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Excel-Based Imaging with Macro AFMs

Developed in Collaboration with NCLT Teacher Professional Development

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Driving Question: How can you measure something so small that you cannot see it?

Sensing Distance

Sight 

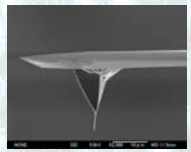
Hearing 

Smell 

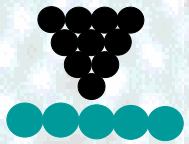
Touch 

1 m

10^{-1} m



10^{-6} m



10^{-10} m

Macro — Nano

Learning goal: The student will demonstrate an understanding of how a touch-based microscope measure the nanoworld.

Activity Development Cycle

Create/Modify Activities → Test Activities → Analyze Data

Plan & Timeline

Pilot: Glenbrook North High School

Session 1	30 minute lecture
Session 2	Design Pattern
Session 3	**Pre-test**
Session 4	Activities at Northwestern
Session 6	Post-test

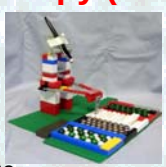
Connections to Standards

National Science Education Standards (9-12)
- Content Standard A: Science as Inquiry (models)
- Content Standard B: Physical Science (structure of matter)
- Content Standard E: Science & Technology

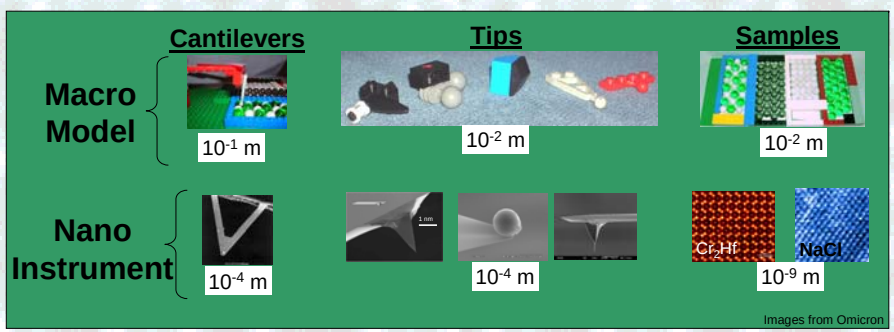
Benchmarks for Science Literacy (9-12)
- 4D, Physical Setting, "all matter is made up of atoms"

Contact Atomic Force Microscopy (C-AFM)

Activity Progression
- Build Model C-AFM
- Build Sample
- Collect & Graph Data in Excel
- Analyze Data & Discussion
- Observe & Analyze Real C-AFM Image



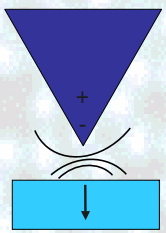
repulsive van der Waals forces



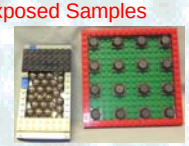
Background: Atomic resolution on Si(111)7x7 in Non-Contact Mode AFM

Magnetic Force Microscopy (MFM): Magnetic Field Imaging

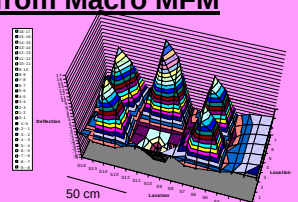
Activity Progression
- Discussion of Magnetic Field
- Modify Tip
- Collect & Graph Data from Mystery Sample
- Analyze Data & Guess At Configuration
- Expose Magnetic Pattern
- Analyze Real MFM image



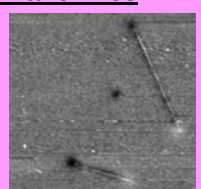
Mystery Samples 

Exposed Samples 

Excel Surface Plot from Macro MFM



Actual MFM image of FeB_2 Nanowires



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