

**PRINCIPLES OF  
ADSORPTION  
AND  
REACTION  
ON  
SOLID SURFACES**



**RICHARD I. MASEL**

*A Volume in the Wiley Series in Chemical Engineering*

# Principles Of Adsorption And Reaction On Solid Surfaces

**Richard I. Masel**



## **Principles Of Adsorption And Reaction On Solid Surfaces:**

**Principles of Adsorption and Reaction on Solid Surfaces** Richard I. Masel, 1996-03-22 Principles of Adsorption and Reaction on Solid Surfaces As with other books in the field Principles of Adsorption and Reaction on Solid Surfaces describes what occurs when gases come in contact with various solid surfaces But unlike all the others it also explains why While the theory of surface reactions is still under active development the approach Dr Richard Masel takes in this book is to outline general principles derived from thermodynamics and reaction rate theory that can be applied to reactions on surfaces and to indicate ways in which these principles may be applied The book also provides a comprehensive treatment of the latest quantitative surface modeling techniques with numerous examples of their use in the fields of chemical engineering physical chemistry and materials science A valuable working resource and an excellent graduate level text Principles of Adsorption and Reaction on Solid Surfaces provides readers with A detailed look at the latest advances in understanding and quantifying reactions on surfaces In depth reviews of all crucial background material 40 solved examples illustrating how the methods apply to catalysis physical vapor deposition chemical vapor deposition electrochemistry and more 340 problems and practice exercises Sample computer programs Universal plots of many key quantities Detailed class tested derivations to help clarify key results The recent development of quantitative techniques for modeling surface reactions has led to a number of exciting breakthroughs in our understanding of what happens when gases come in contact with solid surfaces While many books have appeared describing various experimental modeling techniques and the results obtained through their application until now there has been no single volume reference devoted to the fundamental principles governing the processes observed The first book to focus on governing principles rather than experimental techniques or specific results Principles of Adsorption and Reaction on Solid Surfaces provides students and professionals with a quantitative treatment of the application of principles derived from the fields of thermodynamics and reaction rate theory to the investigation of gas adsorption and reaction on solid surfaces Writing for a broad based audience including among others chemical engineers chemists and materials scientists Dr Richard I Masel deftly balances basic background in areas such as statistical mechanics and kinetics with more advanced applications in specialized areas Principles of Adsorption and Reaction on Solid Surfaces was also designed to provide readers an opportunity to quickly familiarize themselves with all of the important quantitative surface modeling techniques now in use To that end the author has included all of the key equations involved as well as numerous real world illustrations and solved examples that help to illustrate how the equations can be applied He has also provided computer programs along with universal plots that make it easy for readers to apply results to their own problems with little computational effort Principles of Adsorption and Reaction on Solid Surfaces is a valuable working resource for chemical engineers physical chemists and materials scientists and an excellent text for graduate students in those disciplines

**Introduction to Surface and Thin Film Processes** John Venables, 2000-08-31 This book covers the experimental and

theoretical understanding of surface and thin film processes It presents a unique description of surface processes in adsorption and crystal growth including bonding in metals and semiconductors Emphasis is placed on the strong link between science and technology in the description of and research for new devices based on thin film and surface science Practical experimental design sample preparation and analytical techniques are covered including detailed discussions of Auger electron spectroscopy and microscopy Thermodynamic and kinetic models of structure are emphasised throughout The book provides extensive leads into practical and research literature as well as resources on the World Wide Web see <http://venables.asu.edu/book> Each chapter contains problems which aim to develop awareness of the subject and the methods used Aimed as a graduate textbook this book will also be useful as a sourcebook for graduate students researchers and practitioners in physics chemistry materials science and engineering      Bioprocess Engineering Shijie Liu,2012-11-07 Bioprocess Engineering involves the design and development of equipment and processes for the manufacturing of products such as food feed pharmaceuticals nutraceuticals chemicals and polymers and paper from biological materials It also deals with studying various biotechnological processes Bioprocess Kinetics and Systems Engineering first of its kind contains systematic and comprehensive content on bioprocess kinetics bioprocess systems sustainability and reaction engineering Dr Shijie Liu reviews the relevant fundamentals of chemical kinetics including batch and continuous reactors biochemistry microbiology molecular biology reaction engineering and bioprocess systems engineering introducing key principles that enable bioprocess engineers to engage in the analysis optimization design and consistent control over biological and chemical transformations The quantitative treatment of bioprocesses is the central theme of this book while more advanced techniques and applications are covered with some depth Many theoretical derivations and simplifications are used to demonstrate how empirical kinetic models are applicable to complicated bioprocess systems Contains extensive illustrative drawings which make the understanding of the subject easy Contains worked examples of the various process parameters their significance and their specific practical use Provides the theory of bioprocess kinetics from simple concepts to complex metabolic pathways Incorporates sustainability concepts into the various bioprocesses      Fundamentals of Chemical Reaction Engineering Mark E. Davis,Robert J. Davis,2013-05-27 Appropriate for a one semester undergraduate or first year graduate course this text introduces the quantitative treatment of chemical reaction engineering It covers both homogeneous and heterogeneous reacting systems and examines chemical reaction engineering as well as chemical reactor engineering Each chapter contains numerous worked out problems and real world vignettes involving commercial applications a feature widely praised by reviewers and teachers 2003 edition      ,      *Heterogeneous Catalysis and its Industrial Applications* Martin Schmal,2016-09-22 This book aims to introduce the basic concepts involved in industrial catalytic processes It is profusely illustrated with experimental results with the main objective of guiding how to select a suitable catalyst for specific processes The book is divided in two parts In the first part the basic concepts are addressed regarding the existing theories

activity patterns and adsorption-desorption phenomena. In the second part, the key experimental methods for the physicochemical characterization of catalysts are presented, as well as the currently used catalyst pre- and post-treatments. The last chapter describes some important in situ characterization techniques, e.g. XPS and TEM, and surface model patterns related to surface modifications occurring during the reaction. Thoroughly illustrated with microscopy images, spectroscopy data, and schematics of reaction mechanisms, the book provides a powerful learning tool for students in undergraduate and graduate-level courses on the field of catalysis. Exercises and resolved problems are provided, as well as experimental procedures to support laboratory classes. Furthermore, the content is presented in a carefully chosen sequence reflecting the 30-year teaching experience of the author. The author, Professor Martin Schmal, sees the present book as a way of conveying basic knowledge needed for the development of more efficient catalysts, i.e. nanostructured materials and novel industrial chemical processes in the fields of environmental chemistry, fine chemistry, hydrotreating of heavy oils, hydrogen production, and biomass processing.

Inorganic Chemistry James E. House, 2019-11-01. Inorganic Chemistry, Third Edition, emphasizes fundamental principles including molecular structure, acid-base chemistry, coordination chemistry, ligand field theory, and solid-state chemistry. The book is organized into five major themes: structure, condensed phases, solution chemistry, main group, and coordination compounds, each of which is explored with a balance of topics in theoretical and descriptive chemistry. Topics covered include the hard-soft interaction principle to explain hydrogen bond strengths, the strengths of acids and bases, and the stability of coordination compounds, etc. Each chapter opens with narrative introductions and includes figures, tables, and end-of-chapter problem sets. This new edition features updates throughout with an emphasis on bioinorganic chemistry and a new chapter on nanostructures and graphene. In addition, more in-text worked-out examples encourage active learning and prepare students for exams. This text is ideal for advanced undergraduate and graduate-level students enrolled in the Inorganic Chemistry course. Includes physical chemistry to show the relevant principles from bonding theory and thermodynamics. Emphasizes the chemical characteristics of main group elements and coordination chemistry. Presents chapters that open with narrative introductions, figures, tables, and end-of-chapter problem sets.

Essentials of Chemical Reaction Engineering H. Scott Fogler, 2011. Accompanying DVD-ROM contains many realistic interactive simulations.

**Handbook of Materials Modeling** Sidney Yip, 2007-11-17. This Handbook contains a set of articles introducing the modeling and simulation of materials from the standpoint of basic methods and studies. The intent is to provide a compendium that is foundational to an emerging field of computational research, a new discipline that may now be called Computational Materials. This area has become sufficiently diverse that any attempt to cover all the pertinent topics would be futile. Even with a limited scope, the present undertaking has required the dedicated efforts of 13 Subject Editors to set the scope of nine chapters, solicit authors, and collect the manuscripts. The contributors were asked to target students and non-specialists as the primary audience to provide an accessible entry into the field and to offer references for further reading.

With no precedents to follow the editors and authors were only guided by a common goal to produce a volume that would set a standard toward defining the broad community and stimulating its growth. The idea of a reference work on materials modeling surfaced in conversations with Peter Bin eld then the Reference Works Editor at Kluwer Academic Publishers in the spring of 1999. The rationale at the time already seemed quite clear: the field of computational materials research was taking off, powerful computer capabilities were becoming increasingly available, and many sectors of the scientific community were getting involved in the enterprise.

*Heterogeneous Catalysis* Abdullah A. Shaikh, 2020-08-10. This textbook is a perfect introduction to heterogeneous catalysis focusing on the industrial implementation. It is written in a comprehensible manner using language that is easy accessible and provides problems to practice.

*Nanostructured Materials*, 2001-12-18. This thematic volume of *Advances in Chemical Engineering* presents the latest advances in the exciting interdisciplinary field of nanostructured materials. Written by chemical engineers, chemists, physicists, materials scientists, and bioengineers, this volume focuses on the molecular engineering of materials at the nanometer scale for unique size dependent properties. It describes a bottom up approach to designing nanostructured systems for a variety of chemical, physical, and biological applications.

Physical Chemistry Paul M. S. Monk, 2005-12-13. *Understanding Physical Chemistry* is a gentle introduction to the principles and applications of physical chemistry. The book aims to introduce the concepts and theories in a structured manner through a wide range of carefully chosen examples and case studies drawn from everyday life. These real life examples and applications are presented first, with any necessary chemical and mathematical theory discussed afterwards. This makes the book extremely accessible and directly relevant to the reader. Aimed at undergraduate students taking a first course in physical chemistry, this book offers an accessible applications examples led approach to enhance understanding and encourage and inspire the reader to learn more about the subject. A comprehensive introduction to physical chemistry starting from first principles. Carefully structured into short self contained chapters. Introduces examples and applications first followed by the necessary chemical theory.

*Metal-Catalysed Reactions of Hydrocarbons* Geoffrey C. Bond, 2006-10-03. This unique book drawing on the author's lifetime experience critically evaluates the extensive literature on the field of Metal Catalysed Reactions of Hydrocarbons. Emphasis is placed on reaction mechanisms involving hydrogenation, hydrogenolysis, skeletal and positional isomerisation, and exchange reactions. The motivation for fundamental research in heterogeneous catalysis is to identify the physicochemical characteristics of active centres for the reaction being studied, to learn how these may be modified or manipulated to improve the desired behavior of the catalyst, and to recognize and control those aspects of the catalyst's structure that limit its overall performance. By restricting the subject of the book to hydrocarbons, Bond has progressively developed the subject matter to include areas of importance both to researchers and to those working in the industry.

**Modeling and Simulation of Heterogeneous Catalytic Reactions** Olaf Deutschmann, 2013-09-18. The Nobel Prize in Chemistry 2007 awarded to Gerhard Ertl for his groundbreaking studies in surface chemistry highlighted the

importance of heterogeneous catalysis not only for modern chemical industry but also for environmental protection Heterogeneous catalysis is seen as one of the key technologies which could solve the challenges associated with the increasing diversification of raw materials and energy sources It is the decisive step in most chemical industry processes a major method of reducing pollutant emissions from mobile sources and is present in fuel cells to produce electricity The increasing power of computers over the last decades has led to modeling and numerical simulation becoming valuable tools in heterogeneous catalysis This book covers many aspects from the state of the art in modeling and simulations of heterogeneous catalytic reactions on a molecular level to heterogeneous catalytic reactions from an engineering perspective This first book on the topic conveys expert knowledge from surface science to both chemists and engineers interested in heterogeneous catalysis The well known and international authors comprehensively present many aspects of the wide bridge between surface science and catalytic technologies including DFT calculations reaction dynamics on surfaces Monte Carlo simulations heterogeneous reaction rates reactions in porous media electro catalytic reactions technical reactors and perspectives of chemical and automobile industry on modeling heterogeneous catalysis The result is a one stop reference for theoretical and physical chemists catalysis researchers materials scientists chemical engineers and chemists in industry who would like to broaden their horizon and get a substantial overview on the different aspects of modeling and simulation of heterogeneous catalytic reactions

**Dynamics of Molecule Surface Interaction** Gert Due Billing,2000-01-03 Chemical reactions at surfaces do not follow the same reaction dynamics as atoms in the gas phase The changes from ideal interactions depend on the electronic structure and the spatial and geometric shape of the surface The dynamics of chemical reactions at surfaces have all the complexity of gas phase molecules reaction dynamics plus those associated with the additional phenomena due to the presence of a solid surface *Comprehensive Energy Systems* Ibrahim Dincer,2018-02-07

*Comprehensive Energy Systems* Seven Volume Set provides a unified source of information covering the entire spectrum of energy one of the most significant issues humanity has to face This comprehensive book describes traditional and novel energy systems from single generation to multi generation also covering theory and applications In addition it also presents high level coverage on energy policies strategies environmental impacts and sustainable development No other published work covers such breadth of topics in similar depth High level sections include Energy Fundamentals Energy Materials Energy Production Energy Conversion and Energy Management Offers the most comprehensive resource available on the topic of energy systems Presents an authoritative resource authored and edited by leading experts in the field Consolidates information currently scattered in publications from different research fields engineering as well as physics chemistry environmental sciences and economics thus ensuring a common standard and language *Advances in Building Energy Research* Mat Santamouris,2013-07-23 Several high quality scientific journals are published in the area of building energy and indoor outdoor environment however one has been missing *Advances in Building Energy Research* fills the gap I

recommend ABER to all technical libraries research institutes and universities It should also be used by construction companies and those manufacturing building materials and building products Professor Olli Seppänen President of REHVA Federation of Heating and Air conditioning Associations Advances in Building Energy Research is a unique index It will be an inexhaustible resource for energy related sciences and a continuous inspiration for architects around the world N Fintikakis Architect and Director of UIA ARES WP Architecture and Renewable Energy Sources Advances in Building Energy Research ABER offers state of the art information on the environmental science and performance of buildings linking new technologies and methodologies with the latest research on systems simulations and standards As stringently reviewed as a journal but with the breadth of a book this annual volume brings together invited contributions from the foremost international experts on energy efficiency and environmental quality of buildings Spanning a broad range of technical subjects this is a must have reference on global developments in the field suitable for architects and building engineers environmental engineers industry professionals students teachers and researchers in building science technical libraries and laboratories

**Multiphase Catalytic Reactors** Zeynep Ilsen Önsan, Ahmet Kerim Avci, 2016-07-05 Provides a holistic approach to multiphase catalytic reactors from their modeling and design to their applications in industrial manufacturing of chemicals Covers theoretical aspects and examples of fixed bed fluidized bed trickle bed slurry monolith and microchannel reactors Includes chapters covering experimental techniques and practical guidelines for lab scale testing of multiphase reactors Includes mathematical content focused on design equations and empirical relationships characterizing different multiphase reactor types together with an assortment of computational tools Involves detailed coverage of multiphase reactor applications such as Fischer Tropsch synthesis fuel processing for fuel cells hydrotreating of oil fractions and biofuels processing

Surface Science Reports, 2001

**Reactions at Solid Surfaces** Gerhard Ertl, 2010-06-17 Expanding on the ideas first presented in Gerhard Ertl's acclaimed Baker Lectures at Cornell University Reactions at Solid Surfaces comprises an authoritative self contained book length introduction to surface reactions for both professional chemists and students alike Outlining our present understanding of the fundamental processes underlying reactions at solid surfaces the book provides the reader with a complete view of how chemistry works at surfaces and how to understand and probe the dynamics of surface reactions Comparing traditional surface probes with more modern ones and bringing together various disciplines in a cohesive manner Gerhard Ertl's Reactions at Solid Surfaces serves well as a primary text for graduate students in introductory surface science or chemistry as well as a self teaching resource for professionals in surface science chemical engineering or nanoscience



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