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BOOK REVIEWS

Transition Ion Electron Paramagnetic Resonance. By J. R. PILBROW. Oxford University Press, New York, 1991. xx + 717 pp. $195.00.

Intended as an introductory text on transition ion EPR at the beginning graduate student level, this book seeks to bring this subject matter to an audience that Abragam and Bleaney's comprehensive treatise "Electron Paramagnetic Resonance of Transition Ions" (Oxford Univ. Press, Oxford (1970)) was never able (nor perhaps intended) to reach. The author has succeeded admirably.

The book restricts itself to a discussion of paramagnetic ions of the first three transition series. The author commences with an overview of transition ion EPR, including the two-level system, orientational dependencies, spectral response, and spectrometer principles, and then cites several representative examples of single crystal and powder EPR spectra. In subsequent chapters the author unfolds understandable, detailed discussions of crystal and ligand field effects on EPR spectra, spin Hamiltonian solutions of *d*-electron configurations via perturbation theory methods, experimental methodology of CW-EPR, linewidth analyses, and computer simulations of single crystal, powder, and partially ordered systems, and paramagnetic relaxation. Throughout the text the figures are handsomely displayed and annotated. Spectral traces are frequently augmented with energy level diagrams to clarify discussion. The book is primarily concerned with CW-EPR, but short chapters on double resonance (ENDOR and ENDOR-induced EPR), pulsed methods (ESEEM and LEFE), and zero-field EPR (ZRF) can also be found. Most of the examples in the text deal with magnetically dilute paramagnetic centers. However, coupled systems are treated in a separate chapter that focuses primarily on interactions between pairs. A lengthy descriptive chapter on biological applications of transition-ion EPR is also included.

The basic philosophical approach of the book is to treat the magnetic parameters which characterize an observed EPR spectrum as only part of the model of the paramagnetic system. Whereas the solutions to numerous spin Hamiltonians are given prominent coverage, significant attention is also paid to the factors controlling linewidths of EPR transitions. Taken together these provide a complete characterization of the transition ion under scrutiny. With the development of efficient EPR spectral simulation algorithms for sophisticated analysis, computer modeling of the observed lineshapes, discussed at length in this book, has become possible for even the most casual observer of EPR spectra. For them and for any researcher in the field of EPR spectroscopy, this book will be valuable.

However, despite its number of positive attributes, it is doubtful that this book will ever find its intended niche as a required text in a matriculating graduate course on EPR, toting as it does, a hefty price tag.

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Scanning Force Microscopy; with Applications to Electric, Magnetic, and Atomic Forces. By DROR SARID. Oxford University Press, New York, 1991. xi + 254 pp. $45.

The invention of the scanning tunneling microscope by Binnig and Rohrer over 10 years ago has significantly influenced many aspects of materials science. Applications include atom-by-atom analysis of chemisorbed species on clean, crystalline surfaces in UHV and electrochemical environments, investigation of grain morphology in thin films (e.g., high-temperature superconductors), studies of molecular aggregation in liquid crystals and in biological systems, and measurement of nanometer- to micrometer-sized patterns of practical importance in the electronics industry. The invention of the atomic force microscope by Binnig, Gerber, and Quate in 1986 opened similar applications in a broader range of materials, now including electrical insulators. Scanning tunneling and atomic force microscopes are sold commercially and can be found in hundreds of laboratories around the world, but scanning force mi-

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croscopes configured to sense magnetic and electric forces are not yet commercially available. Researchers build them to map magnetic domains and localized electric charge distributions.

Microscopy *applications,* such as those mentioned above, are treated only briefly in this book, with little critical perspective or comparison with other techniques for addressing similar materials problems. These topics may be covered by the review articles cited by Sarid in the preface. Instead, Sarid has focused on the engineering aspects of building and operating the *instrumentation*. Sarid provides a unified theoretical point of view, beginning with first principles such as the equations of motion for a harmonic oscillator or Maxwell's equations. Sarid typically proceeds with a formal derivation of the operating properties of the component, subsystem, or instrument under discussion accompanied by appropriate diagrams and photographs. An unusual feature is the use of tables to summarize instrument or component specifications and performance as reported in the literature. The bibliography is extensive (ca. 250–300 references). The presentation could be improved by giving a list of symbols and their definitions. Some numerical examples of calculations from the formulas should be presented, probably as graphs indicating performance (or other figure of merit) as a function of operating parameters (or other engineering choices). The caption of Figure 1.1 should be corrected: *the six strain components* should be *the six shear stress components.*

Part One treats the mechanical properties of the cantilever, shows how the sensitivity can be enhanced near resonance, and discusses various sources of noise. Part Two discusses seven techniques for sensing minute perturbations of the cantilever: tunneling, capacitance, optical homodyne, optical heterodyne, laser-diode feedback, polarization, and deflection detection systems. Part Three discusses the three classes of instrument mentioned in the title and briefly surveys some applications. Although the theoretical discussion of instrument operation is complete, in some sense, Sarid misses the opportunity to apply the equations to important experimental issues. For example, the Hamaker constant is introduced in the discussion of van der Waals forces between dissimilar objects, but force minimization by the appropriate choice of a liquid medium for imaging purposes is not mentioned. The important areas of image interpretation and identification of artifacts have been ignored completely.

This book is a valuable contribution to the literature, providing a sound theoretical basis for understanding the operation of and interpreting the images produced by various types of scanning force microscopes. However, it will disappoint readers who are looking for a guide to the applications of these microscopes.

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Chemical Synthesis of Advanced Ceramic Materials. By DAVID SEGAL. Cambridge University Press, Cambridge, 1991. xv + 182 pp. paper, \$24.95 (1989, cloth, \$65).

This paperback edition of a book first published in 1989 as the first in a series on the "Chemistry of Solid State Materials" deals with the preparation of ceramic materials. The 10 chapters (plus an appendix) in this relatively short book form a suitable undergraduate text or an overview for those entering the field of ceramics.

The introductory chapter discusses different types of ceramic materials and their applications as refractory materials, composites, bioceramics, electroceramics, combustion- and wear-resistant materials, high-temperature oxide superconductors, and sensors. Properties of the ceramic materials commonly used in these applications, such as toughness, corrosion resistance, thermal expansion, hardness, thermal conductivity, ductility, and electrical resistance, are discussed.

Chapter Two deals with an overview of conventional methods of preparation of ceramics (including precipitation from solution, mixing of powders, and fusion) and has a short section on the need for new preparative techniques for advanced materials. Chapter Three deals with the fabrication of ceramics: sintering, hot pressing, isostatic pressing, reaction-bonding, slip casting, and injection molding.

The next two chapters focus on sol–gel methods. The first deals solely with sol–gel processing of colloids, including a discussion of colloids, hydrolysis, and precipitation methods (especially with reference to applications in the nuclear industry). The second reviews the use of metal alkoxides in sol–gel synthesis with application to coatings and the preparation of submicron powders.

Chapter Six deals with nonaqueous liquid-phase reactions with an emphasis on silanes, while Chapter Seven encompasses the pyrolysis of polysilane polymers, including the synthesis of nitride and oxynitride fibers.

The hydrothermal synthesis of ceramic powders, including a discussion of metal and salt reagents, is pre-