Microscopy TODAY

Coming Events

2009

Microscopy & Microanalysis 2009
July 26–30, 2009, Richmond, VA
www.msa.microscopy.org

Microscopy Conference 2009
August. 30–September. 4, 2009, Graz, Austria
www.microscopy09.tugraz.at/

EMAG 2009
Aug. 30–Sept. 4, 2009, Sheffield, UK
www.emag2009.org

FEMMS 2009
September. 27–October. 2, 2009,
Sasebo, Nagasaki, Japan
www.emag2009.org

Neuroscience 2009
October 17–21, 2009, Chicago, IL
www.sfn.org

CIASEM 2009
October 25–28, 2009, Rosario, Argentina
www.cab.cnea.gov.ar/ciasem2009

American Vacuum Society
November. 8–13, 2009, San Jose, CA
www.avs.org

Materials Research Society
November. 30–December. 4, Boston, MA
www.mrs.org

American Society for Cell Biology
December 5–9, 2009, San Diego, CA
www.ascb.org/meetings

2010

Microscopy & Microanalysis 2010
August 1–5, 2010, Portland, OR

2011

Microscopy & Microanalysis 2011
August 7–11, 2011, Nashville, TN

2012

Microscopy & Microanalysis 2012
July 29–August 2, Phoenix, AZ

Please check the "Calendar of Meetings and Courses in the MSA journal *Microscopy and Microanalysis* for more details and a much longer list of meetings and courses.

Carmichael's Concise Review

Magnetic Resonance Imaging Enters the Nanoscale Realm!

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Magnetic resonance imaging (MRI) has become commonplace in medical practice and research. The quality of spatial information from living patients has proven to be invaluable. Considerable effort has been expended to extend the limit of resolution of MRI to microscopic levels, but this has been hampered by fundamental limitations, especially detection sensitivity. Sensitivity is the key issue since MRI is based on the manipulation and detection of nuclear magnetism which is a relatively weak physical effect. Magnetic resonance force microscopy (MRFM), based on the ultrasensitive detection of magnetic force, is a promising approach that has been developed to overcome the sensitivity limitations of conventional MRI. Recently, Christian Degen, Martino Poggio, John Mamin, Charles Rettner, and Dan Rugar have made a breakthrough on this front that provides a volume resolution about 100 million times better than conventional MRI!

This extreme improvement in resolution is due to several key technical advances, including the generation of very high magnetic field gradients (4 million Tesla per meter), detailed understanding of the MRFM point-spread function, and the application of an image-reconstruction technique capable of converting magnetic force measurements into a three-dimensional map of proton density. The technique is based on the mechanical measurement of very small (attonewton) magnetic forces between nuclear spins in a sample and a nearby magnetic tip. For a sample, they chose particles of the tobacco mosaic virus (TMV) because it is a biologic specimen that is physically robust and is rich in proteins, therefore it has many protons. The TMV particles are deposited onto the flat end of an ultrasensitive silicon cantilever that is positioned close to a tiny magnetic tip that produced a strong and inhomogeneous magnetic field. This tip is on a copper "microwire" that can generate a radiofrequency (rf) magnetic field that excites nuclear magnetic resonance. Frequency modulations of the rf field induces periodic inversions of the proton spins in the sample that in turn cause the cantilever to resonate. These tiny vibrations are detected via a fiber optic interferometer and synchronously detected using a dual-phase lock-in amplifier. Because the field from the magnetic tip is a strong function of position, the resonance is confined to a thin hemispherical "resonant slice" that extends outward from the tip.

Three-dimension imaging of the sample requires 2 steps: data collection and image reconstruction. Without going into details, the spin signal is measured as the magnetic tip is mechanically scanned with respect to the sample in a 3D raster pattern. To reconstruct a real-space 3D image, the extended geometry of the resonant slice must be deconvoluted. This was done using a few thousand iterations of a Landweber algorithm. Degen et al. think that the implementation of more sophisticated reconstruction algorithms will provide even better resolution in the future.

The quality of the reconstruction is remarkable, yielding a spatial resolution down to 4 nanometers! Fidelity of the image was confirmed by correlating with scanning electron micrographs of the same specimen. This new technique promises to complement current techniques, such as cryo-electron microscopy, and in the opinion of this author will certainly develop into a powerful tool for structural biology. MT

1. The author gratefully acknowledges Dr. Dan Rugar for reviewing this article.
2. C L Degen, M Poggio, H J Mamin, C T Rettner, and D Rugar, *Proc Natl Acad Sci* 106 (2009)1313-1317.

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