

equilibrium transport of charge carriers. To each chapter the authors have added some questions and problems on the material covered to provide practice on extending and clarifying the understanding of the material contained in the chapter. An appendix of about 20% of the total content is reserved to laboratory experiments that can be carried out during the course.

The authors of this first volume in a series have succeeded in writing a very complete discussion of the basics of semiconductor physics.

The second volume *Physical Electronics and Circuit Models of Transistors* is a logical continuation of the material contained in the first volume. The authors assume that the reader is familiar with elementary electronic circuits and is able to understand the mechanisms of electrical conduction in semiconductors. The latter can be assumed of the reader who has gone through volume 1 of this series. This second volume deals with the physical operation and the dc behavior of p-n junctions in chapters 1 through 3. In chapter 4 effects are described that show significant differences to the idealized p-n junction behavior (voltage drops, recombination, leakage across the surface of the junction and internal breakdown). In chapter 5 the dynamic behavior of p-n junction diodes is dealt with. In the next chapter lumped-constant models (due to Linvill-Gibbons) for junction diodes are discussed. The second half of the book (chapter 7 through 10) deals with transistors, starting with the structure and operation of transistors. In chapter 8 small-signal models for transistors are discussed and here even more complicated circuit models including space-charge capacitance are described. In the next chapter the large-signal behavior is dealt with by using the Ebers-Moll model for slow-speed conditions—that is, in the low-frequency region. The tenth chapter then is devoted to transistor models for dynamic switching with the aspect of providing a sufficiently accurate model which, however, is simplified in order to obtain a compromise between completeness and simplicity.

In two appendices p-n junction space-charge layers are more closely looked at and the electric field in the neutral regions of a p-n junction is dis-

cussed. Again we find some problems to each chapter for a better understanding of the material covered in each section. Both volumes show material extremely well presented, covering semiconductor physics in the first and diodes and transistors in the second volume. It is obvious that the authors have not only a profound knowledge of the field but also have gained from the preliminary editions combined with the experience of teaching the subject. It may be hoped that the remaining volumes of this series may hold the standard and level of the first two books. The books can be highly recommended as texts for undergraduate courses, for they show clarity, balance in presenting the matter and compactness in the subject covered.

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Surfaces in depth

SEMICONDUCTOR SURFACES. BY A. Manny, Y. Goldstein, N. B. Grover. 496 pp. Interscience, New York, 1965. \$17.50

by H. J. Hagger

Surface effects in semiconductors play a prominent role in semiconductor research. During the past 15 years a vast number of publications reflect the intensive effort devoted to the study of semiconductor surfaces. The authors attempted to provide organized basic information both for the physicist and the chemist active in the field. The extensive references to the literature cover the period up to the end of 1964.

After some historical notes on surface effects the authors consider the semiconductor bulk, giving a very good introduction into the principles of semiconductor physics (band model, occupation statistics, carrier transport and nonequilibrium phenomena). In chapter 3 the lattice structure and chemical reactivity of the surface is treated. The authors start with discussions on studies of clean surfaces, their preparation and measurement, the structure of real surfaces; the chemical processes are then treated. In chapter 4 the surface space-charge



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region is dealt with. The origin of space charge at the surface, space-charge density and the shape of the potential barrier are investigated. Excess surface-carriers and deep-trap characteristics for wide-gap semiconductors are under consideration. In chapter 5, localized states and Tamm and Shockley states at the surface are dealt with, together with the interaction of these surface states with a single band and complex models of surface recombination. The next two chapters are devoted to experimental methods, chapter 6 to the field effect at dc, low and high frequencies and under pulsed conditions, and chapter 7 to measurement of surface recombination velocity, to contact potential, photoelectric emission, high-field effects, optical and magnetic measurements and to noise effects. Chapter 8 deals with a review on existing theoretical and experimental work on surface transport phenomena. From a solution of the Boltzmann transport equation the authors calculated the average and surface mobilities as functions of the scattering conditions at the

surface and despite simplifications introduced into the theory they found their results in good agreement with experimental data. In chapter 9 the electronic structure of the surface is discussed and the authors consider also real germanium and silicon surface and clean surfaces. Further they discuss the role of the surface states in chemisorption (oxygen adsorption that reduces the surface-state density drastically when considering a real surface instead of a clean surface).

Even when the authors state in the preface that this book may serve as a text for graduate students with a general background of solid-state physics, the reviewer's opinion would not support that. The book is written for the specialist in the field and he will gain a lot for his work, for he will not only be guided through the surface-state research of the last 10 years, but he will find an excellent and competent review of both theory and practice of semiconductor-surface problems. The book can therefore be highly recommended for research workers in the field.

Some crystal constants

LANDOLT-BÖRNSTEIN, NUMERICAL DATA AND FUNCTIONAL RELATIONSHIPS IN SCIENCE AND TECHNOLOGY. New Series, Group 3, Volume 1: Elastic, Piezoelectric, Piezoöptic and Electroöptic Constants of Crystals. By R. Bechmann, R. F. S. Hearmon. 160 pp. Springer-Verlag, Berlin, 1966. DM 68

by *Herbert Malamud*

This is another in the justly renowned series of Landolt-Börnstein's collections of numerical and physical data. Group III of the New Series covers crystal and solid-state physics. The present volume, the first, is to be followed by a volume on structural data of crystals and a third on magnetic and other properties of oxide systems.

Volume 1 opens with a 39-page chapter by R.F.S. Hearmon, on the elastic constants of nonpiezoelectric crystals. After an explanatory section, the material covered is organized into sections containing elastic constants, temperature coefficients, pressure coefficients, variation with temperature (which gives the variations of the con-

stants over a wide temperature range, generally from 0°K to the melting point, in graphical form), and references. Materials discussed include cubic materials, (elements, alloys, binary compounds, alums and miscellaneous cubic materials), hexagonal, trigonal, tetragonal, orthorhombic and monoclinic materials.

Chapter 2, by R. Bechmann, is on the elastic, piezoelectric, and dielectric constants of piezoelectric crystals. After an introduction, the elastic constants are given, including elastic compliances and elastic stiffnesses, with their temperature coefficients, and pressure coefficients of the stiffnesses. Electromechanical-coupling factors are given for the few substances for which they are known. Piezoelectric stress and strain constants with their temperature coefficients are given, and dielectric permittivities with accompanying temperature coefficients.

Chapter 3, also by Bechmann, covers piezoöptic and electroöptic constants of crystals. After the now