

## book reviews

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**Advanced structural inorganic chemistry.** IUCr Texts on Crystallography No. 10. By Wai-Kee Li, Gong-Du Zhou and Thomas Chung Wai Mak. Oxford: Oxford University Press, 2008. Pp. xx + 819. Price (paperback) GBP 37.50. ISBN 978-0-19-921695-6.

Crystallography is only a marginal subject in this book; it remains obscure why it has been included in the series 'Texts on Crystallography' by the International Union of Crystallography. It is rather a textbook dealing essentially with the theory of chemical bonding and the molecular structures of inorganic and metal-organic compounds, a fact that is not properly reflected by the title of the book.

The first five chapters (164 pages) are an introductory text on quantum theory, with many mathematical formulas but no mathematical derivations, well explained for the needs of students of chemistry and novices in the field. The main subjects are the electronic structures of atoms and covalent bonding in molecules. Although Chapter 4 is entitled 'Chemical bonding in condensed phases', it does not really deal with bonding in solids. Band theory occupies only three pages, with little attention given to the density of states; important terms like 'crystal overlap population' or 'Brillouin zone' do not appear at all. For ionic compounds, ionic radii and lattice energies are discussed, but topics like Pauling's rules on coordination polyhedra are missing. The theory of bonding is later continued in Chapter 8 (another 40 pages), dealing with bonding in coordination compounds: crystal-field theory, Jahn–Teller distortions and, above all, energy-level diagrams and molecular-orbital theory.

Chapter 6 is dedicated to point groups and molecular symmetry, including irreducible representations and a listing of character tables. Only the Schoenflies symmetry symbols are introduced, without mentioning this name. The approach is descriptive, using selected molecules as examples, with no mathematics (no matrices of symmetry operations *etc.*). In the following chapter, the application of irreducible representations is explained for molecular orbitals and molecular vibrations by means of a number of nicely worked out examples. The vibrational normal modes of a dozen selected molecules are treated in detail. Although the term 'group theory' appears in the titles of both chapters, the group axioms and other fundamental properties of groups are not a subject.

Chapter 9 is the only chapter that is to do with crystallography. Hermann–Mauguin symbols are introduced, but not properly explained; the meaning of the sequence of the symmetry elements in the symbol is not presented. Further sections deal with the 32 crystal classes (including stereographic projections), Bravais lattices, crystal lattices and crystal systems. Unit-cell transformations are explained in the

manner of the old *International Tables* of 1952; the new conventions introduced in 1983 for transformation matrices are ignored. There is no hint that coordinates transform in a different way than basis vectors. Some effort is taken to show how space groups are presented in *International Tables for Crystallography* and how a space group can be deduced from absent X-ray reflections. Three dozen randomly chosen examples are used to explain the relations between crystal structures and their space groups, attention being directed mainly to structural and chemical details. No mention is made of the subgroups of space groups, their importance at phase transitions and their usefulness in relating crystal-structure types.

The important basic inorganic crystal structures like closest packings of spheres, NaCl, CaF<sub>2</sub>, zinc blende, NiAs, rutile, CdI<sub>2</sub>, perovskite, ReO<sub>3</sub>, spinel and a few others are the subject of Chapter 10. This includes some special aspects like defect structures (FeO, NbO), the tolerance factor of perovskites and ferroelectric BaTiO<sub>3</sub>. This chapter is recommended reading for a student of chemistry.

The chapters of the remaining half of the book are entitled 'Structural chemistry of selected elements'. The selected elements, first of all, are those of the main groups of the periodic table and the rare earths. The emphasis is on the structures of molecular compounds of these elements. A lot of material that is important for students of chemistry is covered, along with much more material that is not really important (*e.g.* as many as 11 pages on noble-gas compounds). Altogether, we find a listing of a large number of compounds and their structures with many details that overburden the reader. Fewer details and, instead, some more general concepts would have been more advantageous. For example, the very useful concept of the Zintl phases is mentioned only marginally on page 496 and not properly explained; several Zintl phases like NaTl, polysilicides, polyphosphides and polytellurides are described nicely in separate sections, but their common features do not emerge equally well. For the transition metals, the selection is restricted to compounds with metal–metal bonds and cluster compounds, with an emphasis on metal–carbonyl complexes and electron-counting rules. The last 78 pages make up a quite ample chapter on supramolecular chemistry, dealing with the structures of all kinds of supramolecular assemblies like arrays of organic molecules linked by hydrogen bonds, catenanes, molecular necklaces, supramolecular capsules, filled carbon nanotubes and others.

Summarizing, for a student of chemistry, the book contains some readily understandable chapters on chemical bonding of molecules and on basic inorganic crystal structures, accompanied by good artwork. However, it is not an ideal book for learning the essential aspects of structural inorganic chemistry.

The listing of structures is too extensive, with too many details, and the selection is unbalanced in favour of molecular structures. Some topics, for example, the Gillespie–Nyholm rules, phase transitions, high-pressure modifications and nanostructures, are not addressed.

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