
REVIEWED BY D. L. MARRIOTT

In the past decade a number of major advances have been made in creep analysis, mostly concerned with cyclic loading and with damage accumulation. Although this progress has been widely reported in scientific papers, little has been done to keep up with the current state of the art with a textbook. Several collections of papers have been published in book form, but these lack the continuity of a single author text. For these reasons Professor Kraus's book is both relevant and opportune.

Professor Kraus deliberately confines his treatment of creep to phenomenological or empirical material descriptions and concentrates on computational methods of interest to the design analyst.

All the recognized and understood creep phenomena such as steady state, transient creep, primary, secondary and tertiary phases, variable and multiaxial behavior are discussed adequately. In addition, recent progress in description of material and component behavior under variable loading is reviewed very competently. There are sections on creep ratchetting and creep fatigue interaction which form excellent introductions to these two highly topical subjects.

The main thrust of the book is toward analysis of component behavior. Professor Kraus is an acknowledged authority in the field of finite-element analysis. Not surprisingly the application of finite elements to creep problems is well done. It is obviously impossible to give a full treatment of finite-element analysis as a section of a book on creep but the basic principles are well laid out, several examples of analysis of complex structures are given, and there is useful advice for the newcomer on the availability of standard computer codes.

A large proportion of the book is given over to approximate methods of analysis such as bounding methods, and reference stress applications—the latter particularly with reference to creep rupture. The field of approximate analysis has a long history of application to creep problems. There was some opinion in the 1960's that the advent of finite-element methods would render all this effort redundant. It is interesting therefore that use of such methods is still advocated, partly because of the high cost of exact analysis, but also because of the insight into the basic structural action which is less easy to obtain by numerical methods. Professor Kraus's book is the first textbook to give a full treatment of the developments in approximate analysis which have occurred in the past 5 years.

One area, not always very well dealt with in textbooks, is the relationship between research, analysis, and design codes. Professor Kraus gives a very clear picture of recent ASME Code developments. He devotes a full section to a discussion of ASME Code Case 1592—the most authoritative guide available at present for high temperature design. This section is invaluable to the newcomer to the subject.

This book is written as an introductory text for an advanced subject. It does not claim to examine the most advanced developments in creep but is aimed more at setting down in easily understandable form, those aspects of the subject which can be used to solve current engineering problems. Its main appeal would be to structural analysts in industry, and as a textbook for graduate or senior undergraduate specialist courses. Given this objective the book is well written with clear explanations and amply supplied with worked and unworked examples. There is no doubt that this text is a welcome contribution to the literature and should become a standard introductory text.


REVIEWED: T. MURA

This is the fourth of five volumes devoted to the behavior of dislocations and their influence on the properties of solids. It contains seven papers concerned with the phenomenon of slip in crystal, the predominant mechanism of the process of plastic deformation, and other processes such as precipitation and fracture. The author, title of paper, and summary of contents of each of these papers are listed as follows:

H. W. Balluffi and A. V. Granato, "Dislocations, Vacancies and Interstitials," pp. 1–133. At the present time, the authors say, there is still a serious lack of reliable and quantitative information on the interaction of vacancies and interstitials with dislocations. This is because the basic properties of the point defects themselves are not yet well enough established.

As a necessary preliminary, the authors begin with a brief account of present knowledge of the lattice properties of the vacancies and interstitials. Then, their interactions with dislocations and the manner in which they probably diffuse to and along dislocations are discussed.

In the regime of low point-defect concentrations, the types of basic information on the dislocation climb, the temperature dependence of the yield stress for locked dislocations, and the striking effects in superconductors are obtained from internal friction (ultrasonic attenuation or damping) measurements.

The interaction between the hydrostatic component of the elastic stress field of the dislocation and the dilation due to the defect, electrical interactions in ionic crystals, and the localized vibrational mode interactions are discussed. Calculations of the configuration and binding energies of vacancies and interstitials in the core of dislocations are introduced. No direct measurements have yet been made of the diffusion rates of either vacancies or interstitials along dislocations. However, several theoretical models and indirect experiments are proposed. Granato and Lücke consider a dislocation line with two types of pinning points (strong and weak pinning points) and calculate the damping and modulus changes for all frequencies.

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5 Professor, The Technological Institute, Department of Civil Engineering, Northwestern University, Evanston, Ill. 60201.
F. Larché. "Nucleation and Precipitation on Dislocations," pp. 134–153. Dislocations can act as catalysts for nucleation of a new phase in solids. The misfit strain of a precipitate is accommodated by the strain field of the dislocation, reducing the activation energy necessary to the formation of a nucleus. The difference between coherent and incoherent interfaces is not clearly mentioned in the text from the mechanical point of view.

P. Haason. "Solution Hardening in f.c.c. Metals," pp. 154–189. The f.c.c. metals have low values of the Peierls-Nabarro force whereas b.c.c. metals have high values. The dislocation theory of solution hardening depends strongly on the crystal structure. Haasen writes for f.c.c. metals in this chapter and H. Suzuki writes for b.c.c. metals in the following chapter.

The elementary interactions between a single foreign atom and a dislocation on a nearby slip plane, the force to derive a dislocation through a solid solution at T = 0, temperature and inertia effects, and experimental results are treated in a very organized way.

H. Suzuki. "Solid Solution Hardening in Body-Centered Cubic Alloys," pp. 190–217. This chapter is very original in the sense that most of the materials in the text are the author's work. Nevertheless, the author gives fair credits to other researchers’ papers. The author uses a new statistical method by which he calculates the average velocity of the motion of a kink overcoming a random distribution of barriers caused by solute atoms. The statistics involve finding k solute atoms in N total number of atoms entering the dislocation core and finding possible motion of a kink. His theoretical prediction for lower yield stresses of iron alloys is compared with Takeuchi's experimental results.

V. Gerold. "Precipitation Hardening," pp. 218–260. For shearable particles the author discusses the origins of the interactions between dislocations and particles through chemical, elastic, atomic ordering, and stacking fault considerations. However, our knowledge about the subject is still vague. The theories predicting the macroscopic yield stress from the interactions mentioned previously are not satisfactory when a number of dislocation-particle geometrical encodings are conceivable.

The Orowan process of the dislocation line tension for non shearable particles is treated reasonably well in the text. However, the author's treatment on the dispersion hardening due to Orowan loops contains some ambiguities on the image stress, the average stress in the matrix and that in the inclusions. The author should have read and cited as references the celebrated papers of K. Tanaka and T. Mori, Acta. Met., Vol. 18, 1970, pp. 931–941 and of T. Mori and K. Tanaka, Acta. Met., Vol. 21, 1973, pp. 571–574. They correctly defined these quantities and obtained them rigorously.

Recent progress in the temperature-dependent relaxation mechanism is also not properly mentioned in the text. The author should have studied the review paper by L. M. Brown, Proceedings, 5th International Conference Strength Metals Alloys, 1979, p. 1551.

S. J. Basinski and Z. S. Basinski. "Plastic Deformation and Work Hardening," pp. 261–362. According to Cottrell, this subject was the first problem to be attempted by the dislocation theory of slip and may well prove to be the last to be solved. The authors completely agree with Cottrell and state that the reason lies, at least partly, in the very large number of parameters which, even in the simplest case of tensile deformation of a single crystal, include such variables as crystal orientation and purity. Since many review articles representing many points of view have been published over the years and the available experimental evidence has been documented in reasonable detail, the authors say, special consideration is given to areas where relatively recent work has in some way changed the perspective. In view of the extensive body of literature on plastic deformation, the frame of reference established here is tensile deformation of pure f.c.c. crystals, primarily Cu deformed in single glide. The article contains surface effects, transmission electron microscopy of Ge foil and of neutron irradiated Cu, latent hardening and quantitative secondary slip data, and thermal glide. Well-organized and substantial discussions follow each subject. Only very few mathematical equations appear in the whole text.


Reviewed by T. Mura

This is the last of five volumes devoted to the behavior of dislocations and their influence on the properties of solids. It contains seven review papers which fall into two groups. The first group treats the influence of ordinary translational dislocations and the second group treats the theory and properties of rotational dislocations (disclinations). The author, title of paper, and summary of contents of each of these papers are listed as follows:

C. J. Humphreys. "Image of Dislocations," pp. 1–56. This chapter concentrates on the most important techniques for the imaging of dislocations and in particular upon significant recent developments which have not yet been reviewed in other publications. Early developments, up to 1964, have been covered in the book of Amelinckx (The Direct Observation of Dislocations, Academic Press, New York, 1964).

The article contains a simple quantitative physical explanation of the method and the theory for describing a particular imaging technique, the theory and principles of electron propagation in crystals, the many-beam dynamical theory of electron diffraction, high-voltage electron microscopy, X-ray for bulk specimens, and recent developments in field-ion and optical microscopy.

B. Mutafchiev. "Crystal Growth and Dislocations," pp. 57–126. Half of the chapter is devoted to the theory of crystal growth. The second part of the chapter is limited to examples of growth morphology by a dislocation mechanism. The third part deals with the generation of dislocations during crystal growth.

Within a few months of the presentation of Frank’s theory (1949) for the behavior during growth of flat faces containing dislocations, the first experimental support appeared. L. J. Griffin (1950) found systems of steps corresponding exactly to the prediction of the theory by observation of the surface of natural beryl crystals by phase contrast optical microscopy. Now, however, the authors says, some of the conclusions or interpretations on the crystal growth through dislocations obtained in the last decade are not as sure as they first appeared. For example, the existence of spirals with a step-height much larger than monomolecular shows that the nonsplitting of a step could not be a proof for its elementary height.