

erage of other European and American work is by no means complete. In places further progress has been made than is allowed for in the reports. Thus the account of electron density work in silicon does not properly interpret the differences between the [111] and the [110] directions, although if this had been done it would have thrown some more light on what is meant by the chemical bond in a semi-conductor.

One of the almost inevitable results of a compilation of this sort is that some of the central notions are never fully defined. It would have been very instructive, for example, to have had a definition of what the various authors meant by the phrase 'a chemical bond' in a semi-conductor. If this had been provided it would have helped to clear up some of the confusion between talking about band structures and, at the same time (or nearly the same time), about atomic hybridization. Nevertheless much of the work reported is still very topical; and there is no doubt but that a lot of progress will be made in the near future when we combine together (i) information such as that reported here dealing with the dependence of *K* and *L* X-ray levels, and absorption edges, on the chemical environment of the atom studied, and (ii) even more recent studies of electron spectroscopy and ionization potentials. This collection, therefore, may be welcomed as one part of the great movement of the last few years towards an understanding of what an atom looks like when it becomes part of a molecule or a solid.

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Oxidation numbers and oxidation states. By CHR. K. JØRGENSEN. Pp. 291. Berlin, Heidelberg, New York: Springer-Verlag. 1969. Price \$12.00.

The concept of the oxidation state of an element in a coordination complex is beloved by most inorganic chemists but there is no doubt that it is often used without precision, particularly in organometallic molecules. A carefully written treatise on oxidation numbers and oxidation states would therefore be very welcome but, regrettably, Jørgensen's book does not fulfil this requirement.

Without doubt, a good deal of useful data have been compiled but the style of presentation is poor, if not downright irritating at times; even more important, the data have not been compiled critically.

After some definitions of formal oxidation numbers, we are led on to a discussion of configurations in atomic spectroscopy; there is little new here although it is probably the best section of the book. Characteristics of transition group ions and internal transitions in partly filled shells are then dealt with but together with the chapters on electron transfer spectra and inter-shell transitions, an impression of *déjà-vu* is left with the reader. 'Oxidation states in metals and semi-conductors' is a useful summary but the two chapters on closed-shell systems, hydrides and back bonding and homopolar bonds and catenation are better dealt with in other books. The chapters on quanticule oxidation states and taxological quantum chemistry are such

that I believe the book would have benefited from their omission.

Looking at the bibliography, one might guess that the coverage is much more up to date than it really is. By way of example, complexes such as $[(\text{NH}_3)_5\text{CoO}_2\text{Co}(\text{NH}_3)_5]^{5+}$ are discussed and we are left with the view that the Vlček-Vannerberg views of the geometry of these systems are basically correct – no mention is made of the definitive structural work of R.E. Marsh and his colleagues. Other points, picked largely at random, are that the formula on p. 125 is misleading; on p. 159 the formula is incorrectly drawn while no mention of mass spectroscopic evidence for $\text{NHC}_6\text{H}_4\text{S}^{2-}$ is given.

This book should only be used as a source of references which may have been overlooked.

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Fundamentals of inorganic crystal chemistry. By H. KREBS, translated by P. H. L. WALTER, Pp. xv+405. London: McGraw-Hill, 1968. Price £5.

The spectacular increase in the number of published crystal structure determinations which has resulted from the application of automatic diffractometry and high speed computing to crystallographic problems has underlined forcefully the need for continued classification and reclassification of the known facts of crystal chemistry on the basis of a minimum number of fundamental principles. In this book Professor Krebs continues in the tradition of Bragg, Pauling, Belov and Wells in bringing some order into the apparent chaos of inorganic crystal chemistry. The properties and structures of selected groups of crystals are interpreted in terms of the electronic structures of atoms and the bonds between atoms. Emphasis is placed throughout on theories of the chemical bond derived from quantum mechanical considerations. In his discussions of the chemical bond the author, for the most part, avoids any reliance on traditional notions of 'ionic' and 'partial ionic' character, concepts which probably serve more to confuse than to enlighten.

The first part of the book is devoted to a sketchy introduction to the formalism of quantum mechanics. Mathematical complexities are largely avoided. Brief discussions of crystal and ligand field theories then follow, providing a logical transition from fundamental theory to the experimental data of crystal chemistry.

The groundwork having been prepared, we are then treated to four pages devoted to 'The Seven Crystal Systems' in which the reader is introduced, perhaps for the first time, to concepts of classical crystallography. It is unfortunate that the treatment in the section is so brief; it is certainly too concise for the beginner.

The remaining two-thirds of the volume are devoted to crystal chemistry proper. The structure of the elements and a variety of *AB*, *AB*₂ and *A*₂*B*₃ phases are described in detail with emphasis always on unifying structure concepts and on the interpretation of the crystal structures in terms of the electronic structures of the atoms. Molecular structures are almost totally ignored but fruitful discussions of silicates, borates, alloys and glasses are included.

A useful reading list, a comprehensive table of references and separate author, subject and formula indexes add greatly to the value of this work.

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Perspectives in structural chemistry. II. By J. D. DUNITZ and J. A. IBERS. Pp. vii+159. New York and London: John Wiley, 1969. Price 103s.

The editors of the review series *Perspectives in Structural Chemistry* consider it one of the most important tasks in structural chemistry today to make critical assessments of the mass of already published knowledge in a search for unifying ideas. In Volume II one of the editors, J.D. Dunitz, sets a model example for future contributors with an authoritative review on conformations of medium rings. The specification of conformations is given with the aid of torsion angles which are defined in precise geometric terms. Strain energy is defined in terms of thermochemical measurements as an experimentally observed quantity but in 'theoretical' strain minimization calculations it appears to be related to various potential functions and interaction functions which are not too clearly explained and it is left for the reader to decide for himself the merits of these expressions. The main part of the article consists of a balanced and critical assessment of published structural work on carbon ring systems. Cycloalkanes are treated first and special attention is given to 8-14-membered rings. A few cases of rings containing nitrogen atoms are treated too. Unsaturated rings are treated in the next section. The consequences of introducing one or more double bonds into a cyclic system are considered and a number of structures are discussed. There is apparently little structural information on cycloalkynes which are treated in nine lines only. Most of the structures discussed are based upon X-ray crystallographic studies; many of them have been determined in the author's laboratory in Zürich. It is pointed out that even a well refined structure does not always lead to an unambiguous determination of molecular conformation; there are cases where molecules on equivalent sites may not have quite identical conformations.

The article is very well written and testifies to the author's great knowledge and understanding of crystallography and chemistry.

The second half of the volume is by Bruce R. Penfold on *Stereochemistry of Metal Cluster Compounds*. There are probably good editorial reasons for publishing the articles of Dunitz and of Penfold in the same volume but there are few chemical or stereochemical similarities between the two subjects considered except that rings do occur also in metal cluster compounds.

The author defines a metal cluster as 'a finite group of at least three metal atoms in which at least two pairs are close enough to be linked by covalent bonds'. Three main chemical classes are considered: the lower halides and chalcogenides of the second and third transition series; carbonyls and nitrosyls and related compounds of transition metals; compounds containing bonds between transition metals and elements of main groups II and III; a small group containing various transition metal compounds and another small group containing clusters composed of main group elements only.

The structural data on metal cluster compounds are of rather recent origin. Less than a dozen of 181 references are earlier than 1960. Although it has been known for a hundred years that there were several peculiarities about the chemistry of MoCl_2 and related compounds it was not until 1967 that the complete structure determination of MoCl_2 was reported, giving definite proof for the cluster structure. Principal structural data for a great number of compounds are presented in tables. Typical structures are depicted in well designed drawings. The parallel development of X-ray diffraction techniques and of refined methods for the production of single crystals (*e.g.* transport reactions) has provided a sound basis for the stereochemistries of a number of compounds of simple stoichiometry as for a great variety of rather complex transition-metal carbonyls and nitrosyls and their derivatives.

The article of Penfold is of the same high standard as that of Dunitz and few university libraries could afford to be without this new series. Individual crystallographers should have a broad field of interest in stereochemistry to make good use of both the articles.

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