Solid State Physics: Advances in Research and Applications, *Vol. 50*

Henry Ehrenreich and Frans Spaepen, Editors
(Academic Press, San Diego, 1997)
xi + 403 pages, $120.00
ISBN 0-12-607750-9

The 50th volume of a classic warrants special attention—hence this review. The first of the familiar brown volumes appeared in 1955 under the editorship of Frederick Seitz and David Turnbull, both honored by the Materials Research Society as eminent materials scientists. Indeed, the editors of this latest volume begin their preface by saying, "From its inception, this series has been devoted to solid-state physics in a very broad sense, covering much of what is currently referred to as condensed matter physics and materials science." Turnbull is a physical chemist rather than a pukka physicist; this has been a source of strength and breadth. The books are really about solid-state science in all its ramifications.

Originally, about 12 volumes were planned, to appear approximately every six months. In the event, the usual gap has been about 12 months, and the series has continued steadfastly, with no changes in concept or standards, through several changes of editorship (in 1967, 1986, and 1994); Turnbull remained an editor for almost 40 years. The series' reputation is such that the most distinguished authors regard it as a privilege to undertake the very heavy labor of writing overviews for it, some at a broad-ranging and elementary level, others at an advanced, specialized level, which is a policy that was announced in the first volume and has never changed. Another consideration announced in 1955, still currently valid today, is that "it would be helpful to workers in allied fields if the results of solid-state science, pertinent to their activity, were readily available."

The present volume exemplifies the elementary/advanced dichotomy. The first, short article, by Weaire and McMurry of Ireland, treats the fundamental underpinnings of the vast mass of research on the modeling of grain growth (and of Ostwald ripening also). It resolutely avoids getting bogged down in excessive details, so that the underlying assumptions emerge. David Wu (Los Alamos) offers a detailed treatment of recent developments in nucleation theory (both homogeneous and heterogeneous), following on two other treatments of this topic earlier in the Series. This one is a hardy perennial.

The real heavyweight effort in this volume is a 142-page essay by two French physicists, Martin and Bellon, on "driven alloys," defined as alloys "maintained in non-equilibrium conditions by some external dynamic forcing," such as sustained irradiation, fatigue, high-energy milling, and vapor-deposition. This is a masterly survey of a very wide range both of experimental facts and of theoretical analysis, at a very sophisticated level, quite a lot of it the work of the authors, and it is sure to remain the standard treatment for years to come.

The last of the essays is by Kimerling and three of his colleagues at the Massachusetts Institute of Technology (MIT), and treats, in a fairly concise manner, light-emission from silicon, both intrinsic and extrinsic; it includes a brief overview of nanostructured (especially, porous) silicon.

It is a privilege to be allowed to salute such a sustained and impressive achievement as the 50 volumes of this distinguished Series.

Reviewer: *Robert Cahn is a physical metallurgist turned materials scientist, currently attached in nominal retirement to Cambridge University. He has researched on intermetallics and many other metallurgical themes, has edited a number of journals and book series devoted to materials science, and has striven over the years to popularize materials science in the pages of* Nature. *He is a member of the Editorial Board of* MRS Bulletin.

Semiconducting Transparent Thin Films

H.L. Hartnagel, A.L. Dawar, A.K. Jain, and C. Jagadish
(IOP Publishing, Bristol, 1997)
358 pages, $180
ISBN 0-7503-0322-0

Semiconductor transparent coatings are now widely used in applications as diverse as windscreen heaters for aircraft, laser diode facet encapsulants, gas sensors, solar cells, and displays. The five basic transparent conducting oxides are SnO_2, In_2O_3, ITO (indium tin oxide), Cd_2SnO_4, and ZnO. This timely and extremely useful volume summarizes the basic properties of these compounds, their growth by various chemical-vapor-deposition (CVD) and physical-vapor-deposition (PVD) techniques, the electrical and optical properties of doped and undoped films, and finally a comprehensive discussion of the applications of transparent conducting oxides. The book is written in a clear and lucid fashion by four well-known experts in the field, producing an excellent volume for those new to the subject and those looking for a complete coverage of the topic.

The primary highlight of the book is that the experience of the authors allows them to sift through a great deal of literature and synthesize it down to its key elements. There is an excellent feature in the chapter on growth techniques that compares to relative merits of different deposition methods for producing the various oxides. This is of great help to those entering the field, who might be trying to decide the best approach for their particular application. The chapters have an abundance of figures and tables that allow readers to quickly understand the main points, and the reference list for each chapter is comprehensive.

I found the book well-suited as an excellent overview for those already in the field, or to graduate-level researchers just beginning. The list price makes it available to the individual researcher. My only criticism was that the dark and somewhat murky cover was probably not what one would expect from a book on transparent thin films.

In summary, I found this to be a very well-written monograph on a topic that to my knowledge hasn't been covered in this depth previously, and thus it serves a very useful purpose. The authors have produced a seamless, coherent coverage of transparent conducting oxides, and it should find a welcome niche in the professional community. I recommend it to anybody already in the field of thin film transparent semiconductors or those thinking about entering it.

Reviewer: *S.J. Pearton is a professor at the University of Florida and is a member of the Editorial Board of* MRS Bulletin.

Encyclopedia of Applied Physics, *Vols. 1–19*

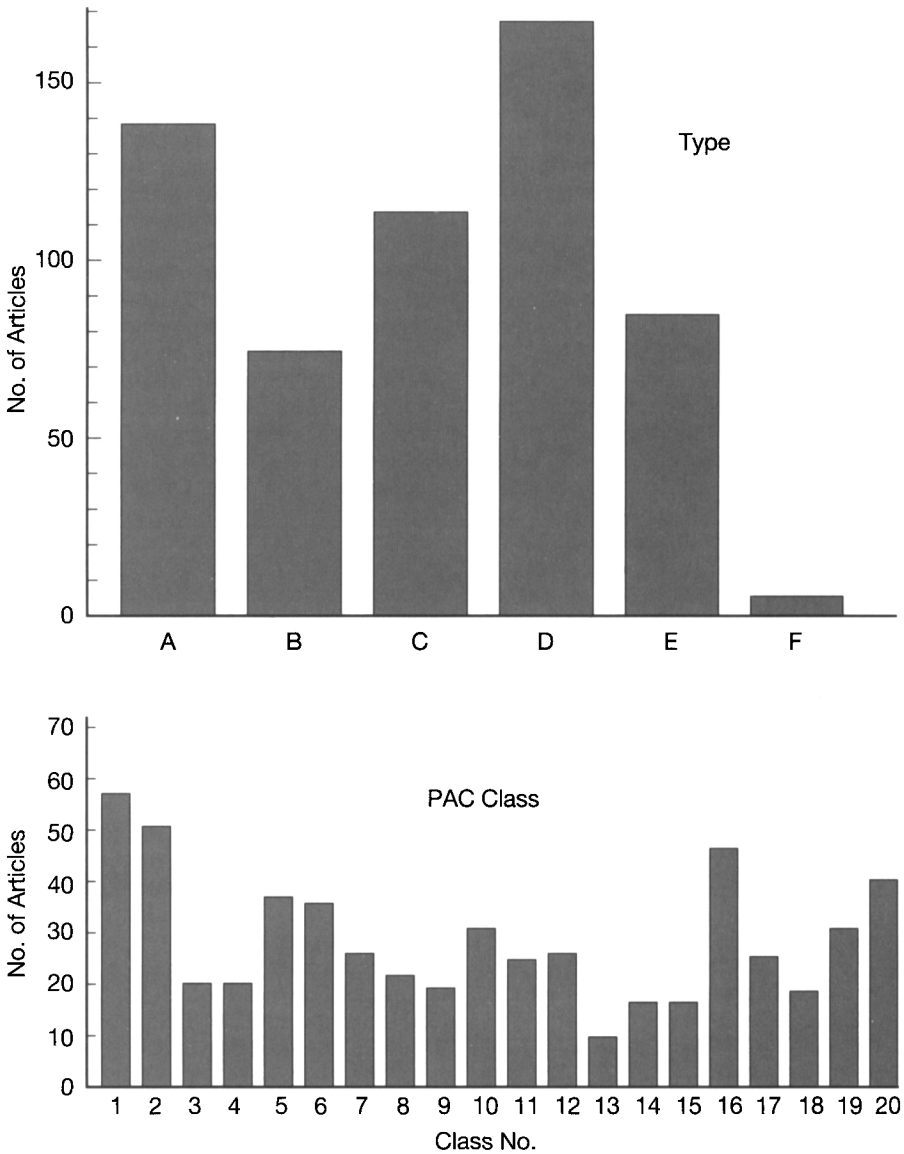
George L. Trigg, Editor
(Wiley-VCH, a division of John Wiley & Sons, 1991–1997)
14,100 pages, $5,950
ISBN 3-527-26841-3

The *Encyclopedia of Applied Physics* (EAP) was conceived to provide a source of information on applications of physics, more detailed than what could be found in a general encyclopedia, but less detailed and extensive than would be available in a textbook or monograph devoted to a particular subtopic. It is sponsored by the American Institute of Physics, Deutsche Physikalische Gesellschaft, Japan Society of Applied Physics, and the Physical Society of Japan. The scope includes not only physics proper, but also astronomy and the overlaps of physics with such fields as chemistry, geology, biology, and medicine. Lewis Branscomb, who wrote

the foreword to the work, asserts that a more accurate, though little used, descriptive term would be "applicable physics," meaning not only discussion of the present successful applications arising from our understanding of the underlying physics but also of the research tools (both physical and computational) and the knowledge with which new phenomena can be explored, understood, and perhaps ultimately applied. Thus he said such an encyclopedia as this is a window on the engineering of the future.

The editor, George Trigg, is retired from Brookhaven National Laboratory and is the former editor of *Physical Review Letters*. He was assisted in the project by Eduardo S. Vera of the Science and Technology Information Center, University of Chile, and Walter Greulich of Ruhr University, Germany. They in turn received advice from a 27-member international advisory board and a 50-member group of editorial consultants. In both cases the groups were well-diversified with about half from the United States and half from other countries, along with half with industrial affiliations and half with university or national laboratory affiliations. A similar distribution of affiliations is found for the contributors but with a moderate predominance of U.S. university types.

The Encyclopedia was produced over a period of eight years. Nineteen volumes have appeared thus far with four more plus an index volume scheduled to be published later this year or early 1998. This review is based on the 19 available volumes. Each volume comprises about 25 articles; each article is typically 20–25 pages although a few are extreme deviations from this norm (e.g., "Semantic Views of Theories," a philosophical piece of six pages and "Scientific Computing by Numerical Methods" of 79 pages). The articles span the technical spectrum from the most fundamental science (e.g., "Electron States: Localized") to the most applied engineering (e.g., "Packaging Technology"). Each article is classified according to a two-faceted scheme by (1) general type: A. Devices, Equipment; B. Materials*; C. Methods, Processes; D. Phenomena, Effects; E. Scientific or Technological Fields; and F. Institutions, Companies, Societies, and other Organizations; and according to the AIP Physics and Astronomy Classification Scheme (PACS):



01 General Aspects: Mathematical, Computational, and Information Techniques
02 Measurement Science, General Devices and/or Methods
03 Nuclear and Elementary Particle Physics
04 Atomic and Molecular Physics
05 Electricity and Magnetism
06 Optics (classical and quantum)
07 Acoustics
08 Thermodynamics and Properties of Gases
09 Fluids and Plasma Physics
10 Condensed Matter A: Structure and Mechanical Properties
11 Condensed Matter B: Thermal, Acoustic, and Quantum Properties
12 Condensed Matter C: Electronic Properties
13 Condensed Matter D: Magnetic Properties
14 Condensed Matter E: Dielectrical and Optical Properties
15 Condensed Matter F: Surfaces and Interfaces
16 Materials Science
17 Physical Chemistry
18 Energy Research and Environmental Physics
19 Biophysics and Medical Physics
20 Geophysics, Meteorology, Space Physics, and Aeronautics

The distribution of articles over these six types and 20 classes as shown in the Figure is seen to be well-diversified. While the editors have categorized only about 15% of the articles in the materials group (B), this reviewer judges that another 15%, categorized elsewhere, are directly related

*A curious anomaly is that articles dealing with coal, natural gas, oil shale and tar sands, petroleum, the interior structure of the earth, the magnetospheres of the earth and planets, muonium and positronium, nucleic acid, proteins, enzymes, ultrasonic biophysics, and nuclear weapons are all classified as materials.

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to materials (e.g., "Magnetostrictive Materials and Devices" in Type A, "Characterization and Analysis of Materials" in C, "Electronic Structure of Surfaces" in D, and "Physical Metallurgy" in E. In addition many other articles, while not materials-related or categorized, will still be useful to *MRS Bulletin* readers. Examples of these include "Algebraic Methods," "Biomedical Engineering," "Catalysis," "Computer-Aided Design in Electronics," "Fractal Geometry," and "Environmental Health and Safety." In sum, at least half of all the articles in the Encyclopedia should be of interest and useful to *MRS Bulletin* readers. Many fields where the Materials Research Society has strong past and present activity, (e.g., electronic materials and processes, ceramics and composites, solid-state physics, semiconductors, and structure and properties of metals and alloys) are especially well-represented in EAP (more than 10 articles each). On the other hand, some omissions are significant. Lead, zinc, and chromium, the fourth, fifth, and sixth most important metals, receive no detailed treatment; yet, the precious and refractory metals do. Some curious redundancies also occur: Separate articles appear on carbon as well as on coal, diamond, and graphite; articles on mechanical properties of crystalline solids and mechanical properties of solids cover much of the same ground.

The EAP may be usefully compared with two other encyclopedic works: *Materials Science and Technology: A Comprehensive Treatment*, edited by R.W. Cahn, P. Haasen, and E.J. Kramer (1990–1997) and the *Encyclopedia of Materials Science and Engineering*, edited by M.B. Bever (1986). The materials coverage in these two works is understandably more comprehensive and frequently in greater depth than the EAP for two reasons. First, the space, 12,000 pages for the treatise by Cahn et al. and 5,500 pages in Bever's encyclopedia versus at best 4,200 pages (14,100 × 30%) for the EAP. Second, the articles in the EAP are largely written by and for physicists; familiar names from the materials science and engineering community rarely appear in the contributor list. This is not to say, however, that the articles in EAP are not useful and understandable by metallurgists, ceramists, polymer engineers, and materials scientists. To illustrate the relative coverage more explicitly, a simple test was run. Search was made in all three works for a dozen, arbitrarily chosen, common materials topics: extrusion, powder metallurgy, joining, corrosion, plastic deformation, polymerization, insulation, creep/stress-rupture, adhesion, electron microscopy, fracture toughness determination, and computer simulation of materials behavior. Of these dozen topics, only five (corrosion, plastic deformation, polymerization, insulation, and electron microscopy) received detailed treatment in the EAP, whereas almost all were covered extensively in the other two works; the only exceptions were corrosion, insulation, and computer simulation in Cahn et al.

Individual articles define the field of the topic under discussion, explain concepts and developments, and outline the engineering aspects. They are illustrated with copious schematic drawings and graphs, black-and-white half-tones, and even the occasional color plate. Other useful features, common to virtually every article, are an introductory outline, a listing of works cited, a glossary of key words and phrases, and recommendations for further reading. The latter two features are very valuable and seldom encountered in other technical encyclopediae.

The articles themselves are arranged alphabetically with frequent inversions of word sequences in titles so as to bring related articles close together in the same volume, thus in volume 14, for example, we have "Polymer Dynamics"; "Polymers, Electrical and Electronic Properties"; and "Polymers, Mechanical Properties of." Yet this approach is not always followed faithfully: "Synthesis, Characterization, and Properties of Model Polymers" and "Technology of Polymer Processing" appear in another volume (20). The editors have inserted cross-referencing chapter titles in proper alphabetic sequence between articles to guide the reader to these separated but closely related articles. Unfortunately these cross-references are sometimes incomplete or inaccurate, (e.g., "Acoustical Measurement, see Measurement, Acoustical" does not appear in the A's; nor do "Computer Interfacing, see Bus Systems and Computer Interfacing"; "Computer Software, see Software Engineering"; "Computing, Optical, see Optical Computing"; and "Computing, Scientific, by Numerical Methods, see Scientific Computing by Numerical Methods" appear in the C's. In the D volume, "Deformation of Materials, see Materials Deformation" appears, but there is no such article. Perhaps "Solids, Crystalline—Mechanical Properties" (vol. 18) or "Mechanical Properties of Solids" (vol. 9) is meant. In the M volume, "Materials Deformation, see Reversible and Irreversible Deformation of Materials" appears, but there is no such article. There are many other instances of this kind. Many of these cross-referencing and titling problems may likely be attributed to late arrival of contracted articles or to the editor's lack of knowledge early in the project of the true scope and content of articles planned for later volumes. Nonetheless, such lapses are disconcerting.

Another useful feature is the inclusion within many articles of cross-references to other relevant articles in the EAP. Thus the article on "Silicon Dioxide" in volume 18 references articles on "Optical Microscopy" (vol. 12), "Quartz" (vol. 15), "Glasses" (vol. 7), "Fiber Optics" (vol. 6), "Electronic Properties of the Si-SiO_2 Interface" (vol. 18), and "Semiconductor Heterostructures and Superlattices" (vol. 7). Unfortunately, authors and editors do not consistently follow this practice. Many articles missed the opportunity to include cross-references. For example, the article on "Solid, Liquid and Gaseous Electrical Insulation" (vol. 18) might well have referenced those on the "Structure of Insulators" (vol. 8), "Conductivity in Insulators and Semiconductors" (vol. 8), "Electrical Properties of Thin Films" (vol. 21), and "Dielectric Properties of Insulators" (vol. 5). These articles and other related information can be located, however, through use of the general index. Each volume contains a listing of recommended units and symbols (not all authors adopted these), but no index to either subjects or authors. All volumes from 12 on include tables of contents of every earlier volume.

We have discussed the scope, format, authorship, and organization of the EAP; let us now turn to an appraisal of the individual articles. As in every multi-authored work, there are significant differences in writing style and in the approach each author takes to the assigned topic. Some authors provide an historical introduction before proceeding to a tutorial review; others begin with a mathematical analysis and assume much of the underlying physics is already understood; some go to some length to show the connection of the subject to engineering applications whereas others only allude to that aspect or leave it to inference. In general the bulk of the articles do precisely what the editors intended: present a tutorial review explaining the physics relevant to current or potential applications of the subject. The articles are understandable, and amazingly few errors, technical or typographical, were encountered.

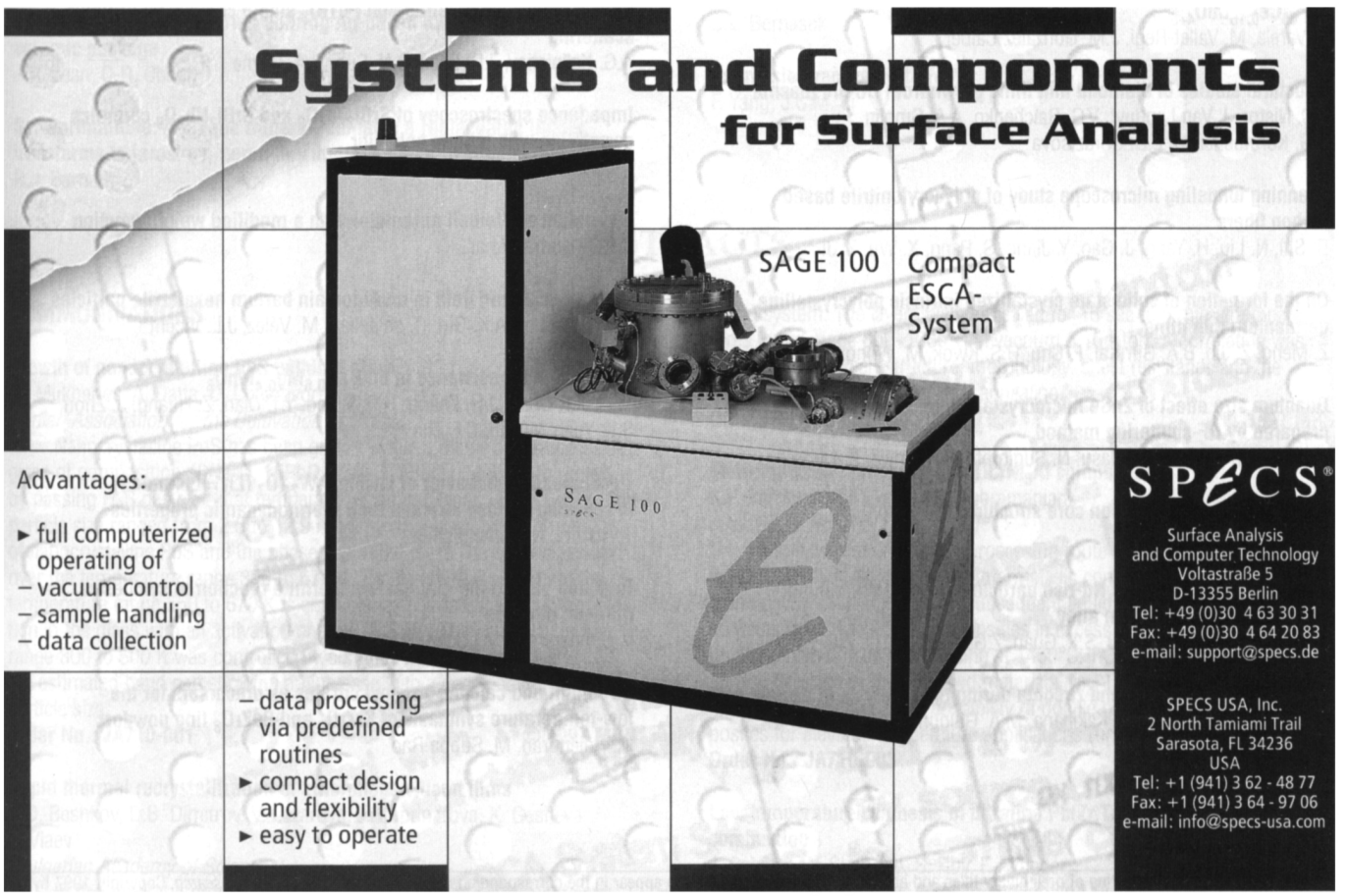
As in all major projects of this kind, currency is a problem. The EAP was published over a period of eight years and the gestation period of individual articles from the end of library research to appearance in print is another 1–2 years. Thus the most recent literature citations from articles in volume 1 are now almost 10 years

old, far too old for adequate treatment of fast-moving fields such as semiconductor technology, artificial intelligence, or biophysics. To cope with this problem, the editor plans two supplementary volumes to appear in 1998 and 1999 which will provide updates where critically needed and articles on some completely new topics (e.g., digital photography). Provisional, paper-backed subject indices have been provided at intervals during the publication schedule of the EAP; the latest covers volumes 1–15. The next such will accompany the soon-to-appear volume 20. A hard-bound complete index to the work is scheduled for June 1998. It is to be hoped that in addition to a subject index, indices to contributors and cited authors will also be included. A compilation of acronyms and their definitions would also be a welcomed feature.

The completed EAP will sell for many thousands of dollars and thus in reality will be accessible only through libraries. Individuals may purchase single volumes at $250; this option is attractive because, as a result of the previously described practice of rearranging title words, articles on related topics will mostly appear adjacent to one another. The $250 cost translates to about 40¢ per page or $10 per article, quite reasonable values in today's market.

In sum, despite the criticisms noted above, the EAP constitutes a tremendous mine of information on a broad range of some of the most exciting science of our day. It is a reliable resource both for a quick answer to a narrow technical question and for self-education in a broader topical area. *MRS Bulletin* readers will do well to consult it for both purposes.

Reviewer: *Jack H. Westbrook is president and principal consultant with Brookline Technologies, Ballston Spa, New York, a consulting firm dealing with the selection and application of materials and the design of materials information systems. His former research interests centered largely on intermetallic compounds, and he has edited several books on this subject.*



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