

Index

a

- absorptance 160
- adaptive windows, fluidic networks for 143, 144
- airlaid paper 83
- angle of incidence 166
- anodic aluminum oxide 84
- antireflection 99
- antireflection biomaterials
 - nipple arrays 100
 - protuberances arrays 101
 - triangular roof-type 103, 105
- attenuated total reflectance (ATR) 164
- AuNP film 95
- AuNPs 78, 79

b

- bioinspired enhancing evaporation rate
 - via interfacial localized heating 81, 86
- bio-inspired icephobicity
 - icing nucleation 226, 230
 - stationary water drops 231, 233
 - surface water drops 230, 231
 - water drops on surfaces 235, 237
- bioinspired materials
 - application of 88, 95
- bioinspired microfluidic cooling
 - biological heat exchange 131, 132
 - wearable fluidics 132, 136
- bioinspired photothermal materials
 - carbon matrix metal functional 116, 122
 - metal-semiconductor 106, 116
 - synthesis approach 106
- bioinspired surface(s)
 - for boiling 49, 51
 - evaporation 82
- bioinspired thermal detection
 - application of 193, 195
- bioinspired thermal materials
 - detection 19
 - dropwise condensation 34, 36
 - for energy conversion 19, 20
 - engineering applications with 33, 44
 - for heat conduction 17
 - heat pipes 37
 - hydrophilic and hydrophobic surfaces 33, 34
 - for thermal storage 18
- biological thermal insulation
 - fat blubber 211
 - feathers and plumage 212
 - hair, fur and wool 212
 - heat transfer processes in animal coats 212
 - inspired by animals 214
 - inspired by black butterflies 216, 219
- biomimetic template synthesis 105
- biomolecule thermosensors 183, 187
- biosensor 136
- Boltzmann constant 160, 203, 228
- Boltzmann equation 12, 13, 15
- Boltzmann theory 15
- Bose–Einstein distribution 12
- boundary conditions 12
- Brownian movement 12, 16

- bulk heating
 evaporation theoretical models of 74, 75
 examples of 76, 80
- butterfly wing
 iridescence of 181
 reflection spectra of 182
- c**
 carbon nanotubes (CNTs) 32
 Cartesian coordinates 25
 Cassie–Baxter model 50
 Cassie state 50
 Cassie wetting 230
 chemical vapor deposition 84
 Clausius–Clapeyron relation 52
 closed-loop autoclave 90
 colorimetric biochemical assays 136
 composite magnetoplasmonic films (CNMF) 120
 computer numerical control (CNC) milling 148
COMSOL Multiphysics software 75
 confocal micro-Raman spectroscopy 27
 contact angle 49, 187, 226, 229
 conventional thermal approach 89
 conventional thermal insulation materials 204, 206
 classification 205
 copper nanowires 54
 critical heat flux (CHF) 40, 48, 65, 67
 critical micelle concentration 61
 cryopumping effect 210
- d**
 Dalton's law 75
 dielectric sealing 147
 digital light processing (DLP) 145
 diphenylalanine (FF) nanotubes 182, 183
 direct emissivity measurements 160, 161
directional emissivity 159, 161, 162, 164, 165, 168
 directional reflectance 159
 droplet motion 36
- dropwise condensation 34, 36
 drug delivery 194
 dynamic equilibrium 74
- e**
 elastomer 149
 electromagnetic field 104
 electromagnetic radiation 16, 179
 electromagnetic waves 11, 179
 electronics cooling system 94, 95
 embedded 3D-printing (e-3DP) 146
 emissivity 159
 energy transfer 203
 energy transportation 10
 entropy 12
 equilibrium freezing temperature 226
 evaporation
 bioinspired materials application in 88, 95
 bioinspired materials in 80
 bulk heating/interfacial heating 74, 75
 Dalton's law 75
 defined 74
 desalination 91, 92
 distillation 88, 89
 electronics cooling system 94, 95
 sterilization 89, 91
 wastewater treatment 92, 94
 evaporation-based cooling approach 74
 evaporation rate (E) 75
 expanded polystyrene (EPS) 205
- f**
 Faraday effect 117
 Fermi-Dirac distribution 12
 finite difference time domain method (FDTD) 104
 flow boiling 62, 66
 fluidic layers, thermal storage in 139, 140
 fluidic networks
 for adaptive windows 144
 CNC milling 148
 fabrication methods for 145
 micro molding 148, 150

RF welding 147, 148
 3D printing 145, 147
 viscous fingering 150
 fluidic thermal control 136
 fluorescence intensity 186, 193
 fluorescence signal 195, 196
 Fourier's law 25
 Fourier-transform infrared reflectance (FTIR) spectrophotometer 162, 163, 165, 168
 four-wire bridge circuit 179
 Fresnel equations 102
 fuel energy 78

g

gaseous thermal conductivity 202
 gases, thermal conductivity of 10
 Gas thermometers 177
 gas transfer 39
 Gibbs free energy 226
 glass wool 205
 gold nanoparticle (AuNP) 81
 graphene, wettability of 84

h

head cooling 134, 135
 heat capacity 2, 8, 9
 heat carriers
 collision 14
 micro/nanoscale 10, 13
 transportation equation 14
 heat conductance 4
 heat conduction
 bioinspired thermal materials for 17
 Fourier's law 25
 heat diffusion 5
 heat dissipation 86
 for artificial devices 74
 from bioinspired cooling porous membrane 87
 capacity 96
 of handheld devices 86
 rate 87
 heat exchange
 biological 131, 132
 wearable fluidics for 147
 heat exchange and storage 12

heat flow
 steady-state 26
 heat flux 2, 38
 heat flux flows 4
 heating, ventilation, and air-conditioning (HVAC) 47
 heat loss 75
 at higher temperatures 113
 heat pipes 37
 with integrated bioinspired design 42
 heat power 83
 heat radiation 190
 heat-to-evaporation conversion efficiency 75
 heat transfer
 conduction resistance to 35
 control volume and interface 4, 5
 conventional macroscale 1, 10
 integral structural 3, 4
 micro/nano-scale 10
 multi-phase medium 6, 8
 non-equilibrium 2, 3
 normalization 2
 phase change 9, 10
 radiation 203
 single-phase medium 6, 8
 super bi-philic surfaces 57
 thermal equilibrium 2, 3
 time constant for 114
 heat transfer area 236
 heat transfer coefficient (HTC) 48, 53, 56, 57, 114
 heat transfer rate 7
 Hele-Shaw cells 151, 152
 hemispherical emissivity 159, 161, 162, 164, 165
 hemispherical reflectance 159
 high frequency welding 147
 high-heat flux 38
 Hsu's theory 52
 hybrid photovoltaic-thermal (PV/T) 139
 hybrid superhydrophilic/
 superhydrophobic wicks 40, 42
 hydrophilic and hydrophobic surfaces 33, 34

- hydrophilic surface(s) 42
 with contact angle 50
 hydrophobic coating 230
- i**
- icing
 nucleation 226, 230
 stationary water drops 231, 233
 surface water drops 230, 231
 water drops on surfaces 235, 237
- infrared photothermal conversion 105, 116, 118
 properties 113
- infrared thermometer 161
- interfacial heating
 evaporation theoretical models of 74, 75
 examples of 74, 76, 80
- intrinsic thermal conductivity 31
- invasive thermal detection 177, 179
- IR light absorption 116
- IR photothermal effect 121
- IR thermo-imaging analysis 232
- k**
- Kerr effect 117
- Kirchhoff's law 160–162
 measurements using 162, 164
- Knudsen effect 203
- l**
- Laplace pressure 60
- Large Area Fluidic Windows 139
- light-absorbing nanoparticles 78
- light absorption property 119
- light incident 101
- light-induced distillation 88
- light propagation, control of 106
- light-to-heat conversion efficiency 83, 91
- light-to-heat converters 81
- liquid cooling garments (LCGs) 132, 134
- liquid–vapor interface 60
- Lotus effect 33, 34
- lower critical solution temperature (LCST) 87, 181
- m**
- magnetization intensity versus temperature 120
- magnetoplasmonic films 122
- magnetoplasmonic integration 120
- magnetoplasmonic materials 116
- Maxwell–Boltzmann distribution 12
- mean-free path 10, 203
- micro-Brownian motion 193
- microcontact printing (μ CP) 188
- micro molding 148, 150
- micro/nanoscale
 heat carriers 10, 13
 molecular dynamics (MD) calculation 15, 16
- photothermal effect via SPR heating 16, 17
- thermal dynamic theory via Boltzmann equation 13, 15
- micro-scale range
 thermal energy transportation 10
- molecular dynamics (MD) 15, 16
- Monte-Carlo algorithm 15, 16
- multicomponent nanoparticle (MNP) 105
- multi-phase medium 6, 8
- multi-scattering effect 79
- multiwalled nanotubes (MWNTs) 27
- n**
- nanopores 204
- nanostructured composites 32
- nanowires 53
- Navier–Stokes equation 12
- near field communications interface 136
- Newton's law 12, 15
- nipple arrays
 antireflection biomaterials 100
 reflectance of 102
- non-equilibrium 2, 3
- noninvasive thermal detection 179, 181
 physical properties 180, 181
- normal emissivity 159
- normalization 2
- nucleation energy barrier 230

o

- one-dimensional heat conduction 14
 one-dimensional steady state heat transfer model 142, 143
 onset of nucleate boiling (ONB) 47, 48
 open-loop autoclave 90
 optical absorbers 203
 optical microscopy 108
 Orlan LCG 133

p

- parameter units 3
 Pauli exclusion principle 12
 phase change materials 94, 139, 140
 phase separation micromolding (PS μ M) 187
 photo absorbance 103
 photo absorption 117
 photocatalytic degradation 93
 photolithography 230
 photoluminescence (PL) 184
 photonic crystals (PCs) 181
 photothermal biomaterials 99
 photothermal conversion
 of CNMF 118
 effect 105
 efficiency 105, 106, 114, 115
 infrared (IR) 105, 116, 118
 material 114
 properties of 114, 115
 solar 115
 photothermal conversion efficiency 77
 photothermal effect 16, 17, 76, 120
 photothermal energy 19
 photothermal mat 103, 105
 photothermal membrane 92
 Planck distribution 12
 Planck's constant 160
Planck's radiation law 160
 plasmonic heating 77, 79
 plasmonic thin film system 83
 plasmon-to-exciton/plasmon coupling 112, 113
 polydopamine (PDA) 33
 polymer composite materials 190
 polyurea-reinforced silica aerogels 207, 208

polyurethane (PU) foam 206

- pool boiling tests 56
 protons & electrons, thermodynamics of 10
 protuberances arrays 101
 pulse tube cryocooler 17

q

- quantum mechanics 10

r

- radiation thermometer 161
 radio frequency (RF) plastics welding 135
 Raman spectrum 180
 random-motion displacement 10
 Rayleigh number 203
 refractive index 175, 180
 regular replica molding (REM) method 188
 relative humidity 94
 relaxation time mechanics 13, 14
 resistance temperature detectors (RTDs) 179
 RF welding 147, 148
 RNA thermal detect 185

s

- Saffman–Taylor instability 150
 scanning electron microscopy (SEM) 30
 Schlieren method 180
 Seebeck coefficient 178
 shape memory alloys (SMA) 194
 Shine–Dalgarno (SD) sequence 184
 silica aerogel 206, 207
 silicone membrane 152
 silicon nanowires 54
 single-phase medium 6
 skin-mimic evaporative cooling system 86, 88
 solar autoclaves 90
 solar collector 115, 116, 139
 solar energy 91, 94
 applications of 144
 solar energy conversion 105
 solar illumination 84

- solar irradiation 84
- solar light illumination 91
- solar photothermal conversion 106, 115
- solar radiation 170
 - levels of 212
- sol-gel phase 190
- sol-gel reaction 206
- sonic transducers 181
- spectral emissivity 159
- steady-state heat flow 26
- Stefan–Boltzmann constant 203
- Stefan–Boltzmann law 160, 161
- stereolithographic (SLA) approach 145
- sunlight-to-vapor conversion efficiency 78
- supercooling temperature 228, 229, 231, 237
- superheat ΔT 47, 48, 57
- superhydrophilic microstructures 65
- superhydrophilic surfaces 54
- superhydrophobic surface 33, 34, 36, 37, 42, 225, 230, 236
- surface enhanced boiling
 - bi-philic and bi-conductive 55, 59
- surface-enhanced Raman scattering detection 106
- surface plasmonic resonance (SPR) 16, 17, 112
- surface structure enhanced pool boiling 52, 55
- surface-to-volume ratio 63
- surface wettability, impact of 84
- surface wettability modification 85
- surfactant enhanced pool boiling 59, 62
 - with water 60
- t**
- temperature-dependent
 - photoluminescence (PL) sensor 182, 183
- temperature sensitive hydro gel (TSHG) 87
- thermal cameras 161
- thermal capacity 9
- thermal conductance
 - of individual MWNT 33
- thermal conductivity 25, 27, 202
 - gas 202
 - intrinsic 31
 - low 83
 - materials development 27, 33
 - of MWNTs 31
 - of porous insulation materials 204
 - of windows 139
- thermal control, forced convection for 140, 142
- thermal detection
 - by biological materials 181, 187
 - using biological materials 176
 - by biological structures 176, 187, 188
 - inspired by skin 189, 193
 - invasive 177, 179
 - noninvasive 179, 181
 - by thermal functions 176, 189, 193
- thermal emissivity
 - attenuated total reflectance (ATR) 164
 - basic radiation laws 160
 - direct emissivity measurements 160, 161
 - hemispherical emissivity 165
 - Kirchhoff's law 161, 162, 164
 - remote sensing 168
 - sample shape problems 168
 - specular and diffuse reflectance 166, 167
 - terminology 159
- thermal energy conversion and storage 18
- thermal equilibrium 2, 3
- thermal ground plane (TGP) 40
- thermal infrared (IR) imaging 141
- thermal insulation 115
- thermal insulation materials
 - for buildings 208
 - conventional 204, 206
 - engineering 204, 211
 - fundamentals of 202, 204
 - heat transfer through 202
 - for mechanical systems 210
 - physical properties of 205

silica aerogel 206, 207
 for spacecraft 208, 210
 for textile industries 210, 211
 thermophysical properties 202,
 205
 total thermal conductivity 204
 thermal interface material (TIM) 32
 thermal materials
 with high thermal conductivity 27,
 33
 thermal conductivity 25, 27
 thermal non-equilibrium 3
 thermal sensing 181
 thermal storage
 bioinspired thermal materials for 18
 in fluidic layers 139, 140
 thermistors 179
 thermocouples 178, 179
 circuit formation of 178
 thermodynamic process 12
 thermodynamics
 first and second law of 1
 thermometers 177
 principle of 177
 thermosensitive biological polymers
 189
 thermosensors 187
 biomolecule 183, 187
 3D printing, fluidic networks 145, 147
 time-resolved photoluminescence
 (TRPL) 184
 transient temperatures 233, 236
 transition temperature (T_m) 193
 triangular roof-type 103, 105

tsGFP1 186
 tsGFP2 186
u
 vapor–liquid interface 37
 viscous fingering 150
w
 water drops
 on hydrophilic surface 233, 234
 transient temperature of 235
 water-to-ice nucleation 228
 water viscosity 235
 wearable fluidics
 head cooling 134, 135
 liquid cooling garments (LCGs) 132,
 134
 microfluidics 136
 wearable liquid cooling and warming
 garment 151
 wearable liquid cooling garments 136
 wearable liquid cooling systems 136
 wearable microfluidics 136
 Wenzel equation 49
 wettability 36, 57
 in tuning evaporation rate 86
 window emissivity 159

y
 Young equation 49
 Young–Laplace equation 52

z
 zinc oxide 53

