

Index

a

- absorption spectroscopy (AAS) 384
- acid-base interactions 290
- acidic hydroxylation of oxide ceramics 89
- acidic vs. basic hydroxylation 89
- additive manufacturing (AM) 69–75
- advanced ceramics 5
- Ag nanoparticles 339
- alcohol dehydrogenase (ADH) 372
- alkylammonium surfactant 370
- alumina
 - applications of 10–11
 - membranes 11
 - solubility 9
 - structure and properties 8–9
- aluminium nitride (AlN) 29
- aminated polystyrene nanoparticles 340
- aminopropyl-functionalised ethane-bridged bifunctional PMOs (APEPMOs) 372
- 3-aminopropyltriethoxysilane (APTES) 95
- 3-aminopropyltrimethoxysilane (APTMS) 95
- aminosilanisation 95
- aminosilanisation with
 - 3-aminopropyltriethoxysilane (APTES) 89
- ammonia-based hydroxylation 89
- amorphous carbon 351
- amplitude-modulation AFM 124
- anti-adhesion coatings 300
- antibacterial activity
 - nanomaterial size on, bacterial viability 339–340
 - nanomaterial surface functionalities, on cellular viability 340–341
 - proposed mechanisms 341–342
- antibacterial agent release 303
- antibiofouling surfaces 300
- antibiotic treatment 296
- antimicrobial materials and coatings
 - biofilm growth and analysis 316, 318–324
 - devices, methods, and analytical tools 312
 - in vitro* 312
 - magnetic resonance imaging 316
 - scanning transmission X-ray microscopy 316
- “antipollution” systems 3
- aromatic polyamide composite ultrafiltration membrane 229
- atomic force microscopy (AFM)
 - biotechnological and environmental purposes 134
 - dry AFM vs. liquid-cell AFM 127–128
 - environmental applications 138–142
 - image processing, analysis and interpretation 131–132
 - imaging modes 122
 - mechanical stability and tip size effects 130–131
 - microbiology 142–145

atomic force microscopy (AFM) (*contd.*)
 piezo-ceramic transducers
 128–130
 scanning process 128
 secondary contrasting techniques
 132–133
 surface charges and surface chemistry
 135–138
 Avogadro's constant 222

b

bacteria adhesion 283
 bacteria-resistant coatings 300
 bacterial cell membranes 352
 bacteria-surface interactions
 DLVO model 292–294
 extended DLVO-theory 294–295
 thermodynamic theory 289–292
 ball-milling 57
 bare substrates 225
 barium titanate (BaTiO_3) 26–28
 β -cristobalite 21
 β -tricalcium phosphate (TCP) 64
 beta-tridymite 21
 binder removal 74
 bio-microelectromechanical systems
 (bioMEMS) 30
 bioblocking 259
 biocatalytic production 377
 biocers 64
 biofilm
 detrimental effects of 295–299
 formation 284
 antibacterial agent release 303
 contact-killing coatings 306
 drug release antibacterial materials
 309–311
 stimuli responsive coatings
 306–309
 negative and positive impacts 283
 biofilm-related infections 283
 BioOmics 312
 biofouling 259
 bioimplants 64
 bioinert coatings 32

biological nanoparticles 261
 biomanufacturing 407
 biomimetic catalytic molecules 392
 biomolecular adsorption 259, 260, 268
 biomolecular layer 259
 biomolecule interactions with functionalized
 material surface
 adsorption 267–268
 biomolecule properties 266
 charged and zwitterionic groups 268–271
 electrostatic interaction forces 262–263
 hydrogen bonds 263–264
 hydration and hydrophobic forces 264
 effect of material properties 265
 effect of media properties 266–267
 multifunctionality and heterogeneity
 273–275
 non-equilibrium interaction forces 265
 polymeric surface functionalization
 271–273
 specific interaction forces 264–265
 specific-binding surface chemistries
 275–276
 steric forces 264
 van der Waals forces 261
 biotechnological downstream processing
 407
 1,2-bis(triethoxysilyl)ethane (BTESE)
 373
 Boltzmann distribution law 195
 Boltzmann statistics 195
 boron carbide (B4C) 30
 boron neutron capture therapy (BNCT) 30
 bovine haemoglobins (BHb) 382
 bovine serum albumin (BSA) 101
 1-bromonaphthalene 417
 1-butyl-3-methylimidazolium bromide
 (BMI-M.Br) 390

C

Caenorhabditis elegans 350
 calcium phosphate 411
 capillary titania-based columns 16
 carbodiimide (EDC) 413
 carbon crystallites 351

- carbon graphite 31
 - carbon nanomaterials (CNMs) 337, 341
 - carbon nanotubes (CNT) 31, 337, 341, 346
 - carbothermal reduction 29
 - carboxylated surface 355
 - carcinoembryonic antigen (CEA) 389
 - catalyst carrier 5
 - ceramic filters 2
 - ceramic injection moulding 56
 - ceramic materials 47, 260
 - advanced ceramics 5–7
 - biotechnological and environmental applications 1–3
 - carbon-based materials 30–32
 - carbon fibres 31
 - CNT 31
 - diamond 32
 - fullerenes 31
 - graphene 31–32
 - non-oxide ceramics 28
 - carbides 30–31
 - nitrides 29
 - oxide ceramics 7
 - aliumina 9
 - alumina 7–12
 - BaTiO₃ 26–28
 - iron oxide 26
 - silica 20, 22–26
 - titania 12–16
 - zirconia 17–20
 - traditional ceramics 4–5
 - ceramic monoliths 410
 - ceramic processing 47
 - ceramic-based adsorbents
 - application of
 - facilitated protein purification 424
 - general chromatography 419–423
 - integrated downstream bioprocessing 424–426
 - bioproduct adsorption, fundametals 418–419
 - characterisation of
 - physico-chemical analysis 416–417
 - surface energetics 417–418
 - chromatography and support 409–411
 - functionalisation of 412
 - chemo-biological functionalisation 413–414
 - composite structures 415
 - self-assembled systems 414–415
 - ceramic-shaping technique 57
 - ceramming 5
 - charged and zwitterionic groups 268
 - chemical vapour deposition (CVD) 48
 - closed-loop piezo scanners 129
 - C₆₀ molecules 348
 - cold plasma treatments 91
 - colloidal shaping 56
 - freeze-casting 61–64
 - gel-casting 59–61
 - slip casting 57–60
 - confocal laser scanning microscopy (CLSM) 313
 - contact mode 122
 - contact-killing coatings 306
 - counter-ions 195
 - crack-free micropatterned surfaces 59
 - cristobalite 20
 - cyclic voltametric method 380
 - cylindrical mesopores 370
- d**
- Debye screening length 196
 - deflection 130
 - degree of heterogeneity 273
 - deoxyribonucleic acid (DNA) aptamers-based impedance biosensors 390
 - Derjaguin-Landau-Verwey-Overbeek (DLVO) theory 289, 417
 - “diagnostic” liquids 417
 - diamond-like carbon (DLC) 351
 - diamond nanoparticles 350
 - diamond thin films 351–353
 - dielectric permittivity 195
 - diffuse charge 195
 - diffuse double-layer charge density 199
 - digital light processing (DLP) 73
 - direct ink writing (DIW) 74
 - doctor-blade method 68
 - downstream processes 407

dry AFM, vs. liquid-cell AFM 127–128
 Dukhin number 209
 dynamic binding capacity (DBC) 419
 dynamic force spectroscopy 125

e

“effective pore diffusivity” (D_p) 419
 “egg-box” model 60
 electric charge density 205
 electric double-layer 194–200
 electric potential 195
 electrochemical biosensor 379–380
 electrochemical sensors 369
 electrodeposition 372
 electrokinetic charge 195
 electrokinetic phenomena-theory 200–212
 electrokinetic surface characteristics
 bare substrates 225–229
 electric double-layer 194–200
 electrokinetic phenomena-theory
 200–212
 electrophoretic characteristics of surfaces
 212
 nano and microparticle suspensions
 212–219
 particle covered surfaces 234–244
 polyelectrolyte modified surfaces
 229–234
 protein covered particles 219–224
 protein covered surfaces 245–250
 streaming current/streaming potential
 224–225
 electron microscopy 119
 electron surface chemical analysis (ESCA)
 163
 electron transfer kinetics 380
 electron-transfer process 380
 electroosmotic flow 201
 electrophoresis 201
 electrophoretic characteristics of surfaces
 212
 electrophoretic mobility of the particle 200
 electrostatic interactions 262, 413
 embryonic stem cells 340
 Environmental Protection Agency (EPA) 3

enzyme immobilisation 375
 ethidium bromide-bridged, fluorescent
 mesoporous organosilica hybrid
 (EB-MOS) 384
 expanded bed adsorption (EBA) 424
 extended DLVO-theory 294–295
 extracellular polymer substances (EPS)
 286, 347
 extrusion-based direct ink writing (DIW) 73

f

fibrinogen 219
 field effect transistor (FET) 16
 filtration process 57
 first order expansion coefficients 210
 flattening routines 132
 fluid colloidal suspension (sol) 18
 fluorescence in situ hybridization (FISH)
 316
 fluorescence microscopy images 60
 Food-Borne Diseases (FBDs) 297
 food processing environments 297
 force spectroscopy 125
 free energy of adhesion 290
 free-swimming cells 284
 freeze gelation process 63–64
 fullerenes 348
 functionally graded materials (FGMs),
 processing 69
 fused deposition modelling (FDM) 74
 fused deposition of ceramics (FDC) 74

g

gas-water-oil separation 32
 gel-casting 59
 Gibbs energy 261
 glass electrodes 19
 glucose oxidase (GOx) 369
 glutaraldehyde (GA) 137, 354, 382, 413
 glutaryl-7-amino cephalosporanic acid
 acylase (GL-7-ACA acylase) 373
c-glycidoxypropyl-trimethoxysilane
 (GPTMS) 373, 377
 Gouy-Chapman (GC) model 197, 222
 gram-negative bacteria 297, 345

graphene 343
 graphene oxide (GO) 343
 hybrid system 380
 sheets 343
 graphene sheets 343
 grinding 52

h

hard corona 268
 healthcare-associated infections (HAI) 296
 hematite nanoparticles 236
 Henry's model 214
 heteropolyanions 374
 hexagonal mesoporous silica (HMS) 370
 hollow mesoporous zirconia nanocapsules
 19
 hot isostatic press (HIP) 54
 Hückel's formula 202
 human immunodeficiency virus (HIV) 390
 human serum albumin (HSA) 219
 hydration and hydrophobic forces 264
 hydrodynamic diameter of the particle 201
 hydrodynamic drag coefficient 205
 hydrogen bonds 263
 hydrophilic interaction liquid
 chromatography (HILIC) 17
 hydrophilic repulsive force 289
 hydrophobic attractive 289
 hydrophobic colloid suspensions 195
 hydrophobic interaction (HIC) 101
 hydrophobic zinc oxide surfaces 340
 hydrothermal activation 90
 hydroxyapatite beads 411
 hydroxyapatite chromatography 421
 hydroxyl groups 87
 hydroxylation 88
 hyper netted-chain closure 198

i

immunoglobulin G (IgG) 219, 221
 implant-associated infection (IAI) 296
 inductively coupled plasma-atomic emission
 spectroscopy (ICP-AES) 384
 inductively coupled plasma-mass
 spectrometry (ICP-MS) 384

inherent antibacterial properties, of carbon
 nanomaterials 341–343
 CNT 346–348
 fullerenes 348–350
 graphene 343–346
 DLC 351–352
 nanodiamond 350–351
 inhomogeneous materials 1
 injection moulding 56
 inkjet printing (IJP) 73
 inorganic-organic-hybrid material 99
 interfacial Gibbs free energy 290
 intracellular bioavailability 340
 ionotropic gelation 64
 iron oxide nanoparticles (IONs) 26
 isoelectric points (IEP) 9, 230, 270

l

laminar Poiseuille flow 206
 laminated object manufacturing (LOM) 74
 Langmuir isotherm model 418
 layer-by-layer (LbL) technique 244
 Lifshitz-van der Waals 289–291
 “ligand-less” base material (beads) 424
 linear superposition (LSA) method 199
 liquid-vapour surface free energy components
 291

m

macroscopic fluid velocity field 205
 matrix-assisted laser desorption/ionization
 (MALDI) 180
 mechanochemistry 52
 medical device-associated infections (MDAI)
 296
 mesopore channels 373
 mesoporous silica 26, 369
 mesoporous silica and organosilica-based
 biosensors
 applications of 381
 glucose sensing 381–383
 haemoglobin and myoglobin sensing
 382–384
 immunosensors 389–391
 for toxic gas sensing 386–387

- mesoporous silica and organosilica-based biosensors (*contd.*)
 for water quality monitoring 384–386
 functionalization of
 electrochemical biosensor 379–381
 immobilisation of, enzymes 375–379
 surface functionalization 373–374
- mesoporous silica materials 370
 for biosensor development 370–373
- mesoporous silica particles (MSPs) 382
- metal oxide particles 87
- methicillin resistant *S. aureus* (MRSA) 296
- methylene blue (MB) 380
- microbes 283
- microbial enzymes 345
- microbial fuel cells (MFCs) 2
- microbial surface thermodynamic theory 289, 292
- microbial thermodynamic theory 292
- microdevices 3
- microelectromechanical systems (MEMS) 3
- milling 52
- minimum bactericidal concentration (MBC) 296
- Minimum Information About a Biofilm Experiment (MIABIE) 312
- minimum inhibitory concentration (MIC) 296
- mixed ionic-electronic conducting (MIEC) ceramic-based membranes 54
- modified micromoulding technique 59–60
- molecular recognition 382
- molecularly imprinted polymers (MIPs) 382
- monoclinic titanium dioxide (B) 13
- monoclinic zirconia 17
- multifunctionality and heterogeneity 273
- multi-walled nanotubes (MWNTs) 346
- multiple gases sensors 387
- Murchinson carbonaceous chondrite 29
- myoglobin (Myo) 382
- n**
- N-acyl homoserine lacton (AHL) 286
- nano and microparticle suspensions 212
- nanodiamond 350, 351
- nanoparticle/electrolyte interfaces 193
- nanoscale secondary ion mass spectrometry (NanoSIMS) 316
- Near-Field Scanning Optical Microscopy (NSOM) 168
- negative temperature coefficient of resistance (NTCR) ceramic sensors 3
- negatively charged sulfonate polystyrene latex (S800) particles 215
- neutral surfactants 370
- NF70 membrane 229
- nicotinamide adenine dinucleotide (NAD⁺) 372
- nitrogen oxides (NO_x) 3
- N,N'-disalicylidene-4,5-diamino-6-hydroxy-2-mercaptopyrimidine (DSAHP) chelate 384
- N,N-dimethyldecylamine 372
- noble metal nanoparticles 195
- non-destructive physisorption 413
- non-equilibrium interaction forces 265
- non-molecularly imprinted polymers (NIPs) 382
- noncrystalline silicas 20
- nonmotile bacteria 284
- nordstrandite 8
- o**
- Ohshima's function 204
- organo-chemical functionalisation of, fullerenes 354
- organosilica 369
- organosilica-based biosensors 369
- orthorhombic crystalline structure 13
- osteosarcoma therapy 64
- outer membrane protein A (OmpA) 285
- oxidative stress 344, 350
- oxide ceramics 87–88
- oxygen plasma parameters 91
- p**
- Paramecium caudatum* 350
- particle covered surfaces 209, 234
- particle monolayers 193
- PEGylated gold nanoparticles 274

- PEGylated surfaces 272
 periodic mesoporous organosilicas (PMOs)
 371
 photocatalytic properties 350
 photoemission spectroscopy techniques (PES)
 161
 photopolymerisation 73
 photothermal effect 354
 piezo-ceramic transducers 128
 plasma deposited fluoropolymer (PDFP) 227
 plastic forming methods 54
 platinum nanoparticles (PtNP) 380
 PM_{2.5} 140
 Poisson-Boltzmann (PB) equation 195, 205
 poly(acrylic acid) layers 229
 poly(allylamine hydrochloride) 229
 poly(diallyldimethylammonium chloride)
 229
 poly(ethyleneimine) 229
 poly(l-glutamic acid) layers 229
 poly(lactic acid) coated MCM-41-type
 mesoporous silica nanosphere
 (PLA-MSN) 372
 polyaniline (PANI) modified platinum
 electrode 380
 polyelectrolyte modified surfaces 229
 polyethyleneimine 11
 polymer pyrolysis 48
 polymeric latexes 195
 polymeric shell 409
 polymeric surface functionalisation 271
 positively charged amidine polystyrene latex
 215
 powder synthesis and preparation 52
 chemical methods 52
 mechanical methods 52
 shaping method, plastic forming 55
 vapour-phase processes 52–53
 powder synthesis and/or preparation 49
 powder-based ceramic AM technologies 71
 precursor-derived ceramics (PDCs) 49
 primary minimum 294
 protein corona 139
 protein covered particles 219, 245
 protein immobilisation 25
 purification processes 23
 pyrolytic carbon 30
 pyrrolidinium 354
- q**
- quorum sensing (QS) 286
- r**
- Raman and infrared (IR) microspectroscopy
 166
 Raman microspectroscopy
 in metal/ceramic composites 179–180
 microlenses 173–175
 SiO₂/TiO₂ and hollow-shell titania
 resonators 175–179
 random sequential adsorption (RSA) kinetic
 model 240
 raw materials 47
 reactive oxygen species (ROS) 338
 recombinant albumin (rHSA) 245
 reduced graphene oxide (rGO) 343
 reversed-phase chromatography (RPC) 101
 robocasting (RC) 74
- s**
- sample-scanning microscopes 128
 Santa Barbara Amorphous-15 (SBA-15) 370
 scanning electron microscopy (SEM) 416
 secondary ion mass spectrometry (SIMS)
 165, 166, 316
 secondary minimum 294
 selective catalytic reduction (SCR) 55
 selective laser melting (SLM) 73
 selective laser sintering (SLS) 73
 self-assembly 414
 sensor devices 11
 shaping 50
 shaping method 53
 colloidal shaping 56–57
 freeze-casting 61–65
 gel casting 59–61
 slip casting 57–59
 sol-gel process 65–68
 tape casting 68–69
 plastic forming 54–57

shaping method (*contd.*)
 extrusion 54–55
 injection moulding 56
 pressing 53–54
 Shiga toxin (Stx) 297
 “ship-in-a-bottle effect” 377
 “sieving” effect 372
 silanisation 93
 silica 20
 application of 23–24
 catalysts 24–25
 properties of 20–22
 silica-based materials 23
 silicon carbide (SiC) 29
 silicon nitride (Si₃N₄) 29
 silicon oxide 20
 single-stranded DNA (ssDNA) 102
 single-walled nanotubes (SWNTs) 346
 sintering 51
 slip casting 57–59
 Smoluchowski’s equation 203, 214, 418
 soft corona 268
 sol-gel 48
 emulsions 24
 process 65–68
 solar hydrogen 14
 solid/electrolyte interfaces 193–194
 solvent-free chemical synthesis 52
 space charge density 195
 spacer 93
 sp² carbon nanomaterials 347
 specific interaction forces 264
 spherical carbon molecules 348
Staphylococcus aureus surface protein G (SasG) 286
 Stöber method 370
 static binding capacity (SBC) 418
 Static SIMS 165
 stearic acid 99
 stereolithography (SL) 73
 streaming current/streaming potential 194, 205
 superparamagnetic magnetite nanoparticles 53
 supra-macromolecular complexes 413

surface chemical analysis of ceramics
 Auger spectroscopy 162–163
 ceramic colloids and nanomaterials
 MALDI 180
 optical sensing and vibrational spectroscopy 169–170
 Raman microspectroscopy 173–175
 whispering gallery modes 171–172
 electrochemical methods 160
 electron spectroscopy 160–161
 Raman and infrared (IR) microspectroscopy 166–169
 SIMS analyses 165–166
 with XPS and Auger spectroscopy 163–165
 XPS and UPS 161–162
 Surface Enhanced Raman Scattering (SERS) effect 167
 surface functionalization 85, 261, 373–374
 surface hydroxyl groups 87
 surface modification 412
 biotechnological applications 100–102
 chemical activation strategies
 hydrothermal activation 90
 metal oxide particles 87
 oxygen plasma treatment 90–92
 surface hydroxyl groups 87
 wet chemical hydroxylation 88–90
 environmental applications 102
 functionalization levels for 86
 physical and (bio)chemical methods 85
 wet chemistry functionalization
 wet chemical non-silane functionalization 97–99
 wet chemical silanization 93–97

t
 tailoring antibacterial properties 353
 CNT 354
 fullerenes 354–355
 graphene 353–354
 diamond thin films 355–356
 diamond-like carbon 355–356
 nanodiamonds 355
 tape casting 68–69

- temperature-induced polyelectrolyte (TIP)
 grafting method 301
- tetraalkoxysilane precursor 370
- Tetrahymena thermophile* 350
- thermodynamic theory 289
- Thermus thermophilus* 415
- tip-scanning microscopes 128
- titania
 applications of 14–15
 for chromatography 16
 gas sensing 15–16
 structure and properties 12–14
- titanium dioxide (TiO₂) 12
- top-down methods 48
- toxic metal contaminants 381
- traditional ceramics 5
- transition aluminas (γ -Al₂O₃) 9
- transmission electron microscopy (TEM)
 416
- triblock copolymer surfactant 373
- triethoxysilanes (TES) 93
- trihydroxydes bayerite (α -Al(OH)) 8
- trimethoxysilanes (TMS) 93
- trimethylsilane (TMS) plasma nanocoatings
 300
- trinitrotoluene (TNT) 388
- tungsten carbide (WC) 30
- two-dimensional electrokinetic charge
 density 215
- two-photon polymerisation (TPP) 73
- U**
- ultrananocrystalline diamond (UNCD) 351
- Ultrogel® 415
- upstream processes 407
- V**
- van der Waals forces 261, 413
- volatile organic compound (VOC) 3, 12, 55
- W**
- water-based slurries 59
- water-in-oil microemulsion 52
- well-dispersed nanosheets 344
- wet chemical hydroxylation 88
- wet chemical non-silane functionalization
 97–99
- wet chemical silanisation 91, 93–97
- X**
- X-ray diffraction (XRD) 416
- X-ray fluorescence spectroscopy (XFS) 384
- X-ray photoelectron spectroscopy (XPS)
 160, 416
- Y**
- Yttria stabilised zirconia (YSZ) 18
- Z**
- zeta potential 202
- zinc oxide nanoparticles 340
- zirconia
 chromatography 18–19
 drug delivery 19
 pH sensors 19
 structure and properties 17–18
- zirconia or alumina membranes 54
- zirconia-based phases 411
- zirconium dioxide (or zirconia ZrO₂) 18
- zirconium orthosilicate 17
- zone of inhibition (ZOI) 312

