

**A90-23444 Optimization of composite shells of revolution with mixed frame and stringer reinforcement (Optimizatsiia obolochek vrashcheniia iz kompozitnykh materialov, podkreplennykh smeshanoi sistemoi nabora).** V. T. TOMASHEVSKII, V. N. KALININ, and V. S. IAKOVLEV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Nov.-Dec. 1989, pp. 1054-1059. 6 Refs.

An approach to the optimization of reinforced polymer composite shells of revolution is examined from the standpoint of mathematical programming. In particular, attention is given to cylindrical shells of revolution with regular frame and stringer reinforcement loaded by uniform pressure. The problem is analyzed using a linear geometrical formulation assuming that the shell material is orthotropic, uniform, and linearly elastic.

**A90-23441 Modeling of the fracture of composite bodies by the numerical/analytical potential method (Modelirovanie protsessov razrusheniia sostavnykh telchislennno-analiticheskimi metodami).** I. U. V. VERIUZHSKI, D. R. GIGINEISHVILI, and A. N. SNITKO, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Nov.-Dec. 1989, pp. 1024-1030. 8 Refs.

By using the numerical/analytical potential method, a procedure has been developed for determining the stress-strain state of composite bodies. The interaction between reinforcement rods and a solution based on epoxy resins is investigated with allowance for friction and slip. Crack formation and stress distributions in element contact zones are simulated on a computer for different classes of reinforcement rods.

**A90-23440 Delamination-type fracture of composite structures (Razrushenie konstruktii iz kompozitnykh materialov po tipu rassloeniia).** A. N. VORONTSOV, G. KH. MURZAKHANOV, and V. N. SHCHUGOREV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Nov.-Dec. 1989, pp. 1007-1023. 81 Refs.

The available literature on the interface fracture mechanics of composite structures is reviewed in a systematic manner. In particular, attention is given to stability problems for compressed elastic elements of composite materials, including rods, plates, and shells with delamination-type defects. Examples of applications of multiparametric fracture mechanics, combined with damage accumulation theory, to the calculation of the stability and endurance of structures with interlayer defects are presented. Equilibrium dimensions and growth kinetics are determined for ellipsoidal delaminations in a spherical shell under cyclic loading.

**A89-54663 A numerical-analytical approach to the study of the deformation of composite shell structures (Chislennno-analiticheskii podkhod k issledovaniiu deformirovaniia obolocheknykh konstruktii iz kompozitov).** V. N. BAKULIN and V. O. KALEDIN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), July-Aug. 1989, pp. 184-188. 6 Refs.

An approach combining the numerical finite element method and the analytical small parameter method is applied to the parametric analysis of the stress strain state of composite shell structures of anisotropic materials. By using this approach, variable-geometry problems for composite shells are reduced to multiple successive repetitions of a solution to a system of linear algebraic equations with the same coefficient matrix. This approach also allows efficient automation of the parametric analysis of reinforced shell structures.

**A89-49175 The use of compensators in tomographic studies of composites (Primenenie kompensatorov pri tomograficheskikh issledovaniakh kompozitov).** V. I. BARAKHOV, V. A. CHERNIAEVA, A. P. STEPANOV, and V. S. KISELEV, *Defektoskopiia* (ISSN 0130-3082), No. 6, 1989, pp. 8-12.

The errors typically occurring during the investigation of the internal structure of composites by computerized tomography are briefly examined, and the need for using a compensating layer is demonstrated. Results of tomographic experiments, with calcium chloride solutions used as a compensator are presented, and recommendations are given concerning the selection of solution concentration and compensator layer thickness.

**A89-54587 A version of the linear theory of composite shells allowing for transverse shear and reduction (Variant lineinoi teorii kompozitnykh obolochek, uchityvaiushchii deformatsii poperechnogo sdviga i obzhatie).** V. K. IVANOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), July-Aug. 1989, pp. 682-687. 7 Refs.

A version of the linear theory of composite shells is presented which includes transverse shear, cross-sectional reduction, and nonlinear displacement distribution over the shell thickness. Equilibrium equations in forces and moments are supplemented by equations eliminating the discrepancy between transverse stresses determined by integrating three-dimensional elasticity equations and Hooke law. The accuracy of the solutions depends on the number of the resolved discrepancies.

**A89-48912 Trends in the development of nondestructive testing methods for composite materials (Tendentsii razvitiia metodov nerazrushaiushchikh ispytaniia kompozitnykh materialov).** I. G. MATIS, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), May-June 1989, pp. 494-502. 19 Refs.

Current developments and trends in the nondestructive testing and quality control of composite materials are reviewed with reference to recent publications in this field and reports presented at international conferences. Particular attention is given to the development of measuring systems using artificial intelligence concepts, systems using new physical phenomena, development of expert systems, and new designs of measuring transducers.

**A89-48904 Elasticity and fracture of triorthogonally reinforced media. II—Shear (Uprugost' i razrushenie triortogonal'no armirovannykh sred. II—Sdvig).** G. A. VANIN, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), May-June 1989, pp. 431-436. 6 Refs.

The thermoelastic equilibrium of multilayer composite shells of revolution of the cylinder-cone type is analyzed for the case of mechanical loading and convective heat transfer between the shell and the ambient medium. Heat conductivity and thermoelasticity boundary value problems for multilayer composite orthotropic shells are formulated. The elasticity analysis is based on hypotheses allowing for the nonlinear distribution of transverse shear deformations over the thickness of a multilayer stack. The heat conductivity and thermoelasticity boundary value problems are solved numerically using the discrete orthogonalization method.

**A89-44691 Radiation-cured polymer composites (Radiatsionno-otverzhdaemye kompozitsionnye polimernye materialy).** I. U. P. BOICHENKO, V. T. BLOKHIN, V. N. KESTEL'MAN, and G. E. VISHNEVSKI, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 305, No. 6, 1989, pp. 1369-1372. 8 Refs.

A process for the production of glass-reinforced composite laminates is proposed which uses radiation curing of the polymer matrix by a beam of accelerated electrons. Typically, the laminate consists of one or several layers of fiber glass fabric impregnated by a reaction-curable polymer matrix material and sandwiched between two layers of a polymer film or copper foil. The process is described with particular reference to results obtained for a three-component matrix system consisting of dimethylacrylate-(bis-triethylene glykol)phthalate, an epoxy oligomer, and an acrylic monomer (methacrylic acid).

**A89-42407 Effective characteristics of governing relations for thermorheologically simple composites (Effektivnye kharakteristiki opredeliaushchikh sootnoshenii termoreologicheskii prostykh kompozitov).** V. M. PESTRENIN and I. V. PESTRENINA, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Mar.-Apr. 1989, pp. 214-220. 15 Refs.

Different forms of governing equations for thermorheologically simple composites are presented in which the effective characteristics include relaxation (creep) function tensors, relaxation (creep) nucleus tensors, thermal expansion function vectors, and temperature stress function vectors. For constructing these mathematical entities, an approach is proposed which is based on the nonlinear approximation of the solution in image space using the Laplace transform. An exact solution is obtained for the case of layered materials.

## Japanese Aerospace Literature This month: Crystal Growth

**A91-21654 Growth and magnetic properties of Ti-Ca-Ba-Cu-O single crystals.** KENICHI KAWAGUCHI and MASAO NAKAO, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 942-946. 13 Refs.

Single crystals of  $Ti_2Ca(n-1)Ba_2Cu(n)O(2n+4)$  where  $n = 1, 2, 3$ , and 4, were grown by a slow-cooling method. The onset critical temperatures were 70, 104, 122, and 113 K for  $Ti_2Ba_2CuO(x)$ ,  $Ti_2CaBa_2Cu_2O(x)$ ,  $Ti_2Ca_2Ba_2Cu_3O(x)$ , and  $Ti_2Ca_3Ba_2Cu_4O(x)$ , respectively. The critical current density  $J_c$  of a  $Ti_2CaBa_2Cu_2O(x)$  single crystal was strongly reduced with increasing temperature:  $J_c$  was 509,000 A/sq cm at 10 K and dropped to 11,000 A/sq cm at 40 K. Large time-logarithmic magnetic relaxation was observed for the same single crystal sample, which suggests a small depinning activation energy of about 0.02.

**A91-21628 Direct observation of LPE growth in GaP.** Y. INATOMI and K. KURIBAYASHI, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 1, Jan. 1990, pp. 124-127. 8 Refs.

An in situ observation technique using an infrared microscope is developed in order to observe the liquid/solid interface from the bottom side of a substrate during the process of LPE growth of semiconductor crystals. Particular attention is focused on macrosteps, types of ripples appearing on as-grown LPE crystal surfaces which are characterized by a terrace and/or wavelike pattern having no relation to the direction of liquid removal. The technique successfully gives clear images of morphological variations during the LPE GaP crystal growth process. It is pointed out that the appearance of macrosteps, shown in the present observation, will be an aid for the precise discussion of the mechanism of macrostep formation.



**A91-32800** A new reactor for metalorganic chemical vapor deposition equipped with an internal rotary flow selector. NAOKI WADA, SHIRO SAKAI, YOSHIHIRO UETA, SHOHEI KOSHIBA, KUNIMASA UEMATSU et al., *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 30, March 1, 1991, pp. L396, L397. 13 Refs.

Heteroepitaxial ultrafine wire-like growth of InAs is demonstrated. Ultrafine InAs whiskers with diameters less than 20 nm are grown selectively on SiO<sub>2</sub>-patterned GaAs substrates using metalorganic vapor phase epitaxy. These InAs nanowhiskers grow epitaxially with a growth axis parallel to the 111 As-dangling-bond direction of the GaAs substrate surface, irrespective of substrate orientation.

**A91-26154** Kinetic studies on beta-SiC formation from homogeneous precursors. KATSUMICHI ONO and YASUO KURACHI, *Journal of Materials Science* (ISSN 0022-2461), Vol. 26, Jan. 15, 1991, pp. 388-392. 9 Refs.

The kinetics of the carbothermic reduction of SiO<sub>2</sub> by carbon to produce beta-SiC from a homogeneous organic precursor has been investigated over the temperature range 1500 to 1800 C in nitrogen by the use of a high-temperature thermobalance. The kinetic behavior differed significantly from that of the heterogeneous reaction of SiO<sub>2</sub> and carbon particles. The weight-loss curves could be fitted well by the Avrami-Erofe'ev equation with an exponent of 1.5. The result was interpreted as showing instantaneous nucleation in a homogeneous matrix followed by the diffusion-controlled growth of beta-SiC. The obtained activation energy of 391 kJ/mol was consistent with the assumption that the reaction is controlled by the diffusion of carbon through the amorphous matrix to the growing surface of beta-SiC.

**A91-25808** New light modulator using GaSe layered crystal. YASUO IWAMURA, MAKOTO MORIYAMA, and NAOZO WATANABE, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 30, Jan. 1, 1991, pp. L42-L44. 5 Refs.

Layered crystals of GaSe are grown by the Bridgman method. Transmission spectra are measured for various sample configurations with respect to the c-axis, applied electric field, direction of incident light, and polarization. Absorption edge shifts toward longer wavelengths by 20 nm under an electric field of 1 kV/cm, the shift being two orders larger than estimated on the basis of the Franz-Keldysh mechanism. Switching time is measured to be 53 ns or less.

**A91-21651** Habit modifications of beryl grown by the flux method. TAKESHI MIYATA, YUKA KAWABATA, ICHIO TAKEDA, and HIRONAO KOJIMA, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 869-874. 7 Refs.

Single crystals of beryl grown by slow cooling from an impurity doped flux without a seed crystal have been grown and their habit modifications studied by SEM and optical microscopic observation. Transition metal doping using Fe<sub>2</sub>O<sub>3</sub>, Cr<sub>2</sub>O<sub>3</sub>, Mn<sub>2</sub>O<sub>3</sub> and alkali metal doping experiments were also carried out. Two characteristics, (1) the ratio (H/W), height to width of the crystals and (2) combination and relative development of crystal faces, were used as a measure of habit modifications. In general, as impurity doping increased, the crystals became slender and the second order prism disappeared. The ratio H/W was less in the larger crystals. This tendency can be attributed to the selective incorporation of impurity atoms on certain faces.

**A91-21631** Fractal aggregation and dendritic crystal growth. MAKIO UWAHA and YUKITO SAITO, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 1, Jan. 1990, pp. 175-178. 16 Refs.

A lattice gas model is used to study random crystal growth in a finite density gas. The model interpolates between the diffusion-limited aggregation (DLA) and the Eden models. In the DLA model, the open fractal structure usually seen in simulated dendrite experiments comes from the fact that the Laplacian field, which is an approximation of the diffusion field, does not have a characteristic length scale. In real diffusion fields the open fractal structure should not extend over a diffusion length. A simple relation between overall growth velocity and the fractal dimension of DLA is proposed and tested by Monte Carlo simulations. At a low finite density and for a short length scale up to the characteristic length, the structure of the solid is fractal and is similar to the DLA. For a large length scale it is compact with a finite asymptotic density. The characteristic length is inversely proportional to the steady growth rate. A sublattice anisotropy is then introduced to make the model closer to real dendritic growth.

**A91-18336** Preferentially oriented crystal growth in dynamic mixing process—An approach by Monte Carlo simulation. MASATO KIUCHI, AKIYOSHI CHAYAHARA, YUJI HORINO, KANENAGA FUJI, MAMORU SATOU et al., *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 29, Oct. 1990, pp. 2059-2065. 19 Refs.

Titanium nitride films produced by a dynamic mixing method have a preferential crystallographic orientation, and the orientation varies with the arrival ratio of the depositing elements. For this study, a Monte Carlo simulation of the damaging process caused by nitrogen ion irradiation onto (111) and (100) planes of a TiN single crystal was performed. The simulation predicts that in (100)TiN, N(+) penetrates through the open channel, losing its kinetic energy mainly by electronic stopping, while N(+) loses its kinetic energy mainly by nuclear stopping in (111)TiN, leading the crystal to be amorphous. The contribution of this dynamic mixing process to the development of preferred orientation is discussed.

**A91-25624** Sequential deposition growth of Bi-Sr-Ca-Cu-O systems observed using in situ reflection high-energy electron diffraction. I. YOSHIDA, M. KAMEI, K. SUZUKI, T. MORISHITA, and S. TANAKA, *Applied Physics Letters* (ISSN 0003-6951), Vol. 58, Feb. 11, 1991, pp. 654, 655. Research supported by New Energy and Industrial Technology Development Organization. 8 Refs.

The crystal growth mechanism in Bi-Sr-Ca-Cu-O thin films has been revealed by sequential deposition with an electron cyclotron resonance (ECR) oxygen plasma using in situ reflection high-energy electron diffraction (RHEED) observation. A series of RHEED patterns presents clear evidence that the unit cell of the Bi-Sr-Ca-Cu-O structure is completed as the Bi layers have sandwiched Sr, Ca, and Cu layers. This crystalline process is not an atomic layer by atomic growth but a 'unit cell by unit cell' growth.

**A91-21679** Gravity effect on solute transport in dissolution and growth of silicon. MASAKAZU KIMURA, AKIRA TANAKA, and TOKUZO SUKIGAWA, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 1295-1299. Research supported by MOESC. 10 Refs.

Dissolution of silicon in an indium solution in the earth's gravitational field was examined using a substrate-solution-substrate 'sandwich' system under near isothermal conditions. A remarkable difference was observed between substrates above and below the solution. This phenomenon is discussed in terms of solutal convection in the solution. A numerical description of this convection and its effect on the dissolution process is given. Comparison with experimental data shows that the observed phenomenon can be explained on the basis of the solutal convection model.

**A91-21677** GaAs solution growth experiment in microgravity. SHIGEO KODAMA, YUICHI SUZUKI, OSAMU UEDA, and OSAMU OHTSUKI, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 1287-1290. 5 Refs.

A GaAs solution growth experiment was run aboard the German sounding rocket TEXUS as a preliminary study for a Space lab D-2 experiment. The experiment involved a growth technique that avoids surface-tension induced convection which destroys diffusion controlled growth, even in microgravity. A remarkable difference in surface morphology was noted between the space-grown crystal and an earth-grown reference crystal. Many hillocks and craters were found on the microgravity-grown crystal, but the surface of the earth-grown crystal was relatively flat. The growth mechanism under microgravity is discussed.

**A91-21668** Nucleation control and selective growth of diamond particles formed with plasma CVD. JING SHENG MA, HIROSHI KAWARADA, JUN-ICHI SUZUKI, YOSHIHIRO YOKOTA, TAKAO YONEHARA et al., *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 1206-1210. 7 Refs.

To obtain polycrystals with large and uniform grain size, diamond particles have been selectively formed on a SiO<sub>2</sub> dot-patterned Si substrate using plasma-assisted CVD. After pretreatment by abrasive powders to increase diamond nucleation densities on both Si and SiO<sub>2</sub>, an Ar beam is used to irradiate obliquely the pretreated surface. As a result, diamond can no longer nucleate on Si; it nucleates only on one edge of the SiO<sub>2</sub> dots and grows over the Si substrate to about 10 microns. Well defined polycrystals having equal grain sizes have been obtained. The role of the Ar beam irradiation on Si and on SiO<sub>2</sub> is also discussed.

**A91-18323** Triangular structures on 111 plane type surfaces of diamond crystals synthesized by the hot-filament CVD method. KEIJI HIRABAYASHI and NORIKO IWASAKI KURIHARA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, Oct. 1990, pp. L1901-L1903. 9 Refs.

The morphology of the diamond crystal deposited by a hot-filament method has been studied by a high-resolution scanning electron microscope to elucidate the mechanism of the crystal growth. The growth of 111 plane type faces is multinucleation, and the 111 plane type surface consists of both many small triangles whose orientations are the same as those of the original 111 plane type face of a cubo-octahedron and triangular pits surrounded by three triangles. The appearance of three 110 plane type surfaces at the edge of the 111 plane type surfaces is possibly explained by the inhomogeneity of the active carbon concentration on the 111 plane type surface.

**A91-17562** Fundamental properties and microstructure of high-Tc superconducting tape prepared by directional melt-growth technique. TOSHIMI MATSUMOTO, MICHIA OKADA, KATSUZO AIHARA, SINPEI MATSUDA, and MASAHIRO SEIDO, High temperature superconducting compounds II: Proceedings of the Second Symposium, Anaheim, CA, Feb. 20, 21, 1990 (A91-17526 05-76). Warrendale, PA, Minerals, Metals and Materials Society, 1990, pp. 483-487. 8 Refs.

A directional melt-growth technique was successfully realized to improve the alignment of the superconducting core in high-Tc superconducting tape. The J<sub>c</sub> of the directional melt-growth treated tape still holds 1,000 A/sq cm even in a magnetic field of 1 T, while the J<sub>c</sub> of the sintered tape decreases rapidly in the very low magnetic fields. The relatively higher transport J<sub>c</sub> in the magnetic fields is thought to be due to the microstructural improvement of grain boundary weak-links by the enhanced alignment of superconducting crystallites.

**A91-21675 Conditions for diffusion-controlled steady-state growth of Pb(1-x)Sn(x)Te under microgravity.** KYOICHI KINOSHITA and TOMOAKI YAMADA, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 1276-1280. 11 Refs.

Diffusion-controlled steady-state growth conditions for Pb(1-x)Sn(x)Te are discussed from the viewpoint of convective flow suppression (Marangoni as well as buoyancy driven convection), appropriate range of growth rates, and solid/liquid (S/L) interface shape. These conditions are examined by the directional solidification of the melt in 2 mm bore capillaries. A growth configuration for suppressing Marangoni convection and improving S/L interface flatness is proposed.

**A91-21667 Growth of diamond films at low pressure using magneto-microwave plasma CVD.** JIN WEI, HIROSHI KAWARADA, JUN-ICHI SUZUKI, and AKIO HIRAKI, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 1201-1205. 11 Refs.

Diamond films have been grown by magneto-microwave plasma CVD at a lower pressure (0.1 torr) than in the more conventional diamond growth systems. At this pressure, a plasma with a high enough density (above 10 to the 11th/cu cm) to form diamond can be obtained around the substrate which is set at the ECR condition. With a CH<sub>4</sub>-CO<sub>2</sub>/H<sub>2</sub> mixture, high quality and uniform diamond films have been obtained at low pressure (0.1 torr) and a lower temperature (500 C). It is speculated that the OH radical is important for the low temperature deposition of diamond.

**A91-21665 Synthesis of B-doped diamond film.** KEN OKANO, YUKIO AKIBA, TATEKI KUROSU, MASAMORI IIDA, and TERUTARO NAKAMURA, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 1192-1195. 6 Refs.

Boron-doped diamond films have been synthesized by the thermal filament CVD method. As the doping source, boron trioxide powder was used instead of diborane. The films obtained were identified as diamond by several methods including Raman spectroscopy. The resistivity of the films was inversely proportional to the doping concentration over four order. p-Type electrical conduction was also confirmed by measuring the Seebeck effect.

**A91-21664 Growth of diamond by atomic vapor deposition.** SATOSHI KOIZUMI, TADAO INUZUKA, ATSUSHITO SAWABE, and KAZUHIRO SUZUKI, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 1188-1191. 5 Refs.

Diamond has been synthesized by a new vacuum deposition method called atomic vapor deposition (AVD). In AVD, most of the evaporated carbon is decomposed to atomic carbon. Diamond growth has been achieved on Si(100) surfaces using AVD at a substrate temperature of 800 C in a hydrogen atmosphere at 0.0002 torr. The average diamond crystalline size, as determined by TEM, is 2000 Å with a number density of 2 x 10 to the 8th/sq cm. It is found that diamond can be deposited at low pressure by the deposition of atomic carbon with the aid of hydrogen.

**A91-21650 Crystal growth of large size Dy<sub>3</sub>Al<sub>5</sub>O<sub>12</sub> garnet single crystals.** HIDEO KIMURA, MASARU SAKAMOTO, TAKENORI NUMAZAWA, MITSUNORI SATO, and HIROSHI MAEDA, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 850-853. 9 Refs.

Crystal growth conditions using the Czochralski technique were examined in order to be able to grow large-size dysprosium-aluminum-garnet single crystals; these are useful as a working material in a practical magnetic refrigeration system. Using the best conditions, large-size bubble-free Dy<sub>3</sub>Al<sub>5</sub>O<sub>12</sub> single crystals 50 mm in diameter were grown from a stoichiometric melt composition using a seed of Y<sub>3</sub>Al<sub>5</sub>O<sub>12</sub> single crystal.

**A91-21633 Heterogeneous silicon crystal growth on a single crystal silicon wafer by a molten silicon spraying deposition method.** T. YOKOYAMA, E. FUJIIYA, Y. MAEDA, S. ITOH, S. TANABE et al., *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 1, Jan. 1990, pp. 235-239. 5 Refs.

Using a new process, a polycrystalline silicon layer has been grown directly from molten Si at a rate 100 times faster than using a conventional CVD process. This has been achieved on a single Si wafer on which V grooves had been etched on an oxide layer. Thicknesses of 100-1000 microns and grain sizes of 10-100 microns were controllably obtained. After the growth of the polycrystalline layer, dislocation densities of 200,000/sq cm were found in the single crystal substrate and 280,000/sq cm in the polycrystalline layer. A substrate with these dislocation densities is sufficient to use for dielectrically isolated substrates.

**A91-18219 Formation process of high T<sub>c</sub> superconducting Bi-Pb-Ca-Sr-Cu-O thick films via melt solidification.** MASAHIRO TATSUMISAGO, KIYOHARU TADANAGA, SHINZO TSUBOI, NOBORU TOHGE, and TSUTOMU MINAMI, *Applied Physics Letters* (ISSN 0003-6951), Vol. 57, Dec. 10, 1990, pp. 2597-2599. 8 Refs.

High-T<sub>c</sub> superconducting thick films Bi(1.6)Pb(0.4)Ca<sub>2</sub>Sr<sub>2</sub>Cu<sub>3</sub>O(x) were prepared by the melt solidification process. The preparation conditions were optimized to obtain films with higher T<sub>c</sub>. Rapid cooling of the molten samples to the heat treatment temperature of 855 C produced superconducting films with a maximum T<sub>c</sub> (zero) of 104 K. Slow cooling of the melt declined the superconducting properties of the films because of the formation of Ca<sub>2</sub>CuO<sub>3</sub>, which may prevent the formation of the 110 K phase, during cooling through the temperature range around 900 C.

**A91-21655 Thin film growth of high-T<sub>c</sub> YBa<sub>2</sub>Cu<sub>3</sub>O(7-delta) phase by an oxygen refilling process.** M. AKINAGA, D. ABUKAY, and L. RINDERER, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 2, Jan. 1990, pp. 947-950. Research supported by SNSF. 15 Refs.

The high-T<sub>c</sub> YBa<sub>2</sub>Cu<sub>3</sub>O(7-delta) phase in thin films has been grown by an oxygen refilling process and low-temperature annealing. Such samples in an MgO substrate showed a small electrical resistivity with exactly linear temperature-dependence below room temperature and sharp transitions with high T<sub>c</sub>.

**A91-21635 Low temperature epitaxial growth of 3C-SiC on (111) silicon substrates.** YASUO HIRABAYASHI, KEN KOBAYASHI, and SHIRO KARASAWA, *Journal of Crystal Growth* (ISSN 0022-0248), Vol. 99, No. 1-4, Pt. 1, Jan. 1990, pp. 284-286. 8 Refs.

3C-SiC single crystals have been grown epitaxially on (111) silicon substrates at relatively low temperature of 850 to 900 C and pressure of 1 torr. The growth method was similar to electron assisted chemical vapor deposition (EACVD). Reflection high energy electron diffraction patterns showed that a layer of 3C-SiC single crystalline was formed on the Si wafer. Auger electron spectroscopy measurement showed that the layers were stoichiometric.

**A91-18335 Temperature-independent internal bias field in L-alpha-alanine-doped triglycine sulfate crystal.** NORIYUKI TAKATANI, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 29, Oct. 1990, pp. 2038-2040. 16 Refs.

The temperature dependence of the internal bias field in L-alpha-alanine-doped triglycine sulfate crystal was investigated by P-E hysteresis loops and I-E curves under application of a triangular field. No changes could be observed in the internal bias field at the Curie point. The internal bias field is almost independent of the temperature from 25 to 55 C. The strict equivalence between the internal bias field and the external applied field is demonstrated by the phenomenological consideration.

**A91-18321 Growth mode of 111 plane type surfaces of diamond crystals synthesized by hot-filament CVD method.** KEIJI HIRABAYASHI and NORIKO IWASAKI KURIHARA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, Oct. 1990, pp. L1862-L1865. 8 Refs.

The substrate temperature dependence of the morphology and the fine structures on 111 plane type surfaces of diamond crystals have been studied using a high-resolution scanning electron microscope to elucidate the mechanism of the crystal growth. A layer-by-layer crystal growth of the 111 plane type surface is suggested from the fact that the 111 plane type surface structures are the same in diamond crystals deposited at different temperatures in spite of the difference in the shapes of 111 plane type surfaces.

**A91-16093 Tensile strength and fracture defects expanded by subcritical crack growth of silicon nitride at high temperatures.** T. OHJI, T. YAMAUCHI, W. KANEMATSU, and S. ITO, *Journal of Materials Science Letters* (ISSN 0261-8028), Vol. 9, Nov. 1990, pp. 1266-1268. 9 Refs.

The effect of fracture defects expanded by subcritical crack growth (SCG) in silicon nitride at 1200 C on the strength properties of the material was investigated using SEM and tensile test measurements. In a fractographic study of internally fractured specimens at 1200 C, a wake of SCG was clearly observed as a circular whitish area. The values of K<sub>IC</sub> were estimated for each expanded crack and plotted against the crack radius. The increments of K<sub>IC</sub> showed good agreement with the previously investigated R-curve behavior of hot-pressed silicon nitride in the temperature range 1140-1260 C.

**A91-13485 Growth of single crystal beta-SiC films on a Si substrate by a direct carbonisation method.** Y. HIRANO and T. INADA, *Electronics Letters* (ISSN 0013-5194), Vol. 26, Sept. 27, 1990, pp. 1638-1640. 11 Refs.

Single crystal beta-SiC films have been formed on an Si substrate by a thermal reaction between the substrate and carbon atoms sublimed from a high purity graphite source. The film properties are characterized by the Rutherford backscattering technique and an electron diffraction method. It has been demonstrated that single crystal beta-SiC films are formed on a (111)-Si substrate by the thermal reaction above 900 C between the substrate and carbon atoms.

**A91-11667 The growth mechanism of diamond crystals in acetylene flames.** YASUJI MATSUI, HIDEKI YABE, and YOICHI HIROSE, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 29, Aug. 1990, pp. 1552-1560. 31 Refs.

The diamond growth mechanism in acetylene flames is numerically studied. Radical concentration profiles in the boundary layer near a water-cooled substrate and overall surface reactions on a growing crystal are investigated. Data are shown for the diamond growth rate and morphology 10 mm from the torch exit where the radicals are considered to be equilibrated. It is shown that stable species such as CH<sub>4</sub> and C<sub>2</sub>H<sub>4</sub> are rapidly produced in the layer, followed by methyl radical formation according to the fast partial equilibrium of the reaction CH<sub>4</sub> + H = CH<sub>3</sub> + H<sub>2</sub>. C-radicals adsorbed onto the diamond surface are etched by H-atoms to form CH<sub>4</sub>; surface reactions do not significantly affect the gaseous concentrations. The dependences of the growth rate on both the substrate temperature and on the C<sub>2</sub>H<sub>2</sub>/O<sub>2</sub> ratio can be explained by the CH<sub>3</sub>-precursor model.