

# Author Index

**A**

Arsenault, R., 155

**B**

Bahei-el-din, Y. A., 20  
Blom, A. F., 219

**C**

Chamis, C. C., 56  
Chiang, Y.-C., 101  
Chou, T.-W., 101  
Coyle, T. W., 124  
Cranmer, D. C., 124

**D**

Daehn, G. S., 70  
Deshmukh, U. V., 124  
Dharani, L. R., 87

**F**

Fujita, T., 165

**G**

Groth, H. L., 219

**H**

Herakovich, C. T., 165  
Highsmith, A. L., 3, 193  
Hong, W. S., 116  
Hopkins, D. A., 56

**J**

Johnson, W. S., 193  
Jun, E.-J., 183

**K**

Kim, J., 183  
Krempel, E., 40

**L**

Larsen, C. G., 235  
Lee, K.-D., 40  
Lee, S.-K., 183  
Lubowinski, S. J., 193

**M**

Melander, A., 219  
Murthy, P. L. N., 56

**N**

Naik, R. A., 3

**P**

Pindera, M.-J., 165  
Preston, S., 219

**R**

Rigdon, M. A., 116  
Rousseau, C. Q., 136

**S**

Schmidt, K., 155  
Shin, D., 3

**Z**

Zweben, C., 155

# Subject Index

## A

Al 2124 aluminum matrix alloy, 219  
 Al 6061 aluminum matrix alloy, 219  
 Al-2Mg alloy, 219  
*Al-SiC* (*see* Aluminum silicon carbide)  
 Aligned continuous fibers, 20  
 Alignment fixture, 235  
 Alloy properties, 156, 220  
 Alumina fibers, 101, 219  
 Aluminum alloy composites, 219, 220  
 Aluminum-silicon carbide, 71–72, 155  
 Analysis (*see also* Loading, Modeling, Testing)  
     accuracy of, 116, 124–125, 235  
     of ceramic matrix composites, 87–88, 116, 124  
     of laminate behavior, 40  
     of loading behavior, 3, 5, 137  
     of stress in fiber/matrix separation, 3, 87  
     thermomechanical, 20, 40, 73  
 Applied load in ceramic matrix composites, 87, 137  
 ASTM Standards E 1012-84, 235  
 Atmospheres, effect on testing, 116  
 Axial deformation rate, 70  
 Axial loading, 5  
 Axial strain, 235

## B

Beam geometry in stress tests, 87  
 Bending strain, 235  
 Bending stress calculations, 87–88  
 Bonding strength, 124, 183  
 Borosilicate glass matrix composite, 125  
 Brittle materials, 87, 235  
 Bundled fiber reinforced composites, 183

## C

Calcium aluminosilicate ceramic fibers, 136  
*CDS* (*see* Characteristic damage state)  
 Cellulose acetate, 4  
 Ceramic matrix composites, 101, 136  
     analysis of, 87, 116, 125  
     bond strength in, 124, 183

delamination in, 137  
 fibers in, 87, 116, 124  
 stress and strain in, 87, 124  
 whisker-reinforced, 101  
 Ceramic reinforcement fibers, 116  
 Ceramics tensile grip, 235  
 Characteristic damage state, 136  
 Classic laminate theory, 40  
 Coefficient of thermal expansion, 20, 171  
     of silicon-carbide reinforced aluminum, 155  
 Compliance in modeling, 20  
 Composite density, 156  
 Composite materials (*see* specific materials)  
 Compressive stresses in ceramic matrix composite, 87  
 Computer based modeling, 56  
 Constant total strain, 41  
 Constitutive equations of unidirectional composites, 21  
 Continuous fiber reinforcement  
     in ceramic matrix composite, 124, 136  
     in metal matrix composite, 3, 70, 183  
 Coupled in-plan mechanical loads, 20  
 Crack  
     density, 136  
     initiation, 219, 220  
     propagation, 101, 102, 219  
     testing, 87, 220  
 Crack closure in aluminum alloy composites, 219–220  
 Crack deflection in whisker-reinforced composites, 101–102  
 Creep, 40, 70–71  
 Critical element, 136–137  
 Critical strain energy release rate, 101  
 Crystalline structure in whisker-reinforced composites, 72  
 CTE (*see* Coefficient of thermal expansion)  
 Cyclic behavior  
     in ceramic matrix composites, 136, 137  
     in metal matrix composites, 56  
 Cyclic thermal loads, 21

## D

Damage mechanisms, 3, 124, 136  
 Database of material properties, 156

Deformation, 70  
 Degradation rate, 56  
*Delamination (see also Ply behavior)*, 137  
 Displacement measurements, 125

**E**

Early crack growth, in aluminum alloys, 219  
 Edge replicas in fiber/matrix separations, 193  
 Elastic properties of metal matrix composites, 3, 20, 165–166  
 Elastic-plastic model, 21, 70, 73  
 Elasticity law, 40  
 Environmental factors and deformation, 70  
 Equations for laminate behavior, 21, 40  
 Expansion mismatch, 72

**F**

Fabrication, 183  
 of high temperature metal matrix composites, 56, 165, 166  
 of whisker-reinforced composites, 102  
 Failure, 3, 193  
 of aluminum alloys, 166  
 in ceramic matrix composites, 87, 102, 136–137  
 in whisker-reinforced composites, 101  
 Fatigue, 136, 193, 219  
 Fatigue threshold, 219  
 Fiber, 40, 116, 219  
 elastic properties, 165  
 size, 125  
 Fiber pull-out, 87, 124  
 Fiber/matrix interfacial strength, 3–5, 124  
 bonding, 124, 183  
 fabrication, 183  
 failures, 3, 193  
 Fibrous composite laminates, 20, 40  
 Finite-element predictions, 5  
 First order model for whisker-reinforced composites, 71  
 Flexure formula, 87  
 Four-point flexure tests, 87, 219, 220  
 Fracture toughness, 87, 101, 219  
 Frictional stress, 124, 184

**G**

Glass-ceramic matrix composites, 124, 136–137

Global thermostructural analysis, 56–57  
 Grain boundaries, 72  
 Graphite fiber-reinforced aluminum 165  
 Graphite-magnesium composites, 21  
 Graphite/copper, 56  
 Gripping methods (*see Ceramic tensile grip*)

**H**

High specific stiffness, 165  
 High temperature applications, 3, 4, 56, 136, 183  
 High temperature tension testing, 40, 87, 116  
 High thermal conductivity, 155  
 High temperature metal matrix composites (HTMMC), 56

**I**

In-plane deformation, 40  
 In-plane mechanical loads in laminates, 21  
 Indentation methods, 124, 183  
 Inelastic strain, 40, 136, 137  
 Instantaneous modulus in fibrous composites, 20  
 Interface, 56, 124  
 Interface/interphase region, 56  
 Interfacial bonding strength, 3, 101, 165, 183  
 Interfacial failures, 3, 165, 193  
 Interphase, 56  
 Iosipescu shear test, 165, 166  
 Isothermal response, 20

**L**

Laminate analysis, 3, 5, 21, 136–137, 193  
 theory and modeling, 3, 21, 40  
 Laminate life in silicon carbide/glass-ceramic composites, 137  
 Laminates, 4, 20, 40  
 Nicalon/CAS, 136  
 Ti-15-3-3-3, 4  
 Layered composites, 40, 125  
 Life prediction, 70  
 Light-weight composite materials, 155  
 Linear elastic analysis, 5, 88  
 Linear elasticity theory, 40  
 Liquid phase vacuum hot pressing, 166  
 Lithium aluminosilicate glass-ceramic composite, 125

Loading tests, 5, 20, 56, 137  
 and laminate behavior, 21  
 shear loading, 70, 87, 165  
 Local/global thermostructural analysis, 56  
 Longitudinal stiffness in laminates, 136

**M**

Magnesium as a wetting force, 220  
 Manufacturing techniques, 116, 183  
 pressure infiltration, 219  
 vacuum-assisted squeeze casting, 193, 220  
 Material properties, 56, 156  
 Mechanical loads, 3, 20, 56  
 Mechanical properties, 3, 20, 101, 116, 165, 184  
 Nicalon/CAS laminate, 136  
 SiC particle composite, 136, 155  
 Ti-15-3 with SCS<sub>6</sub> fibers, 193  
 Mechanisms of failure, 101, 219, 220  
 Metal matrix composites (*see also* specific material), 3, 70, 183  
 elastic properties, 3, 20, 165  
 environmental effects, 70  
 Micromechanics, 3, 87  
 Misfit strains and plastic deformation, 72  
 MMC (*see* Metal matrix composites)  
 MMC1 material, 40  
 MMC2 material, 40  
 Modeling, 20, 71, 87  
 in ceramic matrix composites, 87, 101, 116  
 for deformation in metal matrix composites, 70  
 elastic-plastic, 73  
 in laminates, 20, 40  
 Modulus of unidirectional composites, 88  
 Modulus properties, 116  
 Monofilament reinforced borosilicate glass matrix composite, 124  
 Monolithic ceramics, 101  
 Monotonic behavior, 136  
 Mullite, 117  
 Multiple matrix cracking, 87

**N**

Nextel 480 ceramic fibers, 117  
 Nicalon SiC fibers, 116, 125  
 CAS laminate, 136  
 Nonisothermal response, 20  
 Nonlinear behavior, 56, 166

**O**

Off-axis laminate plies, 193  
 Off-axis tension test, 165  
 Orientation of strands, in whisker-reinforced composites, 101, 102  
 Orthotropic linear elasticity law, 40  
 Overstress, 40

**P**

P100/6061 graphite-aluminum, 165  
 Packaging materials, 155  
 Particulates in Al-2Mg alloys, 155, 219  
 Phase transformation, 72  
 Phase modeling, 20  
 Plane stress, 40  
 Plastic deformation, 70–73  
 Plasticity, 20, 71–72  
 Ply behavior in laminates, 3, 20, 40, 136, 193  
 Poisson's ratio, 193  
 Polymeric matrix composite material behavior, 137  
 Power-law creep based model, 70  
 Predicting failure modes, 3, 88  
 Pressure infiltration technique, 219  
 Processing composites, 116, 156  
 Progressive damage to laminates, 136

**R**

Radiation swelling and crystalline structure, 72  
 Rate sensitivity in laminate theory, 40  
 Ratio of whiskers, 102  
 Reinforcement phase, 116  
 Relaxation, 40  
 Replication techniques for Al-2Mg alloys, 219  
 Residual thermal stress, 3, 40, 193  
 Room temperature tests, 87, 193  
 Rotating bend fatigue, 220

**S**

Saffil reinforced Al-2Mg alloy, 219, 220  
 SCS<sub>6</sub> fibers in Ti-15-3, 193  
 Self-alignment of tensile grips, 235  
 Shear stresses, 70, 87, 165, 166  
 Short fibers in Al-2Mg alloys, 219  
 Silicon-carbide fiber, 3, 102, 155, 193  
 borosilicate system, 124  
 calcium-aluminosilicate 136  
 particle-reinforced aluminum, 155, 219

titanium-aluminide, 4, 56  
 tow reinforced glass ceramic matrix, 124, 137  
 whisker-reinforced ceramic matrix composite, 101  
 Single crystalline SiC whiskers, 101  
 Single fiber reinforced composite, 183  
 Single-fiber pull-out test method, 124  
 Specimen geometries, 116  
 Squeeze casting technique, 183, 220  
 Static strength, 193, 194  
 Stiffness loss, 3, 56, 137, 156  
 Strain deformation in laminates, 136  
 Strain energy release rate, 102  
 Strain testing, 235  
 Strength in graphite-aluminum composites, 165  
 Strength prediction in Ti-15-3, 193  
 Stress, 3  
     in Al-2Mg alloys, 219  
     in ceramic matrix composites, 87, 124  
     in laminates, 20, 136, 166, 193  
     at grain boundaries, 72  
     in metal matrix composites, 3, 20, 70  
     testing, 3, 235  
     thermal, 165, 166  
 Stress/strain curves, 56  
 Structural integrity of high temperature metal matrix composites, 56–57  
     and design considerations, 21  
 Surface crack density, 136, 137

## T

Tailorability of properties in composites, 156  
 Temperature, 71, 116  
     effect on laminates, 40  
     and mechanical properties, 21, 165  
     and plastic deformation, 70  
 Temperature-dependent behavior, 87, 165–166  
 Tensile behavior  
     in aluminum alloy composites, 165, 220  
     in ceramic matrix composites, 87, 101, 116  
     in metal matrix composites, 184  
 Tensile grips, 235  
 Tension testing, 116, 235  
 Test methods (*see also* specific test methods), 116, 125

in aluminum alloy composites, 155, 219  
 for brittle materials, 87, 235  
 for ceramic matrix composites, 87, 116, 124  
     for debond strengths, 3, 87, 124, 193  
     for laminates, 3, 5, 40, 136  
 Thermal changes, 20  
 Thermal cycling, 40, 70, 72–73  
 Thermal expansion stresses, 20, 155, 166  
 Thermal properties, 3  
     of fibrous composites, 20, 155  
     of graphite fiber-reinforced aluminum, 165  
     of laminates, 21, 40, 136  
     of metal matrix composites, 3, 20, 40, 56, 70, 193  
 Thermal viscoplasticity theory, 40  
 Thermal/mechanical cycling, 56  
 Thermomechanical analysis, 3, 20–21, 40, 56  
 Thornel P100 graphite fibers, 166  
 Three-phase models, 5  
 Three-point flexure tests, 87  
 Threshold stress intensity for aluminum alloys, 219  
 Ti-15V-3Cr-3Al-3Sn, 194  
 Time dependent analysis, 40  
 Titanium matrix composites, 193  
 Total strain as a function of time, 40  
 Toughness models, 101  
 Tow reinforced glass ceramic composites, 124  
 Transverse ply cracking, 5, 136–137, 165  
 Tungsten/copper, 56  
 TVBO (*see* Thermal viscoplasticity theory)

## U

Uniaxial tension testing, 87, 136  
 Unidirectional lamina, 20, 21, 88  
 Unnotched specimens, 193

## V

Vacuum-assisted squeeze casting, 183, 220  
 Vanishing fiber diameter model, 20, 21, 23  
 Viscoplasticity, 40  
 Volume fraction effect, 102

**W**

- Wettability of fibers, 183, 220  
Whisker-reinforced composites, 70, 101,  
  219  
Wyoming Iosipescu shear test, 165

**Y**

- Yield stress, 20, 165  
Young's modulus, 166