Focus on microscopy

MICROSCOPIC AND SPECTROSCOPIC IMAGING OF THE CHEMICAL STATE - A BOOK REVIEW

By Barbara Foster

AN OBSERVATION has been made of American scientists that, as a group, we tend to be overly compartmentalized by discipline, often to our own detriment. Chemists rarely speak to biologists; geologists only talk to physicists when it comes to something like tectonic plates. Several months ago, Marcel Dekker (New York) released a book that promises to be a valuable bridge: *Microscopic and Spectroscopic Imaging of the Chemical State*, edited by Michael Morris.

Any researcher, technician, or analyst involved with materials characterization, whether it be polymeric, biological, semiconductor-related, or geological, will find value in this collection. It starts with the most visual of techniques, optical microscopy, moves to the nearby infrared regions, introduces the complexities of image processing, then proceeds to a range of scanning probe and photoacoustical/photothermal imaging. The final third of the book concentrates on imaging in more spectroscopically oriented technologies, including X-ray emission, secondary ion mass spectrometry, and electron paramagnetic resonance(EPR) and nuclear magnetic resonance imaging.

The authors have done an exceptional job of covering an extremely wide range of applications, often including interesting surprises. For example, although acoustical microscopy is typically associated with the semiconductor industry, both it and its companion technology, thermal wave microscopy, have significant biophysical applications. In her chapter on those topics, Joan Power includes measurement of the chromophore distribution in bovine retinal tissue and elucidation of the layered structure in lichens. Another technology, EPR, is usually associated with the chemical laboratory, but in their chapter authors Gareth and Sandra Eaton also present solutions in geology.

Strengths and weaknesses

The greatest strength of this book is its breadth. It is rare to see so many microscopies and so many specific applications covered in one place. By and large, the authors have presented lucid discussions of basic principles, followed by details of equipment design, pragmatic operating considerations, and methods of image formation and interpretation. In most chapters there is enough mathematics to lend credence and depth to the discussion but not so much as to be burdensome or demand expert understanding. This collection is a good, solid starting point for anyone new to any of the technologies discussed.

Ironically, the weakest link in the collection is Chapter 1, "Fundamentals of light microscopy." It is rife with inconsistencies and errors and would have benefitted from simpler, more descriptive diagrams, especially for Koehler illumination and confocal microscopy. It also would have been the logical place for more details on some of the basic contrast-enhancement methods not covered in the applications chapter, most notably oblique and axial illumination, Hoffman modulation contrast, and differential interference contrast. The author suggests reading the appropriate sections of Delly,[1] Spencer,[2] and Inoue[3] for more accurate presentations of the basic principles of light microscopy.

A second doubtful entry, for different reasons, is Robert Morris's discussion entitled, "Fundamentals of computer image processing." Although the presentation itself is laudable, it is overly mathematical in the context of the other chapters. Dr. Morris might have served the reader better by taking a more qualitative approach; for example, discussing the gray level histogram more in terms of input and output, then comparing changes in the histogram to related changes in the image. In his defense, his use of one image to show the results of various types of image processing was effective, as was his discussion of how image filters were created.

Also noticeable by its absence was a chapter on measurement. Although some topics such as hot stage work were discussed in "Applications of light microscopy," the bulk of measurements were overlooked. An overview on interferometry, especially as it applies to thickness measurements and surface roughness characterization, would have been valuable, as would an extension of image processing into the basics of field-specific stereology and feature-specific morphometry. The latter two are expanding at astronomical rates as technologies such as confocal and scanning probe microscopies and image processing mature and are supported by more powerful computers. Investigators need more informa-

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tion on what these technologies provide vis à vis the images collected and how to use them.

On a more positive note, it was good to see cross-fertilization between microscopies. One example was Robert Odom's correlation of confocal laser scanning images of cultured cell Golgi complexes with the ion microscope images of calcium in the same region (Chapter 10, Figure 20). The ultimate illustrations, however, are found in Duane Krueger's "Applications of light microscopy." The chapter was eloquent and meaty, providing one instance after another in which microscopy, spectroscopy, and physical testing were integrated. Rarely has this author seen so much said so simply and concisely.

Hot topics for today and tomorrow

Scanning probe microscopies are beginning to mature, and this section was nicely handled. Bradford Orr's lucid discussion on fundamentals set the stage for the more detailed discussions of scanning tunneling and atomic force microscopy by Patrick and Beebe and near field optical microscopy and related chemical sensors by Kopelman and Tan.

A walk around PittCon '93 emphasized the proliferation of secondary ion mass spectroscopy (SIMS) and especially the new time-of-flight (TOF) spectrometers. Robert Odom's section on this technology was up-to-date and a good starting point for laboratories considering this approach. Another technology to watch for new development in the near future is discussed in the chapter by Gordon and Jones entitled, "X-Ray emission imaging." They did an especially good job of presenting potential sources of interference.

In summary

Microscopic and Spectroscopic Imaging of the Chemical State is a valuable general reference. Although many of the technologies presented are related, most of the chapters can stand alone, providing a quick source of current information. The book is a rich source of bibliographic material and presents an amazingly wide variety of applications, sure to pique the interest of anyone involved in mapping or imaging the chemical state.

References

1. Delly J. Photography through the microscope. Rochester, NY: Eastman Kodak Co., 1988.
2. Spencer M. Fundamentals of light microscopy. Cambridge, U.K.: Cambridge University Press,1982.
3. Inoue S. Video microscopy. New York: Plenum Press, 1986.

Solution to December puzzle

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