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BOOK REVIEWS

The Physical Chemistry of Solids. By R. J. BORG AND G. J. DIENES. Academic Press, San Diego, 1991. xii + 624 pp., $69.95.

The book under review represents a straightforward treatment of selected topics in the areas of solid state chemistry, materials science, ceramics, and metallurgy. The material is presented at the undergraduate level. With eight appendixes, as well as exercises and suggestions for further reading at the end of each chapter, the volume may well be useful as a text at the junior or senior level.

As with any book of its genre, one may ask to what extent this particular volume is superior to the many others that cover roughly the same topics. Just as beauty is in the eye of the beholder, so judgment in this matter depends on the background and interests of the reader. In the opinion of this reviewer, much of the material is well presented with few errors. Certain presentations are nicely detailed and superior to treatments in competing books, such as the thermodynamic equations of state for solids, including the Hugoniot and the Mie–Grüneisen treatments, and generalized potential functions; also, the classification of silicates, the presentation of ternary phase diagrams, surface phenomena, and the subject of diffusion. However, much of the presentation is at too elementary or too superficial a level. For example, the chapter on crystallography, the treatment of band structures, and phase transitions falls in this category.

There are other matters of presentation with which one can quibble. A thirty-four page review of quantum mechanics and chemical bonding, at the senior or first year graduate level, is immediately followed by a nine page treatment of crystal field effects, using only pictorial and qualitative arguments—the reader is not shown any connection between these two treatments at such disparate levels. In the discussion of binary phase diagrams, the free energy vs composition curves on which the former are based are discussed *after* the display of the phase diagrams. This makes it difficult to appreciate why the phase diagrams have such different forms and to understand the origin of the two phase vs the homogeneous phase domains.

Certain topics have not received any attention; for example, zeolites are not discussed, even though several other classes of materials are covered in Chapter 5 and surface phenomena are discussed in Chapter 11. By deliberate choice, the authors also have not included descriptions of electron transport, optical, and mechanical properties of solids—features that would really seem to limit the general utility of this volume. Incidentally, contrary to the claim in the preface, a brief treatment of magnetic properties *is* included on pages 510–518.

Overall, the book ranks well at the level of many other comparable volumes which provide introductory treatments to the subject of solid state chemistry/materials science. All readers must decide for themselves as to which of these treatments they find most appealing.

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Transition Metal Oxides: An Introduction to Their Electronic Structures and Properties. International Series of Monographs on Chemistry. By P. A. COX. Clarendon Press, Oxford, 1992. ix + 284 pp., $75.00.

The book under review is intended as an introduction for chemists and physicists to the wide range of electronic properties in transition metal oxides. An additional stated aim is "*to discuss in a fairly critical way the various models that have been proposed to interpret them.*" The presentation is aimed at graduate students and researchers in solid state chemistry or physics and in materials science. The five chapters in the book deal with electron configurations, structural principles, models of electron states in crystals, insulating oxides, transition metal impurities, magnetic insulators, defect models, transitions to the metallic state, metallic oxides and correlation effects, and superconductivity.

The coverage of so much material in a very limited space required the author to limit severely the exposition of all the topics he has chosen to discuss. As a result, much of the subject matter is covered in dictionary-like style, as, for example, in the section on magnetic ordering in Chapter 3; readers not acquainted with such material are unlikely to profit from such an abbreviated presentation. By choice, the author also omits most of the mathematical discussion that is required to provide the reader with an understanding of the models such as crystal field or band theory, magnetic exchange, the Hubbard model, or superconductivity.

In matters of style, one can always legitimately argue about appropriate levels of exposition in an introduc-

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tory text. More serious are problems with the subject matter itself. It is unfortunate that the seminal contributions by Goodenough in systematically rationalizing band structures and magnetic properties of oxides are only mentioned obliquely. His approach seems particularly well suited for the discussion of these topics at the level espoused by the author. The presentation of properties of the vanadium oxides, magnetite, and titanates is out of date; very little attention is paid to the many new discoveries in this area over the last twenty years. The description of the electrical properties of NiO (p. 165) is based on data published in 1971; much more careful work carried out since then by many investigators leads to an interpretation diametrically opposed to that furnished in the book. The discussion on page 83 indicates that the "band gap" (the author obviously refers to the Mott–Hubbard gap) in this material arises from the repulsion between electrons in the partially filled $3d$ shell. Charge transfer effects are discussed on pages 142 and 262 but are not linked to NiO to provide the necessary background for a more recent overall view of the NiO problem. The formula for the Seeback coefficient (p. 166) is in the form proposed by Heikes but lacks a factor of 2 which was introduced by later workers to render the equation applicable to electrons with spin degrees of freedom. Similarly, no distinction is drawn between the density of states per level vs per spin; depending on what convention one adopts, the formulas for the Sommerfeld specific heat and for the Pauli paramagnetism differ by a factor of 2 from those shown in the book. The concept of the Mott transition serves as an important milestone by which to distinguish ordinary semiconductors and metals from magnetic insulations and correlated metals. This feature is not underlined, so that readers are not properly introduced to the borderline between these two canonical types of systems. On page 83 it is not made clear that there is an important distinction between Hubbard subbands and ordinary valence and conduction bands with respect to the electron spin orientation which is random only in the latter situation. The kinetic exchange mechanism referred to on page 149 does not necessarily just result in antiferromagnetism; it also can give rise to ferromagnetism, depending on the degree of orbital degeneracy and on the number of electrons. Expression (5.24) for the Bose Einstein condensation temperature applies only to 3D (i.e., isotropic) free-particle systems, but not to the quasi 2D (anisotropic) systems relevant to high T_c superconductors. It should also have been mentioned that the latter class evolves directly from antiferromagnetic insulators by doping, quite in contrast to classical superconductors.

The above sampling indicates that problems with details detract from an otherwise eminently readable and lucid account. The book does serve as a guidebook for phenomena and concepts in the chemistry and physics of oxides and does provide a good, readable, elementary introduction to an area that has risen to prominence in the last two decades. However, the reader must constantly be on the alert with regard to the presentation of the technical details, and in many areas the discussion is not up to date.

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