

# MNT-EC SUMMER SEMINAR SERIES

## **Nanotechnology Workshops at Northwest Vista College**

**Neda Habibi**

Program Coordinator at Northwest Vista College

PI, Alamo Institute for Materials (micro, bio, nano) – Technology (AIM-TEC)

Co-PI, Micro-Nano Technology Education Center (MNT-EC)





# Advanced Materials Technology/Nanotechnology at Northwest Vista College

- 2 year program (Associate degree and certificates)
- Nanotechnology lab at NVC
- Southwest Research Institute



# A little about myself

- Ph. D. in Nanobiotechnology, University degli di Genova, Italy (2013)
- Spent 8 Years in academia
- 2016-2017, Research Fellow at University of Texas at San Antonio (UTSA)
- 2017-present, Northwest Vista College as Program coordinator of Nanotechnology program

# Materials Engineering & Nanotechnology

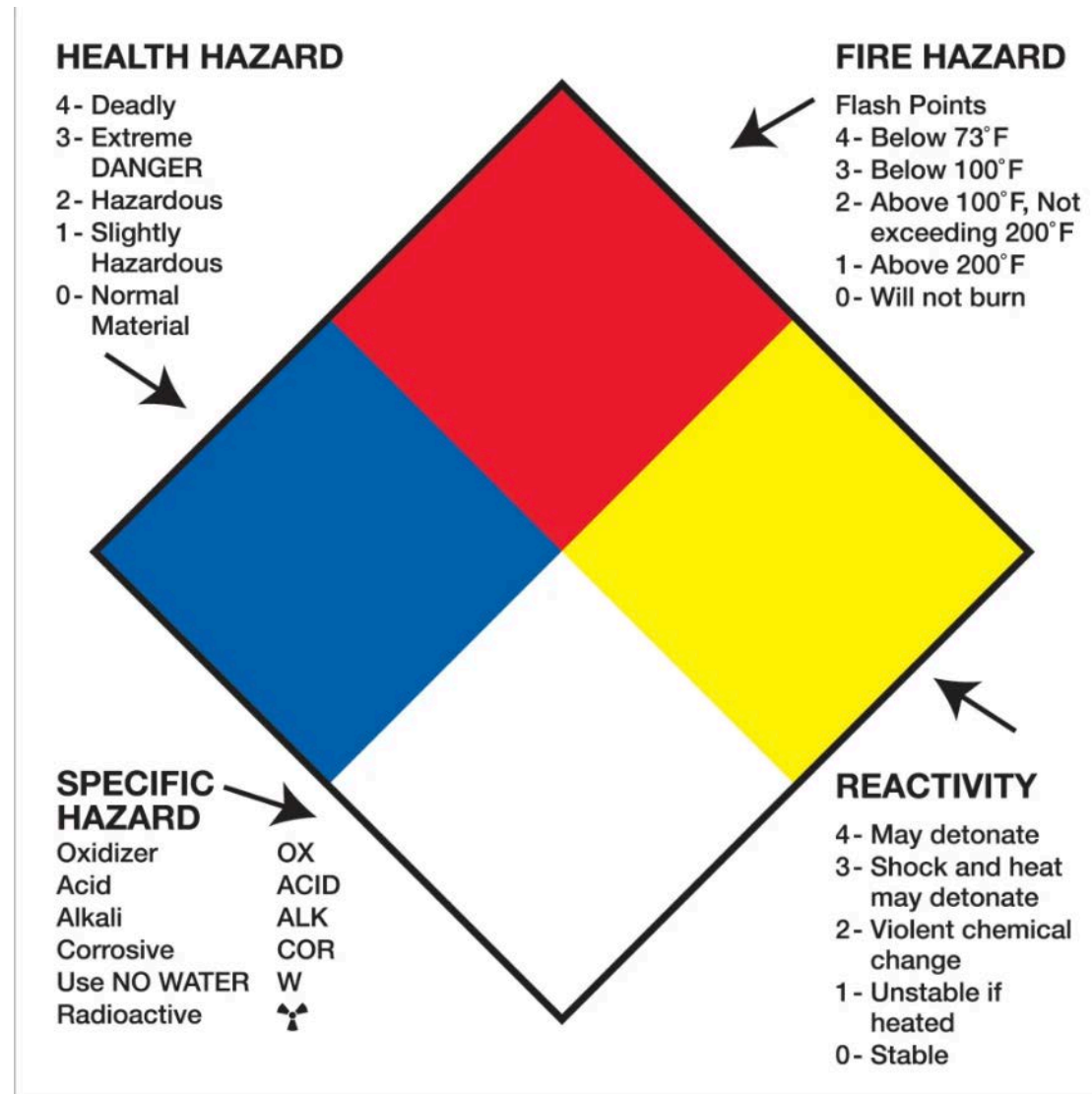
- Materials Engineering was first started mainly as a discipline to study metals, ceramics, and other solid-state materials.
- In the recent years, micro-nanotechnologies has revolutionized the classical field of material science and engineering, where we can work with materials in atomic level to create new and modern materials with superior and enhanced properties.

# Advanced Materials Technology

- Using Nanotechnology to create new Materials
  - Synthesizing Nanoparticles
    - Wet-Chemical
    - Atomic Layer Deposition
  - Characterization
  - Create new Materials

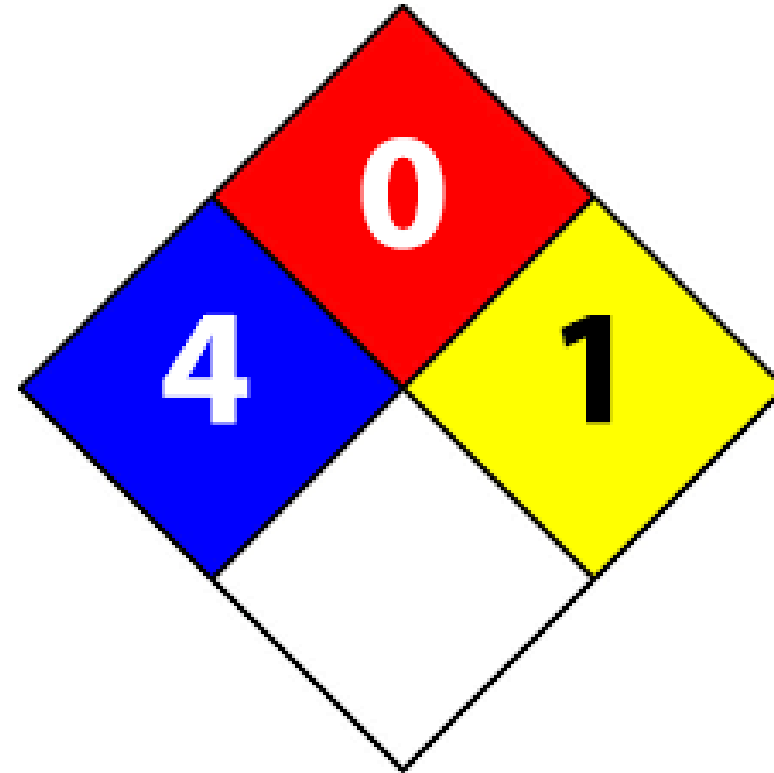
# Lab Safety Protocols

- Review Materials Data Safety Sheets **MSDS**
- **Introducing Hazard Labels**
- **Introducing Diamond Hazard**
- Disposal of Chemical
- Label all bottles



# Review the list of Highly hazardous Chemicals

- Hydrofluoric Acid (HF)
- Sulfuric Acid (H<sub>2</sub>SO<sub>4</sub>)
- Hydrogen Peroxide
- Buffered Oxide Etch



Safety Diamond of Hydrofluoric Acid

# Wet Chemical Synthesis

- Ruby-Red Colloidal Gold Nanotechnology-Chemical Demonstration Kit
- Prepared by Flinn Scientific
- Price: \$ 38





# Magnetic Iron Oxide Nanoparticles

Ferrofluid Nanotechnology-Chemical Demonstration Kit

Prepared by Flinn Scientific

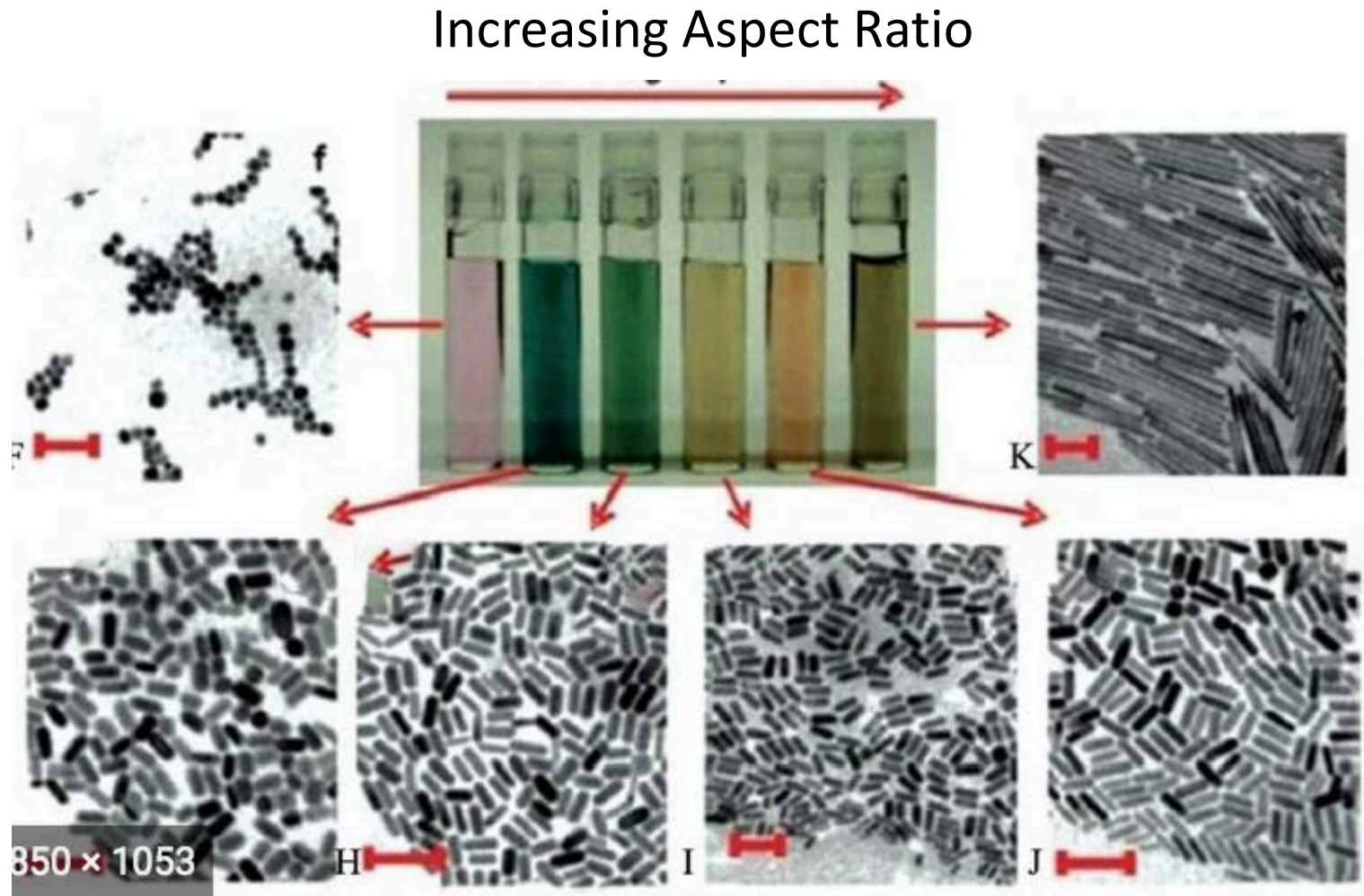
Price: \$ 51



- The Reducing method can easily get adapted to produce other Nanoparticles:

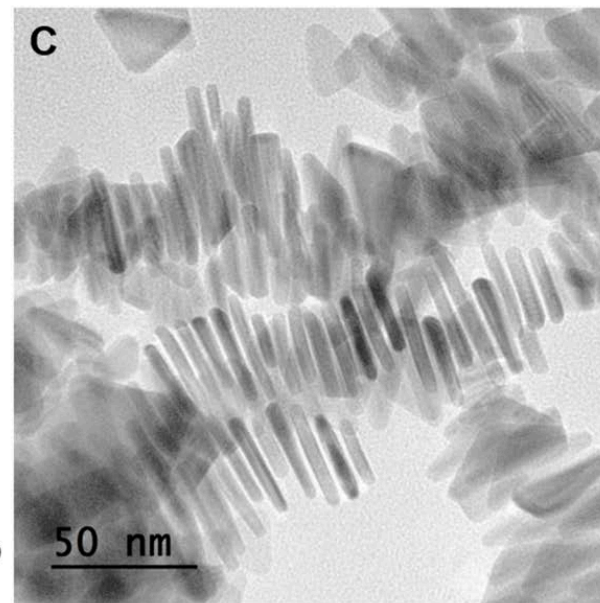
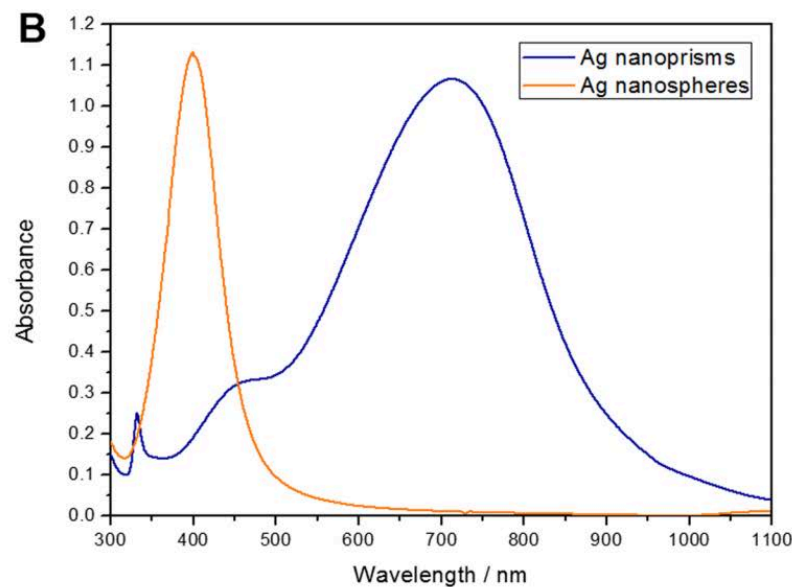
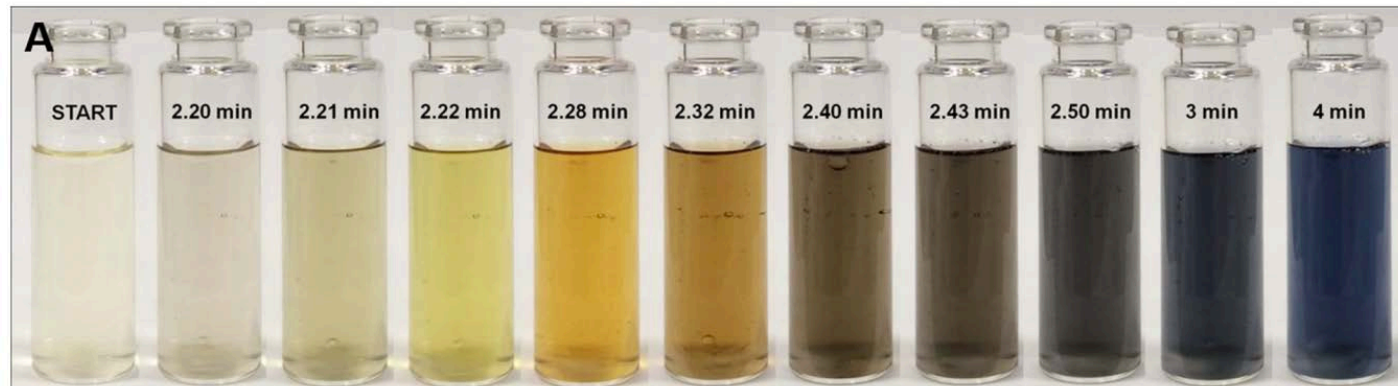
- Copper Nanoparticles
- Zinc Nanoparticles
- Silver Nanoparticles

- Rod, Cube and Prism



# Silver Nanoprism

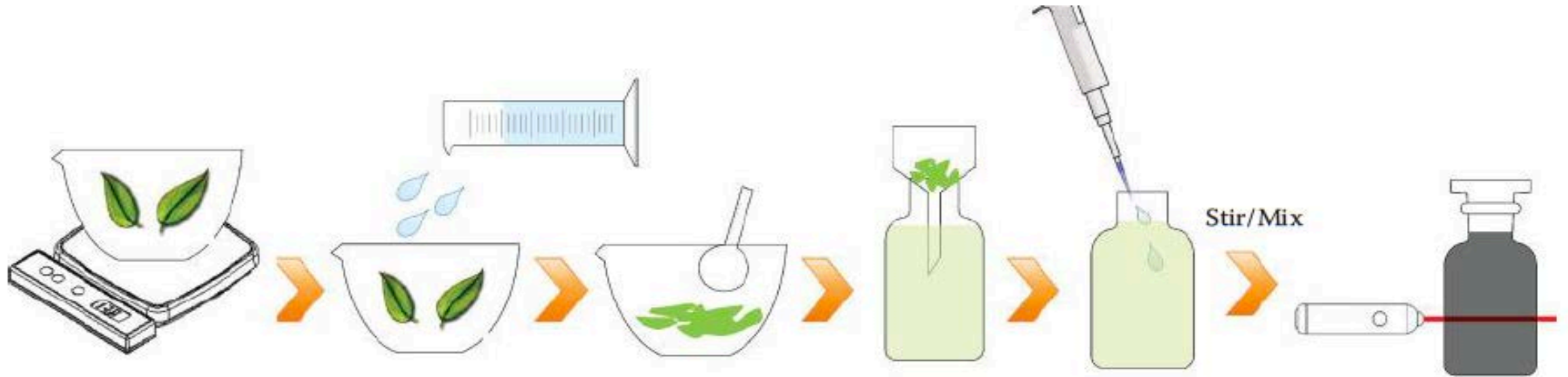
Combination of Oxidizing reagents & Reducing reagents



JOURNAL OF  
**CHEMICAL EDUCATION**

Just What Is It That Makes Silver Nanoprisms so Different, so Appealing?

# Biological Synthesis of Silver Nanoparticles Using Plant/Leaf extract

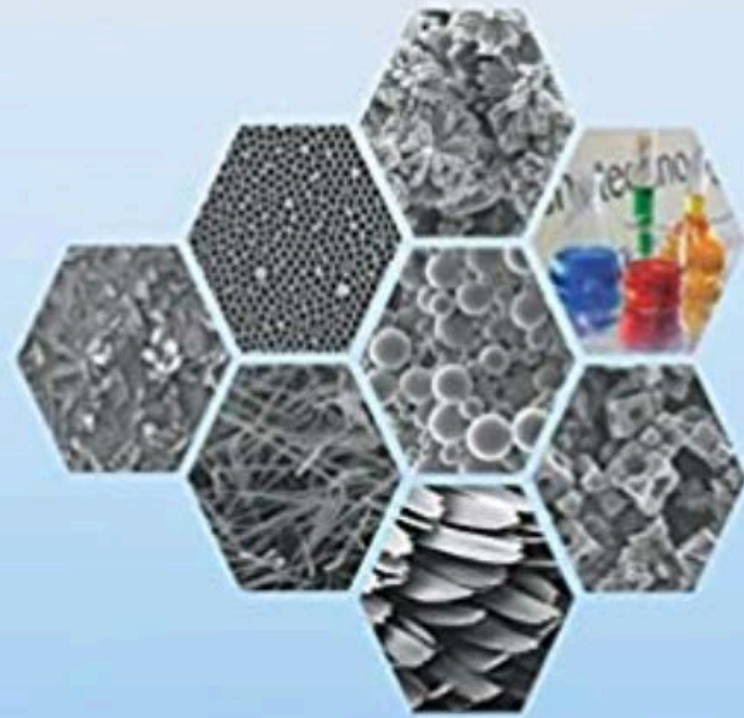




# Textbook & Resources

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## A Laboratory Course in Nanoscience and Nanotechnology



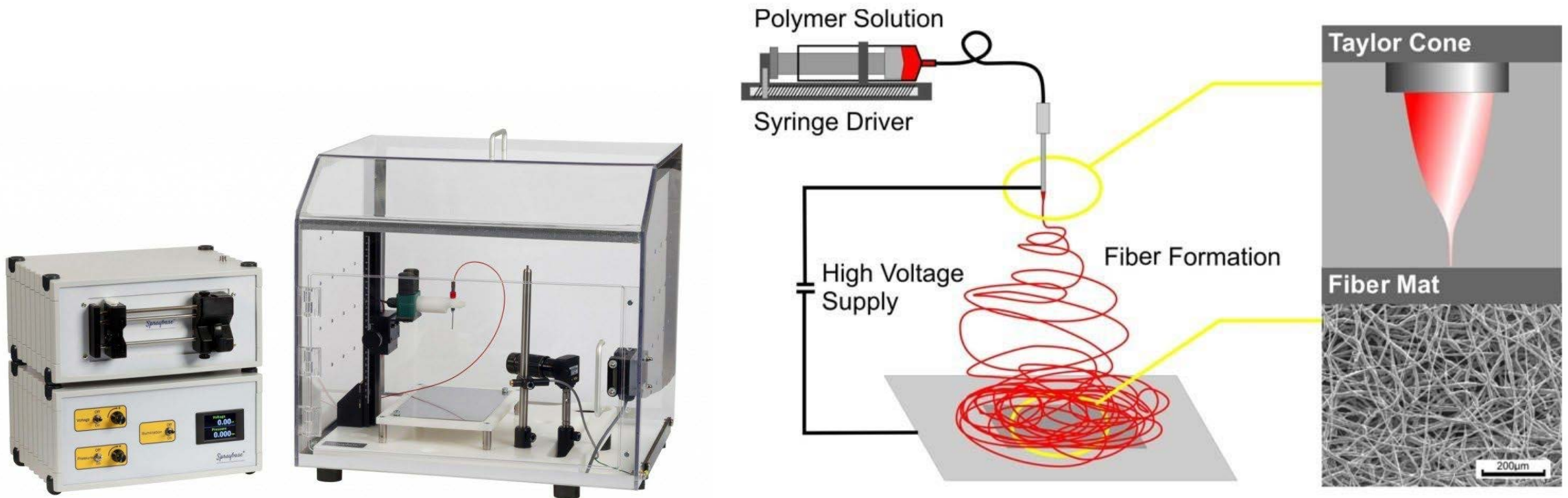
**Dr. G errard Eddy Jai Poinern**

 **CRC Press**  
Taylor & Francis Group

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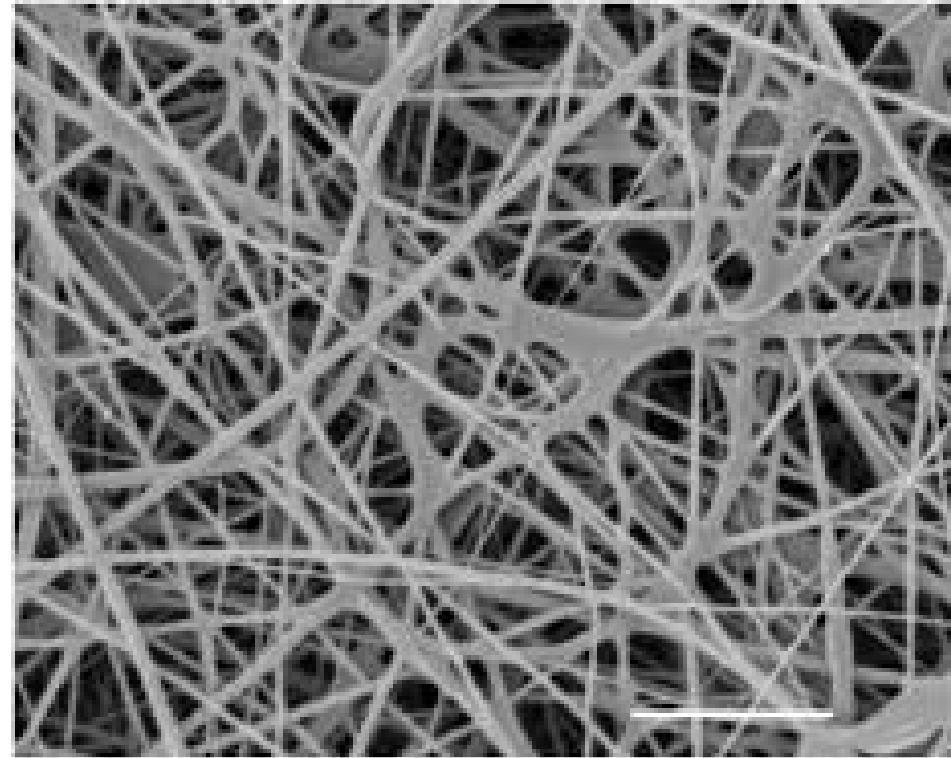
# Electrospinning

- Electrospinning instruments uses electrical charge to convert a polymer solution into micro or nanoscale fibers



# Electrospinning Application

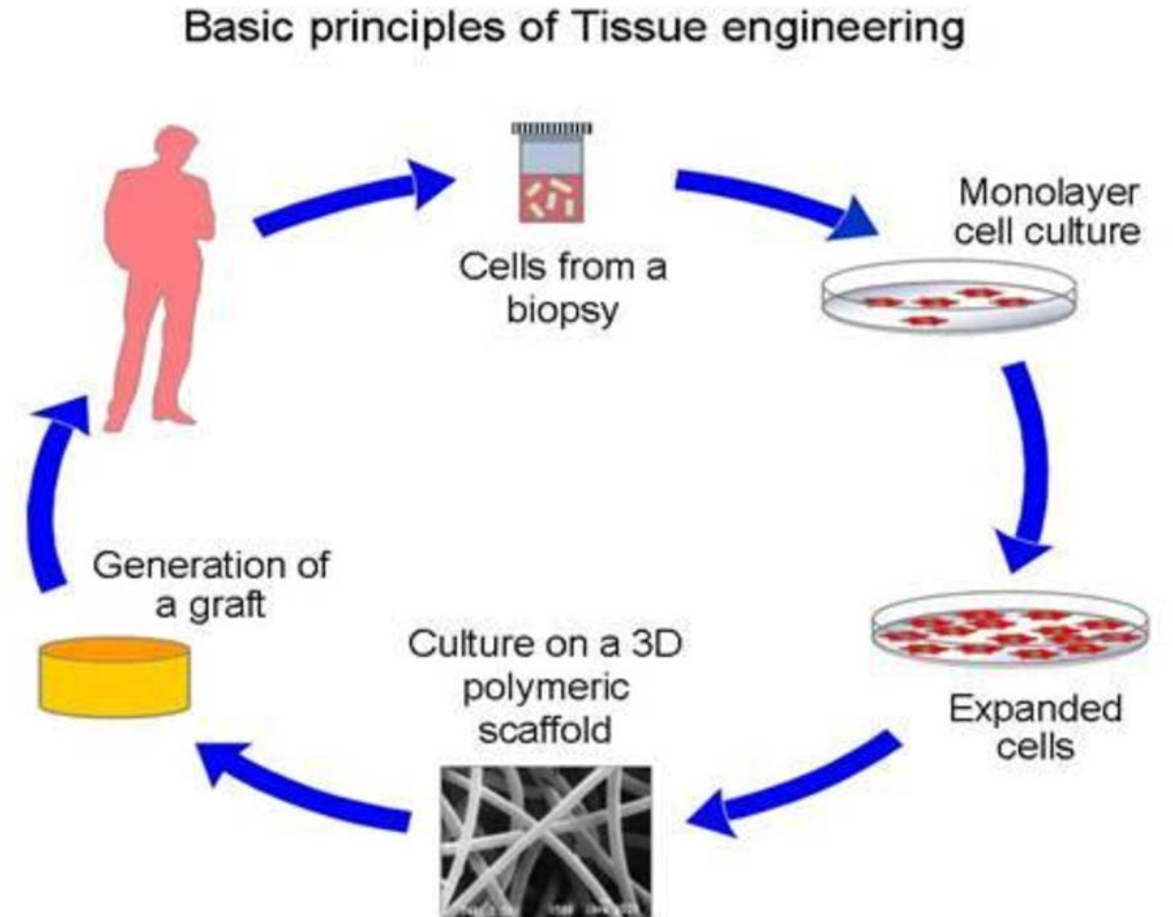
- Regenerative medicine
- Tissue engineering
- Wound healing
- Drug delivery
- Filtration membranes
- Textile



# Research Projects Using Electrospinning

“Develop a 3D Scaffolds from collagen for Cell Culturing”

- What type of Materials are Electrospinnable?
- How Can we Modify Parameters?





# Characterization

- Zeta Potential Sizer
- UV-VIS Spectrophotometer
- Fourier Transform Infrared Spectroscopy
- X-Ray Diffraction
- Scanning Electron Microscopy
- Quartz Crystal Microbalance



# Quartz Crystal Microbalance

A **quartz crystal microbalance (QCM)** measures a mass per unit area by measuring the change in frequency of a quartz crystal resonator. The resonance is disturbed by the addition or removal of a small mass due to film deposition at the surface of the acoustic resonator.

Price: \$ 4435.00

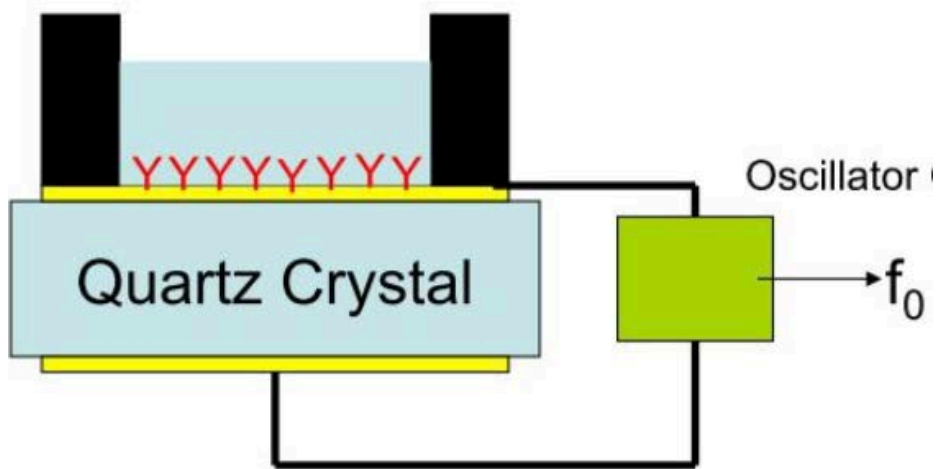


**SRS QCM200 5 MHz Quartz Crystal Microbalance**

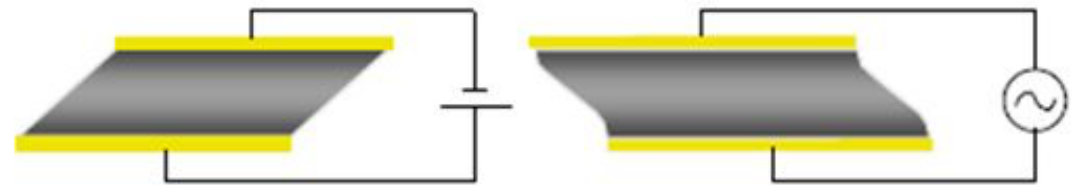


# Quartz Crystal Microbalance

- Piezo Quartz
- Sauerbrey Equation



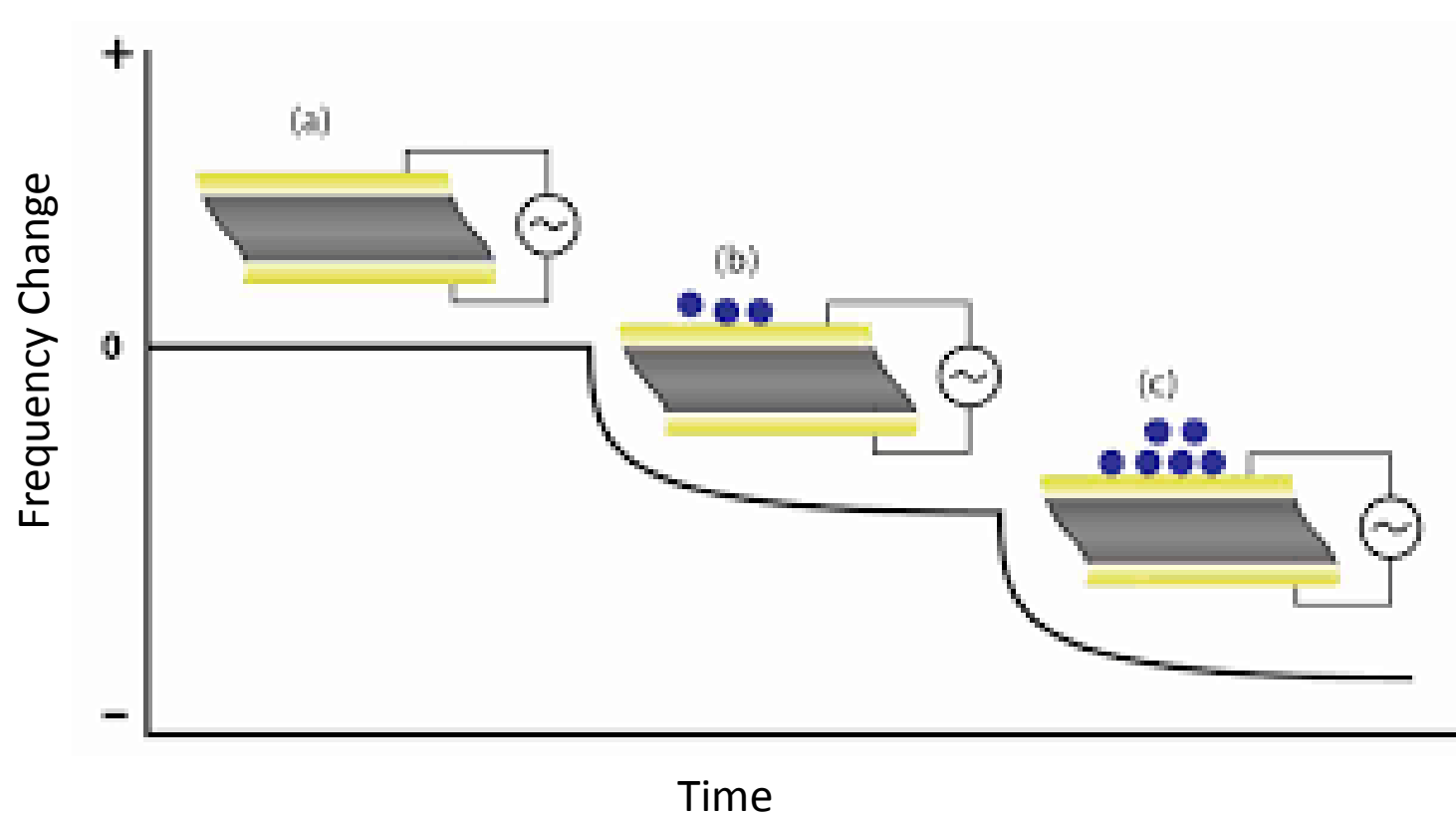
$$\Delta f = -C_f \Delta m_f$$



AC voltage is applied – Vibration  
Vibration at a Frequency

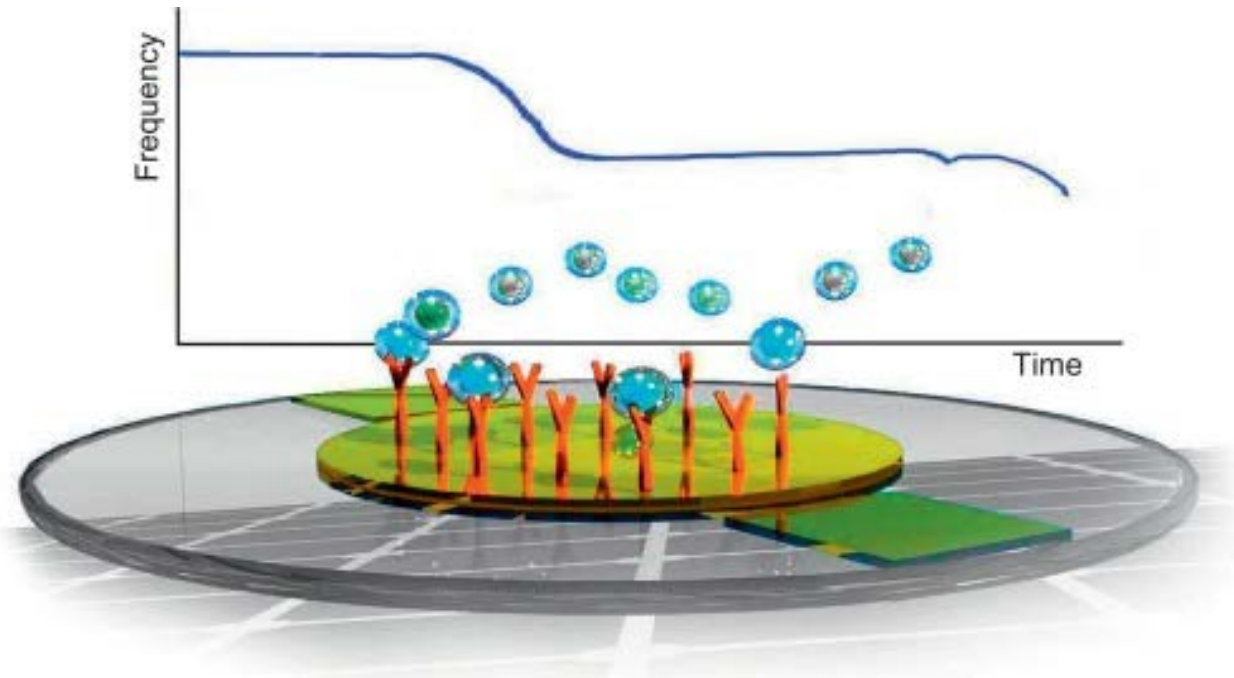
# Thin Film Thickness and Mass

The Sauerbrey equation says that the change in QCM frequency determines the mass of the absorbed analyte.

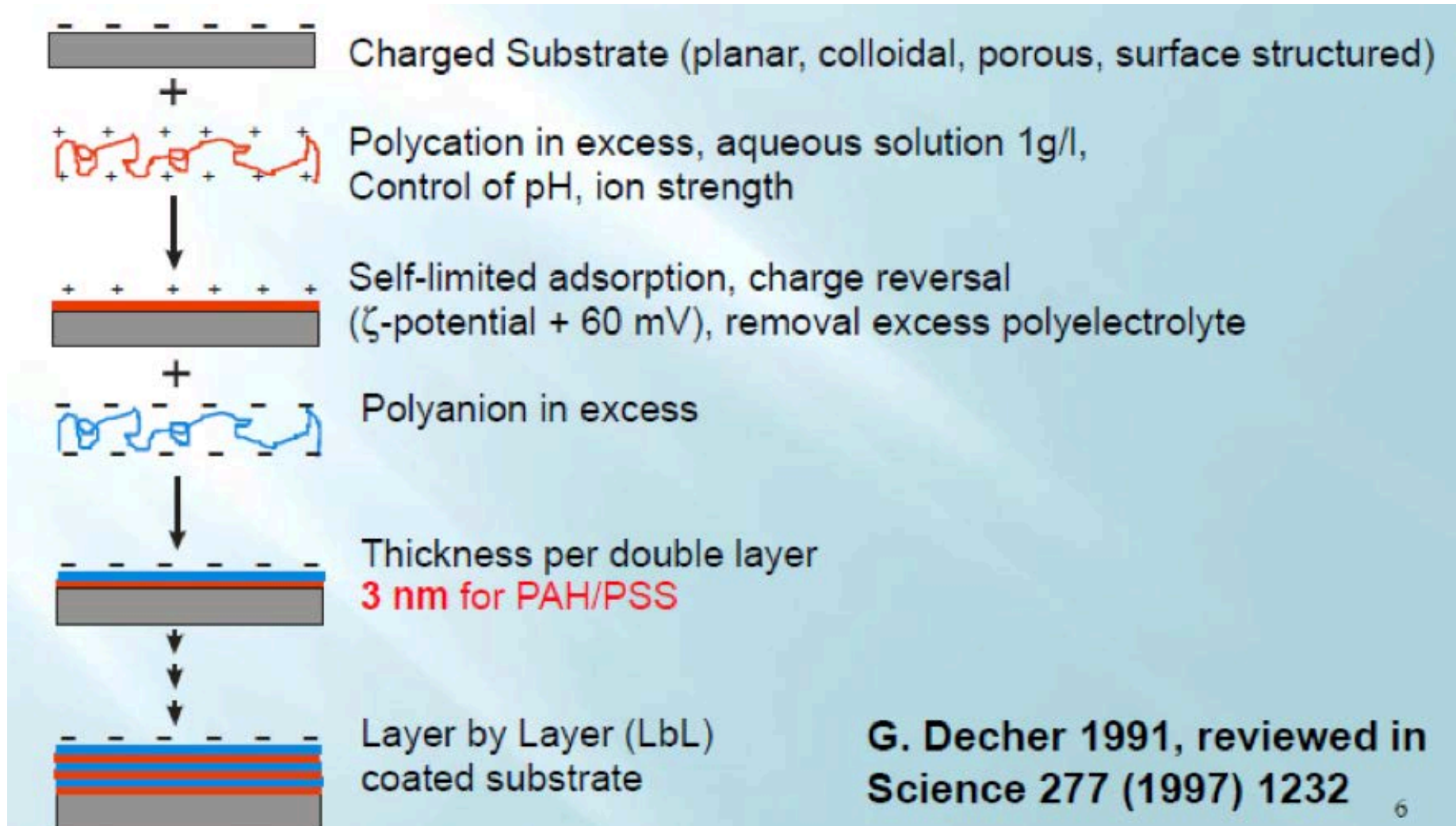


# Research Projects Using QCM

“Make a high sensitive sensor with QCM for detecting molecules”

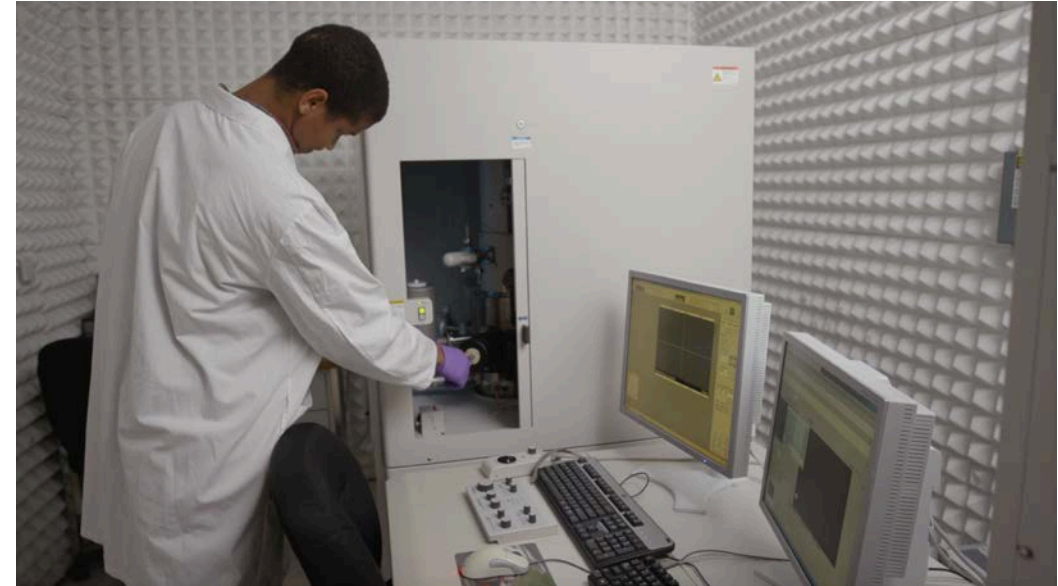


# Build up Multi Nanolayers with Layer By Layer Self-assembly



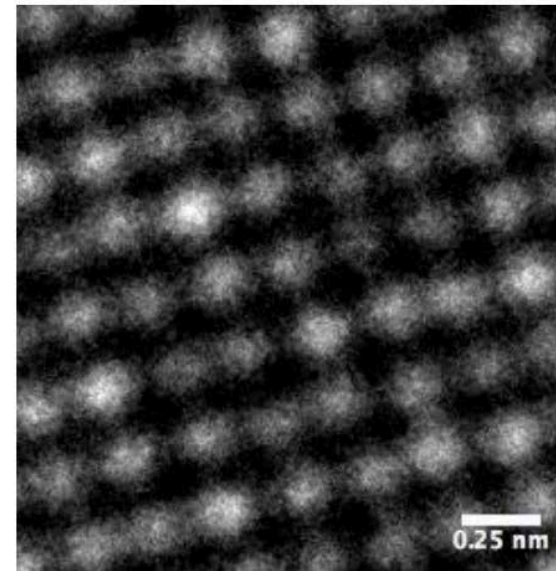
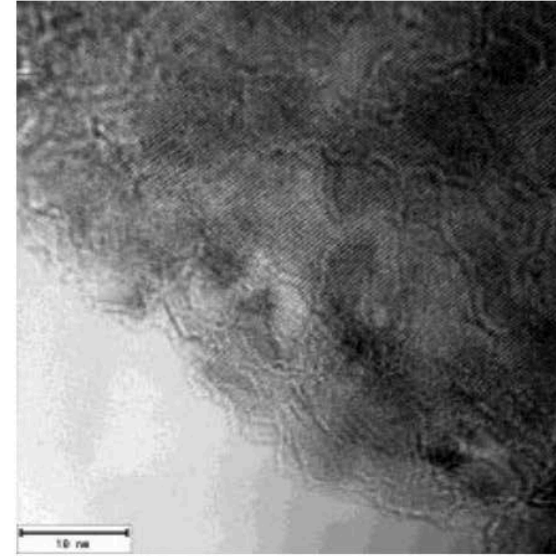
# Kleberg Advanced Microscopy Center at UTSA

- With a total infrastructure investment of >\$5.5 M, the KAMC provides four fundamental services:
- **Research support**
- **Training**
- **Academic instruction**
- **Outreach** is directed towards various community groups, K-12 and other higher education institutions.





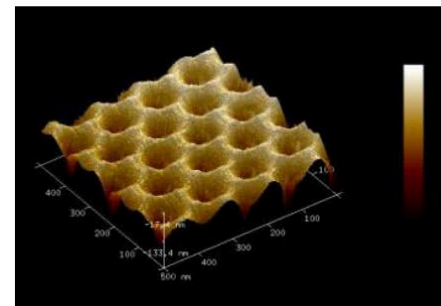
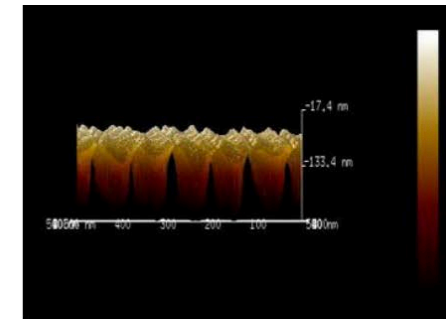
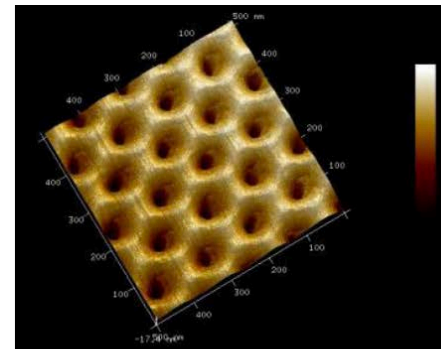
# Transmission Electron Microscope





# Atomic Force Microscope

- This Atomic Force Microscope delivers high-resolution imaging and a wide range functionality for materials and polymer science, biological research and nonelectrical measurements. The scanning probe microscopy is capable of working *in situ* inside liquids, addressing biological samples ranging from biomolecules, isolated membranes, and whole live cells.



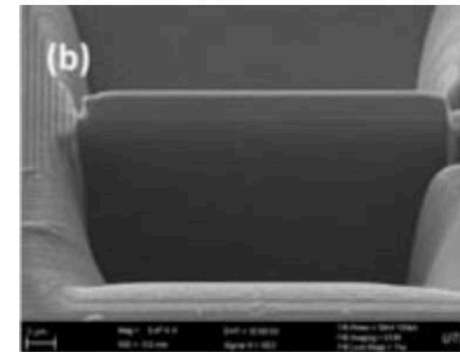
# Panalytical X-Ray Diffractometer

- diffraction measurements on
- (1) powders,
- (2) liquid dispersions,
- (3) thin films,
- (4) nanomaterials,
- and (5) solid objects.



# Focused Ion Beam Scanning Electron Microscope

- The crossbeam combines the field emission SEM performance with a Focused Ion Beam (FIB). Suitable for sample preparation, nanofabrication, and FIB-milling with a uniform high resolution.

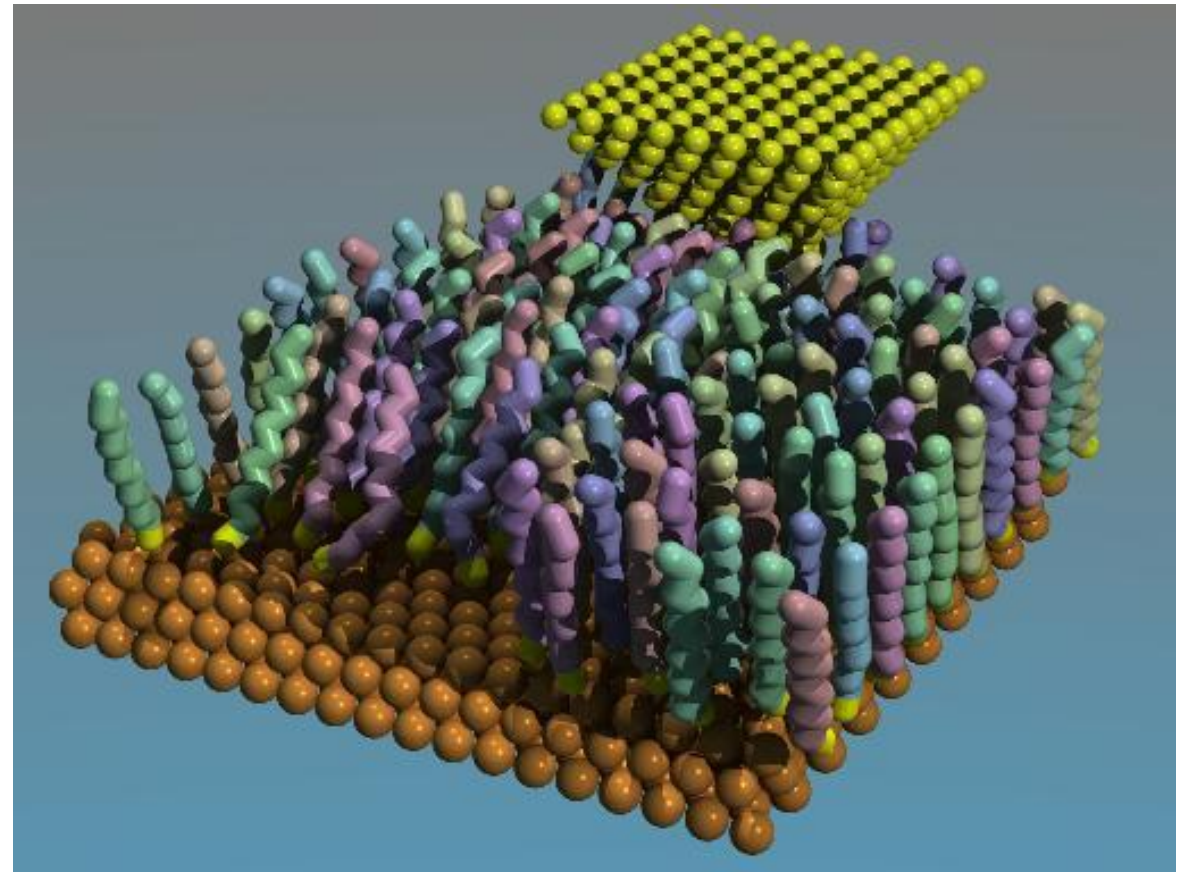


(a) Thick non-transparent sample

# Self-Assembly for creating nanostructures

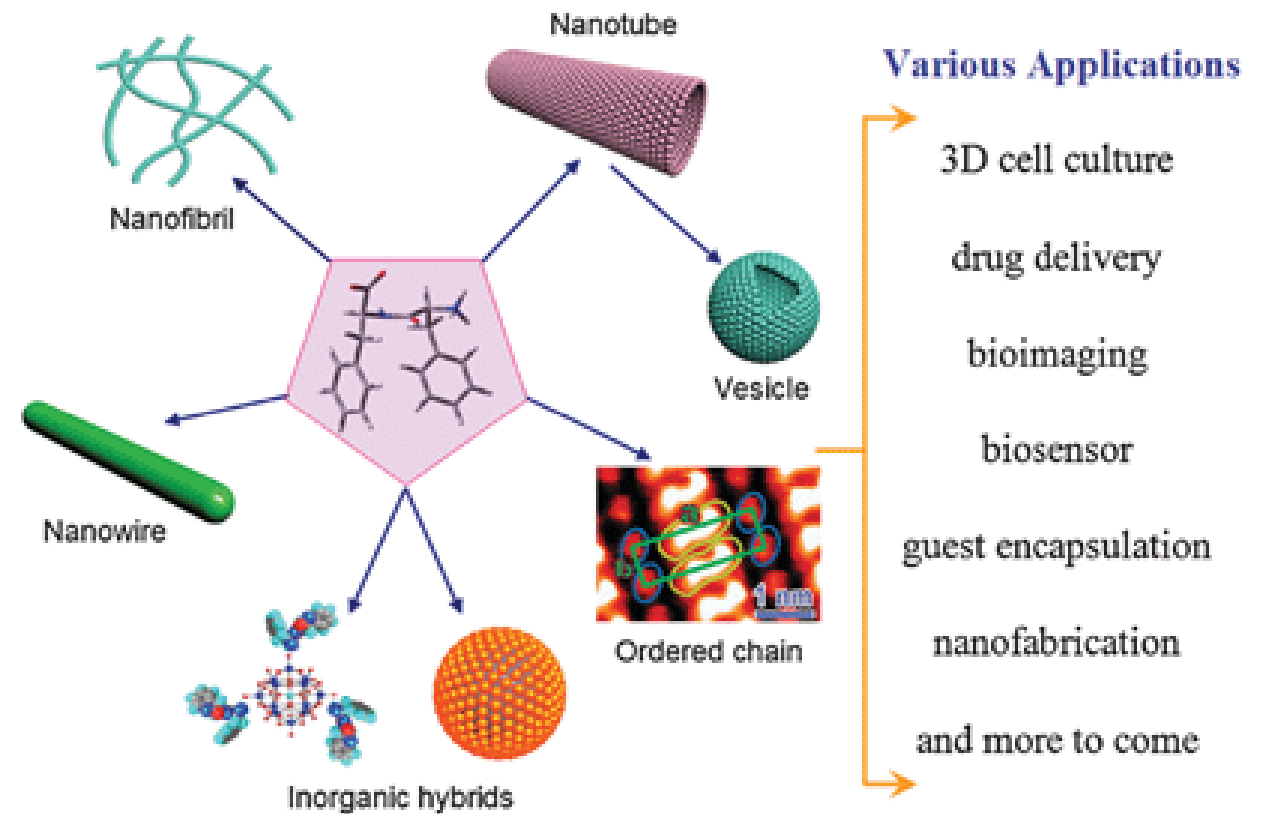
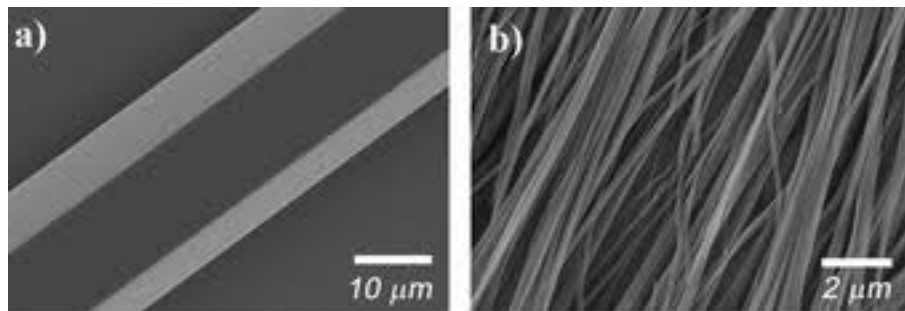
- Spontaneous process where atoms and molecules organize themselves into ordered structures.

- Electrostatic interaction
- Hydrophilic-hydrophobic
- Hydrogen bonding
- Van der Waal's Forces



# Self-assembly with Natural Molecules

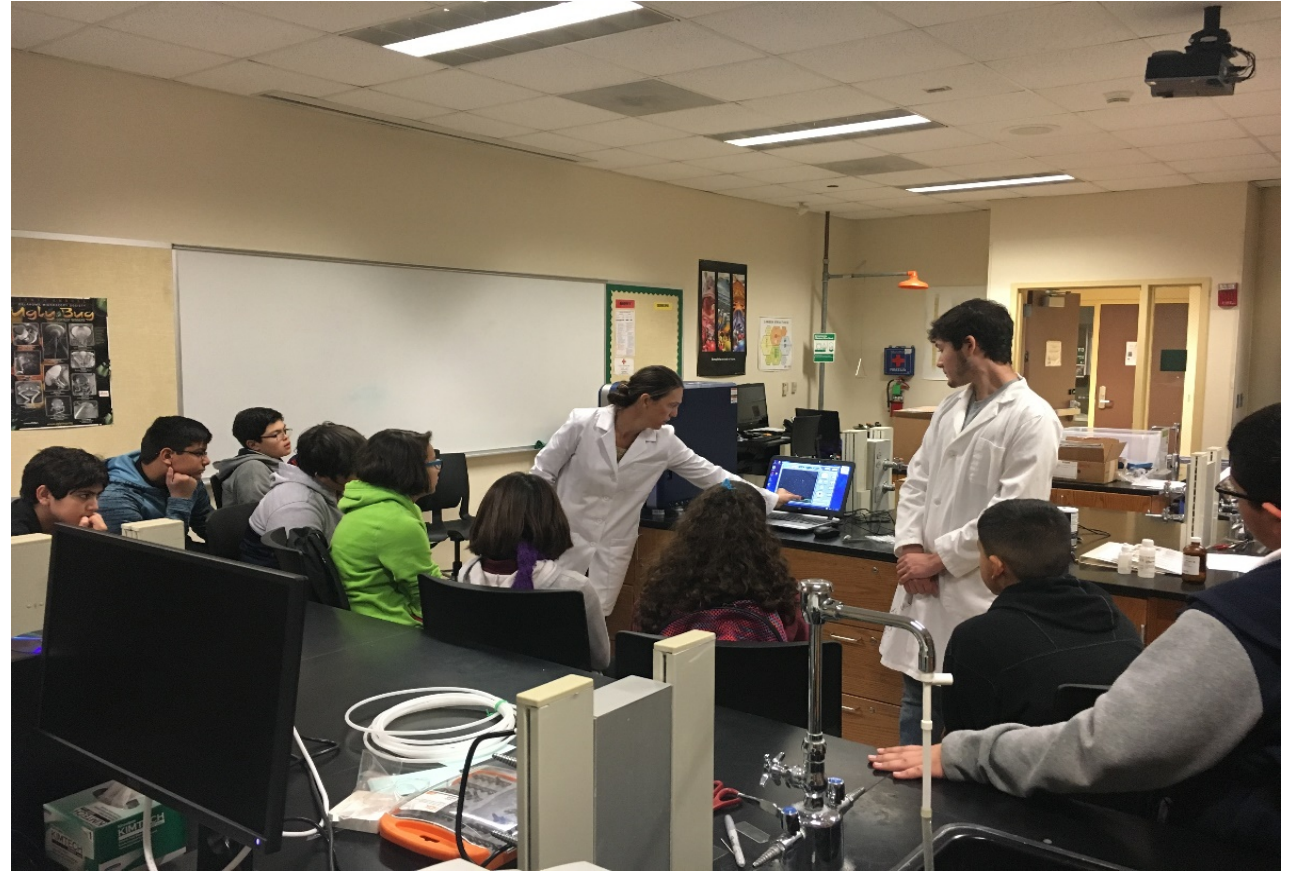
- Di-phenylalanine (Dipeptide)
- Self-assembled micro-nanofibers





# Previous Nanotechnology Workshops

- High School Teachers and High School Educator
- NACK Center, Nanolink, MatEDU



# Future Nanotechnology/Engineering Workshops

- 3D Printers
- Hands Exoskeleton
- Assembly and function
- Micro-Nano-Bio Lab experiments



Any question?

