Imaging Interferometric Microscopy
The University of New Mexico, Center for High Technology Materials
Inventors: Steven R.J. Brueck, PhD, Yuliya Kuznetsova, PhD, Alexander Neumann, PhD

Background

Optical or light microscopes use visible light and a set of lenses to acquire and magnify images. The diffraction limits to optical resolution were established over a century ago; the maximum spatial frequency allowed by an optical system is $2NA/\lambda$, giving a resolution limit of $\lambda/4NA$, where $\lambda$ is the optical wavelength and NA is the numerical aperture of the optical system. The quest for optical super-resolution has long been a topic of great scientific and practical interest. Researchers from the University of New Mexico have developed a technology that is based on structural (complex refractive index) contrast, and extends resolution to linear systems limits of $\lambda/4n$ where $n$ is the refractive index of a substrate/superstrate that can be as high as $\sim 5$; chemical information can be accessed using coherent anti-Stokes Raman (CARS) processes.

Technology Breakthrough

Imaging interferometric microscopy (IIM) is a synthetic aperture approach which uses a low numerical aperture microscope to collect multiple coherent partial images covering different spatial-frequency regions through off-axis illumination and interferometric optics. The partial images are then assembled to form a composite image covering a larger region of frequency space than is available from the low-NA lens.

There are several possible implementations of IIM for improving resolution, ultimately using a thin semiconductor layer with a refractive index of $\sim 5$, IIM will extend microscopy to unprecedented $\lambda/4n \sim \lambda/20 \sim 25$ nm levels, usually associated with electron microscopy. IIM is applicable to existing microscopes with all of the additional optics confined to the front of the microscope objective.

Key Advantages

- Revolutionary advance in optical microscopy - replaces expensive lenses
- Adaptable to current technology such as standard transmission/reflection microscopy configurations
- Extends resolution beyond high numerical aperture techniques
- Removes phase contrast problem for viewing biological samples
- Pushes to the linear system limits of optical microscopy
- Chemical identification through CARS techniques

Intellectual Property

Issued U.S. Patent 7,978,403
Issued U.S. Patent 8,203,782
Issued U.S. Patent 8,115,992
Issued U.S. Patent 8,526,105
Issued U.S. Patent 9,239,455

Contact

For more information, contact Arlene Mirabal, Marketing Operations Coordinator, STC.UNM at amirabal@stc.unm.edu or (505) 272-7886.

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