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Book review

Advanced Structural Inorganic Chemistry, W.-K. Li, G.-D. Zhou, T.C.W. Mak. IUCr Text on Crystallography, vol. 10, Oxford Science Publications (2008). 688 pp., Paperback, Price: US$ 75.00, ISBN: 978-0-19-921695-6

I suppose that some reasons why many college students of chemistry courses dislike inorganic chemistry may be because of mathematical and/or physical difficulties in understanding basic bonding theory as well as the need to learn abundant and complicated items in descriptive examples covering all elements of the periodic table. However, this book shows that structure and bonding are powerful tools to understand various systematic aspects of inorganic chemistry. This book does not cover the reactions and properties of inorganic compounds, but presents a survey of inorganic chemistry focused on the structural and bonding properties of inorganic molecules and supramolecular complexes. It provides excellent outline looking for structural inorganic chemistry from a higher viewpoint.

This book comprises 20 chapters that are divided into 3 parts from fundamental bonding and symmetry theory to descriptive inorganic chemistry of the elements. The first part gives an overview of the fundamentals theory of quantum chemistry and chemical bonds: (1) Introduction to Quantum Theory, (2) The Electronic Structure of Atoms, (3) Covalent Bonding in Molecules, (4) Chemical Bonding in Condensed Phases, and (5) Computational Chemistry. The second part provides symmetry and group theoretical treatment not only of point groups but also of space groups: (6) Symmetry and Elements of Group Theory, (7) Application of Group Theory to Molecular Systems, (8) Bonding in Coordination Compounds, (9) Symmetry in Crystals, and (10) Basic Inorganic Crystal Structures and Materials. The third part offers a variety of descriptive inorganic topics in structural chemistry and includes recent concepts and developments in supramolecular inorganic chemistry: (11) Structural Chemistry of Hydrogen, (12) Structural Chemistry of Alkali and Alkaline-Earth Metals, (13) Structural Chemistry of Group 13 Elements, (14) Structural Chemistry of Group 14 Elements, (15) Structural Chemistry of Group 15 Elements, (16) Structural Chemistry of Group 16 Elements, (17) Structural Chemistry of Group 17 and Group 18 Elements, (18) Structural Chemistry of Rare-Earth Elements, (19) Metal–Metal Bonds and Transition-Metal Clusters, and (20) Supramolecular Structural Chemistry.

The computational chemistry Chapter 5, describes a brief introduction to methodology for calculations such as semi-empirical, ab initio methods (selecting basis sets and considering electron correction for SCF or HF methods), DFT, and composite methods. Inorganic systems are very complex computationally because metal elements have many electrons and inorganic complexes may have many metal atoms. The chapter appropriately shows actual examples of materials with interesting chemical bonds and physical properties.

Chapters 6–10 are written to teach symmetry in chemistry in which the subjects are arranged from mathematical expression of group theory, ligand field theory for coordination compounds, symmetry in crystals, and crystal structure of inorganic materials. It is convenient for many students to study inorganic chemistry where treatments of symmetry for both spectroscopy and crystallography are arranged systematically and summarized in one book.

Chapter 18 deals with structural aspects of rare-earth metals and their coordination and organometallic compounds. The fundamental properties of rare-earth elements such as lanthanide contraction and relativistic effects, valence states, spectroscopic properties, and magnetic properties are clearly explained. Coordination geometries of inorganic solids, coordination compounds, and organometallic compounds (not only rare-earth metals) are reviewed by collecting appropriate examples and properly arrangements throughout this book.

The last Chapter 20 introduces the developing area of supramolecular chemistry from the viewpoint of structural chemistry by employing examples taken from coordination chemistry. The original concepts of “supramolecules” versus “molecules” and related terms such as intermolecular interactions, molecular recognition, self-assembly, crystal engineering, and “synthon” are elucidated by real examples with crystal structures of these compounds. In particular, the results of crystal structure analysis as well as structural schemes play an important role in visualizing hydrogen bonds and coordination bonds forming non-covalent bonded patterns.

In summary, the readers will find the many aspects of this book, a comprehensive textbook about chemical bonds, group theory, and crystallography, descriptive and supramolecular inorganic chemistry to be very useful. It is an important text for teaching inorganic chemistry.

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