

Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (J. H. Robertson, School of Chemistry, University of Leeds, Leeds LS2 9JT, England). As far as practicable books will be reviewed in a country different from that of publication.

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Biological mineralization and demineralization. Edited by G. H. NANCOLLAS. Pp. viii + 415. Berlin, Heidelberg, New York: Springer-Verlag, 1982. Price DM 52.00, US \$23.10.

This book is the report of the six-day Workshop conducted on this subject, in Berlin, in October 1981. It consists of about 15 independent 20-page background papers, plus four group-discussion reports of similar length. The first three rather basic, general papers are particularly useful to the non-specialist reader: *The Solubility Concept*, by Nancollas; *Nucleation*, by Garside; and *The Mechanisms of Crystal Growth and Dissolution*, by Nielsen and Christoffersen. Other papers are more specialized, and the coverage includes physicochemical studies and detailed accounts of phenomena ranging widely over the plant and animal kingdoms, from unicellular systems to those of shell, bone and teeth. The production is unattractive but the book is certainly informative and is well referenced and indexed.

Considerable progress has been made in bioinorganic chemistry over the past ten years or so, by the application of the knowledge and techniques of the exact sciences of physics and chemistry to those problems of biological chemistry where inorganic ions are involved. Progress is, however, very difficult, owing to the chemical complexity of biological systems, and the fine scale of the processes within them. The biologically controlled deposition of mineral materials by living organisms is simply one of these difficult but challenging areas.

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The physics of actinide compounds. By PAUL ERDÖS and JOHN M. ROBINSON. Pp. xi + 213. New York, London: Plenum, 1983. Price US \$39.50.

Despite its general title this book is mainly concerned with the magnetic and to a lesser extent the electronic properties of actinide compounds. This topic is currently an area of active experimental and theoretical research, especially since the basic mechanism for the magnetic behaviour of the actinide compounds is as yet not well understood. In their review Erdős and Robinson place strong emphasis on the behaviour found for these materials in the vicinity of a variety of interesting phase-transition points; the various types are summarized in the introductory Chapter 1.

In Chapter 2 a review of experimental results of properties such as magnetic spin structure (usually determined by neutron diffraction), magnetization and susceptibility curves, electrical resistivity, specific heat, optical properties,

thermal expansion and elastic constants is presented. As noted in their preface, the authors have been selective in their choice of material and included preferably only a number of typical examples rather than all experimental results in order to illustrate the general features of these materials. This choice certainly enhances the pedagogical appeal of the work. Research workers should however be aware of the fact that for more complete details on which studies have been undertaken for specific materials they should consult some of the other reviews quoted in Chapter 1 {e.g. Trzebiatowski [*Ferromagnetic Materials* (1980), Vol. 1, ch. 5, edited by E. P. WOHLFARTH. Amsterdam: North-Holland] for a review of ferromagnetic actinide compounds} or appropriate Abstracting Journals.

An excellent overview of theories that have been applied to the magnetism of actinide compounds is given in Chapter 3. Of those models that assume localized 5f electrons, the crystal-field model is described in particular detail, but its limitations as a valid description for the actinides is also clearly indicated. Spin Hamiltonians used to describe the 5f interactions are discussed, in particular RKKY exchange (applied to actinide compounds by Grünzweig-Genossar *et al.*) and Coqblin-Schrieffer exchange (modified and applied by Cooper *et al.*). First-order magnetic phase transitions as found in actinide compounds like UO₂ are discussed in terms of models based on the picture of localized 5f electrons. Theories of magnetic behaviour that involve itinerant electrons are discussed in less detail since fewer studies subscribing to this viewpoint have been undertaken thus far. However, in recent work it has become clear that for uranium compounds there is a change from localized to itinerant behaviour as their lattice parameters decrease. Therefore, itinerant descriptions are expected to receive increasing attention in future work. A most satisfying feature of this chapter is the way in which experimental results relevant to the theoretical work are introduced in the discussions.

The book is well written in an unpretentious style and excellent care has been taken with the technical aspects of the publication. A wealth of information is contained in 121 figures, most of which are reproductions of experimental results from the literature, and 20 tables. Very few inaccuracies have been observed. A minor one is the statement that the strain measurements on UP reported in Fig. 12 were performed on a single crystal. In fact this work was done on polycrystalline material; rather few studies on single-crystal UP have been reported in the literature because of the limited amount of UP single-crystalline material available. A more serious criticism may be made regarding the contrast that the authors make between the occurrence of a peak in the temperature dependence of the magnetization of USe and the apparent normal behaviour of US and UTe (p. 34, Fig. 27). Their presentation is misleading since the 'peak behaviour' has also been found in UTe [*Phys. Status Solidi A* (1972), 14, K157], US [*J. Magn. Magn. Mater.* (1977), 5, 106] and in β -U₂N₃ and U₃P₄ [*Phys. Status Solidi A* (1972), 9, 317, 629]. Furthermore, as illustrated by the results for β -U₂N₃, U₃P₄ and

US, the 'peak behaviour' only occurs if the sample has been cooled in zero magnetic field through T_c to low temperatures before a constant field is applied and the temperature is increased. Cooling through T_c in a magnetic field leads to a 'normal' magnetization curve. It has been suggested in the above references that this behaviour arises from the large anisotropy and consequent thin domain walls that are found for these ferromagnetic materials.

The Physics of Actinide Compounds will not only serve as a valuable extension to the existing reviews on actinide compounds, but especially stands out as a clear introduction to the fascinating subject of magnetic and electronic properties of these materials. It is highly recommended to graduate students who enter this rather active field of study, and it will also be equally valuable to research workers with a current or planned interest in this field. For more information on specialized topics the reader may also like to consult some of the other reviews quoted in the book, as well as chapters from *Handbook of the Physics and Chemistry of the Actinides* [G. H. Lander & A. J. Freeman (1984), Editors. Amsterdam: North-Holland].

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Comparative crystal chemistry. Temperature, pressure, composition and the variation of crystal structure.

By R. M. HAZEN and L. W. FINGER. Pp. xv+231.
London: John Wiley, 1982. Price £19.50.

Although materials scientists, solid-state physicists and chemists, and geoscientists are confronted with problems involving crystalline matter at extreme conditions of temperature and pressure, there is to date no comprehensive compilation of data or techniques. Information on experimental apparatus and techniques is not commonly available in the published literature.

This book has been written as an introduction and review of 'comparative chemistry' or the study of crystal structure variations with temperature, pressure and composition; it is divided into two sections, which are largely independent. The first is designed as a handbook for high-pressure and high-temperature crystallography. Chapters 1 to 5 deal with techniques for the operation of high-temperature and high-pressure single-crystal X-ray devices. Current experimental methods (single-crystal heaters, diamond cell, high-temperature diamond cell) have been described in sufficient detail. Diagrams of experimental apparatus and detailed descriptions of crystal mounting, orientation, calibration and computational procedures have also been included. Appendices to this section include program listings for strain-tensor and polyhedral-volume calculations, which are useful for practical applications.

The second section of the book is a summary of the results of high-temperature and high-pressure crystallographic studies known to mid-1981. Chapters 6 to 9 contain data on the continuous variation in structure of ionic

crystals resulting from continuous change of temperature, pressure or composition. Chapter 10 deals with structural variations and the prediction of phase equilibria. The phase transitions are excellently interpreted using concepts developed in the previous chapters.

This book will be useful for geologists, mineralogists, solid-state physicists and solid-state chemists, who are interested in the crystalline state at non-ambient conditions. This book is also valuable for the structural studies of complicated organic compounds or metal complexes at extreme conditions.

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The Jahn-Teller effect and vibronic interactions in modern chemistry. By I. B. BERSUKER, Pp. ix+290, Figs. 120. **Series on Modern Inorganic Chemistry**, edited by J. P. FACKLER JR. New York, London: Plenum, 1984. Price \$45.00.

This is the third volume in *Series on Modern Inorganic Chemistry*. It is certainly to the credit of the editor to have selected a subject that has become increasingly important in chemistry within the last few decades. The book is concerned with the theory of vibronic interactions between electronic states and nuclear motions and its widespread manifestations and applications in chemistry. The author, who is one of the pioneers in the field, introduces and defines a general concept of vibronic coupling, which comprises the different aspects of the Jahn-Teller effect. The first and second Chapters are devoted to the basic theory and the underlying symmetry aspects. In Chapter 3 the dynamic and static properties in the ground states of molecular systems, which follow from vibronic instability, are discussed. The fourth chapter surveys the numerous implications of vibronic interactions in spectroscopy. Evidence is given that a deeper understanding of finer spectroscopic details is hardly possible without this concept. Chapter 5 deals with the consequences of vibronic coupling effects in stereochemistry and crystal chemistry. It is devoted to applications and introduces some empirical concepts such as vibronic amplification and the plasticity effect, which show the general validity of the vibronic model. It also considers the cooperative Jahn-Teller effect with respect to structural phase transitions. Finally, many examples - also from inorganic biochemistry - illustrate how useful the very general concept of the pseudo-Jahn-Teller effect is for the understanding of dynamic and static distortions in molecular systems with non-degenerate ground states. The subject of the last chapter is molecular dynamics in chemical reactions. After a discussion of the vibronic instability of the activated state the usefulness of the vibronic approach for the understanding of the elementary steps in chemical reactions and catalysis is pointed