

Russian and Japanese Aerospace Literature

During 1996 the *AIAA Journal* will carry selected abstracts on leading research topics from Russian 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 Microstructure from Russia and Microstructure and Aluminium Alloys from Japan.

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Russian Aerospace Literature This month: *Microstructure*

A95-35411 The peculiarities of structure and properties formation of diamond-containing functional gradient materials in the SHS-regime. E. LEVASHOV (Moscow Steel and Alloys Inst., Russia), *FGM 94; Proceedings of the 3rd International Symposium on Structural and Functional Gradient Materials*, Swiss Federal Inst. of Technology, Lausanne, Switzerland, Oct. 10–12, 1994 (A95-35401 09-23), Lausanne, Switzerland, Presses Polytechniques et Universitaires Romandes, 1995, pp. 95–100. 5 Refs. Documents available from Aeroplus Dispatch.

Some peculiarities of diamond-containing FGM manufacturing in the self-propagating high-temperature synthesis (SHS) regime were studied. Because of the short characteristic periods that a diamond stays in the high-temperature zone of the combustion wave, it appears possible to produce new materials impregnated with diamond grains by the SHS method without application of high pressure. Conditions were found in which a diamond preserves its strength properties in the combustion wave, and a new approach to the FGM synthesis allows one to significantly raise the limit of exothermic mixture dilution by diamond and to produce a material with a diamond concentration in the layer of up to 50 vol. pct. The influence of the mass and composition of the diamond-free exothermic mixture layer on the method of structure formation of various SHS FGMs containing diamond was studied. FGM of the systems NiAl/(NiAl + diamond), TiB/(TiB + diamond) were produced. (Author)

A95-34689 Computer-aided, single-specimen controlled bending test for fracture-kinetics measurement in ceramics. V. G. BOROVIK, V. M. CHUSHKO, and S. P. KOVALEV (Academy of Sciences of Ukraine, Inst. for Problems of Strength, Kiev, Ukraine), *American Ceramic Society, Journal* (ISSN 0002-7820), Vol. 78, No. 5, May 1995, pp. 1305–1312. 24 Refs. Documents available from Aeroplus Dispatch.

Fracture testing of ceramics by using controlled crack growth is proposed to allow study of crack-kinetics behavior under a given loading history. A computer-aided, real-time data acquisition system improves the quality of crack growth parameters obtained in a simple, single-specimen bend test. Several ceramic materials were tested in the present study: aluminum nitride as a linear-elastic material, as well as alumina and yttria-stabilized zirconia, both representative of ceramics with microstructure-dependent nonlinear fracture properties. Ambiguities in the crack-growth diagrams are discussed to show the importance of accounting for crack-growth history in correctly describing nonequilibrium fracture behavior. (Author)

A95-32745 Hot oxidation resistance of an intermetallic Nb-Ti-Al alloy. O. A. BANNYKH, E. N. SHEFTEL, G. S. USMANOVA, and A. A. SHARAPOV (Russian Institute of Sciences, Inst. of Metallurgy, Moscow, Russia), *High-temperature ordered intermetallic alloys VI; Proceedings of the Symposium*, Boston, MA, Nov. 28–Dec. 1, 1994, Pt. 2 (A95-32604 08-26), Pittsburgh, PA, Materials Research Society (MRS Symposium Proceedings, Vol. 364), 1995, pp. 969–974. 7 Refs. Documents available from Aeroplus Dispatch.

Structure, phase composition and air oxidation behavior in the temperature range 800–1400 C of a Nb-Ti-Al-based intermetallic alloy with the chemical composition (wt pct): Nb-47.0; Ti-23.9; Al-21.0, V-4.4, and Cr-4.1 have been studied. The alloy structure is two-phase-sigma (Nb₂Al type) and gamma (TiAl type). Preliminary air oxidation at 1400 C decreases the oxidation rate at 1150 C by a factor 2–3; it is connected with the formation of a protective scale (rutile and corundum with chromium and vanadium additions), refining

of the alloy structure, and the formation of an internally oxidized underscale. (Author)

A95-31461 X-ray investigations of supersmooth surfaces. I. V. KOZHEVNIKOV (Russian Academy of Sciences, Physics Inst., Moscow, Russia), V. E. ASADCHIKOV, B. M. ALAUDINOV (Russian Academy of Sciences, Inst. of Crystallography, Moscow, Russia), A. Y. KARABEKOV, and A. V. VINOGRADOV (Russian Academy of Sciences, Physics Inst., Moscow, Russia), *Optical interference coatings; Proceedings of the Meeting*, Grenoble, France, June 6–10, 1994, Pt. 1 (A95-31426 08-74), Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings, Vol. 2253), 1994, pp. 679–690. 22 Refs. Documents available from Aeroplus Dispatch.

The possibilities of X-ray scattering methods are demonstrated for the quantitative study of supersmooth surface microgeometry. It is shown that the model of a surface which takes into account layered inhomogeneities near a surface enables one to obtain better agreement between theory and experiment in comparison with the steplike model of a surface, which is widely used elsewhere. (Author)

A95-26015 Metallurgical and technological aspects of titanium alloys application for helicopter industry. M. G. VEITSMAN (Mil Moscow Helicopter Plant, Russia), *20th European Rotorcraft Forum*, Amsterdam, Netherlands, Oct. 4–7, 1994, Proceedings, Vol. 4 (A95-25916 06-01), Amsterdam, Netherlands, National Aerospace Laboratory, 1994, pp. 110-2–110-11. Documents available from Aeroplus Dispatch.

The paper gives information on titanium alloys used in helicopters developed by the Mil Moscow Helicopter Plant, shows different principles of technology used for manufacturing of forgings on metallurgical and of parts on machine-building plants, and presents data indicating their quality level. Special attention is given to the development of specific quality control methods for components and half-finished products which assure their high quality and long service life. (Author)

N95-13535 Structure-phase state of thick amorphous and microcrystalline chromium-carbon films deposited by ion-plasma sputtering. A. S. BAKAJ, S. N. SLEPTSOV, I. G. MARCHENKO, and A. N. SLEPTSOV, *Academy of Sciences of the Ukraine, Kharkov (Ukraine). Fiziko-Tekhnicheskij Inst.* p. 7. Documents available from Aeroplus Dispatch.

The structure-phase state of Cr:C films prepared by reactive evaporation with arc discharge was studied. The nonequilibrium structure and phase diagram of the system in the carbon concentration range 0–35 at. pct and at temperatures 300–1100 K was obtained. The temperature-concentration diagram of Cr:C films microhardness is presented.

A95-23481 Preparation and optical properties of porous silicon. V. A. KARAVANSKIY and A. P. MASLOV (RAN, Inst. Obshchej Fiziki, Moscow, Russia), *2nd International Symposium on Advanced Laser Technologies*, Prague, Czech Republic, Nov. 8–13, 1993, Proceedings (A95-23476 05-36), Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings, Vol. 2332), 1994, pp. 101–113. 38 Refs. Documents available from Aeroplus Dispatch.

We have conducted an extensive experimental investigations of optical properties of porous silicon, with special emphasis on their dependence upon

the microstructure of the material. We present the results of direct STM observation of "quantum wires" in porous silicon and of time-resolved optical spectrum of nonlinear transmittance, featuring sharp peaks which can be attributed to the saturation of the optical transitions between spatially quantized levels of carriers in quantum wires. It was found that porous silicon is a strongly nonlinear optical material with the absolute value of $\text{Im } \chi^{(3)}$ equal to about $10 \exp -8 \text{ esu}$. (Author)

A95-22724 Magnesium-gadolinium and magnesium-gadolinium-yttrium alloys. L. L. ROKHLIN and N. I. NIKITINA (Russian Academy of Sciences, Inst. of Metallurgy, Moscow, Russia) *Zeitschrift fuer Metallkunde* (ISSN 0044-3093), Vol. 85, No. 12, Dec. 1994, pp. 819-823. 13 Refs. Documents available from Aeroplus Dispatch.

The microstructure and mechanical properties of magnesium gadolinium and magnesium-gadolinium yttrium alloys have been studied. There are extended magnesium solid solution areas in the systems narrowing as temperature lowers. The decomposition of the magnesium supersaturated solid solutions results in significant strengthening of the alloys. The alloys have good mechanical properties at room and elevated temperatures combined with low density. (Author)

A95-19368 Thermally induced structural and phase transformations of Mo-Si and MoSi₂-Si X-ray multilayer mirrors. A. I. FEDORENKO, A. S. GARBUIZ, V. V. KONDRATENKO, Y. P. PERSHIN, V. E. PUKHA, O. V. POLTSEVA, S. A. YULIN, and E. N. ZUBAREV (Kharkiv Polytechnic Inst., Ukraine), *X-ray optics and surface science—CIS selected papers* (A95-19366 04-74), Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings, Vol. 2453), 1995, pp. 15-24. 10 Refs. Documents available from Aeroplus Dispatch.

The effect of elevated temperatures on the structural stability of Mo-Si and MoSi₂-Si X-ray multilayer mirrors was studied. Multilayers deposited by magnetron sputtering were annealed at temperatures ranging from 300 to 1300 K. A detailed picture of the thermally induced changes in the microstructure is obtained using several techniques, including small- and large-angle X-ray scattering and transmission electron microscopy. The main causes of the degradation of Mo-Si mirrors are interdiffusion mixing of silicon and molybdenum layers and formation of MoSi₂ in both the hexagonal and tetragonal phases. The smoothing of interfaces in MoSi₂-Si mirrors and an increase in their reflectance were observed after annealing at temperatures below 800 K. The MoSi₂-Si mirrors undergo a catastrophic degradation above 1000 K caused by the crystallization of amorphous Si and recrystallization of hexagonal MoSi₂. (Author)

A95-17086 Metastable eutectoid decomposition in Zr-V alloys. A. V. DOBROMYSLOV, N. I. TALUTS, and N. V. KAZANTSEVA (Russian Academy of Sciences, Inst. of Metal Physics, Yekaterinburg, Russia), *Scripta Metallurgica et Materialia* (ISSN 0956-716X), Vol. 32, No. 5, March 1, 1995, pp. 719-724. Documents available from Aeroplus Dispatch.

An investigation is conducted of the microstructure of Zr-V alloys that have been quenched from the beta-region and then reheated, for V contents in the 5-10 at. pct range. Attention is given to XRD and TEM data. The intermediate intermetallic compound lines found on XRD patterns of the 10 at. pct V alloy are related to the large particles in the microstructure, rather than to ZrV₂ plates in the metastable eutectoid.

N94-30076 Development of evaluated data bank of physical properties of perspective nuclear engineering steels and alloys. O. V. SOPOV and V. A. SOLOVEV, *Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii, Obninsk (USSR)*. P. 6. Rept. DE94-607999; FEI-2246. Documents available from Aeroplus Dispatch.

A data bank of physical properties of perspective nuclear engineering steels and alloys is evaluated. The data bank includes the experimental data of the material property investigation by methods of the electric resistance and internal friction determination, of the X-ray structural and metallographic analyses, and also by methods of the hydrostatic weighing, positron annihilation, neutron diffraction analysis, and Moessbauer spectroscopy. The principal purposes for the data bank and the way in which it was realized were examined.

A94-24990 Phase and structure transformations in titanium alloys under thermohydrogenous treatment. A. A. IL'IN, B. A. KOLACHEV, and A. M. MAMONOV (Aviation Technology Inst., Moscow, Russia), *Titanium '92: Science and technology; Proceedings of the Symposium, 7th World Titanium Conference*, San Diego, CA, June 29-July 2, 1992. Vol. 1 (A94-24901 06-26), Warrendale, PA, Minerals, Metals, and Materials Society, 1993, pp. 941-947. 12 Refs. Documents available from Aeroplus Dispatch.

Hydrogen is a sufficiently effective Ti-alloy beta-stabilizer to influence phase and structural transitions. An account is here given of the bases for the novel field of "thermohydrogenous" heat-and-hydrogen treatments for various Ti alloy compositions, their microstructural and mechanical properties effects, and emerging development trends.

A94-24941 The effect of deformation and heat treatment conditions on structure and mechanical properties of gamma-alloys. B. I. BONDAREV, N. F. ANOSHKIN, A. B. NOTKIN, D. V. ELAGIN, and A. V. MOLOTKOV (All-Russia Inst. of Light Alloys, Moscow, Russia), *Titanium '92: Science and technology; Proceedings of the Symposium, 7th World Titanium Conference*, San Diego, CA, June 29-July 2, 1992. Vol. 1 (A94-24901 06-26),

Warrendale, PA, Minerals, Metals, and Materials Society, 1993, pp. 383-390. 5 Refs. Documents available from Aeroplus Dispatch.

An account is given of compositional, deformation, and heat-treatment condition effects on the microstructural and mechanical properties of Ti-50 at. pct Al alloys, as well as alloys characterized by several-percent deviation from stoichiometry in Al. Attention is given to microstructure-mechanical property relationships. It is noted that the hypothesized improvement of mechanical properties by grain refinement should not be considered universally applicable.

A94-22996 The significance of non-elastic deformation in the thermal shock fracture of heterogeneous ceramic materials. G. A. GOGOTSI (Ukrainian Academy of Sciences, Inst. for Problems of Strength, Kiev, Ukraine), *Thermal shock and thermal fatigue behavior of advanced ceramics; Proceedings of the NATO Advanced Research Workshop*, Munich, Germany, Nov. 8-13, 1992 (A94-22976 05-39), Dordrecht, Netherlands, Kluwer Academic Publishers, 1993, pp. 279-291. 13 Refs. Documents available from Aeroplus Dispatch.

The behavior of heterogeneous ceramic materials (HCM) made of alumina, yttria, and zirconia was studied under monotonous heating and quenching. The effect of their nonelasticity on thermal-fracture resistance (brittleness measure X was taken as a characteristic of nonelasticity) was analyzed. Nonelastic HCM exhibit an effect of R-curves, work of fracture gamma-sub-wof exceeds fracture energy values gamma-sub-snb, K1c values measured on notched specimens do not exceed those measured on cracked specimens, and continuous decrease of residual strength with temperature difference of their quenching can occur. It was demonstrated that the length and the number of microcracks in nonelastic HCM increase with an increase in stresses existing in them. It was found for nonelastic Mg-partially stabilized zirconia that, with higher temperature, it becomes elastic and its mechanical properties become poorer. It was established for ZrO₂-doped alumina ceramics that, on quenching, before the appearance of macrocracks, microstructure fractures took place changing deformability and acoustic emission. (Author)

A93-54446 Eigenwaves in uniaxial chiral omega media. S. A. TRET'YAKOV and A. A. SOCHAVA (St. Petersburg State Technical Univ., Russia), *Microwave and Optical Technology Letters* (ISSN 0895-2477), Vol. 6, No. 12, Sept. 20, 1993, pp. 701-705. 8 Refs. Documents available from Aeroplus Dispatch.

The presently considered family of novel materials, in which eigenwaves have the properties of chiral composites and omega structures, are shown to be modelable by uniaxial bianisotropic constitutive relations. Both the chiral and omega composites exhibit suggestive characteristics for various applications.

A93-53487 Structure and physical properties of Fe-implanted fused silica. A. KAZAKOV, A. BUKHARAEV, and R. MANAPOV (RAN, Fiziko-Tekhnicheskij Inst., Kazan, Russia), *24th International SAMPE Technical Conference, and 3rd International SAMPE Metals and Metals Processing Conference*, Toronto, Canada, Oct. 20-22, 1992, Proceedings. Vol. 3 (A93-53376 23-23), Covina, CA, Society for the Advancement of Material and Process Engineering, 1992, pp. M304-M315. 22 Refs. Documents available from Aeroplus Dispatch.

We report the results of Fe implantation into the surface layers of amorphous SiO₂, where the metal volume fraction and particle size have been systematically varied. It has been found that the implanted Fe ions precipitate mostly as oriented alpha-Fe particles during implantation. Magnetic and optical properties of these surface layers were determined by the shape, dimensions, and the extent of the defective crystalline structure of metallic particles. Coercivity of as-implanted samples, as high as 200 Oe at room temperature, has been achieved. Sequential step-by-step thermal annealing led to complete oxidation of iron by the oxygen from the SiO₂ network. After the final annealing at 600 C, the implanted layer consisted of antiferromagnetic alpha-Fe₂O₃ particles. The corresponding changes in magnetic and optical properties have been observed. While increasing the implant dose, the growth of metal particles occurred in the surface plane; therefore, their shape became more flattened. The coercivity was increased by a factor of two to four after pulse laser treatment. This effect is apparently connected with the reduction of the number of defects in the iron lattice during a very fast recrystallization process. (Author (revised))

A93-52325 Effects of grain size and grain boundary structure on yield strength of micro- and submicrocrystalline TiAl. R. IMAEV, V. IMAEV, and G. SALISHCHEV (Russian Academy of Sciences, Inst. for Metal Superplasticity Problems, Ufa, Russia), *Scripta Metallurgica et Materialia* (ISSN 0956-716X), Vol. 29, No. 5, Sept. 1, 1993, pp. 719-724. 23 Refs. Documents available from Aeroplus Dispatch.

The effects of grain size and grain boundary structure on the yield strength sigma-y of microcrystalline TiAl were investigated at temperatures from 20 to 850 C. A plot of yield strength as a function of sqrt grain diameter at different temperatures shows that, over the analyzed range of grain sizes, the Hall-Petch relationship is not fulfilled for TiAl either at room temperature or at elevated temperatures. This is partly due to the strong dependence of the yield strength on the type of slip (i.e., a transition from fine and homogeneous to planar slip occurs when the grain size increased in the interval of 10 micron average diam., resulting in an abrupt drop of the yield strength. This is also because of the peculiarities of the lattice dislocation interaction with random and special grain boundaries.