Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (R. F. Bryan, Department of Chemistry, University of Virginia, McCormick Road, Charlottesville, Virginia 22901, USA). As far as practicable, books will be reviewed in a country different from that of publication.

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Quasicrystals. A primer. (Second edition.) By C. JANOT. Pp. xvi + 409. Oxford: Clarendon Press, 1995. Price £49.50. ISBN 0-19-851778-5.

This book provides easy access to the world of quasicrystals. The origins of that world date back more than twenty years to when Roger Penrose played with non-periodic tilings of the plane. He found that a non-periodic self-similar pattern with local fivefold symmetry can be constructed using two different types of unit tiles. The simple matching rules needed are contained in the shape of the unit tiles – kites and darts or fat and skinny rhombs, for instance – and additional marks on the edges. A dozen years later, 'Penrose tiling' became the prototype of very powerful models explaining the structure of the quasicrystals discovered in rapidly quenched Al–Mn alloys.

Twelve years of quasicrystal research has established the existence of a wealth of stable and metastable quasicrystals with five-, eight-, ten- and twelvefold symmetry, with strange structures and interesting properties. New tools had to be developed for the study and description of these extraordinary materials. This made access to this rapidly growing and diverging field more and more difficult for newcomers. Alongside several thousand research papers, there were only a few monographs on the market, and these were on special aspects of 'quasicrystallography' and directed to advanced scientists already working in the field. Thus, Christian Janot's textbook *Quasicrystals. A primer* really filled a gap when it appeared in 1992. He has now published this revised and improved second edition, still the only single-author textbook on quasicrystals available.

Christian Janot is one of the pioneers in quasicrystal research. His broad experience and expertise, especially in neutron diffraction from icosahedral quasicrystals, is reflected in the structure of the book. Its six chapters discuss selected questions concerning the description, preparation, structure, dynamics and properties of quasicrystals. Each chapter closes with problems (but no solutions) that allow readers to check their understanding.

The book starts with the question 'How to fill space with atoms in condensed matter states'. After a review of basic principles of classical crystallography, a short dicussion of the amorphous state is given. One- and two-dimensional quasiperiodic orderings are explained using as examples the 1D Fibonacci chain and the 2D Penrose tiling. The higher-dimensional approach to the description of quasiperiodic structures is introduced and used nicely to explain why quasicrystals show sharp Bragg reflections. 'Real quasicrystals: preparation and characterization' (Chapter 2) provides insight into the experimental difficulties connected with the growth of quasicrystals and points out the importance of their correct characterization, with emphasis on electron microscopy and electron diffraction methods. The reader is rewarded with beautiful scanning electron microscopy photographs of well facetted quasicrystals and impressive high-resolution transmission electron microscopy images of quasicrystal structures with different types of order.

'High-dimensional crystallography' (Chapter 3) deals mainly with the 6D description of icosahedral quasicrystals. The way of embedding as well as the different kinds of indexing and some of the properties of reciprocal-space images of quasicrystals are discussed. The techniques of actual structure analysis of quasicrystals are exemplarily presented in 'Where are the atoms?' (Chapter 4). The lattice dynamics of quasicrystals as well as the new type of excitations and disorder typical for quasicrystals are reviewed in 'Phonons, phasons, and dislocations in quasicrystals' (Chapter 5). Different mechanisms for quasicrystal growth and transformations are introduced in the last chapter 'A little more about quasicrystals', and the interesting electronic transport behaviour of quasicrystals is also presented briefly.

Janot has revised and enlarged his primer by some 90 pages in this second edition. Besides including new results in quasicrystal research, he also allocates more space to questions that in the first edition were not given the attention they deserved. However, the strengths and the weaknesses of the book are not altered. It remains a very personal reflection of the fields the author has been involved with in his own research. A comprehensive well balanced and systematic introduction to all fields concerning quasicrystals still needs to be written. Nevertheless, Janot's primer, which has no pretensions to such status, is an indispensable, very useful and easily readable textbook for all who are interested in the fascinating world of quasicrystals.

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Electron density and bonding in crystals. By V. G. TSIRELSON and R. P. OZEROV. Pp. xiii + 517. Bristol and Philadelphia: Institute of Physics Publishing, 1996. Price £120, US $240. ISBN 0-7503-0284-4.

The subtitle of this book is *Principles, theory and X-ray diffraction experiments in solid state physics and chemistry.* As is reflected by this subtitle, the book spans a broad range of both theoretical and experimental subjects, and includes reports on a large number of experimental studies. Because

of this broad coverage, derivations of equations are generally not given, and experimental or computational approaches are not described in detail. As a result, this is not a book that could easily be used as the basis for an advanced course on the subject, but it summarizes a wealth of pertinent information, and therefore will be of considerable value as a resource for those working in the field.

After an introduction, in which the importance of the electron density for understanding chemical bonding is emphasized, the book continues with a treatment of quantum-mechanical methods (Chapter 2), followed by a discussion of experimental X-ray techniques (Chapter 3). Complementary methods, including the use of synchrotron radiation, electron diffraction and γ-ray diffractometry, are discussed in Chapter 4, and magnetization and spin densities in Chapter 5. Chapter 6, which carries the title 'Electron density and the chemical bond', includes an enticing description of the history of bonding concepts; it starts with Lucretius Titius Carus, who described interparticle bonding by means of hooks as holders, and continues to the concepts currently used in electron-density analysis, such as atomic charges and pseudoatomic moments, deformation densities and the topology of the total electron distribution. The final chapter (Chapter 7) deals with the derivation of crystal properties from the electron density, including the electrostatic potential, the Coulombic interaction energy and the electric field gradient at the nuclear positions. The theoretical chapters frequently give an insight not found in many other books, though, as is probably unavoidable given the nature of this volume, other theoretical texts will be needed to fill in the details. It should be noted that the experimental chapters cover many interesting Russian contributions, some of which are less known to Western readers. Chapters 4 and 5 have been written by Professor Ozerov, the remainder, constituting the main body of the book, by Professor Tsirelson. Some appendices on related topics, again divided among the authors, conclude the book. Since the book contains an extensive review of the literature through 1993, and a number of references to work published in 1994 and 1995, it will find use as a source of information on past work. For this purpose, it is important that the index be detailed and easy to use. In this respect I was disappointed. Several important subjects are not referred to, or appear only once, even when they are discussed several times in the text. To give two examples, a central concept such as the multipole model, discussed several times in the text, is not listed in the index, while a student looking for a reference to crystal field theory is referred to page 244, though a much more detailed description of the concept appears on page 312. Chemical names or formulas are also omitted from the index, which one hopes will be improved in any later edition of the book, which should also be priced so as to make it more broadly accessible to beginning researchers in the field. Notwithstanding these drawbacks, the authors have produced a highly interesting volume that should be useful for many years, and will find its place on the bookshelves of many scientists interested in this central subject.

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Industrial crystallization – Process simulation, analysis and design. By N. S. TAVARE. Pp. xxviii + 527. New York: Plenum Publishing Corporation, 1995. Price US $95.00. ISBN 0-306-44861-0.

An explosion of papers developing the design-oriented theories of industrial crystallization over the past decades has created a need to summarize what has been accomplished. Thus, several textbooks on this topic have appeared recently that merit mention. These include the completely rewritten third edition of *Crystallization*, by J. W. Mullin (Butterworth-Heinemann, Oxford, 1993), an extensive and instructive general survey of the field of crystallization; *The Kinetics of Industrial Crystallization*, by J. Nývlt, O. Sohnel, M. Matuchova & M. Broul (Elsevier, Amsterdam, 1985), dealing mainly with the effects of various parameters on the kinetics of individual steps in the crystallization process; *Design of Crystallizers*, also by J. Nývlt (CRC Press, Boca Raton, 1992), focuses on the application of kinetics to develop the relationships between the volumes of various types of crystallizer and the resulting product crystal size. Two other books, *Crystallization Technology Handbook*, edited by A. Mersmann (Marcel Dekker, New York, 1995), and *Precipitation*, edited by O. Sohnel & J. Garside (Butterworth-Heinemann, Oxford, 1992), summarize, respectively, our knowledge of design-oriented processes and the role of thermodynamics in the precipitation of less soluble compounds. Now comes this new book by N. S. Tavare, the main thrust of which is the application of mathematical methods to modelling the crystallization process.

The book has twelve chapters. Chapter 1 is a brief introduction to the problem. Chapter 2 deals with phase equilibria in various systems and with the materials balance of crystallization; the chapter is a good survey of the shapes of phase diagrams but, surprisingly, provides almost no hints as to their mathematical description and their practical uses. Chapter 3 gives a very brief survey of the fundamental concepts of nucleation and crystal growth and of the fundamental equations used for chemical-engineering descriptions of the processes. Most interesting are tables showing the range of typical kinetic parameters, with most probable estimates. However, the effects of several other parameters (*e.g.* solution purity, agitation, temperature *etc.*) are not mentioned. Chapter 4 is devoted to crystal-size distribution; important, because that is the basis of most modelling and design methods. The survey of the various distribution functions is very brief, with only a weak emphasis on the advantages of γ-distribution. The main value of this chapter is in its general presentation of the population balance problem and methods of solving it. Chapter 5 illustrates methods of process representation, of operating modes of batch crystallizers, and of process analysis. This chapter, and the related Chapter 6, on characterization of crystallization kinetics from batch experiments, are certainly of great value for those research workers dealing with batch crystallization and, together, the two chapters occupy about 100 pages. Chapter 7 deals mainly with precipitation processes and, perhaps a little inconsistently, with other processes such as Ostwald ripening and agglomeration.

Chapter 8, devoted to continuous crystallizers, treats in the usual way the population balance for an ideal case, as well as for size-dependent growth rate and growth-rate dispersion. Of