

Index

a

- ALD, *see* atomic layer deposition (ALD)
- atomic force microscopy (AFM) 46, 201–203, 205
- atomic layer deposition (ALD) 123
 - applications 137
 - catalytic ALD 127–128
 - CNTs 131
 - conformal Ru thin film 135
 - Ho_2O_3 – TiO_2 nanolaminates 132
 - merits 131, 136
 - metal ALD 129–130
 - nanofilms 132
 - nanostructured templates 132–135
 - pore structures 135–136
 - reaction mechanisms 125
 - schematic representation 124
 - thermal ALD 125–127
 - TiO_2 nanofilms 132

b

- Bi_2O_3 nanocones 64
- bit aspect ratio (BAR) 256
- bit patterned media (BPM) 254–256, 258–261

c

- C-doped GST (GSTC) films
 - properties and microstructure 272, 274
 - reverse phase change 274, 276
- carbon nanotube (CNT)–polymer composite 294, 295
- carbon nanotubes (CNT)
 - ALD 131
 - aligned array 110–111
 - controllable growth 108–110
 - CVD process 106–108
- catalytic ALD 127–128
- chemical solution deposition (CSD) 244
 - coating
 - – dip 162
 - – nebulized droplets 163
 - – spin 162
 - – spray 163
 - nano structural thin films
 - – MOD method 168
 - – PAD, *see* polymer assisted deposition (PAD)
 - – sol–gel technique 167–168
 - precursor solution
 - – chemical strategies 160
 - – MOD 161
 - – PAD 161–162
 - – sol–gel method 160–161
 - process steps 159
 - thermal treatment 163–164
 - thin film microstructure
 - – epitaxial growth 166–167
 - – thermodynamics 164–166
- chemical vapor deposition (CVD)
 - CNTs
 - – aligned array 110–111
 - – controllable growth 108–110
 - – process overview 106–108
 - graphene synthesis
 - – process overview 112–113
 - – quality control 113–115
 - TMDs
 - – growth control 118–119
 - – process overview 115–118
 - – types 105
 - chemoepitaxy 256
- CNT, *see* carbon nanotubes (CNT)
- coercivity 241

- coercivity reduction
- AFM images
 - - CD master 245
 - - NiFe₂O₄ thin films 246
 - - PDMS stamp 245
 - magnetic domain structure 249
 - magnetic hysteresis curve 247, 248
 - nanopatterning surface films 247
 - single and multilayered thin films 249
 - SQUID 247
 - X-ray diffraction (XRD) 246
- combinatorial PLD 24
- complex oxide thin films
- applications 1
 - PLD, *see* pulsed laser deposition (PLD)
 - sputtering 75
- composite metal oxide thin films 75
- continuous flow-type microwave reactor 146, 147
- continuous granular media (CGM) 253
- core–shell upconverted nanoparticles (UCNPs)
- architectures 147, 148
 - multi shell
 - - coupling with plasmonics 154, 156
 - - layer-by-layer way 153
 - - mesoporous silica coating 153
 - single shell
 - - cation exchange reaction 152
 - - Ostwald ripening 151–152
 - - seed-mediated liquid-phase epitaxial growth 150, 151
 - types 148, 149
- curved-lattice epitaxial growth (CLEG) technique 71, 72
- CVD, *see* chemical vapor deposition (CVD)
- d**
- density multiplication 256
- diamond nanocones 70
- Diels–Alder photo polymerization 217
- dip-pen lithography (DPL) 205–206
- direct-writing nanolithography
- DPL 205–206
 - EBL 195–198
 - FIB 198–199
 - gas-assisted electron and ion beam lithography 200–201
 - SPM lithography 201–204
- discrete track media (DTM) 254
- domain wall movement 243
- double lithographic patterning 257
- dynamic random-access memory (DRAM) 267
- e**
- E-beam lithography (EBL) 256
- E-chip 183
- e-type electron gun 35, 38
- electron beam deposition
- modes 34
 - principle 33
- electron beam evaporation deposition 34, 38
- advantages 36–37, 53
 - attention and warning 45
 - electron gun cooling 43
 - heating principle 35–36
 - instrumental system 37
 - - beam control 38–39
 - - crucibles and feed systems 40
 - - filament and electron emission 37–38
 - - power supply 39–40
 - - source materials 40–43
 - - source material evaporation 42–44
 - - thin films 45–46
 - - AFM 46–47
 - - thickness 47–52
 - vacuum deposition process 44–45
- electron energy loss spectroscopy (EELS) 184
- electron-beam lithography (EBL) 195–198
- electron-beam-induced deposition 34, 43, 53
- ellipsometry
- angles *vs.* wavelength 48, 49
 - definition 47
 - effective optical constants 51, 52
 - measurement principle 47
 - parameter fitting spectra 51
 - transmittance method 50
- energy-dispersive X-ray spectroscopy (EDS) 184
- ethylene diamine tetraacetic acid (EDTA) 161
- f**
- ferromagnets 241, 242
- flexible electronics
- bio-integrated circuits 298–300
 - Co₃O₄ nanofilms 287–289
 - concept 285
 - printing 293–294
 - - electrospun ultrathin fibers 295
 - - gold nanotroughs 297, 298
 - - screen printing 294
 - - supercapacitor 295–297
 - TiO₂ nanofilms 286, 287
 - transfer printing technique 290–293
 - ZnO nanorods 289, 290
- focused ion beam (FIB) lithography 198–199

- Frank-van der Merwe film growth mode 7
fused deposition modeling (FDM) 211, 212
- g**
gas-assisted electron and ion beam lithography 200–201
 $\text{Ge}_2\text{Sb}_2\text{Te}_5$ (GST)
– GSTC, *see* C-doped GST films
– GSTN material 270, 271
– phase change material 268–270
graphene synthesis
– CVD process 112–113
– growth control 113–115
– *in situ* liquid analysis 182, 183
graphitic C_3N_4 nanocone array 66
graphoepitaxy 256
- h**
hard disc drive (HDD) 251, 252
heat assisted magnetic recording (HAMR) 254
 $\text{Ho}_2\text{O}_3-\text{TiO}_2$ nanolaminates 132
Hummingbird Scientific 183, 184
hydrogels 217
- i**
InAlN nanorods 68
InAs/GaAs QD structure
– AFM image 102
– band profile 101, 102
inductively coupled plasma atomic emission spectroscopy (ICP-AES) 161
inductively coupled plasma optical emission spectrometer (ICP-OES) 172
in situ liquid cell transmission electron microscopy
– commercial liquid cells 183–185
– nano material development
– – electrodeposition and electropolishing 185–187
– – gold nanoparticles 190–191
– – irradiation 187–190
– schematic illustration and photograph 180, 181
– technological development 180–183
island film growth mode 6, 7
- l**
 $\text{LaBaCo}_2\text{O}_{5+\delta}$ (LBCO) thin film 15, 17
– post-annealing effect 21, 22
– resistivity *vs.* temperature 16–19
– substrate effect 18, 19
– thickness effects 16, 17
– thin-film/substrate mismatch 20
LaNi₅ alloy thin films 73
laser ablation 4
laser MBE 83
layer by layer film growth mode 6, 7
layer plus island film growth mode 7
liquid phase epitaxy (LPE)
– core-shell structures, *see* core-shell structures
– definition 141
– hydrothermal method 141
– – development 142
– – MAHT, *see* microwave-assisted hydrothermal synthesis (MAHT)
longitudinal magnetic recording (LMR) 251, 252
- m**
magnetic dipoles 241, 242
magnetic domains 242, 249, 251, 252, 254
magnetic force microscopy (MFM) 249, 250
magnetic recording trilemma 253
magnetic thin films 239–240
– high-frequency devices
– – coercivity 242–243
– – ferromagnets 241–242
– – magnetic losses 243
– – manufacturing considerations 244–245
– – nanoscale loss reduction 244
– information storage
– – BPM 254–255
– – disk drive 251
– – LMR 251, 252
– – manufacturing considerations 255–256
– – patterned media storage, *see* patterned media storage
– – PMR 252
– – present day solutions 254–255
– – SNR 253
– – superparamagnetic limit 252–253
MBE, *see* molecular beam epitaxy (MBE)
medical grade ABS (MABS) 211
mesoporous silica coating 153
– calcination method 153
– etching method 154
– organic template method 153
metal ALD 129–130
metal dichalcogenides, *see* transition metal dichalcogenides (TMDs)
metal-organic deposition (MOD) 160, 161
metallic SWCNT 110
methane/hydrogen low-pressure CVD 114

- microwave-assisted hydrothermal synthesis (MAHT)
 - aqueous solution 144–147
 - – Ag nanoparticles 145, 146
 - – water 144, 145
 - titania gel spheres 143–144
- mixed ionic/electronic conductors (MIEC) 224
- molecular beam epitaxy (MBE) 81
 - growth mechanisms 91
 - oxide heterostructures
 - – magnetic anisotropy 96
 - – semiconductors 91
 - QDs 101–103
 - RHEED 82–86
 - ultrahigh vacuum (UHV) conditions 82, 83
- MoO₃ nanowires 63
- multi-jet modelling (MJM) 214
- multi-photon polymerization (MPP) 214, 217
- multi-wall carbon nanotube (MWCNT) 106, 108
- n**
- N doped GST film (GSTN) 270
- nanoimprint lithography (NIL) 245–247, 256, 258
- natural polymers 217
- needle-shaped MoO₃ nanowires 63
- Néel–Arrhenius equation 253, 254
- NiFe₂O₄ thin film fabrication procedure 245
- Ni–Mn–In alloy thin films 74
- NIL, *see* nanoimprint lithography (NIL)
- nonvolatile memory (NVM) technology 267
- o**
- O-ring sealed *in situ* liquid 180
- Ostwald ripening 108, 151–152, 189
- p**
- parallel stripe domain 243–245, 249
- pattern rectification 256
- patterned media storage
 - bottom-up approach 256
 - chemoepitaxy 256
 - EBL 256
 - graphoepitaxy 256
 - limitations 261
 - magnetic dots 258, 259
 - NIL 258
 - PS-*b*-PMMA 257, 258
 - recording performance 259
 - submasters 258
 - top-down approach 256
- Pechini method 161
- perpendicular magnetic recording (PMR) 252
- phase change random access memory (PCRAM) 267–268
- GST, *see* Ge₂Sb₂Te₅ (GST)
- TiSbTe, *see* TiSbTe (TST) materials
- PLD, *see* pulsed laser deposition (PLD)
- polydimethylsiloxane (PDMS) 245
- polyethylene glycol (PEG) 217
- polymer assisted deposition (PAD) 161, 162, 169, 174
- carbon nanotubes 171
- self-assemble nano-composite oxide 172, 173
- SiO₂ nanoparticles 170
- surface pattern substrate 173
- XRD 168
- polymethylmethacrylate (PMMA) 195, 197
- polystyrene-block-poly(methyl methacrylate) (PS-*b*-PMMA) 257, 258
- Protobips Inc. 183
- PS-*b*-PMMA, *see* polystyrene-block-poly(methyl methacrylate) (PS-*b*-PMMA)
- pulsed laser deposition (PLD)
 - advantages 3
 - application 1
 - as-grown film parameters
 - – background gas pressure 10
 - – laser fluence and ablation area 11
 - – lattice misfit 12
 - – post-annealing 12
 - – substrate temperature 10
 - – target–substrate distance 11–12
 - complex oxide thin film growth
 - – ferroelectric system 14
 - – ferromagnetic system 15
 - – multiferroic materials 15
 - – nanoscale ordered arrays 23
 - – post-annealing 21
 - – self-assembled nanoscale structure 23
 - – substrate effects 17
 - – superconductor 14
 - – thickness effects 16
 - – disadvantages 3
 - – growth kinetics studies
 - – RHEED 8
 - – SXRD 9
 - – laser–material interactions 4
 - – plasma dynamics 5
 - – schematic diagram 2
 - – system setup 1, 2
 - – thin film nucleation and growth 5
 - – variants 24

q

quantum dots (QDs) 101–103

r

rapid thermal annealing (RTA) 163

reactive plasma/ion etching 59

reflection high energy electron diffraction (RHEED)

- MBE 82, 84–86
- PLD 8

remnant magnetization 241

resistively heated evaporation 33

reverse micelle microemulsion 153

RHEED, *see* reflection high energy electron diffraction (RHEED)

s

scanning probe microscopy (SPM) lithography 201–204

scanning tunneling microscopy (STM) 201–203

selective deposition lamination (SDL) 212, 213

selective laser sintering (SLS) 213

semiconducting SWCNT 110

shingled recording 254, 255, 260

sidewall spacer doubling 257

signal-to-noise ratio (SNR) 253

silicon nanocones 70

silicon-on-insulator (SOI) wafer 292

single-wall carbon nanotube (SWCNT) 106, 108

sol–gel method 160–161

solid oxide fuel cells (SOFCs)

- fabrication

- – fuel cell testing 231–234

- – LSCO films 227, 229, 230

- – vapor deposition 227

- – YSZ film on nickel foil 225

- principle 223, 225

- stack development and testing 234, 237

solid-source MBE 84

spacer defined double patterning 257

spectral-domain optical coherence

- tomography 294

sputter deposition process

- BiFeO₃/BaTiO₃ bilayer thin films 75

- Bi₂O₃ nanocones 64

- graphitic C₃N₄ nanocone array 66

- InAlN nanorods 68

- LaNi₅ alloy thin films 73

- nanostructures, mesoscopic properties of 60

- needle-shaped MoO₃ nanowires 62

– Ni–Mn–In alloy thin films 74

– work mechanism 59, 60

Stöber method 153, 154

stereolithography (SL) 210–211

Stranski–Krastanov growth 7, 87, 90

superconducting quantum interference device (SQUID) 247

superparamagnetic limit 252, 253

surface X-ray diffraction (SXRD) 9

SWCNT, *see* single-wall carbon nanotube (SWCNT)

SXRD, *see* surface x-ray diffraction (SXRD)

synthetic hydrogels 217

t

thermal ALD 125–127

three-dimensional (3D) MBE growth mechanism 87, 88

three-dimensional (3D) printing process 210

- applications

- – daily consumption 219

- – industrial manufacturing 218, 219

- – limitations 219

- – medical 217, 218

- – MPP 214, 217

- – types

- – – FDM 211

- – – inkjet printing 214

- – – MJM 214

- – – SDL 212, 213

- – – SL 210, 211

- – – SLS 213, 214

Ti doped Sb₂Te films 277, 278

Ti doped Sb₂Te₃ materials 278, 280

TiO₂ nanofilms 132

TiSbTe (TST) materials

- reversible phase change 280, 282

- Sb₂Te films 278

- Sb₂Te₃ materials 278, 280

- Sb₂Te films 277

transition metal dichalcogenides (TMDs)

- growth control 118–119

- process overview 115–118

two-dimensional (2D) MBE growth mechanism 87

two-photon absorption 215

v

Volmer–Weber film growth mode 6, 7

von Guericke-type oil-sealed piston vacuum pumps 59

y

yttria stabilized zirconia (YSZ) 223,

225–227, 229, 230, 232, 233

