

Index

a

- acetonitrile 7, 238–239, 270, 308, 399
 2-acetylbenzofuran (ABF) 98
 acrylic acid derivatives
 alkyl-and
 arylcarboxylations 321–323
 hydrocarboxylation 316–321
 silica-and
 borocarboxylations 323–324
 acrylic acids via Fe-catalyzed
 hydromagnesiation 320
 acyclic and cyclic amines 282
 $\text{Al}_2\text{Cl}_6/\text{Al}$ system 49
 AlCl_3/Al system 50
 alcohol-functionalized aziridines 13
 aliphatic ketones 49, 234–235, 424
 aliphatic polycarbonates
 (APCs) 337–346, 348
 alkkenylgold complex 419
 alkkenylsilver complex 419
 alkyl bromides 11, 33, 172, 266
 alkylcarboxylations 321–322
 alkyl silver complexes 398–399
 alkynes 30–33, 38–39, 42–47, 49, 66,
 125–127, 129, 225, 232–233, 270,
 274–276, 291–327, 332,
 369–372, 385, 390, 393, 397–407,
 411, 417–418, 428
 α -alkynylacetophenone 426
 2-alkynylanilines 325
 allenylamines 418, 420
 allylarenes 36, 86, 210, 212, 214
 allyl diiodopropylcarbamate 210
 allyl glycidyl ether (AGE) 105, 106
 allylic C–H bond carboxylation 214,
 369
 3-Allylindole 218
 allylsilanes 294, 427
 α -alkylidene cyclic carbonates 124,
 167, 181, 186, 191
 α,β -disubstituted styrene
 derivatives 257
 α -bromoketones 245–246
 α -carboxylated 230, 234
 α -fluoroflurbiprofen 242
 α -fluoroibuprofen 242
 α -fluoroketoprofen 242
 α -fluoroloxoprofen 242
 α -hydroxycarboxylic acids 49,
 233–234
 α -substituted β -ketoacids 234
 aluminum phthalocyanine
 complex 101
 amine cation **12**, 264
 amino alcohols 124, 157, 164–165
 2-aminobenzonitriles
 reactions 136–137, 176, 390
 amino-functionalized five-membered
 cyclic carbonates 13, 21
 amino-functionalized nanostarch
 ($\text{SNP}-\text{NH}_2$) 134
 aminopropylsilyl-modified silica 101
 3-aminopropyltriethoxysilane
 (3-APTES) 97, 101
 aminotriphenolate-Fe(III) systems 343
 ammonium carbamate 3, 175, 190
anti-cis configured cyclic carbonate
 products 17–18

- anti-Markovnikov
hydrocarboxylation 301
- anti-Markovnikov products 259–260, 279, 301–302
- anti-trans* configured cyclic carbonates 18
- aromatic ketones 233–234, 248–249
- arylboronic acid pinacol ester 430
- arylboronic esters
carboxylation 428–432
- aryl halides 60, 135, 243, 254, 264–267
- 2-aryloxy-3-butenoate 208, 211, 212
- aspulvinone E 427, 429
- atomically precise nanoclusters (APNCs) 127
- Au(I)-catalyzed reaction 60
- azetidines 21
- aziridine 9, 11, 13, 120–121, 124, 157–164, 190, 253, 270–271, 332, 381–382, 385
- b**
- BAM/HNTf₂ 7
- base-mediated C–H carboxylation Cs₂CO₃ 46–47
- DBU-mediated carboxylative cyclization 47, 48
- dimethylaluminum chloride 47
- KOtBu 47, 48
- LiOtBu-mediated carboxylation of NH-free indoles 47
- NaOtBu 48
- propenyl ketones *via* γ -carboxylation 48
- benzimidazole derivatives 282
- benzofurans 244, 275, 376
- benzophenone-based ketimines 262
- benzophenone-derived ketimines 263, 264
- benzothiazoles synthesis 189–190
- benzothiazolones synthesis 188–189
- benzoxazin-2-one 421–422
- benzoxazine-2-one derivatives 418
- benzoxazole 35–36, 61–63, 65–67, 373
- benzoxazolylcopper complex 61–63
- benzyl bromides 240, 399
- benzyl chlorides 135, 239–240
- benzyl halides 240–241
- benzylic carbanion 240, 258, 268
- benzylic C–H bonds 267–269, 276–277
- benzylic C–H bonds
carboxylation 268–269
- benzyl perfluoroisobutyrate 399
- β -carboxylated ester 230
- β -carboxylated products 259, 262, 279
- β -ketocarboxylic acid 423–424, 426
- β -oxoalkyl carbonates 183–187, 191
- bidentated bisamidine
ligands 292–293
- bidentate phosphine ligands 73, 212
- bifunctional N-heterocyclic carbene ligand 65
- bifunctional catalyst 13, 44, 112–120, 138, 176, 180–181, 192, 308, 346, 351, 401, 407
- bifunctional cobalt–salen complexes 180
- bimetallic, O-bridged Al(III)salen complex 2
- bimetallic reaction mechanism 348
- binary catalyst systems 2, 112, 164
- biphenyl 254
- bisamidine (BAM) organocatalyst 7
- bis(boryl)acetal 335–336
- 2,4-bis(3,5-dicarboxyphenylamino)-6-ol triazine (H₄BDPO) 110–111
- 1,2-bis(dicyclohexylphosphinoethane (dcpe) 333
- 1,2-bis(dicyclohexylphosphino)ethane (dcype) 68
- 1,4-bis(diphenylphosphino)butane 301
- bisimidazole 108
- bis-phenol type salen
organocatalyst 2
- bis(pinacolato)diboron 304
- 9-borabicyclo[3.3.1]nonane (9-BBN) 336
- borocarboxylative reaction 304
- brominated ILs 112
- 3-butyl-1-vinylimidazolium chloride ([VBIM]Cl) 107

C

- carbamates 2–6, 9, 11, 19, 21, 131–133, 155, 157–158, 160–161, 166–167, 169, 171–176, 188, 190–191, 214, 270–274, 325, 332, 346, 351, 367, 385, 397, 407–408, 411, 413, 418, 420, 422
 carbanion 226, 238, 240, 243, 258, 262, 268–269, 305, 427–428
 carbene 61–64, 73, 120, 124, 135, 158, 166, 178, 209, 218, 313, 336, 367, 369, 371, 380, 382, 387–389, 399, 423
 carbene–copper(I) hydroxide 61
 carbocarboxylation 260–261, 321–322
 carbodicarbene (CDCs) 121
 carbon capture and sequestration (CCS) 29, 155, 190
 Carbon Capture and Utilization (CCU) 155, 190, 192, 367
 carbon–carbon triple bonds 166, 181, 401, 405, 411, 424
 carbon dioxide (CO_2) 157–177
 2-aminobenzonitriles
 reactions 136–137
 amines reactions 131–133
 aromatic halides
 reactions 134–136
 aziridines reactions 120–121
 carbon–heteroatom bonds
 formation 190–191
 CCS 155
 chemical feedstock 155–156
 cycloaddition of epoxides
 bifunctional catalyst 112–120
 cyclic carbonates 96
 carbon 99–101
 ionic liquids catalyst 103–108
 MOF catalyst 108–111
 oxides 96–97
 salen, porphyrins, and
 phthalocyanines
 catalyst 101–103
 supported nanoparticle and Lewis acid catalysts 98–99
 zeolite catalysts 97
 disadvantages 156
 formylation of amines 127–130
 hydroformylation 133–134
 methylation of amines 130–131
 polyalcohols/olefins
 reactions 121–124
 propargyl alcohols/propargyl amines
 reactions 124–125
 renewable and sustainable
 feedstock 368
 separation and compression 155
 terminal alkynes reactions 125–127
 triatomic and linear molecule 156
 ureas and derivatives 132
 carbon dioxide utilization (CDU) 332
 carbon–heteroatom bonds
 formation 190–191
 carbon nanotube (CNT)-based NHC-coordinated heterogeneous catalysts 408
 carbonyl–ene reactions of alkenes with CO_2
 cobalt catalyst, allylic C(sp³)-H bonds 212–217
 copper catalyst and aluminum ate compounds of allylic C–H bond of alkenes 208–212
 light-induced copper catalyzed carboxylation of allylic C–H bonds 204–208
 low reactivity alkenes with low reactivity carbonyl compounds 199
 Ni-catalyzed 217–223
 organoaluminum 199–204
 pyridine derivative 199–204
 carboxylate 60–62, 67–68, 72–73, 76, 78, 80, 86, 89, 96, 122, 203–204, 212, 216, 226, 240, 242, 246, 256, 258, 260, 263, 267, 271, 276, 280, 302, 314, 376, 381, 399, 401, 403–404, 430–431
 carboxylation of alkenes
 catalytic system 295–300
 difunctionalization of alkenes with CO_2 304–305
 photoinduced 300–303
 stoichiometric 291–295

- carboxylation of alkynes
 acrylic acid derivatives
 alkyl-and
 arylcarboxylations 321–323
 hydrocarboxylation 316–321
 sila-and
 boracarboxylations 323–324
 cyclization products 324–326
 terminal alkynes
 propiolic acids 308–316
 synthesis of propiolic esters 305–308
 carboxylative coupling 30–33, 135,
 369, 371
 carboxylative cyclization of propargylic
 amines 166, 385–387
 carboxylic acid(s) 225
 derivatives 212, 232, 291, 294, 296,
 369, 376
 proton 256
 Cardillo group 5
 catalytic hydrocarboxylation of alkenes
 allylic carboxylation 256
 iron-catalyzed hydrocarboxylation of
 alkenes 297
 nickel-catalyzed 1,4-dicarboxylation
 of 1,3-dienes, 300
 nickel-catalyzed enantioselective
 ring-closing carboxylation 296
 nickel-catalyzed hydrocarboxylation
 of styrenes 299
 nickel-catalyzed hydrocarboxylation
 of unactivated olefins and
 remote sp³ C–H sites 299
 nickel-catalyzed regioselective ring-
 closing carboxylation 295
 reductive carboxylation of styrene
 derivatives 296–297
 silyl-pincer palladium complex 297
 cationic porous organic polymer based
 on a Salen-Al metalloligand
 (Al-CPOP) 112
 CativaTM process 331
 [C4DABCO]Br 160–161
 C–H carboxylations with CO₂
 metal-catalyzed
 cobalt-catalyzed 36
 copper 30–36
 gold-catalyzed C–H
 carboxylation 45
 iridium 45
 molybdenum 38
 neodymium 45–46
 nickel 36–38
 palladium 41–42
 rhodium 39–40
 ruthenium 38–39
 silver 42–44
 metal-free
 base-mediated 46–49
 electrochemical carboxylation 49
 Lewis acid mediated
 carboxylation 49–50
 light driven carboxylation 50–52
 transition metal complexes 52–53
 chiral 2-phenylsuccinates 247
 chiral POMOFs 123
 chitosan-grafted quaternary ammonium
 salt catalyst 105
 chloroacetonitrile 238
 chloro-ferric phthalocyanine 342
 2-chloro-6-methylpyridine 200–201
 chloromethyl-substituted chromium
 salen complex 101
 2-chloropyridine 200
 chromanes 244
 chromium salen catalysts 101
 cinchona alkaloid 248
 cinnamic acid derivatives 247
 CO₂ albeit 2
 CO₂ conversions
 azetidines 21
 carbon–heteroatom bond
 products 156
 C–N bond formation
 isocyanates and linear
 carbamates 172–174
 oxazolidinones 157–172
 quinazolines synthesis 175–177
 urea derivatives 174–175
 C–O bond formation
 cyclic carbonates 178–184
 linear carbonates
 synthesis 185–187
 C–S bond formation

- benzothiazolones
synthesis 188–189
- dithioacetals synthesis 187–188
- benzothiazoles
synthesis 189–190
- high energy starting materials 156–157
- iodine-activation of (homo)allylic substrates 3–8
- non-reductive 1–2
- oxetanes 21
- oxiranes 12–21
- substrate activation via radical-addition / photochemical oxidation processes 9–12
- CO_2 fixation 228
- of carbon–heteroatom bonds 155–192
- organic molecules 155–192
- sustainable development and environmental protection 155
- $\text{Co}(\text{acac})_2$ 36, 86, 212
- cobalt-catalyzed carboxylation, allylic C–H bond of terminal alkenes 212–217
- cobalt-catalyzed C–H carboxylation 36–37
- $\text{Co}(\text{II})$ -based MOF 110
- copper acetylide 400, 418
- copper and aluminum ate compounds, allylic C–H bond of alkenes 2-aryloxy-(Z)-2-butenoate 211
- allyl aryl ethers 209–210
- catalytic carboxylation of 208–209 of allyl aryl ethers 211–212
- copper-and nickel-catalyzed hydrocarboxylations 319
- copper-based catalyst 61
- copper-based magnetic nanocatalyst 98
- copper-catalyzed alkylcarboxylation 322
- copper-catalyzed borocarboxylation of styrenes 304
- copper-catalyzed carboxylation 31, 204–208
- copper-catalyzed C–H carboxylation *pH* controlled extraction 35–36
- 1,2,3-triazol-5-ylidene 35
- CuI and PEt_3 31
- $\text{Cu}(\text{I})/\text{PPh}_3$ catalytic system 33–34
- DEG-ImPy ligand 35–36
- ethylene carbonate 32
- ferrocenyl diphosphine 32, 33
- of $\text{C}(\text{sp}^2)\text{-H}$ bond 33, 35
- of terminal alkynes 30–33
- copper(I)-catalyzed polymerization of terminal dienes 30
- copper(I) triarylphosphine/1,10-phenanthroline catalyst 65–66
- copper/NHC complex 256
- coumarins 41, 47, 73, 76, 78–80, 125, 274–275
- covalent organic frameworks (COF) 108, 120, 130
- Cs_2CO_3 mediated carboxylation of $\text{C}(\text{sp})\text{-H}$ bond 47 of $\text{C}(\text{sp}^2)\text{-H}$ bond 46
- Cu-catalyzed borocarboxylation 324
- Cu-catalyzed silacarboxylation 323
- $\text{CuCl}\text{-TMEDA}$ catalytic system 369
- $\text{Cu}(\text{I})\text{-NHC}$ 33, 36
- $[\text{Cu}(\text{IPr})\text{OH}]$ 35, 373
- Cy_2NMe 263
- cynoacetic acetate 238
- cynoacetic acid 236, 238–239
- cyclic carbamates 3–6, 11, 157, 271–273, 408, 413
- cyclic carbonates 405
- Al-complex coordinated 20 functional (homo)allylic precursors 3
- homo-allylic alcohol substrates 8
- hydroxy-oxetanes 13, 14
- iodonated 6
- multi-phenolic (binary) organocatalysts 2
- photochemical-assisted conversion of CO_2 2–3
- stereochemistry 12, 15
- synthesis of 1
- terminal epoxides and CO_2 albeit 2
- trisubstituted and tetrasubstituted 17

- cyclic carbonates synthesis
 carboxylative cyclization of 1,2-diols
 with CO₂ 182–183
 direct and indirect utilization 178
 epoxide and CO₂
 ion-type catalysts 178–180
 metal complexes
 catalysts 180–181
 propargyl alcohols with
 CO₂ 181–182
 cyclic epoxy alcohols 16–18
 cyclic organic carbonates (COCs)
 CO₂ and epoxides
 boiling temperatures and dipole
 moments 337
 cocatalyst 346
 Fe-based systems 339, 340
 formation of 339
 reaction mechanism 340
 single component bifunctional
 catalyst 346
 single component catalyst 346
 TBAB 344
 tetra-*n*-butyl ammonium
 iodide 344
 intramolecular reaction
 mechanism 351
 stereochemistry of 354–358
 cyclization–carboxylation of vinyl
 bromides 244
 cycloaddition of CO₂ 12, 14, 96–98,
 101, 105, 107, 109, 118, 120,
 158–159, 161–162, 180, 324, 380,
 382–383
 cyclohexene 85, 201, 204, 206, 256, 344
 cyclohexene oxide 343, 345, 349, 351
 2-cyclopentenones 416–417
 4CzIPN 260–261, 266–269, 300,
 302–303, 306
- d**
- DBU/L-histidine 2
 DBU-mediated carboxylative
 cyclization 47, 48
 decarboxylative electrocyclization
 reaction 416
 decarboxylative transformation 412
 dehydronifedipine 282–283
 density functional theory
 (DFT) 20–21, 38, 50, 60, 62,
 78–80, 84, 98–99, 182, 259, 284,
 296, 336–337, 351, 371, 373, 379,
 381, 387, 401, 405, 411, 418–419,
 426
N,N-dimethylaniline 200
 diaryl alkynes 390
 diastereoselective electrochemical
 carboxylation 245, 247
 1,4-diazabicyclo[2.2.2]octane
 (DABCO) 10, 160
 (1,8-diazabicyclo[5.4.0]-7-undecene)
 (DBU) 2, 11, 161, 200, 211, 291,
 333, 376, 405
 diazonium salts 99
 2,6-dibromopyridine 201–202
 dicarbofunctionalization of
 alkenes 257, 258
 dicarbofunctionalization of
 styrenes 304, 305
 dicarboxylate 226, 231, 232, 248
 dicarboxylated ester 230, 279
 1,4-dienes 36, 214–216
 diethyl azodicarboxylate 164
 diethylene glycol-based imidazo
 pyridin-3-ylidenes (DEG-ImPy)
 ligand 35–36, 65, 66, 373
 diethylene glycol-functionalized
 imidazo[1,5-*a*]pyridin-3-ylidenes
 (DEG-ImPy) 65
 difluoroalkyl-functionalized
 oxazolidinones 10
 difluoroalkyl-substituted oxazolidinone
 formation 11
 2,6-difluoropyridine 201
 2,6-dihalogenated pyridines 201
 dihydrogen-coordinated species 337
 dihydroisobenzofuran derivatives 424
 diisopropylethylamine 240
 diisopropyl ethylamine (DIPEA) 14
 (dimethylamino) methyl-polystyrene-
 supported Cu (I) iodide
 (DMAM-PS-CuI) 124
 dimethylaluminum chloride for the
 carboxylation of indole 47

- dimethyl carbonates (DMC) 156, 185–187, 191
 dinuclear system 356
 (4,7-diphenyl-1,10-phenanthroline)
 bis(triphenylphosphine) 66
 direct C–H carboxylation reactions
 allylic Csp₃-H bonds
 1,3-Copper migration 86–87
 Co(I)-catalyzed carboxylation
 of 86, 88–89
 ketones and Cu(I) 86–87
 photoinduced Cu-catalyzed
 carboxylation 85–86
 Csp₂-H bond
 aryl and heteroaryl
 compounds 60
 benzoxazole and benzothiazole
 derivatives 63
 electron deficient arenes 59–66
 electron-deficient to electron-rich
 benzoxazole derivatives 61
 heterocycles 61
 inert Csp₂-H bonds
 palladium-catalyzed 76–85
 rhodium-catalyzed 66–76
 direct hydrogenation 332, 333, 335
 di-*tert*-butyl azodicarboxylate
 (DBAD) 164, 165
 1,3-di-*tert*-butyl imidazolium-2-
 carboxylate 381
 2,6-di-*tert*-butylpyridine 200, 203
 dithioacetals synthesis 187–188
 divinylbenzene (DVB) 107, 108
 [(dmpe)2Fe(H)2] 335–336
 D-ribonic- γ -lactone 247
 drug molecules harmine 282–283
- e**
 electro-catalyzed C–H
 carboxylation 49
 electrochemical carboxylation (EC)
 aromatic and aliphatic organic
 compounds 225
 definition 225
 green technology 225
 olefins 225–226
 organic halides 225
 2,2-ring-fused succinic acid
 derivatives 244
 2-substituted acetic acid
 derivatives 243–244
 carboxylation of benzyl
 chlorides 239–240
 chlorinated and
 brominated 240–241
 CO₂ and DMF for the
 electrosynthesis of N-methyl-N-
 (acetoxy)
 methylformamides 240–241
 cyanoacetic acid *via*
 electrochemical reduction of
 chloroacetonitrile 238
 cyclisation-carboxylation of vinyl
 bromides 244
 electrochemical carboxylation of
 α,α -difluorotoluene derivatives,
 Pt cathode and a Mg anode 241
 electrosynthesis of cyanoacetic acid
via direct carboxylation of
 acetonitrile 238–239
 general mechanism 226
 polyfluoroarenes, regioselective
 synthesis of polyfluorobenzoyc
 acids 243
 stereoselective 245–249
 unsaturated compounds
 1-methyl-1-phenyl ethene 229
 aliphatic ketones 234
 dienes 235, 237
 divergent dicarboxylation of
 alkynes 232
 ethyl cinnamate 230
 flavones 230
 N-brominated amino acids 234
 polycyclic aromatic
 hydrocarbons 231
 styrenes 229
 succinic acids 228
 synthesise 2-arylsuccinic
 acids 229
 synthesis of α -hydroxycarboxylic
 acids 233–234
 terminal alkynes 232–233
 unsaturated compounds 225

- electrochemical CO₂ valorisation 249, 250
 electron-deficient substrate 259
 electrophilic I-containing reagents 3
 enamides 261, 262, 302
 enantio-enriched cyclic carbonates 355
 enantioselective catalysis 248
 Ender's carbene 336
 epichlorohydrin 97, 98, 101, 108, 109, 112, 120
 ethylaluminum dichloride 199, 201, 203
 ethylbenzene 259, 279, 280
 2-ethyl-1-butene 202–204
 ethyl cinnamate 230
 ethylene carbonate 32, 178, 308
 ethylenediaminetetraacetic acid (EDTA) 179
 Evans oxazolidinone 245, 247
 Evan's-type auxiliaries 245
- f**
 FeDOPACu 125–127
 Fe(III) porphyrin complex 342
 ferrocenyl diphosphine ligand 32–33
 fibrous nano-silica (KCC-1) 125, 137
 five-membered cyclic carbonates 9, 12–14, 21, 408, 416, 431
 flavanone-2-carboxylic acids 231
 flavones, 125, 230, 231
 fluorinated benzoic acid 242
 2-fluoro 2-arylpropanoic acids 241
 formamides 388
N-formylation 127, 129, 388
 formylation of amines 127–130, 388, 389
 Friedel–Crafts type carboxylation of arenes 70
- g**
 γ -butyrolactones 36, 215
 γ,δ -unsaturated cyclic acids 244
 γ -hydroxybutenolides 275
 gas-phase hydroformylation 133–134
- glycidyl trimethylammonium (GTA) chloride 105
 gold-catalyzed C–H carboxylation 45
 graphene oxides (GOs) 101
 Graphitic carbon nitride (g-C₃N₄) 101, 137
 Grignard reagent 29, 79, 253, 320
- h**
 halide-free systems 2
 Hantzsch esters 259–260, 267, 301 type molecules 282
 heterolytic cleavage 337
 Hieber base reaction 337
 homoallyl alcohol 51, 256, 427–428
 homogeneous cobalt catalyst 331
 homogeneous iron-based catalysts nonreductive processes
 COCs and APCs 340–341
 mechanistic 346
 oxazolidinones 358–360
 reductive processes
 direct hydrogenation 332
 hydroboration 335
 hydrosylation 335
 mechanistic 336
 Hosomi–Sakurai allylation 427–428
 Hunig's base 200
 hydroboration 335–336
 hydrocarboxylation copper-and nickel-catalyzed 319
 iridium/cobalt dual catalyzed visible-light-driven 321
 Ni-catalyzed reaction 320
 Ni-mediated hydrocarboxylation 318
 Ni-neocuproin catalyst 320
 palladium-catalyzed 317–318
 prototypical nickel-mediated reaction 316–317
 titanium-mediated 319
 hydrocarboxylation of enamides 261, 302
 hydrogen atom transfers (HATs) mechanism 253
 hydrometalation of the styrene 258

- hydrosylation 335–336
 hydroxycarbonyl radical 254, 255,
 282–284
 3-hydroxypyrazoles via
 carboxylation 325
 4-hydroxyquinolin-2(*1H*)-one 325,
 421–423
 hydroxyl-substituted tetrabenzoxazine
 derivative 105, 107
 hydroxymethyl-substituted cyclic
 carbonates 16
 hydroxy-octanes 13, 14
 hyperbranched polyglycerol groups
 (HPG) 137
- i**
- ibuprofen 240, 259, 268, 299
 imidazolium 105–107, 112, 120, 137,
 162, 376, 379–382
 imidazolium carboxylates
 (IMesCO_2) 381
 imidazolylidene 379–380
 indanes 244
 indaone-containing oxazolidinone 247
 indolines 244, 282, 283
 intramolecular cyclo-elimination
 reaction 381
 iodinated cyclic carbonate product 6
 iodine-activation of (homo)allylic
 substrates 3–8
 ion-exchanged zeolite 97
 ionic liquids catalyst 103–108
 (IPr) AuOH 45, 60, 62, 373, 374
 (IPr) AuOH complex 60
 iridium-and ruthenium-based
 photocatalysts 261–262
 iridium-based photocatalyst 304
 iridium-catalyzed C–H
 carboxylation 45
 iridium/cobalt dual catalyzed visible-
 light-driven
 hydrocarboxylation 321
 iridium photocatalyst 5
 iron-catalyzed hydrocarboxylation of
 alkenes 296–297
 iron-complexes, amino-phenolate
 ligands 343, 345
- 1(*3H*)-isobenzofuranylidene acetic
 acids 326
 isocyanates 13, 155, 157, 172–174,
 187, 191
 isonitrile 400
- k**
- KCC-1/Salen/Ru(II) NPs
 nanocatalyst 128
 key intermediate
 CO_2 radical anion
 α -amino acids 276–279
 continuous photo flow
 reaction 277
 deprotonation of 277
 organic oligophenlenes 277
 radical clock
 experiment 281–282
 Stern–Volmer quenching
 experiments 280, 285
 thiocarboxylation of styrenes and
 acrylates with CO_2 280–281
 thiol radical 282
 CO_2 –substrate adduct
 2-quinolones 274
 acid-catalyzed intramolecular
 cyclization 276
 allyl alcohols to perfluoroalkylated
 cyclic carbonates 270–271
 allyl amines to cyclic
 carbamates 270–271
 carboxylative cyclization of allyl
 amines, perfluoroalkyl iodides
 and CO_2 270
 hydroxybutenolides 275
 Ir-/Co-catalyzed carboxylation of
 alkynes 274
 2-Pyrone generated from alkynes
 and CO_2 274–275
 Ru-catalyzed reaction of allyl
 amines to cyclic
 carbamates 272–273
 hydroxycarbonyl radical 282–284
 substrates/intermediates
 aryl halides 254
 benzylic C–H bonds 267–269
 unsaturated 254–264

- kinetic isotope effect (KIE) 70, 259, 301
 Knölker's complex 335, 338
 KOtBu mediated carboxylation of heteroarenes 47–48
 Kolbe–Schmitt reaction 41, 59, 397
- I**
- Langlois reagent 257, 258
 Lewis acid-mediated carboxylation 49–50
 ligand-controlled hydrocarboxylation of styrenes 259–260
 light driven carboxylation
 α-amino acids 51
 benzylic C(sp³)–H bond 51–52
 C–C bond formation 50
 of allylic C–H bonds 50–51
 light-induced copper catalyzed carboxylation, allylic C–H bonds
 2,3-dimethyl-2-butene with xanthone 204–208
 alkenes in 204, 207
 allylcopper species 206, 208
 cyclohexene with xanthone 204, 206
 homoallylic alcohols 206, 208
 ketones 204–205
 reaction mechanism 204, 206
 linear carbamates 172–174
 LiOtBu mediated carboxylation of free indoles 47
 2,6-lutidine 200
- m**
- magnesium oxide 96
 Markovnikov products 259, 301, 302
 Markovnikov-type hydrocarboxylation 320
 Martin's nickel-catalyzed hydrocarboxylation 320
 mass flow controller (MFC) 276
 mesoporous carbon nitride (MCN)
 materials 99
 metal-based catalytic systems 180, 346
 metal-based photocatalysts 262–263
 metal catalyzed C–H carboxylation
 cobalt 36–37
 copper-catalyzed C–H carboxylation 30–36
 gold 45
 iridium 45
 molybdenum 38
 neodymium 45–46
 nickel-catalyzed 36–38
 palladium 41–42
 rhodium 39–40
 ruthenium 38–39
 silver 42–44
 metal-catalyzed coupling reactions 418
 metal-catalyzed hydrocarboxylation of styrenes 259
 metal-free C–H carboxylation
 base 46–49
 electrochemical carboxylation 49
 Lewis acid mediated carboxylation 49–50
 light driven carboxylation 50–52
 metalation-deprotonation process 80
 metal–organic frameworks (MOFs)
 Co(II)-based 110
 Cr-MIL-101 109, 123
 Cu₂(C₄₀H₂₄N₈)_{0.5}(C₁₄H₈O₅)(DMA)] (DMA)(H₂O)₆ 120
 fabricate bifunctional catalyst 120
 Hf-NU-1000 109
 of ZIF-8 109
 Salen–Cu(II)@MIL-101(Cr) 118
 sulfonate 110
 Zn(NO₃)₂ with benzene-1,4-dicarboxylic acid (H₂bdc) 108–109
 metalporphyrin-based microporous organic polymer 103
 meta-Substituted substrates 259
 methylation–Michael addition–cyclocondensation sequence 33
 methylation of amines 130
 N-methylation of amines 387
 1-methyl-1-cyclohexene 201
 Methylformate 130–131
 methylmetallic reagents (MeMX_n) 67
 1-methyl-2-phenylindole 254
 methylrhodium(I) 67

- 7-methyl-1,5,7-triazabicyclo [4.4.0] dec-5-ene (MTBD) 427
 Meyer–Schuster type reaction 413
 Mg–Al mixed oxides 96, 131
 Mg-por/pho@POP catalyst 112, 116
 Mitsunobu reagents 164–165
 $\text{Mo}_2(\text{OtBu})_6/\text{Cs}_2\text{CO}_3$ 66, 67
 $\text{Mo}_2(\text{OtBu})_6$ for carboxylation 66–67
 molecular iodine (I_2) 3
 molybdenum-catalyzed C–H carboxylation 38
 2-mono-and 6-di-carboxylic acids 68
 monodentate phosphines 67, 68
 Monsanto process 331
 multihydroxy benzene 99
 multi-phenolic (binary) organocatalysts 2
- n**
- N*-acyliminium ion 240
 nanoparticulate CeO_2 132
 NaOtBu mediated lactamization of $\text{C}(\text{sp}^2)\text{--H}$ 48
 Nazarov cyclization 416, 417
 N-brominated amino acids 234
 N-carboxylation of 3-methyl-1*H*-imidazole 61
 N-containing ligands 135
 neocuproine 259, 260, 300, 301
 neocuproine nickel(II) complex 300
 neodymium-catalyzed C–H carboxylation 45–46
 NHC–Ag/Pd bimetallic catalysts 371
 (NHC) Au(I) Ar complexes 60
 (NHC) Au(I) hydroxide complexes 59
 (NHC) Au(I) OH-catalyzed reaction 62
 (NHC) Au(OH) catalyst 61
 NHC–Au-oxazole complex 60
 NHC-catalyzed CO_2 fixation organic reactions
 alkylation with CO_2
 N-formylation 388–390
 N-methylation 387–388
 α,β -unsaturated β -boralactone derivatives 390
 carbene 367
 cyclization reactions with CO_2
 cyclic carbonates 379–380
- metal 382–385
 NHCs– CO_2 adducts 380–382
 propargylic amines 385–387
 direct C–H activation with CO_2
 carboxylation of alkenes and organoboronic esters 376
 carboxylation of arenes and heteroarenes 373–376
 carboxylation of terminal alkynes 369–372
 nucleophilic character 369
 quinazoline 391
 thiazolium carbene 390
 NHC– CO_2 adducts 372, 380–382
 NHC copper(I) complex 31, 35, 369, 387, 390
 (NHC) Cu(I) -catalyzed $\text{Csp}^2\text{--H}$ direct carboxylation 64
 N-heterocyclic carbene (NHC) ligands 65, 135, 218, 399
 NH_4I -catalyzed reaction 158
 Ni-catalyzed carbonyl-ene reactions of terminal alkenes with CO_2 217–223
 allylic anion from cinnamyl chloride 219
 cinnamyl moiety to homoallylic alcohol 219
 computational quantum chemistry calculations 222
 coupling reaction 220–221
 enophile 219
 ligand effects 217
 organoaluminum reagent 223
 organoaluminum reagents 219–220
 Ni-catalyzed carboxylation of bromides and triflates 267
 Ni-catalyzed hydrocarboxylation reactions 316
 nickel-catalyzed C–H carboxylation
 of acrylate salt 37
 of benzylic $\text{C}(\text{sp}^3)\text{--H}$ bonds 38
 of $\text{C}(\text{sp}^3)\text{--H}$ bond 37–38
 of sodium acrylate 36
 Ni(0) diphosphine complex 297
 Ni-mediated hydrocarboxylation 317, 318

- N*-iodo-succinimide (NIS) 7, 179, 418
Ni-TCPE1 catalyst 110
 nitrogen-based ligand–iron complexes 342
 nitrogen source 157, 163–164
N,N-bis[(4-dimethylamino) salicylidene] 125
 4-(*N,N*-dimethylamino) pyridine (DMAP) 97
 Nolan’s group 60–61
 non-phosphorous ligand 335
 non-reductive CO₂ conversions 1, 131
 nonreductive processes mechanistic 346–354
 oxazolidinones 358–360
 non-steroidal anti-inflammatory drugs (NSAIDs) 242
 Norrish Type II photoreaction 268
N-proton pyridium iodide (HPyl) 161
- O**
 1-octyl-3-methylimidazolium tetrafluoroborate 380
 olefins 133, 163, 225–226
 organofluorinated compounds 241
 organolithium/magnesium reagents 398
 organometallic ionic complexes (OICs) 125
 organophotocatalyst 256
 organo-silver complexes 305, 398–399
ortho-alkylphenyl ketones 50, 85, 267, 268
ortho-alkyl substituents 268
ortho-methyl benzophenone derivatives 268
 overhauser effect (NOE) 5, 390, 426
 oxazolidinone product 3, 9, 11
 oxazolidinones 15, 120, 248, 418
 2-oxazolidinones 125
 oxazolidinone synthesis amino alcohols and CO₂ 164–165
 aziridine and CO₂ catalyst-free system 163
 reactions 158
 supported catalysts 161–162
- zwitterionic pairs/salts catalysts 158–161
 carboxylative cyclization of allylamines with CO₂ 170–172
 5-membered cyclic carbamates 157
 propargyl alcohol, aliphatic primary amine/2-aminoethanols and CO₂ 167–170
 oxetanes 1, 21, 344
 oxiranes carbon-carbon double bonds 12, 405
 cycloaddition of CO₂ 12
 Lewis acids and co-catalytic halides 12
 nitrogen analogue of 13
 substrate-directed conversion of 16
 oxy-difluoroalkylation of allylamines with CO₂ 172
- P**
 palladium-catalyzed carboxylative cyclization of propargylic alkoxide 405
 palladium-catalyzed C–H carboxylation reactions alkenyl C–H bonds 41
 alkenylpalladium 76, 78
 of arenes 78
 of aromatic compounds 41
 benzylic alcohols 79
 coumarins 76
 cyclocarbonylation of isoquinolones 82, 84–85
 hydroxypyridine 76
 lactonization 79, 82
ortho-carboxylation 42 ehp[PEPSI-IPr catalyzed meta-selective arylation of phenols 41
 phthalimides 80, 82
 spiro lactones 79
 palladium-catalyzed hydrocarboxylation of alkynes 317–318
 palladium nanocatalyst 99
 palladium nanoparticles (PdNPs) 134, 135

- para*-and *meta*-substituted bromoarenes 266
 Paterno–Büchi reaction 21
 “Payne-type” carbonate-to-carbonate rearrangement reaction 16
 P-containing ligands 135
 Pd-catalyzed carboxylation of aryl bromides and chlorides 265
 Pd-Cu/MIL-101 catalyst 127
 $\text{PEG}_{6000}(\text{NBu}_3\text{Br})_2$ 161, 162
 perfluoroalkyl-functionalized oxazolidinones 9, 10
 perfluoroalkyl silver compounds 399
 perfluoroiodides 9
pH dependent NHC-copper(I) catalyzed carboxylation of benzoxazole 36
 phenol-formaldehyde condensation reaction 108
 1-phenyl-1-cyclohexene 201
 5-phenyl-2-oxazolidinone 164
 2-phenylpyridine 67
 2-phenyl-1,1,3,3-tetramethylguanidine (PhTMG) 4
 phenyltrimethylammonium tribromide (TPAT) 342
 phosphine-functionalized nanoparticles 125
 phosphine ligands 129, 212, 223, 259, 260, 296
 phosphinic ligands 333–334
 photoactivated $\text{Pd}(\text{PPh}_3)_4$ catalysis 11
 photocatalyst $[\text{Ru}(\text{bpy})_3]^{2+}$ 10
 photocatalyzed radical-radical coupling reactions 277
 photochemical-assisted conversion of CO_2 2
 photoinduced hydrocarboxylation of alkenes
 alkene derivatives 303
 enamide derivatives 303
 styrene derivatives 301, 302
 photoinduced radical-initiated carboxylative cyclization, allyl amines with CO_2 170–172
 photoredox catalysis 172, 253, 304, 327
 photoredox catalyst 51, 172, 258, 264, 265
 photoredox-catalytic process 10
 plausible reaction mechanism 206, 211, 216, 272, 426, 427
 polyalcohols/olefins reactions 121–124
 polycyclic aromatic compound 266
 polycyclic aromatic hydrocarbons 231
 polyethylene glycol supported potassium hydroxide 132
 polyfluorinated benzoic acid 242
 polyfluoroarenes 242, 2'43
 polyILs@MIL-101 120
 polymer-immobilized nanogold catalyst (Au/poly) 98
 polymer-supported IL (PSIL) 107
 polymer-supported quaternary phosphonium salts 103
 polymethylhydrosiloxane (PMHS) 388
 polystyrene-supported resorcinarennes 105
 poly(4-vinylimidazolium)s-DBU- ZnBr_2 383
 porous organic polymer (POP) 101, 103, 112
 porphyrin-IL bifunctional catalyst 112
 potassium oxazole-2-carboxylate 60
 potassium phthalimide 190
 primary alkylamines 132, 335
 proline 158–159
 propargyl alcohols
 acyclic carbamate 408
 carbon nanotube (CNT) 408
 chemical fixation of 407
 CO_2 -mediated transformation of 412–417
 copper (I) iodide 405
 cyclic enol carbonates 405, 411
 internal alkyne part 405
 Lewis acidic transition metal catalysts 405
 4-methylene-1,3-dioxolan-2-one 408
 vinylene carbonates 407

- propargyl alcohols/propargyl amines reactions 124–125
- propargyl bromobenzene 244
- propargylic amines 5, 125, 385–387
- propenyl ketones *via*
 γ -carboxylation 48
- propiolic acid derivatives 32, 313, 399, 402
- propiolic acid synthesis
 CO₂ generated from combustion 313
- CO₂ insertion in terminal alkynes breakthrough synthesis 309
- copper-catalyzed synthesis of 311
- seminal synthesis 310
- silver complexes 311
- lithiation-carboxylation sequence 316
- metal-free carboxylation of alkynylsilanes 315
- metal-free carboxylation of terminal alkynes 315
- neodymium-catalyzed 314
- propiolic esters synthesis 305–308
- 1,2-propylene glycol (PG) 182
- propylene oxide (PO) 96, 98, 102, 105, 107, 118, 182, 348
- protic onium salts 161
- PS-MImFeCl₄ 162
- [PS-Zn(II)L] catalyst 99
- pyridine derivative 199–204
- pyridylarene carboxylic acids 67
- pyrimid-4(3H)-ones 35
- 2-pyrones 274, 275, 324, 428
- q**
- quinazoline 30, 391
- quinazoline-2,4(1*H*,3*H*)-diones 136, 137, 176, 390
- r**
- radical anion dimer 238
- reduced Robson's ligand 343
- reductive processes
 direct hydrogenation 332
- hydroboration 335–336
- hydroosylation 335–336
- Rh-catalyzed carboxylation of styrenes 259
- rhodium-catalyzed C–H carboxylation reactions 39
- aromatic compounds 67
- 2-arylphenol 73
- chelation-assisted *ortho*-metalation carboxylation 72
- 2-furylphenols 2-thienylphenols, and 2-pyrrolylphenols, 73–74
- 2-heteroarylanilines 76, 77
- 2-(hetero)arylphenols 73
- of 2-(imidazo[1,2-*a*]pyridin-2-yl) phenols 73, 75
- ortho*-carboxylation 67, 69
- 2-phenylanilines and 2-heteroarylanilines 76–77
- phenanthridinones 73
- [RhCl(dcype)]₂ 70
- RhMe(dcype) and RhPh(dcype) 70
- simple arenes 68, 70–71
- 2,2-ring-fused succinic acid derivatives 244
- R₃P 164
- (*R*)-styrene oxide 96, 356
- Ru-based photoredox catalysis 10
- [Ru(bpy)₃]²⁺ 10, 11, 258
- ruthenium-catalyzed C–H carboxylation 38–39
- s**
- Salen–Cu(II)@MIL-101(Cr) catalyst 118
- salt-free hydroxymethylation of alkynes 314
- salt catalysts 158–161
- Saveánt model 248
- SBA-15-SO₃H/TBAB 97
- scorpionate complex 335
- selectfluor® 429
- σ -donor ligands 400
- silica-based amino-functionalized imidazolium IL (Si-IM-NH₂) 105
- silica-based quaternary ammonium salt (Si-TBAI) 107

- silica-coated magnetic nanoparticles (SMNPs) 98
- silver acetate 166, 405, 411
- silver acetylide, 397, 399–401
- silver-catalyzed C–H carboxylation 42–44
- silver-catalyzed CO₂ fixation carboxylation, C–C bond formation enolate 423–424, 426 nucleophilic reagents 427
- carboxylation of terminal alkynes atmospheric pressure 401 bifunctional 401 combustion 402 ligands-free 400–401 nanoparticles 401 one-pot synthesis of arylnaphthalene lactones 402, 404 preliminary reaction 399
- carboxylative cyclization of propargyl alcohols 405 heterocyclic compounds 397 historical background of 398–399 sp-hybridized carbon-silver bond 428, 431
- terminal epoxides 431–432 three-component reaction 411–412 transformation of amine derivatives benzoxazine-2-one derivatives 418 carboxylation and cyclization of allenylamines 418 cascade carboxylation and cyclization 417–418 domino carboxylation–cyclization–migration of unsaturated amines 421–423 three-component reaction of carbon dioxide, amines, and allenyl ethers 419–421
- silver-catalyzed ligand-free carboxylation reaction 401
- silver-NHC catalyzed synthesis of cyclic carbonate 432
- silver tungstate 44, 401, 413
- silyl-pincer palladium complex 297
- single electron transfers (SETs) 253
- single walled metal-organic nanotube 110
- SIPr-ethyl silver complex 399
- sodium acrylate 36–37
- sol-gel protocol 105
- Sonogashira coupling of dibromo-functionalized Salen-Co/Al complexes 102
- Sonogashira coupling of tetrakis(4-ethynylphenyl)methane 108
- sp-hybridized carbon-silver bond 398
- sp²-hybridized carbon-silver bond 428–430
- spiro*-cyclic carbonate 8
- stereodefined triols 13
- stereoselective electrochemical carboxylation diastereoselective 245 enantioselective catalysis 248
- Stern–Volmer plots 258, 262, 263, 267
- Stille coupling reaction 135, 136
- stoichiometric carboxylation of alkenes allenes 291–295 carboxylation of allenes 292 dicarboxylation and/or arylation carboxylation of 3-dienes 293 ethene and styrene, nickel 292 nickel complex with Me₂Zn 293
- styrene difunctionalization 261
- 5-substituted-2-oxazolidinone 163
- substrate driven CO₂ conversion iodine-activation of (homo)allylic substrates 3–8 oxetanes and azetidines 21 oxiranes 12–21 substrate activation via radical-addition/photochemical oxidation processes 9–12
- substrates/intermediates aryl halides 264–267 benzylic C–H bonds 267–269 unsaturated substrates 254–264
- succinic acids 228, 229, 232
- sulfonate-based MOF 110
- sunlight-mediated reaction 263

- supercritical CO₂ (ScCO₂) 32, 129, 164, 311, 344
- Suzuki–Miyaura coupling 324
- syn-cis* configured cyclic carbonates 17
- t**
- TBB-Bpy 112
- t*BuXPhos (2-di-*tert*-butylphosphino-2',4',6'-triisopropylbiphenyl) 264
- tert*-butoxide 204, 206, 212, 304, 430
- 4-*tert*-butylbenzoate 243, 244
- 1,1,3,3-tetramethylurea (TMU) 68
- tetra-*n*-butyl ammonium bromide (TBAB) 13, 158–159, 342
- tetra-*n*-butyl ammonium iodide (TBAI) 344
- tetra-*n*-butyl ammonium salts (TABX) cocatalysts 349
- tetra*-heptylammonium bromide 166
- 5,10,15,20-tetrakis(4-bromophenyl) porphyrin-aluminum(III) chloride (Al-TBPP) 112
- tetrakis(4-carboxyphenyl)ethylene (H₄TCPE) 110
- 1,3,6,8-tetrakis(*p*-benzoic acid)pyrene (H₄TBAPy) 109
- tetramethylguanidine (TMG) derivative 418
- 5,10,15,20-tetraphenylporphyrin (TPP) 103
- tetrameric acid 422, 424, 425
- tetrasubstituted cyclic carbonates 16, 17
- tetrazolyl-carboxyl ligand 5-(4-(tetrazol-5-yl)phenyl)isophthalic acid (H₃tzpa) 110
- tetronec acids 426–428
- thiol radical cation 282
- titanium-mediated hydrocarboxylation 319
- Togni's reagent 170, 171
- Toloxatone 15
- [(TPr)CuCl] (1,4-bis(2,6-diisopropylphenyl)-3-methyl-1,2,3-triazol-5-ylidene-copper(I) chloride) 63
- traditional radical-mediated reactions 253
- transition metal-catalyzed carboxylations direct C–H carboxylation reactions 90
- 1,2,3-triazol-5-ylidene copper(I) chloride complexes 63
- tri*isopropylsilanethiol* 268
- trialkylphosphine 400
- tricarbonyl(η⁴-cyclopentadienone)-iron complex 335
- 1-(triethoxysilylpropyl)-3-*n*-butylimidazolium bromide 105
- triethylamine 263, 333, 405
- triethylammonium formate 333
- 1,3,5-triethylbenzene 102
- trimethyl(2-methylenebut-3-yn-1-yl) silane derivatives 428
- triphenylamine 200
- triporphosphino-iron chloride complex 333
- 2,4,6-tris(imidazol-1-yl)-1,3,5-*s*-triazine (TIST) 112
- trisubstituted cyclic carbonates 15–16
- u**
- unsaturated substrates carboxylation of enamides with CO₂ 261
- dicarbofunctionalization of alkenes 257
- electron-deficient 259
- heterocyclic 261
- 1-methyl-2-phenylindole 254
- p*-cyanostyrene 258
- v**
- vibrational circular dichroism (VCD) 411
- vinyl-functionalized Mg-porphyrin complex 112
- vinyl-functionalized phosphonium salt 112
- x**
- Xantphos 36, 89, 212, 216, 298, 318

y

Yamamoto–Ullmann coupling reaction 112
2-ynoic acid derivatives 232
ynones 426, 427

z

zeolite catalysts 97, 133
zinc(II) porphyrin 112

zinc(II) tetrakis(4-aminophenyl) porphyrin (Zn-TAPP) 112
ZnMOF-1 111
Zn(NO₃)₂ with benzene-1,4-dicarboxylic acid (H₂bdc) 108
Zn/PS-IL[Br] catalyst 107
ZrCl₄@SiO₂ 98
ZrOCl₂·8H₂O 158–159
Zwitterionic pairs 158–161

