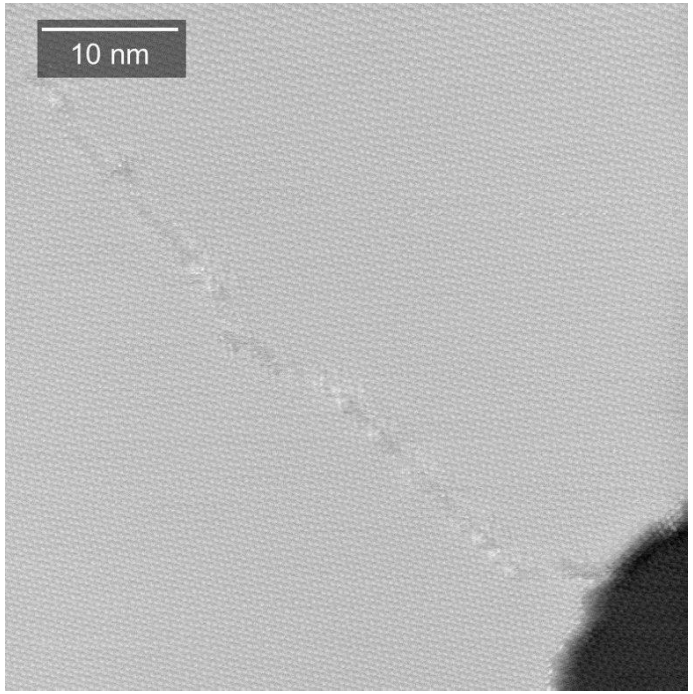
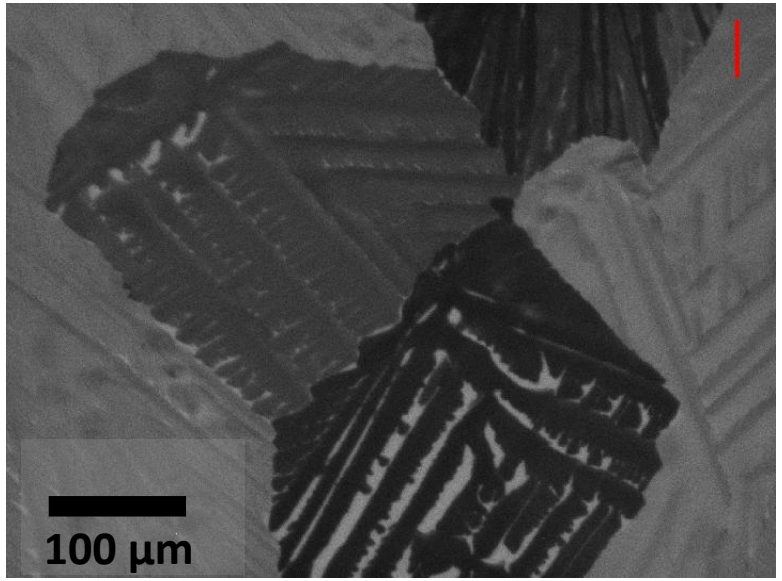
Atomic force microscopes

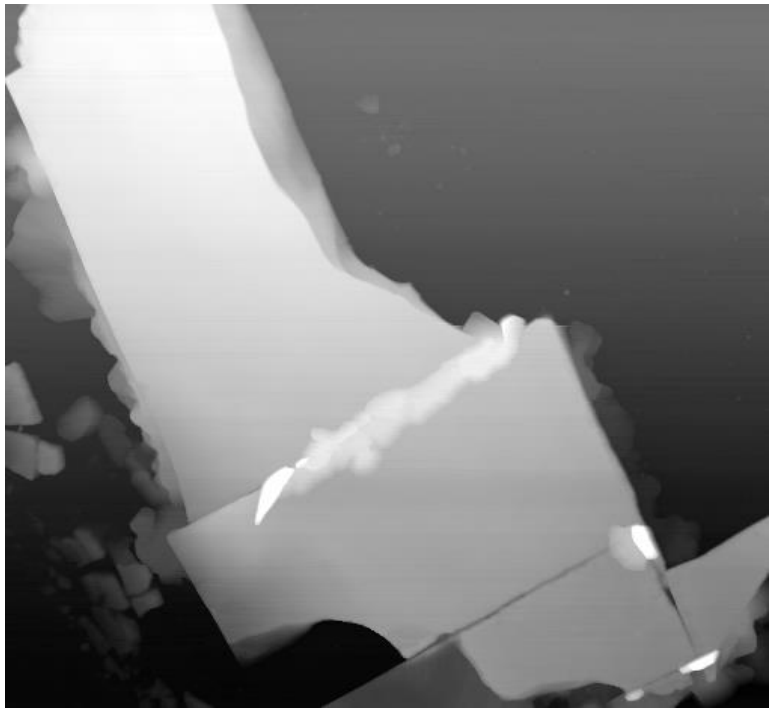
Gabriel Schulmann

Our work

- Our lab looks at the structural optical and electronic properties of materials on the nanometer scale
- We do this with scanning probe microscopy, our lab has an atomic force microscope and a scanning tunneling microscope





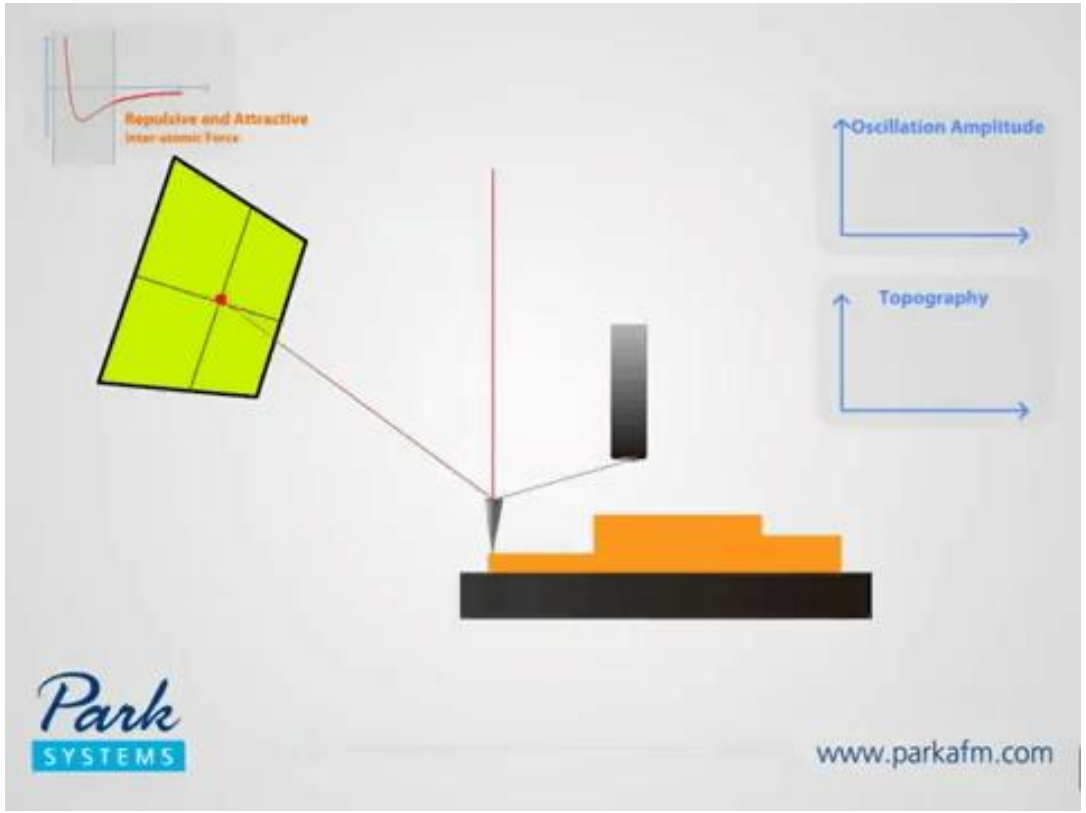


What is an atomic force microscope?

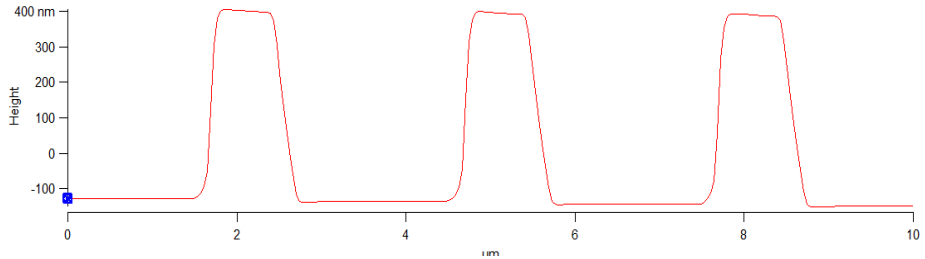
- An atomic force microscope (AFM) is a scanning probe microscope with nanometer resolution.
- The AFM can provide topographical data and electronic mapping across a designated scan window.
- I spent the summer learning how to take topographical images with the AFM.

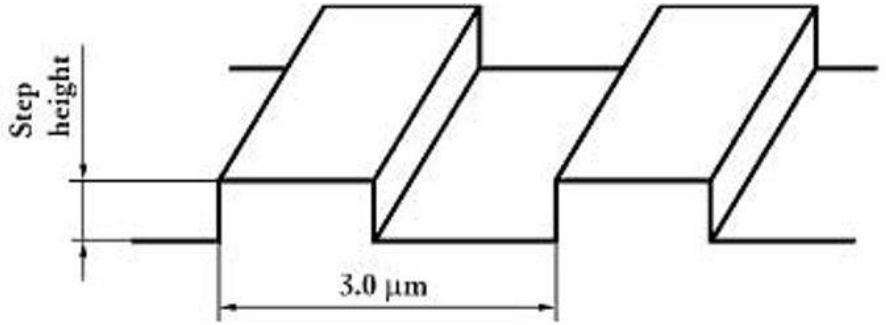
How does the AFM work?

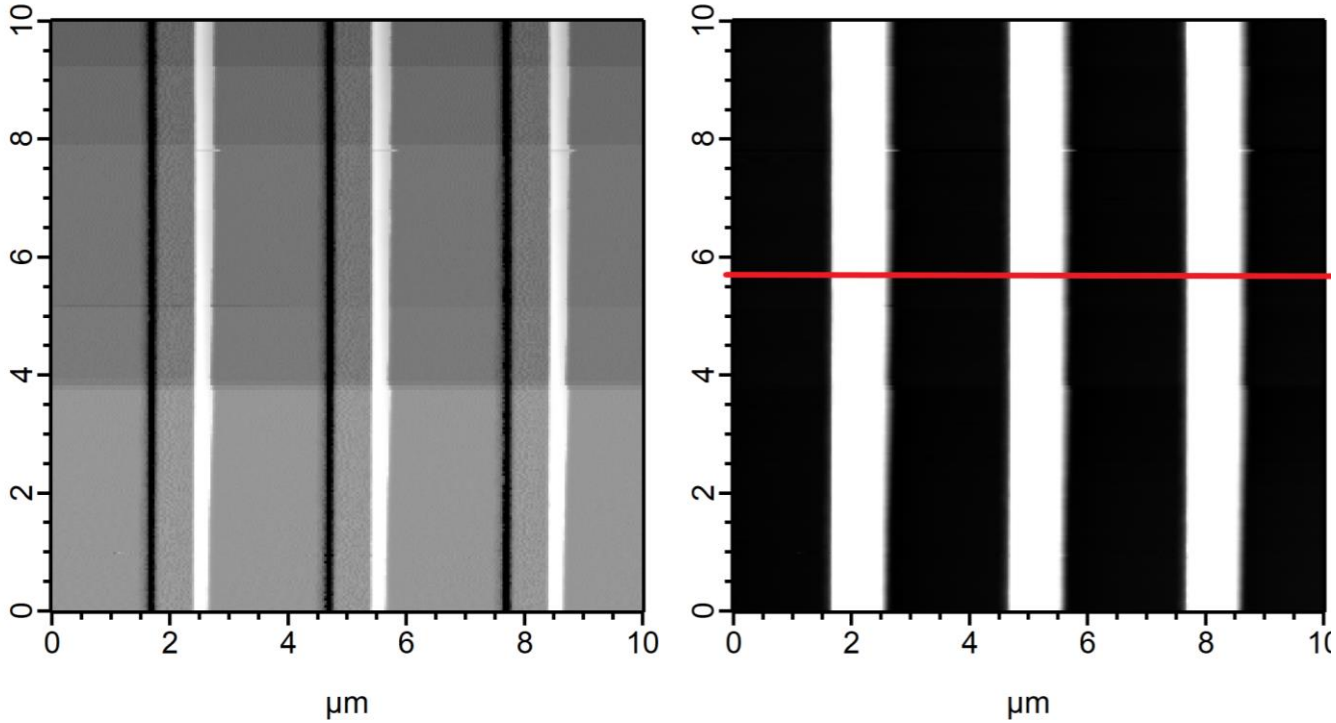
- When the tip is close to the surface there will be a interaction force between the tip and the sample
- The cantilever tip will scan across a line oscillating at a set frequency and amplitude
- The AFM will adjust the distance between the tip and the sample to keep the oscillation amplitude constant
- The height corrections and the amplitude data from the line scans are stitched together to form an image



Test Grating Images





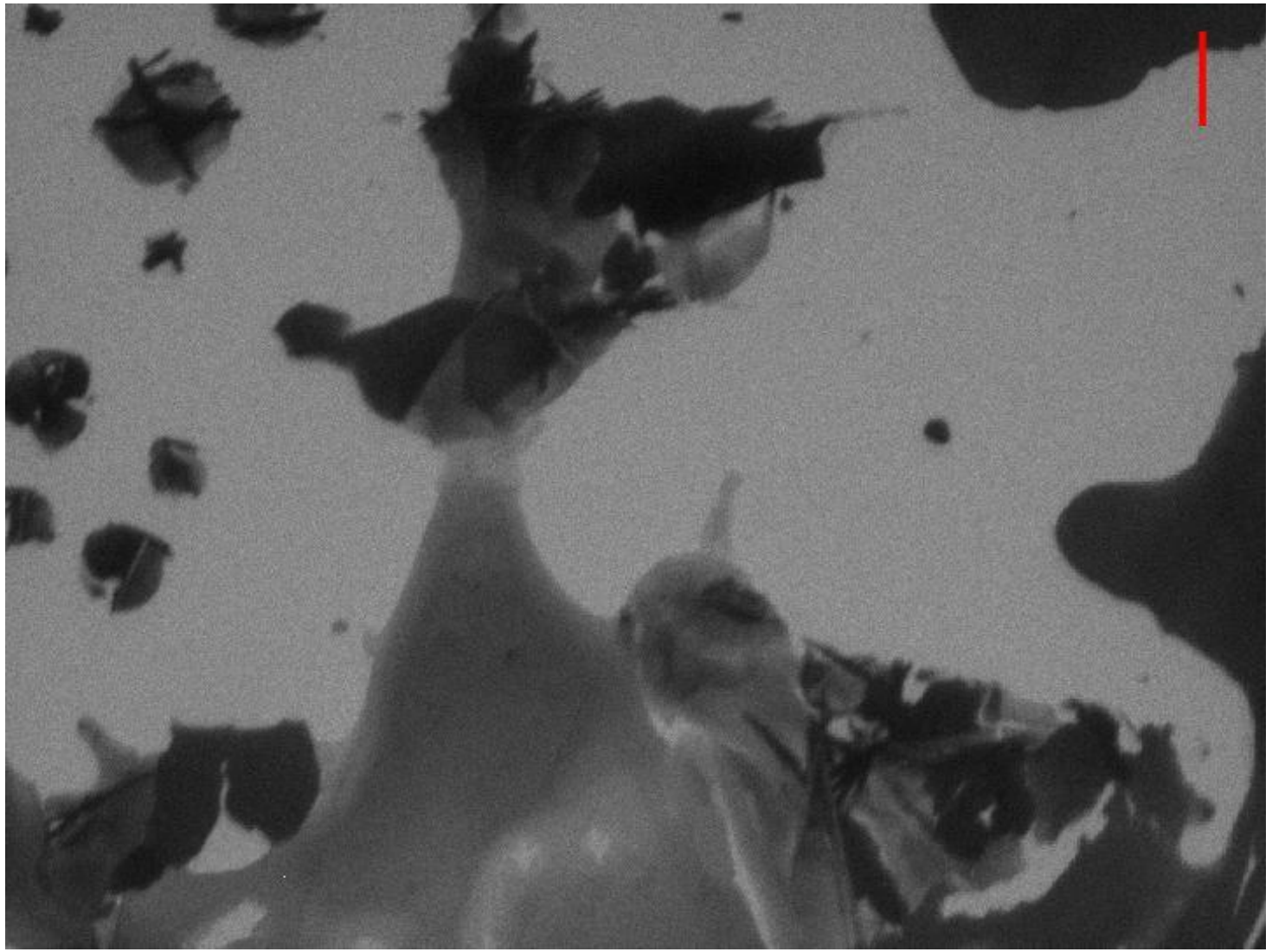


- The height of the features is 540 nm, and their period is 3.02 µm
- Test gratings are useful for determining the condition of the cantilever tip

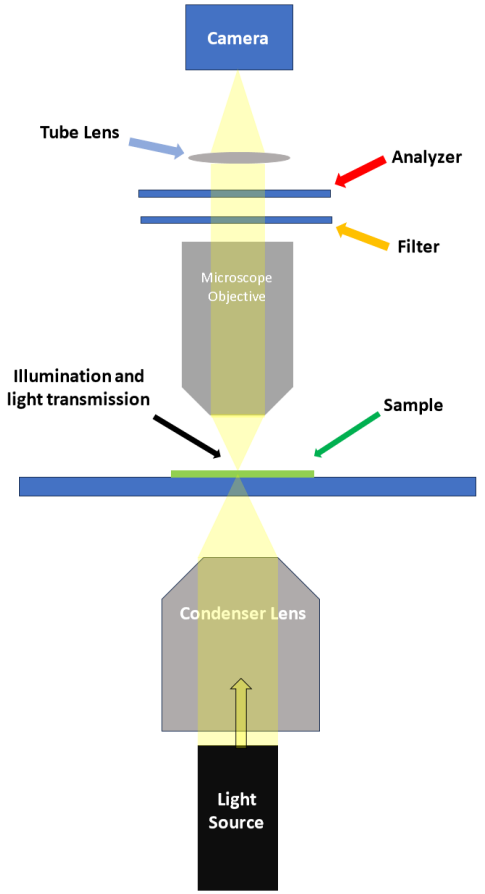
Phthalocyanine (H2-OBPc) thin film project

- My focus this summer has been imaging phthalocyanine samples from the Furis group.
- Phthalocyanine is an organic semiconductor with potential applications in electronic devices.
- These thin film samples are printed onto a functionalized ITO in the Furis lab and then they go through our image process
- The first step is to survey the sample for interesting regions with an optical microscope

Optical survey

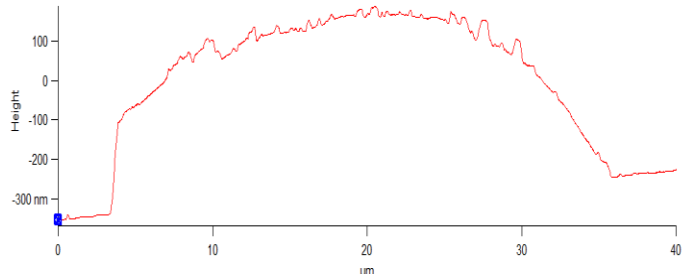


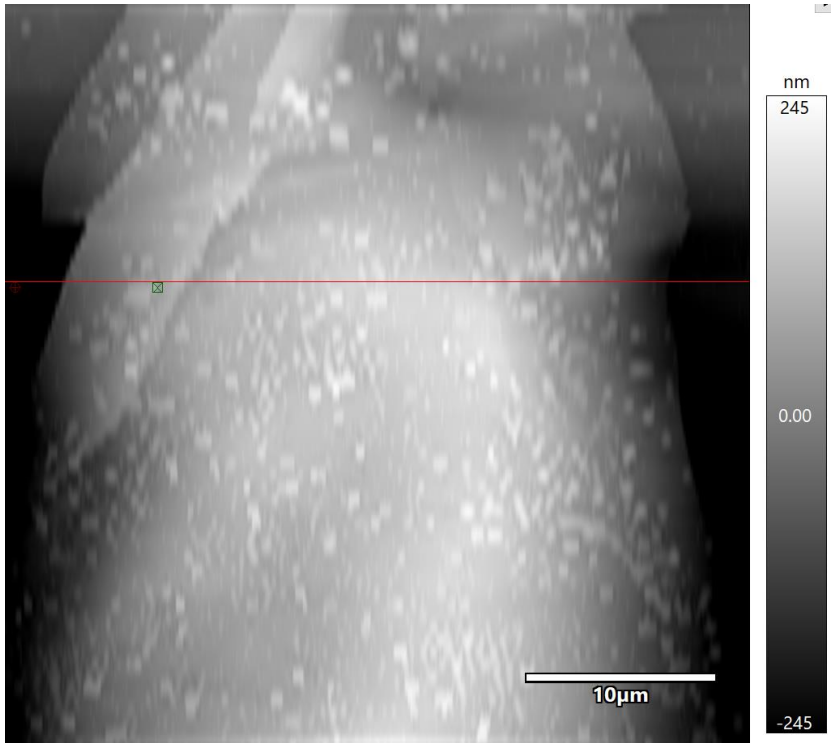
By using a light polarizer, we can exploit the linear dichroism of the sample grains to see the structure of the sample

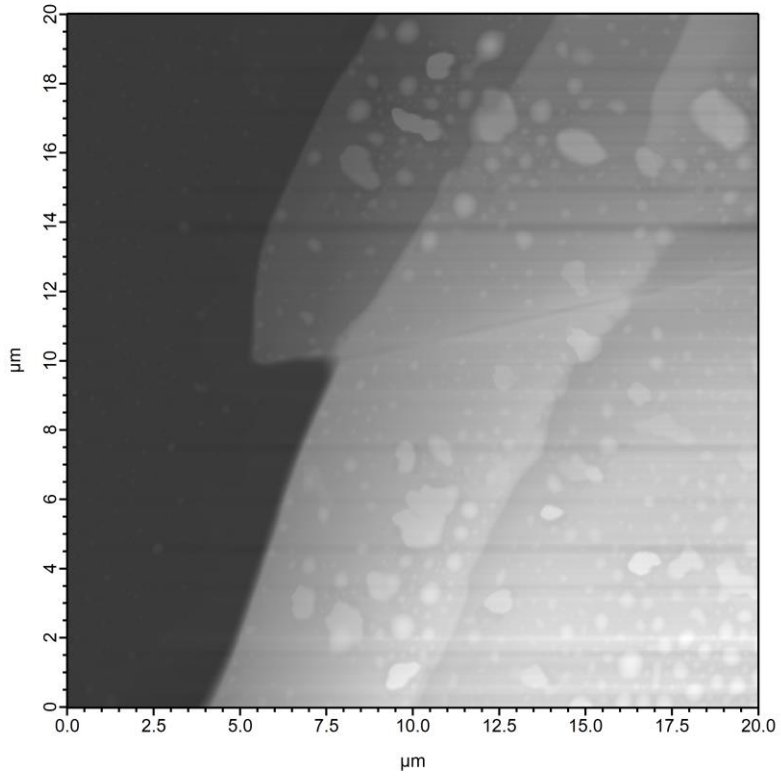


AFM Imaging

- Now that we have interesting places to scan, we'll bring our sample over to the AFM
- The AFM has an optical microscope inside to help us find the location of interest
- Then a navigation image is taken in order to precisely targets the region of interest
- Once you've locked on the detailed imaging can start

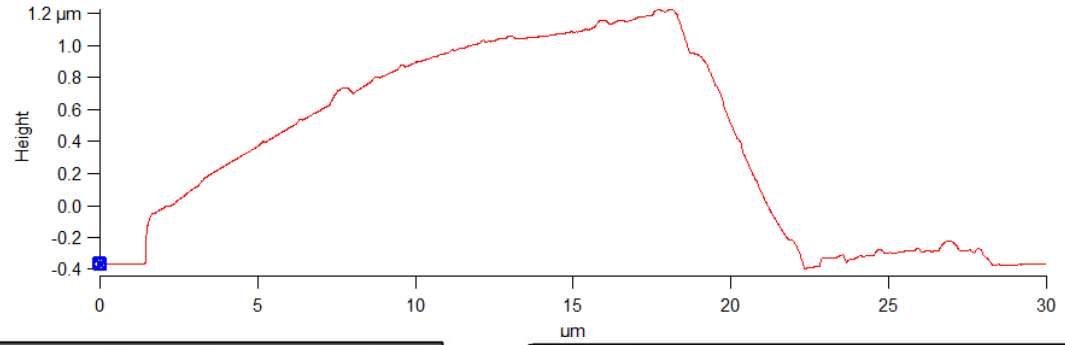


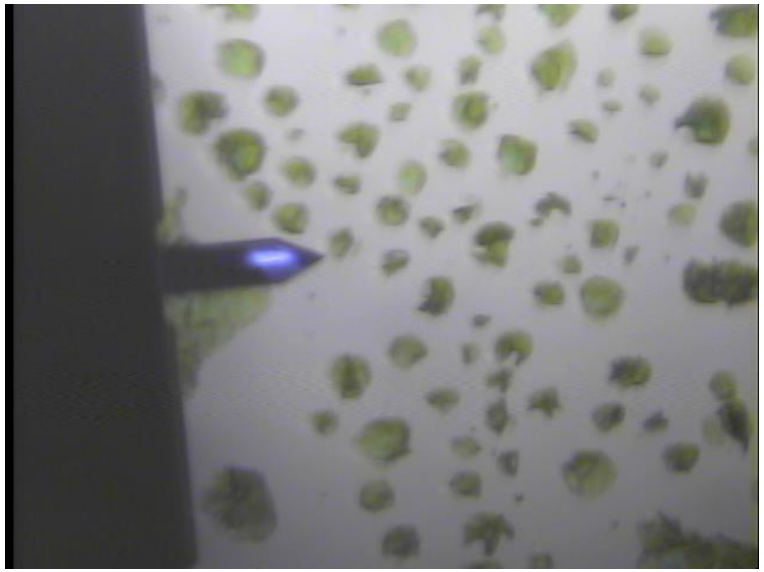


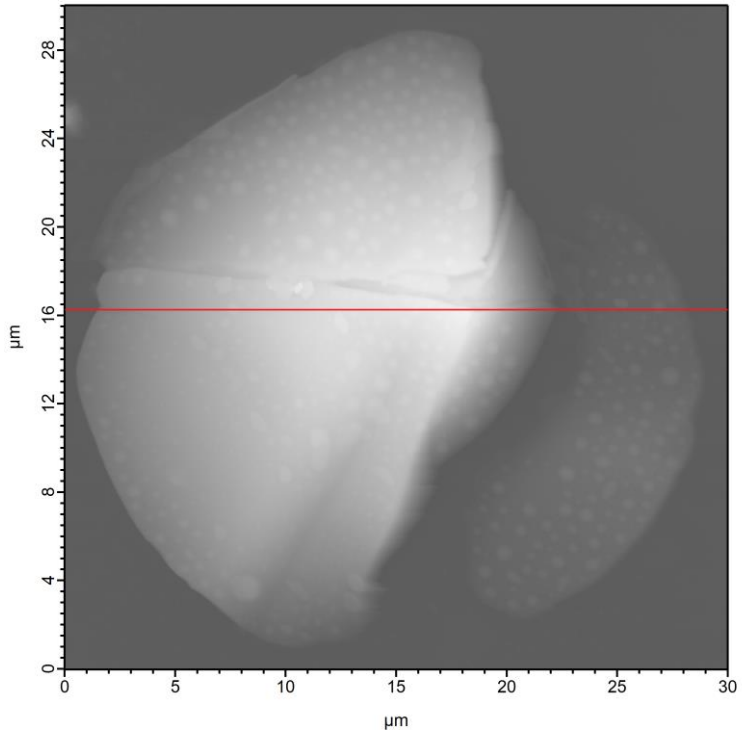


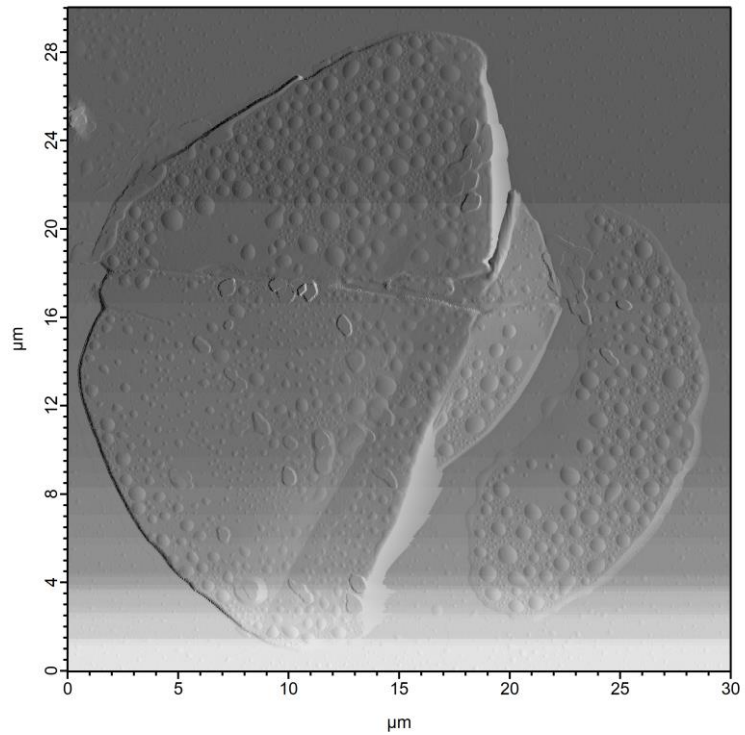
What can we learn from AFM image?

- An AFM image can reveal surface detail with nanometer resolution, much too small for even the best optical microscopes.

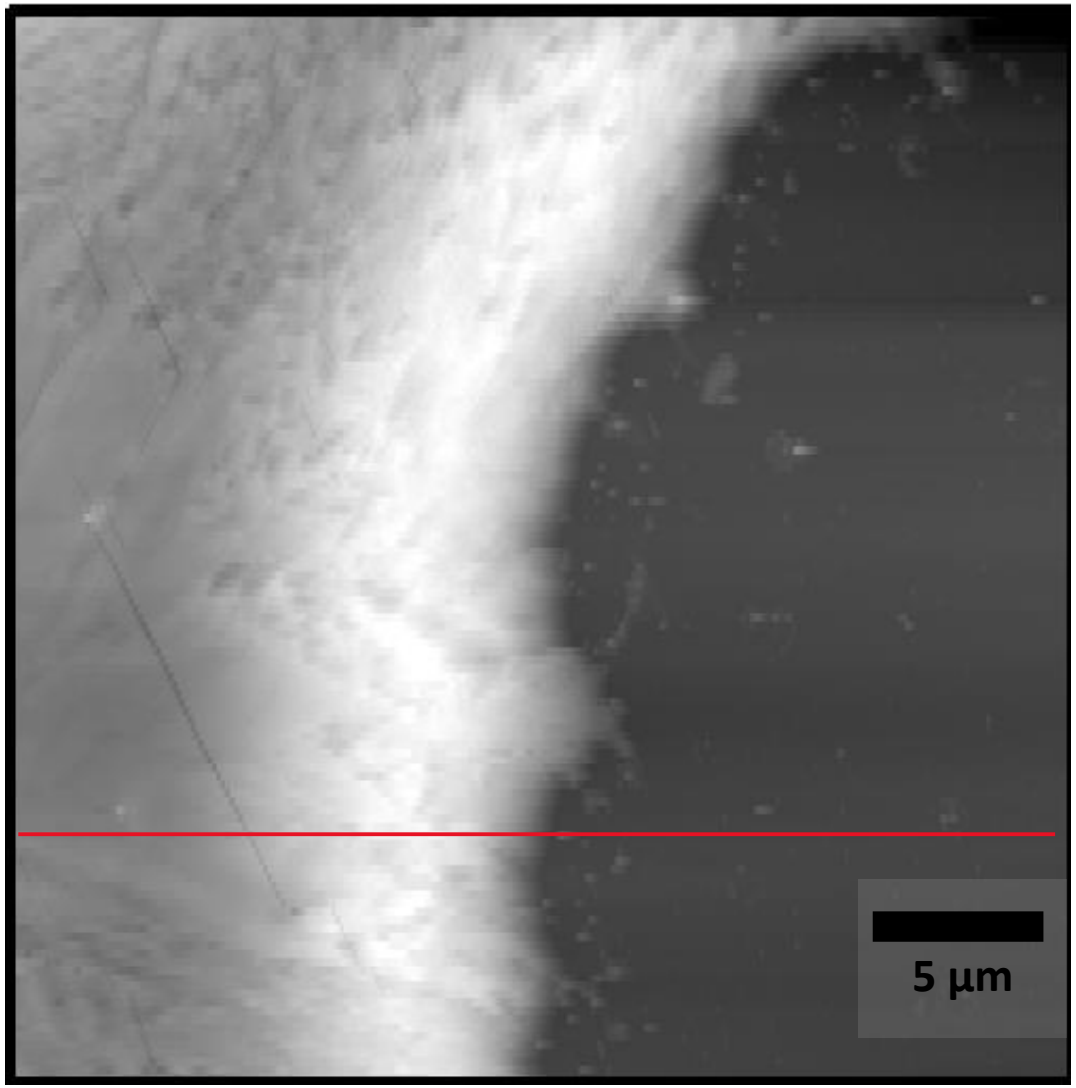




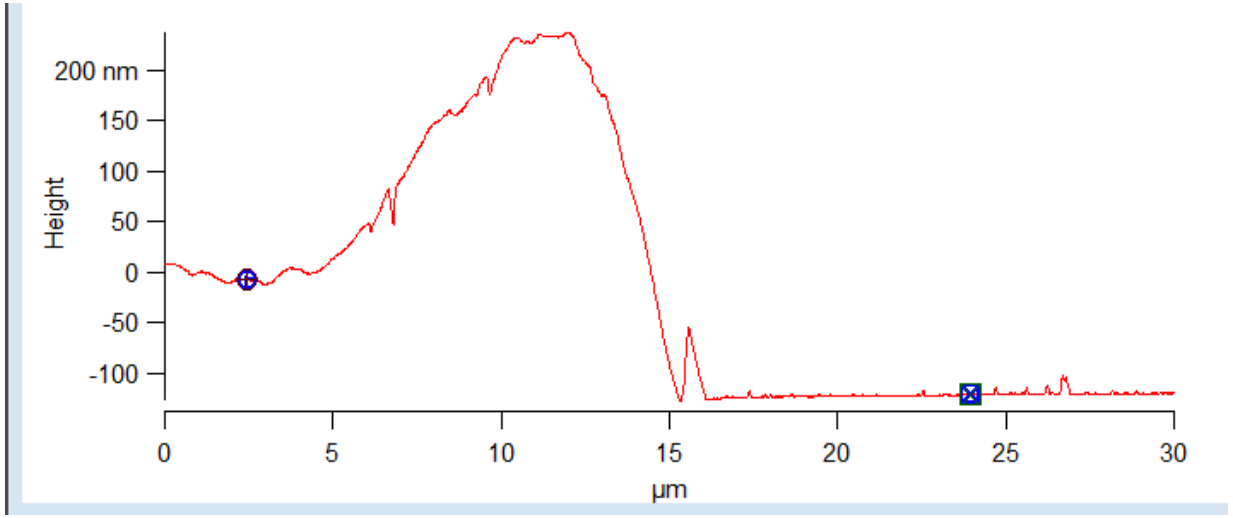




Film thickness study

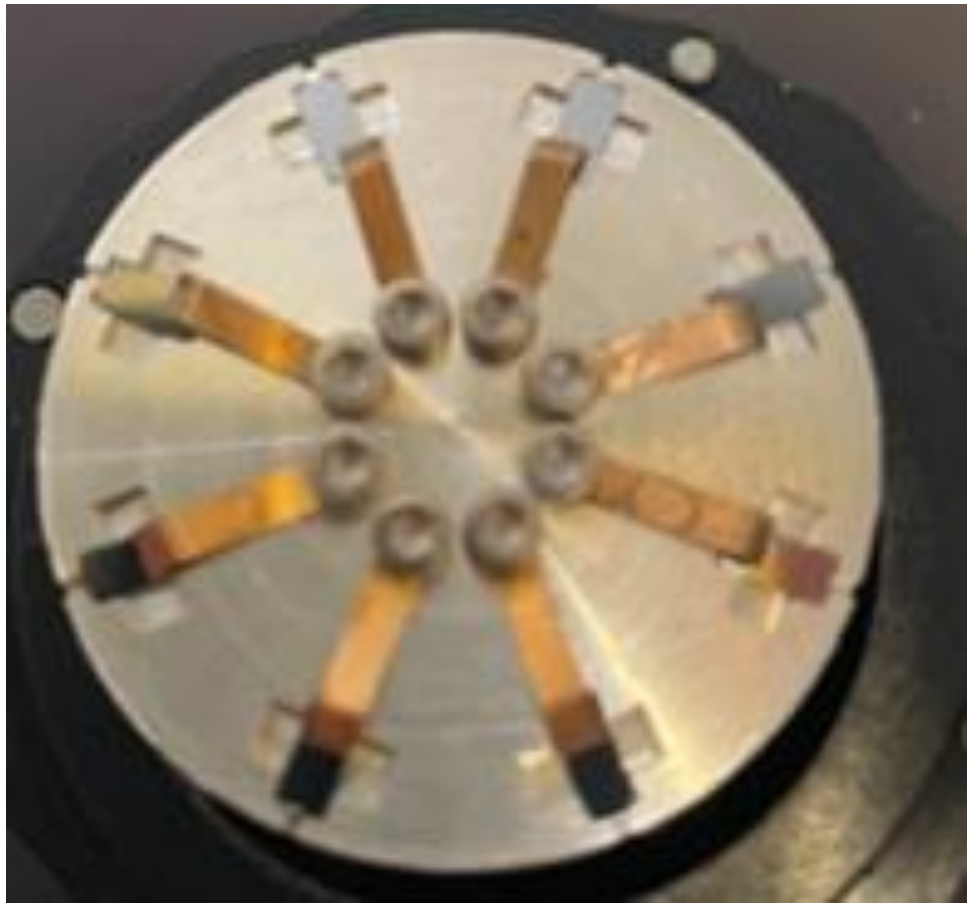


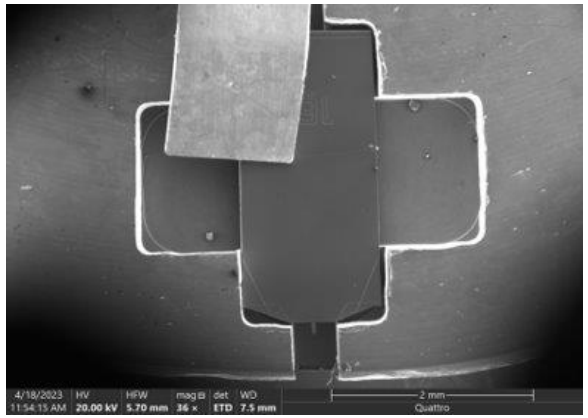
- AFM can also tell you how thick the sample is by imaging the edge and looking at the line scans from these images

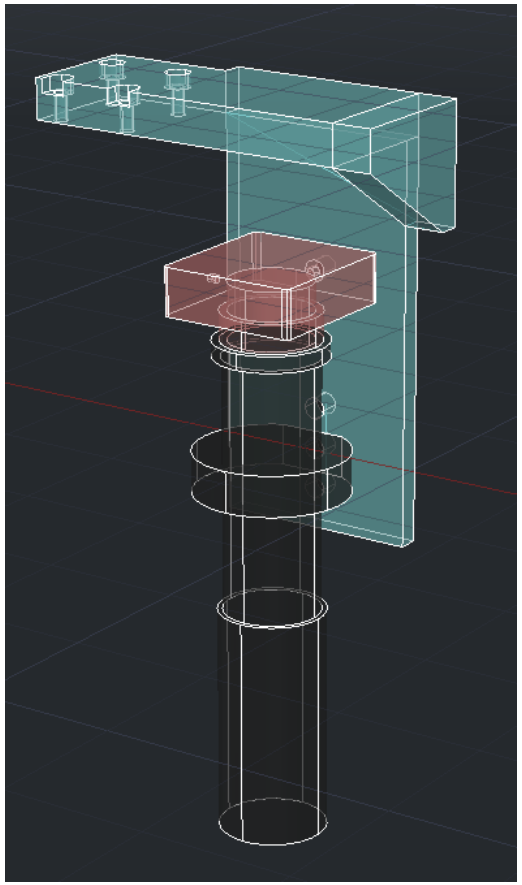


3D Design

- In addition to learning how to use the AFM, I also have designed some tools in AutoCAD for the AFM







Acknowledgements

- Dr. Lloyd Bumm
- Steven Raybould
- Dr. Madalina Furis
- Varun Mapara
- Tabassum Joyee
- Hilbi Akbar
- All of my Fellow REU students