Status Update

Joey Doll

Worm Touch Meeting

3/4/09

Last Time

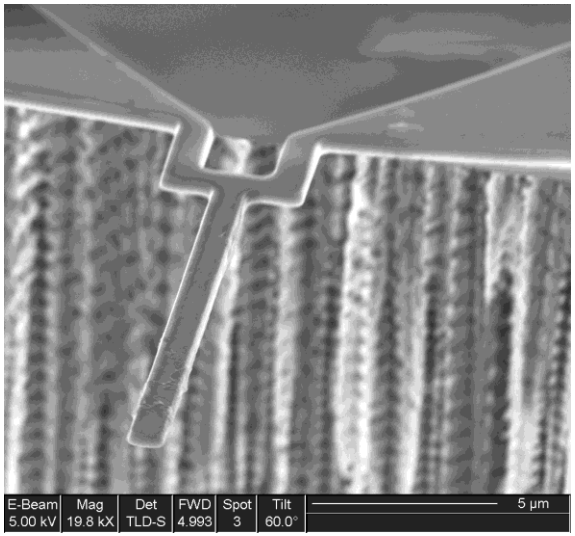
- Assumed that devices would work
- Talked about planned experiments in TRNs and hair cells
- Timeline
  - Feb: Device Characterization
  - Mar: System integrationn
  - May: System characterization
  - June: Experiments

This Time

- **Device Characterization**
- Fabrication Process Debugging
- Calibration with Shana
- Next steps

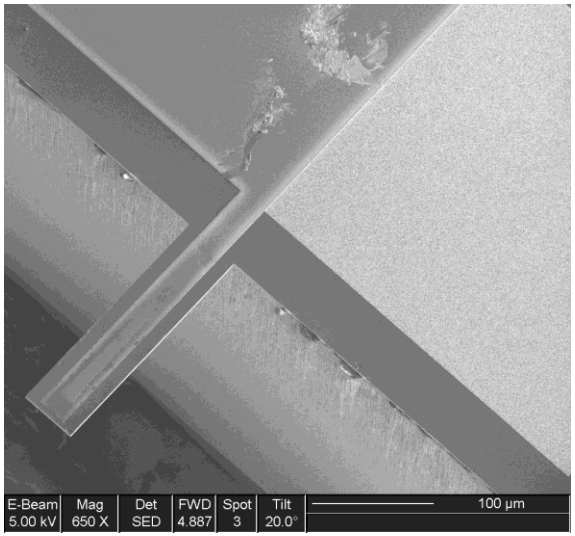
Device Characterization

Piezoresistor Only



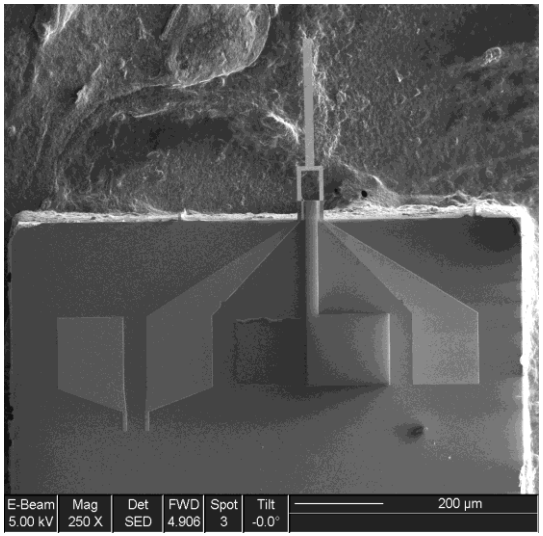
Initial done, starting detailed

Piezoelectric Only



Done

Combined Device

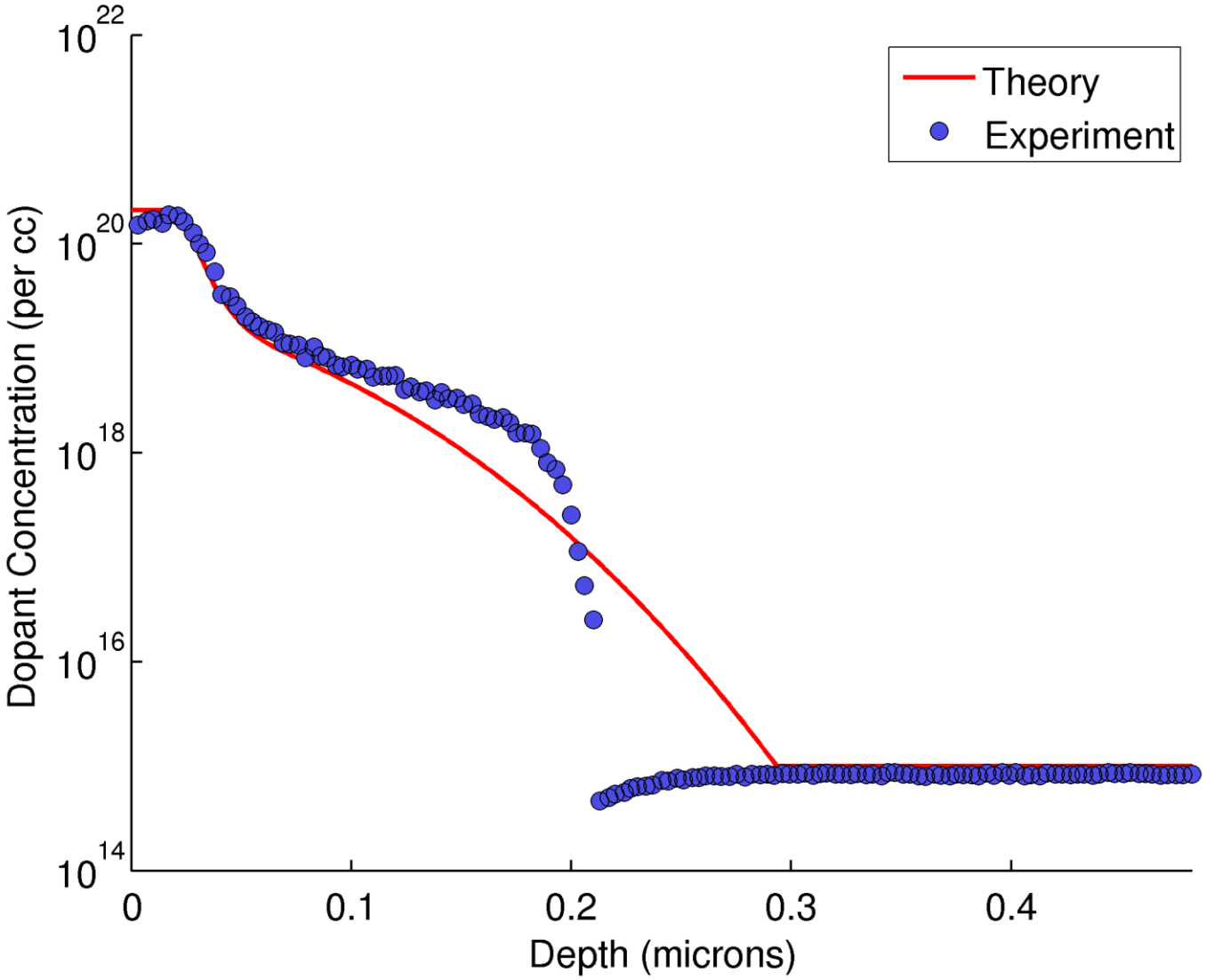


Starting around 3/15

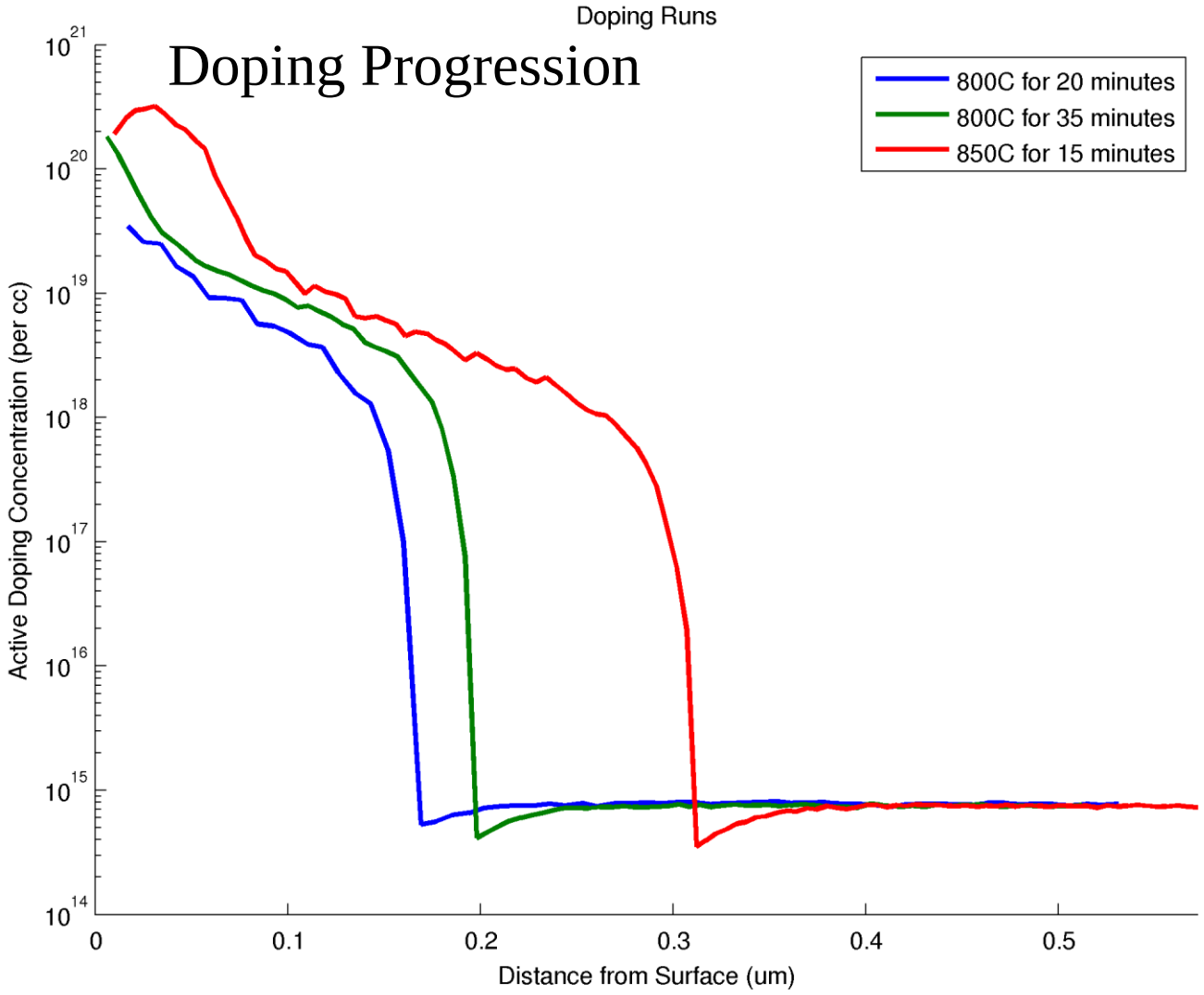
Piezoresistor Noise

- Goals
  - Measure quality of crystal lattice (alpha) for the diffusion doping process
  - Effect of parylene coating
  - Effect of fluid environment
  - Stability for underwater measurements e.g. temp drift
- Why?
  - Noise determines force resolution
- Help from Purnima

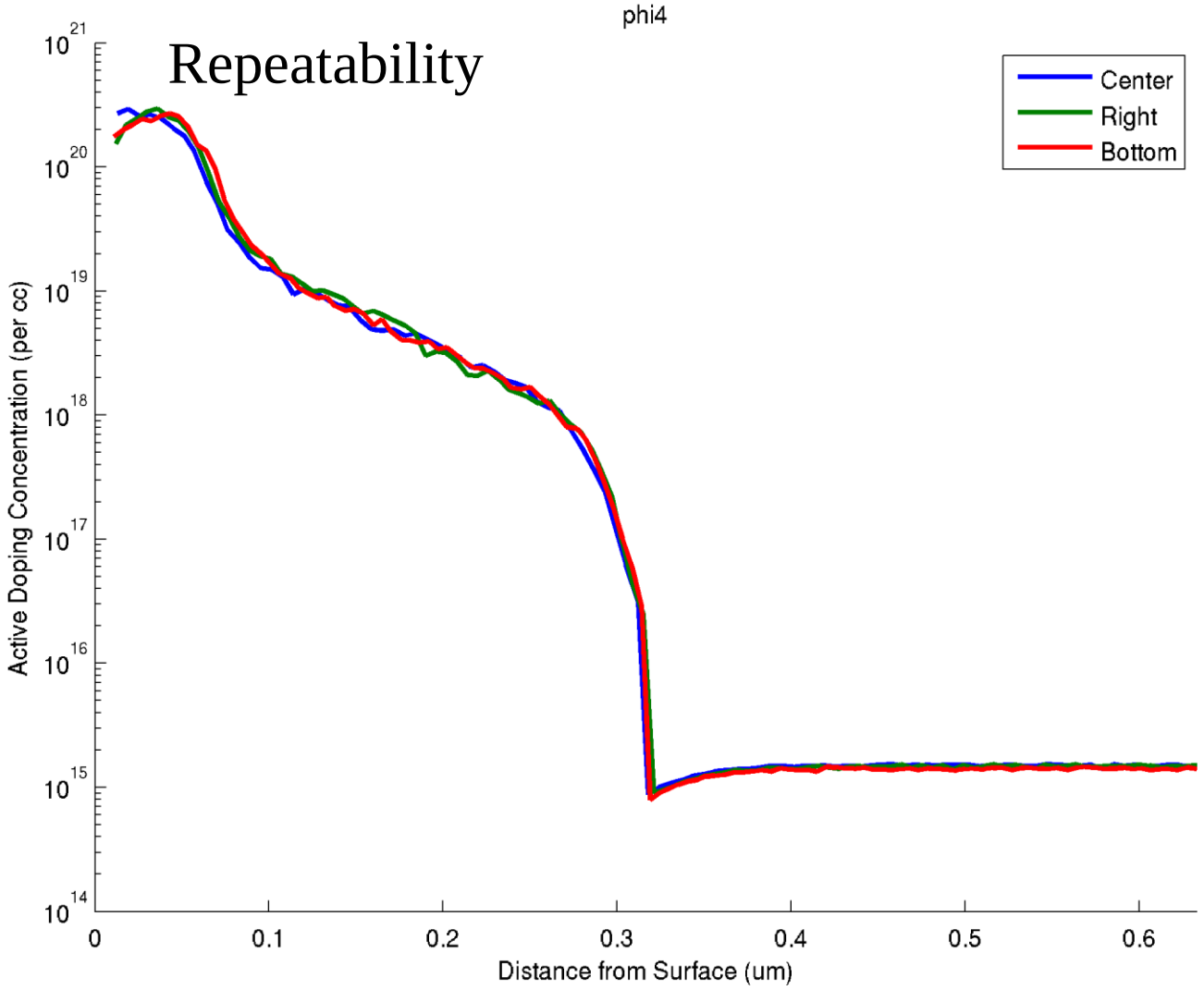
Diffusion Modeling



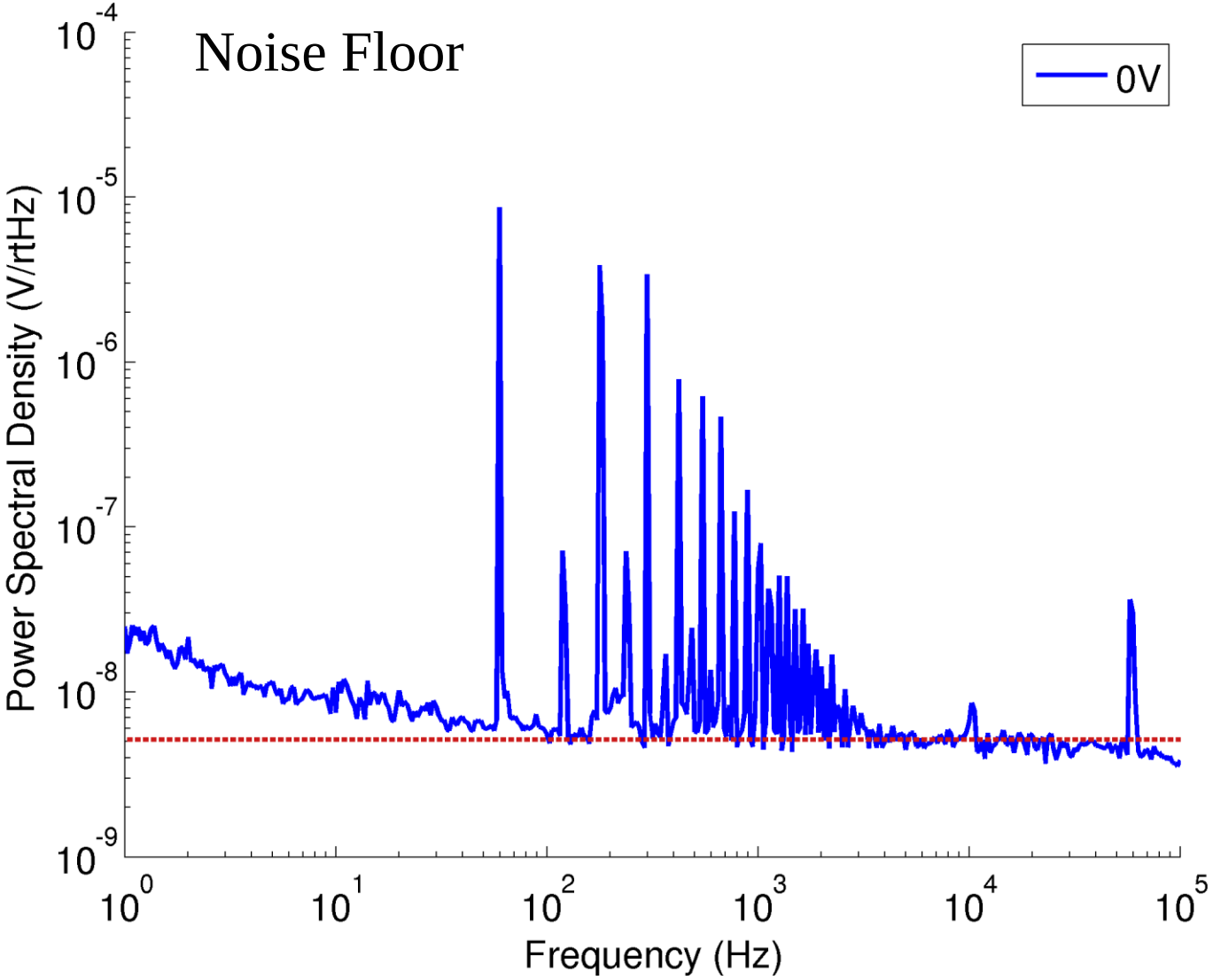
Piezoresistor Noise



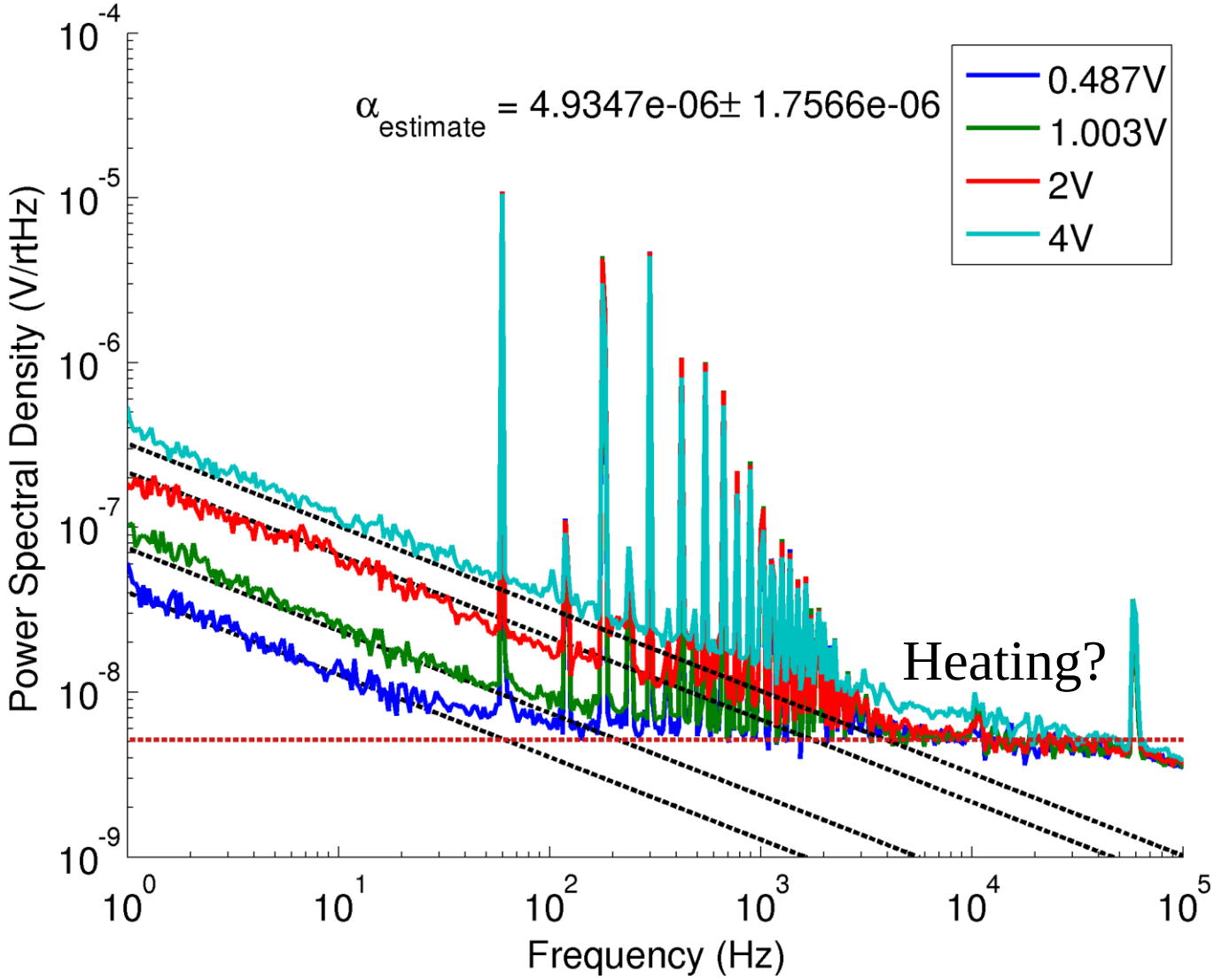
Piezoresistor Noise



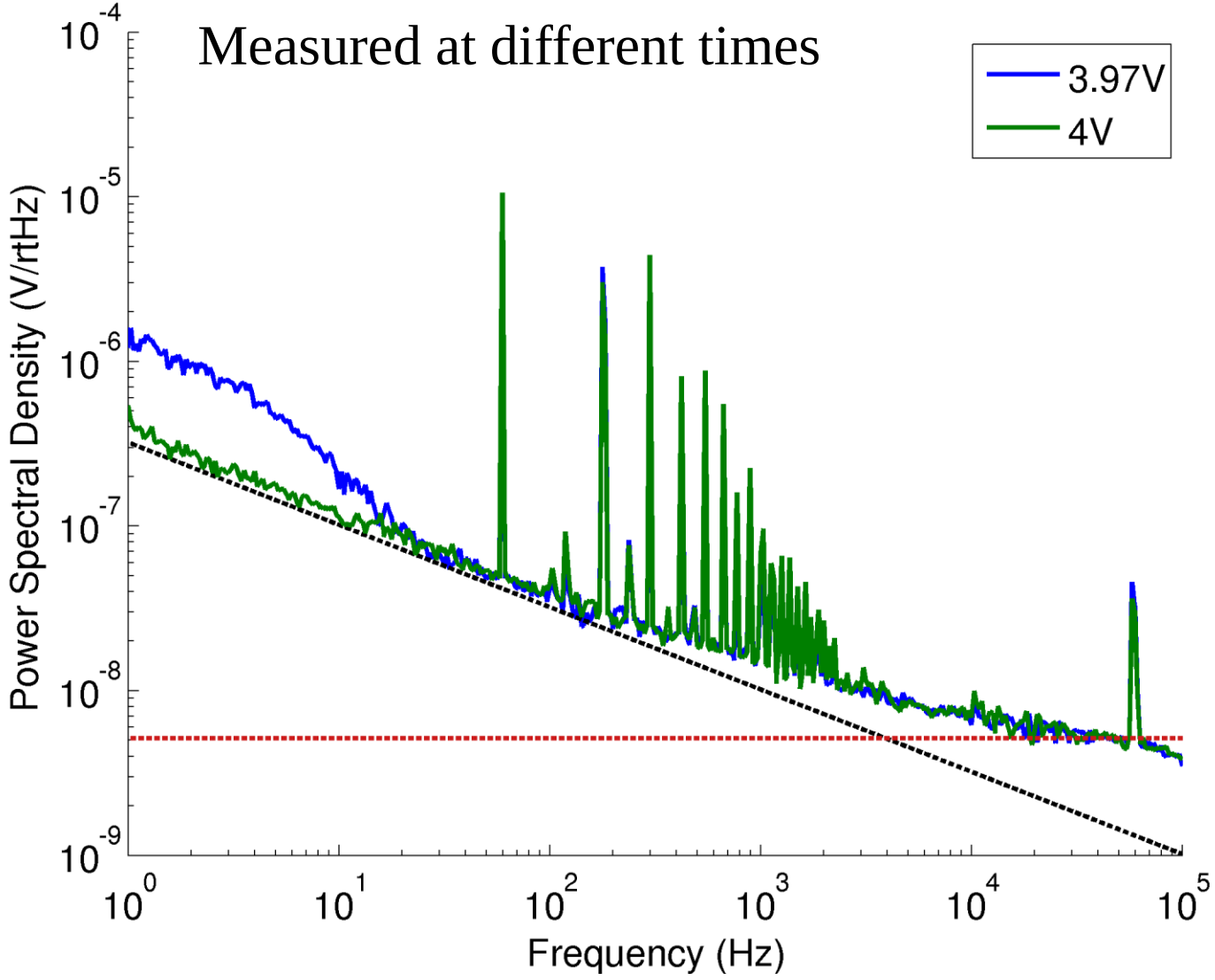
Piezoresistor Noise



Piezoresistor Noise



Piezoresistor Noise



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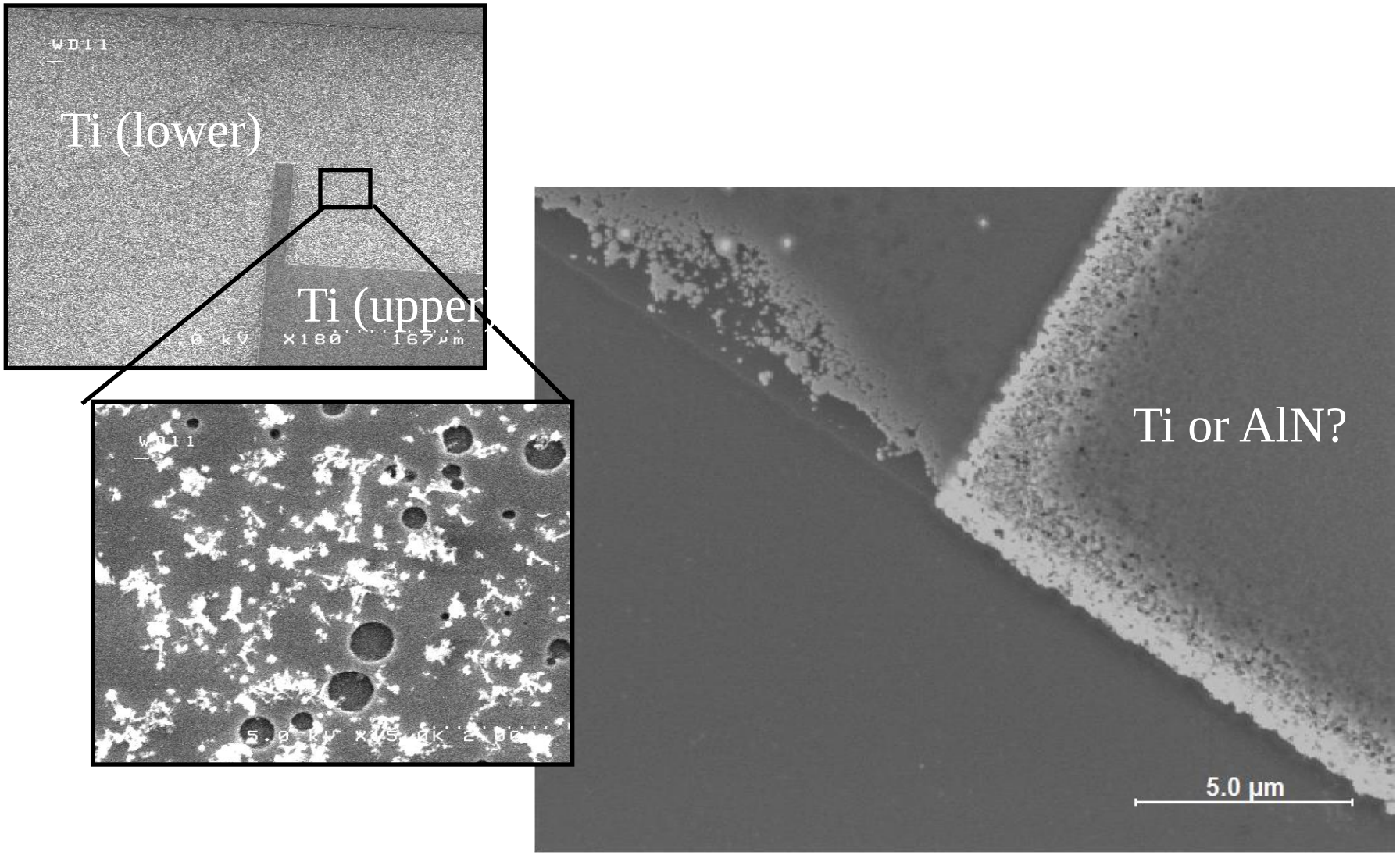
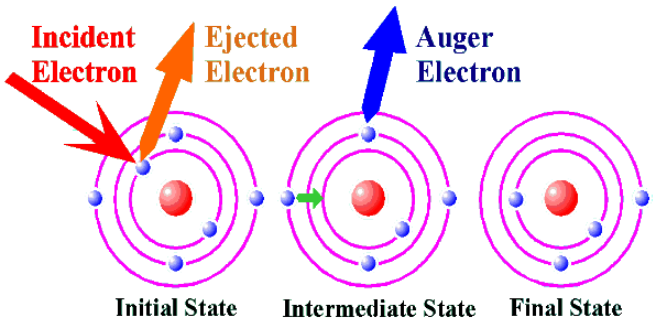
Mystery Etch Processes



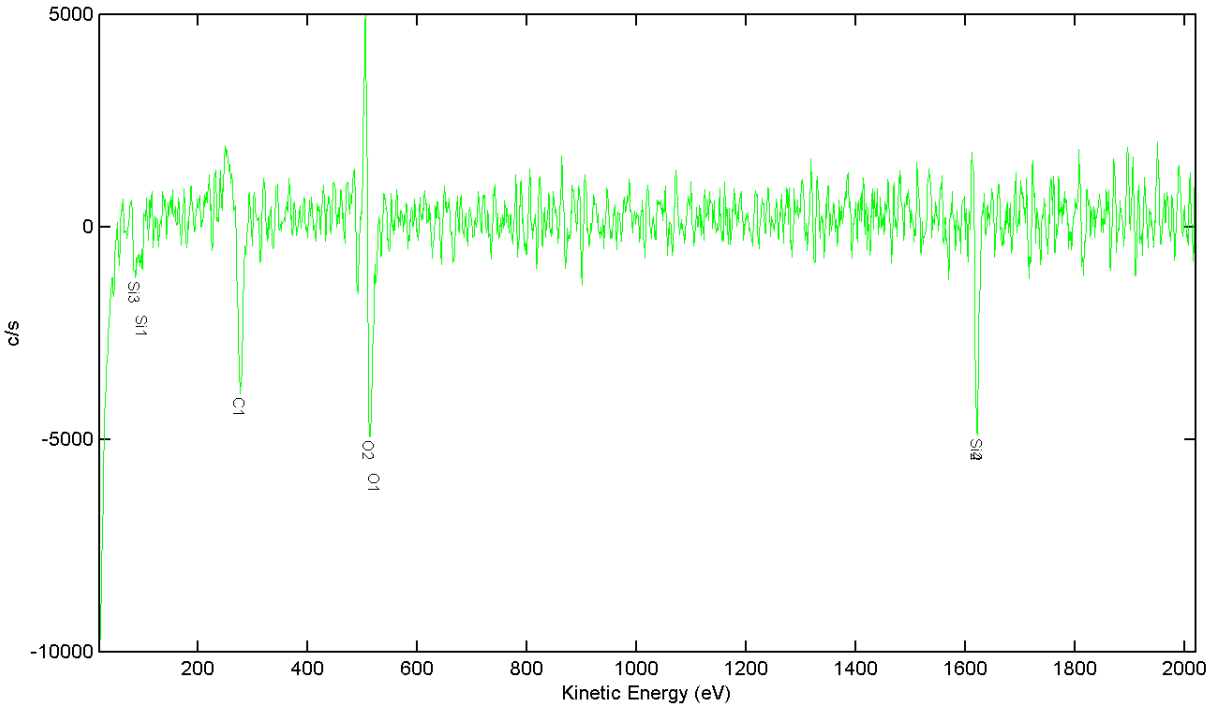
Disappearing Thickness

- Silicon device layer started out 340nm thick
- But measured 180nm during fab
- Etching of the surface would be a very bad thing

Auger Electron Spectroscopy (AES)

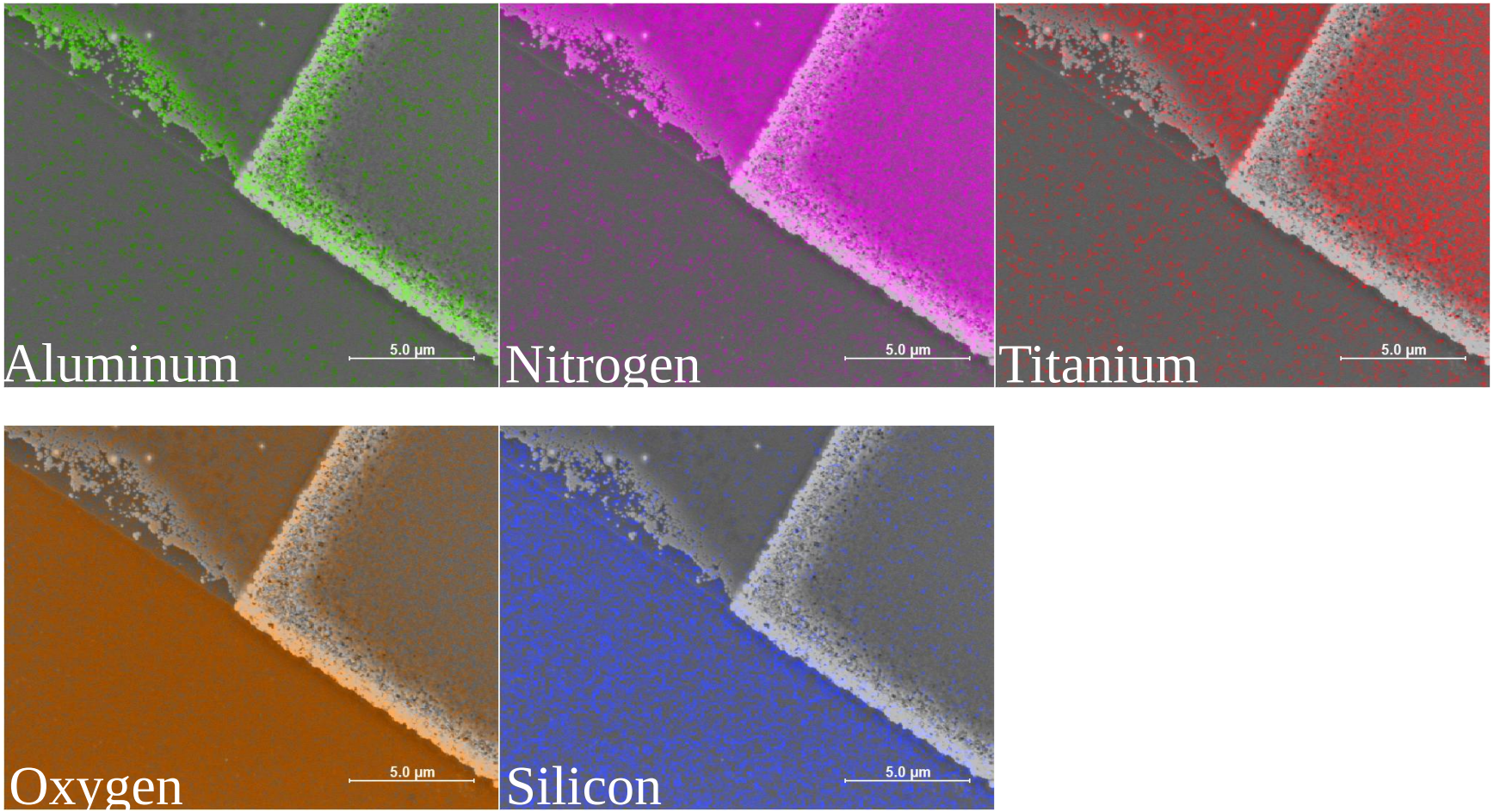


- Semi-quantitative
- E-beam spatial resolution
- Sensitivity to ~1%
- Compare with XPS

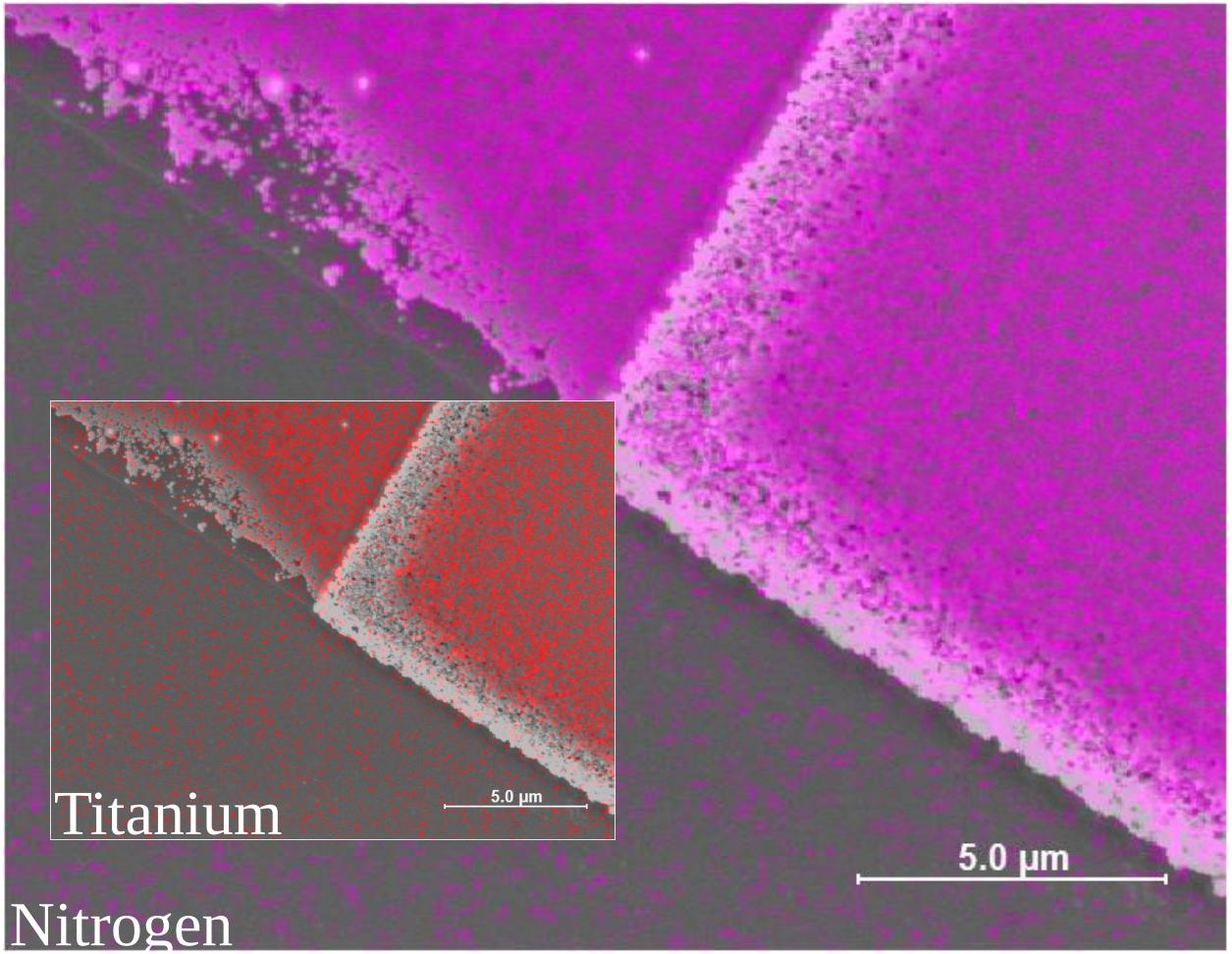


http://www.thermo.com/eThermo/CMA/Images/Various/158Image_17512.gif

AES Characterization



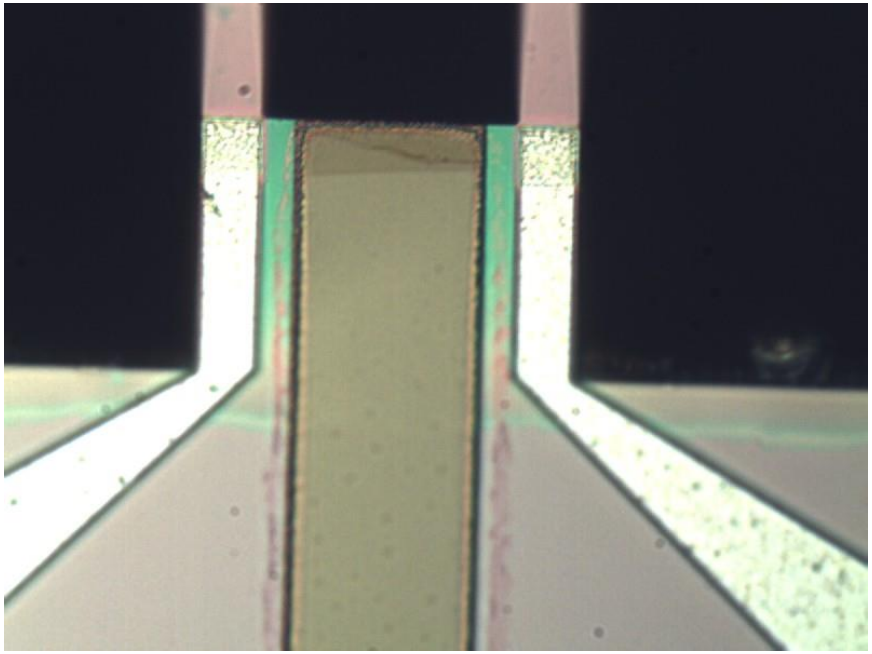
AES Interpretation



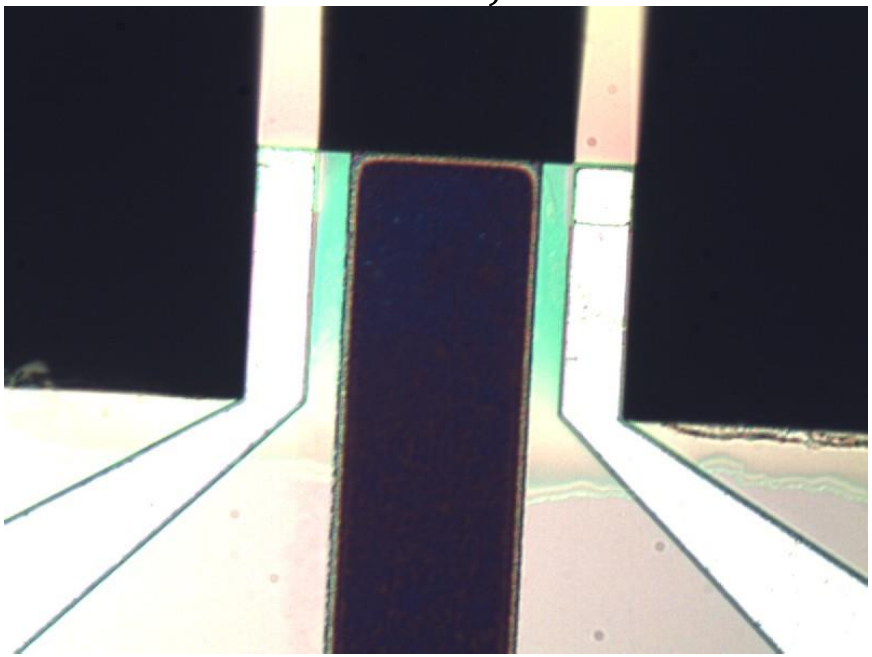
The surface of the titanium electrodes has become nitrided. Also picks up nitrogen from AlN.

AES Interpretation

No FGA

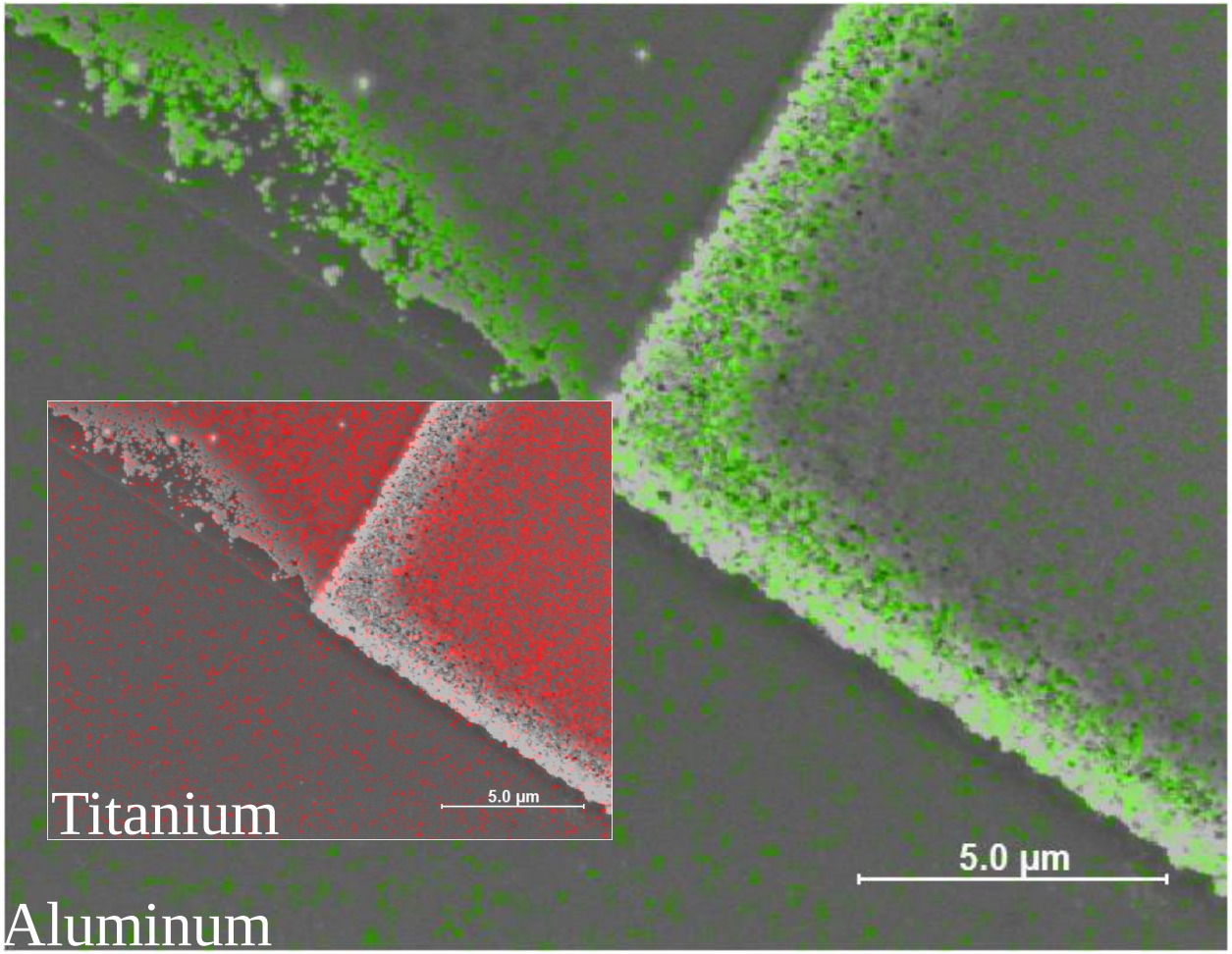


450C FGA, 1 hour



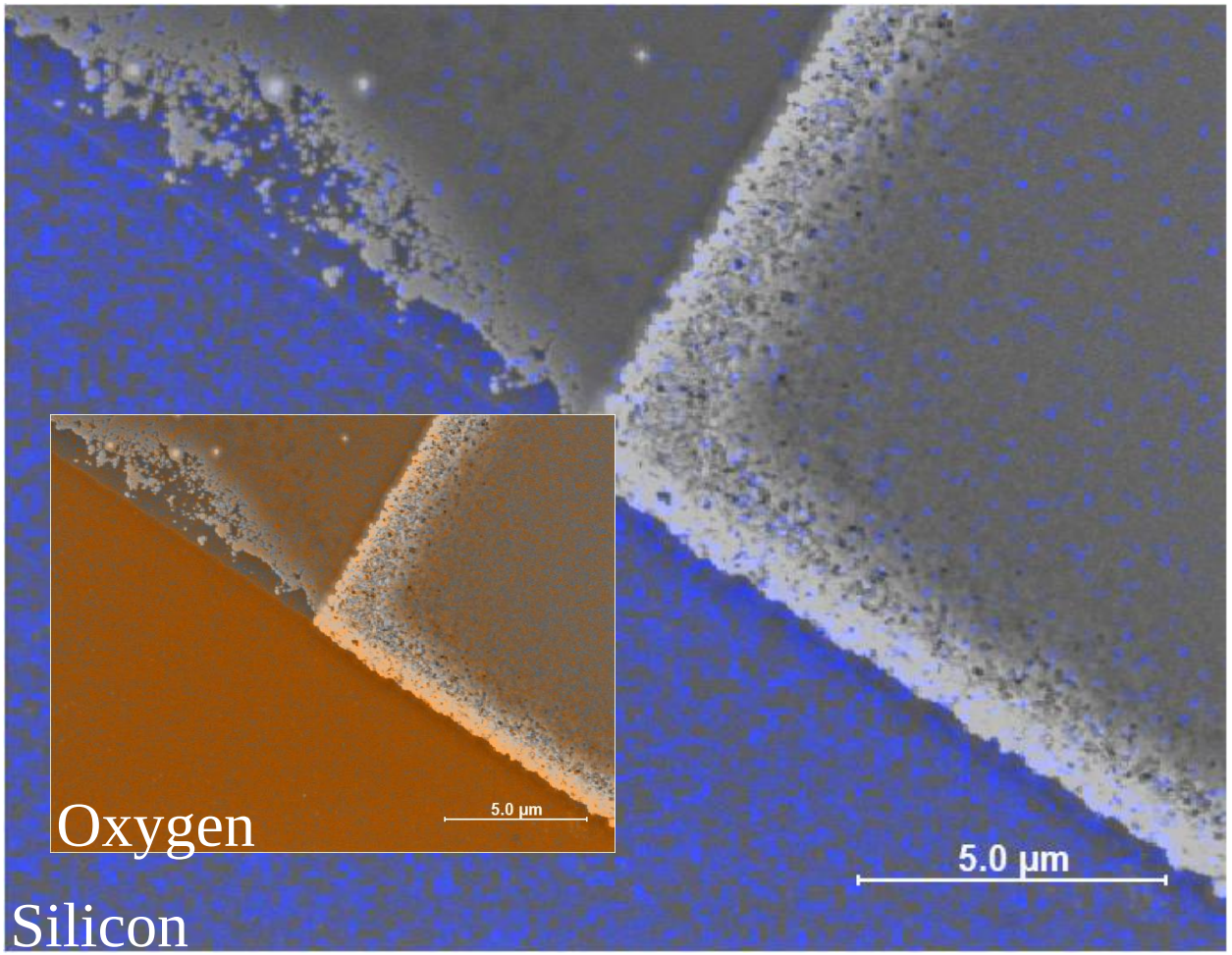
Which explains why the Ti changed colors after the forming gas anneal (N2 and H2).
(But what about the hydrogen distribution?)

AES Interpretation



The Ti electrodes were attacked at the edge.

AES Interpretation



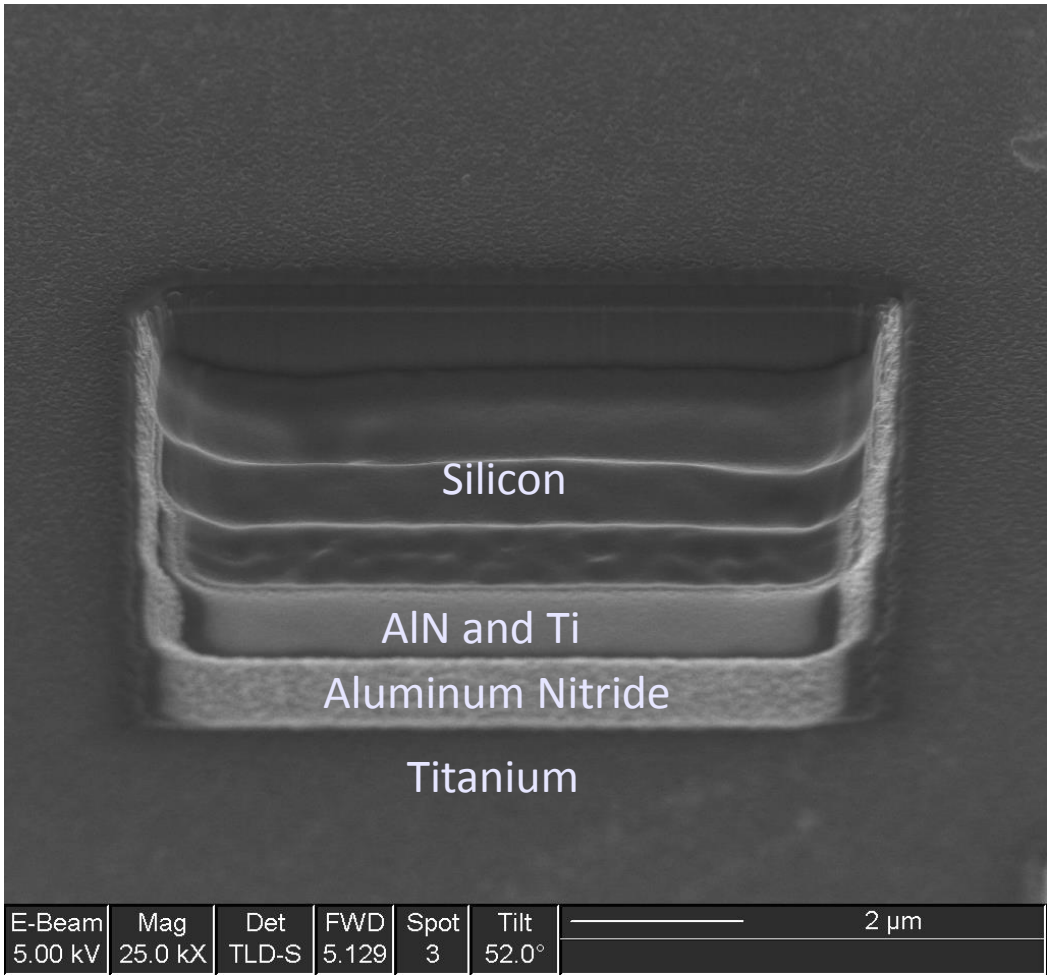
The bottom aluminum nitride layer was etched through to the silicon (oxygen scaling). This suggests that the doped silicon may have been attacked by the TMAH.

What's the Verdict?

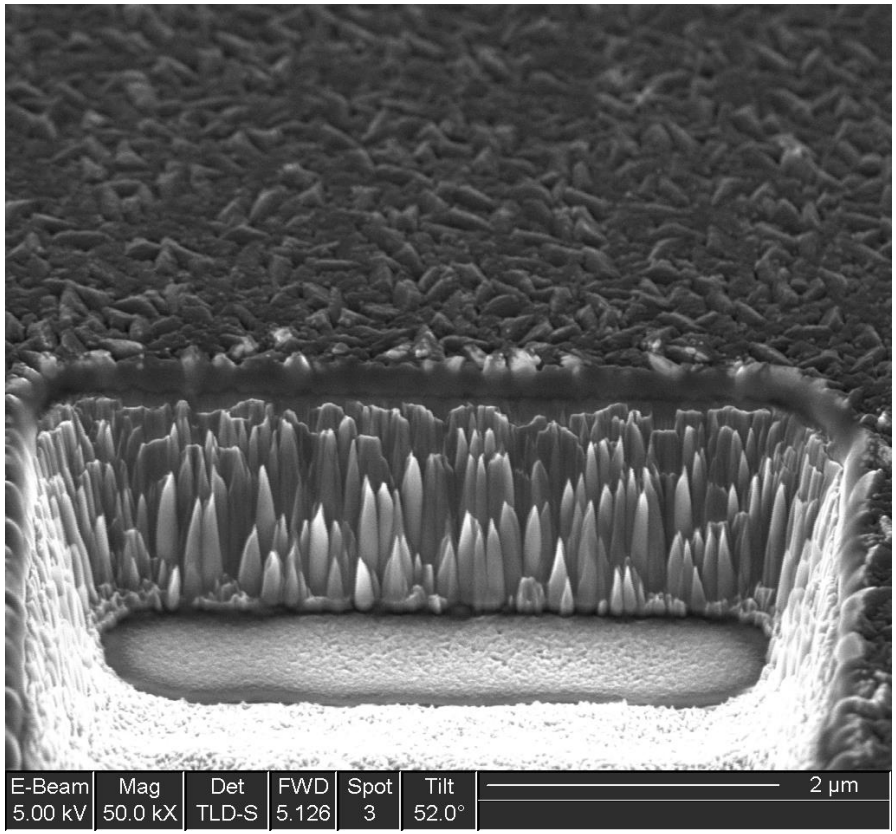
- AES suggests that the TMAH etch attacked the underlying Si
- What about the PR resistance?
  - Measured about 6 kOhm, looks good
- TiN, probably a good thing

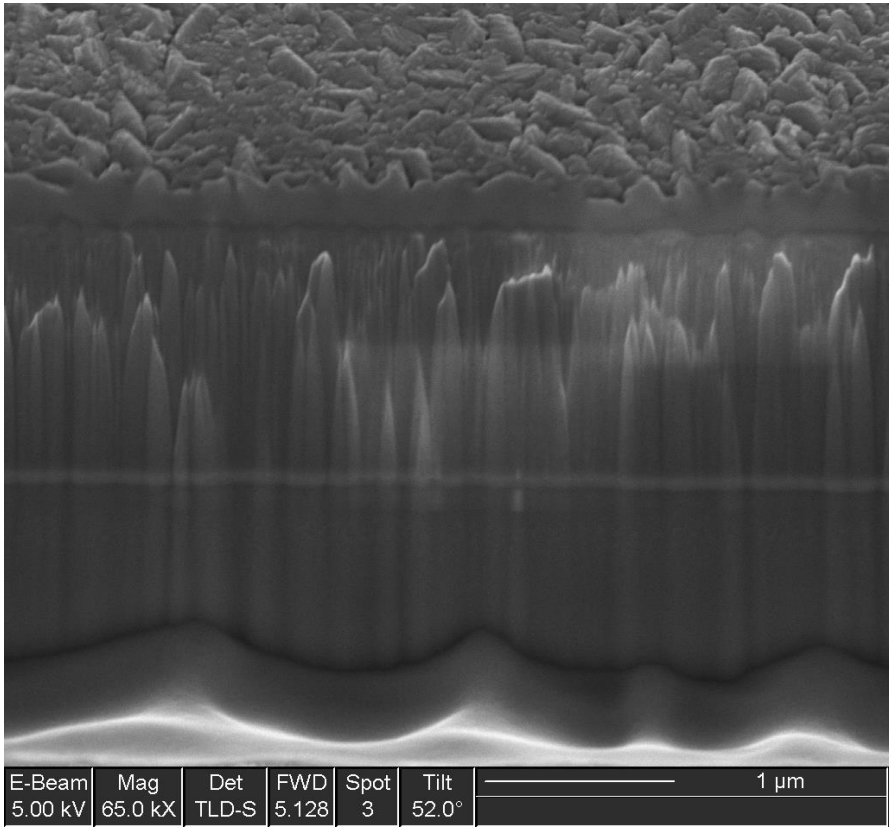
Aluminum Nitride FIB

Focused ion beam milling of Si/AlN/Ti/AlN/Ti sandwiches for thickness and morphology analysis



Aluminum Nitride FIB





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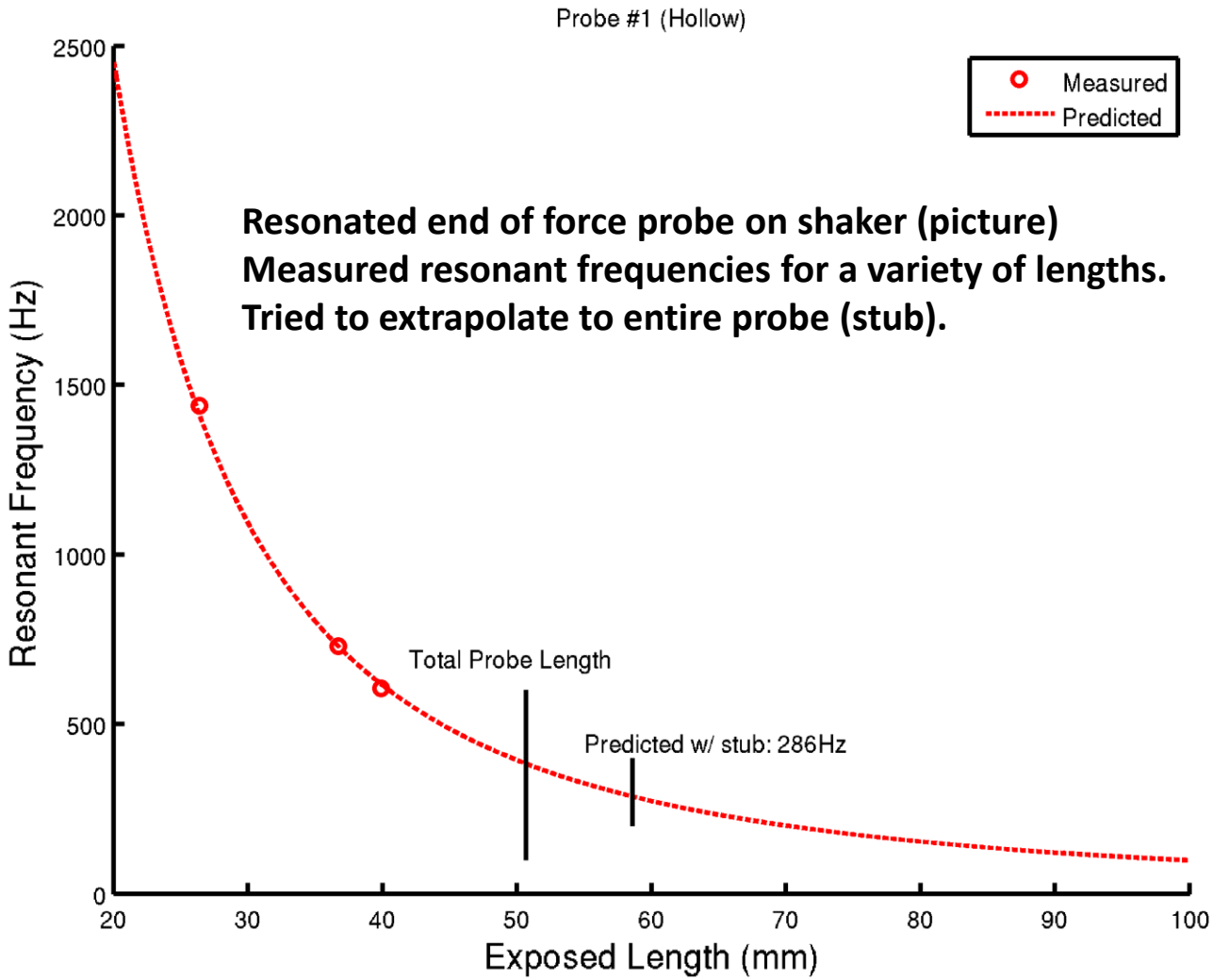
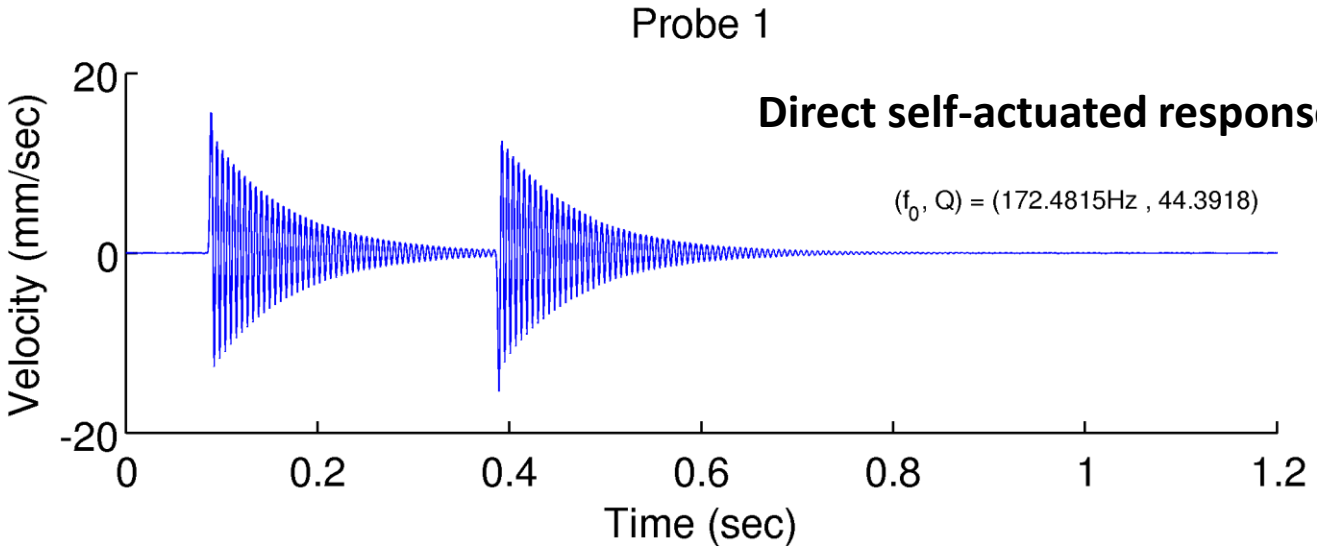
Probe Calibration w/ Shana

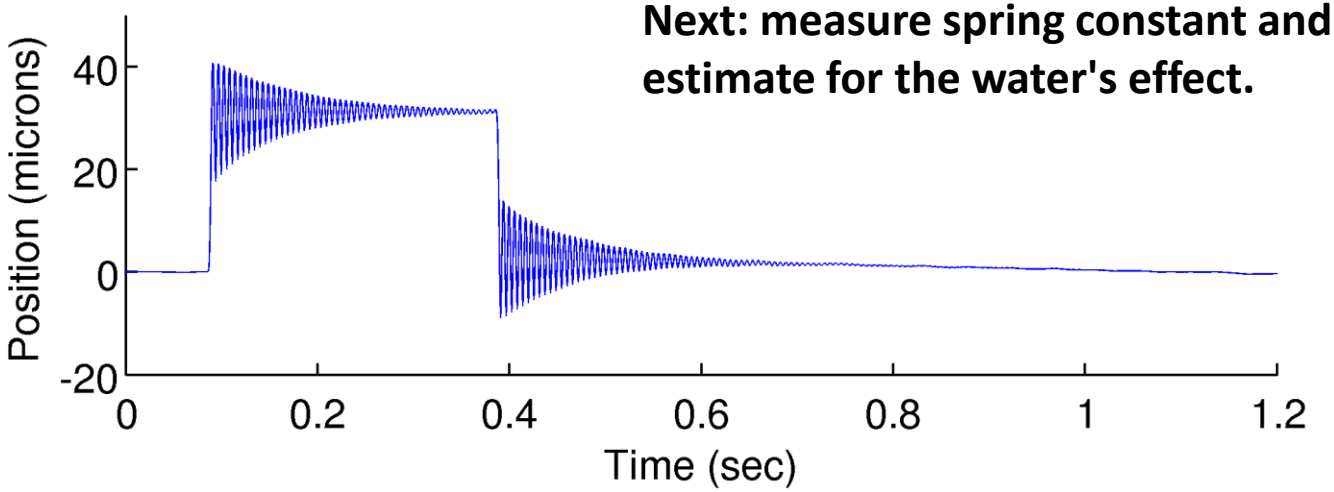


Probe Calibration w/ Shana



Direct self-actuated response w/ LDV

$(f_0, Q) = (172.4815\text{Hz}, 44.3918)$



Next: measure spring constant and provide an estimate for the water's effect.

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Upcoming Stuff

- Conferences/Writing – next 2 weeks
  - Poster for MMB
  - Two posters, two papers for Transducers
  - Optimization Paper – mostly done
  - Aluminum Nitride on Titanium
- Research
  - Wrap up PR testing
  - Combined devices (PR, PE, cross-talk), test actuation on surface using AFM
  - Mockup breadboards, make PCB