620.193 LOO

Contact "Library Services" : info@dss.go.th

Index

Note: Page numbers followed by "b", "f", and "t" indicate boxes, figures, and tables respectively.

A

American Physical Society, 10
Aramid fibers
  Kevlar®, 59
  properties, 58–59, 61t
  sleeve and tapes, 58–59, 59f
  stress–strain curves, 59, 60f
  Twaron®, 59
Arc discharge, 104, 104f–105f
Armchair nanotube, 81, 81f

B

Bismaleimides, 57

C

Carbon allotropes, 74–75, 74f
Carbon fibers, 58, 59f, 61t
Carbon nanotubes (CNTs)
  advantages, 209–213
  applications, 119
    Adidas adizero shoes, 192, 192f
    antibody functionalized single-walled carbon nanotubes, 196–197, 196f
    artificial muscles, 194, 194f
    bicycle with frame, 190, 192f
    catalytic materials, 199, 199f
    CNT-based organic solar cells, 197–198, 198f
    drug delivery systems, 196–197
    Easton baseball bat, 190, 191f
    electrochemical supercapacitor electrodes, 197, 197f
    electromagnetic interference shielding, 201, 201f
    electrophoretic display (EPD) e-paper, 194–195
    hard tissue engineering, 194–195
    hockey sticks, 190, 191f
    hydrophilic microbiosensor, 192–194, 193f
    hydroxylapatite formation, collagen composite, 195, 196f
    lithium-ion battery, 199–201, 200f
    paper-thin cylinder, 199, 200f
    printed CNT transistors, 201–202, 202f
    sail boat, 190, 191f
    Samsung display, 194–195, 195f
    sound frequency electric currents, 199
    synthetic gecko tape, 194, 195f
    tennis racket, 190, 190f
    thermo-acoustic effect, 199
    water molecules, 198, 198f
    wind turbine blades, 192, 193f
chemical fibers and yarns, 228
cost, 213, 214t
  and production capacity, 106–107
  vs. property analysis, 220–221
covalent functionalization, 94, 97f
double-walled carbon nanotube, 75–76, 76f
electrical conductivity, 88, 88t
fiber composites, micromechanics modeling
  critical length, 218–219
  effective fiber, 218–219
  fiber volume fraction, 218
  Halpin–Tsai equations, 217
  hybrid composites, 219–220
  materials cost, 219–220
  nanotube reinforced composites, 217
  single reinforcing phase, 218
  strength efficiency factor, 219
  tensile strength, 218–219
fitting experimental data, 241–244, 242f–243f
graphene sheet, 75–76
hallow carbon fibers, 77, 78f
Halpin–Tsai model, 217
health risk and safe disposal
  asbestos fibers, 109
  electrolyte imbalance, water consumption, 109
  environmental precaution, 110–111
  glove box, 110, 111f
  granulomas, 109–110, 110f
  MSDS, 111–119, 111b
  toxicological effects, 110
hybrid composites, 222
impurities, 89
material selection process, 220
mechanical properties, 85t
  arc discharge, 84
  covalent bond, 83
  density and price, 223, 224t
  nanocomposite materials, 208, 210t
  SEM, 84, 84f
  single-walled carbon nanotubes, 86–87, 86f
  specific resistance value, 83–84
models development, 235–240, 236f
multi-walled carbon nanotube, 75–77, 76f, 79f

Carbon nanotubes (CNTs) (*Continued*)
non-covalent functionalization
adsorption models, 94, 96f
block copolymers, 94, 96f
single-walled carbon nanotube, polyethylene polymer chain, 94, 95f
patents and published articles, 77, 80f
polymer matrix composites (*see* Polymer matrix composites)
production methods
adaptations and improvements, 103–104
arc discharge, 104, 104f–105f
carbon monoxide conversion, 106, 108f
CVD, 105–106, 106f–108f
laser ablation, 104–105, 105f
properties, 213, 214t, 222, 222t
published articles and patents, 208, 209f
purification and oxidation
characteristics, 89–90, 92
hydrochloric acid, 90, 90f
metal oxides, 90
oxidation temperature, MWCNTs, 92f, 92b
oxidation time, MWCNTs, 93f, 93b
single-walled carbon nanotube defects, 90, 91f
solvents and polymer matrices, 93
reinforcement efficiency
applications, 234
3D network, 234
epoxy system, elastic modulus, 234, 235f
percolation threshold, 234
properties, 234
semiconductor carbon nanotubes, 87, 87f
series and parallel
composite modulus, 237
filler volume fractions, 237–238
large-diameter CNT bundles, 236
nano-fillers, 236
percolation threshold, 238
switching function, 237–238
three-phase composite system, 236, 237f
single-phase reinforced epoxy composites, 222
single-walled carbon nanotube, 75–76, 76f–77f
stiffness, 223–226, 226f–227f
structure
armchair nanotube, 81, 81f
C–C bond length, 79
chiral vector, 78, 80f
graphene sheet, 74f, 77–78
SWCNT, 82b
van der Waals attractions, 82
zigzag hexagonal lattice, 78
surface modification, 213
Takayanagi model, 238–240
elastic modulus, 240–241, 240f
tensile strength, 209–213, 213f, 223, 226f–227f
thermal conductivity, 88–89, 89t
tight-binding, superposition energy, 88
types, 75–76
Young's modulus and break up elongation, 209–213, 213f
Ceramic matrix composites (CMC), 50
Ceramics, 61
Chemical vapor deposition (CVD)
apparatus, 105, 106f
nanotube synthesis, 105–106, 108f
structures growth, 105–106, 107f
Composites
advantages and disadvantages, 61, 62t
applications, 69
Boeing aircraft structure, 64
Boeing 787 Dreamliner, 65, 66f
Bulletproof vest, 65–68, 67f
concrete columns, 68, 68f
Enertia, electric bike, 65, 67f
F-22A Raptor fighter aircraft, 63, 64f
Mercedes CLK Cabriolet, body components, 65, 66f
plastic bridge, 68, 69f
polymer composite biomaterials, 68–69, 70f
Super Jumbo Airbus A380, 65, 65f
wind generator with blades, 68, 69f
bamboo and timber, 46, 47f
classification, 50f
CMC, 50
fiber composites, 51, 52f
MMC, 50
particulate composites, 51, 51f
PMC, 51
structural composites, 52, 53f
criteria for, 45
definitions, 45–46
engineering materials
advantages, 45
ceramics, 41
characteristics, 38
metals, 38–41
per capita usage, 41–45, 46t
polymer-based composites, 41–45
polymers, 41, 42t
properties, 38, 39t
fiber length, fiber composites, 62–63, 63f
matrix phase, 46, 47f
function, 48
performance characteristics, 48

properties, 46, 53
reinforcements, 48–49, 49f
aramid fibers, 58–59, 59f–60f, 61t
carbon fibers, 58, 59f, 61t
ceramics, 61
functions, 49, 50f
glass fibers, 57–58, 58f, 61t
phase, 46, 47f
polyester fibers, 60
polyethylene, 60
quartz, 60
types, 57
resins, 53
bismaleimides, 57
epoxy, 55, 55f, 56t
ester cyanates, 57
phenolic resins, 56–57
polyamides, 57
polyester, 54, 54f, 56t
polyurethanes, 57
silicones, 57
thermoplastics and thermosets, 53–54
vinyl ester, 55–56, 56f, 56t
snail shell, 46, 47f
teeth, 46, 47f
CVD. *See* Chemical vapor deposition (CVD)

D

Double-walled carbon nanotubes (DWCNTs), 75–76, 76f
modified Halpin–Tsai model, 149–150
Dual asymmetric centrifuge (DAC), 182–183, 184f–185f

E

Einstein equation
aspect ratio, 134, 135f
vs. Guth model, 134, 135f
reinforced elastomers, 133–134
suspension viscosity, 133–134
Young's modulus, 134
Epoxy resins, 55, 55f, 56t
Ester cyanates, 57

F

Fiber composites, 51, 52f
fiber length, 62–63, 63f
micromechanics modeling
critical length, 218–219
effective fiber, 218–219
fiber volume fraction, 218
Halpin–Tsai equations, 217
hybrid composites, 219–220
materials cost, 219–220
nanotube reinforced composites, 217
single reinforcing phase, 218
strength efficiency factor, 219
tensile strength, 218–219

G

Glass fibers, 57–58, 58f, 61t
Gold and silver nanoparticles, 13–14, 16f

H

Halpin–Tsai model, 139–142, 140f, 142f
Hatta model, 158, 159f
Health risk and safe disposal
asbestos fibers, 109
electrolyte imbalance, water consumption, 109
environmental precaution, 110–111
glove box, 110, 111f
granulomas, 109–110, 110f
MSDS, 111–119, 111b
toxicological effects, 110
High-shear mixer
applications, 178–180
oil emulsions, 177–178
PU matrix composites, 178b, 179f
rotor types, 177–178, 178f

K

Kelly-Tyson approximation, 129–130

L

Laser ablation, 104–105, 105f
Lycurgus cup, 13, 15f

M

Material Safety Data Sheets (MSDS), 111–119, 111b
Matlab® simulation
Halpin–Tsai code, 104
mixtures, code rule, 103–106
Metal matrix composites (MMC), 50
Modified Halpin–Tsai model
DWCNTs and MWCNTs, 149–150
effective fiber modulus, 149
fibrous composites, 147
vs. Halpin–Tsai model, 151, 151f
mechanical properties, 150, 150t
micromechanics-based models, 147–148
nanotube-matrix interface, 147
tensile strength, 149
Young's modulus, 148, 148f

Molecular nanotechnology, 11
Moore's law
  chip development, 15
  computing power evolution, 17–18, 21f
  integrated circuit transistors, 18, 21f
  transistor, 15, 20f
  transistor investors, 15, 20f
MSDS. *See* Material Safety Data Sheets (MSDS)
Multi-walled carbon nanotubes (MWCNTs), 75–77, 76f, 79f
  modified Halpin–Tsai model, 149–150
  oxidation temperature, 92f, 92b
  oxidation time, 93f, 93b

N

Nan model, 157, 158f
Nanoscience and nanotechnology
  applications
    air pollution and water, 28–29, 29f
    aviation and space, 22, 23f
    broken bone, healing process, 23–24
    energy, 27–28, 28f
    flexible color display monitor, 26, 26f
    in food industry, 25–26, 25f
    integrated circuit fabrication, 27
    magnetic random access memory (MRAM), 27
    micro and nano robots, 24–25, 24f
    nanocapsules, 22–23, 24f
    nano-silver crystals, 22–23
    quantum dots, 22–23
    sports, 30, 32f
    textiles, 29–30, 31f
  history, 1–2, 4–10, 12f, 14, 18f
    American Physical Society, 10
    atom rearrangement, 13
    biological system, 9
    computing machines, 11
    electron microscopes, 8–9
    gold and silver nanoparticles, 13–14, 16f
    high school competition, 15–18
    lubrication problems, 10
    Lycurgus cup, 13, 15f
    molecular nanotechnology, 11
    NNI, 12
    scanning tunneling microscope, 11, 11f
    small scale atoms, 13–15
    timeline with events, 15, 19t
    tiny factories, 17–18
  Moore's law
    chip development, 15
    computing power evolution, 17–18, 21f
    integrated circuit transistors, 18, 21f
    transistor, 15, 20f
    transistor investors, 15, 20f
  nano-abacus, 30, 32f
  nanofabrication, 33
  nanoparticles
    electromagnetic properties, 9–10
    mechanical properties, 10
    optical properties, 10
    sinterization, 8–9
    size effect, 8
    thermal properties, 9, 9f
  nanoscale
    area/volume ratio, 6
    atom density, 7
    atoms alignment, 1–2, 2f
    copper atom mass, 8
    definition, 1–2
    gold cube, specific surface area, 5–6, 5f
    International System of Units, prefixes, 1–2, 2t
    material outer surface, 7, 7f
    number of atoms, 4
    objects *vs.* natural organisms size, 2, 3f
    properties, 6, 6t
    specific surface area, 8
  SWCNTs, 31
  types, 13, 14f
National Nanotechnology Initiative (NNI), 12
Nielsen model, 142–145, 143t, 144f, 144t, 159–161, 160f

P

Particulate composites, 51, 51f
Periodic table, 47f
Phenolic resins, 56–57
Polyamides, 57
Polyester fibers, 60
Polyester resins, 54, 54f, 56t
Polyethylene, 60
Polymer matrix composites (PMC), 51
  DAC, 182–183, 184f–185f
  electrical conductivity
    advantages, 161
    composite filler, 162
    conduction path, 164, 165f
    conductive fillers, 161
    contact resistance, 162
    factors, 164–167
    percolation threshold, 161–162, 162f–163f
  high-shear mixer, 177–180, 178f, 178b, 179f
  magnetic stirring, 175–177, 176f
  manufacture of, 172, 173f
  mechanical properties

aspect ratio, 130
constituents density, 131
Cox model, 137–138, 138f–139f
critical length, 128–129
Einstein equation, 133–134, 135f
elastic modulus, nanocomposites, 133
elastic properties, 151
fractions and concentrations, 131, 131t
Halpin–Tsai model, 139–142, 140f, 142f
Kelly-Tyson approximation, 129–130
modified Halpin–Tsai model, 147–151, 148f, 150t
Nielsen model, 142–145, 143t, 144f, 144t
polymers and density, 128, 129t
series and parallel models, 136–137, 136f–137f
SWCNTs, 130, 130f
tensile strength, nanocomposites, 145–147, 146f
mechanical stirring, 177, 177f
melt processing, 172–174, 174f
nanosized reinforcements, 172
preparation methods, 172
properties
chemical modification, 127
molecular chemical bonds, 127, 128f
nano-fillers aggregation, 126, 127f
van der Waals interactions, 126
reaction processing/in situ polymerization, 174–175, 175f
single-screw extruder, 185–187, 186f–187f
solution processing, 172, 174f
sonication, 180–182, 181f–183f
thermal conductivity
geometric model, 154–157, 155f
glass and organic fibers, 152, 153t
Hatta model, 158, 159f
Nan model, 157, 158f
Nielsen model, 159–161, 160f
parallel model, 152–154, 154f
series model, 153–154, 154f
two-phase composites, 152
three-roll mill (calender), 184–185, 186f
Polyurethanes, 57

Q

Quartz, 60

S

Silicones, 57
Single-walled carbon nanotubes (SWCNTs), 31, 75–76, 76f–77f, 130, 130f
defects of, 90, 91f
mechanical properties, 86–87, 86f
polyethylene polymer chain, 94, 95f
Sonication
advantages, 181
cavitation, 180, 182f
industrial sonicators, 182
sodium carbonate, milling process, 180–181, 183f
ultrasonic bath and probe, 180, 181f
Structural composites, 52, 53f

T

Takayanagi model, 238–240
elastic modulus, 240–241, 240f

V

Vinyl ester, 55–56, 56f, 56t