in a large number of applications. Nowhere is the versatility of tin more apparent than in its chemical compounds. Chemical uses of tin account for well over 10% of total tin consumption and range from traditional long-established uses to modern high-technology applications. Understanding the mode of action of tin chemicals in these uses requires a detailed knowledge of the properties of the compounds and the mechanisms involved in their reactions. At a time when the applications are becoming ever more specialized and refined, it is fortunate that a new edition of *Chemistry of Tin* has become available.

This second edition has been considerably revised and updated, with six completely new chapters covering ^{119m}Sn Mössbauer studies; solid-state NMR; uses in organic synthesis; environmental analysis; biological properties; and health and safety aspects. The individual chapters are written by authorities in the field drawn from many parts of the world so that coverage is truly international. The editor has many years of experience in tin chemistry from both practical and theoretical standpoints.

In all there are 15 chapters, covering all the major aspects of tin chemistry, with extensive references and data. The opening chapters look at 'Tin — the element' and general trends in tin chemicals, this including a detailed discussion of structure and bonding in tin(II) and tin(IV) compounds, thereby highlighting the wide range of coordination geometries and lattice structures that are exhibited. Chapter 3 deals with the inorganic chemistry of tin, while Chapters 4–6 discuss various aspects of organotin chemistry. Chapter 7 is a detailed treatment of tin–metal bonded compounds and Chapter 8 examines the radical chemistry of tin.

The next four chapters are particularly important from the point of view of applications of tin chemicals. The use of organotin compounds in organic synthesis has become a major field of organometallic chemistry during the past decade and a very comprehensive review of the use of tin reagents in this area is presented in Chapter 9. Chapter 10 reviews recent studies on the mode of biological action of di- and tri-alkyltin compounds, including a section on their antitumour activity. An interesting conclusion to this chapter suggests that whilst some organotin compounds are gradually being eliminated as environmental contaminants, others are being developed as new medicines.

Tin itself is a non-toxic metal and is reported to be an essential trace element. Indeed, the generally low toxicity of tin chemicals has led to their increasing usage in recent years. However, some health and safety problems have arisen with certain biologically active trialkyltin compounds, which have resulted in restrictions being placed on their use in specific areas. Chapter 11 provides a very useful summary of the toxicology of tin chemicals and, in addition, gives a listing of the world's primary manufacturers of both inorganic tin and organotin compounds.

Chapter 12 gives a concise but comprehensive overview of the many industrial applications of tin chemicals, these being subdivided into the following sections; the plastics industry; glass and ceramics; electroplating; biocidal applications; heterogeneous catalysts; pharmaceuticals; fire prevention; and miscellaneous uses.

The next two chapters deal with two solid-state techniques which have been widely used to investigate structures and bonding in tin compounds; solid-state NMR and ^{119m}Sn Mössbauer spectroscopy. Each chapter provides a brief description of the technique in question, its value with regard to understanding tin chemistry, and a wealth of tabulated data.

The final chapter is concerned with the analysis of organotin compounds from the natural environment and details the modes of entry of tin species into the environment, extraction techniques, and the various chromatographic and spectroscopic methods which have been developed (primarily over the past 20 years or so) to analyse organotin species to sub-ppb levels.

This book, which is addressed to academic researchers and industrial chemists alike, provides an in-depth reference work which will keep its value for many years to come.

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Structure and Bonding, Vol. 87. Structural and Electronic Paradigms in Cluster Chemistry
D. M. P. Mingos (ed.)
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This 87th volume in Springer's excellent 'Structure and Bonding' series was produced to mark the quarter-century that has elapsed since the first papers appeared drawing attention to the way the polyhedral shapes of cluster compounds reflect their formula types and so, by implication, the numbers of electrons they contain. Relationships between molecular shapes and electron numbers are now so commonplace in chemistry in

general, and cluster chemistry in particular, that it must be difficult for today's students to appreciate the excitement those involved in the early days of cluster chemistry felt when they recognized that those perennial 'electron-deficient' rule-breakers, the boron hydrides, conformed to a deltahedral (and deltahedral-fragment) pattern which found echoes among other categories of compound. For example, the same pattern held for metal carbonyl clusters which themselves had appeared anomalous in having shapes difficult to rationalize in terms of two-centre two-electron bonds and 18-electron rules, and indeed metal–hydrocarbon pi complexes were members of the same family.

Professor Mike Mingos, one of those involved in recognising to which jigsaw puzzle those anomalous metal pieces belonged, and himself a major contributor to the development of our understanding of cluster chemistry over the past quarter-century, has edited this present volume, setting the field nicely in context in a preface that draws attention to the wide range of systems now known either to belong to the same cluster family as the boron hydrides that first prompted electron-counting approaches, or to be close recognizable relatives thereof. The great value of generalizations in chemistry, such as cluster electron-counting rules, is not merely in the rationalizations and predictions they permit, but also in allowing genuinely different systems, i.e. rule-breakers, to be recognised as such and so reveal how our assumptions underpinning the rules were themselves deficient or incomplete. The moral implicit in the quotation attributed to R. E. Rundle ('There are no such things as electron-deficient compounds, only theory-deficient chemists') should not be overlooked. Recognition of a pattern may be a reason for brief celebration, but should not stop us from looking for exceptions to prove the next set of rules. Concepts evolve as knowledge increases.

The authors Professor Mingos has assembled to contribute to the present volume illustrate such points in a fascinating variety of approaches. The introductory chapter by Roy Johnston (Birmingham) provides a masterly survey of the various ways (and depths) in which cluster structural and bonding patterns can be treated and understood. This is the most readily understood and authoritative concise treatment of its subject matter that I have read. Under the title 'Mathematical cluster chemistry', Dr Johnston includes geometrical, graphical and group-theoretical, topological, molecular-orbital, Hückel, Tensor-Surface-Harmonic and localized-orbital treatments; having outlined these, he illustrates them with a series of case studies which include hydrocarbon and fullerene cages as well as deltahedral systems. This chapter illustrates beautifully how ideas are refined and evolve, and alone justifies the book's presence on library shelves.

The second chapter by Zhenyang Lin and Man-Fai Fan (Hong Kong) is much more focused. It considers the metal–metal interactions in transition-metal clusters with -donor ligands, analysed using a fragment-frontier-orbital approach, and shows how the 't_{2g}' set of fragment orbitals, which are nonbonding in carbonyl clusters, play a metal–metal bonding role in clusters where π-donor ligands such as halides or alkoxides are present. This is followed by a survey by Jean-François Halet and Jean-Yves Saillard (Rennes) of clusters containing cubic transition-metal cores bridged by Main-Group elements, remarkable for their capacity to accommodate a large range of electron counts, and of particular interest because they bridge the gap between molecular and extended-lattice systems, as the authors' extensions of PSEPT illustrate.

The fourth chapter, concerned with metallaboranes, is by Tom P. Fehlner (Notre Dame), whose own extensive and thoughtful studies of mixed metal–boron clusters have done much to convert crude analogies into refined, beautifully crafted concepts. His analogies between borane and hydrocarbyl fragments are a constant source of rewarding new nuances, and he has developed a real flair for explaining the way ideas evolve, the principles that underpin rules, the continuous quality of nature, and the dangers of trying to force compounds into rigidly defined categories. This chapter conveys these points with real insight. Interestingly, the following chapter, by Catherine E. Housecroft (Basel), adopts a polemic approach in its treatment of clusters containing interstitial *p*-block atoms such as carbon, systems of great interest to organometallic chemists and surface scientists though the emphasis here dwells on perceived differences between approaches that are more apparent than real.

The final chapter in the book is by John D. Corbett (Ames, Iowa), and discusses naked (ligand-free, Zintl-type) clusters of the heavy Main-Group elements. The author himself has devoted his career to the synthesis and characterization of alloys containing polyhedral arrangements of Main-Group metal atoms held together by numbers of electrons reminiscent of their borane counterparts; his own analogies between ionic metal aggregates and borane clusters in the 1960s anticipated the general elaboration of cluster electron-counting approaches. His chapter in the present work provides compelling evidence that his original intuitive foresight was well judged. The range of solid-state systems now known to contain polyhedral metal aggregates, amply illustrated in this chapter, is quite remarkable.

For this reviewer, and I suspect many others, this slim volume will serve as a frequently consulted source of information not only for the considerable number of facts it contains but more importantly for enlightenment on how to interpret and correlate those facts.

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