

be digested by anyone not already familiar with such areas. One feels that these sections are included only for the sake of completeness.

These, however, are but opening preliminaries; the stage is set, and even the modestly informed will approvingly note that the requisite cast of characters is in place. Chapter 2 (95 pp.) moves quickly into internal friction: a formal discussion of anelasticity and relaxation effects, and the experimental means for the observation of these phenomena. Following are three Chapters which form the heart of the book: 'Relaxation of point defects' (99 pp.) 'Dislocation damping effects', with especial emphasis upon the 'vibrating string' model (208 pp.) and 'Two-dimensional defects' (28 pp.). Each of these three chapters contains an extensive review of experimental results.

The typography of the book is clean and appealing. The subject matter is well organized and more than 600 references are included in the bibliography. These appear to be complete through 1969. Well prepared subject and author indices are included which enhance the usefulness of the book. The decision to limit the scope of the book, combined with the balance maintained between theory, technique and a review of available data, have provided both a timely review for the expert and a concise and valuable introduction for those who might wish to become familiar with this area.

BERNHARDT J. WUENSCH

*Department of Metallurgy and Materials Science  
Massachusetts Institute of Technology  
Cambridge  
Massachusetts  
U.S.A.*

**Symmetry and its applications in science.** By A. D.

BOARDMAN, D. E. O'CONNOR and P. A. YOUNG. Pp. xiii + 305. Figs. 49, Tables 38. New York: McGraw-Hill, 1973. Price £4.75.

The first two chapters of this book are devoted to basic group theory and to group representation both in abstract notation and in matrix form. The assumed background is minimal and for readers requiring such assistance there is a lengthy appendix dealing with matrix theory. The material is supplemented in these chapters and throughout the remainder of the book with many helpful figures although the pictures illustrating the point groups  $C_{2v}$ ,  $C_{2h}$  and  $S_2$  in Fig. 1-4 require a vivid imagination on the part of the reader.

Chapters three and four are devoted to the application of group theory to quantum mechanics and crystal symmetry respectively. The treatment is rather abstract and general but perhaps this is inevitable in a book which covers so much ground and attempts to put over a general principle rather than to teach explicit areas of science. The reader really needs a fairly sound prior knowledge of these subjects in order fully to appreciate the elegance of the group-theoretical approach. If the first introduction to these topics was *via* this book then no great feel for them should be expected.

Chapter five deals with symmetry as applied to tensor quantities with particular reference to conductivity, electrical and thermal, and to the piezoelectric effect.

The final chapters are devoted to energy bands in solids,

molecular vibrations and normal modes, molecular orbitals and, finally, the symmetry of atoms. In the final three chapters there is a greater sense of being in contact with real applications to physical problems of interest.

Taken all-in-all this is quite a good book. However, it is the opinion of the reviewer that the authors' stated intention, that it might act as an undergraduate text for those reading physics, chemistry and electrical engineering, is unlikely to be realized. The material is at too advanced a level for any but a few of the very best theoretically-biased undergraduates. On the other hand it provides the basis for an excellent course as part of the postgraduate training of a theoretical physicist or chemist. Many crystallographers should find something of interest in this book. Its value as a textbook is enhanced by the provision of excellent problems at the end of each chapter and a section at the end of the book, some 45 pages, is devoted to detailed solutions of the problems.

It is a sad indication of present day trends to note that a book of this size, with a soft cover and no obviously expensive production features should be the price it is. At this rate books will be luxury items within a few years.

M. M. WOOLFSON

*Department of Physics  
University of York,  
Heslington  
York YO1 5DD  
England*

**Surface and defect properties of solids. Vol. 2.** By J.

M. THOMAS and M. W. ROBERTS - Senior Reporters. Pp. xi + 277, Figs. 36, Tables 33. London: The Chemical Society, 1973. Price £7.50.

This review covers another member of the proliferating series of publications which purport to serve the expert by reporting progress in a specialized area of scientific activity. The range of topics is broad in scope and the coverage is rich in detail. The senior reporters and individual authors have produced an excellent set of 9 specialist reports encompassing Recent Trends in Low Energy Electron Diffraction, Some Developments in Field Ion Microscopy, Electron Spin Resonance Studies of Adsorbed Species, Reactions of Saturated Hydrocarbons with Hydrogen on Metals, Infrared Studies of Species Adsorbed on Oxide Surfaces, Orientational Order and Disorder in Solid Isotopic Methanes, Point Defects in Ionic Crystals, The Role of Structural Defects in the Luminescence of Organic Molecular Crystals and Diffusion in Molecular Solids. The table of contents for each article is detailed and informative.

The authors of each of the articles are acknowledged experts who have provided in several cases not only a summary of recent progress but, in addition, a critical review of the current state of their subjects and a preview of impending developments and possible new directions in their fields. In every case the reports include references to literature published in 1972. The Chemical Society deserves praise for the policy of rapid publication which makes these reports timely as well as authoritative. It is not possible in limited space to mention for each of these reports all of the attractive features which merit comment. However, the coverage of Point Defects in Ionic Crystals by Corish and Jacobs is especially noteworthy for its com-

prehensive coverage of over 400 references and for compilation of extensive tables of thermodynamic and kinetic data related to formation and migration of defects.

At first glance the price seems a bit high for a book of only 268 pages of text, but it should be noted that small print and a terse style have made it possible to succinctly summarize an enormous amount of material. The casual reader may not find this volume to be very useful. However anyone who is genuinely concerned with the topics covered in this book will find it to be a veritable goldmine of information and a good investment.

RICHARD SCHOONMAKER

*Oberlin College*  
*Oberlin*  
*Ohio*  
*U.S.A.*

**Vapour growth & epitaxy (Proceedings of 2nd International Conference on Vapour Growth & Epitaxy – Israel May 1972).** Edited by G. W. CULLEN, E. KALDIS, R. L. PARKER and M. SCHIEBER. Pp. xii + 382. Figs. 316, Tables 72. Amsterdam: North Holland, 1972. Price f 130 00 (about US \$ 47.30).

This collection of nearly fifty papers reprinted from the *Journal of Crystal Growth* constitutes about half of the scientific contributions presented to the Second International Conference on Vapour Growth and Epitaxy held in Jerusalem 1972, and covers both theoretical and many practical aspects of the growth of a wide variety of single crystals and thin films.

The section dealing with crystal growth is largely concerned with studies of compound semiconductors and metal oxides. Substantial attention has been focused on growth by chemical transport; the growth of europium sulphide using high-pressure temperature techniques and the use of plasma for chemical transport of carbon are two apparently fruitful technical innovations described here. The importance of understanding the thermodynamics of the processes involved in chemical transport is borne out by the proportion of papers devoted to the problem. The diversity of crystalline materials and growth methods illustrated in this selection of papers goes some way to satisfying the ever-pressing needs for exotic and increasingly pure single crystals. In the area of thin-film growth the technique of liquid-phase epitaxy appears to be an appropriate and recently dependable method of growing a variety of garnets. The ability to conveniently control the lattice constant by substitution of variable amounts of the rare earth in the melt shows the method to possess enormous potential. Although the method seems to have so far developed by a rather empirical route, efforts which are being made to understand the heat and mass flow processes involved should aid prediction of the most suitable growth conditions.

To get back to fundamentals, the more theoretical aspects of nucleation and growth kinetics are well reviewed in an invited paper by J. P. Hirth showing that a comparison of

some fairly recent experiments with predictions made by capillarity-based nucleation theories regarding the eventual degree of epitaxy lends much support to this type of model. Although perhaps a stage removed from the practical situation of nucleation on solid surfaces, there is Hoare's elegant study of the structural configurations of small clusters of atoms based on total potential energy considerations. The interesting possibility that small atom clusters may in some cases exist in abnormal lattice forms appears to tangle still further our comprehension of the already complicated phenomenon of epitaxy.

All in all, this book contains a diverse and well balanced collection of very relevant papers with a fittingly well produced large number of diagrams and photographs. A worthy addition to the previous volume published in what may be anticipated is a continuing series.

A. P. JANSSEN

*Department of Physics*  
*University of York*  
*Heslington*  
*York YO1 5DD*  
*England*

**Tensors and group theory for the physical properties of crystals.** By W. A. WOOSTER. Pp. x + 344. Figs. 136, Tables 44. Oxford: Clarendon Press, 1973. Price £7.00

When a textbook is written by a teacher of experience and some renown then expectations are high; with this book these expectations are fully realized.

The first part of the book proceeds by easy progression from very simple ideas of symmetry, beautifully illustrated, to the point group and then develops the idea of the second-order tensor. Then there follow a number of chapters devoted to physical properties and their relationship to the symmetry of crystals. Such properties include conductivity, thermal expansion, glide twinning, stress and strain, the piezoelectric effect, the elastic properties of crystals and photoelasticity.

In part II group theory is developed in a relatively painless way and related to space groups. While the average crystallographer is well acquainted with space groups it is usually in a visual form but here the less familiar theoretical background is presented in a way which makes it all seem so easy – and even interesting! Finally there are chapters on: Brillouin zones, the numbers of constants required to define a crystal's physical properties, vibrations of molecules and radicals (excellent illustrations here) and infrared and Raman spectra.

There are numbers of well-formulated problems interspersed with each chapter together with answers in outline form.

M. M. WOOLFSON

*Department of Physics*  
*University of York*  
*Heslington*  
*York YO1 5DD*  
*England*