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Book Review

Principles and Techniques of Scanning Electron Microscopy. Volume 1; Biological application. Edited by M. A. Hayat. Van Nostrand Reinhold Company. 1974. 273 p. $30.00 and Scanning Electron Microscopy. O. C. Wells. McGraw-Hill Book Company. 1974, 421 p. $30.00.

It is now a decade since the Scanning Electron Microscope (SEM) became commercially available and since then these instruments have established themselves as valuable scientific tools and made significant contributions to Biology.

Until recently, literature on the SEM and the associated techniques could only be found in specialized scientific literature and in proceedings of SEM Symposia. Now however, text books dealing with general and specialized aspects of SEM are beginning to appear. The book "Principles and Techniques of SEM" is one in a comprehensive series on Electron Microscopy written or edited by Hayat. In this particular series Hayat plans four volumes. This first presents a general account of the principles of SEM as well as methods for the preparation of botanical material. Subsequent volumes will concentrate on the processing of other biological material.

As with many books of this nature, the style of the contributing authors is variable. In general they are of adequate standard. The initial chapter by Black which introduces the operating principles of the SEM is particularly good. This is written in such a way that the operation of the SEM can be understood with only a minimum knowledge of theoretical electron optics. However, there is sufficient mathematical and theoretical discussion to allow an understanding of the limitations and various compromises which have to be made in operating a SEM. Black considers briefly the production of images with the SEM and the use of stereo pairs. There is also a brief paragraph on the Scanning Transmission Electron Microscope (STEM).

The chapter on Critical Point Drying (CPD) by Cohen is also very comprehensive. He deals first with the basic physics of CPD then with the practical aspects of this useful technique. There is a detailed section on the processing of botanical material for CPD. However, methods of handling other biological material are also given, ranging from micro-organisms to large massive organs such as liver, kidneys and testes. Emphasized in this section is the need for good fixation, particularly the double-fixation techniques using glutaraldehyde and osmium tetroxide. Although not appropriate to this chapter, there is a small section on the storage, mounting, and gold coating and examination of specimens after CPD.

The two short chapters on cryotechniques describe rather briefly the methods of observing internal structures of biological specimens by cracking the material while frozen under liquid nitrogen. These techniques also allow the examination of uncoated material at lower magnifications.

There is a short terse well-written chapter by Nemanic on the preparation of stereo slides

from stereo pairs. He deals with the various methods of viewing stereo pairs, using either polarized light or the red and green light techniques. Particularly exciting here is the anaglyphic technique. This technique allows direct real-time three-dimensional viewing on the SEM and shows how to increase the informational content of SEM images. In a short chapter on low magnification study of uncoated specimens, Howden and Ling by using a modified JEOL SEM show how they can view large biological material without charging effects. They point out the difficulties with this technique, one in particular being the considerable amount of distortion produced with the low magnification.

The three chapters dealing with spores, aerial surfaces of higher plants and plant cell walls and intracellular structures show the difficulties of dealing with delicate plant material. This shows clearly in the shrinkage and other artifacts in the low quality SEM micrographs used as examples in this chapter.

A particularly useful chapter is by Panessa and Gennaro on intracellular structures. They introduce some interesting techniques for producing self-conductive specimens, which obviate the necessity for coating with gold. Also described here are techniques for the removal of material from the SEM and subsequent examination with the Transmission Electron Microscope. The authors illustrate here very clearly how the two methods of observation complement one another.

The final chapter by Borgin on wood is straight forward and illustrates some problems with preparation of hard woods for SEM.

"Scanning Electron Microscopy" by Wells, which has contributions by Boyde, Lifshin and Rezanowich, is quite different from that by Hayat.

The introduction deals briefly with the various forms of SEM and gives a very nice historical account of the development of these instruments. It is interesting to note that one of the first commercial SEM's built (by Cambridge University Engineering Laboratory) was used by the Pulp and Paper Research Institute, Montreal, between 1959 and 1968. Following the introduction, Wells considers in detail various aspects of the SEM such as signal to noise ratio, electron interaction, resolution and instrument design. In each instance he begins with basic principles then develops the topic to the stage where the implications for optimal operation of the SEM are apparent. As in Hayat the various compromises required are indicated, but here the treatment of each topic has more depth. In chapter six on "Contrast and resolution", Wells deals not only with secondary electrons for image formation, but also with low-loss electrons. This latter technique is now being used increasingly to provide much better resolution than possible with secondary electrons. It is here that Wells clearly shows he is up-to-date with the most recent developments in SEM. The contributions by Rezanowich and Lifshin on papermaking and on X-ray generation and detection respectively are comprehensive and well-written.

Boyde contributes two chapters, on "Three-dimensional aspects of SEM images" and on "Histological and Cytological methods". Both are excellent. Boyde pioneered the use of a number of techniques for stereo-images with the SEM and these are well illustrated with stereo-pairs. This chapter is far superior to the similar one in Hayat. The chapter on histology is similarly good, being well illustrated with stereo pairs – a technique for presentation of SEM micrographs that increases information content considerably and should be used more. No doubt editors concerned with costs do not look favourably on this illustrative method. As in Hayat, sources of supply for materials mentioned are given. There is a very good bibliography as well as a name and subject index. Wells' book is more authoritative than that by Hayat and he has edited the contributions well with resultant consistent style and minimum overlap of subject areas. It is also a better value for the money being a larger book, but the two books are complementary. One provides details for biologists with special requirements, the other is concerned with understanding and manipulating the SEM to achieve maximum performance.

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