pp 15-16

[Article by Doctor of Technical Sciences M.Kh. Shorshorov (Metallurgy Institute imeni A.A. Baykov), Engineer V.V. Karabanov, Engineer I.O. Bokhorov, Candidate of Technical Sciences V.I. Khomenko (All-Union Scientific Research Institute for Construction of Major Pipelines), Engineer N.P. Khomutova (Planning and Design Bureau for Mechanization of Power Engineering Construction)]

[Abstract] A study is made of the influence of electromagnetic mixing on the properties and structure of joints in steel made by induction brazing. Electromagnetic mixing of the solder melt was studied on a high frequency 100kW installation operating at 2.4 kHz with powered manganese which forms unlimited solutions with the iron; copper, which forms a limited solution with up to 4% iron; and an iron-manganese brazing compound containing 40% iron, which forms unlimited solutions with iron. Electromagnetic mixing is found to cause significant saturation of the seam zone with iron. The concentration supercooling of the brazing compound is 80-100 C for the compounds with unlimited solubility, regardless of gap size and brazing temperature. With copper, the saturation of the brazing compound with iron exceeds its maximum solubility, and the excess quantity separates upon crystallization as a second iron-based phase. Electromagnetic mixing can increase the strength or decrease the brazing temperature by the supercooling achieved by the use of a brazing compound with a lower melting point. References 3: all Russian.

6508/12223

UDC 621.791.72:621.373.826

**Determination of Limiting Laser Welding Parameters**  
18420240a Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 88, pp 2-4

[Article by Candidate of Technical Sciences S.G. Gornyy, Candidate of Technical Sciences B.A. Lopota, Engineer V.D. Redozubov, Candidate of Physical-Mathematical Sciences I.G. Rudoy, Candidate of Physical-Mathematical Sciences A.M. Soroka and Engineer Yu.T. Sukhov]

[Abstract] Laser welding with deep melting is accompanied by evaporation of a portion of the material. The evaporated metal vapor interacts with the radiation, generating a radiation wave of a certain pressure, which must be limited in order to prevent it from influencing the quality of the welded seam. The use of periodic pulsed laser radiation can reduce plasma formation and

thus allow greater beam intensity. The maximum radiation intensity for steel is about  $2 \cdot 10^6$  W/cm<sup>2</sup>, which determines the maximum melting depth. In the periodic pulse mode, the minimum pulse length depends on the physical properties of the material, while the optimal pulse repetition frequency is proportional to the speed of welding. References 11: 10 Russian, 1 Western.

6508/12223

UDC [621.791.052:620.17]:669.296:546.293+546.291

**Influence of Argon, Helium on Thermal Cycles and Mechanical Properties of Welded Joints in Alloy of Zirconium with 2.5% Niobium**

18420240c Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 88, pp 13-14

[Article by Engineer L.I. Adeyeva, Candidate of Technical Sciences A.B. Goncharov, Candidate of Technical Sciences V.F. Grabin, Engineer V.F. Kirlyuk and Doctor of Technical Sciences M.M. Nerodenko, Electric Welding Institute imeni Ye.O. Paton]

[Abstract] A study is presented of the influence of argon-arc and helium-arc welding conditions on the thermal cycling and mechanical properties of joints made in plates measuring 180x300x2mm using a nonconsumable tungsten electrode. It was found that helium-arc welding produced more rapid cooling of joints due to its greater heat conductivity. Hardening of the metal and the area near the seam was greater with helium-arc welding under all conditions tested. Helium can more than double the cooling rate of the joint. Strength increases from 610 to 780 MPa and chemical heterogeneity of the seam metal is reduced. References 4: all Russian.

6508/12223

UDC 621.791.92.03-52

**Installation for Arc Surfacing, Using Gas-Powder Mixtures**

18420240e Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 88, pp 20-21

[Article by N.N. Dorozhkin, Corresponding Member, Belorussian Academy of Sciences, Candidate of Technical Sciences N.N. Petyushev, Engineer E.A. Shcherbakov, Institute of Problems of Reliability and Durability of Machines, Belorussian Academy of Sciences]

[Abstract] An installation has been developed for automatic arc surfacing using a consumable electrode and alloy powders, with carbon dioxide gas or a mixture of carbon dioxide and argon as the transporting and protective medium. Various powders including ferrochrome and mixtures of the powders with self-fluxing chromenickel alloy were used to apply homogeneous wear-resistant coatings with hardness 57-60 HRC and relative wear resistance three to four times greater than that of

type 45 steel. High quality nonporous coatings with good smoothness were achieved only by simultaneous use of a two-phase jet and an accompanying gas jet surrounding the two-phase jet. References 2: both Russian.

6508/12223

UDC 621.791.3.01:620.19

**Distribution of Boron in Joints in Nickel Alloy VZhL12U Brazed With VPr 27 Solder**

18420240g Moscow SVAROCHNOYE  
PROIZVODSTVO in Russian No 4, Apr 88, pp 41-42

[Article by Doctor of Physical-Mathematical Sciences I.G. Berzina, Candidate of Physical-Mathematical Sciences E.B. Gusev, Engineer G.N. Fedina, Engineer Ye.V. Maksimova, Moscow Institute of Railroad Transport Engineers]

[Abstract] The purpose of this work was to determine the correlation between the distribution of boron in the seam zone and the strength of joints in VZhL12U brazed with VPr 27 solder in which the boron is the major element determining whether the necessary brazing temperature is reached. The distribution of boron was studied by the (n, alpha)-radiography method, which is highly sensitive (10.5%) and accurate. Joints were made in VZhL12U nickel-based alloy, which contains chromium, molybdenum, tungsten and 0.015% boron, plus other elements. The studies performed showed that the distribution of boron differed in joints with different "viability." Metallographic studies indicated that all specimens had approximately the same grain structure, with the strength depending on the penetration of boron into the base metal, which is successfully measured by (n, alpha)-radiography. References 4: 2 Russian, 2 East European.

6508/12223

[621.791.46.052:678.742.3]:620.17

**Influence of Heat Treatment and Extension Rate on Strength and Fracture Type in Polypropylene Welded Joints**

18420252d Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 88 (manuscript received 13 Oct 86; in final form 18 Mar 87) pp 19-23

[Article by S.A. Sergiyenko, engineer, G.B. Yesaulenko, candidate of chemical sciences, T.I. Romanyuk, engineer and L.I. Bezruk, candidate of technical sciences, Electric Welding Institute imeni Ye.O. Paton, Ukrainian Academy of Sciences]

[Abstract] A study is made of the influence of loading rate and thermal prehistory on the strength and fracture mechanism of polypropylene welded joints. Strength tests were performed at 10 and 1000 mm/min on specimens cut from welded plates as well as plates of the base material. Increasing the speed from 10 to 1000 mm/min

did not affect the strength of the base material, but cut the strength of the welded joints in half and altered the crack propagation trajectory in the welded specimens, apparently because fracture through the seam occurs much earlier than orientation restructuring of the material. Fracture through the thermally affected zone predominated at the higher speed. Annealing for 1 hour at 135°C increased strength, probably due to morphologic restructuring in the seam, and expanded the strength test confidence interval range. References 19: 11 Russian, 8 Western.

6508

UDC 621.791.763.1

**Technology, Equipment for Welding Parallel Resistance Bridges to Recessed Instrument Leads**  
*18420240b Moscow SVAROCHNOYE*  
*PROIZVODSTVO in Russian No 4, Apr 88, pp 4-6*

[Article by Engineer A.Ya. Veselis, Engineer M.A. Kaley, Candidate of Technical Sciences V.Ye. Ataush, Engineer E.G. Moskvina and Engineer A.N. Timoshkin, Riga Polytechnical Institute]

[Abstract] The standard method of condenser welding is unsuitable for attachment of bridges of nichrome wire in depressions in products, since it does not provide the necessary curvature of the bridge, needed to avoid breaking due to thermal stresses. A method has been suggested in which the wire, preliminary wound on the electrodes, is brought up to the ends of the leads of the product before the electrodes contact the product. Then the product with the wire pressed against it is moved in a direction parallel to the axes of the electrodes, while their ends are moved toward each other, causing the ends of the wire to move together, forming the necessary bend. This article describes a machine which has been developed to implement this method. In a version designed to attach a wire bridge in a depression, there are four wire clamps located next to the electrodes at the level of the welding zone and controlled by a cam. The wire is fed directly from a capillary tube into a clamp and wound around guides and through the clamps, producing two parallel wire sections suitable for welding of two bridges to four leads in two depressions in a product in one cycle. References 2: both Russian.

6508/12223

UDC 669.1:622.785

**Use of Radioactive Isotope to Study Process of Removal of Nickel from Iron-Ore Materials During Sintering**

18420238e Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 3, Mar 88 (manuscript received 17 Jun 87) pp 132-133

[Article by V.A. Ivyanskiy and Ye.P. Miroshnikov, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] The use of  $Zn^{65}$ , which emits gamma radiation, allowed clear observation of the movement of zinc during sintering and estimation of the influence of various factors on the process of zinc removal. It was

found that the zinc, leaving the combustion zone, is practically all precipitated on the lowest granules of moist charge. The significant increase in radiation in the vacuum test chamber corresponds to the beginning of the increase in flue gas temperature, indicating that only as the drying zone approaches the grate is zinc intensively carried away with the flue gas. Addition of refractory components significantly influences zinc removal, the most positive effect being achieved by the introduction of additional fuel and magnesium. Increasing the pressure over the layer from 0.5 to 3.0 atm. gauge increased residual radiation by 15-25%, which agrees with the thermodynamics of the reaction  $ZnO + Co = Zn_{Gamma} + CO_2$ .

6508/12223

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