Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (J. H. Robertson, School of Chemistry, University of Leeds, Leeds LS9 9JT, England) As far as practicable books will be reviewed in a country different from that of publication.

J. Appl. Cryst. (1984). **17**, 123

Crystals: growth, properties and applications. Vol. 7 (148 pp.) and Vol. 8 (226 pp.). Edited by *H. C. Freyhardt*. Berlin, Heidelberg, New York: Springer Verlag, 1982. Price DM 98.00, US $39.20 (Vol. 7) and DM 144.00, US $57.60 (Vol. 8).

It is becoming increasingly difficult for individuals to purchase (because of the cost) and to read (because of the time) the great number of these volumes, variously labelled Series/Topics/Current topics in ..., *etc.*, which are now published in the field of materials science; and the dilemma grows daily. Generally speaking the articles which appear in this volume, and others like it, fall somewhere between the style of a review and a state-of-the-art summary and are directed primarily at solid-state and materials scientists and engineers. The articles often fall short of the masterly up-to-date review, yet limited areas are covered in enough detail to provide for those with special interests and indicate the current state of development. Some of these articles, if suitably shortened, might be better placed in normal journals where they would be more widely read, rather than in these in-house series. In the midst of all this one somehow feels safer in deliberately consulting only the original literature, but perhaps the personal view is not shared by many.

Volume 7, loosely entitled *Analytical methods, high melting metals* contains four rather diverse articles dealing with crystalline materials.

1. *High-resolution electron microscopy of crystals* (Neumann, Pasemann & Heydenreich). This deals with direct-imaging methods capable of yielding structural information at the atomic level. Applications to studies of crystal defects, interfaces and boundaries are also discussed.

2. *In-situ UHV electron microscopy of surfaces* (Yagi, Takayanagi & Honjo). This deals with recent progress in UHV methods which reveal the microtopography of surface structures both in transmission (TEM) and reflection (REM) modes.

3. *EXAFS studies of crystalline materials* (Knapp & Georgopoulos). This chapter focuses attention on EXAFS as a useful and important technique for the study of atomic structure in materials as diverse as ionic and superconductors and dilute alloys.

4. *Single crystals of refractory and rare metals, alloys and compounds* (Savitsky, Burkhanov & Kirillova). This article surveys established methods of growing single crystals, particularly plasma-arc methods, and then deals with analytical techniques for studying the microstructure and other related physicomechanical properties.

On the whole the reviewer was disappointed with the articles in this volume which did not seem to make for a coherent whole, although the up-to-date reference lists were most useful. Individually, there was often a lack of clarity in expression, quite a few misprints and, once, a transposed figure caption; but these are only minor criticisms which are not meant to imply that this volume would not be a useful addition to any physical-science library. The reviewer is happy to recommend it for that purpose.

Volume 8, titled *Silicon, chemical etching*, contains three chapters.

1. *Czochralski-grown silicon* (Zulehner & Huber). This article comprehensively surveys the practical aspects of growing silicon crystals by a method which produces about three quarters of the world's supply. The application of these crystals in solid-state devices is also discussed.

2. *Dendritic web growth of silicon* (Seidensticker). This chapter deals with a ribbon-growth technique for the large-scale production of 'solar cell' silicon.

3. *Principles of chemical etching – the art and science of etching crystals* (Heimann). This chapter deals with both the theory and the practice of etching, a powerful technique used to characterize single crystals in terms of their purity and dislocations.

In contrast to Volume 7 the reviewer enjoyed reading Volume 8 and is happy to recommend it as a worthwhile purchase for all who are interested. The contents of this volume follow closely and complement Volume 5 (*Silicon*) and, in assembling these articles, the editor (Grabmaier) is to be complimented for his appreciation of the scope of activity and general interest in materials of demonstrated technological importance. Without exception the articles gave clear detailed and well presented state-of-the-art summaries of these high-technology methods and, therefore, this book deserves a place in every physical-sciences library.

A paraphrased quotation from the editor's thoughtful foreword best summarises the question which these authors have set out to answer: 'It can no longer be denied that growing silicon crystals has matured from an art to a science... It is not simply a problem of growing a nice looking crystal (with some artistry!) but of growing a crystal that has precisely the properties requested by the engineers'.

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J. Appl. Cryst. (1984). **17**, 123–124

Crystal lattices, interfaces, matrices. By *W. Bollmann*. Pp. vii + 360. Published by the author, 1983. Obtainable in N. America from Polycrystal Book Services, PO Box 27, Western Springs, IL 60558, USA, price US $ 45.00 *plus* mail & handling costs; or, in all other countries, from Professor W. Bollmann, 22 Chemin Vert, CH-1234, Pinchat, Geneva, Switzerland, price (including mail & handling costs): European countries SwF 70.00, non-European countries SwF 80.00.

This volume is edited and published by the author. It may serve as an example of what can be done without the aid of a publisher who might be unwilling to risk investment in a publication of this nature because of the limited audience. The book is handsomely set out with quite legible and attractive type, broad right-hand margins for notes or illustrations, and many diagrams.

The work is divided into three sections: the geometrical aspects of crystal lattices, interface theory and applications, and matrix algebra and its applications to crystallography. The book does not dwell in any explicit way on group theoretical developments in crystallography. It simply refers to literature available in this area; the definition of a group is given in an exercise at the end of a chapter on crystal symmetries. At the end of each chapter there are review questions and helpful exercises. The book is replete with good examples which are very helpful. All in all, this is an impressive effort to do for working crystallographers what classical mathematical crystallographers do not always do, namely, develop practical mathematical tools for applied work.

The primary objective of the text is to present mathematical methods of ana-

lyzing the structure of interfaces in crystals. Grain and phase boundaries are dealt with in detail and a chapter on the junction of more than two boundaries is included; the author does the calculation for triple lines and the branching of boundaries.

The crystal is viewed from two levels. There is first the *p* level, or possibility level, which represents the single crystal or bicrystal by two interpenetrating point lattices without atoms and, secondly, the *r* level, or reality level, which introduces atoms into the scene and yields models of atomic configurations in crystals.

With each transformation, *A*, the author associates a *displacement field* composed of the vectors $d=(I-A^{-1})y$, where $y=Ax$ and I is the identity transformation. These vectors are embedded into a *displacement vector space (DVS)*. They may or may not fill the whole of the DVS. They form in this space the *reduced displacement field (RDF)* of the transformation *A*. Each displacement vector in the RDF has a *displacement vector element (DVE)* associated with it in the point space (*p* level crystal). By taking appropriate intersections of displacement vector elements, the author builds his *O* lattice or lattice of origins. This lattice is fundamental to his whole presentation. He gives the method for constructing the *O* lattice for many situations encountered in applied crystallography. The connection between the *O* lattice and the displacement field is the author's main reason for defining the concept of a displacement field of a linear transformation. Depending on the rank of $(I-A^{-1})$, the *O* lattice can be a point lattice, a lattice of parallel lines, or a lattice of parallel planes.

The text discusses dislocations in the context of the *O* lattice. An abstract model for a boundary situation is a slice through the *O* lattice cell structure, the atoms on one side of which follow the pattern of crystal number one, and those on the other side the pattern of crystal number two. In between is the transition zone and there the atoms are arranged according to the author's *linear relaxation model*.

The steps for determining Frank's definition of the Burgers vector are given and it is shown how this procedure is applied to a boundary dislocation. In the case of the general dislocation, the side of the extra plane of the edge component is determined, as is also the screw component. To relate the *O* lattice and the point-symmetry elements, the author points out that, when we know the existence of a point-symmetry element, the set of all symmetry elements of the same type form the *O* lattice.

The choice of unit cells is discussed and the procedure for determining closest neighbors is given. It is also pointed out that, of all possible transformations *A* connecting crystal lattices one and two, on the *p* level, the one which determines the closest neighbor relation is the one which gives the largest *O* lattice unit cell, *i.e.* the widest dislocation spacing.

There is a substantive discussion of secondary preferred states. The *coincidence site lattice* is treated and its derivation is given. The *complete pattern shift lattice* is defined and its relation to the coincidence site lattice is given. Secondary preferred states and primary preferred states are compared crystallographically. The coincidence site lattice is a sublattice of any possible *O* lattice between two given crystals. The author states that a necessary condition for a preferred state seems to be that the pattern formed by the two interpenetrating lattices is periodic or, at least, locally periodic. This is not a sufficient condition.

A chapter is devoted to secondary dislocation networks. Methods of constructing secondary dislocation networks are described and secondary dislocation networks with more than one preferred state are treated. Partial secondary dislocations are defined and their genesis is discussed. A chapter is devoted to branching boundaries and the branching condition for boundaries is given.

The final chapter of the main section of the book is philosophical in nature. The author states Gonseths's parable to illustrate that the structure of a theory is strictly related to the purpose that it has to fulfil. He cautions against the reification of theory. He states that the purpose of the *O* lattices is to give an explanation of experimental results arising out of the application of electron microscopy to intercrystalline boundaries and that surely sums it up.

The author admits that the *O* lattice structure is a geometric creation ignoring many important physical properties; it is, therefore, limited in its application. It is a very useful construction, nevertheless. I am afraid that I must leave the final verdict to the experts who will apply this method in their research.

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