heterogeneous catalysis and does an excellent job of capturing the essential elements and tools required. This book is a valuable reference guide and is highly recommended for anyone working in the field of heterogeneous catalysis and in particular those interested in catalytic modeling. This book could also serve as a useful supplemental text for both basic and advanced courses in catalysis.

Matthew Neurock
Dept. of Chemical Engineering
University of Delaware
Newark, DE 19716

Applied Statistical Thermodynamics

By Klaus Lucas, Springer-Verlag, Berlin Heidelberg, 514 pp., 1991

This text takes the reader from the foundations of statistical and quantum mechanics, through the theory of intermolecular forces, and to the prediction of fluid-phase behavior of real systems. It is intermediate in level between Prausnitz et al.'s *Molecular Thermodynamics of Fluid Phase Equilibria* and Gray and Gubbin's *Molecular Theory of Fluids*. Like these texts, *Applied Statistical Thermodynamics* does not address complex fluids or other applications of statistical thermodynamics, such as adsorption. However, it more than adequately fulfills its stated objectives.

While many of the existing texts on statistical thermodynamics and computer simulation emphasize theory and technique above application, Lucas is clearly motivated by the description of real fluids. According to the author, the book could form the basis for a two-semester senior or first-year graduate course. The text covers a broad range of topics from elementary molecular theory to advanced aspects of liquid-state perturbation theory. Although the author claims that the text is suitable for newcomers to the field, it would certainly help if the reader had some previous knowledge of quantum and statistical mechanics.

A most appealing feature of the book is the remarkably clear and convincing argument for the use of molecular approaches in the evaluation of thermodynamic properties of fluids. The interpolation and extrapolation of experimental thermodynamic data and the prediction of mixture properties from properties of the pure components are, of course, topics of considerable importance for chemical engineers. Lucas notes that even the most complex empirical equation is likely to give poor estimates outside the fitting range. This is well illustrated in the text by the Bender equation of state with 20 adjustable parameters. For mixtures, the problem is still more acute. The remedy for this situation is to use equations which have a sound physical basis. If the interaction parameters cannot be obtained accurately from first principles (which is often the case), it is still possible to fit the theoretically derived equations over a relatively narrow range of experimental data and extrapolate with confidence. Numerous examples in the text demonstrate the success of this approach over the empirical route.

Chapter 1 presents a succinct review of classical and molecular thermodynamics. Chapter 2 deals with the tools for the calculation of the intermolecular forces—quantum mechanics—and the evaluation of macroscopic thermodynamic functions from these interactions—statistical mechanics. Chapter 3 is devoted to the ideal gas. Various thermodynamic functions are evaluated as well as the reaction equilibrium constants. Most of this is standard material which is also well treated in other texts, such as McQuarrie's *Statistical Mechanics*.

Chapter 4 presents a thorough discussion of intermolecular forces, beginning with a useful overview. The later sections emphasize the derivation of working formula for pair and three body potentials at long and short range. Some of the multipole expansions are extremely complex. For example, that for interaction between carbon monoxide and methane occupies nearly one page. If induction and dispersion forces are included, the expressions are even more forbidding. One has to wonder, in these days of symbolic computation programs, if it is really necessary to present all the gory details. For practical applications, the author suggests using the Maitland-Smith-Kihara potential for isotropic interactions and the site-site repulsion—multipole approximation (SSR-MPA) for anisotropic interactions. Chapter 5 concentrates on the application of the material developed in the previous chapters to real gases. The properties of real gas mixtures are accurately described with pure component data. Transport properties are also briefly discussed.

Chapter 6 begins with a short discussion of the ideas behind Monte Carlo and molecular dynamics simulation. The reader would need to consult other texts, such as Allen and Tildesley's *Computer Simulation of Liquids*, for detailed information on how to write simulation programs. It is unfortunate that *Applied Statistical Thermodynamics* does not mention a number of powerful new techniques, including the Gibbs Ensemble and Gibbs-Duhem integration, which have revolutionized molecular-based phase equilibria calculations. Other topics considered in Chapter 6 include the corresponding states principle for liquids, distribution functions and their use in evaluating thermodynamic properties, and fluids of spherical and nonspherical hard bodies. Building on this material, the chapter continues with an extended discussion of perturbation theories. Finally, semiempirical models, such as the BACK and COR equations of state, are considered within the framework of generalized van der Waals theory. In Chapter 7, the concepts developed for pure liquids are extended to mixtures.

In general, the book is very well written. The author maintains a sharp focus on the more important issues. A helpful feature is the inclusion of a summary at the end of each chapter. The example problems are also welcome. However, *Applied Statistical Thermodynamics* would be even more attractive as a course text, if it included additional (exercise) problems after each chapter.

Julian Talbot
School of Chemical Engineering
Purdue University
West Lafayette, IN 47907

Handbook of Industrial Crystallization

Edited by A. S. Myerson, Butterworth-Heinemann, Boston, 242 pp., 1993

The editor of the handbook points out in the Preface that the literature on crystallization is scattered, and that this book will correct the situation "by providing a means for scientists or engineers to de-

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).

Ronald W. Rousseau
School of Chemical Engineering
Georgia Institute of Technology
Atlanta, GA 30332

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