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Book Review

Quantitative Stereology

E. E. Underwood

Pp 274 (Addison-Wesley, 1970) £1·85.

The publication of this long-awaited book is an event of major importance for materials scientists who occasionally look down a microscope – that is, for materials scientists. It represents nothing less than a complete and systematic treatment of the quantitative aspects of microstructure. It is not only the best comprehensive account of the subject – it is also the only one. Most of the information collected here has appeared in fragmented form, but it has never before all been brought together in one place.

At first sight, the kind of problem with which Dr Underwood concerns himself is quite simple: for instance, he may want to know the grain size distribution of a piece of metal, the volume fraction and mean separation of a dispersed phase, the degree of orientation of dislocation lines, the degree of elongation of the grains in a recrystallised structure. It is not until one reads the painstakingly rigorous treatment of problems such as these, and the acute care taken in defining terms and proving relationships, that one comes to appreciate the complexity behind the seeming simplicity. As with $E = Mc^2$, the end-results are often simple but the arguments leading to them are not.

Essentially the book is concerned with the derivation of quantitative information about three-dimensional microstructure from measurements made on two-dimensional sections. The author begins by distinguishing the principal categories of measurements – point counts, lineal analysis, area summations – and assessing the basis on which statistical errors can be estimated. He goes on to derive by statistical methods the exact relationships between different one-, two- and three-dimensional quantities, such as for instance those between area and volume fractions of a phase. It is here that a number of surprisingly simple relationships emerge; the author is always punctilious about establishing their correctness by mathematical argument.

The book continues with the methods of quantifying degrees of orientation in microstructure, both for arrays of lines and for arrays of grains in two-dimensional sections. He continues with an analysis of particle and grain characteristics, initially those with uniform dimensions. This is particularly interesting in its detailed analysis of the concepts of diameter and mean free distance. The next chapter deals with the mathematically extremely difficult task of deriving a true *distribution* of grain or particles sizes from an apparently two-dimensional distribution. This is difficult, of course, because even if the grains are in fact all of the same size, the apparent sizes of their cuts by the plane of

section are not, and so we have to deal with two hierarchies of variation at once. The book would be worth having for this chapter alone.

Next there is a detailed treatment of projected images, as for instance dislocation lines as seen by TEM, and finally the author tackles what is conceptually the most difficult part of the subject, the quantitative specification of shape in three dimensions from the examination of section. The derivation of mean curvature in three dimensions from measurements on the section is particularly interesting, and so is the summary of topological relationships.

Throughout the book, formulae are given in a way that permits their immediate use; where they are needed tables of coefficients are given. The reader may test his understanding by attempting the numerical exercises at the end of each chapter. He will be helped by the author's care in specifying the pros and cons of the various alternative ways of deriving particular parameters.

Now that various manufacturers are offering electronic scanning instruments with miniature computers to assess such features as two-dimensional volume fractions of phases, this book will be an essential piece of equipment in properly instrumented metallographic, ceramographic and histological laboratories.

R. N. CAHN

Short Notices

Crystal Growth in Gels

Heinz K. Henisch

Pp 111 (Pennsylvania State University Press, 1970) $6.95

This short volume by the Associate Director of the Materials Research Laboratory at Penn State is the work of an enthusiast, who grows crystals because he loves them, needs them and wants to know why his methods work. Crystals grow well from hydrogels because the reactants diffuse slowly through the gels and because the rate of nucleation can readily be kept down. The author explains what crystals can be grown, how to do it, why gels behave the way they do, and concludes with a chapter full of unsolved problems. As he says, here is one field where "the scales are not completely weighted in favour of the deluxe experimenter".

R.W.C.

Materials Science and Engineering in the United States

Rustum Roy (editor)

Pp 177 (Pennsylvania State University Press, 1970) $9.50

This volume contains the Proceedings of the National Colloquy on the Field of Materials, held at Penn State in April 1969. Various authors survey the development of materials science education in the US and Britain, the role of the US Federal Government in fostering it, the problems of administering large interdisciplinary projects, and the demands likely to be made on the subject (field, discipline, profession?) by future technological tasks in the US. The political accounts in particular make some interesting points, which is perhaps more than one can say for the quasi-theological convolution on matters of terminology. The acicular ballet of angels still, it appears, excites comment.

R.W.C.

Mechanical Behaviour of Materials under Pressure

Ed. H. W. D. Pugh

(Elsevier Publishing Company Ltd). 785 pages £16

More and more industrial processes are making use of high pressure technology in the manufacture of materials and components, and this is a timely volume which seeks to cover the effects on the mechanical properties of materials subjected to pressures of up to 35 Kb.

Following a useful historical introduction to the subject there are specialist review papers