Book Reviews

Works intended for notice in this column should be sent direct to the Editor (P. P. Ewald, Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn 2, N.Y., U.S.A.). As far as practicable books will be reviewed in a country different from that of publication.

Imperfections in Nearly Perfect Crystals

(Symposium held at Pocono Manor, Penna., U.S.A., 12–14 October 1950). Edited by W. Shockley, J. H. Hollomon, R. Maurer and F. Seitz. Pp. xii+490. New York: Wiley; London: Chapman and Hall. 1952. Price $7·50; 60*s*.

This book should be considered in conjunction with J. S. Koehler's *Plastic Deformation of Crystalline Solids* (Carnegie Institute Symposium at the Mellon Institute, Pittsburgh, 19–20 May 1950, published by the Office of Naval Research, 1950). Several authors were present at both symposia; in both cases F. Seitz is the author of the first chapter(s), and footnotes in the book under review more than once mention the Pittsburgh Report. This refers in particular to the first two parts of the book, on the nature of imperfections in nearly perfect crystals and their role in deformation. As is well known, many related publications have come from the Bristol group of physicists (of whom N. F. Mott was present at the Pocono Manor Symposium and F. C. Frank and A. H. Cottrell at the Pittsburgh meeting); consequently there are also several references to the *Report of a Conference on the Strength of Solids*, H. H. Wills Physical Laboratory, 7–9 July 1947 (published by the [British] Physical Society). In certain cases the reader of the book therefore gets the impression of partial repetition, and sometimes even of a certain haste in preparation. One would have liked, for instance, to find a somewhat more detailed treatment of the process of multiplication of dislocations; the diagrams illustrating this process would probably have been easier to follow if they had shown which parts of the moving dislocation line form edge dislocations and which parts form screw dislocations. The same applies to the notions of partial and sessile dislocations in face-centred cubic crystals; the little diagram hidden in a discussional remark on p. 101 of the Pittsburgh Report might well have been reproduced in the book under review and supplemented by a more extensive discussion. One feels the lack of a general treatise on dislocation theory, giving in systematic order all the basic relations: geometry, stress fields, energy considerations, attractions of foreign atoms, locking of dislocations, possibilities for oscillating motion, etc., preferably together with theories for body-centred and face-centred lattices, non-cubic lattices and systems with more than one atomic species. With the book in hand, and likewise when in possession of the other publications and of a collection of reprints, the reader is still forced to collect information on these subjects piecemeal.

Nevertheless, this book is an important document, giving an extremely useful summary of the state of a number of relevant problems in 1950. In particular, the first chapter, by F. Seitz, brings an excellent synthetic view of the various possible types of imperfections in crystals (phonons, electrons and holes, excitons, vacant lattice sites and interstitial atoms, foreign atoms in either interstitial or substitutional positions, dislocations), while, moreover, several forms of interactions between two and more imperfections of different types are considered.

The theory of dislocations and their meaning for deformation form nearly one half of the book; the remaining two parts are devoted to diffusion phenomena and to the properties of internal surfaces of crystals. The addition of these subjects forms a much needed complement to the first topic. Many questions concerning the motion of foreign atoms are treated, and the problems of internal and external surface energy and of surface tensions are considered by more than one author. Here again it appears that none of the subjects has attained a final state, but the reports given by the various authors are excellent. In both halves of the book tables of numerical data have been inserted, giving the most probable values of important quantities after a critical discussion of the relevant literature.

The book consequently will be a valuable aid to everybody occupying himself with properties of crystals. One returns to it many times for comparison of ideas and for references. Every chapter is headed by a short but excellent summary of its contents, and closes with a list of references. Most of the chapters are followed by a record of the discussion which had ensued after the presentation of the paper.

The book is well produced, although one notes occasional errors of print.

It is impossible to write an ordinary review of a collective work like this. It is hoped that the following summary of its main contents (for which the reviewer in many cases reverted to the summaries given by the authors) may be helpful.

Part I. On the Nature of Imperfections in Nearly Perfect Crystals.

1. F. Seitz, *Imperfections in Nearly Perfect Crystals: A Synthesis* (pp. 3–76; no discussion). In this chapter the author considers the various types of crystal imperfections from a unified viewpoint, having regard to their possible interactions.

2. W. T. Read Jr. & W. Schockley, *On the Geometry of Dislocations* (pp. 77–94; no discussion). A review of the geometrical features (which for the greater part have been mentioned in earlier publications).

Part II. The Role of Imperfections in Deformation.

3. C. S. Barrett, *Imperfections from Transformation and Deformation* (pp. 97–125; discussion 3 pages). Review of experimental work on the production of imperfections by deformation in various alloys and in some metals; considers also other distortions connected with plastic flow (glide lamellae, deformation bands, deformation twins, etc.).

4. W. T. Read Jr., *Experimental Information on Slip Lines* (pp. 129–146; discussion 6 pages). Summary of experimental data for a number of metals and for AgCl, without making an attempt at interpretation. The spacing of the slip lines is considered, having regard to the in-

fluence of temperature. In the discussion, E. Orowan deals with deformation bands and states that Barrett's deformation bands should be assumed to be kink bands.

5. B. E. Warren & B. L. Averbach, *X-Ray Diffraction Studies of Cold Work in Metals* (pp. 152–166; discussion 7 pages). A formula is developed by Fourier analysis for the line-broadening due to distortion, which is considered to be the primary cause of broadening, rather than fragmentation. The theoretical predictions are compared with the results of measurements on cold-worked filings of (70/30) α brass. The discussion includes a communication of P. B. Hirsch 'An X-Ray Microbeam Investigation of Cold-Worked Aluminium'.

6. N. F. Mott, *Mechanical Strength and Creep in Metals* (pp. 173–190; discussion 7 pages). The effects responsible for mechanical strength in metals are summarized; attention is given to the influence of impurities; the locking of dislocation lines is treated and a theory is given of exhaustion creep.

7. J. S. Koehler, *The Influence of Dislocations and Impurities on the Damping and the Elastic Constants of Metal Single Crystals* (pp. 197–212; discussion $4\frac{1}{2}$ pages). A treatment is given for the motion of a 'pinned down' edge-type dislocation under the influence of a periodic external stress. An important factor in the total effect is the distribution of free lengths of dislocation. The results are compared with experiments. In the discussion, starting from an observation made by T. A. Read, the author of the paper adds a treatment of the motion of a screw-type dislocation under alternating stress.

Part III. Diffusion and Related Phenomena.

8. R. G. Breckenridge, *Relaxation Effects in Ionic Crystals* (pp. 219–245; discussion 1 page). Values of the activation energies for the motion of lattice defects in alkali halides, AgCl and thallium halides are deduced from observations on temperature and frequency for maximum loss of energy. The number of lattice defects present is found from the magnitude of the maximum loss. Both pure and impure crystals have been studied. The degree of association of lattice defects is calculated.

9. L. Apker & E. Taft, *Studies of Alkali Halides by Photoelectric Methods* (pp. 246–260; no discussion). This paper discusses the production and distribution of '*F*-centres' (bound state of an electron at a halogen-ion vacancy; see Seitz's chapter, p. 65).

10. J. Bardeen & C. Herring, *Diffusion in Alloys and the Kirkendall Effect* (pp. 261–288; no discussion). The 'Kirkendall effect' is a mass flow relative to the initial interface of a diffusion couple, e.g. brass–copper (zinc diffusing out of the brass more rapidly than copper diffuses in). A theory is developed; the effect of dislocations is discussed, while some suggestions are made concerning the atomic nature of the plastic flow which takes place in this effect.

11. C. Zehner, *Theory of Diffusion* (pp. 298–414; no discussion). The problem considered is whether the elementary act of diffusion occurs homogeneously throughout the material or is confined to short-circuiting paths arising from imperfections. The latter case can explain the abnormally low values of the diffusion constant D_0 in chemical diffusion.

Part IV. Surface Properties.

12. J. G. Fisher & C. G. Dunn, *Surface and Interfacial properties of Single-Phase Solids* (pp. 317–343; discussion $7\frac{1}{2}$ pages). The published values of surface and interfacial tensions of single-phase solids are collected and discussed critically. Surface tensions are given for Cu, Ag, Au; grain and twin boundary tensions for Cu; and the variation in grain boundary tension with orientation of adjacent grains is considered for Si–Fe, Sn and Pb. In the latter case the inclination of the interface with respect to the crystallographic axes of either grain is probably of less importance than the orientation difference between the two grains, in particular when this difference is small.

13. W. T. Read & W. Shockley, *Dislocation Models of Grain Boundaries* (pp. 352–371; discussion 5 pages). Starting from Bragg's and Burgers's models of a small-angle grain boundary, the following formula is derived for the surface energy as a function of θ (the direction of the axis of relative rotation being kept fixed): $E = E_0\theta(A - \ln\theta)$, where E_0 is calculable from the elastic constants, while A also involves the energy of atomic disorder immediately around a dislocation line. A good check is obtained with experimental data; even an estimate of the absolute energy comes out not too badly. In the discussion B. Chalmers considers effects of impurities.

14. C. S. Smith, *Interphase Interfaces* (pp. 377–401; no discussion). Data concerning interfacial tensions are given for various systems; also solid–liquid data for a number of pure metals. The geometry of lattice interfaces is discussed.

15. A. Guinier, *Substructures in Crystals* (pp. 402–436; discussion 5 pages). Guinier considers crystalline grains to be divided into 'subgrains', disoriented over a few minutes and separated by 'sub-boundaries'. The subgrains are produced by 'polygonization', as occurs, for instance, when a perfect crystal is slightly deformed and then annealed, without, however, producing recrystallization. The properties of sub-boundaries and their constitution is considered, in particular their relation to dislocation theory.

16. B. Chalmers, *The Properties and Effects of Grain Boundaries* (pp. 441–450; discussion 1 page). The effects of grain boundaries on plastic deformation, the support of shear stress, their liability to fusion below the normal melting point of the metal and chemical properties are considered.

17. R. Smoluchowski, *Movement and Diffusion Phenomena in Grain Boundaries* (pp. 451–471; discussion 4 pages). The present state of empirical data concerning the movement of grain boundaries is reviewed. Preferential diffusion along grain boundaries is also considered.

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Dana's Manual of Mineralogy. Revised by C. S. Hurlbut, Jr. Pp. viii+530, with 471 figs. and 22 plates. New York: Wiley; London: Chapman and Hall. 16th ed. 1952. Price \$6·00; 48*s*.

The original author of the *Manual of Mineralogy* was James D. Dana, who was also responsible for the *System of Mineralogy*. The value of the *Manual* as a handbook of the subject, not only for professional mineralogists but also for mineral collectors, prospectors and mining