



FALL 2004 SEMINAR SERIES

NANOSCALE IMAGING OF
SEMICONDUCTOR AND BIOLOGICAL SYSTEMS

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Two innovative approaches are to be presented to go beyond the capabilities of standard optical microscopy which is limited to a transverse resolution of approximately half a wavelength due to the diffraction, also termed the Rayleigh or Abbe limit. The resolution is inversely proportional to the Numerical Aperture (NA). One method to increase the NA is to increase n , the refractive index of the material in the object space. We recently developed a new technique involving a *Numerical Aperture Increasing Lens (NAIL)* for diffraction limited subsurface microscopy. The NAIL technique is demonstrated by near-IR inspection of Si integrated circuits yielding a 230 nm resolution at 1050 nm wavelength representing a factor of 4 improvement over the state-of-the-art. We experimentally demonstrate a lateral spatial resolution of 1.4 μm and a longitudinal spatial resolution of 7.4 μm , for thermal imaging at free space wavelengths up to 5 μm . We also examine in detail the ability of sharp metal tips to enhance local optical fields and describe a new approach to nano-optics, that of combining solid immersion microscopy with tip-enhanced focusing and show how such an approach may lead to 20 nm resolution with near-unity throughput.

Spatial resolution can also be improved beyond the diffraction limit by collecting spectral information. We have built on our experience on resonant optoelectronic devices and developed a novel application to fluorescence microscopy that promises nanometer resolution in biological imaging. Initial experiments on fluorescently labeled lipid layers successfully determined the binding of fluorescent molecules in membranes with sub-nanometer precision.

Short-Bio: M. Selim Ünlü is a Professor of Electrical and Computer Engineering, Biomedical Engineering, and Physics at Boston University, and serves as the Associate Director of Center for Nanoscience and Nanobiotechnology at BU. Prof. Ünlü received the B.S. degree in electrical engineering from METU, Ankara, Turkey, in 1986, and the M.S.E.E. and Ph.D. in electrical engineering from the University of Illinois, Urbana-Champaign, in 1988 and 1992, respectively. Dr. Ünlü's career interest is in research and development of photonic materials, devices and systems focusing on the design, processing, characterization, and modeling of semiconductor optoelectronic devices, especially photodetectors, as well as high-resolution microscopy and spectroscopy of semiconductor and biological materials. He was awarded NSF Research Initiation Award in 1993, United Nations TOKTEN award in 1995 and 1996, and both the NSF CAREER and Office of Naval Research Young Investigator Awards in 1996. He has authored and co-authored over 200 technical articles and several book chapters and magazine articles; edited one book; and holds several patents. He is currently the chair of IEEE/LEOS *Nanophotonics* and an Associate Editor of *IEEE Journal of Quantum Electronics*.

This NECP Seminar is jointly sponsored by the Center for Nano-Scale Science and Engineering (CeNSE), and the Departments of Electrical and Computer Engineering and Mechanical Engineering.

Refreshments and pastries will be available before the seminar starts.

SEPTEMBER 30, 2004
PHYSICS/CHEMISTRY AUDITORIUM 155
UNIVERSITY OF KENTUCKY, LEXINGTON, KY
12:15 – 1:30 PM