

Index

Note: Page numbers followed by *f* indicate figures, *t* indicate tables and *s* indicate scheme.

A

- Absorption coefficient
 - impedance tube method, 117–120
 - normal incidence absorption coefficients, 107
 - random incidence absorption coefficients, 107
 - resonant absorbers, 107
 - reverberation room method, 117, 120–121
 - statistical absorption coefficient, 106
- Acoustic measurement methods, 109, 111–113
- Acoustic properties
 - absorption coefficient, 106–107, 117–121
 - flow resistance, 103–104, 109–113
 - flow resistivity, 103–104
 - propagation, 105–106
 - scattering, 107–109, 121–124
 - transmission loss measurement, 113–117
- Adenosine triphosphate (ATP), 39–40
- Air flow resistivity, 103
- Air permeability, 131, 142–145, 216–217
- Alternating airflow method, 109–111
- Amberstrand®, 202
- ARAMIS system, 163, 163*f*, 171
- ASTM F2370, 145
- ASTM F 1291 and ASTM F 2370 standards, 49–50
- ASTM F 2668 standard, 50–51
- ASTM F 1868 standard method, 48–49

B

- Bacterial filtration efficiency (BFE), 140–142
- Banned amines, 179, 180*f*, 183–184
- Biodegradable and nonbiodegradable materials, 130
- BIOTEX project, 87

C

- CanShielding, 71
- Cantilever bending method, 70

- Carbon fiber, 68, 69*t*
 - Chloro benzenes, 184–185
 - Clothing physiology, 27, 33–34
 - Comfort testing
 - combat boots and gloves, 35
 - cooling power of garments, 31–32
 - duvets and sleeping bags, 33–34
 - extreme cold protective clothing, 32–33
 - immersion suits, 35
 - military vehicle seats, 35
 - skin sensorial wear, 30–31
 - thermal insulation, 29–30, 29*f*
 - thermophysiological properties, 27–29
 - Conductive fabrics, 72–75
 - Conductive fibers, 67–71
 - Conductive inks
 - electrical resistivity vs. printing passes, 77–78, 78*f*
 - HD-sEMG matrix, 78–79, 79*f*
 - high conductive metal precursor, 75
 - impedance values, 79–80, 80*f*
 - inkjet technique, 75–76, 77*f*
 - number of creasing interactions, 78, 78*f*
 - printed layers, 76, 76*f*
 - resolution and productivity, 75–76
 - screen printing procedure, 77, 77*f*
 - sintering, 77
 - uniform and flat conductive coating, 76
 - Copyright, 4–5
 - Coupling factor, 160
 - Crimp, 42, 219
 - Cyclic 3-point-bending, 162–163, 166–168
 - Cytotoxicity and nontoxicity performance testing, 145–147
- ## D
- Data collection, 5–6, 6*t*, 8, 12, 149–150
 - Dielectric properties, 91–92
 - Digital image correlation (DIC), 163, 171–173
 - Direct airflow method, 109–110

- Discrete wavelet transform (DWT), 166
- Disc-shaped rotor with integrated active damping system, 173–175
- Dynamic mechanical analysis (DMA), 223–225, 231, 231*f*
- E**
- Ecofriendly textile manufacturing and processing
 alternative colorants, chemicals, and heavy metals, 181–182
 ecolabels, 182
 OEKOTEX Standard 100, 182–183, 186
 process based ecolabeling, 183
 sustainable textile production, 183
- Electric impedance, 159–160
- Electromagnetic emission (EME), 165–166
- Electronic textiles (e-textiles), 65
 advantages, 194
 bio-physical monitoring, 202
 categories, 194
 connectors, 195–196, 196*f*
 detachable battery, 200, 201*f*
 disadvantages, 195–196
 elements, 193–194
 EL lines, 198–199, 199*f*
 entertainment and fashion, 209–210
 fabric transistor, 202
 Fibretronics®, 197
 functional inorganic nanocoatings, 202
 health monitoring and athletic training, 207–208
 hermetically sealed sensors, 198
 layered organic polymers, 202
 LEDs, 195, 195–196*f*, 198–201, 200–201*f*
 light-emitting E-Textiles, 195, 198
 military applications, 208
 modern functional textiles evolution, 193
 ongoing research projects, 210, 211–212*f*
 pressure activated switches, 198
 PV flexible solar film, 197
 quality-control testing, 197
 recycling and disposal issues, 203–204
 safety requirements & evaluation criteria, 204–207
 Swiss-based testing facility, 197
 System-on-Flex, creative wiring methods, 197
 waterproofing, 198
- Elektrisola Feindraht AG, 71
- EN 13795, 132–134
- EN 13938-1, 137–138
- EN 14683, 142
- EN 20811, 136
- EN 29073-3:1992, 138–139
- Energy harvesting systems
 available power generation, 88, 88*t*
 bending test experimental setup, 89–90, 89*f*
 Li-ion battery, 90
 piezoelectric effect, 88
 SEM, 89
 solar clothing, 88–89
 solution-based technique, 89
 Thermotron, UNITIKA Co., 90
- EN ISO 11737, 136
- EN ISO 15831, 145
- Environmental textiles
 azo dyes, 179–181
 classification, 177–178
 ecofriendly textile manufacturing and processing, 181–186
 GOTS, 184, 189–191
 historical background, 178–179
 nanoparticles, 177–178
 REACH, 188–189
 risks and limitations, 177–178
 RSL, 186–188
- European Chemical Agency (ECHA), 188–189
- European committee for standardization (CEN), 132–133
- Evaporative heat loss, 31
- Experimental modal analysis 161–162
- F**
- Fabric porosity, 44
- Fiber identification and characterization,
 thermal analysis
 chemical processes, 219–220
 DSC, 220–222
 natural fibers properties, 218
 processing parameters, 218
 TGA, 222–223, 229–231, 230*f*
 thermal behavior, 225–232
 thermal degradation, 219–220
 thermal processes, 218–219
 TMA and DMA, 223–225, 231, 231*f*

- Fiber-matrix-debonding, 165–166
Fiber reinforced polymers (FRP), 155
Fibretronics®, 197
Fineness/linear density, 42
Fit of military clothing
 and head protection, 36–37
 Hohenstein Sizing Chart, 36
Flexibility, 70, 72, 78–79
Flow resistance, 103–104
 acoustic measurement methods, 109, 111–113
 alternating airflow method, 109–111
 direct airflow method, 109–110
Flow resistivity, 103–104. *See also* Flow resistance
- G**
- Galvanomic Skin Response (GSR) sensors, 202, 203*f*
Global Organic Textile Standards (GOTS), 189–191
Guinea pig maximization test (GPMT), 147–148
- H**
- Healthcare textiles. *See* Medical textiles
Heat capacity, 44–45, 226
Helmholtz absorbers, 107
Hexachloro benzene (HCB), 184–185
High-density surface EMG (HD-sEMG)
 sensor matrix, 78–79, 79*f*
Hohenstein Institute in Germany, 27
Hohenstein Skin Model, 27, 28*f*
Homogeneous embedded piezoceramic modules, 169–173
Human skin irritation test, 147–148
- I**
- Impedance tube method, 117–120
Infrared thermography, 165
In situ computed tomography, 165
Intellectual property, 4–5
 interior textiles, 187, 187*t*
Intrinsically conducting polymers (ICPs), 69, 69*t*
Intrinsic/extrinsic process, 68, 69*t*
ISO 811, 143–145
ISO 9073-10, 136–137
ISO 10993, 145–147
ISO 10993-10, 147–148
ISO 22610, 134, 135*f*
ISO 22612, 134, 135*f*
- L**
- Linear mixed model, 11–12
- M**
- MacRae examination, 11–12
Malthus examination, 16–17
Material safety data sheet (MSDS), 206–207
McQueen’s approach, 10
Medical Device Directive (MDD), 132–133
Medical textiles, 177
 applications, 129
 care and quality assurances, 148–149
 classification, 131, 132*s*
 extracorporeal devices, 131
 future trends, 149–150
 healthcare/hygiene products, 131
 implantable materials, 129–130
 nonimplantable materials, 130
 performance testing, 131–148
 properties and performance, 131
Membrane/panel absorbers, 107
Metallic and metallic alloy fibers, 68, 69*t*
Microbial penetration
 barrier index, 134, 135*t*
 dry condition (ISO 22612), 134, 135*f*
 wet condition (ISO 22610), 134, 135*f*
Micrograph analysis, 157–158
Military textiles, 177
 comfort testing, 26–32
 fit analysis, 36–37
 functional properties, 25–26
 thermoregulatory mechanism, human body, 26, 26*f*
 too-warm clothing systems, 25
Modified phase-locked loop (mPLL)
 algorithm, 174
Modulated temperature DSC
 (MTDSC), 226
Moisture accumulation, 35, 43, 45
Moisture vapor transmission rate (MVTR), 143–145
Molecularly engineered/bioengineered textiles, 129–130
Monarch Antenna Inc., 93

N

- Nanowires (NWs), 73, 74*f*
- National Fire Protection Association (NFPA), 48
- Nonyl phenols, 184–185
- Number of contact points, 31

O

- Octyl phenols, 184–185
- OEKOTEX Standard 100, 182–183, 186
- Ohmatex Company, 85
- Optical method, 163–164
- Organization for Economic Co-operation (OECD), 4–5

P

- Particulate matter index (IPM), 136
- Pearson coefficient, 10
- Penta chloro benzene (PCB), 184–185
- Per fluorinated chemicals (PFCs), 184–185
- Performance testing methods, medical textiles, 131
 - CEN, 132–133
 - dry and wet burst strength, 137–138
 - EN 13795, 132–134
 - European Union (EU) rules and regulations, 132–133
 - linting measurement, dry state, 137
 - liquid penetration, resistance to, 136
 - MDD, 132–133
 - microbial contamination, 136
 - microbial penetration, resistance to, 134–135
 - particulate matter, 136
 - surgical masks, 140–148
 - tensile strength, 138–139
- Permittivity (ϵ), 91–92
- Pharad company, 93–94
- Phase change materials (PCMs), 56–58
- Phthalates, 184–185, 188
- Physical tests, 8
- Piezoceramic disc, 159–160, 160*f*
- Piezoelectric effect, 88, 162
- Planning phase, 5
- Poly-brominated diphenyl ethers (PBDEs), 184–185
- Poly(ethylene terephthalate) (PET)
 - microfibers, 225–227, 227*f*

- PONTOS system, 164, 164*f*, 170
- Per fluoro octane sulfonate (PFOS), 184–185
- Preliminary data analysis, 7
- Pressure sensors, 82–84
- Priority hazardous substances, 184–186
- Process based ecolabeling
 - hazardous chemicals, 184–185
 - heavy metals, 185–186
 - high exhaustion dyes, 183–184
 - hypochlorite-based bleaching, 183–184
 - natural fibers and synthetic fibers, 184
 - organic silk, 184
 - polyester, 184
 - Right First Time dyeing, 183–184
- Prospective survey, 13–15

R

- Randomization, 5
- Registration Evaluation Authorization and Restriction of Chemical Substances (REACH), 188–189
- Restricted substance list (RSL)
 - biocides, 186–187
 - chrome mordant dyes, 187
 - coated and laminated textiles, 188
 - easy care finishes, 188
 - flame retardants, 188
 - halogenated carriers, 187
 - heavy metals, 187, 187*t*
 - metal accessories, 188
 - metal complex dye, 187
 - printing paste, 188
 - SVHCs, 186
 - water and oil repellent finishes, 188
- Retrospective survey, 13–15
- Reverberation room method
 - absorption coefficient, 117, 120–121
 - transmission loss measurement, 113–115

S

- Safety requirements and evaluation criteria, e-textiles
 - body heat, flexible PV, motion power generation methods, 204–206
 - fashion statements, 204, 211
 - Lumalive® T-Shirts, 204, 205*f*
 - MSDS, 206–207

- T-Shirts, 204, 205*f*
utility functions, 204
- Scanning electron microscopy (SEM),
75–76, 76*f*, 89
- Scattering
vs. diffusion coefficient, 108–109
directional diffusion coefficient, 108,
124
random incidence scattering coefficient,
122–124
scattering coefficient, 107
specular reflection, 107
- Screen printing procedure, 77, 77*f*
- Shape memory materials (SMMs), 56–58
- Sintering process, 77
- Skin effect, 68
- Smart fiber reinforced composites
cyclic 3-point-bending with integrated
sensors, 166–168
disc-shaped rotor with integrated active
damping system, 173–175
qualitative experimental methods,
156–159
quantitative characterization, 159–166
subassemblies, 156
textile reinforced thermoplastic structure,
169–173
- Smart textiles, 65–66, 81–82, 131
- Sorption index, 30–31
- Sound quality, 103, 126
- Splash resistance (synthetic blood)
cytotoxicity and nontoxicity performance
testing, 145–147
human skin irritation test, 147–148
precondition requirements, 142, 144*t*
test instrument, 142, 143*f*
thermal manikin, 145
water penetration resistance, 142–145
- Standard test method, 8, 72
- Static flow resistivity. *See* Flow resistivity
- Statistical test, 5–6, 7*t*, 8–9
- Stiffness, 30, 70, 72, 105–106
- Strain sensors, 84–85
- Stretchsense®, 85, 86*f*
- Substances of very high concern (SVHCs),
186, 188–189
- Surface index, 31
- Surgical masks
BFE, 140–142
infection transmittance, barrier, 140
splash resistance (synthetic blood),
142–148
types, 140, 140*t*
- Sustainable Textile Production (STeP), 183
- Swiss-Shield®, 71
- T**
- Tactile comfort, 67
- Temperature range of utility (TRU), 28–29
- Textile fibers, 45, 73
chemical constitution, 215
formation and modification, 216–218
identification and characterization,
218–232
natural and synthetic origin, 215
- Textile reinforced thermoplastic structure,
169–173
- Textile research
analysis and significance, 5–8, 6–7*t*
case study, 15–16
cultural issues, 4
design, 5
ethical practices, humans, 4
factorial experiment, 9–12
functional experiment, 9
historical evidence, investigation, 16–17
intellectual property, 4–5
modeling, 17
research, definition, 3
surveys, 12–15, 14*t*
- Thermal analysis
fiber material, evolution of, 232–234
formation and modification, 216–218
identification and characterization,
218–232
- Thermal behavior, textile fibers
conventional DSC thermogram, 226, 226*f*
DMA, 231, 231*f*
dyeing process, 232
glass transition region, 226–227, 227*f*
heat-set processes, 225–226
low-density poly(ethylene), melting
curves, 228, 229*f*
melting behavior, 227–228
MTDSC, 226
Nylon 6 fabrics thermogram, 228, 229*f*
PET microfibers, 225–227, 227*f*
TGA, 229–231, 230*f*

- Thermal comfort performance
 ATP, 39–40
 critical assessment, 52–55
 fabric properties, 43–45
 fiber properties, 41–42
 garment properties, 45–46
 human trial method, 40, 50–52
 new fabrics development, 56–58
 testing methods, 55–56
 sweating guarded hot plate tests, 48–49
 sweating thermal manikin tests, 49–50
 thermal and evaporative resistance values, 40
 yarn properties, 42–43
- Thermal conductivity, 44–46, 52–53
- Thermal insulation, 29–30, 29*f*, 33–35, 41–46, 142–143, 145, 215
- Thermal manikin, 29–30, 29*f*, 33–35, 145
- Thermal resistance of fabrics, 46–47, 52–53
- Thermograms, 165
 annealing process, 228
 conventional DSC, 226, 226*f*
 Nylon 6 fabrics, 228, 229*f*
 polypropylene fibers, 220–221, 221–222*f*
 zero load shrinkage, 225
- Thermogravimetric analysis (TGA), 215–216, 222–223, 229–231, 230*f*
- Thermomechanical analysis (TMA), 215–216, 223–225
- Thermophysiological properties, 27–29
- Thermoplastic compatible piezoceramic modules (TPM), 158, 158*f*, 169–172, 170*f*
- Time domain reflectometry (TDR), 165
- Total heat loss (THL), 46–48
- Transfer matrix method, 113, 115–117
- Transmission loss measurement
 reverberant room method, 113–115
 transfer matrix method, 113, 115–117
- Tributiltin (TBT), 184–185
- Trichloroethane, 184–185
- Tukey's Honest Significant Difference tests, 10–11
- U**
- Ultrasonic testing, 158–159
- W**
- Water penetration resistance, 143–145
- WATson, 32
- Wearable electronic textiles
 chemical and gas sensors, 86–87
 conductive fabrics, 72–75
 conductive fibers, 67–71
 conductive inks, 75–80
 energy harvesting systems, 88–90
 fabric construction platforms, 66, 67*f*
 planar fabric circuit board, 80–81
 pressure sensors, 82–84
 strain sensors, 84–85
 wearable antennas, 90–94
- Wet cling index, 31
- Wireless Body Area Network (WBAN), 90–91
- X**
- X-ray computed tomography (X-ray CT), 156–157
- Y**
- Yarn-spinning process, 72