

Microscopes in Art Galleries?

Stephen W. Carmichael¹
Mayo Clinic
carmichael.stephen@mayo.edu

In addition to concerns about the appearance of a display, curators of art galleries are also concerned about conservation of the artwork and their authenticity. Microscopes have played a role in these latter activities since the 1930s. Various imaging techniques, including X-radiography, infrared reflectography, macrophotography, UV-fluorescence and raking light (light source at a low angle to the surface) imaging have their advantages and disadvantages. Confocal microscopy is most useful compared to the other methods for the purpose of examination of subsurface structure, but the close working distance (a few mm) makes it precarious to use on valuable masterpieces. More recently, Haida Liang, Marta Cid, Radu Cucu, George Dobre, Adrian Podoleanu, Justin Pedro, and David Saunders have demonstrated the usefulness of optical coherence tomography (OCT) for non-destructive examination of artwork.² OCT, as discussed previously in this column,³ is more commonly used to examine biological specimens.

Liang *et al.* used two different OCT systems, operating at two different wavelengths, to examine specimens *en-face*. This means that they are scanned in layers rather than in a series of cross-sections. They showed that OCT gives a higher dynamic range through the thickness of the painting than confocal microscopy because it takes advantage of the coherence properties of light and registers only correlated signals. Furthermore, it amplifies the weak signal from the object arm (examining the specimen) by mixing it with the strong signal from the reference arm. This technique gives approximately twice the penetration depth of confocal microscopy in samples that strongly scatter light, such as layers of aged varnish and paints. Perhaps most importantly, OCT requires a working distance around 2 to 3 centimeters, keeping the instrument safely away from the specimen. The

en-face OCT images could be acquired in a way that easily relates to what is seen with the naked eye, making navigation around a painting intuitive. Information in the z axis showed the thickness of the layer(s) of varnish, paint(s), and even the underdrawing (the sketch made prior to the application of paint, and show the type of drawing (solid or liquid based) and the layer on which the drawing was made!

The ability to acquire this type of information in a non-destructive way has profound implications for art conservators and curators. For example, the layers of varnish provide objective data about the history of conservation efforts. The study of underdrawings is particularly useful for understanding painting techniques and for attributing works of art to specific artists. Liang *et al.* convincingly demonstrated that OCT provides better microscopic images of the surface of the varnish and paint layers than any other system that is currently employed in the examination of museum paintings. It also gives the best dynamic range and resolution of images of underdrawings than other techniques because this interferometric technique takes advantage of the coherence properties of light. OCT is particularly well suited for the examination of paintings because it provides non-invasive imaging (also, in real time) across the surface of the specimen, and modes of acquisition can be changed to give additional information.

One would predict that OCT will become a major player in the armamentarium of art conservators around the world. The art and science of conservation of artworks just got better, and the possibility of forging artworks just got harder!

References

1. The author gratefully acknowledges Dr. Haida Liang for reviewing this article.
2. Liang H., M. Cid, R. Cucu, G. Dobre, A. Podoleanu, J. Pedro, and D. Saunders, *En-face optical coherence tomography – a novel application of non-invasive imaging to art conservation*, *Optics Express* 13:6133-6144, 2005.
3. *Microscopy Today* 01-6:3, 2001.

INDEX OF ARTICLES

Microscopes in Art Galleries?	3	Intermediate Magnification Imaging System for Whole Organs/Organisms	48
<i>Stephen W. Carmichael, Mayo Clinic</i>		<i>Richard W. Cole, Carmen A. Mannella, Christian Renken, and James N. Turner, Wadsworth Center, Albany, NY</i>	
Recent Advances in High-Speed Orientation Mapping	6	The NEST Laboratory: The Art of a Multi-User Facility	52
<i>Matthew M. Nowell¹, Martina Chui-Sabourin², and John O. Carpenter¹</i>		<i>Scott Streiker and Rachel Smith, University of Dayton, Dayton, OH</i>	
¹ EDAX-TSL, Draper, UT, ² EDAX-TSL, Mahwah, NJ		Butyl-methyl-methacrylate for Immunocytochemistry Through the Light Microscope	56
Diffraction Light Contrast: Improving the Resolution of a Basic Light Microscope by an Order of Magnitude	10	<i>Tobias I. Baskin, University of Massachusetts, Amherst, MA</i>	
<i>W. Barry Piekos, Yale University, New Haven, CT</i>		How To Stick Loosely Adherent Cells To Glass Slides	58
Nature's Engineering Marvels: the Structure and Chemistry of a Butterfly Wing	16	<i>Martin Spitaler, Imperial College, London, UK</i>	
<i>V.S. Smentkowski, S.G. Ostrowski, E.J. Olson, J. Cournoyer, K. Dovidenko, R.A. Potyrailo, General Electric Niskayuna, NY</i>		Just Say NO to Microtoming Silicon!	58
Integrating High Resolution Light Microscopy and Real Time Observation of Fluorescent Labels	22	<i>Ron Anderson, Microscopy Today, Largo, FL</i>	
<i>Thomas A. Hasling, Aetos Technologies, Inc., Auburn, AL</i>		Industry News	60
Surface Rippling & Ion Etch Yields of Diamond Using a Focused Ion Beam: With or Without Enhanced-Chemistry, Aspect Ratio Regulates Ion Etching	28	Netnotes	62
<i>W. J. MoberlyChan, T. E. Felter, & M. A. Wall, Lawrence Livermore National Lab., Livermore, CA</i>		Index of Advertisers	70
Internet-Based Administration of Shared Instruments with Facility Online Manager	36		
<i>Shu-You Li and Vinayak P. Dravid, Northwestern University, Evanston, IL</i>			
Andrew Paul Leonard: Capturing the Cover of Time Magazine ...	40		
<i>Lise Millay Stevens, MA</i>			
Streamlining the Modern Lab	44		
<i>Radhika Subramanian, Cornet Technology, Inc., Springfield, VA</i>			

ABOUT THE COVER

Scanning Electron Micrograph of bone marrow derived hematopoietic stem cell grown on a stromal cell matrix (provided by Dr. Adam Asch, MD, Cornell Medical College and The Brody School of Medicine at East Carolina University. Sample was fixed in 2.5% Glutaraldehyde, post-fixed with Osmium Tetroxide, dehydrated and prepared for SEM. Image was digitally color-enhanced. Image by Andrew Paul Leonard. See article on page 40.

COMING EVENTS

2006

- ✓ **American Society for Cell Biology**
December 9-13, 2006, San Diego, CA
www.ascb.org

2007

- ✓ **The 4th Annual Advanced Optical Microscopy Workshop**
January 17-19, UC Berkeley, CA
imaging.berkeley.edu/optical_methods_07workshop.html
- ✓ **SPIE Photonics West, Multiphoton Microscopy/Applications**
January 20-27, 2007, San Jose, CA
spie.org/conferences/calls/07/pw/bios/
- ✓ **Microscopy 2007**
February 5-9, 2007, Auckland, NZ
enquiries@microscopy2007.org.nz
- ✓ **PITTCON 2007**
February 25-March 2, 2007, Chicago, IL
www.pittcon.org
- ✓ **The American Chemical Society**
March 25-29, 2007, Chicago, IL
natlmtg@acs.org
- ✓ **American Soc. for Biochemistry and Molecular Engineering**
April 2007, Washington, DC
www.asbmb.org
- ✓ **Microscopy of Semiconducting Materials' Conf. MSM XV**
April 2-5, 2007, Churchill College, Cambridge
conferences.iop.org/msmxv
- ✓ **SCANNING 2007**
April 10-12, 2007, Monterey, CA
www.scanning.org
- ✓ **Lehigh Microscopy School**
June 3-15, 2007, Bethlehem, PA (multiple choices)
www.lehigh.edu/microscopy
- ✓ **8th Multinational Congress on Microscopy**
June 17-21, 2007, Prague, Czech Republic
8mcm@biomed.cas.cz
- ✓ **34th Annual Mtg. of the Microscopical Society of Canada**
June 18-20, 2007, Alberta, Canada
www.phys.ualberta.ca/MS-2007/
- ✓ **Microscopy and Microanalysis 2007**
August 5-9, 2007, Fort Lauderdale, FL
mm2007.microscopy.org
- ✓ **The American Society for Cell Biology**
December 1-5, 2007, Washington, DC
www.ascb.org

2008

- ✓ **Microscopy and Microanalysis 2008**
August 3-7, 2008, Albuquerque, NM
www.msa.microscopy.com

2009

- ✓ **Microscopy and Microanalysis 2009**
August 3-6, 2009, Baltimore, MD
www.msa.microscopy.com

2010

- ✓ **Microscopy and Microanalysis 2010**
Portland, OR

Please check the "Calendar of Meetings and Courses" in the MSA journal "Microscopy and Microanalysis" for more details and a much larger listing of meetings and courses.

MICROSCOPY TODAY

The objective of this publication is to provide material of interest and value to working microscopists!

The publication is owned by the Microscopy Society of America (MSA) and is produced six times each year in odd months, alternating with MSA's peer-reviewed, scientific journal *Microscopy and Microanalysis*. We greatly appreciate article and material contributions from our readers—"users" as well as manufacturers/suppliers. The only criterion is that the subject matter be of interest to a reasonable number of working microscopists. *Microscopy Today* has authors from many disparate fields in both biological and materials sciences, each field with its own standards. Therefore *MT* does not have a rigid set of style instructions and encourages authors to use their own style, asking only that the writing be clear, informative, and accurate. Length: typical article length is 1,500 to 2,000 words plus images, longer articles will be considered. Short notes are encouraged for our Microscopy 101 section. See our "Instructions to Authors" document on our website.

MICROSCOPY TODAY

ISSN 1551-9295

Ron Anderson, Editor

randerson20@tampabay.rr.com

Phil Oshel, Technical Editor

oshel1pe@cmich.edu

Thomas E. Phillips, Contributing Editor

PhillipsT@missouri.edu

Dale Anderson, Art Director

microscopytoday@tampabay.rr.com

Renée Stratmoen, Advertising Director

oshel1pe@cmich.edu

Regular Mail to:

Microscopy Today, P.O. Box 247, Largo, FL 33779

Courier Mail to:

1001 Starkey Road, Lot #374, Largo, FL 33771

Telephones:

1-(727)507-7101 • Fax: (727)507-7102 • Cell: (727) 631-1022

e-Mail:

microscopytoday@tampabay.rr.com

www Page:

<http://www.microscopy-today.com>

Colophon: *Microscopy Today* is created using components of Adobe Creative Suite CS2®

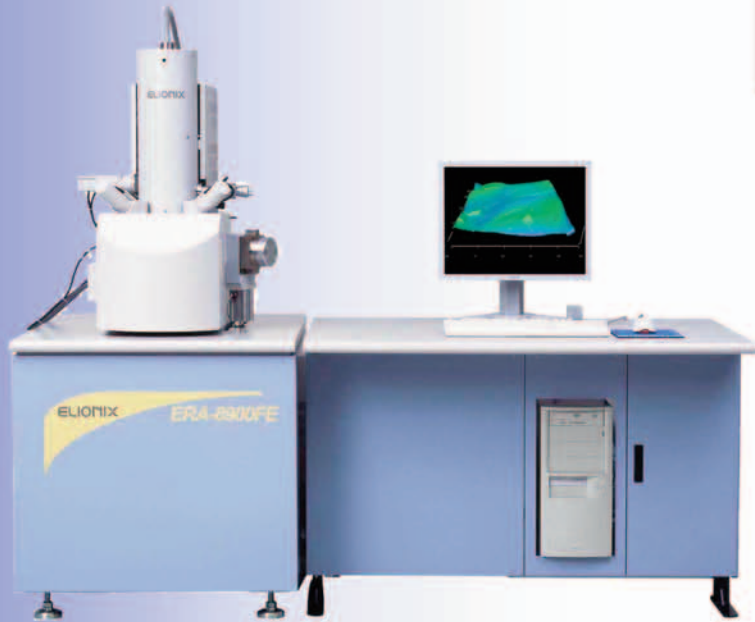
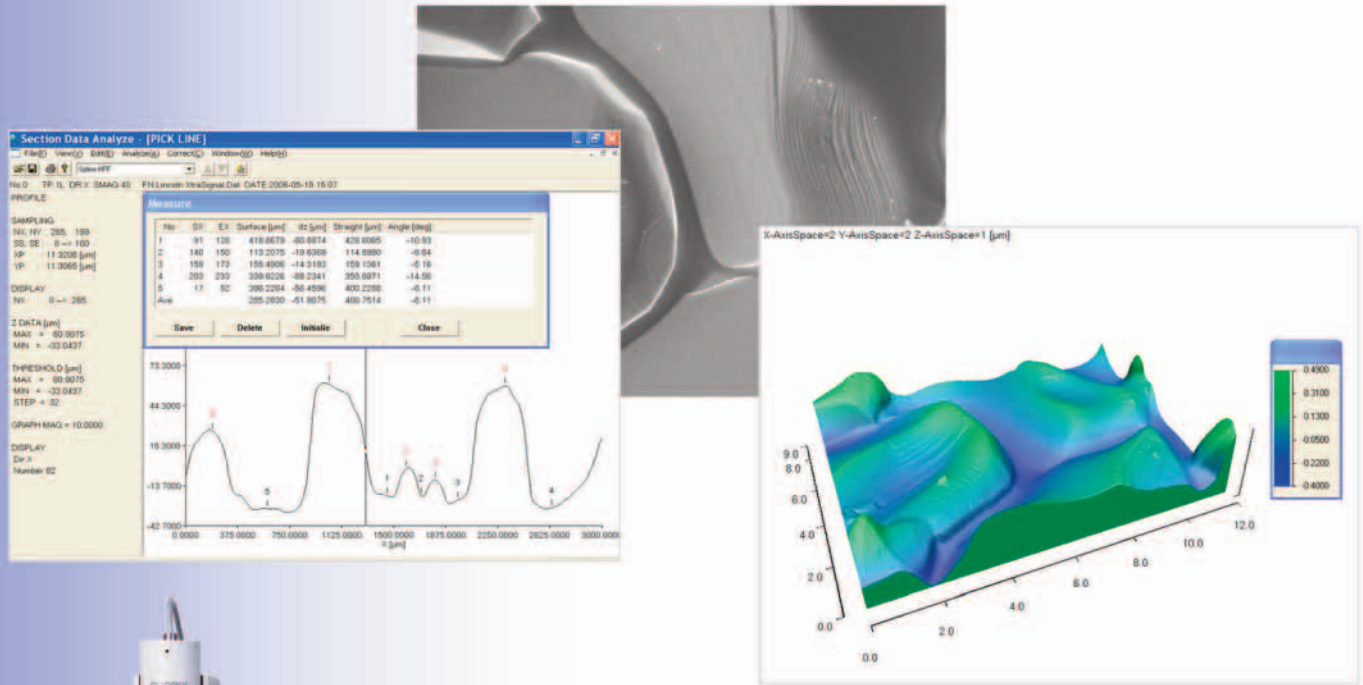
Total Circulation: 14,683

Disclaimer: By submitting a manuscript to *Microscopy Today*, the author warrants that the article is original (or that the author has the right to use any material copyrighted by others). The use of trade names, trademarks, etc., does not imply that these names lack protection by relevant laws and regulations. *Microscopy Today*, the Microscopy Society of America, and any other societies stated, cannot be held responsible for opinions, errors, or for any consequences arising from the use of information contained in *Microscopy Today*. The appearance of advertising in *Microscopy Today* does not constitute an endorsement or approval by the Microscopy Society of America of the quality or value of the products advertised or any of the claims, data, conclusions, recommendations, procedures, results or any information found in the advertisements. While the contents of this magazine are believed to be accurate at press time, neither the Microscopy Society of America, the editors, nor the authors can accept legal responsibility for errors or omissions.

© Copyright, 2006, The Microscopy Society of America. All rights reserved.

e-RAM Electron Roughness Analyzing Microscope

Finally, an E-Beam System Specifically Developed For 3D Surface Roughness Analysis!



e-RAM

- 3D Measurement
 - 1 nm Vertical Resolution
- Statistical Analysis
 - Histograms
 - Ra, Rz
 - Surface Area
 - ... and much more
- 4 Channel SE Imaging
- ZrO/W TFE Gun
- EDS Optional

Now that we have your attention...

www.sts-elionix.com



SEMtech Solutions, Inc. Tel: (978) 663-9822
 6 Executive Park Drive email: sales@sts-elionix.com
 North Billerica, MA 01862