Vanadium The Versatile Metal

This book in the ACS Symposium Series is based on the 5th International Symposium on the Chemistry and Biological Chemistry of Vanadium, which was held in San Francisco on September 10–14, 2006, as part of the National ACS Meeting, sponsored by the Division of Inorganic Chemistry. It is a somewhat unusual monograph, as it consists of about one-third original research papers and two-thirds reviews, but this is in accordance with the rules of the ACS Books Department. The average length of the 30 chapters is about 14 pages; the reviews cite on average about 40 references and the research papers about 30. The addresses of the authors reflect the fact that this Vanadium Symposium indeed had international character: of the 30 chapters, written by 114 authors, 13 have addresses from Europe, 10 from the USA, 5 from Japan, and 1 from Argentina; the remaining one is a multinational research paper authored by scientists from Germany, The Netherlands, and the USA.

Based on the above "statistical" considerations, it is clear that one cannot expect very close coherence between the chapters. However, the three editors, well versed in the field of vanadium chemistry, were aware of this shortcoming and solved it in an elegant way by subdividing the book into six parts, which are described in more detail below. More importantly, the editors have prefaced the book with a "primer" that encompasses 33 pages and provides 258 references! They explain that this summarizes the "highlights of the 5th Vanadium Symposium" and shows "how each chapter in the book relates to mainstream chemistry and biological chemistry". I strongly recommend users of the book to begin by reading relevant parts of this Preface, for example the part about "Catalysis", before studying the section of the book devoted to "Vanadium Catalysis of Synthesis: Organic Compounds and Polymers". Such matters are interrelated, and the reader obtains a nice overview about the topic of special interest.

Vanadium is not a rare element. Its abundance in the earth's crust is 0.014 %, which corresponds approximately to that of zinc. With a concentration of 20–25 nM in seawater, vanadium is the most abundant transition metal in the aquasphere. However, it is a truly chameleon-like element, as is already evident from the history of its discovery. In 1801 Andrés Manuel del Río, a Spanish-born Mexican mineralogist in Mexico City, obtained a sample of "brown lead" ore (now called vanadinite). During his experiments he concluded that he had discovered a new element that forms salts with a wide variety of colors. He therefore named it panchromium (Greek: all colors), and later erythronium because most of the salts turned red when heated. However, the French chemist Hippolyte Victor Collet-Descotils incorrectly declared that del Río's new "element" was only impure chromium. Then, 30 years later, Nils Gabriel Sefström from Sweden rediscovered vanadium in a new oxide while working with some iron ores. Later in 1831, Friedrich Wöhler confirmed del Río's earlier work. The beautiful multicolored chemical compounds of the element led Sefström to name it vanadin (later vanadium) after the Scandinavian goddess of fertility, Vanadis, also known as Freyja.

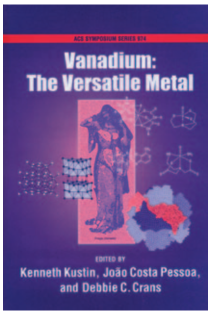
Vanadium does not occur in nature in free metallic form, but approximately 70 minerals are known. Its main industrial use is as an additive to improve the quality of various steels. In the early 1980s, studies of the chemistry and biochemistry of vanadium started to boom, partly because of the synthetic utility of several vanadium complexes in catalysis and as new materials, but mainly because of the discovery of vanadium in haloperoxidases and nitrogenases, in the mushroom *Amanita muscaria*, in ascidians, and (in 1993) in the fan worm *Pseudopotamilla occelata*, as well as in other biological systems. Although much has been achieved during the past decade, this book proves that the developments are still in full bloom. The topics of the six parts of the book are summarized briefly below; the words in *italics* are the headings of the corresponding sections in the Preface mentioned above.

Part 1, "Vanadium *Catalysis* of Synthesis: Organic Compounds and Polymers", consists of six chapters covering redox reactions, ionic liquids, the oxidation of alkenols, alkane functionalization, oxo transfer catalysis, and vanadium alkoxides in catalysis.

Part 2, "*Insulin-Enhancing* Agents: Compound Design and Mechanism of Action", consists of four chapters that summarize the noncompetitive inhibition of protein tyrosine phosphatase-1B by vanadium(IV) complexes, compare administration routes, consider the structure–activity relationship, and ask "do vanadium compounds drive reorganization of the plasma membrane?".

Part 3 is entitled "*Haloperoxidases*: Mechanism and Model Studies". The four chapters in this part focus on structural studies, understanding the mechanism, structural and functional lessons from models, and bioinorganic haloperoxidase mimics.

Part 4, "*Enzymology, Toxicology, and Transport*", encompasses seven chapters that deal with vanadium and bone, toxicity of vanadium compounds, vanadium in the lung, muscle contraction, oxidative stress, and mitochondrial toxicity, as well as with vanadium accumulation by ascidians, reduction of vanadyl in the blood cells of tunicates,



Vanadium The Versatile Metal
Edited by Kenneth Kustin, João Costa Pessoa, and Debbie C. Crans. American Chemical Society, Washington DC, 2007. 448 pp., hardcover $ 175.00.—ISBN 978-0841274464

and insights into the use of vanadium and selenium to prevent cancer.

Part 5, "*Coordination Chemistry*: Speciation and Structure", consists of six chapters that deal with molecular dynamics simulations, biospeciation of insulin-mimetic $V^{IV}O$ complexes, vanadium Schiff base complexes, charge distribution in vanadium quinonate complexes, vanadium(IV) complexes in glassy solutions, and vanadium(IV,V) hydroxycarboxylate complexes.

Part 6 is entitled "*New Materials and Processes*". This final part consists of three chapters devoted to structural determinants in the diphosphonate system, stepwise synthesis of disk- and ball-shaped polyoxovanadates, and a vanadium-based homogeneous chemical oscillator.

From the above short summary it can be seen that somewhat more than 50 % of the chapters are devoted to bioinorganic chemistry, while the rest deal with catalysis, new materials, etc. It is natural that in such a symposium-based book there will always be gaps. Thus, for example, vanadium-containing nitrogenases are not treated in detail. However, the Preface provides access to missing topics through the many references. The subject index consists of 11 double-column pages and facilitates any search. By using it together with the table of contents and the Preface, the reader can easily find the desired topic within this book.

To conclude, I recommend this monograph to everyone with an interest in the role of vanadium in chemistry, in the life sciences, or at the interface between these two fields. Indeed, the bioinorganic chemist may be inspired by the various compounds synthesized and the organic chemist may become aware of the potential use of his compounds in biochemistry.

Roland K. O. Sigel
Institute of Inorganic Chemistry
University of Zürich (Switzerland)

DOI: 10.1002/anie.200900230