

**A87-43647 Control of robot systems and flexible computer-aided manufacturing systems (Russian book)** (Upravlenie robototekhnicheskimi sistemami i gibkimi avtomatizirovannymi proizvodstvami). IGOR' MIKHAILOVICH MAKAROV, VIL' ZAKIROVICH RAKHMANKULOV, VIKTOR MIKHAILOVICH NAZARETOV, SERGEI ALEKSEEVICH BLINOV, ALEKSEI MIKHAILOVICH MIKHAILOV et al. Moscow, *Izdatel'stvo Vysshaya Shkola* (Robototekhnika i Gibkie Avtomatizirovannye Proizvodstva. Vol. 3), 1986, 160 pp. 14 Refs.

The present work examines systems for the remote and interactive control of robots, the automatic control of robots, and the group control of robots and equipment. Methods for the analysis of the kinematic and dynamic characteristics of manipulator and locomotive robots are described. Algorithms for the control of flexible computer-aided manufacturing systems are presented.

**A87-41952 A study of the relative motion of a rigid body in the atmosphere in the presence of perturbations (K issledovaniyu ot-nositel'nogo dvizheniya tverdogo tela v atmosfere pri deistvii voz-mushchenii).** G. M. LOKHOV and S. I. PODZOROV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Mar.-Apr. 1987, pp. 3-11. 9 Refs.

The problem of the dynamics of the relative motion of an uncontrolled rigid body in the atmosphere in the presence of perturbations is solved using an approach combining various asymptotic and numerical methods for solving equations of motion at different sections of the trajectory. The combined algorithm developed here makes it possible to reduce the computation time approximately by an order of magnitude in comparison with finite-difference numerical integration. By using asymptotic equations of the three-dimensional relative motion of a rigid body in the atmosphere in the presence of perturbations, fast computational algorithms are developed which can be used for fast analysis in computer-aided design systems.

**A87-40342 K.E. Tsiolkovskii and problems in the development of science and technology (Russian book)** (K.E. Tsiolkovskii i problemy razvitiia nauki i tekhniki). B. M. KEDROV and A. A. KOS-MODEM'IANSKII, eds., Moscow, *Izdatel'stvo Nauka*, 1986, 192 pp.

Aspects of long-duration space flight are examined in the light of Tsiolkovskii's ideas. Particular consideration is given to advances in rocket and space technology, space-flight mechanics, and space industrialization. A number of biomedical problems connected with the prolonged stay of man in space are examined. Philosophical problems connected with space exploration are discussed along with Tsiolkovskii's theories about scientific prediction.

**A87-40335 Life-support systems for space crews (Russian book)** (Sistemy zhizneobespecheniia ekipazhei letatel'nykh apparatov). VLADIMIR VIKTOROVICH MALOZEMOV, VALERII FEODOS'EVICH ROZHNOV, and VLADIMIR NIKOLAEVICH PRAVETSKII, Moscow, *Izdatel'stvo Mashinostroenie*, 1986, 584 pp. 107 Refs.

The effects on humans of environmental conditions specific for a space flight, such as high altitude, cosmic radiation, weight overloads during the acceleration/deceleration stages, weightlessness, noise and vibration, magnetic fields, and ion-containing atmosphere, are discussed together with the ergonomic and technological demands placed on the life-support (LS) systems of manned spacecraft. Consideration is given to systems designed to regenerate the environment of a spacecraft, including systems for the conservation of air and water, for food storage, and for biological regeneration. Systems for maintaining the temperature and humidity inside the spacecraft and for using external heat sources are discussed. Special attention is given to mathematical models of various LS systems and subsystems. Block diagrams are included.

**A87-36583 Aircraft assembly processes (Russian book)** (Tekhnologiia sborki samoletov). VLADISLAV IVANOVICH ERSHOV, VIKTOR VLADIMIROVICH PAVLOV, MIKHAIL FILIPPOVICH KASHIRIN, and VADIM SERGEEVICH KHUKHOREV, Moscow, *Mizdatel'stvo Mashinostroenie*, 1986, 456 pp. 18 Refs.

The theory of aircraft assembly and the principal assembly processes are reviewed with particular attention to methods of computer-aided manufacture. Topics discussed include mathematical modeling of aircraft assembly organization; interchangeability of structural elements during assembly; typical assembly processes; and automatic control of the specialized equipment of assembly shops. Attention is also given to the evaluation of the cost effectiveness of aircraft assembly processes; design of assembly processes; and software support of CAD/CAM systems.

**A87-31723 Calculation of a plane nonadjustable supersonic air intake for CAD (Raschet ploskogo nereguliruemogo vozdukhobzabornika so sverkhzvukovoi skorost'iu na vykhode dlia SAPR).** A. D. BOROVIKOV, D. M. DAVIDENKO, V. V. DUGANOV, and A. G. TIKHONOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), no. 4, 1986, pp. 20-23.

A procedure is described for the design and analysis of a plane multistep nonadjustable supersonic air intake. The procedure has been implemented in a software module written in FORTRAN-IV for a computer-aided ramjet design system. The program makes it possible to calculate isolated and ventral air intakes at zero and positive angles of attack. The procedure is illustrated by an example.

## Japanese Aerospace Literature This month: Alloys in Structural Design

**A88-47271 Mechanism of plastic deformation of Mn-added TiAl L1(0)-type intermetallic compound.** T. HANAMURA, R. UEMORI, and M. TANINO, *Journal of Materials Research* (ISSN 0884-2914), Vol. 3, July-Aug. 1988, pp. 656-664. 5 Refs.

Titanium aluminum intermetallic compound is a possible candidate for a high-temperature structural material, except for a problem of lack of room-temperature ductility. Recently, this problem was found to be overcome possibly by the addition of Mn, but this mechanism has not been fully understood yet. In order to understand the fundamental mechanism of the ductility improvement by Mn addition, microanalyses have been carried out. The results are as follows. Twin structures in a TiAl intermetallic compound in the as-cast state can be eliminated by high-temperature annealing, while those in Mn-added TiAl are thermally more stable and exist even after annealing for 86.4 ks at 1273 K. The reason for this thermal stabilization of twin structures is considered to be due to the pinning effect of twin dislocations by Mn addition. The enhancement of twin deformation in TiAl by Mn addition is regarded to be caused by two factors. One is the stabilization of twin partial dislocations, becoming the nucleation sites for twin formation. The other is the decrease in stacking fault energy, which makes twin deformation energetically easier.

**A88-49096 Growth and coarsening of G.P. zones in Al-Zn alloys.** KOZO OSAMURA, YOSHIYUKI AMEMIYA, HIROO HASHIZUME, and HIROSHI OKUDA, *Metallurgical Transactions A - Physical Metallurgy and Materials Science* (ISSN 0360-2133), Vol. 19A, Aug. 1988, pp. 1973-1980. 25 Refs.

The structural changes during the precipitation of G.P. zones in Al-Zn binary alloys have been investigated by means of an in situ small-angle scattering technique using synchrotron radiation. Defining a specific time, normalized by the half-completion time, the time-dependent evolution of the precipitation process can be divided into three periods independent of alloy composition and quenching conditions. The structural and kinetic features of the first two periods have been analyzed in detail. The first stage represents a growing process of clusters with diffuse interface into the well-defined G.P. zones. The average size of these clusters increases, and the density decreases. The second stage corresponds to the Ostwald ripening process. This mechanism is described by utilizing a modified Lifshitz-Slyozov-Wagner theory.

**A88-49931 Structure of aluminum oxide films and their gas desorption properties.** YUTAKA KATO, EIZO ISOYAMA, and MINORU HASEGAWA, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 38, Aug. 1988, pp. 462-467. 18 Refs.

The relation between the structure of aluminum oxide films on 6063 alloy and their gas desorption property was studied. 6063 alloy etched in alkali solution shows outgassing rates  $4.2 \times 10$  to the -9th torr l/s sq cm 10 h after initial evacuation at room temperature and  $1.0 \times 10$  to the -12th torr l/s sq cm 10 h after baking at 100 C for 24 h. The alloy etched in alkali solution, dried in vacuum and heated in Ar + O<sub>2</sub> mixture gas shows outgassing rates  $3.2 \times 10$  to the -10th torr l/s sq cm 10 h after initial evacuation at room temperature and  $3.9 \times 10$  to the -12th torr l/s sq cm 10 h after baking at 100 C for 24 h. The alloy extruded in Ar + O<sub>2</sub> shows the same outgassing rates. Porous hydrated oxide films are formed on the alloy etched in alkali solution and stored in air. The formation of hydrated oxide films during storage in air is controlled by heating in vacuum and in the Ar + O<sub>2</sub> mixture after alkali etching. Hydrated oxide films affect outgassing rates.

**A88-46624 Atomistic defect structures of Ni<sub>3</sub>Al containing C, B and Be.** N. MASAHASHI, T. TAKASUGI, and O. IZUMI, *Acta Metallurgica* (ISSN 0001-6160), Vol. 36, July 1988, pp. 1815-1822. 20 Refs.

The atomistic defect structures of Ni<sub>3</sub>Al containing C, B and Be atoms were investigated using Debye-Scherrer technique and X-ray diffractometer. It was proposed that the elements of C and B occupy the interstitial site of the body centered position of the L1<sub>2</sub> structure while the elements of Be substitute for the Al site of the L1<sub>2</sub> structure. Also, it was observed that the additions of C and B atoms into the Ni<sub>3</sub>Al induced the further ordering of the constituent atoms of Ni and Al. This was more significant at the off-stoichiometric compositions of the Ni<sub>3</sub>Al. The energetic consideration, involving the nearest neighbor interactions between the constituent atoms, and between the interstitial atom and the constituent atom, was presented in order to explain the further ordering of the constituent atoms.

**A88-52977 Effects of precipitate particles on structure evolution during hot rolling of 3003 aluminum alloy.** TAKEYOSHI DOKO, SHIGENORI ASAMI, and KEISUKE YAGI, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 38, July 1988, pp. 386-393. 23 Refs.

Direct chill-cast ingots of 3003 Al alloy were homogenized in two conditions and subsequently submitted to single-pass hot rolling, and the rolled plates were held at exit temperature. The precipitation by homogenization and the structural change during the holding were investigated by means of TEM. Homogenization at 450°C results in fine dispersion of small  $\alpha$  Al(Fe, Mn)Si precipitate particles; on the contrary, two-step homogenization at 600-450°C brings about coarse dispersion of relatively larger particles.

**A88-49849 Directionally solidified structure of MgO-ZrO<sub>2</sub>-X (X: Ca, Y, Al, Si) eutectics.** JUN-ICHI ECHIGOYA and HAJIME SUTO, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 52, June 1988, pp. 595-602. 19 Refs.

The directionally solidified structure of MgO-ZrO<sub>2</sub> eutectic with small amounts of additives (CaO, Y<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub>) has been investigated. The oriented microstructure with lamellar and fibrous morphologies has been obtained in the case of CaO and Y<sub>2</sub>O<sub>3</sub> additions, in which the additives can be dissolved in the ZrO<sub>2</sub> matrix. On the other hand, cell boundaries have been developed with a small amount of Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub>. In the case of SiO<sub>2</sub> addition, the precipitation of Mg<sub>2</sub>SiO<sub>4</sub> has been observed at the MgO/ZrO<sub>2</sub> interface. It nucleates coherently at the MgO side of the interface in the early stage of precipitation. This results from the small solubility of the additives in MgO.

**A88-49981 New icosahedral and amorphous phases in Mg-Al-Ag system prepared by liquid quenching.** AKIHISA INOUE, KOH NAKANO, YOSHIO BIZEN, TSUYOSHI MASUMOTO, and HO SOU CHEN, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 27, June 1988, pp. L944-L947. 11 Refs.

New icosahedral (I) and amorphous (Am) phases in the Mg-Al-Ag system have been produced by liquid quenching. Their formation extends in wide ranges of 30 to 67 pct Al and 3 to 30 pct Ag for the I-phase and 5 to 30 pct Al and 3 to 30 pct Ag for the Am-phase. Thus, the change of the ratio of Al to Al + Mg brings about a drastic structural change. The decomposition temperature and electrical resistivity at 273 K are 435 to 540 K and about 130 microhm cm for the I-phase and 352 to 412 K and about 80 microhm cm for the Am-phase; the I-phase alloys have a higher thermal stability and higher resistivity than the amorphous alloys.

**A88-49982 Highly ordered icosahedral quasicrystal of Al-Cu-Fe alloy studied by electron diffraction and high-resolution electron microscopy.** KENJI HIRAGA, BO-PING ZHANG, MAKOTO HIRABAYASHI, AKIHISA INOUE, and TSUYOSHI MASUMOTO, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 27, June 1988, pp. L951-L953. 6 Refs.

An icosahedral quasicrystal in a conventionally solidified Al-Cu-Fe alloy has been examined with electron diffraction and high-resolution electron microscopy. Diffraction and Kikuchi patterns taken with the incident beam exactly parallel to the 5- and 3-fold symmetry axes show strict 5- and 3-fold rotational symmetry. Any systematic shift of diffraction spots, which often appears in rapidly solidified quasicrystals, was not observed at all. A high-resolution electron micrograph taken with the incident beam parallel to the 5-fold axis shows no existence of phason strains in the icosahedral quasicrystal.

**A88-46020 Effects of cooling rate and Zn content on microstructures and mechanical properties of Mg-4.0 pct RE-0.7 pct Zr alloy.** SHIGEHARU KAMADO, MAKOTO TSUKUDA, ICHIROU TOKUTOMI, and KIKOU HIROSE, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 38, May 1988, pp. 251-256. 22 Refs.

Effects of liquid cooling rate, V(LC), and Zn content on microstructures and mechanical properties of unidirectionally solidified and T5-treated Mg-4.0 pct RE-0.7 pct Zr-x pct Zn alloys (x = 0, 2.2, 3.1, 3.9, and 5.7) were investigated. Equiaxed grain size reduces with acceleration of V(LC). The amount of Mg-RE-Zn eutectic compounds increases as V(LC) and Zn content in the alloys increase. Zn in the matrix of as-cast alloys is condensed with decreasing V(LC) and with increasing Zn in the alloys. Tensile strength, elongation, and impact properties decrease, but 0.2 pct proof stress and Brinell hardness increase with increasing Zn content in the alloys. The T5-treated alloys strengthen proportionally with Zn content in the matrix of solidified structures. Tensile properties, Brinell hardness, maximum load and crack initiation energy are improved as V(LC) increases.

**A88-41698 Synchrotron radiation small-angle X-ray scattering study on reversion process of G.P. zones in Al-Zn binary alloys.** KOZO OSAMURA, YOSHIYUKI AMEMIYA, HIROO HASHIZUME, and HIROSHI OKUDA, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 52, April 1988, pp. 375-382. 23 Refs.

The reversion process below the miscibility gap has been investigated for Al-Zn binary alloys by means of in-situ synchrotron radiation small-angle X-ray scattering. In the present study, it was made clear that the structure change during the reversion below the miscibility gap was divided into two processes, i.e., the reversion process and the coarsening process. Also, in the reversion process there were two stages. The early stage of reversion was characterized by the decreasing solute concentration and a constant volume fraction of the zones. The later stage was characterized by the decreasing volume fraction and a constant solute concentration of the zones. Comparison with a model calculation based on two-phase Stefan

problem suggested that the two-phase model could describe well the structure of the G.P. zone during the reversion below the miscibility gap as well as above it.

**A88-41699 Effects of quenching temperature and surface on the reversion in an age-hardened Al-Zn alloy.** AKIRA SAKAKIBARA, MASUO YAMADA, MUTSUO OHTA, and TERUTO KANADANI, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 52, April 1988, pp. 383-387. 9 Refs.

Vickers hardness measurements are used to ascertain the effects of vacancies generated by the free surface, as well as secondary effects, on the reversion of Al-Zn alloy specimens. These were either quenched at 823 or 873 K, where a large number of dislocation loops were formed, or at 723 K, where a small number of them was formed. The results obtained indicate that secondary effects, in addition to the surface, effectively supply free vacancies, in cases where the reversion temperature is sufficiently high for secondary effects to decay.

**A88-38308 Effect of solidification conditions on structures of unidirectionally solidified EZ33A alloy.** SHIGEHARU KAMADO, MAKOTO TSUKUDA, ICHIROU TOKUTOMI, and KIKOU HIROSE, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 38, March 1988, pp. 134-139. 18 Refs.

Liquid cooling rate (LCR), average cooling rate of solidification range (SCR), temperature gradient (G), moving rate of solid-liquid interface (R) and G/R were changed as solidification conditions. Structures of ingots are all equiaxed by presence of grain refining Zr. The grain size is primarily affected by LCR and decreases exponentially with its increase. With increasing R and decreasing G, the amount of Mg-RE-Zn eutectic compound increases. It crystallized along grain boundaries nucleating at boundary triple junctions. The morphology of the eutectic compound remains unchanged after a heat treatment for 5 h at 215°C.

**A88-25820 Repeated precipitation in nitrided Mo-1 mass pct Ti alloy.** S. YANO and S. MOROZUMI, *Scripta Metallurgica* (ISSN 0036-9748), Vol. 22, Feb. 1988, pp. 191-195. 11 Refs.

The morphology of the repeated precipitation in nitrided Mo-1 mass pct Ti alloy is examined, and the conditions of its formation are discussed. The Mo-1 mass pct Ti alloy was prepared by arc melting in the form of button ingots. The ingots were homogenized, cut into pieces, nitrided, and polished. The electron microscopy data reveal that the nitrided structure is dependent on the treatment temperature and depth from the specimen surface. Factors for this type of precipitation, in particular volume expansion resulting in the climb of the dislocation, are studied for the nitrided condition. The data reveal that the low stacking fault energy of the matrix is not necessary for this type of precipitation.

**A88-31201 The microstructure of diffusion-bonded Ti/Ni interface.** S. HINOTANI and Y. OHMORI, *Japan Institute of Metals Transactions* (ISSN 0021-4434), Vol. 29, Feb. 1988, pp. 116-124. 11 Refs.

The microstructure of a diffusion-bonded Ni/Ti interface has been investigated by means of SEM, EMPA, and TEM. The alpha-Ti in the vicinity of the bonding interface is transformed into the beta phase by the penetration of Ni atoms at temperatures between the beta transus and the eutectoid point. This transformation enhances the diffusivity of Ni atoms into Ti and results in microvoid formation due to the Kirkendall effect. Across the Ni/Ti bonded interface from the Ni to the Ti side, the intermetallic compound layers (i.e., hexagonal TiNi<sub>3</sub>, cubic TiNi, monoclinic TiNi, and hexagonal Ti<sub>2</sub>Ni) are formed. The region where the alpha-Ti transforms into the bcc beta-phase without intermetallic compound formation at the bonded temperatures decomposes into the lamellar Ti<sub>2</sub>Ni eutectoid structure directly or after the proeutectoid alpha lath formation during cooling to room temperature.

**A88-28966 High resolution lattice images of ordered structures in Al-Li alloys.** TATSUO SATO, NOBUO TANAKA, and TSUNEO TAKAHASHI, *Japan Institute of Metals Transactions* (ISSN 0021-4434), Vol. 29, Jan. 1988, pp. 17-25. 11 Refs.

A high-resolution electron microscopy technique was used to directly observe atomic arrangements of two Al alloys during heat-treatment and to elucidate the ordered structures formed during the decomposition process; image calculations were performed to interpret the obtained images. It was found that, in the initial stage of decomposition (323 K, 86.4 ks), extremely fine domains with an ordered structure were formed densely. In the next stage of decomposition (at 473 K, 86.4 ks), spherical particles of the delta-prime phase were formed and the atomic arrangement of a L1(2)-type ordered structure was clearly observed within delta-prime particles; the delta-prime/matrix interfaces were very clear. Image calculations for the alloys proved that, under proper defocus conditions, atom sites were revealed as bright contrast dots, and that the image contrast did not change drastically with the total specimen thickness, at least up to about 40 nm, and the depth of the ordered domains investigated.

**A88-40423 Characterization of nickel base superalloy consolidated from rapidly solidified ribbons.** FRAISSE PIERRE, HIROKI YOSHIZAWA, HISAE TERASHIMA, and YUKIYA G. NAKAGAWA, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 28, Jan. 1988, pp. 1-5. 7 Refs.

Rapidly solidified superalloy (Mar M247 LC) ribbons made by the melt spinning method were directly (without pulverization or chopping) consoli-

dated by the extruding process. It was possible to obtain refined microstructures in the extruded bars having a grain size of about 1.5 microns. The microstructure consisted of duplex grains ( $\gamma + \gamma'$ ) and  $\gamma'$  grains. Due to this refined structure a superplastic behavior of the extruded bar was observed with the strain rate sensitivity which was more than 0.6 at a temperature above 950 C. In terms of the grain growth behavior of the consolidated material, a larger grain size was obtained in the extruded Mar M246 by heat treatments. The material was so homogeneous that 1 300 C heat treatment was possible while such a high temperature heat treatment caused incipient melting in conventional castings.

**A88-25816 Effect of solidification conditions on microstructures of unidirectionally solidified AZ91C alloy.** SHIGEHARU KAMADO, MAKOTO TSUKUDA, ICHIROU TOKUTOMI, and KIKOU HIROSE, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 37, Nov. 1987, pp. 714-720. 21 Refs.

AZ91C Mg alloys were unidirectionally solidified at various liquid cooling rates, average cooling rates in solidification range, temperature gradients ( $G$ ), moving velocities of solid-liquid interface ( $R$ ), and  $G/R$  ratios. Equiaxed dendrite structure was obtained by the superheating of molten metal. Dendrite cell size decreases exponentially with increasing liquid cooling rate. With increasing average cooling rate and with decreasing  $G$ , the amount of eutectic compounds increases and extends at triple junctions of cell boundaries and individual cell boundaries. The eutectic compounds dissolve by solution heat treatment. Discontinuous precipitates along cell boundaries were observed by optical microscopy, and their width decreases with increasing liquid cooling rate.

**A88-26140 Effect of welding residual stress on fatigue strength of welded joint.** TOSHIO TERASAKI, TETSUYA AKIYAMA, KOUJI WADA, and TARO OKAMOTO, *Japan Society of Materials Science Journal* (ISSN 0514-5163), Vol. 36, Nov. 1987, pp. 1246-1252. 27 Refs.

This paper describes the effect of the welding residual stress on the fatigue strength of welded joint. The fatigue strength was measured on aluminum alloy, mild and stainless steels under the condition that the factors affecting the fatigue strength of welded joint were not changed except the residual stress produced by electron beam welding. When the residual stress at the initiation area of fatigue was compressive and did not vanish during the fatigue test, the fatigue strength was improved. When the tensile residual stress existed at the fatigue initiation area, the following two cases appeared: the fatigue strength of a nonquench hardening material as well as that of a quench hardening material with high ductility and low yield ratio were not influenced by the tensile residual stress. However, the fatigue strength of a quench hardening material with poor ductility and high yield ratio was lowered by the tensile residual stress.

**A88-23100 High temperature reaction of SiC with Ni and Ni-base alloys.** KAZUYA KUROKAWA, SYOUGO KON-YA, and RYUKICHI NAGASAKI, *Hokkaido University, Faculty of Engineering, Bulletin* (ISSN 0385-602X), Oct. 1987, pp. 93-100. 8 Refs.

Reaction couples consisting of Ni/SiC, Ni-10 Cr/SiC, Ni-10 Mo/SiC, and Hastelloy C/SiC were studied to clarify the structure and growth kinetics of the reaction layer, and behaviors of constituents of alloy and SiC. The reactions were carried out under a pressure of 0.0005 Pa at temperatures ranging from 1173 K to 1373 K. In all systems, the reaction was mainly dominated by the diffusion of Ni into SiC. The resulting products were delta-Ni<sub>2</sub>Si and graphite which formed a banded structure consisting of alternating layers of delta and (delta + graphite). The growth of the reaction layer was suppressed when Cr was present in alloy. The maximum application temperature of Ni-base alloy/SiC composite material for hot machinery is about 1200 K.

**A88-43556 Relationship between structure and mechanical properties of Al-Fe powder metallurgy alloys.** KAZUHISA SHIBUE, HIDEO SANO, and SHIGENORI YAMAUCHI, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 37, Oct. 1987, pp. 698-703. 11 Refs.

The relationship between structure and mechanical properties of extruded Al-(2-10 percent)Fe P/M alloys was investigated. The yield strength is related to the volume fraction of dispersoids ( $V_f$ ) and the average dispersoid radius ( $r$ ). This relationship suggests that higher  $V_f$  and smaller  $r$  result in higher strength. Increased Fe content raises the strength of the Al-Fe alloy because of the increased  $V_f$ . Annealing at temperatures above 400 C lowers the strength of Al-(8 percent)Fe alloy because of dispersoid coarsening.

**A87-53854 Plastic flow of Co3Ti single crystals.** T. TAKASUGI, S. HIRAKAWA, O. IZUMI, S. ONO, and S. WATANABE, *Acta Metallurgica* (ISSN 0001-6160), Vol. 35, Aug. 1987, pp. 2015-2026. 30 Refs.

The effects of temperature, orientation, chemical composition, and strain rate on the flow stress of Co<sub>3</sub>Ti single crystals are investigated. It is observed that the critical resolved shear stress (CRSS) increases rapidly with decreasing temperature below 500 K; increases with increasing temperature above 500 K; and then decreases with increasing temperatures above 900-1100 K. The data reveal that the octahedral 111 slip plane occurs over the entire temperature range, except in samples with an orientation axis near the 111 line; the CRSS is dependent on the strain rate only at temperatures above 500 K; and the peak temperature is dependent on orientation and chemical composition. It is suggested that the plastic flow of Co<sub>3</sub>Ti single crystals at temperatures below 500 K causes the

dislocation movement of the superpartials; the increase in CRSS for temperatures ranging between the minimum and maximum is due to thermally activated cross-slip from the 111 to 001 plane; and the decrease in CRSS is due to the intrusion of a diffusive process on 111 plane dislocation motion.

**A88-14375 Hydrogen embrittlement behavior of structure controlled Ti-6Al-4V alloy.** AKIRA NOZUE, TADATSUNE OKUBO, and DAI IKEGAYA, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 51, Aug. 1987, pp. 730-736. 24 Refs.

The effect of Ti-6Al-4V alloy structures on hydrogen embrittlement behavior are studied. Compact tension specimens were cathodically charged in a 50 mol/cu m H<sub>2</sub>SO<sub>4</sub> solution with a current density of 2 kA/sq m during sustained loading. The time to a given crack growth length is evaluated as the susceptibility to hydrogen embrittlement in stage II in the relation between crack growth rate and stress intensity factor, by eliminating the region of unstable crack growth and initial crack growth. The susceptibility to hydrogen embrittlement is found to be enhanced by the increase of the volume ratio of the primary alpha phase to the matrix phase, the continuity of the beta phase, and the multiplication of the primary alpha grain size.

**A88-10603 Martensitic transformation and microstructures in sintered NiAl alloys.** SHOUICHI OCHIAI, MANABU UENO, and OSAMU NOGUCHI, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 51, July 1987, pp. 686-693. 23 Refs.

The characteristics of martensitic transformation and microstructures in sintered NiAl alloys manufactured by hot-pressed powder metallurgy were investigated. When presintering was followed by hot pressing in vacuum, alloys having a relative density higher than 99 percent of theoretical values were obtained. Sintered NiAl specimens quenched from 1573 K in ice brine had a complete martensitic structure. An increase in density of about 1 percent and a decrease in hardness of about 5 percent were observed in quenched specimens compared with prequenched ones. Both results can be explained qualitatively in terms of crystal structure change. All sintered NiAl alloys exhibited a good shape memory effect. The reverse transformation temperature decreased sharply with increasing Al content, with a slope of about 160 K/at. pct. Al. When the sintered specimens with martensite structure were bent with large deformation at room temperature, they tended to fail by cleavage fracture.

**A87-41007 Phase transformations in Ti<sub>2</sub>Ni<sub>3</sub> precipitates formed in aged Ti-52 at. pct Ni.** M. NISHIDA and C. M. WAYMAN, *Metallurgical Transactions A - Physical Metallurgy and Materials Science* (ISSN 0360-2133), Vol. 18A, May 1987, pp. 785-799. 9 Refs.

Contract No.: NSF DMR-83-16981-10 Optical and electron microscopy and electron diffraction are presently used to determine the morphology and crystallography of Ti<sub>2</sub>Ni<sub>3</sub> transformation products in aged Ti-52 at. pct Ni alloy. The crystal structure of Ti<sub>2</sub>Ni<sub>3</sub> at room temperature is confirmed to be monoclinic by electron diffraction; the sequence of transformation events in this phase is: tetragonal parent phase, to orthorhombic intermediate phase, to monoclinic low temperature phase characterized by needle-like domain morphology. These phenomena are noted to be much like the R-phase transition associated with charge density waves in TiNiFe alloys.

**A87-43312 Ultrasonic pole figure for the texture of aluminum alloy.** M. HIRAO and N. HARA, *Applied Physics Letters* (ISSN 0003-6951), Vol. 50, May 18, 1987, pp. 1411, 1412. 8 Refs.

An approximate method is proposed to calculate pole-figure diagrams based on the elastic anisotropy measured by ultrasonic velocity experiments. An example is taken from the surface texture of rolled plates of aluminum alloy 7075-T651, for which the angular dependence of the Rayleigh wave is measured in the rolling plane and analyzed to obtain the expansion coefficients of the orientation distribution function. The ultrasonic pole figures are favorably compared with the conventional X-ray pole figures, both demonstrating a single texture centered over the (001) 110-line orientation.

**A87-46648 Crystal structure and hardness of TiAl phase containing zirconium.** KAZUO KASAHARA, KENKI HASHIMOTO, HARUO DOI, and TOKUZOU TSUJIMOTO, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 51, April 1987, pp. 278-284. 10 Refs.

The composition, crystal structure, and hardness of TiAl( $\gamma$ ) phase contained in Ti-(48-54) at. pct Al-(0-12) at. pct Zr alloys annealed for one week at 1273 K were studied. Soluble Zr atoms entered only the Ti sites of the sublattice and increased only the a-value of the lattice parameters, while increasing Al content increased the c-value only. These anisotropic effects of the elements on the lattice parameters are attributed to the fact that covalentlike bonds are formed between the Ti atomic layer and the Al layer. A region with a high degree of order shifts from (Ti<sub>1-x</sub>Zr<sub>x</sub>)Al to Ti-rich side on the high-Zr side, due to Ti atoms playing the same role as Al in the high-Zr phase. A region with a low degree of order is located on the high Zr and high-Al side, which is attributed to the existence of a degenerate ternary compound. The hardness depends not on the axial ratio c/a but on the degree of order. Solution-hardening by Zr is observed only when the amount added is small.

**A87-36337 Active control method for passing through critical speeds of rotating shafts by changing stiffnesses of the supports with use of memory metals.** K. NAGAYA, S. TAKEDA, Y. TSUKUI, and T.

KUMAI, *Journal of Sound and Vibration* (ISSN 0022-460X), Vol. 113, March 8, 1987, pp. 307-315. 6 Refs.

This paper describes a method of active vibration control for passing through critical speeds of a rotating shaft by use of support springs made of memory metals. In this method the vibration of the shaft due to whirling is controlled by means of on (heating) and off (cooling) heat control of memory metals for bearing support. In the analysis, the exact solution for whirling problems of a multistep and multispacer shaft carrying a disk which is controlled by this method is derived. Numerical calculations have been carried out for some important problems, and experimental tests also have been carried out to verify the present control method and the theoretical results.

**A87-37751 Fatigue behavior of thermomechanically treated Al-1.8 wt pct Li alloy.** SHIGEOKI SAJI, SHIGENORI HORI, and ZHANG DI, *Japan Society of Materials Science Journal* (ISSN 0514-5163), Vol. 36, Feb. 1987, pp. 123-128.

Effects of microstructures obtained by two kinds of thermomechanical treatment, solution treatment-cold rolling (67 percent)-aging and solution treatment-aging-cold rolling (67 percent), on the fatigue behavior of an Al-1.8 wt pct Li alloy were investigated by means of optical and transmission electron microscopy. Deformation bands perpendicular to the rolling direction were formed inhomogeneously in the cold-rolled specimens, and the dislocation cell structure and microbands were the characteristic features. Fatigue strength in both the thermomechanically-treated specimens was higher than those in the solution-treated specimens, in the solution-treated and cold-rolled specimens and in the aged specimens. Fatigue strength in the specimens with the deformation bands parallel to the axis of fatigue stress was higher than that in the specimens with deformation bands perpendicular to the axis of fatigue stress.

**A87-42492 Diffusion bonding SiC or Si<sub>3</sub>N<sub>4</sub> to Nimonic 80A.** TAKEMI YAMADA, HIDEO SEKIGUCHI, HIROMI OKAMOTO, SHOZO AZUMA, AKIRA KITAMURA et al., *Nippon Kokan Technical Report - Overseas Edition* (ISSN 0546-1731), Feb. 1987, pp. 67-74. 17 Refs.

The diffusion bonding method between SiC or Si<sub>3</sub>N<sub>4</sub> and Nimonic 80A was developed in order to establish the fundamental technology for the application of ceramics to machinery components used at elevated temperature. The analysis of the thermal stress occurred in ceramics/Nimonic 80A bonded composites by the finite element method, and the bonding experiment based on the analytical results were conducted. These composites were produced by the insert metal bonding method, using some of Ni, W, Kovar, Cu, and so on. It was found that residual thermal stress in the ceramic of the composite was extremely low and the composite had the

tensile strength of more than 10 kgf/sq mm at room temperature. Furthermore the paper describes the feasibility of the application of this bonding method to the components for a marine diesel engine.

**A87-43223 Structure and mechanical properties of rapidly solidified Al-(8 mass pct)Fe alloys.** AKIHIKO KAMIO, HIROYASU TEZUKA, SATOSHI SUZUKI, THAN TRONG LONG, and TSUNEO TAKAHASHI, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 37, Feb. 1987, pp. 109-118. 8 Refs.

Various Al-(8 mass pct)Fe alloys were solidified into a ribbon shape by the twin roller technique. The as-solidified microstructures exhibited two categories, zone A and zone B, depending on the cooling rate. Zone A was composed of fine metastable intermetallic compounds dispersed in supersaturated Al solid solution. Zone B had a cellular structure and cell boundaries composed of the fine metastable compounds Al<sub>6</sub>Fe in Al-Fe and Al-Fe-Zr alloys and the stable compound Al<sub>8</sub>CeFe<sub>4</sub> in Ce-added alloys. The Vickers hardness of the two zones in binary alloy was reduced by heating at 350 C for 1 hr, but in Ce- or Zr-added ternary alloys the hardness was reduced by heating at higher temperatures than 350 C. Tensile strengths of the as-solidified ribbon specimens were about 58 kgf/sq mm in Zr-added alloy and about 63 kgf/sq mm in Zr- and Ce-added alloy, and they depended on the fractions of zone A and zone B.

**A87-47995 Superplasticity of near beta type titanium alloy 'SP35' and its isothermal forging tests results.** YOSHIHARU MAE, TSUTOMU OKA, SATOSHI YAMAZAKI, TOHRU YAMAUCHI, and ATSUSHI HIRANO, *IN: Titanium 1986: Products and applications; Proceedings of the International Conference*, San Francisco, CA, Oct. 19-22, 1986. Vol. 1. Dayton, OH, Titanium Development Association, 1987, pp. 438-445.

The effects of thermomechanical processings on the mechanical properties and superplastic workabilities of the Ti alloy, super productivity (SP) 35, are examined. The selection of the proper alpha and beta stabilizing elements and alloying contents is discussed. The annealing characteristics of beta-rolled sheets were investigated from 760-820 C; and cold rolling test were conducted on the 780, 750, and 650 C annealed sheets. The microstructures and mechanical properties of annealed, and solution treated/aged sheets are analyzed. The alloy's superplasticity, and its application to the working process are studied. It is observed that the SP35 has a two-phase structure with fine and equiaxed alpha grains in the beta matrix; its tensile strength in the annealed state is 85-90 kgf/sq mm and 130 kgf/sq mm in the solution treated/aged state; its superplasticity in the 700-750 C temperature range is lower than that of other Ti alloys; and superplastic forging and forming are possible at 800 C and 750 C, respectively.

## SOVIET/JAPANESE ABSTRACTS: HOW DO YOU USE THEM?

Please do us the favor of giving your responses to the following questions and mailing them to me at AIAA headquarters. Thanks very much.

Dr. George W. Sutton  
Editor-in-Chief, *AIAA Journal*  
370 L'Enfant Promenade SW  
Washington, DC 20024-2518

☐ I read abstracts regularly. ☐ Occasionally

☐ I follow up citations by \_\_\_\_\_

☐ I want abstracts continued.

☐ Comments: \_\_\_\_\_

Date of issue: December 1988