velop a basic understanding of industrial crystallization and provide the information necessary to begin work in the field, be it in design, research, or plant troubleshooting." In many respects, the book accomplishes this objective. It is an excellent place *to begin*, but it is not sufficiently comprehensive to be viewed as *the* single source to which engineers and scientists should turn to gain an understanding of crystallization.

The book has 11 chapters, each by a different author(s) easily recognized as an authority in the field covered. Chapter titles include: Solutions and Solution Properties; Crystals, Crystal Growth, and Nucleation; The Influence of Impurities and Solvents on Crystallization; Analysis and Measurement of Crystallization Utilizing the Population Balance; Crystallizer Selection and Design; Precipitation Processes; Melt Crystallization; Agitation and Mixing; Control of Crystallization Processes; Batch Crystallization; and Crystallization of Biological Molecules. Authors attempt to deal with their subjects completely in relatively few pages; mixtures of basic and advanced concepts are presented in varying degrees of completeness, ranging from a summary of key words to a nearly complete treatise.

Chapters 1-4 cover crystallization fundamentals. The discussion of solution thermodynamics is standard, but done well, although it is possible to quibble with such decisions as the inclusion of three figures illustrating the salt effect on solubility when one will do and with presentation of a nomograph for liquid heat capacities when such techniques have limited utility. Coverage of crystal structures is superb and well illustrated. Nucleation does not fare as well, however, as there is repetition of some material from the chapter on solution thermodynamics, and the discussion relating nucleation theory to industrial crystallizers is too brief. The treatment of the role of impurities and solvents in crystallization is superb.

All of the appropriate key concepts regarding population balances are cited, and the use of examples to illustrate the presented material is helpful. Unfortunately, sections on agglomeration and variations of residence time distributions are too brief—the terminology is there, but little of the needed detail.

Chapters 5-11 address applications of crystallization technology. There is a good summary of the different types of solution crystallizers, and principles of crystallizer design are presented along with a nice example covering urea crystallization. The inclusion of a short section on instrumentation and control in the chapter on crystallizer design is puzzling when the topic is covered completely in a separate chapter. Similar duplication of effort is found in the chapter on precipitation processes. It is a well-done survey of the topic but, because it is self contained, there is significant repetition of material presented elsewhere in the text. Batch crystallization is nicely handled by a chapter devoted to the intricacies of this type of operation.

The chapter on melt crystallization gives an excellent overview of the subject. The review of industrial practice and identification of specific systems is done especially well. Coverage provided to mixing is thorough but it could have been improved with examples of applications in crystallization.

The chapter addressing crystallizer control is as fine a treatise on the state of the art in this field as one is likely to find. The problem, its importance, and the options that can be pursued in its solution are presented. The presentation includes control fundamentals such as controller types and controller tuning, always with an eye toward application in crystallization.

The chapter on crystallization of biological molecules is another excellent contribution to the literature. It summarizes the major problems in handling these substances, which often are complex and thermally sensitive compounds.

A comment must be made regarding the work of the publisher: insufficient copyediting, as denoted by several typographical errors, detracts from the presented material. Further, the quality of many of the figures could have been improved to reflect properly the lasting importance of a handbook.

In summary, the handbook is not sufficiently complete to replace other books on the subject, but it is an excellent addition to the library of those interested in crystallization. Other important and relatively recent books on crystallization include: *Crystallization* (J. W. Mullin, 3rd ed., Butterworth-Heinemann, 1993); *Theory of Particulate Processes* (A. D. Randolph and M. A. Larson, 2nd ed., Academic Press, 1988); and *Precipitation* (O. Söhnel and J. Garside, Butterworth-Heinemann, 1992).

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## Physics of Polymer Surfaces and Interfaces

*Edited by Isaac C. Sanchez, Butterworth-Heinemann, 1992, 336 pp.*

This book was conceived with the thought expressed in the Preface, "A well known algorithm for becoming informed on a scientific subject is to read a well-written monograph or review article." This book is neither, but contains sections which would be of the value to many readers. The targeted audience consists of two groups: (1) scientists already familiar with the field and (2) those looking for a "quick indoctrination." The former will find it deficient and the latter nonquick, but all should benefit from the experience.

The first half of the book deals with theoretical concepts of interfaces, with chapters on Theoretical Methods (Fredrickson), Density Functional Theories (McMullen), Mechanical Properties of Polymer Interfaces (de Gennes), Statistical Mechanics of Isolated Chains (di Marzio), Thermodynamics and Gradient Models (Sanchez), Mean-Field Lattice Models (Scheutjens), and Molecular Modeling (Theodorou). Several of these chapters are excellent and will be comprehensible to readers with a theoretical background. The average reader will find de Gennes' Chapter 3 and DiMarzio's Applications (page 93) of value. Chapters by Fredrickson and Sanchez have a tutorial flavor and would be useful to the beginner. The theoretical section lacks a discussion of the fractal nature of interfaces or a presentation of critical issues and problems, and very little information is given on interface structure.

The second half of the book is experimental and, with a few exceptions, has no relation to the first half of the book. The reader will find useful chapters on Neutron Reflection (Stamm), Forward

Recoil Spectroscopy (Shull), Adsorption Dynamics (Granick), Scanning Angle Reflectometry (Gast), Monolayer Dynamics (Yu), Photophysics (Dean), and Self-Assembly (Rabolt). Other than Neutron Reflection and Infrared techniques, the most important relevant experimental methods for interface and surface analyses are missing, such as X-Ray Photoelectron Spectroscopy (XPS), Static and Dynamic Secondary Ion Mass Spectroscopy (SIMS), Scanning Force Microscopy (SFM), Scanning Tunnelling Microscopy (STM), Surfaces Forces Apparatus (SFA), Small Angle Neutron Scattering (SANS), and electron microscopy (TEM, SEM). This section would have benefited from a review article on experimental methods.

The strength of this book is that the reader will benefit from insights of several contributing authors who are giants in the field of surfaces and interfaces.

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## Receptors: Models for Binding, Trafficking and Signaling

*By Douglas A. Lauffenburger and Jennifer J. Linderman, Oxford University Press, 1993, $70.00*

Virtually every aspect of cell behavior is governed at some level by interactions of receptor molecules on the cell surface with ligands in the extracellular environment. The side-by-side coexistence of cells which exhibit markedly different responses to the same ligand soup underscores the sensitivity of control afforded both by the spectrum of receptors expressed by a particular cell and by the mechanisms each type of receptor employs to transmit signals once it binds a ligand. It also suggests a complexity not amenable to a purely phenomenological approach if cellular responses are to be understood at the level they can be manipulated. Molecular biology has brought tremendous analytical power to bear on characterization of cell surface receptors and their ligands. Likewise, it has provided the tools to study the dynamic behavior of these molecules within cells. Molecular biology alone, however, cannot be used to predict how the cellular environment should be manipulated to achieve a desired cell response, any more than spectroscopy alone can be used to predict the course of chemical reactions. In both cases, mechanistic models are needed to describe the complex interactions which occur. Such an approach is sorely needed in the receptor world, where control of cell behavior by application of growth factors, cytokines, and other ligands remains largely serendipitous. This lucid text provides a much-needed rational guide to quantitative mechanistic models of receptor-mediated cell behavior. It clearly demonstrates the power of the modeling approach in gaining insight into these confoundingly complex phenomena.

*Receptors* comprises six chapters which progress from the fundamentals of receptor-ligand binding kinetics to models of receptor-mediated phenomena in cell proliferation, adhesion, and motility. At each step, the authors illustrate the sensitivity of the qualitative aspects of model predictions to the quantitative values of the input parameters. It is a unique contribution to the field of receptor biology and cellular engineering because it is equally accessible—and useful—to the chemical engineer *and* the molecular or cell biologist. From the perspective of a chemical engineer, this book is a departure from many texts which provide a rigorous mathematical analysis of biological phenomena because it is richly informed by a comprehensive view of the underlying biology—it deals with *real* problems rather than tidy but arcane examples. The necessary descriptive information—classes of receptors, the cellular organelles involved in trafficking receptors and ligands, and the ways signals are transmitted—is presented in a clear, logical fashion which orients the novice to the vast literature in this field without watering it down. For the cell biologist, *Receptors* presents a thorough, yet comprehensible, introduction to the mathematical tools and physical basis needed for quantitative analysis of all the major classes of receptor-mediated phenomena. For each phenomenon, the authors describe the elementary models, summarize key results from mathematically more complex models, and provide extensive references and direction to carrying out more complex analysis and numerical calculations. At least one in-depth example is used for illustration, and references are made to numerous other systems amenable to similar analysis. Emphasis is also given to describing the strengths and weaknesses of various experimental techniques employed to obtain the necessary equilibrium and rate data. The reader is thus not overburdened with mathematics, yet can readily identify the benefits of a rigorous analysis and the means to accomplish it.

*Receptors* is an essential reference for engineers working in such diverse fields such as tissue engineering, drug design and delivery, and cell culture. And if the repeated "borrowing" of this reviewer's copy of the text by cell biologist colleagues is any indication, this book will have an impact far beyond the chemical engineering community—it may change the way receptor biologists view their work.

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