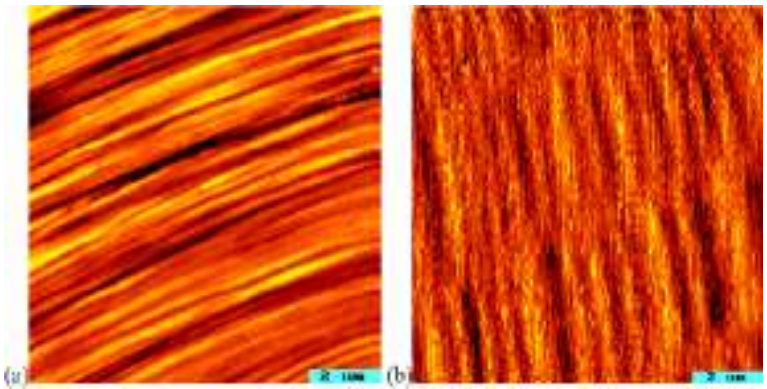
A cryogenic scanning probe microscope

B.H. Hu and C.H. Yang, ECE, University of Maryland, supported by **LPS/NSA & ONR**

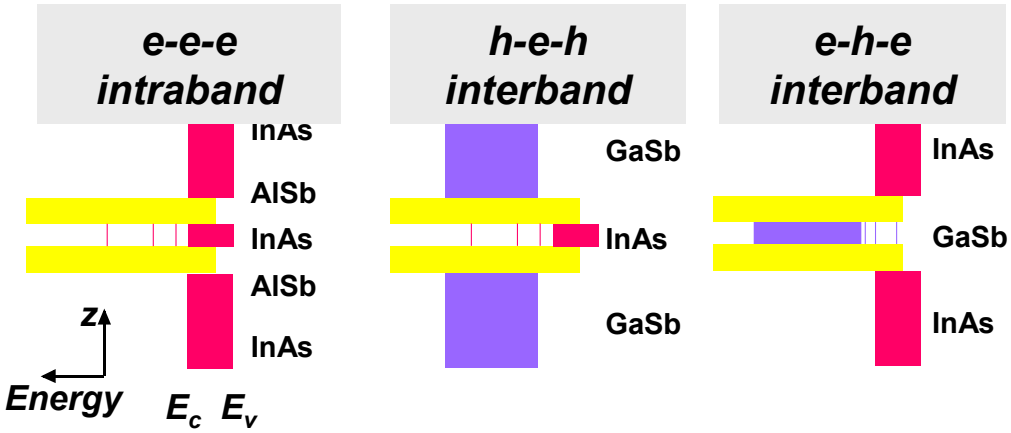
- Specific for probing nanometer-scale devices, we have designed and built a conductive atomic force microscope using a quartz tuning fork as the force sensor.
- The operating temperature is ranged from 4.2K to 300K, and under magnetic field up to 9 tesla.
- There are many applications in the characterization of nanostructures. One example is to probe single electron quantum dots, where the conductive tip directly rests on top of the quantum dots and interrogate the current-voltage characteristics. The results indicate a clear crossover from resonant tunneling behavior to the Coulomb blockade regime.

- **Magnetic force microscope**
- 2.1G/in^2 Seagate hard disk drive

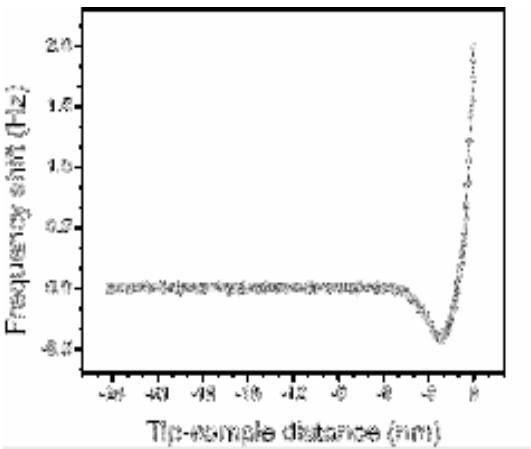
(a) Topography (b) Magnetic domains



- **Dc current-voltage probe**
- MBE-grown double barrier resonant inter-band and inter-subband tunneling diodes
- Etched into nanometer-scale pillars
- Quantum well ➔ quantum dot with few electrons



- **Atomic force microscope**



- The "approach curve"
- The shift in the sensor frequency versus the tip to sample distance
- The attraction and repulsion of the Lenard-Jones potential is observed, showing the systems resolution
- Basis for atomic imaging