Principles and Applications of Tribology

Bharat Bhushan
(John Wiley & Sons, New York, 1999)
xix + 1020 pages, $150.00
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At over 1000 pages, this book, intended as a "text for one- or two-semester graduate courses in tribology as well as for a senior level undergraduate course of mechanical engineering, materials science or applied physics," is a substantial work which will occupy much of a student's rucksack. It is very broad-ranging, covering the subject of tribology from its early history through surface topography and contact, friction, lubrication, and wear to a survey of bulk materials and surface treatments. It also includes a concise introduction to the structure and properties of solids. As would be expected from the author's recent research activities, it contains comprehensive coverage of the new science of nanotribology which aims to understand the fundamentals of the interaction of solid surfaces in relative motion by studying the behavior of isolated contacts at a very small scale through techniques such as atomic force microscopy and molecular dynamics simulation. As a compendium of recent research in certain areas it works well, but as a textbook for those with little previous knowledge who wish to learn more about tribology it is less successful, largely because it is so densely packed with information and is rather unselective in its presentation.

There are at least two ways to write a textbook. One is to build on a long experience in teaching the subject, and develop the reader's understanding through a thoughtful and well-balanced synthesis of primary material and reviews. Each sentence is carefully weighed and each illustration selected from among the many thousands published for the insight it brings to the topic. This method is hard work, but there is an easier way. Collect several textbooks written by others, choose a sentence here and a sentence there, an illustration here and another from there, link them together with some hasty text and leaven with a copious sprinkling of references to add a veneer of respectability. Perhaps this is regarded as acceptable nowadays when undergraduate essays can be downloaded from the Internet and recycled as the student's own, but it is not scholarship. Regrettably, in some places this book exhibits aspects of the second model. Although this reviewer should perhaps feel flattered that even his own prose and artwork are thought worthy of reproduction here without attribution, he finds it hard to accept, especially in a book which also contains the statement: "the so-called Beilby layer in metals and alloys is produced by melting and surface flow during machining of molecular layers that are subsequently hardened by quenching as they are deposited on the cool underlying material." He certainly did not write that.

Reviewer: *Ian M. Hutchings is Reader in Tribology in the University of Cambridge, UK, and Editor-in-Chief of the journal* Wear. *His major research interests are in the tribological behavior of all classes of materials.*

Properties, Processing and Application of Indium Phosphide

Electronic Materials Information Series (EMIS), Series No. 21
T.P. Pearsall, Editor
(Inspec: The Institution of Electrical Engineers, London, 2000)
xiii + 279 pages, $175
ISBN 0-85296-949X

This book is another excellent addition to a leading series of data reviews produced by the IEE under the Inspec/EMIS title. As such, it is a general work of reference, as useful to the new student as the full-time researcher on InP-based materials and devices.

From the introductory chapter on the applications of the materials, through chapters on mechanical, electronic and optical properties, to the final chapter on processing technologies, it contains much valuable information.

For the nonspecialist, the introductory chapter on device applications is particularly well constructed, with logical development and clear diagrams. Even more importantly, the treatment of the subject is discussed in terms of particular applications, identifies the state of the art, compares InP with other materials, particularly silicon and GaAs, and identifies important materials parameters which determine advantages and limitations in device performance. One slight criticism is the absence of any comparison with emerging InSb and Si-Ge technologies in the chapters on high speed devices. Even so, the coverage of device applications is comprehensive, ranging from impact avalanche transit time (IMPATT) diodes and transferred electron devices (TEDs) through laser and optical amplifiers to good reviews of heterojunction bipolar transistors (HBT), high electron mobility transistor (HEMT) technology and space-based solar cells.

One of the characteristics of the EMIS series is the treatment of the mechanical, physical, and optronic data presented. Not only can one expect a thorough literature survey from authors active in that particular specialization but the reader can also expect guidance on the most appropriate data to use for particular applications and an assessment of the relative merits of data from different sources. Clearly this approach is more scientific than extraction of a single parameter from an original paper, or even worse, the use of a value quoted third-hand (and frequently out of context) by subsequent authors. Even so, the spread of values for elastic and piezoelectric constants and even straightforward measurements of lattice parameters indicates the need for more work and refinement in the determination of these parameters. Sadly, while I fully support the author's (S. Adachi) hope that the scarcity of the available data will stimulate further work in the field, the reality is that III-V semiconductor technology is a mature research field, in which funding for further materials research is limited. If the review teaches anything, it is that the determination of fundamental parameters must be done early and well in the lifetime of a material. Scope for extensive revision by a wide variety of techniques and a diversity of research groups later in the life-cycle is unlikely.

The editor and 29 contributing authors have produced a second offering of a highly successful first edition. Of the 49 data reviews, 10 are unashamed reprints from the earlier edition and a further six are revisions of sections in that edition. So then, to the crunch question—is it worth the money? My personal opinion is that it certainly is, though the impact of the demonstrated changes in device applications does not yet appear to be reflected in corresponding changes in the materials data required. Hopefully, the next edition will also contain much-needed data on vapor pressures, particularly over InP-based alloys, on internal strain distributions at interfaces in epitaxial structures, on band-offsets and many more. Reviews of this nature are doubly important; they provide a useful compendium of existing knowledge. If properly used, they also point up the holes and encourage debate.

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