

Index

- 3D printing, 596, 597, 601
 α -phase, 103, 104
A-band, 54–58
ABAQUS, 697, 698
ab initio, 319–322, 325, 327
access, 691–695
aciplex, 175, 180
acoustic actuator, 573
acrylamide, 153, 341
acrylamidomethyl-propanesulfonic acid, (AMPS), 341
actin, 56, 59, 60, 66–68
active bandage, 741
active catheter system, 386
active force, 73
active stimulation, 424
active touch, 423, 424
actuator configurations, 537–539
actuator loads, 353
actuator strain, 262, 276–281, 288
actuators, 4–11, 18, 22–27, 32–40, 96, 120, 129, 660, 666, 668, 669, 671, 672
adaptive materials, 336
agriculture, 22, 737
ambulating character products, 646
admittance spectrum, 472, 479
amoeba, 610, 611
android, 623, 736, 749
Anomalocaris, 598
angle, 247, 249
angle (rad), 247
angular velocity, 247, 249
animal movement, 629
animation, 622–624, 632–639, 643, 644, 648, 654
animatronics, 622, 633–643, 646, 648, 652, 654, 735, 736
anion, 336, 339, 341, 346–349, 352, 359
anionic gel, 339, 348, 359
anisotropy, 540
anitgravity (anti-G) suit, 731, 741
antagonistic muscle arrangement, 588, 589, 591
anthroid, 623, 646, 647, 649
application opportunities, 531
art and entertainment, 627, 646
artificial evolution, 596, 599
artificial intelligence (AI), 622, 623, 627, 630, 632, 635, 643, 652–654
artificial muscle, 54, 67, 72, 83, 84, 275, 299, 304, 533–565, 568, 622, 624, 636, 647, 654
artificial nose, 728, 752
artificial skin, 649
artificial tactility, 422
asteroid rover, 386
axostyle, 69
aligned carbon nanotubes, 264
 β phase, 103, 104
B3LYP method, 324
bandwidth, 543–545
basis set, 321, 324, 327
batteries, 233, 235
behavior-based architecture, 605
bending, 337, 350–353, 357–360
bending beam method (BBM), 243
bending moment, 194–197
bending movement, 238, 240, 244–248,
bending strain, 503
bimorph, 242, 279, 280
biological inspiration, 72
biological muscle, 4, 7, 9, 18, 26, 32, 39, 72, 83, 622, 624, 636, 641, 650, , 691–695, 701
biologically inspired robots, 629, 732, 733, 737, 749, 752
biomimetic, 534, 584
biomimetic mechanics, 627
Biomimetic Robotics Labs, 633
biomorphic entertainment products, 626
biotech, 627
biped, 628, 629, 646

- bisacrylamide, 341
 Bloch sums, 325
 blocked stress, 76, 79
 body gesture, 645
 boundary control, 695
 boundary layer, 200, 202, 210–219
 boundary manipulation, 697
 bow-tie actuator, 555, 556, 560, 561, 565, 566, 573
 Brachiator, 598
 Braille display, 572
 brakes, 82
buccinator muscle, 652
 buckling, 271, 272
 bucky paper, 269–272, 278, 279, 287
 bulky anions, 237, 238, 241
 calix[4]arene, 310
 cantilevered beam, 505
 capacitance, 211, 212, 219, 544, 557, 574
 carbon nanotubes (CNT), 9, 37, 262–271, 275–279, 282, 284, 288, 624, 625
 carboxylic groups, 339
 catheters, 222
 catheter steering, 740
 cathode, 347, 350, 351, 357
 cationic, 339, 341, 349, 351, 359
 cationic gels, 339
 Cauchy stress, 366
 CGI character simulation, 634
 character animation, 622–627, 636
 character-effects shops, 634
 characters, 627, 634, 638
 charge density, 338
 charge distribution, 209, 212
 charge recovery, 546, 548
 chemical actuation, 158
 chemical potential, 337, 338, 340
 chemoelectric field, 344
 chemo-electro-mechanical coupling, 344
 chemo-mechanically active polymer, 14
 chemotactic behavior, 610
 chemotaxis, 611, 619
 chiral vector, 266, 267, 279
 cilia, 602, 604, 605, 614
 ciliate-based controller, 610
 clumped RC model, 513–516
 cockroach muscle, 74, 76
 coercive field, 106, 108, 110
 complex material constants, 476, 481, 486
 complex shape polymer, 435
 compliant, 535, 539, 542–545, 549
 composite EAP, 433, 434, 454
 composite wave, 422, 424
 comprehensive functionality, 745
 computer-aided design (CAD), 387
 computer aided engineering (CAE), 385–387, 396
 computer-aided manufacturing (CAM), 633
 computer-generated imagery (CGI), 634, 635, 636
 condition of neutrality, 339, 343
 conductive polymers (CP), 9, 13, 35–37, 231–238, 241–245, 249–252, 432, 438–442, 453, 624
 conductometric sensor, 728
 conformation change, 388, 396
 constitutive equation, 97, 98, 110
 contraction, 238–241
 control, 584–596, 599, 600, 603–605, 611, 616
 controllability, 550
 controlled weaving, 731
 convection, 343, 344
 convection-diffusion equation, 343, 344
 convective flux, 346
 coordination number, 191, 207
 corona poling, 104, 137, 138
 coupling efficiency, 548
 coupling factor, 100, 101, 111–114, 120–125, 133, 134, 139, 140
 course-graining, 332
 creep, 508, 551
 cross-bridge, 55, 58, 64–67
 cross-linker, 336, 341
 crystallinity, 107, 108, 111, 127, 128
 cycle lifetimes, 276
 cyclic voltammograms, 282
 cyclooctatetraene (COT), 305–307, 310
 cyclooctatetrathiophene (COTH), 305–308
 crystal orbitals, 325
 decentralized system, 603
 deformation gradient, 365, 367, 375, 377
 degrees of freedom (DOF), 412–417
 dehydration, 713–717, 722, 733
 density functional theory (DFT), 320, 322, 324–327
 depolarization, 350, 351
 design challenges, 539
 deswelling, 336, 342, 350, 351, 357
 detection threshold, 422, 423, 424

- Dexterous Manipulation Laboratory (DML), 596
diagnostics, 739
diaphragm actuators, 541, 567, 568, 572, 573
dielectric constant, 97, 111, 112, 119, 132–136, 191, 201, 208, 535, 544
dielectric EAP, 8, 24, 26
dielectric elastomers, 530, 531, 535, 539, 542, 544, 547–550, 553, 570–576, 624
dielectric polymer, 99
diffusion, 343, 344
diffusion-dependent strain, 498
diffusion force, 390–393
diffusive flux, 343
digital images, 634
digital rendering, 622
dipole, 183–186, 190, 191, 213–215, 219–221
direct operator control, 418
discretization, 345, 346, 354
dissociation, 337, 339, 341, 349
dissociation coefficient, 339, 340, 341
dissociation constant, 341
dissociation equilibrium, 339
distributed actuation device, 386
distributed current, 388, 396, 398
distributed elliptic friction drive device, 408
distributed internal stress, 396, 398
domain wall, 109, 110
Donnan equation, 339
Donnan equilibrium, 350
doping p , 232, 233
doping process, 232, 233
driver circuit, 546–548, 576
drops on-demand (DOD), 440
durability, 549, 550, 561, 576
dynamic hysteresis, 551
dynamic stability, 623, 629, 630, 645, 646
- EAP-actuated anthropid head, 654
Echo 1, 687, 688
ecology, 737
effects, 635, 638–642
eigen curvature, 380, 382
eigenstrain, 377–380
elastic compliance, 97, 101, 102, 122, 133
elastic energy density, 96, 119, 125, 127, 132–137
elastic modulus, 101, 119, 125, 127, 134–140, 271–277, 505, 506
elastic potential, 338
- elasticity, 483
electrets, 24, 96, 137–140
electric displacement, 114–116, 468, 469, 474, 475, 483, 490–494, 496
electric energy, 246
electric energy density, 133
electric field, 96–107, 114–138, 336, 337, 342–344, 347–353, 359–360
electrical impedance, 547
electrically controlled force and stiffness (ECFS), 659, 661, 668, 669, 670, 671, 672
electrically controlled stiffness (ECS), 659, 661, 668–673, 677–682
electroactive ceramics (EAC), 5
electroactivity, 268
electroactive polymer (EAP), 81, 83, 300, 336, 337, 386, 387, 388, 396, 418
electroactive polymer fiber, 443, 444
electrochemical capacitor, 282, 293
electrochemical doping, 276
electrochemical potential, 339
electrochemical properties, 266–269, 285
electrochromic devices, 233
electrolysis, 159, 160, 713–719
electromagnetic cylinder, 669–671
electromechanical actuators, 241, 248, 300, 311
electromechanical coupling, 476–480, 485–488
electron correlation, 321, 327
electron gun, 697
electronic conductivity, 266
electronic EAP, 5
electronic EAP materials, 499, 508, 718, 721
electronic noses (ENoses), 236
electronic polymers, 9
electrophoresis, 152, 154
electrorheological fluids (ERF), 38, 659–682
electrospinning, 437, 438
electrostatic actuation, 694
electrostatic force, 388, 390, 393, 394, 415, 544, 550
electrostatic model, 206, 535, 536
electrostatic potential, 327, 328
electrostatically restricted polymers, 530
electrostriction, 99–102, 110, 119, 120, 124, 126, 129–131, 135, 137, 433, 434, 467, 493
electrostrictive actuator, 434
electrostrictive coefficient, 98, 119
electrostrictive (nonlinear) strains, 23

- electronic tongues (ETongues), 236
 elliptic friction drive (EFD) element, 406–410, 413
 embossing and forming, 435
 emotional expressions, 644, 654
 emulsion spinning, 436, 437
 energy conversion efficiency, 546
 engine, 299, 300, 305, 310
 entertainment, 622–628, 631–643, 646, 647, 654
 entertainment industry, 622, 623, 626, 639
 environmental tolerance, 548–550, 575
 epicranius muscle, 652
 equivalent weight, 180, 181, 185, 186, 190, 205, 208, 218
 exchange-correlation energy, 323, 324
 expansion, 238–241
 expressions, 628–632, 635, 636, 641–647, 650, 652–654
 exoskeleton, 667, 671, 672, 682
 external load, 538, 543, 567
 face, 625–628, 630, 636, 638, 643, 644, 649, 651, 652
 face-type actuator, 386
 facial action coding system (FACS), 632, 644
 facial anatomy, 646
 facial animatronics, 636
 ferroelectric polymers, 22, 23
 ferroelectricity, 22, 96, 100, 103–117, 120, 124, 137, 490, 496
 ferrogels, 21
 fibers, 433–440, 443, 452, 453
 fillers, 134
 film, 434, 435, 441, 445–448
 finite difference method, 391
 finite elasticity, 370, 376, 383
 finite element methods, 368
 flapping-wing robot, 565, 566
 Flemion, 34, 173–180, 183, 187, 188, 192–194, 225, 230
 flexural rigidity, 484, 485, 505
 flight muscle, 73, 82
 Flory-Huggins theory, 154, 159
 flying, 77, 81
 flying platforms, 565
 force, 55, 62, 64, 68
 force-feedback devices, 666
 force generation, 73
 force-velocity relationship, 76, 78
 form I, 103–106
 form II, 103, 105
 framed actuator, 568, 569
 Framsticks, 599, 600
 free energies, 337
 free-form fabrication, 435
 frequency characteristics, 398
 frequency dispersion, 488
 G-receptor, 599, 601
 galvanotaxis, 611
 garments and clothing, 731
 gears, 302
 gel, 53, 59, 60, 66, 335–342, 347–350, 360
 gel actuators, 159, 160, 161
 gel elongation, 352
 generator, 547, 552, 574–577
 genetic algorithm, 598, 601, 616
 Gibbs free energy, 337
 Gibbs function, 469
 glass transition, 116, 117, 137
 global shape, 690
 Gossamer spacecraft, 702
 grafted elastomers, 126
 grasping motion, 671
 gravimetric capacitance, 268, 287
 gripper, 712, 718, 732, 750, 752
 Grothuss mechanism, 202, 208
 hand movements, 419–424
 haptic glove, 672
 haptic interfaces, 666, 667, 682
 heel-strike generator, 575, 577
 helically electroded composite EAP fiber (HECEF), 443
 helix-coil transition, 62, 66
 high voltage, 547–549, 576
 hot embossing, 435
 human countenance, 622
 human physiology, 654
 human skin, 638–641, 649, 653
 human-made actuators, 72, 84
 humanoid faces, 653
 humanoid GUI devices, 646
 humanoid robotic head, 622
 humanoid robotics, 623
 humidity, 532, 548, 549, 575
 hydraulic model, 206, 208
 hyperpolarization, 350
 hysteresis plots, 498
 imbedded actuators, 654

- impedance, 532, 542–543, 546, 547, 565, 573, 574
impedance matching, 543, 546, 547, 565
impedance spectrum, 472, 479
in air, 241, 244–248
inchworm, 564, 669, 670
inflatable structures, 17
influence, 691–697
influence function, 694
infrastructure, 6, 7, 39–41, 432, 751
injection molding, 432, 433
ink-jet printing, 737, 746, 751
ink-jet stereolithography, 737, 756
insectlike robots, 720, 735, 737, 746, 747, 751
insect walking mechanisms, 735
instantaneous work, 76
interactivity, 627, 632
interfacial capacity, 277
internal stress, 206
ion intercalation, 284
ion migration, 202, 207, 343
ionic conducting polymer gel film (ICPF), 386, 396, 407, 415
ionic EAP, 5, 9
ionic EAP materials, 498, 499, 503, 715, 719
ionic polymer gels (IPG), 30, 242, 360
ionic self-assembled monolayering (ISAM), 431, 432, 445, 446
ionomeric polymer-metal composites (IPMC), 34–35, 379, 385–388, 396, 407, 415, 418–424, 467, 498–500, 503, 504, 508–517, 624, 709–719, 722, 725, 732, 733, 740, 744, 747, 748, 752
isotonic, 75, 78
isovelocity, 75, 78

jump molecules, 20

Kanno-Tadokoro model, 388, 396, 402, 403, 406, 410, 414, 415
Kohn-Sham orbitals, 323
Kuhn segments, 332

Lagrangian strain, 366
Lagrangian/Eulerian strain, 495
Langmuir-Blodgett technique (LB), 431, 436, 442, 447–449
lattice dynamics, 330
Legged Excursion Mechanical Utility Robot (LEMUR) 594–596

legged robot, 560–562
length change, 248
length extensional mode, 477, 487
Lennard-Jones potential, 328
LIGA, 431, 449–451
linearization, 593
linear actuator, 248, 249
linear movement, 241
liquid-crystal elastomer (LCE), 29–30
light-emitting diodes, 13
load capability, 123
load line, 538
loading condition, 545, 547, 551
local slope, 690
local tilt, 690, 694
locomotion, 622, 628–632, 636, 646, 647
loudspeaker, 569, 570

manufacturing procedures, 633
mass fabrication, 744
mass-specific power, 80
material properties, 691, 692
materials, 691, 692, 705
matrix notation, 97, 98
maximum energy, 542, 543, 574
Maxwell equation, 343
Maxwell strain, 102, 133
Maxwell stress, 96, 101, 102, 126, 132, 133, 135, 137, 370, 495
McKibben actuators, 583
McKibben artificial muscle, 18
mechanical load, 123
mechanical loss factor, 545, 551
mechanical properties, 261, 262, 270–274, 277, 278, 284, 287, 288
mechanical stage, 398
mechanochemical engine, 303, 304
mechanical engineering, 626
medical task, 661
medical therapy, 724
Meissner's corpuscle, 418–421
melt spinning, 435–437
membrane structures, 690, 694, 703
membrane telescope, 689
mesoscale modeling, 319
metropolis method, 331
microactuator, 412
microelectromechanical systems (MEMS), 534, 578, 584, 616, 710, 744–746, 751, 752
microelectrode, 348
microelectrode technique, 350

- micrographic techniques, 499
 microlight scanners, 568
 micromanipulators, 386
 micropump, 386
 microrobot, 36
 microstereolithography, 451, 452
 miniature robotic arm, 718, 732, 750
 miniaturization, 739, 744
 mixing rate, 338
 modeling, 7, 11, 18, 33, 41
 molded interconnect devices (MID), 597
 molecular dynamics, 318, 319,
 329–333
 molecular mechanics, 317, 329
 molecular orbitals, 321
 momentum conservation, 395
 Monte Carlo, 317, 319, 329–33
 motion control, 660
 motion equation, 343, 344, 352, 353
 motion pictures, 637
 motors, 82
 movie animatronics, 635
 movies, 622, 623, 626, 634, 635, 643
 Mulliken charges, 327
 multifield formulation, 342
 multiwall carbon nanotubes (MWNT), 293
 muscle, 8, 172, 222, 225, 229–232, 641, 650
 muscle rings, 615
 muscles of the eyelids, 652
 muscles of the lips, 652, 653
 myosin, 55–60, 64–68
- Nafion, 34–35, 171–188, 192, 194, 198–
 205, 210, 211, 215, 217–220, 222–232,
 498, 499, 505, 506, 509–513
 Nafion-platinum composite, 396, 407
 Nafion-Pt, 386, 388, 401, 407, 408, 417
 nanocomposite, 447
 nanofiber polymer, 437
 nanotechnology, 262
 nanotube (NT) assemblies, 288
 nanotube bundling, 284
 nanotube helicity, 266
 nanotube sheets, 268, 274, 277, 283, 286
 narrative engines, 627
 narrative structure, 627
 natural frequency, 539, 544–546
 neo-Hookean, 367, 376
 Newtonian fluid, 662
 neural activation, 73
 neurons, 451, 599–601
 niche applications, 750
- nonlinear media, 606
 nonvolatile electrolytes, 716
 nylon 11-PVDF blends, 119
- orbicularis oris* muscle, 653
 optical switch, 568
 optimal design, 363, 370–372, 378, 379
 organic light emitting devices (OLED), 13,
 440, 457, 626
 organic particulates, 23
 orthorhombic, 103
 osmotic flow, 198, 207
 osmotic pressure, 159, 182, 200,
 203–205, 213–216, 336, 337, 344, 352,
 356
- Pacinian corpuscle, 421
 palm manipulation hand, 409
 PANi particles, 434
 paraelectric, 104–108, 120
 parameter space, 531
 peristaltic pump, 222
 passive muscle force, 73
 periodic boundary conditions, 318, 330
 peristaltic action, 615
 permittivity, 97, 99, 100, 535, 551
 phalange, 671, 672
 phase diagram, 104, 106
 phase difference, 408–412
 phase space, 331
 phase-transition, 53, 60, 63, 66, 335, 342
 photolithographic techniques, 441
 photolithography, 597
 photomechanical actuation, 304, 305
 photonic polymers, 13
 phototaxis, 605, 606, 612
 phthalocyanine, 134, 145, 160, 168, 264,
 265
- physiology, 628, 641
 piezoelectric ceramics, 387
 piezoelectric constants, 470, 486
 piezoelectric equation, 396, 400
 piezoelectric resonator, 473, 487
 piezoelectricity, 23, 96–100, 103, 104, 110–
 120, 129–134, 137–140, 469, 474, 489
 planetary applications, 710–712
 plant, 591, 592, 602
 point group, 97
 Poisson equation, 343, 344
 polarization hysteresis loops, 106
 polarization switching, 106, 109, 110, 115,
 144

- poling field, 104, 129, 130
polyacrylamide, 152–154, 157
polyacrylic acid, 151–165
poly(acrylonitrile) (PAN), 15, 32, 35
polyacrylonitrile, 158
polyallylamine hydrochloride, 157
polyaniline, 33
polyanions, 232, 237, 238
poly(cyclooctatetraene), 306
polymer elastomer, 96, 101, 102, 132
polymer films, 692, 693
polyelectrolyte gels, 165, 337, 341, 342, 348, 351, 360
polymethylmethacrylate (PMMA), 435, 450
polymer elastomer, 96, 101, 102, 132
polymer gel, 53, 59, 60
poly(*N*-isopropylacrylamide), 20
polypyrrole (PPy), 36, 281–283
polyquinolines, 305
polyurethane, 15, 132
polyvinylalcohol gels, 157, 159, 162
poly(vinyl chloride) (PVC), 33, 45
polyvinyl fluoride, 103
porosity, 190
potential energy function, 328
potential profile, 350, 351
power, 77, 80, 82
power output, 534, 543–546, 553, 566, 569
precision gossamer apertures, 688, 703
precision requirements, 689–691
pressure, 412, 418, 421, 422
prestretching, 206
print-through, 694
processability, 162, 436
producing power, 746
properties matrix, 516
propylene carbonate, 242, 716
protective coating, 715, 717, 733
protein filaments, 56
protists, 604
pumps, 567
puppetry, 634
PVA-PAA, 15
PVDF, 95, 96, 103–111, 114–119, 125, 137, 697–703
P(VDF-TrFE) copolymers, 103, 106, 119, 120, 122, 133
PVDF-Nylon 11 bilaminates, 117
pyroelectricity, 145
quantum step, 67
quasi-static measurements, 490, 496
radial compression, 271, 272, 294
rapid prototyping, 596, 598, 601, 602, 616, 633, 654, 737, 751
Rapid Prototyping Lab, 633
ratchet, 301–303
Rayleigh damping, 401
RC time constant, 544
reduced models, 363, 383
relaxation, 73, 84, 373
relaxor ferroelectric, 624
reliability, 532, 549, 550, 576
remanent polarization, 100, 106–110, 119, 130
repeatability of performance, 745
reptation, 66
resiliency, 271
resistance, 544, 548
resonance, 543, 546, 564
response time, 532, 543, 544
rhythmic activities, 77
robot, 534, 554, 559–564, 584, 585, 588, 594–598, 602–616, 633
robot evolution, 598
robot manipulation, 407
robotic character entertainment, 635
robotic hand, 409
robotics, 622, 625–637, 646–648, 651, 653, 723, 738, 750, 751
robotic fish, 222
rolled actuator, 556, 557, 561, 564
rubber skin, 635, 636, 640
Ruffini endings, 421
running, 77, 80, 81, 82
running figures, 646

S-receptor, 599
salt concentration, 341, 353, 355, 359
sarcomere, 54–68
saturation curvature, 506
scanning electrochemical microscope (SECM), 442
scanning electron microscopy, 267
Schrodinger equation, 321, 322
seams, 695, 699
selective laser sintering (SLS), 597
selective stimulation method, 422
self-organization, 603
semicrystalline copolymers, 111
semiempirical methods, 324
sensors, 96, 120, 129, 137, 235, 236, 585, 596, 599, 603–610
sensory receptor, 418–421

- serpentine manipulator, 563
 shape control, 705
 shape deposition manufacturing (SDM), 596, 597, 633, 654
 shape-memory alloys, 388
 shape-memory polymers (SMP), 16
 shear modulus, 271–273
 shear strain, 662, 663
 shear stress, 662, 663, 674, 675
 sheet resistance, 501–503
 shrinkage, 336
 silicone rubber, 549
 simulation results, 402, 403
 single-molecule, 37
 single wall nanotube (SWNT), 261–263, 267–275, 278, 279, 284–288
 slope error, 689
 SMA, 583
 small anions, 237–241
 smart blobs, 634
 smart bra, 731
 smart materials, 10, 12
 smart structures, 9–12, 44, 449, 579, 723
 smile, 644
 sociable robots, 633
 solarbot, 605, 613
 solid polymer electrolyte, 233, 241, 246–251
 sodium cation travel, 394
 sodium ion travel, 390
 solution spinning, 435–437
 space missions, 689
 space-time finite elements, 345, 346, 360
 special effects, 635–642
 specific capacitance, 268, 284, 285
 specific surface area, 277
 speech emulation, 654
 Sprawlita, 628, 633, 634
 springs, 80, 82
 step response, 396, 397
 stepwise, 62–67
 stereolithography, 597, 598
 stiction, 663
 stiffness, 177, 179, 182, 186–192, 195, 197, 200–206, 219, 660, 667–671, 679, 682
 stilbene, 304, 305
 stimulation, 336, 337, 342, 350, 352, 359, 360
 strain, 96, 98, 99, 101, 102, 108–110, 116–137, 141, 270–280, 285–288, 366, 372, 377–380
 strain-stress, 75
 strain response, 536, 556, 568
 stress, 96–98, 101, 102, 117, 123, 126, 133, 138, 140, 366, 367, 374–378
 stress distribution, 194
 stress generation, 262, 277, 278, 288
 stress generation stage, 398, 400
 stress gradient, 238, 240
 structured electrode, 544
 struts, 81, 82
 supercapacitor, 262, 269, 277, 292
 surface profile, 689, 697
 surface smoothness, 689
 swarm intelligence, 603
 swimming, 77, 82
 syneresis, 156
 solvation number, 207–209
 supercapacitor, 262
 surface area, 266, 275, 277, 284, 285
 swelling, 335–344, 347–360
 swelling and contraction, 388
 swelling ratio, 337–341, 347, 350, 354, 355, 359
 switching speeds, 276, 278
 T-receptor, 599
 tactile array, 667
 tactile haptic display, 387, 709, 727
 tactile interfaces, 723, 736
 telefeeling, 669
 telemanipulation, 416, 417
 telepresence, 660, 682
 telepresence tourism, 646
 telerobots, 623
 temperature, 532, 533, 548, 549, 575
 tensile properties, 271
 terpolymers, 125, 137
 tetrafluoroethylene, 103
 tetramethoxytetraphenylene, 308, 309
 thermal actuation, 697
 thermally activated gels, 21
 theme-park ride seats, 646
 theme parks, 623, 635, 637, 643
 themed entertainment, 624
 thermoplastic material, 432, 433
 thermoset, 433
 thick filament, 54–58, 62–66, 68
 thickness resonance, 473, 474, 480
 thin filament, 53–58, 65–67
 time-constant, 507
 time-discontinuous Galerkin (TDG), 345, 346
 time-series black-box model, 388

- Timoshenko-beam, 353
titin, 54, 60
tools of engagement, 627
touch, 418–424
total analysis systems, 435
toys, 635, 637, 640, 643, 723, 735
transconformation, 103, 108
trifluoroethylene, 103, 129, 137
- unconventional controller, 605
underwater robot, 386
unimorph, 242
useful characteristics of EAP actuators, 626
- van der Waals, 326–328
wave-based computing, 606
verlet, 329
vibration, 421, 422
vibration sensing, 222
vibration suppression, 660, 666
virtual-power principle, 353
virtual reality, 660, 661, 682
viscoelastic, 545, 551–554, 562
viscoelastic engineering, 626, 654
viscoelastic properties, 545, 553, 554, 622, 629
viscosity, 659, 661–664, 668–671, 675, 681
viscous resistance force, 390
visual effects, 634
voltage converters, 547
volume changes, 236, 238, 243
volumetric strain, 207, 209
- W-profile error, 689, 698
walking robots, 560
water, 59, 60, 69, 180, 206
water content change, 389
water travel, 389, 392
wearable stimulation device, 420
web, 623, 627, 634, 638, 653
wettability, 266
Winslow effect, 661
wiper, 386, 406
work-loop method, 77, 81
wrinkle suppression, 701
- x-ray lithography, 449, 450
xerogel, 341
- Yamagami-Tadokoro model, 388, 396, 403, 406
yield stress, 660–664, 667, 675