ADVANCED MATERIALS

Book Reviews

Superconductors, Metals, Polymers, Electronics...

Introduction to the Modern Theory of Metals. By *Alan Cottrell*. The Institute of Metals, London 1988. 260 pp., hard cover, $ 73.50, ISBN 0-904357-97-X

My first book review, written in Chicago in 1955, was on *Cottrell*'s "Theoretical Structural Metallurgy". At that time I was impressed by the non-physical argumentation which *Cottrell* used in that small book for the explanation of metallurgical phenomena, and it is a method I have often made use of during my career in physical metallurgy. Now, 35 years and many book reviews later, I have the opportunity to review the latest offering from *Cottrell*, another review of the basics of the metal state which attempts to incorporate the modern theories of today's metallurgists.

The book is intended to bring the post-war work of *Hume-Rothery* and *Raynor* up to date, work which *Cottrell* experienced at first hand during a stint as Professor in Birmingham from 1949 to 1955. Since that time he has worked at Harwell and at Cambridge, been a government science advisor, and Master of a college and Vice-Chancellor at the University of Cambridge. Here, during his retirement, he writes refreshingly on the electron theory of metals and alloys as if the intervening years had had no effect whatsoever. Truly a fascinating personality and performance!

The 10 chapters and 13 appendices (which make up more than one third of the book and contain the necessary mathematics) discuss the following points:

1. What is the definition of a metal? (Includes a discussion of the insulator-metal transition and electron delocalization).
2. Why are electrons 'free' (based on shielding and pseudopotentials)?
3. What is the effect of electron correlation?
4. What are the effects of band structure?
5. The cohesion in simple metals and the energies of lattice defects.
6. The d-shell transition metals and their magnetism.
7. The problems with Cu, Ag, and Au with respect to the Hume-Rothery rules for alloys.
8. The surface of metals.
9. Superconductors, including the high-T_c variety.

The physics of every example is explained well, the mathematical proofs being restricted to a minimum or confined to discussion in an appendix. The presentation makes the work highly readable, complete but concise. The metallurgist with some background in physics, or the physical chemist will gain much from reading the book. It is a masterpiece which provides an important education in the basic science that is applicable to many areas of materials science.

Peter Haasen
Institut für Metallphysik
Universität Göttingen
Hospitalstrasse 3/5, D-3400 Göttingen (FRG)

Studies of High Temperature Superconductors. Volume 1. Edited by *Anant Narlikar*. Nova Science Publishers, New York, 1989. xiv, 381 pp., bound, $ 85.—ISBN 0-941743-44-3

The discovery of superconductivity in a La-Ba-Cu-O compound by *Bednorz* and *Müller* triggered a world wide race in the search for new superconducting materials with still higher transition temperatures. At the same time an enormous wave of publications was set in motion that continues today without any sign of diminishing. In order to ensure rapid publication, new journals mushroomed overnight everywhere, and it was extremely difficult to keep track of important developments.

Presently, three years after the beginning of high-T_c fever, the first books summarizing the current state of the art in the field are being published. The book in hand is the first volume of a series entitled *Studies of High Temperature Superconductors—Advances in Research and Applications*, edited by *Anant Narlikar* from the National Physical Laboratory in New Dehli, India. The underlying motivation for this series is the need for a convenient access to important advances in the field not only for scientists and engineers, but also for graduate students of physics, chemistry, materials science and related fields. Hence most of the chapters in each of the volumes have the character of a review article focusing on theoretical and experimental aspects of research in the field.

Volume one of this series contains 15 chapters, seven of which discuss theoretical approaches to high-T_c superconductivity. The remaining chapters summarize the processing of bulk and thin film materials, microstructural effects, elastic properties, and X-ray photon spectroscopy (XPS). *C. N. R. Rao* from the Indian Institute of Science gives an overview of the oxygen hole mechanism of superconductivity, including a review of available Auger and XPS data. *S. S. Jha* from the Tata Institute of Fundamental Research in Bombay reviews the generalized BCS pairing at the weak as well as the strong coupling limit, including a modified theory for layered crystals. A discussion of possible pairing mechanisms in high-T_c superconductors concludes this article.

J. P. Carbotte from McMaster University in Hamilton, Canada, and his colleague *F. Marsiglio* from the University of California at San Diego, USA, summarize boson exchange mechanisms and combined phonon-exciton mechanisms. A strong coupling approach to high-T_c superconductivity is considered by *J. Rammer* from the University of Bayreuth, FRG. Experimental studies allowing the assessment of the role of phonons in high-T_c superconductivity are included as well as a discussion of non-phonon and combined non-phonon and phonon mechanisms. *K. Machida* from Kyoto University considers electronically driven instabilities in a number of materials such as heavy Fermion superconductors, Cu-free cubic oxides, and the superconducting cuprates. *G. J. Hyland* from the University of Warwick, UK, looks at ground states of the parent compounds which are Mott-insulators and discusses the role of non-stoichiometry and altered valences in high-T_c superconductivity. Superconducting properties resulting from a short coherence length are discussed by *Y. Iye* from the University of Tokyo, Japan. He discusses fluctuations of diamagnetism and conductivity within the Ginzburg-Landau framework. Flux creep phenomena are discussed in the second part of the article.

Chemical aspects of the preparation of high-T_c superconductors are reviewed by *R. M. Iyer* and *J. V. Yakhmi* from Bhabba Atomic Research Center in Bombay, India. They discuss solid state and solution methods for the preparation of bulk superconductors. The oxygen stoichiometry of $YBa_2Cu_3O_{7-x}$ and processing for high critical current densities are reviewed as well as problems in synthesizing Bi and Tl superconductors. The following chapter by *A. V. Narlikar* et al. from National Physical Laboratory in New Delhi, India, is a comprehensive overview of substitution studies. Numerous tables and graphs summarize data and results of substitutions of the relevant lattice sites in $La_{2-x}Ba_xCuO_4$ and $YBa_2Cu_3O_{7-x}$ superconductors. A short section on substitutions in the Bi and Tl superconductors and an extensive bibliography with 144 entries concludes this review.

Sound velocity and measurements of the elastic constants are reviewed by *R. Srinivasan* from the Indian Institute of Technology. After a discussion of sound velocity data, he considers the possibility of structural change near 230 K; a number of measurements seem to point in that direction, e.g. sound velocity measurements, mechanical loss factors, specific heat, etc. Valence and conduction band XPS studies of high-T_c superconductors are summarized by *B. P. Padalia* and *P. K. Mehta* from the Indian Institute of Technology. The role of twins in $YBa_2Cu_3O_{7-x}$ is discussed at length by *C. J. Jou* and *J. Washburn* from the Lawrence Berkeley Laboratory, USA. Their proposed qualitative model for the formation of twins in $YBa_2Cu_3O_{7-x}$ is consistent with numerous experimental observations such as imperfect Meissner effect, remanent magnetization, etc.

Two chapters discuss thin film superconductors. *K. Wasa* and his colleagues from Matsushita Electric Industrial Co. Ltd. in Moriguchi, Japan, review basic thin film processing. After a short introduction listing the various deposition methods, the remainder of the article discusses deposition of a variety of high-T_c superconductors using RF-sputtering. *O. Meyer* from the Kernforschungszentrum in Karlsruhe, FRG, reviews the modification of thin films by ion beam irradiation and its effect on transport properties and electronic structure. The article closes with the discussion of application of ion beam modification techniques. Finally, the design, preparation, and characteristics of a superconducting three terminal device are discussed by *T. Kobay* and *U. Kabasawa* from Osaka University. Their "superconducting current switching transistor" shows a modest current modulation gain of 5 to 7. The authors close with a tentative interpretation of the current modulation mechanism on the basis of non-equilibrium superconductivity.

The volume certainly offers a wide range of topics and caters to a broad cross-section of scientists and engineers, just as the editor promised in the preface. Although the volume is somewhat heavily biased towards the theory side this will not be the case in future volumes as a glance into the list of planned articles reveals. The subject index in the back of the volume is a welcome supplement which enables the reader to cross-reference specific topics with other articles in the volume. On the negative side, some of the figures are of poor quality due either to the design of the responsible author or to the reproduction. It would improve this series if the editor would insist on higher quality supplied figures; a similar comment applies to the type styles, some of which are not suitable for camera-ready publications. Overall this first volume of the series is a good beginning and one can look forward to the forthcoming volumes.

Herbert Jaeger
Max-Planck-Institut für Metallforschung
Heisenbergstrasse 5, 7000 Stuttgart 80 (FRG)

Chambers Science and Technology Dictionary. Edited by P. Walker, W & R Chambers/CUP, Cambridge 1989. xvi 1008 pp., hard cover, £ 30 – ISBN 1-85296-150-3

Professor *Peter Walker*, a former Professor of natural history at the University of Edinburgh, Scotland, and a distinguished collection of collaborators from fields as disparate as acoustics and zoology have combined to produce a reference work of the highest quality which covers many areas of materials science as well as, amongst 100 other areas, biology, geology, and printing.

With the rate of development of science and technology ever increasing, it is not only the educated layman who becomes baffled, but one professional may have trouble understanding terms used by another in a neighboring field.

define your terms,
you will permit me again to say
or we shall never understand one another
— Voltaire