MICROSCOPY TODAY

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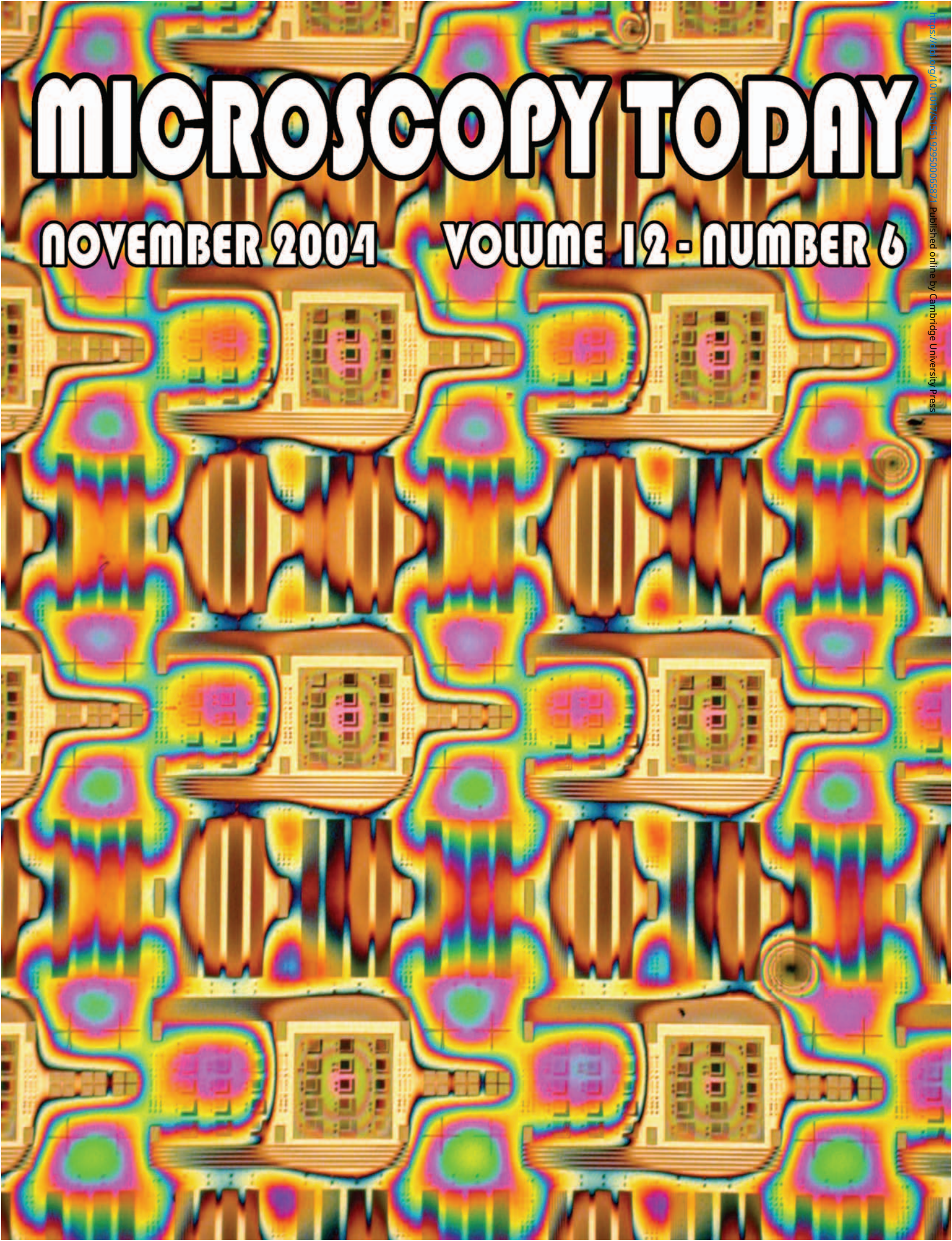

Finding the First Fires with Microscopes

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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.2 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 Alperson, Mordechai Kislev, Orit Simchoni, Yoel Melamed, Adi Ben-Nun, and Ella Werker also used microscopes to provide evidence to answer this question.3 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!

[1] The author gratefully acknowledges Mrs. Lindsey Axe and Dr. Naama Goren-Inbar for reviewing this article.

2 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, *Palaios* **19**:113-128, 2004.

3 Goren-Inbar, N., N. Alperson, M. Kislev, O. Simchoni, Y. Melamed, A. Ben-Nun, and E. Werker, Evidence of hominin control of fire at Gesher Benot Ya'aqov, Israel, Science 304:725-727, 2004.

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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.