

## Index

### a

- abbreviated injury scale (AIS) 389
- Accreditation Board for Engineering and Technology (ABET) 383
- active bloodstain shape model (ABSM) 273
- alanine transaminase (ALT) 160, 166
- American Academy of Forensic Sciences (AAFS) 384
- American Society for Testing and Materials (ASTM) 8, 9
- ammonium nitrate (AN) 66
- ammonium nitrate fuel oil (ANFO) 79
- anodic stripping voltammetry (ASV) 107
- anti-cocaine antibody-functionalised gold nanoparticles 292
- atmospheric pressure chemical ionization (APCI) 74, 291
- atomic adsorption spectroscopy (AAS) 106
- atomic force microscopy (AFM) 167, 325
- attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy 10
- attenuated total reflection (ATR) spectroscopy
  - accessories 59
  - explosives 65
  - FPA detector 67
  - illicit drugs 63
  - paint samples 61
  - plastic packaging materials 60
  - pressure-sensitive adhesive tapes 61
  - soil and minerals 66
- b**
- Base Excision Repair/Single Strand Break Repair (BER/SSBR) 206
- batch-injection analysis (BIA) 110
- biochemical analysis
  - biomarkers characteristic 152
  - blood sample age of
    - absorbance changes 165
    - aging process 168
    - ALT-biocatalyzed reaction 170
    - CK and ALT 166, 171
    - CK-ALT-assay 163
    - CK/ALT biocatalytic assay 172
    - CK/ALT tunable biomarker cascade 171
    - CK/ALT-biocatalyzed reactions 170
    - degree of denaturation 167
    - NADH 169
    - optimized a biocatalytic cascade 168
    - parallel reactions biocatalyzed 168
    - real time response 169
    - time-dependent absorbance 162, 164, 166
  - DNA/ RNA analysis 151
  - ethnicity identification
    - CK and LDH 153, 158
    - CK and LDH concentrations 156
    - CK/LDH-assay 153
    - density histograms 157
    - ethnic groups 152
    - NADH 155
    - NADPH 156
    - PDFs 156
    - ROC analysis 159
    - ROC curve 160
    - selection criteria 152
    - serum samples 159
    - single-enzyme (CK) method 156
    - two-enzyme CK/LDH-assay 154, 156, 159
  - gathering information 151
  - gender identification
    - chromogenic reactant nitroblue tetrazolium 161
    - CK-assay 161
    - CK-PK-LDH biocatalytic cascade 162

- biochemical analysis (*contd.*)
  - CK/ALT concentrations 161
  - enzyme-biomarkers 161
  - healthy samples 161
  - human serum solutions 163
  - NBT and PMS 165
  - immunoassays 151
  - subarea of 151
- biological agents 39
- biomolecular analytical methods 416
- biosensors
  - biological weapons 248
  - cholera toxin (CT) 252
  - DNA sequence 253, 254
  - ganglioside GM1 252
  - multianalyte device 252
  - nucleic acid methodologies 253
  - ricin 249
  - *V. cholerae* 253
  - chemical warfare agents (CWAs) 241
  - explosives
    - NR enzymes 245
    - RDX 248
    - TNT 248, 249
    - triacetone triperoxide (TATP) 248
  - inorganic poisons
    - acetylcholinesterase (AChE) 217
    - arsenic 216, 217
    - As(V) 217
    - cyanide 219
    - *Escherichia coli* 218
    - *Porphyridium cruentum* 218
    - screen printed carbon electrodes (SPCEs) 217
    - surface plasmon resonance (SPR) 217
  - microorganisms
    - *E. coli* 238, 239
    - phages 239
    - salmonellosis intestinal infection 239, 240
  - organic toxics
    - alcohol dehydrogenase (ADH) 223
    - alcohol oxidase (AOx) 222, 223
    - cocaine 225, 226
    - doping agents, *see* Doping agents 230
    - ECL 226
    - ecstasy tablets 224
    - ethanol 223
    - FRET 225
    - M3G 227
    - MA – BSA 225
    - pharmacological drugs 224
    - riboflavin (RF) 225
    - toxins
      - aptamer 238
      - cyanobacterial bloom 234
      - DTX 234
      - *in vivo* Mouse Bioassay (MBA) 233
      - MC-LR 234, 238
      - okadaic acid (OA) 233
      - PSPs 233
      - tetrodotoxin (TTX) 234
- bipyrimidine photoproducts (BPPPs) 195
- bloodstain pattern analysis (BPA)
  - blood aging 277
  - blood components 264
  - bloodstain formation 269
  - crime scenes 263
  - in David Camm case 264
  - drying process 266
  - surfaces interactions 273
  - surfaces manipulation 274
- c**
  - cameras/complementary metal oxide semiconductor (CMOS) sensors 133
  - cathodic adsorptive stripping voltammetry (CA<sub>AdSV</sub>) 110
  - cathodoluminescence (CL) 325
  - chemical warfare agents (CWAs) 79, 241
  - chemometrics 6, 340
  - cocaine 225
    - annual prevalence 284
    - anti-cocaine antibody-functionalised gold nanoparticles 292
    - on banknotes 284
    - cEIA 292
    - chemical structure 283
    - cocaine hydrochloride (HCl) 283
    - Erythroxyllum 283
    - GC and LC-MS technologies 289
    - immunoassay 291
    - IMS detection 291
    - in-gel immunodetection method 294, 296
    - interferences 289
    - polyacrylamide gel coating 294
    - quantitative assay 294
    - screening process 291
    - supply and production 283
  - Collaborative Testing Services, Inc. (CTS) Forensic Testing Program 305
  - competitive enzyme immunoassay (cEIA) 292
  - counterfeit medicine 32
  - creatine kinase (CK) 153, 160, 166
  - Crime Investigation* 313
  - cyanide 219

cyanobacterial bloom 234  
 cyclobutane pyrimidine dimers  
 (CPDs) 195

## d

desorption electrospray ionization MS  
 (DESI-MS) 80  
 diamorphine 286  
 DNA 100  
 DNA damage 193  
 – forensic-type samples  
 – – biological stain 197  
 – – blood stain 198  
 – – dry conditions 198  
 – – hydration 197  
 – – ionizing radiation 197  
 – – microorganism growth 197  
 – – standard short tandem repeat (STR)  
 analysis 198, 199  
 – – strand breaks 198  
 – – VNTR 199  
 – molecular level  
 – – base modifications 204  
 – – Haber – Weiss reaction 200  
 – – local multiply damaged sites (LMDS)  
 203  
 – – mass spectrometric analysis 200  
 – – microorganism growth 204  
 – – relative humidity 204  
 – – STR profiling 200  
 – – strand breaks 204  
 – – UV radiation 200  
 – – UVA/UVB 202  
 – – UVC exposure 200, 201  
 – – UVPP formation 203  
 – ultraviolet radiation  
 – – BPPPs 195  
 – – CPDs 195  
 – – light 194  
 – – radical activity 196  
 – – reactive oxygen species (ROS) 196  
 – – strand breaks 196  
 DNA profiling 151  
 DNA repair  
 – BER/SSBR 206  
 – in vitro 208  
 – PreCR™ enzymes 209, 210  
 – Restorase® DNA polymerase 210  
 – single strand base repair (SSBR) protocol  
 208  
 doping agents  
 – androgenic steroids 230  
 – detection 230  
 – EPO 232

– hGH 232  
 – testosterone 230, 231  
 double pane glass 321  
 DTX toxins 234

## e

*E. coli* O157  
 – H7 239  
 electrochemical detection  
 – AAS and SEM 106  
 – AbrSV 113  
 – batch-injection analysis 110  
 – chemometric treatment 118, 119  
 – complimentary orthogonal methods 118,  
 119  
 – cyclic square-wave stripping voltammetric  
 signals 120  
 – cyclic square-wave voltammogram 117  
 – cyclic voltammetric data 116  
 – cyclic voltammograms 116  
 – fingerprinting 99  
 – forensic-fingers 114  
 – inorganic GSR  
 – – ‘classical’ HMDE 109  
 – – barium (II) 107  
 – – batch injection analysis 110  
 – – components 107  
 – – compounds 104  
 – – Hg-film glassy carbon electrodes 109  
 – – *in situ* deposition, mercury 108  
 – – microfabrication techniques 111  
 – – non-Hg working electrode materials 111  
 – – Pb and Cu 107  
 – – Pb and Sb 108  
 – – solid electrode materials 111  
 – – voltammetric detection 113  
 – multicommutated flow system 112  
 – organic GSR 115  
 – – compounds 104  
 – PCA score plots 119  
 – SWV, SEM and EDX 121  
 – voltammograms 108  
 electrochemical methods  
 – counter electrode 91  
 – DNA 100  
 – drugs 97  
 – electrolysis-etched fingerprint 99  
 – gunshot residues 94  
 – point-of-care electrochemistry 91  
 – poisons 93  
 – potential – time profile 92  
 – potentiometric methods 90  
 – potentiostatic methods 90  
 – reference electrode 91

- electrochemical methods (*contd.*)
  - Rohypnol™ 97
  - schematic diagram 95, 100
  - voltammetric responses 96
  - working electrode 91
- electrochemiluminescent (ECL) 226
- electrochromic windows 323
- electron multiplying coupled-charge device (EMCCD) 142
- electron paramagnetic resonance (EPR) 167
- electrospray ionization (ESI) 73
- engineering
  - AAFS 384
  - accident reconstruction
    - – delta-v 388
    - – Newton's laws 386, 387
    - – occupant's kinematics 388
    - – vehicular accident reconstruction 385
  - biomechanic
    - – AIS Severity Code 390
    - – force measurement 391
    - – HIC 391
    - – threshold injury criteria 390, 391
  - definition 383
  - degree programs 383
  - plane crash 384
  - products liability
    - – design defects 392
    - – FMEA 395
    - – FTA 395
    - – manufacturing defects 394
    - – PSA 396
    - – safety hierarchy 396
    - – warn and instruct failure 394
- enhanced chemiluminescence (ECL)
  - substrate 294
- enzyme linked immunosorbent assay (ELISA) 215
- erythropoietin (EPO) 232
- European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) 284
- exterior easy-cleaning technology 322
- f**
  - face recognition 415
  - failure modes and effects analysis (FMEA)* 395
  - fast atom bombardment (FAB) 74
  - fault-tree analysis (FTA) 395
  - Federal Aviation Administration (FAA) 406
  - Federal Motor Vehicle Safety Standards (FMVSS) 390
  - fibers 347
  - fingerprint spoofing
    - AFIS 376
    - automated biometric recognition systems 374
    - documented cases 377
    - eccrine glands 374
    - fingerprint, at crime scene 377
    - hardware-based liveness detection 379
    - liveness detection 377
    - photosensitive printed circuit board 376
    - robust method 375
    - software-based liveness detection 380
    - UV light 376
  - fingerprinting 99
  - focal plane array (FPA) detector 67
  - forensic DNA analysis
    - bone evidence 178, 184
    - bone mineral matrix 177
    - contamination 183
    - DNA sources 179
    - postmortem taphonomic effects 181
  - forensic electrochemistry 2
  - Forensic Finger 3
  - forensic science
    - biochemistry/molecular biology 1
    - blood stain patterns 3
    - botanical forensic 1
    - definition 1
    - electroanalytical sensing 2
    - engineering disciplines 3
    - schematic delineating voltammetry 3
    - vibrational spectroscopy 2
  - Förster resonance energy transfer (FRET) 225
  - Fourier transform infrared spectrometry (FT-IR) 71
  - Fourier transform mass spectrometer (FTMS) 75
- g**
  - gas chromatography (GC) 106
  - gas chromatography (GC-MS) 71
  - gas chromatography coupled with mass spectrometry (GC-MS) 289
  - glass evidence
    - annealing process 312
    - ATR mid-IR spectroscopy 326
    - bullet entrance 300
    - cathodoluminescence 325
    - chemical composition 313
    - classification 299
    - coatings 302
    - crime scenes 299
    - density determinations 305
    - development, in windows 320

- discrimination 299
- fluorescent color 305
- glass cover 302
- glass density analysis 304
- glass dispersion 312
- glass fragments 301, 302
- GRIM system 306
- irregular surface features 303
- laser induced breakdown spectroscopy 318
- LIBS and LA-ICP-MS data 325
- manufacturing features 302
- Matwejeff's research 300
- microscopical techniques 306
- phosphorescence component 306
- polarized light microscope 325
- post-manufacturing surface features 302
- pycnometer 304
- refractive index 306
- refractive index determination and elemental composition 305
- refractive index distributions 311
- relative density 304
- RI and density 312
- significance 299
- sink/float method 304
- stereomicroscopic and interferometric analyses 303
- topological features 299
- toxic solvents 304
- trace elements 317
- UV light 305
- glycosylase 206
- gunshot residues (GSR) 103

## **h**

- hair analysis 8
- hair, trace evidence
  - anagen phase 343
  - ancestral estimation 345
  - cuticle cortex and medulla 344
  - locations and carriers 344
  - macroscopic appearance 346
  - mitochondrial DNA analysis 347
  - morphological information and DNA 342
  - post-mortem banding 343
  - telogen 343
- hanging mercury drop electrode (HMDE) 109
- head injury criterion (HIC) 391
- high performance liquid chromatography (HPLC) 72, 106
- human growth hormone (hGH) 232

- hyperspectral imaging
  - blood stains 140
  - chemometrics 138
  - CMOS sensor 133
  - conventional imaging 131
  - detector system 131
  - DNA testing 139
  - exploration techniques 138
  - fingerprint analysis 140
  - future aspects 145
  - grayscale/color mapping effects 139
  - gunshot residues 142
  - imaging compression 137
  - light sources 132
  - MCR 138, 144
  - mid-infrared hyperspectral imaging 141
  - multivariate classification model 145
  - NIR-hyperspectral imaging 142
  - PCA 138
  - point scanning systems 133
  - pre-processing strategies 134
  - region of interest (ROI) selection 137
  - spectral pre-processing 137
  - spectroscopy 131
  - three-dimensional hypercube 133
  - VIS/NIR system 142

## **i**

- illicit drugs 29–31
- imaging techniques
  - visual inspection and optical examination 125
- improvised explosive devices (IED's) 65
- in vivo* Mouse Bioassay (MBA) 233
- inductively coupled plasma (ICP) 81
- ink analysis 16, 17
- inorganic GSR (IGSR) 80
- internal reflection element (IRE) 57
- internal reflection spectroscopy
  - ATR, *see* attenuated total reflection (ATR) spectroscopy 59
  - effective thickness 58
  - electromagnetic field 55
  - evanescent wave 57
  - Fresnel's equations 56
  - principles of 56
  - record fingerprints 55
  - Snell's equation 56
  - Snell's law 56
  - transmission spectra 59
- ion mobility spectrometry (IMS) 36, 289
- IR spectrometers 415
- isotope ratio MS (IRMS) 81

**I**

- lactate dehydrogenase (LDH) 153
- laser induced breakdown spectroscopy (LIBS) 36, 318
- liquid chromatography/MS (LC/MS) 71, 72
- liquid crystal technology 323
- liquid injection field desorption ionization (LIFDI) 74
- Locard's Exchange Principle 337
- low-emissivity (low-E) coatings 321

**m**

- magnetron sputtered vacuum deposition (MSVD) process 321
- mass fatality incident (MFI) 178
- mass spectrometry (MS)
  - applications 78
  - – CWAs 79
  - – drugs and toxicology 77
  - – drugs packages 81
  - – dyes 80
  - – fingerprints 80
  - – glass 81
  - – GSR 80
  - – hair 79
  - – paint analysis 81, 82
  - applied area 77
  - detector 75
  - instrumental techniques 71
  - instrumentation 72
  - ionization source 73
  - LC-MS/MS experiment 76
  - MALDI-TOF 74
  - mass analyzers 75
  - samples 72
  - schematic 73
  - separation techniques 76
  - tandem MS 75
- mass spectrometry (MS<sup>2</sup>) detection 286
- matrix assisted laser desorption ionization (MALDI) 73
- MC-LR 234, 238
- methamphetamine-bovine serum albumin (MA – BSA) 225
- methyl ethyl ketone peroxide (MEKP) 65
- micro X-ray fluorescence spectrometry (XRF) 71
- morphine 227
- morphine-3-glucuronide (M3G) 227

**n**

- natural sciences 416
- neutron activation analysis (NAA) 106, 313

- Newton's laws 386, 387
- nitroblue tetrazolium (NBT) 165

**o**

- okadaic acid (OA) 233
- optical examination
  - DNA analysis 126
  - fingerprint visualization 127
  - gunshot residues 127
  - IR light sources 127
  - refractive index (RI) 129
  - thin layer chromatography 128
  - video spectral comparator 130
  - UV – vis lamps 126
- organophosphates (OPs) 241

**p**

- packed cell volume (PCV%) 265
- paint analysis 12, 14, 81
- Paint Database Query (PDQ) 353
- paint, trace evidence 351
- Pan Am 103 disaster 384
- Paralytic shellfish poisoning (PSPs) 233
- partial least squares (PLS) regression analysis 7
- payload 403
- photochromics 324
- photosensitive printed circuit board (PCB) 376
- platform 403
- polarized light microscope (PLM) 325
- polyacrylamide gel 294
- polydimethylsiloxane (PDMS) 67
- polymerase chain reaction (PCR) 183
- PreCR™ enzymes 209, 210
- principal component analysis (PCA) 7
- principal component regression (PCR) 7
- probability density function (PDF) 156
- product safety audit (PSA) 395
- pyrolysis gas chromatography-mass spectrometry 349

**q**

- quadrupole mass analyzer (QMA) 75

**r**

- Raman and scanning electron microscopy-energy dispersive X-ray spectroscopy (Raman and SEM-EDS) 43
- Raman imaging system 142
- Raman spectrometers 415
- Raman spectroscopy 29, 30, 325
- Raman – laser-induced breakdown spectroscopy (Raman – LIBS) 42

- Raman – scanning electron
  - microscopy-energy dispersive X-ray spectroscopy (Raman – SEM-EDS) 42
- receiver operating characteristic (ROC) analysis 159, 160
- remotely operated vehicles (ROVs) 405
- Restorase<sup>®</sup> DNA polymerase 210
- Rohypnol<sup>™</sup> 97
- Royal Canadian Mountain Police (RCMP) 62
  
- s**
- sarin (fluoromethylphosphoryl)oxypropane 245
- scanning electrochemical microscopy (SECM) 99
- Scientific Working Group on Materials Analysis (SWGMAT) 8, 9
- screen-printed electrode (SPE) 94
- small unmanned aerial systems (sUAS) 403
- soft independent modeling of class analogy (SIMCA) 7
- soil, trace evidence 357
- solar heat gain coefficient (SHGC) 321
- spatially offset Raman spectroscopy (SORS) 14
- support vector machine discriminant analysis (SVM) 7
- surface-enhanced laser desorption ionization (SELDI) 74
- suspended particle devices (SPD) 324
  
- t**
- tape, trace evidence 360
- temporally offset Raman spectroscopy (TORS) 39
- tetrodotoxin (TTX) 234
- thermal desorption-mass spectrometry (TD-MS) 289
- thin layer chromatography (TLC) 11
- time-of-flight mass spectrometer (TOFMS) 75
- time-resolved and spatially-offset Raman spectroscopy (TR-SORS) 37
- tip-enhanced Raman spectroscopy (TERS) 42
- toxicological analysis 216
- trace evidence
  - chemometrics 340
  - contamination 341
  - DNA evidence 337
  - fibers 347
  - hair 342
  - light sources 338
  - microscopic evidence 338
  - paint 351
  - physical characteristics 339
  - tape lifting 339
  - transfer and persistence 340
  - vacuuming 339
  - glass 355
  - lamp filament 363
  - limitations and significance 365
  - miscellaneous trace materials 365
  - physical match 364
  - soil 357
  - structural materials 362
  - tape 360
- triacetone triperoxide (TATP) 65
- trinitrotoluene (TNT) 65
  
- u**
- unmanned robotic systems
  - deployment models 410
  - evolution and anatomy 402
  - law enforcement agencies 410
  - law enforcement application
    - – bomb disposal applications 404
    - – crime scene imaging and reconstruction applications 405
    - – search and rescue application 404
    - – standoff and hostage negotiation applications 405
  - privacy advocates 409
  - public safety agencies 409
  - sensory and accountability capacity 401
  
- v**
- Valium<sup>™</sup> 97
- vehicular accident reconstruction 385
- vibrational spectroscopy
  - anthropology 22, 24
  - biology and anthropology
    - – gunshot residue 23, 27
  - body fluids 18–20
  - chemometrics 6
  - controlled substances
    - – illicit drugs 29–31
    - – pharmaceuticals 32, 34
  - counter terrorism and homeland security
    - – bioagents 39
    - – chemical agents 39
    - – explosives 36–38
  - fibers 11
  - hair analysis 8

vibrational spectroscopy (*contd.*)  
– ink analysis 16, 17  
– paint analysis 13–15  
video spectral comparator  
(VSC) 130  
visible transmittance (VT) 321  
voltammetric method 91, 93

**W**

weaponization 408  
WKD™ 97  
World Health Organization 32

**X**

X-ray diffraction (XRD) 72