Technical Subject:

Development of a Nanometer Microwave Imager

Corresponding Applicant:
Prof. Michael Kelly, Stanford University

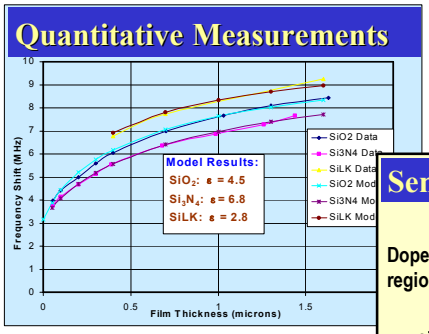
Co-researcher:
Prof. Zhi-Xun Shen, Stanford University

The need:

Rapid submicron characterization of semiconductor devices, maps of protein distributions, and images of other microstructures are needed in many industries. The short-range forces involved in SPM systems make it difficult to rapidly scan the larger areas needed, or to operate with robust sensing tips that are not easily damaged.

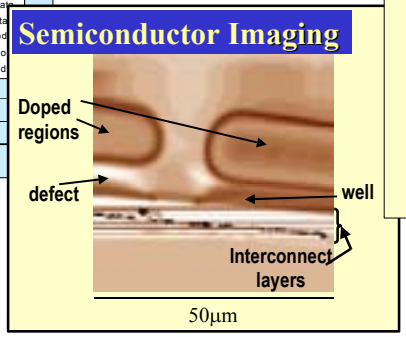
Our Research:

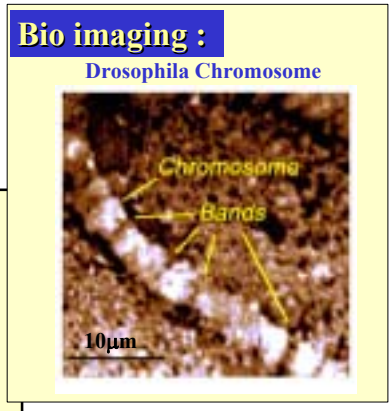
Recently developed near-field microwave probes operate with a longer range force, and provide unique information about the electrical properties of a material[1,2]. Some examples of measurements made in our laboratory with a current microwave probe:



Above: *measurements of a variety of low-k dielectrics deposited on Si. A model relates the measured change in the frequency of a resonant cavity to the dielectric constant*

Below: *A cross section of an implanted semiconductor device. Contrast comes from different electrical properties of dopants, dielectrics, metals*





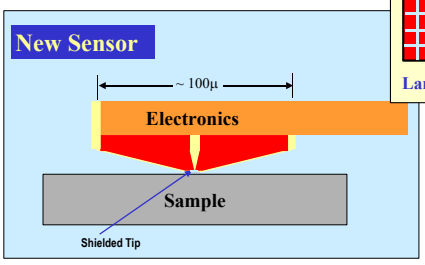
Above: *an image of a biological specimen. Many biomedical applications are envisioned for the technology*

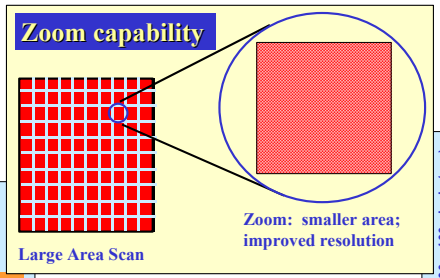
Our Proposal:

To develop a general-purpose imaging instrument, applicable to a wide range of applications, based upon current near-field microwave technology. Specific improvements to the current capabilities are the following:

- Develop a high sensitivity lightweight sensor with a protected tip
- Increase the scanning bandwidth so an image can be obtained in 1 -10 sec.
- Incorporate a "zoom" feature permitting a 100:1 change in viewing area

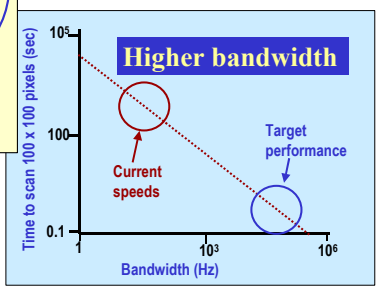
New Sensor: *A guarded tip with an integrated amplifier interacts with the sample. The small size permits high sensitivity, high bandwidth response. Spatial resolution is approximately equal to the spacing between tip and sample*





Zoom: *At a larger tip/sample spacing, a large area can be scanned rapidly; or at a closer spacing, a smaller area can be scanned in the same time yielding a higher resolution image.*

High Scan Rates: *The light sensor can be rapidly scanned over the sample; the high bandwidth electronics provides a high data rate.*



Invitation to collaborate: We would welcome colleagues interested in exploring applications for this new capability, particularly in the biomedical field.

1. Anlage, S. M. et al. "Near-field Microwave Microscopy of Materials Properties" ArXiv: cond-mat/0001075, 7 Jan, 2000

2. Wei, T. et al. "Scanning tip microwave near-field microscope" Appl.Phys. Lett., 1996. vol.68, no.24, p. 3506-8