

## Finding the First Fires with Microscopes

Stephen W. Carmichael<sup>1</sup>  
*Mayo Clinic*  
*stephen.carmichael@mayo.edu*

Coal is remnants of plant matter that were compressed and held at a high temperature for eons. However, if plants are charred first, they become hard and brittle, and may resist compression. Under appropriate circumstances, anatomic detail can be elegantly retained. Ian Glasspool, Dianne Edwards, and Lindsey Axe have performed detailed studies on plant fossils recovered in England, near the Welsh border, that can be considered to be evidence for the earliest wildfire yet described on our planet.<sup>2</sup> They examined a series of mesofossils, about one millimeter in size, which required microscopic study.

It is well known that chemical and structural changes occur to organic tissues during charring. This can mean that charcoal is resistant to decay and compression and it is also more reflective than non-charred material. Glasspool et al. used incident light and scanning electron microscopy to reveal 3-dimensional cellular detail of the specimens. Additional specimens were embedded and polished for reflectance microscopy. The results indicated that the specimens were charcoal. Experiments showed that reflectance can indicate the temperature and duration of the fire that charred the specimens. Subsequently, it was concluded that some of the plants were charred at temperatures above 400 °C but the majority of the specimens were victims of a smoldering fire of lower temperature and were only partially charred. This is of interest because the oxygen content of the atmosphere at that time has been estimated to be about 18%, resulting in less intense wildfires compared to what happens today. Glasspool et al. speculated that approximately 419 million years ago relatively intense wildfires were initiated by lightning strikes, and spread rapidly as a smoldering fire through a desiccated vegetation and litter layer. Events such as these have had an

affect on the plants and atmosphere of Earth ever since.

Another important question is when did human beings (or our ancestors) first control fires for their own use? Naama Goren-Inbar, Nira Alpers, Mordechai Kislev, Orit Simchoni, Yoel Melamed, Adi Ben-Nun, and Ella Werker also used microscopes to provide evidence to answer this question.<sup>3</sup> They used scanning electron microscopy to identify burned and unburned species of wood and grain found at a site in Israel at the northern end of the Dead Sea rift. Of the charred botanical specimens that were found, six taxa were identified, including three that are edible: olive, wild barley and grape. They were also able to identify burned flint microartifacts (under 20 mm in size) that would be expected to be located in or near hearths. This suggested an activity such as cooking, rather than a more widely distributed wildfire.

Human-like activity at this site occurred over a 100,000-year period. Goren-Inbar et al. estimated that controlled fire was used nearly 790,000 years ago. The species occupying the area at the time are assumed to be *Homo erectus*, *Homo ergaster*, or an archaic *Homo sapiens*. Armed with this new ability to control fire for purposes such as cooking and providing warmth, an early species of humans could now venture to cooler climes, allowing the habitation of Europe and Asia.

Microscopes have provided evidence of important events that have profoundly shaped our world!

- <sup>1</sup> The author gratefully acknowledges Mrs. Lindsey Axe and Dr. Naama Goren-Inbar for reviewing this article.
- <sup>2</sup> Glasspool, I.J., D. Edwards, and L. Axe, Charcoal in the Silurian as evidence for the earliest wildfire, *Geology* **32**:381-383, 2004. For a more detailed account see Edwards, D. and L. Axe, Anatomical evidence in the detection of the earliest wildfires, *Palaio* **19**:113-128, 2004.
- <sup>3</sup> Goren-Inbar, N., N. Alpers, M. Kislev, O. Simchoni, Y. Melamed, A. Ben-Nun, and E. Werker, Evidence of hominin control of fire at Gesher Benot Ya'akov, Israel, *Science* **304**:725-727, 2004.

## INDEX OF ARTICLES

<b>Finding the First Fires with Microscopes</b> .....	<b>3</b>	<b>Broadband CARS Microscopy</b> .....	<b>38</b>
<i>Stephen W. Carmichael, Mayo Clinic</i>		<i>Marcus T. Cicerone and Tak W. Kee, National Institute of Standards and Technology</i>	
<b>Combining Imaging and Spectroscopy: Solving Problems with Near Infrared Chemical Imaging</b> .....	<b>8</b>	<b>Microwave Processing of <i>Drosophila</i> Tissues for Electron Microscopy</b> .....	<b>42</b>
<i>E. N. Lewis, E. Lee, and L. H. Kidder, Spectral Dimensions, Inc.</i>		<i>JoAnn Buchanan, Stanford University School of Medicine</i>	
<b>Automated Functions in Electron Microscopy</b> .....	<b>14</b>	<b>Mechanical Polishing Methods for Metal Samples for EBSD</b> ...	<b>42</b>
<i>Bill Tivol, California Institute of Technology</i>		<i>S. Roberts*, D. Flatoff*, B. True,** *South Bay Technology, Inc., **EDAX / TSL</i>	
<b>Variable Magnification Electron Holography for 2-D Mapping of Semiconductor Devices</b> .....	<b>20</b>	<b>High Pressure Freezing User Group Meeting at M &amp; M 2004</b> ..	<b>43</b>
<i>Y.Y. Wang, M. Gribelyuk, A. Domenicucci, J. Bruley, J. Gaudiello, and M. Kawasaki,* IBM Microelectronic Division, *JEOL USA</i>		<b>The Microscopy Society Of America Project MICRO</b> .....	
<b>A FIB Micro-Sampling Technique for Three-Dimensional Characterization of a Site-Specific Defect</b> .....	<b>26</b>	<i>Caroline Schooley, Project MICRO Coordinator</i>	
<i>T. Yaguchi<sup>1</sup>, Y. Kuroda<sup>1</sup>, M. Konno<sup>1</sup>, T. Kamino<sup>1</sup>, T. Ohnishi<sup>2</sup>, T. Hashimoto<sup>2</sup>, K. Umemura<sup>2</sup>, K. Asayama<sup>3</sup>; <sup>1</sup>Hitachi Science Systems, <sup>2</sup>Hitachi High-Technologies Corp., <sup>3</sup>Renesas Technology Corp., Japan</i>		<b>Industry News</b> .....	<b>50</b>
<b>Color Matching to Ink Jet Printers from a Computer Screen, Part 1</b> .....	<b>30</b>	<b>MSA 2005 Undergraduate Research Scholarships</b> .....	<b>55</b>
<i>Jerry Sedgewick, University of Minnesota</i>		<b>NetNotes</b> .....	<b>56</b>
<b>FIB Lift-Out and Milling of Cylindrical Specimens for Electron Tomography (or Atom Probe Field Ion Microscopy)</b> .....	<b>34</b>	<b>Index of Advertisers</b> .....	<b>62</b>
<i>Lucille A. Giannuzzi, FEI Company</i>			
<b>A New Improved Silicon Multi-Cathode Detector (SMCD) for Microanalysis and X-Ray Mapping Applications</b> .....	<b>36</b>		
<i>S. Barkan*, V. D. Saveliev*, J. S. Iwanczyk*, L. Feng*, C. R. Tull*, B. E. Patt*, D. E. Newbury**, J. A. Small**, and N. J. Zaluzec;*** *Radiant Detector Technologies, **National Institute of Standards and Technology, ***Electron Microscopy Center, Argonne National Lab</i>			

## ABOUT THE COVER

The cover micrograph shows the planarization of a silicon substrate that was patterned by dry-etching techniques and coated with PECVD silicon nitride. The picture was taken at 200X utilizing the differential interference contrast capability of a Nikon microscope. The colorful shapes, in the form of mardi-gras masks, are showing thickness variations in the tens to hundreds of Angstroms. This photograph won 19th prize in the Nikon Small World Photomicrography competition and was taken by Dr. Pedro Barrios of the Institute for Microstructural Sciences of the National Research Council of Canada.

Intuitive Operation.  
Outstanding Productivity.  
Expert Support.



- **X-RAY ANALYSIS**
- **X-RAY DETECTORS**
- **IMAGE ANALYSIS**
- **EBSD BY HKL**

We understand how valuable your data and time are. That's why our systems are designed with a simple, intuitive user interface, making it easy for even novice users to quickly get up and running with minimal training time.

We take productivity a step further with software to reliably automate routine analysis tasks and generate concise reports.

We have a superior team of field service personnel, and an applications lab staffed by experienced microscopists to offer assistance with data interpretation.

Visit our website at [www.pgt.com](http://www.pgt.com) or contact us at (609) 924-7310 for more information. Put us to work for you today!



Princeton Gamma-Tech  
1026 Route 518  
Rocky Hill, NJ 08553

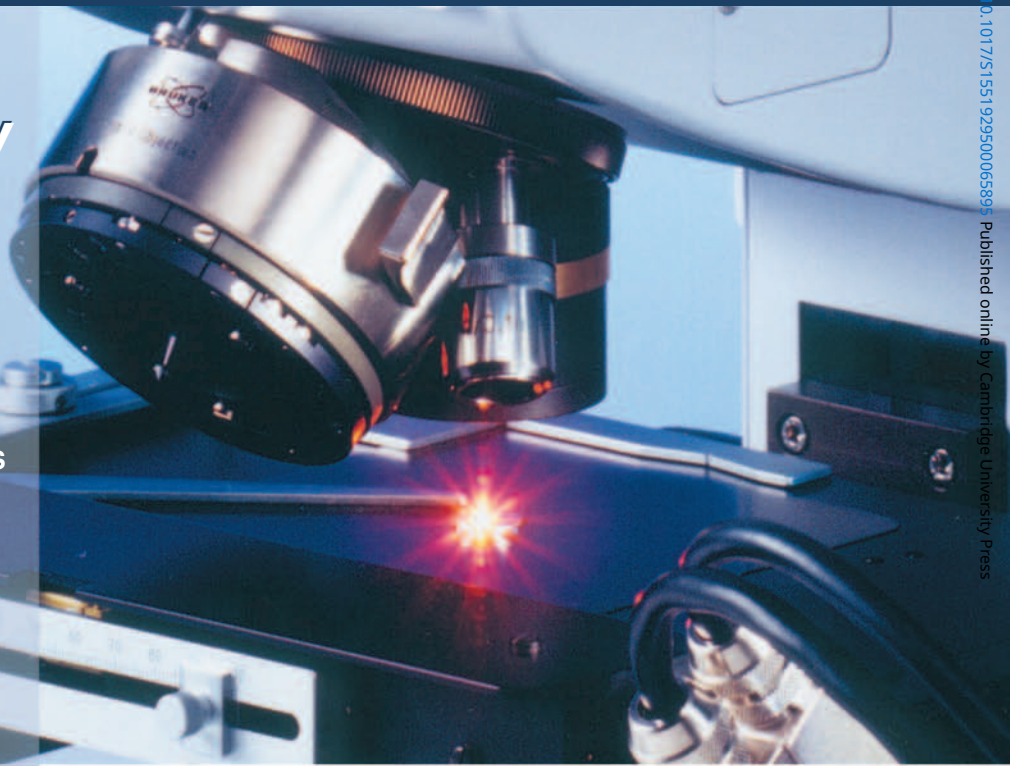
Toll Free: (800) 229-7484  
Tel: (609) 924-7310  
Fax: (609) 924-1729

e-mail: [sales@pgt.com](mailto:sales@pgt.com)    [www.pgt.com](http://www.pgt.com)

Microspectroscopy

**the leader in  
microspectroscopy**

Bruker Optics offers the most advanced FT-IR, FT-Raman and Dispersive Raman microspectroscopy tools to meet all your demanding microanalysis requirements. The countless innovations found on our microspectrometers, epitomize our philosophy of think forward.



**HYPERION™ Series**

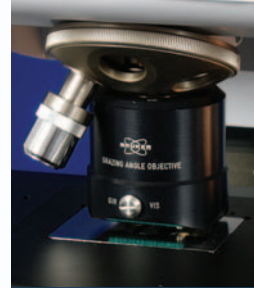
The *HYPERION™ Series* infrared microscope offers state-of-the-art optical microscopy capabilities, which include contrast enhancement with aperture stops, visible polarization, darkfield illumination and fluorescence illumination. The *HYPERION™ Series* also offers unmatched infrared performance, designed to maximize infrared throughput without sacrificing diffraction limited performance. This translates to shorter collection times with the highest quality data possible. The *HYPERION™* is a fully upgradeable microscope platform, from a basic high performance infrared microscope with transmission and reflection capabilities to a dual detector focal-plane-array and single element detector based system.

**The HYPERION™ Series Advantage**



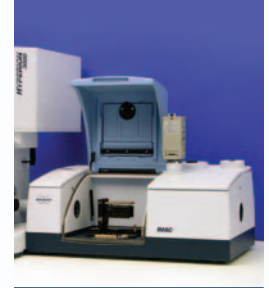
**Proprietary ATR Objective**

- Crystal-clear sample viewing
- Unmatched infrared performance
- 5 pressure settings with automatic pressure detection
- Anvil ATR crystal design with 80 micron contact area
- ATR mapping



**Patented Grazing Incidence Objective**

- Crystal-clear sample viewing
- ALL infrared light rays used at the correct angles of incidence
- 2 reflections off sample
- Breakthrough sensitivity in analyzing thin films and monolayers
- Grazing incidence analysis of monolayers to 20x20 microns



**Focal Plane Array Micro/Macro Analysis**

- Upgradeable from base *HYPERION™ 1000*
- Portable FPA can be easily moved between *HYPERION™* microscope and macrochamber
- "Next generation" FPA detectors utilized
- Lower cost

For more information:  
**please call 1-888-4BRUKER or visit**  
**[www.brukeroptics.com/microscopy](http://www.brukeroptics.com/microscopy)**



## COMING EVENTS

- ✓ **Int'l Soc. for Testing & Failure Analysis (ISTFA)**  
November 14-18, 2004, Worcester, MA  
[www.edfas.org/istfa](http://www.edfas.org/istfa)
- ✓ **Eastern Analytical Symposium**  
November 15-18, 2004  
[www.eas.org](http://www.eas.org)
- ✓ **Materials Research Society**  
November 29-December 3, 2004, Boston, MA  
[info@mrs.org](mailto:info@mrs.org)
- ✓ **American Society for Cell Biology 2004**  
December 4-8, 2004, Washington, DC  
[www.ascb.org](http://www.ascb.org)

### 2005

- ✓ **PITTCON 2005**  
February 27-March 4, 2005  
[www.pittcon.org](http://www.pittcon.org)
- ✓ **Materials Research Society**  
March 28-April 1, 2005, San Francisco, CA  
[info@mrs.org](mailto:info@mrs.org)
- ✓ **American Society for Biochemistry & Molecular Biology**  
April 2-6, 2005, San Diego, CA  
[www.asbmb.org](http://www.asbmb.org)
- ✓ **Scanning 2005**  
April 5-7, 2005, Monterey, CA  
[scanning@fams.org](mailto:scanning@fams.org)
- ✓ **IUMAS and 9th Microbeam Analysis Workshop**  
May 22-26, 2005, Firenze, Italy  
[www.emas.ac.uk](http://www.emas.ac.uk)
- ✓ **Lehigh Microscopy School**  
June 5-17, 2005, Lehigh University, Bethlehem, PA USA  
[www.lehigh.edu/microscopy](http://www.lehigh.edu/microscopy)
- ✓ **Microscopy and Microanalysis 2005**  
July 31- August 4, 2005, Honolulu, HA  
[www.msa.microscopy.com](http://www.msa.microscopy.com)
- ✓ **Society for Neuroscience**  
November 12-16, 2005, Washington, DC  
[info@sfn.org](mailto:info@sfn.org)
- ✓ **Materials Research Society**  
November 28- December 2, 2005, Boston, MA  
[info@mrs.org](mailto:info@mrs.org)
- ✓ **American Society for Cell Biology 2004**  
December 10-14, 2005, San Francisco, CA  
[www.ascb.org](http://www.ascb.org)

### 2006

- ✓ **Microscopy and Microanalysis 2006**  
August 6-10, 2006, Chicago, IL  
[www.msa.microscopy.com](http://www.msa.microscopy.com)

### 2007

- ✓ **Microscopy and Microanalysis 2007**  
August 5-9, 2007, Fort Lauderdale, FL  
[www.msa.microscopy.com](http://www.msa.microscopy.com)

### 2008

- ✓ **Microscopy and Microanalysis 2008**  
August 3-7, 2008, Albuquerque, NM  
[www.msa.microscopy.com](http://www.msa.microscopy.com)

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.

## MICROSCOPY TODAY

ISSN 1551-9295

**Ron Anderson, Editor**

[randerson20@tampabay.rr.com](mailto:randerson20@tampabay.rr.com)

**José Mascorro, Technical Editor**

[jmascor@tulane.edu](mailto:jmascor@tulane.edu)

**Thomas E. Phillips, Contributing Editor**

[PhillipsT@missouri.edu](mailto:PhillipsT@missouri.edu)

**Dale Anderson, Art Director**

[microscopytoday@tampabay.rr.com](mailto:microscopytoday@tampabay.rr.com)

**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](mailto:microscopytoday@tampabay.rr.com)

**www Page:**

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

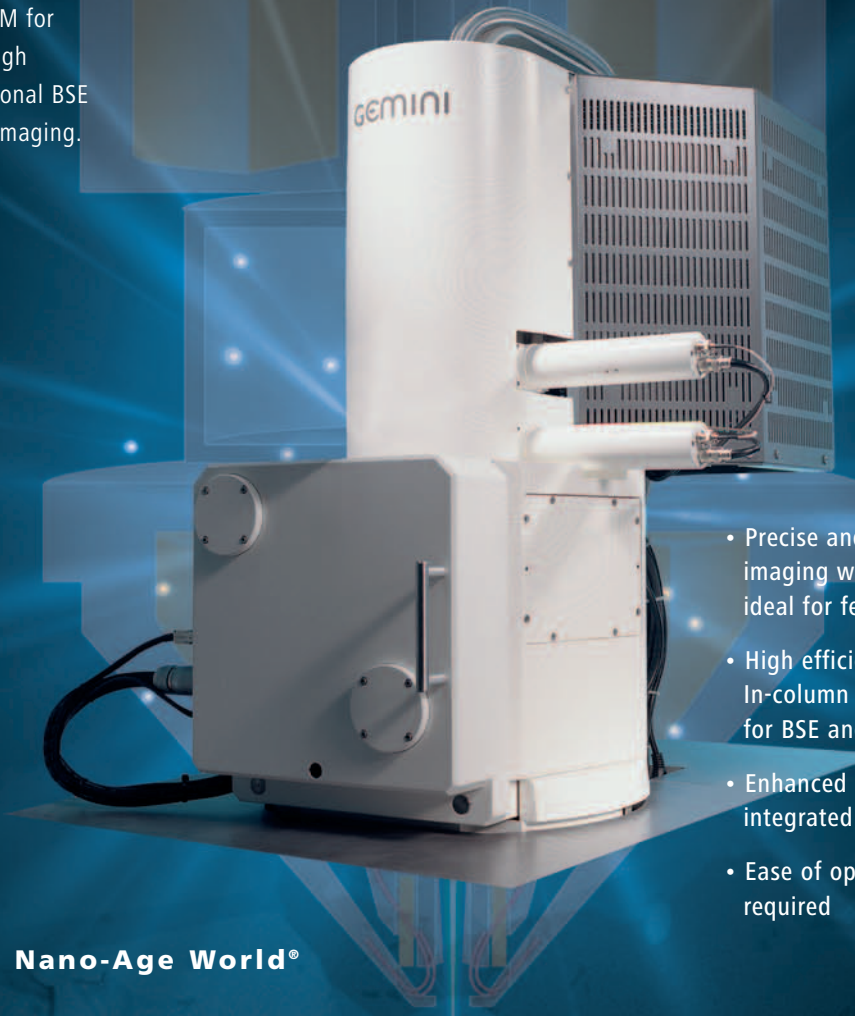
**Total Circulation: 15,822**

**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, 2004, The Microscopy Society of America. All rights reserved.

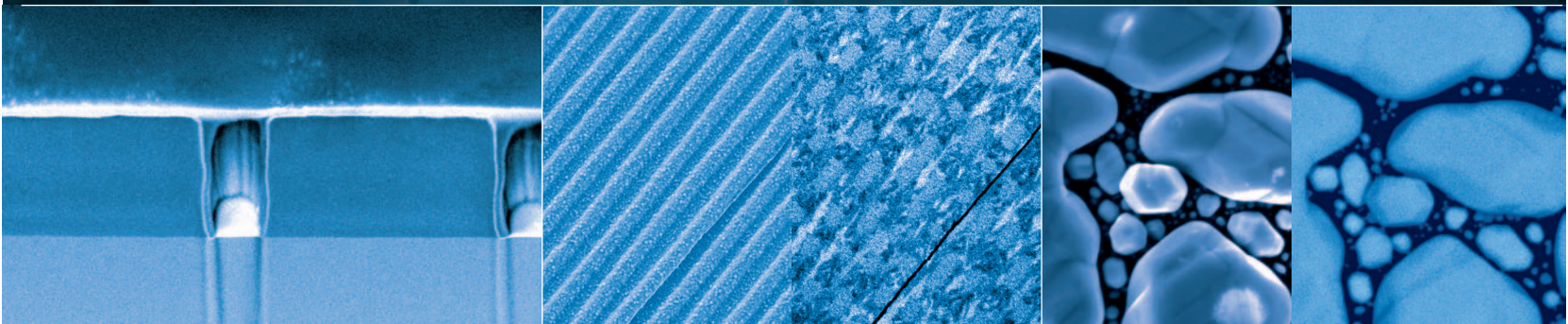
# ULTRA FESEM - Imaging Solutions with Dual In-column Detection System

The new ULTRA FESEM for  
simultaneous ultra high  
resolution, compositional BSE  
and topographic SE imaging.



- Precise and clear compositional imaging without charging effects – ideal for feature measurements
- High efficiency — high contrast In-column direct detection principle for BSE and SE
- Enhanced image quality due to integrated filtering grid
- Ease of operation — no adjustments required

Enabling the Nano-Age World®



**Carl Zeiss SMT Inc**  
One Zeiss Drive  
Thornwood, New York 10594  
USA

Tel. +1 914/747 7700  
Fax +1 914/681 7443  
info-usa@smt.zeiss.com  
www.smt.zeiss.com/nts

Leo Electron Microscopy is now the Nano Technology Systems division of Carl Zeiss SMT

