Modern Heterogeneous Oxidation Catalysis Design Reactions And Characterization

The Earth's natural resources are finite and easily compromised by contamination from industrial chemicals and byproducts from the degradation of consumer products. The growing field of green and sustainable chemistry seeks to address this through the development of products and processes that are environmentally benign while remaining economically viable. Inorganic chemistry plays a critical role in this endeavor in areas such as resource extraction and isolation, renewable energy, catalytic processes, waste minimization and avoidance, and renewable industrial feedstocks. Sustainable Inorganic Chemistry presents a comprehensive overview of the many new developments taking place in this rapidly expanding field, in articles that discuss fundamental concepts alongside cutting-edge developments and applications. The volume includes educational reviews from leading scientists on a broad range of topics including: inorganic resources, sustainable synthetic methods, alternative reaction conditions, heterogeneous catalysis, photocatalysis, sustainable nanomaterials, renewable and clean fuels, water treatment and remediation, waste valorization and life cycle sustainability assessment. The content from this book will be added online to the Encyclopedia of Inorganic and Bioinorganic Chemistry.

Discover the latest research in photocatalysis combined with foundational topics in basic physical and chemical photocatalytic processes In Heterogeneous Photocatalysis: From Fundamentals to Applications in Energy Conversion and Depollution, distinguished researcher and editor Jennifer Strunk delivers a rigorous discussion of the two main topics in her field—energy conversion and depollution reactions. The book covers topics like water splitting, CO2 reduction, NOx abatement and harmful organics degradation. In addition to the latest research on these topics, the reference provides readers with fundamental information about elementary physical and chemical processes in photocatalysis that are extremely practical in this interdisciplinary field. It offers an excellent overview of modern heterogeneous photocatalysis and combines concepts from different viewpoints to allow researchers with backgrounds as varied as electrochemistry, material science, and semiconductor physics to begin developing solutions with photocatalysis. In addition to subjects like metal-free photocatalysts and photocarrier loss pathways in metal oxide absorber materials for photocatalysis explored with time-resolved spectroscopy, readers will also benefit from the inclusion of: Thorough introductions to kinetic and thermodynamic considerations for photocatalyst design and the logic, concepts, and methods of the design of reliable studies on photocatalysis Detailed explorations of in-situ spectroscopy for mechanistic studies in semiconductor photocatalysis and the principles and limitations of photoelectrochemical fuel generation Discussions of photocatalysis, including the heterogeneous catalysis perspective and insights into photocatalysis from computational chemistry Treatments of selected aspects of photoreactor engineering and defects in photocatalysis Perfect for photochemists, physical and catalytic chemists, electrochemists, and materials scientists, Heterogeneous Photocatalysis will also earn a place in the libraries of surface physicists and environmental chemists seeking up-to-date information about energy conversion and depollution reactions.

Heterogeneous Catalytic Materials discusses experimental methods and the latest developments in three areas of research: heterogeneous catalysis; surface chemistry; and the chemistry of catalysts. Catalytic materials are those solids that allow the chemical reaction to occur efficiently and cost-effectively. This book provides you with all necessary information to synthesize, characterize, and relate the properties of a catalyst to its behavior, enabling you to select the appropriate catalyst for the process and reactor system. Oxides (used both as catalysts and as supports for catalysts), mixed and complex oxides and salts, halides, sulfides, carbides, and unsupported and supported metals are all considered. The book encompasses applications in industrial chemistry, refinery, petrochemistry, biomass conversion, energy production, and environmental protection technologies. Provides a systematic and clear approach of the synthesis, solid state chemistry and surface chemistry of all solid state catalysts Covers widely used instrumental techniques for catalyst characterization, such as x-ray photoelectron spectroscopy, scanning electron microscopy, and more Includes characterization methods and lists all catalytic behavior of the solid state catalysts Discusses new developments in nanocatalysts and their advantages over conventional catalysts

While rust is an unwanted oxidation reaction, there are also many other useful oxidation reactions that are extremely important and number among the most commonly used reactions in the chemical industry. This completely revised, updated second edition now includes additional sections on industrial oxidation and biochemical oxidation. Edited by one of the world leaders in the field, high-quality contributions cover every important aspect from classical to green chemistry methods: - Recent Developments in Metal-catalyzed Dihydroxylation of Alkenes - Transition Metal-Catalyzed Epoxidation of Alkenes - Organocatalytic Oxidation. Ketone-Catalyzed Asymmetric Epoxidation of Alkenes and Synthetic Applications - Catalytic Oxidations with Hydrogen Peroxide in Fluorinated Alcohol Solvents - Modern Oxidation of Alcohols using Environmentally Benign Oxidants - Aerobic Oxidations and Related Reactions Catalyzed by N-Hydro xyphthalimide - Ruthenium-Catalyzed Oxidation for Organic Synthesis - Selective Oxidation of Amines and Sulfides - Liquid Phase Oxidation Reactions Catalyzed by Polyoxometalates - Oxidation of Carbonyl Compounds - Manganese-Catalyzed Oxidation with Hydrogen Peroxide - Biooxidation with Cytochrome P450 Monooxygenases By providing an overview of this vast topic, the book represents an unparalleled aid for organic, catalytic and biochemists working in the field.

Organized to enable students and synthetic chemists to understand and expand on aromatic reactions covered in foundation courses, the book offers a thorough and accessible mechanistic explanation of aromatic reactions involving arene compounds. Surveys methods used for preparing arene compounds and their transformations Connects reactivity and methodology with mechanism Helps readers apply aromatic reactions in a practical context by designing syntheses Provides essential information about techniques used to determine reaction mechanisms

A valuable introduction to green oxidation for organic chemists interested in discovering new strategies and new reactions for oxidative synthesis Green Oxidation in Organic Synthesis provides a comprehensive introduction and overview of chemical preparation by green oxidative processes, an entry point to the growing journal literature on green oxidation in organic synthesis. It discusses both experimental and theoretical

approaches for the study of new catalysts and methods for catalytic oxidation and selective oxidation. The book highlights the discovery of new reactions and catalysts in recent years, discussing mechanistic insights into the green oxidative processes, as well as applications in organic synthesis with significant potential to have a major impact in academia and industry. Chapters are organized according to the functional groups generated in the reactions, presenting interesting achievements for functional group formation by green oxidative processes with O2, H2O2, photocatalytic oxidation, electrochemical oxidation, and enzymatic oxidation. The mechanisms of these novel transformations clearly illustrated. Green Oxidation in Organic Synthesis will serve as an excellent reference for organic chemists interested in discovering new strategies for oxidative synthesis which address the priorities of green and sustainable chemistry. "Catalysis" is sure to be of interest to readers working in academia and industry that need an up-to-date critical analysis and summary of catalysis research and applications.

Almost two centuries after the word "catalysis" was first introduced by Berzelius in 1835, the field has been developed to the point where heterogeneous catalysis is at the heart of our today's chemical industry. Nevertheless, one of the grand challenges in this area is being able to tune and design efficient catalysts for processes of interest. In order to do so, a molecular-level understanding of heterogeneous catalysts is of the utmost importance and indeed is a primary focus of modern catalysis research. Conventionally, the single most thermodynamically stable structure of the catalyst obtained under the reaction conditions had been considered as the reactive structure. However, catalysts in the subnano regime, in which there are only up to around 30 atoms per cluster, undergo structural dynamics under reaction conditions, which is triggered by high temperatures and pressures, and changing adsorbates. Using density functional theory and global optimization for structure prediction, in combination with statistical mechanics, we have recently shown that this dynamic fluxionality causes supported clusters to populate numerous distinct structural states under catalytic conditions. Furthermore, considering the single most stable structure gives unrealistic picture and inconsistent results with experiments. Therefore, the catalyst structure should be viewed as an evolving statistical ensemble of many structures. This new idea reforms the accepted models and calls for a new theory and modeling approaches leading to revised design strategies. Our ensemble-average model along with careful sampling of relevant structures suggest that many earlier studies might have overlooked the actual active sites. Ensemble phenomena lead to surprising exceptions from established rules of catalysis such as scaling relations. Catalyst deactivation (sintering, poisoning) is also an ensemble property, and its extent of mitigation can be predicted through the new paradigm. For example, in collaboration with Scott Anderson (U. Utah), we showed that nano-alloying with Sn suppresses both sintering and coking of Pt clusters deposited on SiO2, and on Al2O3, in conditions of thermal dehydrogenation. Theoretically, we showed that this is an ensemble effect, whereby adding Sn quenches electronic spin in all thermally accessible Ptn isomers clusters, closing most of the reaction paths toward deeper dehydrogenation. The ensemble approach leads to a different view on the reaction kinetics and thermodynamics. Chemically distinct states of the catalyst get populated as T increases, and if these states have barriers significantly different from that of the global minimum the Arrhenius

plot should be nonlinear. Therefore, we proposed a modification to the Arrhenius equation using an ensemble-average representation. Spectral signatures are also no longer those of a single structure. In this regard, we showed that for highly fluxional supported nanoclusters, the customary extraction of the oxidation state of the metal from X-ray Absorption Near Edge Structure (XANES) data by fitting to the bulk standards has to be revised. Fitting the experimental spectrum to the calculated spectra of computed ensembles of supported clusters can in contrast provide good agreement and insight on the spectrum-composition- structure relation. These findings were enabled by advances in theory, such as global optimization and subsequent utilization of multiple local minima and pathways sampling as well as catalyst characterization under working condition. More importantly, our proposed model has been tested and confirmed by several experiments, as shown in joint publications with the experimental groups.

With its two-volume structure, this handbook and ready reference allows for comprehensive coverage of both characterization and applications, while uniform editing throughout ensures that the structure remains consistent. The result is an up-to-date review of metal oxides in catalysis. The first volume covers a range of techniques that are used to characterize oxides, with each chapter written by an expert in the field. Volume 2 goes on to cover the use of metal oxides in catalytic reactions. For all chemists and engineers working in the field of heterogeneous catalysis.

The first handbook on this emerging field provides a comprehensive overview of transition metal-catalyzed coupling reactions in the presence of an oxidant. Following an introduction to the general concept and mechanism of this reaction class, the team of authors presents chapters on C-C cross-coupling reactions using organometallic partners, C-Heteroatom bond forming reactions via oxidative couplings, and C-H couplings via C-H activation. The text also covers such groundbreaking topics as recent achievements in the fields of C-C and C-X bond formation reactions as well as C-H activation involving oxidative couplings. With its novel and concise approach towards important building blocks in organic chemistry and its focus on synthetic applications, this handbook is of great interest to all synthetic chemists in academia and industry alike.

Students contemplating careers in chemistry, whether in research, practice, or academia, obviously need a solid grounding in proper research methodology, reasoning, and analysis. However, there are few resources available that efficiently and effectively introduce these concepts and techniques and inspire students to undertake advanced research, particularly in the area of catalysis. Catalysis: Principles and Applications evolved out of a special, resoundingly successful short course for graduate students interested in catalysis. It covers nearly the entire gamut of the subject, from its fundamentals to its modern, applied aspects. The chapters were contributed by catalysis specialists from leading academic institutions, national laboratories and industrial R&D labs. Because they are based on the authors' lecture notes, each chapter is highly accessible and for the most part self-contained. Topics include various spectroscopic methods, biocatalysis, x-ray and thermal analysis, photocatalysis,

and recent developments, such as solid acid catalysts, fine chemical synthesis, and computer-aided catalyst design. The book also contains discussions on a variety of modern applications, including environmental pollution control, petroleum refining, fuel cells, and monomolecular films. Logically presented, well-illustrated, and thoroughly referenced, Catalysis: Principles and Applications offers an outstanding basis for courses in catalysis. It not only imparts the fundamentals, synthesis, characterization, and applications of catalysis, but does so in a way that will motivate students to pursue more advanced studies and ultimately careers in the field.

Catalysts are required for a variety of applications and researchers are increasingly challenged to find cost effective and environmentally benign catalysts to use. This volume looks at modern approaches to catalysis and reviews the extensive literature. Chapters highlight reactions active under oxidative coupling of methane conditions and how they are interlinked, heterogeneous nickel catalysts and their use in laboratory and industry, the reaction mechanism of heterogeneous catalysis with the surface science probe, the concepts of electroless deposition (ED) methods for preparation of true bimetallic catalysts, the general subject of metal-support interactions occurring over ruthenium-based catalysts and benzene as the target volatile organic compound (VOC). Appealing broadly to researchers in academia and industry, these illustrative chapters bridge the gap from academic studies in the laboratory to practical applications in industry not only for catalysis field but also for environmental protection. The book will be of great benefit to any researcher wanting a succinct reference on developments in this area now and looking to the future.

Gathering together the widespread literature in the field, this monograph acts as a reference guide to this very important chemical reaction. Following an introduction, the book goes on to discuss methodology, before treating synthetic and industrial applications -- the latter being a new focus in this completely revised, updated and extended second edition. A must-have for organic, natural products and catalytic chemists, as well as those working in industry, of for lecturers in chemistry.

This Proceedings contains plenary lectures and selected poster communications spanning the entire field of catalysis --- from catalysis by protons to catalysis by multinuclear clusters and ultra-disperse particles. It includes discussion of the recent results of fundamental research conducted at the juncture between homogeneous and heterogeneous catalysis. New ideas, based on modern physical and quantum-chemical methods, and concerning the mechanism of formation and functioning of active sites of catalysts are suggested. It is shown how the cyclic change of atomic distribution in the active site occurs during catalytic transformations. In addition, the Proceedings report new data on methods of "assembling" molecularly organized catalytic systems and on the mechanisms of their action. The various problems such as the effect of strong

metal--support interaction, migration of atoms in active sites, and design of catalytic properties of substances are also widely discussed. Similarities and differences in mechanisms of action of homogeneous and heterogeneous catalysts are considered, using as examples CO hydrogenation, hydrogenolysis of saturated hydrocarbons, selective hydrogenation and oxidation of olefins, metathesis and polymerization of olefins, hydrosilylation and hydroformylation of olefins, etc.

Worldwide efforts have been focused to introduce greener chemical and energetic processes that drive the society away from the dependency on fossil fuels, looking to reduce the environmental footprint of modern societies. Catalysis for instance, has been for decades the winning technology which helps to improve the efficiency of processes in petrochemical, pharmaceutical, and biomedical industries to mention a few. Efficiency of catalysts come mostly from its structure and composition which proportionate high activity and selectivity. However, the use of expensive noble metals as catalyst materials remains a key issue for industrial applications. Thus, developing materials that reduce and mitigate carbon dioxide emissions as well as decrease of waste of the materials using during these processes remain a tremendous challenge to overcome. Nanotechnology for instance, is a growing technology with great impact in the industrial,pharmaceutical and energetical sectors. In fact, nanomaterials provide a better economical option, less waste and still with superior performance than their bulk counterparts which is explained from their reduce size, shape and larger surface areas which leads to overall higher catalytic performance. Nanocatalysis modify the rate of a chemical reaction by speeding up or accelerating the reaction rate without being consumed, making the process more energetically favored. Nanocatalyst have significant impact in different industrial processes as chemical reactions to produce fine chemicals, or for renewable energy and among others. As it was mentioned previously, the high performance of nanocatalyst is associated with the atoms at the surface of the nanostructure which are known as the active sites for catalysis. Moreover, it is well known that surface atoms placed at the corner or edges of the nanocatalyst are more active than those surface atoms at planes, and it the same manner with surface-to-volume ratio, their number will increase with decrease of particle size. In addition to nanoparticle size, crystallographic facets lead to different shapes or morphologies which are also contributing to the number of atoms at the surface, edges and corners. All of these contributing together to the efficiently performance of nanocatalyst for the target reactions . In this thesis is presented nanocatalyst materials development, and studies about their synergetic effect of the different components for heterogeneous catalytic applications. First, benzaldehyde byproduct is an intermediate in the production of fine chemicals and additives. Tuning selectivity to benzaldehyde is therefore critical in alcohol oxidation reactions at the industrial level where the typical methods employ toxic oxidant chemicals for its production. Herein, we report a simple but innovative

method for the synthesis of palladium hydride and nickel palladium hydride nanodendrites with controllable morphology, high stability, and excellent catalytic activity. The synthesized dendrites can maintain the palladium hydride phase even after their use in the chosen catalytic reaction. Remarkably, the high surface area morphology and unique interaction between nickel-rich surface and palladium hydride (-phase) of these nanodendrites are translated in an enhanced catalytic activity for benzyl alcohol oxidation reaction. Our Ni/PdH0.43 nanodendrites demonstrated a high selectivity towards benzaldehyde of about 92.0% with a conversion rate of 95.4%, showing higher catalytic selectivity than their PdH0.43 counterparts and commercial Pd/C. The present study opens the door for further exploration of metal/metal-hydride nanostructures as next-generation catalytic materials. Second, palladium hydride system (PdHx) has been of great interest primarily due to the high solubility of hydrogen on the palladium fcc (Pd-face centered cubic) lattice which make them suitable candidates as environmental friendly materials for applications in terms of storage and use of energy, having specific relevance in hydrogen storage, fuel cell, batteries, kinetics reversibility studies, and more. Palladium hydride properties do not only include adsorption and desorption of hydrogen, but they are also effective for electrocatalytic applications. Overall, palladium hydride and its alloys properties are strongly correlated with their electronic and crystal structure changes. Thus, a deep understanding and methodology for their production is crucial for their use in the mentioned applications. Despite of the studies found in literature, there is still a lack of studies for direct but simple synthesis of palladium hydride with practical applications. For instance, palladium hydride literature studies are mostly based on in-situ studies where a limitation of sample, stability and reproducibility are some of the major problems associated with them which also leads to a lack of studies related to their properties and how to tune them. Herein, we reported a simple yet well designed method for the synthesis of stable palladium hydride with different morphologies and decoration of its surface with organic ligands which lead to different effects in terms of nanocrystal sizes and the ability of tune of its properties. Upon the use of different capping agents during the synthesis, diverse magnetic properties have arisen, as well as an increase in their hydrogen storage capacity. These properties are found to be different from their counterpart of pure palladium and palladium hydride material without coating agents. Third, developing non-platinum materials with enhance performance for electrocatalytic reactions has been gaining attention in recently years. Palladium and Palladium-based materials are the most suitable candidates to substitute platinum catalysts in anodic and cathodic reactions. Here we developed a facile path to synthesize PdCu nanowires having alloy and intermetallic phases within their structures. To the best of our knowledge, the catalytic properties of *PdCu intermetallic nanowires for hydrogen evolution reaction and formic acid oxidation reaction are higher than their PdCu alloy counterpart and those previously reported for 0D

and 1D bimetallic nanostructures. Tafel slopes and overpotential presented here during hydrogen evolution reaction of *PdCu NWs in both acidic and basic conditions are superior than PdCu alloy nanowires, Pd nanowires and comparable to commercial Pt. In terms of formic acid oxidation reaction, *PdCu NWs also exhibits the highest mass activity, followed by PdCu alloy NWs, and being both superior than commercial Pd. In addition, PdCu nanowires also exhibit superior stability for both reactions: hydrogen evolution reaction in acid and basic conditions, and formic acid oxidation reaction as well as good resistance against CO poisoning. Density functional theory (DFT) calculations demonstrate that the improved HER performance at acidic condition is due to the decrease in the hydrogen binding energy of the compressed PdCu-B2 phase, and the improved HER performance at alkaline condition is due to the reduced water dissociation barriers at alkaline condition of *PdCu intermetallic phase.

The demand for novel efficient and environmentally sustainable chemo, regio- and stereoselective catalyst systems for the oxidation of organic substrates is continuously growing in line with toughening economic and environmental constraints. This book addresses these issues; it consists of eleven chapters written by world-recognized experts in green and sustainable oxidation catalysis. The most urgent and challenging topics, in the judgment of the editor, such as green asymmetric epoxidations, sulfoxidatiuons, C–H oxidations; oxidation catalysis by polyoxometalates and oxidations in non-conventional solvents, etc. have been critically reviewed in this book. Both fundamental aspects, such as catalysts design, catalytic properties, nature of catalytically active sites and reaction mechanisms, and practical outlook of the oxidations have been addressed by the authors. The book appeals to a broad readership, particularly graduate students, employees of universities and research organizations, and industrial researchers, particularly those working in the areas of homogeneous oxidation catalysis, asymmetric synthesis, organocatalysis, sustainable catalytic processes and green chemistry, mechanisms of catalytic reactions, synthesis of bioactive compounds, biomimetic chemistry, etc. Konstantin Bryliakov is Leading Researcher at the Boreskov Institute of Catalysis. In 2016, he was elected Honorary Professor of the Russian Academy of Sciences.

Mixed oxides are the most widely used catalyst materials for industrial catalytic processes. The principal objective of this book is to describe systematically the mixed oxide catalysts, from their fundamentals through their practical applications. After describing concisely general items concerning mixed oxide and mixed oxide catalysts, two important mixed oxide catalyst materials, namely, heteropolyacids and perovskites, are taken as typical examples and discussed in detail. These two materials have several advantages: 1. They are, respectively, typical examples of salts of oxoacids and double oxide, that is, the two main categories of mixed oxides in solid state chemistry. 2. Both exhibit excellent catalytic performance in nearly crystalline state and are used in several industrial applications. 3. They have studied for many years. In addition, metal oxides

functioning as a catalyst support (carrier) are included. Although the supports are very important in practical applications, and tremendous progress has been made in the past decades, few systematic reviews exist. It is notable that heteropolyacids and perovskite exhibit unique performance when used as a support. Fundamental catalytic science and technology and solid state chemistry necessary is presented for the proper understanding of mixed oxide catalysts as well as for R&D. For the latter, the concept of design of practical catalysts is very important. This is considered throughout the book. Systematically describes design principles of mixed oxide catalysts Shows how catalysis and solid-state chemistry of metal oxides are inter-related Covers all useful basic concepts of mixed oxide catalysis

Zeolites and Zeolite-like Materials offers a comprehensive and up-to-date review of the important areas of zeolite synthesis, characterization, and applications. Its chapters are written in an educational, easy-to-understand format for a generation of young zeolite chemists, especially those who are just starting research on the topic and need a reference that not only reflects the current state of zeolite research, but also identifies gaps and opportunities. The book demonstrates various applications of zeolites in heterogeneous catalysis and biomass conversion and identifies the endless possibilities that exist for this class of materials, their structures, functions, and future applications. In addition, it demonstrates that zeolite-like materials should be regarded as a living body developing towards new modern applications, thereby responding to the needs of modern technology challenges, including biomass conversion, medicine, laser techniques, and nanomaterial design, etc. The book will be of interest not only to zeolite-focused researchers, but also to a broad scientific and non-scientific audience. Provides a comprehensive review of the literature pertaining to zeolites and zeolite-like materials since 2000 Covers the chemistry of novel zeolite-like materials such as Metal-Organic Frameworks (MOFs), Covalent Organic Frameworks (COFs), hierarchical zeolite materials, new mesoporous and composite zeolite-like micro/mesoporous materials Presents essential information of the new zeolite-like structures, with a balanced coverage of the most important areas of the zeolite research (synthesis, characterization, adsorption, catalysis, new applications of zeolites and zeolite-like materials) Contains chapters prepared by known specialists who are members of the International Zeolite Association

This eBook covers the application of high-throughput R&D to both fundamental and applied catalysis including catalyst synthesis, characterization, and testing in various reactor types. Chapters include topics such as applications ranging from optimizations of established industrial catalysts to the discovery of innovative new materials, examples of the development of innovative parallel characterization methods, and cases of real catalyst testing in small scale reactor systems. Readers will also find chapters that cover commodity chemicals produced using continuous gas phase processes as well as fine chemicals produced in liquid phase batch reactors. The potential of industrial chemicals production from biorenewable feedstocks is also presented. The steadily improving high throughput workflows are today being applied to

relevant reactions and targets such as hydrotreating, Deacon oxidation, Fischer-Tropsch, propane dehydrogenation, C4 oxidation, methane coupling, exhaust gas catalysis, bio-based Nylon, fuel cells and vitamins. The topics presented in this eBook have been contributed by researchers from academia as well as industry, making this eBook a well-balanced reference, which could be of particular interest to professional, industrial or service R&D labs.

Catalysts are required for a variety of applications and industrialists and academics are increasingly challenged to find cost effective and environmentally benign catalysts to use. This volume looks at modern approaches to catalysis and reviews the extensive literature on areas such as electrochemical promotion of catalysis, biodiesel-based metals on emission control devices, deoxygenation of fatty acids and transitioning rationally designed catalytic materials to real world catalysts produced on a commercial scale.

Heterogeneous catalysis plays a part in the production of more than 80% of all chemical products. It is therefore essential that all chemists and chemical engineers have an understanding of the fundamental principles as well as the applications of heterogeneous catalysts. This book introduces the subject, starting at a basic level, and includes sections on adsorption and surface science, catalytic kinetics, experimental methods for preparing and studying heterogeneous catalysts, as well as some aspects of the design of industrial catalytic reactors. It ends with a chapter that covers a range of examples of important catalytic processes. The book leads the student to carrying out a series of "tasks" based on searches of the internet and also on the use of web-based search tools such as Scopus or Web of Science. These tasks are generally based on the text; they can be used entirely for self-study but they can also be tailored to the requirements of a particular course by the instructor/lecturer giving the course. The author has had over 40 years of experience in catalytic research as well as in lecturing on the principles of catalysis. He was for more than 20 years the Editor of Catalysis Today. Coverage of all aspects of catalysis in carefully organised text Inclusion of material on the historical development of the subject and the personalities involved All concepts illustrated by practical examples Inclusion of a wide range of problems and solutions, case studies, and supplementary web based material which will be regularly updated Author has over 40 years research experience of almost all covered subjects Provides companion materials webiste

In recent years the need for sustainable process design and alternative reaction routes to reduce industry?s impact on the environment has gained vital importance. The book begins with a general overview of new trends in designing industrial chemical processes which are environmentally friendly and economically feasible. Specific examples written by experts from industry cover the possibilities of running industrial chemical processes in a sustainable manner and provide an up-to-date insight into the main concerns, e.g., the use of renewable raw materials, the use of alternative energy sources in chemical processes, the design of intrinsically safe processes, microreactor and integrated reaction/ separation technologies, process intensification, waste reduction, new catalytic routes and/or solvent and process optimization.

Covering everything from the basics to recent applications, this monograph represents an advanced overview of the field. Edited by internationally acclaimed experts respected throughout the community, the book is clearly divided into sections on fundamental and applied surface organometallic chemistry. Backed by numerous examples from the recent literature, this is a key reference for all chemists.

For far too long chemists and industrialists have relied on the use of aggressive reagents such as nitric and sulphuric acids, permanganates and dichromates to prepare the massive quantities of both bulk and fine chemicals that are needed for the maintenance of civilised life — materials such as fuels, fabrics, foodstuffs, fertilisers and pharmaceuticals. Such aggressive reagents generate vast quantities of environmentally harmful and often toxic by-products, including the oxides of nitrogen, of metal oxides and carbon dioxide.Now, owing to recent

advances made in the synthesis of nanoporous solids, it is feasible to design new solid catalysts that enable benign, mild oxidants to be used, frequently without utilising solvents, to manufacture the products that the chemical, pharmaceutical, agro- and bio-chemical industries require. These new solid agents are designated single-site heterogeneous catalysts (SSHCs). Their principal characteristics are that all the active sites present in the high-area solids are identical in their atomic environment and hence in their energy of interaction with reactants, just as in enzymes.Single-site heterogeneous catalysts now occupy a position of growing importance both academically and in their potential for commercial exploitation. This text, the only one devoted to such catalysts, dwells both on principles of design and on applications, such as the benign synthesis of nylon 6 and vitamin B3. It equips the reader with unifying insights required for future catalytic adventures in the quest for sustainability in the materials used by humankind.Anyone acquainted with the language of molecules, including undergraduates in the physical and biological sciences, as well as graduates in engineering and materials science, should be able to assimilate the principles and examples presented in this book. Inter alia, it describes how clean technology and ‘green’ processes may be carried out in an environmentally responsible manner.

The worldwide market for heterogeneous catalysts amounts to about 12 billion US$ per year. The use of these catalysts in energy conversion, chemicals manufacturing and environmental processes saves time and money, expanding the margin generated by an estimated 100-300 times. Heterogeneous catalysts may be considered the most important nanostructured materials and their preparation is thus of paramount importance. This practical book combines recent progress with a discussion of the general aspects of catalyst preparation. The first part deals with the basic principles of heterogeneous catalyst preparation, explaining the main aspects of sol-gel chemistry and interfacial chemistry, followed by such techniques as co-precipitation and immobilization. New tools for catalyst preparation, including microspectroscopy and high-throughput experimentation, are also taken into account. The second part heightens the practical relevance by providing ten case studies on such hot topics as the preparation of zeolites, hydrotreating catalysts, methanol catalyst and gold catalysts. Written by one of the world's leading experts on the topic, this advanced textbook is the perfect introduction for newcomers to this exciting field. Concise and clear, the text focuses on such key aspects as kinetics, reaction mechanism and surface reactivity, concentrating on the essentials. The author also covers various catalytic systems, catalysis by design, and activation-deactivation. A website with supplementary material offers additional figures, original material and references.

Masakatsu Shibasaki, Motomu Kanai, Shigeki Matsunaga, and Naoya Kumagai: Multimetallic Multifunctional Catalysts for Asymmetric Reactions.- Takao Ikariya: Bifunctional transition metal-based molecular catalysts for asymmetric syntheses.- Chidambaram Gunanathan and David Milstein: Bond Activation by Metal-Ligand Cooperation: Design of ”Green” Catalytic Reactions Based on Aromatization-Dearomatization of Pincer Complexes.- Madeleine C. Warner, Charles P. Casey, and Jan-E. Bäckvall: Shvo’s Catalyst in Hydrogen Transfer Reactions.- Noritaka Mizuno, Keigo Kamata, and Kazuya Yamaguchi: Liquid-Phase Selective Oxidation by Multimetallic Active Sites of Polyoxometalate-Based Molecular Catalysts.- Pingfan Li and Hisashi Yamamoto: Bifunctional Acid Catalysts for Organic Synthesis.- Jun-ichi Ito, Hisao Nishiyama: Bifunctional Phebox Complexes for Asymmetric Catalysis.

Unique in its focus on preparative impact rather than mechanistic details, this handbook provides an overview of photochemical reactions classed according to the structural feature that is built in the photochemical step, so as to facilitate use by synthetic chemists unfamiliar with this topic. An introductory section covers practical questions on how to run a photochemical reaction, while all classes of

the most important photocatalytic reactions are also included. Perfect for organic synthetic chemists in academia and industry.

Filling a gap in the current literature, this comprehensive reference presents all important catalyst classes, including metal oxides, polyoxometalates, and zeolites. Readers will find here everything they need to know -- from structure design to characterization, and from immobilization to industrial processes. A true must-have for anyone working in this key technology.

A best seller since 1966, Purification of Laboratory Chemicals keeps engineers, scientists, chemists, biochemists and students up to date with the purification of the chemical reagents with which they work, the processes for their purification, and guides readers on critical safety and hazards for the safe handling of chemicals and processes. The Seventh Edition is fully updated and provides expanded coverage of the latest commercially available chemical products and processing techniques, safety and hazards: over 200 pages of coverage of new commercially available chemicals since the previous edition. It will be accompanied by a CD-ROM database of all the substances in the book, fully searchable by chemical name, chemical group, CAS registry number, Beilstein number, etc. * The only comprehensive chemical purification reference, a market leader since 1966, Amarego delivers essential information for research and industrial chemists, pharmacists and engineers: '... (it) will be the most commonly used reference book in any chemical or biochemical laboratory' (MDPI Journal) * An essential lab practice and proceedures manual. Improves efficiency, results and safety by providing critical information for day-to-day lab and processing work. Improved, clear organization and new indexing delivers accurate, reliable information on processes and techniques of purification along with detailed physical properties. * The Sixth Edition has been reorganised and is fully indexed by CAS Registry Numbers; compounds are now grouped to make navigation easier; literature references for all substances and techniques have been added; ambiguous alternate names and cross references removed; new chemical products and processing techniques are covered; hazards and safety remain central to the book.

Sets the stage for environmentally friendly industrialorganic syntheses From basic principles to new and emerging industrialapplications, this book offers comprehensive coverage ofheterogeneous liquid-phase selective oxidation catalysis. It fullyexamines the synthesis, characterization, and application ofcatalytic materials for environmentally friendly organic syntheses.Readers will find coverage of all the important classes ofcatalysts, with an emphasis on their stability and reusability. Liquid Phase Oxidation via Heterogeneous Catalysisfeatures contributions from an international team of leadingchemists representing both industry and academia. The book beginswith a chapter on environmentally benign oxidants and thencovers: Selective oxidations catalyzed by TS-1 and othermetal-substituted zeolites Selective catalytic oxidation over ordered nanoporousmetallo-aluminophosphates Selective oxidations catalyzed

by mesoporousmetal-silicates Liquid phase oxidation of organic compounds by supportedmetal-based catalysts Selective liquid phase oxidations in the presence of supportedpolyoxometalates Selective oxidations catalyzed by supported metalcomplexes Liquid phase oxidation of organic compounds by metal-organicframeworks Heterogeneous photocatalysis for selective oxidations withmolecular oxygen All the chapters dedicated to specific types of catalysts followa similar organization and structure, making it easy to compare theadvantages and disadvantages of different catalysts. The finalchapter examines the latest industrial applications, such as theproduction of catechol and hydroquinone, cyclohexanone oxime, andpropylene oxide. With its unique focus on liquid phase heterogeneous oxidationcatalysis, this book enables researchers in organic synthesis andoxidation catalysis to explore and develop promising new catalyticmaterials and synthetic routes for a broad range of industrialapplications.

Over the past twenty years, Catalysis by Heteropolyacids (HPAs) has received wide attention and led to new and promising developments both at academic and industrial level. In particular, heterogeneous catalysis is particularly attractive because it generally satisfies most of green chemistry’s requirements. By emphasizing the development of third generation catalysts, this volume presents trends and opportunities in academic and industrial research. The book appeals to postgraduates, researchers, and chemists working in the field of environmentally benign catalysts as well as catalytic processes.

Reactive, but not a reactant. Heterogeneous catalysts play an unseen role in many of today's processes and products. With the increasing emphasis on sustainability in both products and processes, this handbook is the first to combine the hot topics of heterogeneous catalysis and clean technology. It focuses on the development of heterogeneous catalysts for use in clean chemical synthesis, dealing with how modern spectroscopic techniques can aid the design of catalysts for use in liquid phase reactions, their application in industrially important chemistries - including selective oxidation, hydrogenation, solid acid- and base-catalyzed processes - as well as the role of process intensification and use of renewable resources in improving the sustainability of chemical processes. With its emphasis on applications, this book is of high interest to those working in the industry.

This book provides an overview of bioinspired metal-sulfur catalysis by covering structures, activities and model complexes of enzymes exhibiting metal sulphur moieties in their active center.

This indispensable two-volume handbook covers everything on this hot research field. The first part deals with the synthesis, modification, characterization and application of catalytic active zeolites, while the second focuses on such reaction types as cracking, hydrocracking, isomerization, reforming and other industrially important topics. Edited by a highly experienced and internationally renowned team with chapters written by the "Who's Who" of zeolite research.

Modern Heterogeneous Oxidation CatalysisDesign, Reactions and

CharacterizationJohn Wiley & Sons
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This two-volume book provides an overview of physical techniques used to characterize the structure of solid materials, on the one hand, and to investigate the reactivity of their surface, on the other. Therefore this book is a must-have for anyone working in fields related to surface reactivity. Among the latter, and because of its most important industrial impact, catalysis has been used as the directing thread of the book. After the preface and a general introduction to physical techniques by M. Che and J.C. Védrine, two overviews on physical techniques are presented by G. Ertl and Sir J.M. Thomas for investigating model catalysts and porous catalysts, respectively. The book is organized into four parts: Molecular/Local Spectroscopies, Macroscopic Techniques, Characterization of the Fluid Phase (Gas and/ or Liquid), and Advanced Characterization. Each chapter focuses upon the following important themes: overview of the technique, most important parameters to interpret the experimental data, practical details, applications of the technique, particularly during chemical processes, with its advantages and disadvantages, conclusions.
Microwave photonics and information optics provide high bandwidth and precision along with ultrafast speed at a low cost. In order to reduce noise at the communication trans-receivers, scattering in the devices needs to be decreased, which can be achieved by replacing optoelectronic devices with photonic devices because in the latter only photons propagate electromagnetic waves. Contemporary Developments in High-Frequency Photonic Devices is a crucial research book that examines high-frequency photonics and their applications in communication engineering. Featuring coverage on a wide range of topics such as metamaterials, optoelectronic devices, and plasmonics, this book is excellent for students, researchers, engineers, and professionals.
HELPS RESEARCHERS DEVELOP NEW CATALYSTS FOR SUSTAINABLE FUEL AND CHEMICAL PRODUCTION Reviewing the latest developments in the field, this book explores the in-situ characterization of heterogeneous catalysts, enabling readers to take full advantage of the sophisticated techniques used to study heterogeneous catalysts and reaction mechanisms. In using these techniques, readers can learn to improve the selectivity and the performance of catalysts and how to prepare catalysts as efficiently as possible, with minimum waste. In-situ Characterization of Heterogeneous Catalysts features contributions from leading experts in the field of catalysis. It begins with an introduction to the fundamentals and then covers: Characterization of electronic and structural properties of catalysts using X-ray absorption fine structure spectroscopy Techniques for structural characterization based on X-ray diffraction, neutron scattering, and pair distribution function analysis Microscopy and morphological studies Techniques for studying the interaction of adsorbates with catalyst surfaces, including infrared spectroscopy, Raman spectroscopy, EPR, and moderate pressure XPS Integration of techniques that provide information on the

structural properties of catalysts with techniques that facilitate the study of surface reactions Throughout the book, detailed examples illustrate how techniques for studying catalysts and reaction mechanisms can be applied to solve a broad range of problems in heterogeneous catalysis. Detailed figures help readers better understand how and why the techniques discussed in the book work. At the end of each chapter, an extensive set of references leads to the primary literature in the field. By explaining step by step modern techniques for the in-situ characterization of heterogeneous catalysts, this book enables chemical scientists and engineers to better understand catalyst behavior and design new catalysts for green, sustainable fuel and chemical production.

C-H, C-O, C-C, and C-Heteroatom bond forming processes by using metal-ligand approaches for the synthesis of organic compounds of biological, pharmacological and organic nanotechnological utility are the key areas addressed in this book. Authored by a European team of leaders in the field, it brings together innovative approaches for a variety of catalysis reactions and processes frequently applied in organic synthesis into a handy reference work. It covers all major types of catalysis, including homogeneous, heterogeneous, and organocatalysis, as well as mechanistic and computational studies. Special attention is paid to the improvements in efficiency and sustainability of important catalytic processes, such as selective oxidations, hydrogenation, and cross-coupling reactions, and to their utilization in industry. The result is a valuable resource for advanced researchers in both academia and industry, as well as graduate students in organic chemistry aiming for chemo-, regio- or stereoselective synthesis of organic compounds by using novel catalytic systems.