Book Reviews

Introduction to Applied Solid State Physics—R. Dalven (Plenum Press: New York and London, 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, JFETs, Schottky diodes, IGFETs, CCDs, 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.

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