

Soviet and Japanese Aerospace Literature

Throughout 1990 the *AIAA Journal* will carry selected abstracts on leading research topics from the Soviet aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Aluminum Alloys from the USSR and Japan.

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Soviet Aerospace Literature This month: *Aluminum Alloys*

A89-52827 Recovery of the fatigue strength of structural elements of aluminum alloys by surface hardening (Vosstanovlenie soprotivleniia ustalosti elementov konstruktii iz aluminievyykh splavov poverkhnostnym naklepom). M. N. STEPNOV, S. P. EVSTRATOVA, V. V. LOGVINENKO, and V. V. MOZALEV, *Problemy Prochnosti* (ISSN 0556-171X), Aug. 1989, pp. 16-19.

An analysis is made of fatigue test data obtained for specimens of AK6 aluminum alloy which were subjected to repeat surface hardening after their useful life had been partially exhausted. It is shown that surface hardening through plastic surface working (e.g., roller burnishing, vibrational hardening, and shot peening) makes it possible to completely restore the safe service life of structural elements of AK6 alloy. The restoration of the service life of the structural elements can be conducted repeatedly.

A89-52753 A study of the effect of aging conditions on the mechanical properties of rolled aluminum alloy 1201 (Issledovanie vliianiia rezhimov starenii na mekhanicheskiesvoistva prokatannogo aluminievogo splava 1201). G. V. SEREGIN, *Metallovedenie i Termicheskaya Obrabotka Metallov* (ISSN 0026-0819), No. 8, 1989, pp. 53-56. 6 Refs.

Specimens of 1201 aluminum alloy (Al-Cu-Mn) were quenched in water from 535 C and rolled at normal temperature with reductions of 0, 30, 50, and 75 percent. The rolled specimens were then heated to 20, 100, 150, and 200 C, held at these temperatures for various times, and tested under static and cyclic loading. It is found that the microhardness of the alloy increases after rolling and during aging at elevated temperatures. Rolling also increases the fatigue life of the alloy at all stress levels. High-temperature heating after rolling is shown to lower all the mechanical properties of the alloy, including its fatigue characteristics.

A89-52746 Effect of complex melt treatment on primary crystallization in ingots of aluminum alloy 1973 (Vlianie kompleksnoi obrabotki rasplava na protsess pervichnoi kristallizatsii v slitkakh aluminievogo splava 1973). G. I. ESKIN, I. U. P. PIMENOV, G. S. MAKAROV, M. V. BELOVA, and V. P. BUROV, *Akademiia Nauk SSSR, Izvestiia, Metally* (ISSN 0556-171X), July-Aug. 1989, pp. 87-91. 14 Refs.

Ingots of aluminum alloy 1973 with 0.3 percent Zr were produced from a melt that had been subjected to a complex treatment including fine filtering, cooling on a water-cooled tray, and ultrasonic treatment. The structure of the ingots was then investigated metallographically. It is found that the complex melt treatment contributes to the formation of a nondendritic structure, suppresses the primary crystallization of Al₃Zr intermetallics, and increases zirconium concentration in solid solution.

A89-52747 Characteristics of the three-dimensional distribution of intermetallics in aluminum alloys (O zakonornosti prostranstvennogo raspredeleniia vklucheniia intermetallidov v aluminievyykh splavakh). V. V. TELESNOV, A. M. DISKIN, and A. D. PETROV, *Akademiia Nauk SSSR, Izvestiia, Metally* (ISSN 0556-171X), July-Aug. 1989, pp. 104-108. 7 Refs.

The distribution of intermetallics in semifinished products of aluminum alloys is described by an expression relating the projection of excess phase inclusions from a layer to the layer thickness and volume fraction of the phases, with the coefficients of the expression determined by the three-dimensional phase distribution in the alloy and orientation of the projection plate. The expression makes it possible to compare results of a fractographic analysis with the actual distribution of intermetallics in the alloy structure.

A89-50846 Macro- and microscopic fatigue crack growth rates in AMg6 aluminum alloy in vacuum at low temperatures (Makro- i mikroskorost' rosta ustalostnoi treshchiny v aluminievom splave AMg6 v usloviakh vakuuma i nizkoi temperatury). N. M. GRINBERG, V. A. SERDIUK, A. M. GAVRILIAKO, V. A. ZOLOT'KO, E. L. MILOSLAVSKAIA et al., *Problemy Prochnosti* (ISSN 0556-171X), July 1989, pp. 26-32. 27 Refs.

The effect of vacuum (0.0001 Pa) and low temperature (140 K) on fatigue crack growth rate and striation spacing in AMg6 aluminum alloy was investigated over a wide range of maximum stress intensity factors. A kinetic diagram of fatigue fracture is plotted, and two regions of the diagram are identified. Crack growth mechanisms in regions I and II of the kinetic diagram are examined.

A89-46437 A study of the static fracture toughness of a high-strength aluminum alloy of the system Al-Cu-Si (Issledovanie staticheskoi treshchinostoiki vysokoprochnogo liteinogo aluminievogo splava sistemy Al-Cu-Si). G. V. KLEVTSOV, A. G. ZHIZHERIN, N. S. POSTNIKOV, I. S. GOTSEV, and ZH. T. BAKIROV, *Problemy Prochnosti* (ISSN 0556-171X), June 1989, pp. 23-26. 5 Refs.

Experimental data are presented on the static fracture toughness and fracture mechanism of a new high-strength Al-Cu-Si alloy with a porosity of 5.2-6.2 percent. It is shown that conditions close to plane deformation can be realized in specimens 0.05 m thick under off-center tensile loading. The fractures of specimens that are 0.03 m thick or thinner feature a macrozone behind the fatigue crack containing a large number of shrinkage voids and dendritic branches. This macrozone is responsible for a sharp reduction in the stress intensity factor of the alloy.

A89-49329 High-temperature oxidation of titanium-aluminum alloys and development of a method for increasing their heat resistance (Vysokotemperaturnoe okislenie titan-aluminievyykh splavov i razrabotka metoda povysheniia ikh zharostoikosti). G. G. MAKSIMOVICH, V. N. FEDIRKO, A. T. SOBOLEVSKII, and M. N. ZIMA, *Fiziko-Khimicheskaiia Mekhanika Materialov* (ISSN 0430-6252), vol. 25, May-June 1989, pp. 49-53. 7 Refs.

Experiments were carried out on titanium-aluminum alloys, alpha-VT5, VT5-1, and alpha+beta-VT6s, to investigate the mechanisms of the formation of Al₂O₃ layers, characterized by good protective properties. It is found that the scale naturally formed on these alloys under conditions of high-temperature oxidation does not provide sufficient protection against high-temperature gas corrosion and that the formation of a protective Al₂O₃ layer can be achieved only through a special high-temperature diffusion treatment. The protective alumina coating increases the heat resistance of the alloys by a factor of 1.5-2.

A89-49328 Effect of Ni and Mo additions on the corrosion and mechanical properties of a Ti-Al alloy (Vliianie dobavok Ni i Mo na korrozionno-mekhanicheskie svoistva splava Ti-Al). A. A. TRUFANOV, K. B. KATSOV, and M. V. CHERVONYI, *Fiziko-Khimicheskaiia Mekhanika Materialov* (ISSN 0430-6252), Vol. 25, May-June 1989, pp. 28-32. 11 Refs.

Experimental results are presented to show that the alloying of titanium by cathode-modifying additives (Ni and Mo) increases by several orders of magnitude its corrosion stability in hot and room temperature acid solutions, with a simultaneous increase in resistance to stress corrosion cracking. The resistance to stress corrosion cracking, however, remains lower than in the Mo-free alloy Ti-2Al-2Ni, which is attributed to the fact that molybdenum contributes to highly localized selective dissolution of the alloy at the crack tip and hydrogen diffusion to the triaxial-stress zone.

A89-49187 Analysis of the deformability of D16Al0 aluminum alloy (Analiz deformiruemosti aluminievogo splava D16Al0). A. M. GOL'TSEV, G. D. DEL', and V. V. ELISEEV, *Akademiia Nauk SSSR, Izvestiia, Metall* (ISSN 0568-5303), May-June 1989, pp. 78-81.

The effect of prior deformation and various heat treatment schedules on the deformability limit and hardenability of D16Al0 aluminum alloy is investigated experimentally. An equation is proposed for calculating deformability limits in multiple-transformation sheet stamping processes with intermediate heat treatments. It is shown that the hardenability factor depends on the type of intermediate heat treatment and remains constant for different combinations of deformations at the process stages.

A89-44701 Effect of aluminum content on the decomposition kinetics of supersaturated solid solution in Mg-Al alloys (Vliianie soderzhanii aluminia na kinetiku peresyschennogo tverdogo rastvora v Mg-Al-splavakh). L. L. ROKHLIN and A. A. ORESHKINA, *Metallovedenie i Termicheskaiia Obrabotka Metallov* (ISSN 0026-0819), No. 4, 1989, pp. 28-32. 7 Refs.

Heat treated specimens of Mg-Al alloys (maximum Al content, 11.9 percent by mass) were aged at 125, 150, 175, and 200 C for periods up to 128 hr, and the decomposition of supersaturated solid solution was determined by using the Brinell hardness test. The experimental results obtained are generalized in an empirical formula, from which it follows that, at a constant aging temperature, the logarithm of decomposition half-time is inversely proportional to the degree of supersaturation. The applicability limits of the formula are defined.

A89-42621 Acoustic emission during the initiation and propagation of a crack in an aluminum alloy in an aggressive medium (Akusticheskaiia emissiia pri stragivanii i rasprostraneni treshchiny v aluminievom splave pod deistviem agressivnoi sredy). A. V. BAKULIN, S. N. ISAEV, A. P. TISHKIN, and A. M. LEKSOVSKII, *Fiziko-Khimicheskaiia Mekhanika Materialov* (ISSN 0430-6252), Vol. 25, Mar.-Apr. 1989, pp. 74-79. 12 Refs.

The characteristics of acoustic emission produced by crack initiation and propagation in an Al-Zn-Mg alloy, B92, were investigated experimentally in a 3-percent NaCl solution and a solution containing 20 g/cu dm K₂Cr₂O₇ and 13.5 g/cu dm HCl using hardened and aged (10 hr at 140 C) double cantilever beam specimens (130x20x20 mm). An analysis of the results obtained shows that the moment of crack increment in an aggressive medium can be best determined by using an energy parameter of acoustic emission, whereas crack growth is best monitored on the basis of acoustic emission activity (number of AE signals per unit of time).

A89-35462 Effect of stress cycle asymmetry on the corrosion fatigue resistance of 1561 aluminum alloy (Vliianie asimmetrii tsikla napriazhenii na soprotivlenie korrozionnoi ustalosti aluminievogo splava 1561). A. P. OLIIK and A. G. SALAMASHENKO, *Fiziko-Khimicheskaiia Mekhanika Materialov* (ISSN 0430-6252), Vol. 25, Jan.-Feb. 1989, pp. 48-52. 8 Refs.

Plane 6x20-mm specimens of 1561 aluminum alloy were tested in pure bending at 17-20 Hz in air and sea water to investigate the effect of stress cycle asymmetry on the corrosion fatigue resistance of the alloy at the stage of macrocrack nucleation. As the cycle stress asymmetry increases, the effect of sea water on the formation of a stress-corrosion crack is reduced. It is shown that, under conditions of asymmetric loading at the stage of macrocrack nucleation, the life of 1561 alloy can be predicted by using the Goodman formula.

A89-49190 Determination of the boundary of low- and high-cycle fatigue regions in aluminum alloys (Ob opredelenii granitsy oblasti malo- i mnogotsiklovoi ustalosti aluminievyykh splavov). V. V. EVSEEV, *Akademiia Nauk SSSR, Izvestiia, Metall* (ISSN 0568-5303), May-June 1989, pp. 132-135. 22 Refs.

Equations are presented for estimating the boundary of low- and high-cycle fatigue regions in aluminum alloys from fatigue life and stress data. With D16, B95, AK4-1, 01420, and 1201 alloys used as examples, it is shown that the location of the boundary depends on the design and process-related factors and test conditions.

A89-42485 Cyclic hardening and evolution of the dislocation substructure of AMg6 alloy in the high-amplitude region (Tsiklicheskoe uprochnenie i evoliutsiia dislokatsionnoi substrukturny splava AMg6 v vysokoaamplitudnoi oblasti). A. M. GAVRILIAKO, N. M. GRINBERG, V. A. SERDIUK, D. V. LYCHAGIN, and E. V. KOZLOV, *Metallfizika* (ISSN 0204-3580), Vol. 11, May-June 1989, pp. 83-88. 13 Refs.

The dislocation substructure and hardening of the surface layer of AMg6 aluminum alloy during cyclic deformation in the high-amplitude region are investigated by transmission electron microscopy and microhardness measurements. A relationship is established between microhardness and the density of dislocations and dislocation loops. Cyclic hardening occurs less intensively in the subsurface layer up to 20 microns deep. The characteristics of the evolution of the dislocation substructure and cyclic hardening in the high-amplitude region are compared with the corresponding characteristics in the low-amplitude region.

A89-40650 A study of the processing characteristics of aluminum and aluminum alloy powders (Issledovanie tekhnologicheskikh svoistv poroshkov aluminia i ego splavov). L. I. EVDOKIMOVA, A. V. DOVYDENKOVA, V. G. GOPIENKO, V. P. CHEREPANOV, and N. L. ISTOMIN, *Poroshkovaia Metallurgiiia* (ISSN 0032-4795), April 1989, pp. 98-102.

Experimental data are presented on the chemical composition, physical properties, and processing characteristics of pure aluminum (ASD-0 and PA-4) and aluminum alloy (D16 and V95) powders produced by melt atomization techniques. It is shown that the powders investigated are characterized by high activity and good compaction characteristics. However, the low flowability of the powders resulting from the characteristic particle shape and their low specific mass makes them unsuitable for the automatic pressing of parts with a large height/diameter ratio. Ways of improving the processability of aluminum and aluminum alloy powders are briefly discussed.

A89-30235 Modeling of sedimentation diffusion in aluminum alloys (Modelirovanie sedimentatsionnoi diffuzii v aluminievyykh rasplavakh). I. U. N. TARAN, A. A. OFENGENDEN, and A. G. PRIGUNOVA, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 304, No. 2, 1989, pp. 393-396. 9 Refs.

A modeling study of the sedimentation behavior of Al-Si melts in a centrifugal force field has been carried out in order to determine, with a high degree of accuracy, the dimensions of ordered microgroupings of Si atoms formed in such melts. The dimensions of the Si atom microgroupings determined by this method are found to correlate with the results of electron microscopy studies of rapidly cooled films. The generally higher values yielded by the melt sedimentation study indicate that the growth of Si particles does not occur during cooling from the liquid state at rates exceeding 10 to the 6th K/s.

A88-50142 Fatigue resistance of aluminum and magnesium alloys under high-frequency loading (Soprotivlenie ustalosti aluminievogo i magnievogo splavov privysokikh chastotakh nagruzheniia). L. E. MATOKHNIUK, A. V. VOINALOVICH, A. A. KHLIAPOV, V. L. BELOV, A. B. PAVLOVA et al., *Problemy Prochnosti* (ISSN 0556-171X), July 1988, pp. 23-28. 8 Refs.

The effect of loading frequency on the characteristics of the fatigue resistance of an aluminum alloy (AMg6N) and a magnesium alloy (IMV-2) was determined using cylindrical samples in tests involving symmetrical axial tension/compression cycles with frequencies in the range 0.5-10 kHz. It was found that the loading frequency within this range did not affect the endurance limit of IMV-2; the endurance limit of AMg6H, on the other hand, increased monotonically with loading frequency up to 10 kHz, with a difference of about 25 MPa in the endurance limit values between 0.5 and 10 kHz. The effective coefficients of stress concentration and the coefficients which determine the effects of welding did not vary in high-frequency tests.

A89-23679 Effect of cryogenic temperatures on the static and cyclic strength of the base metal and welded joints of 1201 aluminum alloy (Vliianie kriogenykh temperatur na staticheskuu i tsiklicheskuiu prochnost' osnovnogo metalla i svarnykh soedinenii aluminievogo splava 1201). V. A. STRIZHALO, S. Z. STASIUK, and A. I. ZINCHENKO, *Problemy Prochnosti* (ISSN 0556-171X), Nov. 1988, pp. 27-29.

A study is made of the effect of low temperature on the strength and ductility characteristics of the heat-hardenable aluminum alloy 1201 and its welded joints made by electron-beam welding. It is found that, under low-cycle loading, quasi-static fracture occurs in the base metal only, within or outside the heat affected zone; fatigue fracture occurs within the heat affected zone or in the weld metal. The cyclic strength of the alloy and its welds increases with decreasing temperature.

A89-48016 Approximation of deformation diagrams for aluminum and titanium alloys (Approksimatsiia diagramm deformirovaniia aliuminiyevykh i titanovykh splavov). V. N. LOGINOV and S. I. FEOKTISTOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1989, pp. 91-93. 6 Refs.

A method for approximating the stress-strain curve is proposed whereby the curve parameters are determined on the basis of the mechanical characteristics of the material. The approximation yields a closed system of algebraic equations, which is solved by the iteration method. Calculation results are presented for D16-ATN, D19-AT, Ag3M, and B95-AT alloys.

A89-42424 Effect of texture orientation of the initial material on the characteristics of spall damage in D16 and AMg6 alloys (Vlianie orientatsii tekstury iskhodnogo materiala na kharakter otkol'nykh povrezhdenii splavov D16 i AMg6). A. P. STEPOVIK, *Problemy Prochnosti* (ISSN 0556-171X), May 1989, pp. 111-113. 8 Refs.

The relation between the initial structure orientation of D16 and AMg6 alloys and the orientation of defects formed in these alloys under dynamic loading is investigated experimentally. It is found that prespall void orientation correlates with structure orientation in the as-received material. The region of tensile stresses is determined in which defects in the form of voids of about 10 microns to tenths of a millimeter are formed during dynamic loading in the 0.9-2.5 GPa range.

A89-32202 Characteristics of the macrostructure of aluminum alloys (Osobennosti makrostrukturnykh aliuminiyevykh splavov). V. I. NIKITIN and G. P. KULINICHEV, *Metallovedenie i Termicheskaya Obrabotka Metallov* (ISSN 0026-0819), No. 1, 1989, pp. 62-64. 7 Refs.

Characteristics of macrostructure formation in commercially pure aluminum (A99, A85, and A7) and cast Al-Mn, Al-Cu, and Al-Si alloys are investigated experimentally. It is found that the visible boundaries of the macrograins in commercially pure aluminum correspond to the boundaries of crystals observed in the microstructure. In the case of aluminum alloys, the smallest macrocrystals correspond to a single microcrystal in solid solution type alloys and to a dendrite (or a dendrite branch) in silumins.

A89-26153 Thermally sprayed coatings on aluminum alloys (Gazotermicheskoe napylenie pokrytii na aliuminiyevye splavy). V. G. ZIL'BERBERG, A. M. VIAL'TSEV, N. I. KIRKUN, and D. M. KARPINOS, *Poroshkovaya Metallurgiya* (ISSN 0032-4795), Dec. 1988, pp. 37-40. 12 Refs.

Work related to thermally sprayed coatings on aluminum alloys published over the past fifteen years is briefly reviewed and summarized. Particular attention is given to factors affecting the coating-substrate adhesion and methods of improving the adhesion between the coating and the aluminum substrate. The discussion is illustrated by experimental results obtained for titanium and stainless steel coatings on V95 and D16 aluminum alloys.

A89-21597 Elastic-plastic properties of AMg6M aluminum alloy at high deformation rates (Uprugoplasticheskie svoistva aliuminiyevogo splava AMg6M privysokikh skorostiakh deformatsii). A. M. BRAGOV and A. K. LOMUNOV, *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Sept.-Oct. 1988, pp. 168-171. 15 Refs.

Experimental data are presented on the behavior of AMg6M alloy at deformation rates of 1000/s. It is found that the deformation rate has a significant effect on the mechanical properties of the alloy. In experiments with dynamic cyclic loading, the elastic characteristics are found to be independent of the deformation history.

A89-13283 Crack growth resistance of heavy extruded and rolled semifinished products of new aluminum alloys (Soprotivlenie razvitiu treshchiny krupnogabaritnykh pressovannykh i katanykh polufabrikatov iz novykh aliuminiyevykh splavov). A. G. VOVNIAKO, L. A. BUKREEVA, and E. A. ZAKHARENKO, *Metallovedenie i Termicheskaya Obrabotka Metallov* (ISSN 0026-0819), No. 9, 1988, pp. 8-11. 5 Refs.

Experimental data are presented on crack propagation rates in extruded and rolled panels of new aluminum alloys 1161, 1163, and 1973 used in load-bearing wing structures. The results obtained for these alloys are compared with crack growth data for the traditional D16ch and V95pch alloys. It is shown that the fracture toughness of the new alloys is significantly higher than that of D16ch and V95pch, making it possible to increase the life of aircraft components and permissible loads while reducing the aircraft weight. It is also shown that the use of extruded instead of rolled panels makes it possible to increase nominal stresses.

A89-13282 Effect of grain size on the structural strength of the aluminum alloy AMg6 (Vlianie razmera zerna na konstruktivnuu prochnost' aliuminiyevogo splava AMg6). M. KH. RABINOVICH, V. G. KUDRIASHOV, and M. V. MARKUSHEV, *Metallovedenie i Termicheskaya Obrabotka Metallov* (ISSN 0026-0819), No. 8, 1988, pp. 42-44. 18 Refs.

The strength and ductile characteristics of AMg6 alloy are investigated experimentally as a function of its grain size. It is found that the longitudinal and transverse strength and ductility of the alloy, its transverse impact toughness, and the conditional stress intensity factor are practically independent of the grain size. An ultrafine-grained structure somewhat reduces the low-cycle fatigue life of AMg6 alloy while increasing its high-cycle fatigue life. The ultrafine-grained AMg6 alloy is isotropic with respect to fracture toughness, whereas the coarse-grained alloy is anisotropic.

A88-53978 Composition and structure of a hardened surface layer on aluminum alloys produced by microarc oxidation (Sostav i struktura uprochnennogo poverkhnostnogo sloia na splavakh aliuminiia, poluchaemogo pri mikrodugovom oksidirovanii). V. A. FEDOROV, V. V. BELOZEROV, N. D. VELIKOSELSKAIA, and S. I. BULYCHEV, *Fizika i Khimiia Obrabotki Materialov* (ISSN 0015-3214), July-Aug. 1988, pp. 92-97. 11 Refs.

Experimental results are presented on the phase composition and structure of a hardened surface layer produced by microarc oxidation on various commercial aluminum alloys, such as A99, AMg6, D16, V96, and A19. It is shown that the phase composition of the hardened layer depends on the chemical composition of the oxidized material and on the oxidation process variables. The results demonstrate the possibility of obtaining hardened layers with specified phase composition and structure, and consequently, with desired properties.

A88-53959 A study of the fatigue of an aluminum alloy of the system Al-Zn-Mg using a two-factor simplex-summable design (Issledovanie ustalosti aliuminiyevogo splava sistemy Al-Zn-Mg s pomoshch'iu dvukhfaktornogo simpleks-summiruemogo plana). G. I. BEL'TIUKOVA, M. P. KRASNOVA, I. A. K. KUL'GAVII, and A. N. LIALINOV, *Problemy Prochnosti* (ISSN 0556-171X), Aug. 1988, pp. 68-70.

The fatigue characteristics of an Al-Zn-Mg alloy are investigated experimentally for different cycle ratios (0.12-0.46) using a two-factor simplex-summable experimental design. It is found that, as the cycle ratio increases by a factor of 4, the conditional fatigue limit of the alloy increases by a factor of 10. The experimental design used here has made it possible to reduce the number of tests while providing more information.

A88-52847 Effect of drawing conditions on the structure and properties of heat-hardenable aluminum alloys (Vlianie rezhima volochenii na strukturu i svoistva termouprochnykh aliuminiyevykh splavov). M. E. SMAGORINSKII and M. V. ROZE, *Akademiia Nauk SSSR, Izvestiia, Metallurgiya* (ISSN 0568-5303), July-Aug. 1988, pp. 113-117.

Experiments have been carried out to investigate the effect of repeated low-temperature thermomechanical treatment on the structure and physico-mechanical properties of drawn wire of AVE aluminum alloy. Detailed experimental data are presented to show that the physico-mechanical properties of the alloy depend on the number of thermal deformation cycles, total deformation, and thermal cycle parameters (heating temperature and holding time). The treatment makes it possible to produce aluminum wire with a wide range of strength-conductivity characteristics.

A88-50124 Quantitative parameters of fast stress relaxation in a high-strength P/M aluminum alloy (Kolichestvennye parametry bystrogo relaksatsii napriazhenii v granuliruemom vysokoprechnom aliuminiyevom splave). V. F. GAIDUCHENIA, E. B. KALMYKOV, V. V. MISHAKIN, V. A. SKUDNOV, and A. L. UGLOV, *Fizika Metallov i Metallovedenie* (ISSN 0015-3230), Vol. 65, June 1988, pp. 1186-1190. 13 Refs.

Stress relaxation mechanisms in a P/M aluminum alloy, B95, are investigated experimentally in the temperature range 293-523 K for strains equal to or greater than 0.0001 and stresses near or below the macroscopic yield strength, with exposures of 150-180 s under stress (fast relaxation). Mechanisms inhibiting plastic deformation during stress relaxation at low stresses in the interval 300-350 K are identified. The principal characteristics of the stress relaxation curves determined by different methods are presented.

A88-49541 Cyclic hardening of AMg6 alloy in vacuum at room and low temperatures (Tsiklicheskie uprochnenie splava AMg6 v vakuume pri komnatnoi i nizkoi temperaturakh). A. M. GAVRILIAKO, N. M. GRINBERG, V. A. SERDIUK, D. V. LICHAGIN, and E. V. KOZLOV, *Metallofizika* (ISSN 0204-3580), Vol. 10, July-Aug. 1988, pp. 36-42. 18 Refs.

The cyclic hardening behavior and evolution of the dislocation structure of AMg6 alloy during cyclic deformation in vacuum at 293 and 140 K are investigated experimentally using electron microscopy and hardness measurements. It is found that hardening and an increase in dislocation density occur in three stages and are primarily confined to a surface layer whose depth does not exceed half the grain diameter. The significant role of dislocation loops in cyclic deformation is demonstrated. The formation of dislocation structures in fcc metals and alloys under cyclic loading in the high-cycle region is discussed.

A88-19600 Determination of the cyclic damage of aluminum alloys by means of diffusive resistance strain gauges (Opredelenie tsiklicheskogo povrezhdeniia aliuminiyevykh splavov s pomoshch'iu diffuzionnykh tensorezistorov). I. M. DASKOVSKII, V. F. LYS, and I. U. I. USTINOVSHCHIKOV, *Problemy Prochnosti* (ISSN 0556-171X), Oct. 1987, pp. 111-116.

The use of diffusive resistance strain gauges based on (BiSb)Te films as fatigue transducers is discussed, and it is shown that such resistors provide information on the accumulated cyclic strain. The dependence of the accumulated cyclic strain on the number of cycles is represented by a curve whose shape yields information on the remaining life of the specimen. It is shown experimentally that, under cyclic loading, D16AT and AK4-1T aluminum alloys first soften, then harden, and then soften again. The value of the maximum cycle stress does not change the nature of the dependence of the accumulated strain on the number of cycles.

A88-19533 Characteristics of the fracture surface structure of rolled aluminum alloy of the system Al-Zn-Mg (Osobennosti stroeniia poverkhnosti razloma aluminievogo prokata iz splava sistemy Al-Zn-Mg). A. A. ARTSRUNI, N. F. KUZOVA, S. M. NEFEDOVA, and B. D. CHUKHIN, *Metallovedenie i Termicheskaya Obrabotka Metallov* (ISSN 0026-0819), No. 10, 1987, pp. 59-61.

The fracture surfaces of rolled Al-Zn-Mg alloy parallel to the rolling plane are investigated with a view to identifying possible chemical or structural inhomogeneities. It is found that specimens with a fish-scale fracture morphology are characterized by local increases in the contents of both principal alloying elements, Zn and Mg, and such impurities as Fe and Si. The formation of a fish-scale morphology in high-strength aluminum alloys can be prevented by overaging.

A88-43622 A study of the dependence of the corrosion rate of aluminum alloys on their composition and the composition of aqueous alkali solutions. II (Izucheniye zavisimosti skorosti korrozii aluminievyykh splavov ot ikh sostava i ot sostava vodnykh shchelochnykh rastvorov. II). V. V. BONDAREV, E. B. KULAKOV, and E. G. MIKHAILOVA, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No. 1, 1988, pp. 88, 89.

An experimental study is made of the effect of the addition of indium (0.2-1.5 mass pct) to the aluminum anode and of the addition of a corrosion inhibitor, tin (0.06 mol/cu dm), to the electrolyte (a 20-percent solution of potassium hydroxide) on the corrosion rate of aluminum. It is shown that the addition of tin to the electrolyte significantly reduces the corrosion rate of the aluminum anode. In a tin-free electrolyte, the corrosion of an Al-In alloy first somewhat decreases but then increases with increasing indium content. In a tin-containing electrolyte, the dependence of the anode corrosion rate on In content has a maximum at 0.6 mass pct In.

A88-43112 Effect of stress concentrations on the mechanical properties of 1201T1 aluminum alloy at low temperatures (Vliianie konsentratsii napriazhenii na mekhanicheskie svoystva aluminievogo splava 1201T1 pri nizkikh temperaturakh). B. I. KOVAL'CHUK, V. N. RUDENKO, A. M. KHVATAN, and A. L. SADOVNIKOV, *Problemy Prochnosti* (ISSN 0556-171X), May 1988, pp. 22-25. 7 Refs.

Experimental results are presented on the deformation and strength characteristics of specimens of 1201T1 aluminum alloy, with and without stress concentrators, under uniaxial tensile loading in the temperature range 20-293 K. The effect of low temperatures on the sensitivity of the alloy to stress concentrators is evaluated. The strength of the material is then examined in relation to the orientation of the fracture surface of plane specimens for the case of a complex stressed state.

A88-36070 Amplitude dependence of internal friction in a Cu-Zn-Al alloy in the presence of deformation martensite (Amplitudnaya zavisimost' vnutrennego treniya splava Cu-Zn-Al pri nalichii martensita deformatsii). V. A. EVSIUKOV, M. N. GARSHINA, and N. V. AGAPITOVA, *Fizika Metallov i Metallovedenie* (ISSN 0015-3230), Vol. 65, Feb. 1988, pp. 395, 396. 5 Refs.

A study is made of the effect of tensile stresses on the amplitude dependence of internal friction in Cu-34.45 wt pct Zn-1.72 wt pct Al alloy at temperatures near the martensitic transformation and in the transformation region. Internal friction vs temperature curves are plotted for various periodic deformation amplitudes, and it is shown that the maximum on the temperature dependences of internal friction increases with amplitude. This effect becomes more pronounced with increasing tensile stress.

A88-23347 A study of the microstructure and service life characteristics of forgings of V93pch aluminum alloy (Issledovanie mikrostruktury i resursnykh kharakteristik shtampovok iz aluminievogo splava V93pch). G. L. SHNEIDER, V. K. ZEL'TIN, A. A. KALUGIN, A. D. PETROV, and A. A. KOL'TSOVA, *Akademiia Nauk SSSR, Izvestiia, Metally* (ISSN 0568-5303), Nov.-Dec. 1987, pp. 100-104. 11 Refs.

The objective of the study was to determine an optimum range of cooling rates for heavy forgings of V93pch aluminum alloy in order to improve their strength and fatigue characteristics. A relationship is established between the structural parameters of the alloy and its strength and durability characteristics. The physical meaning of the critical thermokinetic quenching rate is defined in terms of structural parameters. It is shown that the use of optimum cooling rates (5.2-8.0 C/s) makes it possible to increase the average life of the alloy by a factor of 2 or more.

A88-30070 Effect of heat treatment on the properties of titanium-aluminum low alloys (Vliianie termicheskoi obrabotki na svoystva malolegirovannykh splavov titana s alumiiniem). A. V. URTEV, and S. S. USHKOV, *Fizika Metallov i Metallovedenie* (ISSN 0015-3230), Vol. 64, Dec. 1987, pp. 1147-1151. 13 Refs.

A study is made of the effect of different heat treatment schedules on the mechanical and electrochemical properties of Ti-Al alloys containing 0-6.5 percent Al (by mass). It is found that the strength of alloys containing more than 3 pct Al increases with decreasing rates of cooling from the polymorphic transformation region. Changes in the properties of alpha solid solutions associated with different heat treatment schedules are explained in terms of the formation of coherent ordered alpha-2 precipitates.

A88-28411 Microalloying of high-strength cast aluminum alloys with highiron and silicon contents (O mikrolegirovanii vysokoprechnykh liteinykh aluminievyykh splavov s povyshennym soderzhaniiem zheleza i kremniia). A. A. AKSENOV, N. A. BELOV, V. S. ZOLOTOREVSKII, V. V. ISTOMIN-KASTROVSKII, and I. U. N. MANSUROV, *Akademiia Nauk SSSR, Izvestiia, Metally* (ISSN 0568-5303), Jan.-Feb. 1988, pp. 114-120. 8 Refs.

Phase region distribution in alloys based on Al-Mg-Fe, Al-Mg-Zn-Fe, and Al-Zn-Mg-Cu-Fe systems with additions of Be, Ni, Co, and Mn is investigated, and optimum additive concentrations that result in the formation of compact particles of iron-containing phases are determined. It is shown that additions of Ca, Na, and Li bind silicon into phases that do not contain the principal alloying elements, thus preventing magnesium depletion in solid solution and avoiding the negative effect of silicon on the alloy strength. It is also shown that high-temperature heating for hardening contributes to the spheroidization of silicon-containing phases.

A88-26704 Effect of hot working on the structure of a cast Ti-36 wt pct Al alloy (Vliianie goriachei deformatsii na strukturu litogo splava Ti-36 ves.). O. A. KAIBYSHEV, S. G. GLAZUNOV, G. A. SALISHCHEV, R. M. IMAEV, and V. I. IVANOV, *Fizika Metallov i Metallovedenie* (ISSN 0015-3230), Vol. 64, Nov. 1987, pp. 1005-1010. 11 Refs.

The effect of hot working on the structure of a cast Ti-36 wt pct Al alloy is investigated experimentally with a view to determine the possibility of superplastic deformation. It is shown that the alloy undergoes dynamic recrystallization, and the conditions leading to the formation of a fine-grained structure are determined. It is also found that the twins formed at the initial stage of deformation contribute to the process of dynamic recrystallization.

A87-47525 Some characteristics of the R-curve and its use for evaluating the fracture toughness of aluminum alloys (O nekotorykh osobennostiakh R-krivoi i ee ispol'zovanii dlia otsenki soprotivleniia razrusheniiu aluminievyykh splavov). G. S. NESHPOR, *Zavodskaya Laboratoriia* (ISSN 0321-4265), Vol. 53, No. 5, 1987, pp. 69-73. 7 Refs.

An analysis is made of R-curves obtained, under tensile loading, for 100-500-mm-wide sheets of various aluminum alloys (yield strength, 331-450 MPa) with a central crack. It is shown that the R-curves of aluminum alloys in double logarithmic coordinates form a fan-shaped pattern converging at a certain point; the coordinates of this point are determined. A general equation describing the R-curve of aluminum alloys is derived.

A87-31937 The effect of vibrations during bending on the fatigue strength of titanium and aluminum alloys in the case of repeated static tension (O vlianii vibratsii pri izgibe na soprotivlenie ustalosti titanovykh i aluminievyykh splavov v sluchae povtorno-staticheskogo razlazheniia). T. S. VOZNYI, *Problemy Prochnosti* (ISSN 0556-171X), Jan. 1987, pp. 35-38. 7 Refs.

The effect of high-frequency vibrations during bending on the behavior of titanium and aluminum alloys under repeated static tensile loading is examined with reference to experimental results for TS, OT4-0, VT6, VT14, Al4, and AK8 alloys. For all the materials studied, the superposition of vibrations leads to softening, with a resulting reduction in the number of cycles to failure; the extent of softening depends on the type of material and its state. It is also shown that an increase in the level of repeated static loading by an amount equal to the vibration amplitude (vibration under bending is replaced by static tensile loading) results in a fatigue life that is less than the fatigue life observed under two-frequency loading.

A88-43117 Characteristics of the formation of residual stresses in specimens of aluminum alloys (Osobennosti obrazovaniia ostatocnykh napriazhenii v obraztsakh iz aluminievyykh splavov). G. F. RUDZEI and A. N. MATATANOVA, *Problemy Prochnosti* (ISSN 0556-171X), May 1988, pp. 51-54.

Curves describing residual stresses after forming operations are obtained for simple structural elements of V95, AK4, and D16AT aluminum alloys. In order to increase the fatigue life of structural elements whose manufacture involves plastic forming processes, it is recommended that these elements be made of materials with large values of percent elongation and K, a parameter determining the sensitivity of the material to the formation of residual stresses.

A88-43642 Strength and fracture of AMg6 aluminum alloy under shock wave loading (Prochnost' i razrushenie aluminievogo splava AMg6 pri udarno-volnovom nagruzhении). V. K. GOLUBEV, A. I. KORSHUNOV, S. A. NOVIKOV, I. U. S. SOBOLEV, and N. A. IUKINA, *PMFT - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Mar.-Apr. 1988, pp. 121-128. 18 Refs.

New experimental data are presented on the effect of temperature on the resistance to spall damage of specimens fabricated from annealed sheets of AMg6 alloy. All available data on the spall damage of AMg6 alloy under shock wave loading are summarized in a systematic manner in relation to material production technology, test temperature, and characteristic loading time. It is shown that, when these factors are taken into account, good agreement is obtained between data from different sources.