

ment, however complex, is available. Consequently it is not detailed enough in this respect for people wishing to start up and obtain practice with a particular technique, neither is the information presented advanced enough for workers who have modern well designed equipment available.

The attempted coverage of the book is good. Most modern growth techniques are mentioned, in at least an abbreviated manner. The Czochralski technique, however, is covered in less than two pages of text with one diagram for InSb, which is hardly proportionate to the importance of this technique – nor even to the effort previously devoted to InSb! The section dealing with 'Devices for Crystal Growth' is hopelessly inadequate, but some attempt is made to deal with processing of crystals and a few simple methods of cutting, drilling and polishing are described. Luckily no attempt is made to describe the characterization of crystals.

I feel that the book will be useful to have for students to read in a general manner, and perhaps to give them the basis of ideas for constructing their own apparatus. I cannot see that it really constitutes a laboratory manual, nor, as is stated on the jacket, will it prove to be a useful instrument for teaching crystallography.

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**Crystal chemical classification of minerals.** By A. S. POVARENENYKH. Translated from Russian by J. E. S. BRADLEY. Vol. 1: Pp. xiv + 458, Figs. 211, Tables 30. Vol. 2: Pp. 308. Figs. 88. New York: Plenum Press, 1972. Price \$46.00.

These two volumes contain the ideas of Professor A. S. Povarennykh on a crystal chemical classification of minerals. It is an important and fascinating contribution to mineralogy – there can be no doubt about this, nor about the fact that it will become the source of much controversy.

The proposed classification has the following scheme: each mineral species

is successively assigned to a type, a class, a subclass, a division (eventually a subdivision) and a group (eventually a subgroup). There are four *types*: I. Homoatomic and similar compounds (e.g. carbides); II. Sulphides and analogous compounds; III. Oxygen compounds; IV. Halides. Within each type there are a number of *classes*, according to the kind of elements combined with sulphur, oxygen or halogen. So far the classification is rather chemical and commonly accepted in mineralogy.

The next division into *subclasses* is a structural one. There are six: coordination, framework, ring, insular, chain and sheet. This classification is not purely topological – based on relative positions in space of coordination polyhedra – but also takes into account the kind of atoms that form the polyhedron. To do this the author introduces the bond strength, for which he gives a formula and a table. Unfortunately the reader cannot check the given values because the formula contains two factors that are not further defined. However, some values of these factors can be found in other tables. When the bond strength is larger than 1 the polyhedron is considered to be a radical. Another criterion is the degree of valency completion, *V*, defined (p. 41) as the cation valency divided by the total number of anion valencies in the polyhedron. A third criterion is the number of common vertices between polyhedra. In most cases it is clear why a certain crystal structure has been assigned to a certain subclass, but sometimes it is not. Why should fergusonite, (Ce,Y)NbO<sub>4</sub>, with a scheelite-type structure belong to the coordination subclass, whereas scheelite, Ca[WO<sub>4</sub>], appears in the insular subclass, although both tetrahedra have a bond strength larger than 1?

The classification into *divisions* and *subdivisions* is based on the complexity of the structural feature, such as the composition of a ring or a chain. The sequence of divisions is not arbitrary, but determined by a decrease in bond strength. Similarly the species within a *group* are also arranged according to decreasing bond strength. For example euclase, BeAl[SiO<sub>4</sub>]OH, is found as the second species after topaz, Al<sub>2</sub>[SiO<sub>4</sub>]F<sub>2</sub>, and classified as: type III, silicate class, insular subclass, division A (with isolated [SiO<sub>4</sub>] tetrahedra), subdivision II (with additional anions), topaz group.

Povarennykh relates the constitution (structure) to habit, cleavage, hardness and density. This must sometimes lead to internal inconsistencies as the habit

is determined by the bonds formed in the crystallization process, whereas the classification criteria consider all bonds. For example, epidote belongs to the insular subclass because of the [SiO<sub>4</sub>] and [Si<sub>2</sub>O<sub>7</sub>] radicals, yet the habit is columnar to acicular because of the Al–O octahedral chains, suggesting a chain subclass.

The concept of *mineral species* is defined by Povarennykh as the total of all mineral individuals characterized by an identical structural group and by a chemical composition lying within the range of continuous variation. This is contrary to the usual definition, in which end members of a continuous solid solution series are considered as separate species. For example, in Povarennykh's system celestine, SrSO<sub>4</sub>, does not occur as a mineral species, because it has a continuous solid solution series with baryte, BaSO<sub>4</sub>; in the new classification baryte is (Ba,Sr)SO<sub>4</sub>, while SrSO<sub>4</sub> is called strontio-baryte and BaSO<sub>4</sub> bario-baryte. Although uncommon, it is straightforward and certainly has many advantages. It implies, however, that the concept becomes dependent on *p–T* conditions: separation at a lower temperature creates a new species. Incidentally, it must be remarked that a mineral should be solid, so water and Hg are not minerals; nor are natural organic compounds considered as minerals, even when they are solid.

The *formula* representation is also rationalized by giving the elements in the order of increasing valency and electronegativity, which certainly is an improvement.

The *nomenclature* has also been rationalized by Povarennykh. The name should reflect most or all electropositive elements, the chemical class and the structural pattern. The class is denoted by a suffix (sulphide = -sulfite), the structure eventually by another suffix (-tilite for chain, -phyllite for sheet). The author has fortunately refrained from renaming all minerals, only new minerals and new species have new names. For example, (Mg,Fe)CO<sub>3</sub> is magnifercite. However, it is most unfortunate that the author has not taken advantage of the experience gathered by constructors of synthetic languages, such as Esperanto, because he then might have avoided pronunciation difficulties. In various languages -azite (N), -asite (AsO<sub>4</sub>) and -arsite (As) sound much the same, as do -site (SO<sub>4</sub>) and -cite (CO<sub>3</sub>) (why not -kite?).

The book is divided in two parts.

Part I (189 pp.) deals with all aspects of the new classification. Most of these chapters have a good historical introduction. The systematic Part II (481 pp.) gives for each species: name, chemical composition, space group, unit-cell dimensions, main interatomic distances, density and hardness. Then follows a description of the structure, of chemical variations, of morphology in qualitative terms and of cleavages. Optical, electric or magnetic properties are not given. For the hardness a new scale is introduced by Povarennykh, ranging from 1 to 10 as does Mohs's scale, but not directly comparable with this.

Minerals with unknown crystal structure are classified on the basis of chemical composition and properties as morphology, hardness and density.

It is hard to expect that this work will satisfy everybody, however rational and straightforward the classification is. Several objections to the presentation can be made: insufficient information about the quantities used as criteria in the classification; formulae are not derived; a subject index is lacking; sometimes different crystallographic settings are used in the description of the structure, the accompanying illustration and the morphology, as on p. 256 (chalcostibite) and on p. 257 (lorandite). Besides there are many small errors. On p. 67 the structural changes 4) and 5) are incorrect and should be replaced by the corresponding entries of Table 15. On p. 190 an Å is seemingly defined as a nm. The illustrations have been taken from many sources, some are original, so their quality varies, but nevertheless Figs. 23, 25 and 26 should not be upside down. On p. 223 the cleavage of sphalerite should read (110), not (111). The translation is well done, but there are very awkward mis-spellings.

Povarennykh's book can be considered as a major contribution to mineralogy. It marks a stage in the development of the mineral classification, clearly based on Dana's *System of Mineralogy* and on Strunz's *Mineralogische Tabellen*. The silicate classification occurring in the latter work evidently served as a model for Povarennykh's classification. Notwithstanding the objections, the book should form part of any mineralogical library.

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**Grain boundaries and interfaces.** By P. CHAUDHARI and J. W. MATTHEWS. Pp. ix + 622, Figs. 365, 33 Tables. Amsterdam: North Holland, 1972. Price £140.00 (ca. US \$43.75).

This volume reports the proceedings of a Conference held in New York in August 1971; it has already appeared as volume 31 of *Surface Science* in 1972 and is now issued by North Holland as a separate book. The 27 papers (plus discussion) contained in it have a strong 'metals' bias and include several substantial review papers on recent developments in the field. One third of the papers deal with theoretical aspects of boundary structure and energetics, another third with dislocation structures at boundaries as observed by transmission electron microscopy. The last five papers are concerned with grain-boundary sliding and migration, and diffusion effects.

Many libraries will already possess this volume as a result of their subscription to *Surface Science*. Research groups in physical metallurgy and materials science which do not have access to *Surface Science* would be well advised to obtain a copy.

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**Les textures dans les métaux de réseau cubique.** By PIERRE COULOMB. Pp. vii + 217, 81 Figs., 8 Tables. Paris: Dunod, 1972. Price 78 F.

It has been some years since the subject of preferred orientation in metals was first put into text-book form. The present volume represents a bold step on the part of the author in view of the ever increasing amount of research and application in this field. The standard of the book is essentially post-graduate but the presentation includes a large amount of fundamental work which should be of interest to final year students.

The foreword places the subject in perspective, differentiating between crystallographic anisotropy and mechanical fibering and attempts to justify the

almost complete exclusion of non-cubic metals by quoting world usage.

The commencing chapters on texture and symmetry, representation and determination of textures give adequate coverage of principles and methods available to date. Pole figures are introduced in a way which aids basic understanding. Techniques are discussed in brief rather than in working detail. Further chapters cover adequately the role of defects, quantitative relation of single and polycrystalline properties, deformation of single crystals and formation of textures in polycrystals.

As with experimental methods the author has chosen to review theories in brief but the trend of the book changes slightly as recrystallization textures are presented in review form rather than as a generalization of results. The section on phase transformations might have been more adventurous, especially from a crystallographic approach, in view of increased interest in this variable over the last few years.

The chapters on laboratory and industrial applications will be extremely useful to readers, and the final chapter considers problems encountered in non-cubic metals, single crystals of non-metals, eutectics and composites. A concluding paragraph justifies the merit of the book by quoting specific examples of texture control which have resulted in considerable cost savings over the years.

One major criticism is that the language of publication may restrict interest in the book. For a subject such as this, of world-wide appeal, it should be worthwhile to the publisher to consider an edited version in English.

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## Books Received

*The following books have been received by the Editor. Brief and generally uncritical notices are given of works of marginal crystallographic interest; occasionally a book of fundamental interest is included under this heading because of difficulty in finding a suitable reviewer without great delay.*

**Advances in X-ray analysis,  
Vol. 16. Proceedings of 21st  
Annual Conference on Ap-  
plication of X-ray Analysis,**