

# REDUCTION POTENTIAL OF RED LIGHT-EMITTING SI NPS

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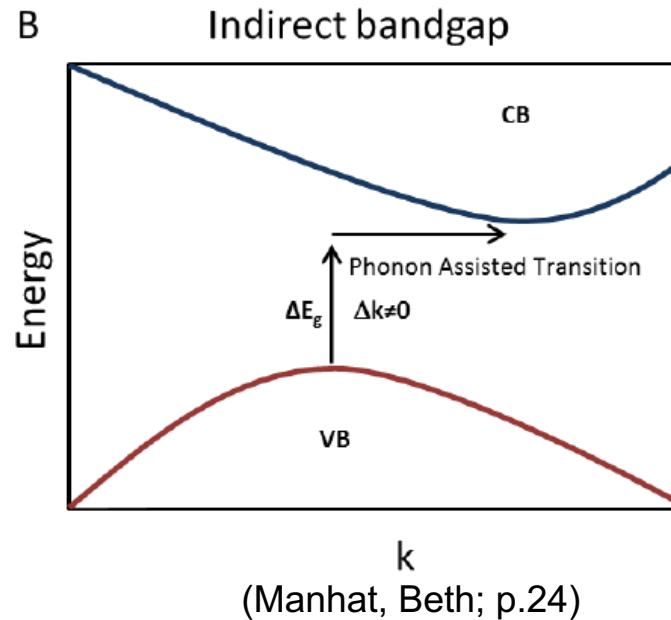
Summer 2013

# Overview

- General Background
- Objective & Project Background
- Methods & Experimentation
- Results
- Future Work

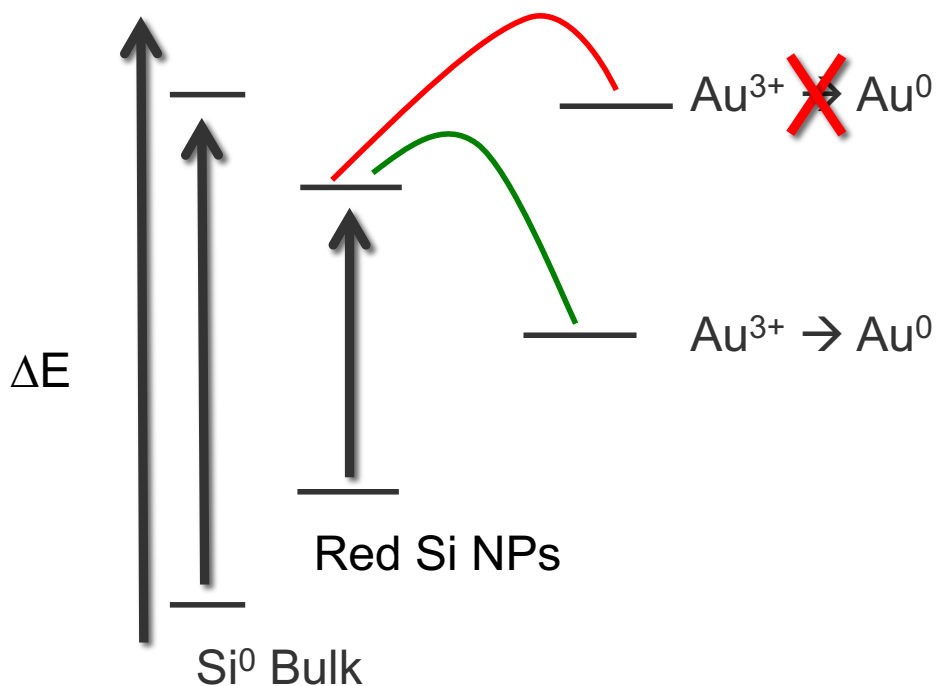
# Background

- Bulk Si:
  - Cheap
  - Abundant
  - Has an indirect band gap
- Indirect bandgap



# Project objectives

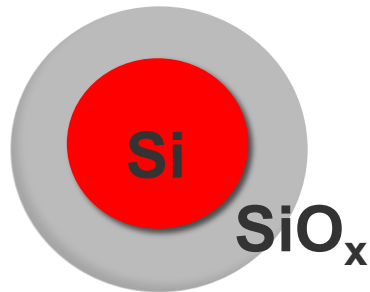
- Use red fluorescent Si NPs to reduce metals
- Find where conduction and valence bands lie in Si NPs



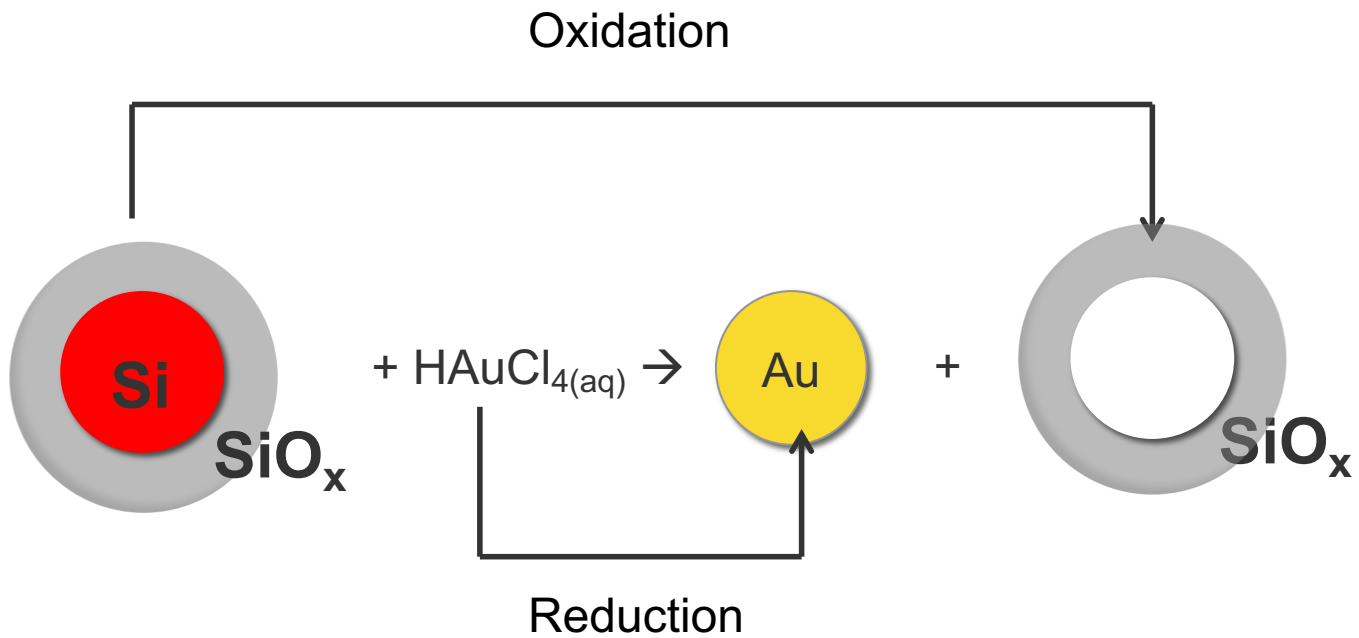
# Project Background

- Work previously done
- Particles synthesized have Si core surrounded by  $\text{SiO}_x$  shell.

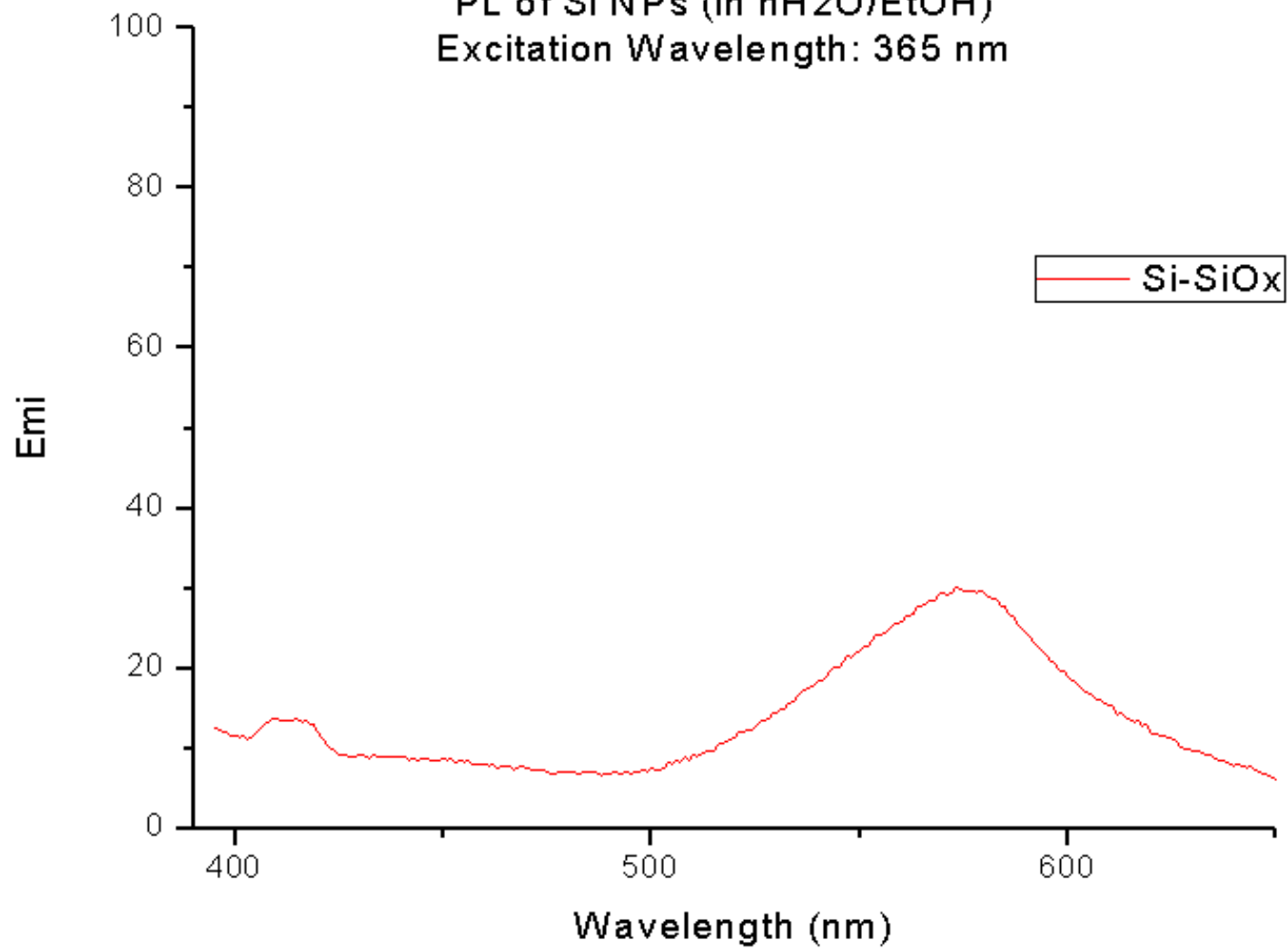
Proposed Model:



# Reduction Reaction



PL of Si NPs (in nH<sub>2</sub>O/EtOH)  
Excitation Wavelength: 365 nm



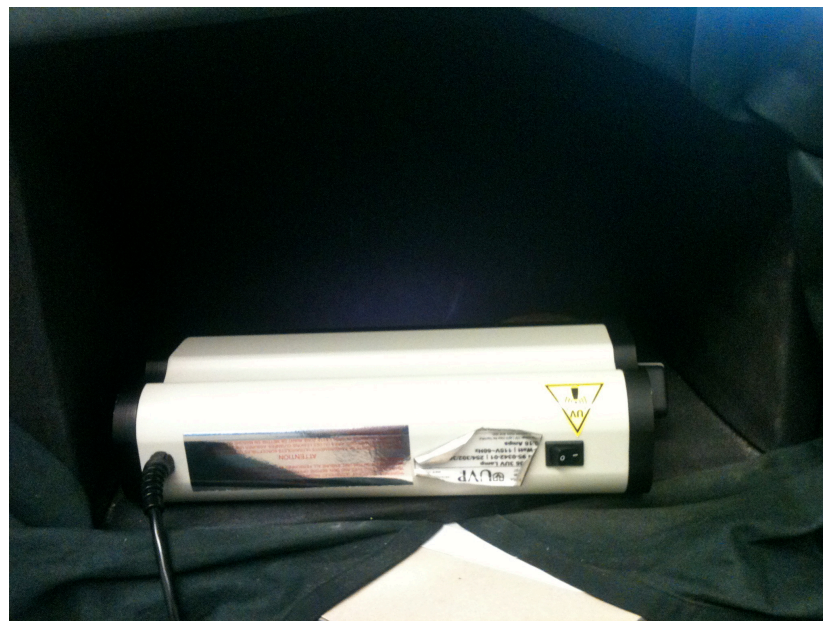
# Methods

- Photoluminescence (PL) Spectroscopy
- UV-Visible (UV-Vis) Spectroscopy
- X-Ray Diffraction (XRD)
- Transmission Electron Microscopy (TEM)
- Energy Dispersive X-Ray (EDX)



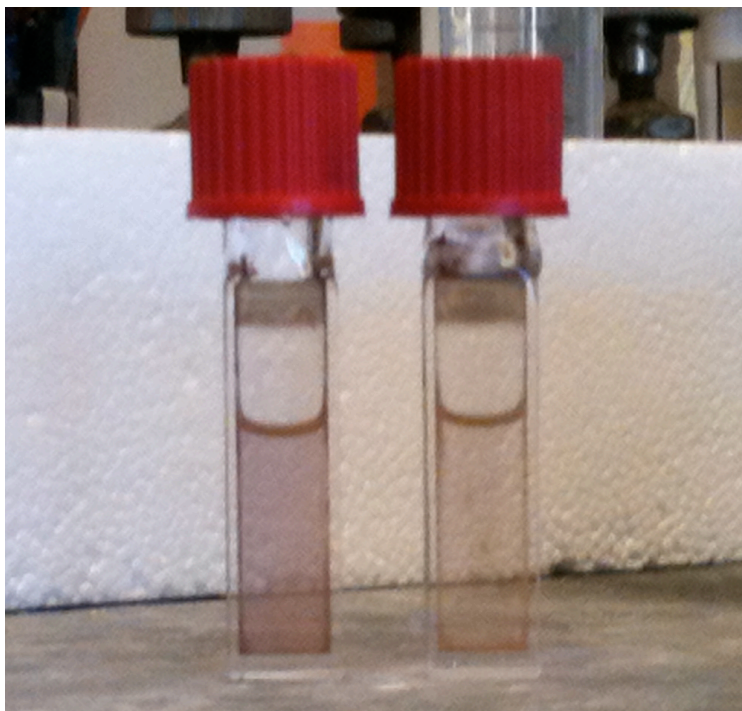
# Experimental Setup

- Light Reduction Chamber
  - UV Lamp (365 nm)
- Irradiate sample for 1 hour:
  - 2min x5
  - 5min x4
  - 15min x2
- UV-Vis and PL spectroscopy between each interval

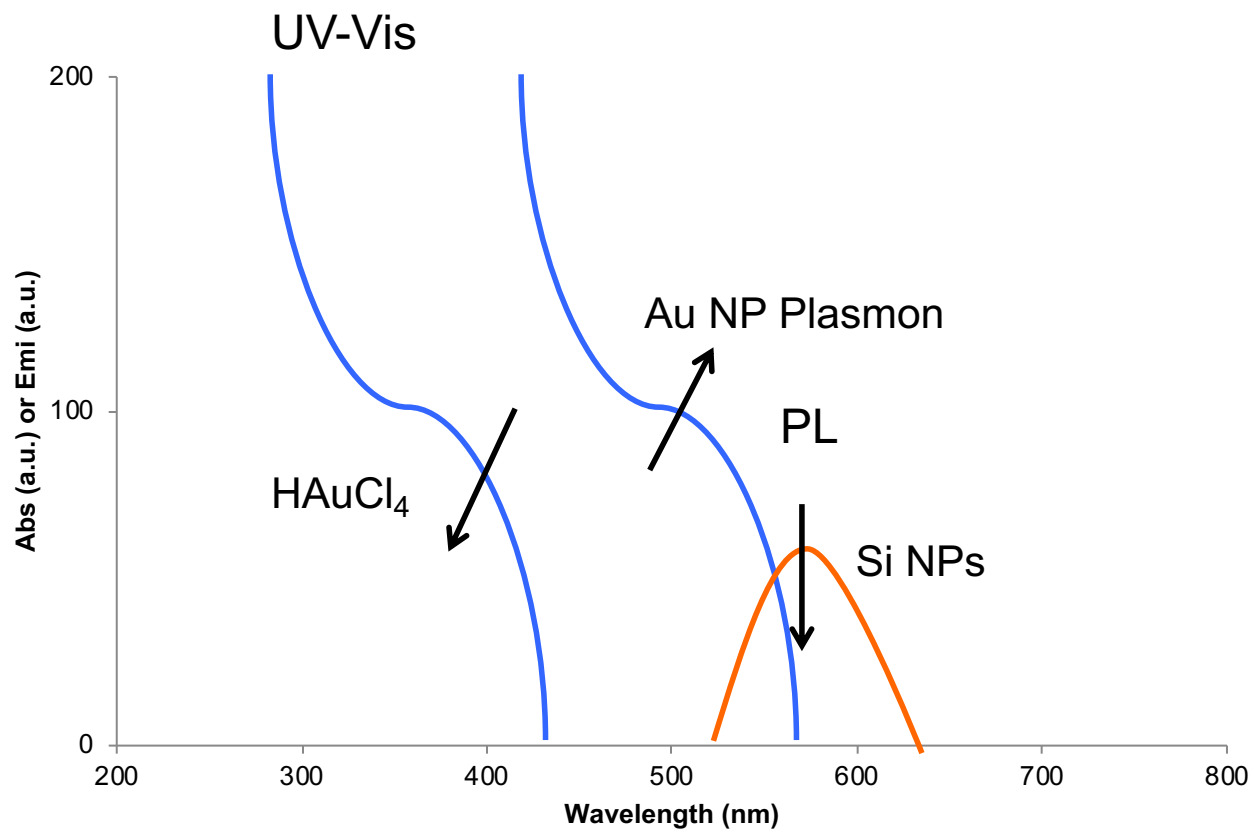


# Gold

10mM (left) and 15mM (right)  
Solutions  
after being irradiated

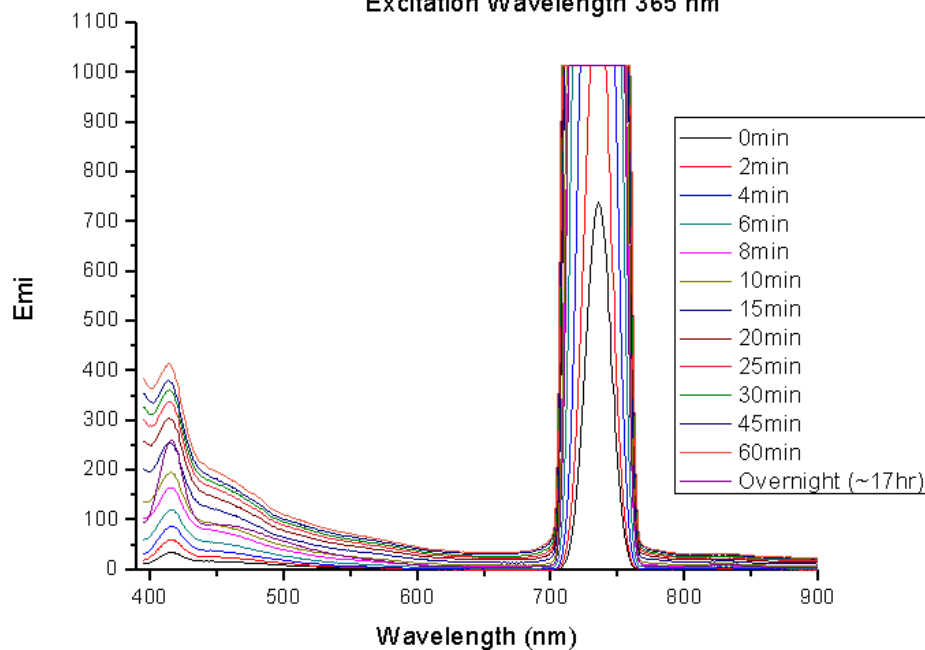


- Chloroauric Acid + Red Si NPs
  - 0.2 mL  $\text{HAuCl}_4$  + 0.8 mL Si NP
- Trials using:
  - Si NPs in ethanol and nanopure water
  - Si NPs in ONLY nanopure water or ONLY ethanol
- With and without intense UV irradiation

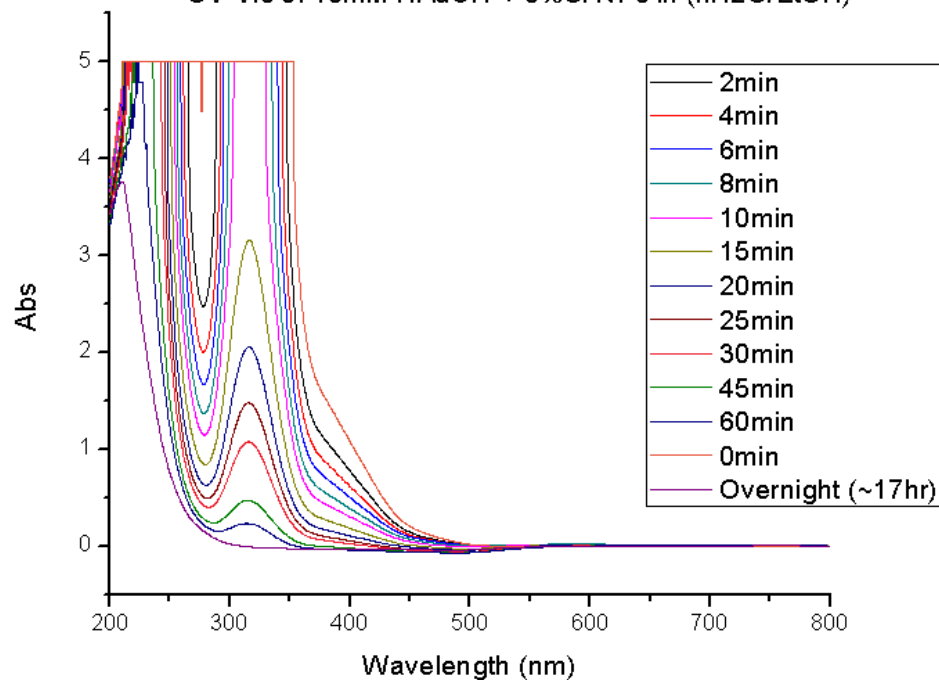


# Gold Results

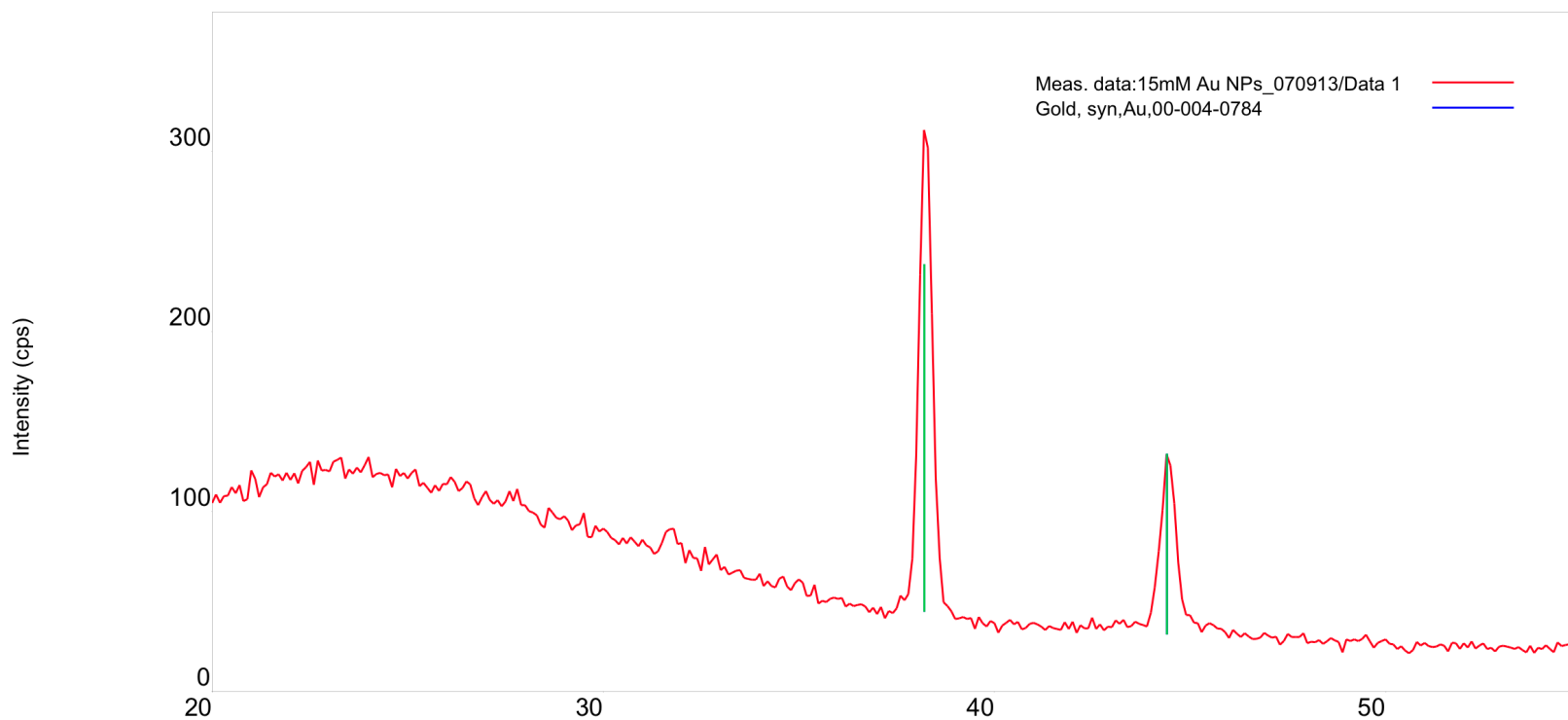
PL of 15mMHAuCl<sub>4</sub> + 5% SiNPs (in nH<sub>2</sub>O/EtOH)  
Excitation Wavelength 365 nm



UV-Vis of 15mM HAuCl<sub>4</sub> + 5%Si NPs in (nH<sub>2</sub>O/EtOH)

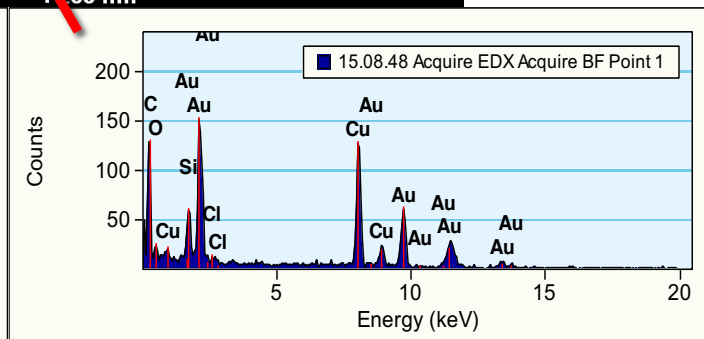
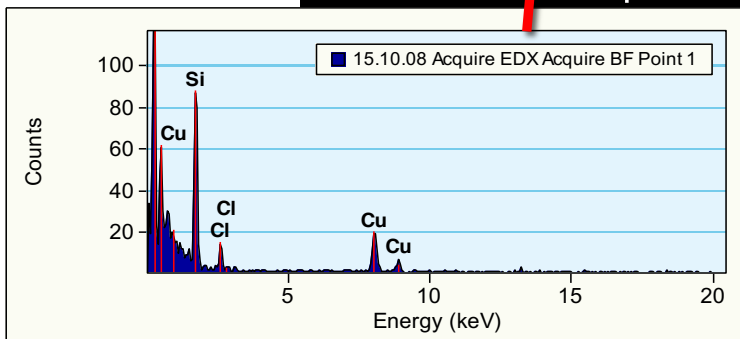
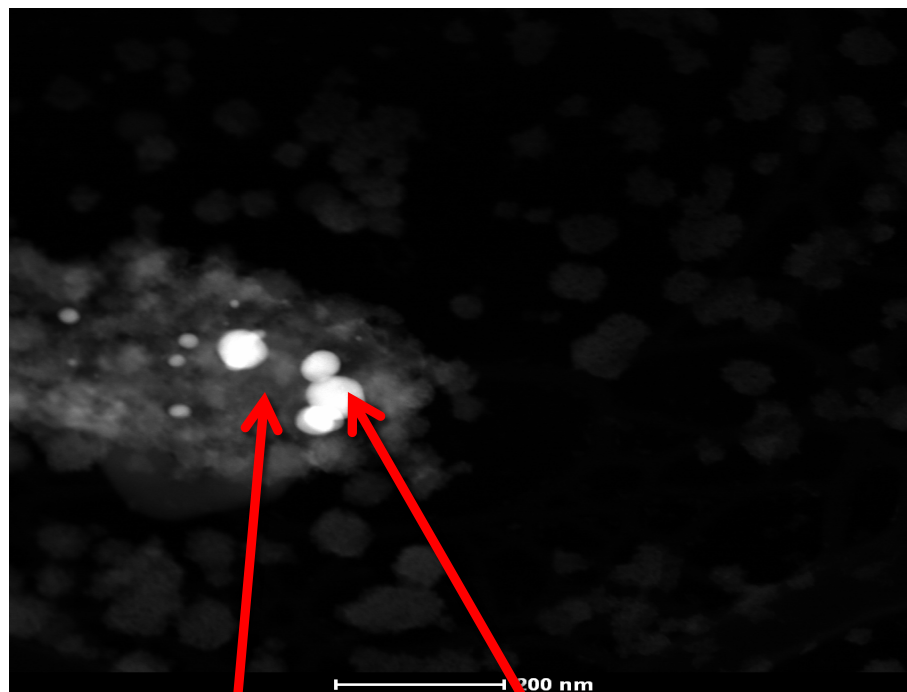


# X-Ray Diffraction



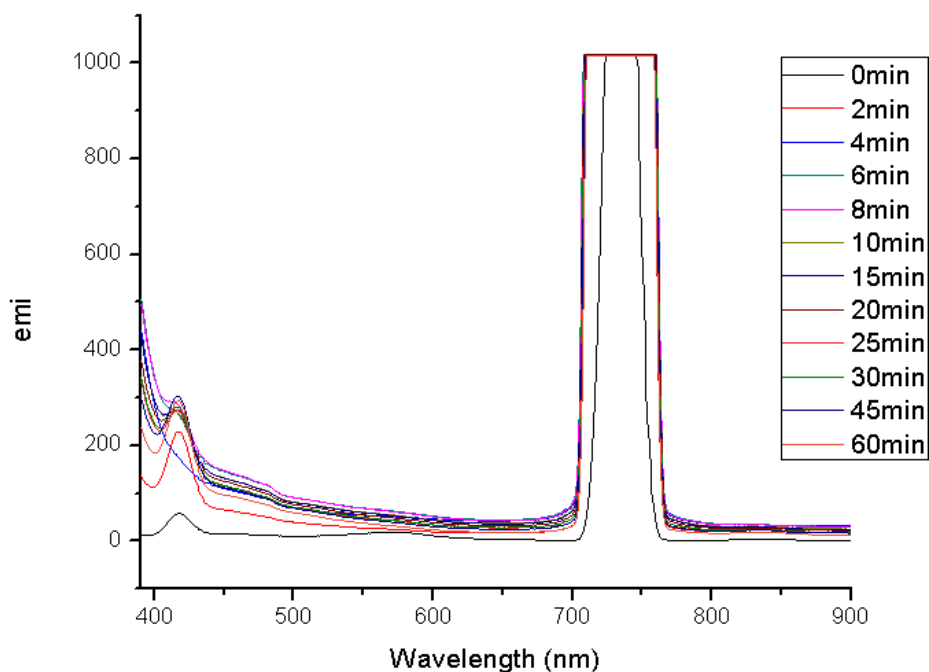
# TEM & EDX

TEM Image from sample using 15mM HAuCl<sub>4</sub> + 5% Si NPs (in EtOH/nH<sub>2</sub>O)

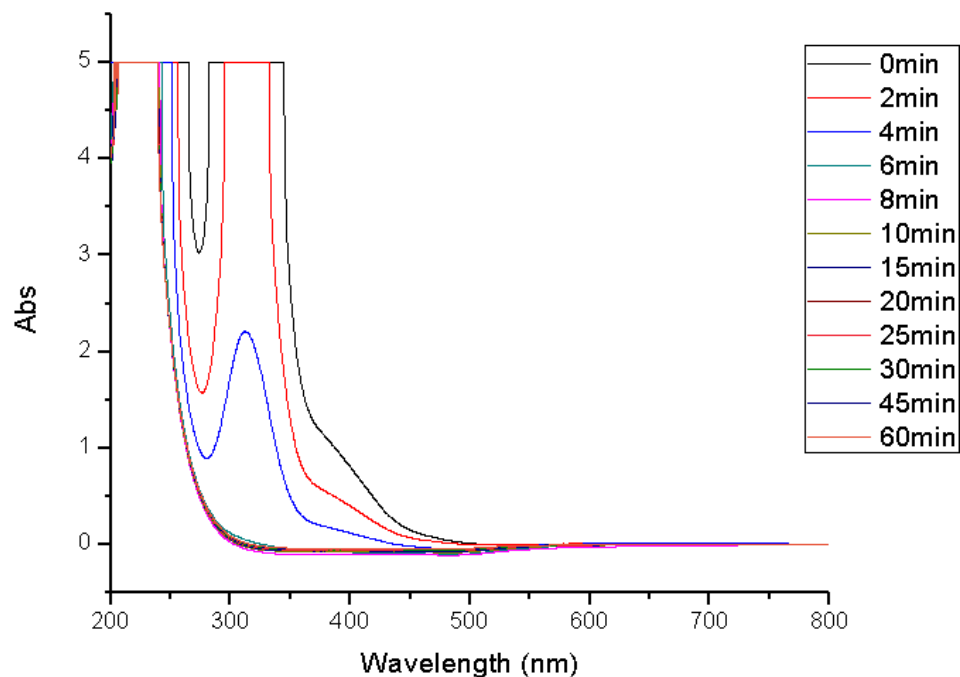


# Using Nanopure Water

PL of 15mM H<sub>AuCl</sub>4 + Si NPs (in nH<sub>2</sub>O)  
Excitation Wavelength

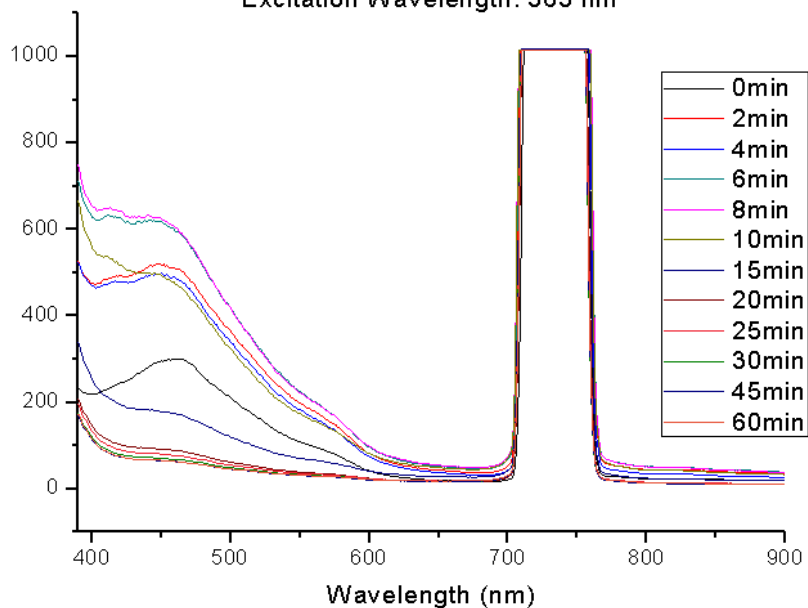


UV-Vis of 15mM H<sub>AuCl</sub>4 + Si NPs (in nH<sub>2</sub>O)

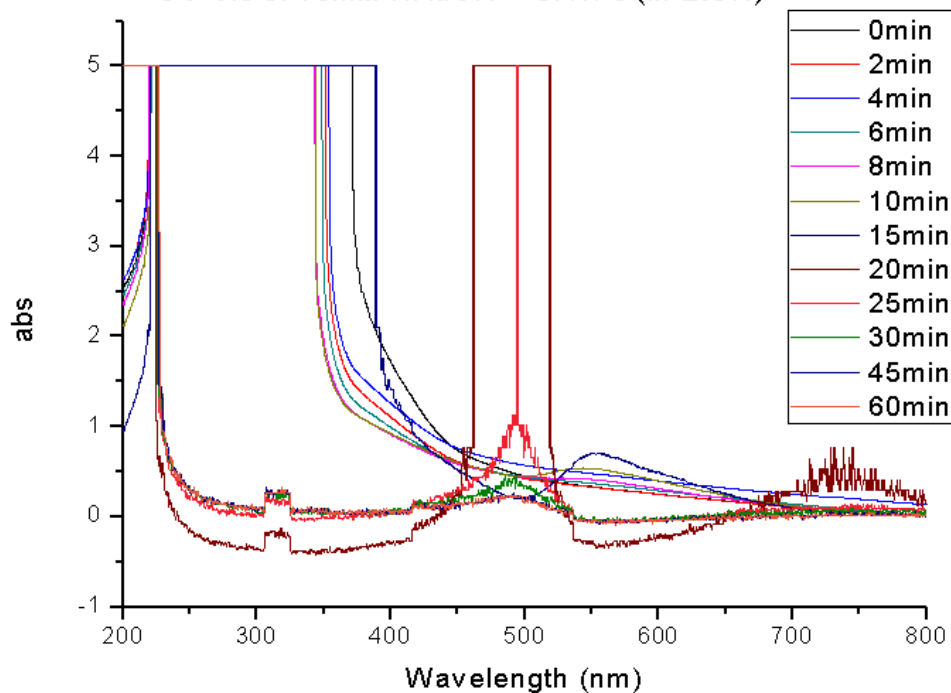


# Using Ethanol

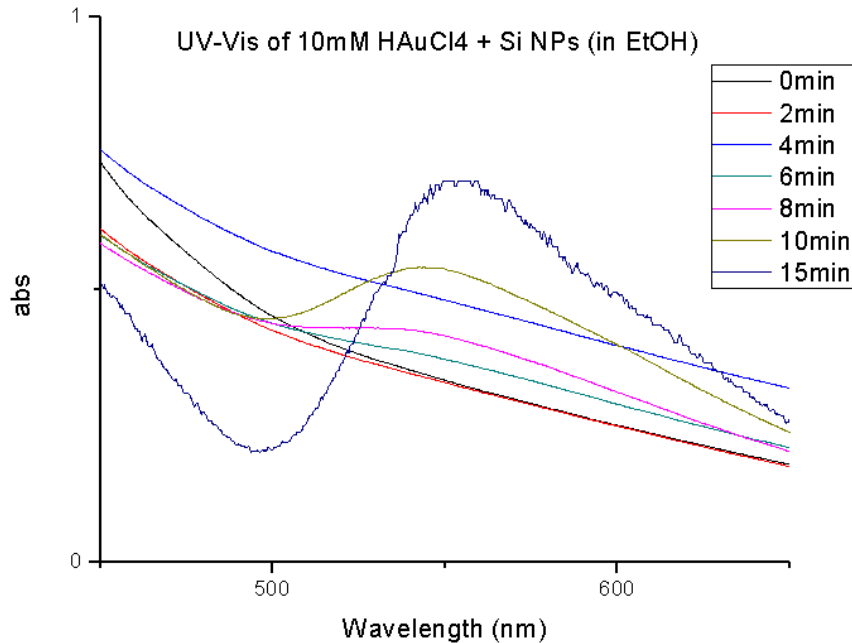
PL of 10mM HAuCl<sub>4</sub> + Si NPs (in EtOH)  
Excitation Wavelength: 365 nm



UV-Vis of 10mM HAuCl<sub>4</sub> + Si NPs (in EtOH)



UV-Vis of 10mM HAuCl<sub>4</sub> + Si NPs (in EtOH)





# What next?

- Different surfactants/capping agents to control NP size.
- Further experimentation with silver.
- Reduce organic molecules.
- Remove  $\text{SiO}_x$  shell

# Acknowledgments

- Dr. Andrea Goforth
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- Center for Electron Microscopy & Nanofabrication



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Questions?

# References

- Manhat, Beth. “Fluorescent Semiconductor Nanomaterials for Biological Applications.” Powerpoint Presentation. Portland State University, Portland, OR, 30 Oct 2012.