

Index

a

age-old pottery techniques 137
 agricultural fertilizers 9
 α -tricalcium phosphate (α -TCP), (α -Ca₃(PO₄)₂) 26
 amorphous calcium phosphates (ACPs) 27–29
 antimicrobial effect, CaPO₄ 38
 arachidic acid Langmuir monolayer system 101

b

BCP formulations
 – biphasic TCP (BTCP) 37
 – *in vitro* properties 37
 – multiphasic formulations, biomedical properties 38
 – triphasic formulations 38
 β -tricalcium phosphate (β -TCP), (β -Ca₃(PO₄)₂) 25
 bioactivity and biodegradation, CaPO₄
 – angiogenesis and vascularization 396
 – bone-resembling hierarchical organization 396
 – cell attachment and proliferation 392
 – hydrolysis reactions 391
 – polymer dispersion and solutions 400
 – stress-shielding atrophy prevention 391
 – tissue engineering 395
 – trabecular bone bonding 393
 bioceramics, CaPO₄
 – bone defects 136
 – chemical composition and preparation 135, 136
 – electric/dielectric and piezoelectric properties 162
 – forming and shaping 137
 – history 135

– mechanical properties 142, 159–161
 – microporosity 166
 – porosity 164, 165, 169, 170
 – preparation techniques 136
 – sintering/firing procedure 139, 140, 142
 – thermal stability 142
 – transparency 163
 biocomposites and hybrid biomaterials
 – α -TCP and β -TCP-based formulations 296, 297
 – apatite-based formulations 292, 293, 295, 296
 – biochemical composition, bones 263
 – bioorganic and inorganic domains 271
 – bioorganic compounds and/or biological macromolecules 309, 310, 312
 – biosensor 321, 322
 – CaPO₄-based IBS 312, 314
 – ceramic-plastic material 287
 – ceramic/polymer powder mixture 290
 – with collagen 304–309
 – co-precipitation and electrochemical co-deposition 290
 – filling and augmentation 298
 – glasses, inorganic compounds, carbon and metals 313, 315–320
 – hydrophilic PEG/vancomycin composite 298
 – inorganic self-setting CaPO₄ formulations (cements) hardening 299–301
 – *in situ* formation 290
 – material processing strategies 292
 – nanodimensional and nanophasic materials formulations 301–304
 – natural bone tissue repairment 298
 – with polymers 287–289
 bioglass[®] 280
 biological apatite 10

- biological properties and *in vivo* behavior, CaPO_4
 - bioactivity 211, 212, 214
 - biodegradation 209–211
 - cellular response 215–217
 - dissolution/precipitation phenomena 209
 - fracture healing 207
 - hematoma formation 207
 - inflammation 207
 - neovascularization 207
 - osteoclastic resorption 207
 - osteoinduction 207–209
 - tissues and host responses 205, 206
 - biomedical applications, CaPO_4
 - alveolar ridge augmentation 189
 - coatings, films and layers 196
 - FGMs 197, 200
 - immediate tooth replacement 189
 - ingrowth, fibrous tissue 189
 - maxillofacial reconstruction 189
 - mechanical limitations 189
 - orthopedics and dentistry 189
 - self-setting (self-hardening) formulations 196
 - types 195, 196
 - biomimetics
 - biological process 109
 - bone graft production 110
 - CaPO_4 -based biomaterials and bioceramics 121
 - chemical crystallization 110
 - classical crystallization theory 112
 - *in vitro* crystallization 110
 - of synthetic materials, biomedical applications 109
 - biomineralization, CaPO_4
 - antlers 80, 82
 - biological apatite 59
 - bone/osseous tissue, *see* bone/osseous tissue, CaPO_4 61
 - chemical composition 59
 - inorganic and bioorganic components 59
 - optical and X-ray analysis of bones 60
 - pathological calcifications 59
 - physico-chemical and crystallographic study, biological apatite 61
 - teeth, *see* teeth, CaPO_4 73
 - velvet shedding 81
 - biphasic calcium phosphate (BCP) 37
 - bone grafting, CaPO_4
 - chemical similarity 275
 - inflammatory foreign body response 277
 - inorganic materials and compounds
 - – carbon nanotubes 280, 281
 - – ceramics, metal oxide 280
 - – glasses and glass-ceramics 279, 280
 - – metals 279
 - osteoblast adhesion and proliferation 275
 - polymers 275, 276, 278
 - bone hierarchy 65
 - bone/osseous tissue, CaPO_4
 - acid phosphatase 69
 - atomic force microscopy 65
 - bioorganic matrix 68
 - blood cell formation 61
 - bone formation (ossification) and growth 67
 - bone graft substitutes 73
 - calcium balance 69
 - chemical mechanism 69
 - classification, shape 64
 - cortical bone specimens 64
 - electron diffraction studies 67
 - epitaxial growth mechanism 68
 - hierarchical organization 65
 - inorganic and bioorganic phases 62
 - inorganic phases 61
 - *in vivo* stress distribution 68
 - lamellar bones 62
 - locomotion 62
 - maturation mechanism 70
 - mechanical properties 64
 - medullar cavity 62
 - mineral composition 61
 - mineralized organic matrix 63
 - OCP transition phase 67
 - organic matrix-mediated 72
 - organic–inorganic composite nanostructure 66
 - osteoarthritis 68
 - osteocalcin 68
 - precipitated phase 70
 - programmed cell death (apoptosis). 67
 - regenerative medicine 68
 - remodeling process 68
 - SAXS and transmission electron microscopy studies 67
 - sizes and shapes 62
 - types 62
- c**
- calcium-deficient hydroxyapatite (*CDHA/Ca-def HA/CDHAp*), $(\text{Ca}_{10-x}(\text{HPO}_4)_x(\text{PO}_4)_{6-x}(\text{OH})_{2-x})$ ($0 < x < 1$) 29
 - calcium-deficient hydroxyapatite (*CDHA/Ca-def HA/CDHAp*), $(\text{Ca}_{10-x}(\text{HPO}_4)_x(\text{PO}_4)_{6-x}(\text{OH})_{2-x})$ ($0 < x < 1$) 30, 31

- calcium dihydrogen orthophosphate
 - anhydrous 22
- calcium dihydrogen orthophosphate monohydrate 18
- calcium hydrogen orthophosphate anhydrate, mineral monetite 23
- calcium hydrogen orthophosphate dihydrate, mineral brushite 22
- calcium orthophosphate bioceramics, medicine
 - biological processes 237
 - and biomaterials, trademarks 190–195
 - biomedical ceramics 132
 - biomimetic materials 132
 - bone augmentation 127
 - CaPO₄-based formulations 127
 - chemical elements 127
 - clinical applications 131
 - composites 127
 - cranio-maxillofacial reconstruction 127
 - dental fillings and periodontal treatments 127
 - drug-delivery capability 132
 - fracture treatment 127
 - HA bioceramics 169
 - healing of bone defects 127
 - health care 127
 - health care domain 131
 - hierarchical pore size distribution 233
 - implantation, HA surface 214
 - linear shrinkage, ACP powders 141
 - living systems 131
 - materials science and engineering 254
 - material synthesis and processing 131
 - ophthalmology 127
 - orthopedics 127
 - osteoconductive bioceramics 254
 - otolaryngology 127
 - plasma-sprayed HA coating 198
 - pore-graded bioceramics 199
 - porosity 236
 - self-assembling/nanofabrication 255
 - sintering 140
 - spinal surgery 127
 - 3D printing 138
 - tissue replacements 132
 - total joint replacement 127
 - transparent HA bioceramics 163
 - types, ceramic porosity 166
- calcium orthophosphates (CaPO₄)
 - ACP structure 29
 - adult human calcified tissues 11
 - atomic arrangement 5
 - biological apatite 60
 - biological mineralization, *see* biomineralization, CaPO₄ 59
 - in biological systems (human) 100
 - chemical composition 3
 - chemical elements 3
 - chemical/physical weathering 8
 - classical solubility phase 21
 - crystallographic data 19
 - geological and biological occurrences, *see* geological and biological occurrences, CaPO₄ 7
 - *in vivo* mineralization of a collagen fibril 71
 - mammalian bone 63
 - natural FA 9
 - pathological calcification, *see* pathological calcification, CaPO₄ 99
 - and properties 4
 - surface-directed mineralization 102
 - and technological and scientific uses, apatites 10
 - types 20
- CaPO₄-based bulk bioceramics 142
- CaPO₄-containing biocomposites
 - alloplastic/synthetic bone grafts 261
 - biological calcified tissues 262
 - bone growth 263
 - bone tissue repair 262
 - complex composite 270
 - continuous and dispersed phase 269
 - covalent bond formation 375
 - degradation kinetics 263
 - elastic collagen fibers 262
 - fabrication technologies 264
 - FTIR 376
 - graded composite 270
 - healing process 271
 - hierarchical composite 270
 - immunogenicity 261
 - *in vivo* mechanisms, tissue regeneration 264
 - lint-reinforced plaster 264
 - organic-inorganic hybrid biomaterials 264
 - simple composite 270
 - strain shielding 263
 - tissue transplantation 261
 - traumas/natural aging 261
 - xenografts 261
- CaPO₄ tribasic beta/tricalcium bis(orthophosphate) beta) 25
- cellular biodegradation, CaPO₄ bioceramics 216
- clinical implantology 131
- computer-aided design and manufacturing (CAD/CAM) 137

- computer-modeling techniques 35
 co-precipitation technique 381
 cryogenic energy-dispersive X-ray spectroscopy 70
 crystallization, dissolution and phase transformation processes, CaPO_4 17
- d**
 decalcium oxide hexakis(phosphate), mineral voelckerite 35
 deer antlers 80, 81, 83
 dentine-enamel junction (DEJ) 78
 diary industry, DCPD 23
 dicalcium phosphate anhydrous (DCPA/DCP), CaHPO_4 23
 dicalcium phosphate dihydrate (DCPD), $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ 22–23
 Dulbecco's modified Eagle's medium (DMEM) 111
- e**
 Eagle's minimum essential medium (MEM) 111
 Earle's balanced salt solution (EBSS) 111
 enamel formation/amelogenesis 79
 energy-dispersive X-ray spectroscopy analysis 298
 European classification of food additives 17
 ϵ -caprolactone monomer 295
- f**
 FDA approved biodegradable polymers 277
 fluorapatite (FA/FAP), $(\text{Ca}_5(\text{PO}_4)_3\text{F}/\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2)$ 33, 34
 formation process, enamel 77
 Fourier-transformed infrared (FTIR) spectra 375, 377
 freeze-drying method 308
 functionally gradient materials (FGMs) 197, 200
- g**
 geological and biological occurrences, CaPO_4
 – apatites 7
 – biological liquids 11
 – crystallographic defects 8
 – food industry 17
 – francolite 7
 – human bones 10
 – lattice flexibility 10
 – morphology of precipitates 9
 – in primitive organisms 9
 – solubility isotherms 17
 – spherulitic clusters 8
 – triprotic equilibrium 17
 – types 7
- h**
 HA bioceramics 32, 38
 HAPEX™™ 289
 high resolution elastic modulus mapping 78
 hydrothermal hot pressing method 142
 hydroxyapatite *HA/HAp/OHAp*, $(\text{Ca}_5(\text{PO}_4)_3(\text{OH}))$ 31, 32
- i**
 injectable bone substitutes (IBS) 312
in vivo experiments inflammatory reactions 207
 ion-substituted CaPO_4 38
- k**
 Kramers-Kronig equation 376
- l**
 low-dose selected-area electron diffraction technique 70
- m**
 monocalcium phosphate anhydrous (MCPA/MCP), $(\text{Ca}(\text{H}_2\text{PO}_4)_2)$ 22
 monocalcium phosphate monohydrate (MCPM), $(\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O})$ 18
- n**
 non-biomedical applications, CaPO_4
 – chemical similarity 227
 – surface acidity/basicity 227
 noninvasive X-ray microtomography 68
- o**
 octacalcium bis(hydrogenphosphate) tetrakis(phosphate) pentahydrate 24
 octacalcium phosphate (OCP), $(\text{Ca}_8(\text{HPO}_4)_2(\text{PO}_4)_4 \cdot 5\text{H}_2\text{O})$ 24
 orthophosphate-based apatites 32
 osteogenesis 207
 osteoinductive CaPO_4 bioceramics 208
 oxyapatite (OA/OAp/OXA), $(\text{Ca}_{10}(\text{PO}_4)_6\text{O})$ 35
- p**
 pathological calcification, CaPO_4
 – ageing 99
 – apatite diseases 100
 – biochemical processes 101
 – biological apatite precipitation 101
 – chronic renal disease 99

- DCPD 101
- hyperparathyroidism 99
- intestinal calcium absorption 100
- massive bone destruction 99
- metastatic 99
- non-osseous viable tissue 99
- nucleation process 101
- occurrence, non-apatite phases 100
- physiological biomineralization 99
- plasma-sprayed coatings of CaPO_4 35
- poly(α -hydroxyesters) 278
- polydioxanone 276
- polyphosphazenes 276
- preparation techniques of OCP 24
- protein-free acellular simulated body fluid (SBF) 111

r

- Raman spectroscopic indications, OCP precursor phase 70
- revised SBF (rSBF) 112
- rheumatoid joint synovitis, HA 38

s

- scanning probe microscopy 380
- skeletal tissue regeneration 276
- solid-state pressureless sintering 141
- solid-titration approach 17
- super-phosphate of lime 18
- surface grafting polymerization, ethylene glycol methacrylate phosphate 380
- surface induced nucleation 67

t

- teeth, CaPO_4
 - AFM study 76
 - biological apatite 73
 - cellular control 78
 - cementoblasts 77
 - dental abrasion and attrition 79
 - dental enamel 75
 - dental follicle 77
 - dentine and cementum 74
 - fibroblasts 77
 - *in vivo* formation and development 77
 - nano-indentation technique 79
 - osteoblasts 77
 - primary function 73
 - structural hierarchy 75
 - structure 74
 - thermogravimetric studies 78
 - types 73
- template-assisted colloidal processing technique 165

- tetracalcium hydrogen orthophosphate diorthophosphate pentahydrate 24
- tetracalcium oxide bis(orthophosphate), mineral hilgenstockite 36
- tetracalcium phosphate/tetracalcium diorthophosphate monoxide (TTCP/TetCP), $(\text{Ca}_4(\text{PO}_4))$ 36
- tetra-hydrogen calcium phosphate, $\text{H}_4\text{Ca}(\text{PO}_4)_2$ 22
- thermal printing process 137
- thermodynamic properties, HA 32
- thermoplastics 278
- time and energy efficient densification techniques 142
- tissue engineering, CaPO_4 bioceramics
 - applications 237
 - bioceramic scaffolds 235
 - biochemistry 232
 - bioengineering and clinical research 232
 - bone regeneration 238
 - cell and molecular biology 232
 - clinical application 238
 - grafting 231
 - healthcare technology 231
 - *in situ* regeneration 237
 - manufacturing procedures 167, 168
 - material sciences 232
 - organ transplantation 231
 - osteoinductivity 237
 - scaffolds and their properties 232, 233
 - self-hardening formulations 234
 - synthetic materials 231
 - therapeutic strategies 237
- transmission electron microscopy (TEM) 381
- tricalcium diorthophosphate beta 25
- triclinic structure of OCP 24
- two-step sintering (TSS) 142

w

- water inclusions, DCPA 23

x

- X-ray absorption spectroscopic data (EXAFS) 29
- X-ray diffraction 380
- X-ray diffraction technique 37
- X-ray photo-electronic spectroscopy (XPS) technique 378, 379

y

- Young's (or elastic) modulus, HA 161

