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BOOK REVIEWS

Superconductivity in Complex Systems. Structure and Bonding, 114. Edited by K. Alex Müller (Physik-Institut der Universität Zürich) and Annette Bussmann-Holder (Max-Planck-Institut für Festkörperforschung, Stuttgart). Series Edited by D. M. P. Mingos. Springer: Berlin, Heidelberg, New York. 2005. xii + 394 pp. $339. ISBN 3-540-23123-2.

This latest volume in the *Structure and Bonding* series is a collection of 11 articles representing a review of theoretical and experimental studies of superconductivity in unconventional and novel superconductors. Although an excellent review on fullerene superconductors is given by Gunnarsson et al., the volume largely focuses on high-temperature cuprate superconductors and follows many of the trajectories Müller pursued, which directed his Nobel winning search.

The idea that lattice degrees of freedom, and in particular the role of degeneracy-lifting Jahn−Teller phonons, play an important role in the cuprates was for a long time not at center stage in the discussion of the physics of high-temperature superconductivity. The lattice scenario did not seem obvious a priori, due to the lack of isotope dependence on the transition temperature T_c for "optimized" superconductors, the uncovering of the anisotropic d-wave rather than s-wave pair state from transport, thermodynamic, spectroscopic, and SQUID measurements, as well as the high value of T_c itself, which had not been thought possible for large electron−phonon coupling due to an envisioned instability in a charge-density insulator rather than a superconductor. Thus, electronic mechanisms, such as superconductivity mediated by spin fluctuations, became more or less "the standard model" for the cuprates. Still, a great deal of evidence regarding strong phonon renormalizations with temperature and doping as well as isotope dependences for the penetration depth and T_c for nonoptimal cuprates indicated that the lattice could not be an innocent bystander in the role of superconductivity, a matter that many of the contributing authors of this book have long emphasized, which is well summarized in the Introduction by Müller.

However, as the quality of cuprate samples has improved and experimental techniques have advanced, many new findings, described in this book, have brought the importance of the lattice back to center stage. This includes substantial isotope dependence found in penetration depth measurements (Keller), phonon renormalizations found in neutron scattering (Egami), charge relaxation and inhomogeneity revealed from neutron scattering measurements of crystal field transitions (Furrer), electron paramagnetic resonance (Kochelaev and Teitel'baum), X-ray absorption (Bianconi and Saini), and pump−probe studies (Mihailovic and Kabanov). These articles by and large provide a good overview of recent experimental techniques, although some of them would have benefited from greater elaboration of the ideas and limitations behind the technique as well as links to findings from other measurements and materials other than the cuprates. Another weakness is that other techniques, such as angle-resolved photoemission, scanning tunneling microscopy, and Raman and infrared conductivity measurements, have largely been left out. That notwithstanding, the overall picture that emerges is that inhomogeneity in the form of charge and/or spin structures as well as lattice degrees of freedom are intimately coupled with superconductivity, indicating the shortcomings of "standard model" approaches alone.

As admitted in the Introduction, this is not a book that is very much concerned with electronic contributions to the pairing mechanism and as such may not be widely accepted in the community of theorists working in high-temperature superconductivity. However, the articles on theory provide a context from which to view the experimental results in connection with superconductivity. In particular, the article by Micnas et al. provides a very nice review, suitable for graduate students, on superconductivity in multiband systems such as MgB_2. This is complimentary to the chapter on the role of bandstructure and pairing reviewed by Deng et al.

Finally, a summary of the experimental and theoretical evidence for polaron formation is given at the end. The limitations of theoretical techniques that handle simultaneous strong electron−phonon and electron−electron interactions are summarized in an article by Gunnarsson et al., in which they discuss many of the problems and challenges of understanding superconductivity in these systems.

By and large, most of the articles are accessible to graduate students, which is in conflict with the high cost of the book. As a result, I would expect that this book will be accessible as a valuable library resource rather than a personal handbook. However, it provides a very good summary of the importance of lattice effects in unconventional superconductors and fills a very important niche in the canon of work on cuprate superconductivity.

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Frontiers in Crystal Engineering. Edited by Edward R. T. Tiekink (The University of Texas at San Antonio) and Jagadese J. Vittal (National University of Singapore). John Wiley & Sons, Ltd: Chichester. 2006. xiv + 332 pp. $195.00. ISBN 0-470-02258-2.

Engineering is "the application of scientific and mathematical principles to practical ends", according to *The American Heritage Dictionary of the English Language*, Fourth Edition. Designing materials for practical ends is often the goal of the authors of the chapters in this book; however, unlike traditional engineers, crystal engineers cannot simply apply scientific principles to make a crystal structure. They are still discovering which factors and combinations of factors are important in determining three-dimensional arrangements in solids; thus, engineering is more a metaphor than a method in this field. The material presented in this book represents an excellent

overview of efforts to discern the principles that determine the aggregation of molecular species into crystals. Many of the authors of the various chapters note how difficult it is to turn explanations of the structures they find into guiding "engineering" principles: to quote from one chapter, "Finally, the unexpected must be expected while researching new compounds that associate by means of only weak attractions". In light of this difficulty, the contribution of all of the authors in providing this broad review of the work toward establishing the science behind crystal assembly is all the more valuable.

This book is a compilation of some of the leading work in the field of crystal design from 12 laboratories, each chapter written by a separate group. The book provides the reader with a good overview of the breadth of efforts in crystal design and the range of factors that affect the aggregation of molecular species into three-dimensional assemblies. The work described ranges from efforts to develop solvent-free supramolecular chemistry, template-controlled solid-state synthesis, pharmaceutical cocrystals with novel physicochemical properties, and halogenated heteroaromatic clathrates that form bricks, spheres, and grids to efforts to understand interpenetrating networks and networks formed by molecular hosts. Several of the chapters contain descriptions of experiments designed to probe the factors affecting aggregation, including distortion of soft coordination environments, steric effects due to metal- or ligand-bound substituents, $\pi-\pi$ and metal−metal interaction in coordination supramolecular architectures, and the structure-directing influence of hydrogen bonding in coordination polymers.

The comprehensiveness of the material and the clarity of the writing in most chapters make this book an invaluable reference for structural chemists because it illuminates the variety of approaches that have been used and the systems that have been investigated with care and depth. Each chapter is mainly focused on the work of its authors and is thoroughly referenced up to 2004.

The chapters are extensively illustrated; unfortunately the lack of stereographic images and the absence of color make the figures accessible only to readers skilled in visualizing in three-dimensions. The difficulty of understanding complex three-dimensional relationships in crystal packing arrangements, networks, and coordination polymers, plus the lack of stereo images, makes this book most useful to expert structural chemists.

The book lacks a concluding and summarizing chapter that pulls the contents together to provide an overall message to the scientific community. Such a summary might have addressed the lessons learned regarding the importance of various factors in determining crystal structures and proposed the research agenda for the future. Still, this book is a useful review of the breadth of activity and leading thinking in the field of crystal design.

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Frontiers in Chemical Sensors: Novel Principles and Techniques. Springer Series on Chemical Sensors and Biosensors, 03. Edited by Guillermo Orellana and Maria C. Moreno-Bondi (Universidad Complutense, Madrid, Spain). Series Edited by O. S. Wolfbeis. Springer: Berlin, Heidelberg, New York. 2005. xii + 370 pp. $199.00. ISBN 3-540-27756-0.

The field of chemical sensing has witnessed enormous, and continuing, growth over the past decade, and *Frontiers in Chemical Sensors: Novel Principles and Techniques* provides a welcome overview of the current state-of-the-art. Ranging from detection methods for very small molecules (gas sensors) to large molecules (DNA) and cells, this book provides thorough discussions of many active areas of research in sensing. Most chapters also include discussions of current limitations associated with each technique or challenges associated with the preparation of sensor surfaces and the immobilization of probe molecules. Readers should be aware that some sensing methods receive very limited discussion; surface plasmon resonance, for example, will be the subject of a separate volume in the series.

Although probe molecules and their design do not constitute a primary focus of the book, they are not neglected. For example, strategies used in the optical sensing of enantiomers are described, and a chapter detailing combinatorial methods of self-assembled molecular recognition surfaces is particularly noteworthy. However, for readers interested in gaining a broad overview of aspects of the molecular recognition of chemical sensing, this volume is probably not the place to start. Rather, a particular strength of the book is that considerable attention is paid to the device physics and quantitative treatment of sensor data.

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