Transmission Electron Microscopy of Minerals and Rocks

Alex C. McLaren
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Although transmission electron microscopy (TEM) is now used extensively for the observation of microstructures in minerals and rocks, this is the first single-authored TEM book primarily for geologists. Alex McLaren, one of the pioneers of the subject, writes with authority and clarity.

This is not a book for the novice nor is it intended to be a practical manual. Rather it is, as the author states, "an introduction to the basic principles of the technique and of the interpretation of electron micrographs and electron diffraction patterns."

After a short introduction that incorporates a brief history of the application of TEM to mineralogy, the book is divided into two roughly equal parts. The first part deals with the essential physics of the electron microscope and the basic theories required for the interpretation of images and diffraction patterns. This section should be accessible to those with limited training in physics and mathematics, requiring readers to have studied those subjects only to first-year university level. However, most geologists do not have even this amount of training in physics and mathematics and may find the theoretical sections difficult. However, the physical significance of the theories is clearly explained, and the diagrams are excellent. I would recommend the first section of the book to any materials scientist as a clear, thorough, and up-to-date introduction to the theory of electron microscopy.

Chapter 1 deals with the principles of image formation. The experimental conditions for image formation using light-optical lenses (the Porter experiments) are described in detail, and readers may use this section for teaching purposes. In the second chapter, the TEM and light microscopes are compared. Lens aberrations, the effect of defocus, and specimen preparation are also covered, but unfortunately only a page is devoted to the latter topic. Considering its importance, a more detailed discussion of ion/atom thinning, with the minimization of artifacts and "tricks of the trade," would have been useful.

Chapter 3 is devoted to the kinematical theory of electron diffraction. The geometry of Kikuchi lines and the measurement of s is clearly explained, but the omission of a section on Kikuchi maps and the use of Kikuchi bands for finding one's way around reciprocal space is unfortunate. A discussion of the conditions for which the kinematical theory is valid and examples of its breakdown lead into Chapter 4 and the dynamical theory. The theory is developed from the points of view of the solutions of both the Schrödinger and Howie-Whelan equations.

Chapter 5 describes the contrast from defects such as planar defects (using the treatment of Gevers van Landuyt and Amelinckx), dislocations, and small precipitates. A particularly valuable section is devoted to weak beam imaging of dislocations and the experimental conditions required to obtain them.

High-resolution TEM is covered in Chapter 6 and includes a summary of the necessary experimental factors for optimum HREM images. The last chapter in this section is a brief summary of chemical analysis in TEM, including ALCHEMI.

The remainder of the book describes examples of mineralogical applications of TEM. Defects and microstructures from undeformed specimens are covered in Chapter 8, and microstructures associated with deformation are covered in Chapter 9. The examples reflect the author's own interest but cover most types of defects found in minerals and materials in general. However, the non-mineralogist may find this section difficult to follow as mineralogical terms are not explained.

Most of the topics are well supported by references for readers who want to take the subject further; the only exception is the section on specimen preparation. The single disappointing aspect of the book is the quality of the micrographs and diffraction patterns, some of which are so dark that the features of interest are difficult to see.

Reviewer: P.E. Champness is a reader in crystallography in the Department of Geology, University of Manchester, United Kingdom. □