Book Reviews

Works intended for notice in this column should be sent direct to the Editor (P. P. Ewald, Polytechnic Institute of Brooklyn, 333 Jay Street, Brooklyn 1, N.Y., U.S.A.). As far as practicable books will be reviewed in a country different from that of publication.

Handbuch der Physik. Bd. VII. 2. Kristallphysik II.

Ed. by S. FLÜGGE. Pp. 273 with 190 figs. Berlin: Springer-Verlag. 1958. Price DM. 76.

This volume of Handbuch der Physik contains two articles. The first, which occupies the major part of the book, is on 'Plasticity of Crystals' and is written by Dr A. Seeger. Some forty pages at the end of the book contain a short article by Prof. U. Dehlinger on 'Transformations and Precipitation in Crystals'.

Seeger's article is an excellent review of work on glide and work-hardening of metallic single crystals. Within this framework it is very comprehensive and includes references to all important papers published upto about the spring of 1958. A little space is devoted to non-metallic crystals but the emphasis is throughout on metals.

An excellent account is given of calculations of the theoretical shear strength of crystals including details of Mackenzie's thesis, so often referred to, and so long unpublished. The experimental facts on the deformation of single crystals in tension are then reviewed. Separate sections are devoted to the critical resolved shear stress, the stress-strain curve and the surface appearance of plastically deformed crystals. In each of these sections, face centered cubic metals and alloys, hexagonal metals and alloys, body centered cubic metals and other crystals are dealt with separately. The whole presentation is thus very systematic which makes the task of referring to a particular point very easy. The author has also been at some pains to replot diagrams from original works so that his chosen method of presentation can be followed throughout.

The description of slip line observations using the optical and electron microscopes is perhaps the best part of the book and a beautiful and much needed demonstration is given of the relation between the two.

The modern theory of glide in crystals is next presented and could be read easily by anyone with only a slight knowledge of dislocation theory. Again the various groups of metals and alloys are dealt with separately, and sections are devoted to suggested explanations of the values of critical resolved shear stress and of rates of work hardening. It is in these sections that a definite point of view is presented, which is that contained in the author's many papers on the subject. This is difficult to avoid in such a rapidly moving field and it will be of great interest to see how long the sections on the explanation of work hardening remain of interest. It is therefore a pity that additional experimental results have been introduced into the theoretical sections.

Within the limits the author has set himself he has produced a magnificent review of the voluminous data on glide of metal crystals. The title crystal plasticity is perhaps unfortunate since no mention is made of twinning or fracture and hence this article cannot replace Schmid and Boass' classic work, though, within its chosen framework, it is a worthy successor. Since little of the recent work on plasticity of ionic crystals is mentioned no comparison with metallic crystals is made. From the crystallographer's point of view it is very interesting how attempts are now made to explain the plastic properties of the latter in terms of fine details of the crystal structure and this approach will presumably be extended to all crystals in the future.

Dehlinger's article is a short review of some of the theoretical aspects of transformations and precipitation in solids. In particular the difficulty of accounting for the origin of the original nucleus is made evident and an account given of the analogy between diffusionless phase transformations and plastic flow by the motion of dislocations. The crystallographic aspects of transformations in general, are not particularly emphasized and the number of references is not extensive.

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Fourier Transforms and X-ray Diffraction.

By H. LIPSON and C. A. TAYLOR. Pp. vii + 76, with 70 figs. and 59 tables. London: Bell and Sons. 1958. Price 18*s*·6*d*.

This interesting monograph has been written in an effort to make more popular the important vantage point in diffraction theory afforded by the Fourier transform approach. The discussion is, on the whole, restricted to the transform of the contents of the unit cell of a crystal, and no applications are made to diffraction by gases, liquids, or amorphous solids.

Six chapters of the monograph contain brief discussions of diffraction, of Fourier inversion, of properties of transforms, and particularly of the important convolution theorem of which a number of practical applications are given. Although there is some discussion of elementary concepts of diffraction theory, including that of the reciprocal lattice, a working knowledge of particularly this last item will be found useful in the study of the book. The discussion of transform properties is quite brief, and some useful aspects are hardly treated, if at all; e.g. the illuminating fact that any central planar section of a transform is determined entirely by the projection of the original function on a plane parallel to this section is mentioned in an oblique way only (p. 19). This reviewer would, of course, have liked to see a reference to the elaborate paper on Fourier transforms he wrote with V. Schomaker (1953).

The last chapter, on applications, is the best of the book and the most interesting. Besides describing applications to structure determinations, important insights by the transform approach are provided into such matters as effects of crystal size and shape, temperature motion, and stacking disorder. It would have been welcome to see some discussion here of Hoppe's recent method (1955, 1956) of unravelling structures from the information contained in the transform showing up under favorable conditions in the thermal background scattering. Indeed, a lucid qualitative interpretation of this last phenomenon is given on p. 50. This chapter is all too short also.

There are three brief appendices on computing transforms and on obtaining them by optical methods, with the handsome plates one has come to expect from the authors. The reviewer only wishes that a good deal more of their beautiful published work (including plates) had found its way into their book.

Highly useful features are a system of numbering equations which includes the page number on which a given equation appears, and indication in the reference list of the pages to which any given reference applies.

In summary, this is a handsome, if too brief, monograph which will be of interest to anyone doing structural work.

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ТЕОРИЯ СТРУКТУРНОГО АНАЛИЗА. By А. И. Китайгородский. Анализа издательство академии наук ссср. Москва – 1957.

The Theory of Structural Analysis. By A. I. KITAIGORODSKII. Publishing House of the Academy of Sciences of the USSR. Moscow. 1957. 283 pages. Price 10 rubles, 65 kopeks.

This concentrated book sets forth the methods which can be used to find the atomic arrangement in a crystal, after the diffraction data—X-ray, electron, or neutron—have been collected and reduced to tables of the magnitudes of the structure factors $|F(hkl)|$.

The first chapter contains a mathematical introduction concerned mainly with Fourier transforms, convolutions of functions, and the concept of reciprocal space. The second chapter presents a neat and condensed development of kinematic theory of the scattering of radiation by objects, both amorphous and crystalline, and defines the structure amplitudes, $F(hkl) = F_H$, and the 'structure products', $F_H F_K F_{H+K}$, etc., to which the author has devoted so much fruitful and original work.

Chapter III is devoted to the statistical properties of structure amplitudes and products. The work of A. J. C. Wilson and his colleagues is presented and developed by the author to apply to structure products. The notion of 'unitary' structure factors is extensively used here, as well as elsewhere throughout the book (to the delight of this reviewer). The identification of symmetry elements by statistical methods is well described, and the predominant positivity of the structure product $F_H F_K F_{H+K}$ is derived in what is believed to be a new and illuminating way.

Chapter IV is a very complete exposition of inequality methods for establishing the signs of structure amplitudes and products. In it is a great deal of original development by the author, who states that his direct methods are successfully applicable to all cases where other methods work. A defect in this chapter, it seems to this reviewer, is the lack of a presentation of the valuable work of Karle & Hauptman; these authors are merely mentioned as having developed methods of sign determination which also work. Another omission is any discussion of the problems in phase determination presented by crystals without centers of symmetry; this reviewer feels strongly that the structures of crystals such as these will be important subjects of research during the coming years.

Chapter V, entitled 'A Study of the Convolutions of the Electron Density', contains a treatment of the Patterson function. This treatment is quite mathematical—not one example of a Patterson function is depicted—but contains the essentials of the methods being used at present in solving crystal structures. The author refers the reader who wishes to know more about the practical use of the Patterson method in structure determination to the published work of others.

Chapter VI—the last one—is concerned with methods of refining structures. Sections are devoted to the R-factor, Booth's method of steepest descent, least squares, the differential method, and the difference method. The estimation of the error of a structure determination is the subject of an original treatment, toward the end of which appears the comment: 'We see that a deterioration in the accuracy of the determination of the structure amplitudes to 50% (this means 100% for the intensities) has little effect on the result of the analysis'. This refers, of course, to atomic positions; but even for these—in the opinion of this reviewer—precise bond distances and angles cannot be obtained from such data, and the discovery of atomic shapes and ionizations, bonding effects, hydrogen positions, etc., is quite impossible under these conditions.

The book ends with a three page 'Conclusion' which states, in essence, that structures containing more than about 100 atoms per asymmetric unit are impossible to solve by diffraction methods. This is probably true if one is limited to the methods described in this book—methods which make use of only one crystalline specimen. This reviewer feels he must point out that other methods are known, such as the isomorphous replacement method, or the use of anomalous dispersion, which can be extended to much more complicated structures, and also that the history of the subject shows that new methods are discovered from time to time which progressively increase the complexity of the structures capable of solution. As a counterbalance to the pessimistic flavor of his last statement, the author points out that the determination of crystal structures is now ready, in principle, to be made fully automatic—computing machines could be programmed to work directly on the observed intensities and come out with the atomic positions in crystals having up to perhaps 20 atoms per asymmetric unit.

This is a good book and contains much of the author's original work on the subject. Every X-ray crystallographer could benefit from a study of this volume. It is another one in the growing number of reasons why every professional scientist should acquire at least a reading knowledge of the Russian language. Meanwhile a translation of the book is due to appear shortly (Consultants Bureau, Inc., New York, Publishers).

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