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USSR Report

MATERIALS SCIENCE AND METALLURGY

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26 June 1985

USSR REPORT

MATERIALS SCIENCE AND METALLURGY

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ALUMINUM AND ITS ALLOYS

UDC 669.71'721'793:621.785.374

EFFECT OF $ScAl_3$ PHASE DISPERSION ON HARDENING OF ALLOY Al-6.3% Mg-0.21% Sc

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 85 pp 48-50

DRITS, M. Ye., BYKOV, Yu. G. and TOROPOVA, L. S., Institute of Metallurgy imeni A. A. Baykov

[Abstract] Studies have shown that Al-Mg alloys with scandium have increased strength due to their stable sub-structure. The present article reports on study of the quantitatively different effects of particles of the $ScAl_3$ phase in various degrees of dispersion in the alloy Al-6.3% Mg-0.21% Sc. After hot deformation, the alloy was examined by electron microscope and particle dimensions determined by dark-field microphotography. Results showed that the alloy's structure consisted of fine sub-granules whose field was practically free of dislocations; coherence with the lattice structure was high. The distance between particles was also important in determining the mechanism of particle-dislocation interaction. Regardless of the dispersion of the scandium phase, a stable polygonal structure with regular granules formed after hot deformation. Hardening was effected much more by the coherent emission of the $ScAl_3$ phase than by the sub-structural hardening effect. Figures 1; references 9: 8 Russian, 1 Western. [156-12131]

UDC 621.893:621.762.621.8

MECHANICAL MODIFICATION OF FRICTION SURFACES OF ALUMINUM ALLOYS BY FRICTION TRANSFER

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 1, Jan-Feb 85 (manuscript received 27 Sep 83) pp 64-67

STUPKO, A. V., TUCHINSKIY, L. I., PADERNO, V. N., KARPINOS, D. M. and MARTYNENKO, A. N., Institute of Problems of Material Sciences, UkSSR Academy of Sciences, Kiev

[Abstract] Various patterns of microplastic deformation of surface layers of self-lubricating polymers based on phenol-furfuric resin were studied

along with surfaces of V95 aluminum alloy under friction loads. The tested composition materials were free of pores and had heterogeneous structure with clear interphase boundaries; fluoroplast 32L, AP-3 aluminum powder and S-1 colloidal graphite were distributed evenly as fillers. KM-1 composition material formed a relief surface typical for friction surfaces, with lines of creep and fine spheroids forming at friction points. Introduction of colloidal graphite improved durability and prevented pitting, but as friction increased, this material failed to protect the surfaces. Results showed that formation of lubricating layers is associated with failure of cohesive bonds between polymer molecules, break-down of polymer chains and gradual transfer of polymer particles to the aluminum surface. With phenol-formaldehyde oligomers, macromolecule failure took place at methyl bonds. The friction coating formed on the aluminum surface eventually formed cracks and failed to provide lubrication protection. While fluoroplast and graphite coatings eventually broke down, they did improve friction characteristics of aluminum alloys for meaningful periods. Figures 3; references 5: all Russian. [151-12131]

UDC 669.715.017

STUDY OF PHASE EQUILIBRIA AND CRYSTALLIZATION PROCESSES IN Al-Zn-Mg ALLOY SYSTEMS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 85 (manuscript received 3 Feb 84) pp 88-93

KUZNETSOV, G. M., BARSUKOV, A. D., KRIVOSHEYEVA, G. B. and ISTOMIN-KASTROVSKIY, V. V., Department of Research for Nonferrous, Rare, and Radioactive Metals

[Abstract] Study of highly durable Al-Zn-Mg aluminum alloys has partially shown the nature of such systems, but certain contradictions have occurred in results. The present article reports on study of such alloys with large amounts of aluminum by thermal, microscopic, X-ray structural, and micro-X-ray spectral methods to determine chemical and phase characteristics. Divergences between calculated and experimental results suggest the usefulness of chemical potential data in thermodynamic calculations, while diverging temperature values are related to irregular crystallization. A diagram of state and excess chemical potential values were used to analyze equilibrium and its absence in alloy crystallization. The methods were effective for up to 20% Zn and Mg in the alloy, and showed that the actual crystallization process could be described by a model with limited diffusion in the liquid state. Micro-X-ray spectral analysis was useful in selecting that model as well as a model of intracrystalline liquation in dendrite cells. Figures 4; references 13: 9 Russian, 4 Western. [150-12131]

UDC 669.715:620.1

THE PROCESS OF DESTROYING PRESSURE-HARDENED ALUMINUM ALLOYS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 85 (manuscript received 28 Jan 84) pp 133-134

LIPCHIN, T. N. and NISHTA, A. P., Department of Metal Studies and Heat Treatment, Perm Polytechnical Institute

[Abstract] Crystallization of alloys under pressure is known to improve durability and plastic properties, but alloys hardened under pressure have received little study. The present article reports on the process of destroying such hardened alloys by impact cracking and static bending. Test samples were cut to a depth of 1.5 mm and subjected to vibrations until the cracks were 3 mm deep. Tests showed that application of pressure on crystallized metal increased the mean work of destroying such samples by eliminating gas precipitate defects, reducing granular dimensions and increasing alloy homogeneity of the solid state. References 3: all Russian.
[150-12131]

UDC: 669.715.046.516

POSSIBLE CAUSES OF MODIFICATION AND STRENGTHENING OF ALUMINUM BY SCANDIUM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, TSVETNAYA METALLURGIYA in Russian No 5, Oct-Nov 84 (manuscript received 27 Aug 82) pp 101-105

BAZIN, Yu. A., POPEL', P, S., D MASHINKOV, B. P., ZAMYATIN, V. M. and BAUM, V. A., Urals Polytechnical Institute, Department of Physics

[Abstract] To determine the significance of heat treatment in the formation of the structure and properties of Al-Sc alloys, a study was made of the effect of scandium on the dispersion of the structure and mechanical properties in the cast state. Commercial master alloys containing 0.05 to 1.3% Sc were used. Nonuniformity of the modifying influence of scandium was found: the structure of an ingot becomes increasingly fine with increasing concentration of scandium at 0-0.05% Sc and 0.3-0.4% Sc, while in the 0.05-0.3% Sc range and at concentrations over 0.4% Sc the grain size remains practically unchanged. A comparison of the surface activity of scandium and its influence on density and viscosity of liquid aluminum indicated that the grain size reduction at up to 0.05% scandium is related to the development of tightly packed groups of $ScAl_N$ atoms, where $N \simeq 60$. The increase in modifying effects at 0.3-0.4% Sc was explained by microstratification of the liquid solution, forming areas rich in $ScAl_3$. Figures 2; references 17: 16 Russian, 1 Western.
[99-6508]

UDC: 669.22:533.9:539.89

ACTION OF PLASMA AND EXPLOSION PRODUCTS ON SILUMINS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 85 (manuscript received 9 Mar 83) pp 51-57

POPOV, Ye. G., POPOVA, N. V., PRIGUNOVA, A. G. and BREKHARYA, N. V., Dnepropetrovsk

[Abstract] Metallographic and X-ray structural analyses were used in a study of the effect of plasma and explosion products on Al-Si alloys, which can be compared to the crystallochemically similar system Fe-C, which the authors previously studied under identical conditions. The alloy specimens were subjected to the effect of an air plasma at $3 \cdot 10^4$K and pressure about 1 GPa for $3 \cdot 10^{-4}$ s in an explosive shock tube. After the explosion a batch of specimens was extracted from the installation and visually studied. The height of the specimens was measured to determine loss of material. The specimens were then separated, filled with epoxy resin and sections were prepared to allow the surface structure of the alloys to be studied. X-ray structural analysis was performed on a diffractometer in Fe radiation. The plasma and explosion products formed a hardened layer on the surface. The sharp drop in pressure at the end of the explosion resulted in blistering and separation of a superheated portion of the outer layer and the development of pores. The brief time at high temperatures and pressures and subsequent cooling at 10^6 K/s caused the formation of metastable phase supersaturated solutions, fine conglomerate phase structures with pores as centers of crystallization of silicon. The metastable modifications of silicon SiI and SiII can be produced in the melt at comparatively low pressures, ~1GPa, and fixed due to the rapid hardening of the melt at atmospheric pressure. Figures 4; references 16: all Russian. [132-6508]

UDC: 669.71:536.421

CRYSTALLIZATION OF ALUMINUM-BASED ALLOYS IN WEIGHTLESSNESS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 85 (manuscript received 20 Mar 84) pp 65-68

PIMENOV, V. N., MASLYAYEV, S. A., SASINOVSKAYA, I. P., BIROVA, G. S., BETSOFEN, S. Ya. and RUBINA, Ye. B., Moscow

[Abstract] The purpose of this work was to produce new fundamental results on crystallization of alloys under weightless conditions as in spacecraft and to study the specifics of the effect of reduced gravitation in this process. Studies were done on aluminum alloys in the systems Al-W, Al-Sb and Al-Cu which crystallize under identical temperature conditions on earth

and in space on board the Salyut-6-Soyuz orbital complex. The absence of free convection in melts under space conditions caused a decrease in intensity of seed formation and facilitated a greater supercooling of melts during crystallization than under terrestrial conditions. The Al matrix of the alloys Al-5% Cu and Al-17% Sb after terrestrial and space experiments had different crystallization texture in the direction of the temperature gradient. Under terrestrial conditions the direction of preferential orientation of the primary α solution was <100>; under space conditions at was <110>. A correlation was found between the change in texture of crystallization under the conditions compared and the change in morphology of α solution grains.
Figures 4; references 9: 6 Russian, 3 Western.
[132-6508]

UDC: 669.71:621.79:533.9

SPECIFICS OF FINE STRUCTURE OF PRESSED ALUMINUM ALLOYS MANUFACTURED BY PLASMA ATOMIZATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 85 (manuscript received 2 Dec 82) pp 73-76

RYBIN, V. V., ALIPOVA, A. A., ALEKSEYEVA, T. N. and KUCHKIN, V. V., Leningrad

[Abstract] A detailed study was performed of the defect structure of certain typical plasma-atomized aluminum alloys by transmission electron microscopy. Alloys in the system Al-Mg (6% mg) and Al-Zn-Mg with Mg:Zn = 0.5 were obtained by plasma atomization in air. The trinary alloy was located in the α + T area of the state diagram. Structures were studied in two states: the initial state, directly after completion of the corresponding technological process, and after gas-static pressing with 25% compression at 500°C, thirty minutes, pressure 5 kg/mm2. The results indicate that the presence of dispersed segregations within grains and fragments in the plasma-atomized material results from the thermal cycle of the corresponding technological processes and does not reflect the specifics of plasma atomization itself. Plastic deformation during pressing of the initial material leads to appearance in its structure of other characteristic peculiarities not related to the process of plasma atomization, including an increase in density of dislocations homogeneously distributed through it, typical for the structure of hot pressed aluminum alloys, plus additional fragmentation of the grain body into disoriented microareas separated by low-angle dislocation boundaries, generally without segregations. The only significant peculiarity corresponding to the specifics of the process of plasma atomization itself is the presence at high-angle boundaries of film or chain second phase segregations.
Figures 2; references 4: 2 Russian, 2 Western.
[132-6508]

COATINGS

NICKEL COATING OF TITANIUM ANODES

Kishinev SOVETSKAYA MOLDAVIYA in Russian 19 Apr 85 p 4

[Text] Kishinev--Not even titanium can withstand the corrosive agents of modern electroplating industry for very long. Scientists of the Moldavian Academy of Sciences' Institute of Applied Physics, with the collaboration of Moscow scientists, undertook the task of making titanium anodes insoluble in electrochemical processes.

It was decided to use a layer of nickel to protect the titanium against corrosion. A special spark-generating unit had to be developed, with which two metals resistant to 'symbiosis' could be joined.

The film formed on the surface of the anode proved to be more resistant to corrosion in electrochemical solutions than each metal separately. This innovation has been acquired by the "Khimprom" (chemistry industry) Production Association in Ufa.

FTD/SNAP
CSO: 1842/157

UDC: 669.715:621.793

INFLUENCE OF TYPE OF PROCESSING OF AK4 ALLOY ON ITS SURFACE STATE AND STRENGTH OF BONDING OF PLASMA COATINGS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 85 (manuscript received 18 May 83) pp 77-81

NOVIKOV, N. N., PUSTOTINA, S. R. and SOLOV'YEV, B. M., Odessa

[Abstract] A study is presented of piston alloy AK4 containing Mg (1.8 mass %) and Si (1.2 mass %), both diffusion and chemically active. The structure and composition of oxide films on the surface arising upon heating in air, in the process of plasma atomization and the possibility of using a glow discharge in the stage of surface preparation of parts and finish working of coatings to increase the bond strength of the coatings was studied. Coatings were applied using composite powders with a plasmotron and an argon-nitrogen plasma-forming mixture. The state of the surface of the alloy was studied by x-ray spectral-microanalysis, electronography and ellipsometry. The oxidation of the alloy when heated in air and in plasma atomization was found to be determined by the magnesium atoms, forming a two-layer oxide film containing MgO in the outer layer, $MgAl_2O_4$ in the inner layer. The oxidation rate is limited by diffusion of magnesium through the spinel layer. The use of a glow discharge in plasma technology can increase the bond strength of the coating by a factor 1.3 to 2 in comparison to traditional sandblasting. Data on the phase composition and thicknesses of oxide films on the alloy with various types of processing must be considered in the development of atomization conditions, since thick and chemically stable films of oxides prevent the formation of strong bonds between the coating and the substrate. Figures 3; references 8: all Russian. [132-6508]

UDC: 539.4.01:621.891:621.357

PHYSICAL-MECHANICAL CHARACTERISTICS AND WEAR RESISTANCE OF COATINGS APPLIED BY MICROARC OXIDATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 85 (manuscript received 20 May 83) pp 82-87

MALYSHEV, V. N., BULYCHEV, S. I., MARKOV, G. A., FEDOROV, V. A., PETROSYANTS, A. A., KUDINOV, V. V. and SHORSHOROV, M. Kh., Moscow

[Abstract] A study was made of the effect of physical and mechanical characteristics of coatings applied by microarc oxidation onto D16T aluminum alloy, their wear resistance and the correlation between the physical and mechanical parameters and wear resistance to allow prediction of the wear of coatings. The method of kinetic microhardness was used to estimate the physical and mechanical properties of the coatings. This method is based on a microindentor with continuous recording of load on the indentor versus depth of impression. Coatings obtained by microarc oxidation were used to establish for the first time the relationship between porosity and the HV_h/HV ratio; histograms of distribution of pores by dimensions and the coefficient of variation of microhardness; and intensity of wear and parameters of kinetic microhardness. Figures 3; references 9: 8 Russian, 1 Western.
[132-6508]

UDC 539.431:669.245:620.197.2

EFFECT OF PROLONGED HIGH TEMPERATURE ON DURABILITY OF COATED HIGH-TEMPERATURE NICKEL ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Mar 85 (manuscript received 21 Nov 83) pp 26-30

PAVLOV, V. N., PALIYENKO, Ye. Ya. and POGREBNIK, A. D., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Protecting gas turbine engines from oxidation damage during high-temperature operation is often achieved by various coatings, but these undergo structural changes that have not been thoroughly investigated. The present article reports on study of aluminide coatings applied to smooth cylindrical samples using technology typical for turbine blade production, including aluminizing in ferro-aluminum and two types of alumosylation. Preliminary tests showed that both uncoated and coated samples lost durability after prolonged treatment at 950°C. Structural changes leading to structural instability are cited as the cause for lost durability. Figures 3; references 6: all Russian.
[153-12131]

COMPOSITE MATERIALS

UDC 539.4.011:669,715:677-15

STUDY OF FAILURE MECHANISM OF FIBROUS COMPOSITTION MATERIALS TAKING INTO ACCOUNT PHYSICOCHEMICAL REACTIONS OF COMPONENTS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 85
(manuscript received 28 Feb 83) pp 64-69

ZABOLOTSKIY, A. A. and IGNATOVA, N. P., Moscow

[Abstract] The present article reports on study of surface flaws occurring under varying technical regimens as a means for describing failure of composition materials (CM) which undergo various degrees of physicochemical reaction. The test materials were reinforced with carbon, boron or silicon carbide fibers. Flaws were studied by Raster electron microscope. Preliminary results showed that carbon- and boron-reinforced CM showed smooth surfaces after accumulation of major defects. This type of failure was related to concentration of tension in defects, the development of cracks and their subsequent expansion. Silicon carbide fibers showed both scaly and smooth breaks after fatigue failure. Where the original components ahd insufficient interaction, delaimination and related types of flaw appeared. The CM samples coud retard breaks only if loads were slight. Those CM samples with optimal component interaction were also the most resistant to these types of brittle failure and delamination. Figures 3; references 9: all Russian.
[153-12131]

UDC 539.4.011.2:677-15

EFFECT OF MATRIX PLASTICITY ON DURABILITY OF FIBROUS COMPOSITION MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 85
(manuscript received 28 Feb 83) pp 94-96

ZABOLOTSKIY, A. A., OVCHINSTKIY, A. S. and BILSAGAYEV, N. K., Moscow

[Abstract] In recent years study of mechanical properties of fibrous composition materials (FCM) has successfully employed structural modeling.

based on determination of elementary micromechanisms of failure and projecting final results. The present article reports on study of plastic properties of matrices related to durability of CM samples in optimum condition. The test CM was a carbon-aluminum combination with 45% reinforcing fibers by volume. The material was subjected to deformation until failure. The modeling of loading was conducted in a step-by-step manner with monitoring of breaks at every stage. Results indicated that failure was preceded by gradual accumulation of fiber breaks and delamination or cracks in the matrix. Calculations showed that increased plasticity in the matrix did not increase durability. Results indicated that the ratio of extreme deformations of matrix and fibers should exceed three for maximum durability. Figures 2; references 5: all Russian.
[153-12131]

CONFERENCES

FOURTH SCIENTIFIC RESEARCH CONFERENCE "SHOCK-ABSORBING METALLIC MATERIALS"

Moscow METALLOVEDENIYA I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 4, Apr 85 pp 62-63

FAVSTOV, Yu. K.

[Abstract] The conference, held 20-22 June 1984 in the city of Kirov, was organized by the Kirov Polytechnical Institute and the Kirov Oblast Scientific Production Association "Mashprom." Topics discussed included production of highly shock-absorbing materials based on the relationship between composition and properties, the stability of manganese-copper alloys and special thermal processing needs when they are used for shock absorption, casting and shaping problems of highly shock-absorbent materials, Fe-Cr-Al alloy systems, methods for increasing shock absorption of chromium-nickel steels with austenite-martensite structure, titanium alloys and Ni-Ti and Ni-Ti-Cu systems with form memory as shock-absorbing materials. Amorphous metallic materialswwith mechanical magnetic properties of dispersion, materials reinforced with boron fibers and laminated materials were also discussed in reports at the conference. The author notes with regret that few papers were presented that reported on industrial applications of shock-absorbing materials discussed at the conference.
[156-12131]

UDC: 621.791:061.3:621.791.539.378.3

11th ALL-UNION SCIENTIFIC CONFERENCE "DIFFUSION JOINING OF METALLIC AND NONMETALLIC MATERIALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 85 pp 40-41

RUSIN, S. P., engineer

[Abstract] The conference was held 24-25 May 1984 at the Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy. Some 186 reports were heard on important problems related to diffusion joining (welding) of materials, both identical and dissimilar materials and alloys, nonmetals with metals, diffusion metallurgy, the investigation of physical-chemical and physical-mechanical processes of diffusion joining of materials, equipment optimization and automation of technological processes and quality assurance problems.

Topics included: the current status and future development of diffusion welding; diffusion welding of hard tungsten and tungsten-free alloys with steels; diffusion welding of powder interlayers and composite interlayers; the phenomenon of anomalously high mass transfer rate at the contact zone of solid bodies under pressure; prospects for development of diffusion welding machines; and the status and problems of quality assurance of diffusion welded joints. Over 300 persons took part in the conference. [115-6508]

CORROSION

UDC 620.194

RESISTANCE TO CORROSION FATIGUE IN ALUMINUM ALLOY 1561 IN SEA WATER

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 1, Jan-Feb 85 (manuscript received 16 Jan 84) pp 34-36

BAKULIN, A. V., KOBZARUK, A. V. and OLIK, A. P., Physico-Mechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences, Lvov

[Abstract] Study of sensitivity to corrosion cracking and failure in pressed Al-Zn-Mg alloy panels has shown that ribbed surfaces are more susceptible to damage than smooth ones. The present article reports on further study of this phenomenon using samples of alloy cut from between ribs. The samples were bent while moistened with a 3% NaCl solution, then subjected to low-cycle fatigue bending. Experimental data showed little difference between ribbed and unribbed panels, so that previous data did not represent a specific feature of Al-Mg alloys, but rather was related to submicroscopic conversions in the solid phase of Al-Zn-Mg alloys. Figures 2; references 5: all Russian.
[151-12131]

UDC 669.018.8

ON COMPOUNDING NICKEL ALLOYS AS DEFENSE AGAINST SULFIDE-OXIDE CORROSION

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 1, Jan-Feb 85 (manuscript received 11 Apr 83) pp 176-181

NIKITIN, V. I.

[Abstract] Of all the elements which can be used to increase the corrosion resistance of Ni alloys, only Cr has been well studied; the effect of other elements has often been expressed in "Cr equivalents" which do not facilitate comparisons between these other elements. Analysis of av ilable data on the critical temperature of sulfide-oxide corrosion, indicates that Cr and Ti reduce the corrosion, while Al, Mo and W increase it. Limiting concentrations of these elements appear to be >18-20% Cr; <1.5-2.0% Al; >3% Ti; <4% Mo; and <3% W. Examination of relative weight losses indicates

the concentration ratio of Ti to Al should be less than 1.5, and of Cr to Al less than 10-12. Data on Y, Ce, and Zr indicated border concentrations of 0.02-0.05%, 0.02-0.05% and 0.05-0.1% respectively; higher concentrations degrade thermal stability and plasticity characteristics; oxides of these metals also improve corrosion resistance. Concentrations of Nb, Fe or Co below 2-3% do not appear to affect the corrosion resistance; small amounts of Ta improve alloys with Mo apparently by combining with any Na present. Platinum metals and Hf also have been reported to provide corrosion resistance. Figures 5; references 20: 6 Russian, 14 Western.
[116-12672]

UDC 669.265-151:669.094.3

CHANGES OF STRUCTURE OF EP648-BI ALLOY AS RESULT OF HIGH-TEMPERATURE GAS CORROSION

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 1, Jan-Feb 85 (manuscript received 29 Jun 83) pp 164-167

MONAKHOVA, L. A., LAZAREV, E. M., KOZLOV, A. T., ROMANOVICH, I. V. and PSHECHENKOV, P. A.

[Abstract] For samples heated in air to 1150° C, oxidation depended upon thickness. Samples 1.4 mm thick lost weight, apparently from vaporization of Cr and possibly Ni oxides. Samples 1.0 mm thick gained weight; this was attributed to adsorption of oxygen followed by diffusive penetration further into the alloy. Coatings of the NiCoCrAlY type limited the diffusion of Cr into the oxide layer and consequently slowed its vaporization. Samples heated in fuel combustion products (80% N_2, 12% O_2 and 8% CO_2) formed a Cr_2O_3 surface layer with traces of Cr nitrides. Carbon diffused along the intergranular boundaries, forming light-colored carbides. Sulfur penetrated half way into the surface layer when the speed of the gas stream was 120 m/s and into the body of the alloy when the speed of the gas stream was doubled. In these cases, the protective coating appears to act by limiting vaporization of the Cr_2O_3. Since oxidation of Cr appears to be the dominant factor, the Cr gradient in the subsurface zone can serve as a measure of oxidative interaction. Figures 4; references 12: 3 Russian, 9 Western.
[116-12672]

FERROUS METALLURGY

NEW SIBERIAN METALLURGICAL FACTORY

Moscow EKONOMICHESKAYA GAZETA in Russian No 7, Feb 85 p 4

[Article by B. Vladimirov: "The Far East Metallurgical Factory"]

[Text] Construction of the conversion metallurgical factory at Komsomol'sk-na-Amure began in mid 1981. In the current year its first echelon is to be put into operation.

The enterprise is aimed at refining of local resources--ferrous metal scrap. The project for the factory, developed by the Sibgipromez Institute, foresees the construction of facilities for an annual production of 700,000 tons of molten steel and 664,000 tons of blank castings and billets. The estimated cost is nearly 550 million rubles, of which more than 350 millions are to be spent on construction and assembly work.

The start-up complex of the current year is the electric steel melting shop, which includes two 100-ton electric steel melting furnaces with 6-channel continuous casting machines for production of 125 X 125 mm billets.

The furnaces and continuous casting machines are being provided by the Sibelektronterm production association of Novosibirsk and by the Southern Ural Machine Factory according to designs of the VNIIelektrotermicheskogo oborudovaniya and the VNIImetmash.

The specifications and basic design strategies of the local industry will be on the level of the best world standards.

The machining of the billets will be done in a merchant mill, manufactured by the SKET company (GDR), with an annual output capacity of 500,000 tons of rollings. The rolling shop is scheduled to be introduced in 1986.

In order to build the factory, a general construction trust Komsomol'skmetallurgstroy and a specialized Spetsstroy-2 for the road building and structural communications were created within the Glavdal'stroy of the Minvostokstroy.

The volume of work completed so far is equal to nearly 100 million rubles. Last year a department for comprehensive refining of metal scrap with an annual capacity of 513,000 tons was put into service.

In 1985 facilities for the melting and casting of 530,000 tons of steel per annum and production of 15,000 cubic meters of technical grade oxygen per hour are scheduled to be brought on line. For the workers of the new industry, 25,000 square meters of living space will be made available.

The work to be done is immense. The construction program has been increased twofold over last year. The first month of work in the current year shows that it is necessaryynot only to merely double the efforts, but also sharply improve the coordination among all the builders of the mini-factory.

The construction and assembly workers surpassed their scheduled responsibilities in January. But not all the suppliers have proved equal to the task. The Southern Ural Machine Factory has failed to meet the delivery schedule for the continuous steel casting machines. The production association Sibelektroterm of Novosibirsk is slow in building the second electric steel melting furnace. In such circumstances, the Ministry of Heavy Machinery and the Ministry of the Electrotechnical Industry must intensify their supervision of performance of contractual obligations by the enterprises, especially since both these factories are taking part in a broad economic experiment.

GLASS AND CERAMICS

UDC: 666.3

CERAMIC BASED ON FUSED QUARTZ AND STRONTIUM TITANATE MODIFYING PHASE

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY
in Russian Vol 21, No 2, Feb 85 (manuscript received 24 May 82) pp 312-316

POPIL'SKIY, R. Ya. and BERESNEVICH, L. A., Moscow Institute of Chemical Technology imeni D. I. Mendeleyev, Novomoskovsk Branch

[Abstract] To determine the possibility of chemical interaction between quartz glass and strontium titanate, thermodynamic calculations were performed for the reactions of formation of three known strontium silicates. The molar ratios of initial components in the reaction were selected to correspond to the maximum of strontium titanate in the mixtures studied. The thermodynamic probability of the reactions was estimated from the change in Gibbs energy as a function of temperature. The thermodynamic calculations show that with the ratio of components selected a reaction forming $SrSiO_3$ is possible, the thermodynamic probability of this reaction significantly increasing with increasing temperature. Hot pressing of quartz glass plus strontium titanate was used to produce a ceramic whose dielectric permeability was double that of compact quartz ceramic, while the thermal expansion coefficient, mechanical strength and tg δ meet the requirements for usage. Figures 1; references 3: all Russian.
[131-6508]

Pages 17 and 18 are blank.

MECHANICAL PROPERTIES

UDC 620.178.38

EFFECT OF TEMPERATURE AND TYPE OF TENSION ON DURABILITY OF HEAT-RESISTANT CAST ZhS3DK ALLOY

Kiev PROBLEMY PROCHNOSTI im Russian No 3, Mar 85
(manuscript received 19 Jun 83) pp 10-14

POGREBNYAK, A. D., SINAYSKIY, B. N., YASHCHUK, N. V. and PALIYENKO, Ye. Ya., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Recent aviation gas turbines have used high-temperature cast blades of ZhS3DK alloy based on nickel. High temperatures, tension, compression and bending all affect longevity of rotor blades. The present article gives results of study of durability of samples of the test alloy at 20 to 900°C under both pure bending during rotation and tension-compression dynamics. After standard rotor production procedures, residual stress was removed by mechanical processing and annealing in a vacuum at 950°C for 4-4.5 hours. Then the samples were subjected to various loading cycles at temperatures of 20, 700, 850 and 900°C during rotation, and at 700 and 850°C during compression. Tempering effects were found to be closely tied to improvements in durability for the alloy tested. As temperature increased to 850°C, fatigue damage accumulated through thermal activation of various types. Fine cracks developed both in the body and on the edges of granules. The type of loading had no particular effect on fatigue patterns. Figures 6; references 4: all Russian.
[153-12131]

UDC 620.178.3

EFFECT OF THERMOCHEMICAL PROCESSING ON FATIGUE RESISTANCE OF TITANIUM ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 85
(manuscript received 27 Feb 84) pp 14-20

MATOKHNYUK, L. Ye., VOYNALOVICH, A. V., YAKOVLEVA, T. Yu. and NOCHOVNAYA, N. A., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev; Moscow

[Abstract] A well-known method for increasing longevity of titanium alloys, thermochemical processing includes oxidation and nitrogenation. The present

article reports on the structure and properties of VT23 and OT4 alloys as they affect resistance to fatigue and sensitivity to stress concentrations. Samples were oxidized or hydrogenated or given neither treatment. Results indicated that chemical heat treatment had little effect on either static durability or impact strength, since gas-saturated layers were thin and the main body of the alloys showed no changes. Saturation of VT23 with nitrogen by ionization in a vacuum chamber at residual pressure of 20-40 Pa for 2 hours at 700°C, with 900 volts and 0.4 zmperes on the electrode brought surface changes, but no deep penetration. The same superficial changes were true with oxidation tests. TiO compositions and diffusion were noted only in the surface layer. There were brittle faults in the surface layers and viscous failure occurred in central parts of the alloy samples, resulting in reduced resistance to fatigue in the core and reduced useful life in the surface layers. Figures 6; references 8: 7 Russian, 1 Western.
[153-12131]

UDC 539.4:621.45

CORRECTION OF CALCULATED ESTIMATE OF FATIGUE PROPERTIES OF MATERIALS UNDER BIHARMONIC LOADING

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 85
(manuscript received 30 Nov 83) pp 7-10

BOZHKO, A. Ye., SAVCHENKO, V. I. and SHIPILLO, S. V., Institute of Problems of Machinebuilding, UkSSR Academy of Sciences, Khar'kov

[Abstract] Aircraft, ship and engine parts are subjected to periodic distorted loads that have received little theoretical explanation. The present article reports on a new method for calculating fatigue properties of materials under biharmonic loading that can serve to generalize poly-harmonic load values. The first hypothesis is based on the independent accumulation of fatigue damage for each component of a given material, while the second is an empirical hypothesis that the effect of damage is a result of one-time stress. The energy aspect of the failure process was also considered from various approaches. The results indicated that the intenstiy of fatigue accumulation was proportional to the rate of energy exchange between the test samples and external forces; this was indirectly confirmed by phase shifts between the components. The procedure gives calculated results that approximate experimental values. Figures 4; references 6: 5 Russian, 1 Western.
[153-12131]

POWDER METALLURGY

INTERNATIONAL POWDER METALLURGY EXHIBITION IN MINSK

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 27 Mar 85 p 3

[Article by V. Roshchin, Minsk correspondent, appears under the rubric: "Powder Metallurgy-85"]

[Text] Yesterday, the international specialized exhibition "Powder Metallurgy-85", which is the fourth exhibition and the most representative, opened in Minsk. For comparison: about fifteen foreign companies participated in the first exhibition, organized more than ten years ago, and there are 66 exhibitors from 14 countries in the present exhibition.

It is not by chance that Minsk has become the traditional place for holding the exhibition. Foreign scientists and specialists are greatly interested in the research and work organization experience of the Belorussian SSR Scientific Production Association of Powder Metallurgy, a winner of the international award "Golden Mercury". The scientific production association helps to successfully solve regional intersector problems, and makes a significant contribution to the implementation of the republic's over-all scientific-technical program "Powder Metallurgy".

"From contacts to contracts--this is the motto of the exhibition, which indicates its practical orientation," says O. V. Roman, deputy chairman of the exhibition organizing committee, general director of the Belorussian Scientific Production Association of Powder Metallurgy, and doctor of technical sciences. "For example, we actively started to cooperate with the enterprises and companies of Bulgaria, German Democratic Republic, Hungary, Switzerland, Federal Republic of Germany. Mutually advantageous contacts are established with the companies of France, Japan, Sweden and Italy. The samples of equipment and scientific research apparatuses, brought to Minsk, in most cases are technical innovations that enable us to judge the present developmental level of this promising direction in metal working.

A seminar is scheduled for the days that the exhibition is open--scientists and specialists from 22 countries and representatives of international organizations exchange opinions on the problems of powder metallurgy development in machine building.

12525
CSO: 1842/139

UDC 666.798.2

HIGH-TEMPERATURE OXIDATION OF REACTION-ROASTED SILICON NITRIDE WITH VARIOUS ADDITIVES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 85
(manuscript received 8 May 84) pp 35-39

LAVRENKO, V. A., GOGOTSI, Yu. G., GONCHARUK, A. B., ALEKSEYEV, A. F., GRIGOR'YEV, O. N. and SHCHERBINA, O. D., Kiev Polytechnical Institute

[Abstract] Materials based on silicon nitride for high-temperature applications must be resistant to oxidation, which starts at about 800°C. The present article reports on study of mechanisms and kinetics in such nitrides with additives of MgO, Y_2O_3, ZrO_2 and HfO_2, produced by thermoplastic casting and subsequent reaction roasting in nitrogen at 1600-1700°C. Spectral analysis was used to determine amounts of Ti, Cu, Al, Ca, Ni, Mg and Mn in quantities of less than 0.01%, and oxidation kinetics were studied by thermogravimetry at 1000 and 1300°C. While active oxidation was observed at 1000°C, at 1300°C a silicate layer formed and became a glassy coating that contained elevated amounts of Ca, Al and Fe, as well as the metal of the additive being tested. The key factor in durability was determined to be porosity; this was particularly true in the initial stages of oxidation at 1300°C. At 1000°C and in later stages at 1300°C, the rate of oxidation depended on the protective properties of the coating formed. Materials containing Y_2O_3 and HfO_2 were the least resistant to oxidation. Figures 3; references 11: 3 Russian, 8 Western.
[152-12131]

UDC 620.18

EFFECT OF SURFACE STATE ON DURABILITY OF ALUMINIZED BORON FIBERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 85
(manuscript received 27 Mar 84) pp 39-43

CHERNYSHOVA, T. A., TSIRLIN, A. M., GEVLICH, S. O., REBROV, A. V. and OBOLENSKIY, A. V., Institute of Metallurgy, USSR Academy of Sciences

[Abstract] Reinforcement with highly durable modular fibers, such as boron filaments, is a common means for strengthening metallic materials, but problems of failure due to radial cracking and other defects caused by structural irregularities are frequently encountered. The present article reports on study of the effects of the surface state of boron fibers on reaction with aluminum and the initiation of failure under static loads. Natural fibers of 140 mcm diameter, ones etched by electrolyte and fibers with a boron carbide coating were tested for physicochemical properties and reaction to compression, tension and bending. Electron microscope examination showed that the boron fibers reacted with aluminum along inter-granular channels, which could be smoothed to bring greater durability. After long contact, borides that weakened the materials formed. Metallization of boron fibers added to durability. Free carbon in the coating led to chemical reactions that reduced durability. Figures 5; references 9: 6 Russian, 3 Western.
[152-12131]

UDC: 621.793:620.197

ATOMIZED MAGNESIUM-ALUMINUM PROTECTIVE COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 85
(manuscript received 24 Jan 84) pp 45-48

SHARIVKER, S. Yu., MIKHAYLOV, B. N., ZIL'BERBERG, V. G., KARPINOS, D. M., SULTANOVA, V. I., TOMIN, V. P. and GORDIYENKO, A. I., Irkutsk Polytechnical Institute

[Abstract] Corrosion protection of steel heat exchange equipment can be achieved by atomizing a protective coating onto heat exchange pipes. Considering the high effectiveness of magnesium-aluminum alloy protectors, the authors studied the characteristics of coatings in the system Mg-Al applied by gas thermal atomization of powders. Atomization charges were prepared by dry mixing of aluminum and magnesium powders. Atomization was performed onto a steel surface after shot peening. The coating specimens were separated from their substrates for chemical, x-ray phase and microstructural analysis. The results produced were statistically processed assuming normal distribution with a confidence probability of 90%. It was found that gas thermal atomization provides reproducible assigned compositions of protective layers for the protection of low-carbon steel from

corrosion. The optimal protector properties are those of a coating containing aluminum and magnesium in a ratio of 3:1. Figures 2; references 7: all Russian.
[109-6508]

UDC: 620.1868:669.71:669.781

FEATURES OF THE INTERACTION BETWEEN FIBERS AND MATRIX IN PRODUCTION OF ALUMINUM-BORON COMPOSITE MATERIAL

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 85
(manuscript received 24 Jan 84) pp 34-36

DAUTOVA, L. I. and LANDA, E. M., Ufa Aviation Institute

[Abstract] A study is made of the early stages of interaction of components in the system Al-B, when intensive boride formation does not occur. The measure of the interaction is the intensity of adhesion seizing of the fiber with the matrix. To estimate it the composite material was broken down into its component layers, boride fibers extracted and their surface state studied. It was found that in the early stage of the interaction (deformation at 65 MPa, temperature 200°C with subsequent annealing at 450°C, 25 minutes), tracks of adhesive seizing of fibers with matrix have a cellular configuration like a grid. The height of the grid on the surface of the fiber is up to 1 μm, dimensions of cells 10-30 μm. The interaction of components in the system Al-B may begin at grain boundaries of the matrix alloy extending to the surface of the foil. The leading role in formation of the zone of interaction of matrix and fiber is played by plastic deformation of the foil leading to breaks in the surface of the oxide film along matrix alloy grain boundaries. The physical and chemical interaction resulting in the formation of intermetallide phases can be initiated by plastic deformation of the aluminum foil at low temperatures. Figures 2; references 4: all Russian.
[109-6508]

UDC: 621.762

DISTRIBUTION OF DENSITY IN CLOSED-IMPRESSION DIE FORGING OF AXISYMMETRICAL PRODUCTS FROM METAL POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 85
(manuscript received 6 Apr 83) pp 22-25

BONDAREV, A. A., VARTANOV, K. B. and SOBOLEV, Yu. P., Moscow

[Abstract] Deformation with compacting of porous materials in closed impression die forging requires the use of special stress state systems, one

which is implemented with radial flow toward the center. Preforms for forging were manufactured of granules of heat resistant alloy EP741P by hot isostatic pressing in thin wall steel capsules. A section was cut through the diameter of a preform to study the distribution of density in the initial state. The density through the cross section was determined indirectly by measuring Brinell hardness at individual points. The template was then replaced, the cutting thickness being compensated by special inserts of a material with similar deformation resistance, also preventing the template from being welded with the rest of the blank. After forging, the template was extracted and the distribution of density studied again by the same method. It was found that the initial density heterogeneity had little influence on the distribution of density in porous preformed blanks. The decisive contribution to the intensity of compacting in individual zones of the blank is that of the boundary conditions of the process which determines the stress state. An effective means of increasing hydrostatic pressure in individual zones of blank might be forging in multisection stamps allowing successive deformation of the blank from the periphery toward the center. Figures 5; references 3: 2 Russian, 1 Western.
[109-6508]

UDC: 621.762

INFLUENCE OF DISPERSION MEDIUM ON MAGNETIC PROPERTIES OF $SmCo_5$ ALLOY POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 85
(manuscript received 16 Apr 84) pp 1-5

POVOLOTSKIY, Ye. G., BOGATIN, Ya. G. and SAMARKINA, N. A., Saratov Polytechnical Institute

[Abstract] A study is presented of the relationship between magnetic properties (coercive force) and specific residual magnetization of powders of the magnetically hard alloy $SmCo_5$ and the coefficient of viscosity of various media and grinding time in the media. The $SmCo_5$ alloy obtained in a vacuum electric arc furnace was ground in a type M-10 ball mill with a mass ratio of alloy to milling bodies of 1:16 in various media (air, freon, toluene and water), dispersion time 30 minutes to 20 hours. The magnetic properties of the powders were measured on a vibromagnetometer. The results of the studies showed that the reduction in particle dimensions in all media varied linearly with the logarithm of time, the graphs having different slopes as a function of viscosity coefficient of the media. The higher the coefficient of viscosity, the greater the time required to produce particles of a given diameter. This difference disappears with grinding times of over 15-20 hours. Grinding is a complex physical and chemical process related not only to simple mechanical crushing of particles, but also to the influence of the grinding medium on the state of the surface and magnetic properties of the particles. Deformation phenomena in the particles caused by the mechanical impact of the milling bodies are not the dominating factor determining the magnetic properties of the powder. These characteristics

depend essentially on the mechanochemical reactions in the dispersion zone, rlated to the nature of the grinding medium. Each grinding medium has its own unique grinding time allowing production of a certain optimal mean particle diameter in terms of magnetic properties, this time being proportional to the coefficient of viscosity of the medium. Figures 6; references 8: all Russian.
[109-6508]

REFRACTORY MATERIALS

SOLAR FURNACE FOR REFRACTORY MATERIALS

Moscow KOMMUNIST in Russian 14 Apr 85 p 2

[Text] Scientists of the Tashkent Physical-Technical Institute imeni Starodubtsev are obtaining superpure refractory and heat-resistant materials by a 'sterile' process, with the aid of the sun. High-temperature solar concentrators which have been developed and successfully tested by the scientists make it possible to obtain temperatures as high as 4,000 degress Celsius.

Industrial production of highly refractory, superpure materials that are extremely difficult to obtain by other methods will be launched with the aid of the solar furnace of a new complex. Scientists are now producing such materials only in small quantities, in laboratories. But their output will soon be reckoned in hundreds of tons, as the interests of modern technology require.

(The photograph shows senior project engineer L. V. Nechayeva and senior engineer Ye. Ye. Tasybayev adjusting a solar furnace 2 meters in diameter.)

FTD/SNAP
CSO: 1842/157

SEMICONDUCTOR TECHNOLOGY

UDC: 546.221'231'57+546.221'231'47

THE TRINARY RECIPROCAL SYSTEM $Ag_2S + ZnSe \rightleftarrows Ag_2Se + ZnS$

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 2, Feb 85 (manuscript received 11 May 83) pp 210-213

TRISHCHUK, L. I., OLEYNIK, G. S. and MIZETSKAYA, I. B., Institute of Semiconductors, Ukrainian Academy of Sciences

[Abstract] A study was made of the physical and chemical interactions in the trinary reciprocal system $Ag_2S + ZnSe \rightleftarrows Ag_2Se + ZnS$, and the liquidus surface was constructed in order to use the compounds Ag_2S and Ag_2Se as solvents for the production of single crystals of the solid solutions. Thermodynamic calculations are used to determine the temperature variation of free Gibbs energy ΔG and equilibrium constants K_p of the reaction $Ag_2S + ZnSe \rightleftarrows Ag_2Se + ZnS$. Differential-thermal and microstructural analyses are used to study the state diagram of the quasibinary system Ag_2Se-ZnS and construct the liquidus surface of the trinary reciprocal system $Ag_2S + ZnSe \rightleftarrows Ag_2Se + ZnS$. A moving heater method is used with Ag_2S and Ag_2Se as solvents to obtain solid single crystals of ZnS, ZnSe and their solid solutions. The influence of the rate of movement of the heater on density of solvent inclusions in the crystals produced is studied. Figures 2; references 15: 8 Russian, 7 Western.
[131-6508]

STEELS

PROCESS FOR OBTAINING HIGH-NITRIDE TOOL STEELS

Moscow NTR: PROBLEMY I RESHENIYA in Russian 5-18 Mar 85 p 1

[Text] The USSR Ministry of Ferrous Metallurgy, the USSR Academy of Sciences and the Metals Technology Research and Production Association (People's Republic of Bulgaria) are working jointly on the development of a back-pressure method for casting economical high-nitride, non-nickel alloy stainless, high-temperature corrosion-resistant, heat-resistant and tool steels with a decreased tungsten and molybdenum content. A process for obtaining such steels has been developed. Their parameters surpass those of steels in series production, and they require no additions of scarce alloys. Results that have been obtained indicate that economical alloy tool steels with heightened nitrogen content will make it possible to increase the durability of cutting and stamping tools by 30 percent.

FTD/SNAP
CSO: 1842/157

SUPERHARD MATERIALS

50,000-TON PRESS SYNTHESIZES SUPERHARD POLYCRYSTALS

Ashkhabad TURKMENSKAYA ISKRA in Russian 19 Mar 85 p 3

[Text] Moscow--At the USSR Academy of Sciences' Institute of High-Pressure Physics imeni Vereshchagin, large polycrystals of diamond-based superhard materials have been produced. A unique unit is being used for their synthesis--a press with a force of 50,000 tons, which was built to specifications of the institute's scientists by specialists of the Novokramatorskiy Machine Building Plant. The size of the unique installation is impressive--an entire shop had to be built for it.

The newly developed polycrystals are being widely used in industry as parts of high-pressure apparatus and grinding and cutting tools in metalworking and other branches of the economy.

(A photograph is given showing the press.)

FTD/SNAP
CSO: 1842/157

NEW DIAMOND-BASED COMPOSITE FOR GRINDING

Moscow NTR: PROBLEMY I RESHENIYA in Russian 5 Feb 85 p 4

[Text] Industry makes extensive use of superhard materials, including diamond, which is the hardest of known minerals. But only crystals of the so-called 'clear water' [grade] possess the requisite hardness. More often it is other kinds--shapeless, cloudly and possessing many microscopic cracks--that are found. These crystals are not even suitable for lathe cutters and drill bits; they are too brittle.

How is 'ordinary' diamond to be made tougher, correcting the mistakes of nature? Many terms of scientists who are developing various diamond-based composites are working on this problem, which is an important one for metalworking.

At the Leningrad Technological Institute, a fundamentally new material--karbal (carboneium plus diamond)--has been developed. The toughenss of polycrystals of it which are 150-200 micrometers is size approaches that of synthetic diamonds.

Karbal is a composite obtained by the growing together of separate diamond grains by means of carbon in various hybrid states. The main advantages of the new material are high roughness, which promotes the 'adhering' of grains in conventional bonds, and a large number of cutting faces that emerge to the surface.

Laboratory experiments have confirmed that karbal withstands very high loads, and in abrasive working it removes more material, even from the hardest alloys, than all the cutters previously used.

FTD/SNAP
CSO: 1842/157

SUCCESSES IN GROWING DIAMONDS FROM GASEOUS PHASE

Moscow PRAVDA in Russian 21 Apr 85 p 3

TARASOV, A.

[Abstract] The author of the article visited the USSR Academy of Sciences' Institute of Physical Chemistry, where he was acquainted with successes in growing a variety of synthetic diamond products from the gaseous phase. It is noted that at the recent general assembly of the USSR Academy of Sciences, the academy awarded its Prize imeni Mendeleyev to the institute's Dmitriy Valerianovich Fedoseyev, a doctor of chemical sciences and head of a laboratory, and Boris Vladimirovich Deryagin, a corresponding member of the academy and head of a department of the institute, for a cycle of works on the synthesis of diamonds from condensation of carbon at high supersaturation and rapid cooling of the resulting solid phase. A co-recipient of the award was V. Golyanov of the Institute of Atomic Energy imeni Kurchatov.

Fedoseyev explained that three 'rules' must be observed in the technology of diamond synthesis from the gaseous phase: synthesis must take place at very high supersaturation of the gas with carbon atoms; process conditions must be such that diamond and not graphite forms; the diamond must be kept from rearranging into graphite. In the process, an infrared laser beam strikes drops of octane falling from a dropper; supersaturated vapors form instantaneously, and in them carbon crystalizes instantaneously in various phases, including the diamond phase. Cooling rapidly, the diamond particles are hardened instantly, and they will not turn into graphite in subsequent heating. Fedoseyev mentioned that these particles, which are less than one-tenth of a micrometer in size, can be used in polishing to give a superfinish to laser mirrors. A method of separating diamond from graphite powder was devised by junior science associate V. Bukhovets, who works on the topic of interaction of diamond and graphite with low-temperature plasma. The method is based on the fact that graphite particles burn up 10,000 times as fast as diamond particles.

The institute has a group for the synthesis of diamond films, which is headed by Candidate of Chemical Sciences V. Varnin. It has developed a unit in which carbon atoms are deposited on a molybdenum substrate in ionized hydrogen at 1,000 degrees, forming a diamond film.

Another success of the technology for obtaining diamond from the gaseous phase reportedly is that it can be accomplished also without a catalyst and at ordinary atmospheric pressure. Fedoseyev did hundreds of experiments with various gas compositions and alser pulse powers. Parallel with his work, Golyanov at the atmoic energy institute directed the development of a unit in which a stream of carbon atoms is directed onto a cooled substrate, forming a diamond-like film on it.

It is also mentioned that the physical chemistry institute and the Ukrainian Academy of Sciences' Institute of Superhard Materials have developed a process for sintering diamond powder coated with a damond-graphite layer into a diamond polycrystal called karbonit. Weighing as much as 8 carats, these synthetic diamonds can be used in cutting tools.

FTD/SNAP
CSO: 1842/157

TITANIUM

UDC 669.295'71'28'296'

INVESTIGATION OF PHASE EQUILIBRIA IN Ti-Zr-Al-Mo SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 1, Jan-Feb 85 (manuscript received 16 Aug 84) pp 193-196

NARTOVA, T. T., TARASOVA, O. B. and NOTKIN, A. B.

[Abstract] A study was made of phase equilibria for isothermal sections at 500° C parallel to the side of the Ti-Zr-Al tetrahedron at constant Mo concentrations of 0.5 and 2.0 mass % with concentrations of Zr up to 50 mass % and of Al up to 16 mass %. Samples were prepared by induction melting in a helium atmosphere, heat treated in evacuated quartz ampules and tempered from 500° C by quenching in cold water. Analysis by x-ray diffraction and by optical and electron microscopes was used to construct phase diagrams which showed the presence of α-, β-, and α_2-phases and corresponding two- and three-phase regions. Increasing Zr content led to a lessening of Mo content in the α-phase. Al showed a solubility of 6.1 mass % in the α-solid solution of the Ti-Al system. Figures 3; references 9: all Russian.
[116-12672]

UDC 669.295:621.785.34

KINETICS OF GAS SATURATION PROCESSES AND SUBLIMATION OF TITANIUM ALLOYS IN VACUUM AT 1123 and 1273°K

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 1, Jan-Feb 85 (manuscript received 7 Jun (83?)) pp 36-39

MAKSIMOVICH, G. G., FEDIRKO, V. N. and LUK'YANENKO, A. G., Physico-Mechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences, Lvov

[Abstract] While most researchers agree on the effects of vacuum processing on durability of titanium alloys, the kinetics of gas saturation have given ambiguous results. The present article reports on those kinetics with residual gases in an approximately 1 mPa vacuum at 1123 and 1273°K using thin titanium samples. The samples were polished, then cleaned with acetone and

alcohol. Partial oxygen pressure in the chamber was approximately 0.07 mPa, so that V_2O_5 did not form because of its dissociation. Titanium and zirconium did not sublimate in the same manner. From OT4-1, manganese sublimated, while tin sublimated from VT5-1. At 1123°K residual gases reacted with VT5-1, PT-7M and PT-3V to form a gas-saturated coating of great hardness, with little surface corrosion. Increased temperature to 1273°K intensified the process. Only the VT5-1 samples showed qualitative differences as tin sublimation from the alloy was activated. Figures 3; references 4: all Russian.
[151-12131]

UDC 669.245:539.4.019.3

EFFECT OF DEFORMATION AND ANNEALING ON FORM MEMORY EFFECT AND BUFFERING IN TiNiCu ALLOY

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 85 (manuscript received 5 Dec 83) pp 108-112

YERMOLAYEV, V. A., KUZ'MIN, S. L., LIKHACHEV, V. A., SHIMANSKIY, S. R. and POMYTKIN, S. P., Leningrad State University, Scientific Research Institute for Mathematics and Mechanics, Laboratory of Resistance of Materials

[Abstract] Form memory and related phenomena in metals with reversible martensite conversions depend on composition, thermal processing and mechanical cold working. The present article reports on a study of changes in internal friction, conversion plasticity, form memory and temperature factors in an alloy with 50% Ti, 47.5% Ni and 2.5% Cu (by atomic weight), after intensive plastic deformation and subsequent annealing at various temperatures from 470 to 1170°K. The alloy was found to be brittle at temperatures of 100-500°K, and reached a maximum durability under tension at 130 MPa. Intensive cold rolling almost completely suppressed conversion plasticity and eliminated form memory, but martensite conversion remained. The temperature interval for martensite conversion after low-temperature annealing was expanded markedly, and deformation plasticity increased the temperature of martensite conversions. Figures 4; references 10: 8 Russian, 2 Western.
[150-12131]

UDC 669.017

DETERMINING PARTIAL MOLAR VOLUME OF HYDROGEN IN TITANIUM ALLOYS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 1, Jan-Feb 85 (manuscript 27 Oct 83) pp 135-137

FISHGOYT, A. V. and KOLACHEV, B. A., Department of Metal Studies and Hot Processing of Metals, Moscow Institute of Aviation Technology

[Abstract] Partial molar volume of hydrogen in metal is a thermodynamic feature determining hydrogen's distribution under tension and consequent brittleness. The present article reports on study of the hypothesis that partial molar volume of hydrogen in alpha+beta alloys at room temperature will be close to that for beta alloys, rather than that for alpha+beta alloys at higher temperatures. Samples of VT6 alloys were impregnated with hydrogen at 1023 and 1323°K, then etched in $HF+HNO_3$ to a depth of 20 mcm. Then the samples were dehydrogenated until a stationary state was reached. A differential equation was developed to show the correctness of the stated hypothesis. References 4: 2 Russian, 2 Western.
[150-12131]

UDC 620.178.3

FATIGUE RESISTANCE OF VT3-1 TITANIUM ALLOY RELATED TO SURFACE COLD WORKING

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 85
(manuscript received 1 Mar 83) pp 20-23

STEPNOV, M. N., VEYTSMAN, M. G., GIATSINTOV, Ye. V., AGAMIROV, L. V. and GUS'KOVA, L. N., Moscow Institute of Aviation Technology

[Abstract] Fatigue failure generally starting in component surfaces results from concentration of mechanical and metallurgical defects related to tension and loading. Surface cold processing to improve durability has been found effective, but little study has been given to it. The present article reports on study of VT3-1 titanium alloy strengthened by cold rolling and vibration processing. Details of both processes are discussed. X-ray structural analysis was then used to determine residual tension and the depth of cold processing effects. The most effective hardening, cold rolling at 500 H of pressure, increased strength by 32%, while vibration working increased strength by 27%. Experimental data showed considerable variations in results. Figures 4; references 4: all Russian.
[153-12131]

UDC: 621.745.552/557.001.57

MATHEMATICAL MODEL OF ORE-THERMAL FURNACE WITH SINGLE-STAGE MELTING OF IRON-TITANIUM CONCENTRATES

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY. TSVETNAYA METALLURGIYA in Russian No 5, Oct-Nov 84 (manuscript received 13 Jan 83) pp 47-50

KRIVODUBSKIY, O. A., PECHENKIN, V. P. and KUZ'MA, N. M., Donets State University; All-Union Scientific Research and Planning Institute of Titanium

[Abstract] A study is made of a periodic method of melting titanium concentrates in which a charge is placed in a furnace so as to fill completely the furnace space with slag. After reduction of ferrous oxide to a predetermined content in the slag the melting products are tapped from the furnace. The cycle is then repeated. The major chemical reactions occurring in the orethermal furnace in the process are as follows:

$$FeO+C=Fe_T+CO\uparrow,$$

$$Fe_3O_4+4C=3Fe_T+4CO\uparrow,$$

$$FeO\cdot TiO_2+C=Fe+TiO_2+CO\uparrow,$$

$$2FeO\cdot TiO_2+3C=2Fe+Ti_2O_3+3CO\uparrow,$$

$$3FeO\cdot TiO_2+4C=3Fe+Ti_3O_5+CO\uparrow,$$

$$Ti_2O_3+C\rightleftarrows 2TiO+CO\uparrow,$$

$$2TiO_2+C\rightleftarrows Ti_2O_3+CO\uparrow.$$

A mathematical model of the technological process is developed. This model is numerically solved by the Runge-Kutta method, and a graph of the change in TiO_2 and FeO content in the slag during melting is computed. The mathematical model has been used to create an automatic control system of the melting process for the Berezniki titanium-magnesium combine. Figures 2; references 4: all Russian.
[99-6508]

WELDING

DIFFUSION WELDING OF INCOMPATIBLE MATERIALS

Moscow KHIMIYA I ZHIZN' in Russian No 12, Dec 84 pp 15-18

[Article by Lenin prize winner and Doctor of Technical Sciences N. F. Kazakov (deceased) and Candidate of Chemical Sciences A. A. Zharkikh appears under the title "Compatibility"]

[Text] Among the studies in the field of science and technology that received a Lenin prize in 1984 is the development and large-scale implementation into production of the diffusion welding of metal and nonmetal materials. We bring to the reader's attention an article on the new welding method, its merits and physico-chemical principles.

As early as several decades ago, most of the works on welding technology were devoted to the joining of uniform materials or materials, which differed little in their basic physical and chemical properties from each other. Such materials are not difficult to join by the widely known classical methods--fusion welding, gluing and soldering. The classical methods of permanent joining of materials are still important today; however, these methods are unable to solve all the problems that are advanced by present-day technology. Titanium and zirconium, beryllium and magnesium, heat resistant alloys and composites, glass and ceramic, semiconductors and pyroceramics, graphite and carbides--this is a far from complete list of the different type metals and nonmetals that have to be strongly and reliably joined in different apparatuses and structures.

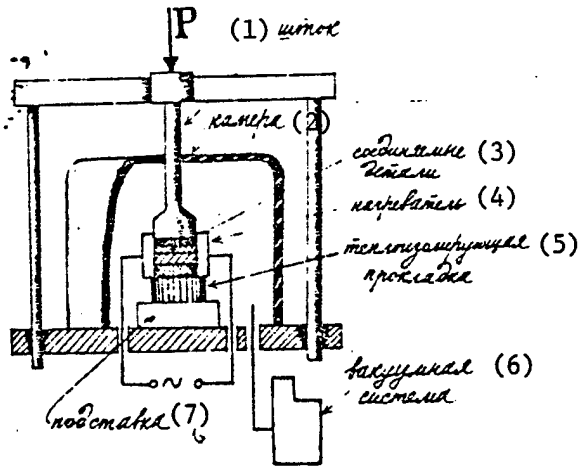
Many properties of the materials to be joined are contradictory, indeed, they are completely opposite: brittleness and plasticity, low melting point and refractoriness, often they are insoluble or slightly soluble in each other, and form brittle intermetallic phases between themselves that may rupture the weld. Seemingly, all this forms an insurmountable barrier of incompatibility between materials which have to be joined together.

The barrier of incompatibility between metals with completely opposite properties and between metals and nonmetals has been overcome with a new welding method, developed in our country--diffusion welding in a vacuum (abbreviated to DSV). Its principle is quite simple: the details to be welded, after their contact surfaces have been prepared, are placed into the chamber of a welding unit; the chamber is evacuated or filled with an inert gas, the heat is switched on, and the details are pressed together with force, which depends on the properties of the materials being welded. In a few moments, a strong joint is formed that generally requires no additional processing.

One of the most important merits of diffusion welding is the high quality of the welded joints, which keep the initial properties of the materials being welded and the dimensions of the details being joined. The weight of the finished structure does not increase as in the case of fusion welding, soldering and gluing. When conditions are carefully selected, the strength and plasticity of the material in the joint and close to it practically do not differ from the strength and plasticity throughout the volume.

With diffusion welding the particles of the materials being joined interact directly with each other--this means there is no need for fluxes and electrodes or filling wire made of platinum, gold or silver. Diffusion joining enables us to form structures and details of very complex shape that were practically impossible until recently. No radiant energy is given off nor any kind of harmful wastes during diffusion welding; in other words, the new method is ecologically faultless.

Today, permanent joints of materials, which are extremely difficult or impossible to join by standard welding, are produced by diffusion welding in a vacuum. The technology has been completed in detail for hundreds of pairs: for steel with tungsten, molybdenum, titanium, for silver with stainless steel, for steel with graphite, for quartz with copper and aluminum, for semiconductors with dielectrics, for glass and ceramic with Kovar (magnetic alloy, whose composition includes iron, nickel and cobalt), copper titanium and others. The new method of joining has enabled the solution of large technical problems. For example, with diffusion welding in a vacuum, for the first time in domestic and world practice, the manufacture of large-scaled (up to 100 meters in length) apparatuses of layered structure has been achieved, domestic assemblies of powerful accelerators with a plasma source of ions have been produced, and new designs of completely airtight electric inlets, whose conductors are welded into refractory glass, have been developed. The use of diffusion welding in a vacuum has been quite efficient for the manufacture of durable stamps for cutting out magnetic circuits, and for the manufacture of cermet airtight inlets, assemblies made of ferrites and cermet, turbine blades and porous pipes for the chemical industry.



Unit for Diffusion Welding in a Vacuum

Key:

1. Rod
2. Chamber
3. Details being joined
4. Heater
5. Heat insulating gasket
6. Vacuum system
7. Stand

What is the reason for the remarkable compatibility that absolutely incompatible materials find in the chamber of the new welding units, how can the special mechanical strength of the permanent joints, produced by diffusion welding in a vacuum, be explained?

According to modern concepts, for the strong joining of two materials, first, there must be a reliable physical contact between them. The second required stage is the formation of a chemical bond between the atoms and the ions, brought into close contact, of the surfaces being joined. If these conditions are not fulfilled, then no method can produce a reliable permanent joint.

With diffusion welding physical contact is achieved as a result of crumpling and flow of the microprojections on the surface of the softer material that is being joined. Naturally, deformation of the microprojections is feasible only at specific temperatures and pressure. With diffusion welding, in principle, ideally smooth, fine surfaces could be joined even without pressure. However, with the most thorough finishing, rough spots still remain that are measured in microns, and the interatomic and interionic distances, on which forces of attraction start to act, are measured in angstroms. In addition, the surfaces to be joined are always covered with layers

of oxides and adsorbed gases. Thus, pressure cannot be avoided in the solid phase with welding. The magnitude of pressure depends on the hardness of the materials being welded and the machining finish, and the temperature required for making physical contact is generally half or three quarters of the melting point of the material that melts more readily of the two materials.

The weld between the steel details, produced by diffusion welding in a vacuum, is practically impossible to find on the microphotograph (300X magnification). The welding zone may be determined by the special molybdenum wire, left between the details.

The forces of cohesion, formed by the molecular bonds, that appear with physical contact of the materials cannot produce anywhere near a strong joint. A chemical interaction of the materials is necessary, as metioned earlier. The materials have to be activated so that they would interact--convert them to a reactive state, raise the heat movement energy of the atoms and molecules, and produce defects in the crystal lattice. Temperature is needed for this as well.

The vacuum in a welding unit chamber plays a very important role. Evacuation is very reliable protection against high-temperature oxidation of metal surfaces. No new oxide layers are formed in the vacuum, and the old layers disintegrate. The oxides either sublimate into the space of the chamber or they diffuse into the depth of the material.

The nature of the chemical reaction depends on the nature of the materials being joined. With the welding of glass or ceramic to metals, which have a high affinity for oxygen, the permanent joint is formed as a result of exchange reactions in the contact zone. For example, precise joints of quartz glass with aluminum and its alloys are produced as a result of an oxidation-reduction reaction, which is accompanied in the welding zone by the formation of new crystalline phases--silicon and aluminum oxide:

$$3SiO_2+4Al \rightarrow 3Si+2Al_2O_3.$$

Copper, nickel, iron and certain other metals interact with ceramic according to another mechanism. These metals are exposed to oxidation before welding to form oxide films on their surfaces that, in reacting with the glass or ceramic ions, produce new compounds--of the spinellide, silicate and double salt types:

$$MeO+Al_2O_3 \rightarrow MeAl_2O_4,$$
$$aMeO+bSiO_2 \rightarrow aMeO \cdot bSiO_2.$$

The appearance of new phases and chemical interaction products of the materials being welded is often difficult to detect because the reactions take place in the very thin precontact layers. For this reason, welding processes are generally modeled: a mixture of powders of the materials under study are sintered and the reaction products undergo X-ray phase analysis or X-ray microanalysis. A similar study of aluminum oxide ceramic compounds with copper and nickel confirmed the formation of a new crystalline phase of the spinel type $CuAl_2O_4$ and $NiAl_2O_4$ in the welding zone.

Finally, with diffusion welding of metals with ceramic, a permanent joint may be produced as a result of solid solutions of one material forming in the other. For example, titanium and polycrystalline aluminum oxide interact in this way.

Thus, as a result of the chemical interaction at the point of contact of the materials being joined, a transitional zone is formed that consists of products which have the most varied physico-chemical properties and, for this reason, these properties can either strengthen or, just the opposite, weaken the welding zone. With correct selection of conditions, the mechanical and other important characteristics of a material change smoothly in the transitional zone, gradually--from properties of a metal to those of a nonmetal. For this reason, the residual stresses in the welded joint are in-

significant; the joint is strong and reliable.

The chemical interaction of materials, joined by diffusion welding, is accompanied by electron exchange; the interphase bonds that have formed are, as a rule, covalent or ion-covalent bonds, which are the strongest chemical bonds. This explains the strength, the high vacuum and the other physico-technical characteristics of the joints, produced from different type materials with diffusion welding. However, the same kind of chemical bonds may form with fusion welding or with soldering. Why is the joint less strong, less solid and less reliable in these cases?

With fusion welding and soldering, the physical contact of surfaces takes place in the melt and is reached very rapidly--immediately after the metal melts; the physical and chemical interaction processes flow very rapidly and intensively at the boundary of the melt--solid substance. Under such conditions it is very difficult, and sometimes impossible, to produce a welded joint without brittle interlayers in the contact zone when joining different type materials (particularly with limited solubility or intermetallic compounds forming between them).

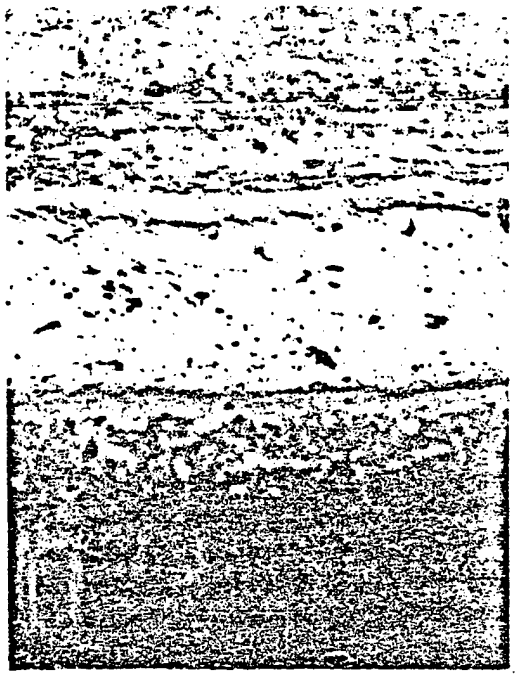
Diffusion welding is quite a different matter as well as the processes which take place in the solid phase. They flow considerably slower than the liquid phase processes, they are easy to control and to adjust by changing the temperature and pressure gradually. Finally, the weld that has already formed can be made more uniform and strong by continuing its exposure to the action of temperature and pressure. At the same time, interdiffusion of the atoms, ions and molecules of the materials being welded intensifies, and the plasticity of the material in the transitional zone increases.

Diffusion welding in a vacuum enables us to join materials with very different properties. But, there are cases that are absolutely hopeless, cases of absolute incompatibility, for example, copper with graphite. However, a solution can be found for these hopeless cases. If it is impossible to weld materials A and B, but they are both compatible with material C, why not try to join them through a gasket, to make an A-B-C welded joint? If it is difficult to find a C material, then a different, more difficult variant is possible: join A with B, and C with D and obtain an A-B-C-D joint.

Copper cannot be welded to graphite because graphite does not form solid solutions or chemical compounds with carbon during heating. However, copper interacts with niobium very well, as does graphite with titanium; and, niobium and titanium form between themselves solid solutions with unlimited reciprocal solubility. Copper has been successfully joined to carbon with diffusion welding through a niobium-titanium activating gasket.

Here is another example. When welding titanium to copper, intermetallic compounds $TiCu_3$, $TiCu_2$ and TiCu may form that, as a rule,

are quite brittle and, because of this, sharply reduce the strength of the weld. For this reason, it is better to weld copper to titanium through a so-called barrier gasket--niobium foil. Niobium does not produce brittle phases with titanium or copper; however, it does produce solid solutions with both metals.



Incompatible materials--molybdenum (top) and ceramic--welded through a nickel gasket. 500X magnification.

When joining materials with sharply differing coefficients of thermal expansion, so-called compensating gaskets are used that smoothly change the coefficients of thermal expansion in the welding zone and reduce the thermal stresses in the weld. Finally, there are plastic gaskets. They are useful when the pressure of welding (force with which details are pressed together) has to be reduced, or in those cases when thorough preparation of surfaces to be welded is impossible for some reason or other.

The new method of welding is already widespread and has become the technology of today. And, at the same time this is the technology of the future, as we are only beginning to discover its immense potentialities.

READING MATERIAL ON DIFFUSION WELDING

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12525
CSO: 1842/145

UDC 620.178.3

EFFECT OF PROTECTIVE METHOD ON CYCLIC DURABILITY AND NATURE OF FAILURE OF TITANIUM ALLOY WELDED JOINTS

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 85
(manuscript received 28 Nov 83) pp 26-29

MOZEYKO, B. Yu. and YAKOVLEVA, T. Yu., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Various welding techniques can be better assessed of a comparative evaluation of cyclic durability factors is made for the resulting joints. The present article reports on study of complex items of titanium alloys that were joined by argon arc welding. Some samples had durable coatings of acrylic resin BMK5 in an ethanol-acetone solvent. Seam strength was tested by cyclic loading at 20 herz, with a test basis of 1.10^6 cycles. Fractographic and microstructural study was made of a sample that had failed at a pressure of 324 MPa. Fractographic results showed that failure occurred in numerous zones on the protected surface, in the case of samples welded in argon, while those welded with a haloid coating in another series had only a single failure zone. Thus the type of coating used for protection had a clear impact on microstructure of the seam and surrounding metal, and on durability. Uncoated joints were less homogeneous and had lesser viscosity. Figures 6; references 5: all Russian.
[140-12131]

UDC 621.791.4-97.01:539.378.3

EFFECT OF HEATING TEMPERATURE IN A VACUUM ON STATE OF SURFACE LAYERS OF WELDED OT4 TITANIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 83
(manuscript received 3 Apr 84) pp 15-17

PESHKOV, V. V., candidate of technical sciences, MILYUTIN, V. N., engineer and RODIONOV, V. N., candidate of technical sciences, Voronezh

[Abstract] The physicochemical state of contact and external surfaces of welded elements has great impact on the quality and durability of diffusion

joints. The present article reports on study by Raster electron microscope of the effect of the thermal cycle of diffusion welding on OT4 titanium alloy samples. Some samples were polished, while others were milled to have ca. 12 mcm projections on the surface. During heating, oxygen dissolved in the titanium to form a gas-saturated layer and subsequent brittleness, reduced resistance to cracking and increased resistance to high temperature deformation. Surface reactivity also decreased. The brittleness was further studied by grooving surfaces to a depth of 2.5 mm and applying bending force. Effects of heating to 900°C are summarized. Results indicated that gas interaction with the titanium alloy led to formation of not only oxide coatings but brittle gas-saturated layers with the previously mentioned effects. This layer increased at temperatures up to 600°C, after which it gradually diminished, disappearing at about 800°C. Figures 4; references 3: all Russian.
[155-12131]

UDC 621.791.4:[669.295+669.14]

VACUUM PRESSURE WELDING OF COMMERCIAL TITANIUM WITH 2Kh13 AND 12Kh18N10T STEELS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 85
(manuscript received 29 May 84) pp 56-58

KIREYEV, L. S., engineer, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences

[Abstract] Titanium-steel welded combinations have low plasticity and operational potential due to low solubility of the two metals. Intermediate layers of tantalum, niobium, copper alloys or vanadium partially solve that problem, but corrosion remains a problem. The present article reports on welded joints of VT1-0 commercial titanium and chromous ferrite or chrome-nickel austenite steels without intermediate layers. Cylindrical samples of VT1-0 and 2Kh13 or 12Kh18N10T steels were welded after chemical etching to eliminate impurities. Results suggested the importance of the size and ratio of free neutron particles released in the process in determining seam strength. Physical contact involved deformation of the least durable metal, titanium. While it proved impossible to identify the best methodology for such a joint, excellent results were obtained at a temperature of 650-670°C, pressure of 400 MPa and a time rate of 1-3 minutes. Aging at 400°C for 50 hours had no noticeable effect on durability. Figures 7; references 10: all Russian.
[155-12131]

UDC 621.791.052:620.18

STRUCTURE AND PROPERTIES OF VT23 ALLOY WELDED JOINTS AFTER THERMOCYCLIC PROCESSING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 85 pp 22-24

LYASOTSKAYA, V. S., candidate of technical sciences, RAVDONIKAS, N. Y., MAYSTROV, V. M. and KALENOVA, M. V., engineers, Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy

[Abstract] Thermocyclic processing (TCP) of steel is finding increasing application in pulverizing granules for producing items with large-granular structure. TCP has not, however, been as effective with titanium alloys due to their polymorphic properties, low heat conductivity and other properties. The present article reports on the effects of TCP on the structure and properties of welded joints of VT23 alloy welded by argon arc with SPT2 rod. Results showed that the alpha-phase contained the largest plates in the welded seam. The best thermocyclic processing results were at temperatures of 950°C followed by cooling to 550°C, or a 950-750°C regimen. The first pattern gave the greatest durability. Fractographic study showed that TCP of VT23 alloy welded joints increased intragranular fracturing over that found with standard tempering processes. In general, TCP increased homogeneity and blow resistance while general durability and plasticity were maintained. Figures 3; references 9: all Russian.
[154-12131]

UDC 621.791.052:539.4

FATIGUE RESISTANCE OF HOMOGENEOUS AND HETEROGENEOUS WELDED JOINTS OF TS5 TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 85 pp 21-22

GONSEROVSKIY, F. G., candidate of technical sciences, REZNICHENKO, N. V., SHILOVICH, N. N. and ROMANOV, V. N., engineers

[Abstract] The need to reduce wear of steam turbines blades led to the present study of three approaches to protect their surfaces: by soldering on erosion-resistant plates, welding on inserts and flow coating. Then resistance to fatigue was determined in symmetrical and asymmetrical cycles. The samples were annealed at 880°C for 1 hour, than cooled in normal air. The effects of geometric form on fatigue failure were also assessed. Excess brittleness unrelated to porosity was found to be the key factor determining fatigue. Annealing procedures had no clear impact on failure, which occurred in the weaker or more brittle component of bonded metal combinations. Figures 2; references 4: all Russian.
[154-12131]

UDC 621.791.3.052:669.35:620.193/.199

CORROSION OF BRAZED COPPER ALLOY JOINTS IN SEA WATER

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 85
(manuscript received 12 Mar 84, in final form 30 Aug 84) pp 65-66, 69

LUCHKIN, P. S., candidate of technical sciences and PETERAYTIS, S. Kh., Tol'yatti Polytechnical Institute

[Abstract] Heat exchange pipelines involves numerous brazes, whose durability has received little study. The present article reports on a comparative study of M3 copper and MNZhMts30-1-1 copper alloys soldered with PMFS6-0.15 solder. Corrosion in synthesized sea water was measured in special cells of organic glass that permitted visual monitoring. The sea water flowed through the stand at various speeds. Corrosion was measured by polarized features of anode processes. The 30-50 hour exposure showed sharp electrochemical destruction of the metal because of the low protective properties of the initial oxide coating. Details of this process are summarized and used to develop a mathematical formula. Results suggest useful life of M3 copper brazes to be 11.4 years, and that of MNZhMts30-1-1 alloy to be 12.9 years. Figures 2; references 2: both Russian.
[155-12131]

UDC [621.791.042:669.168].002.237

PASSIVATING FERROALLOYS WITH ORGANIC SILICON WATER-REPELLENT LIQUIDS IN WELDING ELECTRODE MANUFACTURE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 85
(manuscript received 18 Apr 84, in final form 4 Jun 84) pp 62-64

GUMEN, V. S., SHEVCHENKO, L. A., candidates of technical sciences, OS'MAKOV, O. G., engineer, Kiev Polytechnical Institute; ANGLICHANOV, D. I., engineer, Leningrad Shipbuilding Plant imeni A. A. Zhdanov

[Abstract] Coatings on welding electrodes are made of mineral and ferroalloy components bonded with glass. The present article reports on study of ways to reduce reaction between the glass bonding substance and ferroalloys containing silicon, manganese or titanium, as well as various water-repellent organic silicons with levels of polymerization of 30, 400, and 1000 units. Ferroalloys were pulverized until particles did not exceed 0.063 mm. After mixing with the organic silicon liquids, chemical activity was assessed. Results indicated that the most effective liquids were polyalkylsiliconates of sodium and a polymethysiloxane; these had the least viscosity and the lowest level of polymerization. Passivation effectiveness of the tested coatings did not reduce technical properties of the electrodes, and reaction between liquid glass and the ferroalloys (and subsequently crystallization and structural changes in the coatings) were reduced. Figures 3; references 9: all Russian.
[15-12131]

UDC 621.791.4:[669.295+549.517.14]

PRODUCING TITANIUM-SAPPHIRE ITEMS BY SOLID-PHASE BONDING THROUGH ALUMINUM GASKET

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 85
(manuscript received 25 May 84) pp 59-61

NAYDICH, Yu. V., corresponding member, UkSSR Academy of Sciences, GAB, I. I., engineer, ZHURAVLEV, V. S., candidate of technical sciences, KURKOVA, D. I., engineer, Institute of Problems of Materials, UkSSR Academy of Sciences; YEVPLOV, Yu. N., Institute of Problems of Strength, UkSSR Academy of Sciences

[Abstract] The high mechanical, optical and other properties of sapphires make them very attractive for numerous practical applications. The present article reports on production of titanium-sapphire compositions through aluminum gaskets to make tools to be used at 500°C and 10 MPa pressure. Alloys VT1-0, VT6S and VT16 and L-V leucosapphire disks and slugs were bonded and polished, then tested for strength and useful life. Results showed minimal mechanical strength at 540°C, 2 MPa and 5 minutes of welding, but strength increased thereafter up to 5 MPa, 630°C and 40 minutes. Above those values, mechanical strength declined as surface defects and residual stress weakened the bonds. Titanium-sapphire orifices of 50 mm were subjected to heating and cooling (20-500-20°C at 20°C/min) and to pressures of up to 10 MPa, without damage. Figures 2; references 4: all Russian.
[155-12131]

UDC: 621.791.762

LOW PRESSURE ARC BUTT WELDING OF DISSIMILAR METALS

Moscow SVAROCHNOYE PROIZDSTVO in Russian No 2, Feb 85 pp 9-11

SIDYAKIN, V. A., candidate of technical sciences and MACHNEV, Ye. A., Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy

[Abstract] The authors' institute has developed a method of pressure welding, butt welding in a low pressure electric arc, which is more effective than traditional methods in manufacturing a number of structures of dissimilar metals. The method is distinguished by the fact that an AC electric arc burns in a gap between parts in an inert low pressure medium to heat the ends of the parts. The parts are placed in a vacuum chamber with a gap between them, the chamber is evacuated, filled with an inert gas and an electric arc is excited between the ends of the parts. The arc discharge is uniformly distributed over the ends of the parts thanks to the low pressure of the inert gas and selected current. After the ends are heated and a layer of melted metal is formed they are rapidly brought together to force out the liquid metal and deform the high temperature zone

of the joint. The method is used for welding of pipes of dissimilar metals 60 to 30 mm in diameter with wall thickness 1 to 3 mm and rods 3 to 16 mm in diameter for the manufacture of structural elements of aircraft, bimetallic tools, etc. Figures 4; references 4: all Russian.
[115-6508]

UDC: 621.791:[669.15+669.715]:629.12.011.554.911.17

WELDING OF STEEL-ALUMINUM COOLING PANELS FOR THE HOLDS OF REFRIGERATOR VESSELS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 85
(manuscript received 26 Apr 84) pp 42-44

RYABOV, V. R., RABKIN, D. M., doctors of technical sciences, KIRPATYY, V. A., MURAVEYNIK, A. N., engineers, Kiev, GIL'DENGORN, M. S., candidate of technical sciences, Moscow, AVDEYEV, Ye. S., BALANDIN, I. A., candidate for technical sciences and BORISOVA, N. M., engineer, Odessa

[Abstract] A major factor in increasing the effectiveness of refrigerator units used in ship holds is the use of aluminum panels for cooling, requiring welding of galvanized steel tubing to aluminum panels. Bimetallic tubing was produced by pressing of aluminum alloy tubing layered on the inside with alloy ATS 2 containing 1-3% Zn. The bimetallic pipe was welded to the frame with a semiautomatic welding device using a type SvAMg 6 welding wire, concurrent 180-240 A, feed 25-30 m/Hr. Other seams on the panel were welded by manual argon-arc welding with a tungsten electrode. Low thermal resistance between the dissimilar metals is achieved by metal contact arising in the bimetallic pipe under the influence of the thermal cycle of welding which activates diffusion processes in the adjacent dissimilar metals. The replacement of steel by aluminum alloys allows lighter, more effective cooling panels to be manufactured. Figures 4; references 3: all Russian.
[106-6508]

UDC: 621.791.4:539.378.3:[669.715+621.315.612]

DIFFUSION WELDING OF ALUMINUM WITH VACUUM-TIGHT CORUNDUM CERAMIC

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 85
(manuscript received 24 Feb 84; in final form 5 Jun 84) pp 24-26

KARAKOZOV, E. S., doctor of technical sciences, KHARLAMOV, B. A. and RAVICH, A. M., engineers, Moscow

[Abstract] An attempt was made to determine the mechanism controlling the process of formation of a joint between aluminum and a vacuum-tight corundum ceramic in the stage of formation of the physical contact and activation and

development of the volumetric interaction, including seizing. The experiments involved the AMTs aluminum-manganese alloy and the widely used VK 94-1 vacuum-tight corundum ceramic containing a glass phase. The strength of the welded joint was shown to be determined by the following processes: breakdown of hydroxide included in the oxide film on the aluminum; diffusion of aluminum ions through the oxide film; and dehydration of the ceramic surface. These processes allow direct interaction between aluminum and reactive oxygen on the surface of the ceramic forming chemical bonds Al-O-Al. Figures 4; references 8: 6 Russian, 2 Western.
[106-6508]

UDC: 621.791.052:54.021

CHEMICAL COMPOSITION AND KINETICS OF LIBERATION OF GASES UPON WELDING OF ALUMINUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 85 pp 27-30

ABRALOV, M. A., doctor of technical sciences, ABDURAKHIMOV, A. A., engineer, ABDURAKHMANOV, R. U., candidate of technical sciences, Tashkent Polytechnical Institute

[Abstract] Studies were performed on sheets of aluminum alloys 1420, 1201 and AMg6, 1.2-3.0 mm thick. The chemical composition of gases liberated during welding and melting of aluminum alloys was determined chromatographically. Samples for analysis were taken over the surface of the heated alloy in a quartz reactor with a controlled atmosphere of argon, dry or moist air. Specimens were heated slowly in a crucible furnace. It was found that carbon monoxide, carbon dioxide, hydrogen and water vapor were liberated as the alloys were heated and melted. Alloy 1420 also liberated methane, a source of large pores which form chains at the roots of seams along the melting line. The methane results from chemical reactions in the surface layer between hydrogen, carbon dioxide and air in the presence of $AlLiO_2$ which acts as a catalyst. The use of type TFA-8 flux reduces porosity under these conditions by loosening the surface film, partially dissolving it and by catalytic oxidation of methane. Removal of a 0.23-.025 mm surface layer simultaneously removes the $AlLiO_2$ catalyst. Vacuum heat treatment degases the alloy. Figures 6; references 7: all Russian.
[115-6508]

UDC: 621.791.052:520.192.47:669.71:669.788

MEANS FOR REDUCING HYDROGEN CONCENTRATION UPON SURFACING OF ANTIFRICTION ALUMINUM ALLOYS WITH POWDER ELECTRODE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 85 pp 36-38

KABANETS, A. N., engineer, ZUSIN, V. Ya., candidate of technical sciences, Zhdanov Metallurgical Institute and SILANT'YEVA, S. A., Msocow Aviation Technology Institute imeni K. E. Tsiolkovskiy

[Abstract] Experiments involving extraction of gases and hydrogen from powder and compact master alloy specimens in a vacuum at various temperatures were performed to determine the coefficient of liberation of hydrogen from the surface and powder material. The data obtained allow computation of the hydrogen dissolved in the surfaced metal. Vacuum annealing at 700°C is found to reduce the content of hydrogen significantly. The concentration of hydrogen in the welding bath can be greatly reduced by electropolishing of the surface to a depth of at least 0.4 mm, screening of filler fractions larger than 150 μm and vacuum annealing of the filler at 700°C for two hours. Figures 2; references 3: all Russian.
[115-6508]

MISCELLANEOUS

ULTRASONIC MICROFORGING PROCESS FOR OBTAINING EXTRA-THIN METAL

Ashkhabad TURKMENSKAYA ISKRA in Russian 9 Apr 85 p 3

[Article by D. Patyko]

[Text] A new metalworking process called ultrasonic microforging has been proposed by scientists of the Minsk Radio Engineering Institute to specialists from the "Svetlana" association in Leningrad.

The Minsk scientists solved a problem that had been troubling specialists of the industry for a long time. Extremely thin tungsten strip is needed for the production of many units, electrical measuring instruments, vacuum-electronic instruments and computers. This strip is extremely difficult to obtain.

Theoretical analyses and tests of experimental units developed in Minsk demonstrated that conventional rolling can be replaced by forging with an ultrasonic frequency. Metal cannot stick to tools when this method is used. The new process not only ensures a 95-percent yield of high-quality products but has proved to be a high-speed one as well.

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ELECTROSLAG CASTING PROCESS FOR PRODUCING BIMETALS

Vil'nyus KOMSOMOL'SKAYA PRAVDA in Russian 13 Apr 85 p 3

[Excerpt] Bimetals--materials consisting of two layers of different metals and alloys--are widely employed in industry. A new process for obtaining bimetals has been developed at the All-Union Scientific Research Institute of Electrothermal Equipment. Doctor of Technical Sciences Lev Volokhonskiy told APN correspondent I. Demchenko about this process.

"A so-called transition zone forms in the place where two metals are joined. This zone is the weakest point of a bimetallic ingot.

"Specialists of our institute have proposed a new method of obtaining bimetallic products which makes it possible to eliminate this shortcoming.

"The essence of this method is indicated by its name--electroslag casting, which was developed in our country.

"We developed a process for manufacturing round and hollow bimetallic blanks with various diameters. Plain bearings, vessels and tanks can be made from these blanks, for example. Shaped blanks can also be obtained by the new method. Items made from such blanks are now being employed in our electrothermal equipment.

"We have also tried to manufacture composite materials. This is a new and promising direction. Obtaining composites by the method of electroslag casting has proved to be advantageous in cases where metal is the filler. The same equipment is used; the only difference is that bars made of a refractory material, for example, are fastened to the bottom plate.

"A single electroslag casting unit yields savings of 100,000 rubles a year. A specialized section for the production of bimetals by the new method is now being organized in our country. Electric furnaces in which the new process is utilized have been introduced into production at plants of the Ministry of the Electrical Equipment Industry."

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REPUBLIC ACADEMY ASSUMES DIRECT CONTROL OF METALS-SCIENCE BUREAU

Baku BAKINSKIY RABOCHIY in Russian 6 Apr 85 p 2

[Article by A. Lerner]

[Excerpt] The presidium of the Azerbaydzhan Academy of Sciences recently adopted a decision to place the Special Design-and-Technological Bureau of Metals Sciences (SKTBM) and its "Kristall" experimental plant directly under the jurisdiction of the Azerbaydzhan academy's presidium and to affiliate them with the academy's department of physical-technical and mathematical sciences. This decision was adopted for the purpose of creating the most auspicious conditions for the further development of work and in accordance with an appeal issued on March 1, 1985, by academician B. Ye. Paton, chairman of the USSR Academy of Sciences' scientific council on the problem "New Processes for Obtaining and Working Metallic Materials".

It was emphasized at the meeting of the presidium that over a number of years the SKTBM, which was organized under the Azerbaydzhan academy's Institute of Physics, has been successfully developing economical structural and tool alloy steels, as well as methods for thermal hardening of metal products. The accomplishment of these tasks has necessitated a whole complex of basic research in the field of the structure of metals, as well as the formulation of new principles for creating a highly dispersed structural state in steel and establishment of a relationship between this state and alloying and conditions of heat treatment.

Taking into account the great importance of saving acutely scarce metals, the USSR State Planning Committee has included a non-tungsten steel production facility developed by the "Kristall" plant in the national economic plans of a number of the country's ministries.

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MATERIALS SCIENCE INSTITUTE HEAD PROFILED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 23 Mar 85 p 1

[Article by A. Valentinov]

[Excerpt] An ability to take the long-range view and to define main directions of scientific-technical progress is a characteristic trait of academician Viktor Ivanovich Trefilov, vice-president of the Ukrainain Academy of Sciences and director of the academy's Institute of Materials Science Problems. He has devoted his scientific career to developing new materials. He is the author of works which have earned general recognition both in our country and abroad--works on contemporary dislocation theory of cold brittleness of refractory metals, formulation of scientific principles for controlling sets of mechanical properties of refractory metals, and on principles for the development of new materials.

He came to the Institute of Materials Science Problems as a physical-mathematical specialist in the theory of deformation and failure of metals, and as the founder of a scientific school of the physics of strength and plasticity. At this institute, he mastered a field that was new to him--metal powders. He became chairman of the scientific council on the problem "Powder Metallurgy and Composite Materials" of the State Committee for Science and Technology, and also the director of a large-scale, targeted state technological program on powder metallurgy.

Taking part directly in scientific developments, he has devoted much energy also to the practical utilization of results. Last year alone, the economic effect from the use of developments of his institute in the economy was over 90 million rubles.

He has supported talented young people in every way possible, creating every condition for their creative development. Four doctors and 40 candidates of sciences are among his pupils.

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UNIVERSITY'S METALLURGY DEVELOPMENTS IGNORED BY INDUSTRY

Moscow IZVESTIYA in Russian 15 Apr 85 p 2

KOLMAKOV, A., director of Institute of Applied Mathematics and Mechanics, Tomsk University

[Abstract] The author discusses problems his institute encounters with industry in trying to get developments in metallurgy introduced into production. He cites a couple of examples. Ten years ago the institute developed pulsed pneumatic apparatuses for grinding, grading, drying, mixing and purifying powders. In addition to powder metallurgy, they are said to be needed by the chemical industry and other industries. Two all-Union seminars were held in Tomsk by the USSR State Planning Committee (Gosplan) and the State Committee for Science and Technology (GKNT) to publicize the advantages of the new technology. Departments of Gosplan repeatedly have adopted decisions on organizing production of the apparatuses. The latest was in 1983, when the department of petroleum and chemical machine building ordered the Ministry of Chemical and Petroleum Machine Building to manufacture experimental prototypes in 1984. The Severodonetsk affiliate of the Scientific Research Institute of Chemical Machine Building was named the chief industry organization for the pneumatic apparatuses.

The author relates that one month after delivering specifications to the Severodonetsk affiliate, his institute received a letter from the ministry's technical administration stating that the specifications were not adequate for organizing production of the apparatuses. The author admits that naturally the specifications needed some further elaboration, which was presumed in the assigning of an industry organization, but claims that the affiliate never contacted his institute on this matter.

He complains that access to industry is jealously guarded by industry institutes and design bureaus, whichhregard innovations from the outside as an infringement of their authority.

The author recalls another case in which his institute and the USSR Academy of Sciences' Institute of Chemical Physics developed a simple process for nitriding ferrovanadium, an alloy needed for making cold-resistant tool steel. The work was done at the assignment of GKNT and Gosplan. But the author syas the Ministry of Ferrous Metallurgy has taken 10 years 'getting around' to introducing the process.

In view of such experience, the author makes the following observations:

"Departments of Gosplan and of GKNT do not have the capability of realistically influencing the introduction of technical achievements. The economic system is no help either. Industry institutes are in now way responsible for losses incurred due to red tape. Therefore higher-school science goes around as a beggar. It needs a status that corresponds to its role.

"Consider this comparison. Industry research institutes today employ over half of the country's scientific workers. They get 90 percent of the funds allocated for research from the state budget. They enjoy priority allocations of funds, credits and capital investments. Higher-school sciences has one-third less workers than industry science. But it receives only 1/30th the funding that industry science does. Moreover, these rubles are not backed up by material resources. And really, where could these resources come from, considering that the RSFSR Ministry of Higher and Specialized Secondary Education is financed under the article 'Education', and its patron in the RSFSR Gosplan is the department of culture."

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HEAD OF NEW INFORMATION CENTER ON MATERIALS INTERVIEWED

Moscow NTR: PROBLEMY I RESHENIYA in Russian 19 Mar-2 Apr 85, No 6, p 8

[Abstract] The article is an interview with Candidate of Technical Sciences Aleksandr Dmitriyevich Kozlov, head of the All-Union Scientific Research Center on Materials and Substances, which was created recently in the system of the USSR State Committee on Standards. Kozlov explains that the center was created because of the increasing difficulty of selecting the right materials for products. Its extensive data bank contains reference information not only on existing materials, but also on ones that are being developed. Kozlov says the center's primary task is to collect data on the entire nomenclature of materials that are being produced, that are planned for production, and that are being removed from production, and to make the information available to all interested specialists. With the capability of categorizing and comparing materials that are recorded in its data bank, the center will also be able to serve an advisory function in the optimization of assortments of materials in production.

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UDC: 669.24'71'293:620.17

PROPERTIES OF HEAT RESISTANT Ni-Al-Nb ALLOYS WITH UNIDIRECTIONAL EUTECTIC STRUCTURE

Moscow METALLOVEDENIYA I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 9, Sep 84 pp 11-15

TOROPOV, V. M. and BONDARENKO, Yu. A.

[Abstract] Results are presented from studies of directed crystallization of alloys in the trinary system Ni-Al-Nb, intended to select the optimal chemical composition of the $\gamma/\gamma'-\delta$ eutectic in the system $Ni-Ni_3Al-Ni_3Nb$. Temperature parameters of directed crystallization were determined by thermocouples contained in the ceramic mold at various heights. It was found that in the lower portion of the ceramic mold near the crystallizer the temperature was below the melt liquidus. Crystallization was found to occur in the ceramic mold at a height of up to 15-20 mm, similar to that which occurs in an arc furnace but somewhat more slowly. Analysis of microstructure shows that with a content of 22.5-23.0% Nb primary separation of δ phase occurs in the form of long needles, between which the eutectic crystallizes. The microstructure of the alloy in the middle and the upper portion of the casting shows that with a content of 22-23% Nb after directed crystallization a unidirectional structure is formed with a slightly excess quantity of δ phase in the form of plates between $\gamma\delta\delta$ columns. The time to failure of alloys with unidirectional structure in long-term strength testing at 1100°C and stress of 120 MPa is 14 to 24 hours. Alloying with chromium shows that alloying requires analysis of the tendency of the alloy toward joint oriented phase growth. Addition of 2-4% Cr to the alloy with 22% Nb and 2-2.5% Al increases time to failure to 69-81 hours under the same test conditions. Figures 4; references 8: 7 Russian, 1 Western. [011-6508]

UDC: 541.13+546.31

CONCENTRATION VARIATION OF WORK FUNCTION OF ALLOYS IN THE SYSTEM NICKEL-TITANIUM-ALUMINUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 85 (manuscript received 12 Nov 82) pp 104-108

SAVITSKIY, Ye. M., deceased, BUROV, I. V., IVANYUSHENKO, Ye. V. and KOROL'KOV, V. A., Moscow

[Abstract] A study was made of the major features in the nature of the concentration variation of work function in alloys in the system nickel-titanium-aluminum. The isothermal cross section at 850°C was studied in the nickel corner of the system. Work function was measured by the contact potential difference method in a medium of air at 20°C. The data

produced were used to construct isothermal hardness surfaces and work function of the alloys in an axonometric projection. The results of measurement of the work function under atmospheric conditions were highly reproducible and correspond to definite concentration dependencies characteristic for a given phase area of the state diagram. The major regularities in the nature of the concentration variation of work function of the alloys coincide with the corresponding regularities which obtain in binary alloys studied today. The data confirm the possibility of using the results of measurement of work function by this method as a method of physical and chemical analysis of multicomponent metal systems. Figures 3; references 7: all Russian. [132-6508]

UDC 669..:539.32

EFFECT OF PRE-RECRYSTALLIZATION HEATING ON INTERNAL FRICTION AND JUNG MODULE OF DEFORMED SINGLE-PHASE BRASS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 4, Apr 85 pp 45-47

PIGUZOV, Yu. V., DRAPKIN, B. M. and FOKIN, B. V., State Scientific Research and Planning Institute for Alloys and Processing of Non-Ferrous Metals, Institute of Aviation Technology, Andropov

[Abstract] Intensive development of thermal power plants has called for increased use of alpha-brass for numerous types of installations. In shaping such appliances, questions of annealing and reheating short of recrystallization temperatures must be considered. Such heating increases strength, hardness and elasticity, but other effects have not been studied sufficiently. The present article reports on changes in internal friction and the Jung module in a variety of brasses made with aluminum, tin and a Cu + 48% As alloy. The Jung module was determined by a resonance method, while internal friction was measured using a logarithmic attenuation decrement method. Temperature factors related to internal friction are attributed to relaxational maxima and an upward shift in peak temperature after repeated heating that reduced the maximum internal friction. The number of crystallization defects had a direct bearing on internal friction. Arsenic and tin caused the greatest distortion of the crystalline structure. Figures 2; references 10: 7 Russian, 3 Western.
[156-12131]

UDC 669.018.44:539.4

STOCHASTIC PREDICTION OF CREEP IN HEAT-RESISTANT ALLOYS USING THE MONTE CARLO METHOD

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 85
(manuscript received 10 Jan 83)ppp 7-10

BADAYEV, A. N., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Earlier studies of creep and the duration of temperature and loading duration have dealt with the ZhS6KP construction heat-resistant nickel alloy. The Monte Carlo method has been used with good effect to predict creep probability. The present article reports on development of an algorithm and a program for stochastic prediction of creep using a sub-program that models random standard parameter vectors consistent with given distribution factors, and another subprogram with a Simpson method for cipher integration. Experimental results were consistent with the model, but shifted toward higher time values. This shift was attributed to either the small number of examples, or the nature of the coefficients developed by I. I. Trunin, which used shorter time intervals. Further calculations were used to polish the application programs. Figures 2; references 8: all Russian.
[140-12131]

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