

# Microscopy Innovation Awards

Congratulations to the winners of the  
2014 *Microscopy Today* Innovation Awards:



- Abberior Instruments
- AppFive
- Applied Nanostructures
- Asylum Research, an Oxford Instruments company
- CoolLED
- FEI
- Leica Microsystems
- Max Planck Institute for Biophysical Chemistry
- NanoMEGAS
- Stanford University
- University of Missouri
- Yale University

Entry deadline: **March 15, 2015**

Application forms at [www.microscopy-today.com](http://www.microscopy-today.com)

representing 49% and 13% of the normal force (about 150 pN) were observed in common tapping mode conditions as a silicon tip intermittently contacted a glass substrate in aqueous solution. As a consequence, the direction of the force vector tilted considerably more than expected. When addressing the surface of a lipid bilayer, the behavior of the force components differed significantly from that observed on glass. This is attributed to the lateral mobility of the lipid membrane coupled with its elastic properties. Direct access to interaction components  $F_x$ ,  $F_y$ , and  $F_z$  provides a more complete view of tip dynamics that underlie force microscope operation and can form the foundation for improved 3D AFM.

Existing 3D AFM techniques require recording thousands of frequency shift curves at different lateral locations, followed by off-line integration (to yield energy) and lateral differentiation (to yield lateral force). That procedure is inherently slow and is largely restricted to studies of static samples.

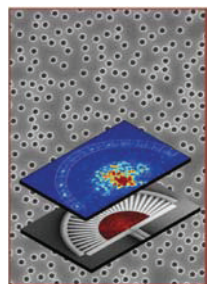
The direct 3D AFM is expected to permit new research in many areas of nanoscience. The instrument has already provided the first measurements of the 3D trajectory of a tapping tip as it interacts with a surface, the first determination of the 3D spring constants of an AFM tip, and the first direct determination of the 3D tip-sample force vector in AFM.

The direct 3D AFM opens new avenues in multi-dimensional AFM in perturbative operating conditions such as mapping the 3D trajectory of flexible and disordered protein motifs in physiological buffer solution. In addition to biophysics, the method is applicable to other fields that use AFM routinely such as nanotechnology, materials science, and chemistry.

## Chip-Scale Random Spectrometer

Hui Cao and Brandon Redding of Yale University

Developers: Hui Cao and Brandon Redding



The operation of this compact, general-purpose on-chip spectrometer is based on multiple-scattering in disordered nanostructures. Traditional spectrometers rely on a grating or prism to disperse light into different wavelengths, and the spectral resolution scales with the optical path length from the grating to the detectors. By using a disordered structure as the dispersive element, the random spectrometer overcomes this trade-off by increasing the optical path length through multiple scattering. Optical scattering in random media has been studied for years because of its prevalence in natural systems such as biological tissue and the atmosphere. But historically the goal has been to mitigate the effects of scattering. In this work, disorder was intentionally introduced into the device and shows that optical scattering can be used to improve device performance. In this case, the long path

length through a scattering medium enables high spectral resolution in a small footprint.

The proof-of-principle device was fabricated on a silicon-on-insulator wafer, and the disordered structure consisted of cylinders etched in the silicon. The spectrometer operates by measuring the seemingly random intensity pattern produced by light diffusing through the scattering structure. Because the scattering structure is fixed, the same input wavelength will always produce the same intensity pattern, whereas different wavelengths produce distinct patterns. These intensity patterns can be used as fingerprints to identify the input spectrum. To overcome the low-transmission usually associated with a disordered structure, a photonic crystal boundary was introduced to confine the light within the semi-circular scattering structure until it reaches the detectors. Out-of-plane scattering loss was reduced by introducing structural correlations to the positions of the scattering elements. The result is a 25  $\mu\text{m}$  radius random spectrometer that provides 0.75 nm spectral resolution with a 25 nm bandwidth at  $\lambda = 1500$  nm.

The on-chip random spectrometer could enable a host of new spectroscopy applications which were previously impractical because of the large size and cost of existing spectrometers, including new applications in field spectroscopy, lab-on-a-chip, and hyperspectral imaging. Moreover, the extremely compact size of the random spectrometer provides the possibility of integration with other photonic components. This could enable lab-on-a-chip systems with enhanced sensitivity and new functionality.

MT

Expand your Knowledge of Microscopy with

## MSA Membership!

**Whether your primary focus is in the biological or the physical sciences, MSA takes your knowledge to the next level!**

### Members Receive:

- A personal subscription to MSA's official journal, *Microscopy and Microanalysis*, and MSA's popular bi-monthly magazine, *Microscopy Today*.
- Peer Networking through the Society's Focused Interest Groups and Local Affiliated Societies.
- MSA Awards Programs, Scholarships, Speaker Opportunities, and much more!

### Join MSA Today!

For more information:  
visit [www.microscopy.org](http://www.microscopy.org)



or call 1-800-538-3672