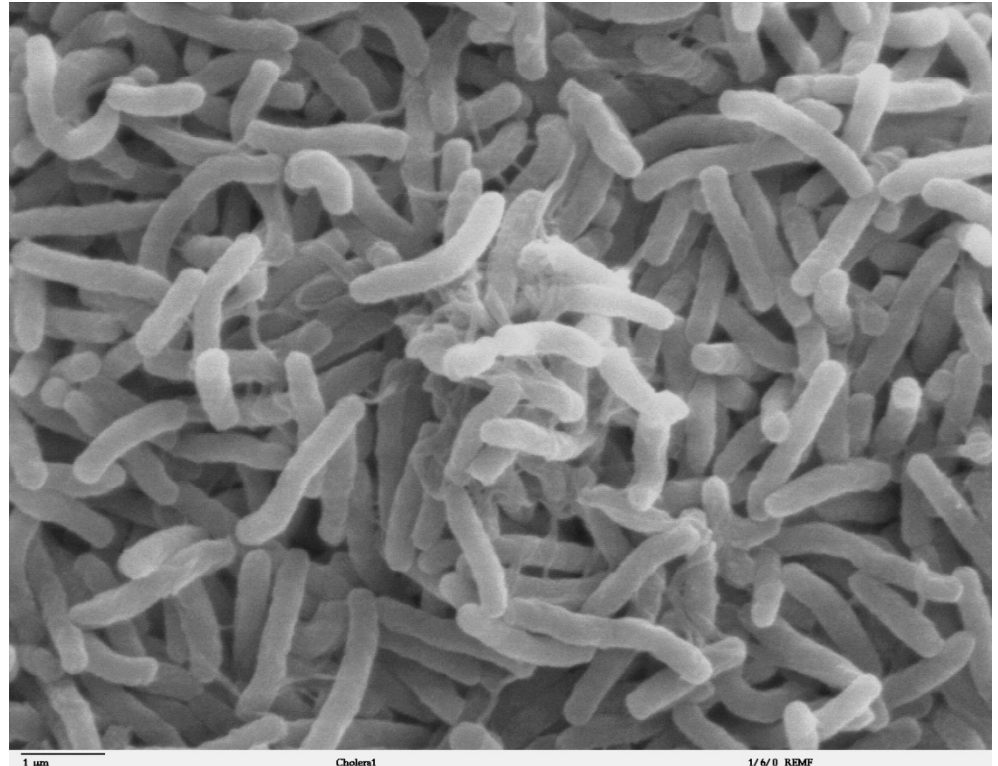


Preparing Metal Tips Suitable for Tip Enhanced Raman Spectroscopy

- Veronica Mota
- Ventura community college
- Environmental Science major
- Lab Mentor: Isaac Riisness
- Faculty Advisor: Mike Gordon
- Chemical Engineering Department
- Funding: CNSI Seed Fund

The Big Picture

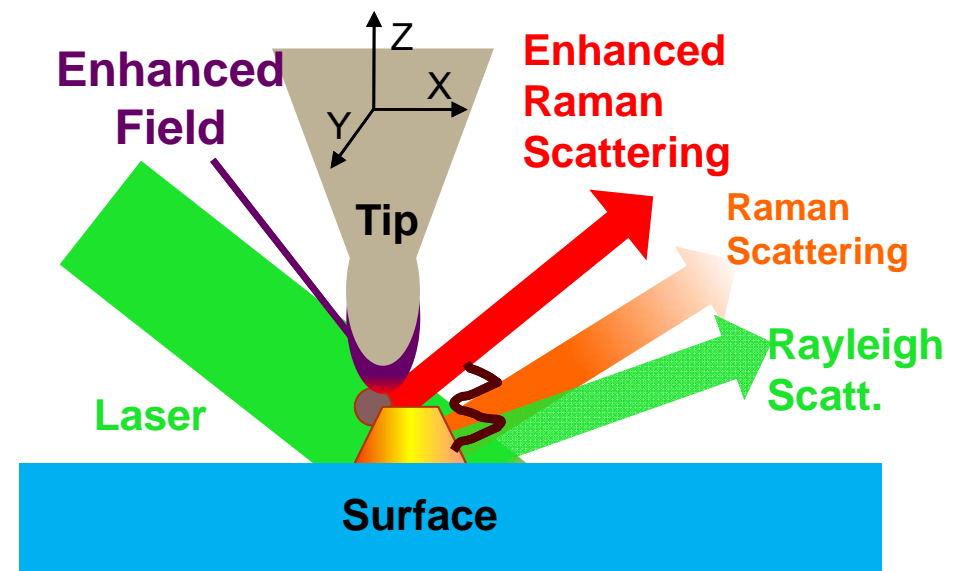
- Surface chemical imaging via Raman Spectroscopy.
- TERS; Physical properties and chemical properties of molecules as well.
- Applications; images of biomolecules and study of catalytic surfaces.



Picture of E.coli bacteria taken with SEM.

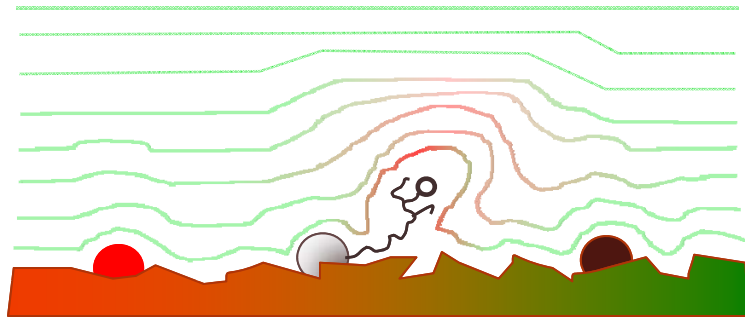
Tip Enhanced Raman Spectroscopy(TERS)

- Laser is directed at surface and metal tip.
- Molecule; two types of scattering occurs.
- Tip; laser light excites electrons.(plasmonic coupling)
- Enhanced Electromagnetic field is created.
- Only Gold and Silver can be used.

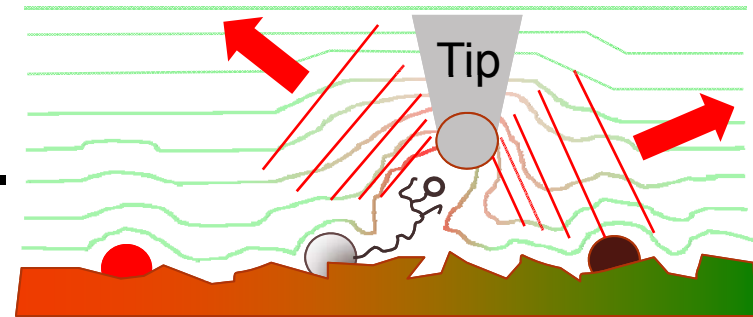


Tip enhanced Raman spectroscopy enhances Raman scattering.

Goals



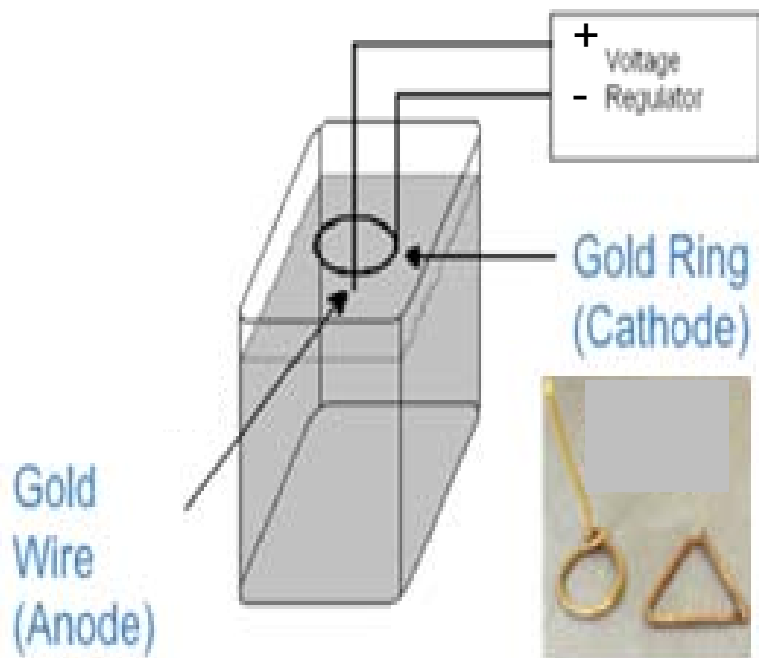
vs.



Tip Enhancement Allows Sub- λ details to propagate

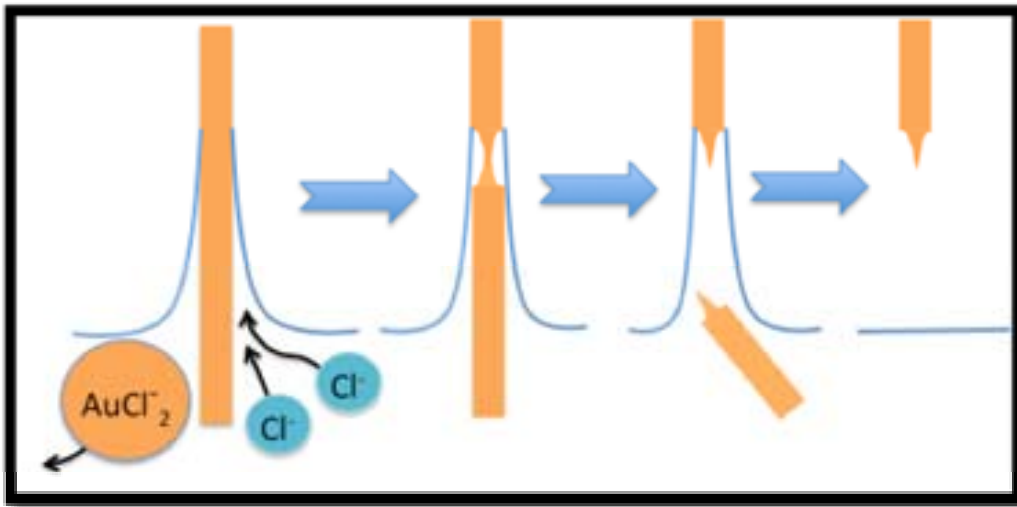
- Metal tip is the main reason for field enhancement.
- Quality of tips is of importance, the sharper the tip the better the enhancement.
- Preparation and Characterization of metal tips to be used in Tip-enhanced Raman Spectroscopy.

Electrochemical Etching Setup for Gold Tips

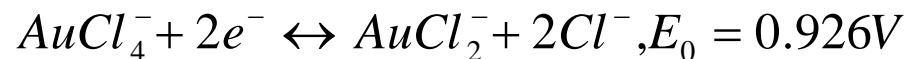
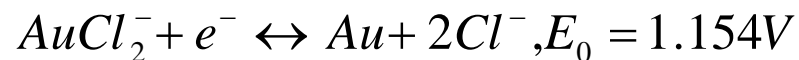
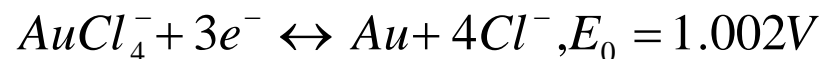


- Electrolyte composed of 1:1 HCl and Ethanol by volume.
- The gold ring and wire are suspended from hooks which are in turn connected to a voltage regulator.
- The anode is connected to the (+). The cathode is connected to the (-).

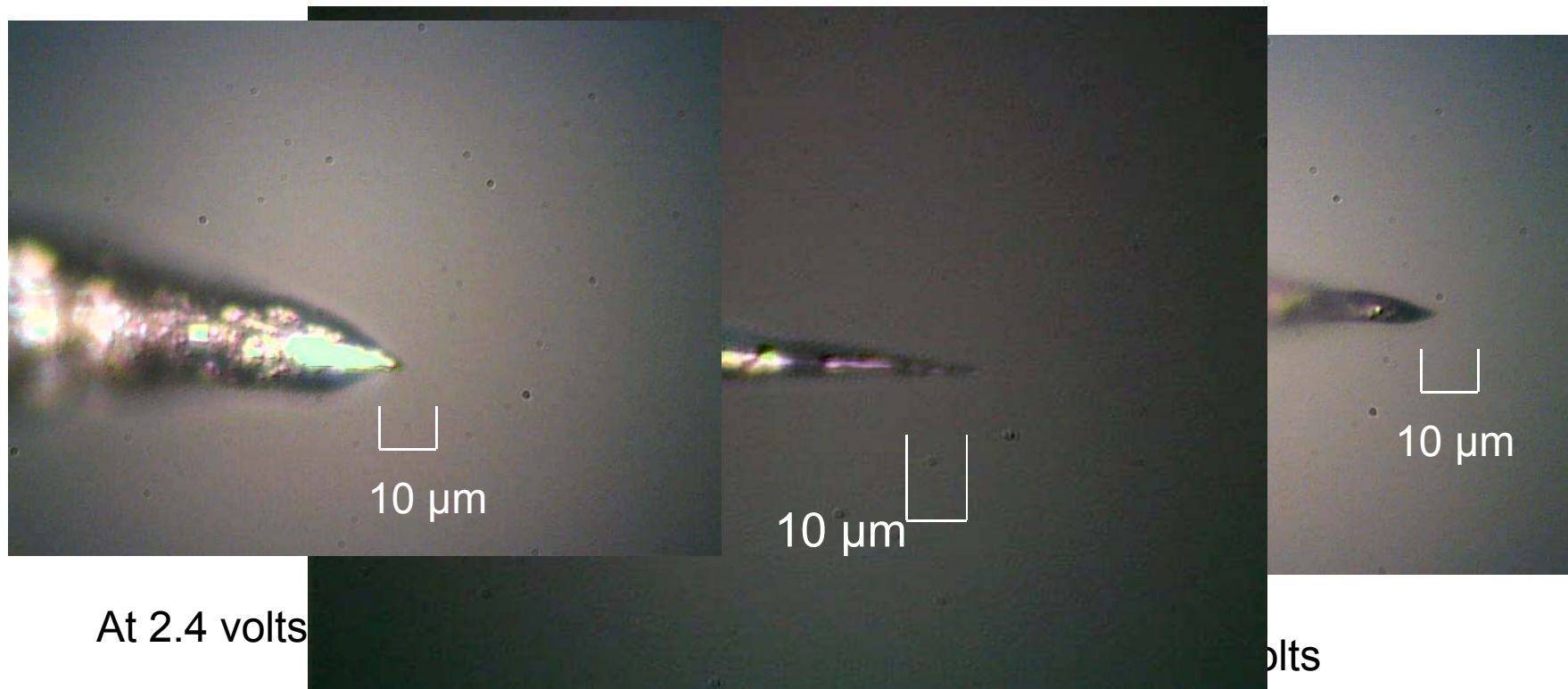
The Etching Process



Reactions Occurring:

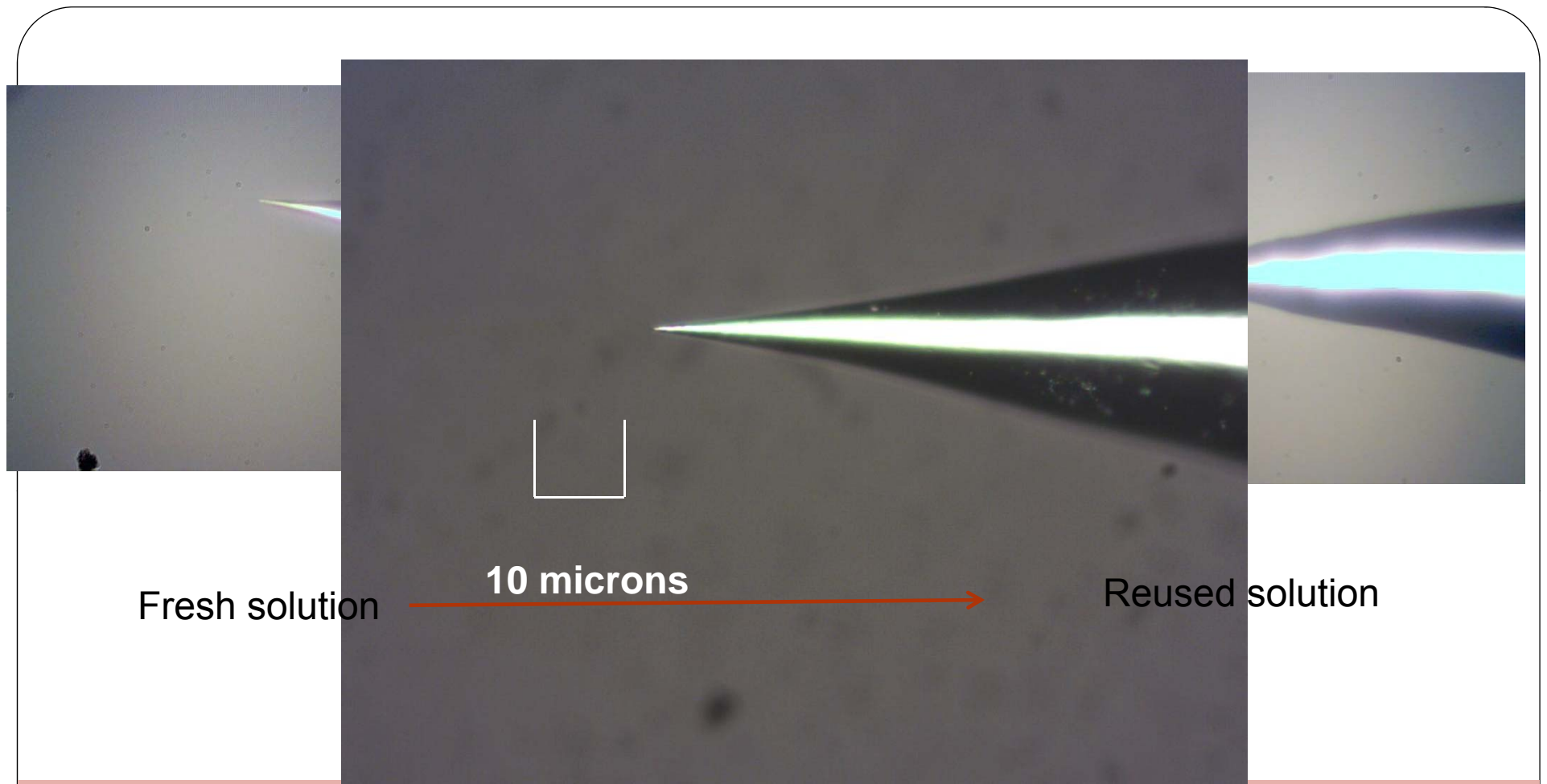


- Chloride ions react with the gold wire producing $AuCl_2^-$ in solution.
- The Cl^- ions keep trying to react with the gold in the wire.
- Voltage regulator stops the etching process.



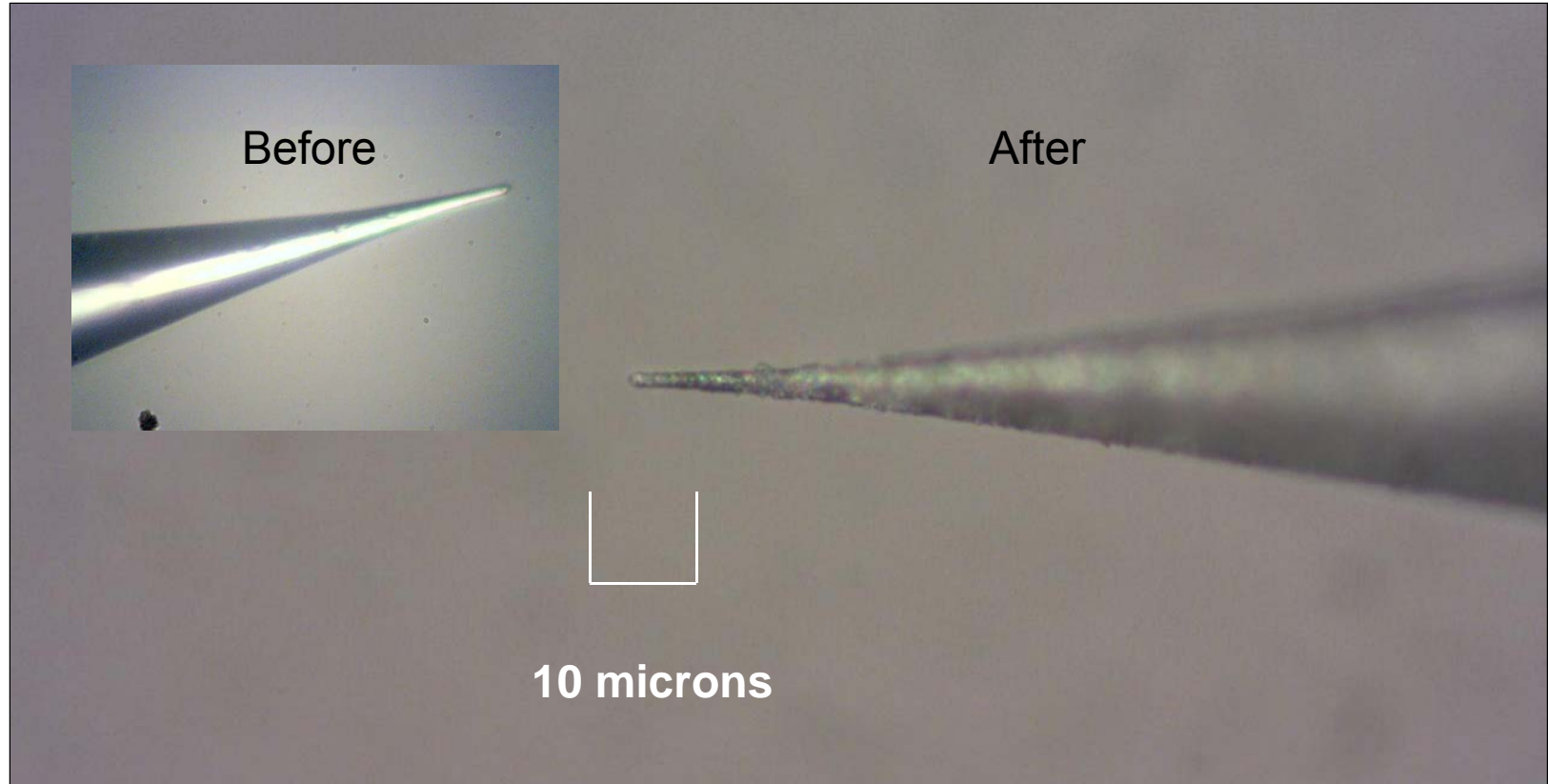
Gold tip etching

- Preferred voltage is 2.4-2.5v for .250 mm wire in HCl/Ethanol solution.
- After experimenting with new wire(0.04mm) realized smaller wire requires smaller voltage.



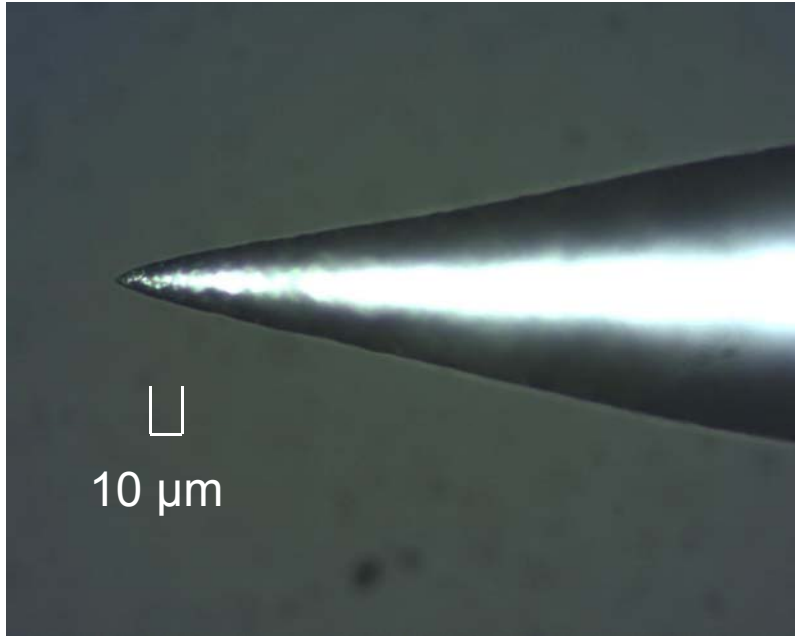
Tungsten Etching

- Preferred voltage 7.5v in 3M KOH solution
- Concluded tip quality becomes worse after subsequent reuse of solution.

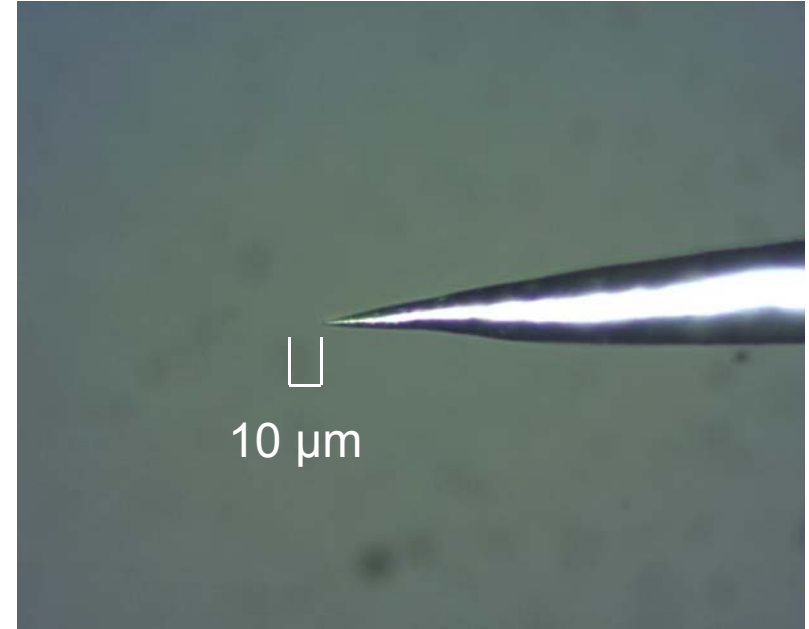


Tungsten silver plating

- Plating solution composed of AgNO_3 , KI and H_2SO_4
- Voltage of 3.0 v
- Reaction time 20-30 seconds



First trial silver etching



New solution etching

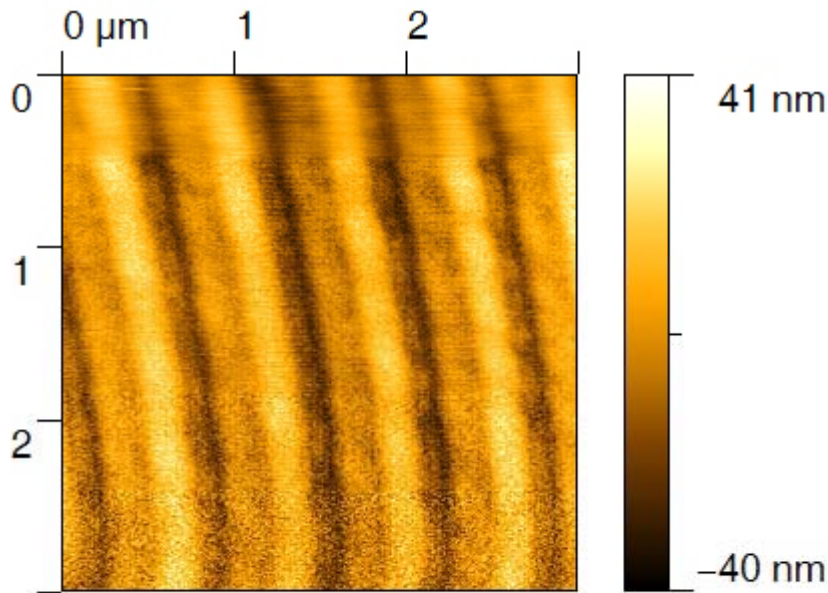
Silver Etching

- **First trial electrolyte:** ethanol, ammonia, and Hydrogen peroxide, 20-24 v
- Resulted in dull tips
- **New Solution:** Ammonia /Ethanol 5:1 by volume
- Voltage; 10.5v

Summary

- Several different tips were made in different solutions and voltages.
- **Gold**; smaller wire requires smaller voltage.
- **Tungsten**; reuse of solution produces less fine tips over time.
- **Silver**; produced successful tips with ammonia ethanol electrolyte.

Achievements



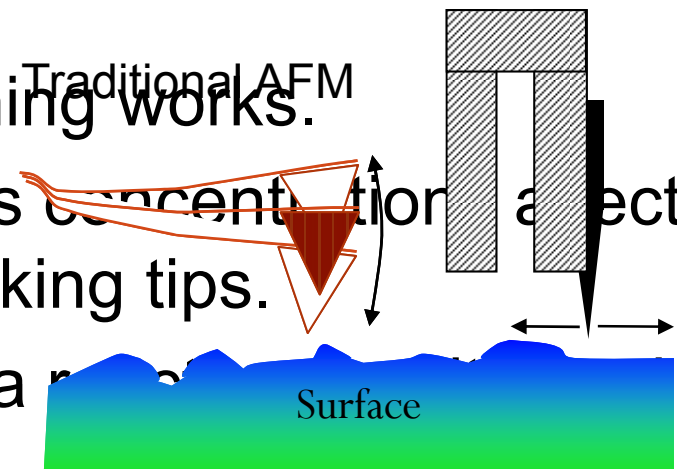
Improvement in Raman

Tuning fork AFM; our approach

Traditional AFM

it's concentration affect
making tips.

Surface



- Achieved a successful silver etching procedure.
- Used tungsten tips in AFM (atomic force microscopy) calibration.

AFM scan with tungsten tip

Future Plans

- Improving silver etching
- Using gold and/or silver for actual TERS
- Seeing if silver plating of Tungsten will in fact produce successful scans.

Acknowledgments

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- P.I Mike Gordon
- Mentor Isaac Riisness
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