

**A88-39895 Development of a continuous optical discharge at high pressures (Gorenje nepreryvnogo opticheskogo razriada pri povyshennykh davleniyakh).** I. U. P. RAIZER and S. T. SURZHNIKOV, *Kvantovaya Elektronika* (ISSN 0368-7147), Vol. 15, March 1988, pp. 551-553. 9 Refs.

Equations describing a continuous optical discharge (COD) at pressures of 2-60 atm are integrated numerically. The CO<sub>2</sub>-laser power threshold for the existence of the COD is found. It is shown that a COD with a small focusing spot radius exists at all the pressures investigated. An upper pressure limit appears at a large focusing spot radius.

**A88-50749 The lasing mode structure under four-wave mixing with feedback (Struktura mod generatsii pri chetyrekhvolnovom vzaimodeistvii s obratnoi svyaz'iu).** A. A. BETIN and N. I. RUSOV, *Kvantovaya Elektronika* (ISSN 0368-7147), Vol. 15, May 1988, pp. 1021-1031. 11 Refs.

The diffraction approximation is used to determine the structure of stimulated emission during four-wave mixing with feedback. Conditions of phase conjugation are elucidated. For a signal beam with a smooth amplitude distribution, the phase conjugation is achieved if its transverse size decreases after it passes the feedback loop. For a multimode signal beam, the cavity length or the length of the nonlinear medium should exceed the length of spreading of the transverse field inhomogeneity.

**A88-39878 Injection locking of the radiation frequency in a pulsed dye laser with a compound resonator (Inzheksionnyi zakhvat chastoty izlucheniia v impul'snom lazere na krasiteliakh s sostavnym rezonatorom).** A. P. VOITOVICH, M. N. NENCHEV, A. I. SMIRNOV, and L. L. TEPLIASHIN, *Kvantovaya Elektronika* (ISSN 0368-7147), Vol. 15, March 1988, pp. 460-464. 23 Refs.

Experimental results are presented on a rhodamine 6G laser with injection of the priming radiation in a compound four-mirror cavity with two active media pumped by radiation from a single ruby laser. Conditions for obtaining a narrow-band lasing spectrum without background are established. A spectrum narrowing of the primary emission from 30 to 0.002 nm was obtained without a reduction in output power.

**A88-36042 The focusing of a high-power laser beam under thermal self-defocusing in a moving medium (Fokusirovka moshchnogo lazernogo puchka pri teplovom samovozdeistvii v dvizhushcheisya srede).** P. A. KONIAEV and V. P. LUKIN, *Kvantovaya Elektronika* (ISSN 0368-7147), Vol. 15, Feb. 1988, pp. 341-346. 13 Refs.

Features of the self-defocusing of high-power laser radiation upon propagation in the atmosphere under conditions of wind velocity fluctuations are considered. Consideration is given to medium-motion rate fluctuations which are longitudinal and transverse to the average flow direction. The wind velocity fluctuations are shown to significantly weaken the nonlinear refraction and thermal blooming of focused beams.

**A89-21641 A study of alexandrite laser parameters (Issledovanie parametrov lazera na aleksandrite).** V. S. BURAKOV, V. V. ZHUKOVSKII, and A. V. ISAEVICH, *Akademii Nauk BSSR, Doklady* (ISSN 0002-354X), Vol. 32, no. 11, 1988, pp. 972-975. 14 Refs.

The principal parameters of a flashlamp-pumped alexandrite laser are determined by measuring the time and energy characteristics of stimulated emission. Depending on the pumping power, the gain factor of the alexandrite laser is 0.02-0.06/cm, the probability of chromium ion excitation being 850-2000/s. The harmful loss factor is 0.005/cm; the nonlinearity parameter is 0.03 cu cm/erg. No effect of noise generation on the characteristics of laser emission has been observed experimentally.

**A88-34009 A study of the self-induced phase conjugation of a light beam during the parametric generation of SBS (Issledovanie samoobrashcheniia svetovogo puchka pri parametricheskoi generatsii VRMB).** V. V. ELISEEV, N. N. ZHUKOV, O. P. ZASKAL'KO, A. A. ZOZULIA, and V. T. TIKHONCHUK, *Akademii Nauk SSSR, Izvestiia, Seriya Fizicheskaya* (ISSN 0367-6765), Vol. 52, Feb. 1988, pp. 393-395. 8 Refs.

An experimental study is made of the effect of the feedback loop parameters on the quality of phase conjugation in a nonlinear ring resonator. It is shown that the quality of phase conjugation improves with increasing power of the pump beam and depends on the beam compression ratio in the feedback loop. The results of the study are relevant to the phase conjugation of large-diameter laser beams, where the application of the known methods of self-induced phase conjugation during convective SBS is difficult.

**A88-28323 Increase in the lifetime of an optical-breakdown plasma in air (Effekt uvelicheniia vremeni zhizni plazmy opticheskogo probiia v vozdukh).** S. F. BALANDIN, I. D. KOPYTIN, L. A. LITNEVSKII, I. S. TIUL'KIN, V. A. KHAN et al., *Pis'ma v Zhurnal Tekhnicheskoi Fiziki* (ISSN 0320-0116), Vol. 14, Jan. 12, 1988, pp. 45-48. 5 Refs.

Optical breakdown was initiated in air by radiation from a CO<sub>2</sub> laser with a wavelength of 10.6 microns and a pulse duration of 1 microsec. The air temperature varied from 14 to 30 C, while the humidity varied from 35 to 99.9 percent. The effect of humidity on the lifetime of the breakdown plasma is evaluated. It is suggested that plasma lifetime increases may be due to thermochemical and photochemical reactions leading to the formation of excited atoms and molecules, e.g., excited-state O<sub>2</sub>, Ne, O, and N. These reactions are examined in detail.

**A88-28322 Acoustic response of an aerosol medium under pulsed optical excitation (Akusticheskii otklik aerol'noi sredy pri impul'snom opticheskome vozdeistvii).** N. N. BOCHKAREV, A. A. ZEMLIANOV, N. P. KRASNENKO, V. A. POGODAEV, and A. E. ROZHDESTVENSKII, *Pis'ma v Zhurnal Tekhnicheskoi Fiziki* (ISSN 0320-0116), Vol. 14, Jan. 12, 1988, pp. 25-29.

The paper reports an investigation of sound generation during phase transitions of quasi-monodisperse water aerosol particles under the effect of pulsed laser radiation in cases of evaporative and explosive sound-excitation modes. The aerosol medium is exposed to pulsed radiation from a TEA CO<sub>2</sub> laser with an energy of 5 J and a pulse duration of 3 microsec. The dependence of the generated acoustic energy on the concentration of aerosol particles for various values of laser energy density is assessed along with the dependence of the acoustic energy on the laser energy density for various values of aerosol concentration.

**A89-23595 Design of a tunable carbon monoxide laser (Konstruktsiia perestraivayemogo lazera na okisi ugleroda).** V. I. MASYCHEV and V. K. SYSOEV, *Kvantovaya Elektronika* (ISSN 0368-7155), no. 35, 1988, pp. 38-41. 8 Refs.

The general design and performance characteristics of a continuously tunable wideband source of coherent emission based on a commercial sealed CO laser with a diffraction grating are described. The laser emits at 90 lines in the range 1626-1910/cm, with a line emission power ranging from 50 mW to 3 W. Possible applications of the tunable source include studies of the water absorption spectra of IR materials, investigations of band structure of semiconductor materials and heterostructures, and applications in other fields of scientific research.

## Japanese Aerospace Literature This month: *Refractory Materials*

**A89-34395 Influences of environment in heat treatment and pre-aging at room temperature on age-hardening of Ti-Mo alloys.** MORI-TAKA HIDA, EIICHI SUKEDA, and YOSHITO JIM TAKEMOTO, *Materials Transactions* (ISSN 0021-4434), Vol. 30, Feb. 1989, pp. 102-106. 5 Refs.

The effect of environment on the aging behavior of two Ti-Mo alloys (Ti-14 mass pct Mo and Ti-20 mass pct Mo) was investigated by measuring Vickers hardness values of the specimens that were solution-heat-treated at different degrees of vacuum, preaged at room temperature for a different periods, and aged at 623 K in different environments (the atmosphere, the pure-Ar current, and a vacuum). It was found that specimens preaged at room temperature for a short period displayed a two-stage hardening, in which the first stage was due to a product formed by reactions of quenched-in vacancies, interstitial atoms, and metallic atoms, and the second stage was caused by the formation of aged omega phase. The age-hardening behavior of specimens preaged for a short period was more active as compared with specimens preaged for a long period. It was also found that, the greater was the oxygen content during the aging period, the higher was the age-hardening rate in the surface layer and in the interior of the alloys.

**A89-34393 Isothermal forging of nickel-base superalloy modified IN-100 disk.** KIYOYUKI OHUCHI, YOSHINORI NAKAZAWA, and KEN-ICHI MATSUNO, *JIM, Materials Transactions* (ISSN 0021-4434), Vol. 30, Jan. 1989, pp. 67-76. 8 Refs.

In order to clarify the effect of die materials on the isothermal forging properties such as forging load, die filling and heat power consumption, forging tests of nickel-base superalloy Mod.IN-100 from a cylindrical preform to a disk shape with boss and rim have been performed. The die materials used are two refractory alloys, TZM and W-2ThO<sub>2</sub>, ceramic Sialon, and nickel-base cast superalloy IN-100. Forging with refractory alloy dies are done in a chamber filled with Ar or vacuumized to prevent oxidation of the die. With ceramic or cast superalloy dies, forging can be done in air without the use of the chamber. In these tests, the HIPed and extruded preform from Mod.IN-100 powder is used as a test material, and a glass powder suspended in water is used as a lubricant. By using the optimum size preform, isothermal forging of Mod.IN-100 can be carried out successfully in all cases. There are no differences in load and material flow in forgings, regardless of the die material selected.

**A89-27967 Characterization of refractory W, WN(x), and WSi(x) films on GaAs using thermoreflectance measurements.** NAOTAKA UCHITOMI, MASAMI NAGAOKA, and NOBUYUKI TOYODA, *Journal of Applied Physics* (ISSN 0021-8979), Vol. 65, Feb. 15, 1989, pp. 1743-1746. Research supported by the Ministry of International Trade and Industry. 14 Refs.

Thermal-wave measurements have been carried out for characterizing refractory W, WN(x), and WSi(x) films on GaAs substrates. Thermal-wave signals from these films were measured as a function of annealing temperature up to 900 C, together with four-point probe measurements and X-ray diffraction analysis. The thermal-wave signals indicated a good linear relation to electrical resistivity, as shown in the cases of W and WN(x) films formed by sputtering deposition. This relation was associated with the grain formation and growth of W and W<sub>2</sub>N microcrystals, as the annealing temperature increased. It was found that the thermal-wave measurement was a very sensitive method for detecting phase transformation and degradation at the metal-GaAs interface, which were shown in the case of WSi(x) films formed by low-pressure chemical vapor deposition.

**A89-32996 Temperature range of formation of athermal omega phase in quenched beta Ti-Nb alloys.** MASAHIKO IKEDA, SHIN-YA KOMATSU, TAKASHI SUGIMOTO, and KIYOSHI KAMEI, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 52, Dec. 1988, pp. 1206-1211. 21 Refs.

The negative temperature dependence (NTD) of electrical resistivity rho was investigated in several Ti-Nb alloys quenched from 1073 K in relation to alpha-double prime martensite and thermal omega phases. The estimation of starting and ending temperatures of the athermal omega formation, omega(s) and omega(t) respectively, was attempted. The double-prime was observed in the 20-35 percent Nb alloys, and in the alloys with more than 40 percent Nb only the retained beta was observed. The NTD was observed only in the 40 percent Nb alloy, and both a maximum and a minimum of rho appeared in the 77-350 K temperature range. The values of omega(s) and omega(t) estimated from resistivity temperature curves decreased with Nb content. The composition range of alloys, in which the so-called quenched omega phase was observed, coincided with that of the alloys which was intermediate between omega(s) and omega(t) at room temperature. Therefore, the quenched omega may be athermal omega with a large volume fraction at room temperature.

**A89-14593 Grain boundary structure and mechanical properties of covalent-bonded ceramics.** YUICHI IKUHARA, HIROAKI KURISHITA, and HIDEO YOSHINAGA, *Proceedings of the Second International Conference on Composite Interfaces (ICCI-II), Interfaces in polymer, ceramic, and metal matrix composites*, Cleveland, OH, June 13-17, 1988 (A89-14551 03-24). New York, Elsevier, 1988, pp. 673-684. 12 Refs.

Grain boundary structure and intrinsic high temperature strength in covalent-bonded ceramics, such as pressureless sintered SiC, reaction-bonded Si<sub>3</sub>N<sub>4</sub>, and sialon with no additives, have been investigated by using high-resolution electron microscopy and three-point bending at high temperatures up to 2070 K. It is shown that the bending strengths of these materials do not decrease up to the highest test temperature and grain boundaries with random orientation have a relaxed structure. Two types of relaxed structures were observed: one is an amorphous-type layer 1-5 nm thick and the other is the boundary that connects two grains by continuous lattice bending. A boundary having either of these relaxed structures with some extension is called an 'extended grain boundary' by analogy with an 'extended dislocation'. The concept of an extended grain boundary can well explain the observed behavior, including the absence of strength loss at high temperatures, the occurrence of dihedral angles larger than the critical angle of 60 deg for densification, and the lattice growth into the amorphous-type layer under electron irradiation.

**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.

**A89-21084 Effect of porosity on strength of zirconia refractory.** TOSHIHIKO HOSHIDE, TAKASHI FUKUI, and TOSHIRO YAMADA, *Japan Society of Materials Science Journal* (ISSN 0514-5163), Vol. 37, Oct. 1988, pp. 1139-1145. 13 Refs.

Flexural strength tests and fracture toughness tests were conducted using 3 wt pct MgO partially stabilized zirconia refractories with varying porosities, and a statistical analysis was made of the dependency of strength properties on porosity. The flexural strength and fracture toughness obtained under four-point bending decreased in more porous materials, while variation in porosity did not affect the fracture toughness obtained under three-point bending. When the Weibull function was used to find the flexural strength distribution, the results for material with higher porosity indicated larger shape and smaller scale parameters. The statistical strength properties are discussed based on fractographic observations. The scatter of such properties is found to depend on the pore distribution characteristics, especially the formation of pore clusters in individual specimens.

**A89-15010 Atomic configuration of carbon fibers studied by field ion microscopy.** NOBUO OHMAE, MASAHIKO TAGAWA, MASATAKA UMENO, and KAZUMA GUMI, (STLE, 42nd Annual Meeting, Anaheim, CA, May 11-14, 1987) *STLE Tribology Transactions* (ISSN 0569-8197), Vol. 31, Oct. 1988, pp. 481-488. 26 Refs.

A field ion microscope has been used to investigate the atomic configurations of carbon fibers. A stable field ion micrograph was obtained by using Ne as an image gas, and the aligned fibers were imaged as small net plane rings. As-received high-modulus fibers made from polyacrylonitrile showed the notable fibril alignment only at the periphery, while repolymerized fibers at 3000 C indicated the formation of aligned fibril at the central area as well as at the periphery. The pitch carbon fibers repolymerized at 3000 C showed a uniform distribution of aligned large fibrils, which correlated to the high Young's modulus. A model based upon FIM observations was proposed in relating microscopic structures of fibrils to tribological design of carbon fiber composites.

**A88-54748 Tungsten-beryllium multilayer mirrors for soft X rays.** YUICHI UTSUMI, HAKARU KYURAGI, TSUNEO URISU, and HIDEKI MAEZAWA, *Applied Optics* (ISSN 0003-6935), Vol. 27, Sept. 15, 1988, pp. 3933-3936. 23 Refs.

Multilayer structures of tungsten and beryllium were synthesized onto flat silicon single-crystal substrates by the neutral atom beam sputtering technique. Structures of constituent tungsten and beryllium thin films were evaluated. The standard deviation of the interface roughness of the multilayer was estimated to be about 2.5 A. Reflectivities of multilayer mirrors were measured at a grazing incidence of 5.0 deg. The observed reflectivity of 30 percent at 1055 eV was in good agreement with the calculated value considering the interface roughness and oxygen contamination for a tungsten-beryllium structure having a period of 77.0 A.

**A89-12095 Cyclic fatigue crack growth from indentation flaw in Si<sub>3</sub>N<sub>4</sub>.** SUSUMU HORIBE, *Journal of Materials Science Letters* (ISSN 0261-8028), Vol. 7, July 1988, pp. 725-727. 5 Refs.

The fatigue crack propagation from indentation flaw was investigated using specimens of Si<sub>3</sub>N<sub>4</sub> sintered with spinel and Y<sub>2</sub>O<sub>3</sub>, that were indented at the center by Vickers indentation. Fatigue tests were conducted in four-point bending at a frequency of 1 to 20 Hz, using an electrohydraulic testing system. The results indicate that the crack in the sintered Si<sub>3</sub>N<sub>4</sub> propagates by cyclic loading and that the effect of static loading on the crack behavior is very limited. Cyclic crack propagation from the indentation flaws reflects the configuration of the stress intensity factor K near the crack tip, and is controlled not by the as-indented crack length, but rather by the crack length after the first application of the external stress equivalent to the maximum stress of the subsequent cycling.

**A88-46296 Introduction to fine ceramics: Applications in engineering (Book).** NOBORU ICHINOSE, KOMEYA KATSUTOSHI, NAOHIKO OGINO, AKIHIKO TSUGE, and YUJI YOKOMIZO, Chichester and New York, John Wiley and Sons, Ltd., 1987, 169 pp. Translation.

Recent advances in ceramics technology and applications are discussed in a question-and-answer format and illustrated with extensive diagrams, drawings, graphs, photographs, and tables of numerical data. Chapters are devoted to the fundamental properties of ceramics, structural ceramics, electronic ceramics (piezoelectric materials, sensors, and ferrites), and glasses and optical fibers. Also considered are biological applications, amorphous ceramics, high-thermal-conductivity ceramics, and laminated and multilayer ceramics.

**A88-32869 Fracture strength of Y<sub>2</sub>O<sub>3</sub>-partially-stabilized ZrO<sub>2</sub> HIPed under oxygen-containing atmosphere.** TAKAKI MASAKI, KIICHI NAKAJIMA, and HIROSHI KUWAJIMA, *Japan Society of Materials Science Journal* (ISSN 0514-5163), Vol. 37, Feb. 1988, pp. 119-125. 21 Refs.

The effects of heat treatment at 1000-1400 C on the bend strength and microstructure of Y-PSZ materials prepared by white Hipping are reported. The bend strength of 5.0 mol pct. Y-PSZ material after heat treatment at 1100 C for 1000 hr increased greatly from 720 to 1080 MPa. The strength enhancement is explained by a crack-precipitate interaction toughening mechanism. The modulated, tweed, or colony structures of fine strip crystals orthogonally crossing each other were within the cubic ZrO<sub>2</sub> matrix. The 5.0 mol pct. Y-PSZ material showed less decrease in strength at temperatures above 600 C and higher strength at 1000-1200 C than the 4.0 mol pct. Y-PSZ material.

**A88-43378 Microstructure and mechanical properties of Al<sub>2</sub>O<sub>3</sub>-Cr<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub> composites.** TADAHISA ARAHORI and E. DOW WHITNEY, *Journal of Materials Science* (ISSN 0022-2461), Vol. 23, May 1988, pp. 1605-1609. 16 Refs.

SEM, XRD, ESCA, Vickers hardness tests, and bending strength tests, have been used to ascertain the microstructure and mechanical properties of Al<sub>2</sub>O<sub>3</sub>-Cr<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub> composites produced by hot pressing in order to harden the Al<sub>2</sub>O<sub>3</sub> matrix in such zirconia-toughened aluminas. ZrO<sub>2</sub> was found to inhibit the grain growth of Al<sub>2</sub>O<sub>3</sub>-Cr<sub>2</sub>O<sub>3</sub>; ZrO<sub>2</sub>'s grain growth increased with the fraction of this material in the composite. Monoclinic ZrO<sub>2</sub> increased with increasing Cr<sub>2</sub>O<sub>3</sub> in the composition. Stress-induced transformation was confirmed on the specimen fracture surface after bending.

**A88-32385 Superpolished single-crystal molybdenum mirror for X-ray ultraviolet to X-ray radiation.** K. YOSHIDA, K. TAKEUCHI, Y. KATO, E. FUJIWARA, and K. YAMASHITA, *Applied Physics Letters* (ISSN 0003-6951), Vol. 52, April 4, 1988, pp. 1111-1113. 10 Refs.

High-quality single-crystal molybdenum fabricated by a secondary recrystallization method has been polished with a new polishing technique. The superpolished surface of the Mo single crystal has a surface roughness of 3.5 Å rms. This superpolished single-crystal Mo has been used for a high-power electron beam pumped argon excimer laser (of 126 nm wavelength) as a cavity mirror. Peak output power of more than 3 MW has been achieved without any damage to the mirror surface.

**A88-30941 Characterization of tungsten-related deep levels in bulk silicon crystal.** YOSHIHISA FUJISAKI, TOSHIO ANDO, HIROTSUGU KOZUKA, and YUKIO TAKANO, *Journal of Applied Physics* (ISSN 0021-8979), Vol. 63, April 1, 1988, pp. 2304-2306. 9 Refs.

The nature of deep levels induced in silicon crystals by tungsten impurity was investigated using deep level transient spectroscopy as a characterization technique. Tungsten was introduced into the silicon crystal by annealing with a WO(x)-coated wafer; tungsten diffusion was carried out at 1000 C for several hours. Tungsten diffusion was found to make a hole and an electron trap, with activation energies of 0.41 and 0.22 eV, respectively. The major fraction of the diffused tungsten atoms stays near the surface, but the remainder diffuses deeper than 1 micron from the surface and seriously degrades the device characteristics.

**A88-28846 Sintering of Si<sub>3</sub>N<sub>4</sub> with the addition of rare-earth oxides.** NAOTO HIROSAKI, AKIRA OKADA, and KAZUO MATOBA, *American Ceramic Society Communications* (ISSN 0002-7820), Vol. 71, March 1988, pp. C-144 to C-147. 21 Refs.

The effect of rare-earth oxide additives on the densification of silicon nitride by pressureless sintering at 1600 to 1700 C and by gas pressure sintering under 10 MPa of N<sub>2</sub> at 1800 to 2000 C was studied. When a single-component oxide, such as CeO<sub>2</sub>, Nd<sub>2</sub>O<sub>3</sub>, La<sub>2</sub>O<sub>3</sub>, Sm<sub>2</sub>O<sub>3</sub>, or Y<sub>2</sub>O<sub>3</sub>, was used as an additive, the sintering temperature required to reach approximate theoretical density became higher as the melting temperature of the oxide increased. When a mixed oxide additive, such as Y<sub>2</sub>O<sub>3</sub>-Ln<sub>2</sub>O<sub>3</sub> (Ln = Ce, Nd, La, Sm), was used, higher densification was achieved below 2000 C because of a lower liquid formation temperature. The sinterability of silicon nitride ceramics with the addition of rare-earth oxides is discussed in relation to the additive compositions.

**A88-29075 Production of high quality coatings by thermal plasma processing.** MICHIO TAKASUGI, SETSUO SAEKI, OSAMU FUKUMASA, and KATASHI OSAKI, *Yamaguchi University, Faculty of Engineering, Memoirs* (ISSN 0372-7661), Vol. 38, Oct. 1987, pp. 111-118. 17 Refs.

By using the plasma spray gun which has high stability, the thermal plasma spraying of refractory materials (i.e., Al<sub>2</sub>O<sub>3</sub>, TiC and ZrC) at pressures of 200 and 760 Torr is studied. The spray gun consists of the local wall constricted type dc plasma jet generator and the feed ring to inject coating materials into plasma jet. To characterize the sprayed coatings, SEM and X-ray diffractometers are used. According to the present results, it is found that sprayed coatings at a pressure of 200 Torr are denser than at 760 Torr, and that adhesion of sprayed coatings at a pressure of 200 Torr to a substrate is stronger than that of a 760 Torr. It is shown that low pressure plasma spraying is one of the most accessible methods for producing high quality coatings of refractory materials.

**A88-27621 Ceramic component design for assuring long-term durability.** T. SOMA, Y. ISHIDA, M. MATSUI, and I. ODA, *Advanced Ceramic Materials* (ISSN 0883-5551), Vol. 2, Oct. 1987, pp. 809-812. 15 Refs.

A theoretical estimate of mechanical design and material selection of ceramic components is made to guarantee long-term reliability of ceramic components for high-temperature applications. A fracture map, which consists of a stress-temperature distribution map of a component, and an allowable stress-temperature map, which relates strength, required lifetime, and required survival probability, are proposed. The stress-temperature distribution of a ceramic component in operation is estimated by means of finite element method numerical analysis. The allowable stress-temperature map is based on long-term durability data of ceramic materials considering temperature dependence. An application of the fracture map to a ceramic turbocharger rotor design is discussed.

**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.

**A89-15751 On the longitudinal and transverse tensile strength and work of fracture of a continuous fiber metal matrix composite subjected to thermal exposure.** T. KYONO, I. W. HALL, and M. TAYA, *IN: Testing technology of metal matrix composites* (A89-15726 04-24). Philadelphia, PA, American Society for Testing Materials, 1988, pp. 409-431. Research supported by Toray Industries, Inc. and University of Delaware. 37 Refs.

The mechanical properties of many metal matrix composites are known to be degraded when the metal matrix composite is subjected to thermal exposure. The effect of thermal exposure on the mechanical properties, namely, longitudinal and transverse strength and work of fracture of a boron fiber-reinforced 1100 aluminum composite is studied. It is found in this study that, as the thermal exposure time increases, the longitudinal strength and work of fracture decrease, whereas the transverse strength increases slightly. The above experimental results are explained by analytical models, with reasonably good agreement between the experimental and analytical results.

**A88-31099 Thermomigration of hydrogen and deuterium in vanadium, its alloys, niobium and tantalum.** HIDEO NAKAJIMA, MASAHIRO KOIWA, and MASAMI YOSHIOKA, *Japan Institute of Metals Transactions* (ISSN 0021-4434), Vol. 28, Dec. 1987, pp. 949-956. 20 Refs.

Thermomigration of hydrogen and deuterium in vanadium, its alloys (V-Ti, V-Cr, V-Fe, and V-Mo), niobium, and tantalum has been measured by a steady-state method. Both isotopes migrate toward the colder end. The observed heat of transport in pure metals increases in order of vanadium, niobium, and tantalum, and is significantly smaller for hydrogen than for deuterium. The addition of Ti and Cr increases the heat of transport in vanadium, but Fe and Mo do not much affect it. A model of trapping of hydrogen (deuterium) by substitutional elements is applied to explain the increase in the heat of transport for vanadium alloys.

**A88-26614 Intergranular fracture in molybdenum alloy ingots.** KOJI TANOU, HIDEHIKO MATSUDA, HATSUSHI ARII, and YASUNAO KAI, *Japan Institute of Metals Journal* (ISSN 0021-4876), Vol. 51, Nov. 1987, pp. 1003-1009. 22 Refs.

Bending tests are made using bicrystals prepared from the ingots of arc and electron-beam melted pure Mo and its alloys. The character of grain boundaries, the scavenging effect of alloying elements, and their effect on the grain boundary fracture stress are mainly investigated. Most of grain boundaries are mixed types having a common rotation axis distributed randomly in the unit stereographic triangle except for the vicinity of (001) pole. It is anticipated that a large amount of oxygen and carbon segregated at the grain boundaries of arc-melted pure Mo can fairly be reduced by the addition of titanium and electron-beam melting. Especially, the scavenging effect of titanium on oxygen is successful. The grain boundary strength has a tendency to decrease with increasing atomic misfit of the alloying elements to the solvent in electron-beam melted dilute molybdenum alloys.

**A88-24341 Si<sub>3</sub>N<sub>4</sub> whisker-reinforced aluminum alloy composite.** H. MATSUBARA, Y. NISHIDA, M. YAMADA, I. SHIRAYANAGI, and T. IMAI, *Journal of Materials Science Letters* (ISSN 0261-8028), Vol. 6, Nov. 1987, pp. 1313-1315. 7 Refs.

Due to the lower Vickers hardness of Si<sub>3</sub>N<sub>4</sub> by comparison with SiC, aluminum alloy matrix composites using Si<sub>3</sub>N<sub>4</sub> whiskers may prove easier to machine. The microstructure of the Si<sub>3</sub>N<sub>4</sub>/6061 alloy composite studied shows no alignment of the whiskers. The strength of the composite decreased with increasing temperature, but remained substantially higher than the neat 6061 matrix alloy at up to 400 C. Squeeze casting was used to fabricate the samples presently studied.

**A87-52429 High aspect ratio hole filling by tungsten chemical vapor deposition combined with a silicon sidewall and barrier metal for multilevel interconnection.** K. SUGURO, Y. NAKASAKI, S. SHIMA, T. YOSHII, T. MORIYA et al., *Journal of Applied Physics* (ISSN 0021-8979), Vol. 62, Aug. 15, 1987, pp. 1265-1273. 25 Refs.

A newly developed processing for high aspect ratio hole-filling by tungsten chemical vapor deposition, combined with a Si sidewall technique and resist etch back, is proposed. A high aspect ratio hole was completely filled with W and W-Si alloy without voids. It is also proposed to interpose a TiN/TiSi<sub>2</sub> layer between W and Si in order to suppress rapid silicidation of W at high temperatures above 800 C. Silicidation rates for W/TiN/TiSi<sub>2</sub>/Si systems were 2-2.5 orders of magnitude lower than W/Si systems. Electrical contact resistivity was kept to be lower than 1 x 10 to the -5th Ohm-sq cm even after 900 C annealing by suppressing rapid silicidation of W.

**A88-27618 Combustion reaction characteristics in the nitridation of silicon.** KIYOSHI HIRAO, YOSHINARI MIYAMOTO, and MITSUE KOIZUMI, *Advanced Ceramic Materials* (ISSN 0883-5551), Vol. 2, Oct. 1987, pp. 780-783. 17 Refs.

The combustion reaction characteristics in the nitridation of Si were investigated by measuring the combustion velocity (in the propagation process) and the combustion temperature. Silicon powder mixed with the proper amount of Si<sub>3</sub>N<sub>4</sub>, which was added to produce a uniform and steady-state combustion reaction without residual Si, was packed into a porous refractory container and burned under high nitrogen pressures (up to 50 MPa). The combustion velocities and the maximum combustion temperatures were independent of the starting compositions despite large differences in the adiabatic combustion temperatures depending on the starting compositions. The combustion reaction is considered to be strongly controlled by the decomposition reaction of Si<sub>3</sub>N<sub>4</sub>. The primary structure of the combustion wave in the nitridation of Si is proposed.

**A89-33495 Effects of gamma-prime phase content in Rene 95 and its derivative alloys on parameters of superplasticity and high temperature tensile properties. I.** ISAO TOMIZUKA, HIROSHI HARADA, SHIZUO NAKAZAWA, YUTAKA KOIZUMI, and MICHIO YAMAZAKI, *Proceedings of the International Conference on PM Aerospace Materials*, Lucerne, Switzerland, Nov. 2-4, 1987, (A89-33451 13-26). Shrewsbury, England, MPR Publishing Services, Ltd., 1988, pp. 51.1-51.11. Research sponsored by the Agency of Industrial Science and Technology.

Powders of a series of Ni-base superalloys (in which the compositions of the gamma- and gamma-prime-phase were identical with, but their contents were different from, those in a commercial alloy) were HIP-consolidated and extruded. The materials were subjected to a test of superplastic behavior and to tensile testing at 1323 and 1033 K, respectively. The maximum pressure observed during the extrusion had the minimum at a gamma-prime phase content (CGPP) of 55 percent. Voids, cracks, and undeformed powder particles in the extruded materials increased with increase in CGPP. Superplasticity (as defined by superplastic elongation)

and the maximum flow stress were at a minimum near CGPP of 25 percent, where the specimen was considered to be a single-phase alloy at the temperature of the superplastic testing.

**A89-33496 Effects of gamma-prime phase content in Rene-95 and its derivative alloys on parameters of superplasticity and high temperature tensile properties. II - Superplastic forging of HIP-consolidated powder.** ISAO TOMIZUKA, TATSUYUKI MAEDA, SHIZUO NAKAZAWA, YUTAKA KOIZUMI, HIROSHI HARADA et al., *Proceedings of the International Conference on PM Aerospace Materials*, Lucerne, Switzerland, Nov. 2-4, 1987, (A89-33451 13-26). Shrewsbury, England, MPR Publishing Services, Ltd., 1988, pp. 52.1-52.11. Research sponsored by the Agency of Industrial Science and Technology.

Powders of a series of Ni-base superalloys (in which the compositions of the gamma- and gamma-prime phase were identical with, but their contents were different from those in a commercial alloy) were HIP-consolidated and subjected to high-temperature tensile testing. The maximum ultimate tensile strength (UTS) of the obtained materials was seen at a content of gamma-prime-phase (CGPP) of 85 percent. Elongation of fracture decreased with increase in CGPP. The HIP-consolidated materials were forged in a superplastic condition. Deformation resistance thereby was almost independent of CGPP, except when CGPP was extremely low or high. The maximum UTS for the forged materials was seen at a CGPP of 70 percent.

**A88-52976 Active reaction of CrAl7 intermetallic compound in Al-Cr alloys by cathodic treatment.** OSAMI SERI and KOHSUKE TAGASHIRA, *Japan Institute of Light Metals Journal* (ISSN 0451-5994), Vol. 38, July 1988, pp. 379-385. 9 Refs.

The maximum current on anodic polarization curves for Al-Cr alloys after cathodic treatment in deaerated 0.1 M Na<sub>2</sub>SO<sub>4</sub> solution was examined in detail. The origin of the maximum has been found to be the oxidation of Cr from the CrAl<sub>7</sub> intermetallic compound into chromic hydroxide.