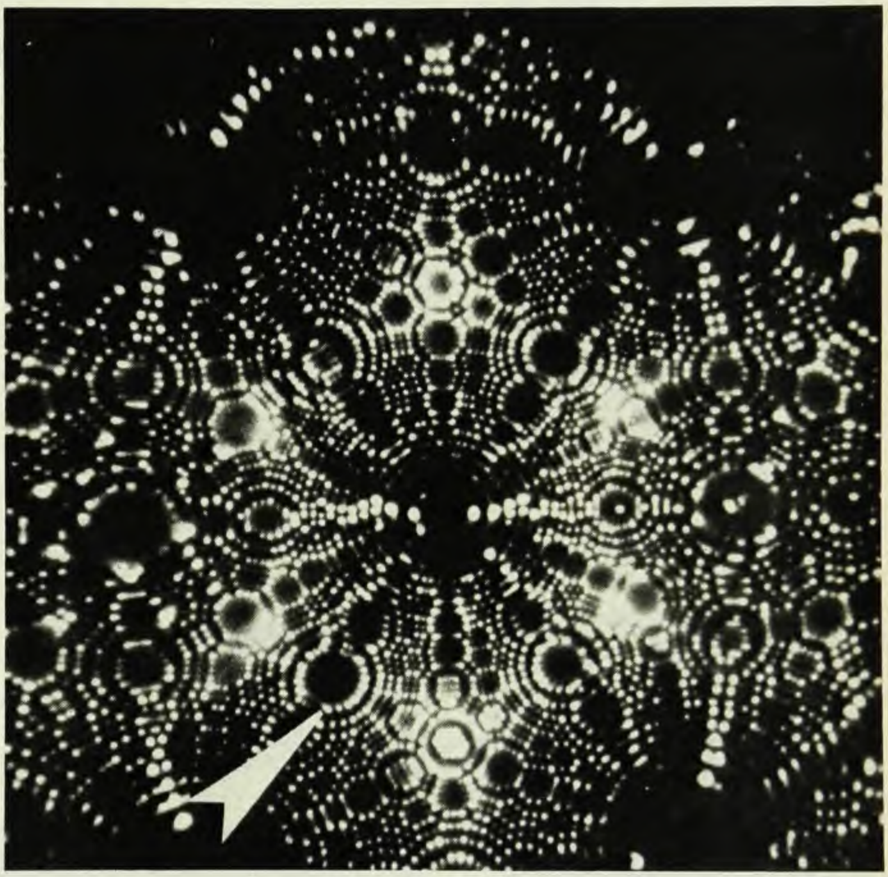
books

Unscrambling alphabet soup: a beginner's guide

Microscopy of Materials: Modern Imaging Methods Using Electron, X-ray and Ion Beams

D. K. Bowen, C. R. Hall
304 pp. Halsted, New York, 1976. $27.50

Reviewed by John M. Cowley



A single tungsten atom (arrow), magnified more than two million times, is picked out from the thousands surrounding it by an atom-probe field-ion microscope. Pennsylvania State University.

It was just twenty years ago, in 1956, that the first direct observations of dislocations were made with the electron microscope. Since then we have seen a great proliferation of new techniques for the study of the microstructure of materials, resulting in an enormous expansion in the knowledge of the structures and defects of solids within the size range from the micrometer level to atomic dimensions. An adequate theoretical basis for the interpretation of the image contrast shown by dislocations and other defects was provided by Peter Hirsch, Archie Howie and Mike Whelan in the late 1950's and early 1960's in Cambridge, and later also in Oxford. Then Andrew Lang of Bristol showed how x-ray-diffraction topography could be used to image such defects on a coarser scale, while the group in the Engineering School in Cambridge developed the scanning electron microscope. Raymond Costaing in Paris introduced the electron microprobe analyzer, Erwin Müller showed how to image single atoms on metal surfaces in the field ion microscope, and a whole alphabet soup of special techniques for studying surfaces (AES, ESCA, LEED, SIMS and others) has grown up in the last few years.

All of these techniques and many more related ones have generated a mass of literature that can only be confusing to the uninitiated. There is a definite need for beginners' guides in this field, to provide good clear summaries of what techniques are available, what they can do and what they cannot do. One such guide is *Modern Metallographic Techniques and Their Applications* by Victor Phillips, who covers both diffraction and imaging techniques. In the book under review, David Bowen and Christopher Hall have taken a somewhat different approach, concentrating on the imaging methods. They state that undergraduates are their primary audience. The level of presentation appears appropriate, and undergraduates could get a kick out of reading some parts, but it is difficult to see how such a verbal barrage of state-of-the-art details could form a satisfactory undergraduate course. The secondary audiences suggested, interested graduates and practicing researchers in related fields, appear more appropriate.

The presentation is well organized. First the authors briefly summarize the techniques to be covered and suggest introductory reading. Then chapters follow on scanning electron microscopy, microanalysis (including Auger electron spectroscopy, laser-microprobe analysis and so forth), transmission electron microscopy, x-ray topography, field ion microscopy and finally "unconventional and new techniques," with a guide for further reading and a selection of key references for each chapter. The authors have tried to keep the book nonmathematical, apart from a partially successful attempt to present a simplified dynamical diffraction theory. They provide a description of the essential features of each technique and examples of typical applications, without too much involvement with the rapidly changing instrumental scene. For the most part they succeed, but there are sections where the writing is rather turgid and the ideas confused. One notes several bad minor errors, such as the association of a terminating fringe in one of the figures with the extra half-plane of atoms of an edge dislocation, or the use of incoherent imaging theory and even ray diagrams in their discussion of the reciprocity relationship of wave optics.

As disciples of the Oxford–Cambridge school, the authors naturally follow the original Hirsch–Howie–Whelan presentation of electron-microscope contrast, but it is surprising that they should do so to the extent of ignoring the many other aspects of electron microscopy and other contributions to image-contrast theory. Here their account is unbalanced. The ultra-high resolution capabilities of the scanning transmission electron microscope receive mention, but the extensive applications of equivalent resolution with the conventional transmission electron microscope, which have been much more fruitful for materials research, are ignored. Defects of this sort may be unavoidable in a survey of a rapidly developing field. Inevitably the book is already slightly outdated, and it will be completely so in five or ten years; within this finite lifetime, it will serve its purpose well.

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The Measurement of Appearance

R. S. Hunter
348 pp. Wiley, New York, 1975. $19.50

The quality of materials and products is judged largely on the basis of appearance. Apart from shape and size, with which Hunter's book is not concerned, appearance is governed by color and surface properties (such as gloss, sheen and haze), the measurement of which is the subject of this book. Based on the author's almost half-century as the foremost contributor to the measurement of surface characteristics, this is a unique compendium of information; it includes history, instrumentation and practical suggestions for evaluation of the appearance of such varied materials as paper, cotton, tomato juice, oil and chrome plating.

The author began his work on the subject at the National Bureau of Standards, continued it at the Gardner Laboratory (one of the first commercial laboratories engaged in appearance evaluation) and then established the Hunter Associates Laboratory, which is devoted to instrumentation, service and consulting for appearance measurement. The commercial importance of the subject is indicated by the large number of pertinent standards adopted by the American Society for Testing Materials, the NBS and the Commission Internationale de l'Eclairage.

The CIE established the standards for specifying color, but not for gloss or other surface characteristics. Hunter's book is without peer for measurement of the latter but seems myopic concerning color. *Principles of Color Technology,* by Fred W. Billmeyer Jr and Max Saltzman (Wiley, 1966) is better balanced and less confusing as an introduction to color measurement. *Color in Business, Science, and Industry, 3rd edition,* by Deane B. Judd and Gunter Wyszecki (Wiley, 1975) clearly and authoritatively covers most of Hunter's material on color.

Table 6.1, which distinguishes six types of gloss, appears to contain an error. The reflectance function of surface-uniformity gloss is listed as being "not a function of reflectance", whereas, for the other five types of gloss, reflectance is reported to be a function of *viewing angle.*

Although spectrophotometric measurements are basic to the measurement of color, and many spectrophotometric curves appear in the book, Hunter devotes only three pages of text to spectrophotometry. The remainder of the short chapter on instruments for measuring color deals with Hunterlab 3- (or 4-) filter colorimeters.

Hunter states that "additive mixtures are always lighter than any of the individual components." This has been shown by many workers to be not true. For example, the white light obtained by additively mixing red light (say, 630-nm spectral light) with a suitable amount of its complementary bluish-green (around 492 nm) is noticeably darker than the latter, even though its radiant power is the sum of the two components. This visual effect complicates both photometry and specification of lightness of opaque materials, for which it can be significant.

The parenthetical statement that "only Munsell Value is a true reproduction of visual data" is an example of the circular reasoning that characterizes the use of Munsell data for testing formulas and color diagrams and spaces in this book and in much of the other literature of color. The so-called "visual data" had their source in the quintic function that is here said to reproduce them. That function was originally derived to fit (approximately) the reflectances of a series of gray papers that had been painted so as to appear equally different. Subsequently, the aim reflectances for repainting the papers were revised to agree exactly with the function. As Hunter indicates, the aims and subsequently repainted chromatic Munsell Colors underwent similar revision to fit more closely a theoretical color diagram. Consequently, the Munsell Renotation data also should not be called "visual data"; use of them to test color diagrams or spaces is fallacious.

A similar fallacy appears in the captions of two of the figures (8.5 and 8.9). The ellipses shown do not represent just-noticeable differences. In both figures, they are merely transformations of circles drawn on Judd's 1935 diagram, which only very crudely fitted the fragmentary visual data available at that date.

The book is definitive concerning gloss and related surface characteristics; I recommend it for anyone interested in those subjects. For color, however, familiarity with *Principles of Color Technology* or *Color in Business, Science and Industry* is advised.

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Four classes of objects. Left to right, the plastic box shows diffuse reflection, the candleholder specular reflection. Diffuse and specular transmission are seen with the tumbler and glass jar.