

# Russian and Japanese Aerospace Literature

Throughout 1993 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 and Structures from Russia and Synthetic Aperture Radar from Japan.

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## Russian Aerospace Literature This month: *Composite Materials and Structures*

**A93-18438** A study of the mechanical characteristics of the flywheel as the main component of an inertial mechanical energy storage system on board a space vehicle (Issledovanie mekhanicheskikh kharakteristik makhovika kak osnovnogo elementa IMES na bortu kosmicheskogo apparata). G. S. GOLOVKIN, E. I. STEPANYCHEV, and V. S. RUCHINSKII, Studies on the mechanics of space flight in the light of K.E. Tsiolkovsky's ideas; Lectures Devoted to K.E. Tsiolkovsky's Ideas, 25th, Kaluga, Russia, Sept. 11-14, 1990, Transactions (A93-18420 05-12). Moscow, AN SSSR, Institut Istorii Estestvoznaniia i Tekhniki, 1991, pp. 120-122.

The mechanical properties of a composite flywheel with compliant spokes are briefly examined as part of research concerned with inertial mechanical energy storage devices for space applications. Results of an experimental study of the stiffness coefficients of the spokes in the radial direction and resonance frequencies of the flywheel provide the basis for formulating material selection criteria and developing technology for fabricating flywheel components.

**A93-15193** Effective parameters of composite strength in conjugate physicomechanical fields (Effektivnye parametry prochnosti kompozitov v sopriazhennykh fiziko-mekhanicheskikh poliakh). V. A. BURIACHENKO and V. Z. PARTON, *PMTF—Prikladnaia Mekhanika i Tekhnicheskaya Fizika* (ISSN 0044-4626), No. 4, July-Aug. 1992, pp. 124-130. 14 Refs.

A method is proposed for constructing the strength surface of composite materials in static conjugate physicomechanical fields. The method allows for field coupling, arbitrary anisotropy of the physicomechanical properties, and shape and orientation of the filler inclusions. The single-point first and second moments of the conjugate fields in medium components are determined using previously proposed methods.

**A93-12972** A method for calculating a fiber-reinforced flywheel with allowance for the matrix (Metod rascheta voloknistogo makhovika s uchetom svyaziushchego). A. M. MOKEEV and S. G. SIDORIN, *Problemy Prochnosti* (ISSN 0556-171X), No. 6, 1992, pp. 39-41. 2 Refs.

A new method for calculating structures of fiber composites is proposed which is based on the net theory of composites. The method allows for the effect of the stiffness and strength characteristics of the matrix material. Results of calculations are presented for a chord-type composite flywheel.

**A92-40769** The effect of structure on the deformation of metal knitted fabric for the reinforcement of composite materials (Vlianie struktury na deformatsiiu metallotrikotazha dlia armirovaniia kompozitsionnykh materialov). L. R. VISHNIAKOV, L. I. FEODOS'EVA, and S. N. IAKIMENKO, *Poroshkovaia Metallurgii* (ISSN 0032-4795), No. 3, March 1992, pp. 20-26. 7 Refs.

A procedure is proposed for calculating deformations and elasticity moduli of a metal knitted fabric used for the reinforcement of composite materials. The shape of the loop and displacements of the structural elements are calculated as a function of the applied load. This procedure makes it possible to calculate net reinforcement elements for specified loading conditions.

**A92-51364** Solving problems of the stressed state of composite materials with warped layers using a geometrically nonlinear formulation (K resheniiu zadach o napriazhennom sostoianii kompozitnykh materialov s iskrivlennymi sloiami v geometricheski nelineinoi postanovke). S. D. AKBAROV, A. N. GUZ', Z. R. DZHAMALOV, and E. A. MOVSUMOV, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 28, No. 6, June 1992, pp. 3-8. 8 Refs.

An approach to the solution of geometrically nonlinear problems of the stress-strain state of composites with warped layers is proposed which is based on a piecewise homogeneous model and exact three-dimensional nonlinear elasticity equations. The layers are assumed to consist of homogeneous isotropic Hookean materials. Numerical results are presented which illustrate the substantial influence of geometrical nonlinearity on the self-balanced stress distribution.

**A92-51363** Some physical properties of zirconium-based composite materials (Nekotorye fizicheskie svoistva kompozitsionnykh materialov na osnove tsirkoniia). L. R. VISHNIAKOV, V. P. MOROZ, and P. I. MAL'KO, *Poroshkovaia Metallurgii* (ISSN 0032-4795), No. 6, June 1992, pp. 93-97. 10 Refs.

The heat conductivity, electrical resistivity, and thermal expansion coefficient of zirconium-based composites reinforced by tungsten and molybdenum fibers and nets are investigated in the temperature range 20-1100 C. The composites have been produced by compacting packets consisting of alternating layers of iodide zirconium foils and reinforcing elements.

**A92-46616** Bending of composite cylindrical lattice shells (Izhib setchatykh kompozitnykh tsilindricheskikh obolochek). P. S. BELOUSOV and V. A. BUNAKOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 2, Mar.-Apr. 1992, pp. 225-231. 2 Refs.

Consideration is given to a new class of composite structures developed to sustain intense compressive loads, i.e., cylindrical shells consisting of helical and annular ribs with coatings reinforced in the circumferential direction. Governing equations of a continuum model of the structures are based on a version of the asymmetric elasticity theory containing an independent vector of rotation. Constitutive equations take into account stiffness of the ribs in tension/compression, shear, and bending in normal and tangential planes and torsion. A solution for the cantilever shell is obtained on the basis of the membrane theory of shells.

**A92-25311** Effect of mechanical layer characteristics on the internal instability of a composite (Vlianie mekhanicheskikh kharakteristik sloev na vnutrenniuiu neustoiichivost' kompozita). I. A. GUZ', *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 27, Dec. 1991, pp. 110-114. 10 Refs.

The effect of the mechanical characteristics of the filler and the matrix on the critical deformation of a layered composite is investigated in the context of three-dimensional nonaxisymmetric and plane problems. The analysis is carried out on the basis of the second version of the theory of small subcritical deformations in the three-dimensional linearized stability theory for deformable bodies. Expressions are presented which relate the critical deformation to each of the mechanical properties of the layers.

**A92-46618** An experimental/theoretical method for the study of the residual technological stresses in products made of composite materials (Eksperimental'no-teoreticheskiy metod issledovaniia ostatochnykh tekhnologicheskikh napriazhenii v izdeliakh iz kompozitnykh materialov). G. V. VORONTOV and A. I. REZNICHENKO, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 2, Mar.-Apr. 1992, pp. 239-246. 7 Refs.

A method for analyzing residual stresses in products made of composite materials by forced winding, pyrolytic precipitation, casting or extrusion is proposed. It is shown that each initial stressed state of a product may have an equivalent temperature field causing identical thermoelastic stresses in the product. This method is verified by means of analysis of the technological stresses in thick-walled conic shells made by pyrolytic carbon precipitation at temperatures above 2000 C. The method makes it possible to determine the stresses of the whole volume of the product with comparatively few data on the deformation relaxation provided by the attached strain gauges. Satisfactory agreement was found between the theoretical and experimental values of the stresses in places of the fixed strain gauges.

**A92-46617** Coupled flexural-torsional vibrations of anisotropic bars from polymer composite materials. II—Comparisons of calculated and experimental data for carbon-fiber composite bars (Sviazannye izgibno-krutil'nye kolebaniia anizotropnykh sterzhnei iz polimernykh kompozitnykh materialov. II—Sopostavlenie raschetnykh i eksperimental'nykh dannykh dlia sterzhnia iz ugleplastika). V. S. EKEL'CHIK, A. A. PERREN, V. M. RIABOV, and B. A. IARTSEV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 2, Mar.-Apr. 1992, pp. 232-238. 5 Refs.

A number of primary natural frequencies of flexural and torsional vibrations are determined experimentally for specimens cut from a unidirectional CFRP plate at the angles  $\phi = 0, 90$  deg to the reinforcement direction. The flexural and torsional vibration values yielded primary values of elasticity and shear moduli, which were then corrected on the basis of a comparison of the experimental data and theoretical calculations of the frequencies of coupled flexural-torsional vibrations of specimens cut at angles of 15, 30, 45, 60 and 75 deg. Good agreement between the calculated and experimental data is obtained, and it is shown that the flexural-torsional interaction must be considered in studying the natural vibrations for specimens whose longitudinal axes do not coincide with the elasticity symmetry axis.

**A92-46573** Trends in the design of composite materials for use in friction joints (Tendentsii sozdaniia kompozitsionnykh materialov dlia osnashcheniia uzlov treniia). I. M. FEDORCHENKO, *Poroshkovaia Metallurgiya* (ISSN 0032-4795), No. 5, May 1992, pp. 44-53. 39 Refs.

The literature on the design of friction-alleviating composites for friction joints is reviewed. Consideration is given to the effects of the metal base, the composition of hard lubricants, and the material structure on the triboengineering properties, the friction mechanism, and the wear of the bearings. Present trends in the design of antifriction materials based on iron, metallofluoroplastics, aluminum alloys, and ceramics are discussed together with the methods developed for increasing their strength and load-bearing capacity. In general, the trend in the development of antifriction materials follows the direction of improving the properties of copper-iron composites, methods for reinforcement and dispersion strengthening, and methods for plasma spraying.

**A92-44113** Comparison of interlaminar shear strengths of composites determined by some conventional methods (Sopostavlenie znachenii prochnosti pri mezhslainom sdvige kompozitov, opredeleniia nekotorykh iz naibolee rasprostranennykh metodov). V. I. ZHIGUN, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 1, Jan.-Feb. 1992, pp. 67-72. 11 Refs.

Shear strength values obtained by test methods based on different loading schemes are analyzed, and the influence of specimen parameters on the shear strength is studied. Loading schemes under consideration include loading a rectangular waisted prism under forces applied at an angle to its base and torsion; loading specimens notched in two cross sections; transverse bending of a freely supported beam; and distribution of tangential stresses in an adhesive interlayer over the bond length. It is shown that the proper selection of the specimen parameters yields good comparative strength values of all the methods considered.

**A92-44110** The brittle fracture characteristics of dispersely filled composites under different adhesive conditions (Zakonomenosti khrupkogo razrusheniia dispersno-napolnennykh kompozitov v razlichnykh usloviakh adgezionnoi svyazannosti). V. G. OSHMIAN, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 1, Jan.-Feb. 1992, pp. 34-42. 5 Refs.

Mechanisms of interface debonding and fracture in composite materials are analyzed using the energy criterion of crack propagation in the elastic media. It is found that, for ideal bonds, the composite strength increases with the filling due to the increasing rigidity and surface deformation. For low adhesive strengths, the composite strength decreases due to reduction of elastic moduli and fracture surfaces. When the adhesive fracture accompanies the crack propagation and occurs in the front points or in their vicinity, the composite strength increases with the filling. For certain ratios of adhesive/cohesive fracture parameters, composite strength values can exceed the values associated with ideal bonds.

**A92-46579** Bordoni relaxation in aluminum-alloy-based composite materials (O relaksatsii Bordoni v kompozitsionnykh materialakh na osnove aluminievyykh splavov). A. N. KACHEVSKII, *Rossiiskaia Akademiia Nauk, Doklady* (ISSN 0002-3264), Vol. 323, No. 1, 1992, pp. 78-81. 12 Refs.

The formation and behavior of the Bordoni peak in aluminum-alloy-based composites under thermal loading were investigated. Practical applications of this effect are examined, including the evaluation of the degree of thermal plastic deformation of composite matrices according to the magnitude of the Bordoni relaxation.

**A92-44112** Determination of the short-term macrostrength and fracture toughness of orthotropic composite materials in a complex stress state (Opredelenie kratkovremennoi makroprochnosti i treshchinostoikosti ortotropnykh kompozitnykh materialov pri slozhnom napriazhennom sostoianii). M. V. DELIAVSKII, L. T. BEREZHNIISKII, and L. I. ONYSHKO, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 1, Jan.-Feb. 1992, pp. 55-66. 27 Refs.

Techniques are presented to determine structural characteristics of fracture toughness and anisotropy of orthotropic composite materials. These techniques include calculation of the stress field in biaxial tensile shear of a unidirectional composite; determination of specimen dimensions for stress field uniformity; experimental determination of the ultimate load value; and the method of least squares. The fracture toughness of a continuous anisotropic specimen is calculated using equations for a continuous rectangular orthotropic plate and an infinite plate with a crack under compensated loads, which are based on Green functions. Calibrated curves describe the dependence of the stress intensity factor on the notch length of the specimen. A structural fracture criterion is proposed for an orthotropic composite material with a crack.

**A92-42766** Torsion of a cylindrical composite shaft of finite length (O kruchenii kompozitsionnogo tsilindricheskogo vala konechnoi dliny). D. IA. BARDZOKAS, A. L. KALAMKAROV, and O. B. RUDAKOVA, *Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 1, Jan.-Feb. 1992, pp. 58-66. 8 Refs.

The problem of the torsion of a multilayer composite hollow cylindrical shaft of finite length is analyzed using the general approach proposed by Ufland (1976). This approach and the averaging method are used to obtain a new generalized integral equation which is then used to obtain an analytical solution for the problem. In the particular case of a homogeneous material, the generalized integral representation is shown to reduce to known relations, which have been used in a earlier study (Arutiunian et al., 1986).

**A92-42667** Determination of edge effect regions in layered composites in the presence of filler discontinuities (Opredelenie oblastei kraevykh effektov v sloistnykh kompozitakh pri nalichii razryvov napolnitelia). A. N. GUZ', IU. V. KOKHANENKO, and E. S. IAKOVLEVA, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 28, No. 3, March 1992, pp. 14-19. 8 Refs.

The problem of determining edge effects in a layered composite material in the presence of two cracks in adjacent filler layers is analyzed in the context of three-dimensional linearized elasticity using a piecewise homogeneous model of a medium consisting of homogeneous contacting bodies. Particular attention is given to integral characteristics, such as the extension of edge effects and the configuration of the edge effect region, which are determined by using the finite difference method. Edge effect regions are shown for certain ratios of the elastic moduli of the filler and the matrix.

**A92-40709** The mechanical properties of polymer and composite materials in various high-speed loading modes (Mekhanicheskie svoistva polimernykh i kompozitnykh materialov pri razlichnykh vidakh vysokoskorostnogo nagruzeniia). A. P. VASHCHENKO, E. G. SAFAROV, V. A. GUS'KOV, and S. A. ZAKOSHCHIKOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 6, Nov.-Dec. 1991, pp. 1103-1108. 8 Refs.

Methodology and results of dynamic testing of polymer and composite materials in compression and shear are presented. The compression tests with loading rates reaching 5 m/s were carried out using a vertical impact machine for a cylindrical specimen of 7.5 mm in diameter and 15 mm high. Dynamic testing of materials in plane stressed state with loading rates up to 250 m/s was carried out using a pneumatic impact test machine. The results of mechanical testing in various high-speed loading modes show a significant growth in the strength characteristics of the materials with increasing deformation rates up to 100,000/s.

**A92-40704** New generalized integral transforms in axially symmetric boundary value problems in composite mechanics (Novye obobshchennye integral'nye preobrazovaniia v osesimmetrichnykh kraevykh zadachakh mekhaniki kompozitov). A. L. KALAMKAROV, B. A. KUDRIAVTSEV, and D. BARDZOKAS, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 6, Nov.-Dec. 1991, pp. 1005-1014. 8 Refs.

An analytical method to solve axially symmetric problems in composite mechanics is proposed. Integral transforms and expansions which generalize the Fourier-Bessel series, Hankel and Weber-Orr transforms are used to obtain analytical solutions to boundary-value problems for composite multilayer shells of finite length and for axially symmetric composite layers with or without circular holes.

**A92-40708 Thermal expansion of carbon reinforcements for composite materials (Teplovoe rasshirenie ugleodnykh armiruiushchikh napolnitelei dlia kompozitnykh materialov).** E. I. LUKINA, S. I. FOKIN, and V. V. ROGOZIN, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 6, Nov.-Dec. 1991, pp. 1059-1064. 3 Refs.

Thermal expansion of polyacrylonitrile and viscose fibers has been studied at various temperatures of thermal processing using a high-temperature dilatometer. A special device was used to exclude bending flexure and sagging of the specimens. The temperature of preliminary thermal processing determined the degree of structural perfection, thermal stabilization temperature, the temperature coefficient of linear expansion (TCLE), and changes in the shape. A shrinkage of the specimens was observed which was caused by carbonization in the fiber specimens at processing temperatures lower than 1500-1700 C. When the temperature was increased from 1300 to 2800 C, the fiber TCLE decreased almost by half, while the TCLE of fabrics changed insignificantly.

**A92-31914 A dielectric composite based on high temperature superconductors (Dielektricheskie kompozit na osnove VTSP).** A. M. GRISHIN, N. I. MEZIN, G. S. IAROSH, and N. I. STAROSTIUK, (Vsesoiuznoe Soveshchaniye po Vysokotemperaturnoi Sverkhprovodimosti, 3rd, Kharkov, Ukraine, Apr. 15-19, 1991) *Fizika Nizkikh Temperatur* (ISSN 0132-6414), Vol. 17, Nov.-Dec. 1991, pp. 1489, 1490. 2 Refs.

A composite has been prepared using an epoxy matrix and single-phase superconducting powders based on YBa<sub>2</sub>Cu<sub>3</sub>O(7-x) ceramic with T<sub>c</sub> = 91-93 K. The composite was used to produce strip lines; the microwave characteristics of the lines were measured in the frequency range 8-12 GHz. An analysis of the experimental data shows that small magnetic fields can significantly change the microwave parameters of the strip lines. The dielectric composite can thus be used to produce magnetically controlled microwave components.

**A92-31895 A method for the strength analysis of composite structures (Metodika poveroknykh raschetov prochnosti konstruktii iz kompozitsionnykh materialov).** V. D. GRIGOR'EV, A. S. DZIUBA, A. A. IONOV, I. U. A. KAMYSHOV, and V. F. KUT'INOV, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 22, No. 3, 1991, pp. 81-91. 5 Refs.

A method for analyzing the stress-strain state and strength of composite structures is proposed which employs multilevel highly accurate finite element models of typical areas of the structures. The models allow for the design characteristics, type, and anisotropic properties of the structural elements and for the presence of manufacturing defects, with a correction for experimental data. As an example, the method is applied to the strength analysis of the large doors of a freight compartment, and good agreement is obtained with experimental data.

**A92-27580 Algorithm for the structural analysis of large-scale concentrating systems made of composite materials (Algoritim rascheta konstruktii krupnogabaritnykh kontsentrirovannykh sistem iz kompozitsionnykh materialov).** M. A. GURBANIAZOV and E. NAFASOV, *Akademiia Nauk Turkmenskoi SSR, Izvestiia, Seria Fiziko-Matematicheskikh, Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk* (ISSN 0002-3507), No. 4, 1991, pp. 98-101. 2 Refs.

An algorithm for a structural analysis of large-scale concentrating systems is proposed. Module elements of the reflecting surface of facets under wind and temperature loads are studied. Solutions of equations for the deflection of rectangular plates of mean thickness are obtained.

**A92-25287 Analysis of the dynamic characteristics of an energy storage system with a composite flywheel. II—Effect of internal friction in the flywheel on rotation stability (Analiz dinamicheskikh kharakteristik modeli sistemy nakopleniia energii s makhovikom iz kompozita. II—Vliianie vnutrennego treniia v makhovike na ustoiichivost' vrashcheniia).** G. G. PORTNOV, P. A. MOORLAT, and I. N. BARINOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1991, pp. 851-860. 21 Refs.

A simple energy storage system is considered which consists of a rim and a massive shaft with elastic damping couplings (spokes); the shaft rotates in elastic damping bearings. For such a system, a parametric analysis is made of the position of the rotation stability limits. It is shown that, with damping in the bearings, vibration instability during the rotation of a flywheel with internal friction can be practically avoided, provided that the stiffness of the bearings is substantially less than that of the flywheel. Examples of flywheel designs with high structural damping, which cannot be operated in the postcritical regime, are presented.

**A92-25279 Engineering composite mechanics in the USSR (Inzhenernaia mekhanika kompozitov v SSSR).** I. U. M. TARNOPOL'SKII, (ASEE and CSEE, Sovmestnaia Ezhegodnaia Konferentsiia, Toronto, Canada, June 1990) *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1991, pp. 787-795. 73 Refs.

Recent theoretical and experimental research in the field of engineering composite mechanics conducted in the USSR is briefly reviewed. In particular, attention is given to the micromechanics and macromechanical approaches to the study of composites; composite strength theories; the principle of energy smoothing; and development of generalized methods for the strength analysis of composite structures. The discussion also covers the development of specialized theories accounting for the specific structural properties of composites and studies of the fracture modes of composites.

**A92-25289 Analysis of the shape of the multidimensional domain of optimized composite properties (Analiz formy mnogomernoi oblasti svoistv optimiziruемого kompozita).** A. F. KREGERS and M. F. REKTIN'SH, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1991, pp. 876-884. 10 Refs.

The problem of the multifactorial optimization of five composite properties (three elastic moduli and two thermal expansion coefficients) is solved for a layered composite with three reinforcement directions. Particular attention is given to a method for determining the coordinates of the end points defining the dimensions of the five-dimensional region and to a procedure for constructing projections of the five-dimensional region onto a specified plane, with identification of Pareto's optimality subregions.

**A92-25284 Determination of the load-bearing capacity of composite panels under compression (Opredeleniie nesushchei sposobnosti kompozitnykh panelei pri szhatii).** N. S. AZIKOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1991, pp. 831-838. 2 Refs.

A method is proposed for the analysis of the postcritical behavior of a compressed composite panel supported by elastic ribs. The method is based on a single-term approximation of the deflection of a panel with unknown amplitude and wave numbers. The critical stress, affected by the rib stiffness, and the threshold stress corresponding to the skin damage are determined. Calculation results are presented for carbon composite panels with different reinforcement patterns.

**A92-23591 Effective strength parameters of matrix composites (Effektivnye parametry prochnosti matrichnykh kompozitov).** V. A. BURIACHENKO, I. U. S. SKORBOV, and S. V. GUNIN, *Problemy Prochnosti* (ISSN 0556-171X), Dec. 1991, pp. 47-51. 21 Refs.

A method has been developed for constructing the effective strength surface of matrix composites from the properties of the components with allowance for the arbitrary anisotropy of the strength, elastic, and geometrical parameters of the components. The method is based on estimating the mean values of the first and second stress tensors for the components of a composite material. Some particular results based on this method, which are consistent with the well-known criteria, are examined.

**A92-21584 Low-temperature forming of thick-walled composite rings (Nizkotemperaturnoe formovanie tolstostennykh kolets iz kompozita).** E. I. STEPANYCHEV, V. V. MUSATOV, V. S. PICHUGIN, and A. P. RIAZANOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), July-Aug. 1991, pp. 721-724. 7 Refs.

A method for producing filament-wound thick-walled composite rings is proposed whereby the layers of the material are cooled while being wound around the mandrel. A method for determining the optimal cooling temperature of the semifinished product is presented. It is shown experimentally that the use of low-temperature winding increases the strength of glass fiber composite rings under radial tension and interlaminar shear.

**A92-21581 Effect of delaminations on the stability of cylindrical composite shells (Vliianie rassloenii na ustoiichivost' tsilindricheskikh obolochek iz kompozitov).** V. T. TOMASHEVSKII, A. S. ZAKHVATOV, and V. S. IAKOVLEV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), July-Aug. 1991, pp. 683-691. 7 Refs.

The stability theory for thin orthotropic shells, geometrical and physical linearity hypotheses, and the formalism of impulse functions are used to obtain analytical expressions for estimating the effect of delaminations on the critical compressive stress in the case of axisymmetric buckling and on the external pressure and axial compressive force in the case of the multiwave buckling mode. It is shown numerically that the stability of shells with delaminations is largely determined by the delamination area, location of delaminations, and the opening displacement and intermittence of delaminations.

**A92-18338 Theory of the small elastoplastic deformations of randomly reinforced composite materials (K teorii malykh uprugoplas-ticheskikh deformatsii khaoticheskii armirovannykh kompozitsionnykh materialov).** I. S. MAKAROVA and L. A. SARAIEV, *PMTF—Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Sept.-Oct. 1991, pp. 120-124. 8 Refs.

The elastoplastic properties of a composite material containing nonoriented ellipsoidal inclusions are investigated in the context of the mechanics of randomly inhomogeneous media. Expressions for calculating the elastoplastic properties of randomly reinforced composites are obtained and applied to a composite made of a sintered aluminum powder (14 percent Al<sub>2</sub>O<sub>3</sub>). The results are compared with experimental data.

**A92-18285 A study of the disintegration of composite materials under the effect of laser radiation and supersonic flow of nitrogen (Issledovanie razrusheniia kompozitsionnykh materialov lazernym izlucheniem i sverkhzvukovym potokom azota).** A. A. BETEV, V. T. KARPUKHIN, M. M. MALIKOV, and N. I. SHAL'NOVA, *Fizika i Khimiia Obrabotki Materialov* (ISSN 0015-3214), Nov.-Dec. 1991, pp. 58-65. 5 Refs.

Experiments were carried out to investigate the combined effect of laser radiation and supersonic flow of nitrogen on specimens of composite materials containing a phenol formaldehyde matrix. Results are presented for laminated and porous specimens tested in nitrogen flow at Mach 4.1 and irradiated by a CO<sub>2</sub> laser (100-10,000 W/sq cm). It is found that laser radiation accounts for most of the observed mass loss.