

Index

- Adaptive multilevel model 88, 124, 135, 146
- Aluminum matrix composite (AMC) 39, 81, 84
- Anisotropic (Anisotropy) 8, 33, 65, 93, 134, 139, 140, 153, 159, 163, 274, 283, 335-337, 339, 344-345, 356, 373-374, 381, 395, 403, 425, 432-433, 438-439, 452, 458-460, 531, 558, 575, 577
- Asymptotic expansion 91, 95, 208, 581, 589, 591
- Bonded joint 130-131, 153, 162
- Bottom up 87-88, 157
- Bridging fibers 68-71, 75, 141, 544
- Bulk modulus 4, 30, 274, 276, 283, 286
- Carbon fiber reinforced plastic (CFRP) 30, 34, 39, 58, 81, 465, 576
- Cauchy stress 139, 211-212, 214, 217-218, 226, 228, 556
- Ceramic matrix composite (CMC) 39, 80, 82, 159, 162, 538, 540, 543-544, 553, 556-557
- Characteristic damage state 26
- Characteristic function 5, 10
- Characteristic stress 51, 66-67
- Coefficient of friction 42, 44, 65, 66-67, 71-72, 76
- Coherent mixture 3
- Cohesive zone model (CZM) 135, 137, 141, 497, 508-509, 512, 524-526, 594-596, 598, 600, 610-611, 618, 620, 623
- Complementary energy 103, 136, 303, 308
- Constraint effects 65-66, 565-568
- Constraint parameter 550, 552, 563-565, 567
- Continuum damage mechanics (CDM) 29, 134, 139, 140-144, 148, 153, 158-160, 162, 301, 369, 434, 500, 507, 525, 533, 555-556, 560-567, 569, 572
- Continuum damage mechanics model 158, 162
- Continuum homogenization 203-205, 207, 211, 213, 216-218, 221, 223, 225-226, 228, 230-231
- Correlation functions 4, 18, 19, 112
- Coulomb friction 44, 65, 69
- Crack growth rate 68-69, 73, 75
- Crack opening displacement (COD) 510, 533, 545, 548, 552, 563, 565, 567-569, 577
- Crack propagation 33-34, 37, 70, 74, 161, 171, 355, 510, 525-526, 580, 583, 586, 588, 621-623
- Crosslinked silica aerogel vii, 463, 466-467, 474-479
- Cross-ply laminates 2-3, 23, 26-29, 32-35, 308-309, 454, 457, 459, 575-577
- Cryogenic 464-465, 476, 479
- Cumulative probability 7, 50, 55-56
- Damage vii, 1-3, 22-23, 26-30, 32, 35, 37-42, 44, 46-57, 59-61, 63-64, 66, 68-69, 71-72, 75, 78-83, 85, 87-88, 101, 103, 108, 117,

- 134-136, 139-141, 143-146, 148, 150, 152-153, 157-163, 166-168, 170-172, 175-178, 200-202, 235, 271-273, 289-293, 301-302, 304-305, 307, 309, 315, 318-319, 327, 334, 354, 356, 359-360, 360, 362-363, 368-369, 373, 376, 380, 382, 386-387, 394, 396-398, 432, 434, 438, 445, 451-455, 459, 461-462, 469, 495, 500-501, 505-510, 512, 514, 521, 524-525, 527, 529-534, 537-538, 541-548, 550-577, 595, 610, 620
- Damage effect tensor 139
- Damage mode tensor 546-547, 556, 569
- Damage modes 41, 177-178, 291, 387, 537-538, 552, 557, 561, 564, 566, 573
- Debonding 23, 28, 37, 40-41, 44, 56-57, 59, 80, 88, 103, 108, 118, 130, 134-136, 139-141, 147-151, 154, 156, 158, 160-162, 170, 177, 320, 386, 396, 422, 530, 533-534, 537, 542-544, 546-548, 553, 559, 561, 565, 575-576, 578, 601, 608-611, 613, 624
- Delamination 27-30, 34, 41, 130, 178, 182, 272, 386, 464, 530, 532, 536-537, 553-554, 574, 576-578, 621
- Differential effective medium theory 6
- Dirichlet tessellation 21
- Distinct element analysis 467, 469
- Durability 2, 30, 83, 363, 368, 387, 454-455, 457, 459, 570, 573, 577
- Effective deformation 211-213, 215, 222, 224-225, 231
- Effective properties 15, 19-20, 22, 31, 33, 85, 93, 166, 177, 187, 204, 211, 272, 274, 277-278, 282, 289, 335, 436
- Effective strain 73, 207, 209-211
- Effective stress 73-74, 139, 176, 182-183, 203-205, 207, 209-210, 212-213, 217-219, 222-223, 226, 228, 230-232, 292, 306, 322-333, 335, 337, 340
- Elastic modulus 46, 57, 59, 65-66, 113, 182, 379, 402, 479, 563, 618
- Embedded cell approach 6
- Failure vii, 1, 22-23, 29, 34, 37-41, 46, 48, 50-57, 60, 63, 64, 66-69, 72, 75, 77-78, 80, 82, 85, 87, 109, 118, 130, 135, 166-167, 170, 173, 176-178, 196-198, 200-202, 207, 272-273, 320, 334, 342, 344, 352, 355, 359, 361, 364, 366-367, 372-373, 391-392, 394-395, 397, 421, 452, 456, 461, 464, 474-476, 479, 493, 495-496, 498-499, 530-532, 535, 537-542, 558-559, 572, 574-577, 590, 595-596, 605, 608, 611, 613, 615, 620-621
- Fatigue life 38-39, 68-69, 73, 75-76, 79
- Fatigue life predictions 68, 73, 79
- Fiber 7, 30-33, 37-60, 62-85, 88, 98, 101-102, 106, 109-111, 113-114, 116, 118, 121, 124-125, 130, 134, 137, 145-147, 152, 157, 159-160, 165, 176-178, 180, 182-184, 189, 193, 195-197, 200-201, 271-272, 274, 277-278, 280-283, 285, 289-290, 294-295, 306, 307, 317, 320, 322, 328-329, 333, 341-342, 344-345, 349, 354-357, 359-360, 363-365, 368-375, 381-387, 392, 394-397, 421-422, 424-427, 429-434, 436, 440, 445, 451-462, 465, 530, 532-538, 540-543, 545-548, 553, 557-559, 561, 572-576, 578, 596, 600-601, 605, 617-618, 620
- Fiber bundle strength 50-51, 55, 58, 60, 67
- Fiber microbuckling 535

- Fiber reinforced composite (fibrous composite) 5, 37, 157, 176-177, 179, 183-185, 280-282, 534
- Fiber volume fraction 42, 48, 57, 59, 65, 77, 178, 182, 195, 295, 341, 427, 429, 432, 545, 548
- Fiber spacing 33, 45, 47, 62, 71, 73-74, 432
- Finite element analysis 15, 34, 43, 160, 162, 166, 177, 182, 185, 200, 273, 356-357, 422, 434, 500, 577
- First Piola-Kirchhoff stress 212, 214
- First ply failure 532, 539
- Four-point bend test strength 53
- Fourth order damage tensor 139
- Fractal 10, 32, 466-468, 488, 490, 493-494
- Fractal dimension 466-468, 487-488, 490, 493
- Fracture 22, 30, 32-34, 40-41, 51, 53-54, 64-66, 69-70, 74, 80-82, 85, 159, 178, 201, 233, 272, 351-353, 355, 366, 451, 495-496, 498, 503, 509-510, 519, 525, 527, 530-531, 534, 537-538, 545, 555, 571, 574-576, 588, 595-596, 599-600, 610-611, 620-624
- Gibbs hard core process 7
- Global Load Sharing model 51
- Green's function methods 46
- h-adaptation 96, 101, 143
- Hashin-Shtrikman bounds 4, 5
- Heterogeneous materials 20-22, 30, 33, 38, 83, 85-90, 124, 159-162, 587, 589
- Hierarchical modeling 7, 56, 77, 81, 161, 163, 394-495, 529, 558, 579, 581, 594, 623
- Hierarchical multiscale modeling approach 39
- Hill's macro-homogeneity conditions 213-214
- Homogeneity distribution parameter 8
- Homogenization 34, 38, 85-91, 93, 95, 108, 114-115, 117, 134, 139, 148, 157-162, 202, 211, 213, 215-218, 221, 223, 225-226, 230-233, 238, 329, 334, 348, 424, 427, 503, 506, 508-510, 525-526, 533, 555, 558, 561-562, 581, 589-590, 622
- hp-adaptation 96, 125
- hyperelastic 217-219, 221, 223
- Indicator function 5, 10
- Interface 37-42, 44, 46, 51, 54, 56-57, 65, 67, 69, 74, 77-78, 81, 85, 88, 98, 101, 103, 106, 108, 118-120, 123-126, 130-132, 134-137, 139, 141, 145-146, 148-150, 152, 168, 170, 177-178, 180, 187, 201, 250, 254, 257, 259, 268-269, 272, 290, 322, 335, 338, 244, 359, 360, 363, 365, 368, 370, 374, 386, 394, 396, 421, 422, 424-425, 427, 429, 433-434, 445, 451-452, 513, 519, 533, 435, 537, 541, 546, 548, 553, 572, 576, 580, 581, 588, 596, 601, 603, 611, 617, 622
- Interfacial debonding 40, 44, 108, 130, 134-135, 140, 147, 149, 151, 155, 157-158, 160, 162, 533-534, 537, 543, 546, 575, 578
- Interfacial shear stress 45, 47, 56, 60, 62, 67, 69, 82
- Interfacial sliding 64-65, 534-535, 543, 548, 457
- Internal state variable (ISV) 533, 555-556
- Lagrangian 204, 223-225, 230-231
- Lagrangian MD 204
- Laminated composite 30, 40-41, 106, 177, 185, 196, 211, 272, 289, 309, 317-321, 335, 354-356, 456, 527, 574, 621

- Large deformation 204, 211-214, 235
 Length scale 12, 38, 46, 96, 235, 238, 272, 499-505, 508-510, 545, 547-548, 553-554, 556-557, 560-561, 572
 Level-0, Level-1, Level-2 121
 Lineal-path function 5, 18, 30
 Local volume fraction 7, 10-12, 20, 30, 32, 124
 Low-cycle fatigue 39, 67-68, 73, 76-77, 79
 Marked correlation function 108
 Matrix vii, 1-4, 6-10, 13, 15-16, 20-29, 31-34, 37-44, 46-50, 53-54, 56-57, 59-60, 62-75, 77-85, 88, 97-98, 101, 103-107, 109, 111, 113-114, 118, 121, 123-124, 128, 130, 134-137, 141, 143, 145-147, 152, 157-159, 162, 165-172, 176-178, 180-182, 185, 187, 192, 195, 196, 200-202, 272-277, 279, 283, 290, 295, 307, 317-320, 322-328, 330, 333, 337, 339, 341-342, 344-349, 354, 359-360, 363-366, 368-370, 374, 381-382, 384-387, 392-397, 412, 421-434, 436-437, 445, 451-452, 454-457, 459-461, 530-538, 540-548, 550-551, 553-554, 556-559, 561, 563, 565-566, 568-569, 572, 574-577, 592-593, 599-601, 603, 605, 608, 614-615, 617-621
 Matrix cracking 2, 23-24, 26-29, 33-34, 81, 85, 170, 177-178, 386-387, 427-428, 530-532, 538, 540, 542-544, 546-548, 550, 553, 559, 561, 565, 568, 574-577
 Matrix yielding 37, 47, 56-57, 59, 78
 Maxwell's method 273, 277, 307
 Mean-window technique 19-20
 Mechanical properties 7, 30, 39, 56, 80, 83, 203-205, 226, 231-232, 235, 249, 363-364, 366, 369-370, 372, 387-389, 395, 398, 409, 438-439, 451-452, 454, 456, 461, 463, 492-493, 533, 536, 574-575
 Mesopores 466-467, 478
 Microcrack 139-381, 532, 426-427, 440, 500-501, 503, 505, 507, 531-532, 555
 Microdamage mechanics (MDM) 558, 561, 564-566, 572
 Microlevel 166, 167, 170, 177, 182, 185, 559, 573
 Micromechanical unit cell model 40, 435
 Micromechanics 7, 14, 32-33, 39, 42, 56, 87, 90, 102-103, 106, 120, 124, 139, 157, 159, 161, 163, 201-203, 233, 255-256, 297, 422, 461, 499, 526, 533, 558-560, 562-563, 565, 567, 574, 576, 580, 588, 621
 Molecular dynamics (MD) 201, 203, 231, 233, 398, 451, 529, 579-582, 587-588, 593-594, 596, 600, 602, 621, 624
 Monte Carlo model 40
 Morphology 20, 13-14, 18, 31, 76, 85, 88, 95, 113, 371, 373-374, 425, 467, 478
 Multifractal spectrum 10, 26
 Multifunctional material 80, 476
 Multiscale 37-41, 43-44, 56, 65, 68, 77-79, 82-83, 85, 87-89, 91, 121, 127, 134, 138, 142, 147-148, 151, 153, 157-160, 165-166, 172-173, 176-178, 184-185, 197, 199, 235-238, 245, 254-255, 262-263, 270-271, 309, 317, 319-321, 341-343, 345, 349-354, 363, 365, 369, 398, 434, 495, 501, 503, 509-511, 513, 515, 518-519, 524, 527, 529-530, 538, 541, 543, 558-560, 564, 566, 572-574, 580-581, 587-590, 611, 616, 620

- Multiscale modeling 39-41, 44, 56, 65, 68, 77-79, 82, 87, 91, 127, 134, 159, 235-237, 271, 342, 345, 352, 365, 369, 398, 434, 495, 501, 529-530, 558-559, 564, 572-574, 580-581
- Nanostructure 269, 463, 467, 493-494
- Orthogonal cracking 302, 304-305, 310
- Pair distribution function 109
- Parrinello-Rahman 230
- Particle system 203-205, 217, 225, 228, 231
- Particulate composite 165, 173, 176, 201, 271, 277, 283-284
- Particle volume fraction 168, 170, 173, 176, 273
- Periodic 1, 3, 6, 8, 14-17, 19-20, 48, 57, 87, 91, 93, 96, 109, 114, 117, 138, 140-141, 145, 158-159, 161, 169, 208, 210, 215, 218, 222-224, 226, 227, 231, 244, 264-265, 268, 322, 328, 342, 424, 533, 556, 581, 583-584, 589-591, 610, 620
- Periodic BCs 215-216, 218, 222-224, 226, 227
- Periodicity 87, 92-93, 109, 114, 117, 141, 144-145, 150-152, 208, 424, 592-593
- Physical RVE 19
- Ply crack closure 296, 298-299, 302, 306-307, 313
- Ply cracking 35, 272-273, 289, 292, 302, 305-309, 316, 538, 543, 549-550, 553, 561-562, 565, 575
- Poisson's ratio 57, 59, 182-184, 240, 256, 278, 286, 569, 617
- Polymer matrix composite (PMC) 83, 84, 111, 146, 366, 429, 538, 556,
- Porosity 374, 466-468, 478, 480, 482, 489, 493
- Radial distribution function 9, 13, 467
- Ramberg-Osgood relationship 65, 69
- Random 1, 6-10, 12-17, 19-20, 22-26, 28-34, 51, 54, 146, 264, 351, 385, 468, 556, 603, 610
- Random microstructure 1, 29
- Reciprocal function 107
- Reconstruction 14, 18-19, 33
- Representative volume 3-4, 32-33, 86-87, 91, 95, 98, 108, 148, 162, 207-208, 240, 277, 424, 460, 502, 508, 545, 589
- Representative volume element (RVE) 4, 13-14, 19-21, 27, 32-33, 86-87, 89, 91-93, 95, 98, 108, 111, 113-114, 117-118, 124-125, 128, 130, 134, 138, 140-142, 144-146, 148-149, 162, 207-215, 218-219, 221-224, 228, 240, 244-245, 277, 424, 426-427, 429, 432, 434, 460, 501, 508-509, 545-546, 548, 550, 555-557, 559-565, 567, 573, 589, 617
- Seamless coupling of methods 39
- Second-order intensity function 8, 9, 19, 109
- Sensitivity study 485
- Shear modulus 240, 256, 276, 280-281, 284, 287, 536, 584
- Shear yield strength 57
- Shear-lag model 46, 56, 59, 60, 81
- Shielding effect 23, 25, 29 29
- Size scaling 37, 41, 46, 54-55, 57, 63, 67, 78
- Spatial distribution 3, 22, 25, 29, 36, 50, 85
- Statistical homogeneity 3, 556
- Statistical volume element 21
- Stiffness degradation 139-140, 565, 567, 569
- Strain energy release rate 69, 73-74

- Stress 1, 4, 15-16, 18, 20, 22-25, 27-29, 33, 35, 37-40, 42-54, 56-57, 59-77, 79-82, 86-87, 91, 93, 95-96, 98, 102-109, 111, 113-115, 117-118, 120-122, 124-128, 131-133, 137, 139, 141-143, 145-147, 150, 154-155, 161-162, 166-168, 170, 172, 174, 176-177, 179-183, 185, 187, 189, 190, 192-194, 201, 203-207, 209-219, 221-223, 225-243, 245-254, 256-257, 259-261, 263-267, 272-273, 289-299, 301-310, 318-331, 333-340, 344-346, 348-351, 354-356, 362, 364, 366, 368, 382, 388, 392-397, 403, 421, 434, 435, 456, 458, 461, 469, 474, 477-479, 481-482, 484-485, 487, 492, 493, 499, 502, 504, 507, 510, 515, 521, 524, 532, 540, 544-556, 557, 559, 561, 622
- Stress concentration factor (SCF) 44-46, 52-60, 62, 63, 71
- Stress intensity factors 40, 81
- Stress loop 166-167, 170, 176-177, 179, 181, 185
- Stress redistribution 38, 40, 42, 51, 60, 63, 307, 537
- Stress-strain relations 291-294, 298-299, 319, 322, 324-326, 330-331, 334, 337-340, 348
- Structural integrity 30, 273, 531, 559, 570-571, 573
- Structure-property relationship 463, 467-468, 493
- Switching 95, 114-117, 144-145
- Synergistic damage mechanics (SDM) 533, 537, 562, 566, 577
- System of particles 225
- T300/914 11, 24-26
- Tensile fatigue 23, 25, 26, 29
- Thermal expansion coefficient 59, 83, 274, 276, 278, 282, 284, 288, 533
- Titanium matrix composite (TMC) 67, 77, 80, 73, 79
- Top down 87, 88, 157
- Transition layer 89, 148
- Twin specimens 22-23, 25-26
- Two-parameter Weibull model 50, 57
- Ultimate tensile strength 50, 72
- Unidirectional fiber composite 39, 460
- Uniform strain 210, 214-215, 218, 222, 224
- Uniform stress 210, 214-216, 325
- Virial stress 204-205, 217, 219, 226, 228-230, 234
- Voronoi cell finite element model 89, 101, 106, 117, 160, 161
- Voronoi tessellation 7
- Weibull modulus 50, 54, 57, 59-60, 62, 63, 66
- Weibull strength 50, 57, 66
- Woven fabric composite 184-185, 189, 196, 201
- Young's modulus 11, 16, 65, 106, 130, 293, 468, 472, 474-478, 536, 546, 569, 617