Biological Templated Nanowires

Danielle Showalter
Biology Department, Santa Barbara City College

Mentor: Yan Gao
Faculty Advisor: Dr. Evelyn Hu
Materials and ECE department
University of California, Santa Barbara

Motivation for bio-templated nanowires

- The use of biological materials as templates for nanowires
- Creation of wires that are very small (<100nm)
- Placement of assembled nanowires
- Cost effective
- Potential to integrate with current fabrication technology

Potential for bio-templated nanowires

- Constructed wires will replace current larger scale wires found in circuit boards
- Smaller wires will enable the device to function at a much faster rate

Research Procedures

Assisting:

1. Synthesis of the nanowires using biological materials
2. Locating wires using Scanning Electron Microscopy (SEM) and making contacts on the bio-templated nanowires using E-Beam Writing (EBW) technique

My Project:

-Using Atomic Force Microscopy (AFM) to locate and characterize wires both before and after the contacts are made.

Before contact:

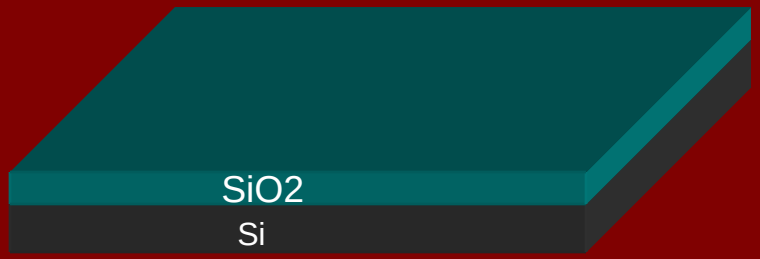
-looking at the quality of the wires by checking the coverage of the Au particles

After contact:

-check the morphology of the wires, as they may change during contact procedures

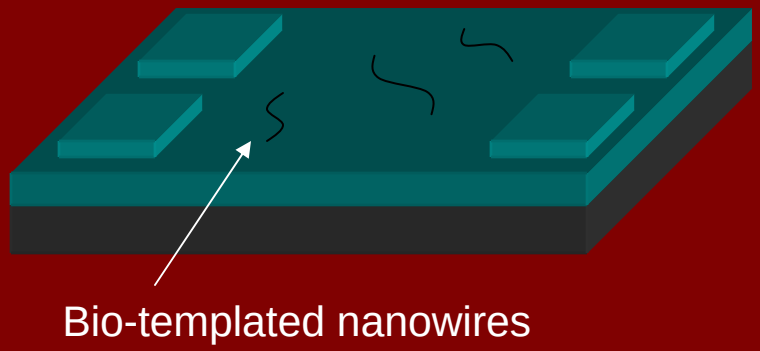
Procedures

1. Prepare SiO2/Si substrates

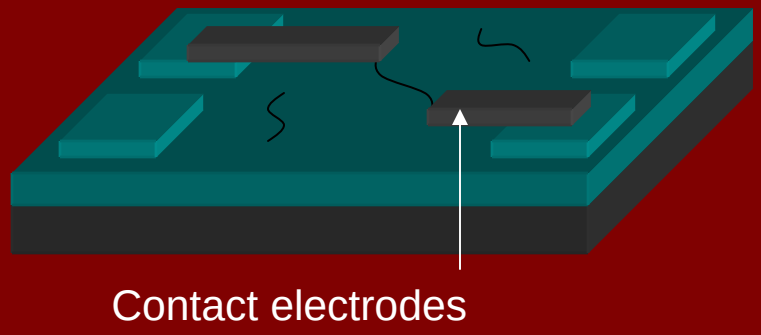


2. Pre-pattern the Ti/Au contacts

3. Deposit the bio-templated nanowires solution on these substrates



4. Locate the nanowires via SEM and deposit the contact electrodes using E-Beam Writing (EBW) technique



Atomic Force Microscopy

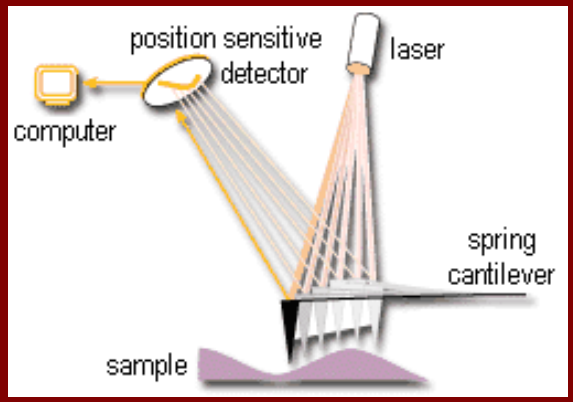
What is AFM ?

A scanning probe microscope, which measures the attractive and repulsive forces between a tip and the sample

*http://www.mrl.ucsb.edu/mrl/centralfacilities/microscopy/index.html

How does AFM work?

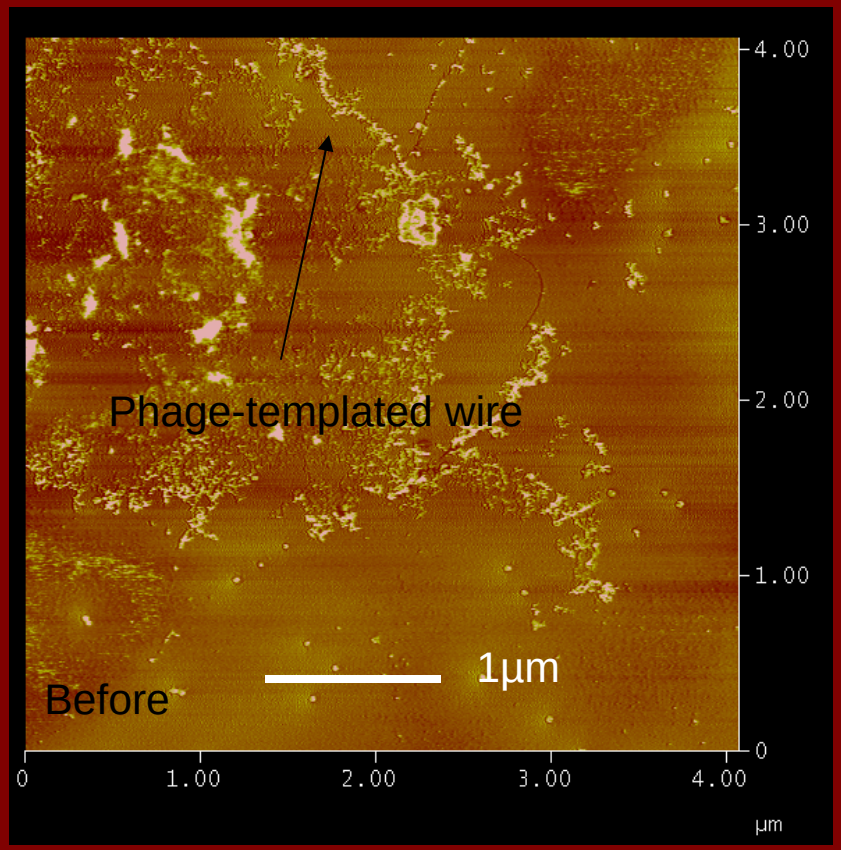
a sharp tip is scanning on sample surface in a controlled contact or tapping mode and the signals carrying surface information are collected, processed and then plotted on a computer screen.

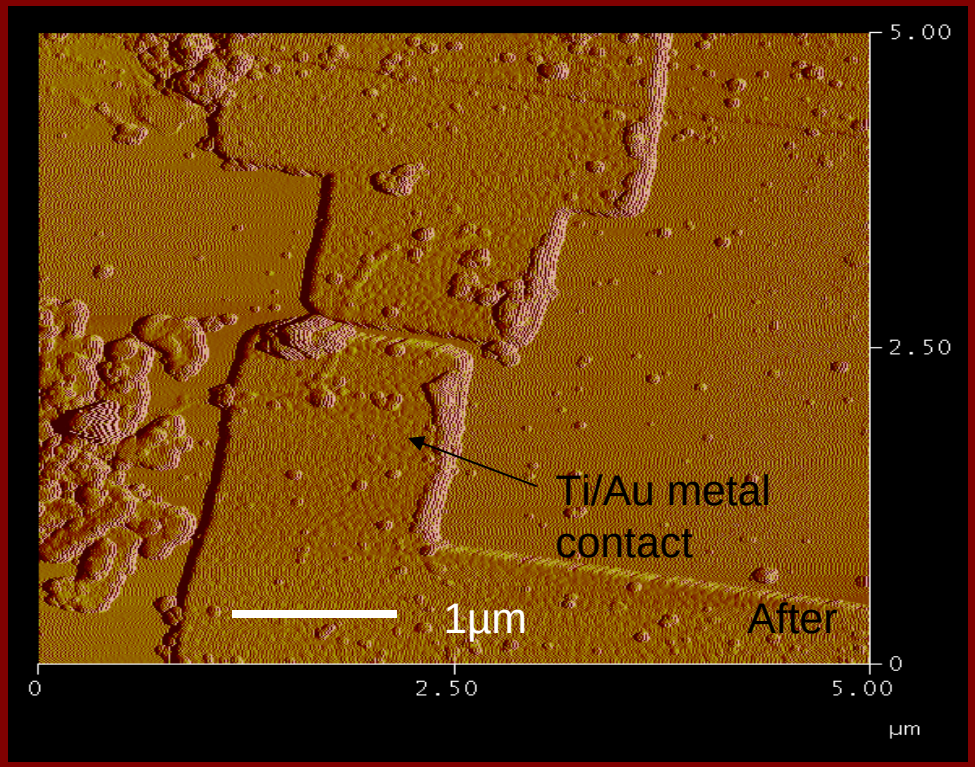


*http://www.che.utoledo.edu/nadarajah/webpages/whatsafm.html

Initial Results

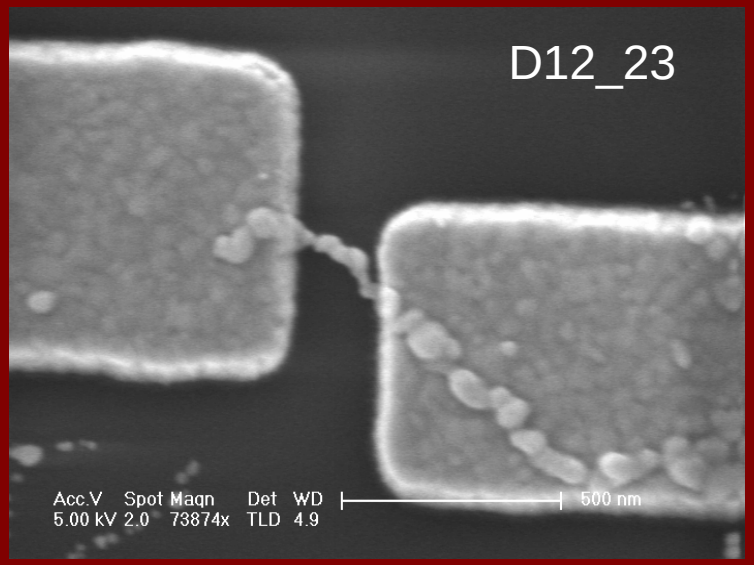
AFM of nanowires before and after contact (Ti/Au as contact metal)



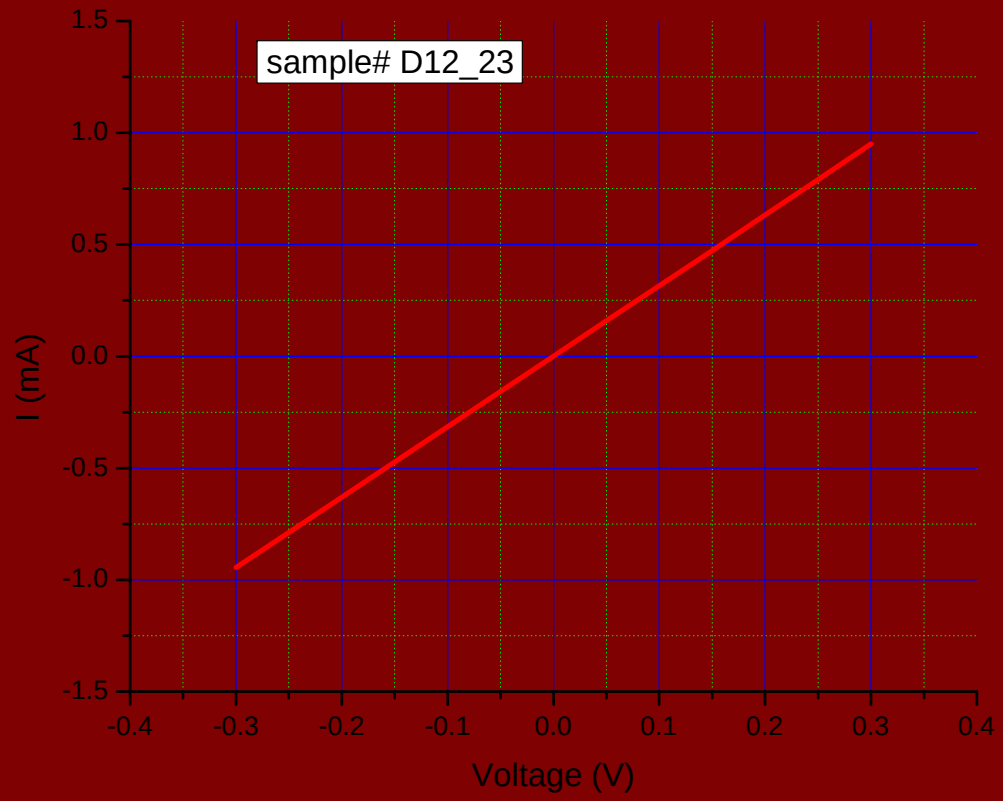


Electrical result of Au Phage-templated nanowire

SEM of contacted Au phage-templated nanowire

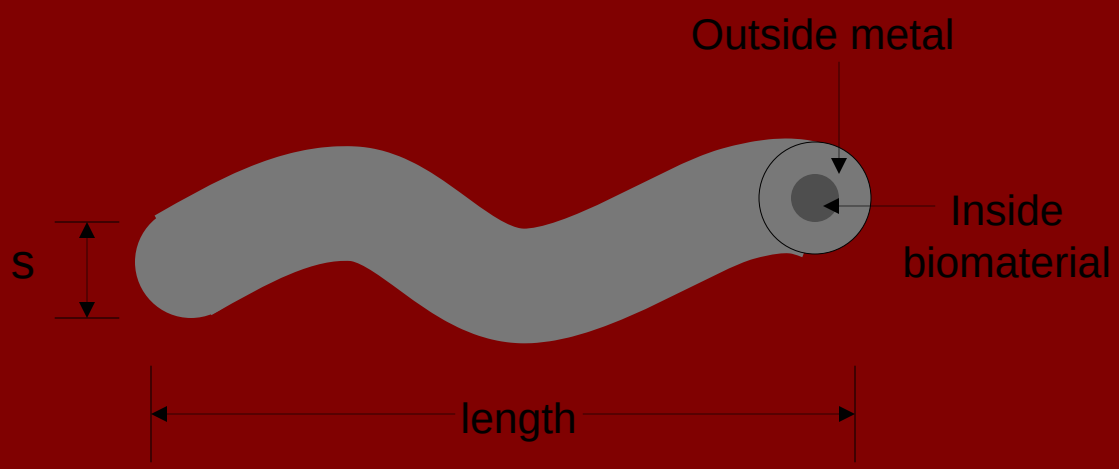


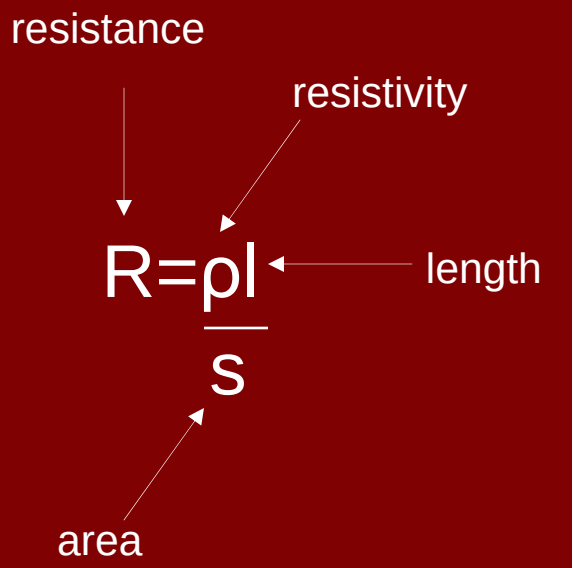
I-V of Phage-templated Au nanowire



Electrical result of Au Phage-templated nanowire

Schematic of bio-templated nanowire





- Resistivity of measured gold wire is 2.18x10^-6 Ωm
- Theoretical value of wire is 2.24x10^-8 Ωm
- Measured gold wire has ~100 times lower conductivity than calculated value

Summary

- Electrical characterization was carried out on phage-templated nanowires
- Spin-on technique was used to pattern the bio-templated wires, with final contacts formed by E-Beam writing
- Resistivity of phage-templated Au wire was calculated using IV curve measurements

Future work

- Optimize conditions during synthesis of wires
- Improve quality of wires by thermal annealing
- Temperature dependance to explore the electron transport of these nanowires

Acknowledgments

Hu Group:

Mentor: Yan Gao

F aculty advisor: Dr. Evelyn Hu

Inset Program

Trevor Hirst, Nick Arnold

Liu-Yen Kramer, Mike Northern

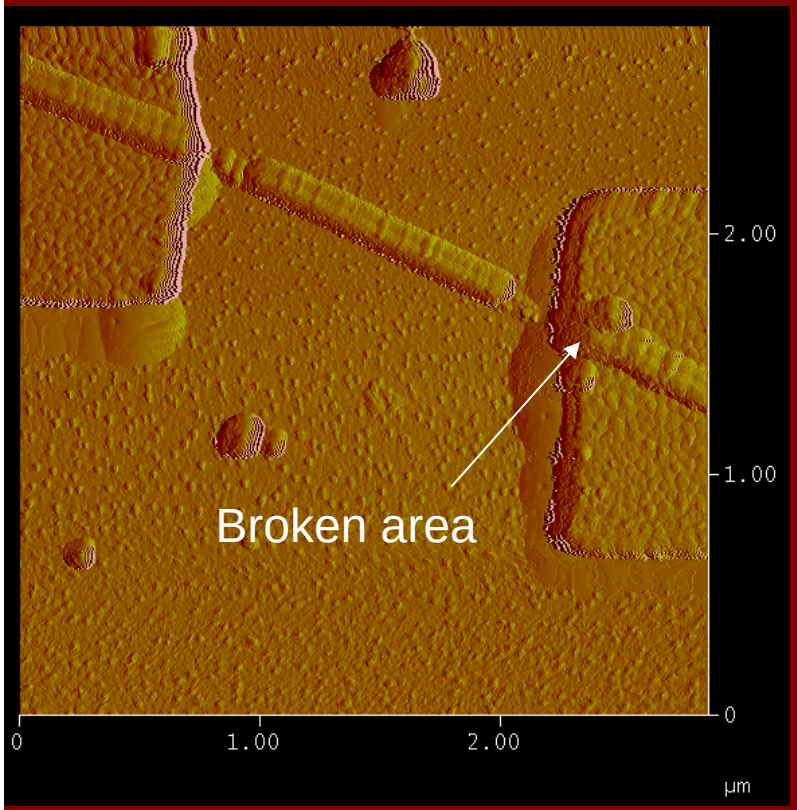
Financial support

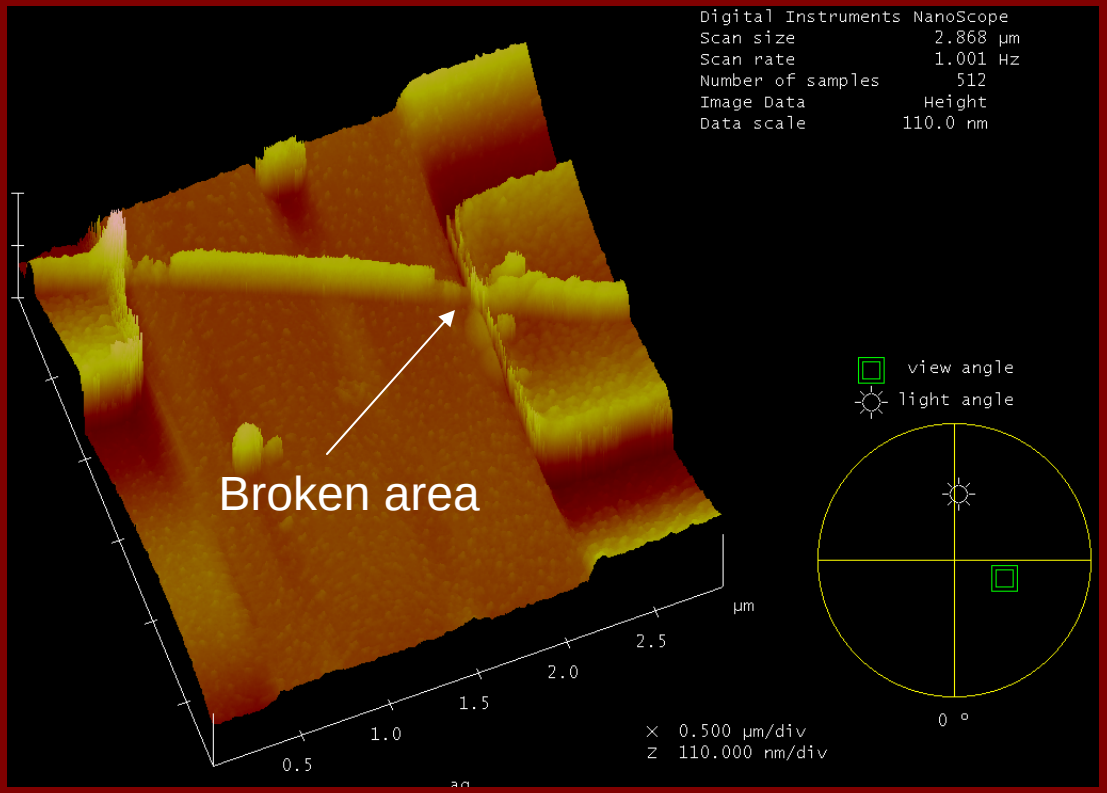
National Science Foundation

Institute for Collaborative Biotechnologies (ICB)

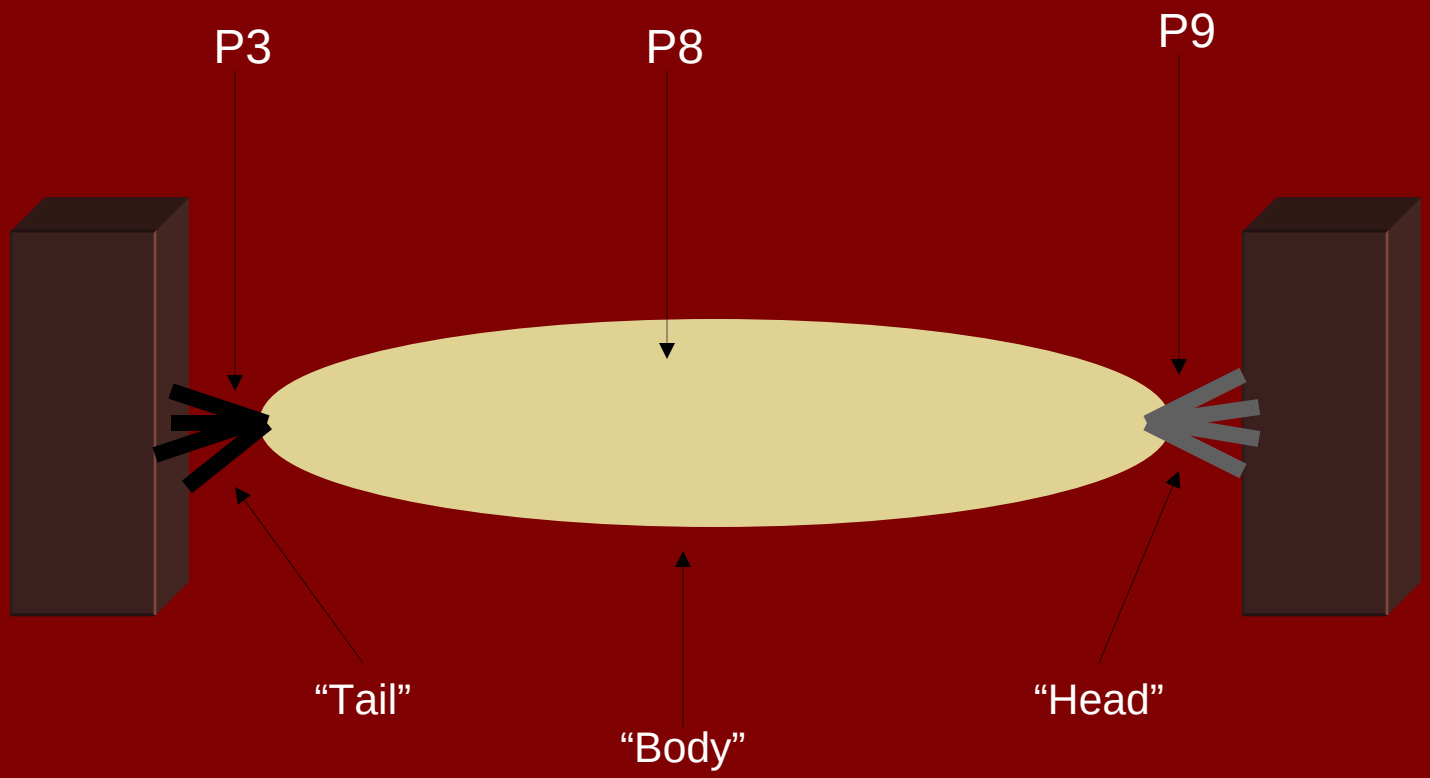
Center for Function Engineered Nano Architectronics (MARCO/FENA)

Morphology of wire after contact procedures





M13 bacteriophage



-The P3 has binding affinity specifically to gold due to its unique peptide sequence

-The P8 can be genetically modified to bind to gold