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Russian and Japanese Aerospace Literature

During 1995 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 Composite Materials from Russia and Structural or Aerodynamics Computerized Simulation from Japan.

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Russian Aerospace Literature
This month: *Composite Materials*

A95-16479 Magnetic-field-sensitive polymer composite materials. A. T. PONOMARENKO, V. SHEVCHENKO (Russian Academy of Sciences, Inst. of Synthetic Polymeric Materials, Moscow, Russia), C. KLASON (Chalmers Univ. of Technology, Goteborg, Sweden), and A. I. PRISTUPA (Russian Academy of Sciences, Inst. of Chemical Physics, Moscow, Russia), *Smart Materials & Structures* (ISSN 0964-1726), Vol. 3, No. 4, Dec. 1994, pp. 409–415. 21 Refs. Documents available from Aeroplus Dispatch.

This paper reports the results of investigations on magnetoresistance in composite materials prepared by direct polymerization of propylene on graphite particles. The method ensures grafting of polymer to the filler surface, imparting remarkable properties to the composite. For composites with graphite, magnetoresistance is positive for a filler volume fraction above the percolation threshold. The maximum value of magnetoresistance exceeds 10 percent. Below the threshold the samples show weak negative magnetoresistance characteristic of conduction through localized states in disordered systems. This result correlates with our model of double percolation over filler particles, surrounded by thin layers of injected charge. New magnetic effects have been found, such as oscillations of dark conductivity in magnetic field and resonance magnetic-spin effects. (Author)

A95-15615 Increasing the accuracy of determining the shear modulus of orthotropic rods in torsion (Povyshenie tochnosti opredeleniya modulej sdviga ortotropnykh sterzhnej pri kruchenii). A. V. BOGOMOLOV and V. A. BORISENKO (ANU, Inst. Problem Prochnosti, Kiev, Ukraine), Problemy Prochnosti (ISSN 0556-171X), No. 3, 1994, pp. 60–62. In Russian. 7 Refs. Documents available from Aeroplus Dispatch.

A method is presented whereby the accuracy of shear modulus measurements in torsion is increased by allowing for the compliance of the elements of the loading rig through the testing an additional specimen. It is noted that, in the case of the high-temperature testing of composite materials (e.g., carbon fiber composites), this method makes it possible to improve the accuracy of shear modulus measurements without using expensive strain gages and is the only practical method at temperatures above 2000 K.

A95-14925 Determining the kinetic strength constants and the critical fracture size of a composite material from pulsed electromagnetic emission recorded during fracture (Opredelenie kineticheskikh konstant prochnosti i kriticheskogo razmera razrusheniya kompozitsionnykh materialov na osnove registratsii impul'snogo ehlektromanitnogo izlucheniya pri ikh razrushenii). V. V. IVANOV, P. V. EGOROV, V. I. KLIMOV, L. A. KOLPAKOVA, A. A. MAL'SHIN, L. F. TUGOLUKOVA, V. V. YUNNIKOV, and V. P. BERVENO, *PMTF—Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0869-5032), Vol. 35, No. 4, Aug. 1994, pp. 153–159. In Russian. 7 Refs. Documents available from Aeroplus Dispatch.

The possibility of determining the kinetic strength constants and fracture parameters of composites by using a method based on the detection of pulsed electromagnetic emission during fracture is demonstrated experimentally. The underlying theory is examined, and the experimental setup is described. Experimental results are presented for several composite materials, including glass textolite, polyamide composites, and composite foams.

A95-11835 Prospective polymer composites with electrophysical properties—Highly-filled fibers. A. T. PONOMARENKO, A. V. BUTS, V. G. SHEVCHENKO (Russian Academy of Sciences, Inst. of Synthetic Polymeric Materials, Moscow, Russia), and C. KLASON (Chalmers Univ. of Technology, Gothenburg, Sweden), *In: Smart structures and materials 1994: Smart sensing, processing, and instrumentation; Proceedings of the Meeting,* Orlando, FL, Feb. 14–16, 1994 (A95-11801 01-35), Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 2191), 1994, pp. 399–406. 4 Refs. Documents available from Aeroplus Dispatch.

This paper studies the electrophysical properties of highly filled fiber polymer composites containing disperse conducting or ferromagnetic fillers and attention is given to variances in electric and magnetic properties. Fillers used include: polycrystalline Z-type ferrite, carbon black natural graphite, and isotropic synthetic graphite. Flow curves are measured with a rotational viscerometer, and cavity perturbation and magnets are used to assess electric/magnetic properties. Fibers with electrically conducting fillers show percolation in one dimension,and the fibers are possibly strain sensitive. Ferromagnetic fillers cause fibers to have magnetic properties superior to those of compacted ferrite samples. The results are of interest to the development of space structures with properties other than those of 3D composite materials.

A95-10412 Strain-sensitive polymer composite material. V. G. SHEVCHENKO, A. T. PONOMARENKO (Russian Academy of Sciences, Inst. of Synthetic Polymeric Materials, Moscow, Russia), and C. KLASON (Chalmers Univ. of Technology, Gothenburg, Sweden), *In: Smart structures and materials 1994: Smart materials; Proceedings of the Meeting,* Orlando, FL, Feb. 14–16, 1994 (A95-10401 01-23), Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 2189), 1994, pp. 162–169. 11 Refs. Documents available from Aeroplus Dispatch.

Composites of polypropylene and graphite with concentrations varying from 4 to 60 percent by volume were produced by in situ polymerization filling. The resistance of the material was measured by a conventional four-electrode method at room temperature or in a liquid helium cooled thermostat. Conductivity under tensile deformation was measured at a strain rate of 10 exp −4/min. The composites are found to have a positive temperature coefficient of resistance and strain-dependent conductivity. Both properties are time-dependent, with the time dependence defined by the mechanical relaxation behavior and heat conduction of the samples.

A95-10411 Magnetic-field-resistive polymer composite materials. A. T. PONOMARENKO, V. G. SHEVCHENKO (Russian Academy of Sciences, Inst. of Synthetic Polymeric Materials, Moscow, Russia), C. KLASON (Chalmers Univ. of Technology, Gothenburg, Sweden), and A. I. PRISTUPA (Russian Academy of Sciences, Inst. of Chemical Physics, Moscow, Russia), *In: Smart structures and materials 1994: Smart materials; Proceedings of the Meeting,* Orlando, FL, Feb. 14–16, 1994 (A95-10401 01-23), Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 2189), 1994, pp. 143–152. 20 Refs. Documents available from Aeroplus Dispatch.

Results of an experimental study of the magnetoresistance of composite materials prepared by the direct polymerization of propylene on graphite particles are reported. The magnetoresistance of such composites is shown to be positive for filler volume fractions above the percolation threshold, with

the maximum magnetoresistance exceeding 10 percent. Below the threshold, the samples exhibit weak negative magnetoresistance, characteristic of conduction through localized states in disordered systems. The results are consistent with a model of double percolation over filler particles surrounded by thin layers of injected charge.

A95-10388 The influence of the mechanical properties of a unidirectional composite on the optimal reinforcement law of fiber-reinforced materials (O vliyanii mekhanicheskikh kharakteristik odnonapravlennogo kompozita na zakon optimal 'nogo armirovaniya KVM). Y. P. ROMASHOV and S. G. SIDORIN (Kazanskij Khimiko-Tekhnologicheskij Inst., Kazan, Russia), *Problemy Prochnosti* (ISSN 0556-171X), No. 12, 1993, pp. 78–85. In Russian. Documents available from Aeroplus Dispatch.

The problem of the effect of the mechanical properties of a unidirectional composite material and filament winding methods on the optimal reinforcement paths is investigated analytically. The requirements for a reinforcement pattern that must be met when designing uniform-strength structures with allowance for the elasticity of the matrix are formulated. A glass fiber reinforced cylindrical shell is considered as an example, and it is shown that the optimal reinforcement angle for the shell is 56 deg.

A95-10348 General trends for development of composite structures in the Russian aircraft industry. A. G. BRATUKHIN, V. S. BOGOLYUBOV, and O. S. SIROTKIN ('ONC' Composites Research Center of Russian Aviation Industry, Moscow, Russia), *In: Broadening horizons with advanced materials and processes; Proceedings of the 14th SAMPE International European Chapter Conference*, Birmingham, United Kindgom, Oct. 19–21, 1993 (A95-10326 01-37), Niederglatt, Switzerland, SAMPE European Chapter, 1993, pp. 447–456. 7 Refs. Documents available from Aeroplus Dispatch.

This paper presents general results of research and experience of the Russian aviation industry in the field of composite material (CM) structures technology development, CM properties, applications, and their most cost-effective applications. The results of an analysis of the prospective development of structures technology and production are described. The paper considers computer-aided process planning (CAPP) techniques for the production of tooling for thin walled products made from CM. It includes a demonstration of the solution of technical problems associated with the mechanical design and development of polymeric structures through the creation of mathematical modeling programs for CAPP systems. (Author)

A95-10344 Formation of permanent joints in welding-soldering of aluminium-base composite materials to stainless steels. V. F. KHORUNOV, A. N. SHATS, V. S. Kuchuk-Yatsenko, V. I. SHVETS, and I. V. ZVOLINSKIJ (Academy of Sciences of the Ukraine, Welding Inst., Kiev), *In: Broadening horizons with advanced materials and processes; Proceedings of the 14th SAMPE International European Chapter Conference*, Birmingham, United Kingdom, Oct. 19–21, 1993 (A95-10326 01-37), Niederglatt, Switzerland, SAMPE European Chapter, 1993, pp. 405–412. 4 Refs. Documents available from Aeroplus Dispatch.

Joining of structural members of aluminum-base composite materials to other metals causes some difficulties due to brittle intermetallic phases forming in the joint zone. This leads to degradation of mechanical characteristics of the joints. The present paper considers the process of formation of a soldered joint in the welding-soldering of aluminum-matrix boron reinforced composites to stainless steels. The effect of filler materials and welding-soldering process parameters on formation of brittle intermetallic phases has been studied. As a result, the type of solder and the optimum welding-soldering process parameters minimizing the probability of the formation of intermetallics have been determined. (Author)

A94-23840 New estimates of the effective elastic moduli of two-component composites (Novye otsenki ehffektivnykh uprugikh modulej dvukhkomponentnykh kompozitov). A. V. EFIMENKO and G. N. KUVYRKIN, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 1, Feb. 1994, pp. 18–26. In Russian. 6 Refs. Documents available from Aeroplus Dispatch.

A method is proposed for estimating the elastic properties of an isotropic composite material using the criterion of the minimum energy of component interaction in the case of variable mean stress and strain fields in the components and constant mean (effective) stress and strain fields in the composite as a whole. The region of possible values of elastic moduli determined by this method is narrower than the Hashin–Shtrikman region. In the case of an isotropic composite, the upper boundary of the region corresponds to the arithmetic mean of the Voight and Reuss estimates.

A94-22542 Black Shark Ka-50 combat helicopter. S. REZNICHENKO, *Military Parade*, Feb. 1994, pp. 8–13. In English and Russian. Documents available from Aeroplus Dispatch.

An account is given of the design features and performance capabilities of the Ka-50 assault helicopter, giving attention to its advanced weapons suite and capability for air-to-air as well as air-to-ground engagement. Composite materials make up 35 percent of the helicopter's primary structure; advanced armor is used to protect the pilot from direct hits of 20 mm shells to the cockpit.

N94-18833 JPRS report: Science and technology; Joint Publications Research Service, Arlington, VA, Mar. 1993 Page: 80P, Russia, Country of Publication: United States. Documents available from Aeroplus Dispatch.

Articles cover the following topics: aluminum-based composite alloys; analytical techniques for predicting elastic properties of three-dimensional reinforced composites; stability of composite materials with interlaminar cracks; characteristics of strain gauge measurements on composites; corrosion cracking of high-strength steels in neutral media; experimental methods and devices for studying metal fracture toughness; effect of structural state on fatigue crack nucleation mechanism and growth kinetics in aluminum and magnesium alloys; and the effect of structural state of TiN coats on their strength.

N94-16854 Production and application of chemical fibers with special properties for manufacturing composite materials and goods of different usage. R. LEVIT, *In NASA. Langley Research Center, FIBER-TEX 1992: The Sixth Conference on Advanced Engineering Fibers and Textile Structures for Composites*, pp. 139–145 (SEE N94-16845 03-24). Documents available from Aeroplus Dispatch.

The development of modern technologies demands the creation of new nonmetallic, fibrous materials with specific properties. The fibers and materials developed by NII 'Chimvolokno', St. Petersburg, can be divided into two groups. The first group includes heat-resistant fibers, fire-resistant fibers, thermotropic fibers, fibers for medical application, and textile structures. The second group contains refractory fibers, chemoresistant and antifriction fibers, fibers on the basis of polyvinyl alcohol, microfiltering films, and paperlike and nonwoven materials. In cooperation with NPO 'Chimvolokno' MYTITSHI, we developed and started producing heat-resistant high-strength fibers on the base of polyhetarearilin and aromatic polyimides (SVM and terlon); heat-resistant fibers on the base of polyemede (aramid); fire-retardant fibers (togilen); chemoresistant and antifriction fibers on the basis of homo and copolymers of polytetrafluoroethylene (polyfen and ftorin); and water soluble, acetylated, and high-modulus fibers from polyvinyl alcohol (vylen). Separate reports will deal with textile structures and thermotropic fibers, as well as with medical fibers. One of the groups of refractory fibers carbon fibers (CF) and the corresponding paperlike nonwoven materials are discussed in detail. Also, composite materials (CM) and their base, which is the subject of the author's research since 1968, is discussed. (Author (revised))

N94-16853 New textile composite materials development, production, application. P. Y. MIKHAILOV, *In NASA. Langley Research Center, FIBER-TEX 1992: The Sixth Conference on Advanced Engineering Fibers and Textile Structures for Composites*, pp. 125–138 (SEE N94-16845 03-24). Documents available from Aeroplus Dispatch.

New textile composite materials development, production, and application are discussed. Topics covered include: super-high-strength, super-high-modulus fibers, filaments, and materials manufactured on their basis; heat-resistant and nonflammable fibers, filaments, and textile fabrics; fibers and textile fabrics based on fluorocarbon polymers; antifriction textile fabrics based on polyfen filaments; development of new types of textile combines and composite materials; and carbon filament-based fabrics.

A94-13146 Frequency dispersion of elastic waves in disordered composites (Chastotnaya dispersiya uprugikh voln v neuporyadochennykh kompozitakh). G. A. SHATALOV, *Prikladnaya Matematika i Mekhanika* (ISSN 0032-8235), Vol. 57, No. 4, Aug. 1993, pp. 104–113. In Russian. 17 Refs. Documents available from Aeroplus Dispatch.

A version of the nonlocal theory of disordered composites (or in a wider sense, randomly inhomogeneous media) is proposed which is formulated in terms of effective characteristics. The latter are functions of the wave vector and frequency, which makes it possible to describe the effects of spatial and frequency dispersion during wave propagation. The propagation of elastic waves is analyzed, with only frequency dispersion taken into account. The results are obtained in the approximation of strong dispersion, corresponding to the long-wave high-frequency approximation.

A94-12801 Averaging of equations of the dynamics of composites consisting of weakly compressible elastic components (Osrednenie uravnenij dinamiki kompozitov, sostavlennykh iz slabo szhimaemykh uprugikh komponent). N. S. BAKHVALOV and M. Eh. EHGLIT, *Zhurnal Vychislitel'noj Mathematiki i Mathematicheskoj Fiziki* (ISSN 0044-4669), Vol. 33, No. 7, July 1993, pp. 1066–1082, In Russian. 7 Refs. Documents available from Aeroplus Dispatch.

Equations are considered which describe the dynamics of composites with a periodic or random structure consisting of weakly compressible elastic components. Averaged equations are obtained under certain constraints on the governing parameters. The equations are written in explicit form and describe, in particular, the effect of a reduction in sound velocity in composites consisting of essentially dissimilar materials.

A94-11035 Numerical modeling of the fracture of composite laminates in impact (Chislennoe modelirovanie razrusheniya sloistykh kompozitov pri udarnykh vozdejstviyakh). V. V. BOLOTIN and A. A. GRISHKO, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 3, June 1993, pp. 151–160. In Russian. 11 Refs. Documents available from Aeroplus Dispatch.

The damage and fracture behavior of composite materials under conditions of low-velocity impact is investigated in the context of the theory of layered media with a periodic structure. Results of a numerical experiment are presented for a wide range of loads, impact times, and layer stiffness ratios. The number of cracks and their distribution over the thickness of a composite are investigated as a function of the composite characteristics, interface conditions, and impact parameters.