the credit of the editor. It is unlikely that this book would make a suitable graduate text, but it does provide the interested reader with an excellent review of the current status of a rapidly growing and dynamic field of phase transitions.

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**Computing in crystallography.** Edited by R. DIAMOND, S. RAMASESHAN and K. VENKATESAN. Pp. 450. Bangalore: Indian Academy of Sciences, 1980. Price US $17.00, Rs 125/-; price for individuals US $8.00, Rs 50/-.

*Computing in Crystallography* contains the text of 29 lectures which were delivered at a Winter School on Crystallographic Computing which was organized in January 1980 in Bangalore, India. The crystallographic techniques described in this volume range from data collection and processing to the refinement and display of completed structures.

The level of prior knowledge expected of the reader by each lecturer varies widely. Many chapters will not be understood unless the reader has a proper grasp of matrix notation. The beginner may be slightly bewildered by the lack of uniformity in the mathematical notation employed. At least three ways of denoting a matrix transpose are used, two of them being employed in one chapter. Many chapters are followed by exercises, sometimes with answers, which often add valuable material to the book.

The first four chapters of the book cover the topics of diffractometry, absorption and extinction corrections and microdensitometry of film data with a good balance between theory and practice. The next five chapters are concerned with the solution of the phase problem. An excellent chapter by Nordman describes automated vector search methods for solving Patterson functions including useful practical advice and illustrations of possible pitfalls. Multisolution methods of solving the phase problem are described in chapters by Main and Woolfson which provide good background reading for users of the packages *MULTAN*, *MAGIC* and *YZARC*.

Three chapters deal with the theory of errors and least squares. The introductory chapter on least squares in crystallography is one of the few disappointing chapters in the book. Poor explanation and typographical errors mean that the chapter is of limited value. Fortunately, Hendrickson & Konnert give a well presented and comprehensive account of restrained least squares, which is now an important technique in the refinement of macromolecules. A chapter on error analysis by Huml discusses the statistical theory of propagation of error and collects together much current wisdom concerning weighting schemes and analysis of weights from least-squares refinement. A chapter by Johnson gives a general survey of thermal motion analysis and two chapters describe charge density studies and the high-precision crystal structure analysis which is required to make them possible.

Four chapters of special interest to protein crystallographers describe heavy-atom refinement, phase determination by multiple isomorphous replacement, and structure factor least squares with fast Fourier algorithms and automated map interpretation.

The last part of the book deals principally with computing. A chapter by Hall & Stewart describes the principles of design of the *XTAL* system and the use of the *RATMAC* preprocessor. Two chapters on mini- and microcomputers are interesting but clearly the information will rapidly become dated. Excellent chapters by Johnson and Diamond describe computer graphics, including methods of molecular displaying and interactive graphics.

In summary this book contains a wealth of information for practising crystallographers and excellent surveys for those wishing to keep up to date with recent developments in crystal structure analysis.

The Indian Academy of Sciences is to be congratulated in producing this volume cheaply enough for every crystallographer to have his own copy.

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**Amorphous semiconductors. (Topics in Applied Physics,** Vol 36.) Edited by M. H. BRODSKY. Pp. xvi + 337. Berlin: Springer, 1979. Price US $49.50.

This book presents a clear review of the understanding of electronic phenomena in amorphous semiconductors, with the emphasis on those phenomena principally dependent upon energy levels in and near the semiconductor bandgap. Readers can understand those concepts which are novel to the *amorphous* state of semiconductor materials as well as those which are easily described by analogy with the well-established base of knowledge of *crystalline* semiconductors, as the editor has commented in the preface.

The introductory chapters (1–3) present the principal definitions, outline current and future trends, and describe the physical band theory of bandgap and defects in amorphous semiconductors. There are various theoretical approaches relating energy states to the spatial structure of amorphous systems. States in the gap and defects are discussed in three distinct groups: the tetrahedrally coordinated silicon-like materials, the chalcogenide glasses, and the amorphous arsenics.

Optical absorption, electronic transport, luminescence, spin effects, short-range order, doping and solar cells are described in turn (chapters 4–10). Optical absorption from defects in the gap, band tails, and interband transitions are interpreted with experimental observations. Band models are used to classify electrical conduction in amorphous semiconductors. The concept of hard and soft centres, as the origin of the electron spin resonance signals in pure and hydrogenated amorphous silicon, is discussed. Probes of short-

range order are exemplified by EXAFS or IR and Raman vibrational spectroscopy. The preparation of semiconducting materials, and doping by glow discharge, sputtering and ion implantation are reviewed; also, electronic transport properties of the doped materials are considered. Finally, reference is made to the properties of doped and undoped amorphous silicon containing hydrogen bonds, as rendering such materials attractive for use in solar cells.

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**Ferroelectric semiconductors.** By V. M. FRIDKIN. (Translated from Russian.) Pp. xiii + 318. New York: Consultants Bureau, 1980. Price US $69.50.

In eight very condensed chapters, V. M. Fridkin presents an extensive and detailed picture of phenomena and theories related to ferroelectric semiconductors. As pointed out in the preface of the book, the special modification of semiconductor properties by some ferroelectric characteristics make these materials not very favorable objects for the study of elementary processes in semiconductors. However, when the effect of electrons on the fundamental thermodynamic functions and the conduct of these electrons near the Curie temperature were investigated, a series of new phenomena was discovered. They originate in the high concentration of carriers in ferroelectric semiconductors, on the ground of which the contribution of the electron subsystem free energy to the lattice free energy becomes noticeable at the Curie point. The effect of photoactive illumination produced by nonequilibrium carriers on Curie temperature and spontaneous polarization leads to phenomena which have already found practical applications in holography and optical memory systems. In addition, Fridkin stresses the point that photoelectric phenomena in ferroelectrics will play an important role in the further development of electrooptics and nonlinear optics.

It should be added here that the original Russian text was published by Nauka Press in 1974 and that, except for minor corrections and comments, no changes appear in the English edition.

As to the basic idea behind the book, Fridkin emphasizes that he intended to give a description, as complete and systematic as possible, of phenomena and interpretation of electric processes in ferroelectrics, but not a description of the typical ferroelectric semiconductor materials.

In the first three chapters, a very detailed mathematical treatment (more than 300 equations) of the thermodynamic and microscopic theory of ferroelectric semiconductors is given, including, among other topics, phase transitions, the ferroelectric mode of vibration, screening of spontaneous polarization, forbidden band width, photoferroelectric phenomena.

The fourth chapter discusses the temperature dependence of the width of the forbidden band ($Eg$) near first- and second-order phase transitions for a very large number of ferroelectrics, from Rochelle salt to trihydrogen and trideuterium selenides and to singular ferroelectrics like $Gd_2(MoO_4)_3$ and trimetal boracites, *e.g.* $Fe_3B_7O_{13}Cl$. It then gives, and discusses, experimental data about the intrinsic optical absorption edge of ferroelectrics with $Eg \geq 3$ eV (single crystal $BaTiO_3$ as an example) and high-resistance semiconductors with $Eg \simeq 2$ eV ($A^{V}B^{VI}C^{VII}$ and $A^{V}_{2}B^{VII}_{3}$ crystals as representatives). After analyzing the shift of the absorption edge at the Curie point produced by an electric field, the chapter closes with reports from several investigators about calculation of the band structure of perovskite, $A^{V}B^{VI}C^{VII}$ and $A^{V}_{2}B^{VII}_{3}$ ferroelectric compounds.

Photoferroelectric phenomena (starting with the thermodynamics of these phenomena) and photostimulated phase transitions are the content of the fifth chapter. Also given is the thermodynamic treatment of photostimulated phase transition in nonferroelectric materials. Examples of those phenomena include – among others – photosensitive phase transitions in ferromagnetic semiconductors and photocrystallization of selenium and hydrocarbons. Photocondensation of the vapors of water (Tyndall) and other liquids, which had previously been explained as photochemical reactions, are now known to be caused by the increase of the energy of the intermolecular interaction with electron excitation of the molecules.

Introducing chapter 6, entitled *Screening phenomena*, Fridkin stresses the fact that the screening of the spontaneous polarization by equilibrium and nonequilibrium carriers determines the basic ferroelectric and semiconductor properties and that a number of photoferroelectric phenomena are produced by the screening action of the latter. Various methods for the observation of screening effects are described and a number of examples are recorded and shown by microphotographs.

The report about screening phenomena is continued in the following chapter where the formation of photoelectrics is theoretically and empirically discussed. A number of graphs illustrate the dependence of photoelectric and pyroelectric charge density of $BaTiO_3$, SbSI and $SbSI_{0.35}Br_{0.65}$ on several independent variables. The inverse effect on the polarization of some of these compounds produced by the internal field of the photoelectric is evidenced by various graphs. Finally, the effect of radiation on ferroelectric polarization reversal is distinctively proved by several series of hysteresis-loop photographs.

The book closes with a chapter about *Ferroelectrics as nonlinear semiconductors*. Here, Fridkin points out that much of the work which has been done on relevant problems is quoted in the detailed monograph of E. V. Bursian: *Nonlinear crystals. Barium titanate*, Nauka (1974). Therefore, Fridkin discusses in the chapter only some relatively new phenomena to the investigation of which he and his co-workers have made a definite contribution.

There is no doubt about the great value of this book written by a distinguished expert. Profound theoretical knowledge and extensive familiarity with current problems, solved and unsolved, are combined in the book and make it a very useful source of information in its special field.

The very condensed presentation of the content was probably necessary in order to accommodate the great amount of detailed information. However, it makes the study difficult in some sections especially when new magnitudes or equations are introduced or results quoted without sufficient