Microscopes in Art Galleries?

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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 Sauders 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

ABOUT THE COVER

Scanning Electron Micrograph of bone marrow derived hematopoieitic 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/MSC-2007/

✓ **Microscopy and Microanalysis 2007**
August 5-9, 2007, Fort Laurderdale, 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

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✓ **Microscopy and Microanalysis 2010**
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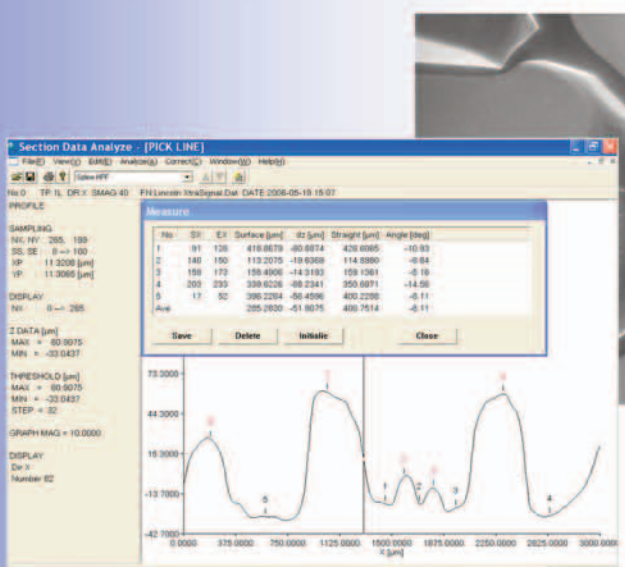

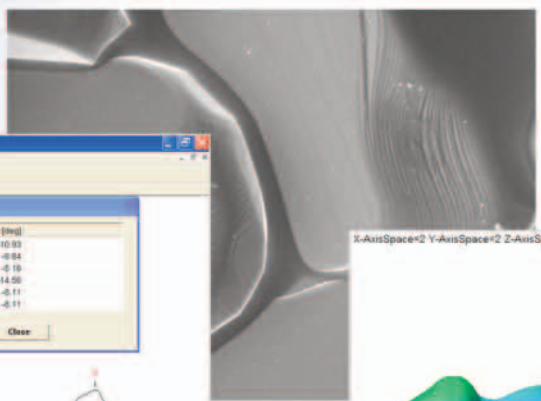

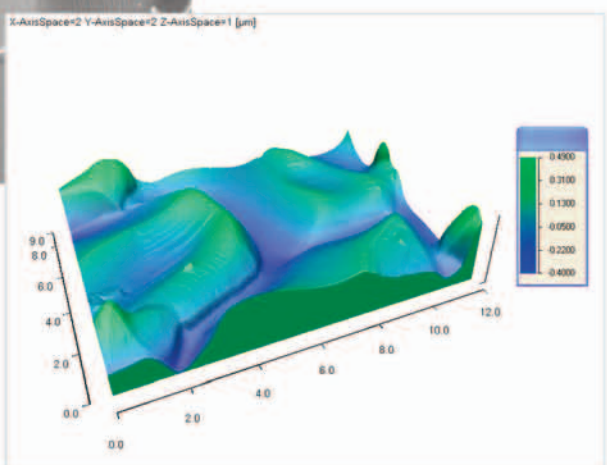

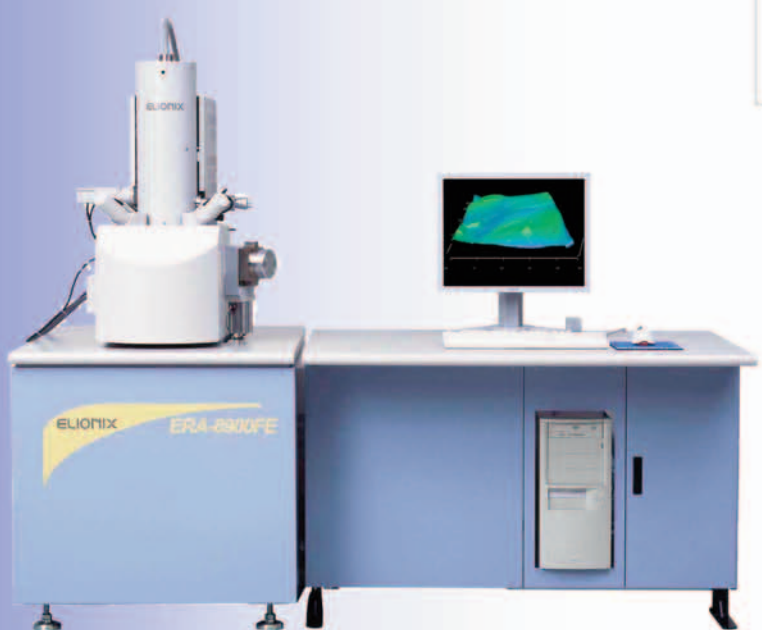

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