Using EUV Reflection to Understand Thin Film Surfaces

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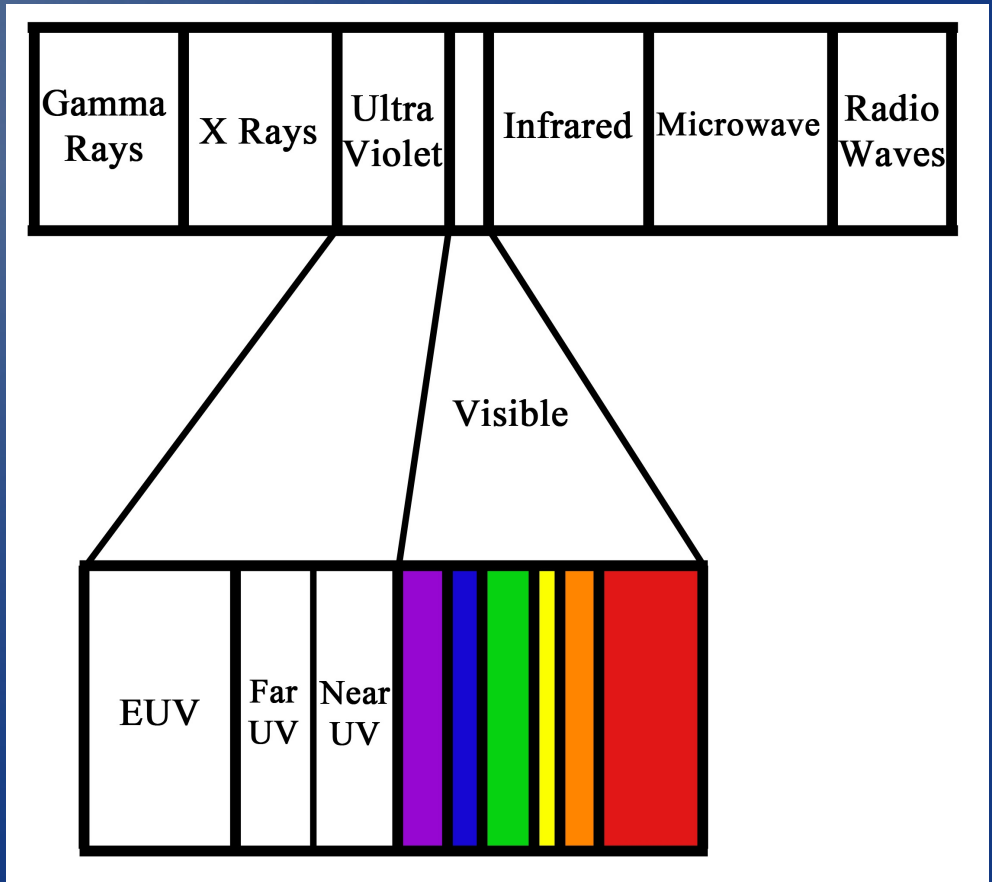
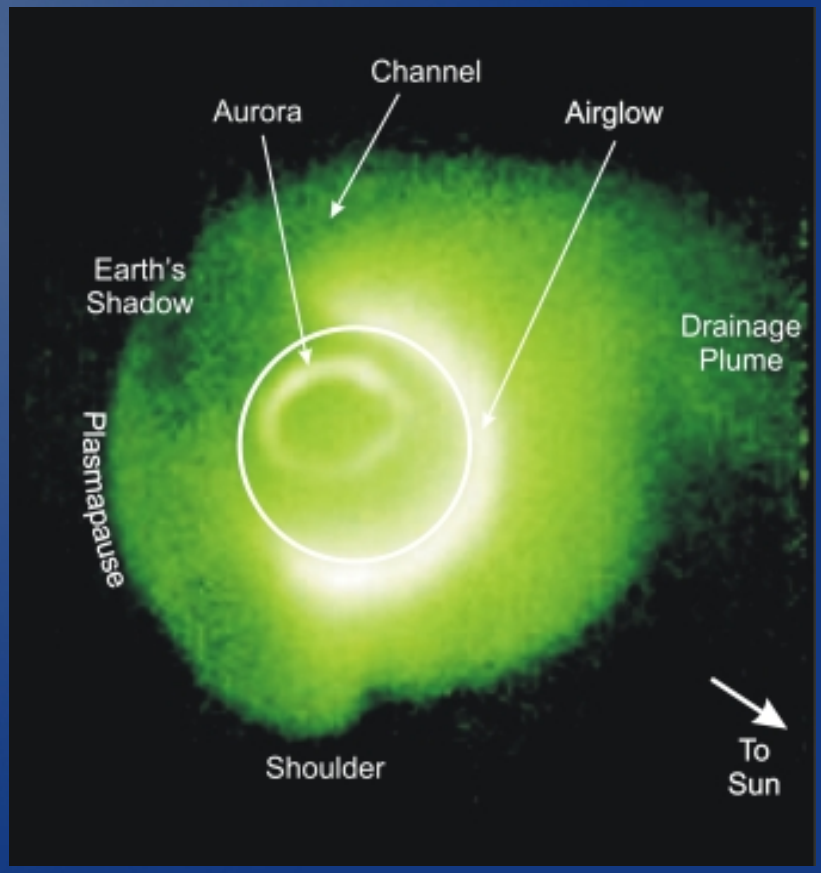
Background

- EUV
  - We use wavelengths of 5nm to 50nm
  - EUV light is very sensitive to absorption in most materials



Background

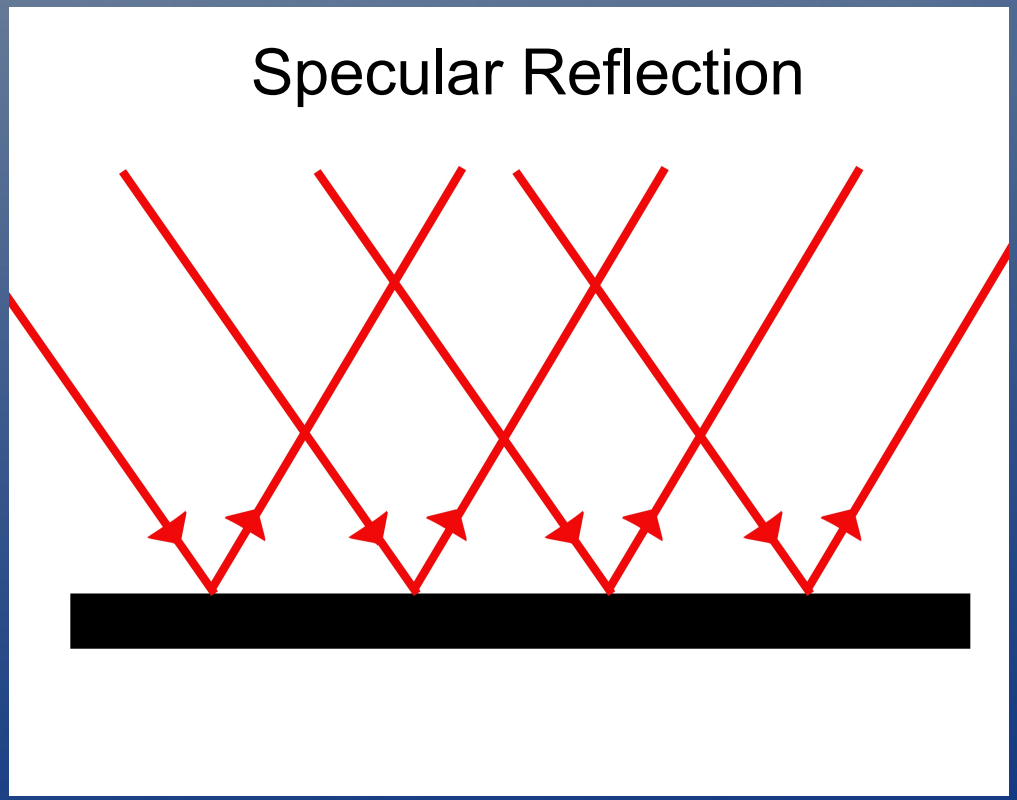
- EUV
  - We use wavelengths of 5nm to 50nm
  - EUV light is very sensitive to absorption in most materials
- Applications
  - Astronomy
  - EUV Lithography
  - Microscopy
  - Etc.

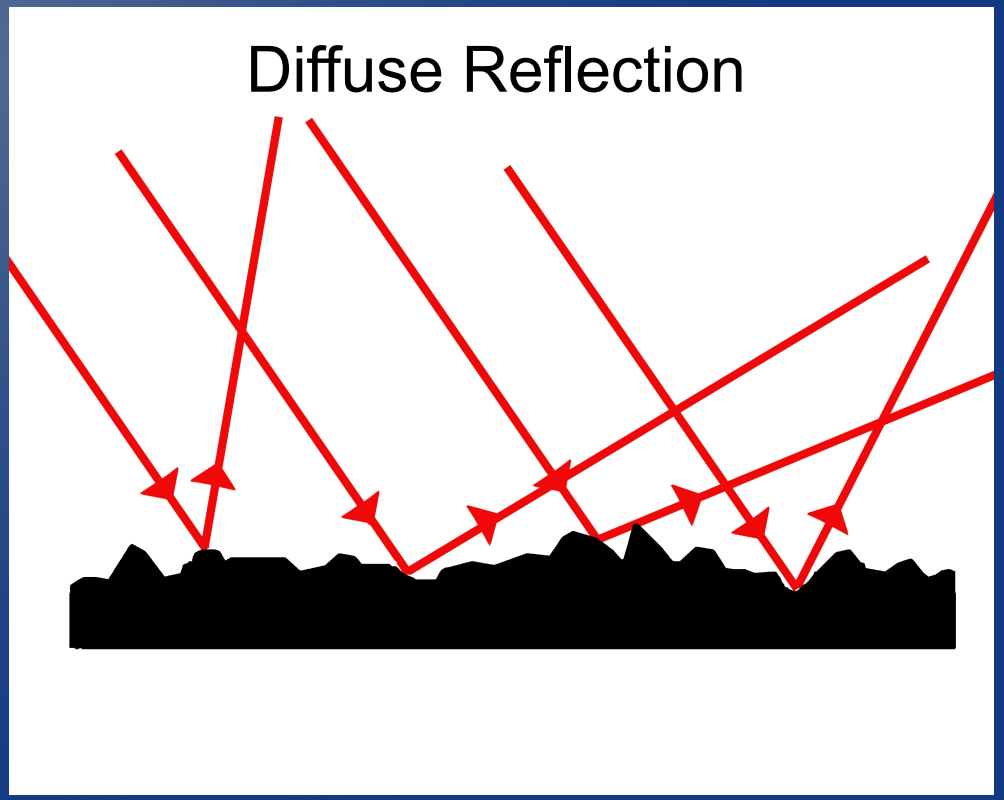


http://euv.lpl.arizona.edu/euv/

Background

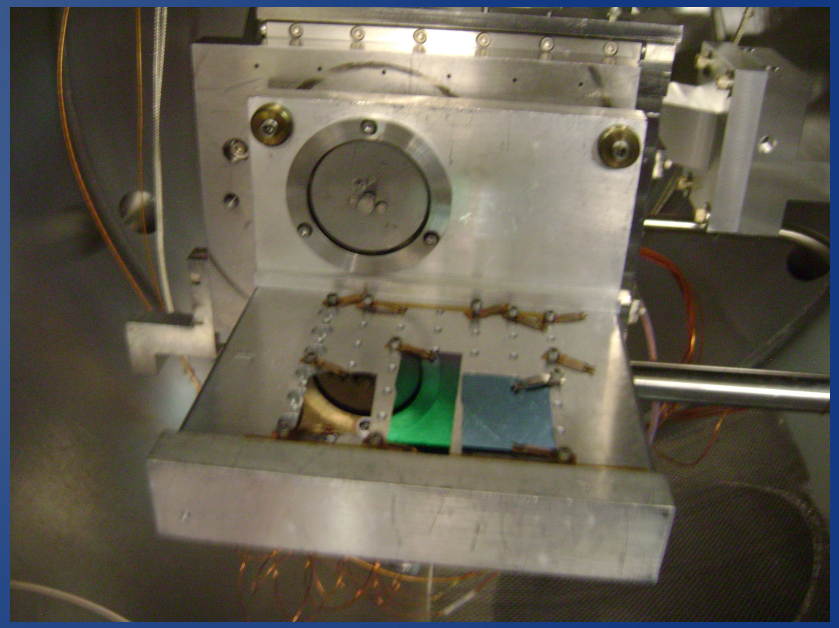
- Diffuse Reflection
  - EUV light is sensitive to deviations in the surface roughness that are comparable to the wavelength of EUV light.





Goal/Method

- Goal
  - Learn something about thin film surface features.
- Method
  - Calculation/AFM
  - Reflection Measurements

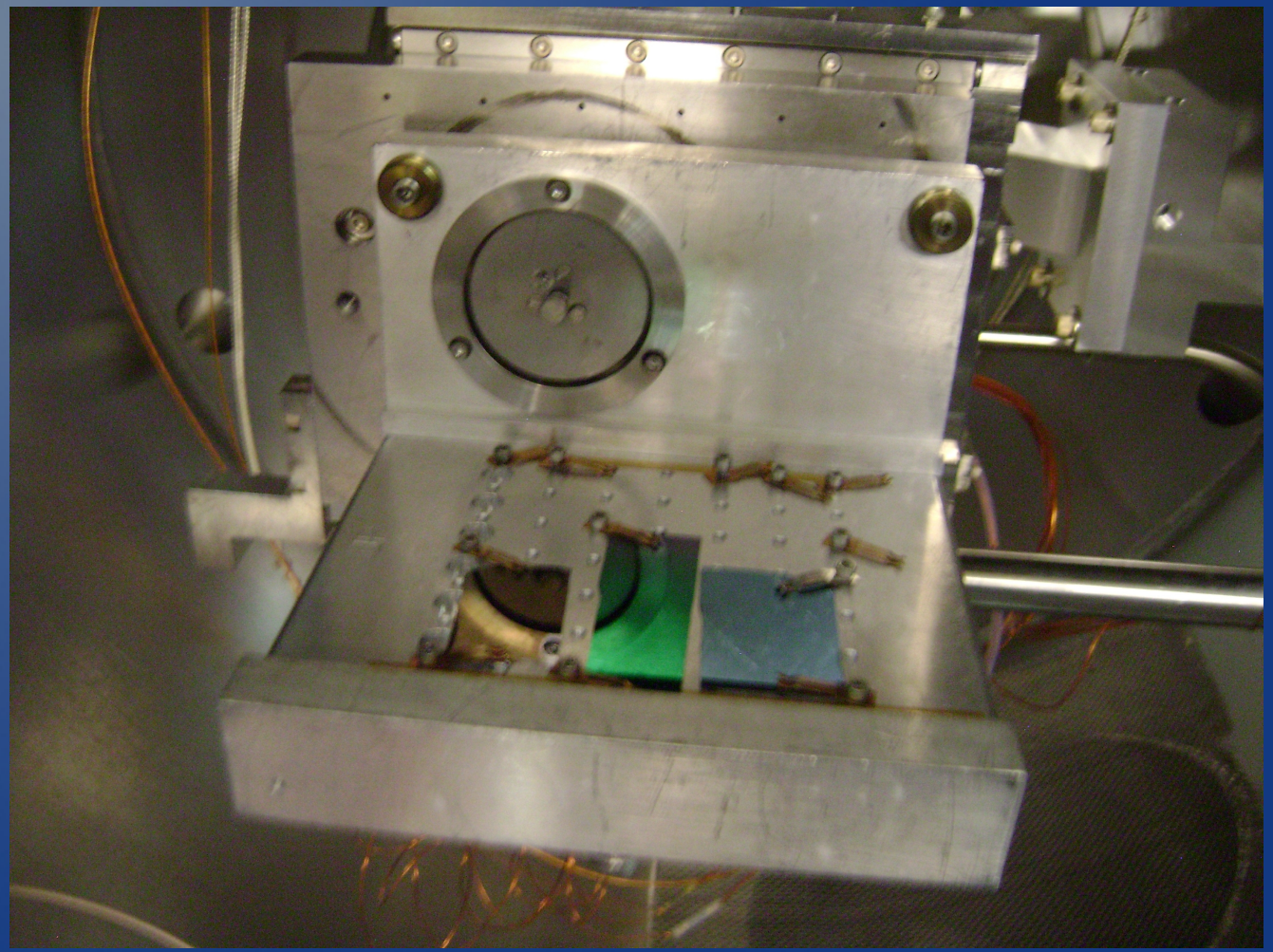


Samples

- Taken on two UO_3 Thin Films

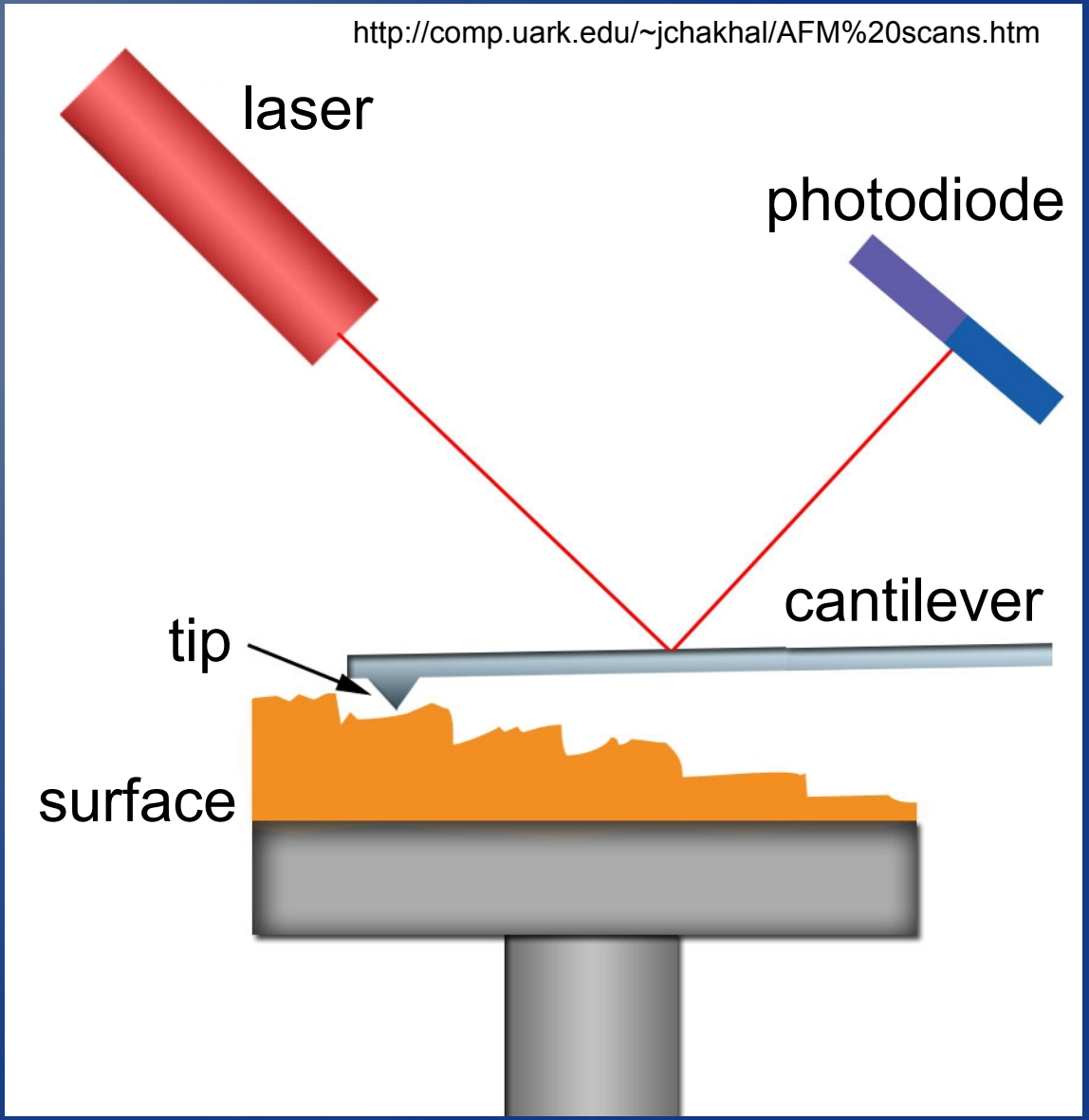
  44nm Thick

  412nm Thick

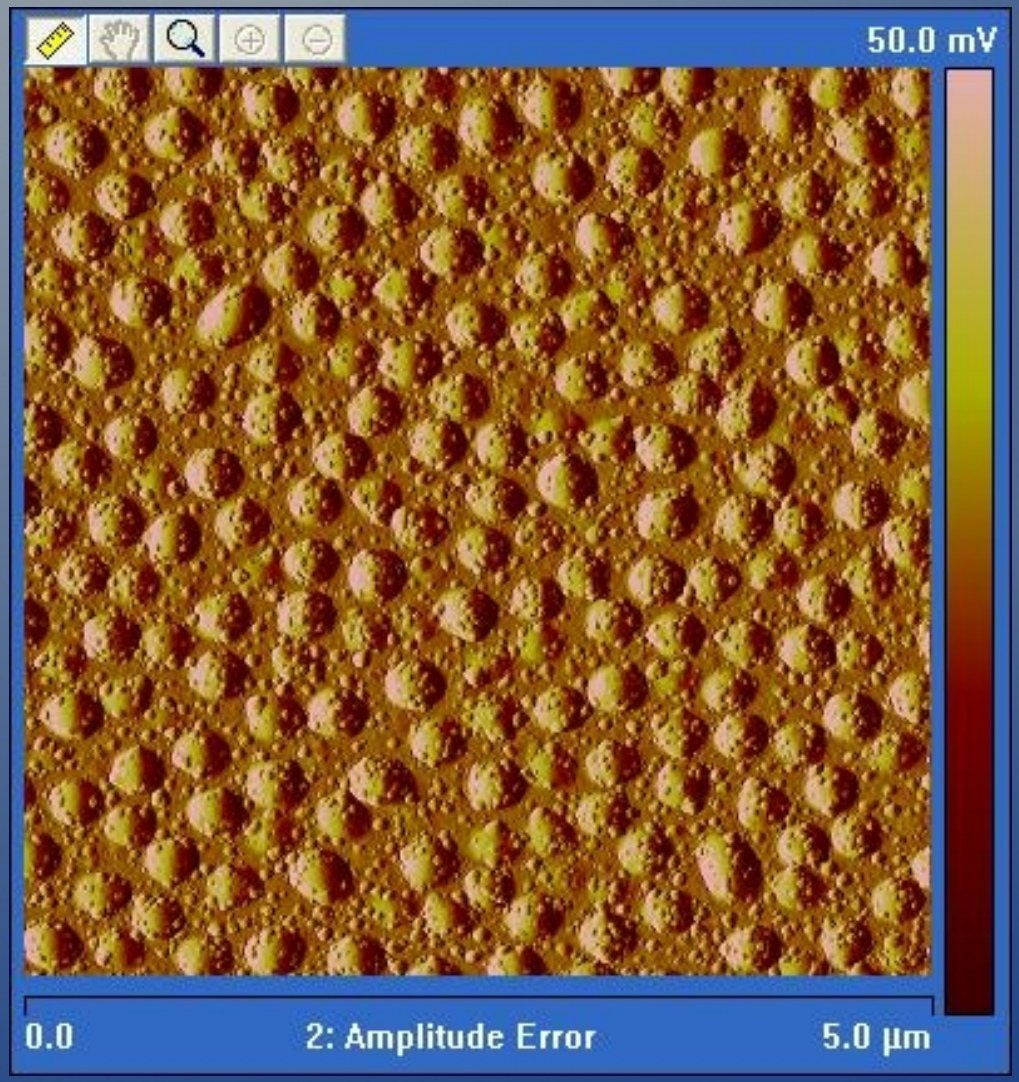


AFM

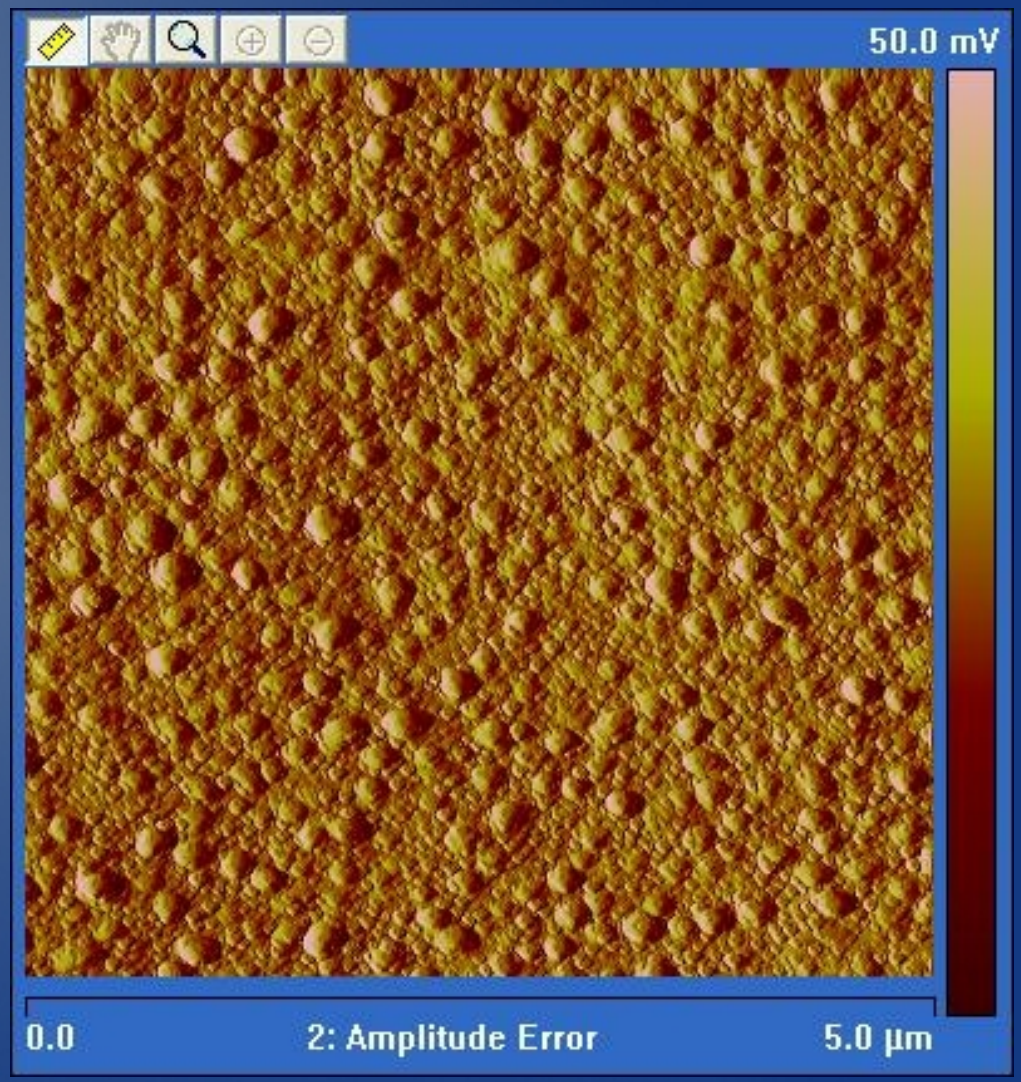
- Tip is bounced across the surface.
- Laser detects movement of the cantilever and height is recorded.



AFM



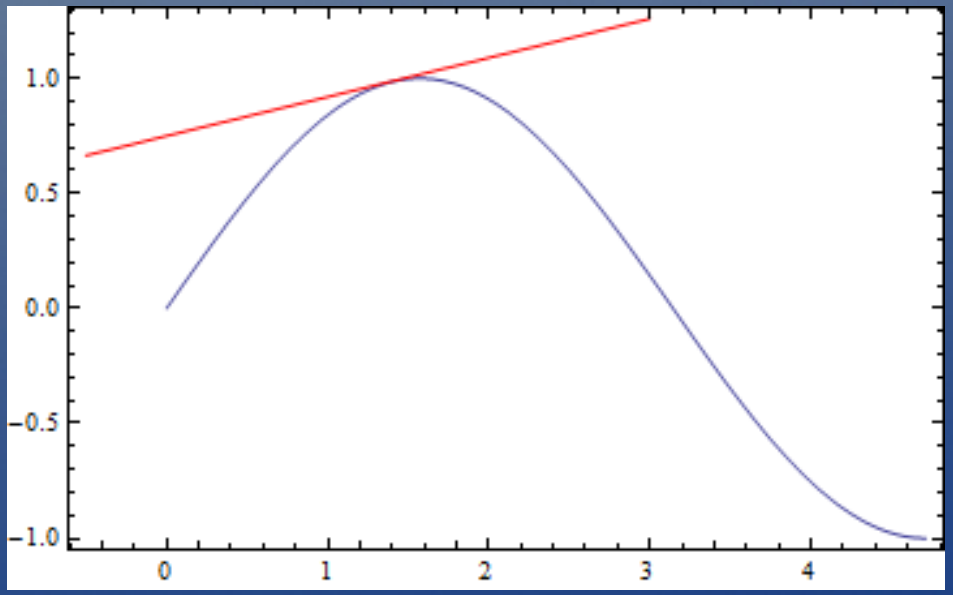
Thickness: 44nm
RMS height: 16.8nm



Thickness: 412nm
RMS height: 9.39nm

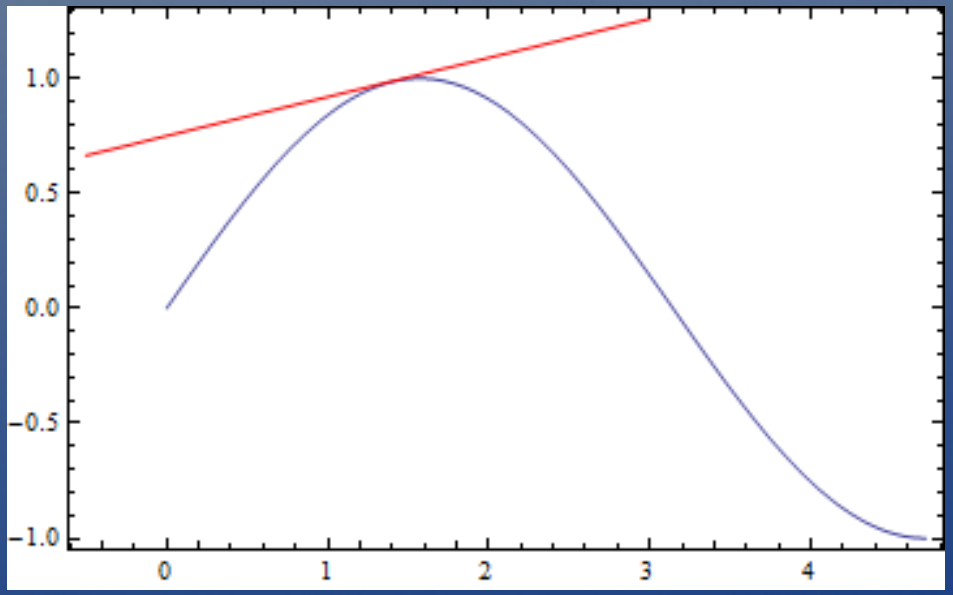
Physical Optics Calculation

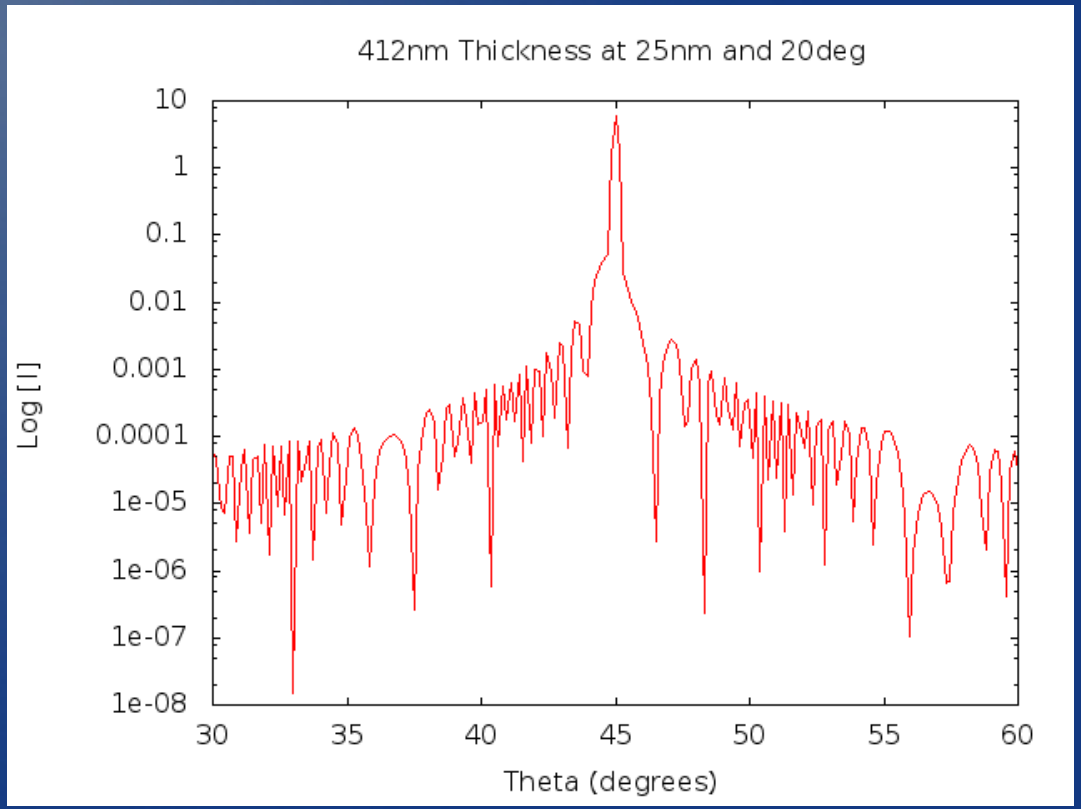
- Kirchhoff approximation



Physical Optics Calculation

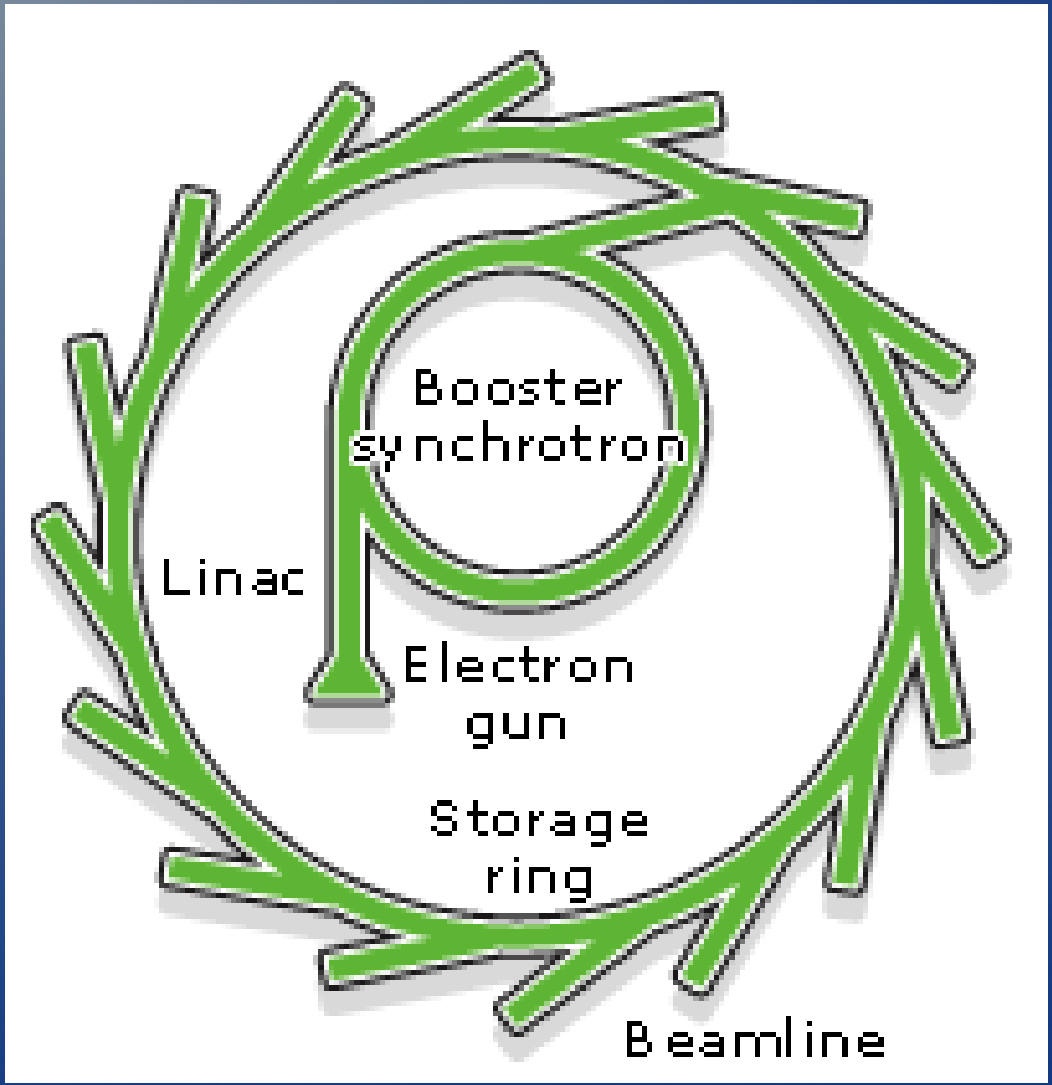
- Kirchhoff approximation
- Use Maxwell's equations to calculate the current induced by incident light
- Calculate radiation in the far field



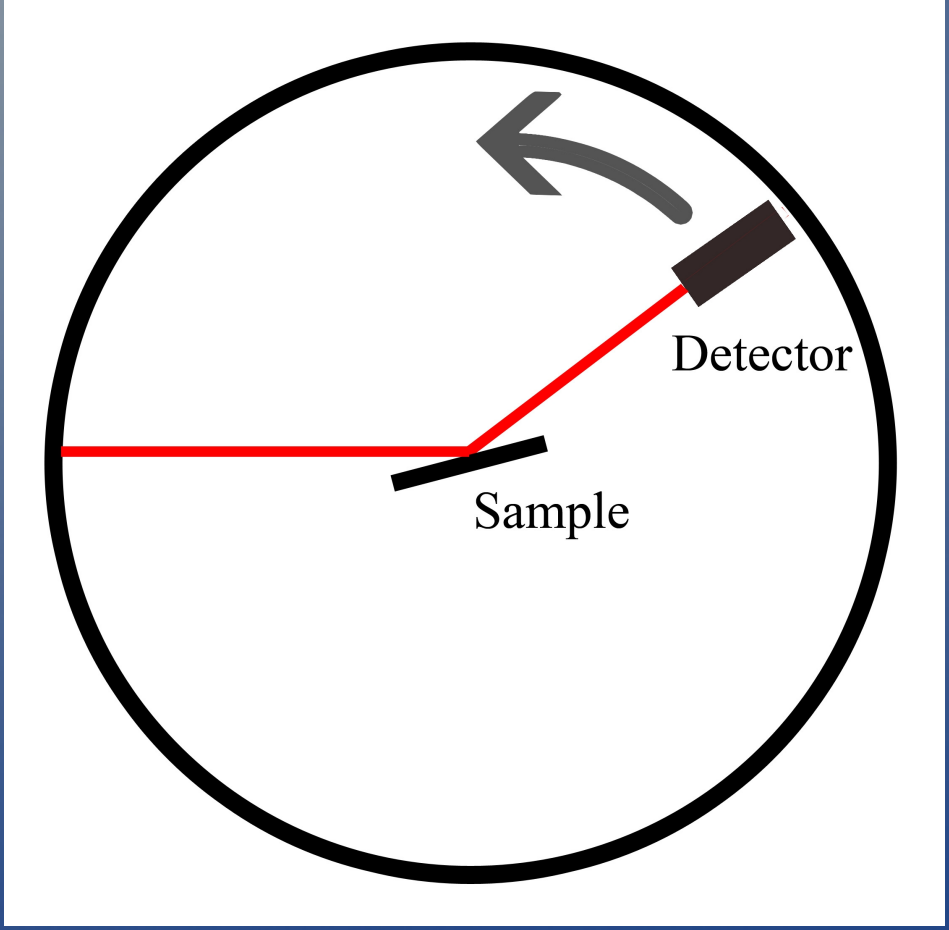


Reflection at The ALS

- Synchrotron Radiation



ALS Reflectometer



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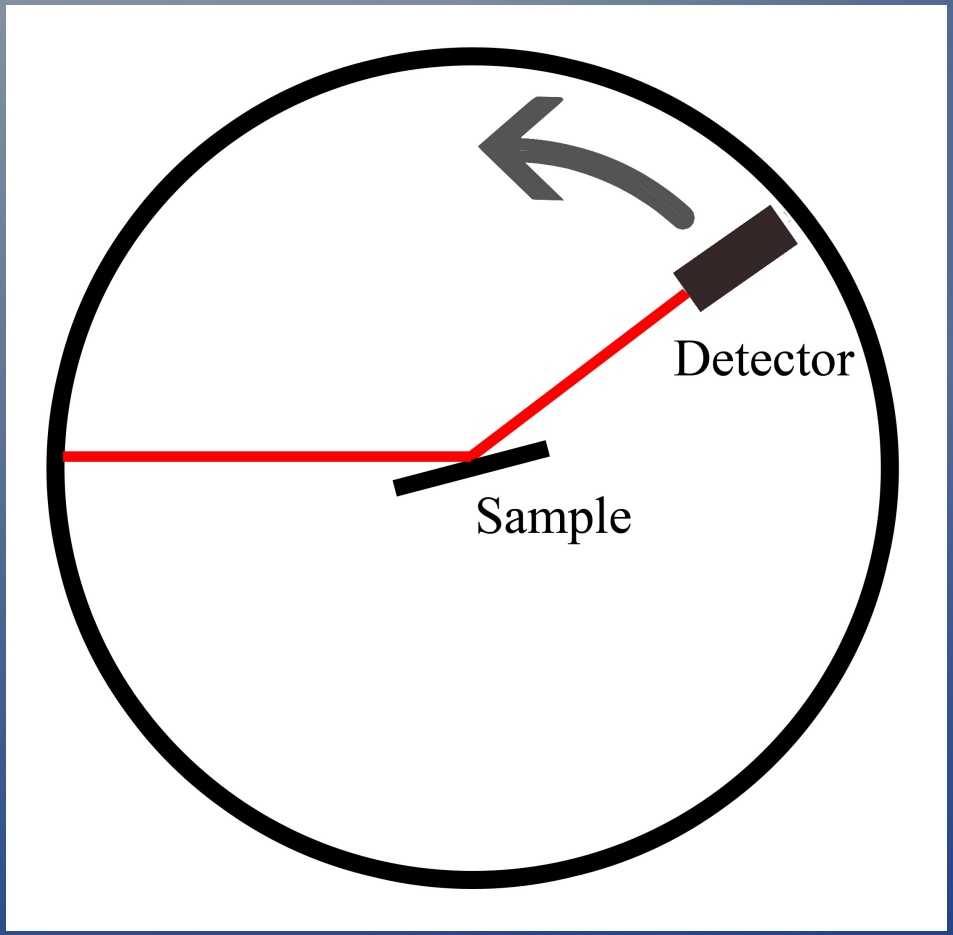

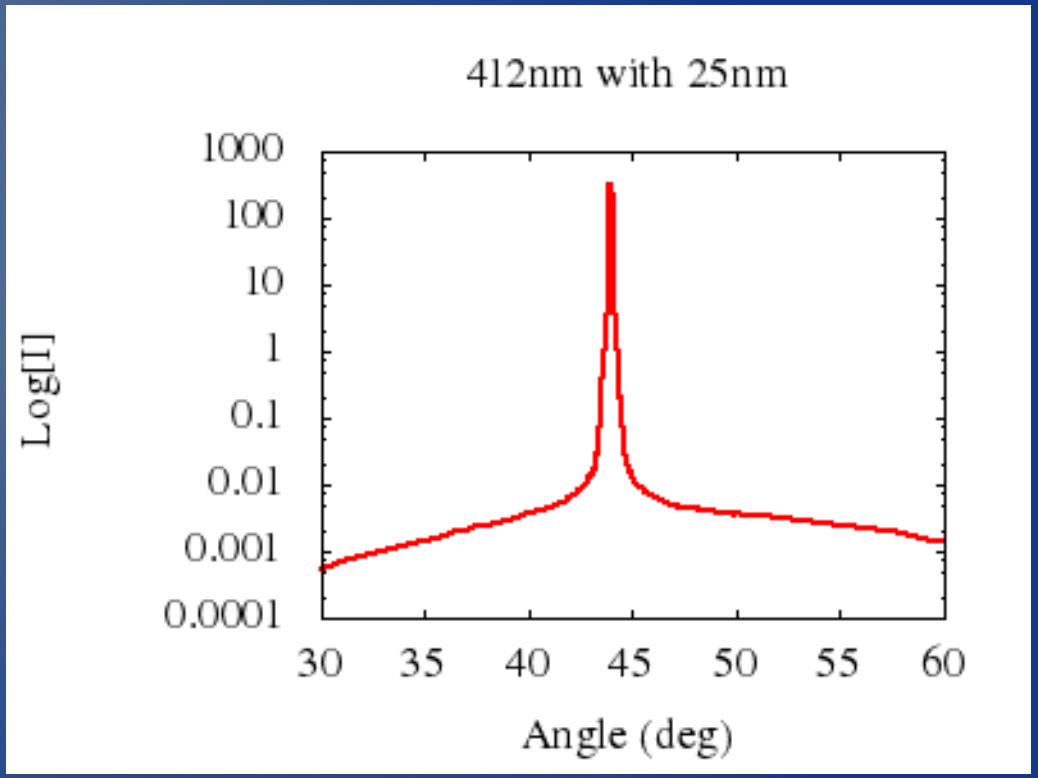

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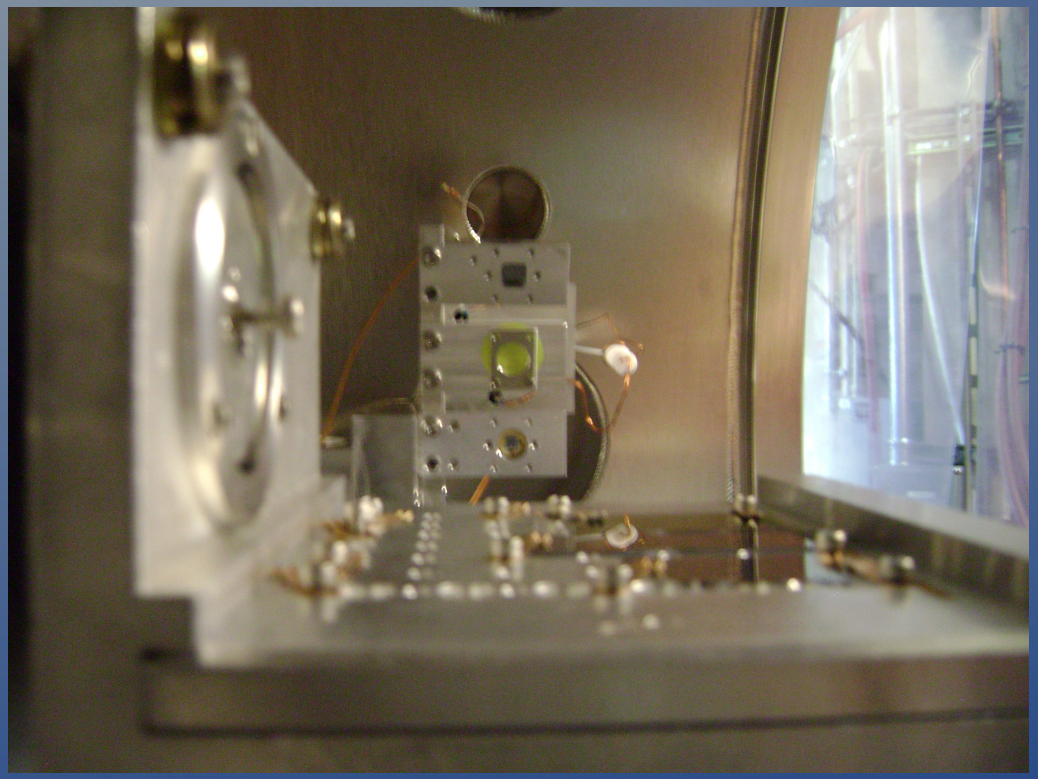
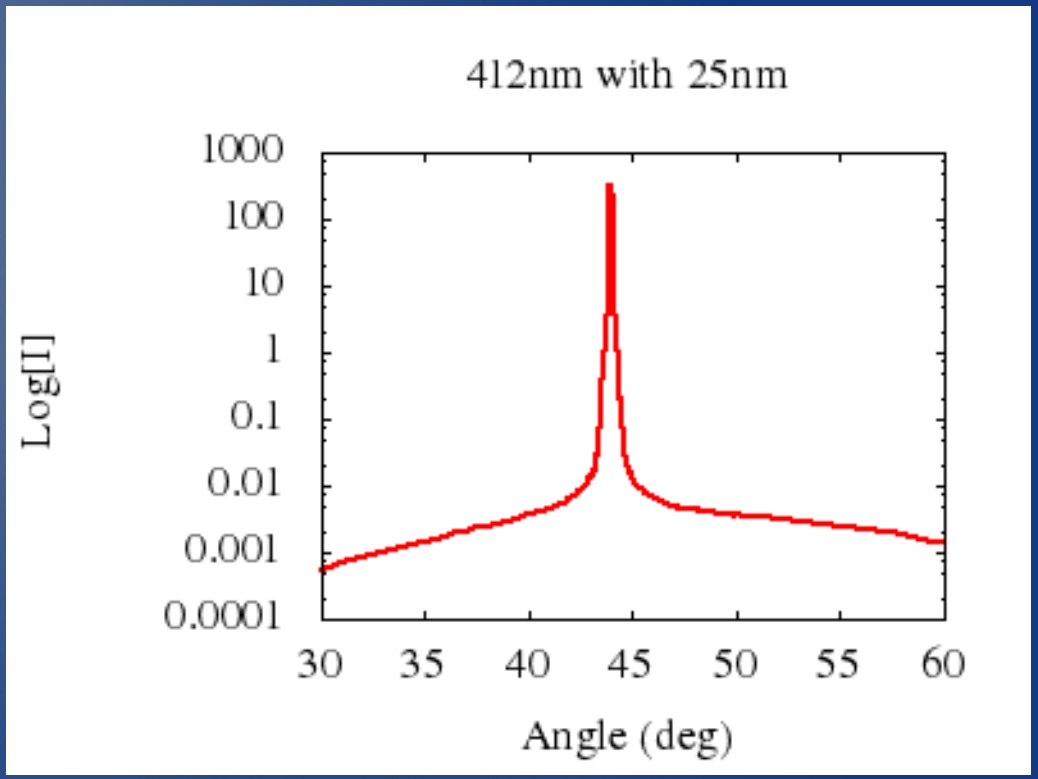
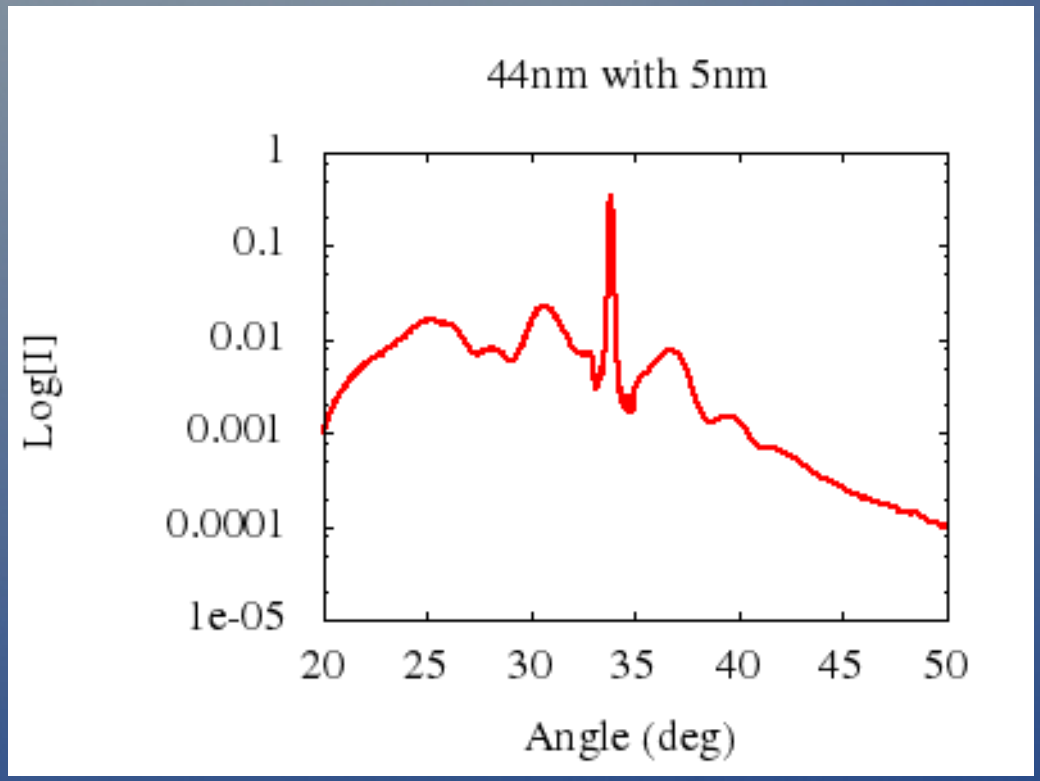
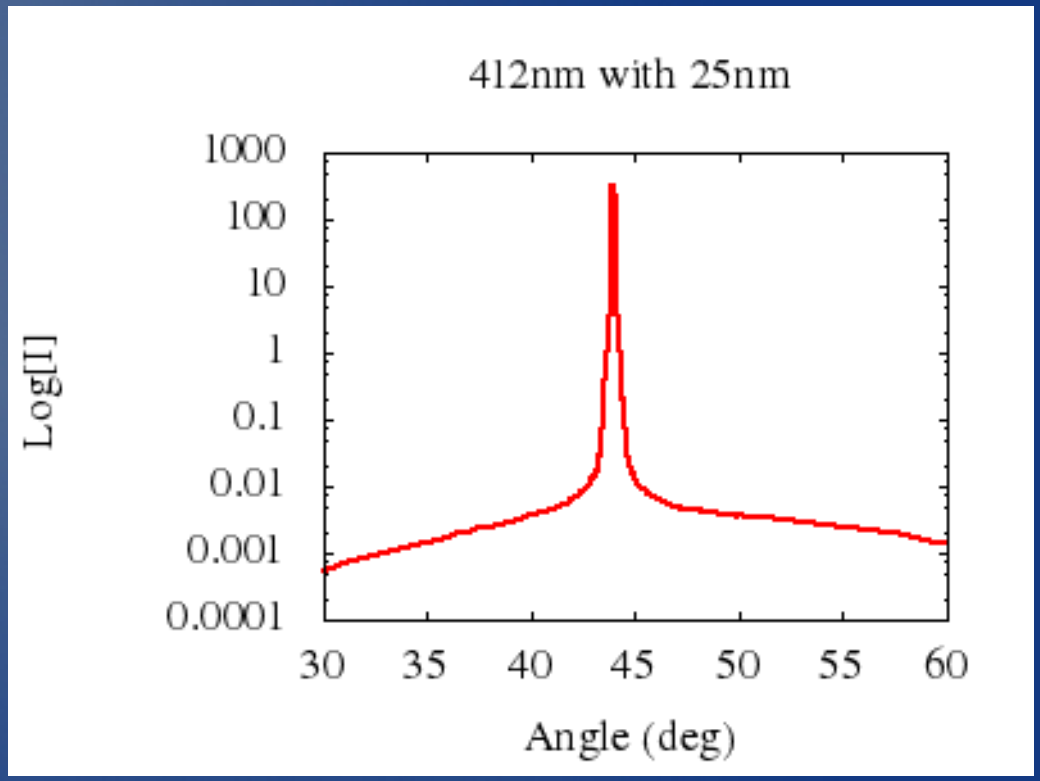




1. Channeltron
2. Photodiode

Reflection Results

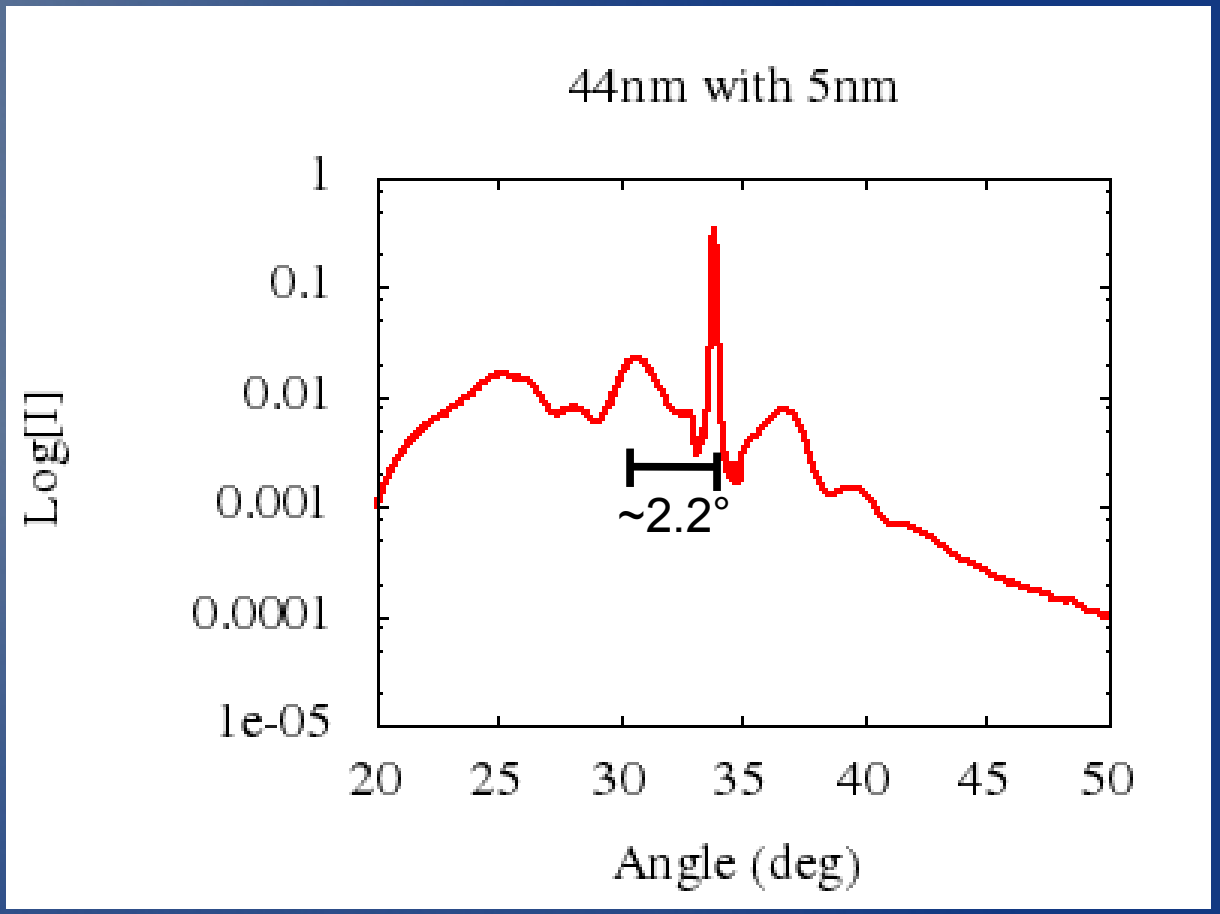




Diffraction Grating?

- Grating Equation

$$d \sin(\theta) = m \lambda$$



Diffraction Grating?

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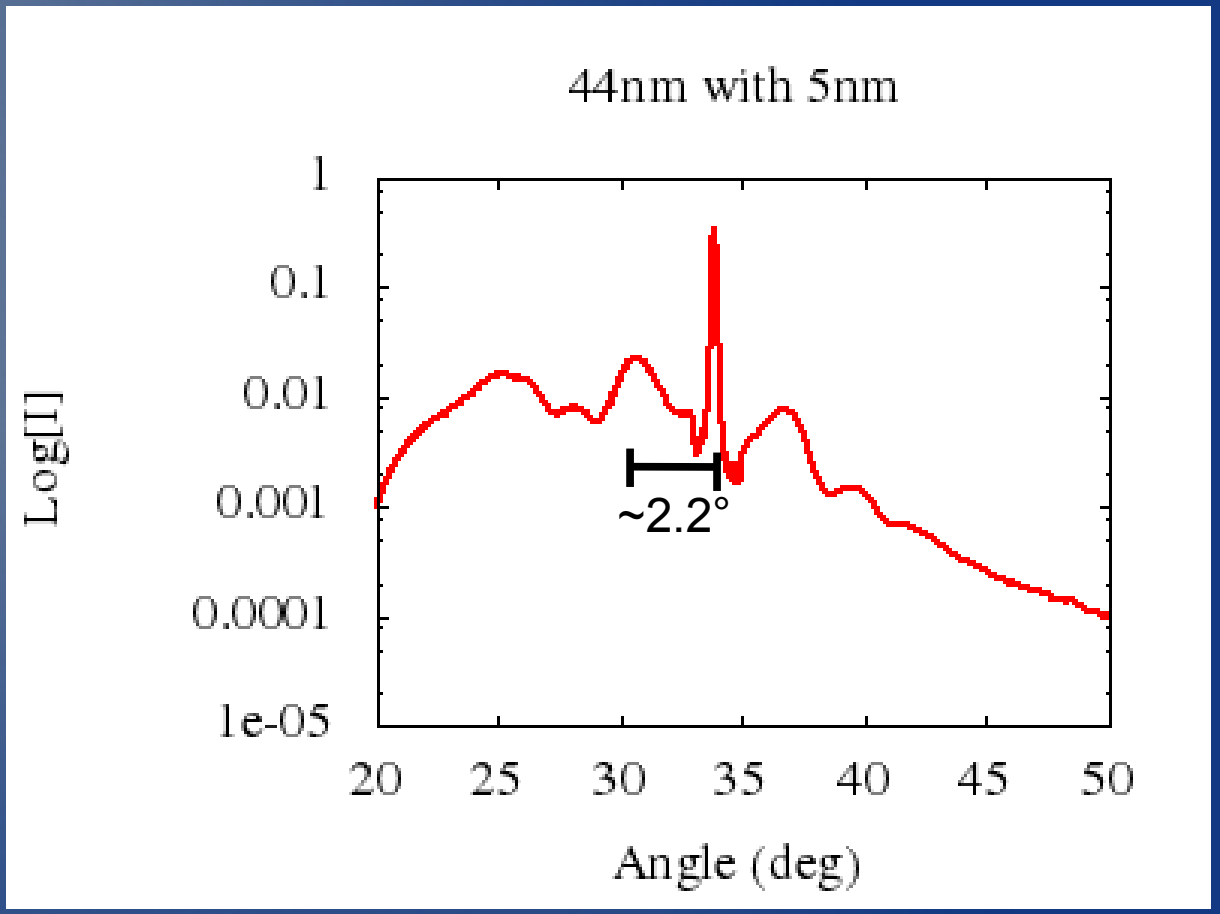
$$d\sin(2.2^\circ)=(1)*5\text{nm}$$



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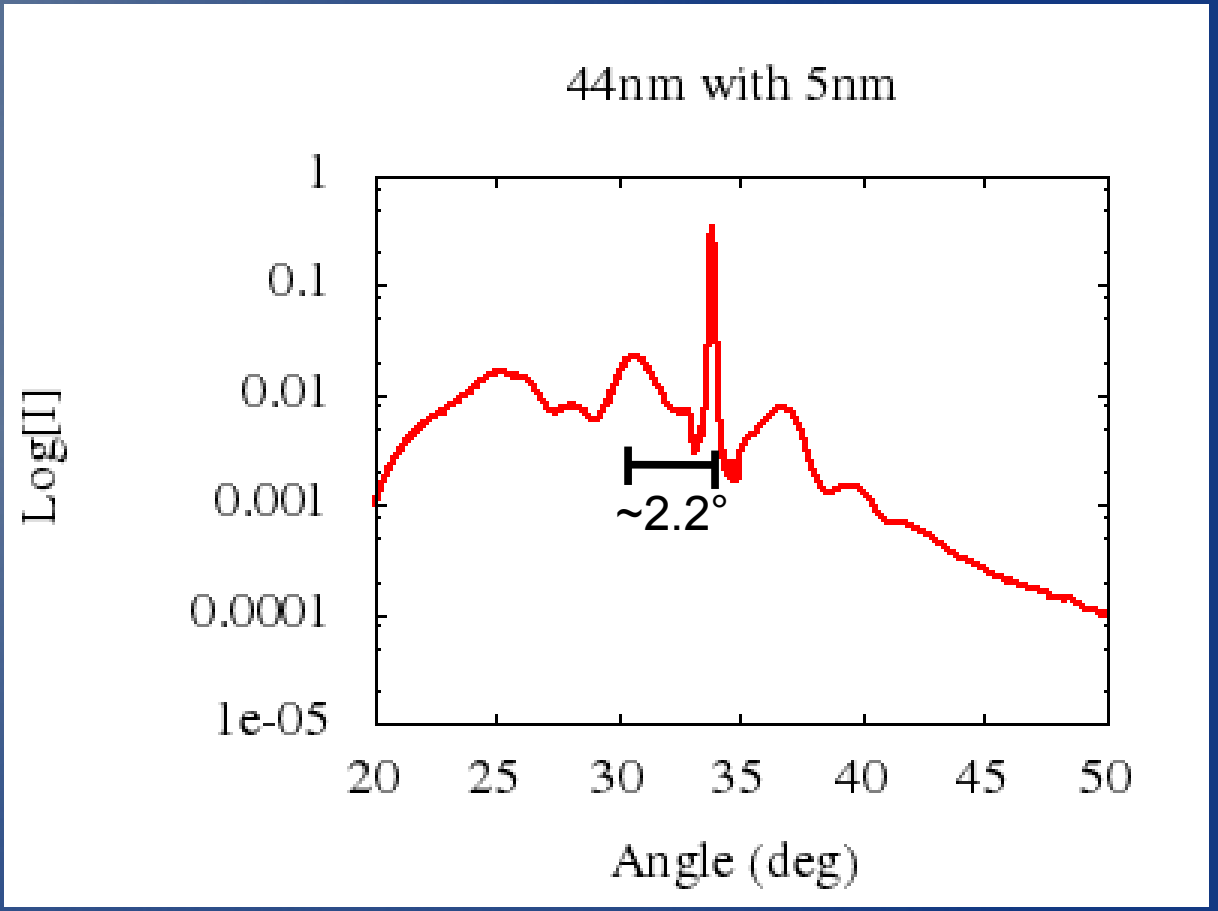

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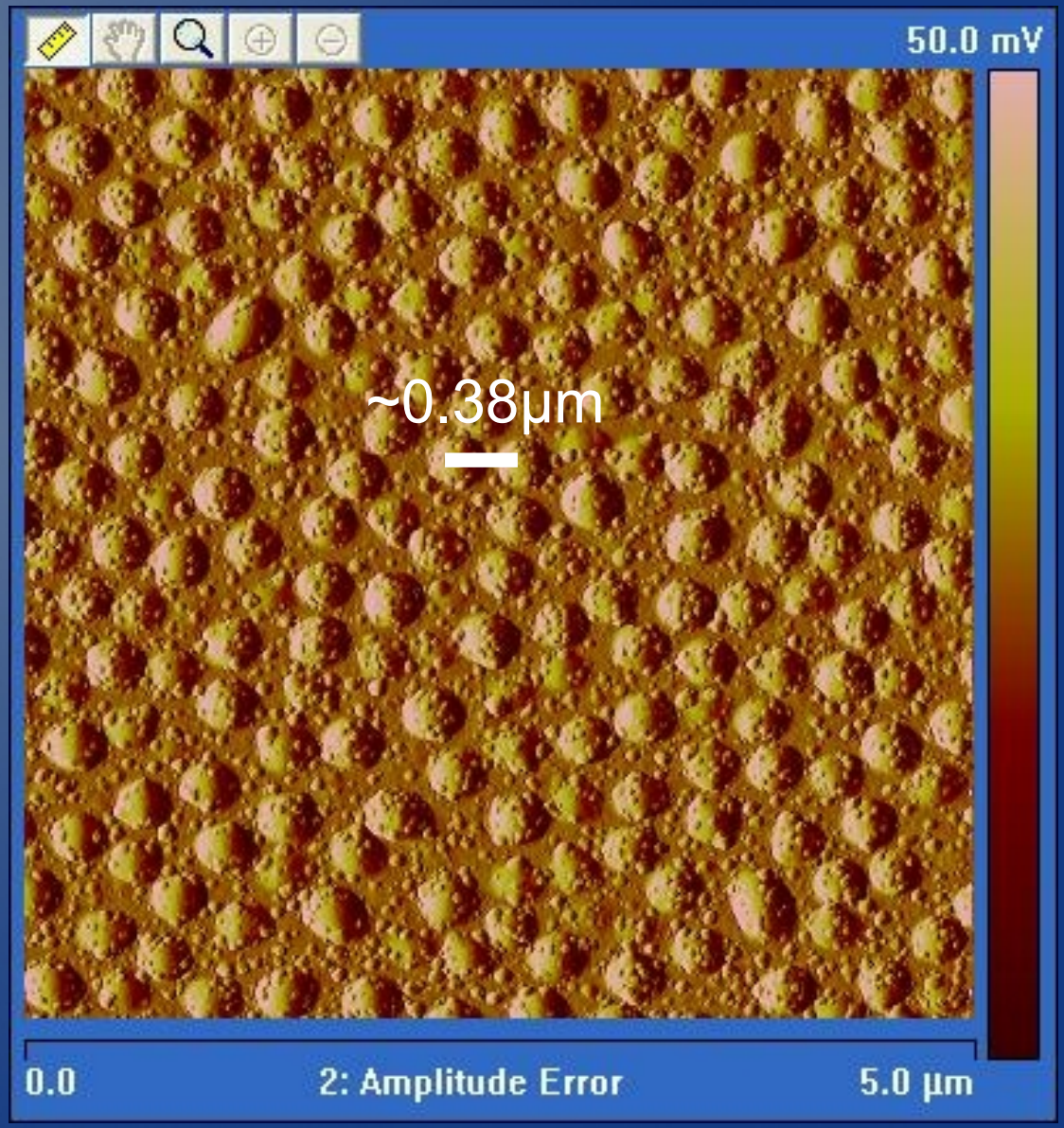
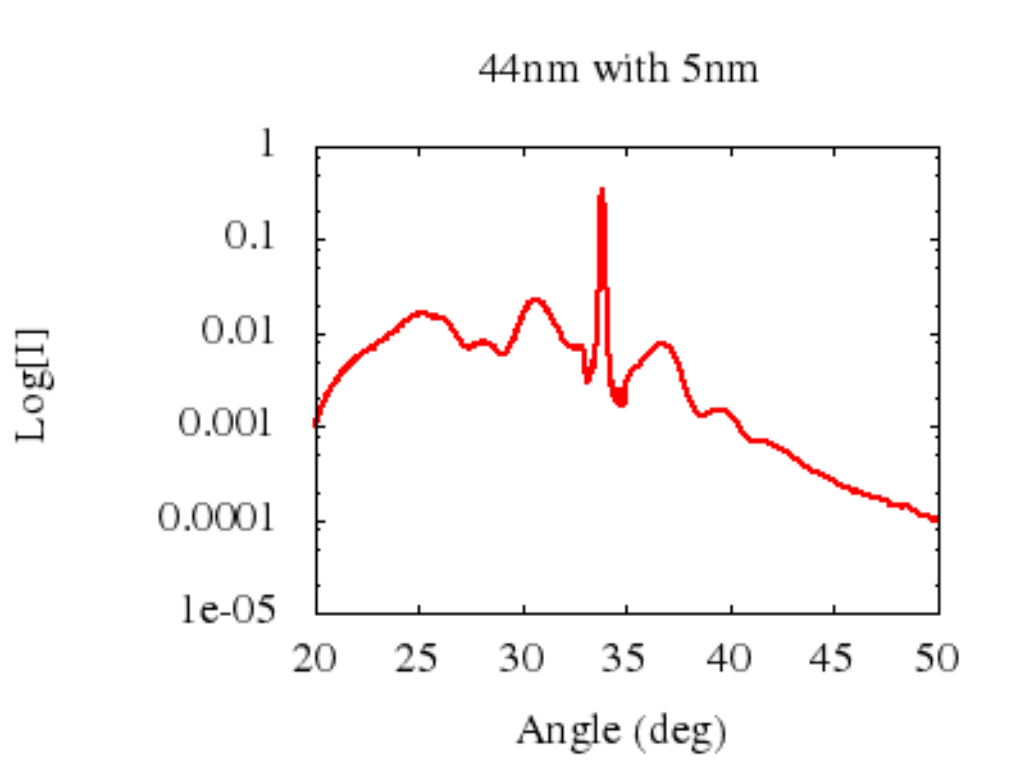
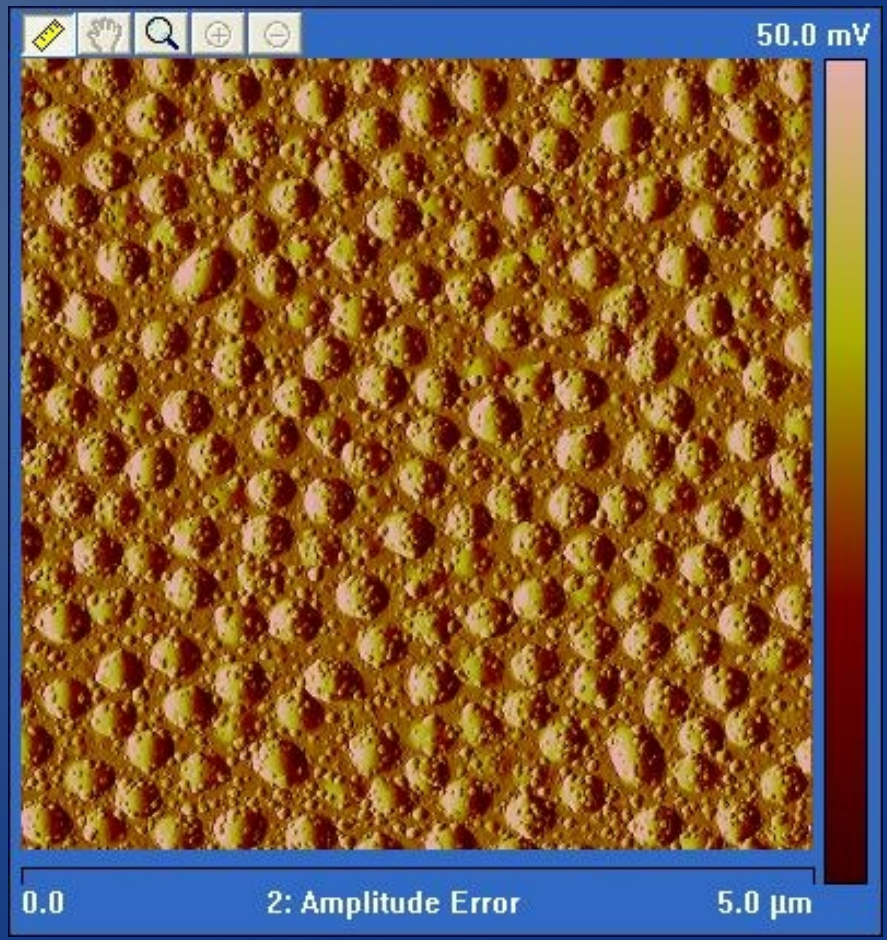


Conclusion

- From these results we conclude that reflection measurements have the potential to tell us new things about our thin film samples.





Acknowledgements

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