**About the Center for Probing the Nanoscale**

Stanford University and IBM Corporation, with funding from National Science Foundation, founded the Center for Probing the Nanoscale to achieve five principal goals:
- develop novel probes that dramatically improve our capability to observe, manipulate, and control nanoscale objects and phenomena
- educate the next generation of scientists and engineers regarding the theory and practice of these probes
- apply these novel probes to answer fundamental questions in science and technology
- transfer our technology to industry in order to make these novel probes widely available
- inspire students, teachers and the public about nanotechnology

**Nanoscale Electrical Imaging**

Goldhaber-Gordon, Shen, Pruitt

- Measure electronic properties of materials at 10-nm resolution.
- Tools under development:
  - Scanning Gate Microscopy (SGM): Electrostatic coupling of a quasi-DC tip voltage to sample. Continuing studies on local charge transport in graphene, complex oxides, and topological insulators.
  - Microwave Impedance Microscopy (MIM): Electric or magnetic coupling of a microwave signal from a tip to a sample. Continuing studies on electronic phase transitions in manganites, 2DEG systems, topological insulators, and ferroelectrics.

**Individual Nanomagnet Characterization**

Moler, Kirtley, Kapitulnik, Rugar

- Develop and demonstrate techniques with the magnetic sensitivity and spatial resolution to characterize individual nanomagnets.
- Advancing development of Nanoscale Magnetic Resonance Imaging toward a molecular structure microscope.
- Tools under development:
  - Scanning Superconducting Interference Device (SQUID) Microscopy: Extremely sensitive sensor for imaging local magnetic fields.
  - Scanning Sagnac Microscopy: Interferometric technique for magneto-optic imaging based on the polar Kerr Effect.
  - nanoMRI: Chemically specific 3D imaging of molecular structures using magnetic resonance force microscopy and nitrogen-vacancy (NV) centers in diamond.

**Bio-Probes**

Melosh, Solgaard, Butte

- Measure the forces, mechanical properties, and dynamics of biological membranes with critical resolutions of nanometers, microns, and pN by developing and using novel probes.
- Combine ultrafast cantilevers with bio-functionalized stealth probes to insert into the membrane in order to gain insight on designing improved cell-entry agents.
- Use probes to stimulate and characterize T-cells in order to understand immune activation.

**SEM image of ultrathin cantilevers for dynamic force measurement.**

These interdigitated AFM probes are fabricated using standard MEMS processing techniques. The relative displacement between these two sets of fingers (measured interferometrically) is a measure of the tip-sample interaction force.

**SEM image of an AFM probe assembled onto an optical fiber.**

With their micron-size form factor, fiber facet AFM systems open up new applications of the technique, such as in vivo imaging of live cells. The device uses a Fabry-Perot Cavity made of photonic crystal mirrors where the cavity doubles as the release structure of the device. In the image shown, the tip was made on a separate wafer and welded onto the final device using a focused ion beam.

**Selected Recent Publications**


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