Nanotech drives imaging toward faster, smaller, more economic

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Nanotechnology is having a big effect on imaging equipment [1]. In semiconductor parlance, it is driving a strong "lab to fab" transition: Equipment once found only in the research and development laboratory is now finding its way into production and the classroom. While the more sophisticated laboratory versions retain their role for high precision and applicability to multiple applications, their new counterparts are becoming faster, smaller, sleeker, and more economical. This paper is a non-commercial discussion of a number of new entries in the field.

Cameras Lead the Way

Collecting low-light-level images at high speed has long been a challenge for microscopists, especially those involved in light or confocal microscopy. One historical solution has been to leave the camera shutter open over a period of time and integrate the resulting data. By its very nature, however, this process is slow, and the longer integration times often add unwanted stray light and electronic noise. In addition, as microscopists need to capture and measure real-time action, the call has gone out for higher speed image acquisition. New cameras are now available to collect 512x512 pixels images at 2000 frames per second, even under low light level conditions.

Image capture, however, is only half the story. The second half centers on the challenge of rapid data transfer. Among the cameras discussed in this section will be the FocusScope SV200-I (Photron, San Diego, CA) and the Miro (Vision Research, Wayne NJ).

SEM moves to the desktop

Three key companies have taken up the mantle of developing instruments in this new category, in some cases, replacing conventional optics and electronics with high tech MEMs (microelectromechanical devices) and silicon stacks. Among the instruments discussed in this section will be the Phenom (FEI, Hillsboro OR), the TM-1000 (Hitachi High Tech America, Pleasanton CA) and mySEM (NovelX, Lafayette CA)

Light microscopy gets a nanoboost in thin film measurement and imaging nanotubes

The mysterious evanescent wave, found in the first few nanometers adjacent to a surface, can often boost signals and drop limits of resolution dramatically, receiving increasing press and attention in recent years. NanoLane (distributed in the US through MicroPhotonics, Irvine CA) has designed a contrast-enhancing support, the "Sarfus Surf", which uniquely controls the reflection of polarized light impinging on the surfaces, enhancing both contrast and resolution. Light microscopy now extends easily into the nanorealm to image double walled carbon nanotubes (Fig. 1a) and thin film steps on the order of tens of nanometers (Fig 1b).

New ways to image surface texture, profiles, and roughness

Surface texture and profiles have long been important to industry and engineering students, both in the general study of materials, but more practically, in wear studies and performance testing. Optical profilometry has been the most direct approach, but the profilometers have been large and costly. New instruments, available in both stand-alone and modules retrofittable to a light microscope, collect data that can be used to create 3D images, 2-D profiles, step height, waviness parameters, and a wide variety of roughness characteristics.

Where optical profilometry leaves off in its ability to resolve nano height and roughness, Atomic Force Microscopy picks up. Several companies now offer smaller, less complex systems ideal for entry-level labs and teaching.

The Microscopy/Spectroscopy convergence continues

Any microscopist familiar with electron microscopy is also familiar with the accompanying elemental analysis such as EDS, WDS, and XRF. More conventional chemical finger-printing relies on molecular analogs using vibrational spectroscopy techniques such as FTIR and Raman. FT-IR has been integrated with light microscopy for well over a decade but the new systems are sleek, stream-lined, and make imaging plus chemical fingerprinting easy.

Raman, a complementary technique to FT-IR, has been more of a challenge because of its weak signal (just as fluorescence is often $1/1000^{th}$ to 1/10,000th the intensity of ambient light, Raman is often $1/1000^{th}$- $1/10{,}000^{th}$ the intensity of fluorescence) and difficulty in segmenting the signal from fluorescence. On the research level, Raman has found a happy partnership with AFM and over the past 18 months, Raman manufacturers have opened their architecture to make the AFM-Raman interface easier and more adaptable [2]. But what of Raman and light microscopy? An intriguing new hand-held Raman system holds promise for the future.

References

[1] B. Foster, *Am. Lab*. 6 (2007) 20-23

[2] B. Foster, *Am. Lab*. 3 (2007) 13-14

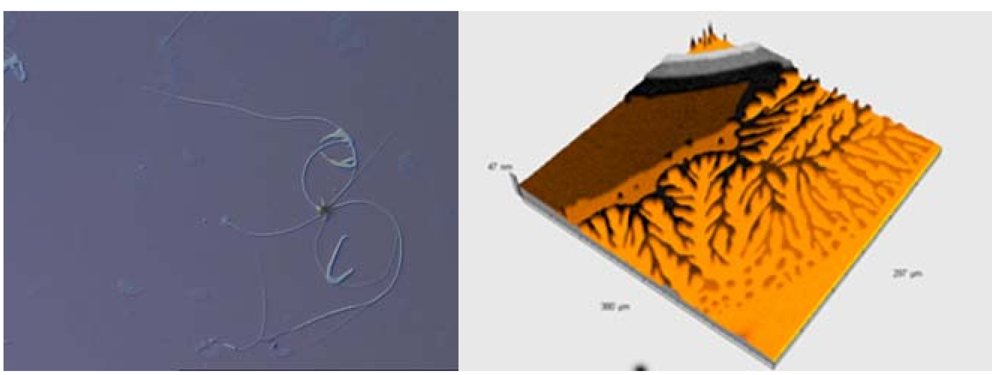

FIG. 1. Surf substrates extend light microscopy's imaging in X, Y, and Z. (a) Double walled carbon nanotubes (50nm diameter) (b) When the liquid crystal 4-n-octyl-4-cyanobiphenyl (8CB) is deposited on a Surf at its smectic/nematic transition temperature, the drop spontaneously spreads to form steps of regular heights on the order of tens of nanometers (Image courtesy of **Micro Photonics**).