panded at the expense of other matters which clearly interest the author and receive greater attention than is necessary. Lists of references to original papers and text books, given at the end of each chapter, help to repair some of the deficiencies and should prove useful to anyone wishing to delve more deeply into particular subjects. Altogether there are about 300 references; not all of these are the most appropriate and one or two important books are omitted.

The second ciricism concerns the appalling number of errors; these are too varied and too extensive for detailed discussion. Most serious are the errors in fact and in logic; one of the latter (page 225) is quite absurd but, like many of these errors, may seriously trouble the novice. Two examples will be quoted from the first chapter; they are chosen because they are easily recognized out of context. (i) page 2. 'There are 230 space groups among crystals, all identifiable by the occurrence of absences or extinctions'; (ii) page 5. 'The discovery that cells have centres other than those at the unit-cell corners was made by Bravais. This discovery resulted in 14 lattices instead of the original six. These 14 lattices are often called Bravais lattices because of his discovery of them by *optical* means' (the italics are the reviewer's). Here there are two mistakes, one of which arises out of the author's attempt to regard the rhombohedral system as a subdivision of the hexagonal system.

After these criticisms it is only fair to add that many sections of the book *are* presented clearly and that several examples are worked out in great detail. Certain features will appeal to the experienced crystallographer. In particular one finds well known topics treated in new and interesting ways and there are many original diagrams.

The first two chapters, introducing the fundamentals of classical crystallography, are particularly prone to the faults already noted; but one unusual feature is worthy of mention—a thorough, though space consuming, discussion of point group operators and the derivation of the point groups. The nomenclature is sometimes unorthodox and not always consistent; the terms point group and space group seem to be regarded as interchangeable. X-rays, diffraction, X-ray cameras and the interpretation of photographs are discussed in chapter 3. The following chapter, on the determination of space groups, is confined to the interpretation of systematic absences; to clarify the general procedure the space groups and unit-cell contents of two materials are worked out starting from the X-ray and physical data. The equation for the integrated intensities of diffraction from crystals of known structure is developed in chapter 5; most of the correction factors are discussed although absorption is mentioned only in passing and primary and secondary extinction not at all. The next chapter, on the nature and properties of Fourier series, introduces convolutions and the main types of Fourier series used in X-ray analysis; an important omission is the difference synthesis. The phase problem is considered in chapter 7; particular attention—almost 40 pages—is devoted to the various Patterson and statistical methods. There follows an interesting, but rather unbalanced, chapter on computing aids. The final chapter illustrates the principles discussed in preceding chapters by describing, in considerable detail, the methods used to determine six particular structures. To conclude there is an appendix on special recording techniques.

The book is profusely illustrated by line diagrams which are neatly drawn and well reproduced. A few are inadequately described and mistakes in drawing or lettering occur far too frequently. The printing, paper and binding are excellent.

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The Powder Method in X-ray Crystallography.

By LEONID V. AZAROFF and MARTIN J. BUERGER. Pp. xv+342 with 127 figs. New York: McGraw-Hill Book Co. Inc. 1958. Price $8·75; £3.8.0.

Two books have been published in recent years which deal comprehensively with X-ray diffraction by powders. H. P. Klug and A. E. Alexander's X-ray Diffraction Procedures for Polycrystalline and Amorphous Materials came out in 1954, whilst X-ray Diffraction by Polycrystalline Materials containing contributions from many different authors, and edited by H. S. Peiser, A. J. C. Wilson, and the present reviewer, was issued in 1955. Leonid Azaroff and Martin Buerger's book is deliberately much more limited in scope than these. Its avowed purpose is simply to provide an authoritative guide to the taking and the interpreting of a powder photograph. The word photograph must be stressed because the diffractometer method is dismissed as outside the scope of the book in two or three sentences on page 3. The authors further confine their attention for the most part to practice with the precision type of American cylindrical camera of either 5·73 or 11·46 cm. diameter; there is a brief reference to flat cassettes on pages 42 to 44, and the existence of back-reflexion focusing cameras is recognized on page 220.

It was thus possible to concentrate attention on basic principles and to discuss in detail how, as the authors put it, to 'ferret out' from the Debye–Scherrer pattern as much structure information as possible. One would expect a book in the preparation of which Martin Buerger had had a hand to be authoritative, accurate, and clearly written, and in this expectation the reader will not be disappointed, provided the limitations of aim to which reference has just been made is accepted. The authors have, moreover, succeeded in writing a text which will appeal to the chemist, physicist, or metallurgist who may be called upon to take powder photographs and interpret them.

The first forty-five pages can be said to deal with the practice of powder photography. Such matters as camera design and alignment, film arrangement, specimen making, choice of radiation, and so on are briefly described. There follows a chapter on interpretation, which includes guidance to the use of Hull-Davey, Bunn, Bond, Bjurström, and Harrington charts in indexing the powder lines. Analytical methods of indexing are described in chapter 8.

In chapter 9 the reciprocal lattice is simply explained and from there on the concept is used freely. Indexing with the aid of the reciprocal lattice is discussed in chapter 10 and the method illustrated by showing how to handle step by step a spacing list for $MgWO_4$. The

subjects of reduced cells and the Delauney reduction are dealt with in chapters 11 and 12 respectively.

Later sections of the book are devoted to identification, sources of error in measured spacings, and the problem of attaining high accuracy in lattice parameter determination. The chapter on errors is short but covers most of the important points clearly. A fair appraisement of ultimate limits of accuracy is given, and well-balanced advice is offered on the choice between analytical and extrapolation procedures in lattice parameter determination.

There is a final chapter on the appearance of powder photographs. The discussion is a most useful one because it is not until the various effects that are obtained by accident or design can be certainly recognized and explained by a practician that he will realize the full potentiality of the powder method. In this chapter air scattering, fluorescence scattering, general radiation scattering, causes of line doubling, maladjustment of the camera, misalignment of the track and so on are considered. Line broadening, preferred orientation, and crystal texture are briefly referred to but obviously not in sufficient detail to provide any basis for serious work on these topics. Not the least helpful items in this chapter are the four reproductions of sets of patterns illustrating several of the effects and faults mentioned in the text.

Lists of literature references are included at the ends of chapters. Though not by any means complete these show the reader where to turn for further information on the different subjects. Three appendices comprise quadratic forms for cubic, tetragonal, and hexagonal crystals, tables for conversion of d to $1/d^2$ (a useful innovation), and tables of extrapolation functions respectively. The combined subject and author index is adequate. The printing and binding of the volume are excellent and maintain the usual high standard set by most United States publishing houses.

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Ferroelectricity in Crystals. By H. D. MEGAW. Pp. xi+220 with many figs. and tables. London: Methuen. 1957. Price 27*s.* 6*d.*

Ferroelectricity is a fairly young subject that has so far led a rather sheltered existence. This situation is understandable for as yet it has not proved necessary to invoke it as a process basic to the interpretation of physical phenomena occurring outside a fairly restricted set of substances. Furthermore, in spite of obvious possibilities, it appears that no ferroelectric devices are yet in production, partly on account of their unreliability. However, ferroelectric crystals provide an interesting field for basic research and a mass of literature on the subject has steadily accumulated over the past two decades. The recent appearance of several books and review articles on the subject can be taken as a sign of its coming of age.

Dr Megaws' book is intended to cover certain aspects of the various ferroelectrics that had been discovered by mid-1955. Since that time many more ferroelectrics have been discovered (and, presumably, will continue to be discovered) and this leads to a possible criticism of the book—its usefulness may decline quite rapidly. On the other hand, at some time in the growth of a subject it is highly desirable to have a book available to serve both as a reference work and as a discerning review of early work.

Dr Megaw, who is primarily a crystallographer, believes that the key to the understanding of ferroelectrics lies in a knowledge of their structure, and this viewpoint is much in evidence throughout the book. Nevertheless, she has succeeded in making the book readable for those not trained in crystallography while making it, at the same time, a useful compilation of facts concerning those crystal structures discussed.

After an introductory chapter concerned, chiefly, with the very basic dielectric properties of ferroelectrics and anti-ferroelectrics, the author devotes separate chapters to Rochelle salt, the tetragonal phosphates, and barium titanate. In these chapters, the effect of temperature on the crystal structure and the dielectric properties, the nature of the phase transitions, and the mechanisms believed responsible for the ferroelectricity are discussed. Then follow two chapters in which structural considerations of the family of perovskite-type crystals are treated in some detail and Dr Megaw's approach to ferroelectricity becomes apparent. This section of the book is rounded off with a chapter on miscellaneous structures, the most recently discovered ferroelectric that is discussed being guanidine aluminium sulphate hexahydrate. These chapters provide a very good account of the crystal structures covered and are particularly informative in their discussions of the ferroelectric mechanisms. On the other hand, there are large omissions concerning the electrical properties of ferroelectrics—permittivity and polarization measurement as a function of temperature find a place in the book because of their obvious close connection with structure studies and theory, but, for example, the variation of the permittivity and dielectric loss with field strength or frequency, and relaxational (fatigue) effects are not mentioned. Such topics as well as other electrical properties have been well covered in a recent book on ferroelectrics by Sachse, and, in this sense, the two books can be regarded as complementary. Domain structures in barium titanate are described briefly and there is only an inadequate report of experiments on domain wall motion. Surprisingly, no mention is made of the energetics of domain formation and the sequence by which a crystal reverses its direction of polarization, subjects of vital interest to those concerned with the switching properties. Dr Megaw justifies omitting such topics as the piezoelectric effect and optical properties on the gounds that the former has been adequately treated elsewhere and that the latter has not yet been studied sufficiently.

The book concludes with three chapters on theories of ferroelectricity. In these a distinction is made between phenomenological theories (exemplified by Devonshire's, which is based on general thermodynamic principles) and model theories. The latter are based on the postulation of some mechanism in the crystal structure as being responsible for its ferroelectric properties, and other properties are then deduced. As a result, there are nearly as many model theories as there are types of ferroelectrics. The basic assumptions of, and the objections to, the various theories are stressed. The author concludes by again expounding her belief that the best road