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USSR AND EASTERN EUROPE SCIENTIFIC ABSTRACTS
MATERIALS SCIENCE AND METALLURGY

No. 47

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USSR

UDC 669.715.3:539.26:536.42

AGE HARDENING OF Al-Cu ALLOYS AT THE STAGE OF RELAXATIONAL PHENOMENA

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian No 3, 1977 pp 545-553
manuscript received 3 Mar 1976

GITGARTS, M. I., and KOMAROVA, V. I., Institute for Problems of Reliability and Durability of Machines, Academy of Sciences, Belorussian SSR

[Abstract] The alloy tested contained 5 wt% Cu. Specimens 20 mm in diameter and 5 mm thick were tempered at 530°, then quickly cooled. They were then age-hardened at 130, 175 or 250° for 1300, 980 or 160 hours, respectively, and measured by X-ray and dilatometry. Results indicated that increasing the duration of hardening caused a marked increase in the hardening maximum. At 100 hours in the 175° test, the solid solution has lost elastic interphasal tensions. With complete removal of elastic deformation, expected elimination of dislocations does not take place; this happens only gradually after the elimination of dislocations during the formation of equal crystalline structures. Dilatometry indicated that at both 175° and 250°, the observed differences in quantitative effects is connected to some variation in chemical composition of the alloys in the theta phase, and thus a difference in their atomic volume. Transformation to the theta phase appears to take place without elasticity and is accompanied by plastic deformations, causing dislocations in the matrix. These dislocations decrease with the increase of the duration of age hardening, bringing steady reduction of the breadth of the diffraction line. Figures 2; references 21: 10 Russian, 11 Western.

USSR

UDC 669.2

REMOVING IRON FROM CAST ALUMINUM ALLOYS

Ordzhonikidze IZVESTIYA VUZov, TSVETNAYA METALLURGIYA in Russian No 2, 1977 pp 56-59
manuscript received 9 Mar 76

GRIGORENKO, V. M., POPOV, V. A., and OFENGENDEN, A. A., VNIIPvtortsvetmet
[expansion not known]

[Abstract] The paper gives the results of laboratory studies on removing iron-rich phases from cast aluminum alloys by a technique developed at the VNIIPvtortsvetmet Institute (Soviet patent No 1964533/22-1 granted 27 March 1975). The alloy systems studied were Al-Si-Mg and Al-Si-Mn-Mg with iron content in the initial alloy ranging from 0.83 to 2.14%. The experiments involved heating the alloy to 850°C, adding manganese in the form of an Al-Mn ligature, cooling with agitation to 750°C, adding finely pulverized manganese, cooling to 20-50°C above the solidus temperature, filtering through a layer of alkali chloride and a layer of heat-treated aluminum shavings, and analyzing for content of iron, manganese, silicon and copper. On the basis of the results, approximating functions are recommended for determining optimum conditions for filtering iron out of

Ak7 and Ak9 alloys. The results show that when the initial iron content is 0.8-0.9% the Mn:Fe ratio should be 1.24-1.34, and when the iron content increases from 1.0 to 2.0% the Mn:Fe ratio should be about 1.7. The maximum yield of filtrate is realized at 650°C. References 8 (Russian).

USSR

UDC 621.78:620.186.4:669.715

INFLUENCE OF MECHANICAL AND HEAT TREATMENT ON THE PROPERTIES OF ALLOY D16

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 55-58

VOROB'YEV, N. A., and BICH, E. N., All-Union Institute for Light Alloys

[Abstract] Studies were performed on bars 25 mm in diameter of D16 alloy (4.48% Cu, 1.55% Mg, 0.66% Mn, 0.43% Fe, 0.23% Si, remainder Al). The bars were pressed with an extrusion factor of 11 and a degree of compression of 90% at 400 and 300°C. After pressing of the blanks for the specimens for mechanical testing, they were hardened from 500°C (1 hr) by quenching in water and subjected to natural and artificial aging at 190°C, 8 hr. The structure was studied by x-ray and metallographic methods utilizing an electron microscope. The degree of recrystallization was determined on the basis of the appearance of the first point reflexes in a special reflection chamber. The electron microscope study was performed on oxide replicas with an accelerating voltage of 100 kV. The long-term strength of D16 alloy in the polygonized state is higher than in the recrystallized state after natural aging following up to 2000 hours of service, and after artificial aging (at 190°C, 8 hr)--up to 100 hours of service. With the identical aging mode, the rate of strength loss of polygonized bars is higher than that of recrystallized bars. With artificial aging, the rate of softening of D16 alloy in the polygonized state is lower than in the case of natural aging. The creep resistance of the alloy with the recrystallized structure is higher than that with the polygonized structure. In D16 alloy in the polygonized state, the decomposition of the solid solution occurs more intensively than in the recrystallized state. Figures 3; references 7: 6 Russian, 1 Western.

USSR

UDC 621.785.78:669.715

AGING OF CASTINGS OF Al32 ALLOY PRODUCED UNDER PRESSURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5,
May 77 pp 54-55

SAMOLOV, I. V., Ufa Motor Plant

[Abstract] The alloy Al32, consisting of Al-Si-Cu-Mg, is cast under pressure and strengthened by subsequent artificial aging. The tendency of Al32 toward natural aging was determined from the hardness of specimens cut from castings of cylinder blocks made of this material and by x-ray structural analysis. Hardness was measured during the first day after production of the castings, then after 5, 10, 20 and 30 days. After aging at 170-210°C, the hardness is increased by an average of HB 7-8. The maximum increase in strength and hardness was produced by aging at 180°C for 8 hours. It was found that natural aging of the specimens did not lead to an increase in hardness. References 3 (Russian).

EVOLUTION OF GRAIN ORIENTATION IN ROLLING OF BERYLLIUM

Ordzhonikidze IZVESTIYA VUZov, TSVETNAYA METALLURGIYA in Russian No 2, 1977
pp 115-121 manuscript received 30 Sep 76

KAPCHERIN, A. S., PAPIROV, I. I., and TIKHINSKIY, G. F., Khar'kov Physico-
Technical Institute, Academy of Sciences UkrSSR

[Abstract] An investigation is made into the nature and mechanism of formation of grains during unidirectional rolling of cast beryllium over a wide range of experimental conditions. Particular emphasis was placed on processes of plastic deformation responsible for grain formation, and on the evolution of grain orientation with a transition from sheets about 1 mm thick to thin foil 250-20 μm thick. The authors observed and studied an effect of intensive scattering of the basis grain and displacement of the density of maxima for poles $\{10\bar{1}0\}$ to a position of 30° to the direction of rolling in the case of thin sheets, and also an increase in the density of basis poles on the periphery of the pole figure. The influence of various factors (temperature, deformation, impurities and ratio l/H) on the grain orientation was determined. A four-stage model is proposed for the evolution of grain orientation that accounts for only basis and prismatic slipping in beryllium. All observed orientations can be explained by a change in the kind of slip or competition between the two different kinds of slip. The change in the nature of the grain with a transition from sheets to thin foils is due to an increase in the contribution of surface layers to the structure of the rolled piece. Figures 5; references 4: 2 Russian, 2 Western.

Coatings

USSR

UDC 621.357.7

CONCERNING THE CONTENT OF PHOSPHATE AND SULFATE IONS IN AN OXIDE FILM ON ALUMINUM THAT HAS BEEN ANODIZED IN $H_3PO_4-H_2SO_4$ SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 13 No 3, May/June 77 pp 367-369 manuscript received 24 Mar 75

ALEKSANDROV, YA. I., BOGOYAVLENSKIY, A. F., and MATAYZH, N. K., Kazan' Aviation Institute

[Abstract] An investigation is made of some of the reasons for poor adhesion of anodized coatings to aluminum alloys with slight variations in the composition of the sulfuric-phosphoric acid electrolyte or in the composition of the alloy being coated. The studies were done on commercial alloys AD1M, AMg-3M and D16AT and on special binary alloys of aluminum with magnesium, copper or silicon in different amounts. It was found that the content of the sulfate ions, and especially that of the phosphate ions in the oxide is very sensitive to the composition of the alloy and that of the electrolyte. The adhesion of the oxide coatings was more than 700 kgf/cm^2 for the commercial alloys, and less than 100 kgf/cm^2 for the special binary alloys, which can be attributed to the reduction of phosphate ion content in the oxide. However, no quantitative relation could be established between the phosphate ion content in the anodized oxide and adhesion. Figures 1; references 16: 10 Russian, 6 Western.

USSR

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INFLUENCE OF OXIDE COATINGS ON THE CORROSION RESISTANCE OF AT3 AND AT6 ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 13 No 3, May/June 77 pp 317-320 manuscript received 5 Apr 76

KORNILOV, I. I., deceased, KENINA, YE. M., BORISKINA, N. G., and ZABRODSKAYA, M. N., Academy of Sciences USSR, Institute of Metallurgy

[Abstract] An investigation is made of the effect of long-term oxide coating (25-500 hours) of AT3 and AT6 alloys at $600-800^\circ\text{C}$ on their stability in 40% H_2SO_4 at 20°C , in a boiling solution of 1% oxalic acid and in 20% HCl at 60°C . The film formed at 800°C is loose with a tendency to peel, and after 250 hours takes on the appearance of ceramic. Corrosion tests show that with an increase in oxidizing time at 600°C , the corrosion resistance of the alloys increases more or less monotonically. The maximum resistance is reached after 25 hours of oxidizing for H_2SO_4 , after 200 hours for oxalic acid, and no sooner than 500 hours for HCl. The corrosion rate for oxide coating at 700°C shows a minimum in all cases that falls into the time interval of 25-250 hours. AT6 alloy showed less corrosion resistance in all media. The results seem to indicate that aluminum has a detrimental effect on the corrosion strength of titanium in the most aggressive media. While oxidizing reduces the corrosion rate of the alloys, they still show lower resistance to corrosion than oxidized titanium. For use in 40%

sulfuric acid at 20°, the optimum duration of oxide coating for AT3 and AT6 alloys at 600-700°C is 50 hours. Oxidizing treatment should last for 50 hours at 700°C for protecting these alloys against corrosion in boiling oxalic acid. This treatment cannot be recommended for protecting the alloys against corrosion in hydrochloric acid. Figures 1; references 7 (Russian).

Composite Materials

USSR

UDC 539.5:620.18

STRUCTURE AND PROPERTIES OF THE HEAT-RESISTING NICKEL-BASE ALLOY--VKM REINFORCED WITH TUNGSTEN FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 130-132 submitted for publication 15 Oct 76

SHORSHOROV, M. KH., ANTIPOV, V. I., DORONIN, I. V., RYBAL'CHENKO, M. M., and TRUNIN, V. F., Moscow

[Abstract] Results are presented from a study of the properties of nickel-base alloy VKM comprised of alloy EP-202 with tungsten-rhenium wire as the reinforcing material. Samples of VKM were produced by explosive forming and their structural stability was investigated by vacuum annealing between 800 and 1200°C. Alloy KhN67VMTYu was used as the matrix with packets of it and 0.3-mm VAR-5 wire placed together and subjected to explosive forming. Heat resistance tests of samples in a vacuum at 1100°C and a stress of 5 kG/mm² showed that the average time to failure was about 142 hours as compared to 0.3 and 1.4 hours for alloys KhN67VMTYu and KhN57VMKYuR, respectively. Structural stability of VKM was tested by vacuum annealing from 800 to 1200°C with two- to 50-hour soaks every 100°. Samples annealed for 50 hours at 1100°C revealed the formation of a white unetchable reaction zone between matrix and fiber having a microhardness of 1000 kG/mm² which was twice the hardness of the matrix. Micro-x-ray spectral analysis showed that the high-hardness reaction zone consisted of an intermetallic compound of the WNi₄ type. The extremely hard reaction zone was deemed much too hard for practical application and the authors state that it is necessary to search for an intermediate transition layer which would prevent active reaction of matrix-fiber and the recrystallization process which starts after annealing at 1100°C for 100 hours. References 5 (Russian).

USSR

UDC 639.71:539.4

MATRIX STRAIN HARDENING IN FIBROUS COMPOSITES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 112-117 submitted for publication 16 Sep 76

YAVOR, A. A., Volgograd

[Abstract] The mechanism of matrix strengthening in fibrous composites was studied in the limits of the elastic-plastic and plastic sections. The presence of a strongly bonded fiber with the matrix primarily changes the character of slip development in the grains of the matrix layers and the conditions of stress relaxation in the slip planes which become dependent on the corresponding conditions in the reinforcing material. Thus, deformation of the matrix in the plastic region of tension of a composite occurs, as in the elastic-plastic region,

by restriction of dislocation movement with the reinforcing fiber being the "restrictor." Features of the plastic deformation mechanism in the matrix layers under tension were: 1) intense formation of dislocations uniformly distributed in the matrix layer; 2) simultaneous shear along the previously blocked slip planes; and 3) dislocation movement controlled by the reinforcing fibers in the slip planes under conditions of partial stress relaxation. Figures 4; references 11: 5 Russian, 6 Western.

USSR

UDC 621.762.4.001

LIQUID-PHASE PRESSURE SINTERING OF TUNGSTEN-NICKEL-COPPER COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 77 pp 43-49 submitted for publication 14 Jul 76

NAYDICH, YU. V., LAVRINENKO, I. A., and YEVDOKIMOV, V. A., Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] The principles of liquid-phase sintering under pressure were studied for the W-Ni-Cu system along with investigation of the effect of applied pressure magnitude, liquid-phase quantity and amount of refractory component dissolution, solid-phase granularity and other factors for the purpose of finding the minimum values of pressure and modes at which total compaction of the investigated compositions could be achieved. It was established that shrinkage and compaction during pressure sintering for this system was similar to the W-Cu system and almost independent of solid-phase particle size for granularities above 100 microns. The presence of an element that will dissolve the refractory component promotes increased shrinkage and a high degree of compaction at a lower content of the liquid phase which is necessary for systems with an insoluble component. Microstructure analysis showed that increased nickel content in the liquid phase along with increased pressure promoted tungsten grain growth. Results of this study gave foundation for selecting optimum sintering modes which promote complete compaction of compositions and the desired grain size for the production of pseudo-alloys with specific mechanical properties. Figures 5; references 12: 9 Russian, 3 Western.

USSR

UDC 621.763:621.785.062

INVESTIGATION OF PROCESSES OF HEAT TREATMENT OF EXTRUDED FIBERS BASED ON IRON

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5(173), May 77 pp 1-6 manuscript received 29 Mar 76

MOROZ, A. L., KOSTORNOV, A. G., FEDORCHENKO, I. M., CHIKALO, A. P., KOZIOROVA, T. N., and SIGAL, M. B., Institute of Problems of Material Science, Academy of Sciences UkrSSR, All-Union Scientific Research Institute of Artificial Fiber

[Abstract] Research is done to verify the feasibility of producing continuous fibers less than 50 μm in diameter by adding finely dispersed powders to a polymer binder solution with subsequent processing with chemical fiber techniques, and also to study processes of removing the binder and baking the monofilaments as well as a layer of precipitated fibers both in a static position and when the study objects are in motion. The binder was a cellulose xanthate solution to which finely divided carbonyl iron had been added. Heat treatment of the fibers was made up of two stages: oxidation of the fibers to break down and remove the main mass of the binder, and baking to remove the carbon residue of the binder and to convert the fibers to a non-porous state. The filled chemical fibers can be treated in motion. Maximum elimination of the binder from the fibers is achieved at the following rates of motion through the temperature zone: no more than 14 mm/min during oxidation, and from 5 to 60 mm/min during baking, which is equivalent to a time of stay in the temperature zone of no less than 15 minutes and no more than 2 minutes respectively. Nonporous iron fibers can be obtained after sintering at 1300°C in a hydrogen atmosphere initial fibers that have been pre-oxidized in air at 300°C. Figures 7; references 5 (Russian).

USSR

UDC 669.24'25:669-419.4

INFLUENCE OF ALLOYING OF THE MATRIX ON THE STRUCTURAL STABILITY OF NICKEL-TUNGSTEN AND COBALT-TUNGSTEN COMPOSITE MATERIALS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 6-11

KLYPIN, B. A., MASLOV, A. M., and MASLENKOV, S. B., Central Scientific Research Institute for Ferrous Metallurgy imeni I. P. Bardin

[Abstract] A study is made of the influence of the composition of nickel and cobalt alloys on the structural stability of composite materials reinforced with tungsten fibers. Three groups of alloys were studied: 1) nickel, nichrome and ternary alloys based on nichrome containing about 10 at. % of the tertiary element; 2) commercial heat-resistant and scale-resistant nickel alloys with varying degrees of alloying; and 3) cobalt and a cobalt-based alloy. The specimens were reinforced with commercial wire of unalloyed tungsten of over 99.95% purity. All materials were produced by pouring the melted matrix over the

2-mm-diameter reinforcing wire and subsequent pressing producing 0.5 mm wires in the final specimens, with a reinforcing wire content of about 33%. It was concluded that embrittlement and slight dissolution of tungsten fibers are characteristic for composites with nickel-chromium based matrices. An effective method of slowing recrystallization of the fibers and eliminating pore formation is to alloy such matrices with refractory metals of groups VA and VIA, particularly tungsten, as well as the use of matrices of such alloys as ZhS6K and TsZh24. In cobalt-based matrices, in contrast to nickel-based matrices, the tungsten fibers are embrittled to a much lower extent and no accelerated recrystallization occurs. However, one serious shortcoming of these matrices is the intensive dissolution of fibers at high temperatures. In matrices of thermally stable alloys containing up to 0.05% C and less than 4% (Ti + Al), after annealing at 1100°C 1000 hr, no intermediate phases are found on the boundaries with the fibers. When the carbon content is increased to about 0.10%, a carbide phase interlayer is formed and at over 7% (Ti + Al) a binary interlayer of a carbide phase and a γ' phase is formed. An interlayer of the phase $\text{Co}_7(\text{W}, \text{Cr})_6$ is formed in a matrix of cobalt alloy. Figures 4; references 11: 9 Russian, 2 Western.

USSR

UDC 539.4:669.24'26'28

THE STRENGTH OF NICHROME REINFORCED WITH COATED MOLYBDENUM FIBERS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 2-5

MAKSIMOVICH, G. G., LYUTYY, YE. M., FEDORENKO, V. K., and FILLIPOVSKIY, A. V., Physico Mechanical Institute, Academy of Sciences UkSSR, L'vov, Institute of Problems of Material Science, Academy of Sciences UkSSR, Kiev

[Abstract] A study is made of the influence of protective coatings on the high-temperature strength of nichrome-based composite materials. The composites were produced by hot pressing of Kh20N80 powder reinforced with continuous type MCh molybdenum fibers about 80 μm in diameter with a volumetric fiber content of 10-30%. Thermodynamically stable coatings of zirconium carbide and titanium nitride were applied to the fibers, assuring good bonding of the fibers to the matrix. Coating thickness was 3-4 μm , to avoid possible problems resulting from the difference in coefficients of thermal expansion of the contacting phases. Stamped and finished specimens of the sheet material produced were tested for short-term tensile strength at 20, 400, 600, 800, 900 and 1100°C, with the high-temperature tests performed in argon. The tests showed the method of stabilization of the interphase boundary by application of coatings to the refractory fibers to be effective. This method allows the temperature and time limits of use of the composites, as well as their specific strength, to be increased. Figures 3; references 8: 7 Russian, 1 Western.

USSR

UDC 620.22

STRUCTURAL CERAMIC MATERIALS

Moscow MASHINOSTROITEL' in Russian No 5, May 77 p 17

KARPINOS, D. M., GROSHEVA, V. M., MIKHASHUK, YE. P., and KALINICHENKO, V. I.

[Abstract] Modern structural materials must maintain their strength and stability at high temperatures, must have high wear resistance, must be chemically inert, and must have low density and low thermal conductivity. The major structural metals and alloys do not meet all these requirements, but ceramics do. The latter have, however, a low resistance to mechanical and thermal shock. Solving these problems by proper reinforcement of the ceramic matrix with anisometric oxide crystals, rather than with metallic fibers, has rendered such materials suitable for an increasing number of applications. The oxide crystals here are 1.0-30 μm wide and 150-1000 μm long, with triangular or regular quadrilateral cross section, their melting point lying above 1500°C. At the Institute of Problems of Material Science (Academy of Sciences Ukrainian SSR) research has been done on producing, by the hot molding process, various materials based on refractory oxide-nitride compounds (Al_2O_3 , ZrO_2 , MgO , Cr_2O_3 , TiO_2 with AlN , BN , Si_3N_4 , TiN) reinforced with acicular crystals of nonmetallic oxides. Such a reinforcement has been found to increase the resistance to thermal shock 10-100 times and the impact strength 5-10 times. The excellent abrasion and wear resistance of these materials makes them desirable substitutes for precious-metal alloys in low-friction devices.

USSR

UDC 678.029+661.66

STRUCTURE AND PROPERTIES OF CARBON-MATRIX COMPOSITE MATERIALS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 234 No 5, 1977 pp 1078-1081
manuscript received 7 February 77

ANDRIANOV, K. A., Academician, KOLESNIKOV, S. A., REZANOV, V. I., FROLOV, V. I., BELKINA, T. I., YEMEL'YANOVA, V. M., and KHANANASHVILI, L. M., Moscow Institute of Fine Chemical Technology imeni M. V. Lomonosov

[Abstract] A study was made of the use of organosilicon polymers with ladder and ring lattice molecular structure as binders in carbon-matrix composite materials in order to decrease the defect content of the matrix resulting from oxidation of the carbon. It was believed that these materials, with their high content of nonvolatile products, should reduce the formation of carbonization defects. Experiments indicated improved homogeneity and relatively low numbers of defects in materials based on organosilicon polymers of ladder and ring lattice structure as well as organosilicon polymers with added boron. Figures 2; references 3 (Russian).

Conferences

USSR

UDC 621.791.061.3

ALL-UNION SCIENTIFIC-TECHNICAL CONFERENCE ON NEW METHODS OF COATING BY SPRAY DEPOSITION

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 77 pp 56-57

KHARLAMOV, YU. A., Candidate of Technical Sciences

[Abstract] A conference of 202 specialists from 115 institutions in 40 cities was held 12-14 Oct 1976 in Voroshilovgrad, to discuss the major trends in spray deposition of protective coatings. Included were reports on electric-spark alloying of powder in an electric field, gas-flame methods, sputter methods, gas-percussion, and plasma techniques. Other reports dealt with thin-film technology as well as with the wear and overall service characteristics of spray deposited coatings.

USSR

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CONFERENCE OF CEMA MEMBER NATIONS ON ULTRASONIC WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 77 pp 55-56

VOLKOV, S. S.

[Abstract] A conference of specialists from CEMA member nations, on the topic "Ultrasonic welding of metals and plastics: analysis of the process, development of the technology, and construction of the equipment," was held 11-16 Oct 1976 in Nove Mesto on the Vah (Czechoslovakia). The Soviet delegation from the Institute of Metallurgy imeni A. A. Baykov reported on the optimization, by mathematically planned experiments, of the process of welding gold and aluminum conductors to oxidized, metallized, and pure silicon crystals. The Soviet delegation from the All-Union Scientific Research Institute of Electric Welding Equipment reported on an experimental 1.5 kW ultrasonic machine for spot and contour welding of plastics, particularly suitable for heat-resistant polyvinyl chloride separators. The Soviet delegation from the Moscow Higher Technical School imeni Bauman reported on the feasibility of joining polymers and industrial cloth by compression welding, seam welding, or seam-stitch welding with controlled deformation.

USSR

THIRD ALL-UNION CONFERENCE ON THE PHYSICS OF BRITTLE FRACTURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 77 pp 75-76

BOTVINA, L. R., and FONSHTEYN, N. M.

[Abstract] Kiev was the site of a conference, held 7-9 December 1976, on the problems of fracture physics. It was organized by the Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR, and the Republic Hall of Economic and Scientific Propaganda of the Znaniye Society Ukrainian SSR in conjunction with resolutions of the Scientific Council on the complex problem of Solid State Physics, Academy of Sciences USSR, and the same council for the Academy of Sciences Ukrainian SSR. More than 30 plenary reports and 100 papers were heard and discussed. Summary reports were given for the topics of fracture physics (V. I. TREFILOV), the role of metal and compound electron structures in the brittle fracture mechanism (V. YE. PANIN and YU. V. MIL'MAN), the effect of interstitial impurities in metals with a b.c.c. lattice (A. N. RAKITSKIY), principles of grain-boundary brittle failure (A. S. DRACHINSKIY and V. N. MINAKOV), associated with intercrystalline internal adsorption (YE. E. GLIKMAN), and with the features of fracture of composites (S. T. MILEYKO and D. M. KARPINOS). Much attention was given to dislocation models of fracture (V. I. VLADIMIROV) and to the role of substructure (I. A. GINDIN), as well as to a discussion of various phenomenological data characterizing the effect of a number of structure and substructure factors: crystallographic orientation (O. A. BELOUS), prior plastic deformation (G. A. AVTONOMOV), aging (A. I. YEBSTYUKHIN), structure heterogeneity (A. S. DRACHINSKIY) and precipitation hardening (V. F. MOISEYEV). Special attention was given to reports on the kinetic aspects of fracture (V. L. IDENBOM, A. I. SLUTSKER and V. A. STEPANOV). A large number of reports testified to successes in using microfractography to establish the principles of fracture and the effect of structural and substructural factors (S. A. FIRSTOV, A. D. VASIL'YEV, V. V. RYBIN, A. N. PILYANKEVICH and G. S. OLEYNIK). The laws of propagation and establishment of brittle cracks for various physical actions was examined in a report by V. M. FINKEL'. Other reports dealt with local indenter loading (O. N. GRIGOR'YEV), change of the SD-effect (A. S. DRACHINSKIY and YU. N. PODREZOV) and Auger spectroscopy. The Fourth All-Union Conference on the Physics of Brittle Fracture is planned for 1979.

STRENGTH AND SAFE STRESS OF POLYMER GLASSES IN THE BRITTLE STATE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian No 2, 1977 pp 28-34
manuscript received 8 Jun 76

BARTENEV, G. M., and TULINOV, B. M., Institute of Physical Chemistry of the USSR Academy of Sciences, Moscow, and the Moscow Engineering Physics Institute

[Abstract] The engineering concept of "safe stress" is a controversial one at the present time. The authors of this paper demonstrated recently that there is a safe stress other than zero stress for inorganic glass when tests were made in the range of low stresses making possible a service life of five years. The purpose of this paper is to calculate and compare the safe stresses for polymer glasses in the brittle state, using two different approaches, the thermodynamic and kinetic. The first, suggested by Griffith (1920), uses the balance between the elastic energy of a compact material with a fracture and the surface energy of the fracture surface formed. The second takes into account the energy balance between the elastic energy of an individual chemical bond (or group of bonds) at the peak of the fracture and this same surface energy. The thermodynamic approach considers the conditions for the growth of a fracture from the energy balance viewpoint, taking mechanical losses into account. The kinetic approach employs the molecular model of a fracture created by Bartenev, Razumovskaya, and Rebinder, according to which bonds are broken and restored due to heat fluctuations at the peak of the fracture. Tensile stress increases the probability of the bonds' breaking and reduces the probability of their restoration. Both approaches are discussed in detail. A calculation is made of the safe stress of an acrylic plastic, polymethyl methacrylate (PMMA). Comparative curves are given showing the relationship between length of the fracture and safe and critical stresses for PMMA at room temperature, plotted by using the kinetic approach, and between length of the fracture and safe stress, plotted by using the thermodynamic approach. The curves are analyzed in terms of these two approaches. Both approaches to studying the process of fracture make it possible to conclude that there is a safe stress. Formulas are given here for calculating this safe stress under uniaxial extension and for a complicated stressed state. These formulas are used to specify criteria for evaluating safe microfractures in a solid. It is demonstrated that Griffith's fracture threshold corresponds to the safe stress, and not to the critical stress, as was generally believed up to this time. Figures 3; references 31: 24 Russian, 7 Western.

USSR

UDC 621.783

INCREASING THE ACCURACY OF HEAT TREATING MODES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 77 pp 54-57

MODYLEVSKIY, V. B., NAGORNIY, L. K., NESTERENKO, I. I., CHULAYEVSKIY, YE. E., and BURMISTROV, V. G.

[Abstract] Studies were made at the Novokramatorsk Machine Building Plant imeni V. I. Lenin on the lack of uniformity in temperature fields of parts being heat treated which in turn prevents automation of the heat treating process. Tests using one of the open-hearth furnaces at the plant were conducted where this furnace had 30 burners (6 rows-5/row) and a heating capacity of 1800 Mcal/hr. For the soaking process the temperature difference was 55°C, while in the tempering phase this difference was 75°C. As the result of the above test it was decided to modernize two identical open-hearth furnaces by replacing the GNP burners on one furnace with 28 GTP-15 burners in seven rows. These burners were developed by NIIPMASH (Scientific Research and Engineering Design Institute for Machine Building). The second furnace was equipped with 12 GTPS rapid burning burners with six burners in two rows. Both of these modified furnaces had a heating capacity of 2400 Mcal/hr. Results from tests in these furnaces were primarily the same with a temperature variation amounting to only 15°C for soaking and 12° for tempering for the furnace with GTP burners and 10 and 15°C respectively for the GTPS fast burners. Heat treating automation can be achieved with these modified furnace heating designs which will result in increased productivity and savings(modernization of one furnace has an economic effect of about 6-8 thousand rubles per year). References 3 (Russian).

Mechanical Properties

USSR

UDC 669.24:620.17:620.18

MECHANICAL PROPERTIES OF SEMIFINISHED PRODUCTS OF DISPERSION-HARDENED NICKEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 11-15

LYUKEVICH, V. I., LEVINSKAYA, M. KH., and ROMASHOV, V. M., All-Union Institute for Aviation Materials

[Abstract] Bars 12.3 mm in diameter and sheets 0.85 mm thick of dispersion-hardened nickel containing 3 vol. % HfO_2 were subjected to long-term deformation. The bars were produced by extrusion at 1100-1050°C of powder blanks and subsequent cold drawing with a total drawing factor of 67, followed by annealing at 1400°C. The sheets were produced by rolling at 1000-900°C of extruded blanks in the transverse direction with a total compression of 83%. The semifinished products were additionally cold deformed and annealed for 1 hour at 400 to 1400°C. The bars were additionally drawn with compressions of 30, 50 and 67%, and also axially compressed by 10-50 and 75%. The sheets were rolled in the direction of previous deformation with compressions of 10, 30 and 50%. The structures were studied by optical metallography and x-ray analysis. The structure of the dispersion-hardened nickel was found to be related to the nature of the textural changes occurring in the material under the influence of the various deformation and heat treatment conditions. The strength at 1100°C of the bars increases significantly after additional cold drawing, while subsequent high-temperature annealing does not decrease the mechanical properties at this temperature, a result of the reinforcement of the axial texture and the retention of the initial lattice. Additional rolling and subsequent high temperature annealing, causing significant structural changes, was found to have no significant influence on the mechanical properties of sheets of dispersion-hardened nickel at 1100°C. Axial compression of bars of dispersion-hardened nickel creates conditions for intensive recrystallization at low temperatures. Figures 4; references 3: 1 Russian, 2 Western.

QUANTITATIVE CRITERIA OF THE POROUS STRUCTURE OF PERMEABLE FIBER MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 77 pp 80=87 submitted for publication 12 Jun 76

KOSTORNOV, A. G., Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] This work was devoted to the formulation of special experiments for investigating the fine porous structure of permeable fiber materials in order to develop newer and more accurate concepts regarding the quantitative characteristics of these porous structures. The distinguishing feature of the examined materials (unspecified) was that they were formed from a chaotic orientation of fibers with a strictly determined ratio of length to diameter. Using methods of mercury porosimetry and replacement of liquid by gas, experimental data were collected on the effect of porosity on maximum pore diameter, the effect of thickness on maximum pore diameter, the effect of porosity on the average hydraulic pore diameter and the effect of thickness on average hydraulic pore diameter. Nomograms were constructed for determining equilibrium values of the maximum and average hydraulic diameters of pores in fiber materials. Empirical formulas were derived from the nomograms to determine the equilibrium values mentioned above. Figures 6; references 8 (Russian).

Single Crystals

USSR

UDC 669.017.539.216

HARDENING OF MOLYBDENUM SINGLE CRYSTALS CONDENSED ON THE SURFACE OF TUNGSTEN FILMS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43 No 4, Apr 77
pp 866-868 manuscript received 25 Aug 76

YAROSHEVICH, P. YU., MUKHIN, I. P., and BELOMYTTSEV, YU. S.

[Abstract] A study is made of the influence of tungsten films 0.04, 0.08 and 0.15 mm in thickness on the creep rate of a molybdenum single crystal. The tungsten single crystal films were applied by the method of cathode ray evaporation and condensation in a vacuum of $1 \cdot 10^{-6}$ mm Hg at a rate of 0.001 mm/min; the initial material used was tungsten of 99.999% purity. Creep testing at 1600°C was performed on an installation producing a static vacuum of $5 \cdot 10^{-5}$ mm Hg. X-ray structural and metallographic analysis showed that the application of tungsten films to the surface of the molybdenum specimens did not change the slip system during deformation. The rate of stable creep as a function of tungsten film thickness produced indicated that mechanical reinforcement with a tungsten film also makes a significant contribution to hardening of molybdenum single crystals. The hardening effect increases when polycrystalline tungsten films which are quite strong and form a more effective barrier preventing deformation dislocations from reaching the surface of the specimen are applied to the surface of molybdenum single crystals. Figures 2; references 7: 4 Russian, 3 Western.

USSR

UDC 537.312.62

MAGNETIC PROPERTIES OF SINGLE CRYSTALS OF NIOBIUM-TITANIUM ALLOYS IN A SUPERCONDUCTIVE STATE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian No 3, 1977 pp 526-530

AVRAAMOV, YU. S., BYCHKOVA, M. I., MEDVEDEV, S. A., SAVITSKIY, YE. M., and SEIN, V. A., Institute of Metallurgy imeni A. A. Baykov manuscript received 25 May 1976

[Abstract] The alloys Nb37wt%Ti and Nb63wt%Ti were obtained by electronic beam melting of single crystal Nb and titanium iodide. The microstructure was exposed using nitrogen and fluoride acids, and the magnetic state was measured in a superconductive solenoid by the ballistic method. The magnetization curves reflected the force of the interaction of the vortexes with the structural defects in the specimen. Results indicated that in the single crystals of the Nb-Ti alloys the irreversibility of the curves came from this interaction. The field where deflection of the reverse magnetization curve from the primary curve occurred was the magnetic field above which interaction of the magnetic filaments with the pinning centers was overcome by the interaction of the filaments with each other. Comparison of the curves for various single crystals

shows that with increased amounts of titanium, the magnitude of anisotropy increased, with the high point deflected in the direction of lower values in the external magnetic field. The experimental values for the magnetic field can be used to evaluate other features of Nb-Ti alloys, proving that they are superconductors with a high Ginsburg-Landau value. Figures 3; references 9: 7 Russian, 2 English.

Steels

USSR

UDC 669.15'26-194:620.178.2

INCREASING THE RESISTANCE OF CHROMIUM STEEL TO HYDROGEN EMBRITTLEMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 77 pp 11-14

STARCHAK, V. G., KUSLITSKIY, A. B., KLYACHKO, YU. A., and TAMARINA, I. A., L'vov Polytechnical Institute and the Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Chromium steels 20Kh, 40Kh and 50Kh and Cr-Ni-Mo steels 15KhNMA, 20KhNMA and 40KhNMA, produced by open-hearth and electric-arc melting were studied with respect to refining them as a means to improve their fatigue strength when subjected to media which cause hydrogen embrittlement. The refining process consisted of heating to 860°C, oil quenching, and tempering at 200 and 600°C for two hours which produced martensite-troostite and sorbite-perlite structures. Samples of the steels were chemically and galvanically treated to plate them with various metallic coatings. It was observed that by using the above refining process the chemical resistance of the steels to hydrogen embrittlement can be improved due to the removal of sulfide inclusions and oxide stringers. The best thermally diffused coating turned out to be chromium plating plus boriding while the galvanically treated samples showed best results when copper coated. References 6: 5 Russian, 1 French.

USSR

UDC 669.14.018.29:620.18:620.17

EFFECT OF VARYING GRANULARITY ON THE MECHANICAL PROPERTIES OF STEEL 18Kh2N4MA

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 77 pp 2-5

GULYAYEV, A. P., and SEREBRENNIKOV, L. N., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Low alloy steel 18Kh2N4MA was subjected to varying heat treatments and mechanical tests to determine the effect of grain size on its mechanical properties. Heat treating was employed to produce three initial austenitic structures: fine-grain, varying grain size and coarse-grain. Strength tests revealed that varying granularity, especially with a large content of coarse grains, strongly influences ductility caused by the tendency of the investigated steel to be more susceptible to brittle failure at higher sub-zero (°C) temperatures. The properties of this steel were independent of initial grain structure, being more a function of the heat treatment employed. Neither high- nor low-temperature tempering improves the brittle strength of the steel. Figures 5; references 3 (Russian).

USSR

UDC 669.25:669.14.018.29

EFFECT OF COBALT ON THE STRUCTURE AND PROPERTIES OF STEEL 18Kh2N4MA

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 77 pp 14-17

SHAROV, B. P., and ZIKEYEV, V. N., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin.

[Abstract] The effect of up to 3% cobalt on the structure and mechanical properties of steel 18Kh2N4MA was studied in an effort to determine how the cobalt elevates the martensite transformation temperature and retards diffusion processes during tempering of the hardened steel. Small amounts of cobalt (0.2-0.5%) have almost no effect on the kinetics of phase transformations, structure and mechanical properties of the steel but do lower its rollability. Adding up to 3% Co increases the critical points and reduces the quantity of retained austenite. Also the steel's strength is improved but low-temperature ductility is impaired by 1-3 kgf-m/cm². Cold-shortness temperature is increased by 20°C after quenching and high tempering and after low tempering the percentage of brittle component is increased in the fracture samples. Rollability of the steel at the indicated cobalt levels is lowered by as much as 40%. It is recommended that cobalt content of steel 18Kh2N4MA should not exceed 0.5%. Figures 3; references 5 (Russian).

USSR

UDC 539.4.019.3

CONCERNING CHANGES IN THE MICROHARDNESS OF STEELS AT HIGH PRESSURES OF THE SURROUNDING MEDIUM UNDER THE ACTION OF LASER RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 133-136 submitted for publication 17 Jun 76

UGLOV, A. A., and NIZAMETDINOV, M. M., Moscow

[Abstract] A GOS-30M laser on glass with neodymium was used in a free generation mode to irradiate metallic targets with one-microsecond pulses and energies from one to tens of joules. The targets were polished steel St. 3 and St. 45 samples placed in a pressure chamber and subjected to pressures of 30 to 120 atm nitrogen. Graphs were plotted for microhardness vs pressure and microhardness vs diameter which showed that microhardness increased with pressure up to a maximum around 90 atm after which hardness dropped. This relationship was associated with the rise in intensity of chemical reactions in the formation of nitrides. Upon achieving maximum hardness competing factors come into play in the opposite direction--lowering of the thermal flux on the target due to a rise in the coefficient of plasma absorption, laser beam refraction in the plasma, and a lowering of target surface temperature. Microhardness was found to be highest in the center of the sample diameters with a steep, smoothly shaped bell curve showing the hardness distribution across the diameter. Figures 3; references 5 (Russian).

USSR

UDC 539.216.2

FORMATION OF THIN FILMS FROM GALLIUM ARSENIDE AND CERTAIN PERMALLOY TYPE ALLOYS BY LASER SPRAYING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 57-60 submitted for publication 2 Mar 76

PROTAS, I. M., and ZAKHAROV, V. P., Kiev

[Abstract] Gallium arsenide and permalloy type alloys (1) 82.5% Ni, 17.5% Fe; (2) 35% Ni, 65% Co; and (3) supermalloy) were used to study the process of forming thin films upon being subjected to the beams from a ruby laser and deposited on a glass substrate. It was noted that the presence or absence of complex (polyatomic) particles in the vapor phase, other conditions being equal, had a decided effect on the structure of the resulting thin film. These particles are the ready-made additional (critical or near-critical) centers of growth which facilitate the formation of an amorphous condensate and correspond to the basic conclusions of the theory of nucleus formation relative to the plane and rate of formation and stability of the nucleation of the new phase on the substrate. References 12: 10 Russian, 2 Western.

Titanium

USSR

UDC 669.295:538.214:537.311.31

ANISOTROPY OF MAGNETIC AND ELECTRIC PROPERTIES OF α -TITANIUM ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43 No 4, Apr 77
pp 759-765 manuscript received 26 Oct 76

ADAMESKU, R. A., and MITYUSHOV, YE. A., Ural Polytechnic Institute imeni S. M. Kirov

[Abstract] This article presents a study of the nature of the anisotropy of the magnetic and electrical properties of α -titanium alloys with various types of crystallographic texture and a study of the analytic dependences of physical properties described by second-rank tensors on directions in textured materials. Experimental data are presented on anisotropy of magnetic susceptibility and electric resistivity. A method is presented for calculation of the anisotropy of physical properties described by second-ranked tensors in metals and alloys with hexagonal close-packed lattices. The values of magnetic susceptibility and resistivity calculated agree well with experimental data. Texture is the defining factor in the formation of the anisotropy of magnetic susceptibility and resistivity in α -titanium alloys. The methods produced can be used to determine the physical properties of single crystals on the basis of results of measurements made on polycrystals. References 12: 10 Russian, 2 Western.

USSR

UDC 539.52:669.295

THE DUCTILITY OF VT20 ALLOY AT 20-1000°C

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5,
May 77 pp 52-53

ZOLOTOV, M. A., SKUDNOV, V. A., VINOGRADOVA, V. YE., and SOKOLOV, L. D.,
Gor'kiy Polytechnic Institute imeni A. A. Zhdanov, Gor'kiy Aviation Plant
imeni S. Ordzhonikidze

[Abstract] Longitudinal specimens were cut from sheets 2 mm in thickness and tensile tested on an Amsler press with a special heating device assuring a temperature constancy of $\pm 5^\circ\text{C}$ over the gauge section of the specimen, 300 mm in length. The microstructure was studied using a microscope; microhardness was measured on a type PMT-3 instrument. Throughout the entire range of temperatures studied (20-1000°C), VT20 alloy manifested a direct correlation between ductility and index $m = \partial \log \sigma_v / \partial \log \dot{\epsilon}$. At 900°C with a deformation rate of $1.64 \cdot 10^{-3} \text{ s}^{-1}$, VT20 alloy manifests superplasticity, which can be utilized in the technology of hot stamping of parts without preliminary preparation of the structure. Figures 3; references 5: 4 Russian, 1 Western.

USSR

UDC 669.094.3:669.295

KINETICS OF LONG-TERM OXIDATION OF TITANIUM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 49-51

KORNIKOV, I. I., deceased, ZABRODSKAYA, M. N., BORISKINA, N. G., and BRYNZA, A. P., Institute of Metallurgy imeni A. A. Baykov, Dnepropetrovsk State University

[Abstract] A study was made of the process of oxidation of titanium in air upon heating over a broad temperature range for up to 1000 hours. Preliminarily degreased, polished specimens of VT1-0 titanium 9 mm in diameter and 10 mm high were oxidized in air, in muffle furnaces at 200, 300, 400, 500, 600, 700 and 800°C for 25, 50, 100, 250, 500, 750 and 1000 hr at each temperature. After heating, the specimens were cooled in a dessicator. The oxidation was defined by the change in thickness of oxide films formed on the surface of the specimens, as well as the weight gain of specimens oxidized at 600, 700 and 800°C. The process of oxidation of titanium upon long-term heating in air was found to follow the same regularities observed for short-term oxidation, although the oxidation rate constants have higher values. References 2 (Russian).

USSR

UDC 621.785.78:669.295

THE NATURE OF EMBRITTLEMENT OF α ALLOYS OF TITANIUM IN THE PROCESS OF AGING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 46-49

BODUNOVA, M. B., RAZUVAYEVA, I. N., SEREBRENIKOVA, N. A., KHESIN, YU. D., and CHECHULIN, B. B.

[Abstract] In an investigation of the processes of aging of α alloys, in parallel with estimation of changes in impact toughness, the kinetics of the change in low-cycle endurance of notched specimens in a corrosive medium and the magnitude of internal friction were determined. Blanks cut from bars 20 x 20 mm in cross section of the alloys Ti-6% Al, Ti-6% Al-2% Zr and Ti-6% Al-6% Zr were studied after quenching from temperatures in the upper portion of the α area. The blanks were aged at 300-700°C for 15 minutes-100 hours with subsequent cooling in water. C-shaped decomposition curves of the α -solid solution in the α alloy Ti-6% Al-6% Zr were constructed, reflecting the kinetics of the formation of zones rich in zirconium and aluminum. Accelerated cooling (quenching) from the β , $\alpha + \beta$ or upper portion of the α area greatly decreases the possibility of formation of concentration heterogeneities in the α -solid solution and allows the optimal combination of properties of α titanium alloys to be produced. Figures 2; references 8: 2 Russian, 6 Western.

USSR

UDC 621.78:669.295

INFLUENCE OF LONG-TERM HEATING ON THE THERMAL STABILITY OF THE PHASES OF $\alpha + \beta$ TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 42-46

GUS'KOVA, YE. I., YERMOLOVA, M. I., LASHKO, N. F., and SOLONINA, O. P.

[Abstract] Parts operating for long periods of time at temperatures of 400-500°C are often made of $\alpha + \beta$ titanium alloy. The operating life of these alloys was determined by studying the influence of heating at the usage temperatures on thermal stability, determined by evaluating the stability of the β phase after long-term heating to 400-550°C. Alloy VT3-1 was studied, containing 5.97% Al, 2.25% Mo, 1.44% Cr, 0.3% Fe, 0.25% Si, as well as alloy VT9, containing 6.34% Al, 2.96% Mo, 1.0% Zr, 0.08% Fe, 0.24% Si. Blanks were heat treated by two methods: isothermal annealing at 870°C, 1 hour, transfer to a furnace at 650°C, 2 hours, cooling in air and hardening heat treatment--quenching from 880°C (1 hour) and aging at 550°C (5 hours), cooling in air. Specimens of VT9 were also heat treated in two modes: heating to 925°C 1 hour, cooling in water plus 570°C 2 hours, cooling in air, and heating to 950°C, 1 hour, cooling in air plus 530°C, 6 hours, cooling in air. After heat treatment, the tensile-test specimens were heated to 450, 500 and 550°C for 2000 hours, then tested at 20°C. The results of phase analysis agreed with the changes in strength properties of the alloys. Long-term, low-temperature heating of the two alloys brings them to a stable corresponding to the heating temperature, which is accompanied by a change in the quantity of β phase and the concentration of β stabilizing elements. Figures 5; references 3 (Russian).

USSR

UDC 620.18:621.78:669.295

INFLUENCE OF STRUCTURE AND HEAT TREATMENT ON THE PROPERTIES OF HIGH-STRENGTH TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 38-42

MOISEYEV, V. N., ZNAMENSKAYA, YE. V., and TARASENKO, G. N.

[Abstract] This work is dedicated to the search for a possible method for increasing the strength of titanium alloys with $\alpha + \beta$ structure to 150 kg/mm² or more, a study of the physical and mechanical properties of these alloys and of their usage characteristics. Rods 20-30 mm in diameter of VT3-1, VT22 and VT15 were studied, after production by rolling at the temperatures of the β and $\alpha + \beta$ area with deformation between heating cycles of at least 40%. This technology produced a fine-grain structure. It was found that to produce a material

with a strength of 150 kg/mm² or more, it is preferable to perform hardening heat treatment on an alloy of critical composition such as VT22 (with martensitic conversion temperature near room temperature) with a strength of at least 110-120 kg/mm² in the annealed state. Hardening and aging can produce the desired strength levels, although the sensitivity to stress concentration increases. Figures 1; references 5 (Russian).

USSR

UDC 620.17:669.295'3

INFLUENCE OF ALLOYING ON THE PROPERTIES OF THE THERMALLY HARDENED ALLOY Ti-2.5% Cu

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 36-38

BORISOVA, YE. A., KIRICHENKO, N. I., and MAREYEVA, V. S.

[Abstract] The alloy Ti-2.5% Cu (IMI-230) has good technological ductility allowing products of complex shape to be produced by cold deformation, and has an ultimate strength of 70-80 kg/mm² after aging. In the annealed state, tensile strength is 50-60 kg/mm², δ = 25%, while after hardening and aging by the optimal method (400°C 24 hr plus 475°C 8 hr), tensile strength is 70-75 kg/mm², δ = 14%. The influence of alloying with aluminum, tin, zirconium, niobium and molybdenum in quantities not exceeding their limits of solubility in the α solid solution was studied in order to determine the possibility of increasing the strength of the alloy in the annealed and thermally hardened states. The introduction of a third element (with the exception of zirconium) was found to increase the strength by 2-15 kg/mm² with a slight reduction in ductility throughout the entire temperature interval studied (from -269 to +500°C). Best results at 350 and 500°C were produced by the addition of 1% Al. The alloys in the annealed and thermally hardened states retain good plasticity right down to liquid helium temperatures and good impact toughness right down to liquid nitrogen temperatures. The addition of 1% Al was considered most promising due to the combination of good properties and easy availability of aluminum. Figures 2.

NONHYSTERESIS "MEMORY" EFFECTS IN TiNi-BASED ALLOYS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 234 No 5, 1977 pp 1059-1062
manuscript received 14 December 76

KHACHIN, V. N., GYUNTER, V. E., MONASEVICH, L. A., and PASKAL', YU. I., Siberian Physico Technical Institute imeni V. D. Kuznetsov, Tomsk State University

[Abstract] It is demonstrated that TiNi and alloys based on it, in addition to the properties of "memory" which are manifested during the well-known martensitic transition, also show practically hysteresis-free "memory" effects resulting from other, nonhysteresis martensitic conversions. The studies were performed on five alloys of the following compositions (wt. %): 1) Ti + 55.0 Ni; 2) Ti + 55.5 Ni; 3) Ti + 56.0 Ni; 4) Ti + 50.0 Ni + 5.0 Co; 5) Ti + 50.0 Ni + 5.0 Fe. The beginning of the martensitic conversion gradually drops in the order in which the alloys are numbered here from positive to deeply negative temperatures. A combined study of structural changes, physical properties and "memory" properties shows that in TiNi and its alloys there are two thermoelastic martensitic conversions. The placement of their temperature intervals may vary and depends on the composition and previous heat treatment history of the alloy. Figures 2; references 13: 1 Russian, 12 Western.

Welding

USSR

UDC 621.791.75.052:621.791.72.052:669.14.018.44

COMPARATIVE EVALUATION OF THE PROPERTIES OF WELDED JOINTS IN HEAT-RESISTANT NICKEL ALLOYS MADE BY ELECTRON BEAM AND ARC WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 77 pp 28-32

MOROCHKO, V. P., SOROKIN, L. I., YAKUSHIN, B. F., and MORYAKOV, V. F.

[Abstract] The purpose of this investigation was to compare the mechanical properties of welded joints of commercial nickel alloys with intermetallic hardening, to study their crack formation tendency during electron beam welding, immersed argon-arc welding, manual multipass argon-arc welding and arc welding with covered electrodes, and to select the optimal method. Electron beam welding of heat-resistant nickel alloys 12 mm thick at 15 m/hr reduces the energy requirement (from 4300 to 2070 cal/cm), seam area (from 108 to 24 mm²) and width of area of thermal influence (from 0.9-1.8 to 0.4-0.8 mm) in comparison to argon-arc welding with an immersed arc. The use of electron beam welding expands the variety of heat-resistant nickel alloys which can be welded. In comparison to automatic argon-arc welding and manual welding with welded wire made of the base metal, electron beam welding reduces the crack formation tendency both in the seam metal and in the near-seam zone (both during welding and during heat treatment). However, electron beam welding improves the resistance to the formation of hot cracks only in mild welding modes (welding speed less than 45 m/hr). The welded joints of heat-resistant nickel alloys with intermetallic hardening, when produced by the electron beam method, have strength, ductility and impact properties which are superior to arc-welded joints, while the dispersion of the test results is less. Figures 7; references 13: 7 Russian, 6 Western.

USSR

UDC 621.791.01:620.192.4:669.15-194.56

INFLUENCE OF DEFORMATION AGING ON THE TENDENCY OF AUSTENITIC STEEL TYPE Kh25N16G7AR (EI835) TOWARD FORMATION OF CRACKS IN THE ZONE AROUND THE SEAM OF A WELDED JOINT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 77 pp 23-25

PRONINA, YE. M., DEGTYAREV, I. YA., SHCHENNIKOVA, A. YE., FOMENKO, YE. D., and SLAVIN, G. A.

[Abstract] In order to establish the mechanism of crack formation in the seam zone and seek methods to control cracking, the influence of various factors on crack formation was studied: degree of deformation in extension and hardening mode of the base metal before welding; level of residual stresses and ductility characteristics resulting from the varying degree of deformation of the metal before welding; plasticity of welded joints; structural transformations in the metal of the welded joint when it is stretched before welding with various

degrees of deformation and with various heat treatments. The results of the experiment showed that deformation by 8-12% extension leads to redistribution of stresses through the thickness of the specimen, with residual tensile stresses arising on the surface (20-40 kg/mm²), the greatest stresses being in specimens deformed by 8%; hardening after deformation does not completely eliminate residual stresses. Deformation aging (precipitation of secondary brittle phases) and the sharp reduction of plasticity in the 650-850°C temperature interval are judged to be the primary causes of the increased tendency of EI835 steel toward the formation of cracks (tears) in the metal around the welded seam. The most effective measure to reduce the crack formation tendency is heat treatment by hardening from 1050°C, as well as fluxing of the reverse side of the joint before automatic welding. Figures 7; references 3 (Russian).

USSR

UDC 621.791.001:669.018.9

DEVELOPMENT OF INTERNAL STRESSES IN COMPOSITE MATERIALS UPON HEATING AND COOLING IN THE THERMAL CYCLES OF WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 77 pp 21-23

GUKASYAN, L. YE., and BELOV, V. V.

[Abstract] A study was made of a composite material consisting of chrome-nickel alloy EI445 reinforced with fibers made of an alloy of tungsten with rhenium, type VR5, with a volumetric fiber fraction of 10%, produced by explosive welding. Specimens with a cross-section of 31.5 mm², 100 mm in length, were cut along the fibers. The specimens were heated and cooled to a maximum temperature of 1300°C in the center of the specimen, heating time 5 seconds, cooling rate in the 600-500°C interval 18 C/s, total cooling time 5 minutes, specimen length heated 60 mm. The study of the free thermal expansion of this composite material, of the fibers and of the matrix when heated and cooled in the thermal cycle encountered in welding allowed estimation of the mean internal deformations and stresses in the components of the composite material, as well as the residual internal stresses and strains existing in the composite material after manufacture. It was found that the direction of stresses and strains changes twice (once during heating, again during cooling) during the process of thermal cycling of the zone around the seam during welding. After complete cooling, the internal residual stresses in the fiber remain at the level of the proportionality limit; the stresses in the matrix are less. Internal deformations and stresses arising in a composite material as it is heated agree rather well in the elastic area with the calculated values if one considers the temperature at which internal residual stresses are relieved upon heating. Figures 4; references 4 (Russian).

USSR

UDC 621.791.052:62-462:620.17

LOAD-BEARING CAPACITY OF CIRCULAR COMPOSITE WELDED JOINTS IN LARGE-DIAMETER PIPE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 77 pp 12-14

BAKSHI, O. A., ANISIMOV, YU. I., PUYKO, A. V., GOLIKOV, V. N., Chelyabinsk Polytechnic Institute, RAKHMANOV, A. S., CHABURKIN, V. F., All-Union Scientific Research Institute for Welding Technology, MONOSHKOV, A. N., LUPIN, V. A., NIKULIN, YU. N., Ural Scientific Research Pipe Institute, and SERGEYEV, I. I., Chelyabinsk Pipe-Rolling Plant

[Abstract] An experimental study was performed of the load-bearing capacity of circular composite seams in seamless pipe 720 mm in diameter with a wall thickness of 9 mm. The pipe material was steel, similar in its chemical composition and mechanical properties to type 17GS steel [0.18% C, 1.24% Mn, 0.25% Si, 0.01% P, 0.2-0.3% S, 0.12-0.13% Cr]. The seam hydraulically tested was welded by a technology involving production of the first (root) seam using type E42A-F electrodes, the second and third seams using type E50A-F electrodes. The same steel and similar technology were used to weld plates for the manufacture of macro- and micro-sections and specimens for monaxial tensile testing. The load-bearing capacity of the composite seams was found to be equal to that of the base metal. Analysis of macrosections showed that the ratio of thickness of the soft and hard layers of the seam was 0.3-0.45:1. The metal of the inner layers of the welded seam had a dispersed ferrite-pearlite microstructure; the outer layers had the same structure, but the grain was coarser. Figures 5; references 8 (Russian).

USSR

UDC 621.791.75:052.001.5:669.295

THERMAL EFFECT OF THE ARC ON THE SHAPE, STRUCTURE AND PROPERTIES OF JOINTS IN TITANIUM ALLOYS PRELIMINARILY WELDED IN THE SOLID STATE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 77 pp 5-7

MATYUSHKIN, B. A., Candidate of Technical Sciences, and SHORSHOROV, M. KH., Doctor of Technical Sciences

[Abstract] Solid-phase welding was performed by cyclical application of pressure, which intensifies the welding process owing to the periodic relief of the deformation hardening of the metal in the contact zone during pauses in pressure application. Welding was performed on an experimental laboratory installation, using specimens of the heat-resistant titanium alloy VT20, a Ti-Al-Zr-Mo-V alloy. The experiments showed that the process of solid-state welding occurs most rapidly and completely in the central zone of the joint. The peripheral areas generally have the greatest number of defects, characteristically incomplete melting for chamfers, formed as a result of the incomplete compression

of microscopic projections in the process of welding. Metallographic studies showed that solid-state welding at 980°C after mechanical working produces good quality joints. In order to increase joint quality still further, a new welding method was developed, based on the use of subsequent partial melting of the solid-phase joint in an arc, intended to produce melting to the minimum possible depth required to increase joint reliability. The thermal influence of the arc in this case also has a favorable effect on joint quality. The endurance of T joints under repeated static load was increased from 30 to 75 kg/mm², of butt joints--from 30 to 42 kg/mm². Figures 8; references 6 (Russian).

USSR

UDC 621.791.01:620.192.2:669.855:669.7

EFFECT OF CERIUM ON THE TENDENCY OF ML 10 ALLOY TOWARD HOT CRACKING DURING WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 77 pp 25-26

BALOSHKO, V. A., KOPYLOV, A. G., and SHARYPOV, A. Z.

[Abstract] Hot cracks appear in ML 10 magnesium alloy during welding, even after preheating to 380-400°C, with welding rods of the same material. A study was made to establish the effect of adding cerium to the material of the welding rods on the quality of welded joints. An ADSV-2 automatic welder was used and joints were made with a current of 170 A at the rate of 7.0 m/h. Phase analysis and mechanical tests of the product, welded with rods containing various amounts of cerium, revealed that 1.65-2.52% Ce modifies the structure of the melt so as to ensure a higher resistance to cracking at the preheat temperature, without degrading the mechanical properties of the welded joint. Figures 4; references 2 (Russian).

USSR

UDC 621.791.763.1:669.71

RESISTANCE SPOT WELDING OF O1420 ALUMINUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 77 pp 17-20

RYAZANTSEV, V. I., ORLOV, D. B., and SHAVYRIN, V. N.

[Abstract] The deformable and heat hardenable grade O1420 Al-Mg-Li alloy has a lower density and a higher modulus of elasticity than the conventional Al-Cu-Mg and Al-Mg alloys. Its other advantages include high corrosion resistance, so that it can be used without surface treatment. The feasibility of spot welding this alloy as well as the O1420+D16T combination was studied on sheet and strip stock 1.0-3.0 mm thick, after the following heat treatments: 1) quench from 450°C in water (temper T1) and 2) quench from 450°C in air with subsequent artificial aging at 120°C for 5.0 h (temper T4). A model MTK-75 capacitive welder was used with a variety of electrodes. An analysis of the process parameters and an evaluation of the product quality reveal how the thermophysical properties of the alloy, the geometry of the electrodes, the stiffness of the current pulse, and the ratio of thicknesses in the stack affect the kinetics of the melt core and the formation of a sealing strip. Figures 3; references 5 (Russian).

USSR

UDC 621.791.052:620.18

INFLUENCE OF ELECTROMAGNETIC ACTION ON THE PROPERTIES AND STRUCTURE OF O1420 ALLOY WELDS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 5(290), May 77 pp 21-24, 29 manuscript received after final revision 21 Dec 76

ABRALOV, M. A., candidate of technical sciences, ABDURAKHMANOV, R. U., engineer and YULDASHEV, A. T., engineer, Tashkent Polytechnical Institute

[Abstract] The porosity and low mechanical properties of O1420 alloy welds can be attributed to a great extent to the conditions of primary crystallization of the welding bath. This paper is a report on studies in which the process of primary crystallization is controlled by electromagnetic action on the welding bath. The electromagnetic field was applied in the form of square pulses of heteropolar current with controllable duration of pulses and pauses. The experiments proved that electromagnetic action on the bath improves the structure of welds, cutting the number and dimensions of pores in the seams approximately in half and improving the mechanical properties of O1420 aluminum alloy welds. The optimum parameters of the electromagnetic action for material 2 mm thick are $B = 0.009-0.013$ T, $\text{prf} = 1.5-4$ Hz, and ratio of pause duration to pulse duration--3-4. The reduction in the numbers and dimensions of pores under electromagnetic action is due to a reduction in supersaturation of the molten metal with gases at the crystallization front and in the welding

bath, facilitation of the rise of gas bubbles that develop on the crystallization front, and healing of defects due to shrinkage. Figures 5; references 7 (Russian).

USSR

UDC 621.791.92.04

MOISTURE ADSORPTION ON THE SURFACE OF AD-1 ALUMINUM AND AMg6 ALLOY WELDING ROD

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3(288), Mar 77 pp 24-26 manuscript received 13 Sep 76

TYUL'PAKOVA, R. V., engineer, ARBUZOVA, L. A., candidate of chemical sciences, and CHERNYKH, N. YE., engineer, Moscow

[Abstract] A thermodesorption mass spectrometer technique is used to estimate the gas content in AD-1 aluminum and AMg6 alloy welding rod as a function of storage time after pretreatment (electropolishing, chemical polishing, chemical etching). The content of water vapor and hydrogen in the rods (2 mm in diameter) was determined after each kind of pretreatment. The results of the studies show that the principal gas impurity introduced into the seam metal by welding rod after storage is adsorption water that forms additional hydrogen when it interacts with the metal. The amount of hydrogen from the adsorbed water may exceed the concentration of dissolved hydrogen by a factor of 2-7. Storage of AMg6 alloy rod after pretreatment increases the gas content in the rod by 0.1 cc per 100 g after one day, and by 0.5-1.0 cc per 100 g after 20 days as compared with the initial level. Electropolishing increases the gas content of AMg6 rod less than the other two types of treatment. Electropolishing of AD-1 aluminum rod produces an oxide film on the surface that has a high gas content in the initial state but adsorbs almost no water over the next 20 days, so that the gas content in the wire does not change. This effect is not observed in cases of chemical etching and chemical polishing, which ensure a lower initial gas content. Figures 4; references 8 (Russian).

INFLUENCE OF THE METALLURGICAL HISTORY OF AMg6 ALLOY INTERMEDIATE WORKPIECES
ON THE TIGHTNESS AND MECHANICAL PROPERTIES OF WELDS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 5(290), May 77 pp 25-29 manuscript
received after final revision 27 Oct 76

LOZOVSKAYA, A. V., candidate of technical sciences, ISHCENKO, A. YA., candidate
of technical sciences, RABKIN, D. M., doctor of technical sciences, SAYENKO,
M. I., engineer, and CHAYUN, A. G., engineer, Institute of Electric Welding
imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] The authors investigate the influence of hydrogen and impurities
on the weldability of a large number of melts of AMg6 alloy based on aluminum
of different degrees of purity. Some specimens were made from alloys with
the usual amount of hydrogen, and others were made from alloys that had been
outgassed in vacuum, reducing the hydrogen content by a factor of 2-3. The
aluminum impurities were chiefly iron and silicon. The welds were tested for
inclination to pore formation in the heat-affected zone by a heat probe method,
and with welding under conditions leading to overheating of the metal. It was
found that reducing the silicon and iron content in AMg6 alloy improves the
mechanical properties of welds and reduces the porosity of the seam metal, as
well as narrowing the heat-affected zone. A change of initial hydrogen con-
tent from 0.6 to 0.2 ml/100 g is reflected to a lesser degree in the tightness
and strength of welds. Tests of the metal for inclination to pore formation in
the heat-affected zone and to peeling by the heat probe method and by direct
welding under various unfavorable conditions do not yield comparable results.
The heat probe is an excessively severe test of the material and cannot be con-
sidered suitable for determining whether intermediate workpieces can be used
in welded structures. This can be decided only on the basis of tests under
conditions corresponding to the welding method to be used. Figures 4; refer-
ences 5 (Russian).

USSR

UDC 621.791.72:621.373.8

A STATE-OF-THE-ART SURVEY OF CW LASER WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 5(290), May 77 pp 44-50 manuscript received 16 Sep 76

VELICHKO, O. A., candidate of technical sciences, MOLCHAN, I. V., engineer, and MORAVSKIY, V. E., doctor of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] This survey covers research in cw laser welding published up to 1976. Although only the first steps have been made in this important field, the data that have been accumulated indicate directions for future research to establish the principles of this new process. The most important problem to be solved is finding ways to improve efficiency, which is associated chiefly with the problem of eliminating the plasma cloud over the surface of the bath, i.e., developing the appropriate gas-feed systems and choosing the most effective gas mixture. It is important to know the distinguishing features of seam formation (formation of a channel in the bath, deformation of the bath, motion of the molten metal, etc.), and the way that seam parameters depend on welding conditions. This will enable development of a procedure for choosing the welding conditions to match the grade and thickness of the metal, and also to formulate requirements for the parameters of the focusing system. Besides, the study of specifics of the metallurgical process in the bath (and hence the feasibility of predicting the quality of the crystallized weld) requires an investigation of the composition and partial pressure of the gases in the plasma cloud. The main advantages of welding with a powerful laser beam are the capability of deep-penetration melting of thick metal, and also welding thin metals at a higher rate of speed than with other techniques. Figures 4; references 39: 7 Russian, 32 Western.

USSR

UDC 621.791.01.001.5:669.017.3:669.295

INFLUENCE OF STRUCTURAL TRANSFORMATIONS ON THE PROPERTIES OF THE HEAT-AFFECTED ZONE IN THE WELDING OF VT22 ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5(511), May 77 pp 12-13

PERMYAKOVA, E. M., candidate of technical sciences, Kuybyshev Polytechnical Institute imeni V. V. Kuybyshev

[Abstract] The influence of structural transformations of metastable phases on the physical properties of the heat-affected zone in the welding of VT22 alloy was studied by microstructural analysis and measurement of resistivity, microhardness and hardness. The results show that the high-temperature action on the metal that takes place in welding in the heat-affected zone leads to formation

of regions with different degrees of alloying, which apparently causes the formation of a cellular relief. A change in the phase makeup and state of the structure of the β -phase causes a considerable change in the resistivity, microhardness and hardness of the metal of the heat-affected zone. Segregations in the form of platelets (observed on electron photomicrographs) are apparently ω -phase, which can be ascertained from the increase in resistivity on these sections of the weld. Annealing of a weld at 750°C eliminates nonhomogeneity of the structure and hardness of the heat-affected zone. Figures 3; references 2 (Russian).

USSR

UDC 621.791.052:620.192.7

DESTRUCTION OF AMg5 ALLOY UNDER CONDITIONS OF THERMAL CYCLING WITH INTERMEDIATE LOADING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5(511), May 77 pp 23-24

IBATULLIN, R. L., engineer, KIM, S. KH., candidate of technical sciences, and KALININA, A. P., engineer

[Abstract] The authors investigate the mechanism of destruction of AMg5 alloy specimens under conditions of thermal cycling with intermediate loading that simulate the work of the metal in air-fractionating equipment. The results of the studies show that intermediate loading of AMg5 alloy specimens by stretching to values close to the calculated stresses at normal temperature in combination with periodic heating does not have any decisive effect on the ultimate strength or the yield stress at residual longitudinal extension of 0.2% in either the base metal or the weld, and the residual longitudinal extension decreases only at a test temperature of minus 196°C. Despite comparatively high mechanical characteristics, intermediate loading with thermal cycling leads to embrittlement of base metal and welds, which makes them very dangerous for use at low temperatures. The study showed that knowledge of the mechanical characteristics of the material alone does not make it possible to judge its workability at low temperatures. It is also necessary to study the nature of fracture of the specimens under conditions approaching actual operation as closely as possible. Figures 2; references 2 (Russian).

USSR

UDC 621.791.053.001.5.669.715

CONCERNING CERTAIN FACTORS THAT INFLUENCE THE FORMATION OF OXIDE INCLUSIONS IN AMg6 ALLOY WELDS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5(511), May 77 pp 24-27

ZUBRIYENKO, G. L., candidate of technical sciences, TENENBAUM, F. Z., candidate of technical sciences, PETROVANOV, V. M., candidate of technical sciences, SITYAVIN, YU. I., engineer, STEBLOVSKIY, B. A., candidate of technical sciences, ZAVIRYUKHA, V. I., engineer, and SLEPCHENKO, N. N., engineer

[Abstract] The authors analyze the nature of oxidation and temperature distribution on the workpiece surfaces in contact with the welding bath in butt welding. The degree of oxidation of the butt ends was evaluated from longitudinal fractures made with momentary de-energizing during welding. As the welding current was switched off, argon was blown in from the molten side to protect the surface from further oxidation until completely cool. It was found that the butt ends are oxidized in front of the welding bath, the dimensions of intense oxidation being determined to a great extent by the thermal cycle of the welding process, and on all specimens are limited to a zone corresponding to temperatures exceeding 360°C. The results of experiments showed that the amount and extent of oxide films in welds can be reduced by increasing the linear energy, which displaces the oxides from the working section of the weld into the molten side. Figures 5; references 3 (Russian).

USSR

UDC 621.791:620.192.47

EVALUATING THE TENDENCY OF LIGHT ALLOYS TO BECOME POROUS DURING WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5(511), May 77 pp 49-52

SUSHKOV, V. N., engineer, and KRYUKOVSKIY, V. N., candidate of technical sciences

[Abstract] The authors examine engineering and theoretical methods of evaluating the tendency of aluminum and magnesium alloys to form pores during gas-shielded arc welding. An experimental technique is worked out that consists in using an inert gas with high moisture content followed by determination of weld porosity by hydrostatic weighing. The minimum (critical) concentration of water vapor that causes porosity to develop is taken as the criterion of the tendency of the alloy to form pores, and the ratio of the total pore volume to the square root of the difference between the given and critical water vapor concentration is taken as a criterion of the tendency of the alloy to develop porosity. A comparative evaluation is made of the tendency to form pores and develop porosity in AMg6 and MA2-1 alloys under argon-arc welding conditions. It is found that AMg6 alloy has a greater tendency to form pores, and that MA2-1 alloy has a higher tendency to develop porosity. A study is made of the way that an oxygen dopant in the shielding gas affects the tightness of welds in AMg6 alloy

that are made by argon-arc welding with nonconsumable electrode. It is established that increasing the oxygen content in argon to 5% by volume increases the density of the weld metal by an appreciable reduction in dissipated porosity without an appreciable detrimental influence on seam formation. Figures 8; references 7: 6 Russian, 1 Western.

USSR

UDC 621.791.72:621.373.8

RAPID LASER WELDING OF THICK-SHEET NICKEL

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 77 pp 69-70

YELICHKO, O. A., Candidate of Technical Sciences, AVRAMCHENKO, P. F., YEMEL' YANOV, V. G., and KOSYREV, F. K., Engineers, and MORYASHCHEV, S. F., Candidate of Technical Sciences

[Abstract] An investigation into fast laser welding of nickel with a thickness of 0.5 mm at welding speeds of 500-1500 m/hr was conducted by the Institute of Electric Welding imeni Ye. O. Paton and the Institute of Atomic Energy. An LT-1 laser unit was used at beam energies of 4.5-5.5 kWt. Good results were achieved for all welding speeds, 500-750 and 1500 m/hr. Defects that occurred were felt to be due to laser beam deviation from the working axis. Better weld joints were produced in the 500-750 m/hr range, but all weld joints were equal in strength to the base metal for all speeds used and could sustain a 180° bend. Figures 2; references 1 (Russian).

USSR

UDC 621.791.4:539.378.3

WELD-JOINT QUALITY OF DIFFUSION-WELDED TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 77 pp 68-69

KOTEL'NIKOV, A. A., Candidate of Technical Sciences and BASHURIN, A. V., and GOLODOV, I. V., Engineers

[Abstract] Use of electric resistance measurements in the diffusion welding of titanium alloys as a means of weld-joint quality control was investigated at the Kursk Polytechnical Institute. The four-contact method was used to measure electrical resistance which made it possible to exclude the effect of contact quality between the metallic sensor and the part. Tests were performed with alloys VT6S, VT3-1, VT5-1 and VT-15 with similar results. The authors felt that intensive distortion of microirregularities should occur in the initial stages of welding which would lower the electrical resistance sharply, but

found none. Resistance of the weld zone almost equaled that of the base metal within eight minutes of welding for the alloy with a coarse-grain structure and in 16 minutes when the structure was fine-grain. Impact strength of the weld joint was 20% below that of the base metal. It was concluded that this method was satisfactory for quality control of diffusion welded joints for titanium alloys. Figures 1; references 2 (Russian).

USSR

UDC 621.791.75.042

FILLER WIRE FOR WELDING AMg6 ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 77 pp 65-66 submitted for publication 19 Mar 76

ISHCHENKO, A. YA., Candidate of Technical Sciences, SAYENKO, M. I., Engineer, IGNAT'YEV, V. G., Candidate of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton; KUROCHKO, R. S., Candidate of Technical Sciences, Moscow; ZAMYATIN, I. P., Leningrad

[Abstract] An attempt was made to find a filling wire of the proper chemical composition to improve the chemical composition of AMg6 alloy weld joints and thus produce a better quality joint as the authors felt the unfavorable chemistry of AMg6 weld joints was the cause of pore and crack formation. Three filling wires were tested: SvAMg6, SvAMg6vch and SvAMg6Tsvch, where the last two wires differ from the alloy by much smaller amounts of iron and silicon and the last (SvAMg6Tsvch) contains Zr. All three wires had Mg, Mn and Ti quantities similar to those in the base metal (AMg6). Tests showed that SvAMg6Tsvch wire gave much better weld joints with seam metal ductility and impact strength increased by 20-30; resistance to hot cracks improved by one-half to 2 times. Also, weld joints using this wire had a more uniform structure with fewer micropores, resulting in better hermeticity of the joints. Figures 1; references 3; 2 Russian, 1 Western.

USSR

UDC 621.791.01:539.3783:669.295

DIFFUSION WELDING OF TITANIUM ALLOYS WITH DIFFERENT PHASE COMPOSITIONS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 77 pp 53-57 submitted for publication 13 Oct 76

GEL'MAN, A. A., Candidate of Technical Sciences, KOLODKIN, N. I., Engineer, KOTEL'NIKOV, A. A., Candidate of Technical Sciences, and BASHURIN, A. V., Engineer, Kursk Polytechnical Institute

[Abstract] Determination of optimum parameters was studied for diffusion welding of typical alpha-, alpha+beta- and beta-titanium alloys. It is possible to produce defect-free weld joints when diffusion welding alpha+beta alloys with a fibrous structure and even achieve a degree of superductility of the joint; however these types of alloys (VT3-1 and VT6S) have an elevated notch sensitivity, resulting in a lower impact strength than the base metal. The alpha-alloy tested (VT5-1) exhibited many more welding defects than the alpha+beta alloys, but both tensile and impact strengths of this alloy were on a level with those of the base metal. Welding of alloy VT15 (beta-structure) provided the same results as welding of VT5-1, but VT15 welding must be done 280-300°C above the alpha+beta to beta temperature, while for alloy VT5-1 the welding is done below this transformation temperature. Figures 7; references 3: 2 Russian, 1 Western.

USSR

UDC 621.791.753.9

EFFECT OF FLUX COMPOSITION ON THE PROCESS OF WELDING TITANIUM WITH A NONCONSUMABLE ELECTRODE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 77 pp 22-26 submitted for publication 23 Apr 76

ZAMKOV, V. N., Candidate of Technical Sciences, PRILUTSKIY, V. P., Engineer, GUREVICH, S. M., Doctor of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences Ukrainian SSR

[Abstract] The effect of flux composition during argon-arc welding of titanium with a nonconsumable electrode on melting of the base metal was studied. In making this study the authors determined the vapor pressures of single-component fluxes in the arc for the following variants of flux dispensing: 1) constant flux layer thickness, 2) constant flux mass and 3) amount of flux proportional to the molecular mass (equimolar mass). Fluxes used were alkaline and alkaline-earth fluorides where the relationship of their degree of dissociation to temperature and the chemical reactions involved were plotted. Also plotted were the quantity of dissociating vapors in relation to temperature, relative depth of melting of the base metal using single-component fluxes, and the relationship of equilibrium dissociation reactions of titanium fluorides to temperature. A table is presented showing the reaction products (TiF_2 , TiF_3 and TiF_4)

and the constants of reaction equilibrium for the fluoride fluxes. Conclusions from this study were that the flux should possess good adhesion to the metal being welded and form dissociating vapors in the arc zone; flux boiling temperature should be higher than the metal being welded; the flux should interact with the metal in both solid and liquid states of the metal; and reaction products should be stable at arc temperatures, contain electrically negative elements and have a highly effective cross section of electron capture. Electrical conductivity of the molten flux should be less than the metal in the weld bath. Figures 5; references 10: 8 Russian, 2 Western.

USSR

UDC 621.791.72

ELECTRON-BEAM WELDING OF AN ALUMINUM-BERYLLIUM-MAGNESIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 77 pp 48-50 submitted for publication 20 Jul 76

KOMAROV, M. A., Candidate of Technical Sciences, and SHIGANOV, I. N., Engineer, Moscow

[Abstract] Samples of alloy Al-30%Be-5% Mg were welded with an electron beam where the weld parameters of frequency and oscillation magnitudes were varied to find the optimum parameters to produce good seams. Results of weld tests showed that it is necessary to use electron-beam oscillation and amplitude of 50-100 Hz and 3-4 mm respectively to prevent the formation of surface defects. Addition of an insert with up to 3.3% Mg into butt joints eliminates internal discontinuities in the form of pores or flaws, providing the fraction of filler in the seam is not less than 45%. Mechanical properties of weld joints of the studied alloy were best when using a filler of alloy AK8. Figures 1; references 1 (Russian).

Miscellaneous

USSR

UDC 669.017

INVESTIGATION OF THE PARTICULARS OF DEFORMATION AND DESTRUCTION OF V93 ALLOY UNDER TENSION AFTER AUSFORMING

Ordzhonikidze IZVESTIYA VUZ, TSVETNAYA METALLURGIYA in Russian No 2, 1977 pp 122-124 manuscript received 26 Feb 76

RABINOVICH, M. KH., LUTFULLIN, R. YA., and DOBROLYUBOV, V. I., Ufa Aviation Institute

[Abstract] To establish the way that ausforming improves the mechanical properties of V93 alloy the authors studied the development of plastic deformation and destruction of specimens in different structural states (after ausforming and series treatment). It was found that the peculiarities of the structural state of V93 alloy after ausforming and series treatment influence the nature of deformation under tension. Deformation takes place more uniformly after ausforming than after series treatment. The contribution of intergranular deformation to overall deformation is low in absolute magnitude and is about the same for both kinds of treatment. The uniformity of intragranular deformation under tension after ausforming causes high uniformity of boundary slipping and impedes formation of intergranular cracks. The growth and merging of such cracks is impeded by the twisting disposition of grain boundaries after ausforming. The peculiarities of development of intragranular deformation and the associated peculiarities of nucleation and growth of cracks under tension after ausforming increase ductility, toughness, static fatigue strength, resistance to the growth of a preapplied fatigue crack and an increase in corrosion resistance under stress as compared with the properties of the alloy after series treatment. Figures 5; references 8: 6 Russian, 2 Western.

USSR

UDC 621.762

INVESTIGATION OF PROCESSES OF PYROLYSIS OF FORMATES OF SOME METALS

Ordzhonikidze IZVESTIYA VUZ, TSVETNAYA METALLURGIYA in Russian No 2, 1977 manuscript received 10 May 76

KHOKHLACHEVA, N. M., SHILOVSKAYA, M. YE., PAVLOVA, V. V., and FLEGONTOVA, L. N., Moscow Aviation Technology Institute

[Abstract] A systematic study is done on the kinetic and thermodynamic parameters of processes of pyrolysis of copper, nickel and iron formates to determine optimum temperature conditions for making fine metal powders. Experiments on the kinetics of pyrolysis of metal formates were done on the Hungarian OD-103 derivatograph in a thermogravimetric analysis technique. Heating rate was 4°C/minute. The results show that pyrolysis of copper formate takes place with liberation of heat, while the processes of pyrolysis of formates of nickel and iron are endothermic. Pyrolysis of copper formate should be carried out at

about 180-200°C, while the optimum temperature for pyrolysis of nickel formate lies in the interval of about 270-290°C, and that for pyrolysis of iron formate is in the range of about 280-300°C. The reaction products must be protected from oxidation. However, it is pointed out that the optimum temperature may vary depending on the properties needed in the fine metal powder. Figure 1; references 10: 8 Russian, 1 Czech, 1 Western.

USSR

UDC 621.791.947:669.715

RESISTANCE-REACTION CUTTING OF ALUMINUM AND ITS ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 77 pp 37-39

LASHKO, S. V., SHVARTSER, A. M., and LASHKO, N. F.

[Abstract] In the resistance-reaction cutting process, separation of metal masses is effected by removing the liquid which has formed by melting. The basic parameters governing the productivity of this process and the quality of the cut are cutting speed, cutting width, tool wear, and rate of liquid removal. This process has been applied to aluminum and its alloys, with copper or brass cutters (aluminum with copper and zinc forms eutectic alloys which have low melting points). Both the specimen and the cutter are preheated, and flux is used except in cases where fluxless cutting has been found feasible. The process consists of four stages: melting, increasing cutting speed, constant cutting speed, and again increasing cutting speed. The third stage (steady cutting) is most important in the process. Tests have established at what temperature and pressure for a given combination of cut material and cutter material this process will be optimized with the other (transient) stages reduced to minimum. Figures 2.

THE TEMPERATURE DEPENDENCE OF THE YIELD POINT OF AUSTENITIC ALLOYS UNDERGOING MARTENSITIC CONVERSION UPON DEFORMATION

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43 No 4, Apr 77
pp 786-792 manuscript received 14 Apr 76

SHTEYNBERG, M. M., ZHURAVLEV, L. G., POVOLOTSKIY, V. D., and PEYSAKHOV, YU. B.,
Chelyabinsk Polytechnic Institute

[Abstract] Studies were made of the alloys N28, N29 and N31, encompassing the area of transition from isothermal to athermal explosive conversion kinetics, as well as the isothermal alloys N23G3 and 40N15Kh2. The martensite point was considered to be the temperature corresponding to the appearance of about 1% martensite upon cooling at 5°C/min. Mechanical testing was performed on IM-4R, UM-5 machines, with the lower clamp moving at rates of 1 to 4 mm/min. During the testing, the specimens were held in vessels of alcohol, helping to equalize the temperature and maintain it at the required level. Temperatures were measured with accuracies of no less than 1°C. The anomalous temperature dependence of yield point, it was found, can occur not only in alloys with athermal martensitic conversion, but also in alloys with isothermal kinetics, preliminarily hardened by external or phase strain hardening or having increased values of austenite yield point resulting from peculiarities of chemical composition. The formation of stress-assisted martensite is a necessary condition for the development of this phenomenon. On the other hand, the development of stress-assisted martensite is most probable in alloys with a high austenite yield point, above M_s . In alloys with low yield point, strain-induced martensite is formed, increasing the hardening deformation factor, hindering appearance of the anomaly. It also does not appear if any significant quantity of martensite produced by cooling accumulates before the formation of stress-assisted martensite. It is assumed that the formation of stress-assisted martensite can lead to a decrease in the yield point due to the interaction of peaks of internal stresses arising at points of appearance of martensite with external stresses. Figures 4; references 19: 10 Russian, 9 Western.

STUDY OF THE STRUCTURE OF THE γ -AND α -PHASES IN Fe-Ni ALLOYS NEAR THE MARTENSITIC CONVERSION POINT. II. STABILITY OF THE CRYSTALLINE LATTICE AND CLOSE ORDER OF DISPLACEMENTS IN THE AUSTENITE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43 No 4, Apr 77
pp 826-832 manuscript received 11 May 76

PUSHIN, V. G., ROMANOVA, R. R., TYAPKIN, YU. D., BUYNOV, N. N., and KONDRAT'YEV, V. V., Institute of Metal Physics, Ukrainian Scientific Center, Academy of Sciences USSR

[Abstract] The purpose of this work is to establish which peculiarities of the fine structure of the austenite are responsible for the diffusion scattering discovered in earlier works which showed that in iron-nickel alloys near the temperature of the beginning of the martensitic conversion, the fine structure of the austenite changes, related to a decrease in the stability of the face-centered cubic lattice, established by detailed analysis of the diffusion scattering of electrons and x-rays, which depends essentially on the composition, heat treatment and observation temperature. Knowledge of these features will allow a more complete determination of the mechanism of martensitic conversion. In the alloys studied, upon $\gamma \rightarrow \alpha$ martensitic conversion, α martensite with body-centered cubic lattice is formed. Analysis of the transformation of the spectrum of fluctuation waves and changes in elastic constants in the γ -solid solution of iron-nickel alloys as a function of composition and temperature can reveal certain regularities concerning the changes in the structure of austenite as the transition point is approached. The diffusion scattering observed in the austenite of Fe-Ni alloys is related to the presence of close order atomic displacement. Possible plans of restructuring of the austenitic lattice to martensitic are analyzed. Models are suggested for the structure of the austenite with local configurations in the displacement of atoms close to the configurations of the body centered cubic α martensite in various orientation relationships with the mean lattice of the matrix. Individual points of the spectrum of fluctuation waves of displacements are characteristic for the hexagonal close-packed configurations of the displaced atoms as well. Figures 6; references 18: 12 Russian, 6 Western.

EUTECTOID DECOMPOSITION OF THE COMPOUND SmCo_5

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 43 No 4, Apr 77
pp 885-887 manuscript received 3 August 76

YEGOROV, V. A., SIDORENKO, L. M., and DOMYSHEV, V. A., Irkutsk Pedagogical
Institute

[Abstract] A study is made of the eutectoid decomposition of the system RCO_5 . Since this decomposition is of heterogeneous type, its rate is higher in sintered pressed powders with small grain diameter than in massive cast or homogenized specimens. A film 0.8-1 μm thick was precipitated onto glass substrates by thermal evaporation in a vacuum of 10^{-6} mm Hg at about 1000 A/s by vibration feeding a powder of SmCo_5 alloy onto a heated tungsten crucible. The substrate temperature was held at 450°C . X-ray analysis and study of the crystal-line structure were performed on a DRON-2.0 diffractometer in the filtered $K\alpha$ radiation of iron. Both massive and film specimens of compounds RCO_5 manifested eutectoid decomposition to R_2Co_7 and R_2Co_{17} . The nature of this decomposition is identical for compounds with both light and heavy REM. The rate of phase conversion increases with increasing ordinal number of the REM. The highly dispersed state of the film specimens results in a higher rate of diffusion processes and allows observation of the full eutectoid decomposition at lower temperatures than in massive alloys. Figure 1; references 16: 7 Russian, 9 Western.

STUDIES OF THERMAL FIELDS ARISING UPON PLASTIC DEFORMATION OF CRYSTALS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 234 No 5, 1977 pp 1067-1069
manuscript received 30 November 76

GOVORKOV, V. G., CHISTYAKOV, I. G., SIZOVA, N. L., GORINA, I. I., PETUKHOV, B. V., and AKCHURIN, M. SH., Institute of Crystallography, Academy of Sciences
USSR, Moscow

[Abstract] Up to the present time, no reliable methods have been developed for analysis of the heterogeneity of the temperature field in crystals during deformation. In order to measure the temperature fields arising during plastic deformation of crystals, highly sensitive cholesteric liquid crystals (CLC) were developed, with the property of changing color upon changing temperature. Specially prepared thermally sensitive CLC compositions with selective reflection at room temperature are capable of providing a sharp color contrast over a narrow temperature range ($1.5-2^\circ\text{C}$). Compositions based on several cholesterol esters were particularly useful in this work. Rectangular prisms $4 \times 4 \times 8$ mm

cut from crystals of sodium chloride along the $\{100\}$ planes, as well as prisms cut on the same planes from crystals of cesium iodide, were tested in compression; specimens in the form of blades cut from rolled sheets of silver chloride single crystals were tested in extension. A thin layer of CLC was applied to the surface of the specimens immediately before testing. The change in color of the CLC was recorded by color cinematography. Color photographs are presented. The satisfactory agreement between theoretical and experimental data indicates that the use of CLC with high sensitivity to changes in temperature caused by processes of plastic deformation is promising as a solution to the problem of the significance of thermal effects in the movement of dislocations. Figures 3; references 7: 5 Russian, 2 Western.

USSR

UDC 621.791.92:669.018.25:621.879

SURFACING AND REINFORCEMENT OF EXCAVATOR BUCKET TEETH WITH WEAR-RESISTANT COMPOSITE ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 77 pp 16-18

DUDKO, D. A., Corresponding Member, Academy of Sciences UkSSR, MAKSIMOVICH, B. I., NETESA, I. V., MAZIYENKO, P. V., ZELENIN, V. I., Institute of Electric Welding imeni Ye. O. Paton

[Abstract] The promise of strengthening the functional surfaces of excavator bucket teeth by surfacing with wear-resistant composite alloys based on hard particles such as refractory metal carbides with a plastic metal matrix has been confirmed. In order to obtain a more precise idea of the operational life of the surfaced composite alloy, specimens were tested not only for impact-abrasive wear with actual abrasives, but also by operation on excavator buckets under actual conditions, exposed to all of the other factors which determine wear. Arc surfacing using tubular and cast electrodes with refractory filler compounds and a protective surface coating, argon-arc and gas-flame surfacing with powder wire, as well as surfacing by saturation of solid particles enclosed between a mold and a part with a metal binder melt and heating in a furnace were used. This last method provides the highest volumetric content of solid particles, for example tungsten carbide particles, in the surfaced layer and, consequently, the best wear-resistance of the composite alloy. The use of wear-resistant composite alloys in place of existing cast alloys for surfacing of worn excavator bucket teeth was shown to increase the service life by many times and to increase the productivity of the excavator as a whole. The Krivorog Mine has introduced this method, providing a savings of about 50,000 rubles. Figures 2; references 3 (Russian).

USSR

UDC 669-418:621.785:539.219.3

STUDY OF REACTION DIFFUSION IN A THREE-LAYER ALUMINUM-BRASS BIMETAL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 19-22

YERSHOV, A. A., SYCHEVA, T. A., and ZASUKHA, P. F., Ural Scientific Research Institute for Ferrous Metallurgy

[Abstract] A study was made of the kinetics of the growth of intermetallic phases at the division boundary of a three-layer bimetal consisting of A6 aluminum, L90 brass and A6 aluminum, manufactured by cold rolling with initial aluminum blank thickness 2-3.05 mm, brass blank thickness 1.52 mm. The blanks, after wire-brush cleaning of the contacting surfaces, were rolled with a compression of about 60% per pass (final thickness 3.0 ± 0.1 mm). Annealing was performed at temperatures of 480 to 540°C (at intervals of 20°C), with times varying from 0.5 to 4 hr. It was found that reaction diffusion forms a layer consisting of phases in the following sequence (from brass to aluminum): α -solid solution of aluminum in copper, γ_2 phase (Cu_9Al_4), δ phase (Cu_3Al_2) and θ phase (CuAl_2). The δ phase is formed first, the θ phase appearing only at higher temperatures. All phases are rich in zinc. The growth of each phase and layer follows a parabolic rule with increasing holding time, while growth rate varies exponentially with temperature. Figures 3; references 4: 3 Russian, 1 Western.

USSR

UDC 620.186.1:620.18:669-419.4

STUDY OF THE PHASE COMPOSITION AND STRUCTURE OF INTERLAYERS IN THE ZONE OF FUSION OF BRONZE WITH STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 77 pp 15-19

VAYNERMAN, A. YE., KAPITONOVA, N. P., SYUT'YEV, A. N., and DOBRODEYEVA, N. M.

[Abstract] A study is made of the nature of the interlayers formed in the fusion zone by x-ray structural analysis, in order to determine the possibility of regulating the conditions of growth of interlayers and, consequently, of producing optimal bimetal properties. The studies were performed on specimens of three types produced by various methods: contact of liquid bronze and steel in a furnace; surfacing; manufacture from an alloy with a chemical composition corresponding to the mean chemical composition of the interlayers. The first two types of specimens were used to make slides for metallographic study; the third type was used to make powders. It was found that in the fusion zone of steel-silicon or aluminum bronze bimetals, produced by methods of welding, surfacing or casting, diffusion interlayers have a columnar structure, grain boundaries of the interlayer are placed perpendicular to the division surface and are enriched with copper and silicon or aluminum which have diffused through

the material. The interlayers in the melting zone of the bronzes studied plus type St3 steel consist of alloyed ferrite with lattice parameters 2.854-2.877 Å and 2.878-2.880 Å for the bimetals Br.KMts3-1--St3 and Br.AMts9-2--St3 respectively. In order to decrease the thickness of the interlayers it is necessary that the temperature and duration of the interaction of the bronzes with the steel be minimal. Therefore the surfacing of the bronze onto the steel is best performed with a compressed arc without melting the steel with minimum overheating of the fused bronze. References 12 (Russian).

USSR

UDC 546.47-31+546.46-31+546.623'171.1:548.522

CAUSES OF THE DIFFERENCE OF MORPHOLOGY OF CONDENSATES OF ZnO, MgO AND AlN PRODUCED FROM ELEMENTS IN THE FORM OF VAPOR

Moscow IZVESTIYA AKADEMII NAUK SSSR, NEORGANICHESKIYE MATERIALY in Russian Vol 13 No 5, May 77 pp 851-855 manuscript received 30 Dec 75

POKROVSKIY, D. D., SAMOLYUK, N. P., GRIBKOV, V. N., BOROVINSKIY, L. A., UMANTSEV, E. L., and OSIPOV, V. P., All-Union Scientific Research Institute of Aviation Materials

[Abstract] An investigation is made of the differences in morphology of refractory powders made by precipitation of elements from the vapor phase. In particular, it has been observed that ZnO precipitates as acicular crystals or whiskers, MgO takes the form of isometric cubic particles, and AlN condenses from vapor as nearly ideal spheres and fibers. The results of the study show that the differences in morphology of these condensates stem from the possibility of realization of different condensation schemes: vapor--solid phase for MgO; for ZnO, vapor--solid phase for the formation of primary nuclei, and vapor-liquid-solid phase in crystal growth on the nuclei; for AlN, vapor-liquid-solid phase in most instances on both stages. Figures 4; references 15: 9 Russian, 6 Western.

USSR

SOME OPTICAL PROPERTIES OF SINGLE-CRYSTAL AND POLYCRYSTALLINE MOLYBDENUM AND TUNGSTEN IN THE ULTRAVIOLET REGION OF THE SPECTRUM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 234 No 3, 1977 pp 644-645
manuscript received 31 Jan 77

SAVITSKIY, YE. M., corresponding member of the Academy of Sciences USSR, BURKHANOV, G. S., SAGITOV, S. I., STAVROVSKIY, D. B., OTTENBERG, YE. V., and KUZ'MISHCHEV, V. A., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR, Moscow

[Abstract] The authors measured the reflection coefficient of electromagnetic radiation in the spectral range of 100-300 nm for single-crystal and polycrystalline molybdenum, and the reflection coefficient in vacuum ultraviolet on a wavelength of 58.4 nm for tungsten single crystals. The measurements were done on the normal-incidence VMR-2 vacuum monochromator. The spectral width of the slit was 0.3 nm. The emission source was a glow discharge in hydrogen. The angle of incidence of radiation on the specimen was 12° . Random and systematic measurement errors were within 2 and 5% respectively. A considerable difference was observed in the values of the reflection coefficients for polycrystalline and single-crystal specimens, the reflection for single crystals being several times greater than that for polycrystalline specimens over a wide spectral range. The difference in reflection coefficients for crystallographic planes (110), (111) and plane (100) amounts to 20%, which may be due to anisotropy of the optical properties of molybdenum single crystals. A mirror was made by depositing nine alternating layers of LaF_3 and MgF_2 on a single-crystal molybdenum substrate. The reflection coefficient of this mirror is about 72% at wavelengths of 113-185 nm, and the radiation strength of the structure is superior to that of an aluminum coating with protective layer of MgF_2 . This should make the mirror competitive with aluminum coatings for use in laser cavities. Figures 1; references 2: 1 Russian, 1 Western.

USSR

UDC 535.211

EFFECT OF LASER RADIATION FOCUS ON THE MELTING OF STEEL

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 3-6 submitted for publication 10 Mar 74

BALATSKIY, A. A., UGLOV, A. A., LOBACHEVA, G. YA., and OREKHOV, M. V.

[Abstract] The features of melting steel using a laser in relation to the conditions of radiation focusing were investigated. Tests were conducted using a radiation flux density on the order of 10 v/cm^2 . It was found that for the identical radiation parameters the volumes of the melting zones, for the case of focusing the laser beam above and below the irradiated surface, were the

same if there was no flame, but at the same time the melting-zone outlines were different. In the presence of a developed flame, upon laser activation, neither the outlines of the melting zones nor the volumes of molten metal were the same. These differences in focusing below the sample surface were associated with radiation energy losses to the debris products; for the case of focusing the beam above the surface the differences were associated with hydrodynamic phenomena from liquid-phase oscillations of the metal. References 4 (Russian).

USSR

UDC 539.127.3

EFFECT OF LASER RADIATION ON THE MOBILITY OF IRON ATOMS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 7-9 submitted for publication 28 Sep 76

GUREVICH, M. YE., LARIKOV, L. N., MAZANKO, V. F., POGORELOV, A. YE., and FAL'CHENKO, V. M., Kiev

[Abstract] A ruby laser was employed to investigate the effect of laser radiation on the mobility of iron atoms using radioactive isotopes. The ruby laser, developed by the Department of Quantum Electronics at the Institute of Physics, Academy of Sciences Ukrainian SSR, was used to produce a series of 0.24-joule pulses, each 30 nano-seconds long with a period between pulses sufficient for sample stabilization. The pulses were directed on Armco iron which had been coated with Fe⁵⁵+Fe⁵⁹ isotopes up to one micron thick. It was observed that the isotope atoms penetrated the iron to a depth which significantly exceeded the heated zone during the radiation process. The rate of mass transfer was determined and the possible mechanism of the observed effect was examined for which it was suggested that the significant increase in the atom mobility is due to migration of internodular atoms into the crystal lattice. The authors expressed thanks to M. S. SOSKINA for making it possible to conduct this experiment. Figures 1; references 10: 9 Russian, 1 Western.

USSR

UDC 535.211

INTEGRAL HEATING OF TUNGSTEN FOIL WITH MILLISECOND LASER IMPULSES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 10-14 submitted for publication 4 May 76

ARIFOV, U. A., ZINOV'YEV, A. V., LUGOVSKOY, V. B., and MAKARENKO, V. A., Tashkent

[Abstract] This work involved examination of the integral heating of tungsten foil and the thermoelectronic emission associated with it, taking into account the reflective capacity of the metal for a soft mode of irradiation. The ultimate goal was to determine if it was possible to diminish the effect of metal vaporization, establish the maximum temperature at which it was still possible to describe the heating process without having to account for the temperature relationship of the metal's thermophysical parameters, and to obtain data on the relationship of the adsorptive capacity of the metal with its surface temperature in the region of high temperatures. A ruby laser was used which had a pulse time of 2.5 milliseconds and an average power density of 10^5 v/cm². Experimental data were obtained from the heating of tungsten foil with the laser where the time path of the coefficient of reflection was compared with the calculated shape of the temperature impulse, thus yielding the reflection coefficient as a function of surface temperature. A discontinuity in the relationship was associated with the surface layer transforming from the solid to the liquid phase. Peak heating in this region amounted to 100-150° and the complete calculated temperature change corresponded to 2950-3000°C. Figures 2; references 5: 4 Russian, 1 Western.

USSR

UDC 621.791.85

SCATTERING OF AN ELECTRON BEAM BY TARGET VAPORS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 21-25 submitted for publication 2 Nov 76

VLASOV, M. A., DUBAS, L. G., and ZHARINOV, A. V., Moscow

[Abstract] A short mathematical treatise is presented for the scattering of an electron beam by the beam-created vapors from melting a target metal. An evaluation of the effect of beam scattering by target vapors on beam parameters in the vaporization zone was conducted where it was found that the velocity of the vaporization front was proportional to the square of the voltage. Specific data are given for the effect of increasing the voltage and its effect on the rate of treating steel for a constant beam flux. It was concluded that there is a solid foundation to recommend use of electron beams with energies greater than 500 kv for rapid treatment of metals and other materials. Figures 3; references 6: 4 Russian, 2 Western.

USSR

UDC 539.23

PRODUCING REFRACTORY METAL SINGLE-CRYSTAL FILMS BY VACUUM CONDENSATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 50-56 submitted for publication 29 Mar 76

POSTNIKOV, V. S., IYEVLEV, V. M., and ZOLOTUKHIN, I. V., Voronezh

[Abstract] An electron microscope investigation was made into the structure and orientation of Pt, Re, Ti, Mo, V, Ta and W epitaxial films produced by vacuum condensation at 600-1050°C on the surface of a fluorophlogopite slice. It was noted that to produce single crystals (or oriented epitaxial) films it is necessary to suppress one or several other orientations, depending on the lattice type. Single crystal films were produced with Pt, Re and Ti, which have face-centered-cubic (Pt) and hexagonal-close-pack (Re and Ti) structures. For the other metals, being body-centered cubic in structure, complex epitaxial films were formed with regions of three azimuthal orientations for the parallelism of the (110) and (001) planes (metal and fluorophlogopite respectively). Figures 3; references 14: 5 Russian, 9 Western.

USSR

UDC 669.04:539.4.014.2

EFFECT OF ALLOYING ADDITIVES ON THE STRUCTURE OF TITANIUM-NIOBIUM ALLOYS AFTER THERMOMECHANICAL TREATMENT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 82-88 submitted for publication 20 Sep 76

KADYKOVA, G. N., and SVEDLOV, N. V., Moscow

[Abstract] The effect of V, Ta, Mo and Fe on the structure of Ti-Nb alloys was studied for the following heat treatments: 1) heated to 750°C, oil quenched; 2) same as 1 plus cold deformation with reductions of 65 and 98%; 3) same as 1 plus aging at 250-600°C; and 4) same as 1 plus cold deformation plus aging. The Ti-Nb alloys had amounts of other alloying additives up to 0.8% Fe, 5% Mo, 5% V and 10% Ta. It was found that all the studied additives except tantalum retarded formation of the tau-phase upon cold rolling and the alpha-phase upon aging while iron and vanadium increase the quantity of omega-phase which forms during quenching and aging. The additives decrease the amount of unstable beta-solid solution relative to the alpha-formed displacements. Figures 2; references 9: 6 Russian, 3 Western.

VARIATION IN THE RATE OF GROWTH OF FATIGUE CRACKS IN SHEETS MADE OF ALLOYS D16A AND V95A WHEN THE TEMPERATURE IS LOWERED

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian No 2, 1977 pp 5-10
manuscript received 26 Aug 76

YAREMA, S. YA., OSTASH, O. P., BELETSKIY, V. M., BELYAYEV, V. N., and ZBOROM-IRSKIY, A. I., Physico Mechanical Institute of the Ukrainian SSR Academy of Sciences, L'vov, and the Kiev Mechanical Plant

[Abstract] There have been few studies of temperature-related changes in the kinetics of fatigue failure in structural aluminum alloys, although these alloys are used in domestic structural elements designed for low temperatures. This paper reports on studies of the relationship between temperature and the development of fatigue cracks when the temperature is lowered from room temperature to -70°C and the level of the cyclic load changes from its threshold to critical value in naturally aged alloy D16 and in alloy V95 in three structural states corresponding to different modes of artificial aging. Tensile tests were made using an almost pulsating load on disks cut from clad sheets 5 mm thick. Rates of crack growth and the maximum values of the coefficient of cycle strain intensity corresponding to these rates, found from analysis of the experimental data, were used to plot kinetic curves for fatigue failure, which at a specific temperature are described well by a familiar kinetics equation. It was found that in all the alloys studied and at all load levels the rate of spreading of the fatigue crack decreases with a reduction in temperature. This effect is most obvious in the low-range region of the failure curve, accompanied by a marked growth in the threshold coefficient of strain intensity, which at -70°C is approximately 50% higher than at room temperature. With an increase in load level the influence of temperature gradually becomes less. The danger of failure from accidental overloading is considerably greater at low temperatures than at normal. Alloy D16AT was found to be most resistant to fatigue-type crack development. Each alloy reacts to a reduction in temperature differently, i.e., its resistance to the development of cracks increases to a different degree. The least sensitive to a reduction in temperature is alloy V95AT3, and the most, alloy V95AT1, with alloy D16AT somewhere between. An evaluation is made of the accuracy of the kinetics equation suggested by T. Yokobori (1969) to describe the relationship between temperature and the rate of fatigue crack growth. Within certain limits this equation is found to be as accurate as other descriptions for the load range levels and temperature ranges to which they apply. A uniform, monotonic relationship at mid-range loads makes it possible to consider that there are no qualitative changes and that there is a uniform mechanism for failure at the micro level as the temperature goes from 20 to -70°C . Figures 3; references 15: 9 Russian, 6 Western.

USSR

UDC 669.71:539.4

FEATURES OF CONTACT INTERACTION BETWEEN CERTAIN REFRACTORY OXIDES AND CARBON

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 118-122 submitted for publication 5 Nov 76

KONOKTIN, V. V., GUSEVA, N. P., KRAVETSKIY, G. A., KOSTIKOV, V. I., DERGUNOVA, V. S., and SHMAKOVA, YE. S., Moscow

[Abstract] Contact reaction between refractory oxides of zirconium, aluminum, and silicon with carbon in the compact and powder states as well as powder oxides of titanium and chromium with carbon was studied by high-temperature x-ray radiography. The operating long-time temperatures of oxide coatings on graphite were also refined. For ZrO_2 a previously established mechanism was confirmed in that the process of reaction with carbon goes through a stage of oxycarbide formation with the kinetic process changing to a diffusion process for particles larger than 30 microns. The Al_2O_3 -C reaction results in the formation of aluminum carbide and oxycarbide, both of which are unstable. SiO_2 reacts with carbon to form a dense and stable silicon carbide. Titanium dioxide and carbon react to form a strong carbide at $1300^\circ C$ through a series lower of to higher oxide formations. Cr_2O_7 goes through processes similar to titanium dioxide until achieving the stable Cr_7C_3 and Cr_3C_2 compounds. The process of refractory oxide-carbon interaction is diffusive in nature where the forming carbide layers have barrier properties to reduce the diffusion of carbon. A table is presented which shows the carbide formation temperatures and maximum operating temperatures for the studied oxides. Figures 3; references 6 (Russian).

USSR

UDC 535.211

DETERMINATION OF DIAPHRAGM DIAMETER IN THE LASER PROJECTION METHOD OF MATERIALS TREATMENT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 77 pp 141-142 submitted for publication 20 Feb 76

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[Abstract] For a mode of short impulses the size of the treatment zone can be determined by the distribution of light flux density in the plane of the projection diaphragm image. The correspondence between size of the treated zone and scale of the projection can be achieved if the light flux density at the edge of the diaphragm image is larger or equal to the threshold density. The magnitude of the threshold density can be determined by the mechanism of radiation action on a substance (vaporization, melting, heat treatment). This work consisted of determining the diaphragm diameter at which the maximum treatment zone size could be achieved if the law of radiation intensity distribution in

the laser generation spot was known. The mathematics of the problem are developed to arrive at an expression for obtaining the maximum radius of a rupture point for the given conditions of materials treatment. References 4 (Russian).

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THE NATURE OF SPACIAL DISTRIBUTION OF PRECIPITATES IN A NICKEL-BERYLLIUM ALLOY TEMPERED UNDER LOAD

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[Abstract] Dark-field electronic microscopic pictures, processed statistically, were used to study the effects of a 25 kg/mm^2 load on Ni-Be alloy specimens along the [001] axis, after age hardening at 500°C for periods of one and eight hours. Similar tests were made of the planes of [110] and [100]. Results presented both a picture of volume as a whole and of spacial distribution of particles. There was a rapid change in distribution in a radial direction, accompanied by little variation in a tangential direction. This indicates that interaction among particles, as a function of their spacing, undergoes little change during hardening. Similar conclusions were made concerning the disintegration of Cu-Be alloys. Isomorphic disintegration of alloys is accompanied by an analogous interaction that would suggest that this complex interaction between particles is common in phase transformations. It may be explained by a similar interaction of the fields of elastic distortions around the nuclei of emerging phases, which appear to be related strongly to the direction of particle distributions. Figures 3; references 10: 9 Russian, 1 English.

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