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No. 51

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USSR AND EASTERN EUROPE SCIENTIFIC ABSTRACTS  
MATERIALS SCIENCE AND METALLURGY

No. 51

This serial publication contains abstracts of articles and news items from USSR and Eastern Europe scientific and technical journals on the specific subjects reflected in the table of contents.

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## Coatings

USSR

UDC 539.431+669.245:620.197.2

### EFFECT OF ALUMINIDE COATINGS ON THE FATIGUE STRENGTH OF GRADE ZhS6U NICKEL ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 77 pp 34-38 manuscript received 8 Feb 77

BELYAYEV, M. S., ZHUKOV, N. D., KRIVENKO, M. P. and TEREKHOVA, V. V., All-Union Scientific Research Institute of Aviation Materials, Moscow

[Abstract] A study was made to determine the effect of protective aluminide coatings on the fatigue strength of grade ZhS6U heat-resistant nickel alloy. Smooth toroidal specimens with various depths of the aluminide layer (with a 10-13% Cr content) were subjected to cyclic flexure, at a frequency of 50 Hz, by rotation at room temperature or at high temperatures for 500 hours. The results indicate that a 40-60-micron-deep aluminide layer provides the best compromise between protective and fatigue characteristics. Metallographic examination has shown that a 20-micron-deep layer, while not yet reducing the fatigue strength, does not provide sufficient protection against corrosion after 300 hours. On the other hand, aluminide layers deeper than 90 micron reduce the fatigue strength by behaving as a separate material which easily develops macrocracks, the latter acting as stress concentrators and thus facilitating oxidation. Exposure to high temperature, 1050°C for 1000 hours, was also found to reduce the fatigue strength of this alloy with aluminide coating, but not as much as that of an uncoated alloy. This is attributed to structural changes such as coarsening of the grain boundaries and coagulation of the  $\gamma'$ -phase. Figures 5; references 5: 4 Russian, 1 Western.

USSR

UDC 621.762.5:621.762.34

## ON DISPERSION HARDENED CHROMIUM-ALUMINUM NITRIDE ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR METALLY in Russian No 4, Jul/Aug 77  
pp 191-193 manuscript received 17 Mar 74

SAMSONOV, G. V. (deceased), and ALFINTSEVA, R. A., Kiev

[Abstract] Sintered composites of chromium with dispersed aluminum nitride particles were studied. The specimens were produced from electrolytic chromium of 99.7% purity, particle size not over 6  $\mu\text{m}$  and high purity aluminum nitride. Mixtures of chromium with 0.5, 1, 2, 4, 8, 12 and 16 vol. % aluminum nitride were produced, then sintered under a pressure of 4 t/cm<sup>2</sup> in a vacuum of 10<sup>-4</sup> mm Hg at 1,300, 1,400 and 1,500°C for 1 hour. The dispersed particles tend to increase the density of the alloy, the greatest value (98% of theoretical) being achieved in the alloy with 8 vol. % aluminum nitride. The AlN particles also increased the oxidation resistance of the chromium, reducing weight gain at 1,000°C by a factor of 100. Figures 5; references 5: 3 Russian, 2 Western.

USSR

UDC 621.419:620.183

## INVESTIGATION INTO THE STRENGTHENING OF THIN LAYERS OF DUCTILE METALS IN COMPOSITES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 4, Oct 77  
pp 888-891 manuscript received 22 Nov 76

RYBAL'CHENKO, N. D. and TRON', A. S., Physico-Technical Institute, Academy of Sciences Ukrainian SSR

[Abstract] Metallographic investigations into the process of deformation and fracture of thin layers were conducted and the fine structure of the layer material under tension was studied for composites Ti-Nb-Cu-Kh18N10T, Kh18N10T-Cu-Kh18N10t, and steel 30KhSVFA-silicon Fe-30KhSVFA. For samples of composite Ti-Nb-Cu-Kh18N10T (using VT6S titanium alloy as the Ti layer) fracture occurred in the copper layer and stress-strain cracks for these samples showed greater strength and less ductility when the ratio of thickness to cross section area was smallest for the copper layer. Plastic deformation of the copper took place by intragranular slip. In the steel-silicon Fe-steel samples, plastic deformation started out as slip but shifted to a twinning mechanism and fracture, ductile at high thickness-to-area ratios, changing to brittle at low ratios. For the Kh18N10T-Cu-Kh18N10T composite there was significant multiplication of dislocations in the copper layer when stressed with the dislocations accumulating at the copper-steel boundary. This dislocation buildup caused brittle fracture in the copper layer. Thus, "contact strengthening" occurs from several different mechanisms of slip and dislocation movement. Figures 7; references 8: 7 Russian, 1 Western.

Conferences

USSR

UDC 621.791:65.016<<313>>:061.3

OBLAST SCIENTIFIC-TECHNICAL CONFERENCE ON PROGRESSIVE WELDING METHODS AND PROSPECTS FOR WELDING PRODUCTION DEVELOPMENT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 77 pp 59-60

KORCHEMKIN, A. YE., Candidate of Technical Sciences, Chairman of the conference organization committee

[Abstract] The oblast conference on welding was held in Kirov on 17-18 May 1977. Fifteen reports were given on the state of welding production and prospects of its improvement. Reports were as follows: A. A. UGOL (Moscow) and V. V. MELYUK (Kirov) - application of methods of optimum control of electron-beam welding processes; V. F. TYURIN (Moscow) - the work of the journal Svarochnoye Proizvodstvo in the tenth five-year plan and its immediate problems for 1976-80; V. A. BACHIN - the advantages of vacuum diffusion welding; V. A. ORLOV - experience in contact relief welding instead of brazing; A. I. BYKOV - implementation of mechanized welding at the Kirov Repair Administration and methods of preparing edges for welding and quality control of welding different types of pipe; M. I. POLITOV - experience in welding with carbon dioxide and carbon dioxide + oxygen at the Kirov Machine Building Plant imeni 1 May. Representatives of the Kirov Polytechnical Institute reported results from investigating arc-welding of small-scale parts, increasing quality of spot welding at high frequencies and the effectiveness of using computers to optimize spot welding machines. It was also reported that the institute has developed an experimental model of a synchronous welding generator and electrodes for welding Mn-Cu damping alloys. Recommendations were made for improving welding production, particularly in using the experience of plants in the oblast for introducing contact relief welding and welding with  $CO_2 + O_2$ .

USSR

UDC 621.791:061.3

SEMINAR ON MEANS OF INTENSIFICATION AND INCREASING THE EFFECTIVENESS OF WELDING PRODUCTION

Kiev AVTOMATICHESKAYA SVARKA in Russian No 8, Aug 77 pp 73-74

PANASHCHENKO, N. I., candidate of Economic Sciences

[Abstract] A national scientific and technical seminar on means of intensification and increasing the effectiveness of welding production was held in Moscow 21-22 February 1977. Some 250 specialists representing enterprises, organizations and educational institutions attended, hearing 26 reports. The subjects covered by the reports included: increasing the quality of joints of high strength alloy steels; means for improving the quality of manufacture of automobile bodies; electric slag welding with the addition of powdered

additive metals to the slag bath to more than double the speed of welding and simultaneously improve the structure and mechanical properties of the seam metal; economically effective use of semiautomatic welding in CO<sub>2</sub> in the construction of thermal electric power plants; prediction of the development of welding production; mechanization and automation of welding production; friction welding in the construction of tractors; individual welding techniques for the production of specific products; improvement of welding equipment; and the influence of the method of manufacture of welded structures on the effectiveness of their production and product quality. The seminar developed recommendations for further expansion of the use of progressive technologies of welding and intensification of the production of welded structures.

USSR

UDC 621.791.4:539.378.3.061.3

EIGHTH ALL-UNION CONFERENCE ON DIFFUSION JOINING OF MATERIALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 77 pp 57-58

KAZAKOV, V. N., engineer

[Abstract] Moscow was the site of the Eighth All-Union Scientific and Technical Conference on Diffusion Joining of Metallic and Nonmetallic Materials attended by 450 Soviet scientists and engineers and specialists from East Germany and Poland. E. K. KALININ, Chief of the Main Administration for the Ministry of Higher Institutes of Learning RSFSR, opened the plenary session, which consisted of seven basic reports: diffusion joining of metallic and nonmetallic materials, modern state and prospects of development of diffusion welding in the tenth five-year plan (N. F. KAZAKOV), state and development prospects of vacuum engineering (V. P. BORISOV), increasing weld joint quality and the development of methods and means of weld joint inspection (O. R. ZABOROVSKIY), composite materials and methods of joining them (M. KH. SHORSHOROV) and intensification of the diffusion welding process (L. N. LARIKOV and G. K. KHARCHENKO). The section on diffusion welding of similar metals heard 29 reports and papers. YE. A. VINOKUROV, S. I. GUSEV, L. P. MOYDANOV and A. A. NILOV reported on diffusion welding of large-scale parts and rib constructions made of titanium alloys. V. F. KVASNITSKIY, S. G. KULIK and N. V. ALTUKHOV reported on diffusion welding of high-temperature alloys and the functioning of their joints. Problems in using diffusion welding for production of high precision bimetallic pipe and hot deformed pipe by internal pressure were presented (V. YA. OSTRENKO, R. G. KHEYFITS, YU. V. CHICHKOV, et al). A. G. SHCHERBAK and B. A. KHOKHLOV discussed technological construction forms of telescoping joints. Much attention was given to the technology of joining the parts of electrovacuum instruments, joining of porous and dense nickel by means of micropowders as well as the effect of welding modes on the properties of electrotechnical steel (G. V. KONYUSHKOV, S. D. KHARITONOV and V. G. NOVIKOV). G. K. KHARCHENKO, R. A. MUSIN, L. M. MARKASHOVA, YU. B. MALEKSKIY, YE. K. KOVSHIKOV, I. V. ZUYEV, et al reported on various areas of

practical application of diffusion welding. The diffusion joining of a hard alloy with steel in the manufacture of cutting, stamping and measuring tools was reported on by I. I. MUKHA and L. I. SHCHERBAKOVA, E. R. GALINSKIY and R. L. SARANDI, and V. A. BACHIN and S. G. TKACHENKO. B. N. ZOLOTYKH, N. F. KAZAKOV and M. M. YAKUNKIN familiarized conference participants with diffusion kinetics during welding copper with tungsten. The weldability of Nb and Mo with Nb with protective coatings of refractory metals was discussed by O. V. YEVTUSHENKO, G. V. SAMSONOV and S. M. BRAUN. Welding titanium and certain refractory metals with aluminum was the subject of a report by A. V. SERGEYEV, V. N. KAZAKOV and A. I. ASADCHEV. A. G. FESENKO, V. V. NICHUSHKIN and V. A. LYSENKO discussed the weldability of nickel alloys with niobium. A. V. SERGEYEV, N. P. METIK, et al reported on cladding piston ends with erosion-resistant titanium alloys. The welding of corrosion-resistant and carbon steels was reported on by V. YE. SUKHANOV, A. P. SUROVTSEV and S. A. GOLOVANENKO. The welding of Fe-Co alloys with steel was discussed in the report of A. A. MIKHEYEV and A. I. KORCHAGIN. YU. T. KUREVICH reviewed the state of welding steel with titanium nitride. Other reports were as follows: A. F. METELKIN and V. M. FELIKSOV - manufacturing bimetallic adapters from titanium and steel; V. N. ANTSIFEROV and A. B. LADOGOVSIIY - making fibrous composites; and S. A. BYSTROV - restoration of worn meat-cutting tools; N. F. KAZAKOV and G. M. CHERGESHTOV - specialized equipment for diffusion welding; E. R. GALINSKIY and P. V. KHION - specialized equipment for diffusion welding; B. P. KAPRALOV and A. P. SIGACHEV - equipment for diffusion welding in a vacuum; V. T. KEDROV and A. G. SHCHERBAK - a device for multiposition welding of parts and assemblies of various instruments; V. M. STUCHEBNIKOV, et al - unit for diffusion welding of semiconductor sensors. V. G. LOMONOSOV, et al - quality improvement and new methods of ultrasonic inspection of joint quality in the process of diffusion welding; V. P. ANTONOV, et al - diffusion welding of semiconductor elements with metals and semiconductor crystals with metals and alloys; I. M. PESEGOV - welding of glass-metal airtight entrances with double windows and a heating device for joining glass-metal pairs; V. A. BRAUN and V. P. KRYUCHKOVA - the use of intermediate inserts for producing metal-glass joints; Z. A. KLYUCHAREVA - diffusion joining of ceramics with metals by means of copper insert. G. A. OSIPOVA and V. N. KAZAKOV - features of the diffusion welding of piezoceramics. In the concluding plenary session G. MIL'KHORNA (East Germany) reported on the use of diffusion welding in precision instrument making, and Kh. LANGE (East Germany) - on the development of technological, design and other documentation on use of diffusion welding. S. PINOVAR, YE. MALISHEVSKI, et al (Poland) presented a report on intensifying the processes of diffusion welding of metals and alloys.

## Corrosion

USSR

UDC 620.193.43:541.13-143

### CORROSION OF THORIUM IN MOLTEN SODIUM CHLORIDE, POTASSIUM CHLORIDE, AND THEIR EQUIMOLAR MIXTURES

Moscow ZASHCHITA METALLOV in Russian Vol 13, No 6, Nov/Dec 77 pp 725-729  
manuscript received 21 Jun 76

SMIRNOV, M. V., KUDYAKOV, V. YA., and POSOKHIN, YU. V., Institute of Electrochemistry, Ural Science Center, USSR Academy of Sciences

[Abstract] A thorough study was made to verify the earlier found high corrosion rate of metallic thorium in molten alkali chloride salts (NaCl, KCl, and equimolar NaCl+KCl) at various temperatures ranging from 973 to 1223°K. The corrosion current was first calculated from readings of the static electrode potential, taking also into account the diffusion coefficients of bivalent and tetravalent thorium (similar to those of zirconium, with the ratio  $D_{Th^{2+}}/D_{Th^{4+}}$  approximately equal to 1.3). The corrosion current was also calculated from the loss of mass. The results obtained by both methods are in close agreement and indicate that, at the same temperature, thorium corrodes 2-3 times faster than zirconium and 8 times faster than iron, more intensively in KCl and less intensively in NaCl, but in each case increasingly at higher temperatures. Figures 1; references 17: 15 Russian, 2 Western.

USSR

UDC 620.195

### EFFECT OF HEAT TREATMENT ON THE CORROSION RESISTANCE OF GRADE St 3 STEEL

Moscow ZASHCHITA METALLOV in Russian Vol 13, No 6, Nov/Dec 77 pp 716-718  
manuscript received 27 Feb 76

KALMYKOV, V. V. and GRECHNAYA, I. YA., Dnepropetrovsk Institute of Ferrous Metallurgy

[Abstract] A study was made of the corrosion resistance of hardened grade St 3 steel after heat treatment. Specimens were alternately immersed in 1 N  $H_2SO_4$  and plain water from the Azov Sea at room temperature, with the corrosion rate of quenched steel found to be respectively 37% and 25% lower than that of normalized steel. The corrosion rate was also found to change nonmonotonically with the hot-rolling (temper) temperature, first increasing to a maximum within the 350-450°C range and then decreasing with higher temperatures. The tests were performed in an urban residential and in an industrial environment. Figures 2; references 12: 6 Russian, 1 Romanian, 1 German, 4 Western.

USSR

UDC 620.197.3

EFFECT OF ORGANIC AND INORGANIC OXIDIZERS ON THE CORROSION OF GRADE  
12Kh18N10T STEEL AND GRADE VT1-0 TITANIUM IN SULFURIC ACID

Moscow ZASHCHITA METALLOV in Russian Vol 13, No 6, Nov/Dec 77 pp 684-689  
manuscript received 26 Mar 76

GLEYZER, M. M., TSEYTLIN, KH. L., SOROKIN, YU. I., ISAYENKO, G. I., and  
BABITSKAYA, S. M., Scientific Research Institute of Organic Intermediates  
and Dyestuffs

[Abstract] A study was made concerning the effect of various oxidizers on the corrosion of grade 12Kh18N10T stainless steel and grade VT1-0 titanium in 10% H<sub>2</sub>SO<sub>4</sub>, pure or containing fluorine and chlorine ions. As organic oxidizers, such aromatic compounds as nitrobenzene, m-dinitrobenzene, n-nitrozodimethyl anilin, and n-benzochinon were used. Nitric acid and sodium nitrate were used as inorganic oxidizers. The results of these corrosion tests at 60°C for 25 hours, and selectively for 100 hours, indicate that the aromatic organic oxidizers effectively inhibit corrosion of both metals (almost to the same degree) even at low concentrations (3 mmole/liter). Inorganic oxidizers inhibit corrosion of both metals beginning at higher concentrations (100-200 mmole/liter). In this case both metals are affected differently, grade 12Kh18N10T steel being more easily passivated. The presence of fluorine and chlorine ions also affects both metals differently: chlorine ions intensify corrosion of steel and do not impede passivation of titanium; fluorine ions intensify corrosion of titanium more than corrosion of steel. Nitrochlorobenzenes, depending on their composition and structure, either effectively inhibit or do not appreciably influence corrosion of both metals. Figures 1; references 14: 11 Russian, 3 Western.

USSR

UDC 620.197.3

SODIUM SALTS OF ORGANIC ACIDS AS CORROSION INHIBITORS FOR ALUMINUM AND ITS  
ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 13, No 6, Nov/Dec 77 pp 679-683  
manuscript received 17 Mar 76

ROZENFEL'D, I. L., KUZNETSOV, YU. I., KERBELEVA, I. YA., FILIMONOVA, G. V., and  
ZHAVORONKOVA, V. V., Institute of Physical Chemistry, USSR Academy of Sciences

[Abstract] A study was made concerning the effectiveness of sodium benzoate, sodium 3,5-dinitrobenzoate, sodium phthalate, and sodium oleate as corrosion inhibitors for aluminum (grade AV 000) and its alloys AMg 6, V 95, and D 16. Mechanically polished and degreased specimens were corrosion tested at room temperature for 15 days under natural aeration and full loading in buffer

solutions. Anodic and cathodic polarization curves were plotted by the potentiodynamic method at the rate of 2 mV/s, as the supporting electrolyte serving one with pH= 8.08, and the corrosion rate was determined from the loss of mass. The results indicate that anions of organic acids, especially oleates, prevent pitting in neutral and weakly alkaline solutions of chlorides and sulfate. Sodium oleate is particularly effective, because of its adsorbability which retards both electrode reactions, but only in neutral solutions. Its protective action weakens with an increasing pH factor. Least effective is sodium 3,5-dinitrobenzoate, because of its oxidizability, but adequate corrosion protection can be achieved by combining it with sodium oleate. Figures 4; references 8: 3 Russian, 5 Western.

USSR

UDC 620.18:669.14.85

HEAT RESISTANCE AND THERMAL FATIGUE OF VZhL-12U ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11,  
Nov 77 pp 13-16

VEKSLER, YU. G., LESNIKOV, V. P. and SOROKIN, V. G., Ural Polytechnical  
Institute imeni S. M. Kirov

[Abstract] Changes occurring in the fine structure of VZhL-12U alloy during thermal fatigue tests were investigated where the alloy was heated to 1100°C in 40 seconds, soaked for 10 seconds and cooled to 150°C in 30 seconds under a load of 10 kgf/mm<sup>2</sup>. The alloy was cast and had the following chemical composition (in %): 0.16 C, 9.8 Cr, 5.6 Al, 3.2 Mo, 14.5 Co, 1.3 W, 0.8 V, 0.85 Nb and 4.5 Ti. During thermal fatigue tests it was found that in the first stages of testing the coherent bond between the gamma-prime phase is broken and the dislocation density in the solid solution is increased. Then redistribution of dislocations into stable configurations and fusion of individual particles of the gamma-prime phase occurs. This process is accompanied by the formation of pores along interdendritic axes which leads to the formation of cracks. It was noted that a heat treatment which improves structural stability also improves the characteristics of heat resistance and thermal fatigue not only in dead air space but also in a rapid air flow. V. V. POLEVA participated in this work. Figures 4; references 4: 2 Russian, 2 Western.

USSR

UDC 669.6'71'721'884

## STUDY OF THE SYSTEM Mg-Li-Sn-Al IN THE AREA OF ALLOYS RICH IN MAGNESIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR METALLY in Russian No 4, Jul/Aug 77  
pp 220-223 manuscript received 15 May 76

DRITS, M. YE., PADEZHNOVA, YE. M. and GUZEY, L. S., Moscow

[Abstract] The method of microstructural analysis was used to study alloys in the system mentioned in the title with constant content of aluminum 1 and 5%, tin content up to 9% and lithium content up to 20% at temperatures of 400, 300 and 200°C. The cast alloys were upset to 50% at 300°C, then annealed in quartz ampules filled with purified helium for 100 hours at 400°C. Some of the alloys were then hardened from this temperature; the others were held 100 hours at 300°C. Some were then hardened, while the final portion was annealed for 200 hours at 200°C. The specimens were hardened by quenching in water with breaking of the ampules. Microstructural studies of deformed and annealed specimens were performed at magnifications of 440 and 1,500 x. The etchant used was a 0.5% solution of  $\text{HnO}_3$  in alcohol. It was found that the  $\beta$  lithium solid solution and solid solutions based on the compounds  $\text{Mg}_2\text{Sn}$ ,  $\text{Mg}_2\text{Li}_2\text{Sn}$  (x),  $\text{Mg}_{17}\text{Al}_{12}$  and  $\text{AlLi}$  were in equilibrium with the magnesium solid solution. Quaternary phases were not found in the system. The area of the magnesium solid solution decreases with decreasing isothermal annealing temperature and with increasing content of aluminum in the alloys. Figures 2; references 6: all Russian.

USSR

UDC 669.295:539.52

EFFECT OF THERMOMECHANICAL TREATMENT ON THE STRUCTURE AND PROPERTIES OF VT22 TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 4, Oct 77 pp 843-848 manuscript received 8 Dec 76

ANISIMOVA, L. I., POPOV, A. A., MEL'NIKOVA, V. I. and MAKHNEV, YE. S., Ural Polytechnical Institute imeni S. M. Kirov

[Abstract] VT22 alloy was deformed 30% by rolling it into 16 x 16-mm rod at temperatures above the polymorphous transformation ( $860^{\circ}$ ):  $900-1100^{\circ}\text{C}$  and in the two-phase region:  $800-860^{\circ}$  followed by water quenching. The alloy was also deformed at room temperature after quenching from  $900^{\circ}\text{C}$  to the beta-solid solution. Samples were cut perpendicular to the direction of rolling. From metallographic examinations it was found that with increased deformation temperature the alloy weakens intensely and the fastest rate of weakening occurs during the alpha+beta to beta transformation. This transformation is accompanied by the formation of a considerable amount of precipitated alpha-phase, and deformation formation of the alpha-phase probably causes a change in the free energy of the alloy. It was determined that the beta-solid solution in VT22 alloy, with the formation of the alpha-phase, decomposes above  $270^{\circ}\text{C}$ , which is the main cause for the change in mechanical properties of this alloy. Figures 5; references 3: 2 Russian, 1 Western.

USSR

UDC 548-162:539.219.3

PECULIARITIES OF RECRYSTALLIZATION OF THIN POLYCRYSTALLINE FILMS ON A SOLID SUBSTRATE

FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 2, 1977 pp 329-335  
manuscript received 25 Oct 76

GEGUZIN, YA. YE., MAKAROVSKIY, N. A. and BOGDANOV, V. V., Khar'kov State University

[Abstract] A new mechanism is suggested for the recrystallization of thin polycrystalline films on a solid-phase substrate, in which the grain size varies only in the direction perpendicular to the substrate. This process should be accompanied by the formation of holes in the film, i.e., by breakdown of the film. An elementary theory of the process is constructed. The mechanism is experimentally tested in experiments involving films of nickel and silver. It is shown that at thickness 100-2,500 Å, mass transfer between grains occurs by surface autodiffusion and is limited either to the diffusion element or processes at the boundaries. Figures 7; references 4: 3 Russian, 1 Western.

USSR

ELECTRIC SPARK WORKING OF THIN FILMS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 4, 1977 pp 5-9

SAZHIN, I. I. and BOYKO, P. I., Moscow

[Abstract] Dimensional working of thin films, as are required in new micro-electronic devices, by the electric spark method has the following differences in comparison with electric spark working of ordinary small parts: extremely low thickness of the material worked and small dimensions of film structure elements (micron range); location of the film on a dielectric; significant resistant of the very thin films. A mechanism has been developed for guiding an electrode wire for use in the A207.59 electric spark machine. The mechanism guides the wire in a glass capillary tube, pressing it against the dielectric substrate by means of a weight and oscillating the glass tip to reduce friction by means of an electromagnetic vibrator which works against the weight to pull the wire away from the substrate, after which it drops back on the substrate under the influence of the weight. Other new devices utilize the side surface of the wire and erosion of films through templates. Slots as little as 3 µm wide can be made in a film 700 Å thick when the side surface of the wire is used. Figures 8; references 3: all Russian.

## ON THE QUESTION ON ION BEAM PROPAGATION IN THIN METALLIC FILMS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 4, Oct 77  
pp 704-709 manuscript received 4 Mar 77

KONDRAT'YEV, A. S., KUCHMA, A. YE. and MEYLANOV, R. P., Leningrad State  
University imeni A. A. Zhdanov

[Abstract] The features of ionic sound propagation in thin metallic films were examined where the measured quantization of carrier movement in an external magnetic field was perpendicular to the film plane. Using the case where perturbation wavelength was much longer than film thickness and applying Fourier components for diagonal matrix elements, equations were derived which utilized particle type (electron and ion) indices and the cyclotron frequencies of these particles. Analysis of derived expressions showed that the velocity of ion-sonic wave propagation contains both the dependent magnetic field and oscillating constituents whose magnitude decreases with an increase in the number of filled film subzones at absolute zero. An analysis of shielding of interparticle Coulomb interaction was made in consideration of electron interaction in the Fermi-liquid approximation. Results of this study are directly applicable for describing acoustical vibrations in a two-component confluent electron-hole plasma of polymetallic semiconductor films in the case of highly variable effective carrier masses. Here, as in ionic sound, there are vibrations of the "heavy" subsystem, and the Coulomb interaction between particles is shielded by particles of the "light" subsystem. V. V. USTINOV provided useful remarks. Figures 1; references 7: 6 Russian, 1 Western.

USSR

UDC 669.295:669.017.3

## DECOMPOSITION OF METASTABLE PHASES DURING HEATING OF HARDENED VT23 TITANIUM ALLOY

Moscow IZVESTIYA AKADEMII NAUK SSSR METALLY in Russian No 4, Jul/Aug 77  
pp 160-164 manuscript received 21 Jul 75

TOMSINSKIY, V. S., IVANOV, A. S. and GAVRILOVA, O. V., Perm'

[Abstract] A 2-phase titanium alloy with ( $\alpha + \beta$ ) structure, after hardening from various temperatures, may have various phase compositions. Subsequent aging results in decomposition of the metastable  $\alpha'$ ,  $\alpha''$  and  $\beta$  phases, leading to a change in the properties of these alloys. The processes of phase conversion were studied during heating of hardened VT23 alloy in a vacuum installation attached to a diffractometer. The specimens, in the form of thin plates measuring 20 x 14 x 2 mm, were hardened from 750, 800, 820 and 950°C, then heated in a vacuum chamber to 700°C at an average rate of 20 degrees/min. During heating, X-ray studies of the specimens were performed in filtered cobalt radiation. Recordings were made each 25-50°C. The results were used to calculate the periods of the crystalline lattice of the 3 phases. The quantitative relationship of the phase during the course of heating was judged on the basis of the relationship of intensities of the  $(200)_\beta$  and  $(022)_{\alpha''}$  lines to the background intensity. The studies showed that the stability and decomposition temperature of metastable phases in VT23 alloy depends on their concentration, which is determined by the temperature of preliminary hardening. Decomposition of metastable  $\alpha''$  and  $\beta$  phases occurs by redistribution of the alloying elements to form impoverished and enriched areas. Equilibrium  $\alpha$  and  $\beta$  phases are formed in these areas upon subsequent heating. The decomposition of the metastable  $\beta$  phase in VT23 titanium alloy occurs most actively at 300-500°C. The temperature range of decomposition of the metastable  $\alpha''$  phase is quite broad, stretching from 150-450°C, depending on hardening temperature and decomposition mechanism. Figures 4; references 5: all Russian.

USSR

UDC 669.295.37

## THERMODYNAMICS AND HEAT PHYSICS OF THE PROCESS OF MAGNESIUM-THERMAL REDUCTION OF TITANIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR METALLY in Russian No 4, Jul/Aug 77  
pp 29-35 manuscript received 12 May 76

IODKO, E. A., Berezniki

[Abstract] When titanium tetrachloride is reduced by liquid magnesium, in order to avoid deterioration of the quality of the sponge (primarily due to an increase in the content of residual chlorine), it is necessary to limit the flow rate of the tetrachloride. The physical nature of the phenomena

requiring this limitation is not fully clear. Due to the exothermic nature of the "summary" reaction of reduction, an increase in the flow rate of titanium tetrachloride results in an increase in the temperature in the reaction zone. It is, therefore, most simple to assume that the limitation in flow rate is thermal in nature, i.e., it results from the thermodynamics and heat physics of the process. This article analyzes these questions. It is concluded that the second stage of reduction, from titanium trichloride to titanium dichloride, is most different from the thermodynamic standpoint. An increase in the temperature shifts the equilibrium of this reaction to the left, resulting in a significant increase in the equilibrium content of titanium trichloride vapor in the atmosphere in the reactor. A thermal model is developed of the process of magnesium-thermal reduction of titanium, indicating that the determining factor is the temperature of the reaction zone. The higher this temperature, the higher the content of trichloride in the atmosphere of the reactor and the higher the content of residual chlorine in the sponge. The thermal model predicts the influence of geometric and technological factors on the temperature of the reaction zone and, therefore, on the quality of the sponge and productivity of the reactor. Figures 2; references 6: all Russian.

USSR

UDC 669.295:620.251.1:620.181.1

#### KINETICS OF PHASE TRANSFORMATIONS IN VT6 ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 1, Jul 77  
pp 141-145 manuscript received 14 Jan 77

D'YAKOVA, M. A., POTYMKINA, T. G. and KRASIL'NIKOVA, N. A., Ural Polytechnical Institute

[Abstract] The method of X-ray structural analysis is used to study phase transformations in VT6 alloy hardened from various temperatures, and also supercooled from 900°C to 100-700°C. It is determined that in the process of hardening of VT6 from the 2-phase area at 860-960°C, a martensitic  $\beta \rightarrow \alpha''$  transformation occurs, while hardening from higher temperatures leads to  $\beta \rightarrow \alpha'$  transformation. In the alloy, supercooled from 900°C, the martensitic transformation temperature is in the 300-350°C interval. When supercooled from 900°C to isothermal holding temperatures below the martensitic point, the  $\alpha''$  martensite decomposes to produce  $\alpha + \alpha''_{enr}$ , then in the enriched  $\alpha''$  martensite areas, particles of the  $\beta$  phase are formed. With isothermal holding above the martensitic point, the  $\beta$  solid solution decomposes to produce  $\alpha + \beta_{enr}$ . Stabilization of an impoverished  $\beta$  phase occurs at a certain period of time for each supercooling temperature above the martensitic point. Figures 3; references 6: 3 Russian, 3 Western.

USSR

UDC 669.295:539.389.3

INITIAL STAGE OF DEFORMATION AGING OF  $\alpha$  TITANIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 1, Jul 77  
pp 201-203 manuscript received 26 Oct 76

ANTSIFEROV, V. N., ALEKSANDRIVA, YE. P. and SHUBIN, V. N., Perm' Polytechnical  
Institute

[Abstract] A study was made of the regularities of deformation aging of titanium at room temperature immediately after plastic deformation. The study was performed on technical titanium containing 0.4 and 1.6 at. %  $O_2$ . The studies performed establish the tendency of titanium toward low temperature deformation aging, the effect of which depends on the holding temperature and oxygen content. It can be assumed that the aging effects result from the interaction of impurity atoms with dislocations. Figures 3; references 9: 6 Russian, 3 Western.

USSR

UDC 536.+669.295.04.5+669.295.5

EFFECT OF THE TEMPERATURE AND OF THE OXIDATION MECHANISM ON THE MECHANICAL PROPERTIES OF HEAT-RESISTANT TITANIUM ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 77 pp 103-104 manuscript  
received 10 Mar 76

ZAIKIN, YU. K., SHIROKOVA, N. I., and KRYUKOVSKIY, V. V., Titanium Institute,  
Zaporozh'ye

[Abstract] A study was made concerning the basic mechanical properties of heat-resistant titanium alloys after oxidation and, especially, the changes in these properties due to high-temperature oxidation. Grades VT9 (with an  $\alpha+\beta$ -structure) and ST-1 (with an  $\alpha$ -structure) were tested. The specimens were oxidized in air at temperatures ranging from 700 to 1000°C and in silvery graphite sand. The results of mechanical tests and metallographic examination indicate that, in order to avoid excessive loss of plasticity and fatigue strength, heat-resistant titanium alloys must be oxidized in graphite sand at temperatures not above 900°C ( $\alpha$ -alloys) or above 800°C ( $\alpha+\beta$ -alloys). Figures 1; references 4: 2 Russian, 2 Western.

## STRENGTH OF TITANIUM ALLOYS IN MEDIA CONTAINING HYDROGEN SULFIDE

Kiev FIZIKO-KHIMICHESKAYA MEKhanIKA MATERIALOV in Russian Vol 13, No 5,  
Sep/Oct 77 pp 49-52 manuscript submitted 9 Dec 76

RADKEVICH, A. I., LEBEDEVA, N. G., TENENBAUM, S. S. and VASILENKO, I. I.  
Institute of Physico-Mechanics, Academy of Sciences UkrSSR; All Union  
Scientific Research Institute of Petroleum Technology, Kuybyshev

[Abstract] AT-3, AT-6, VT-14 and 3V titanium alloys were tested in corrosive solutions containing  $H_2S$  to determine their corrosion cracking tendency, crack stability and electrochemical properties. Corrosion cracking tests were made in solutions of 3% NaCl, 3% NaCl plus 0.5%  $CH_3OOH$  and in 5% HCl with all solutions at room temperature and saturated with  $H_2S$ . Crack stability tests were made using the 3% NaCl solution with  $H_2S$ . All tested alloys were passive until potentials of 2-2.5 volts were achieved and had a high resistance to corrosion cracking as long as there were no surface defects. VT-14 and 3V alloys had the highest crack stability although their normal strength is not as high as AT-6, which had the lowest cracking stability and corrosion resistance. Figures 4; references 7: 5 Russian, 2 Western.

USSR

UDC 621.791(088.8)

## RESULTS OF THE THIRD ALL-UNION COMPETITION FOR EXTENSIVE INTRODUCTION OF DIFFUSION WELDING INTO INDUSTRY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 77 pp 77-78

DUBTSOVA, I. P. and KARTSEVA, M. A., Engineers

[Abstract] Results of the Third All-Union Competition on the Extensive Introduction of Diffusion Welding into Industry, conducted from 1 Aug 73 to 31 Dec 74, are presented. The competition results thus far have produced savings of more than 12 million rubles, and 700 enterprises and scientific organizations are using diffusion joining of materials. The number of composite materials joined by vacuum diffusion welding has risen 1.3 times, to 500 parts, of which 420 could not be joined by traditional welding methods. First prize went to the collective of the Scientific Research Problems Laboratory of Vacuum Diffusion Welding, directed by Professor N. F. KAZAKOV, for the investigation, development and introduction of technology and equipment for the vacuum diffusion joining of metals, alloys and nonmetallic materials. One second prize was awarded to a group of workers at the Tambovskiy Chemical Machine Building Plant 'Komsomolets', managed by N. S. ARTEMOV, for developing technology and equipment and mastering the series production of apparatus for silver plating by vacuum diffusion welding. This approach has yielded an annual savings of 2.114 million rubles. Another second prize was given to a group of specialists supervised by N. V. SOLOMIN and O. V. SHAYEV for new technology of vacuum diffusion welding of metal-ceramic air-tight intakes (savings of 463.1 thousand rubles). Third prizes were given for the investigation and development of the technology and units for hermetically sealing metal-ceramic electrovacuum instruments using diffusion welding and for welding individual assemblies of instruments made of ferrite (resulting in savings of 766 thousand rubles--G. V. KONYUSHKOV and B. M. ZOTOV--Saratov, Supervisors; diffusion welding for the manufacture of high-strength stamps for cutting sheets of magnetodrives for electric motors at the enterprises of Minelektrotekhprom with a savings of 1.3 million rubles (E. R. GALINSKIY, R. I. SARANDI and YE. D. KHUTORIANSKIY--Tallin, Supervisors); diffusion welding of high-temperature and high-strength nickel alloys and alloy steels, glass materials with metals and hard alloys with steels, and investigation into joining of aircraft assemblies (savings of 884.7 thousand rubles)--YU. N. KOPYLOV--Kuybyshev, Supervisor; diffusion welding of refractory metals (annual savings of 185 thousand rubles)--G. V. SAMSONOV, Scientific Supervisor; design of units, mastering diffusion welding of elastic blank elements for DDV [expansion unknown] sensors and organization, based on the proposed technology, of series production of instruments at the Tenzopribor Plant (economic effect of 981.5 rubles)--YE. I. FELIKSKON, Supervisor. Incentive awards were given for completion of 23 projects pertaining to diffusion welding.

USSR

UDC 621.791.01

STUDY OF THE PARAMETERS OF CRYSTALLIZATION DURING WELDING OF ALUMINUM-BERYLLIUM-MAGNESIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 8, Aug 77 pp 12-16 manuscript received 27 Dec 76

KOMAROV, M. A., Candidate of Technical Sciences, Moscow

[Abstract] A method based on experimental determination of the equations relating dimensionless welding criteria was used to produce general data on the influence of the welding load on bath geometry. Dimensionless criteria for full-length, length of trailing portion, half width, area and welding mode were used. Sheets of an alloy consisting of Al plus 30% Be and 5% Mg, 1.2 and 2.0 mm thick were used, welded with infusible tungsten electrodes using DC current of forward polarity in an argon atmosphere. The logarithms of the dimensionless criteria of the welding mode and geometric dimensions of the bath were found to be related by linear equations. The numerical expressions for the relationship can be used to select welding modes assuring the desired seam dimensions. When welding at high speeds, the crystallization parameters and time of existence of the melted bath are much less sensitive to changes in the energy applied. Figures 7; references 9: all Russian.

USSR

UDC 621.791.72:669.14.018.4

ELECTRON-BEAM WELDING OF HEAT-RESISTANT ALLOYS USING POWDERS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 77 pp 30-31

SOROKIN, L. I., Candidate of Technical Sciences, MOROCHKO, V. P., and PANOV, YU. P., Engineers, and MORYAKOV, V. F., Candidate of Technical Sciences

[Abstract] KhN62VMYut (EP708) and KhN45MVTYuBR (EP718) heat-resistant alloys were electron-beam welded on an ELU-4 unit with powders of tungsten, molybdenum or cobalt in an attempt to eliminate the formation of hot cracks in the weld seam. The W and Co powders have almost no effect on seam fusion and formation but Mo powder causes weld-bath boiling and molten metal spraying due to the liberation of volatile molybdenum oxides. Use of 0.25-mm-thick foil eliminates the boiling and spraying. Alloying the seam metal with W and Co powders prevents hot crack formation due to decreased shear formation along grain boundaries as a result of suppression of transcrystallinity and structure refinement. Using Mo powders or foil results in hot cracks. Mechanical tests showed that seams alloyed with Co powder (9-10%) possessed better elongation and impact strength, which was associated with increased solubility of the gamma-phase in the Cr-Ni solid solution. Figures 1; references 4: 3 Russian, 1 Western.

USSR

UDC 621.791:621.038.8:62-551.43

HERMETICALLY SEALING SMALL-SCALE INTEGRATED CIRCUIT PACKAGES BY LASER WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 77 pp 25-26

ZAKIROV, R. G., Engineer, VIGDOROVICH, V. N., Doctor of Technical Sciences, ZUYEV, I. V., Candidate of Technical Sciences, and OSTRETSOV, YU. N., Engineer

[Abstract] The thermal actions on a metal-glass joint without heat-releasing contact with the package was studied and the optimum radius of curvature of the angle during hermetic sealing with linear movement of the package was determined. Packages measuring 11 x 11 and 15 x 20 mm with a total side thickness of 0.4-0.6 mm and width of 0.4-0.6 mm were welded using a Kvant-17 unit. The temperature in the metal-glass joint zone, located 0.8-1.0 mm from the edge being welded, did not exceed 80°C; in the center of the base the maximum temperature was 55°C. Leakage in 98% of the packages was found to be less than  $5 \cdot 10^{-5}$  liter-micron/sec. The smallest radius of curvature for which a stable and quality joint could be produced was experimentally determined to be 0.5 mm. References 4: all Russian.

USSR

UDC 621.791:621.3.038.8:669.14

USING A FIVE KILOWATT LASER TO WELD STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 77 pp 24-25

GROZDEV, V. F., KOSYREV, F. K., KOSYREVA, N. P. and LUNEV, YE. I., Engineers, MORYASHCHEV, S. F., Candidate of Technical Sciences, and FROMM, V. A., Engineer

[Abstract] The possibility of obtaining "knife" fusion was studied along with the stability of the geometric dimensions of the seam upon changing focal point immersion in the metal for different convergence angles using an LT-1 laser which was previously described in the article "Experimental Laser Unit LT-1" by F. K. KOSYREV (Svarochnoye Proizvodstvo, No 9, 1976). The LT-1 can operate continuously for two hours at 4 kw or 5-10 minutes at 6 kw. Samples of 5-mm-thick Kh18N10T steel were laser welded using a convergence angle of 30°, welding speed of 30 m/hr, laser power at 3 kw and focal point depths in the metal of -3, -1.5 and 1 mm from the surface. Maximum fusion depth was just over 5 mm when the -1.5 mm focus depth was used. At the higher convergence angles, 30 or 50°, a small change in the focal plane reduces the depth of fusion by a large factor. Thus, convergence angles of 5-15° will attract the most interest. Figures 4; references 1: Russian.

USSR

UDC 621.791:621.3.038.8

LASER WELDING WITH "KNIFE" FUSION

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 77 pp 23-24

BELEN'KIY, A. M., ZUYEV, G. M., and KOSYREV, F. K., Engineers, MORYASHCHEV, S. F., Candidate of Technical Sciences, and POLYASHEV, N. N., SERGIN, A. S., FEOFILAKTOV, V. A., FROMM, V. A. and SHULAKOV, V. N., Engineers

[Abstract] A CO<sub>2</sub> laser with radiation power up to 19.5 kw was used to study the principles of seam formation and determine the possibility of obtaining "knife" fusion in carbon steel samples. With a welding speed of 60-70 m/hr, laser power of 6-8 kw and beam convergence angle of 45°, weld joints were produced with "knife" fusion to a depth of 6-8 mm. Increased radiation produces a much wider beam but very little extra fusion depth because of the large angle of beam convergence irradiating a large area but with a low flux density interacting with the metal. By using a convergence angle of 10° and the same conditions as above, "knife" fusion to a depth of 24 mm was achieved. Figures 6.

USSR

UDC 621.791.052.001.24:539.4

FATIGUE STRENGTH OF WELD JOINTS MADE FROM 1915, AMg5 AND AMg2 ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 77 pp 41-43 manuscript received 30 Mar 77

USTILOVSKIY, S. YA., Candidate of Technical Sciences, Scientific Research Institute of Automobiles and Automobile Engines; IGNAT'YEV, V. G., Candidate of Technical Sciences, PORITSKIY, M. P., Engineer, and RABKIN, D. M., Doctor of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton; and SHEKHIREV, R. I., Engineer, NIIATM [Expansion unknown]

[Abstract] Argon-arc automatic and manual (with a tungsten electrode) and semi-automatic (consumable electrode) welding modes were used to join sheets of AM2 and AMg5 aluminum alloys with SvAMg6 welding rod while sheets of 1915 alloy were welded using Sv1557 rod. Weld samples were fatigue tested under symmetrical bend at 1000 cycles/min and compared to the base metal. AMg5 had the best overall durability, AMg2 the worst. However, butt joints of 1915 were strongest but at smaller loads the difference was less pronounced. At N greater than 10<sup>7</sup> cycles the fatigue strength of AMg2 was the same as AMg5 and even surpassed that of 1915. The fatigue strength of these alloys depends on alloy composition, sheet thickness, type of joint (butt, lap and tee joints were made) and welding method and amounted to 4-8 kgf/mm<sup>2</sup> at 10<sup>7</sup> cycles. Butt joints had the best fatigue strength as well as the best durability when welded with a tungsten electrode. Figures 1; references 4: all Russian.

USSR

UDC 621.791.052:620.18

EFFECT OF ALLOYING ELEMENTS ON THE PROPERTIES OF A HIGH-TEMPERATURE  
COBALT-BASE SURFACING METAL

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 77 pp 34-37 manuscript  
received 30 Mar 77

SOROKIN, L. I., Candidate of Technical Sciences, All-Union Scientific Research  
Institute of Aviation Materials

[Abstract] The effect of alloying a cobalt-base surfacing alloy, applied by argon-arc welding, was studied to determine if and what alloying elements would reduce the tendency of the alloy to hot cracking. Experimental samples were alloyed with C, W, Mo, Nb, Ni and Fe. The addition of carbon was simply detrimental, especially at a content greater than 0.4%. Adding 7-8% W or 6-7% Mo increases cracking resistance significantly with formation of a single-phase structure and cellular crystallites without secondary boundaries. Combined alloying with W + Nb lowers cracking resistance. No attempt was made to explain the drop in crack resistance with the addition of Ni or Fe. The formation of cracks during welding of high-temperature alloys with a relatively narrow interval of crystallization proceeds in two steps. Microcracks are nucleated at first in the solid-liquid state. These microcracks, in conjunction with the narrowness of the crystallization interval, can develop into a mainline crack both in the solid-liquid and solid states. The main crack then develops in the solid state with the formation of secondary boundaries. High-temperature strength of the surfaced cobalt alloy increased when alloyed with Nb, W, Mo and C. Ductility also increased with the addition of W, Mo, Ni and Fe but decreased when more than 2% Nb or C was added. Figures 5; references 6: all Russian.

USSR

UDC 621.791.052.100.24:539.43:669.715

INFLUENCE OF THE AMOUNT OF BACKING RUNS ON THE STRENGTH OF WELDED JOINTS OF  
AMg6M ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 77 pp 31-32

KLOCHKOV, N. A., Candidate of Technical Sciences, and ROMANENKO, G. P.,  
engineer, Tula Polytechnical Institute

[Abstract] Flaws in welds which occur when welding articles made of AMg6M alloy can be corrected with a backing run, but increasing the number of backing runs results in considerably reduced tensile strength and resistance to hydraulic loads. This phenomenon was studied by making backing runs on the reinforcement side on specimens having a lengthwise high-quality weld. The original weld was made with an automatic argon arc welder with a two-element nonconsumable electrode. The test specimen was notched on the

reinforcement side. Rewelding was performed with a manual argon arc welder with a nonconsumable electrode, using a filler wire made of AMg6 alloy. Another notch was made before making another backing run. The first run was made from left to right, the second in the opposite direction, and the third in the same direction as the first. Rough spots on the backing run were smoothed down flush with the original weld. The quality of the original weld and backing runs was monitored visually, with penetrating radiation, and by chromatic internal flaw detection and metallography. The welded joints were tested under biaxial static and repeated static loads by simulating the effect exerted on the wall of a cylindrical pressurized tank. A comparison was made between the results of static tests of joints with and without backing runs. Increasing the number of backing runs results in an insignificant reduction in strength of the joint, but there is a considerably more drastic drop in the plastic properties of the joint with an increase in number of backing runs. Angular strain was introduced in specimens by creasing the toes of rolled elements, which were then welded in a single pass. It was found that distorting the geometrical form of the joint in the area of the weld, by introducing angular strain, for example, in combination with backing runs can cause joints of alloy AMg6M to break in the region close to the material's yield point. Fractures occurred in specimens regardless of the number of backing runs and the procedure for applying welds along the zone of fusion of the original weld at a distance of 6 to 10 mm from the end of the backing run last applied. The number of loading cycles has but a slight effect on the drop in strength of joints with backing runs. It is concluded that increasing the number of backing runs to three results in a slight reduction in strength of an AMg6M alloy joint under static loading and a considerably drop in ductility. The addition of a concentrator of the angular strain type results in a drastic reduction in ductility and strength of the joint. Figures 1; references 3: all Russian.

USSR

UDC 621.791.01:620.192.4:669.018.28

ON THE INFLUENCE OF COMPOSITION OF THE WELD METAL ON CRACK FORMATION IN WELDING  
MAGNESIUM FOUNDRY ALLOYS OF THE Mg-Zn-Zr SYSTEM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 77 pp 25-27

NIKITIN, V. M., Candidate of Technical Sciences, SKORNYAKOV, YU. L., engineer,  
and ROMANOV, A. YU., engineer, Moscow Aviation Technological Institute imeni  
K. E. Tsiolkovskiy

[Abstract] Foundry alloys of the Mg-Zn-Zr system have evidenced a strong tendency toward crack formation in fusion welding, as used in repairing flaws in castings. ML 12 alloy (4.0 to 5.0% Zn, 0.6 to 1.1% Zr, base--Mg) has the highest tendency and a wide brittleness range with a narrow margin of ductility over this range. Here a study is made of the feasibility of increasing the processing strength of welded joints of alloys of this system by alloying the filler metal with rare earth metals and changing the content

of zinc in it. Alloys with a different lanthanum content were studied for their tendency toward crack formation in fusion welding, inasmuch as lanthanum has the most substantial influence on increasing the ductility of alloys of this system in the solid-liquid state. Metallography was employed to establish the relationship between location of cracks and the lanthanum content in the base metal and weld metal. A crack forms in the weld metal when welding with a filler wire with a lanthanum content equal to or less than that of the base metal, whereas a crack forms in the area near the weld at a distance of three to five grains from the border of the weld when the lanthanum content of the filler wire is greater than that of the base metal. It was proven that addition of lanthanum to alloy ML12 results in reduction of the temperature range for embrittlement (TIKh) by raising the temperature of its lower limit. The formation of hot checks in the area near the weld is the most probable phenomenon when the lanthanum content of the weld metal is higher than that of the base metal. Effective filler materials should make possible an inverse relationship between the temperatures of the TIKh of the weld metal and base metal. Adding lanthanum alone to increase the processing strength of the weld metal when welding alloy ML12 is ineffective because the lower limit of the TIKh is adversely affected. When adding rare earth metals to the weld metal alone to increase its ductility in the TIKh range, the proportions of basic alloying elements in the weld metal must also be changed at the same time for the lower limit of the weld metal's TIKh to be lower than the corresponding temperature limit of the base metal. Increasing the content of zinc in magnesium alloys results in lowering the temperature of the lower limit of the TIKh. The weldability of ML12 alloy is improved considerably by adding lanthanum to the weld metal and increasing its zinc content at the same time. A filler wire has been developed for welding ML12 alloy, with the following composition, in percentages: 7 to 9 Zn, 0.5 to 0.8 Zr, 0.7 to 1.0 La; base--Mg. Use of this wire makes it possible to obtain welded joints equal in strength to that of the base metal. Figures 4; references 7: all Russian.

USSR

UDC 621.791.052:539.378.3:620.18

QUALITY CONTROL OF THE JOINT IN DIFFUSION WELDING OF TITANIUM ALLOYS BY REGULATING THE INITIAL STRUCTURE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 77 pp 18-20

PESHKOV, V. V., Candidate of Technical Sciences, RODIONOV, V. N., engineer, and GRIGOR'YEVSKIY, V. I., Candidate of Technical Sciences

[Abstract] A study is made of the influence of the initial structure of the metal on the strength of joints obtained in diffusion welding of titanium alloys and of ways of controlling this structure to obtain low residual strain. High-temperature creep, dependent on the metal's structure, is conducive to formation of physical contact which hampers obtaining a high-strength joint in diffusion welding of titanium. Titanium alloys as supplied

vary considerably in structure: Some have an equiaxial fine-grained structure, and others a lamellar coarse-grained structure. A study was made of the influence of structure on high-temperature creep for OT4 alloy. Both types of structure underwent compression and stress tests in the 800 to 1050°C and 0.1 to 0.7 kg-f/mm<sup>2</sup> ranges. It was shown that the creep rate with identical stresses is considerably lower in alloys with an initial lamellar coarse-grained structure than in alloys with an equiaxial fine-grained structure in the range of temperature up to polymorphic transformation. Increasing the test temperature to 1000 to 1050°C results in an increase in rate of straining. Specimens welded from OT4 alloy with an equiaxial fine-grained structure have considerably higher strength in the alpha range than those with a lamellar coarse-grained structure. This is caused by a larger area of resulting physical contact in the first case, as revealed by metallographic and fractographic studies. On the other hand residual strain is considerably lower in the second case. It is therefore recommended that for welding parts with a low degree of strain a layer with an equiaxial fine-grained structure in the contact zone be combined with a layer with a lamellar coarse-grained structure in the dominating volume of the metal. The first provides for good physical contact, and the second for low residual strain in the article. Residual strain in parts is reduced by localizing it in a narrow area. This type of structural combination can be obtained by first annealing the specimens in vacuum at a temperature above the  $\alpha + \beta \rightarrow \beta$  transformation, cooling them in air, machining the surfaces to be joined, and welding at temperatures below polymorphic transformation but above the alloy's recrystallization point. Machining produces a strained layer in which an equiaxial fine-grained structure forms when welding, because of recrystallization. It is also possible to use onlays made of sheet material with a fine-grained structure, which are sandwiched between two parts made of an alloy with a lamellar coarse-grained structure when welding them together. This method is used in making honeycomb panels. Figures 6; references 4: all Russian.

USSR

UDC 621.791.001.5:621.3.038.8

#### ESTIMATION OF THERMAL PROCESSES IN LASER IMPULSE SEAM WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 77 pp 1-2

MOSTYAYEV, V. A., Candidate of Technical Sciences, and UGLOV, A. A., Doctor of Technical Sciences

[Abstract] A method is suggested for estimating thermal processes and conditions during laser seam welding, as used in sealing quartz resonators for electronic wristwatches. The materials used in this process are fernico and nickel, 0.5 mm thick. Welding is performed along the crimped edge. The concentration factor, representing the reciprocal of the square of the radius of the molten spot in the beam's focus, is used to derive a time constant for sources with normal heat distribution over the surface of the

material. Formulas are then derived for the temperature at the center of a fixed source with normal distribution when heating a semi-infinite body, for the maximum heat flux at the center of the molten spot, and for power density. The results of calculations of these parameters are given for nickel and fernico, using the thermophysical characteristics of these materials. Ideal thermal efficiency of the process is calculated by comparing calculated and experimental power density. For a more precise estimate of critical power density a formula is given for the temperature at the center of a fixed source when heating a plate. Ideal thermal efficiency for laser impulse seam welding is found to be within the range of 0.1 to 0.15. A formula is given for determining the fusion depth of the metal, an important parameter in obtaining airtight welded seams in laser seam welding. A formula is given for determining the maximum temperature to which quartz resonators, which are very sensitive to heat, are heated in the laser seam welding process. At a distance of 1 mm from the source, the maximum temperature for articles made of fernico is 393°C, and at a distance of 3mm from the source, 43.6°C. Good agreement is found between calculated and experimental values of fusion depth. Good agreement is found between experimental data and calculations made using N. N. Rykalin's theory (Moscow, 1951) for estimating maximum temperature. Figures 3; references 9: 8 Russian, 1 Western.

USSR

UDC 621.791.4:539.378.3

DIFFUSION WELDING OF TITANIUM WITH TUNGSTEN AND MOLYBDENUM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 77 pp 66-67

KIREYEV, L. S. and SABOKAR', K., Engineers, and KUSHNIRENKO, N. A., and ZAMKOV, V. N., Candidates of Technical Sciences

[Abstract] The Institute of Electric Welding imeni Ye. O. Paton conducted investigations for the purpose of increasing and stabilizing the mechanical properties of Ti-W and Ti-Mo diffusion-welded joints and shortening the welding time. VNZh alloy, technical tungsten, MCh molybdenum and VT1-0 titanium were used. Diffusion welding in the 9000-1100°C range did not reduce welding time nor were weld joint strengths any more stable. The MCh-VT1-0 and W-VT1-0 joints had equal strengths since fracture occurred in the VT1-0 alloy. In VNZh-titanium, fracture occurred on the VNZh side. There were no differences in the structure of the fracture or base metal. Contact lines were highly pronounced and no pores or cracks were detected. On the titanium side a narrow band of recrystallized metal was observed since welding was done in the range of VT1-0 recrystallization temperature interval. No structural changes were noted on the W or Mo sides of the weld seams. Figures 1; references 1 Russian.

## ELECTROSLAG WELDING OF AMg6 ALUMINUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 77 pp 52-54 manuscript received 31 Dec 76

SAFONNIKOV, A. N., Candidate of Technical Sciences, RABKIN, D. M., Doctor of Technical Sciences, and SINCHUK, A. G., Engineer, Institute of Electric Welding imeni Ye. O. Paton

[Abstract] AMg6 alloy was electroslag welded using electrodes made of AMg6, modified with zirconium, to make circular weldments 140 mm thick. Mechanical tests of welded samples showed the weld seam to have at least 0.7 the strength of the base metal. A histogram plotted from the fracturing of 360 samples revealed that 88% of the samples had tensile strengths greater than 22 kgf/mm<sup>2</sup> as compared to base metal strength of 29 kgf/mm<sup>2</sup>. Change of seam width also increases mechanical properties as noted for widths of 60 and 80 mm which had the following properties: TS = 21.2 and 24.3 kgf/mm<sup>2</sup>, YS = 12.6 and 14.1 kgf/mm<sup>2</sup> and elongation = 10.2 and 12.5%. Macrostructure of the weld seams had no visible defects and a refined structure. Electroslag welding of AMg6 greatly increases productivity since this process requires only one welding pass while manual argon-arc welding requires 100-150 passes; welding time is reduced from 900 to seven minutes. Current density in the electrode is also less in electroslag welding. Engineers V. V. BORODIN, A. A. ANDREYEV, A. YE. PETROV, E. P. RAD'KO AND L. G. MARKOV participated in this work. Figures 3; references 4: all Russian.

## Miscellaneous

USSR

### FRICION CHARACTERISTICS OF A TITANIUM ALLOY HARDENED BY ELECTRIC-SPARK ALLOYING WITH REFRACTIVE CARBIDES

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep/Oct 77 pp 35-38

TKACHENKO, YU. G., GORBATOV, I. N., YURCHENKO, D. Z., and MIKHAYLOV, V. V., Kiev and Kishinev

[Abstract] A study was made to establish the feasibility of plating OT4 titanium alloy with carbides and borides of refractive metals by the electric-arc process, and to determine the friction characteristics of this plate in air at high temperatures. Plates were produced with TiC, ZrC, NbC, Cr<sub>3</sub>C<sub>2</sub>, Cr<sub>3</sub>C<sub>2</sub>+15%Ni, WC, and (TiC)B<sub>2</sub> electrodes which had been hot-molded from powder. Subsequent structural examination revealed a 50-100 micron thick carbide layer of varying consistency, depending on the material. The brittleness of carbides is known to decrease successively from those of group-IV metals to those of group-V metals and then to those of group-VI metals, which decreases the anode erosion in the same order and correspondingly increases the liquid content in the erosion products. X-ray phase analysis revealed that the plate consists of the anode material and intermetallic compounds. Both friction and wear are determined by oxide films forming on the surface. Friction tests indicate that the friction coefficient is almost independent of the load, up to 30 kgf/cm<sup>2</sup> in this study. Measurements of the friction coefficient under a load of 10 kgf/cm<sup>2</sup> indicate that it is in all cases lowest at room temperature, owing to the presence of oxide films and adsorbed gases at the surface. It increases with rising temperature, but above 400°C it again decreases. Oxides such as CrO<sub>2</sub> and TiO<sub>2</sub>, forming at 600°C, constitute a plastic layer with lubricating characteristics. The wear resistance of all plates increases correspondingly with increasing oxidation resistance of the refractive compound contained in them, and the latter decreases in the order Cr<sub>3</sub>C<sub>2</sub> > TiC > ZrC > NbC > W. Tests have shown that hardening the titanium alloy with TiC, Cr<sub>3</sub>C<sub>2</sub>, and Cr<sub>3</sub>C<sub>2</sub>+15% Ni improves its wear resistance most and extends the temperature range within which this alloy can be used for friction elements in machinery. Figures 2; references 4: 3 Russian, 1 Western.

USSR

DIAMOND-ELECTROCHEMICAL GRINDING OF BINARY TITANIUM ALLOYS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep/Oct 77 pp 25-27

SEDYKIN, F. V., BELOBRAGIN, YU. A., SOTOV, I. N., TORMYSHEV, V. A., and NAZARETS, V. S., Tula Polytechnic Institute

[Abstract] Residual tensile stresses produced in the surface layer of titanium alloys during grinding cannot be overcome by compensation with compressive stresses, but can be avoided by lowering the grinding temperature under 950°C. Abrasion with a diamond wheel accompanied by electrochemical dissolution has yielded the best results on VT3-1 and VT22 titanium alloys. Metallographic and x-ray structural examination of treated specimens revealed no change in the phase composition and no alphenation (increase in the  $\alpha$ -phase content) or other transformations, as a result of such a grinding under a wide range of process conditions. Fatigue tests indicate that flat specimens of these alloys have an endurance limit of approximately 500 MPa, reduced to approximately 470 MPa by vacuum annealing after grinding. References 11: all Russian.

USSR

UDC 669.25 536.425

FEATURES OF MORPHOLOGY AND MECHANISM OF INTERMEDIATE SIGMA-PRIME PHASE PRECIPITATION IN RELATION TO QUENCHING CONDITIONS OF AN AGEABLE Al-Li ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYA in Russian Vol 44, No 4, Oct 77 pp 790-795 manuscript received 6 Oct 76

TROFIMOVA, L. N. and CHUISTOV, K. V., Institute of Metal Physics, Academy of Sciences Ukrainian SSR

[Abstract] A study was made of the effect of quenching method on the mechanism and morphology of sigma-prime phase precipitation from a matrix with an elastic-isotropic lattice. Thin foil of Al + 2.85 wt. % Li was sealed in argon-filled ampules and annealed for 2.5 hours at 550°C with the ampules quenched in water (method I). The foil was taken from some of the ampules and heated in air to 550°C for 15 minutes and quenched in a salt bath heated to some preselected temperature ranging from 150-450°C (method II). Electron microscope inspection showed the nucleation mechanism to be independent of quench method and homogeneous in nature except in the case where small supersaturations of lithium in the solid solution (method II) caused the formation of disks on dislocations at temperatures close to the boundary of sigma-prime phase solubility (250-270°C). Method II lowers the sigma-prime phase boundary caused by the formation of excess vacancies and the greater ease of diffusion processes to increase the rate of nucleation of the new phase. Figures 3; references 14: 5 Russian, 9 Western.

USSR

UDC 669.24'25'71:539.292

MARTENSITE TRANSFORMATION IN Ni-Co-Al BETA ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 4, Oct 77  
pp 826-833 manuscript received 6 Dec 76

LITVINOV, V. S. and ARKHANGEL'SKAYA, A. A., Ural Polytechnical Institute  
imeni S. M. Kirov

[Abstract] An investigation into the stability of the beta phase in Ni-Co-Al alloys was made using four groups of alloys of the type  $Ni_{100-x-y}Co_yAl_x$ , where  $x = 38, 36, 34$  and  $32$  at. % and  $y = 0$  to  $18$  at. % for a constant content of Al. The addition of Co displaces the martensite transformation temperature downward but does not effect beta-phase stability, and after either slow or fast cooling from  $1200^\circ C$  the alloys remain single-phase -  $(Ni,Co)_3Al$ . The beta-phase stability of these alloys is a result of the stable and ordered body-centered cubic structure provided by the addition of Co which keeps the 'c' lattice parameter more in line with the 'a' parameter, thus preventing a shift to the metastable face-centered tetragonal structure of martensite. Figures 3; references 17: 7 Russian, 10 Western.

USSR

UDC 548:539

CREEP AND RECRYSTALLIZATION OF TUNGSTEN AND MOLYBDENUM WHISKERS COATED WITH A THIN LAYER OF NICKEL

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 44, No 4, Oct 77  
pp 892-895 manuscript received 21 Dec 76

GEGUZIN, YA. YE., KIBETS, V. I., KLINCHUK, YU. I. and CHEKANOV, M. I.,  
Khar'kov State University imeni A. M. Gor'kiy

[Abstract] Results of tests are presented to trace the relationship between creep and recrystallization processes using the same material (W or Mo) with different initial coating thicknesses of Ni. Data plotted from creep tests showed that there are two distinct stages of creep. In the initial active stage creep proceeds at a rapid rate which increases with the magnitude of applied load independently of coating thickness. This stage shifts sharply to a stage of slow creep which dampens with time. The two stages are quite obvious on curves showing deformation of molybdenum whiskers in relation to annealing time at  $1250^\circ C$  under a constant load ( $10^8$  dyne/cm<sup>2</sup>) and different coating thickness (0.3-5 microns) or constant thickness (1.2 microns) and varying load ( $10^7$ - $10^8$  dyne/cm<sup>2</sup>). Both creep and recrystallization are functions of dislocations and movement of these along and through grain boundaries to cause weaknesses and strength of metals and alloys. The primary physical facts obtained from these tests were establishment of a parallelism between creep and recrystallization in refractory metals

with intergranular boundaries of increased diffusion permeability and establishment of the fact of a sharp change in the kinetic law determining recrystallization and creep. Figures 3; references 7: 5 Russian, 2 Western.

USSR

UDC 541.13:532.7

DISSOLVING THE Kh20N80 ALLOY IN SULFURIC ACID UNDER THE EFFECTS OF ALTERNATING CURRENT

Moscow IZVESTIYA VUZ CHERNAYA METALLURGIYA in Russian No 3, 1977 pp 146-151  
manuscript received 21 Apr 76

MOGORYAN, N. V. and FOKIN, M. N., Moscow Institute of Steel and Alloys

[Abstract] Controlled displacement of the operating potential in the trans-passive state was used to eliminate the possibility of leakage on the electrode being tested. An electrochemical cell with 3 electrodes was used with separated anode and cathode space. Weight losses after an hour of exposure were calculated on the equivalent density of the dissolving current, with the assumption that the alloy components pass into the solution in the form of  $Cr^{6+}$  and  $Ni^{2+}$  ions. Since no increase in weight loss or in the compensation current was noted, it follows that the anode and cathode processes were completely reversed. The melting rate in sum with oxygen emission was  $15 \text{ mA/cm}^2$  higher than the summary compensational current, suggesting that the purely electrochemical dissolving process should be at sufficiently high speed or else should have a decrease in valence of the transfer of metal ions into the solution. The formal 110% emission of oxygen into the current indirectly confirms the hypothesis on possible supplemental oxidation of the alloy chemically. Also confirmed is the electrochemical conception that excess dissolving of the alloy may result from the transfer of metal ions of lower valence, or increased depolarization effectiveness of the cathode. The possibility of successful AC application at frequencies of 25 and 500 Hz was found. Figures 4; references 4: 3 Russian, 1 English.

USSR

UDC 669.184.2.042.39:546.21

PURGING A 250-TON CONVERTOR BATH THROUGH AN EIGHT-JET OXYGEN TUYERE

Moscow IZVESTIYA VUZ CHERNAYA METALLURGIYA in Russian No 3, 1977 pp 39-42  
manuscript received 24 Sep 76

MERKER, E. E., AKBIYEV, M. A., YAVOYSKIY, V. I., LUZGIN, V. P., KUSKOV, N. P.,  
DEDURENKO, A. I., IBRAYEV, I. K., and BURLAKOV, L. V., Factory Training School  
at the Karaganda Metallurgical Factory

[Abstract] The nozzle developed with eight jets had a central coolant supply from an aimed copper reservoir. Due to the copper shortage the plan used shortened jets, which gave more stable oxygen currents although without metering. Results indicated that the best design for the nozzle used a 25 degree from vertical deflection of the jet streams, with the nozzle located 1.0 -- 1.2 m from the surface of the metal bath. No metal deposits or slag deposits were observed on the nozzle, in contrast to the results with nozzles having four jets. Production tests of the eight-jet oxygen tuyere indicate that it provides an improved purging process for 250 ton convertor baths, and this is of particular importance as high-phosphorus cast iron comes into greater use. Figures 3; references 8: 7 Russian, 1 English.

USSR

UDC 669.162.683

THE LEVEL OF METAL REFINING IN A CURRENT DURING VACUUM OXYGENATION OF CAST IRON

Moscow IZVESTIYA VUZ CHERNAYA METALLURGIYA in Russian No 3, 1977 pp 35-38  
manuscript received 9 Feb 76

TERESHCHENKO, V. T., GOLUBEV, A. A., TIN'KOVA, YE. V., and KURDYUMOV, B. V.,  
"Tulachermet" Research and Production Association

[Abstract] To obtain data on the development of oxygenation reactions during processing of cast iron, the experiment used a cast iron consumption rate of 600 kg/min, a pressure in the vacuum chamber of 150 mm, and a theoretical value for oxygen consumption for the process of 32 m<sup>3</sup>/min. Then metal samples for chemical analysis were selected from various locations in the charge. Since varying oxygen content indicates the degree of oxygenation, this parameter was used to determine that two zones existed. Metallographic tests showed that the metal matrix was abnormally porous and contained surface cementite on a eutectoid-perlite base. No changes in the microstructure appeared when the material was cut. Experiment No 20 in the series showed that the process removed some 1.7% of the carbon from the cast iron. The increased level of metal atomization brought an increased level of metal dust in exhaust gases at a steady rate, indicating that current refining of cast iron can benefit by operation within a vacuum oxygen atmosphere. Figures 3; references 3: 2 Russian, 1 German.

USSR

UDC 620.197.001.2:621.643

CALCULATING THE POLARIZATION EFFECT DURING CATHODIC PROTECTION OF PIPELINES FROM CORROSION

Kiev DOPOVIDI AKADEMII NAUK UKRAIN'SKOY RSR in Ukrainian No 10, Oct 77  
pp 947-951 manuscript received 21 Oct 76

ZHAPAKOVA, F. N., Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] The problem of determining the parameters of cathodic protection from corrosion for a system of pipelines is examined with consideration of the polarization effect. It was suggested that resistance of the insulating coating depends only on current density. The problem is formulated as a system of integral equations which can be solved with the aid of a spline approximation. A Hermite polynomial is used to construct the spline function, and the solution to the system of integral equations is reduced to solving algebraic equations. Numerical results are presented for the various forms of the relationship of insulation resistance to current density which indicate the necessity of considering polarization effect, especially for low values of insulation resistance. References 7: all Russian.

USSR

UDC 621.373.826

STRUCTURE AND PROPERTIES OF ALUMINUM FILMS PRODUCED BY DIFFERENT METHODS

Minsk VESTSI AKADEMII NAVUK BSSR in Russian No 3, Jul/Sep 77 pp 29-32  
manuscript received 11 Nov 76

BOLDYREV, V. P., GURSKIY, L. I., LESNIKOVA, V. P. and TARASIKOV, M. V.,  
Physico-Technical Institute, Academy of Sciences Belorussian SSR

[Abstract] Results are presented of a comparative analysis of the electro-physical properties of vacuum-sprayed films produced by methods of electron beam and thermal vaporization. Oxidized silicon plates were used as substrates at a temperature of 150°C. Condensation rate was restricted to 170-22 Å/sec. Electron-beam power was 4-4.5 kw with a 10-15-mm diameter, producing a film thickness of 0.8±0.05 microns. Tungsten and titanium diboride vaporizers were employed for the thermally vaporized films. Results of x-ray and electron microscope examination showed that electron-beam-produced films had superior structural homogeneity, increased thermal stability and adhesive properties and reduced specific resistance. The thermally vaporized films had pyramid "hills" of growth which disturbed film homogeneity. Heat treating did not reduce the heterogeneity of the thermally vaporized films and they did not possess the qualities of electron-beam-produced films. In the case

that one is forced to use thermally vaporized films it is recommended that titanium diboride vaporizers be employed. Figures 3; references 4: 3 Russian, 1 Western.

USSR

UDC 669.1'71'849

PHYSICO-CHEMICAL STUDY OF Re-Fe-Al ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR METALLY in Russian No 4, Jul/Aug 77  
pp 211-214 manuscript received 26 Dec 75

BURNASHOVA, V. V., STARODUB, P. K., STROGANOV, G. B. and DORONIN, V. N.,  
L'vov, Moscow

[Abstract] The Re-Fe-Al system, as well as its limiting binary system, was studied by a combination of methods: X-ray-structural, microstructural, local X-ray-spectral and chemical. Cast alloys as well as alloys annealed at 600, 950 and 1,000°C were studied. Isothermal cross sections of the state diagram at these temperatures were constructed. At 1000°C, 2 ternary compounds were found:  $\text{ReFe}_2\text{Al}_5$  and  $\text{Re}_6\text{Fe}_{5.5}\text{Al}_{1.5}$ . The compound  $\text{ReFe}_2\text{Al}_5$  decomposes at 950-1,000°C. The structure of  $\text{Re}_6\text{Fe}_{5.5}\text{Al}_{1.5}$  is similar to that of  $\text{W}_6\text{Fe}_7$  ( $\mu$  phase) with lattice periods  $A = 4.726$ ,  $C = 25.36$  Å for the hexagonal unit cell. The compound  $\text{ReFe}_2\text{Al}_5$  is isostructural with S phase of the system Mo-Fe-Al. Figures 3; references 9: 6 Russian, 3 Western.

USSR

UDC 543.221:[546.83/82.171+546.74-72-46-31]

SOLID PHASE INTERACTION OF NITRIDES AND OXIDES WITH NaCl-TYPE STRUCTURES

Moscow IZVESTIYA AKADEMII NAUK SSSR, NEORGANICHESKIYE MATERIALY in Russian  
Vol 13, No 9, Sep 77 pp 1618-1622, manuscript received 3 Jul 76

KHRUSTALEV, B. N., LEONOVICH, B. I., IL'CHUK, V. S. and GUREVICH, YU. G.,  
Chelyabinsk Polytechnical Institute

[Abstract] A detailed study of the solid phase interactions in nitride-oxide systems was undertaken using  $\text{TiN}_{0.95}$  and  $\text{ZrN}_{0.89}$  and oxides of Mg, Fe and Ni as initial products. Solid phase interactions in the TiN-MgO, NiO, FeO; ZrN-NiO systems were studied at high temperatures in a vacuum. It was demonstrated that the phase transformations involving partial gas liberation, formation of titanium and zirconium oxynitrides and subsequent transformations in the oxides of the system are complex. Interaction diagrams are presented for various nitride/oxide ratios. Figures 2; references 15: 10 Russian, 5 Western.

USSR

UDC 546.3-19.27+546.3-19.26

THERMAL STABILITY OF METAL CARBIDES AND BORIDES

Moscow IZVESTIYA AKADEMII NAUK SSSR, NEORGANICHESKIYE MATERIALY in Russian Vol 13, No 9, Sep 77 pp 1600-1602 manuscript received 5 May 74

KOBER, V. I. and NICHKOV, I. F., Ural Polytechnical Institute

[Abstract] A discussion is presented of the relationship between thermal stability of phases, their quantities in metal carbides and borides and the electron states of the component atoms. It is qualitatively demonstrated that the number of phases in boron-metal systems and carbon-metal systems results from restructuring of the electron shells of the carbon and boron acceptor atoms to the  $s^2-$ ,  $s^2p^3-$ ,  $s^2p^6-$  and  $d^5-$  bond configurations. The stability of electron states and the number of bond orbitals of the acceptor component atoms determine the variations in thermal stability of the phases. References 7: all Russian.

USSR

UDC 669.539:551.001.4

ON THE DETERMINATION OF DUCTILE FRACTURE OF METALS AND ALLOYS UNDER CONDITIONS OF LOCAL FRACTURE SIMILARITY

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 13, No 5, Sep/Oct 77 pp 31-45 manuscript submitted 10 Mar 77

IVANOVA, V. S., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR

[Abstract] The criteria of similarity of local fracture were presented making it possible to compare the behavior of metals and alloys at the moment of formation of plastic instability in the apex of a crack or defect. Eleven steels were subjected to cyclic loading at stresses close to their fatigue limit under conditions of circular band. Crack length and size of the zone of plastic deformation were measured which revealed that critical dimension of the zone of plastic deformation for a defect (crack), before formation of plastic instability, can be determined by the ratio of yield strengths in shear and tension for a given material and is also a function of the mechanism of plastic deformation occurring at the instant of plastic instability onset. The criteria of similarity for impeding plastic deformation can be used to recalculate the critical parameters which control the formation of plastic instability for different conditions of loading. Determination of ductile fracture for 38KhN3MFA steel is given as an example using the principles of this study. Figures 6; references 23: 22 Russian, 1 Western.

USSR

UDC 620.172'174:669.245'26'25

RELAXATION STABILITY OF HIGH TEMPERATURE ALLOYS CONTAINING COBALT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11,  
Nov 77 pp 16-20

BORZDYKA, A. M., Central Scientific Research Institute of Ferrous Metallurgy  
imeni I. P. Bardin

[Abstract] Industrial high-temperature nickel-chromium alloys containing cobalt -- KhN62MVKYu (EI867), KhN60MVKYu (EI661) and KhN55VMTKYu (EI929) -- were studied to determine their relaxation stability in comparison with KhN70VMTYU alloy without cobalt. Since it is economically feasible to use high-temperature alloys above 800°C, relaxation and creep tests were conducted at 800-850°C. Tests showed that by adding a significant amount of Co (10-12%) to a nickel alloy containing 10% Cr, 5-10% Mo and 5% W and a total Ti+Al content greater than 5%, it is possible to produce alloys possessing a very high relaxation stability for temperatures up to 850°C. KhN62MVKYu alloy, with 5% Co, had the least resistance to relaxation, but this property can be significantly improved by repeated loads ("conditioning"). In these studies of cobalt-containing alloys, no correlation was observed between the characteristics of relaxation and creep (long-time strength) at high temperatures. Figures 2; references 5: all Russian.

USSR

UDC 669.245:621.791.052

WELDABLE HIGH TEMPERATURE NICKEL ALLOYS AND PRINCIPLES OF THEIR ALLOYING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11,  
Nov 77 pp 2-7

ZIMINA, L.N., Central Scientific Research Institute of Ferrous Metallurgy  
imeni I. P. Bardin

[Abstract] The mechanical and physical properties and weldability of three new high temperature nickel-base alloys containing niobium are presented. Designations of these new alloys are: KhN55MBVYu (EP691), KhN62MBVYu (EP709) and KhN68VBM Yu (EP902). Comparisons are made with other nickel-base alloys to point out why the new alloys have much better weldability. This is basically due to the formation of fewer cracks in the heat-affected zone as a result of reduced internal stresses created by producing a strengthening phase with lattice parameters close to those of the solid solution. Addition of niobium produces the strong intermetallide phase  $Ni_3(Nb Al)$  with the desired lattice parameters and yields an alloy with high heat resistance and good technological effectiveness which can be recommended for weldments having an 800°C operating temperature. V. S. TASHCHILOV and K. N. LEMARIN'YE participated in this work. Figures 5; references 9: all Russian.

## HEAT RESISTANCE OF NICKEL ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 77 pp 7-10

TYUVIN, YU. D., ROGEL'BERG, I. L., RYABKINA, M. M. and PLAKUSHCHAYA, A. F., State Institute for Planning and Processing of Nonferrous Metals and the Kamensk-Ural'sk Plant for the Treatment of Nonferrous Metals

[Abstract] Ternary nickel-base alloys containing Si and Al, Cr and Si, Si and Mn and Al and Mn were studied to determine their heat resistance. These alloys were furnace oxidized at 1000-1200°C for 10 hours and weighed while still in the furnace. Total content of the alloying elements did not exceed 8%. It was found that Si increases heat resistance of binary alloys of nickel with Cr, Al and Mn. Manganese lowers the heat resistance of Ni-Si and Ni-Al alloys. Initial additions of Al to Ni-Si alloys (up to 3%) decreases heat resistance while more than 3% increases this property. At higher contents of Si any additions of Al increase the heat resistance. When adding up to 3% Al in Ni-Mn alloys containing up to 8% (sic) Mn the heat resistance is diminished, but upon adding Al this property once again increases. Maximum heat resistance is possessed by Ni-Si alloys (more than 3% Si) and Ni-Al alloys (more than 6% Al) as well as Ni-Si-Al and Ni-Cr-Si ternary alloys with more than 2% Sr. These alloys have a heat resistance that is 3-4 times greater than plain nickel at 1000°C and 10 times greater at 1200°C. Figures 1; references 8: 6 Russian, 2 Western.

## INFLUENCE OF ADSORBED FERROCENE ON MORPHOLOGY OF PYROLYTIC ALUMINUM FILMS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 233 No 5, 1977 pp 862-865 manuscript received 14 Dec 76

ZHUK, B. V., KHAMYLOV, V. K., NESTEROV, B. A., DOMRACHEV, G. A. and ZAGLUMONINA, N. K., Institute of Chemistry, Academy of Sciences USSR

[Abstract] This work is dedicated to a study of the mechanism of etching and the possibility of improvement of surface relief. Aluminum films were precipitated in a flow-through vacuum chamber onto substrates of metal and polished silicon. The evaporation temperature of triisobutylaluminum (TIBA) was 80-90°C. The substrate temperature was 300-370°C. Toluene or ferrocene was added to the TIBA stream in a molecular ratio of TIBA:toluene -- 1, ferrocene -- 0.1. The chamber pressure was maintained at  $5 \cdot 10^{-1}$  torr. It was established that the morphology of aluminum films precipitated upon thermal decomposition of TIBA in a flow-through system is similar to the morphology of films precipitated in a closed system, all phenomena being

shifted in the direction of higher temperatures. The addition of toluene does not influence the morphology of the film, which indicates the leading role of adsorption of the products of thermal decomposition of TIBA in the formation of the film and the insignificant contribution of radical reactions. The addition of ferrocene to the TIBA flux suppresses etching of the Al in the process of growth. It is established that by increasing the precipitation temperature to 370°C, the effectiveness of ferrocene decreases. Based on the influence of the addition of ferrocene, an adsorption mechanism is suggested for the influence of additives on the precipitation of films by thermal decomposition. References 4: all Russian.

USSR

UDC 539.4

#### CREEP OF ALUMINUM UNDER STATIC AND CYCLIC LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 77 pp 52-56 manuscript received 20 Jan 76

KUROV, I. YE. and SKURINDIN, A. M., Gorkiy

[Abstract] A study was made to determine the effect of transition from static to cyclic loading and of the temperature on the plastic deformation and the fracture of technical-grade 99.9% pure aluminum (polycrystalline with an average grain diameter of 0.1 mm). Cylindrical specimens 3 mm in diameter and 20 mm in gage length were tested under loads sufficiently heavy to make the plastic strains measurable in the process. The temperature was varied from  $0.3T_{melt}$  to  $0.7T_{melt}$  at three loading frequencies: 0.2, 0.02, and 0.002 Hz. The results, plotted in  $\sigma$ - $\log \tau$  ( $\tau$  - length of one cycle) and  $\log N$  -  $\log \Delta \epsilon_p$  coordinates, fit very closely on a single straight line different for each temperature. The data indicate that, regardless of the temperature and the loading frequency, the increment of plastic strain is a function of the number of cycles before fracture. An analysis of the mechanism, with the aid of metallographic microexamination and electrical resistance measurements, has revealed that cyclic loading produces more defects than does static loading and thus that fracture under a cyclic load is due to development of plastic strains with a resulting higher concentration of vacancies. Figures 5; references 9: 7 Russian, 2 Western.

ON SOME TRENDS IN THE FATIGUE RESISTANCE OF HEAT-RESISTANT NICKEL ALLOYS  
UNDER COMBINED ALTERNATING AND STATIC LOADS

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[Abstract] A study was made to establish how the fatigue strength, the static strength, and the cyclic creep of two heat-resistant nickel alloys (standard grades EI867 and VZhL12U for turbine blades) vary over the 20-1000°C temperature range, depending on the ratio of alternating stress to static stress. The tests were performed with cylindrical specimens in a uniform state of tensile-compressive stress and under soft loading conditions. The asymmetric load was alternated about five or six different levels at a frequency of 35 Hz, with the test basis varied from 20 to 50 million cycles (160 to 400 hours). A static tensile load was found to affect the fatigue strength to a degree, depending on the temperature range. Also the static strength was found to depend on the temperature. Below  $0.6T_{melt}$  the relation between ultimate static stress and ultimate alternating stress amplitude remains linear, but above  $0.6T_{melt}$  the amplitude of ultimate alternating stress decreases with increasing average stress level. Accordingly, two modes of fracture are possible: fatigue-induced and quasi-static. Figures 6; references 20: 12 Russian, 8 Western.

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