Leica's LED5000 illumination system represents the company's shift toward LED light sources in its microscopes. Courtesy of Leica Microsystems Inc.

CLOSE-UP
on forensic microscopy

BY LAURA S. MARSHALL,
FEATURES EDITOR

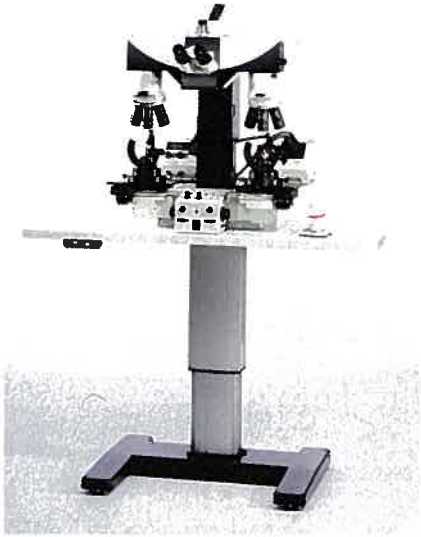
When it comes to the role of the microscope in forensics, Richard E. Bisbing is very clear.

"Microscopy is essential to the forensic sciences and has been since the beginning – the 19th century," he said. "Virtually all trace evidence requires microscopical analysis: stereomicroscopy, polarized light microscopy, scanning electron microscopy and x-ray spectroscopy, infrared microspectroscopy."

Bisbing is executive vice president of McCrone Associates Inc., a microscopy group in Westmont, Ill. He is clear about the future, too: "Microscopy will continue to be essential."

It is, after all, the go-to tool for the forensic scientist when it comes to the analysis of hairs, fibers, fluids, tissue, blood type, DNA, drugs, gunshot residue, bullet and cartridge markings, paint, ink, gemstones – even insects and microorganisms.

Microscope makers are working hard to stay on the cutting edge, incorporating technological trends such as LED light sources, built-in digital cameras and 3-D modeling systems into the instruments they build for the crime lab.



The Leica FS C comparison macroscope was designed specifically for the forensic sciences. Its versatile system configurations offer simultaneous observation of evidence for training and consultation. Courtesy of Leica Microsystems Inc.

Innovations at Leica

"Leica has an enviable position for the forensic laboratories," said Wayne A. Buttermore, marketing manager for forensic microscopy at Leica Microsystems AG in Bannockburn, Ill. The company offers a range of instruments, from low-magnification stereomicroscopes to its current high-powered microscope platform, which debuted in 2003.

The comparison macroscope was introduced for the examination of tool marks and firearms, according to Buttermore. "It was a quantum leap forward – the future of crime laboratory work," he said. "The old microscope was a manual tool; we took advantage of human engineering and ergonomics."

The result is a device with automated

Innovations in the field include built-in digital cameras,

calibration and image acquisition options and a direct communications link with a computer system, among other features. The "intelligent automation" system even remembers objectives once they have been entered and can revert to the same settings every time those objectives are input.

"The thought behind it was that it allows the operator to concentrate on the science, on the samples, rather than worrying about making changes on the microscope," Buttermore said. "Of course, a manual override is also available."

Leica engineers have been working not only on innovations but also on improving their existing line of microscopes, and a major focus of their efforts has been illumination. To decrease the carbon footprint of their products, they have begun looking at bulbs that last longer and at materials that do not require hazardous waste disposal, and they are "increasingly using LEDs where appropriate," Buttermore said.

"The beauty of LEDs is tremendous life," he added. A halogen bulb burns for 100 hours, he said, but an LED can give light "for 20,000 to 25,000 hours – and it's cool, unlike halogen, which tends to get warmer as it gets brighter." He said the consistent, uniform illumination produced by LEDs is highly useful for microscopy as well.

One of Leica's LED microscope developments, he said, is a "ring type" light source that surrounds the objective so that

> "The single most important microscope for forensic use [is] the polarized light microscope."

there are multiple light elements in a ring around the sample. "You can create contrast on the specimen with a push of a button," Buttermore said. Another innovation involves a compact stand with LEDs built into the base; yet another incorporates a multichannel LED for oblique illumination.

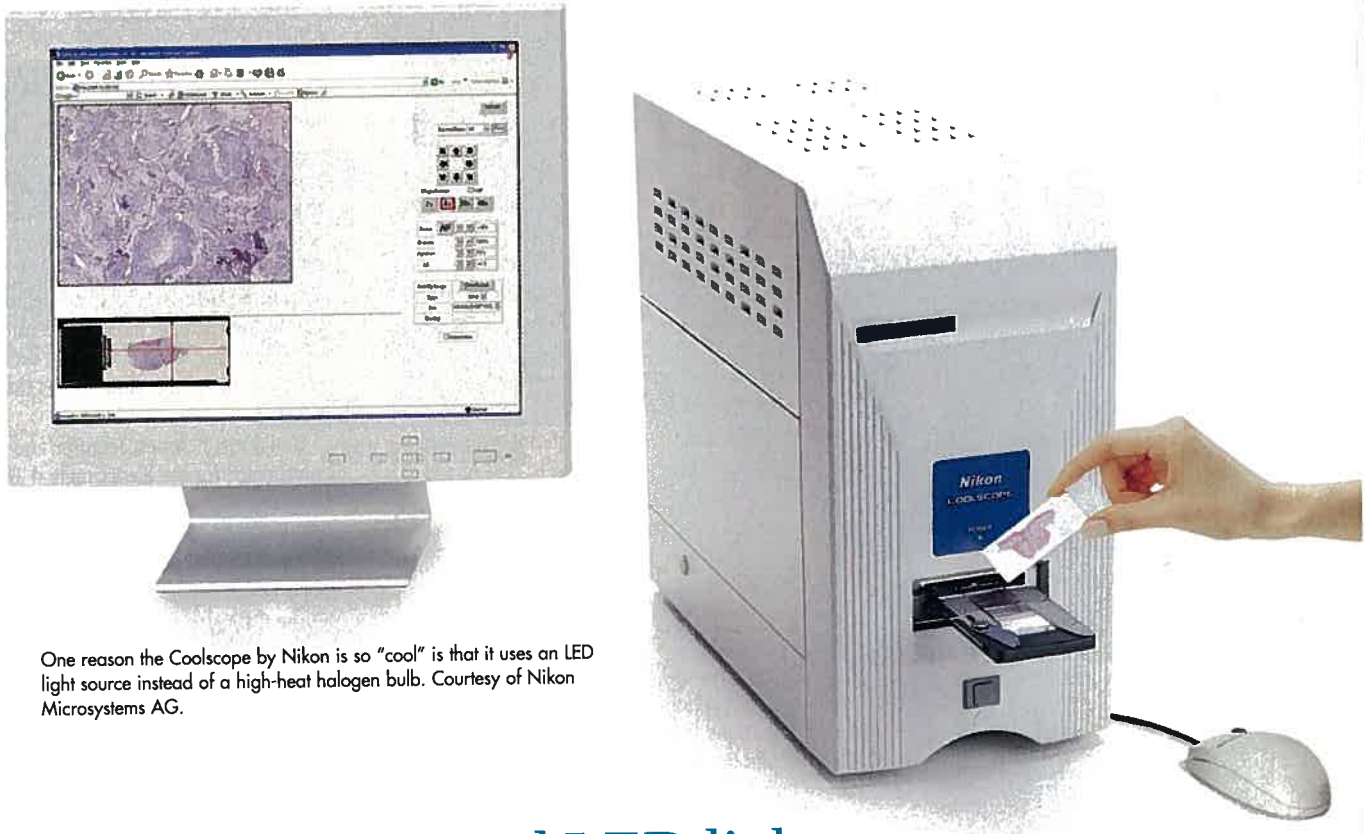
Nikon's software solutions

"The single most important microscope for forensic use has been in the past – and I know that 'cause I used to do that for a living – the polarized light microscope," said Stanley A. Schwartz, vice president of product and marketing at Nikon Instruments Inc. in Melville, N.Y. "It's the first and original tool for the forensic scientist, the only real analytical optical microscope."

Nikon's student-quality binocular microscope with 10×/40×/100× magnification and the company's bonding stereomicroscope, which shows larger objects in three dimensions at magnifications from 5× to 40×, are the two general tools used by forensic scientists, according to Schwartz.

"The next most important tool is to document everything," he said. For that purpose, systems are increasingly incorporating digital cameras. "I don't think we sell any microscopes without digital cameras these days."

Next comes software. Nikon's NIS-Elements program "controls the microscope, the camera," he said. "It brings in data from the microscope so you don't have to write everything down." The date, the camera settings, the focal length of the lens, the magnification, the objective – the program remembers the information and can calibrate itself.



One reason the Coolscope by Nikon is so "cool" is that it uses an LED light source instead of a high-heat halogen bulb. Courtesy of Nikon Microsystems AG.

3-D modeling systems and LED light sources.

The Coolscope II lives up to its name: It is a self-contained microscope in a box, the size of a computer, with a camera built in, but the cool part is that it can be controlled via the Internet. "You plug it into the Internet and put a slide on it," Schwartz said, "and the expert that's a thousand miles away can look at what you're looking at – can move the slide and change the magnification and so on."

And there's another cool thing: "LEDs are starting to be used – that's why the Coolscope is called a 'cool' scope," Schwartz noted.

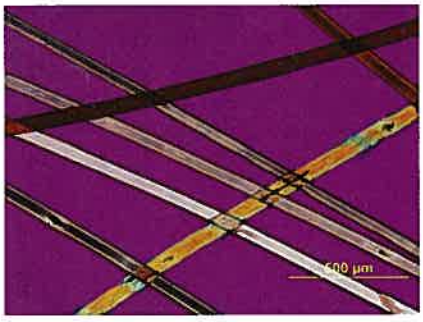
Keyence: microscopy in the palm of your hand

For the forensic scientist on the go, Keyence Corp. of Osaka, Japan, offers a 3-D digital microscope that isn't chained to the crime lab worktable. "Unlike conventional microscopes," said Leila Javidi, applications engineer for the company's Micro Analysis Group in Chicago, "the VHX-600 has a handheld camera, enabling anyone to take the microscope out to the field and make their observations outside of a laboratory setting."

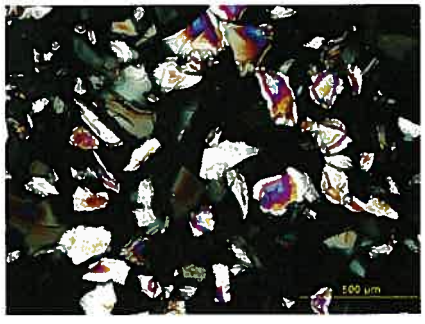
Javidi said the magnification powers of the VHX-600 range from 0.1× to 5000×, and the built-in camera can capture 54-megapixel images as well as video. The stage can rotate 360°, and the camera can be tilted almost 180° from side to side.

"By doing this," Javidi said, "we can see almost around the entire part without touching or mounting the part." The light source has been integrated into the tip of the lens, she added, "to ensure optimal reproducible lighting."

The 3-D profile capabilities of the VHX-600 allow for more sophisticated measurement of evidence specimens. "Perhaps you need to measure the depth of a crack in a sample," Javidi said. "The 3-D profiling and measurements eliminate the guesswork and enable this analysis."



Human hair is viewed under crossed polars with first-order red compensator using an Olympus microscope. Courtesy of the McCrone Group.



Quartz is viewed under crossed polars using an Olympus microscope. Courtesy of the McCrone Group.

Adaptability from Olympus

For Jeffrey D. McGinn, vice president and director of instrument sales at McCrone Microscopes and Accessories, another division of the McCrone Group, one of the most important features in a forensic microscope is modularity.

"We'll go into a forensics lab and, depending on the needs of the end users, we'll configure the microscopes," McGinn said.

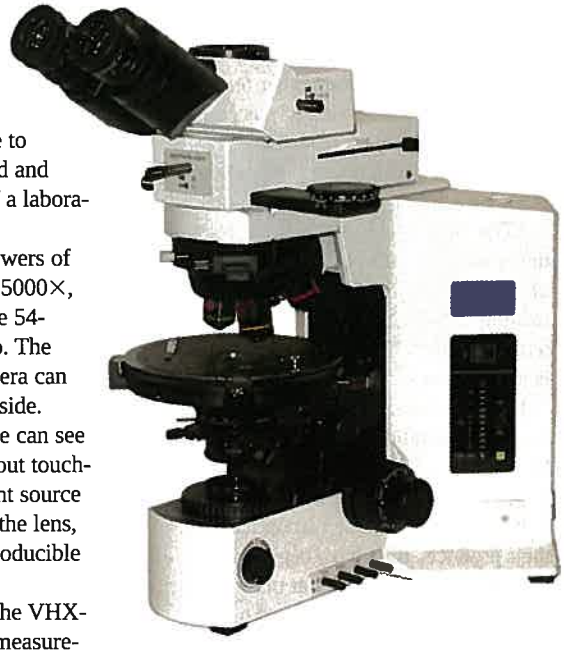
McCrone is the national polarized light microscope dealer for Olympus Microsystems America, and McGinn said the manufacturer's BX line is especially suited to forensics applications. "What's most special is its modularity," he said, noting that a BX microscope can be outfitted with a number of contrast methods, including fluorescence, as well as motorized, automated and thermal stages.

He said the digital imaging options also vary and that the microscopes are designed to work with cameras from Olympus or other makers. "It depends on what the end user needs," he said.

New angles, new approaches

Researchers are coming up with new applications for microscopy, from analyzing bullet holes to using scanning electron microscopy (SEM) to study fingerprints.

Peter J. Diaczuk, adjunct instructor in the department of sciences and director of forensic science training in the Center for Modern Forensic Practice at John Jay College of Criminal Justice, City University of New York, has been studying bullet holes under the microscope.



The BX51 microscope by Olympus is designed for modularity. Courtesy of the McCrone Group.

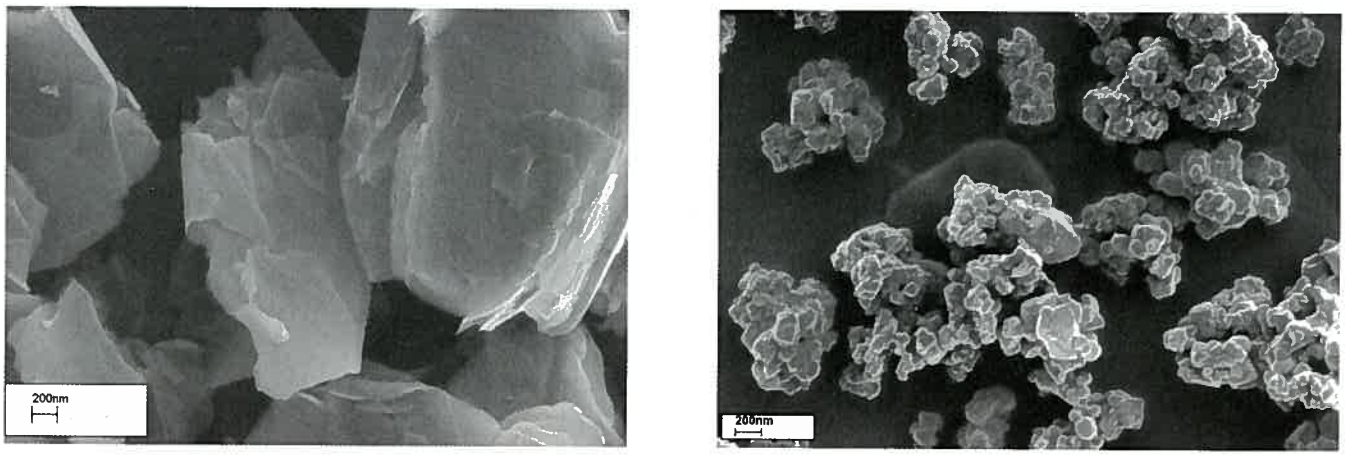
Diaczuk has devised a way to tell whether a given bullet hole is an entry or exit hole.

There are other methods, he admitted. "If a bullet comes out of a gun and it's got lead residue on it – if there is lead on the bullet, then there is likely more lead on the entry hole than the exit hole.

"But there are ways of making that test more challenging: using lead-free ammunition, which is being used more often now. Or if there is an excessive amount of blood at the two holes." Sometimes, he added, evidence can be mishandled or damaged, preventing performance of the chemical test for the residue, so his method, which relies on the depth of the bullet holes themselves, is useful.

Benjamin J. Jones, lecturer and research coordinator for the Experimental Techniques Center at Brunel University in Uxbridge, UK, not only has applied atomic force microscopy to the forensic analysis of SIM cards but also is working with the UK Home Office to find new fingerprint detection techniques for wet or adhesive surfaces such as packing tape and porous materials like paper.

"The use of techniques such as SEM, TEM and [x-ray photoelectron spectroscopy] as well as [atomic force microscopy] can investigate physical and chemical structure on a micro and nano level," said Jones, "and allow investigations of the latent prints and the way development powders,



Scanning electron microscopy, transmission electron microscopy, x-ray photoelectron spectroscopy and atomic force microscopy allow forensic scientists to determine the micro and nano physical and chemical structures of substances such as fingerprint development powders. Courtesy of Benjamin J. Jones, Experimental Techniques Center, Brunel University.

for example, interact with the print."

Diaczuk, Jones and countless other scientists around the world are helping to advance forensic microscopy by approaching very real problems from new angles.

"Very often, we get a call from the city of New York or a private attorney, and they have a specific case," Diaczuk said. "And all of us are proponents of empirical testing. Some things warrant a confirmatory test – if you don't do these things, you could be challenged on cross-examination."

Thus, the line between research and practice can be a bit blurred, but that's a good thing, according to the manufacturers, who appreciate the feedback.

"I look at the forensic laboratory as being the ultimate research lab – the mindset of the forensic scientist has to be that of a researcher," said Buttermore, of Leica Microsystems. "You have to be able to test for all of the variables. A lot of the time, especially with trace evidence, you don't just use one set of tools, you use several tools, and all together, they give you a final answer."

laura.marshall@laurin.com