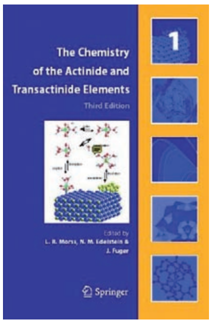
The Chemistry of the Actinide and Transactinide Elements



3rd ed., 5 vols. Edited by *Lester R. Morss*, *Norman M. Edelstein*, *Jean Fuger*, and *Joseph J. Katz*. Springer, Dordrecht 2006. 3440 pp., hardcover $ 1800.00.—ISBN 1-4020-3555-1

The first edition of this work (J. J. Katz, G. T. Seaborg, *The Chemistry of the Actinide Elements*, Methuen, London; Wiley, New York, **1957**; 503 pp.), which explained and interpreted a relatively new field of chemistry, appeared almost half a century ago, a mere 13 years after the actinide concept had been proposed. At that time, the chemical properties of thorium (At. No. 90) and uranium (At. No. 92) had been investigated for more than a century and those of actinium (At. No. 89) and protactinium (At. No. 91) for more than half a century, but all the properties of neptunium (At. No. 93) and heavier elements as well as much of the newer chemistry of uranium had been discovered only since about 1940. The first edition described the chemical properties of the first transuranium elements, neptunium, plutonium (At. No. 94), and americium (At. No. 95), in considerable detail, but the last two actinide elements (nobelium, At. No. 102, and lawrencium, At. No. 103) had yet to be discovered.

When the second edition appeared (J. J. Katz, G. T. Seaborg, L. R. Morss, Eds., *The Chemistry of the Actinide Elements*, 2 vols., Chapman & Hall, London/New York, **1986**; xii + 1677 pp.), all the actinide elements (At. Nos. 90–103) had been synthesized and characterized to some extent. The edition contained a separate chapter for each of the elements except the ones beyond einsteinium (At. No. 99), which were combined into one chapter, and it dealt systematically with various aspects of the chemical and electronic properties of the elements, ions, and compounds caused by the filling of the 5f subshell. Although six transactinide elements had been synthesized by 1986, their experimentally determined chemical properties occupied only 1.5 pages of text in that edition.

By 1997, the editors of the second edition realized that the study of the chemical properties of the actinide elements had progressed to the extent that distinct subdisciplines had emerged, which had matured enough so that researchers could make more substantial contributions to predicting and controlling the fate of actinides in the laboratory, in technology, and in the environment. Scientists now understood and could predict to some extent the chemical bonding and reactivity of actinides in actinide materials, actual environmental matrices, and proposed nuclear waste repositories. In addition to nuclear research groups working on the actinides, similar research groups in various countries conducted systematic and important experimental investigations on the transactinides for several decades.

The latest, 31-chapter edition is edited by Lester R. Morss, Program Manager for Heavy Element Chemistry at the Office of Science, U.S. Department of Energy, Norman M. Edelstein, Senior Staff Scientist, Emeritus, Lawrence Berkeley Laboratory, and Jean Fuger, Professor Emeritus at the Université de Liège, Belgium. All three contributed to Chapters 1 and 15 (along with Joseph J. Katz). Also, Morss contributed to Chapters 2 and 19, Fuger contributed to Chapter 19, and Edelstein contributed to Chapter 20.

The three-part *Chemistry of the Actinide and Transactinide Elements*, an international venture authored by 72 contributors, follows the plan of the first edition, but also includes full consideration of the transactinide elements: "This book is intended to provide a comprehensive and uniform treatment of the chemistry of the actinide elements for both the nuclear technologist and the inorganic and physical chemist" (p. xvi).

The first part follows the format of the first and second editions by starting with chapters (1–14) that describe and interpret the chemical properties of individual elements or groups of elements, including updated treatment of the chemistry of all the actinides and authoritative reviews of the chemical properties of the transactinides. The second part (Chapters 15–26) summarizes and correlates the physical and chemical properties that are generally unique to the actinide elements because of their partially filled shells of 5f electrons. The third part (Chapters 27–31) deals with specialized topics that involve contemporary fields related to actinide species in the environment, the human body, storage, or wastes. Two separately paginated appendices tabulate important nuclear properties of all actinide and transactinide isotopes.

Each chapter is intended to provide enough background for readers who are not specialists in actinide science, nuclear-science-related areas (nuclear physics, health physics, or nuclear engineering), spectroscopy, or solid-state science (metallurgy or solid-state physics). Collectively, the set provides a balanced and insightful treatment of the latest research on these elements and related topics.

The meticulously documented volumes, which are cumulatively paginated, are printed on heavy, glossy, acid-free paper and include 723 numbered figures (diagrams and photographs) and schemes and 454 numbered tables (some several pages long), as well as numerous unnumbered reaction schemes, mathematical, chemical, or nuclear equations, and tens of thousands of references, some as recent as 2005. All of the chapters contain numbered sections and subsections, and some contain glossaries, lists of abbreviations, and discussions of future trends. Each of the five volumes contains the following items for the entire set: a table of contents, list of contributors and their affiliations, preface, and subject index. The final volume also includes an author index consisting of 157 double-column pages.

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According to the editors, "[We] hope that this new edition will make a substantive contribution to research in actinide and transactinide science, and that it will be an appropriate source of factual information on these elements for teachers, researchers, and students and for those who have the responsibility for utilizing the actinide elements to serve humankind and to control and mitigate their environmental hazards" (p. xvii).

The editors have successfully attained these goals, and I heartily recommend this latest edition of a classic text to the audience for which they have intended it, and to scientists and engineers unfamiliar with the field who want to learn how to deal in their research with these two fascinating families of elements at the frontier of the Periodic Table. This authoritative, comprehensive, balanced, and insightful compilation of the chemical properties of these elements should remain the definitive work on the subject for many years to come.

George B. Kauffman
California State University
Fresno, CA (USA)

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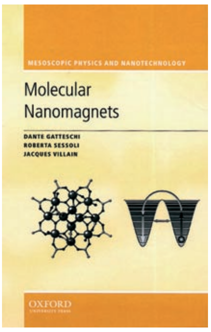
Molecular Nanomagnets



Mesoscopic Physics and Nanotechnology. By *Dante Gatteschi*, *Roberta Sessoli*, and *Jacques Villain*. Oxford University Press, Oxford 2006. 395 pp., hardcover £ 55.00.—ISBN 0-19-856753-7

Everyday life is full of useful magnets: solids, oxides, metals, and alloys. On the other hand, molecules are usually considered to be nonmagnetic. However, recent discoveries show that molecules can carry large magnetic moments, which can have a stable orientation similar to conventional magnets. These have therefore been called molecular nanomagnets or single-molecule magnets, and they might be the ultimate limit on the density of information storage. They exhibit not only the classical macro-scale property of magnets, but also new quantum properties such as quantum-tunneling of magnetization and quantum phase interference, the properties of a microscale entity. Such quantum phenomena are advantageous for some challenging potential applications, such as molecular information storage or quantum computing.

This book is the first attempt to cover in detail this new area of molecular nanomagnets, for which no other book is available. It addresses a readership of chemists and physicists. It is written for newcomers, and can be a reference book for scientists working in this research area. As the authors are two chemists and a theoretical physicist, the book is rich in molecules and equations. It covers the experimental and theoretical aspects of the chemistry and physics of the subject. The book can therefore be strongly recommended for everyone who is working in this or a related area, or intends to do so.

The book is divided into 15 chapters, which can be read independently. Only a few parts are a little dry and theoretical. The book contains about 450 literature references altogether, and most sections include abundant references to the original literature, with an emphasis on work published in the past 10 years, mainly between 1993 and 2003. It would have been helpful sometimes to list a few selected references for further reading.

The first chapter provides an introduction to the scope of molecular nanomagnets. Chapter 2 addresses the basic theories of magnetic interactions in molecular systems. It discusses mainly the spin-Hamiltonian approach and different exchange interactions. A certain amount of background knowledge is needed to appreciate it. Chapter 3 gives a very brief description of the main measurement techniques that are needed to characterize the magnetic properties of molecular nanomagnets, and explains what kinds of information can be obtained from the different techniques. A basic knowledge of experimental magnetism is assumed.

Chapter 4 summarizes the main synthetic strategies that have been used to obtain molecular nanomagnets. It should give the reader some basic tools to understand what is behind the chemical formula of molecular nanomagnets. The chapter also discusses the magnetic properties of the single-molecule magnets that have been investigated most thoroughly: Mn_{12}, Mn_4, and Fe_8. The spin-coupling schemes are shown, and the effective spin Hamiltonian for each species is discussed.

Chapter 5 deals with the thermally activated magnetic relaxation of molecular magnets. Transition probabilities and important equations are discussed. The basic features of spin–phonon interaction are described. To follow the discussions, readers will sometimes need to refer to the book by Abragam and Bleaney (1986).

Chapter 6 describes in detail the magnetic tunneling of an isolated spin. As well as discussing numerical diagonalization, the authors derive many analytical results. Even "diabolic points" are discussed.

Chapter 7 presents a short introduction to path integrals, which are useful to understand tunneling and quantum interference. Chapter 8 deals with tunneling in a time-dependent magnetic field, and Chapter 9 briefly describes the interaction of a spin with the external environment. The focus is on the hyperfine interaction and the dipolar interac-

