Introduction to applied solid state physics

Article *in* IEEE Transactions on Electron Devices · April 1981

DOI: 10.1109/T-ED.1981.20343 · Source: IEEE Xplore

1 author:

Richart Slusher
Booz Allen Hamilton

Book Reviews

The following reviews were selected from those recently published in various IEEE TRANSACTIONS *and Group/Society Magazines and Newsletters. They are reprinted here to make them conveniently available to the many readers who otherwise might not have ready access to them. Each review is followed by an identification of its original source.*

Introduction to Applied Solid State Physics—R. Dalven (New York: Plenum Press, 1980). *Reviewed by R. E. Slusher, Bell Laboratories, Murray Hill, NJ.*

During the past three decades an impressive array of solid-state devices has evolved. A list of these devices is long and filled with acronyms, e.g., MOSFET, JFET, MESFET, CCD, LASER, SQUID, JAWS, HUFFLE, DMOS, HMOS, etc. Although many physicists and engineers are familiar with a major fraction of these devices, it's hard to remember how they all work. For students it should be fun to become familiar with this ever growing zoo. Richard Dalven's book offers brief descriptions of the basic physics and concepts of many of the presently useful devices. For both students and workers in basic research or development, this book should serve as a readable introduction to the basic physics of devices. It can be read by both undergraduate and graduate students who are familiar with solid-state physics at the level of Kittel's *Introduction to Solid State Physics*.

A familiarity with device physics can be valued on several different levels. Experimentalists and engineers often use these devices routinely in modern apparatus and it is useful to understand the basic concepts involved in their operation, typical failure modes, and relative advantages and limitations. Devices evolve from basic solid-state phenomena; understanding their functioning aids in clearer and deeper insights into these phenomena. New initiatives in basic research or development often arise due to the improved capabilities of devices. New initiatives in research may evolve from interest in phenomena which contribute to or limit device performance. In many laboratories a symbiotic relationship between device fabrication and research is evolving where processes such as small scale lithography, molecular beam epitaxy, interface and surface preparation, and diagnostic techniques are common to device development and basic research. Finally, it is simply great fun to see how many of these clever and extremely useful devices function.

The general approach to describing the application of solid-state physics to devices in this book is a simple, slow, and careful qualitative description followed occasionally by some introductory quantitative descriptions or references to further reading. A few of the descriptions seem a bit long and redundant; overall, however, they are clear and readable. There are summaries at the end of each group of devices which I did not find very helpful. The references suggested reading, and problems (projects), in each chapter are well chosen and helpful although they are far from complete.

There are a broad range of devices covered in this book including semiconductor pn junctions, bipolar transistors, tunnel diodes, JFET's, Schottky diodes, IGFET's, CCD's, negative electron affinity photodetectors, Gunn oscillators, photodetectors, solid state lasers, Josephson devices, and nonlinear optical devices. Each is treated very briefly using simple (sometimes too simple) models (e.g., energy band models for semiconductors). Introductory chapters and sections on the p-n junction, metal-semiconductor junctions, metal-insulator-semiconductor junctions, and surface states are helpful, but again they are described in terms of simple models. Some of the sections seem too brief to be of much value. For example, the section on lasers is quite simplistic and brief; it should be strongly coupled to supplementary material.

Although the author's choice of topics is broad and interesting, some areas are not covered, e.g., solar-energy conversion cells and noise in devices, which are also important, involve interesting physics, and are presently active fields. It might be better for a course to include some of these topics and omit sections in the book which are too thinly covered or out of context. An example of the latter is the section on high-temperature superconductors at the end of the chapter on superconducting devices.

Several important aspects of applied physics are omitted in this book which I think are important to include in a course. First, very little is said about how devices and materials are actually fabricated and prepared. This is often important for understanding how the device functions (or fails to function) and is interesting in its own right. Second, most of the devices described are still evolving and are limited in various aspects by interesting physical phenomena or lack of understanding and experimental data. This "edge of the art" aspect is not well communicated in this book and is important in a course or for general reading. Finally, it is important to point out that the utility of a device is often based on some specific aspect of its performance. For example, for semiconductor or Josephson switches, the switching-power-delay product is of great interest for VLSI applications. The author chose not to include these aspects, probably due to space limitations, unity of style, and rapid change in many fields; however, I think it is important to include them in a course.

This book is a handy compilation of careful but brief descriptions of the basic physics of a broad range of semiconductor, superconductor, and optical devices. It is appropriate and potential great fun for senior year undergraduates, graduate students, physicists, engineers, and people in related fields. It is much less detailed, and thus easier and more pleasant to read, than texts such as Sze's, *Physics of Semiconductor Devices*. It should be supplemented in a course context by additional material to bring students closer to the reality of fabrication techniques, limitations of models, device performance, device failure, and the current state of the many rapidly evolving fields that are discussed.

Reprinted from *IEEE Transactions on Electron Devices*, March 1981.

Computer Image Processing and Recognition—Ernest L. Hall (New York: Academic, 1979, 584 pp.). *Reviewed by R. W. Ehrich, Department of Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.*

After working on narrow research topics for a period of time one tends to forget about the scope and depth of one's general research area. For those of us involved in digital picture processing, there is a new book available that really drives home that point. Its title is *Computer Image Processing and Recognition*, written by E. L. Hall of the University of Tennessee.

The author's intent is to provide a coverage of five area of picture processing–enhancement, communications, reconstruction, segmentation, and recognition. This is not a text on scene analysis, but those looking for a solid text on the foundations of the field will be well rewarded. The author believes the text suited to a one-year course in picture processing and pattern recognition for seniors and graduate students in electrical engineering, computer science, or one of the related disciplines. An instructor using the text for an audience of students without background in system theory or Fourier analysis may have to do some fancy footwork in a few places, but then, some topics such as sampling theory just cannot be explained clearly without that perspective. The techniques discussed in the book are well illustrated by examples which give the reader a good means of assessing their effectiveness. Another characteristic of the book is that the chapters are only minimally interdependent, and this gives an instructor using the text a great deal of freedom to select the topics he wishes to include in his course.

The book begins quite appropriately with some radiometry, photometry, and a discussion of image formation. This chapter is a little bit surprising in its heavy orientation toward human perception and nonlinear models of the visual system. This is probably the only section that seems peripheral to the principal subject of the book.

The next two chapters are rather classical in their presentations of 3-D imaging, sampling theory, transformations, enhancement, and restoration. Here the book reveals its system theoretic orientation; mention image representation to a scene analysis person and he will expect piecewise polynomial decompositions or, still more likely, hierarchical data structures. This, of course, is not the intent or orientation of the book.