

Index

a

acetocell procedures 46
 acetosolv method 46
 acetylated cell wall (Ac-CW) 47
 acetylated Spruce MWL, ^1H chemical shifts
 of 56, 57
 acid-catalyzed $\text{C}_\beta\text{-OAr}$ bonds cleavage
 acid-mediated lignin
 depolymerization 250–253
 acid-promoted tandem process 260–263
 lignin acidolysis
 with homogeneous metal salts and
 organic metal compounds 255–258
 with liquid acid catalysts 253–255
 with solid acid catalysts 258–260
 acid-catalyzed condensation 381–382
 acid-catalyzed systems, for ether bond
 cleavage 147
 acid-mediated lignin
 depolymerization 250–253
 acidolysis-hydrogenation tandem pathway,
 for lanthanide triflate/Pd-mediated
 ether bond cleavage 148–149
 acid-promoted tandem process, for lignin
 $\text{C}_\beta\text{-OAr}$ bonds cleavage 260–263
 acid-treated mesoporous MCM-41 molecular
 sieves 260, 397
 adjacent functional group modification
 (AFGM) 137, 138, 220
 Adler's model 28
 Alcell[®] method 45
 alcohol(butanol)-pretreated lignin
 linkages 373
 alkali lignin 40, 52, 258, 387
 alkaline α -aryl and β -aryl ether bonds
 cleavage 243

alkali-promoted condensation reactions,
 with formaldehyde and ketone
 fragments 244
 alkyl-aryl ether bonds 33
 alkyl-free phenols, one-pot preparation
 of 424–425
 4-alkylphenols 426
 alkylphenols, catalytic upgrading
 of lignin 420
 ammonia fiber explosion (AFEX)
 process 53
 aryl alkyl ether conversion 156, 157
 aryl ethers, dealkylation/debenzylation
 of lignin 172
 ASAM pulping 46

b

base-catalyzed $\text{C}_\beta\text{-OAr}$ bond cleavage
 base-mediated lignin depolymerization
 mechanism 241–247
 base-promoted tandem process 247–250
 base-catalyzed condensation 50, 382–384
 base-mediated lignin depolymerization
 mechanism 241–247
 base/organometallic systems 8, 140,
 155–161, 180
 base-promoted tandem process, for $\text{C}_\beta\text{-OAr}$
 bond cleavage 247–250
 Battelle-Geneva process 46
 Beech MWL, ^1H chemical shifts of, 56, 57
 Beech wood lignin, structure model
 of 28, 29
 benzene production 427
 BHT (2,6-bis(1,1-dimethylethyl)-4-
 methylphenol) synthesis method 200

- biomass-derived lignin, noble-metal catalyzed hydrodeoxygenation of 150–151
- bio-oil 90, 152, 152, 167, 178
- 2,2'-biphenols, C(aryl)–C(aryl) bonds catalytic activation 228–229
- Birch lignin, solubility of 85
- Bobbitt's salt 202, 203
- bond dissociation enthalpy (BDE) of C_α–C_β bond 136 of linkage bonds 135–136
- β–O-4 bond protection mode 84, 139
- bottom-up approach 8, 88–89
- Brauns lignin 40
- Brauns Native Lignin (BNL) 43
- Brønsted/Lewis acid + metal systems 140, 147–155, 180
- Brown-Rot lignin 49
- butanosolv process 372
- C**
- carbohydrate hydrolysis with bio-enzyme 48–49 with metal ion and oxidant 48 with mineral acid 47–48
- C–Ar bonds, direct hydrogenative cleavage of 9, 140, 147–155, 161–170, 180
- Carbon Spectra (¹³C NMR) 56–58
- Cascaded mode, for lignin conversion 8, 137, 139, 145, 247
- catalytic C–OAr bond hydrogenolysis, of methyl phenyl ether 159
- catalytic conversion, of lignin 83, 91, 247, 250, 258, 259, 317, 334, 368, 431
- catalytic fast pyrolysis 151–152, 259
- catalytic lignin decomposition, to benzene 427–428
- catalytic oxidation, of syringyl alcohols 191
- catechol 67, 70, 245, 261, 401, 418, 422, 430
- Catechyl lignin (C-lignin) 400–401, 415, 418–419 normal lignin structure and benzodioxane structure 400–401
- C_α defunctionalization-hydrogenation strategy 391
- cellulolytic enzyme lignins (CEL) 48–49
- chemical oxidation methods 90
- ¹³C–¹H HSQC (heteronuclear single-quantum correlation spectrum) 58
- chromatography technology 429 hydrogenolysis monomer yields of 418–419
- C_β–OAr bond cleavage dehydroxylation-hydrogenation strategy for 392
- cobalt salen ([Co(salen)]) complexes 190
- C–O bond hydrogenolysis of methyl phenyl ether (PhOMe) 158, 159 of diphenyl ether 156, 158
- CO₂ explosion (CDE) 53
- C_α–OH heterolysis acid-catalyzed C_β–OAr bonds cleavage 250–263
- C_αO–H heterolysis base-catalyzed C_β–OAr bond cleavage 241–250
- Co@Nb₂O₅@Fe₃O₄ catalysts 154–155
- coniferaldehyde coupling with lignin fragment 27
- coniferyl alcohol 15, 16, 18–21, 23–26, 28, 189, 383
- coniferyl alcohol, dehydrogenation of lignin β–β linkage in resinol structure 24–25 lignin β–O-4 linkage 23–24 lignin β-5 and α-O-4 linkage 23–24 lignin 4-O-5 linkage 24–25 lignin 5-5 linkage 24–25
- coniferyl alcohol glucoside 20
- copper–N-heterocyclic carbene-catalyzed aerobic cleavage, of β-1 lignin models 372
- C_α–OR alkaline bond cleavage 383
- Co-Schiff base catalysts 195
- Cp*Ir-bipyridonate system 370
- β-1 cross-coupling mechanisms 25, 26
- CuCl/TEMPO-promoted deformylation mechanism 211, 373
- Cu-doped porous metal oxide catalyst 247
- cuoxam lignin 48
- cuproxam lignin 48
- d**
- defunctionalization, of lignin depolymerization monomers 419
- demethylation, of lignin 67
- DFRC (derivatization followed by reductive cleavage) method 252, 294, 295, 391, 392
- diaryl ether bond cleavage 178
- dibenzodioxocin unit formation 26, 30
- 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) 65, 225, 226, 291, 296, 320

9,10-dicyanoanthracene (DCA)
 photocatalyst 215, 216
 α,γ -diol lignin stabilization
 strategies 388, 389
 dioxane (acidolysis) lignins (DL) 45
 direct hydrodeoxygenation, of woody
 biomass 153
 direct hydrogenative ether bond cleavage
 base/organometallic systems
 for 155–161
 Brønsted/Lewis acid + metal systems
 for 147–155
 direct reductive ether bond cleavage
 with hydride reagents 170–177
 direct reductive lignin ether bond cleavage
 with e^- 178–179
 dye-sensitized photoelectrochemical cell
 (DSPEC) system 201, 202, 304
 photocatalytic chemoselective C–C bond
 cleavage 202

e

electrocatalytic hydrogenation (ECH), of
 β -O-4 lignin model
 compounds 178, 337
 electrocatalytic systems via aryl
 cation radical
 lignin C_α - C_β bonds
 cleavage 213–214
 electrochemical aminoxyl-mediated
 oxidation, of primary
 alcohols 370, 372
 electrochemical cleavage, of aryl
 ethers 179
 electrochemical conversion, of spruce
 lignosulfonate 199
 electrochemical lignin
 depolymerization 199
 electron spin resonance (ESR) absorption
 spectroscopy, of lignin 61, 308
 electro/photo-electro systems
 lignin C_α - C_β / C_{Ar} - C_α bonds
 cleavage 198
 enzymatic mild acidolysis lignin
 (EMAL) 49
 α , β ester structure generation 27
 ethanol-soluble lignin 87
 ether bond cleavage
 catalytic lignin 169
 lanthanide triflate/Pd-mediated 149
 stoichiometric reactions for
 C–O 147–148
 ether bonds, direct hydrogenative cleavage
 of 147–155

f

Fengel lignin 48
 ferulic acid 18, 422
 O- and C-dealkylation of 422
 Formacell pulping process 46
 formaldehyde-blocked lignin
 condensation 389–390
 formaldehyde stabilization method 84,
 139, 388–389
 Fourier transform infrared spectroscopy, of
 lignin 53–54
 fragmentation–hydrogenolysis
 process 85–87
 Fredenhagen lignin 47
 Freudenberg lignin 48

g

gel-permeation chromatography
 (GPC) 41, 42, 292
 glass transition temperature, of lignin 42
 guaiacyl models, catalytic oxidation
 mechanism of 195–196

h

halogenation reaction, of lignin 68
 Halse lignin 47
 hardwood lignin structure models 28
 hardwood MWLs 44
 HAT-DSPEC process 201
 hemiacetal (hemiketal) strategy 220, 221
 hemicellulose 5, 15, 33, 34, 42, 47, 48, 52,
 53, 82, 163, 255, 260, 261, 334, 368
 herbaceous plant lignin, structure models
 of 32–33
 heteropoly acids (HPAs) 253, 263
 high-boiling-point solvent (HBS) method 47
 high-performance size-exclusion
 chromatography (HPSEC) 42
 $^1\text{H-NMR}$ 56, 58
 HPA-5 catalyzed oxidative cleavage, of
 non-phenolic β -O-4 bonds 211
 HTC-based materials 248
 hybrid CuO_x /ceria/anatase ($\text{CuO}_x/\text{CeO}_2$ /
 TiO_2) nanotube catalyst 363
 hydrogenation 6, 7, 9, 62, 65, 82, 85, 90, 99,
 135, 139, 164, 168, 220–225, 277–307,
 332–338, 350, 389, 418, 425
 hydrogenation-oxidation-decarboxylation
 strategy 425
 hydrogenolysis
 of diaryl ether C–O bonds 167–168
 of lignin-derived aromatic
 ethers 150–151
 of lignins 65, 151, 169, 248, 289, 426

5-hydroxyconiferyl alcohol incorporation
mechanism 26
hydroxymethylation reaction, in lignin 69

i

inert aryl C–O bonds, selective reductive
cleavage of 173–174
in-situ aldehyde intermediates
conversion 394–395
in situ conversion, of reactive aldehyde
intermediate 394
in-situ membrane extraction, of reactive
fragments 393, 399
inverse disassembly analysis (IDA), for
lignin conversion 8, 133–135, 137,
140, 145
ionization difference spectrum (ΔE_i
spectrum) 55, 56

k

Klason lignin 47, 388
Kraft lignin 49
electrodegradation of 200
high-temperature electrolysis of 200

l

La(OTf)₃ catalyzed lignin
transformation 424
Lewis acid-catalyzed β -O-4 linkage
cleavage, with Rh-catalyzed
decarbonylation 396, 424
Lewis acid-catalyzed depolymerization of
soda lignin 256, 391
lignification 15, 16, 18, 21, 26, 27, 55, 415
lignin
alkylation 66–67
biological function in plants 15
chemical properties 61–70
oxidation 62–65
conversion methods, classification of 90
demethylation of 67
dissolvability 40
electrochemical properties 40–41
electron spin resonance absorption
spectroscopy 61
esterification/acetylation 65
etherification 65
Fourier transform infrared
spectroscopy 54
hydrogenation 65
hydrolysis 65–66

major linkages, frequencies of 83–84
nuclear magnetic resonance
spectroscopy 56–61
nucleus-exchange reaction in 70
number-average molar mass 41
optical properties 40
phenolation process 66–67
physical properties of 39–41
polydispersity index 41
relative density and calorificity 39
resource, outlets of 412–413
sulfonation 68–69
technical 49–53
thermal stability of 42
unit compositions, 2D NMR spectra
of 28, 29
UV-vis spectroscopy 54–56
weight-average molar mass 41
lignin acidolysis
with homogeneous metal
salts and organic metal
compounds 255–258
with liquid acid catalysts 253–255
with solid acid catalysts 258–260
ligninase peroxidase (LiP)-catalyzed
mechanism 206
lignin biaryl structure derivatives 413
lignin biosynthesis 15–16
monolignols
generation of 16–17
polymerization of 21–27
transport of 20–21
primary and secondary metabolic
pathways 16, 17
lignin-carbohydrate complex (LCC)
linkages 33, 149
lignin C–C bond cleavage
first-C_γH₂OH activation to
-C_γHO/-C_γOOR 368–373
with C_β-H bond direct
activation 363–367
lignin C_α-C_β bonds cleavage
after phenolic hydroxyl group
dehydrogenation 189–205
biodegradation systems via phenolic
radical 204–205
electro/photo-electro systems via
phenolic radical 198–204
thermal systems via phenolic
radical 189–197
via first single-electron transfer of
aromatic ring 205–220
biocatalytic oxidation
systems 206–209

- chemically mimetic systems 206–209
- electrocatalytic systems via aryl cation radical 213–214
- photocatalytic methods via aryl cation radical 215–220
- thermal catalytic oxidation systems via aryl cation radical 209–213
- lignin C_{Ar}–C_α bonds cleavage
 - after phenolic hydroxyl group dehydrogenation 189–205
 - biodegradation systems via phenolic radical 204–205
 - electro/photo-electro systems via phenolic radical 198–204
 - thermal systems via phenolic radical 189–205
- lignin C–C/C–O bonds cleavage 140–141
- lignin C_β–OAr bond cleavage
 - with C_γ first sulphonation 374–375
 - with C_β–H bond direct activation 363–367
- lignin C_β–OAr bond
 - hydrogenolysis 149–150
- lignin C_{Ar}–OC bonds cleavage
 - via first partly-hydrogenation/partly-addition of neighboring aromatic ring 220–225
- lignin conversion
 - cascaded mode 139
 - definition of 99
 - in methanol with Ni/AC catalyst 164–165
 - inverse disassembly analysis for 133–135
 - protection mode 139
 - tailoring mode 137
 - wedging mode 138–139
- lignin C(sp²)–C(sp²)σ bond cleavage
 - via adjacent aromatic groups activation/extra radicals attack 225–230
- lignin C(sp²)–OAr bonds cleavage
 - via adjacent aromatic groups activation/extra radicals attack 225–230
- lignin cupric oxide oxidation 63
- lignin depolymerization 81, 83, 167
 - to aromatic chemicals 82
 - base-mediated 241–247
 - bottom-up approach 88–89
 - direct plant powders/isolated lignin conversion 87–88
 - with β–O-4 fragments 393
 - iridium-catalyzed primary alcohol oxidation and hydrogen transfer 369, 371
 - methylation-hydrogenation method 387
 - microwave-assisted methylation of benzylic alcohols 387
 - by nickel-supported layered double hydroxide catalysts 248
 - with nitrate-intercalated hydrotalcite catalysts 248
- lignin-derived aromatic ethers,
 - hydrogenolysis of 151, 162
- lignin fragmentation reaction 45, 62, 85, 86, 154, 155, 195, 287
- lignin fragments condensation
 - mechanism 381
 - acid-catalyzed condensation 381–382
 - base-catalyzed condensation 383
 - lignin linkage transformation 384–386
 - radical condensation 384–386
 - restraining methods
 - catalysts modification and design 396–397
 - first transformation of active group 391–393
 - ideal lignin substrate 400–401
 - in-situ conversion, active intermediates and scavenging unwanted species 393–396
 - intensifying reaction systems 397–399
 - pre-protection of active groups 386–391
- β–O-4 lignin fragments
 - recondensation 385
- lignin halogenation reaction 68
- lignin hydroxylic structure derivatization
 - with fluorine reagents 61
 - with HMDS and Me₃SiCl 60
 - with TMPD 59
- lignin hydroxymethylation reaction 69
- lignin isolation methods 43
 - from lignocellulose by lignin dissolution 43–47
 - from lignocellulose with lignin as the residue 47–49
 - with mixed mineral acid 47–48
- lignin linkages cleavage
 - with C_α–H, C_α–OH, or C_αO–H bond activation 143
 - with C_αO–H/ArO–H heterolysis/C_α–OH bond heterolysis 142
 - with C_β–H, C_γ–H, or C_γO–H direct activation 144
- lignin Mannich reaction 69
- lignin model compounds, reductive cleavage of 176
- lignin nitration reaction 67
- lignin nitrobenzene oxidation 62–63

- lignin oxidation
 with ClO_2 64
 with H_2O_2 63–64
 with hypochlorite 64
 with O_2 and O_3 63
- lignin oxidation mechanism
 in Cu-substituted perovskite catalysts 197
 with Cu^{2+} and Fe^{3+} in NaOH 197
- lignin phenolic group modification 396
- lignin pre-chemical modification 62
- lignin utilization 430
 as materials 411
 challenges of 413
- lignocellulose (LC)
 components of 81
 solubilization 47
- lignosulfonates (LS) 40–41, 49, 51–52, 63,
 68, 166, 199, 212–213, 296, 411–412
- β -O-4 linkages 134, 136–137, 140
 with atoms denomination 140
- β -1 linkages transformation 386
- liquid-phase reforming 91
- low-molecular aliphatic acids formation 64
- m**
- MALDI-TOF profiles of dissolved Birch
 lignin 86
- maleic acid hydrotropic fractionation
 (MAHF) 417
- Mannich reaction 69–70
- membrane bioreactor, for lignin catalytic
 oxidation 399
- MeOH/DMC co-solvent system 396
- metal-catalyzed transformations, of aryl
 ethers 161
- metallophthalocyanines 207
- 2-methoxy-1,1'-biphenyl 229
- methyltrioxorhenium (MTO)
 catalyst 224–225, 256–257, 316
- Mg-IRMOF-74 catalysts 154
- microemulsion method 398
- microwave-assisted fast conversion, of lignin
 β -O-4 linkage 258
- microwave irradiation method 398
- MIL-140 Zr metal-organic frameworks 430
- milled softwood-lignin model 30, 32
- Milled-Wood Lignin (MWL) 43–45, 49,
 56–57, 259
- Milox procedure 46
- mineral acid-catalyzed conversion
 strategy 254
- MOF-based Catalysts 155
- molecular weight determination 41–42
- monolignols
 generation of 16
 monolignol-specific pathway 18–20
 phenylpropanoid pathway 18–20
 shikimic acid pathway 17–18
- polymerization of
 dehydrogenation of precursors 21
 radical polymerization 21–27
- radicals, resonance structures of 22
- transport of 20–21
- monomeric and dimeric phenylpropanoids,
 oxidative degradation of 193
- multi-steps γ -TTSA method, for β -
 O-4 linkage cleavage 375
- n**
- NaBH_4/I_2 catalysts 171
- Ni/AC catalysts 163–167
- Ni-catalyzed cleavage, of aryl ethers in
 aqueous phase 162
- Ni-catalyzed protocol, of inert Ar–OR
 bonds 175
- Ni-catalyzed reductive cleavage, of aryl
 ethers 174
- Ni-catalyzed reductive inert $\text{C}_{\text{Ar}}\text{-O}$ bonds
 cleavage 223
- nickel-catalyzed reductive cleavage, of aryl
 alkyl ethers 161
- $\text{Ni-Mo}_2\text{C}/\text{C}$ catalyst 167–168
- Ni-NHC catalyzed hydrogenolysis, of aryl
 ethers 160
- Ni N-heterocyclic carbene catalyst
 (Ni-SIPr) 156, 159
- $\text{Ni}_{85}\text{Ru}_{15}$ catalyst 169–170
- nitrate lignin 67–68
- noble-metal catalyzed hydrodeoxygenation, of
 biomass-derived lignin 151
- non-phenolic α -aryl ethers 66
- non-sulfur lignins 49
- 4-*n*-propylphenol (4-*n*-PP) 421
 steam-assisted dealkylation of 420
- nuclear magnetic resonance (NMR)
 spectroscopy, of lignin 56
- $^1\text{H-NMR}$ 56
- $^{13}\text{C-NMR}$ 56–58
- $^{19}\text{F-NMR}$ 60–61
- $^{29}\text{Si-NMR}$ 60
- $^{31}\text{P-NMR}$ technology 59–60
- solid NMR 58–59
- two-dimensional 58–59
- nucleus-exchange reaction, in lignin 70

O

one-pot catalytic hydrocracking, of raw woody biomass 164
 organocatalytic chemoselective primary alcohol oxidation 371
 Organocell process 47
 organosolv lignin (OSL) 6, 45–47, 49, 82, 153, 163, 170–171, 245, 247, 255–256, 290, 306–307, 313, 322, 394, 424, 427
 Organosolv (Methanol) lignin, catalytic hydrogenation
 depolymerization 418
 oxidation-(reduction)hydrogenation strategies 391–392
 ozonolysis 63–64

P

palladium-catalyzed formal cross-coupling, of diaryl ethers 173
 palladium-catalyzed hydrolytic cleavage, of aromatic C–O bonds 221
 palladium-catalyzed reductive insertion of alcohols 221
 p-coumaryl alcohol 15–16, 19–20, 26, 28
 p-coumaryl alcohol glucoside 20
 Pd-catalyzed ether bond cleavage and rearrangement, of 4-O-5 lignin models 224
 Pd-catalyzed hydrogenolysis, of dibenzodioxocin lignin model compounds 177
 periodate lignin 40, 48
 peroxidases 21, 33, 189, 205–207, 214–215, 263
 phenolic β -O-4 lignin substructure model 204
 phenolization reaction, in lignin 67
 L-phenylalanine ammonia-lyase (PAL) 18–19
 photocatalytic C–C bond cleavage
 of β -1 lignin models 364
 under visible light on mesoporous graphitic carbon nitride 366
 photocatalytic methods via aryl cation radical 215–220
 lignin C $_{\alpha}$ -C $_{\beta}$ bonds cleavage 215
 photoinduced biaryl compounds
 dearomatization, for spiro-lactones preparation 413
 phthalocyanine catalysts 209
 plant lignification 15
³¹P-NMR technology 59

porous Ru/Nb₂O₅ catalyst 153, 427
 porphyrin catalysts 208–209
 product yield, for lignin 99
 proline-catalyzed retro-aldol reactions 369
 protection mode, for lignin conversion 8, 137, 139, 145
 Protobind lignin depolymerization 256
 proton-coupled electron transfer (PCET) process 9, 217, 341
 Pt₁/N-CNTs 366–367
 Pt/NbOPO₄ catalyst 153
 p-toluenesulfonic acid (p-TsOH) 416
 Purves lignin 48

R

RCF (reductive catalytic fractionation) process 261, 398, 426
 redox-neutral ([R-N]) methods 91
 reductive lignin degradation 177
 reed stem lignin structure model 32
 retro-aldol strategies, for biomass C–C bond cleavage 369
 retrosynthetic analysis (RSA) method 8, 133–135, 145
 Rh-catalyzed reductive cleavage, of C–O bond 174
 Ru-catalyzed redox-neutral C–C bond cleavage, of 3-diol 368
 Ru nanoparticle (Ru NP)–Brønsted acidic IL system 261
 Ru/NbOPO₄ catalyst 153–154, 225
 Ru-WO_x bifunctional catalyst 169
 Runkel lignin 48

S

S-dominant lignin, with high β -O-4 linkage content 400
 self-reforming-driven hydrogenolysis 426–427
 Shikimate–Chorismate pathway 17
 shikimic acid pathway 16–18
 sinapyl alcohol 15–16, 18–20, 26, 189, 414
 sinapyl alcohol glucoside 20
²⁹Si-NMR 56, 60
 softwood lignin structure models 28–32
 solid ¹³C-NMR CP/MAS method 58
 Spruce lignin model 30–31
 standardized lignin substrate 10, 413–430
 standardized products 10, 413–430
 steam-exploded lignin 52–53
 stoichiometric reactions, for C–O ether bonds cleavage 148

sulfite lignin 50–52
sulfite-pulping procedures 51
sulfonation reaction 68–69
sulfur-containing lignins 49
 Kraft lignin 49–50
 sulfite lignin 50–52
supercritical alcoholysis 91
swelled enzyme lignin (SEL) method 48
synthetic metalloporphyrins 207
syringol-based compounds 415

t

tailoring mode, for lignin conversion 8, 137, 145
tandem catalytic system, for reductive fractionation of woody biomass 150
terephthalic acid (TPA) generation process 428
terephthalic acid (TPA) production 428
 β -O-4 and β -1 tetrameric lignin model compounds 215
thermal catalytic oxidation systems via aryl cation radical 209–213
 lignin C_α - C_β bonds cleavage 210
thermal stability, of lignin 42
thioacidolysis 147
 γ -tosylation induced methods 374–375
transfer hydrogen-based retro-aldol mechanism 370
1,5,7-triazabicyclo[4.4.0]dec-5-ene (TBD) 246
triflic acid-catalyzed methods 255, 394
 γ -TTSA strategy 375

two-dimensional nuclear magnetic resonance spectroscopy methods 58
tyrosine ammonia-lyase (TAL) 18–19

u

uranyl-photocatalyzed hydrolysis of diaryl ethers 219
urban lignin 47
UV-vis spectroscopy, of lignin 54–56

v

vanadium-catalyzed aerobic oxidative cleavage, of 2-phenoxy-1-phenylethanol 365, 367
vanillin 62–63, 196, 199–200, 212–213, 245, 263, 312
veratryl alcohol oxidation
 via Co/[EMIM][DEP]/OH system 195
 with Co(salen) media 194
visible-light photoredox-catalyzed C_{Ar} -O bond cleavage, of diaryl ethers 228

w

wedging mode, for lignin conversion 8, 137, 138–139, 145
Willstätter lignin 47

z

zeolites (catalysts) 150–152, 154, 163, 194, 253, 259–260, 263, 317, 397, 420–421, 423–424, 427–428, 430
ZSM-5 zeolites 152, 421