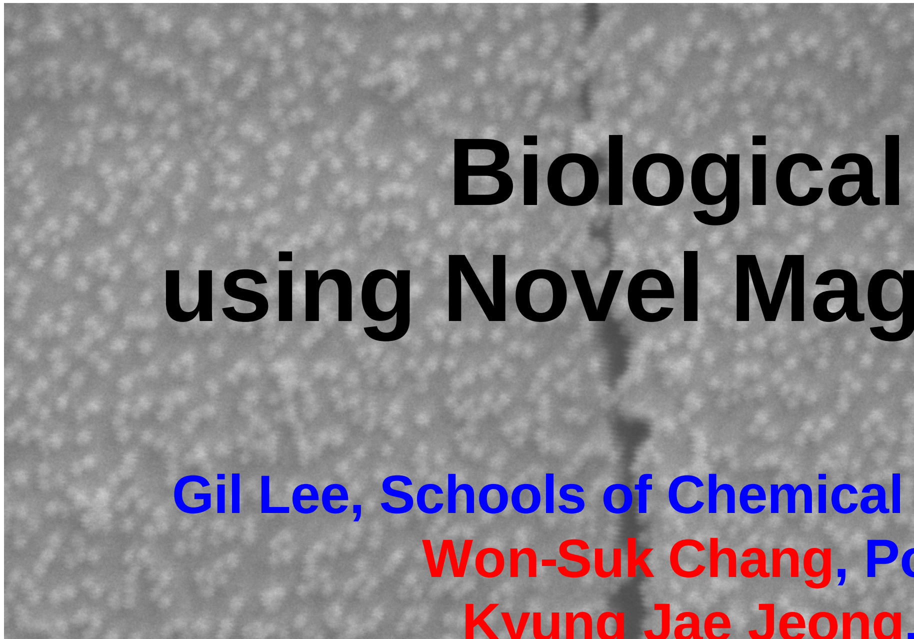

Biological Sensing using Novel Magnetic Materials

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Dong Myung Oh, Ph.D. Candidate, Physics
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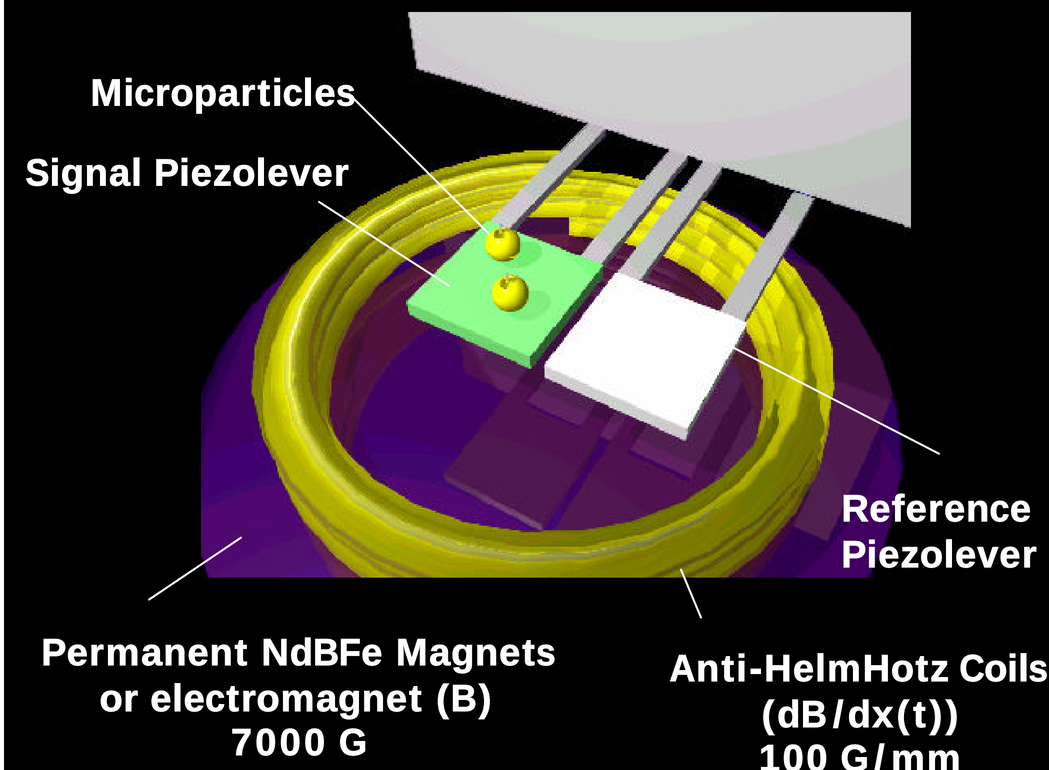
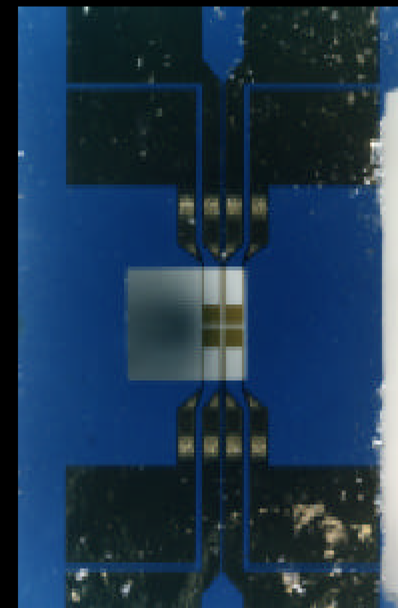
PURDUE UNIVERSITY

Background

Force Amplified Biosensor (FABS)





Batch 1:
300 x 100 x 1 um
K = 0.0073 N/m
fr = 3.75 kHz
dR/R = 0.21 1/nm
sensitivity ~ 0.42 pN

D. Baselt, et al, *J.Vac. Sci.* 1996; D. Baselt, et al, *Proc. IEEE* 1997; D. Baselt, et al , Biosensor Bioelect 1998; G. Lee, et al, *Bioanalytical Chem.*, 2000.

Integrated Approach to Sensing with Nanonparticles

Area 1: Enhance Mass Transport - New Material

A new class of magnetic gold-iron nanoparticles has been created by Dr. W.S. Chang and Dong Myung Oh. These particles will allow the analyte to be efficiently collected and reacted with a surface.

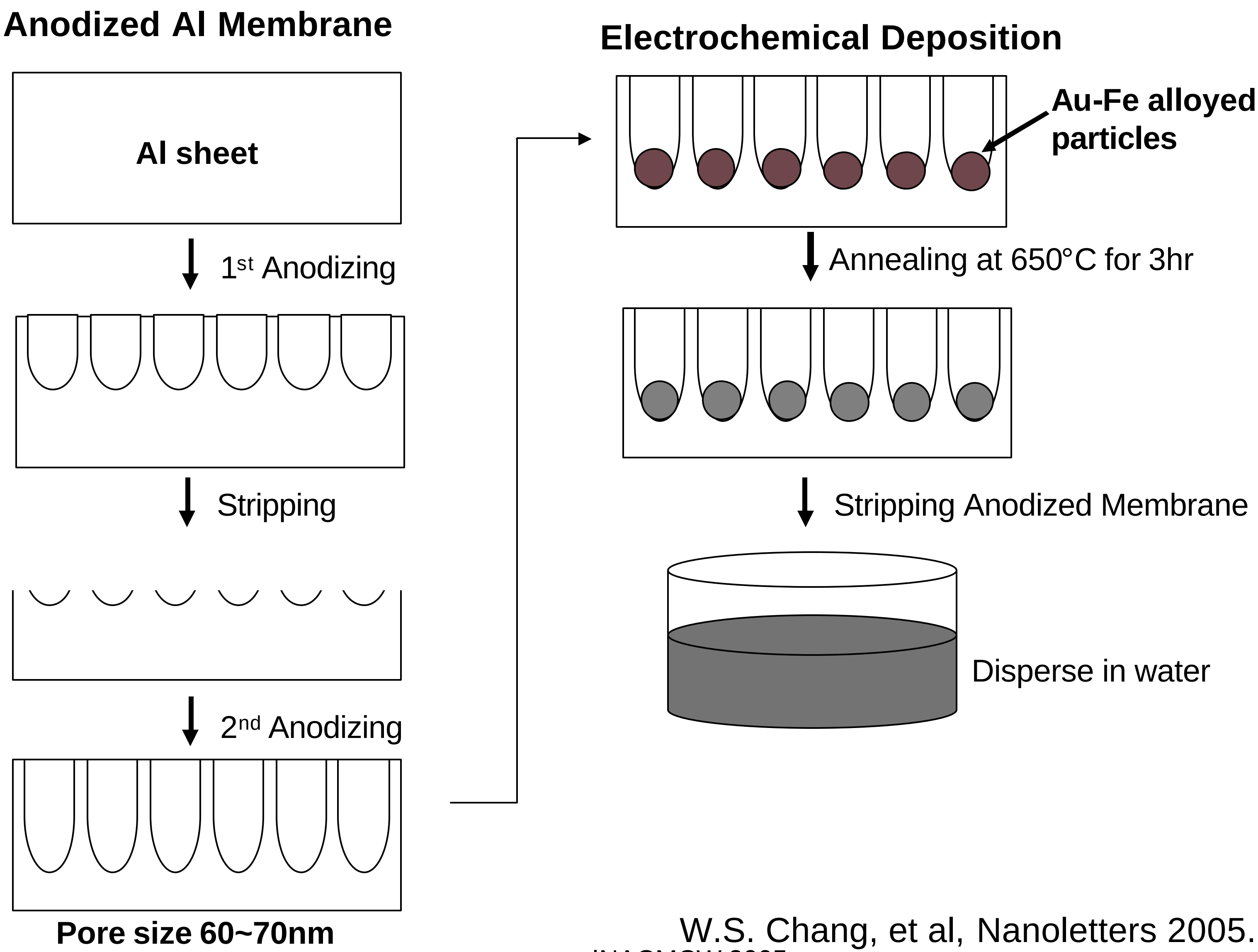
Area 2: Enhance Reaction Kinetics – Surface Chemistries

The reaction kinetics of nanoparticles with surfaces has been studied by K. Jeong and A. Fung. Optimized surface chemistries will allow us to quickly and efficiently capture nanoparticles on surfaces using specific molecular reactions.

Area 3: Enhance Signal - Surface Chemistries and Microfabrication

The conductivity of the double-stranded DNA and DNA coated nanoparticles assembled on break junctions have been studied by A. **Mahapatro** ***and S.*** **Bhattacharya.**

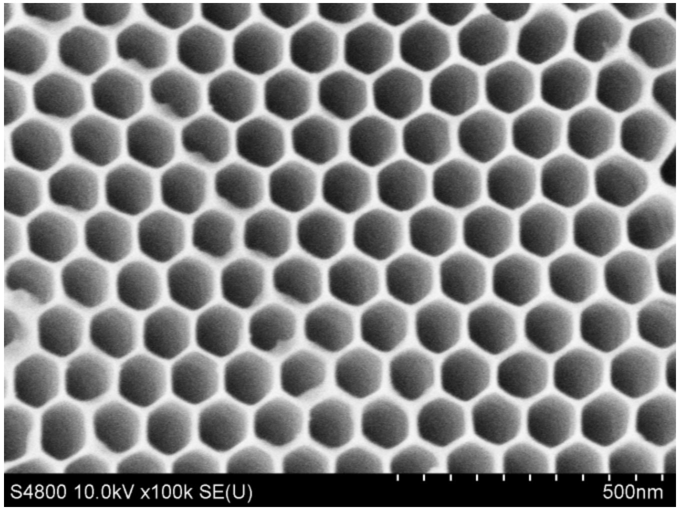
Area 1 - Gold-Iron Alloy Nanoparticles



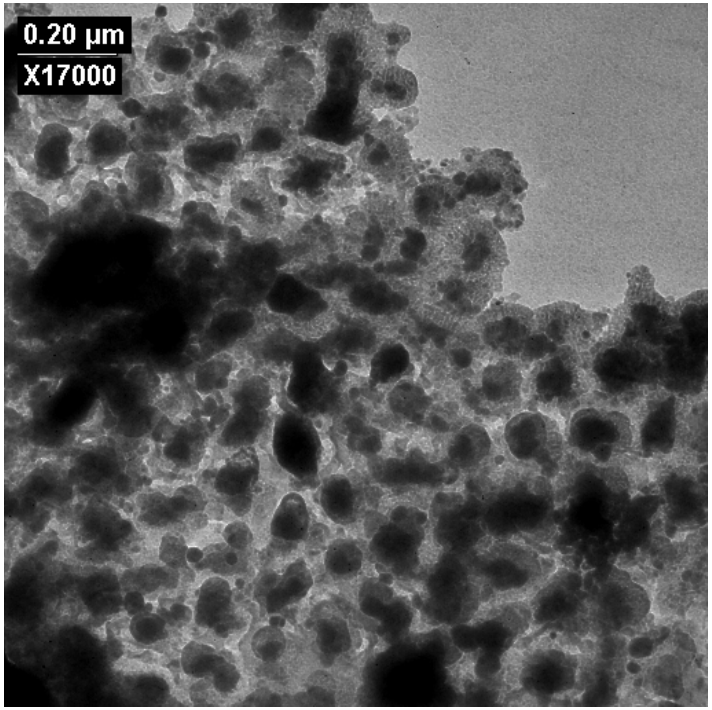
W.S. Chang, et al, Nanoletters 2005.

Synthesis Results

Mesoporous Alumina Membrane
Fabricated by Anodic Oxidation

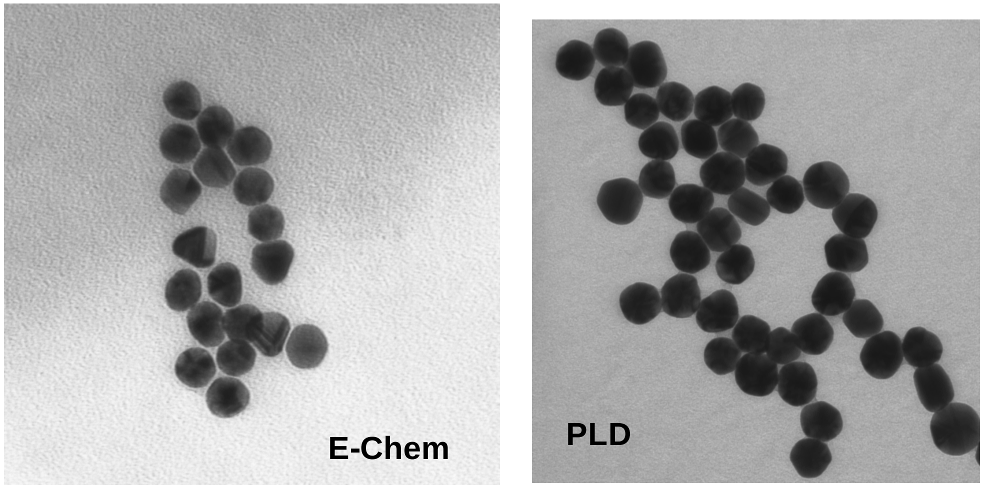


Partially Released Au-Fe Alloy
Particles

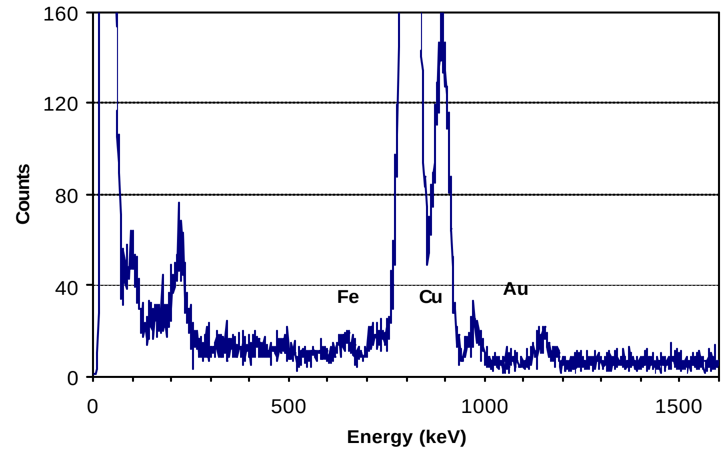


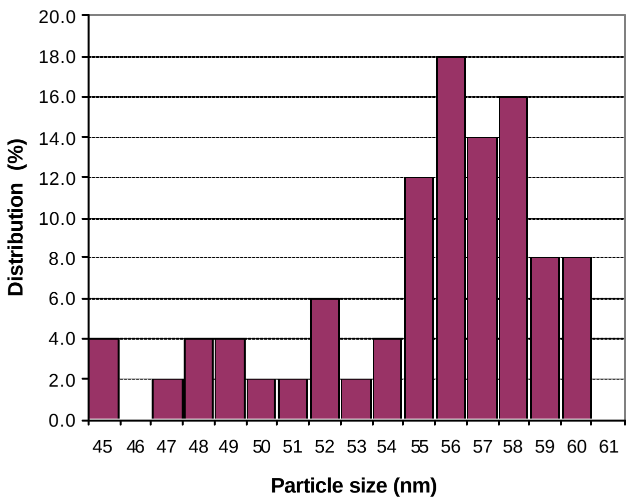
Characterization

TEM Images of Au-Fe Alloy Particles

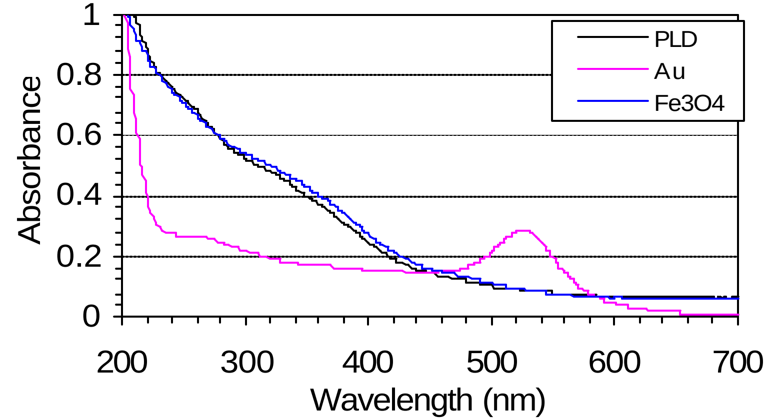


EDS (25: 75 Fe:Au)



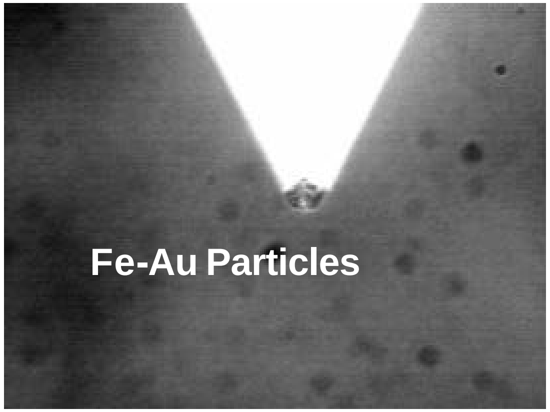


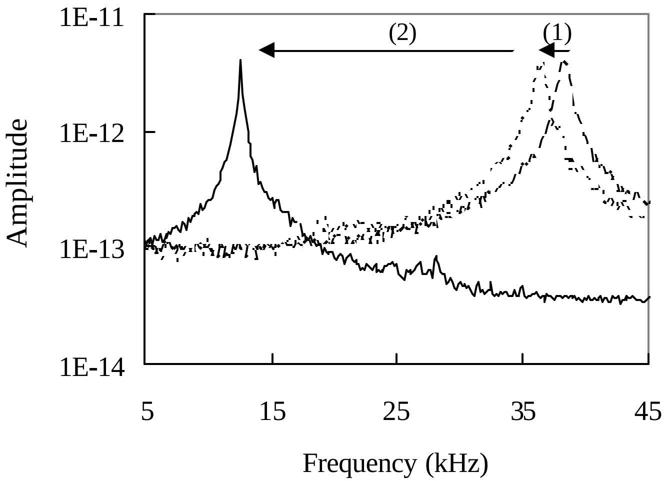
Optical Spectra

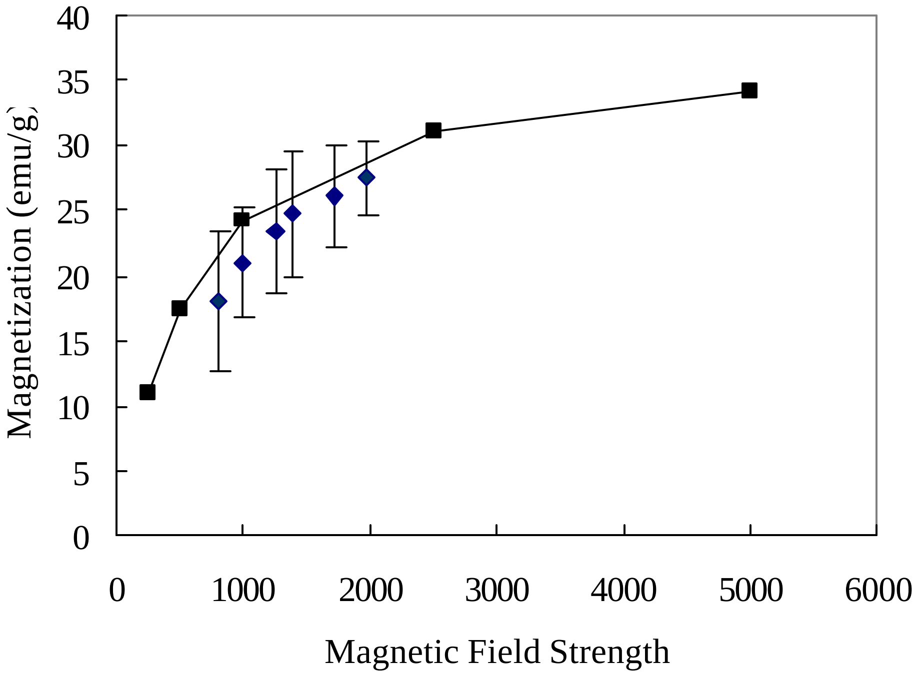


Magnetic Properties

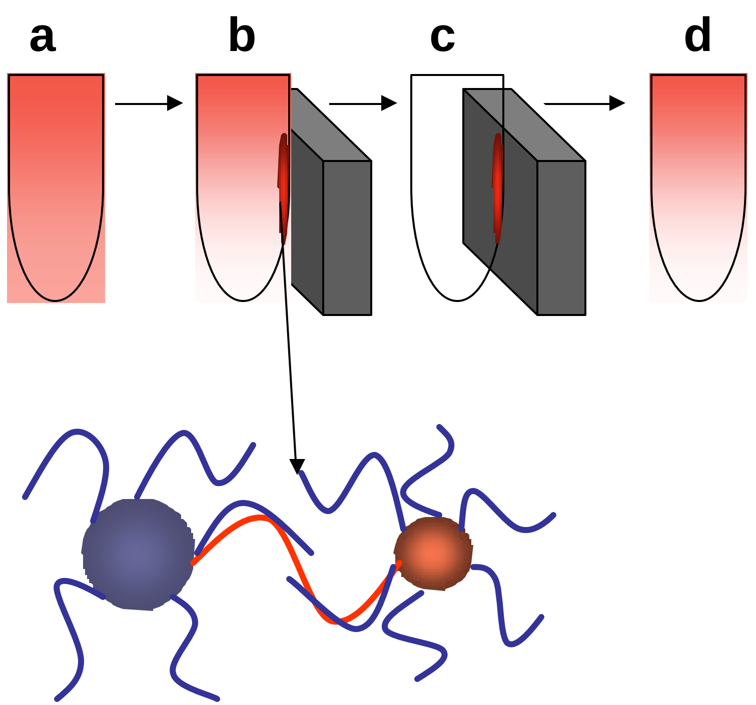
Force Magnetometry

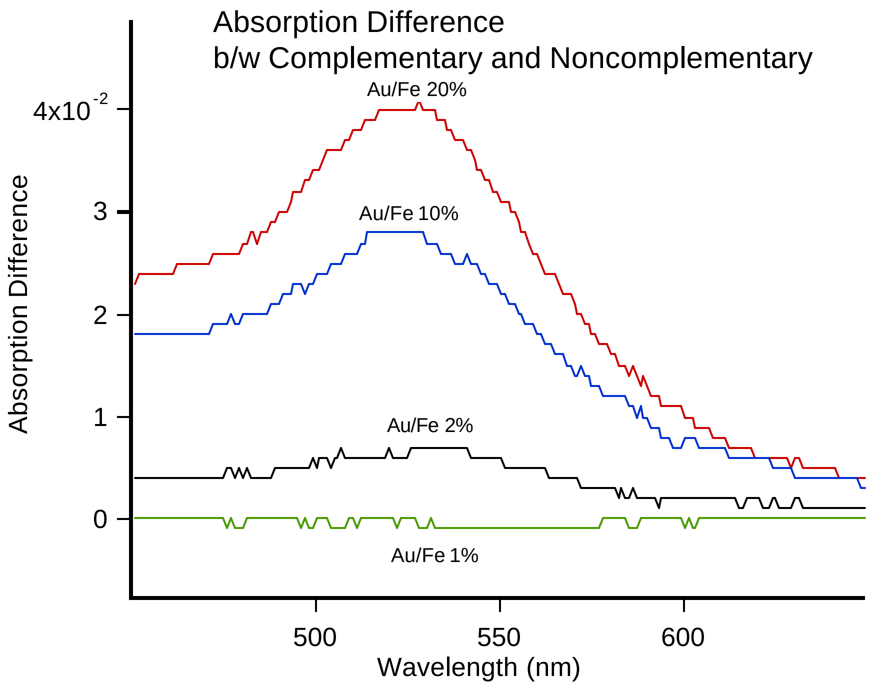






Demonstration of DNA Sensing with Au-Fe Nanoparticles



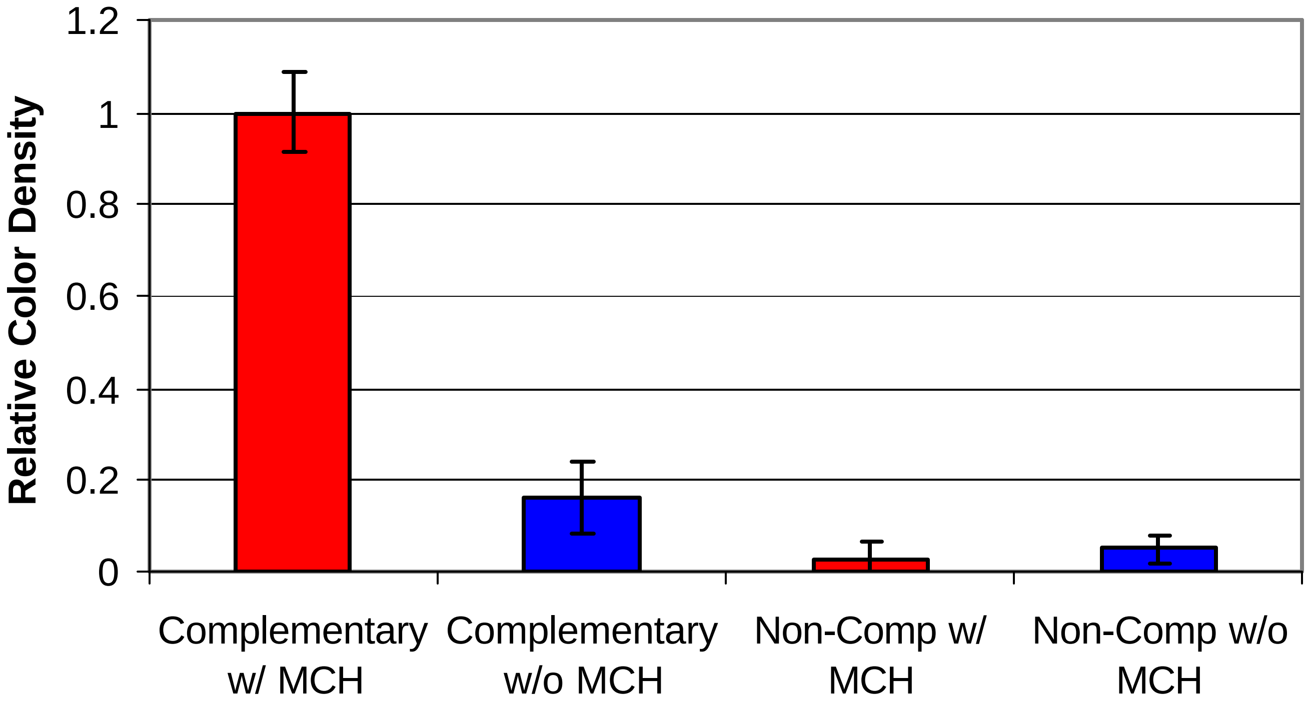


a. Au/Fe + Au + target DNA

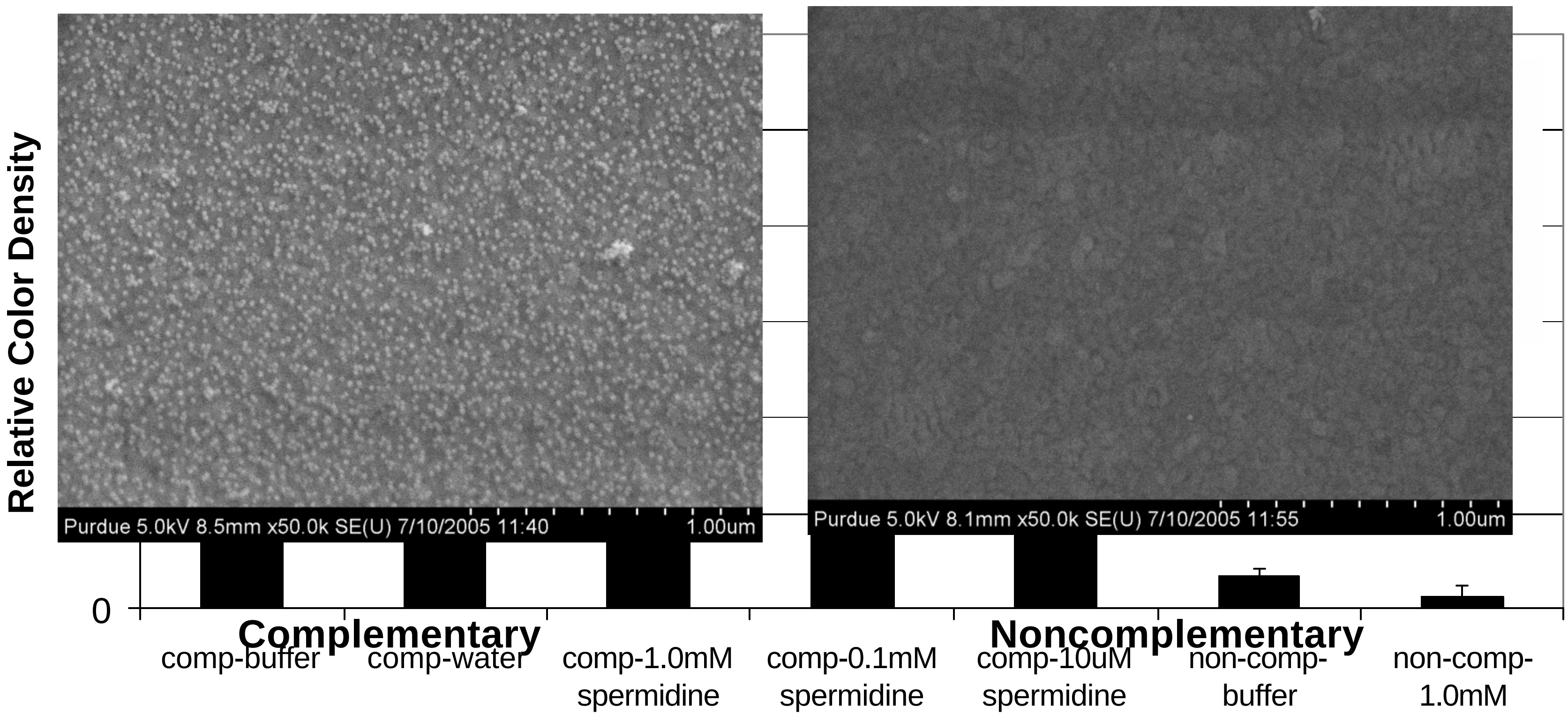
b. Separate and c. remove Au

d. Redispersion of Au/Fe-Au assembly in water and separation of Au/Fe

Area 2 - Forces Controlling Assembly of Nanoparticles on Surfaces



Immobilization of Gold-DNA Nanoparticles on Surfaces with Polycations



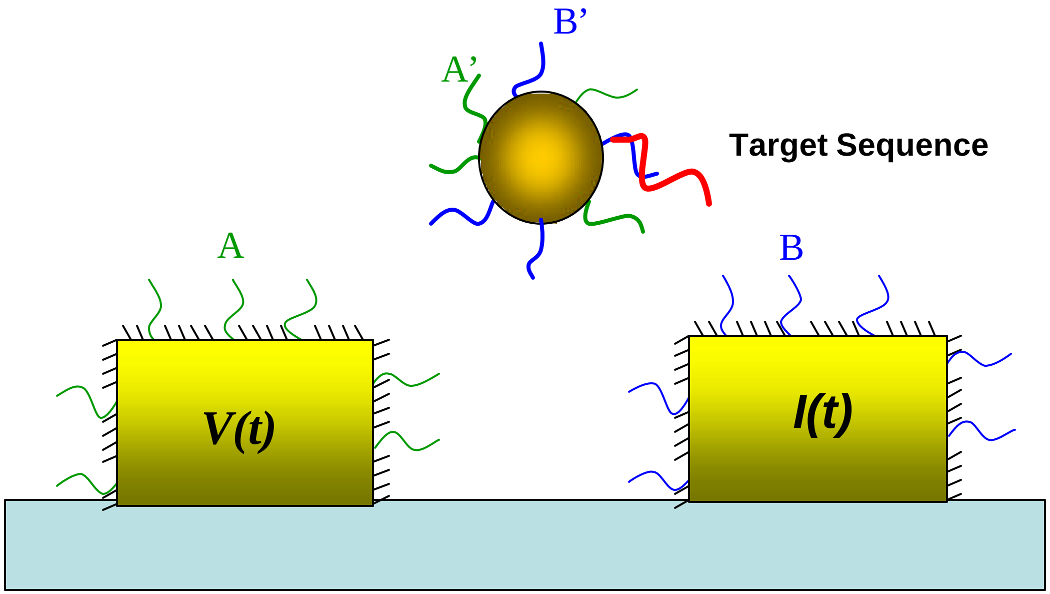
Area 3 - Magnetic Nanoparticle Sensor Design

DNA Sensor

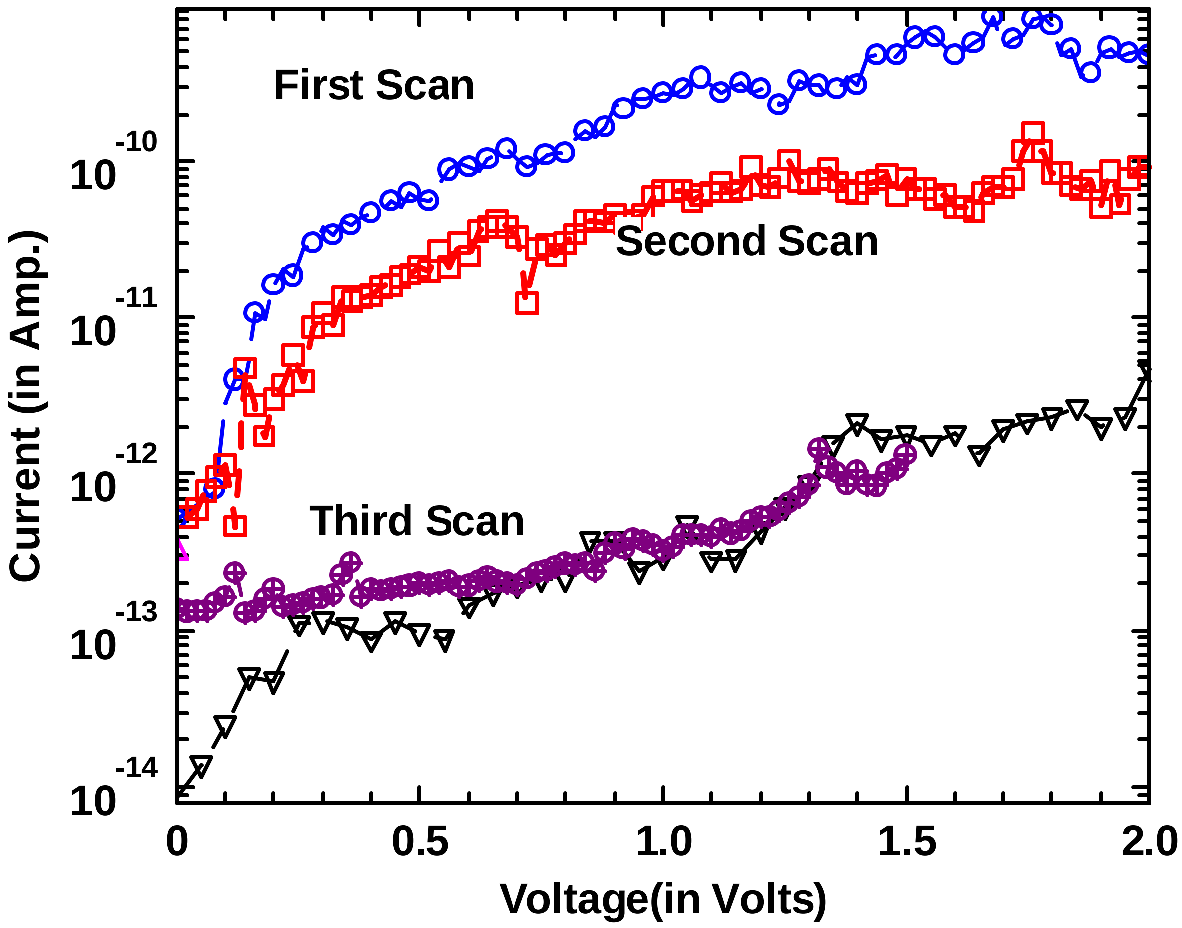
Hybridize the Fe-Au particles with the target

Apply a current in the interdigitated fingers to produce an magnetic field

Sense the presence of the particle by direct electrical measurement

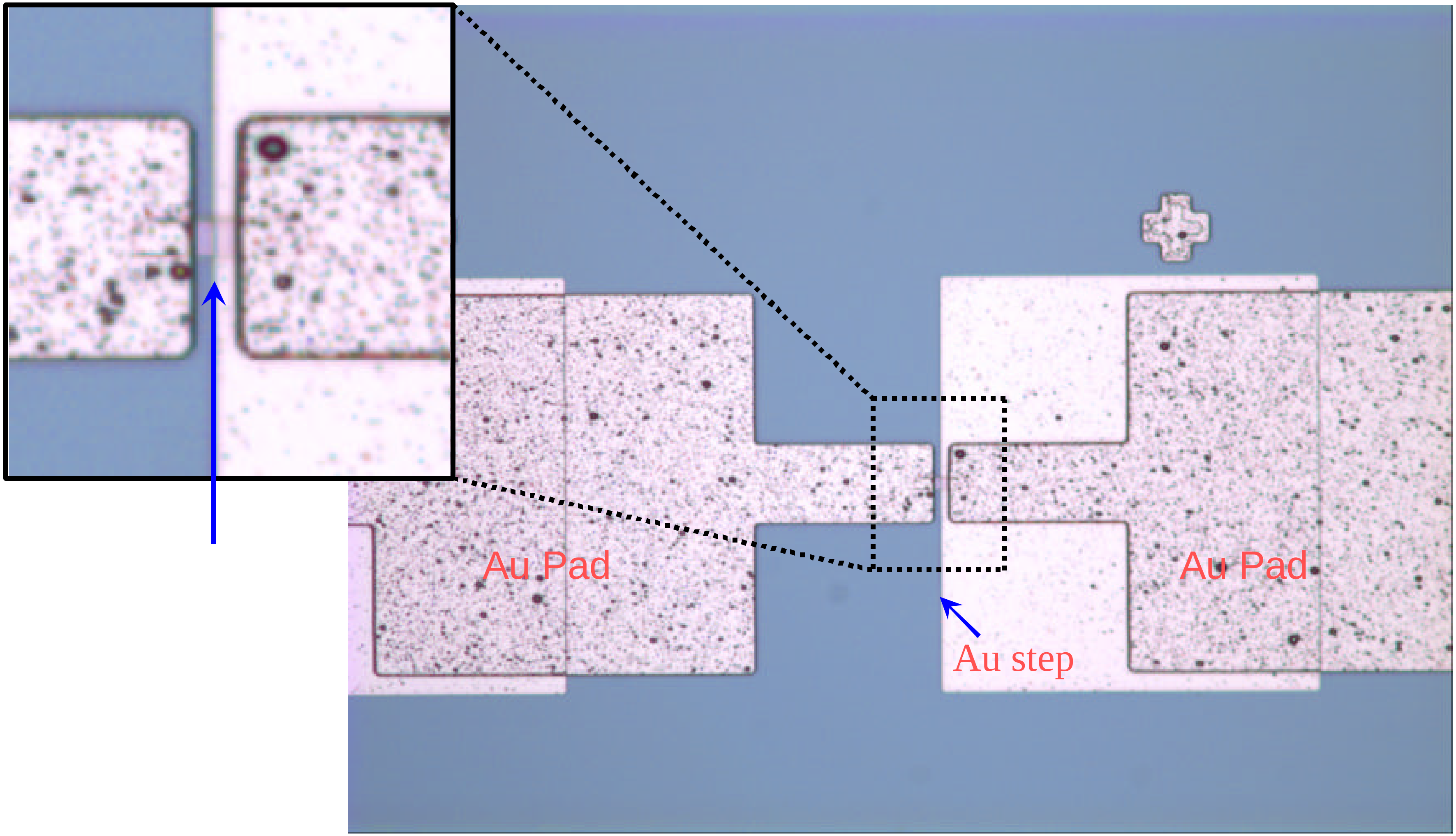


ds-DNA Oxidation Damaging

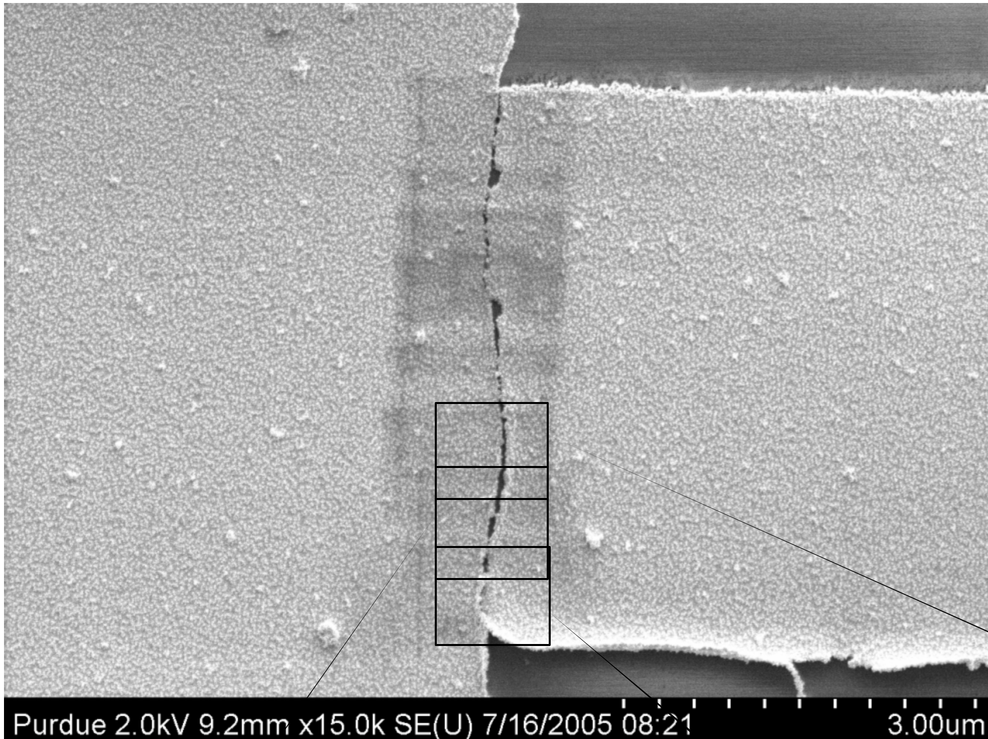


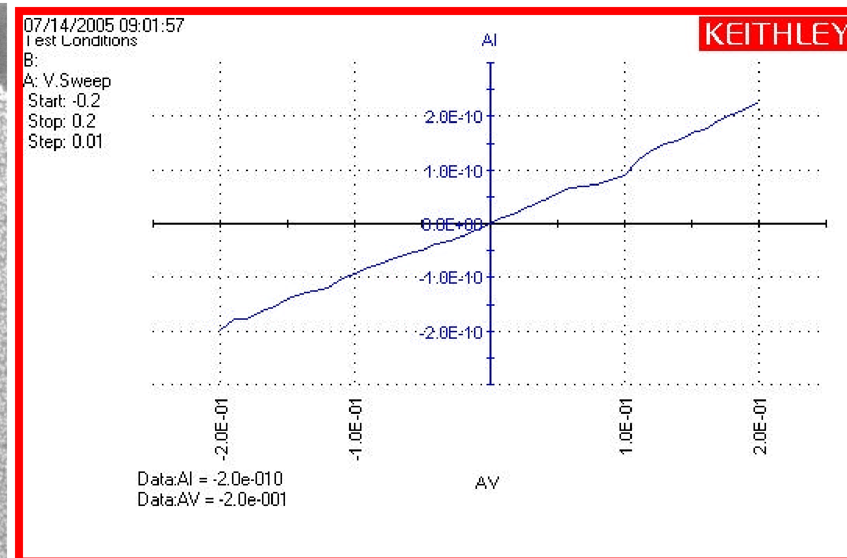
Au/GC-rich-ds-DNA(0.137mM)/Au

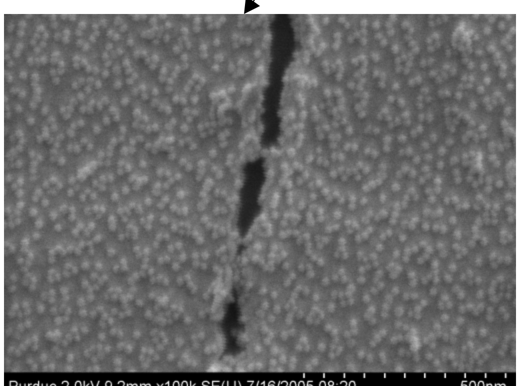
Microscopic photograph of Step Junction

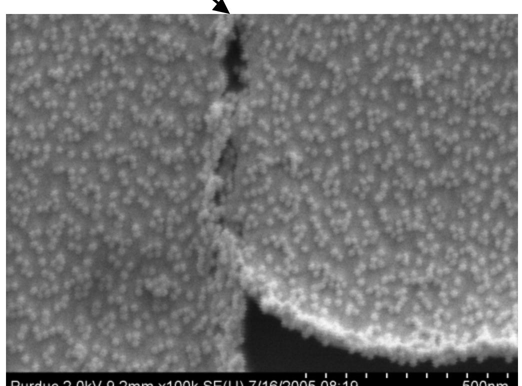


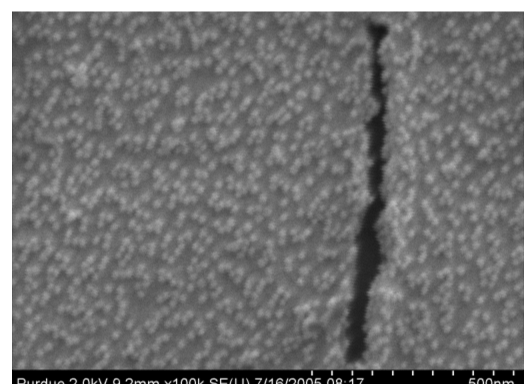
Step Junction Results



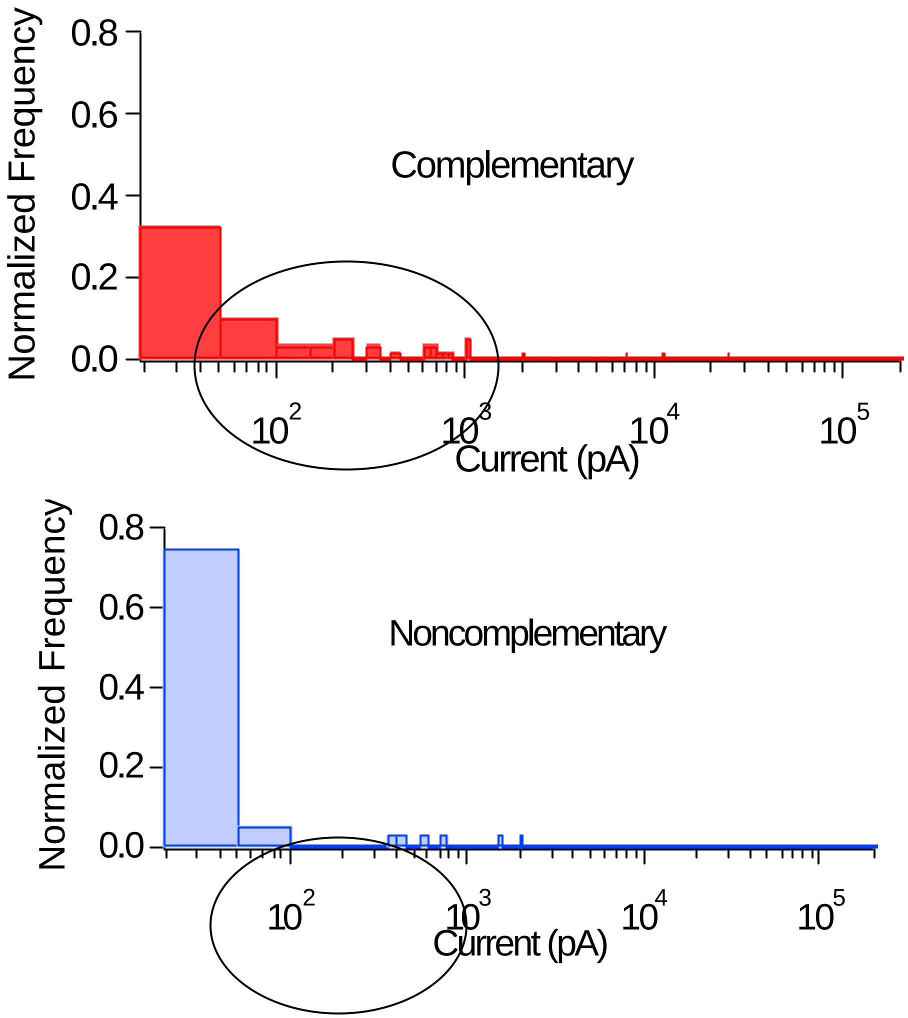








Summary of Step Junction Results



Average Current = 144pA

Conclusions

1. We have create a Fe-Au nanometer scale magnetic particles that *we believe* will allow us to efficiently collect an analyte and react it with a surface. The technique we are using will allow us to create a wide range of sizes and shapes.

2. We have optimized a ligand immobilization surface chemistry to allow nanoparticles baring receptors to efficiently react with surfaces.

3. Break junction work confirms that double stranded DNA is a poor conductor and that it's conductance is highly dependent on the manner in which the DNA is attached to the surface and nucleic acid base content.

3. Step junction work is underway that will allow us to measure the conductance of single gold nanoparticles attached to surfaces through double-stranded DNA.