

Index

a

- absorption bands 985
- absorption spectrum 984, 1031
- acetaldehyde (AC) 494, 972
 - reactor outlet 345
- acetalization 618
- acetate 896
- acetic acid 77, 593, 972
 - esterification 760, 773
 - oxidation to vinyl acetate 487
 - synthesis 503, 835
- acetone 518
- acetonitrile 741
- acetophenone 242
 - transfer hydrogenation reaction of 140
- acetoxysilicone ink 375, 376
- acetoxysilicone polymer 373
- acetylene 508
 - carbon-catalyzed hydrochlorination 21
- ACF. *see* activated carbon fiber (ACF)
- acid–base bifunctional (MNP-NH₂-Ru^{III}) catalyst 167
- acid–base interactions 984
- acid-base properties 76
- acid catalysis 49, 719
 - esterification reaction 135
 - processes 629
 - – acetylation 629
 - – alkylation 629
 - – dehydration 629
 - – esterification 629
 - – etherification 629
 - – hydrolysis 629
 - – reactions 133, 636
 - – acylation processes 134
 - – alkylations 133
 - – esterifications reactions 135
- acid-functionalized carbons 777
- acidic electrolytes 916, 929
 - PEM electrolysis 961
- acidification 285, 603, 916
- acid leaching 237
- acid zeolite catalyst 458
- acrolein 490
- acrylic acid 503, 507, 508, 527
 - synthesis 835
- acrylonitrile 505, 507, 515, 521, 527
- activated carbon (AC) 394, 776
- activated carbon fiber (ACF) 641
- activation energies 851, 904, 909, 963
- active acid materials 721
- active carbons 723
- active catalyst phase 97
- active metal oxides 514
- active oxygen 424
- active phase–support interactions 225
- active sites 225, 235, 243
- acylation toluene 135
- adamantine-containing diquaternary alkylammonium iodides 252
- additive digital fabrication 359
- additives 5, 14
- adsorption 60, 209, 220, 425
 - of benzaldehyde and propanal at Lewis acid site 1073
 - enthalpy 1071
 - properties 862
- advanced oxidation processes (AOP) 50, 873, 884
- AEM (tertiary amino groups) 917
 - electrochemical reforming data 969
 - ethanol electrochemical reforming 971
- AEN-zeotype structure 262
- aerogels 10, 39
- aerosol pyrolysis method 158
- affinities 209
- Ag/ α -Al₂O₃ catalyst 484
- agglomeration 3, 228, 236

- aggregation 239
- Ag⁺ ions 14
- Ag metal nanoparticles
 - schematic depiction of 130
- Ag nanocrystals 14
- Ag–O bond formation 486
- AgPd nanoparticles 234
- agricultural waste 754
 - biomass residues 755
- Ag/SiO₂-Al₂O₃ catalysts 493
- AgTa_{0.7}Nb_{0.3}O₃ 854
- Ag trimers 490
- air calcination 747
- alcohol oxidation 970
 - anode 965
 - catalyzed by Au/MOx 25
 - kinetics 965
 - rate-determining step 24
- alcohols 241, 964
 - aerobic oxidation 25
 - catalyzed by sulfated zirconia 791
 - dehydrogenation 25
 - direct oxidation 25
 - electrooxidation 965, 972
 - oxidation of 22–25
 - – carboxylation 821
 - – size dependence 22
- alcoholysis 764
- ALD. *see* atomic layer deposition (ALD)
- aldol reactions 602
- ALE. *see* atomic layer epitaxy (ALE)
- algae biomass 808
- algae pond systems 808
- aliphatic hydrocarbons 665
- alkali-free (AF) Sn-Beta 613
- alkali metals 210, 612, 613
- alkaline anion exchange membrane 963
- alkaline conditions 972
- alkaline earth metal cations 857
- alkaline electrolysis 915, 916, 929, 961
 - water electrolysis process 962
- alkaline electrolyzer 962
- alkaline-mediated desilication 774
- alkali promoters 209, 210, 487
- alkanes, oxidation of 27
- alkenes
 - activation 998
 - gold-catalyzed oxidation of 26
 - oxidation of 26
 - 2-pentene 1067
- alkoxides 24
 - in H-ZSM-5 1068
- alkoxycarbonylations reactions 183
- alkylation, benzene/derivatives 133
- alkyl fructoside 606, 618
- alkyl glucosides 618
- alkyl glycosides 617
- alkyl lactate 612
- alkyl levulinate 620
- alkylphenols 289
- alkylpyridines 286
- alkyl shifts 623
- alkyl-SPO ligand-protected Au NPs 32
- alkyne alcohols
 - hydrogenation of 182
- allylic C–H bond 27
- Al-MCM-41 material
 - for catalytic pyrolysis of biomass 674
- Al₂O₃ ALD
 - film, cross-sectional SEM image 339
 - overcoats 346, 347
- γ-Al₂O₃ and MgO supports 214
- Al₂O₃-P₂O₅-MgO-H₂O system 262
- Al₂O₃-P₂O₅-Na₂O-H₂O system 262
- alpha-alumina 484
- [Al₅P₄O₂₆(OH)₃]²⁰⁻ building unit 263
- AlPO zeolites 991
- Al-rich MTT zeolite 256
- alternative energy 386
- alumina 342
 - supported heterogeneous catalysts 231
- aluminophosphate molecular sieves
 - organotemplate-free synthesis of 260
- aluminophosphate (APO-11) 77, 266
 - based molecular sieves
 - – organotemplate-free synthesis of 262
 - Na₆[(AlPO₄)₈(OH)₆]-8 H₂O 262
- aluminosilicate zeolites 138, 275, 471, 477, 1056
 - organotemplate-free synthesis 252
 - – BEA zeolite 254
 - – ECR-1 zeolite 252
 - – EMT zeolite 252
 - – FER zeolite 259
 - – MEL zeolite 258
 - – MTT zeolites 255
 - – RTH zeolite 257
 - – ZSM-34 zeolite 253, 254
 - – ZSM-5/ZSM-11 260
- aluminum 619
- aluminum defects 771
- aluminum molybdate 473
- aluminum nitrate 6
- aluminum phosphate (AlPO) crystals 991
- aluminum plant 807
- Al-zeolites 605, 619

- Amberlyst resins 759
- ameliorates 724
- amination 637
- aminoalkyl-functionalized zeolites 30
- aminoaromatics 238
- 1-(-aminobenzyl-2-naphthol 185
 - as organocatalysts 185
- aminocarbonylations reactions 183
- amino groups, electron-donating properties 30
- aminoindolizines, one-pot synthesis of 182
- aminophenol 725
- 4-aminophenol 196
 - catalyst and, bonding between 181
- aminopropylsilane 185
- 3-aminopropylsilane
 - as silane precursor 184
- 3-aminopropyl trimethoxysilane 192, 198
- ammonia 10, 16, 851, 962
- ammonia borane reaction, hydrolysis of 187
- ammonia calorimetry 784
- ammonia synthesis 209, 211
- ammonium chloride 476
- ammonium-exchanged COK-14 sample 342
- ammonium heptamolybdate 472
- ammonium heptamolybdate tetrahydrate 739
- ammonium niobium oxalate 740
- ammonium persulfate 42
- ammoxidation 505, 521, 637
- amorphous silica alumina (ASA) 465, 694
- amorphous solids 1029
- anatase nanoparticle chains 343
- anatase N-TiO₂ 881
- anatase phase 220
- anatase TiO₂ carrier concentration 221
- Anderson–Schulz–Flory (ASF)
 - distribution 450
 - strategies to break 450
 - – encapsulation strategies 451
 - – physical mixtures 450
 - – zeolite-supported FT 451–453
- aniline 239
- anion exchange membrane (AEM) 915, 963, 965, 968
 - electrochemical reforming 968
- anionic Au core 22
- anionic dye 991
- anisotropy 992
- annealing temperatures 366
- annihilation 1031, 1037
- anode architecture schematics 970
- anode catalysts 968
- anode–cathode proximity 912
- anode electrode 970
 - fabrication 968
- anode materials 941
- anodic oxidation 11
- anodization 11
- anodization setup 12
- antibiotic resistant bacteria (ARB) 884
- antiferromagnetic materials
 - magnetic moment 146
- aqueous-phase hydrogenation (APH) 347
- arenesulfonic 77
- arene-sulfonic acid SBA-15 788
- aromatic hydrocarbons 471
- aromatic nitro compounds 238
- aromatics 472, 592
- aromatization 718
- Ar pyrolysis 233
- Arrhenius plots 904
- artificial photosynthesis 396, 825
- artificial/solar light sources 877
- arundo donax 964
- aryl boronic acids 235
- aryl bromides, carbonylation of 186
- β-aryl ether bond
 - acid-catalyzed cleavage of 549
 - cleavage in phenolic and nonphenolic units 553
- α-aryl ether bonds 541
- β-aryl ether bonds 541
- aryl halides 235
- aryl-SPO ligand-protected Au NPs 32
- ASA. *see* amorphous silica-alumina (ASA)
- ascorbic acid 227, 744
- ASF. *see* Anderson–Schulz–Flory (ASF)
- Aspargillus niger* 168
- ASPEN HYSYS software 964
- As Sn-containing zeolites 605
- atmospheric CO₂ reduction 931
- atomic absorption 767
 - spectroscopy 727
- atomic force microscopy (AFM) 164
- atomic layer deposition (ALD) 219, 335
 - bimetallic nanoparticles 350
 - catalysis, role in 319–350
 - in catalyst design 340
 - cycles 336
 - monometallic nanoparticles 348
 - oxide cycles 342
 - processes
 - – characteristics 336
 - reaction cycle
 - – schematic illustration 336
 - – schematic representation 346
 - supported catalyst design, role in 340

- synthesized Co catalysts 342
 - temperature window 338
 - thickness evolution of Pd 351
 - atomic layer epitaxy (ALE) 335
 - atomic ratio 726
 - attenuated total reflection (ATR) 163
 - Au₂₅
 - phenylthiolate-protected 32
 - Au-Al₂O₃ interface 31
 - Au-aryl SPO clusters 31
 - Au-catalyzed reactions 21
 - Au/C catalyst 972
 - Au/C gave cyclohexene oxide 26
 - Au clusters
 - Au₂₅ clusters
 - thiolate-stabilized 26, 30
 - Au₅₅ clusters
 - catalysts 26
 - phosphine-stabilized 26
 - phenylthiolate-protected 32
 - preparation and deposition 21
 - thiolate-stabilized 26
 - Au counter electrode 212
 - Au, EDX mapping images 864
 - Au, electronic state 12, 23
 - Au-Fe₃O₄ magnetic catalyst 181
 - Auger electron 1031
 - Au/graphene catalyst 235
 - Au-maghemite nanocatalysts 182
 - Au-magnetite nanocatalysts 181
 - Au nanoparticles 487, 954
 - Au-NiO core 25
 - Au-YSZ catalyst-electrode 955
 - based catalysts 235
 - electron-enriched 29
 - electronic properties 30
 - Au_n clusters
 - deposition of glutathionate-protected 27
 - Au particles
 - Pd-Fe₃O₄ magnetic nanocatalysts 182
 - size dependence 21
 - YSZ composite film 954
 - Au–S bond 31
 - Au/SiO₂ catalysts 495
 - Au/SiO₂ monohydrogenated
 - dinitrobenzenes 31
 - automobile exhaust treatment 339
 - automotive catalysis 371
 - autothermal steam reforming 952
- b**
- backscattering 1033
 - Baeyer-Villiger oxidation 602
 - bagasse 592, 755
 - balance of system (BOS) 914
 - nanoparticles 943, 944
 - bandgap energy (BG) 215, 853, 854, 860, 873, 876, 880, 910, 984
 - BAS. *see* brønsted acid (BAS)
 - base leaching 276, 284
 - batch reactor 13
 - batteries 336
 - Bayer–Hoechst process 487
 - BEA zeolite 451, 607
 - bed reactor 369
 - benzalacetone hydrogenation 29
 - benzaldehyde 723, 726
 - conversion of 321
 - benzaldehyde adsorption
 - on Au clusters on Al₂O₃ 34
 - benzaldehyde hydrogenation
 - size dependency 33
 - benzene 986
 - alkylation 317
 - hydroxylation 67–69
 - benzenediamine 730
 - benzenedicarboxylate (BDC) linker 1063
 - benzene ethylation 317
 - benzene oxidation to phenol 741
 - benzene selectivity 472
 - benzene, toluene, and xylene (BTX) 673
 - aromatics 681
 - benzoic acid esterification 772
 - benzyl alcohol 726
 - aerobic oxidation 23
 - selective oxidation of 138
 - benzylation 738
 - beta-SDS
 - crystals 255
 - samples, TEM images 256
 - textural parameters 255
 - beta zeolites 255, 279, 607, 615, 670, 673
 - seed-directed synthesis 255
 - BG value 875
 - bidisperse model 457
 - Bi, EDX mapping images 864
 - bifunctional catalysts 450, 821
 - bimetallic core–shell nanoparticles 169
 - bimetallic nanoparticles 341, 349
 - catalytic systems 169
 - bimetallic nickel 231
 - bimetallic Ni-Re/Al₂O₃ catalyst 412
 - bimetallic Ru-Pt/HY catalyst 452
 - bimodal meso-macropore networks 763
 - binder jetting 372
 - binder liquid 363

- binder printing process 363
- binding energies (eV) 29, 1031
 - of metals 100
- bio-based chemicals 643
 - molecular structure of 628
 - production costs of 628
- bio-based feeds 599
- bio-based feedstocks 590
- bio-based feed streams 410
- biocatalysis 91, 394
- biodegradable fuel 757
- biodiesel 76, 754, 964
 - applications 764
 - polarity 765
 - production 757, 782
 - – H₂SO₄ for 778
 - synthesis 762, 767
- bioethanol 76, 964
- bioethylene glycol 601
- biofuel production, and upgrading with mesoporous catalysts 75–77
- biofuels 75, 76, 385, 387, 388, 538, 587, 601, 629, 753
 - bioethanol 538
 - butanol 538
 - feedstocks 754
- biofuels production
 - influence of reactor design and operating conditions 790
- biogas 836
 - steam reforming 411
- biomass 75, 385, 387, 537, 592, 595, 601, 602, 627, 716, 734, 808, 963
 - components, thermal/catalytic pyrolysis 669
 - conversion processes 588, 589, 592, 594, 599, 734, 753
 - derived precursors 629, 634
 - pyrolytic thermal decomposition 755
 - thermochemical conversion of 655
- biomass fast pyrolysis (BFP)
 - acidity and pore structure on yield and product distribution 671
 - bio-oils produced by catalytic upgrading 681
 - carbon balance with HZSM-5 667
 - catalysts
 - – acidity/porosity/morphology, effect of 698
 - – fast pyrolysis, with zeolites 661
 - – with hierarchical zeolites 680
 - – with mesoporous aluminosilicates 674
 - – with metal-modified zeolites 688
 - – with metal oxides 693
 - cellulose pyrolysis 699
 - CFP selectivity 680
 - corncob with HZSM-5 zeolite catalyst 664
 - Co(10%)/ZSM-5 catalyst, TEM analysis 691
 - glucose with ZSM-5 701
 - lignin
 - – catalytic fast pyrolysis of 669
 - – noncatalytic/catalytic fast pyrolysis 703
 - lignocellulosic biomass
 - – catalytic upgrading 690
 - – pyrolysis vapors, upgradation 663
 - liquid products in noncatalytic and catalytic fast pyrolysis of corncob 664
 - lumped yields to monoaromatic hydrocarbons 687
 - meso-Ce-HZSM-5, SEM image of 682
 - mesoporous aluminosilicates
 - – MCM-41 materials 676
 - – SEM micrographs 679
 - metal exchanged meso-ZSM-5 catalysts 688
 - MgO and olivine catalytic bio-oils 698
 - model biomass-derived compounds, catalytic pyrolysis 666
 - molar carbon selectivity 683
 - monoaromatics, production of 702
 - nitrogen adsorption-desorption isotherms 679
 - oil fraction in noncatalytic/catalytic fast pyrolysis of corncob 665
 - operating parameters 656
 - organic fraction of bio-oil produced by beech pyrolysis vapors upgrading 696
 - oxygenates and phenolics in upgraded bio-oils 685
 - phenols production 676
 - renewable fuels and chemicals 655
 - in situ (single-step) upgrading 23, 660
 - switchgrass hemicellulose 700
 - upgrading with cracking catalysts 660
 - wood (beech wood) 657
 - – derived crude bio-oil 658
 - – pyrolysis 656, 695
 - with zeolites 672
 - – catalysts, chemical composition/porosity/cidity characteristics of 662
 - – used as pyrolysis catalysts 661
 - ZSM-5 (MFI-Pa), TEM image 686
- biomass gasification 907
- biomass processing 778
- biomass production 964
- biomass pyrolysis 756
- biomass recalcitrance 543
- biomass sources 628
- biomass valorization 592, 661
- biomolecule immobilization 759

- bio-oil
 - esterification 777
 - feedstocks 762
 - over H-ZSM-5 703
 - biooils 595, 599, 656
 - extraction from aquatic biomass 755
 - H/C_{eff} ratios 659
 - pyrolysis 761
 - biopharmaceuticals 808
 - bioplastics 601, 622
 - biopolymers 122, 539, 601
 - cellulose 539
 - hemicellulose 539
 - lignin 539
 - biorefineries 388, 538, 585, 589, 599, 794, 907
 - biorefinery schemes 538, 542
 - alternative categorization of 561–563
 - base-catalyzed processing 543
 - categorization based on processing mechanism 542
 - fate of lignin in 542–561
 - hydrothermal processing 543
 - organic solvent-assisted processing 543
 - reductive processing 543
 - thermochemical processing 543–545
 - biorefining 755
 - biowaste 386
 - biphenyl 231
 - bipolar membranes 916, 917
 - Bi/Sr/Au, SEM image images 864
 - bis(triethoxysilyl)benzene (BTSB) 782
 - bis(trimethoxysilyl)-ethane (BTME) 782
 - Bi₂WO₆ 854
 - block copolymers 630, 631
 - blocking temperature (T_B) 147
 - bond length 1035
 - borate 896
 - boron dipyrromethene (BODIPY) 991
 - Boudouard reaction 438, 815
 - Bragg reflection 981
 - bright field (BF) 951
 - Brønsted acid site (BAS) 230, 285, 393, 455, 473, 474, 477, 606, 609, 611, 616, 619, 622, 767, 985
 - acidic sites 610
 - acidity 452, 723
 - acidity gradient 986
 - acidity, Pd doping effect 774
 - catalysts 778
 - catalyzed 4-methoxystyrene dimerization 986
 - catalyzed 4-methoxystyrene oligomerization 986
 - catalyzed sugar transformation 616
 - in H-ZSM-5 1061
 - MoO_x coordination 473
 - zeolite 1067
 - bronchial carcinomas 281
 - buffer anions 918
 - buffered electrolytes 916
 - bulk reduction 438
 - buried junction (BJ) 909
 - buta-1,3-diene 14
 - butane partial oxidation 515
 - butanol 759
 - esterification 784
 - butenes 14
 - butyl glucofuranosides 618
 - butyl glucopyranosides 617, 618
 - butyl glucosides 617–619
- C**
- cake effect 452
 - calcination 8, 17, 23, 61, 181, 182, 200, 231, 339, 632, 718, 739, 743, 946, 989
 - calcination temperature 24
 - calcined beta-TEA zeolites 255
 - calcium carbonate 441
 - Calophyllum inophyllum 780
 - capacitances 233
 - capacitance–voltage (C–V) measurements 219
 - capital costs 915
 - capital expenditure (CAPEX) 495
 - capping agents 12
 - caprylic acid 719
 - carbides 598
 - carbohydrazide (CH) 97
 - carbonaceous deposits 475, 479
 - carbonaceous materials 23, 121, 629, 716, 718, 737, 743
 - functionalization, for catalytic applications 634–638
 - graphitization degree of 634
 - carbonaceous matrix 240
 - carbonaceous nanostructures 232
 - carbonaceous species, gasification 409
 - carbon allotropes 396
 - carbonate 896
 - and polycarbonate synthesis 820
 - carbon-based catalysts 628, 635, 638, 641, 647, 649, 650
 - hydrothermal stability of 649
 - performances of 648
 - synthesis routes for cellulose transformation 638–642

- carbon black (CB) 790
- carbon capture and storage (CCS) 806
 - routes of 806
- carbon capture and utilization (CCU) 806–809
 - routes of 806
- carbon chemistry 718
- carbon-coated MNPs 159
- carbon composites 200
- carbon credits 838
- carbon cycle, anthropogenic 813
- carbon dioxide (CO₂) 435, 851, 907
 - atmospheric content, strategies to reduce 806–809
 - catalytic utilization 836, 841
 - chemical utilization 839
 - as cofeed gas 816
 - conversion 839
 - challenges/outlook/perspectives 830–842
 - economic aspects 835–839
 - thermodynamic aspects 830–835
 - conversion 808
 - (cyclo)addition to epoxides 820
 - oxidative coupling of 818
 - oxidative dehydrogenation, advantages for 817
 - utilization 807
- carbon fibers 634, 641
- carbon fibrils 633
- carbon filaments 633
- carbon footprint 809
- carbon gels 38
 - production 39
- carbon hydrogenation 79
- carbonization process 233, 234, 237, 629–631, 634, 636, 716, 748, 776
 - Fe-MOF 243
 - MIL-88A nanorods 244
 - MOF 236
 - of Ni-MOF [Ni(HBTC)(4,4'-bipyridine)] 238
 - reactions 747
- carbon materials 232, 233, 236, 628, 637
 - characterization methods 40
 - chemical (surface) properties of 37
 - magnetic supports 201
 - overview of reactions 48
 - physical (textural) properties 37
 - recycling of 650
 - sulfonation 718
 - surface chemistry of 39
 - tuning 41
 - surface functional groups 39
- carbon materials
 - titration methods 40
- carbon mesostructures 632
- carbon monoxide 743
 - adsorption 1034
 - oxidation of 230, 743
- carbon nanocomposite catalysts 629
- carbon nanodots 927
- carbon nanofiber (CNF) 38, 633, 637, 649, 951
 - advantages of 43
 - catalytic cellulose conversion on 645
 - diameters 38
 - graphene layers 38, 640
 - types of 633
 - bamboo-shaped herringbone CNF 633
 - bamboo-shaped multiwalled CNF 633
 - fishbone (f-CNFs) 633
 - platelet-carbon nanofibers (p-CNFs) 633
 - ribbon (r-CNFs) 633
 - YSZ composite-electrodes 951
- carbon nanohorns 633
- carbon nanoparticles 193, 476
- carbon nanostructures, types of 633
 - fishbone (herringbone)-carbon nanofibers 633
 - multiwalled carbon nanotubes 633
 - platelet-carbon nanofibers 633
 - ribbon-carbon nanofibers 633
- carbon nanotube (CNT) 38, 46, 122, 395, 452, 633, 777, 929
 - advantages of 43
 - diameters 38
 - electronic properties 994
 - graphene layers 38
 - sulfonation method for 638
- carbon–nitrogen composite 242
- carbon oxidation 747
- carbon oxides 515
- carbon precursor 630
- carbon quantum dots 395
- carbon reservoirs 807
- carbon resources 753
- carbon sequestration 449
- carbon sources 239, 388
- carbon-supported Pt catalyst 365
- carbon xerogel 43, 45, 48, 777
 - catalysts 49
- carbonylation reaction 191
- carbonyl group hydrogenation 732
- carboxylate salts
 - neutralization of 25
- carboxylation 841
- carboxylic acids 40, 41, 719
- carboxylic groups 722, 723
- carboxymethylcellulose 641

- carburization process 240, 473, 639
- car catalytic converters 371
- carrier reduction 424
- catalysis 91, 809
 - applications 91
 - in biological reactions 91
 - types of 91
- catalysts 91, 209
 - activity 585, 587
 - adsorbate complex 1030
 - characterization 981
 - consumption 588, 590–592
 - containing systems 376
 - cost 589
 - deactivation 594
 - – destruction 596
 - – fouling 595
 - – poisoning 595
 - deactivation, by carbon formation 19, 407
 - – ensemble size control concept 408
 - – gasification agents 408
 - – surface of nickel nanoparticles 408
 - degradation 599
 - design of 628
 - – catalytic performance, thermodynamics and economics 839–842
 - destruction 589, 595
 - fouling 589, 595
 - life 585, 588, 589
 - loading 587, 588
 - longevity 599
 - poisoning 410, 411, 589
 - pores 646
 - recycles 777
 - recycling, magnetic separation enabled 766
 - selectivity 585, 586
 - separation methods 164
 - stability 593
 - structure 1040
 - surface 209
- catalytic ability 602
- catalytic activity 15, 209, 289, 877, 928, 985
 - site/modeling 1058
 - – determining the nature of the active site 1060
 - – taking into account topology 1058
 - – spatiotemporal distribution of 990
- catalytically active channel wall 371
- catalytically active material 371
- catalytically active oxides 366
- catalytically active sites 342
- catalytic conversion of cellulose
 - to bio-based chemicals in water 643
 - over bifunctional carbon nanofiber-based catalysts 646
 - over functionalized mesoporous carbon-based catalysts 644
- catalytic cracking 286, 321
- catalytic dehydrogenation, of isobutane 232
- catalytic depolymerization 639
- catalytic esterification 793
- catalytic fast pyrolysis (CFP) 660
- catalytic hydrocracking 323
- catalytic hydrogenation 726, 1034
- catalytic materials 225
- catalytic methane combustion 747
- catalytic oxidation 984
- catalytic processes 234, 602, 628
- catalytic properties 102
 - exhaust catalysis 106
 - hydrogenation 113
 - hydrogen production 110
 - measurements 3
 - polluted water remediation 103
- catalytic pyrolysis 592
- catalytic reactions 59, 181, 225, 287
 - cycle 523
 - heterogeneous 187
 - – 4-nitrophenol, reduction of 187
 - – olefins, hydrogenation of 187
 - – oxidant free dehydrogenation 187
 - – transfer hydrogenation 187
 - mechanisms 209
- catalytic reactivity 179
- catalytic reactor 1029
- catalytic reduction 984
- catalytic routes 385, 627
- catalytic sites 628
- catalytic stability 198
- catalytic testing 982
- catalytic transformation, of sugars 601
- catalytic zone 369
- cathode compartment 916
- cathodic polarizations 943
- cation-exchangeable resins
 - sulfonated polystyrene-based 778
- cation exchange membrane (CEM) 915
- cationic doping 8
- C–C bond cleavage 485
- CCS. *see* carbon capture and storage (CCS)
- CCU. *see* carbon capture and utilization (CCU)
- Ce3d-core level spectra 100
- Ce-doped ZrO₂ photocatalyst 875
- Ce isopropoxide 875
- cell coupling 827
- cell design 27, 918

- cellobiose 45, 721
 cello-oligomers 650
 cell potentials 945, 963
 cell temperature 967, 970
 cellulose
 – delamination of 649
 – derivatives, heterogeneous hydrogenation of 964
 – derived carbon solid acid (CCSA) 778
 – polymerization of 539
 – schematic transformation into glucose 167
 cellulose hydrolysis 543
 – carbon materials, contribution of 642
 cellulose microfibrils 539
 cellulosic backbone 647
 cellulosic biomass 628
 cellulosic materials 963
 CeO₂/Au nanocatalysts 15
 CeO₂-based catalysts
 – solution combustion synthesis (SCS) 93
 – synthesis and evaluation of 94
 Ce precursor 231
 ceramics 939
 – stereolithography 378
 – tiles 885
 ceria lattice parameters 431
 ceria nanoparticles 430
 – from precipitation, undoped 428
 ceria-zirconia supported nickel catalysts 411
 cerium oxide 410, 746
 cerium precursor 743
 cerium-zirconium 410
 cesium-doped dodecatungstophosphoric acid (CsPW) 788
 cesium tungsten niobate 519
 cetane number (CN) 464
 cetyltrimethylammonium bromide (CTAB) 154, 160, 279, 822
 Ce_{1-x}M_xO_{2-δ} catalysts 95
 Ce_{1-x}Pt_xO_{2-x} catalyst 95
 CFB. *see* circulating fluid bed (CFB)
 CH adsorption energy, on Ni(111) 213
 chalcogenides 854, 857
 charge depletion 215
 charge transfer 16, 213, 216, 220
 – amount of 215
 – controlling 16, 217
 – from supported Pt nanoparticles to CeO₂ 217
 Char yield 692
 CHA (S-CHA) zeolite
 – solvent-free synthesis 266
 chemical charge 440
 chemical composition 875
 chemical energy 908
 – conversion 385
 – storage 385, 390
 chemical fuels 914
 chemical functionality 375
 chemical heterogeneity 594
 chemical industry, oxidation reaction role 22
 chemical inertness 236
 chemical kinetics 1091
 chemical looping
 – catalyst assisted 435–440
 – concept 419–423
 – materials 423–435
 – schematic representation 422
 chemical looping combustion (CLC) 421
 chemical looping dry reforming (CLDR) 423
 chemically active promoter materials 425
 chemical reaction 718
 – rate 79
 chemical stability 239, 862
 chemical titration method 41
 chemical transformations 339
 chemical vapor deposition (CVD) 93, 146, 336, 473, 605, 634
 chemisorption 16, 998
 – capacity 218
 – process 411
 chemisorption, of reactants 770
 chemoselective hydrogenation 732
 – catalyst 732
 chemoselective 4-nitrostyrene reduction 988
 chemoselectivity 239
 chiral catalysts 182
 chiral ketone@SBILC@MWCNT@Fe₃O₄ catalyst
 – schematic synthesis of 168
 chitosan 201
 chloroanilines 113
 chloroarene, dechlorination of 182
 chlorohydrin route 484
 chlorohydrocarbon feed modifier 486
 chloronitrobenzenes 31
 4-chlorophenol
 – hydrodechlorination of 201
 chlorophenols 201, 235
 chloropropyl trimethoxysilane 193
 chlorosulfuric-impregnated zirconia 769
 2-chloro-thiophene 997
 C₂H₄ oxidation 211, 212
 CH₄ oxidation 110
 chromia catalyst 232
 chromogenic reaction 984
 chromophore 984

- chronoamperometric response 238
- chronoamperometry 904
- CH_x species
 - dehydrogenation degree of 409
- C4 α -hydroxyacid esters 614
- cinchoidine, as chiral substrate 188
- cinnamaldehyde 723
 - hydrogenation of 28, 30, 44
- cinnamic alcohol 732
- cinnamic aldehyde 732
- cinnamic aldehyde hydrogenation to cinnamic alcohol 732
- circulating fluid bed (CFB) 507, 660
- cis-2-butene 982
- citronellal
 - one-pot 2-step reaction 139
- city planning 753
- clay minerals, hybridization of 240
- CLDR. *see* chemical looping dry reforming (CLDR)
- clean-burning fuels 464
- clean liquid transportation fuels, production of 449
- clean synthetic diesel process 464
- climate changes 805, 839
- cluster model, with Lewis acid site 1063
- CMK-3 mesoporous carbon 237
- CN. *see* cetane number (CN)
- C–N bond formation 372
- CNF. *see* carbon nanofiber (CNF)
- CNT. *see* carbon nanotube (CNT)
- CO adsorption energy 220
- coal-fired power plant 807
- CO₂ and H₂O electrolyzers 940
- CO₂, artificial photosynthesis 82
- cobalt catalysts 815
 - based non-PGM catalysts 236
- cobalt(III)acetylacetonate [Co(acac)₃]
 - precursor 342
- cobalt nitrate hexahydrate 229
- cobalt oxide nanoparticles, on hydrochar 728
- cobalt–phosphate (CoPi) complex 916
- cobalt–zeolite interaction 453
- Co-based materials 243
- CO₂ capture 807, 836
 - absorption 836
 - adsorption 836
 - cryogenic separation 836
 - membrane separation 836
 - methods 836
- cocatalysts 891, 899
- Co/C-600 catalyst 243
- cocondensation 60
- CO₂ conversion 808, 809, 840
- CO dissociation energy 79
- CO₂ emissions 75, 449, 753, 809
 - chemical synthesis, effect on reduction 808
 - and global warming 805
- coercivity 244
- Co–Fe alloy nanoparticles 947
- Co-Fe₃O₄ nanocatalyst 181
- CoFe₂O₄ nanocomposites 229
- CO₂ formation 490
- coherent anti-stokes Raman scattering (CARS) 997
- cohesive properties 879
- CO hydrogenation 211, 214
- CO₂ hydrogenation 78, 812, 814, 832, 833
- CO hydrogenation, low-temperature 243, 469
- C=O hydrogenation selectivity 29
- COK-14 (OKO framework type) 343
- coke burn-off 597
- coke/carbon deposition 815
- coke deposition 78, 284
- coke formation 340, 341, 792, 986
- coking 340, 478
- colloidal catalysts 3
- colloidal polystyrene nanospheres (hard)
 - templating methods 763
- colloidal zeolites 278
- combinatorial catalyst libraries 367
- combinatorial catalyst screening
 - inkjet printing 368
- combined chemical looping
 - schematic working principle 440
- combined chemical looping (CCL) 440–442
- combined heat and power (CHP) 794
- combustion 281, 422
- CO₂ methanation 78
- commercial biodiesel 757
- commodity chemicals 59
 - production of, pathways for 824
- compatibility 916
- complementary insights from spectroscopy 1085
- π -complexes 1068
- complex perovskite-type oxynitride 25, 856
- composite materials 722, 735
 - from hydrothermal carbonization in presence of metal/oxide precursors 735–742
- computational fluid dynamics 371
- computational modeling 492, 1055
- computational spectroscopy 1058
- computed IR spectrum 1089
- computer-aided fabrication technologies 359

- computer-controlled positioning system 359
- Co nanoparticles 242
- concentrated solar power (CSP) 827
- condensation degree 718
- condensation reactions 756
- conduction band (CB) 227, 853, 861, 873
- conduction band minimum (CBM) 854
- conductivity 219, 912, 918, 931
- confocal fluorescence microscopy (CFM) 987, 990
- conformal deposition 341
- Co–N interactions 236
- contact angle measurements 785
- contaminants 589, 876, 891
- continuous flow reactors 740
 - 3D printing 375
- continuous hydrothermal ripening 8
- controlled simultaneous reduction 349
- conventional catalysts 76, 394
- conventional commercial zeolites 288
- conventional cracking 388
- conventional drying 39
 - reforming 423
- conventional extruded ceramic monolith 370
- conventional photocatalysts 82
- conventional silica 58
- conventional steam reforming 422
- conventional/superior porous zeolites, types 277
- conventional zeolites 281
- conversion cost 586
- Co₃O₄-carbon hybrid 238
- Co₃O₄ nanoparticles, supported on hydrochar spheres 728
- CO oxidation 21, 69–72, 220, 222, 230, 231, 243
 - activity 218
 - rate 218–221
- copolymers 631
- copper-based catalysts 239
- copper chromite catalysts 347
- copper-containing hydrotalcites 496
- copper ferrite MNP 184
- coprecipitation 339, 403
- Co-promoted ZSM-5 catalysts 690
- Co@Pt catalyst
 - magnetic autorecycling of 171
- Co@Pt core–shell nanoparticles, dual integrated functionality of 170
- CO–Pt system 900
- CO₂ purification 836
- cordierite monolith 97
- CO₂ recycling 806
- CO₂-related reactions
 - thermodynamically equilibrated yields, conditions for 832
- core–shell catalysts 945
- core–shell magnetic carbon material 200
- core–shell magnetic nanoparticles 151, 152
 - characterization 163, 164
- core–shell nanoalloys
 - synthetic route of 161
- core–shell nanoparticle 341
- core–shell structures 194, 209
- core–shell systems 193
- corrosion 929
- CO₂ selectivity 952
- CO₂ storage 807, 808
 - geological 808
 - ocean and underground 807
- CO₂ storage facilities 807
- CO₂ to CH₄, catalytic conversion 78
- CO₂ transportation 807
- counterrotating leveling roller 363
- coupling catalysis 394
- coupling micromixer 8
- coupling reactions 181
- CO₂ utilization 808–810, 812, 831, 839
 - catalytic utilization, ways of 809–830
 - – hydrogenation reactions 809–814
- covalent bonds 875
- covalent organic framework (COF) 314
- covalent semiconductors 215
- CO₂ valorization 809, 831, 833–837, 839, 841
- CO₂ yield 213
- Co/ZSM-5 catalysts 453
 - Brønsted acidity in 453
- cracking/condensation 424
- Cr/metal cocatalyst system 901
- Cr/M H₂ cocatalysts 901
- Cr₂O₃/Al₂O₃ catalysts 232
- cross aldol condensation 1074
- cross-channel structure, advantage 372
- crotonaldehyde
 - selective C=O hydrogenation 30
- croton aldehyde hydrogenation 29
- crude jatropha oil (CJO) 761
- crude oil 504
 - palm oil 136
 - refining 449
- cryogels 39
- crystal axes 995
- crystal growth 4, 5, 9
- crystallization 58, 61, 282
 - time 612
- crystal nucleation 278

- crystal size 606
 - crystal structure 981
 - C-scorpionate complex [FeCl₂] 46
 - Cs-doped catalysts 765
 - CSP. *see* concentrated solar power (CSP)
 - CTAB. *see* cetyltrimethylammonium bromide (CTAB)
 - Cu-Al-MCM-41 675
 - Cu-BDC (1,4-benzenedicarboxylate) MOF 228
 - cubic close-packed (ccp) 149
 - Cu-BTC/TiO₂ composite 231
 - Cu²⁺ cations 227
 - Cu/Cr hydrotalcites 497
 - Cu/Cu₂O/C composite 239
 - Cu/Cu₂O NPs 239
 - Cu deactivation 347
 - Cu-Fe₂O₃ magnetic nanocatalysts 182
 - cumene 834
 - Cu nanoparticles 227
 - Cu-Ni/SBA-15 catalysts 76
 - CuO and CeO₂ nanoparticles 231
 - CuO/TiO₂ catalyst 231
 - current concentration 918
 - current densities 919, 928, 962, 970
 - current density 237, 895, 912, 967, 970, 972
 - current–potential curves 896, 897
 - Cu/TiO₂ photocatalysts 227
 - CVD. *see* chemical vapor deposition (CVD)
 - cyclic carbonates 821
 - butylene carbonate (BC) 821
 - direct synthesis of 821
 - ethylene carbonate (EC) 821
 - glycerol carbonate (GC) 821
 - propylene carbonate (PC) 821
 - cyclic reaction-regeneration
 - carbon yield 320
 - cyclic voltammograms 899
 - cyclohexane oxidation 44, 240
 - size specificity of Au_n/HAP 27
 - cyclohexanol 44, 742
 - cyclohexanone 44, 610, 746
 - cyclohexene 189
 - aerobic oxidation 26
 - hydrogenation 29, 188
 - oxidation 26, 27
 - cyclohexenyl hydroperoxide 27
 - cyclohexylbenzene 231
 - cyclooctene 733
- d**
- deactivation 225, 435, 475–478, 589
 - hierarchical zeolites 476
 - reactor engineering 478
 - regeneration 477
 - deactivation phenomenon 402
 - dealuminated beta zeolite (deAl-Beta) 605
 - dealuminated Y (DAY) 214
 - dealumination 278, 321, 473
 - Debye–Waller factor 1033
 - decahydronaphthalene 986
 - decarboxylation 699
 - decomposition 442
 - temperature 471
 - deep eutectic solvent (DES) 629
 - deforestation 754
 - degradation 599
 - degree of photocatalysis 855
 - Degussa P-25 catalyst 83, 229
 - dehalogenation 239
 - dehydration reactions 623, 669, 723
 - dehydrogenation 80, 227, 506
 - delamination 928
 - density Functional functional Theorytheory (DFT) 928
 - calculations 214, 220
 - VdW-DF adsorption energies for CO 221
 - density functional theory (DFT) 406, 442, 608, 857, 876, 1059
 - deoxygenating lignin-derived oxygenates 670
 - deoxygenation catalysts 756
 - deoxygenation reactions 594
 - 3-deoxyglucosan (3-DG) 615
 - department of energy (DOE) 914
 - depolymerization 538
 - deposition precipitation 339
 - deprotonation 917
 - derivatization process 636
 - DES. *see* deep eutectic solvent (DES)
 - desilication 279, 322, 771
 - desorption 209
 - deuterated ethylene 485
 - DFT. *see* density Functional functional Theorytheory (DFT)
 - β-D-glucopyranose 642
 - diacetylglycerol 77
 - diallyldimethylammonium chloride 733
 - diaminoglyoxime 184
 - diamond-like carbon (DLC) 951
 - diazonium salts 638
 - dibenzodioxocin 541
 - dibenzothiophene 231
 - dielectric constant 215
 - Diels-Alder condensation 700
 - Diels-Alder cyclization 375
 - Diels–Alder reaction 43, 717

- between furanic molecules to form aromatics 717
- diesel quality 464
- diffraction 437, 1030
- diffusion 293, 730, 896
 - catalysts with monomodal pore systems 312
 - – limitations of the reaction rate 312
 - – properties of the reactants and products 312
 - catalysts with multimodal pore systems 315
 - catalytic reaction and 294
 - coefficients 896, 897, 991
 - complex pore spaces 299–302
 - free reaction 778
 - implications on catalysis 311
 - interplay of conversion and 295
 - – catalyst of sorption capacity 297
 - – Einstein equation 295
 - – Fick's second law 295
 - – first-order conversion for mass transfer 295
 - – first-order reactions 295
 - – hydrogenation of benzene 297
 - – IR microscopy 297
 - – loading-dependent diffusivities 299
 - – Thiele modulus 295
 - mesoporous materials 315
 - micro-/mesoporous nanocatalysts 317
 - principle aspects of 294
 - rates 83
 - reaction equation 308
 - – in nanomaterials 18, 294
 - role of 293
 - transport mechanisms and assessment 302–310
 - – chemical potential 303
 - – coefficient of long-range diffusion 305
 - – corrected diffusivity 303
 - – Fick's first law 302
 - – Fick's second law 303
 - – frequency response method 304
 - – interference microscopy (IFM) 309
 - – self/tracer diffusivity 303
 - – transition state theory (TST) 307
 - – zero length column 304
 - types, of active sites 323
- diffusivity 286
- digital fabrication 376
 - flow 376
 - recent developments 377
 - tools 360–363, 371
- digital fabrication methods 375
- digital manufacturing methods 359
- digital mirror device (DMD) 362
- digital revolution 359
- dihydroxyacetone 609
- dimethoxymethane 1,1-dimethoxymethane (DMM) 391
- dimethylcarbonate (DMC) 835
- dimethyl ether (DME) 812, 832
 - synthesis 833, 840
- diphenylphosphine ligand 192
- dipole moment 992
- direct aerobic oxidative esterification, of alcohols 242
- direct current (DC) 220
- direct epoxidation 484
- direct methanol fuel cells 367
- direct oxidation process 484
- direct water splitting photocatalysts 854
- discussion 897
- disinfecting agent 484
- dispersed superparamagnetic 164
- distillation–precipitation polymerization method 196
- divinyl benzene 196
- DMC. *see* dimethylcarbonate (DMC)
- DME. *see* dimethyl ether (DME)
- 1D metal–semiconductor 210
- DMM. *see* dimethoxymethane 1,1-dimethoxymethane (DMM)
- DMSA. *see* meso-2,3-dimercaptosuccinic acid (DMSA)
- dodecylamine-inorganic oxide 60
- dopamine (DOPA)
 - as modifier for magnetite 184
- dopaminequinone 196
- dopants 217, 219
- doping 217, 218, 874, 928
 - efficiency 875
 - with metals 874
 - with nonmetals 874
- double metal cyanide (DMC) 788
- downhill reactions, catalytic reaction path 852
- 3D printing
 - chain 373
 - chromatographic media 378
 - enables reactors 373
 - extrusion-based methods 362
 - molds 373
 - pore structure 237
 - powder bed methods 363
 - stereolithography 361
 - technologies 362
- DRIFTS studies 101
- dry CO₂ 807

- dry hydrocracking 463
- drying 339
- dry oxidation 636
- dry reforming 423
- 2D structures 927
- d⁰-transition metal oxynitrides 855, 856
- 3D-type electrodes 386
- d¹⁰-type oxynitrides, (Ga_{1-x}Zn_x)(N_{1-x}O_x) 855
- dumbbell-like nanoparticles 194
- dyeing industry 729
- dynamic approach 1082
- dynamic light scattering 163

- e**
- eco-friendly strategy 235
- ECR-1
 - aluminosilicate zeolite of 252
- ectrofonton degradation 182
- EDS. *see* energy dispersive X-ray spectroscopy (EDS)
- EFAL acid sites 620
- EGR. *see* enhanced natural gas recovery (EGR)
- ehydrogenation 17
- EISA. *see* evaporation-induced self-assembly (EISA)
- elastomer batch reactors 375
- electrical conductivity measurements 218
- electrical energy 387, 971
- electrical polarization 211, 953
- electric conductivity 927
- electric current 919
 - concentration 919, 920
- electric fields 222
- electricity consumption 878
- electrification 907
- electrocatalysis 226, 232, 234, 394, 822, 892, 905
 - thermal catalysis, advantages over 822
- electrocatalysts (EC) 364, 386, 394, 892, 897, 905, 908, 927, 963
 - ink formulations 365
- electrocatalysts, low-cost 926
- electrocatalytic activity 724, 945
- electrocatalytic performance, in photocatalysis 897
- electrocatalytic process 892
- electrocatalytic reactors 972
- electrochemical impedance spectra 238
- electrochemical potential 917
- electrochemical promotion 212
- electrochemical promotion of catalysis (EPOC) 209, 941
 - effect 211
 - reactor 940, 941
- electrochemical reactions 899, 911, 941
- electrochemical redox reactions 892
- electrochemical reforming 961–964, 968, 975
 - cell performance 965
 - polarization curves 970
 - potential of biomass-derived alcohols in 964
- electrochemical sensors 939
- electrochemical switching 948
- electrochromism 918
- electrode material 233
- electrodialysis 916, 917
- electroless deposition 349
- electrolysis 838, 915, 961, 963
- electrolyte 914, 915, 928
 - engineering 893
 - membrane reactor 515
- electromotive force 899, 939
- electron binding energy 1032
- electron diffraction (ED) pattern 99
- electron-donating alkyl SPO 32
- electronegative promoters 211
- electronegativity 596
- electronically conducting matrix
 - catalytic nanoparticles dispersed in 951
- electronic metal support interaction (EMSI) 214
- electronics
 - conductivity 942
 - conductor 941
 - effects 12
 - π - π^* electronic transition energy 985
 - energies of formation, experimental and calculated 443
 - inkjet-assisted manufacturing 376
 - properties 222
 - reaction energies 444
 - transition 984
- electronic transitions, in metal 984
- electron microscopy characterization 970
- electron paramagnetic resonance (EPR) 876
- electron potential 895
- electron scattering 1033
- electron tomography reconstruction 430
- electron transfer 29, 862
 - characteristics 237
 - number 237
- electro-osmosis 930
- electro-oxidization 965
- electropositive contaminants 595
- electropositive minerals 599
- electropromotion 951
 - effects 953

- electroreduction 965, 994
- electroreforming
 - under acidic conditions 965
 - concept 965
- electrospinning 634
- electrostatic attraction 862
- electrostatic forces 865
- electrostatic interactions 180
- electrooxidation 972
- Eley–Rideal mechanism 1030
- ELISA. *see* evaporation-induced self-assembly (ELISA)
- ellipsometric porosimetry (EP) 344
- Embden–Meyerhof–Parnas glycolysis 612
- emulsion polymerization 197
- β -enaminones 745
- enantioselectivities 182
- enantioselectivity 188
- encapsulated catalyst 451
- endotemplating 631
- endothermic dehydrogenation 506
- endothermic reaction 478
- energy balance 912
- energy band 216
- energy consumption 806, 809, 880, 964, 971
- energy demand 913
- energy densities 964
- energy dispersive X-ray (EDX) 987
- energy dispersive X-ray spectroscopy (EDXS) 100, 190, 436
- energy efficiency 238
- energy gap 852
- energy-intensive solvent reflux 764
- energy storage 390, 442
- energy transition 387
- energy vectors 390
 - production 389
- engineering 897
- engine exhaust 939
- enhanced natural gas recovery (EGR) 808
- enhanced oil recovery (EOR) 807, 808
- eni Slurry Technology (EST) 388
- enthalpies 4, 607, 1056
- environmental hazards 929
- environmental pollution 755, 880
- enzyme catalysis 91
- EOR. *see* enhanced oil recovery (EOR)
- epimerization 604
- EPOC effect, permanent 954
- epoxidation catalyst 137, 487, 733, 745, 991
- epoxy resins 912, 930
- equipment threshold 376
- eriochrome black-T (EBT) 882
- erionite (ERI) zeolites 253
- Eruca sativa Gars (ESG) oil
 - transesterification of 789
- erythrose (ERO) 613
- erythrose (ERU) 614
- EST. *see* eni Slurry Technology (EST)
- ester hydrolysis 991
- esterification 77, 636, 719, 720, 722, 733, 757
 - of glycerol 719
 - reactions 759
- esters 602
- estragole, hydroformylation of 191
- etching 194, 731, 988
- ethanol 211, 587, 601, 618, 619, 962, 964, 965, 972
 - oxidative dehydrogenation to acetaldehyde 494
- ethanol dehydration 76
- ethanol dehydrogenation 496
 - equilibrium conversion 495
 - mechanism 496
- ethanol fermentation 601
- ethanol oxidation 964
- ethanol oxidative-dehydrogenation, mechanism 497
- ethanol steam reforming reaction 76
- ethanol/water mixture 228
- ethanolysis reaction 594
- ethene
 - hydroformylation of 342
- etherification 77, 986
- 5-ethoxymethyl furfural (EMF) 603
- ethyl acetate formation rate 49
- ethylammonium 528
- ethylbenzene, acylation of 134
- ethylene 471, 587, 593, 982
 - adsorption energies 220
 - oxidation to vinyl acetate 487
- ethylene-butylene cross metathesis 505
- ethylene carboxylation 818
- ethylenediamine (EDA) 258
- ethylene dichloride 515
- ethylene epoxidation 211
- ethylene formation
 - simplified reaction scheme 489
- ethylene glycol (EG) 227, 964
- ethylene hydrogenation 220, 222
 - TOF 215
- ethylene oxidation 492
- ethylene oxide 483
 - combustion 485
 - cyclization 486

- formation 486, 491, 492
 - – mechanism 486
 - ethylene oxide process 489
 - Ag-based catalysts 493
 - ethylene to ethylene oxide, direct oxidation of
 - by O₂ 484–487
 - ethylene total oxidation mechanism 488
 - ethyl fructoside 619
 - ethyl glucoside 619, 620
 - ethylidyne adsorption energies 220
 - ethyl lactate (EL) 609
 - reduction to 1,2-propanediol 725
 - ethyl vinylglycolate (EVG) 614
 - EtOH/furfuryl alcohol ratio 594
 - European Biomass Industry Association (EUBIA) 716
 - evaporation-induced self-assembly (EISA) 60, 631
 - E-vinyl sulfones, synthesis of 181
 - EXAFS. *see* extended X-ray absorption fine structure (EXAFS)
 - exchangeable electrodes 376
 - exhaust catalysis
 - CO oxidation 107
 - NO reduction
 - – by CO 13, 108
 - – by H₂ 109
 - – over Ce_{1-x}M_xO_{2-δ} coated, on cordierite monolith 109
 - – selective catalytic reduction, by NH₃ and CO 13, 109
 - exoskeletons 727
 - exotemplating 60
 - exothermic methanation reaction 78
 - exothermic oxidation 506
 - exothermic reactions 511
 - experimental entropy 444
 - exposed crystalline faces 3
 - extended X-ray absorption fine structure (EXAFS) 981, 1032
 - for Cu-UiO-67 1045
 - external magnetic field 732
 - extrusion 371
- f**
- face-centered cubic geometry 371
 - FAME. *see* fatty acid methyl ester (FAME)
 - Faradaic efficiency 917, 929, 950, 953
 - fatty acid methyl ester (FAME) 76, 757
 - fatty acids 720
 - Faujasite-type zeolite (FAU)
 - polymorph 252
 - schematic representation 264
 - FCC. *see* fluid catalytic cracking (FCC)
 - Fischer–Tropsch conditions
 - hydrocracking under 453–464
 - F-doped titanium suboxides 218
 - Fe-Al-MCM-41 675
 - Fe-based MOFMS systems 243
 - Fe-beta zeolite
 - organotemplate-free and seed-directed synthesis 255
 - Fe-BTC
 - Fe phase transformation during pyrolysis of 241
 - Fe catalysts 210
 - FeCl₂ catalyst 820
 - feedstock consumption 586
 - Fe(III) oxo-clusters 240
 - Fe-MIL-88A samples 239
 - FeMo catalyst 391
 - Fe/N/C composites 233
 - Fenton-like reaction 244
 - Fe₂O₃-CeO₂, ceria nanovoid structure 430
 - Fe₂O₃-CeO₂ samples
 - conventional CO₂-TPO of 427
 - Fe₃O₄ nanoparticles
 - formation 160
 - γ-Fe₂O₃ nanoparticles 239, 642
 - Fe/Pd mixed metal nanoparticles
 - incipient wetness impregnation approach for 129
 - fermentation 587, 601, 963
 - Fermi energy 218
 - Fermi level 215
 - ferrierite (FER) 259
 - ferrimagnetism 150
 - ferrimagnets 146
 - ferromagnetic materials 146
 - magnetic moment 146
 - ferromagnets 146
 - few-layer graphene (FLG) 38
 - Fe-Zn double-metal cyanides 790
 - FFA. *see* free fatty acid (FFA)
 - first-generation bio-fuels 754
 - first-order reaction
 - effectiveness factor of 296
 - Fischer–Tropsch synthesis (FTS) 72–75, 240, 386, 390, 449, 452, 728, 737, 814, 825, 829
 - gasoline-selective and diesel-selective 450–453
 - hydrocracking under 455
 - waxes 464
 - Fischer–Tropsch (FT) synthesis
 - catalyst 454, 465
 - cracking catalyst 449

- IR spectroscopy 230
 - fixed bed PR 877
 - flame spray pyrolysis 200
 - Flemion® 915
 - flue gas 836
 - fluid catalytic cracking (FCC) 321, 389, 465, 507, 659, 995
 - catalysts 252
 - fluid dynamics optimization 375
 - fluidizable solids 879
 - fluidized bed 515
 - fluidized bed FPG-PR 880
 - fluidized bed reactor 514, 515
 - FBPR 879
 - fluidized reactor technology 512
 - fluorescence microscopy 28, 989, 990, 992, 994, 996
 - reveal intraparticle heterogeneity 990
 - fluorescence microscopy techniques 989
 - fluorescent acid-base indicator 367
 - fluorescent dyes 990
 - fluorite 428
 - fluorogenic carboxyfluorescein diacetate 991
 - fluorogenic reaction, studies reveal suboptimal catalytic performance 991
 - fluorosulfonic 77
 - flux-controlled deposition methods 338
 - forestry waste 754
 - formaldehyde (FA) 39, 493, 513
 - commercial production 494
 - formate 972
 - formic acid 214, 234, 393, 724, 907, 965
 - formulated Pt/C-Nafion ink 365
 - formyl and nitro groups
 - size specificity for hydrogenation 33
 - fossil carbon
 - exploitation of 627
 - fossil-derived chemicals 628
 - fossil-derived precursors 628
 - fossil fuels 385–389, 394, 449, 537, 794, 806, 851, 914, 961
 - alternative 387
 - consumption 838
 - reserves 753
 - fouling 589, 595, 599
 - to mitigate 595
 - foundry casting molds 363
 - Fourier transform 1033
 - Fourier transform infrared spectroscopy (FT-IR) 163
 - Fourier transform infrared spectroscopy (FTIR) 344, 495
 - framework aluminum (FAL) 611
 - free energy 3, 4, 1079
 - and partition function, in statistical physics 1092
 - profile for the methylation of benzene 1077
 - free fatty acid (FFA) 76, 757
 - free-standing anatase TiO₂ nanoparticles 343
 - freeze drying 39, 282
 - Friedel–Crafts acid catalysts 820
 - Friedel–Crafts alkylation 767
 - Friedel–Crafts benzylation reaction 133
 - Friedel–Crafts-type treatment 196
 - fructose 602–604, 606, 612, 616, 618, 619, 622
 - fructose dehydration 622
 - fructose distribution 607
 - fuel cells 336, 339, 369, 376, 422, 440, 629, 939, 940, 942, 955
 - energy density 841
 - fabrication, inkjet printing 365
 - fuel consumption 449
 - fuel crops vs. traditional agricultural cultivation 754
 - fullerenes 396
 - fully connected OKO-type framework 342
 - Fumapem® 915
 - Fumasep® 917
 - fuming sulfuric acid 776
 - functionalized ink 375
 - functionalize mesoporous materials 121
 - furanic compounds 716
 - furans polymerization 703
 - furfural 593, 594, 621
 - furfural dimethyl acetal (FDA) 621
 - furfuryl alcohol (FA) 233, 593–595
 - fluorescent products 992
 - oligomerization 995
 - – H-ZSM-5 acid-catalyzed 992
 - – reaction on crystals 995
 - furonic derivatives 619
 - fused deposition modeling 362, 363, 373
 - future directions 478
- g**
- gadolinia doped ceria 953
 - GaInP–GaInAs tandem structure 922
 - galvanic replacement 15
 - gamma-valerolactone 740
 - two-step transformation into pentanoic acid 741
 - GaN photoelectrode 900
 - GaN, require UV light excitation 855
 - GaN: ZnO photocatalyst 902
 - GaP nanowires 922
 - gas chromatograph (GC) 107, 981

- gas evolution, time courses of
 - water splitting
 - – over $\text{RhCrO}_x/\text{LaMg}_{1/3}\text{Ta}_{2/3}\text{O}_2\text{N}$. catalyst 858
 - – over $\text{RhCrO}_y/\text{LaMg}_x\text{Ta}_{1-x}\text{O}_{1+3x}\text{N}_{2-3x}$ 858
 - gas fields 386
 - gas hourly space velocity (GHSV) 109
 - gasoline 232
 - gas permeability 931
 - gas-phase oxidation 818
 - gas-phase reactions 16, 21
 - gas–solid hydrodynamics 516
 - gas–solid reactions 336
 - gas-to-liquid (GTL) processing 449
 - conversion 386
 - gas velocity 510
 - Gaussian hills construct 1078
 - $(\text{Ga}_{1-x}\text{Zn}_x)(\text{N}_{1-x}\text{O}_x)$ photocatalyst 859
 - $(\text{Ga}_{1-x}\text{Zn}_x)(\text{N}_{1-x}\text{O}_x)$, utilize visible light 855
 - generalized gradient approximation (GGA) 442
 - $\beta\text{-Ge}_3\text{N}_4$, require UV light excitation 855
 - geometrically complex reaction vessels 372
 - geometric effects 214
 - germanium 281
 - GGA. *see* generalized gradient approximation (GGA)
 - GHG. *see* greenhouse gas (GHG)
 - Gibbs free energies 442, 445, 832, 851, 1080
 - glass sphere (GS) 875
 - global energy crisis 655
 - global warming 805
 - glucose 602, 603, 606, 616, 619
 - aerobic oxidation 22
 - conversion 618
 - derived material 720
 - isomerization 603, 605–610, 621
 - oxidation 23
 - pyrolysis
 - – on ZSM-5 700
 - glucose-fructose isomerization 607
 - glyceraldehyde 609
 - glycerol 76, 593, 962, 964, 987
 - conversion 77
 - electrooxidation 972
 - esterification 77
 - oxidation 972
 - glycolaldehyde (GA) 612, 613
 - glycolate 972
 - glycolic acids 77, 726
 - glycols 593
 - glycolysis 616
 - β -1,4 glycosidic bonds 539, 541
 - gold catalysts 817
 - gold-coated iron nanoparticles 160
 - magnetic core–shell nanoparticles 160
 - gold nanoparticles (Au NP) 13, 14, 196, 198, 730, 743, 996
 - magnetite, synergistic effect between 181
 - preparation imbedded into CeO_2 hollow spheres 743
 - gold on metal oxides (Au/MO_x) 24
 - grain boundary resistance 862
 - graphene-based materials 38
 - graphene nanosheets 927
 - graphene oxide (GO) 38, 243, 633
 - from natural graphite 38
 - structure of 38
 - graphenes 396
 - graphenic 37
 - graphitic carbons
 - nanostructures 629, 639
 - synthesis and functionalization 628–642
 - graphitic nanostructures 633
 - lignin-derived carbons 634
 - nanofilamentous carbons 633
 - green chemistry 145
 - greenhouse emissions 964
 - greenhouse gases (GHG) 805
 - atmospheric content, strategies to reduce 806
 - – carbon capture and storage (CCS) 806
 - – carbon capture and utilization (CCU) 806
 - emissions 838
 - green hydrogen 824
 - Grignard reagent 820
 - Grob fragmentation 700
 - growth per cycle (GPC) 337
 - growth rates 3, 5
- h**
- HAADF-STEM image 429, 433, 435
 - H_2 adsorption
 - on Au clusters on Al_2O_3 34
 - halogen-substituted nitroarenes 239
 - hard template method 60, 630
 - hardwood lignin 541
 - Hartridge–Roughton (vortex) micromixers 7
 - H/Au ratio 29
 - H-Beta zeolites 452
 - health, safety, and environment (HSE) 280
 - heat-generating resistor 361
 - heat of reaction 512
 - heat transfer 588
 - coefficient 514
 - heat treatments 227, 230, 237

- of Fe-BTC 240
- heavy components, removal of 595
- Heck reaction
 - coupling reaction 16, 184
 - of iodobenzene with methyl acrylate 731
- hematite 443
- hematite (α -Fe₂O₃) 149
- hemicellulose 540
- hemicelluloses
 - hardwood
 - – glucuronoxylan 541
 - softwood
 - – arabinoglucuronoxylan 541
 - – galactoglucomannan 541
- hercynite 830
- heteroatom doping 637
- heterogeneity 990
 - intraparticle 995
- heterogeneous catalysis 45, 91, 179, 191, 225, 226, 236, 241, 242, 293, 339, 344, 347, 589, 590, 628, 629, 813, 814, 821, 823, 839, 986, 989, 1029, 1030, 1043, 1056, 1057
 - catalysts for 92
 - characteristics of 1065
 - gas phase reactions 373
 - rate of 91
 - role for abatement of pollutants 92
- heterogeneous nucleation 4
- heterogeneous photocatalysis 873, 876, 884
 - reactors 26, 877
- heterogenization 45
- heterojunction structure 228, 874
- heteropolyacids (HPA) 764
- hexadecylamine 154
- hexagonal mesoporous silicas (HMS) 129
- hexanediamine 184
- hexanuclear oxozirconium clusters 229
- hexitols 645, 647
- hexoses 593, 609
 - sugars 603
- HF. *see* hierarchy factor (HF)
- H-ferrierite zeolites 774
- HfO₂ ALD layer 344
 - electron tomography reconstructions 345
- HfO₂-coated mesopores 345
- Hägg carbides 240
- H₂, heterolytic dissociation 32
- hierarchical zeolites 317, 476
 - factor 320
 - stability toward coking 319
 - ZSM-5, nitrogen adsorption isotherm 276
- hierarchy factor (HF) 476
- high-angle annular dark field (HAADF) 951
- high angle annular dark field scanning transmission electron microscopy (HAADF-STEM) 219
- high-fructose corn sirup (HFCS) 602
- highly oriented pyrolytic graphite (HOPG) 43
- high-performance Au catalysts 22
- high-performance electrocatalysts 727
- high-resolution scanning electron microscopy (HR-SEM) 987
- high-resolution transmission electron microscopy 3, 519
- high-surface-area solid materials 339
- high-temperature reactions 229
- high-throughput evaluation method 367
- high-throughput screening, inkjet-based 367
- H₂O/C ratios 941
- hollow carbon nanofibers 233
- homogeneous catalysis 45, 91, 179, 214, 589, 590, 1030, 1044
- homogeneous nucleation 3, 4, 16
- homogeneous precipitation 13
- homogenous catalysts 821
- HOMO–LUMO (π – π^*) separation 989
- Honda–Fujishima effect 851
- H₂ production 228, 390, 971
- HSE. *see* health, safety, and environment (HSE)
- 1,2-H shift 492
- H-SSZ-13 zeolites 995
- H₂ storage 390
- HTC 715. *see* hydrothermal carbonization (HTC)
- H₂-temperature programmed reduction profiles 29
- humidification 929
- Hummers method 38
- hybrid organic–inorganic architectures 794
- hydration 601, 859
- hydrazine hydrate (N₂H₄·H₂O) 239
- β -hydride elimination 488
- 1,2-hydride shifts 612, 623
- hydrocarbon-based reactions 814–820
 - carboxylation 817–820
 - – alkene and alkyne carboxylation 818
 - – aromatic carboxylation 820
 - – paraffin carboxylation 818
 - methane dry reforming 815
 - oxidation by CO₂ 816
- hydrocarbons 82, 469, 739, 943
 - based automobiles 78
 - cracking 941
 - oxidation 110
- hydrochars 719, 734
 - as classical carbon supports 723–729

- formation from glucose and xylose 716
- as sacrificial component in catalyst synthesis 742
- surfaces and possibilities for catalysis 718–723
- hydrocracking 450, 452, 454, 459
 - CO, effect on, over Pd/H-MFI catalysts 455–459
 - H₂O, effect on, over Pt/H-MFI catalysts 459–464
 - MFI zeolites, drawback of 464
- hydrocracking catalysts 388, 453
 - diesel-selective 455
- hydrodechlorination 31, 201, 235, 735
- hydrodenitrogenation (HDN) 231
- hydrodeoxygenation (HDO) 389, 658, 754, 756
- hydrodesulfurization (HDS) 209, 227, 231, 323, 739
- hydroformylation reaction 191
- hydrofracturing 449
- hydrogasification 233
- hydrogen 92
 - adsorbing sites 28
 - atom 520
 - as clean fuel 92
 - conditions 220
 - cost 913
 - electrode 854
 - evolution 963
 - rate 902
 - production 28, 961
 - rate 961
 - reactions 110
 - CO–PROX reaction 112
 - steam reforming 110
 - water-gas shift reaction 111
 - production of 92
 - selectivity 76
 - source of energy 92
 - storage capacity 233
 - transfer reactions 225
 - yield 964
- hydrogenation metals
 - stability window of 597
- hydrogenations 14, 28–33, 78, 138, 226, 231, 236, 240–242, 590, 723, 731, 741, 982, 987
 - activity 240
 - of benzene
 - transient concentration 298
 - catalysts 597
 - of CO 240
 - metals 598
 - of nitrobenzene 239
 - of nitro compounds 239
 - phases 598
 - protocols 241
 - rate 220
 - reactions 1040
- hydrogen evolution photocatalyst (HEP) 861
- hydrogen evolution reaction (HER) 861, 892, 908
 - electrocatalytic activity 901
- hydrogenolysis 593, 645
- hydrogen peroxide 737
- hydroisomerization 124
- hydrolysis 10, 60, 594, 991
 - of furan groups 719
- hydronium ions 894, 895, 897
- hydrophilic surface 729
- hydrophobic carbonaceous coatings 598
- hydrophobic channels 17
- hydroprocessing catalyst, diesel-selective 450
- hydroquinone 741
- hydrotaalcite (HT) 25
- hydrothermal carbonization 715, 717–721, 729, 735, 737, 738, 743
 - in presence of metal oxide nanoparticles 729–735
- hydrothermal carbonization (HTC) 629, 715
 - coating 722
 - glucose-derived carbonaceous microspheres
 - sulfonation of 780
- hydrothermal conditions 598
- hydrothermal crystallization 451
- hydrothermal decomposition 182
- hydrothermal method 154, 202
- hydrothermal ripening 7
- hydrothermal saline promoted grafting (HSPG) 762
- hydrothermal stability 58, 276, 740
- hydrothermal synthesis method 58, 60, 278, 747
- hydrotreatment 388
- hydroxide ions 915
- hydroxide-ion transport 916
- hydroxy 722
- hydroxyacetic acid 756
- α -hydroxy acids 602
- hydroxyapatite (HAP) 24
- 4-hydroxybenzyl alcohol
 - aerobic oxidation 22, 23
- α -hydroxy- γ -butyrolactone (HBL) 615
- hydroxyethylsulfonic acid 638
- hydroxy group of alcohol, deprotonation of 24
- hydroxyl anions 915
- hydroxylation 77

- hydroxyl ions 895
- hydroxyl radicals 891
- 3-hydroxy-3-methoxy benzaldehyde 756
- hydroxymethylfurfural 716
- 5-hydroxymethylfurfural (HMF) 33, 593, 603
- α -hydroxy products 602
- hysteresis loop 147, 244
- HZSM-5 catalyst 663
 - catalyst in Py-GC/MS system 670
 - zeolite 393, 666, 672, 702, 992
 - – core 986
 - – in deoxygenating the pyrolysis 678
 - zeolite to binder ratio (Z/B) 692

- i*
- IEM materials 914, 919
- IL. *see* ionic liquid (IL)
- imidazolium 186
- imidazolium-based supramolecular ionic
 - liquid-grafted graphene oxide 24
- imidazolium salts
 - as catalysts 822
- impregnation 92, 339, 349, 403, 472
- incipient wetness impregnation (IWI) 342
- incipient wetness method 92
- inductively coupled plasma atomic emission
 - spectroscopy 733
- industrial FCC catalyst particles
 - conversion to gasoline 322
- In, electron-deficient properties 30
- infrared (IR) 981, 1085
 - spectroscopy 284
 - spectrum of HKUST-1 1087
- ink formulation 361
- inkjet-compatible catalysts 376
- inkjet patterns 361
- inkjet printing 359, 360, 364
 - application of 364
 - drop-on-demand 360
 - piezoelectric approach 361
 - thermal approach 361
- inkjet technology, applications of 364
- ink solvent 361
- integrated circuit (IC) 336
- inter-electrode distance 911
- interparticle heterogeneity 983, 988, 989
 - structural 988
- interzeolite transformation 264
 - without organic templates 262
- intracrystalline mesopores 279
- intraparticle heterogeneities 983, 985, 991
- inverse gas chromatography (IGC) 785
- iodobenzene 731

- ion exchange 92
- ion-exchange materials 921
- ion exchange membrane (IEM) 908
- ion-exchange resins 24
 - sulfonic resins 136
- ionic conduction 931
- ionic conductivities 915, 916
- ionic current 915, 916, 919
 - concentration 919
 - density 918
- ionic liquid (IL) 185, 229, 629
 - pyridinium-based 185
 - sulfonic acid containing 789
- ionic radii 857
- ionic semiconductors 215
- ionic transport 913
- ionothermal carbonization 629
- ion transport 909
 - losses 918
- Ir_4 clusters 214
- iridium nanoparticles 14
- iron acetate 233
- iron catalysts 814
- iron oxides 149, 425
 - nanoparticles 434
 - reduction 440
- iron precatalysts 820
- isobutane 232
 - oxidative dehydrogenation of 47
- isobutane dehydrogenation 232
- isobutene 232
- isolated lignin
 - depolymerization of streams to phenolic
 - compounds 564–568
- isolation method 538
- isomerizations 23, 230, 286, 452, 453, 455, 459,
 - 461, 603, 604, 606, 609, 611, 615
 - esterification of trioses 609, 610
 - reactions 606
 - of sugars 602
- isooctane, autothermal reforming (ATR) 411
- isoparaffins 452
- isopropanol 242, 605, 618
- isopropyl alcohol 875
- isothermal reaction temperatures 438
- isotopologue 1040

- j*
- Jatropha curcas 754
- jet fuel 389
- Joint Center for Artificial Photosynthesis
 - (JCAP) 914
- JU93 synthesized 262

k

K⁺ cations 951
 Keggin-type phospho- and silicotungstic acids 764
 ketonization 697
 kinetic enhancement 929
 kinetics expression 4
 kinetic stabilization 598
 K⁺ ions 955
 K loading 491
 Knoevenagel condensations 185
 Knoevenagel reaction 314
 Knudsen diffusion 305, 315
 K₂O–Cr₂O₃/Al₂O₃ catalysts 232
 kraft pulping 553
 Kramers–Heisenberg equation 1032
 Kubelka–Munk function 876, 984

l

La- and Rh-codoped SrTiO₃ (SrTiO₃ – La,Rh) 863
 La_{0.43}Ca_{0.37}Ni_{0.06}Ti_{0.94}O_{3–γ} electrodes 948
 lactic acid 603
 Lambda sensors 939
 LaMg_{2/3}Ta_{1/3}O₃ oxide 857
 LaMg_xTa_{1–x}O_{1+3x}N_{2–3x} 860
 LaMg_xTa_{1–x}O_{1+3x}N_{2–3x} series photocatalytic activity 857
 Langmuir adsorption 255
 Langmuir–Hinshelwood–Hougen–Watson mechanism 775
 Langmuir–Hinshelwood kinetics 105
 Langmuir–Hinshelwood mechanism 1030
 Langmuir-type isotherms 307
 lanthanides 146
 lanthanum nitrate 746
 lanthanum oxide 410
 lanthanum strontium chromite 947
 La₂O₂CO₃ particles 409
 large-scale industrial oxidation processes – metal nanocatalysts 484–488
 laser beam 362
 laser scanning approach 362
 LaTaON₂, water splitting under visible light 856
 lattice fringes 100
 lattice matching 16
 lattice oxygen 112
 lauric acid 77
 layered device 369
 layered double hydroxide (LDH) 735, 927
 LCA. *see* life cycle analysis (LCA)

LCAO. *see* linear combination of atomic orbitals (LCAO)
 LCC. *see* lignin-carbohydrate complexes (LCC)
 leaching 188, 279, 593, 727, 767, 928
 lean trap catalyst (LTC) 942
 leukodopaminechrome 196
 levels of theory (LOTs) in periodic codes 1069
 levulinate esters 594
 levulinic acid (LevA) 590, 594, 595, 603
 – derivatives 621
 LEV zeolite 263
 Lewis acid 230, 606, 767
 Lewis-acid 614
 Lewis acid-catalyzed dehydration 614
 Lewis acid-catalyzed glycolytic reaction pathway 615
 Lewis acid-catalyzed isomerization 610
 Lewis acid-catalyzed sugar transformation 602
 Lewis acidic oxozirconium clusters 230
 Lewis acidic property 611
 Lewis acidic sites 230, 602, 606, 609–611, 663, 1063
 Lewis acidic zeolites 603, 623
 life cycle analysis (LCA) 838
 ligand-assisted method 60
 ligand effect 23, 214
 ligand-to-metal (LMCT) charge transfer 983
 light distribution 878
 light-emitting diode (LED) 879
 lignin biosynthesis 541
 lignin-carbohydrate complexes (LCC) 541
 lignin composition 539
 lignin isolation 538
 lignin pyrolysis
 – by TG-FTIR analysis 699
 lignin structure 538
 lignin transformations 542
 lignin valorization 538
 lignocellulose 537, 587, 590–592, 594, 598
 – structure 539–542
 lignocellulose biomass 539
 lignocellulose biorefinery 537
 lignocellulose composition 539
 lignocellulose conversion 591, 592
 lignocellulose processing methods 542
 lignocellulose pyrolysis 754, 755
 lignocelluloses 964
 – sources 537, 541
 lignocellulosic biomass 537, 698, 715, 717
 – location/structure of
 – – cellulose 540
 – – hemicelluloses 540
 – – lignin 540

- lignocellulosic residue 592
 Li⁺/MgO catalyst 817
 Lindar's catalyst 187
 linear carbonates 820
 – diethyl carbonate (DEC) 820
 – dimethyl carbonate (DMC) 820
 linear combination of atomic orbitals (LCAO) 1035
 linear ion pathway 912
 lipase enzyme, covalent immobilization of 169
 lipid transesterification 754
 liquefaction 386
 liquefied petroleum gas (LPG) 506
 liquid base-catalyzed transesterification 757
 liquid electrolyte (LE) 908
 liquid energy 387
 liquid extraction 595
 liquid fuels 82, 387, 388, 450, 469, 755
 – production of 449
 liquid-phase catalytic reactions 785
 liquid-phase colloidal synthesis 146
 liquid phase electrolysis 929
 liquid-phase organic molecules 782
 liquid-phase oxidation 636
 liquid-phase processes 3
 liquid-phase syntheses 3
 lithium aluminate 373
 lithium ions 616
 lithography
 – mask-based 359
 London forces 786
 long-chain hydrocarbons 321
 low-carbon economy 469
 low emission 421
 low-energy ion scattering (LEIS) 488, 522
 low-melting wax binders 373
 low vapor pressure 964
- m**
- macro-mesoporous catalysts 77
 macropore/mesopore/micropore ratio 233
 macroscale transport 366
 Magbans 629
 maghemite (γ -Fe₂O₃) 149
 – crystalline structure 150
 magnetic alloys 146
 magnetic carbon hollow spheres 202
 magnetic carries 179
 magnetic catalysts 183, 184
 – heterogeneous 179
 magnetic coercivity vs particle size 149
 magnetic compounds, formation 180
 magnetic core-shell nanoparticles 151
 – evolution of publications 165
 – schematic structure 157
 magnetic dipoles 147
 magnetic field 179
 magnetic iron oxide particles (MNP-HPA) 745, 766
 magnetic mesoporous carbon catalyst 201
 magnetic microspheres
 – monodisperse 196
 magnetic nanocatalysts 180, 181
 – heterogeneous 181
 – seed-mediated synthesis of 180
 magnetic nanoparticle (MNP) 146, 148, 179, 195, 197
 – coating of 186
 – functionalized 201
 – – silica-coated 188
 – magnetic attributes 148
 – modification 180
 – with organic groups 183
 – – amine-based molecules 184
 – – miscellaneous 184
 – – polymers 183
 – with silane agents 184
 – silica-coated, as magnetic supports 187
 – types of 153
 magnetic polymeric beads 195
 magnetic porous carbon (MPC) 235
 magnetic-silica core-shell structures 158
 magnetic supports 188
 – aminofunctionalized silica 191
 – aminosilica-modified 189
 – magnetic composite nano- or microspheres as 197
 – magnetic core-polymeric shell as 195
 – magnetic hollow spheres as 193
 – magnetic polymer materials 197
 – nonfunctionalized 189
 magnetic yolk-shell nanocomposites 193
 magnetism, type of 147
 magnetite (Fe₃O₄) 149, 153, 179, 196, 443
 – composite hollow spheres 198
 – – synthesis of 198
 – crystalline structure of 150
 – magnetic moment of 150
 – microspheres 196
 – nanoparticles 184, 186, 193, 196
 – – magnetic saturation values of 150
 – – polydopamine-coated 196
 – oxidation of 149
 – particles 729
 – spheres 199
 magnetron sputtering 220

- maleic anhydride 508, 515
- mannose 604, 606, 607
- Mars–van Krevelen mechanism 494, 507, 517
- mask projection 362
- mass spectrometer 473, 981
- mass transfer 76, 588
- mass transport coefficient 930
- materials synthesis 715
- MCM-41 (Mobil Composition of Matter) 674
 - high-accuracy localized reaction 309
 - mesoporous 631
 - sulfonic acid-functionalized 782
- m-CN-material-based catalysts 238
- MDA. *see* methane dehydroaromatization (MDA)
- MD-averaged TD-DFT computations 1090
- mechanical milling methods 92
- (MeCpPtMe₃)/O₃ process
 - SEM image of nanoparticles 348
 - on silicon 347
- Meerwein-Ponndorf-Verley (MPV) reduction 138, 602, 604
- MeIM linkers 242
- MEL. *see* ZSM-11
- melamine 42
- 10-membered-ring (10MR) 471
- membrane conductivity 931
- membrane electrode assembly (MEA) 928
- membrane reactor 478
- membrane selectivity 917
- membrane thickness 967
- MeOH synthesis catalysts 244
- mercaptopropyl trimethoxysilane (MPTMS) 759
- meso-Ce-HZSM-5, SEM image of 682
- meso-2,3-dimercaptosuccinic acid (DMSA) 184
- meso-/macroporous nanocatalysts 323
- meso-MFI 684
- mesopore diffusion 760
- mesoporegen 476
- mesoporosity 77, 79, 83, 233, 279, 287
- mesoporous (Sn-SBA-15 and Sn-MCM-41) 615
- mesoporous aluminosilicates (MMZ) 123, 276, 677
- mesoporous carbon (MC) 60, 495, 630, 631, 636, 639, 647, 649
 - in catalytic depolymerization of cellulose 642–649
 - catalytic depolymerization of cellulose in presence of 644
 - fibers
 - acid-functionalized 646
 - hard-template synthesis 630
 - ordered 630
 - elaboration of 629–632
 - synthesis by EISA method 632
 - soft-template synthesis 631
 - synthesis of 631
- mesoporous carbon nitrides (m-CN) 238
- mesoporous crystals 229
- mesoporous materials 57, 59, 120, 716
 - carbon-based 789
 - strategies for preparation 59–61
- mesoporous metal oxides preparation
 - by direct synthesis approach 60
 - by postsynthesis approach 60
- mesoporous MFI zeolites 681, 684, 685
- mesoporous–microporous architectures 773
- mesoporous nickel-alumina xerogel 79
- mesoporous oxides 60
- mesoporous photocatalyst 82
- mesoporous silicas 60, 339, 342, 759
- mesoporous stannosilicates 606
- mesoporous titania film 344
 - containing ink-bottle-shaped pores 344
- mesoporous titania-organosilica material 83
- mesoporous walls 238
- mesoporous zeolites 342
- mesoscopic modeling 759
- mesotheliomas 281
- mesoxalate 972
- mesoxalic acid 726
- metadynamics (MTD)
 - simulation 1083
- metal-alcoholate formation 496
- metal carbides 739
 - catalysts 816
- metal carbonyls, thermal decomposition of 180
- metal catalysts 78, 211, 238, 817, 987
 - preparation by supporting metal nanoparticles, on hydrochar 724
 - structure and morphology of 181
- metal cations 854, 857
- metal clusters 222
- metal cocatalysts 901
- metal containing precursors 236
- metal cupferronates 154
- metal dispersion 79
- metal–electrolyte double layer 212
- metal–gas interface 212
- metal hydrides 242
- metal ions 226, 232
 - substituted CeO₂ catalysts 96

- in heterogeneous catalysis 95
- redox property 95
- substitution of noble metal ions in 95
- substituted CeO₂ catalysts 95
- substituted TiO₂ catalysts 96, 97
- metallic alkoxide 9
- metallic cations 16
- metallic cobalt 154
- metallic film resistance 909
- metallic nanoparticles 12, 119
 - aqueous syntheses 13
 - hollow particles by galvanic replacement 15
 - polyol-mediated syntheses 14
- metallic nanoparticles (MNPs)
 - coating of 156, 186
 - colloidal stability 156
 - core coated with surfactants/polymers 162
 - Ru catalysts, schematic preparation procedure of 166
 - synthesis of 152–156
- metallic oxides 3, 6
 - anodization 11
 - (co)precipitation 6, 11
 - homogeneous (co)precipitation and/or ripening in nonaqueous solvents 11
 - homogeneous (co)precipitation by thermohydrolysis (aqueous solutions) 10
 - hydrolytic sol–gel 9
 - ripening 6
- metallic particles 12, 13, 15, 16
- metallic substrates 15
- metallic tellurium 525
- metallocenes 60
- metallo-organic framework (MOF) 275
- metallozeolites 392
 - catalysts 393
- metal microchannel reactors 366
- metal nanoparticles 16, 179, 196, 197, 199, 230, 236, 340, 635, 737, 744, 899, 984
 - anchoring procedure 187
 - immobilization of 179, 197, 200
 - magnetic carbon-based materials as supports
 - core–shell magnetic carbon supports 199
 - magnetic carbene-based yolk–shell materials 201
 - miscellaneous 201
 - MOFs-derived magnetic carbon supports 200
 - on magnetic nanomaterials 179
 - on magnetic nanoparticles
 - coprecipitation 181
 - incipient wet impregnation 181
 - miscellaneous methods 182
 - seeding process 180
 - within yolk–shell nanostructures 193
- preparation imbedded into hollow mesoporous silica 744
- metal organic framework (MOF) 24, 226, 232, 240, 314, 347, 376, 821, 996, 1043, 1056
 - applications of 1044
 - carbonization of 200
 - catalytic reaction rate 314
 - derived cobalt heterogeneous catalysts 241
 - derived metal NPs 239
 - carbons 232
 - ZnO 228
 - derived N-doped NPC-Pd heterogeneous catalyst 235
 - derived samples 237
 - derived sulfided material 231
 - derived system 238
 - Fe₂O₃@TiO₂ 228
 - followed by in situ EXAFS and XANES 1043
 - hydrogenation of octenes 314
 - mediated synthesized metal oxides 229
- metal–organic precursors 338
- metal oxides (MO) 123, 214, 225–227, 421, 598, 854, 875
 - ALD catalysis, role in 341
 - catalysts 15
 - coated MNPs 161
 - hybrids 15
 - interface 16
 - nanomaterials 227
 - particles 729
 - incorporation, as cores of hydrochar spheres 729
- metal particles 899
- metal peroxide 859
- metal precursors 735
- metals 3, 227, 876
 - semiconductor interface 215, 901
 - substituted silicates 602
 - support interaction 92
 - work function 216
- metal support interaction (MSI) 941
- metal-support interactions 214
- metal-support interface 78
- metal-to-ligand (MLCT) charge transfer 983
- methacrolein, to MMA
 - oxidative esterification of 25
- methanation activity 217, 814
- methane 408, 469, 943
 - activation 479, 952
 - dissociative adsorption 408

- nonoxidative conversion to higher hydrocarbons 470
- methane combustion 746, 945
- electrochemical promotion 954
- methane conversion 386
- routes, overview 470
- methane dehydroaromatization (MDA) 471, 474, 475, 478
- methane dry reforming 834
- methane monooxygenase 392
- methane/oxygen ratio 954
- methane production 951
- methane steam reforming 366, 838
- methanol 211, 609, 610, 612–614, 616, 720, 907, 954, 962, 963, 965, 967, 968, 972
- oxidative dehydrogenation to formaldehyde 493
- methanol carbonylation 503
- methanol electrolysis 968
- methanol oxidation 213, 727, 736
- Ag catalysts, role of 493
- methanol synthesis catalysts 813
- methanol-to-gasoline conversion
- catalytic conversion 319
- methanol-to-olefin (MTO) 1065
- methanol-to-olefin (MTO) technology 812
- methanotrophic bacteria 392
- methionine-bound chitosan 183
- 4-methoxyiodobenzene 192
- 5-methoxymethyl furfural (MMF) 616
- 4-methoxystyrene oligomerization 988
- 4-methoxy styrene 992
- 4-methoxy styrene oligomerization 992
- methylation 1075, 1079
- methylcyclohexane 17
- (methylcyclopentadienyl)trimethylplatinum (MeCpPtMe₃) 347
- methylene blue (MB) 229, 366, 881, 885
- conversion, as function of contact time 883
- discoloration 885
- methyl formate 954
- methyl fructoside 618
- methyl-2-hydroxy-3-butenolate (MVG)
- formation, from tetroses 614
- 2-methyl-1-indanone 182
- methyl lactate (ML) 610, 613, 623
- methyl methacrylate (MMA) 25
- methyl-4-methoxy-2-hydroxybutanoate (MMHB) 615
- methyl orange (MO) 881
- 1-methyl-2-pyrrolidinone (NMPO) 160
- α-methylstyrene 746
- methyl vinylglycolate (methyl-2-hydroxy-3-butenolate, MVG) 613
- methyl xyluloside 618
- MFI-type zeolite (ZnMFI) 259, 268, 393, 453, 464
- encapsulated catalyst 451
- micropores 459
- Mg-loaded hierarchical ZSM-5 687
- Mg-modified USY zeolite 693
- MgO catalysts 697
- Mg orbital 857
- micellization 186
- microchannel flow reactors 791
- microchannel reactors 366
- microelectronics 341
- microemulsion technique 92, 154
- microfluidic electrolysis device 930
- microfluidic flow reactors 373
- micro/mesoporous zeolite-4 material 342
- micromixing 375
- microporosity 275, 738
- microporous (Sn-Beta) 615
- aluminosilicates 771
- H-β-zeolite 762
- materials 120, 602
- surface area 233
- microscopy techniques 982
- microwave-assisted hydrothermal synthesis 366
- microwave heating 15
- microwave irradiation 775
- MIL-101 crystals
- ADF-STEM image 349
- Cr pore sizes 349
- metal–organic framework 232
- millifluidic flow reactors 373
- MIL-100, SEM micrographs of 314
- mineralization 880, 881
- mixed CeO₂-Fe₂O₃ samples, schematic illustration 426
- mixed CuO/CuAl₂O₄ catalyst 372
- mixed ionic and electronic conductor (MIEC) electrode 211, 952, 953
- catalytic nanoparticles dispersed in 952
- mixed metal electrocatalysts 367
- inkjet-based screening 367
- mixed (alloy) nanoparticle 341
- Mn₃O₄ crystals 229
- MNPs. *see* metallic nanoparticles (MNPs)
- modeling techniques 928
- modified carbonaceous materials 24
- MOF. *see* metal organic framework (MOF)
- MOF-mediated synthesis (MOFMS) 226

- Mo/HZSM-5 catalysts 471–475
- carburization in methane, TPR profile 474
 - chemistry 472
 - coke 475
 - MDA mechanism over 474
 - physicochemical aspects 471
 - shape selectivity 471
- Mo/HZSM-5, simplified MDA mechanism 475
- moisture tolerance 243
- molar selectivity 594
- molecular beam epitaxy (MBE) 93
- molecular dynamics (MD) 1056
- molecular exchange 759
- molecular oxygen 489
- molecular transformations 754
- molybdenum 524, 738
- bronze 521
 - carbides 473, 739
 - center 231
 - hydrochar composite catalysts 739
 - nickel sulfides 231
- molybdenum oxide 737
- molybdenum sulfide 598
- molybdenum trioxide 472, 738
- monoaromatic hydrocarbon (MAH) 686
- monodisperse iron oxide magnetic nanoparticles
- production of 154
- monolithic design 913
- monolithic designs 921
- monolithic solar hydrogen generators, nanostructured components in 921
- monosaccharide isomerization/epimerization 602
- monosaccharides 606
- Monte Carlo simulation 299, 300
- montmorillonite (Mt) 240
- MoO₃ particles preparation, embedded into mesoporous hydrochar 738
- mordenite (MOR) 259
- zeolite crystals 269, 995
- MoS₂ lamellae 388
- MoVTenbO catalysts 518, 524
- active M1 phase 519
 - active sites of M1 phase 521
 - doping, supporting, and dilution of M1 phase 527
 - dynamics of M1 phase under catalytic conditions 523
 - synergetic effect with M2 Phase 526
- MPVO redox reactions 623
- MS. *see* multiple scattering (MS)
- Mössbauer spectroscopy 163
- MSU (Michigan State University) 674
- MTFB. *see* multitubular fixed bed (MTFB)
- multielectron transfers 892
- multiple printheads 367
- multiple scattering (MS) 1033, 1045
- multisite complexation models 16
- multitubular fixed bed (MTFB) 507, 508
- heat capacity 513
 - internal structures 512
 - oxygen-distributed (membrane-type) reactors 514
 - propane/propylene retrofit 513
- multiwalled carbon nanotubes (MWCNTs) 38, 159, 343
- SEM/TEM image 344
- MWCNT. *see* multiwalled carbon nanotube (MWCNT)
- myristic acid, esterification 770
- n**
- Na⁺ cations 952
- Nafion 365, 826, 915
- membranes 366, 929, 967
 - resins 759
- nanoarchitecture 386
- nanobeads 200
- nanocage 395
- nanocapsulate 395
- nanocarbons 395
- anchoring of metal complexes 45
 - as catalysts 12, 47
 - applications of 43
 - supports 43
 - definition of 37
 - metal-free 386
 - in photocatalysis 45
 - supported metal catalysts 43
- nanocasting 60, 631
- procedure 639
- nanocatalyst (NC) 16, 145, 293, 385–387, 484
- for energy production, in SOFCs 943
 - process 484
 - at research stage
 - quo vadis 489, 497
 - solar fuels production, role in 385
- nanochemistry 57
- nanocones, in BiVO₄-perovskite tandem cell 927
- nanocrystallites 79
- ZnO-supported platinum nanoparticles 230
- nanodiamond (ND) 38

- nanodispersed catalysts, electrochemical
 - promotion of 950
- nanofabrication techniques 395, 921
- nanofilamentous carbon 633
- nanofiltration 595
- nanohorn 395
- nanomaterials 402
 - catalytic applications of 132
 - definition 119
- nanometer accuracy by stochastic chemical
 - reactions (NASCA) 991
 - microscopy 992, 995
- nano-oxide mesoporous catalysts
 - and catalytic applications 61–83
 - synthesis strategies 59
- nanoparticle (NPs) 5, 145, 209, 210, 225, 429, 496
 - definition 402
 - immobilization and stabilization of 119
 - magnetic properties of 15, 146
 - methods, for stabilization of 156
 - properties of 151
 - protection by mesoporous silica shell 730
 - ripening 5
 - size 983
 - distribution 981
- nanophotocatalysts 873
 - characterization of 26, 876
- nanoporous carbon (NPC) 232, 233
- nanoporous materials 1056, 1057
- nanoribbon 395
- nanorods 14
- nano scale objects 125
- nanosized carbons 38
- nanosized GdCoO₃ perovskite oxide 229
- nanosized zeolites
 - 3D model 278
 - MFI zeolites 606
- nanostructured carbons 232, 234
 - advantages and limitations in catalytic
 - cellulose processing 647
 - porous carbons 37, 38
- nanotechnology 57, 402
 - nanostructured supports 343
 - nanostructuring, advantage of 928
 - tools 225
- nanowire array (NA) 238
- natural gas 392, 469, 503
 - sources 386
- natural photosynthesis 851
- N-(2-bromoethyl)phthalimide 186
- n-C₁₆ hydrocracking 456, 457, 462
 - over FT catalysts 454
- N-containing components 599
- N₂ dissociation 210
 - rate 211
- N-doped carbon 636
 - gels 42
- N-doped mesoporous carbon-supported Ni
 - nanoparticle catalyst (Ni/m-CN) 238
- N-doped porous carbon 243
- NdT/OP photocatalytic activity 881
- near-neutral pH electrolytes 916
- near-neutral photoelectrochemical water
 - splitting 916
- Neosepta[®] 915
- Nernst equation 893, 939
- NETmix reactor 375
- neutralization 589
- Newtonian fluids 361
- NHC. *see* n-heterocyclic carbene (NHC)
- n-heterocyclic carbene (NHC) 182
- NH₃ pyrolysis 233
- NH₃-TPD measurements 621
- NH₃-treated Sn-Beta 608
- NH_x removal rate 211
- nickel-based catalyst
 - deactivation of 815
 - stability of 815
- nickel–borate complex 916
- nickel catalysts 815, 820
- nickel nanoparticles
 - activation of methane on 402
 - development, of catalysts 402–404
 - fabrication of 403
 - face-centered cubic (fcc) structure 405
 - location in micropores 403
 - nature of surface sites 405–407
 - rate, of steam reforming of methane 402
 - top-down and bottom-up approaches 403
 - turnover frequency 406
- nickel phosphide 598
- nickel sintering 815
- Ni-/Co-based catalysts 238
- NiFe LDH nanosheets 927
- Ni-Fe₂O₃-CeO₂, TEM micrograph 436
- Ni–Ga catalysts 814
- Ni/m-CN catalyst 238
- Ni nanoparticles 640
- Ni-NiO HER catalyst 928
- niobia–hydrochar composite preparation 740
- NiO_x or NiFeO_x catalyst 902
- Ni particles 949
- nitrate 942
- nitric acid (CNT-N) 41, 42
 - oxidation 636

- nitrides 598, 854, 855
 - nitroarenes 200, 239
 - nitroaromatics 724, 744
 - selective hydrogenation 31
 - nitrobenzaldehyde
 - hydrogenation
 - transition metal ions, effect of 32
 - hydrogenation of 32
 - 4-nitrobenzaldehyde, hydrogenation 31, 32
 - selective hydrogenation 31
 - nitrobenzene 239, 734
 - adsorption on Au clusters on Al₂O₃ 34
 - hydrogenation 34, 240
 - nitrogen 421, 851
 - adsorption energy 211
 - desorption isotherm 285
 - doped carbons 637
 - doped nanoporous carbon 235
 - functionalization 42
 - plasma 43
 - nitrogen-doped graphenes (NG) 24
 - nitrogen oxides 942
 - nitrophenol 725
 - 4-nitrophenol (4-NP) 181, 189, 196, 235, 238
 - reduction of 181
 - nitrophenols 238
 - nitrostyrene hydrogenation
 - role of support 31
 - 3-nitrostyrene hydrogenation 31
 - Ni/YSZ cermet 941, 943
 - N,N-dimethylformamide (DMF) 256
 - N₂/NH₃ plasma 347
 - noble metals 341
 - catalysts 95
 - nonaqueous systems 12
 - nonedible oil feedstocks 794
 - non-Faradaic electrochemical modification of catalytic activity (NEMCA) 941
 - nonfood-based feedstocks 758
 - nonfood crops 754
 - nonmetals 876
 - nonnoble Cu/Cu₂O NPs 239
 - nonordered mesoporous chromia/alumina catalysts 232
 - nonordered nanographene sheets 778
 - nonoxidative methane conversion, equilibrium conversion of
 - temperature dependence 470
 - nonoxides 854
 - nonradiative relaxation 989
 - nonrefined liquids 388
 - nonrenewable fuels 805
 - nonthermal plasma (NTP) 394
 - nontransition metal oxides 443
 - N-TiO₂ nanoparticles 875
 - N-TiO₂ photocatalyst 876, 881
 - N-TiO₂ supported on OP (NdT/OP), photocatalytic activity 881
 - NTP. *see* nonthermal plasma (NTP)
 - N-(3-triethoxysilylpropyl)-4,5-dihydroimidazole 186
 - NTSG catalyst 882
 - photocatalyst, evaluation of MB decolorization with 883
 - nuclear magnetic resonance 285
 - nucleation 3–5, 14
 - 2D model 5
 - nucleation centers 238
 - nucleation kinetics 4
 - nucleation rate 4
 - numerical models 930, 931
 - NU-1000 structure 230
- o**
- OCM. *see* oxygen carrier material (OCM)
 - O₂ conditions 218
 - octane number 232
 - ODH. *see* oxidative dehydrogenation (ODH)
 - offretite (OFF) 253
 - ohmic junction 900
 - ohmic losses 913, 915, 920, 930
 - Ohmic overpotential 909
 - Ohm's law 909, 920
 - oil and gas reservoirs 807
 - oil and petrochemical industry, performance windows applied in 586
 - oil prices 386
 - oils transesterification 758
 - olefines 288, 821, 822
 - olefins 80, 288, 503, 505, 592, 812, 816
 - hydrogenation of 199
 - manufacturing methods
 - dehydrogenation 816
 - ethane cracking 816
 - fluid catalytic cracking 816
 - naphtha steam cracking 816
 - α -olefins 455
 - oxidative carboxylation 821
 - readsorption pathway 453
 - oleic acid 719, 722
 - capping agents 194
 - esterification with methanol 760
 - methylic esterification 778
 - oleochemical feedstocks, biodiesel production 757
 - oleylamine 194

- oligomerization 453, 737, 988, 992
 - pathways 458
 - – of styrene derivatives 993
- oligomers 985
- oligosaccharides 617
- O₂/MeOH ratio 494
- O²⁻ migration 211
- O-, N-, and S-containing functional groups
 - schematic representation of 40
- o-nitroaniline 730
- on-site Coulomb interactions 442
- Operando methodology 982
- O₂ plasma 347
- optical absorption bands 855
- optical microscopy 992
 - reveal interparticle heterogeneity 987
 - studies 28, 985
- optical properties 987
- optical spectroscopy techniques 982
- optical transmission images 988
- optimal catalyst is 209
- optimal industrial catalyst 487
- ordered mesoporous carbon (OMC) 38, 39, 275, 780, 789
 - soft-templating routes 39
- O₂ reduction reaction (ORR) 367, 899
 - activity 233
 - catalysts 237
 - performance 237
- organic acids 543, 718
- organic chemicals 808
- organic chromophores 984
- organic dyes 728, 875, 984
 - photocatalytic degradation of 26, 880
- organic fuels 965
- organic functional groups 30
- organic-inorganic composite 630
- organic-inorganic hybrid material 375
- organic linkers 230, 231
- organic material 745
- organic matter, sulfonation of 789
- organic monomer 279
- organic-organic self-assembly strategy 631
- organic pollutants 227, 228
- organic precursor, thermal carbonization of 630
- organic printed electronics 364
- organic solvent 595
- organic surfactants 57
- organometallic complexes 589
- organometallic compounds
 - thermal decomposition 154
- orthosilice 430
- orthoxylyene oxidation 503
- oscillatory baffled reactor (OBR) 792
- Ostwald ripening (OR) mechanism 5, 12, 405, 458
- Ostwald rule 5
- overall heat transfer coefficient 512
- overcracking 450, 452
- overoxidation 726, 746
- oxalate 972
- oxalic acid 50, 726
- oxalyl dihydrazide (ODH) 97
- oxametallacycle intermediate 485
- oxidation 21–27, 225, 226, 236, 237, 421, 590, 601, 928
 - ability 857
 - activity 214
 - of alcohols 243
 - catalysis 483
 - energies 443
 - products 975
 - reactions 137, 242
- oxidative corrosion 927
- oxidative coupling of methane (OCM) 470
- oxidative dehydrogenation of ethane, catalysts 80, 81
- oxidative dehydrogenation of hydrocarbon (ODH) 47, 80, 493, 522, 524
- oxidative dehydrogenation reaction 80
- oxidative esterification 182
- oxidative etching 14
- oxides 3, 15, 227, 596
 - catalyst surfaces 899
 - decorates 410
 - materials 8
 - matrix 16
 - metal interface 16, 17
 - metal interfaces 15
 - semiconductor 217
 - semiconductor photocatalysts 15
 - surfaces 16
- oxidic window 597
- oxozirconium clusters 230
- oxychlorination 515
- oxydehydrogenation 506
- oxygen
 - activation 496
 - electrochemical sensors 940
 - for gas-phase oxidation 41
 - oxygenated biomass pyrolysis model 668
 - oxygenated bio-oil model 668
 - oxygenated chemicals 602
 - oxygen carrier material (OCM) 423
 - oxygen distributor 515

- partial pressure 939
 - plasma treatment 637
 - reduction 209
 - oxygen evolution photocatalyst (OEP) 861
 - oxygen evolution reaction (OER) 16, 236, 237, 861, 892, 908
 - catalysts 902, 927, 928
 - current 238
 - kinetics 903
 - oxygen reduction reaction (ORR) 16, 51, 236
 - oxygen speciation 484
 - oxygen storage materials, first-principles modeling challenges 442
 - oxygen vacancies 21, 219, 525
 - oxynitrides 854–856, 860, 868
 - compounds 855
 - photocatalysts 856
 - oxysulfide 868
- P**
- PA and EC components, nanostructuring of 922
 - packaged consumables 364
 - packed bed (PB) 508
 - palladium (Pd) 724, 741
 - based anode electrocatalysts 972
 - heterogeneous catalyst 191
 - – recycling of 191
 - metal nanoparticles
 - – scanning transmission electron microscopy images of 132
 - metal nanoparticles (MNP)
 - – supported on silica, TEM micrographs of 130
 - Pd-Fe₃O₄ catalyst 183
 - Pd-Fe₃O₄ magnetic nanocatalyst 185
 - Pd-Fe₃O₄ nanocatalysts 182
 - Pd-iron oxide magnetic nanocatalysts 182
 - palladium catalysts 813, 818
 - for hydrogenation reactions 1034
 - palladium chloride 192
 - palladium nanoparticles (Pd NP) 14, 16, 183, 197, 199, 346, 487, 724, 731, 744, 954, 968, 970, 1034
 - based catalyst 235
 - for coprecipitation-based magnetic nanocatalysts preparation methods 181
 - EDS elemental mapping of 190
 - encapsulation of 197, 198
 - immobilization of 186, 190, 193
 - palladium precursors 234
 - palmitic acid 720
 - esterification 759, 764, 766, 790
 - PAN. *see* polyacrylonitrile (PAN)
 - paraffins 508
 - synthesis 451
 - paramagnetic materials 146
 - paramagnetism 146
 - parasitic gas-phase reaction 517
 - partial amorphization 285
 - partial carbonization 789
 - partial oxidation 748
 - particle-based photocatalysis 907
 - particle migration and coalescence (PMC) mechanism 405
 - particle size 3, 8, 10, 14–16, 234, 237, 853, 875, 983, 988
 - particle–support interfaces 3
 - particle transfer methods 862
 - Pd/Au ratio 487
 - Pd/H-MFI catalysts 456, 457
 - Pd/H-MFI zeolites 455
 - cyclohexane, diffusivity of 458
 - PdO nanoparticles 954
 - Pd polypyrrole 235
 - Pd supported, on mesoporous starch
 - TEM images of 123
 - Pd/TNTA-Web
 - anode 971, 975
 - electrode preparation process 970
 - PEM electrochemical reformer 972
 - PEM electrochemical reforming 966, 967
 - PEM electrolysis 929
 - PEM electroreforming process 967
 - PEM methanol–water solution electrolysis 967
 - PEM water electrolysis 967
 - pentamers 523
 - 1,2,2,6,6-pentamethylpiperidine (PMP) 258
 - pentanoic acid 740
 - pentoses 609
 - PEO-PPO-PEO block copolymers 632
 - perimeter interface mechanism 30
 - periodic mesoporous organosilica (PMO) 787
 - periodic VASP code 1064
 - perovskites 434, 436, 747, 830
 - peroxymonosulfate (PMS) 229, 243
 - persistent organic pollutants (POP) 882
 - pervaporation methods 791
 - petrochemical industry 585
 - petrochemical refinery 537, 542
 - petrochemicals 388, 627, 817
 - petrochemistry 78
 - petroleum
 - based precursors 634
 - derived diesel 757
 - derived fuel oil 657

- PFA/MOF-5 composite 233
- pH conditions 897
- pH-controlled facies of submicrometer particles 9
- phenantroline 233
- phenethanol 242
- phenol 50, 229
- phenol degradation 229
- phenol formaldehyde resin 239
- phenolic compounds
 - upgrading to fuels, chemicals and polymer-building blocks 568–574
- phenolic monomers
 - lignocellulose processing, obtained in 558
 - upgrading routes of 569
- phenolic resin 632
- phenolic resol 632
- phenol oxidation 229
- phenol selective hydrogenation into cyclohexanone 742
- phenoxy radicals 541
- phenylacetaldehyde 745
- phenylacetic acid esterification 772
- phenylacetylene 192
 - hydrogenation of 187
- phenylboronic acid 730, 745
- phenylcoumaran 541
- 2-phenylindole
 - tandem synthesis of 182, 183
- phenyl-PMO preparation 785
- phenyltriethoxysilane 476
- phenyl vinylsulfonate 43
- pH gradient 916
- phonon dispersions 444
- phonon energy 444
- phosphate buffer 897
- phosphate concentration 897
- phosphides 598
- phosphoric acid 747
- phosphorus species 233
- phosphotungstic acid 775
- photoabsorber (PA) 859, 908
 - low-cost 923
 - – silicon as buried PV 923, 924
 - – PEC configuration 923
- photo- and electrocatalysis, variations in 994
- photoanode 918
 - absorber 826
 - semiconductor 827
- photobleaching 990, 992
- photocatalysis 11, 226, 228, 236, 341, 343, 394, 823–827, 851, 881, 885, 892, 904, 905
 - photoelectrocatalysis 826
 - pure photocatalysis 825
- photocatalyst 825, 858, 862, 876, 877, 891, 899
 - luminescence spectrum 877
 - material 862, 893
 - – design 25, 854
 - particles 853, 859
 - process 899
 - semiconductor materials 893
 - sheet 862, 865
 - – preparation process for 863
 - surface 877, 881
 - systems 867
- photocatalytic activity 15, 83, 877
 - variations in 865
- photocatalytic decolorization 882
- photocatalytic degradation 26, 882
- photocatalytic efficiency 892, 904, 905
- photocatalytic H₂ production 227
- photocatalytic oxide layers 343
- photocatalytic performance 874, 885
 - in S₂O₈²⁻ (electron acceptor) solution 902
- photocatalytic properties 227
- photocatalytic rate 897
- photocatalytic reactions 227, 891, 905
- photocatalytic reactors (PR) 894
 - for water and wastewater treatment 877
- photocatalytic solar fuel 227
- photocatalytic water splitting 81, 867
- photocatalytic water splitting, basic principles 852
- photochemical reactor 103
- photocorrosion phenomena 874
- photocrosslinking ceramic powders 378
- photocurrent 367
 - false color map 368
 - imaging methodology 368
- photodegradation 227, 229
 - reactions 229
- photodeposited oxides 859
- photodeposition 860
- photo(electro)catalysis 824
- photoelectrocatalytic cell 827
- photoelectrochemical routes 911
- photoelectrochemical systems 867, 911
- photoelectrochemistry 907
- photoelectrode 909, 910
 - performance 897
- photoelectrolysis 367
 - device 930
- photoelectron kinetic energy 1033
- photoelectron migration 15
- photoinduced holes 229
- photoinitiators 362

- photoirradiation 858
- photon energy 851, 853, 1031
- photon scattering 1032
- photo-oxidative dissociation 854
- photopolymer resins 361
- photopolymers 362
- photoreactors, design of 879
- photoreduction 82
- photoresin 362, 375
- photosensitization 82
- photosensitizers 395
- photostability 852
- photosynthetic organisms 907
- photosystem configurations 910
- photovoltaic-coupled electrolysis 911
- photovoltaics 336
- photovoltaic water electrolysis 853
- phthalic anhydride 508
 - synthesis 503
- physical promoters 425
- physical vapor deposition (PVD) 338, 954
- physisorption 337
- piezoelectric printer model 366
- plasma-based derivatization 637
- plastic injection molding 359
- platform molecules, upgrading of 593
- platinic acid 727
- platinum (Pt)
 - alloy 963
 - -based alloys 365
 - catalysts 233
 - clusters 219
 - -coated cobalt 161
 - deposition 218, 220
 - loading 220
 - particles 216, 218, 220
 - precursor 230
- platinum nanoparticles 14, 210, 347, 899, 929, 951, 953, 1034, 1039
 - immobilization of 200
 - size 230
 - supported on hydrochar–ion liquid material 727
 - supported on hydrochar-Pt-octahedron 736
- platinum sulfide 17
- plug flow 792
- poisoning 928
- polarization curves 238, 903, 970, 971
- polar molecules 860
- polar silica surfaces, hydrophilic nature 781
- pollutants 238, 873
 - from gas streams, removal of 884
- polluted water remediation
 - advances and challenges 105
 - experimental set-up and procedure 13, 103
 - photocatalytic activity 104
- polyacrylonitrile (PAN) 634
- polyalcohols 965, 968, 972
 - selective partial oxidation of 972
- polyaniline 183
- polyaniline functionalized with
 - methanosulfonic (MSA-Pani) 789
- polyaromatic hydrocarbons 471
- polycationic magnetic hollow spheres 198
- polycrystalline materials 119
- polycyclic aromatic hydrocarbon (PAH) 663
- polycyclic organic molecules 996
- polydispersity 5
- polydivinylbenzene (PDVB) 789
- polyethylene glycol 183, 199
- polyethyleneimine 183
- polymer-building blocks
 - production from alkylated cyclohexanols 573
- polymer chains, branching of 1034
- polymer electrolyte membrane fuel cells (PEMFC) 233, 365
- polymer film 930
- polymeric nanoreactors 197
- polymerization 9, 60, 589, 756
 - dispersion 197
 - microemulsion 197
 - miniemulsion 197
 - suspension 197
- polymers 122, 336, 877
- polymer-stabilized gold nanoparticles 122
- polymer surface layers 931
- polymer thin films 931
- poly(methyl methacrylate) 185
- poly(N-vinyl-2-pyrrolidone)-stabilized Au NPs 22
- polyolefins 1034
- polyols 14, 15
- polyorganophosphazenes 122
- polyoxometallate clusters 764
- polyoxymethylenedimethylether (POMM) 391
- polypropylene 378, 504
- polypyrrole 183
- polysaccharides 716
- polysilsesquioxanes 782
- polyurea nanocapsules 197, 198
- polyvinylpyridine 122
- poly(vinyl pyrrolidone) 731
- POMM. *see* polyoxymethylenedimethylether (POMM)

- POP. *see* porous organic polymer (POP)
- poragens 759
- pore formation, of MOF 229
- pore size 604, 615, 618
 - distribution 285
- pore space 226
- pore volumes 285
- porosity 232, 876, 1056
- porous carbon materials 629, 630
 - synthesis and functionalization 628–642
- porous carbons 629
 - sulfur doping of 43
- porous material 120
 - advantage of 120
 - preparation of metal nanoparticles 120
 - supported metal nanoparticles on 124
 - use of 120
- porous organic polymer (POP) 196
- postdeposition annealing 341
- postprinting functionalization 362
- postsynthesis 59, 60
 - grafting 61
- potassium acetate 971
- potassium carbonate 623
- potassium peroxymonosulfate 728
- potassium promoters 210
- potential intermediate products 973
- potential losses 917
- potentiometric gas sensors 939
- Pourbaix diagrams 927
- powder bed 3D printing methods 363
- powder binding 363
- powder layer spreading mechanism 363
- powder pyrolysis 146
- powder X-ray diffraction 488
- power density 945
- P123 pluronic surfactant 764
- precious metals-coated MNPs 160
- precipitation 5, 10
 - method 737
- pressure pulses 360
- primary cracking 462, 464, 465
- primary hydrocracking 463, 464
- printed alumina supports 366
- printheads 361
- printing catalysts 364–372
- printing reactors 372–375
- pristine hydrochar 717
- pristine MWCNTs 42
- product concentration 589–591, 594
- product degradation 590
- product distribution 974
- product price 587
- product recovery 599
- product yield 592
- promoters 209, 210
- 1,2-propandiol 965, 968, 972, 975
- propane 211
- propane dehydrogenation 504
- propanediol 725
- propane oxidation 524
- propene distribution 311
- propene epoxidation 491
 - with O₂, selected catalysts 490
- propene methylation 1066
- propionic acid 518
- propylene 504
- propylene ammoxidation 515
- propylene carbonate synthesis 823
- propylene epoxidation 16, 490, 492
 - proposed pathways 492
- propylene glycol 593
 - etherification 998
- propylene oxidation 511
- propylene oxide formation 491
- propylene to propylene oxide, direct oxidation of
 - by using O₂ 489
- propylsulfonic 77
- protected Au clusters 24
- protective coating 346
- protic polar solvents 30
- protolignin 541
- proton 915
- protonated methanol 1062
- protonation 917
- proton-conducting SOFC (PC-SOFC) 940
- proton exchange membrane (PEM) 915, 963, 965
 - electrochemical reforming 965
- proton transport 915
- PRs for depollution of gaseous streams 879
- PRs having flat plate geometry (FGPR) 877
- PrSO₃-SBA-15 catalysts 759
- p-Si photocathode 924
- Pt ALD 347
- Pt/Al-MCM-48 materials
 - TEM images of 124
- Pt atom 220
- Pt-based cathodes 233
- Pt/C catalysts 965
- Pt/CeO₂ catalyst 1042
- Pt/C inks 365
- Pt-CO system 899
- Pt-Fe₃O₄ peroxidase mimic catalyst 185
- Pt/HY catalyst 459

Pt-loaded aluminosilicate COK 342
 Pt-Meso-MFI 684
 p-toluene sulfonic acid 617
 Pt–Pd bimetallic/Nafion nanocomposite
 membrane 967, 968
 Pt–Pd core–shell synthesis 349
 Pt RDE electrode 903
 Pt rotating disk electrode 894
 PtRu/C, as anode catalyst 967
 Pt₃Sn/C anode catalyst 972
 Pt₇Sn₂/C anode catalyst 972
 Pt-supporting ZnO nanoparticles 230
 Pt/TiO₂ catalytic diode 213
 p-type semiconductor 214
 Pt/YSZ catalytic layer 952
 Pt/zeolite catalyst
 – characterization 461
 Pt/ZnO catalyst conventional 230
 Pt/ZrO₂ catalyst 816
 pulsed field gradient (PFG) technique
 305
 pure siliceous mesoporous materials 120
 push–pull organic fluorophores 984
 PV-PEC configuration 910
 Py-GC/MS system 669, 693
 pyranose 608
 pyrex windows 879
 pyridine 609
 – adsorption 230
 pyridinic (N-6) 40
 pyridinic nitrogen 724
 pyrolysed rice husk bio-oil 791
 pyrolysis 234, 236–238, 240, 243, 367,
 718, 758
 – in argon of Co MOF 242
 pyrolytic carbon 635
 pyrrole 728
 pyrrolic (N-5) 40
 pyrrolidine template 256
 pyruvaldehyde (PA) 610, 613
 pyruvaldehyde dimethyl acetal (PADA) 609
 pyruvate 972
 – selectivity on Au/C 972

q
 quantitative electron tomography 345
 quantum efficiency 860, 866–868
 – apparent 867
 quasi-elastic neutron scattering (QENS)
 308
 Quasi in'situ 523, 525
 quaternary oxynitrides 855
 quinone-hydroquinone redox cycle 47

r

radiant power 879
 radiation energy 877
 radiative emission
 – emission process for 1031
 radical polymerization 197
 Raman microspectroscopy 996
 – reveal inter- and intraparticle
 heterogeneity 997
 Raman scattering microscopy 998
 Raman spectroscopy 102, 876, 983
 Raman spectrum 191
 Raney nickel 814
 rapeseeds 76, 964
 rate constants 235, 1056
 reaction chemistry 475
 reaction rate 618
 – vs. Au particle size 28
 reaction temperature 79
 reactionware 373
 reactive distillation 791
 reactive oxygen 425
 reactor design 586
 reactor fabrication
 – 3D printing, use of 374
 reactor layout
 – computational optimization 375
 reactor modeling 423
 reactor productivity 587, 588, 590–594
 reactor size 587
 reactor technology 509
 reactor vessels 360
 recrystallization 599
 redox chemistry
 – of UiO-67-Cu 29, 1043
 redox exsolution 948
 redox potentials 853
 redox power 527
 redox processes 509
 redox reactions 425, 426, 737
 redox stability 941
 redox transmetalation 160
 reduced graphene oxide (rGO) 38
 reducibility 442
 refineries 387, 389
 reflectance data 876
 refractive index 984
 regenerated solids 516
 regenerative agents 478
 relative humidity (RH) 929, 931
 renewable biomass-derived alcohols 964
 renewable energy 59, 385, 388–390, 537, 629,
 754, 812, 838, 851

- sources 385–387, 389, 851
 - storage 385, 390
 - renewable feed cost 587
 - renewable hydrogen 76
 - reoxidation 423, 439, 507
 - repeated templating method 60
 - repolymerization 538
 - resazurin 994
 - resinol 541
 - resol/triblock copolymer ratio 632
 - resonance inelastic X-ray scattering (RIXS) 1032, 1038
 - resonant photoelectron spectroscopy (RPES) 216
 - resonant-XES (r-XES) 1032
 - resorcinol 39
 - resorption 286
 - resorufin 994
 - retro-aldol fragmentation of sugars 612
 - retro-aldol products 616
 - retro-aldol reactions 602, 612, 613, 616, 623
 - retro-Michael addition 602, 616
 - reverse emulsion 186
 - reverse water gas shift (RWGS) 79, 832
 - reaction 812, 814, 832
 - RhCrO_y cocatalyst 857, 859
 - Rh film 211
 - Rh-maghemite catalyst 182
 - for chloroarene dechlorination 182
 - Rh nanoparticles (Rh NP) 188, 211
 - Rhodamine B (RhB) 882
 - rhodium catalyst 820
 - Rh+Sb-codoped SrTiO₃ 854
 - rice husk char 781
 - Rietveld refinement 284
 - Rietveld technique 519
 - RIXS. *see* resonance inelastic X-ray scattering (RIXS)
 - robocasting 362
 - rotating disk electrode (RDE) 894
 - RUB-37 zeolite 259
 - Ru/carbon nanotubes 452
 - Ru/CeO₂ catalyst 953
 - Ru-loaded SrTiO₃ · La_xRh/Au/BiVO₄ photocatalyst sheet
 - time course of Z-scheme water splitting 866
 - RuO₂ nanoparticles 639
 - ruthenium (Ru)
 - catalysts 214
 - particles 241
 - ruthenium (Ru) nanoparticles 14, 200, 452, 953
 - r-XES. *see* resonant-XES (r-XES)
- s**
- Sabatier principle 209, 210
 - saponification 758
 - S–Au(I)–S bond 23, 26
 - SBA-15
 - sol–gel syntheses 782
 - SBA-15 (Santa Barbara Amorphous) 674
 - mesoporous aluminosilicates 675
 - silica framework 675
 - synthesis 789
 - SBA-12 material
 - Transmission electron microscopy 127
 - S-Beta samples crystallized
 - ²⁹Si NMR spectra of 269
 - S-beta, UV-Raman spectra 269
 - scaling factor 919
 - scanning electrochemical microscopy 367
 - scanning electron microscopy (SEM) 284, 338, 343
 - scanning transmission electron microscopy (STEM) 951, 982
 - scanning tunneling microscopy (STM) 216, 488
 - Scherrer equation 981
 - Schottky diode structure 220
 - Schottky-type junction 901
 - β-scission 455
 - screen printing 365
 - secondary cracking 454, 455, 458, 460–462, 464, 465
 - secondary isomerization 462, 464
 - secondary phosphine oxide (SPO) 31
 - secondary porosity 289
 - second generation bio-based fuels 754
 - second-generation biomass
 - carbon catalysts development 780
 - seed-directed synthesis (SDS) 254, 268
 - selective catalytic reduction (SCR) 64–67, 324, 942
 - selective chemisorbed oxygen species
 - formation 494
 - selective C=O hydrogenation 29
 - selective electrochemical reduction (SER) 942
 - selective hydrogenation 28
 - catalysts 742
 - of cinnamaldehyde by Au₂₅ mechanism 30
 - selective hydroisomerization 450
 - selective NO_x electrochemical reduction, in SOCs 944
 - selective permeability 859
 - selective photoresin solidification 361
 - selective sintering/melting processes 364
 - selectivity 210, 522, 586, 587, 590, 594, 733

- impact of 590
- Selemon[®] 915
- self-assembly technique
 - layer-by-layer (LBL) 199
- self-cleaning effect 885
- self-cleaning surfaces, under visible light 885
- self-diffusion 303
 - measurements 308
- self-interaction errors 442
- self-limiting surface chemistry 338
- self-nucleophilic attack 822
- self-oxidation 858, 859
- SEM. *see* scanning electron microscopy (SEM)
- semiconducting materials (SC) 873
- semiconducting oxides
 - photoactivity of 45
- semiconducting TiO₂ support 216
- semiconducting ZnO 214
- semiconductor–catalyst interface 892
- semiconductor–liquid junction (SLJ) 909, 910
- semiconductor manufacturing 219
- semiconductor–metal–electrolyte interface 899
- semiconductor photocatalyst 859
- semiconductors 215, 216, 228, 341, 826, 852–854, 873, 874
 - sensitization 26, 874
- semicrystalline mesoporous metal oxides 60
- sensing electrode 939
- sensor technology 336, 939
- sequestration process 421
- sequestration technology 807
 - drawbacks 807
- shale gas 386, 388, 391
- shape selectivity 471, 985
- Si/Al ratio (SAR) 266
- silanol groups 58, 607, 608
- silica CHA zeolite (S-CHA) 266
- silica coated MNP 192
 - modification of 189
- silica FER zeolite 259
- silica gel
 - phenylethylsulfonic acid-functionalized 760
- silica mesoporous materials 404
- silica nanoparticles 190
- silica shell 157, 158
- silica-supported silver catalyst 988
- silica to alumina ratios (SAR) 666
- silica walls 59
- silicoaluminophosphate (SAPO) 993
- silver catalyst 484
- Silver-coated MNPs 160
- silver nanoparticles 988
 - continuous flow synthesis 13
 - dispersion on hydrochar hollow spheres 736
- simulated bio-oil medium 760
- simulated IR spectrum 1087
- single-component profiles 311
- single crystal X-ray diffraction (SXRD) 1063
- single particle catalytic activity testing 988
- single scattering (SS) 1033, 1045
- single-step coating of Ce_{1-x}M_xO_{2-δ} 13, 97
- single-step preparation method 92
- single-walled carbon nanotubes (SWCNT) 38, 159, 396
- sintering 339, 341, 373, 404, 433, 493, 599, 928
 - mechanisms of 405
- sintering process 945
- SiO₂/Al₂O₃ ratio
 - SEM images 261
- SiO₂/Al₂O₃ ratios 258, 260
- SiO₂-supported metal NPs 496
- size-exclusion chromatography 595
- S leaching 761
- slurry coating 97
- small-angle neutron scattering 163
- smart grid 390
- SMNPs synthesis
 - physicochemical routes 131
 - flame spray pyrolysis 131
 - sonoelectrochemistry 131
 - routes 126
 - chemical routes 128
 - coprecipitation 129
 - coprecipitation method 129
 - deposition–precipitation 130
 - impregnation 129
 - microemulsions 131
 - physical routes 126
 - microwave irradiation 127
 - plasma reduction method 128
 - pulsed laser ablation (PLA) 14, 128
 - sonochemistry 126
- Sn-Beta 607, 615, 621, 623
- Sn-Beta-NH₃ 609
- Sn-Beta zeolites 612, 613
- SNG. *see* synthetic natural gas (SNG)
- Sn-MCM-41 606
- ¹¹⁹Sn-NMR 608
- SnO₂
 - ALD growth of 338
 - growth saturation 337
- Sn-zeolite 605, 606, 608
- sodium aluminates 277
- sodium borohydride 726, 744
- sodium formate 234

- sodium hydroxide 723
- sodium silicates 277
- SOFC. *see* solid oxide fuel cell (SOFC)
- soft templates 60
- softwood lignin 541
- SO₃H functionalization process 642
- solar cells 396
- solar cycle technology 827
- solar dish system 828
- solar energy 228, 385, 394, 396, 827, 851
- solar fuels 47, 227, 388–390, 395, 827
 - production 385
- solar hydrogen community 918
- solar hydrogen generators 27, 908, 909, 913, 915, 921, 926, 928
 - design aspects 914
 - integrated and nonintegrated 911
 - integrated *vs.* nonintegrated 911
 - major bottlenecks 914
 - operated in alkaline conditions 909
 - scaling of 27, 918
 - wired *vs.* wireless 911
 - working principle 908
- solar hydrogen production 868
- solar radiation 884, 885
- solar refineries 388
- solar simulated photocatalysis 26, 884
- solar spectrum 227
- solar syngas 829
- solar-to-hydrogen (STH)
 - efficiency 913
 - energy 865
- sol–gel, deposition 92
- sol–gel method 10, 39, 42, 97, 129, 158, 192, 366, 404, 747
- solid adsorbents 391
- solid biomass 595
- solid catalysts 91, 642
- solid electrolyte (SE) 908
- solid–liquid–gas systems 1030
- solid oxide cell (SOC) 939, 940
- solid oxide electrolyte 928
- solid oxide fuel cell (SOFC) 441
- solid (hydr)oxides 6
- solid photocatalysts 994
- solid–solid transformation 425
- solid-state electrochemical cells 939
- solid-state electrolyte 928
- solid-state polymer membrane 965
- solid surface tension 3
- solution combustion synthesis (SCS) 92, 97
 - adiabatic flame temperature 93
 - merits of 93
 - oxide catalysts 95
 - preparation of nanocrystalline oxide materials 93
 - rapid heating, of aqueous redox mixture 93
 - synthesis of oxide materials 93
- Solvay process 808
- solvent washing 595
- solvothermal reactions
 - high-throughput optimization 373
- sonication 361, 862
- Sonogashira coupling 182, 192
- sorbents 275
- Soxhlet extractor 636
- SO₄/ZrO₂ surface coatings 759
- spanning ceramics 360
- spatiotemporal heterogeneities 983
- specific surface area (SSA) 876
- spectroscopic reaction monitoring 376
- spectroscopic techniques 982, 984
- spin coating 365
- spinel ferrites 154
- spiramycin (SP) 884
- spray pyrolysis methods 404
- sputtering 220, 451
- spyramicin mineralization efficiency 884
- Sr, EDX mapping images 864
- SrTiO₃ . La,Rh and BiVO₄ photocatalytic systems
 - water splitting activities, 864
- SrTiO₃ . La,Rh/Au/BiVO₄ photocatalyst sheet, SEM-EDX mapping images 863
- S-SAPO-34 crystallization 267
- stable CNF composite-electrodes 951
- stainless steel monoliths 371
- standard Gibbs free energies 445
- standard potentials (RHE) 967
- stannosilicates 605, 606, 608, 611, 612, 615
- static approach –transition state theory (TST) 30, 1080
- Stöber method 158, 198
- steady state transient kinetic analysis (SSITKA) 1040
- steam electrolysis 928
- steam reforming of methane (SRM) 401
 - endothermic reforming reaction 401
 - exothermic water–gas shift reaction 401
- stereolithography 361, 362, 373
 - advantages 362
- STH efficiency 865–867, 913, 922, 929
- stimulated Raman scattering microscopy
 - mapping of CD₃CN 998
- stoichiometric coefficient 512
- stoichiometric oxidizing agents 22

- stoichiometry 153, 715
- storage devices 394
- strong metal support interaction (SMSI) 214
- structural diversity 1056
- structure–catalytic property relation 92
- structured catalyst fabrication
 - 3D printing, use of 370
- structured catalysts 369
- structured monoliths 371
- styrene 31
 - carbocation 985
 - carbonate
 - one-pot synthesis of 822
 - chemoselective epoxidation 746
 - hydrogenation 31
 - oligomerization 995
 - oxidation 26
 - oxide formation 26
- subnanometer metal nanoparticles 222
- subreactive temperatures 286
- substrate morphology
 - tuning 344
- subsurface oxygen 486
- substrate–nanoparticles interfaces 4
- succinic acids 627
- sugar 590, 592, 598, 599
 - conversion 593
 - derivatives 595
 - isomerization 605, 606
 - to lactic acid derivatives 609
 - monomers 717
 - valorization 593
- sugarcane 964
- sulfated zirconia (SZ) 767, 770
- sulfated $\text{ZrO}_2/\text{TiO}_2$ nanocomposites 769
- sulfating agent 769
- sulfided CoMo catalysts 658
- sulfided NiMo catalysts 658
- sulfonated carbons synthesis
 - via incomplete carbonization 778
- sulfonated cellulose 720
- sulfonated glucose-derived carbon-based catalyst
 - application of 778
- sulfonated graphene 43
- sulfonated hydrochar 720
 - preparation from glucose 719
- sulfonated single-walled carbon nanotubes 789
- sulfonation 718, 723, 733
 - of hydrochar 719
- sulfonation agents 638
- sulfonation methods 43
- sulfonic acids 42, 77, 638
 - grafting 789
- sulfonic groups 719, 720
- sulfur-containing organics 231
- sulfur-containing triazoles 181
- sulfuric acid 719
- sulfur leaching 771
- sulfur resistance 941
- sulfur-resistant nickel catalysts 411
- sunflower oil transesterification 788
- supercapacitors 394, 629
- supercritical drying 39
- supercycle approach 341
- superior porous zeolites, catalytic performance 280
- superparamagnetic (SPM)
 - iron oxide particles (Fe_3O_4) 153
 - magnetic modification of 172
 - materials 147
 - oxides 123
 - properties 730
 - radius 148
 - theoretical magnetic field curve for 148
- superparamagnetism 148
- superresolution fluorescence microscopy 982
- superresolution imaging 992, 994
- supersaturation 3–5, 10, 16, 875
- supported Au catalysts 31
- supported bimetallic noble metal catalysts
 - by ALD 349
- supported iron oxide nanoparticles 138
- supported metal nanoparticles 124
 - characterization 125
 - properties of 14, 125
- supported monometallic noble metal catalysts
 - by ALD 347
- supported Pd nanoparticles 346
- support materials 344
 - catalytic activity and selectivity, role in 24
- surface acidity 521, 527
- surface area-normalized esterification rates 768
- surface chemical potential 4
- surface chemistry 225
- surface conductivity 218
- surface modifiers 484
- surface oxidation 15
- surface plasmon resonance (SPR) 984
- surface properties 862
- surface tension 3, 4
- surface-to-volume ratio 149, 239
- surfactant-inorganic interface 60
- surfactants 14, 631

- supramolecular self-assembly 57
 - template extraction 764
 - sustainable energy 385, 386
 - catalysis, role in 389
 - production 385
 - sustainable feedstock 755
 - sustainable industrial development 78
 - sustainable land management practices 754
 - sustainable resources 754
 - Suzuki coupling reactions 185, 200
 - Suzuki cross-coupling reaction 16, 235, 744
 - Suzuki–Miyaura coupling 12, 235, 725, 730
 - of 4-iodoanisole and phenylboronic acid 725
 - Suzuki–Miyaura cross-coupling reaction 729
 - SWCNT. *see* single-wall carbon nanotube (SWCNT)
 - switchgrass 754
 - syngas 449, 455, 464, 812, 815, 828, 834
 - synthesis of 386, 392, 522, 829
 - synthesis gas 469
 - synthesized pure silica 57
 - synthetic methods
 - summary comparison of 155
 - synthetic natural gas (SNG) 78
 - syringe-type nozzle 362
 - S-ZSM-5 zeolite
 - crystallization of 270
- t**
- Tafel plots 904
 - Ta₃N₅ photocatalyst 902
 - tapered element oscillating microbalance (TEOM) method 304
 - technoeconomic analysis 867, 919, 921
 - tellurium 520
 - temperature-programmed desorption (TPD) 106, 286, 485, 609
 - temperature-programmed reaction spectroscopy 106
 - temperature-programmed reduction (TPR) 106, 485
 - temperature programmed techniques 106
 - temperature window 337
 - template-directed synthesis 629, 630
 - Te nanowires (Te-NW) 233
 - Te-NW MOF-templated mesoporous carbon 233
 - terephthalic acid 601
 - terpyridine ligands 191
 - tert-butyl hydroperoxide (TBHP) 24, 26, 822
 - tert-butyl phenylboronic acid 745
 - tetrabutylammonium bromide (TBAB) 822
 - tetrabutylammonium hydroxide (TBAOH) 258
 - tetracoordinated tin(IV) 602
 - tetraethoxysilane 477
 - tetraethyl orthosilicate (TEOS) 744
 - tetrahexylammonium bromide (THAB) 822
 - tetrakis(dimethylamino)tin (TDMASn)/H₂O process 337
 - tetramethylammonium (TMA⁺) 252
 - tetramethylammonium bromide (TMAB) 822
 - 3,3',5,5'-tetramethylbenzidine (TMB) 184
 - tetramethylorthosilicate 230
 - tetrapropyl ammonium (TPA) 279, 989
 - tetrapropylammonium cations 277
 - tetrapropylammonium hydroxide (TPAOH) 682
 - tetratopic pyrene carboxylate linkers 230
 - tetroses 612, 614
 - textile industry effluents 880
 - TFB. *see* turbulent fluidized bed (TFB)
 - TFEL. *see* thin film electroluminescent (TFEL)
 - THAB. *see* tetrahexylammonium bromide (THAB)
 - theoretical modeling 1055
 - theoretical selectivity 587
 - thermal activation 236, 337
 - thermal and solar cycles 827
 - thermal carbonization 630
 - thermal conductivity 512
 - thermal decomposition 153, 229
 - thermal degradation 424
 - thermal energy 386, 388
 - thermal expansion 437
 - thermal inkjetting 365
 - thermal stability 57, 60, 200, 479, 942, 945
 - thermal treatment 621, 728
 - thermodynamic advantage 929
 - thermodynamical system 4
 - thermodynamic carrier conversion 424
 - thermogravimetric analysis (TGA) 164, 947
 - thermogravimetric analyzer, coupled with Fourier transform infrared spectroscopy (TGA-FTIR) 677
 - thermolysis 231, 242
 - thermoplastic polymer 363
 - Thiele modulus 296
 - thin catalyst layers 364
 - thin film
 - deposition techniques 336
 - devices 364
 - insulators 341
 - technologies 926
 - thin film electroluminescent (TFEL) 335

- thiol 17
- thiolate ligands 23
- thiol-ene chemistry 623
- thiophene 739
 - hydrodesulfurization of 324
- thiophene-poisoned Au/ZnO 30
- Thomas–Fermi screening length 215
- three-dimensional dealuminated
 - mordenite 317
- three-dimensional printing (3D printing) 359
- three-way catalyst (TWC) 97
- Ti-containing mesoporous materials
 - epoxidation of cyclohexene 137
- Ti-MCM-41 catalyst 991
- time-on-stream evolution of CO
 - conversion 241
- time-resolved in'situ and operando
 - spectroscopy
 - on ceria-based oxidation catalyst 1039
- time-resolved photoluminescence (TRPL) 877
- tin-containing silicates 611
- tin oxide 340
- titanium (TiO₂) 82, 161
 - ALD process 343
 - carrier concentration 219
 - catalysts 879
 - catalytic reaction of 104
 - coated zeolite-4 material 338
 - coating, photocatalytic properties of 885
 - deposition 860
 - gel 10
 - ink-bottle-shaped pores 346
 - nanoparticles 10, 83, 228
 - nanorods
 - photoanodes 994
 - ZrO₂-modified 769
 - nanotube arrays 968
 - nanotube electrodes 968
 - nanotubes arrays 11, 12
 - photoactivity of 105
 - photocatalysts 15
 - precursors 366
 - support 214
 - supported vanadia 373
 - thin films 219
 - ZnO-based catalysts 873
 - ZrO₂ photocatalyst 82
- titanium dioxide thin film 929
- titanium interstitials 219
- titanium isopropoxide (TTIP) 97, 137, 228, 875
- titanosilicate ETS-10 crystals 994
- titanosilicates 603
- titanyl hydroxide [TiO(OH)₂] 97
- titanyl nitrate 97
- TMAB. *see* tetramethylammonium bromide (TMAB)
- TMB. *see* 3,3',5,5'-tetramethylbenzidine (TMB)
- Tollens' test 735
- toluene 471, 986
 - benzylation of 134
 - hydrogenation of 342
- torrefaction 716
- torrefied biomass 716
- total organic carbon (TOC) 881
- trade-off 590
- transesterification 77, 991
 - of TG 136
- transesterification processes 136
- transient effect of current application for C₂H₄
 - oxidation 954
- transition metal 16, 854
 - alloys 927
 - catalysts 210
 - cations 854
 - CO₂ oxidation screening in CLDR 424
 - ion 984
 - oxides 442, 443
 - surface 210
- transition state (TS) 1058
- transition-state regions, for complex chemical transformations 1072
- transmetallation 819
- transmission electron microscopy (TEM) 125, 284, 343, 902
 - studies 99
- transparent conductive oxide (TCO) 912
- transport assessment 300
- transportation fuels 75
- transport resistances 914
- triacylglycerol 77
- tributyrin transesterification 765
- trichloroethane (TCE) 491
- trickle bed conditions 347
- triethylbenzene 759
- triglycerides (TAG) 757
 - transesterification 792
 - transesterification of 14, 136
- trihydroxy-3-hexenoic acid methyl ester (THM) 615
 - from glucose via 3-DG 615
 - from sugars via 3-DG 617
- triisopropylbenzene 759
- trimethylbenzene 759
- triolein 76

- trioses 609, 612
 - triple-phase boundary (TPB) 941
 - triton X-100 875
 - tunable solid acid catalysts 763
 - tungsten 411
 - tungsten carbide 645
 - tungsten carbide electrodes 902
 - tungsten loadings 768
 - tungstophosphoric acid (TPA) 766
 - tunnel shape selectivity 315
 - turbulent fluidized bed (TFB) 506, 508
 - turn over frequency (TOF) 22, 49, 187, 211, 218, 241, 605, 759
 - turnover number (TON) 611
 - two-zone fluidized bed reactor 478
- u**
- UiO-66
 - conventional unit cell of 1064
 - Ullmann-type coupling reactions 372
 - ultradispersed diamonds 38
 - ultrastable faujasite 275
 - ultrastable Y (USY) 609
 - ultraviolet (UV)
 - curable liquid layer 362
 - irradiation 366
 - light irradiation 899
 - light source 361
 - Raman spectroscopy 260, 265
 - vis absorbance measurements 984
 - vis diffuse reflectance 984
 - – $\text{LaMg}_x\text{Ta}_{1-x}\text{O}_{1+3x}\text{N}_{2-3x}$ 857
 - – spectroscopy (UV-vis DRS) 876
 - visible microspectroscopy 983, 985, 986, 989
 - – absorption 983
 - undoped CeO_2 , surface reduction 429
 - undoped TiO_2 supports 219
 - undoped titania-functionalized tiles (tile K) 885
 - α,β -unsaturated aldehydes 28
 - electronic effect of Au 30
 - role of support 29
 - selective hydrogenation of 28
 - size dependence 28
 - unsaturated carbon atoms 39
 - uphill reactions, catalytic reaction path 852
 - urban wastewater treatments plant (UWWTP) 884
 - urea 42, 942, 962
 - synthesis 809
 - uronic acid 541
- v**
- vacancy diffusion 425
 - vacuum distillation 388
 - vacuum gas oil (VGO) 288
 - cracking 659
 - valence band (VB) 15, 861, 873
 - valence band maximum (VBM) 854
 - levels 854
 - valence electrons 1037
 - valeric biofuels 590, 591
 - valorization 823, 830, 1057
 - valuable chemicals, cogeneration of 972
 - vanadium 520
 - hydrochar oxidation 524, 741, 747
 - vanadium phosphorus oxide 504
 - vanadium pyrophosphate catalyst 514
 - van der Waals interactions 1069
 - vapor-phase alkylation 134
 - vapor-phase device 930
 - vapor-phase electrolysis 928
 - vapor phase operation 929
 - vapor-phase operation 928
 - of PEM electrolyzer 929
 - solar hydrogen generators 928
 - vegetable oils 595
 - vibrating sample magnetometry (VSM) 163
 - vibrational spectroscopy 1030
 - vinyl acetate (VA) 483, 487
 - synthesis 488
 - vinylbenzene chloride 196
 - V–I polarization curves 946
 - viscosity 897
 - modifiers 363, 366
 - visible light active photocatalysts 878
 - visible light irradiation 884
 - visible light responsive nanophotocatalysts, method of preparation 875
 - hydrothermal (HT) method 875
 - precipitation (PM) method 876
 - sol–gel (SGM) method 875
 - visible light-sensitive photocatalysts, for water splitting 855
 - volatile organic compound (VOC) 884
 - volatile solar cycles 830
 - volcano-shaped activity curve 209
 - voltage loss 912
 - voltammograms 895, 898, 904
 - cyclic 901
- w**
- Wacker process 495
 - washcoating 97
 - catalyst 325

- growth of 98
 - preparation of 98
 - waste biomass valorization 753
 - waste cooking oil 758
 - waste management 586
 - wastewaters 238
 - removal of pollutants from 880
 - water/alcohol ratio 10
 - removal of pollutants from 880
 - water bodies 880
 - water consumption 930
 - water dissociation 214
 - water electrolysis 961, 963
 - light-induced 825
 - water electrolyzer cell architectures 962
 - water gas shift reaction 211
 - water managing, in devices 931
 - water photoelectrolysis 395, 851
 - water scarcity 929
 - water splitting 825–829, 851, 853, 854
 - overall, parameters for 893
 - reaction 396
 - on semiconductor photocatalyst, theory on 852
 - on surface-coated photocatalyst
 - reaction mechanism 860
 - under visible light 854
 - water tolerance 766
 - water-tolerant HPAs 765
 - water-tolerant solid acids 781
 - WC/SrTiO₃ photocatalyst 902, 903
 - wet air oxidation (WAO) 50
 - wet hydrocracking 463
 - wet impregnation 16, 187
 - wet oxidation 629, 636
 - wet peroxide oxidation (WPO) 50
 - wide-field fluorescence microscopy (WFM) 990
 - Wilkinson's catalyst 818
 - wired devices 919
 - wired solar hydrogen generators 912
 - wired/wireless solar hydrogen generators 913
 - wireless designs 921
 - wood-derived crude bio-oil 658
- x**
- XANES. *see* X-ray absorption near edge spectroscopy (XANES)
 - XANES, for palladium hydride 1037
 - XANES spectra 1036, 1037, 1046, 1047
 - XAS. *see* X-ray absorption spectroscopy (XAS)
 - xerogels 10, 39
 - XES. *see* X-ray emission spectroscopy (XES)
- X-ray absorption 473, 1031
 - X-ray absorption fine structure (XAFS) 22
 - studies 101
 - X-ray absorption near edge spectroscopy (XANES) 1034
 - for Pd cluster 1037
 - Pd L₃ edge 1036
 - X-ray absorption spectroscopy (XAS) 525, 1029, 1030
 - spectra 1031
 - X-ray adsorption 518
 - X-ray diffraction (XRD) 58, 125, 284, 981
 - 2D model 438
 - studies 99
 - X-ray emission 1031, 1038
 - detection of valence structure by 1037
 - nonresonant 1032
 - resonant 1032
 - X-ray emission spectroscopy (XES) 1029, 1030, 1041
 - resonant 1041
 - X-ray fluorescence 1041
 - X-ray photoelectron spectroscopy (XPS) 22, 40, 100, 125, 164, 522, 524, 525
 - measurements, in situ synchrotron 346
 - X-ray photon 1032
 - X-ray reflectivity measurement 346
 - X-ray spectroscopy 1029, 1040
 - Xylan thermal pyrolysis 669
 - xylose 606, 613, 621
 - xylulose 619, 621
- y**
- yolk–shell nanocomposites 194
 - yolk–shell nanostructures 198
 - yolk–shell structure 194, 198, 201
 - yttria-stabilized zirconia (YSZ) 211
 - porous electrode 946
- z**
- zeolites 24, 214, 236, 275, 312, 313, 339, 388, 392, 471, 475, 594, 606–609, 616, 617, 619, 620, 942, 985, 988, 992, 1043, 1056
 - Beta seeds 254, 673, 677
 - catalysts 251, 287, 317, 453, 462, 592
 - characterization, analytical techniques 283
 - dealkylation 289
 - hydrothermal synthesis 251
 - manufacturing 290
 - methylation 1076
 - characterization 282–286
 - adsorption 285
 - chemisorption 286

- diffusion 286
- spectroscopy 284
- classification of 312
- crystals 991
- dry-gel conversion and ionothermal synthesis 265
- ECR-1 synthesized
 - SEM image 253
- frameworks, structure 472
- framework types 773
- industrial appeal 279–282
 - advances 282
 - HSE 17, 280
 - ingredients 281
 - unit operations 281
- lewis acidity 693
- MFI layer 451
- organotemplate-free synthesis 252
- performance 286–289
- seeds 258
- synthesis of 259
- solvent-free synthesis of 265
 - aluminophosphate molecular sieves 266
 - aluminosilicate zeolites 265
 - supported metal carbides 471
 - sustainable synthesis 17, 268
 - types 276–279
 - mesoporous crystals 279
 - MOF 242
 - nanosized zeolites 278
 - wide-pore zeolites 278
- ZSM-11 (MEL) 258, 259
- zeolite topology
 - a 1 T cluster 1059
- zeotype materials 620
- zero gap 961
- zero point energies (ZPE) 444
- zero-valent gold nanoparticles (Au NPs) 21
- zeta potential 16
- ZIF-8 233
 - derived carbon 233
- ZIF-67 239
 - mediated synthesis 243
 - nano 237
- ZIF-8 nanofibers, nanowire-directed templating synthesis of 234
- zinc halogens
 - transmetallation agents, used as 819
- zinc-organic compounds 819
- zinc salt 876
- zirconia 340
- zirconium-containing periodic mesoporous organosilicas (Zr-PMOs) 782
- ZJM-6, crystallization time of 257
- ZJM-2 zeolite 259
- Zn(CH₃COO)₂·2H₂O 876
- Zn(NO₃)₂ 876
- ZnO 876
 - photocatalytic activity of 47
- ZnSO₄ 876
- (Zn_{1+x}Ge)(N₂O_x) 855
 - utilize visible light 855
- ZPE. *see* zero point energies (ZPE)
- ZrO₂-supported H₃PW₁₂O₄₀ catalyst 594
- Zr propoxide 875
- Z-schemes 396, 861
- Z-scheme water splitting 861
 - based on two-step excitation 861
- ZSM-5 catalyst 260, 270, 393, 661, 663, 665, 693, 985, 986, 989, 991, 997
 - Ni catalysts 695
- ZSM-23, crystallization time of 257
- ZSM-11 zeolite 260
- ZSM-22 zeolite 260
- ZSM-34 zeolite 253, 260