BOOK REVIEWS

DIRECT METHODS IN CRYSTALLOGRAPHY by M. M. Woolfson, Oxford University Press, London and New York, 1961. $4.80. 144 pp.

Direct Methods in Crystallography by M. M. Woolfson is one of a series of monographs on the physics and chemistry of materials. It has been divided into two parts; the first, of which the theoretical aspects are relatively simple, is devoted to those applications of direct methods which may be made by hand calculation, rather than to the earlier highly trial and error methods that have been used in the past in solving crystal structures. The author points out, very properly, that the book is intended for those with a solid background in crystal structure analysis. It is expected that the reader is familiar with the standard older methods of solving crystal structures.

In the first portion of the book, a discussion of the nature of direct methods is given. The Harker-Kasper inequalities are treated in some detail, particularly for centrosymmetric structures. An application of the Harker-Kasper inequalities is given, and inequalities are given for some other specific symmetry elements. The sign relationships are treated rather thoroughly with quite a few pages devoted to the application of the sign relationships in the structural determinations.

In Part II a somewhat more involved subject matter is treated, and the mathematical requirements for this section are somewhat greater than those necessary for an understanding of Part I. The three chapters of the second part deal with computer methods of applying sign relationships with additional criteria for sign determination. In the final chapter, the author considers the past, the present, and the future so far as the determination of crystal structures by these relatively direct methods is concerned.

The crystals chosen for illustrating the methods are from the realm of organic rather than from that of inorganic compounds. In a series of appendices are the derivations of a number of results given without proof in the main body of the monograph. Following the appendices are solutions to four examples contained in the text proper.

Woolfson's monograph is a concisely stated, well-organized study of the general principles of direct methods and techniques for their application to structure determination. For an inexperienced worker in the field of crystallography, the monograph might seem immoderate in its mathematical prerequisites. For the seasoned crystallographer, *Direct Methods in Crystallography* has much to offer.

R. M. Denning
The University of Michigan

AN INTRODUCTION TO THE METHODS OF OPTICAL CRYSTALLOGRAPHY by Donald Bloss, Holt, Rinehart and Winston, New York, 1961, 294+vii pp. $7.00.

The text of *An Introduction to the Methods of Optical Crystallography* by F. Donald Bloss is presented in eleven chapters and three appendices. The first four chapters consist of material of an introductory nature on light, lenses, and microscopes. The following seven chapters cover uniaxial and biaxial crystals in "orthoscopic" and "conoscopic" observation. Chapter XI covers the solution of some important optical problems with the aid of the stereographic projection. An excellent list of references is included. In Appendix I, the construction of conjugate radii of an ellipse is given. A method of constructing an ellipse is also included. Appendix II is a determinative table of minerals, based upon axial character, sign, and indices of refraction. The list includes 342 uniaxial, 426 biaxial positive, and 442 biaxial negative entries. Also included in the list are 177 optically isotropic entries. Some minerals are repeated in the lists, since their indices of refraction are not constant.

The data for all of the optically anisotropic minerals are also presented graphically. Appendix III illustrates a printed form to be used in recording data.

It can be seen that in a general way, the coverage is conventional, and the presentation is in a rather conventional order. Numerous features are, however, outstanding and deserving of further comment. A fold-out color chart (after Kerr) relating the interference color between crossed polars to thickness and birefringences is included. Several useful charts are given for the graphical solution of interference figure phenomena, the axial angle formulas, and the ϵ for the rhombohedral carbonates. Dispersion curves are used to explain colored Becke lines, "anomalous" interference colors, and the dependence of 2V upon the dispersion of indices of refraction. The illustrations are well prepared and leave little to the student's imagination.

In a text such as the one under review, it is practically impossible to avoid all errors, misstatements and omissions. A few are here noted. The treatment of optical absorption could be improved. In the discussion of the depth of focus of a microscope, the role of visual accommodation is not mentioned. The formation of the interference figure image is not explained, although reference is given to such an explanation. The numbering of orders in the flash figure (7–22A) is incorrect. The adjustment of the light source is not discussed, nor is there mention of the use of the iris as an aperture stop. In general the equations presented in the book are given without derivation. In Fig. 3–6 there is an error. None of the rays is bent at P′.

The student who is well grounded in optics will not be satisfied with the casual treatment of the formation of interference figures which fails to show where the figure lies in the optical system. The cone of rays which pass through a single point and then diverge to form a mythical image on all ill-defined plane, as for example in Fig. 7–19, leads only to a rule of thumb understanding.

Figure 7–10 can lead to the erroneous conclusion that somehow, in itself, the convergence of light upon the crystal makes the interference figure visible.

Why the author recommends in Table 7–1 that the condenser aperture should be kept low while making orthoscopic observations with a 0.85 objective is not clear. Such a procedure is contrary to general practice, as well as to theory.

The choice of the G_2 orientation for hexagonal crystals seems as unfortunate one, particularly since the G_2 orientation is not clearly defined in Fig. 11–6, and the transformation matrix is not given. However, the angle ϕ need not be computed for optical problems involving uniaxial crystals. Thus in the tetragonal system

$$\tan \rho = \frac{c}{l} \sqrt{h^2 + k^2}$$

The reviewer would hesitate to use the tables for the identification of the rarer minerals, since data on indices of refraction and birefringence only are given. In the case of many minerals information on orientation, cleavage, color, composition and association is essential for a high confidence in microscopic identification.

On the positive side, the thorough treatment of optical orientation and the inclusion of the excellent charts make this text nearly as satisfactory as, and in a few respects, better than any American text for a beginning course in determinative optical mineralogy.

R. M. Denning
The University of Michigan