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Scribble, scribble, scribble ☆

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ABSTRACT

Recent publications of interest to ultramicroscopists are surveyed.

1. Manchester and nanology

Carelessness, or perhaps a laudable desire to economize in hyphens, sometimes leads to the omission of one where it is manifestly a case of all or none. Neither can be dispensed with in two-year-old horses, three-quarter-hour intervals, submarine-cable-laying ships.
Fowler's *Modern English Usage*

There are two odds-on favourites for the lead position here: the two volumes of the *Handbook of Nanoscopy*, edited by G. van Tendeloo, D. van Dyck and S.J. Pennycook and the Proceedings of the 15th European Congress on Microscopy EMC-2012. I have decided that the winner should be the proceedings volumes as a gesture of thanks to the organisers for producing real printed books as well as a mere CD, of uncertain longevity, in which browsing can be a nightmare (the EMC15 one is user-friendly, say the RMS). The abstracts fill three stout volumes: Physical Sciences: Applications, Physical Sciences: Tools and Techniques and Life Sciences [1]. It is the second of these that is most relevant here, 842 pages of abstracts plus xxxiii of prelims and nine of name index (there is no subject index). Volume 1 is even huger, 1022 pages of abstracts. Tools and Techniques is divided into Scanning probe microscopy, SEM, *In situ* and environmental EM, 3D/4D imaging, EM instrumentation and methods, Electron diffraction and crystallography, Spectroscopy in STEM and CTEM, Ion microscopy and, to conclude, Emerging and late breaking topics in physical sciences. As I am obliged to be selective, let us turn directly to Advances in EM instrumentation and methods, which opens with a study of residual aberrations in C_s-corrected TEM, by J. Biskupek, P. Hartel, M. Haider and U. Kaiser (CEOS and Ulm); this is particularly timely though such aberrations have been troublemakers ever since electron microscopy began. Next is an equally timely paper on bright-field STEM in an aberration-corrected instrument, in which F. Krumeich and 3 co-authors show that phase contrast STEM is suitable for studying such materials as cerium oxide and quasicrystals. T. Niermann and M. Lehmann then describe recent progress in electron holography using a C_s-corrected TEM with two biprisms. R.F. Egerton discusses dose after which P. Wang and 6 co-authors show that 3-D scanning confocal electron microscopy is becoming truly quantitative. T. Walther shows the benefits of increasing the condenser aperture in an aberration-corrected STEM, after which M. Dries and 6 co-authors discuss Hilbert-type phase plates. C.T. Koch revives in-line holography, which has been largely neglected though the early writings of K.-J. Hanszen dealt extensively with this case. "The design and applications of aberration-corrected scanning transmission electron microscopes (STEMs) continue to advance rapidly", we are told by O.L. Krivanek and 3 co-authors; "At Nion, we are concentrating on improving STEM resolution and detection limits, and on increasing the range of experiments our STEM is able to do. In the area of spatial resolution, we have been able to achieve about 1 Å resolution at 60 keV and about 0.5 Å at 200 keV". But I must move on, there are 78 papers in this section alone and most would merit mention here! Among the other topics are dark-field electron holography (M. Hÿtch and 5 co-authors), simulation (S. Majert et al.), field emission from carbon nano-cone tips (F. Houdellier and 3 co-authors), vortex electrons (P. Schattschneider et al., E. Humphrey and 3 co-authors), holography with C_s–C_c correction (M. Linck and 4 co-authors), electrostatic Zach phase plates (N. Frindt and 7 co-authors), 'A fingerprint to determine resolution and residual aberrations from reconstructed electron waves' (A. Wang et al.), chromatic correction (J. Zach et al.), 'A new linear transfer theory for image detectors' (A. Lubk et al.), several papers on STEM imaging, 'Beyond the limits of imaging: recent advances and applications of model-based (scanning) transmission electron

☆ "Another d'mned thick, square book. Always scribble, scribble, scribble! Eh! Mr Gibbon?" The brother of King George III to Edward Gibbon, on receiving the second volume of *The Decline and Fall of the Roman Empire*.

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microscopy' (S. van Aert and 3 co-authors), magnetic rings as phase plates (C. Edgcombe), 'New concepts for quantifying the optical properties of modern high-resolution transmission electron microscopes' (A. Thust et al.), 'Imaging with a hole-free phase plate' (M. Beleggia and 3 co-authors), 'A "tulip aperture" providing in-focus phase contrast in TEM' (B. Buijsse [from Holland of course] and 6 co-authors), 'Monochromated high resolution STEM' (R. Schillinger), ptychography (M.J. Humphrey and 4 co-authors; P. Wang and 4 co-authors), evaluation of 30-kV microscope with C_c and C_s correction tandem system (H. Sawada and 9 co-authors), 'Magnetic imaging using a pixelated detector for differential phase contrast in the scanning transmission electron microscope' (D. McGrouther et al.), 'A direct approach to coherent diffractive imaging' which is not the same as ptychography (L.J. Allen and 4 co-authors) and 'Low-voltage TEM' (U. Kaiser).

Many of the other sections of this extremely rich volume deserve equally detailed reporting but I must limit myself to a tiny selection: Fourier transform holography (M. Saliba and 3 co-authors), 'Using Bloch waves for amorphous materials?' (J. Rusz and 3 co-authors), 'Multivariate statistical analysis of energy filtered TEM spectral images' (G. Lucas and 3 co-authors). In Advances in ion microscopy, I noticed 'Beyond helium', in which M. Ananth and 5 co-authors use neon, and 'A novel concept for producing high brightness, low energy spread ion beams of various ion species' (D.S. Jun et al.).

The nine sections of 'Applications' cover Functional materials, Thin films, coatings and interfaces, Art, heritage and forensics, Advanced materials, Healthcare, Nanomechanics, Towards sustainable energy and environmental protection, Earth and planetary materials and Low dimensional materials [surely that needs a hyphen, alas a threatened species!]. In Art, I enjoyed a paper by N. Sugioka and M. Kitada, who tell us that "Valuable fabrics, such as Indian print, had been brought into Japan from the 15th to 19th century from Southeast Asian countries. The fabric was used for clothes worn in high society at that time; even now, antique pieces are highly valued, for example, as pouches to wrap tea bowls used in the Japanese tea ceremony. However, scientific details of the dyes have not yet been clarified because of the limited number of investigations. In our previous investigation of European yellow and orange threads used for cotton fabric imported into Japan in the 19th century, it was found that chrome-yellow and chrome-orange dyestuffs were used. Nanometre-size particles of these compounds have been observed in cotton, wool, and silk fibres. In this study the blue dyestuff used for an imported printed cotton fabric, called chintz or European "Indian print" is clarified. It is said that Prussian blue was used for the blue dyestuff of printed cotton fabric such as Indian print".

In the same section J. Douin and 6 co-authors examine a very different example of 'heritage': 'TEM investigations of the fine-scale microstructure of an aluminium-alloy from a WW2 USA bomber (A26 Invader airplane)'. The specimen lives in the French Air and Space Museum and is showing signs of corrosion. There is good news in Healthcare: P. Zeng et al. have examined a hip prosthesis that had failed by 'loosening' after 12 years in position ("The thigh bone's NOT connected to the hip bone"). It showed signs of severe wear in some regions but even there "sub-surface damage of the retrieved *in vivo* alumina femoral head were [sic] restricted to the outer layer of grains". Potential good news too for cancer victims for whom gadolinium-based nanoparticles are "promising radiosensitisers to improve the killing effect of conventional radiotherapy concerning radioresistant tumours": W. Rima and 10 co-authors (among whom is the organiser of the next EMC, in Lyon) contribute to 'the comprehension of interactions mechanisms between radiosensitising nanoparticles and cancerous cells'. The paper by S. Richter on nanoparticles in food supplements is less comforting: "The improvement of nanoparticles is chiefly based on the ease of cell entry and the huge enlargement of the specific particle surface area compared with differences of biological effects. However, smallness of these particles implies besides the favoured capacity of detoxification the negative ability to cross the blood–brain barrier".

Volume 3, Life Sciences is more manageable (510 text pages). Alas, the European proceedings fall far behind those of the MSSA meetings in local colour; there, such exotic (exotic to us Europeans) creatures as the black-shouldered kite, the emu, the ostrich, Wahlberg's epauletted fruit bat and the silver catfish abound. I thought I had found a European example—R. Kostanjsek and J. Strus study woodlice—but I am told that these friendly and inoffensive beasts are found everywhere. The papers are classified under Organelle dynamics, Biology of the cell nucleus, Cytoskeleton and signalling, Applied imaging brain structure and function across different spatial and temporal scales, Uninvited guests: visualising host–pathogen interactions, Imaging and flow cytometry in cancer biology, *In vivo* imaging of multicellular dynamics and complexity, Super-resolution fluorescence microscopy for life sciences, Applications and advances in high content imaging, Probes for light and electron microscopes, Image processing, 3-D electron microscopy of structure–function studies, Emerging and late breaking topics in life sciences and finally, Correlative microscopy in life sciences.

Here I can mention only a tiny selection. First, hope for corpulent ultramicroscopists: T. Sanlidag and 6 co-authors (whose Turkish names have defeated the compositor who produced the list of contents) suggest that obesity may be caused, or at least exacerbated, by adenoviruses (cause of the common cold); stout colleagues are in fact suffering from 'Infectobesity'. (This is in the nicely named 'Uninvited guests' section.) Athletic ultramicroscopists will like to know that green tea with glycine is good for inflammation of the Achilles tendon (G.P. Vieira and 3 co-authors). And to conclude, a 'late-breaking' analysis by E.A. Favret and B. Pidal using Rotated Image with Maximum Average Power Spectrum of the waviness and roughness of rice leaves. Why this is of interest we are not told.

A magnificent record of what was clearly a splendid and exhausting congress.

A lengthy trailer for the *Handbook of Nanoscopy* has already appeared ([48] in [41]) and the two volumes are indeed very impressive [2]. Volume 1 and the first seven chapters of Volume 2 are all concerned with the various types of microscope and associated techniques. The remainder of Volume 2, which will date more rapidly, presents a range of applications. Volume 1 begins with a short introduction to the transmission electron microscope by M. de Graef (see [1] in [42]). In 32 pages, he says a few words about the TEM, lenses and their aberrations, imaging and diffraction modes, dynamical diffraction theory, perfect crystal theory, the Fourier space approach, the real space approach, the Bloch wave approach, analytical two-beam solutions, numerical multibeam approaches, other dynamical scattering phenomena, and defect images. Inevitably, each topic is covered superficially. He is followed by D. van Dyck on Atomic resolution electron microscopy, which enlarges on the relevant parts of de Graef's chapter, and by K.W. Urban and 6 co-authors on Ultrahigh-resolution transmission electron microscopy at negative spherical aberration. We then move over to the STEM: Z-contrast imaging by S.J. Pennycook and 3 co-authors. They manage to compress a mass of information into a mere 37 pages and it is here that the work of Krivanek and his colleagues is properly acknowledged for the first time—it was somehow overlooked by G. van Tendeloo and D. van Dyck in their short introductory chapter on 'The past, the present, and the future of nanoscopy', where only the TEM correctors are referenced.