

Book reviews

Negative Staining and Cryoelectron Microscopy: The Thin Film Techniques. By J. R. HARRIS. RMS Handbook No. 35. Bios Scientific Publishers, 1997. 208 pp. £16.95/US\$33.95 (paperback); £12.50 for RMS members. ISBN 1-85996-120-7.

The creation and manipulation of thin films containing molecular or ordered macromolecular assemblies has offered biologists the opportunity to investigate structure using the high-resolution imaging methods available with transmission electron microscopy. This book charts the course taken over approximately the past 50 years by experimentalists exploiting steadily improving microscope performance in order to elucidate better structural information from their samples. This is an excellent book for someone just starting to use electron microscopy. It is written in a relaxed, easy-to-read style and contains many practical hints and technical insights. The author has been at pains to point out the personal preferences and idiosyncrasies in the protocols. I found the descriptions well focused on the important task of preparing not only the sample, but also the researcher. Together with the instructions are examples of what can go wrong, what it will look like when it goes wrong, what special requirements some samples have and how other investigators have negotiated similar difficulties. The text is a particularly rich resource of cited literature. It provides a fund of references – both current and reaching back to important early publications.

The book is divided into two extensively linked halves, the first of which deals with negative staining in historical and preparative sections together with extended descriptions of particular applications. Described variations include Valentine's method, Lake's adaptation, immunolabelling, staining samples over holes and combined staining/shadowing. Factors relevant to good staining are outlined and advice given on aspects of carbon surface properties, glow-discharging, additives such as bacitracin, etc.

Unstained cryoelectron microscopy is described in the second half of the book, and the methodology is especially well illustrated. The choice of cryogen, operational requirements of a cold stage, additional anticontaminator and methods of sample storage are all given adequate coverage, together with concern for new potential issues of safety.

This Handbook belongs in the laboratory rather than the library and I imagine it located on a shelf equally distant from a bottle of uranyl acetate and a cylinder of ethane. As a guide its main weakness is brevity, but this is forgivable

as the content spans two wide subjects within about 200 pages. In fact, the section on computer processing and image reconstruction I would describe as extremely thin. However, the reference lists at the end of each chapter compensate by directing the reader to more extensive reviews and research papers. There is also a helpful appendix of suppliers of equipment and software.

I am sorry to say that I found that the frequent references to the possible benefits of trehalose were somewhat irritating (15 indexed and more besides) and upset the overall balance of the book – an additive too far perhaps? However, I certainly don't want to end negatively. Such *idées fixes* are the pulse of the subject: some people neutralize their PTA with sodium, others with potassium and there are others who would use nothing other than lithium. The essence is in the hunt for the best preparative conditions in order to get the best images, be they heavy metal or ice cool.

JOHN BERRIMAN

Near-field Optics – Theory, Instrumentation and Applications. By MICHAEL A. PAESLER and PATRICK J. MOYER. John Wiley & Sons, Inc., New York, 1996, xii + 355 pp. ISBN 0-471-04311-7.

This is the first book on an emerging field in physics and microscopy: near-field optics (NFO), i.e. the optics of subwavelength-sized material structures. At first glance it may seem surprising to find blank unexplored territory at all within the mature, respected and well-documented field of optics. Optical microscopy especially has been explored, developed and perfected through centuries, with its multitude of contrast methods, application in all sciences and operation from astronomical distances way down to the diffraction limit of the wavelength itself. The near-field domain beyond the diffraction limit, dealing with non-propagating waves, has stayed beyond the scope of classical opticians. In the currently developing age of 'nanotechnology', the study and understanding of the near-field optical properties of 'nanostructures' is rapidly gaining importance, thus stimulating NFO instrumentation and theory. Experimental NFO took off in 1982, directly following the development of scanning tunnelling microscopy in 1981, even before atomic force microscopy. Though among the first in the expanding variety of scanning probe methods, within the scanning probe community near-field optics has long been considered as

an eccentric curiosity of mainly academic character, especially compared with the booming impact of force microscopy. Only gradually, with improving efficiency and versatility through the development of adiabatic fibre pulling and shear force feedback in 1991, has NFO started showing its latent promises of 'optical contrast' at nanometre dimensions. The steadily growing number of applications, ranging from materials science to biology, demonstrates the potential of NFO and the timeliness of this book.

The authors are both strongly committed to NFO, contributing to the development and promotion of the field for many years. The organization of the 2nd international NFO conference in Raleigh, North Carolina, in October 1993, and the first SPIE NFO symposium in San Diego, California, in July 1995, was in their hands. Moreover, P. Moyer is the designer of the first commercially available near-field scanning optical microscope (the Aurora) with the TopoMetrix Corporation, California.

With the awareness of describing an unsettled research field and running the risk of writing a topical issue, the authors have shown the courage to face this challenge and use their valuable research time to open up the specialized near-field to a wider range of interested readers. The book provides a very good introduction for newcomers into this exciting field. It serves both as a reference and as a users' guide. The book is very readable, clear and instructive, written from a practical point of view, accessible to graduates in a wide range of sciences. Though focused on engineering and physical disciplines, the book is certainly a good introduction to readers interested in chemical or biological applications. With their vivacious style the authors add a certain verbal imagery to the visual aspect of NFO microscopy, sometimes with a critical wink to the near-field community. The text is complemented with practical graphs and schemes. Several NFO images, of which a few are in colour, are reproduced, though more might be expected from a microscopical technique. The book is up to date, covering NFO developments and applications up to the 3rd international NFO conference in Brno, Czech Republic, in May 1995. I am grateful to the authors for making systematic use of the acronym NSOM (near-field scanning optical microscope) throughout the book, in order not to confuse the reader with the burdensome overabundance of acronyms as scattered in near-field literature.

After opening with a clear index and a foreword by Dieter Pohl (IBM Zürich), founder and conscience of the near-field optical discipline, the contents are divided into four parts.

(I) *Theory and instrumentation.* The near-field aspects are extracted from conventional imaging theory. The NFO 'aperture-type' probe (i.e. the metal-coated tapered optical fibre) is treated in detail as to mode coupling efficiency and fabrication by fibre pulling and etching. Moreover, alternative probe designs to surpass the cut-off dimension and to introduce versatility are discussed. Theory contains an

insightful Fourier treatment, the dipole approach and more rigorous numerical approaches which cope with the complicated near-field interaction between probe and sample. General instrumentation aspects of probe microscopy, such as vibration isolation, piezoelectric scanners, electronics, light sources and detectors, force feedback, and spectroscopic and cryogenic operation, are extensively described. This part ends with an unexpected chapter on photon tunnelling microscopy (PTM), an effective combination between lens-based parallel imaging and near-field-based vertical sensitivity.

(II) *Practice.* The reader is guided systematically along contrast modes that have been explored with NSOM: intensity, polarization, wavelength, amplitude and phase, time and plasmon. After some early demonstrations of super-resolution, characteristic achievements of each contrast mode are presented and discussed, illustrated with highlights from NFO literature. The authors are cautious with image interpretation, being aware of coupling topological and optical information.

(III) *Applications.* Though most applications are of an exploratory nature, several remarkable results are presented, which are illustrative of the potential of NSOM. In surface chemistry, examples of liquid crystals and Langmuir-Blodgett films are shown. Single molecule detection and spectroscopy is prominent, with determination of the spatial molecular dipole orientation and single molecular photo-dynamics from nanoseconds to minutes. In biology, imaging of cellular structures, single proteins and photosynthetic membranes is discussed. In materials science, unique low-temperature NFO spectra of quantum wells are presented, together with applications on waveguide analysis. This part ends with magneto-optical data storage and some speculations on IR and UV developments.

(IV) *Related techniques.* This is a short chapter on alternative experimental approaches which are hard to classify, such as: the use of 'forbidden' angle detection (beyond Snell's law) in an 'inverted' photon tunnelling arrangement; Wiener fringe, near-field acoustic and ellipsometric microscopies; ending with the trapped particle optical microscope, in which a nanometric particle trapped in a tight focus ('optical tweezers') acts as a probe.

Ironically and certainly justified, the controversial PSTM (photon scanning tunnelling microscope) with which the authors originally joined the near field, is mentioned only briefly as a dark-field NSOM. It is argued that the PSTM based on mode coupling, which has been the subject of considerable debate on 'true optical contrast' in the early 1990s, is fundamentally diffraction limited.

Though some very recent NFO achievements, such as tuning fork shear-force feedback, operation in liquid, 'apertureless' NSOM and some new applications are not covered, the book provides the perspective to appreciate new developments in their proper context. In conclusion, the

book breathes the enthusiastic spirit of an exciting and lively field. It systematically covers the progress from the early, often historically overlooked, concepts and experiments, through the frantic world of scanning probe microscopy, fighting the challenges of the efficiency-resolution trade-off, 'optical' contrast and probe versatility,

up to current state-of-the-art, all in great instrumental detail with complete coverage of NFO literature, the various imaging modes and the main applications demonstrated so far.

NIEK F. VAN HULST