

ATOMIC FORCE MICROSCOPY FOR NANOTECHNOLOGY

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Research Plan

Building Blocks

Functional Polymers, Biomolecules and Nanoparticles

Biological, Ethical and Societal Implications

- Biocompatibility
- Ethical/Societal Implications

Non-Cleanroom Manufacturing Technology

- Top-down
- Bottom-up + Top-down

Transport Properties

- Transport at Nanoscale
- Nanofluidic Design
- Multiscale/Multiphase Phenomena

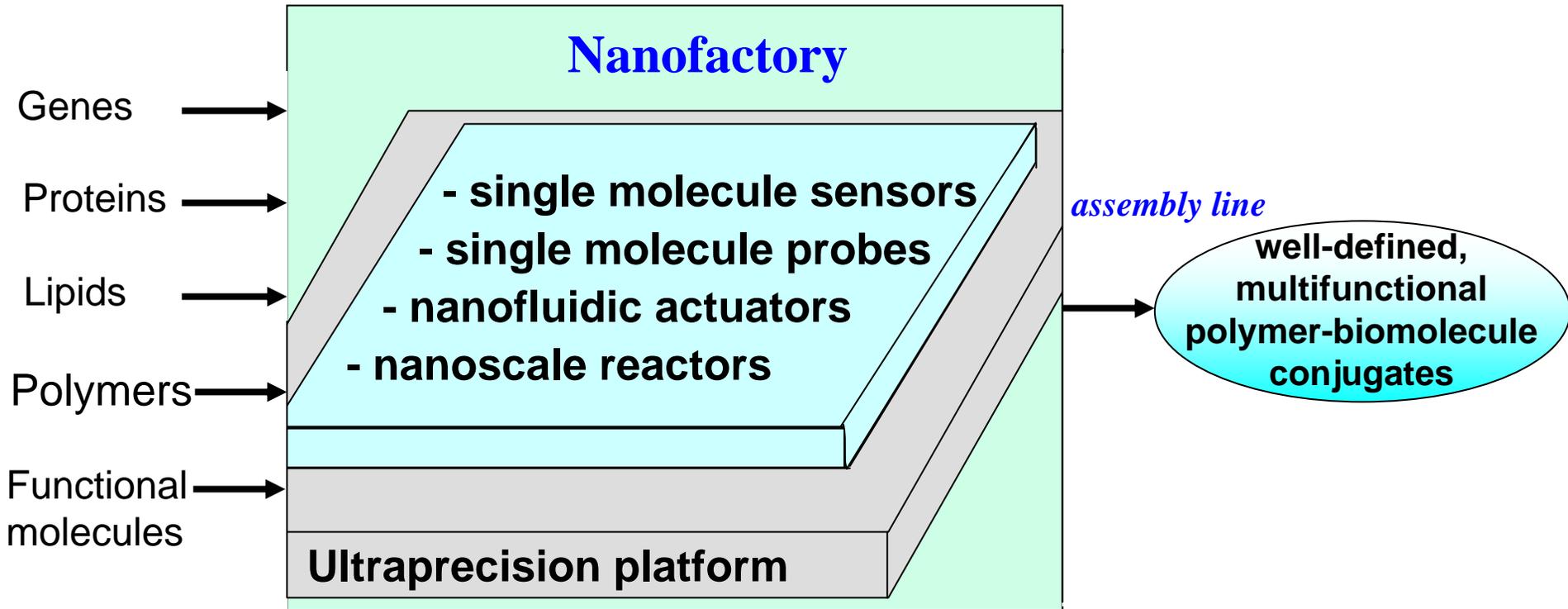
System Integration

- Nanofluidic Circuits
- Nanofactory

Multiscale and Multifunctional 3D Structures/Devices

- Magnetic protein separation, Nanopump as synthetic ion channels
- Gene delivery/therapy, DNA cloning and repair

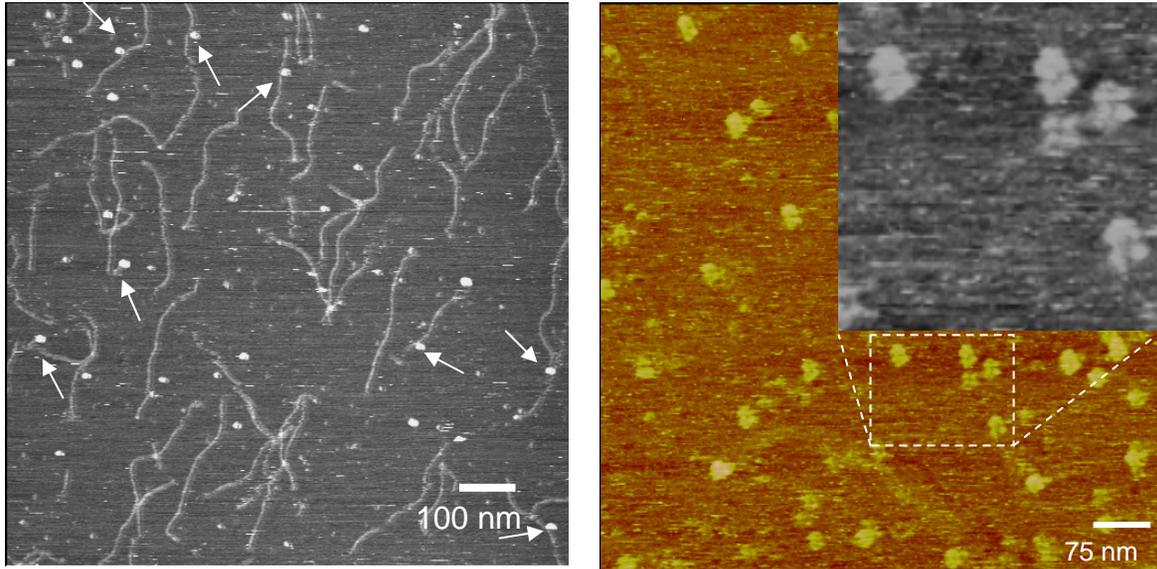
Nanofactory Concept



Potential Applications:

- Synthesis of liposomes, artificial chromosomes and nanoparticles for gene therapy
- Cloning (DNA recombination)
- Gene repair

Single Molecule Imaging

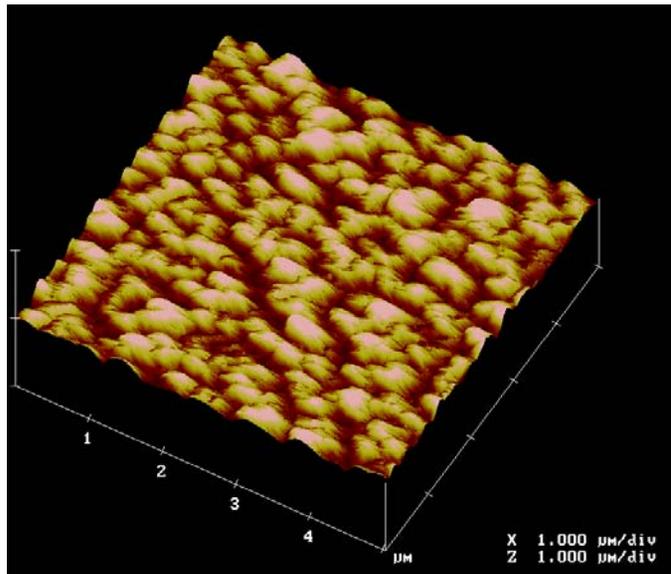
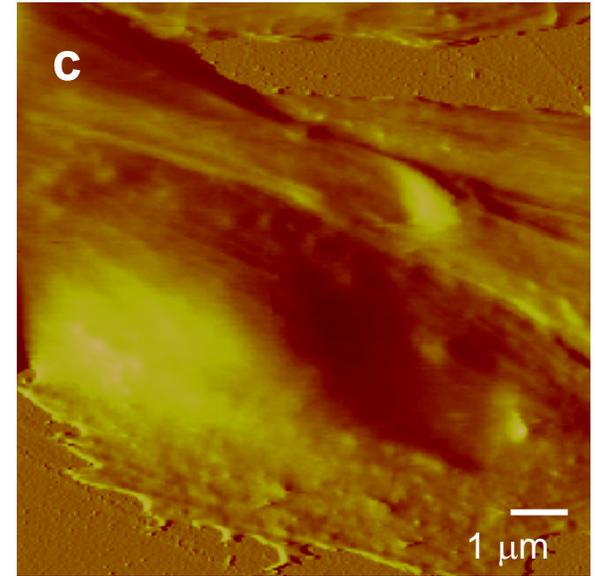
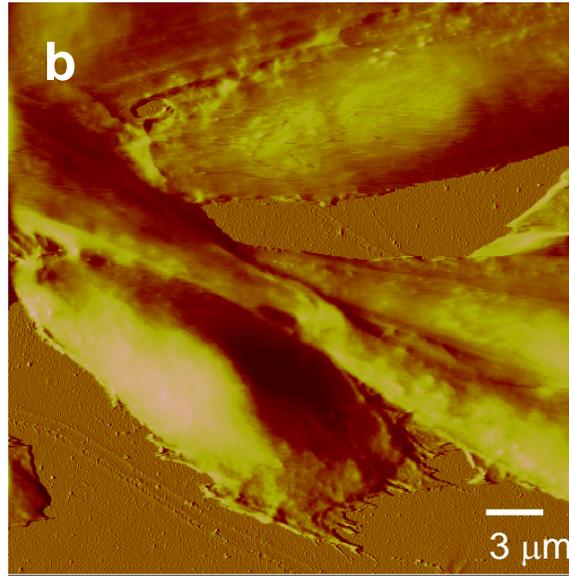
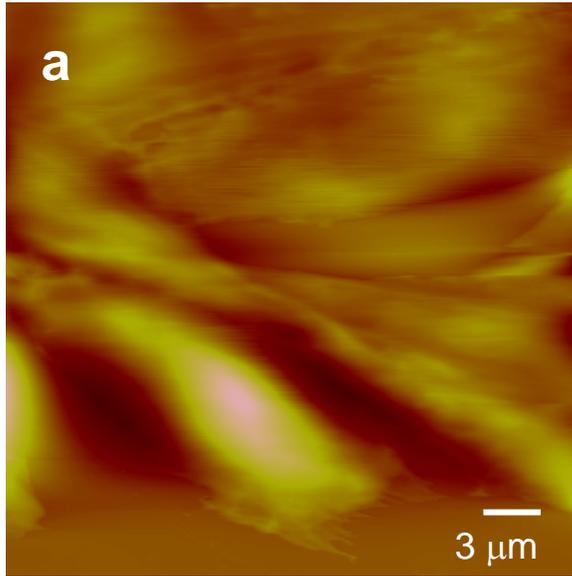


AFM height image of (a) a collagen binding protein DDR2 binding to single collagen molecules and (b) oligomers of DDR1. All images were acquired using tapping mode in a fluid environment. As demonstrated above, single molecule imaging by AFM can help locate site-specific binding and determine stoichiometry of protein complexes.

The Future:

Single molecule imaging of biomolecules assembled on polymer surfaces as outlined in the Nanofactory concept

Live Cell Imaging



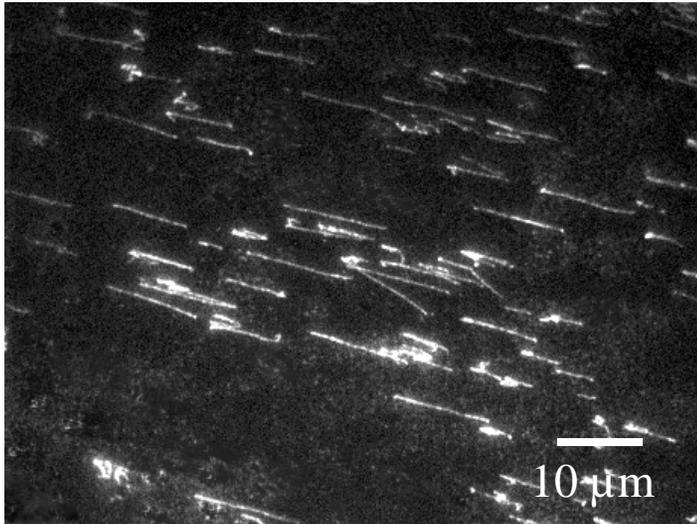
(Top) Live CHO cells imaged in fluid media using AFM in tapping mode. (a) height and (b, c) amplitude images.

(Left) Three-dimensional AFM top view of height image of a RIE treated PET surface imaged in PBS buffer.

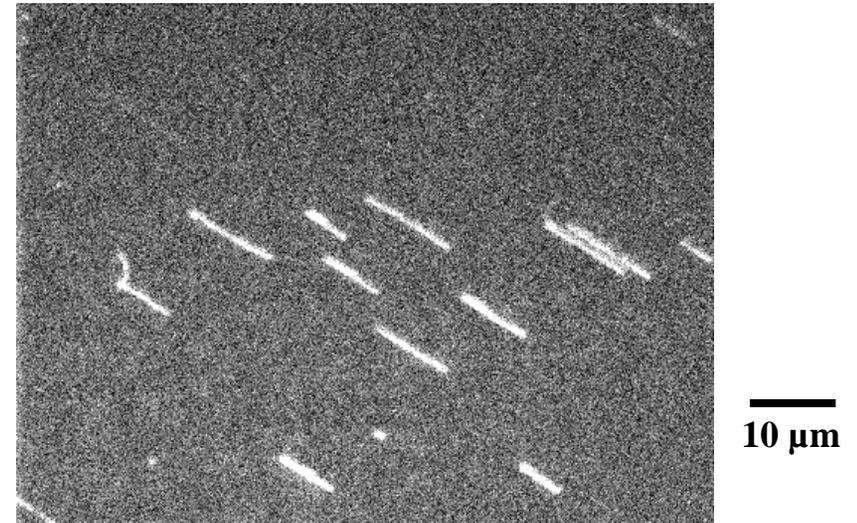
The Future:

**Live cell imaging on polymer surfaces
for creation of functional polymer-
biomolecular conjugates**

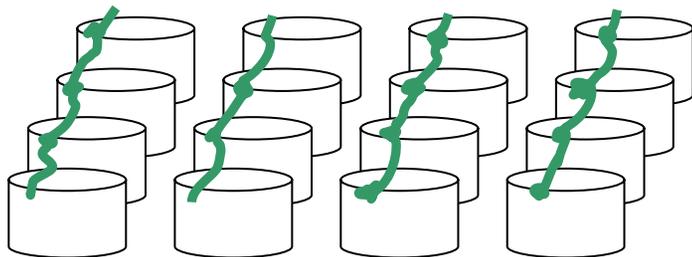
Stretching DNA on Charged/Patterned Polymer Surface



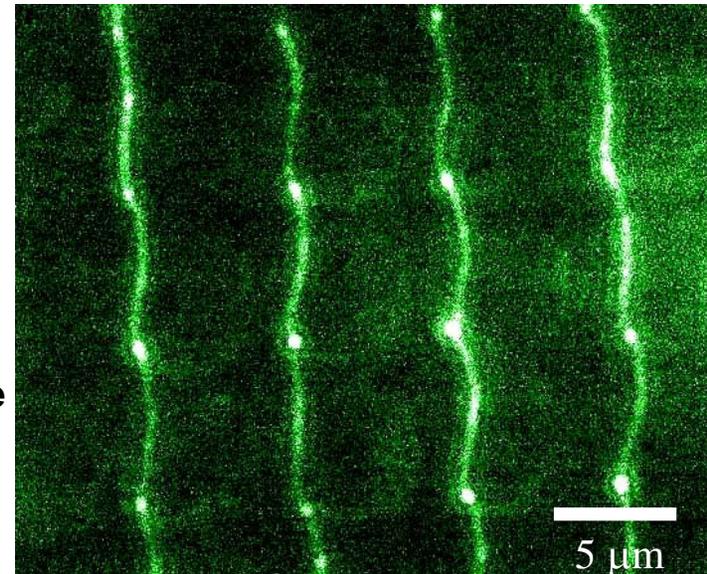
Stretched DNA on amino-silanes surface (high surface charge)



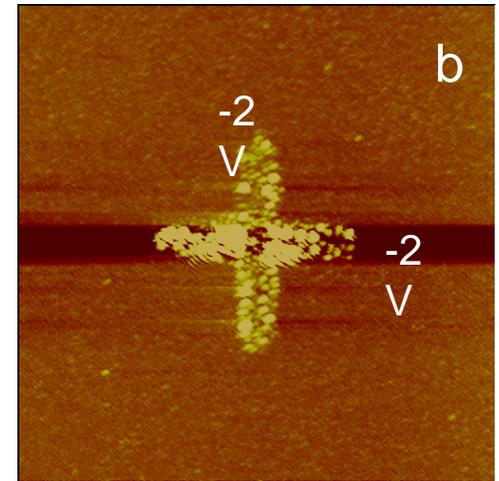
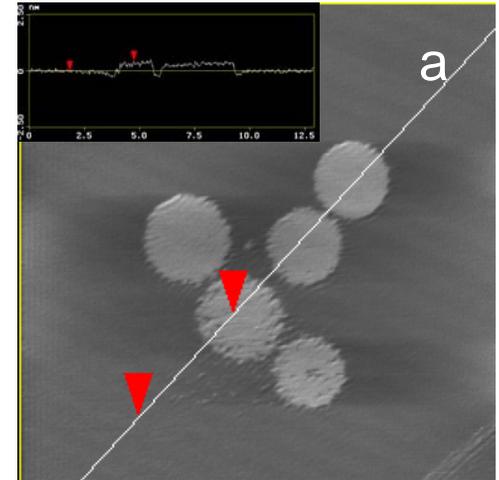
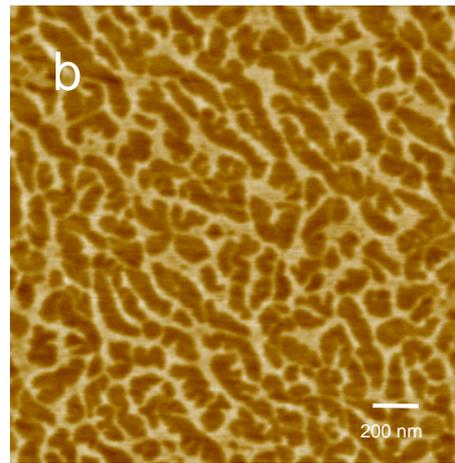
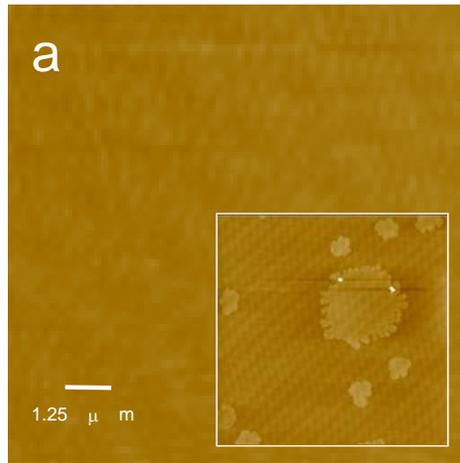
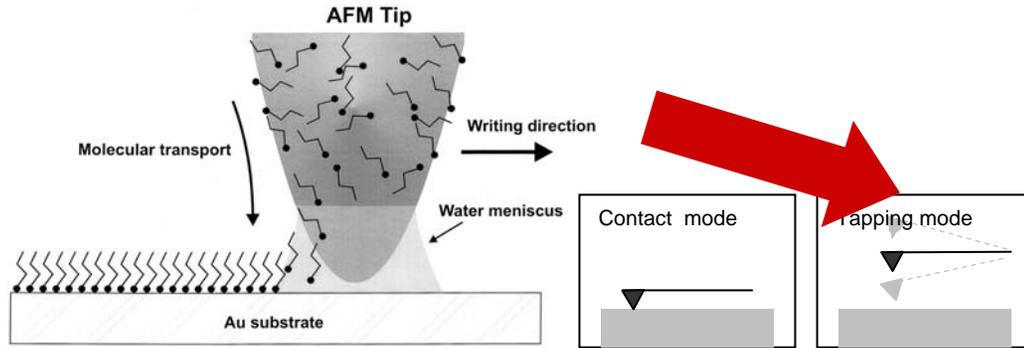
Stretching and relaxation of DNA tethered to amino-silanes surface (low surface charge)



Stretched DNA on patterned PDMS (hydrophobic) surface



Dip Pen Nanolithography in Tapping Mode



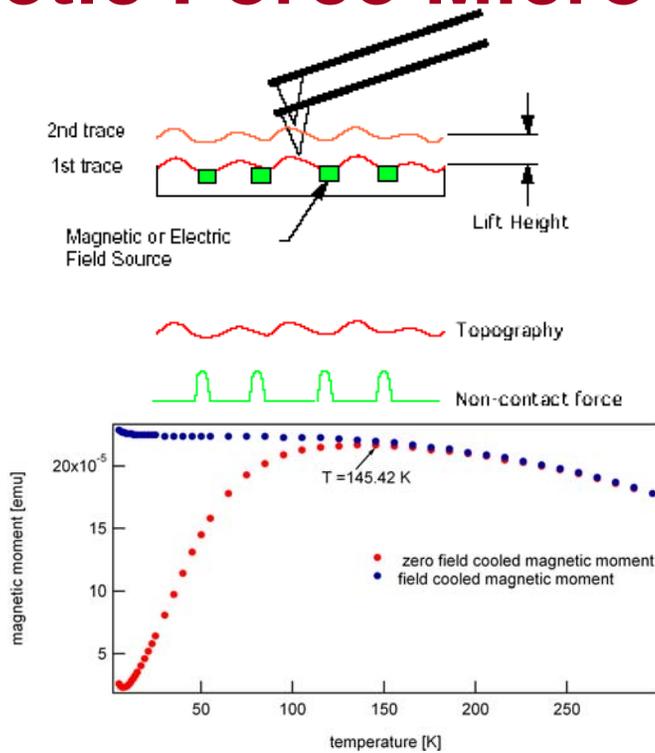
AFM height images of Langmuir Blodgett layers on mica of (a) the lipid phosphatidylcholine (PC) and (b) lipid with collagen type 1. PC forms uniform monolayers on the mica surface. Patch-like microdomains (inset, a) can occur due to lipid reorganization upon drying of LB films.

AFM height images of patterns formed by DPN in tapping mode of (a) peptide on mica surface and (b) protein on nickel surface.

The Future: DPN of biomolecules on soft surfaces

J. Rathman and G. Agarwal, OSU

Magnetic Force Microscopy



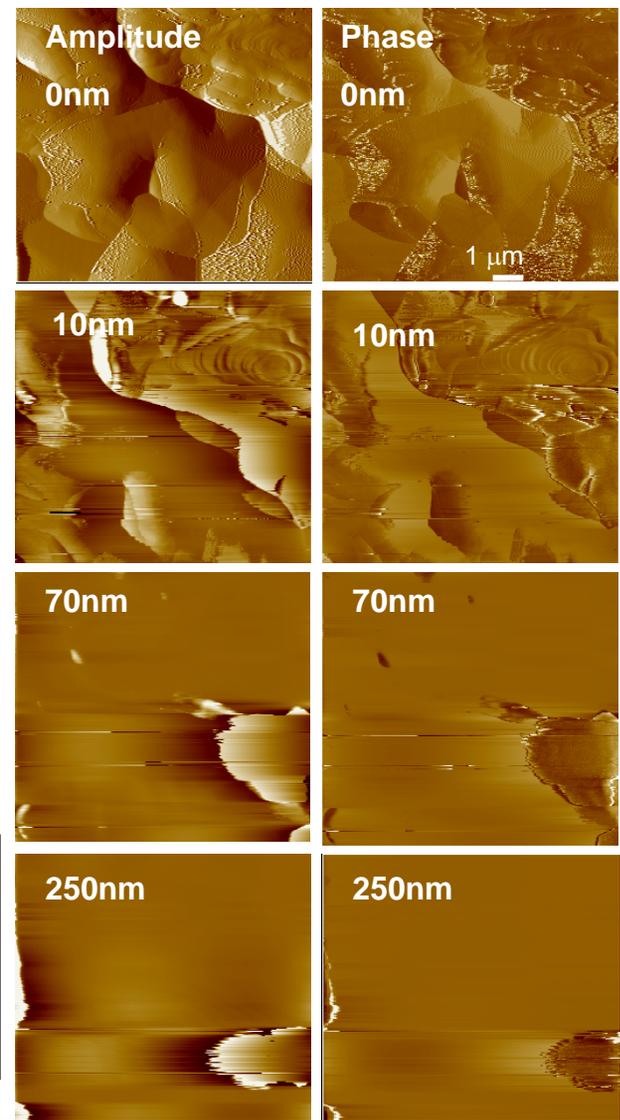
Temperature dependence of total magnetic moment of MACS beads using SQUID. Blocking temperature (T_B) is 145.42°K. Ferromagnetic below T_B and super-paramagnetic behavior above T_B is observed making it possible to detect these beads at room temperature

The Future:
Label cells with magnetic beads



MFM in fluids on live cells

J. Chalmers, C. Hammel and G. Agarwal, OSU



MFM images of human hippocampus tissue obtained using a magnetic tip at different lift heights (indicated) in tapping mode. A domain near bottom right is detectable even at lift-heights > 100 nm