SCME & THE URE PROGRAM
IT'S ABOUT THE STUDENTS!

Matthias Pleil; Ph.D.
PI - SCME

OVERVIEW

Who Is SCME?

What we do?

URE – a new opportunity for your students

Other Opportunities

SCME

WHO IS SCME

- Support Center for Microsystems Education - History
  - Started in 2004 as the Southwest Center for Microsystems Education at ABQ TVI
  - Moved to the University of New Mexico in 2008
  - Started the MNT Annual Conference in 2011 – collaborated with MATEC, Nano-Link and NACK, then added SHINE, NEATEC, and now MNT-EC
  - Continually funded as a Center
  - Support Center established 2017 with LSC – Lone Star College
  - Established the MNTeSIG in 2018 – Supplemental Funding for conference support
  - 2019 – additional supplemental for the URE project
- Current CC Partners across the country
  - PCC, Rio Salado, Ivy Tech, Lone Star

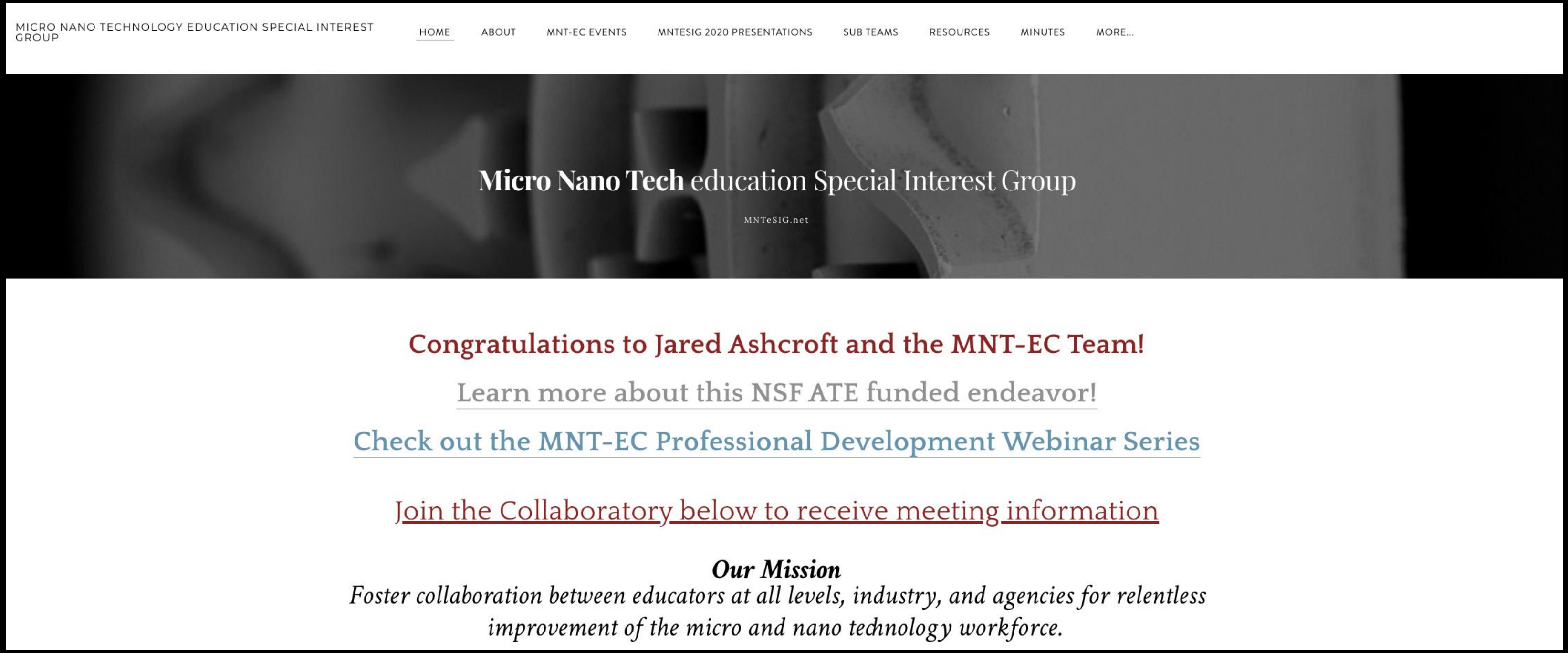
WHAT WE DO

- Educational Materials
  - Downloadable from SCME-Support. Org
  - Asynchronous online Short Courses at SCME.online
  - Hands-on Kits

MNT^eSIG
MICRO NANO TECHNOLOGY
education
SPECIAL INTEREST GROUP

MNTESIG COMMUNITY

- Online meetings
- Annual Conference
- Website: MNTeSIG.net
- Industry Map Project



PROFESSIONAL DEVELOPMENT & OUTREACH

- Support Faculty Professional Development with Cleanroom 1-week Pressure Sensor workshops.
- Conference workshops, webinars and one-to-one activities
- Fab tours, RAIN Sessions, speaking at STEM events

URE - UNDERGRADUATE RESEARCH EXPERIENCE

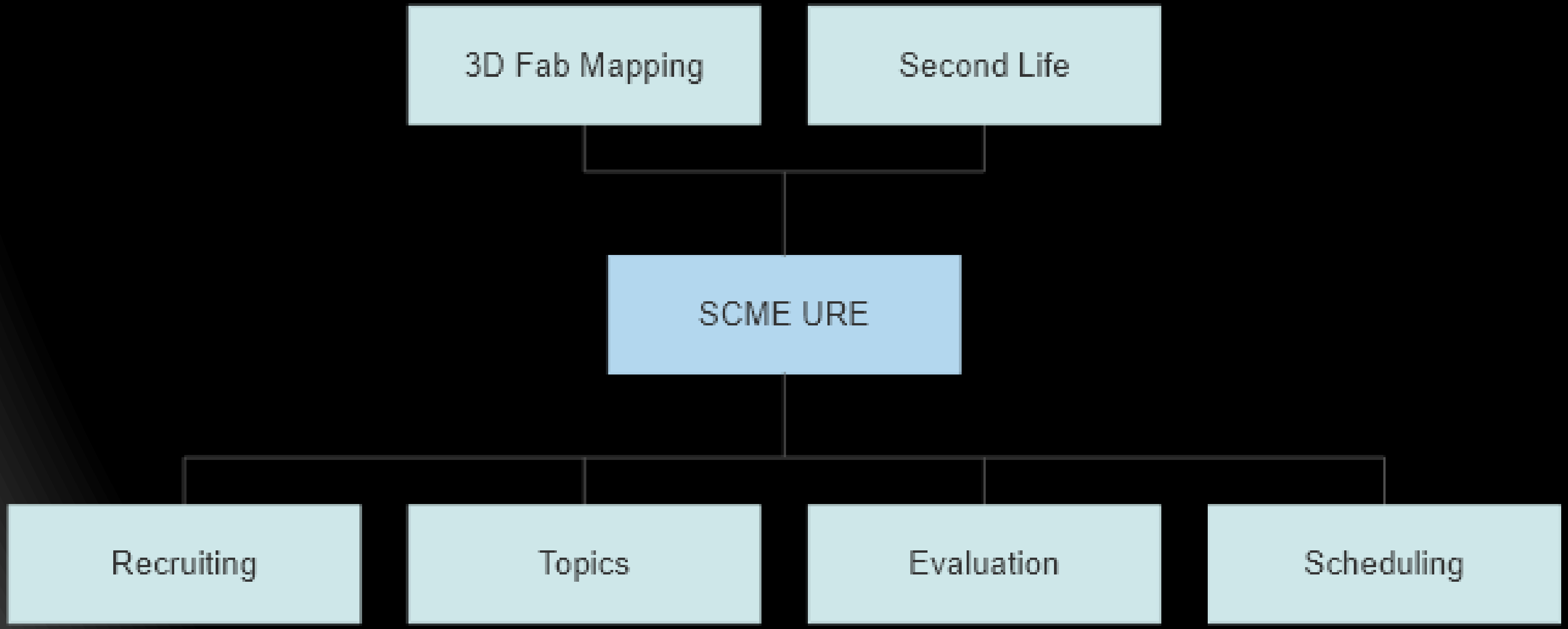
Targeting 2yr technician students

Primary Partners:

- Lone Star College – Danny Kainer, Pamela Auburn
- Pasadena City College - Jared Ashcroft
- Ivy Tech – Caitlin Cramer, Andrew Bell
- Rio Salado – Rick Vaughn

More Welcome!

URE KEY COMPONENTS



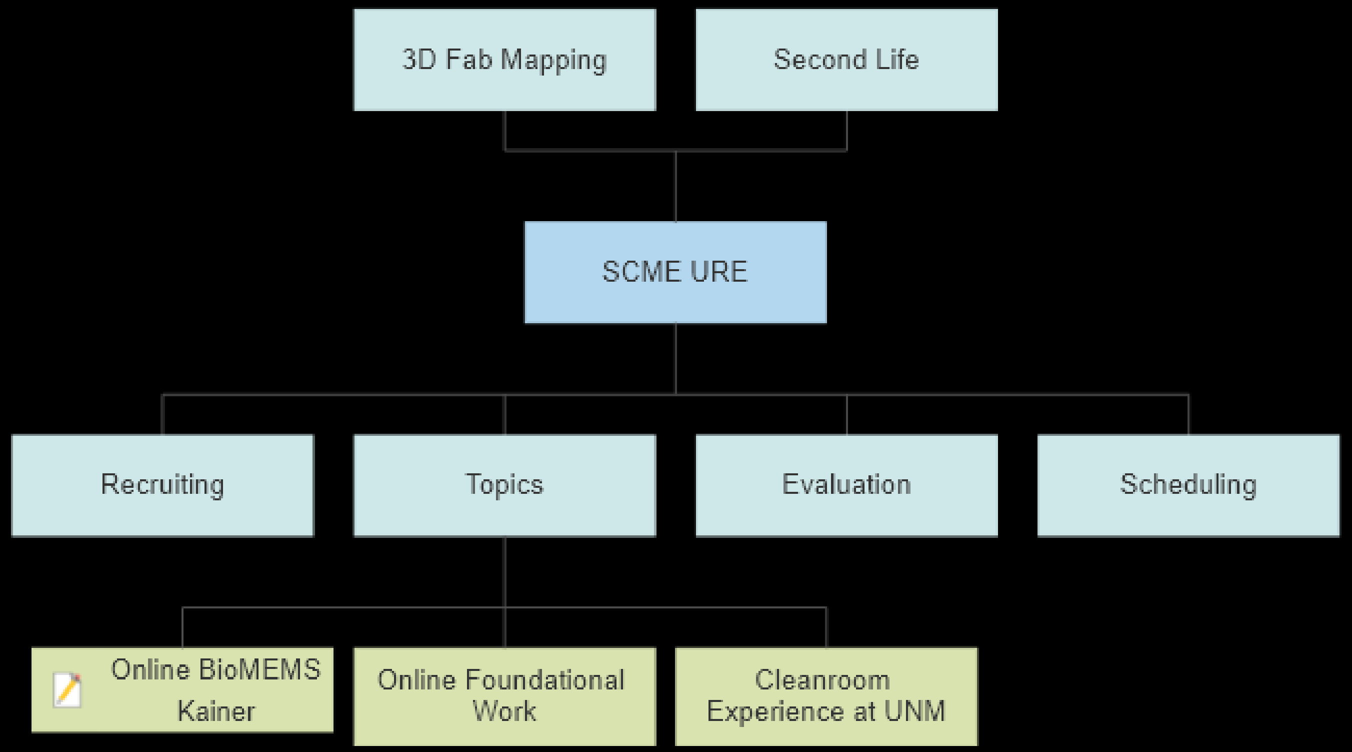
URE STRUCTURE

Recruit Students Fall 2020

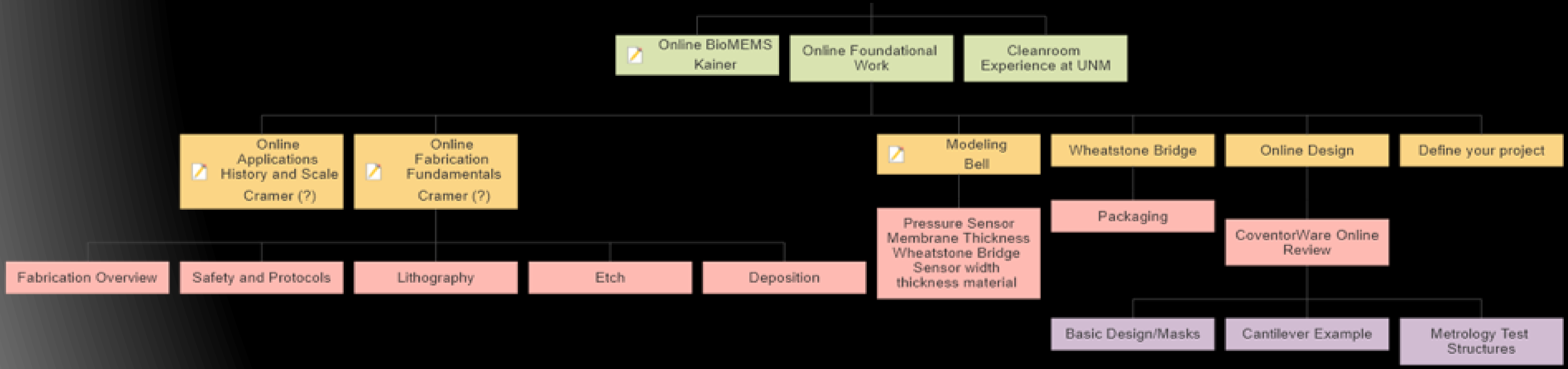
Set up online prep work – Fall 2020

Online short courses to students & faculty – Spring 2021

Plan and Execute Level 1,2 URE experiences at the University of New Mexico MTTC Cleanroom – Summer 2021



PROVIDE STUDENTS WITH EDUCATIONAL MATERIALS – SPRING 2020



Start with MEMS Overview (Applications and History)

Continue with Fabrication Overview

- Choose fabrication topics of interest
- Can include self study

Jackson, Kainer – BioMEMS

Pleil, Cramer – Fabrication

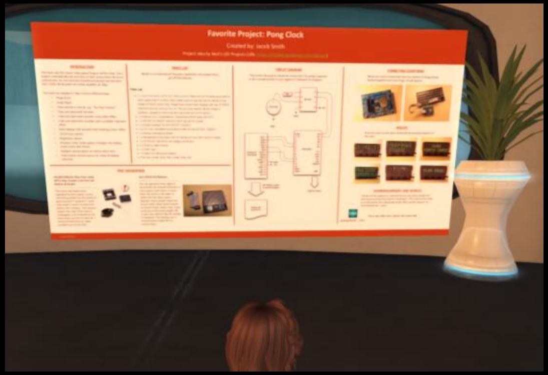
Bell, Jackson - Modeling

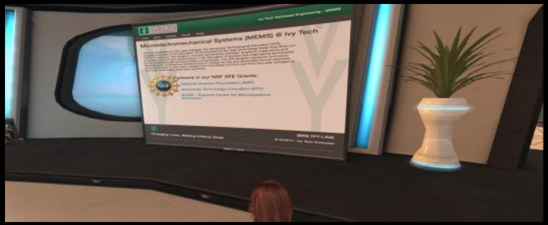
Online Safety Course

MANY TOPICS TO CHOOSE FROM

- Fabrication Process Characterization
  - Lithography
  - Wet and Dry Etch
  - Deposition – Sputter, Evaporation, CVD
- Electrical Characterization
- MEMS Design Principals
- Device Applications
- BioMEMS
- Flexible Electronics
- Modeling
  - Cantilever
  - Pressure Sensor
- Metrology
- Micro/Nano/Bio - DNA

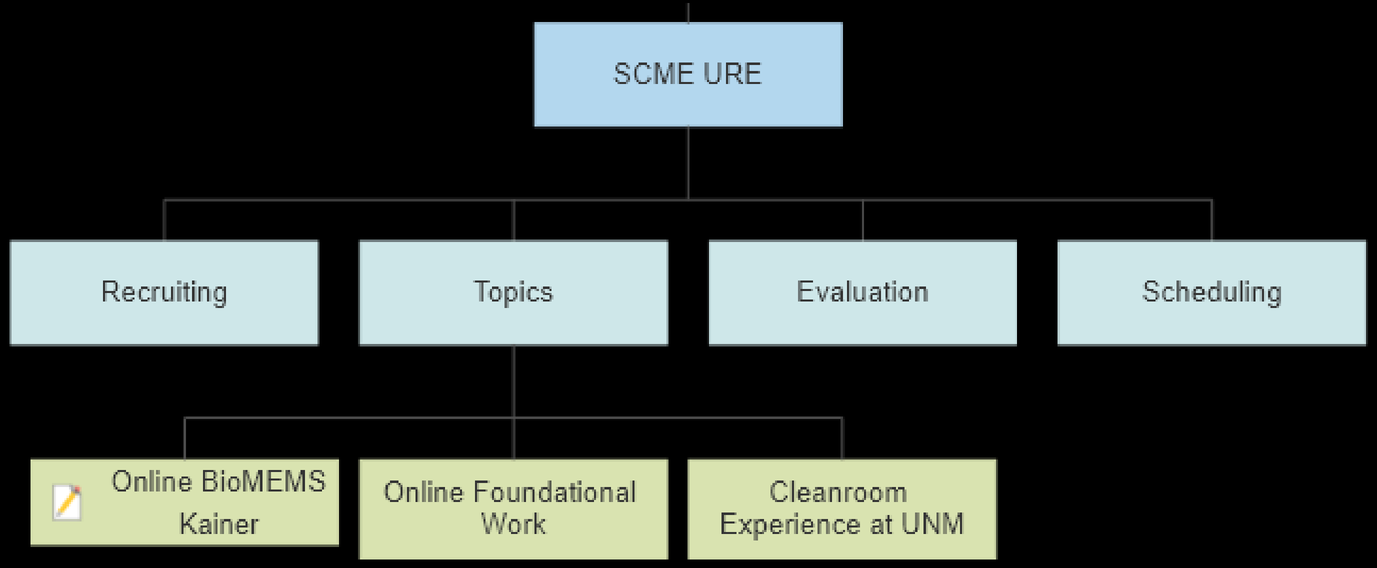
3D FAB TOUR AND SECOND LIFE



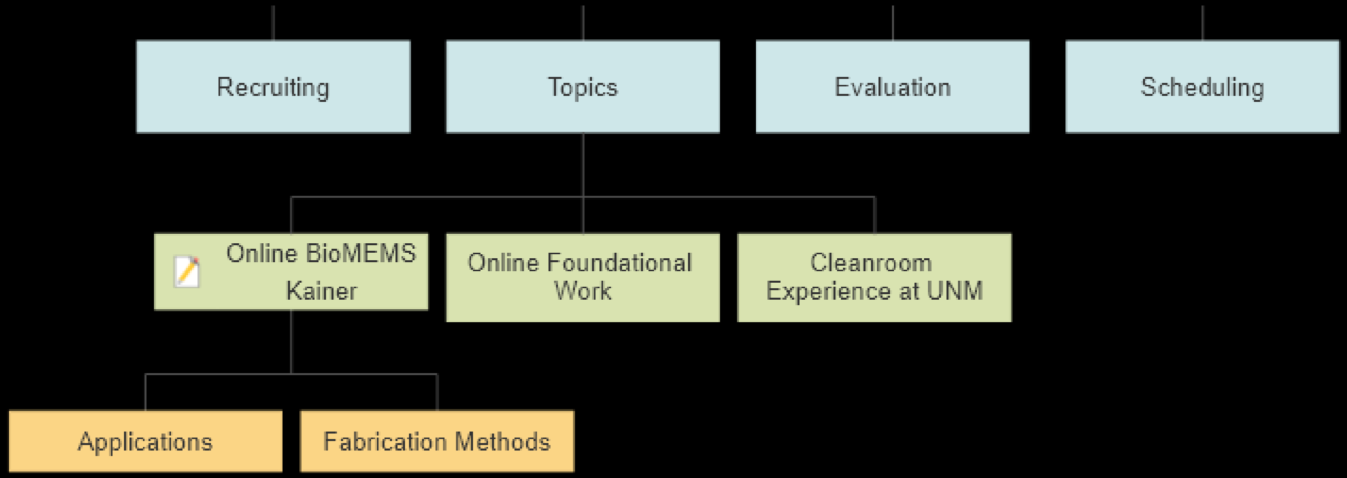


URE PROJECT TOPICS

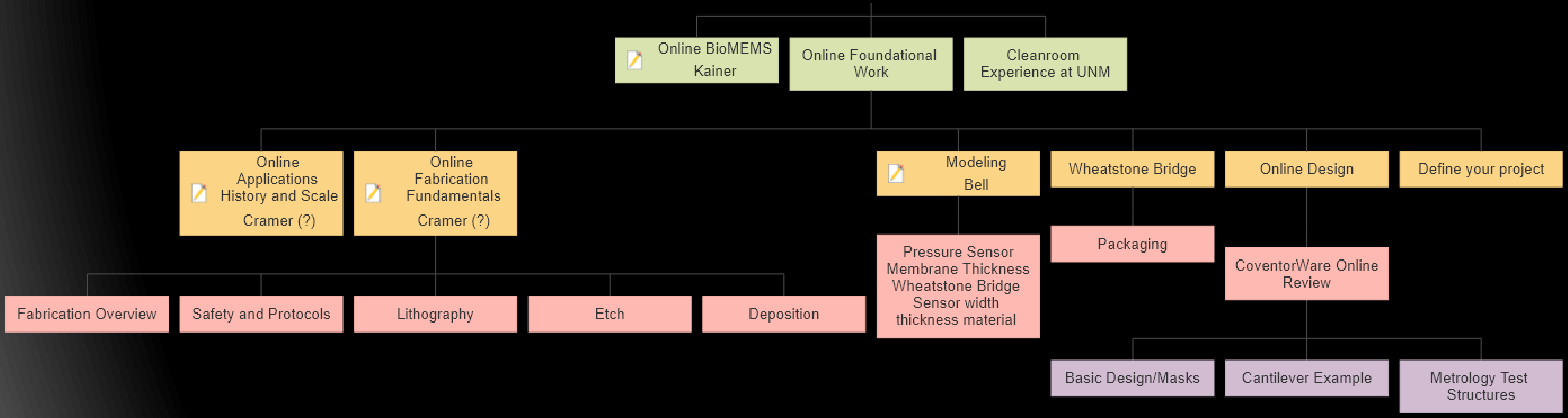
- Online
  - BioMEMS
  - Foundational Work
    - Fabrication
    - History/Applications
    - Cleanroom Safety
- Cleanroom Experience



- BioMEMS Overview
- BioMEMS Applications
- Biomolecular Applications for BioMEMS
- BioMEMS Therapeutics Overview
- BioMEMS Diagnostics Overview
- Clinical Lab Techniques & Microtechnology
- MEMS for Environmental & Bioterrorism Applications
- Cells - The Building Blocks of Life
- DNA Overview
- DNA to Protein
- DNA Microarrays



BIO MEMS ONLINE



ONLINE FOUNDATIONAL WORK

Asynchronous Short Courses and/or Educational Materials

MEMS FOUNDATIONS

APPLICATIONS, HISTORY AND SCALE

- History of Microsystems Technology
- Introduction to Sensors
- Introduction to Transducers
- Introduction to Actuators
- Career Pathways for Microtechnology
- Units of Weights and Measures
- A Comparison of Scale
- Introduction to SPC for Microtechnology
- Problem Solving for Microtechnology

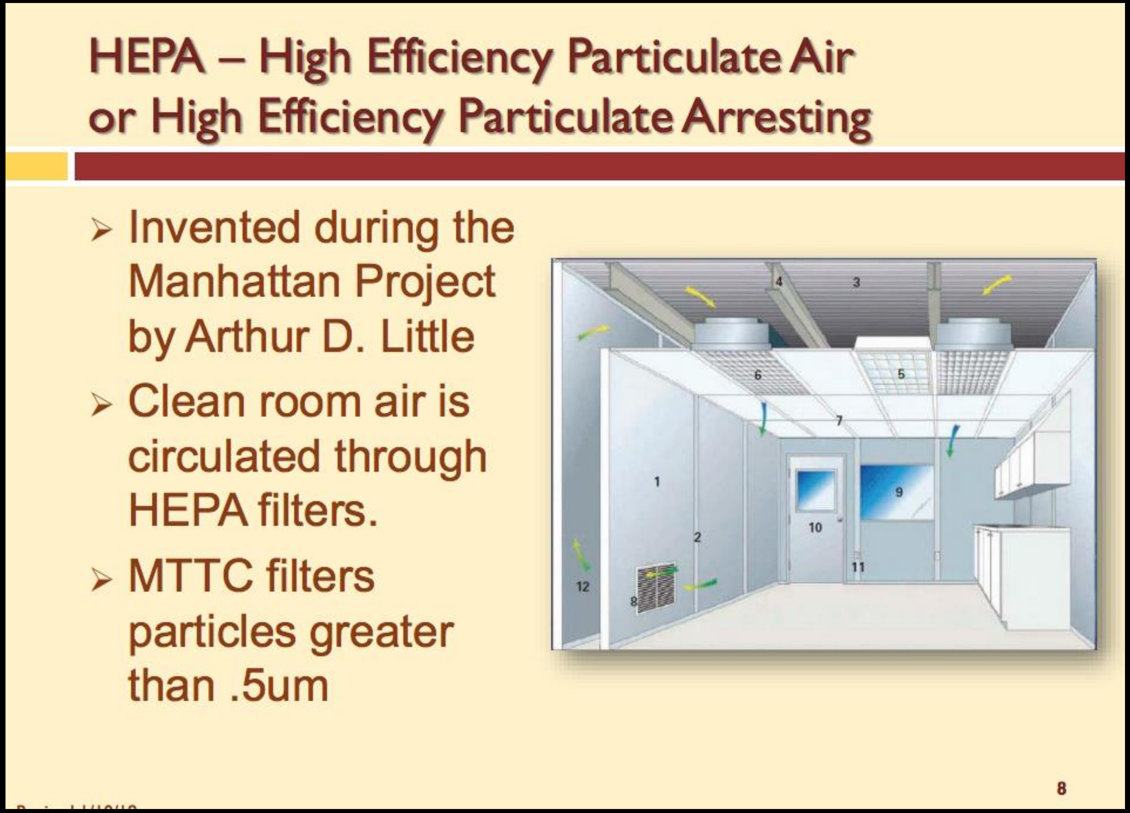
MEMS FABRICATION

Process

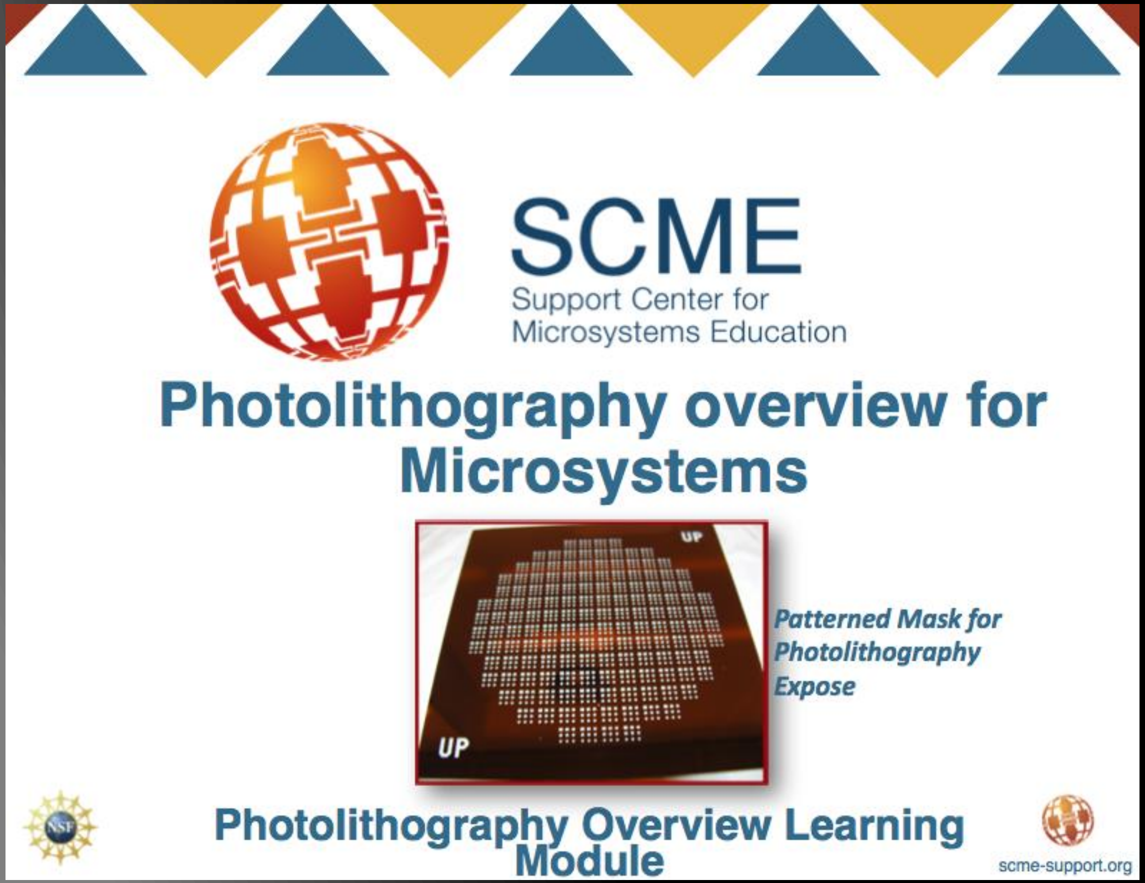
Materials

- Photolithography Overview for Microsystems
- Deposition Overview for Microsystems
- Etch Overview for Microsystems
- MEMS Micromachining Overview
- MTTC Pressure Sensor Process
- MEMS: Making Micro Machines Learning Module
- Crystallography for Microsystems

CLEANROOM SAFETY AND PROTOCOLS

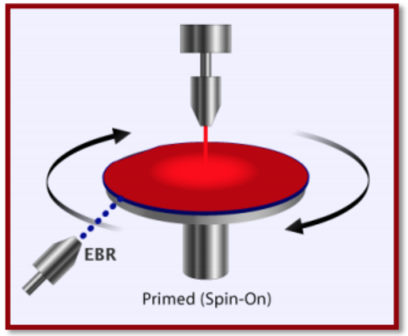


LITHOGRAPHY

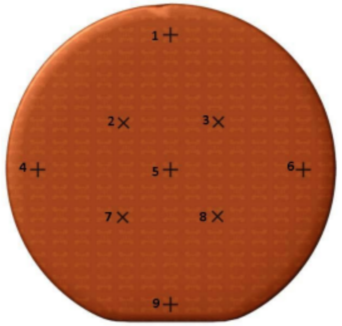


Spin coating is the most common method for coating a wafer; therefore, the data and references in this activity relate to a spin coat process. Here are the steps of that process:

- The wafer is placed on a vacuum chuck.
- A vacuum chuck holds the wafer.
- Photoresist is applied either before the chuck begins to spin (static dispense), or when the chuck starts to spin slowly (dynamic dispense).
- The chuck quickly accelerates to a pre-programmed rpm to spread the resist across the entire wafer.
- At maximum spin speed (SS) the excess resist is thrown off the wafer and a uniform resist thickness results.
- The chuck continues to spin until most of the solvents in the resist have evaporated.
- While the chuck is spinning, acetone is sprayed on the bottom edge of the wafer to eliminate resist "beading" on the wafer's edge (EBR ="edge bead removal").



The final photoresist thickness is a factor of its viscosity and the final spin speed of the chuck (the "casting speed"). After this coating process, photoresist thickness is measured to ensure that it is within specifications for mean and uniformity. In an automated test, dozens of film thickness points are measured on a single wafer. For the purpose of this activity, we acquired the data manually using an ellipsometer. Nine measurements were taken in a radial pattern across the wafer: one measurement at the center, four on a circle approximately half the radius of the wafer and four more measurements close to the edge of the wafer. The image shows a resist coated wafer and the placement of the nine test points (TP). Using these nine TPs, the thicknesses can be averaged to identify the mean film thickness of the wafer, and the standard deviation (STD) or range, can be determined. Data is usually presented and tracked as the mean ± 3STD written as $\bar{x} \pm 3\sigma$



In this activity you will be given a data set of measured film thicknesses. You will use this information to determine the relationships between film thickness and spin speed as well as film thickness and resist viscosity.

ETCH

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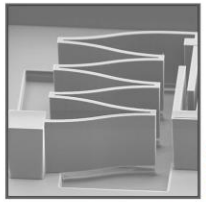
Microsystems Education

Etch overview for microsystems



MEMS Leaf Spring - expands and contracts above the substrate [Graphics courtesy of Khalil Najafi, University of Michigan]

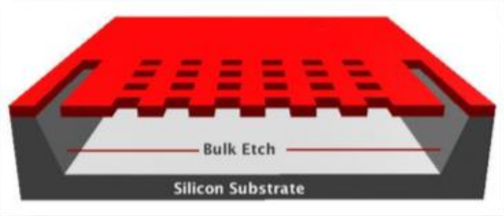
Etch for Microsystems Learning Module

scme-support.org

Release Etch

- The material underneath the object is removed to "release" the object.
- Specific etch processes remove select material from underneath the structural layer without affecting the structural layer.
- The etched material (or sacrificial layer) may be another surface layer *(left graphic)* or bulk material from within the silicon substrate *(right graphic)*.

A bulk etch was used to create an opening under a perforated membrane. This process is called Bulk Micromachining.



Part of a Gear Train built using Surface Micromachining Technology. Sacrificial layers were etched (removed) in order to create released or moveable devices. [Image courtesy of Sandia National Laboratories, www.mems.sandia.gov]

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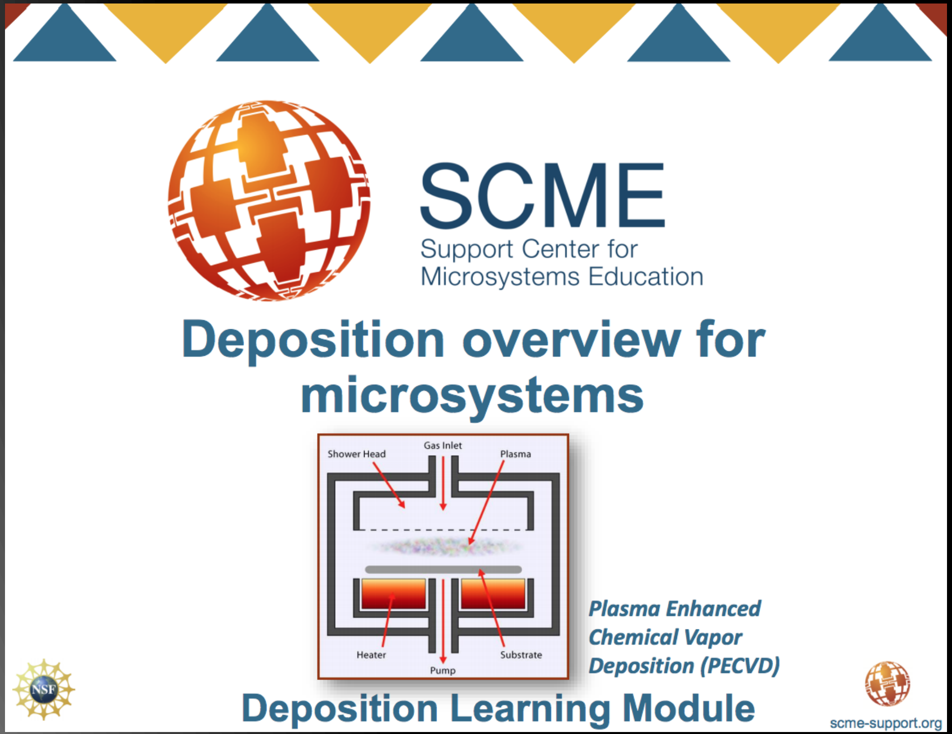
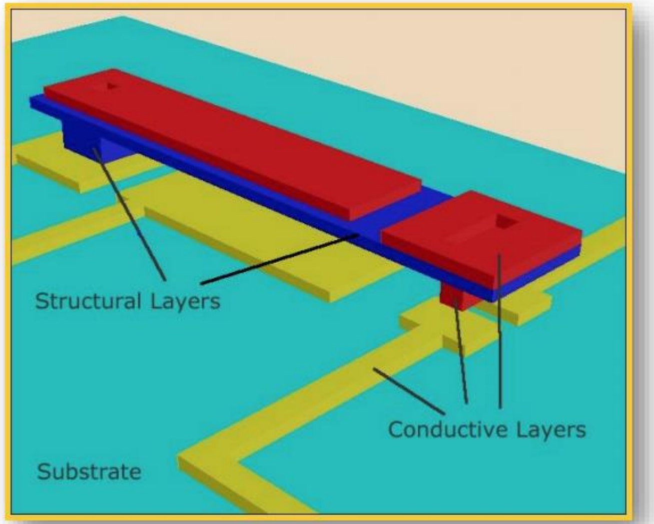
DEPOSITION



Function of a Deposited Layer

- Insulating layer
- Sacrificial layer
- Conductive layer
- Structural layer
- Protective layer
- Etch stop layer
- Etch mask layer



Different Layers for building a MEMS [Khalil Najafi, University of Michigan]

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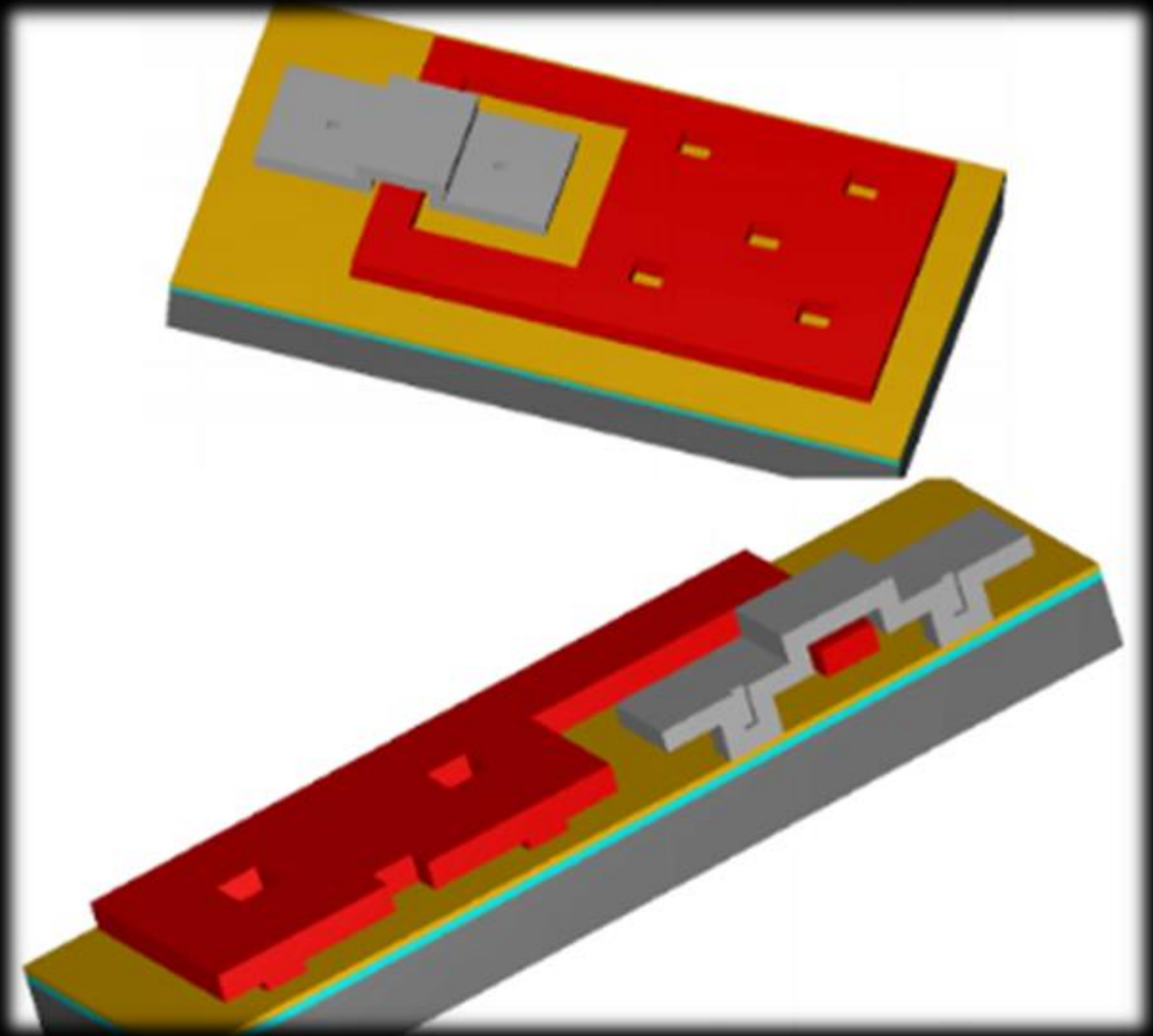
DESIGN WITH COVENTORWARE

Making Masks

Design to a Process

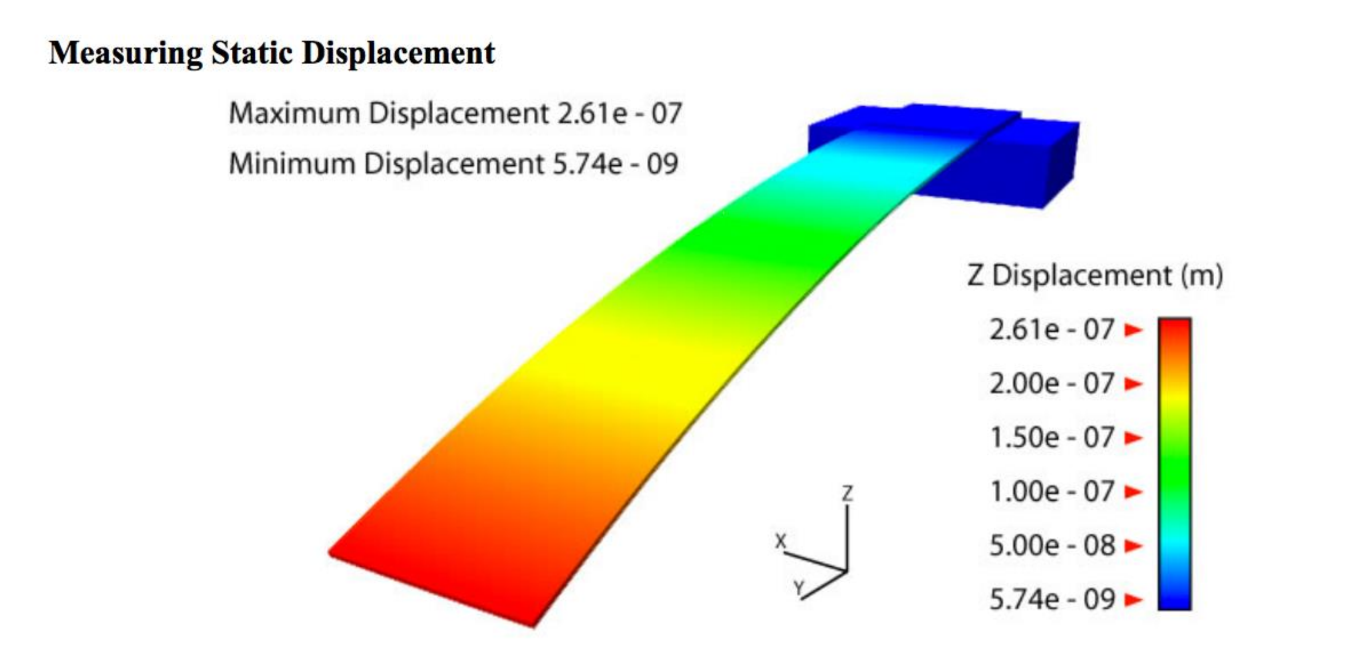
Cantilever Example

Characterization (Metrology) Test Structures



MODELING

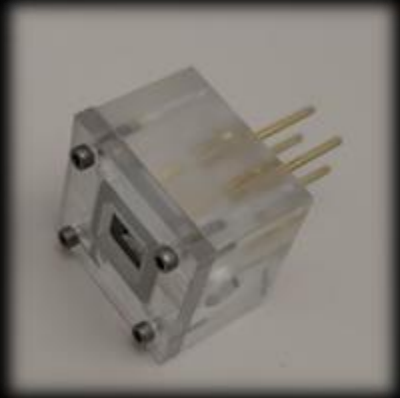
Access to Coventorware software

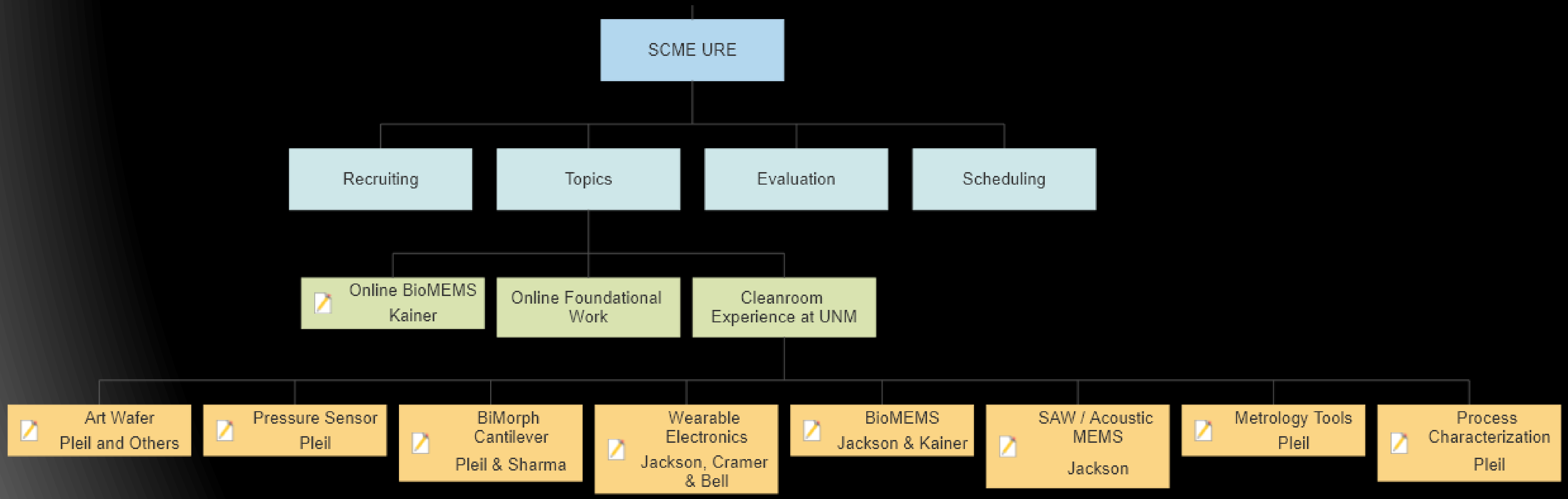


A finite element analysis (FEA) model showing Microcantilever Displacement under Stress

WHEATSTONE BRIDGE

- Includes Hands-on Kit
- Package Project





CLEANROOM EXPERIENCE

Putting the Online to Work!

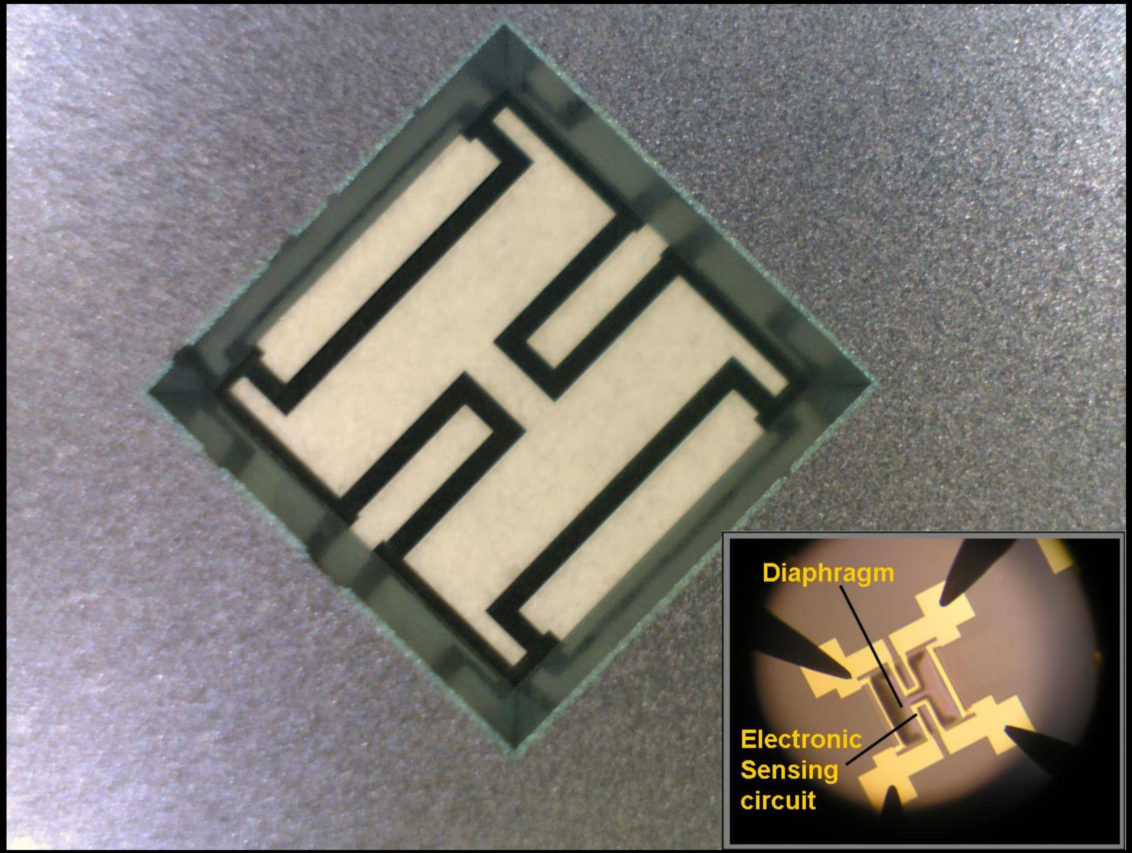
ART WAFER

Basic Photolithography and Wet Etching hands-on experience

3hrs plus online prep work

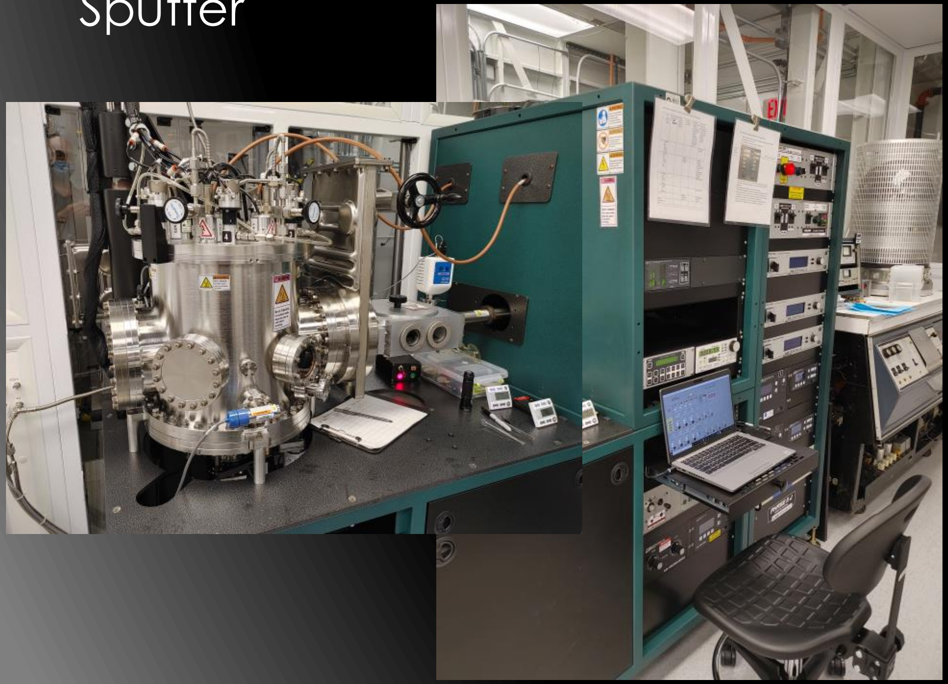
PRESSURE SENSOR PROCESS

- 1 week cleanroom experience
- Simple two – mask layer process
- Backside (chamber) pattern
- SiN Etch (DRIE)
- Frontside (Wheatstone Bridge) pattern
- Sputter Deposition
- Liftoff
- KOH Anisotropic Etch
- Characterization



DEPOSITION

Sputter



Parylene

Oxide

LITHOGRAPHY

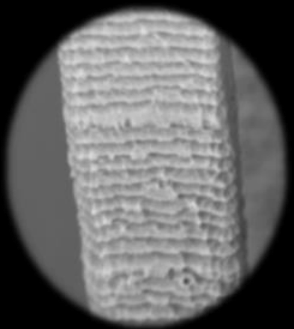
Coat

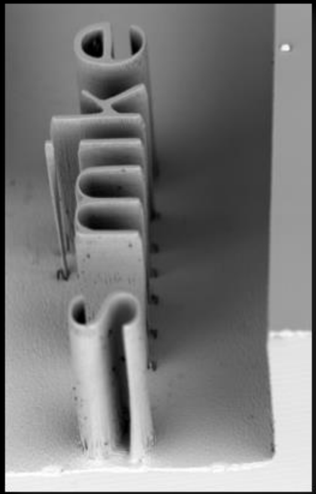
Expose

Develop

Spin Rinse Dry

ETCHING

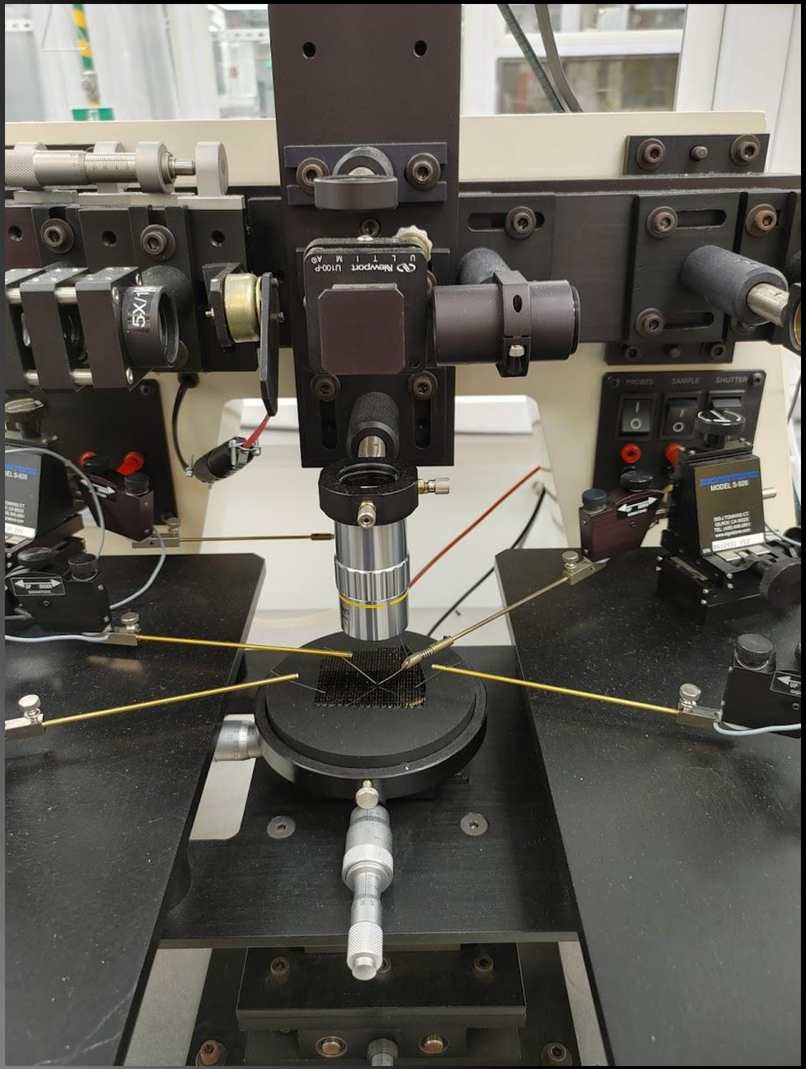




March Reactive Ion Etcher

Alcatel Deep Reactive Ion Etcher

ELECTRICAL PROBE

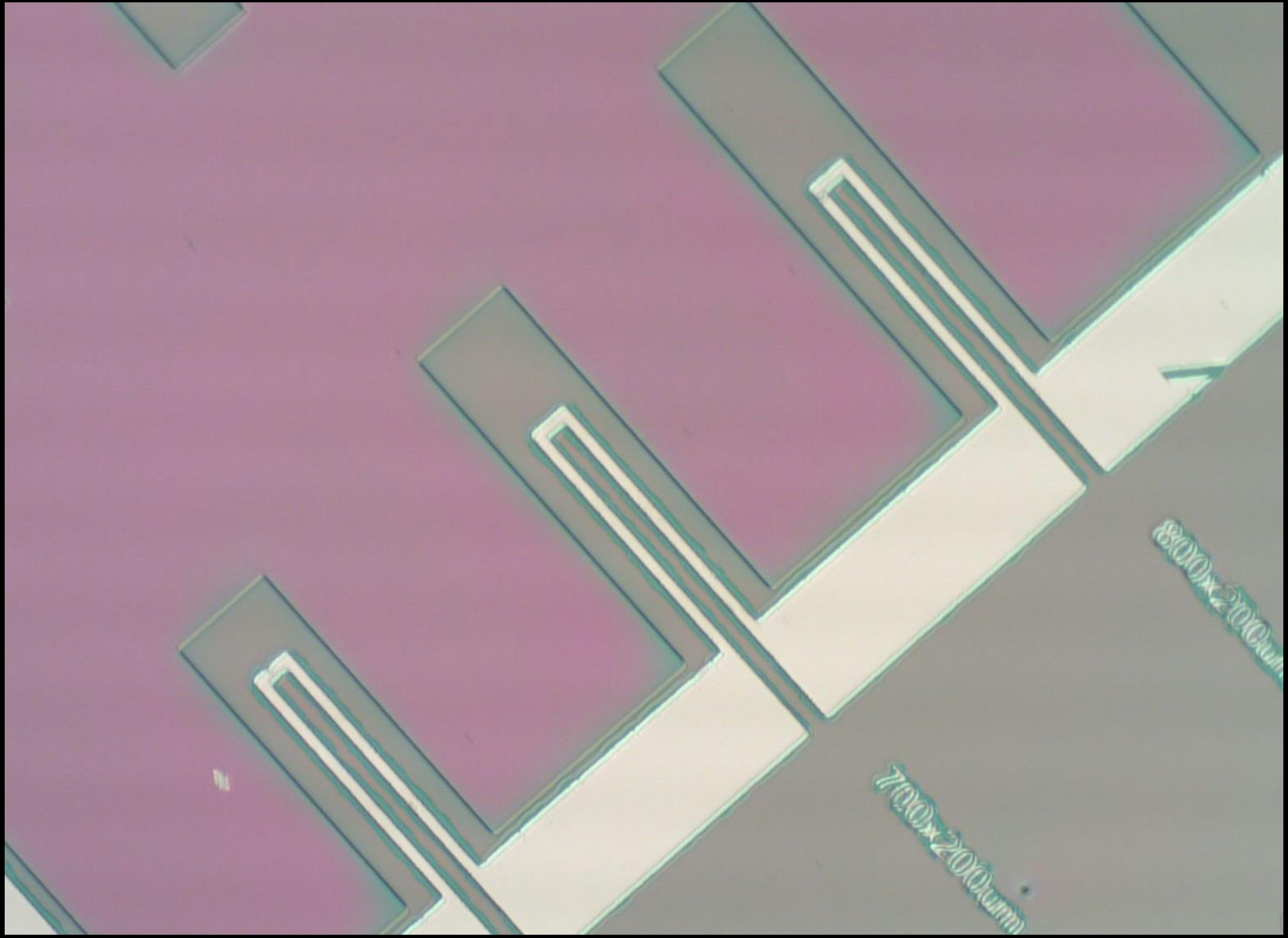


Wafer Test with z-displacement

BI MORPH CANTILEVER

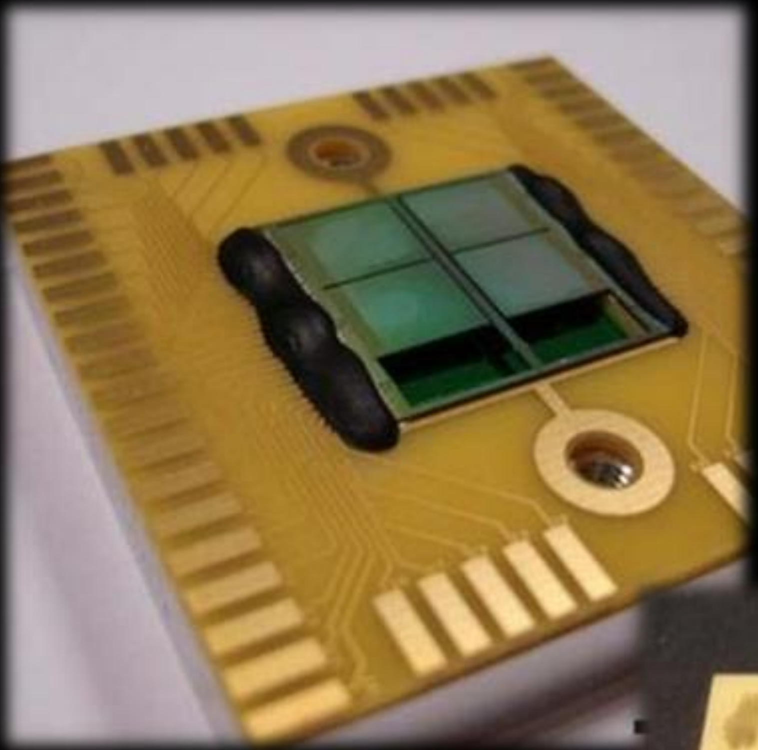
1 week cleanroom experience

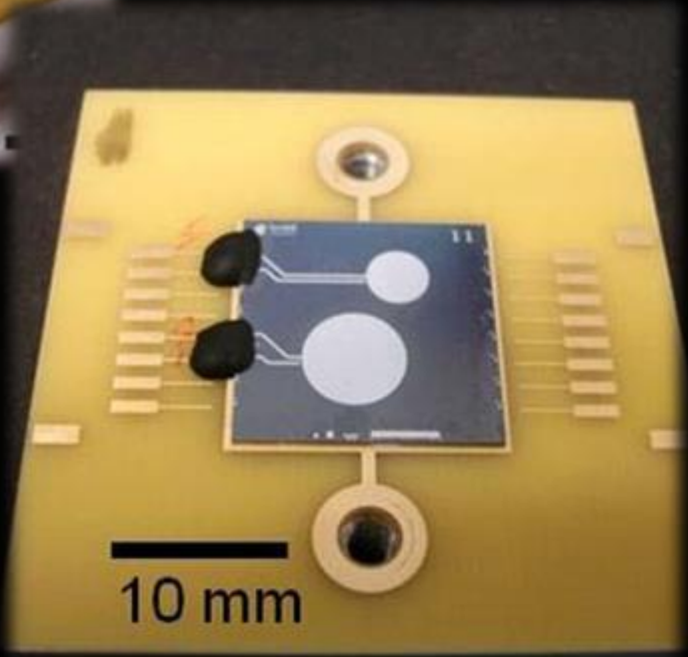
Simple two – mask layer process



HANDS-ON BIO APPLICATIONS

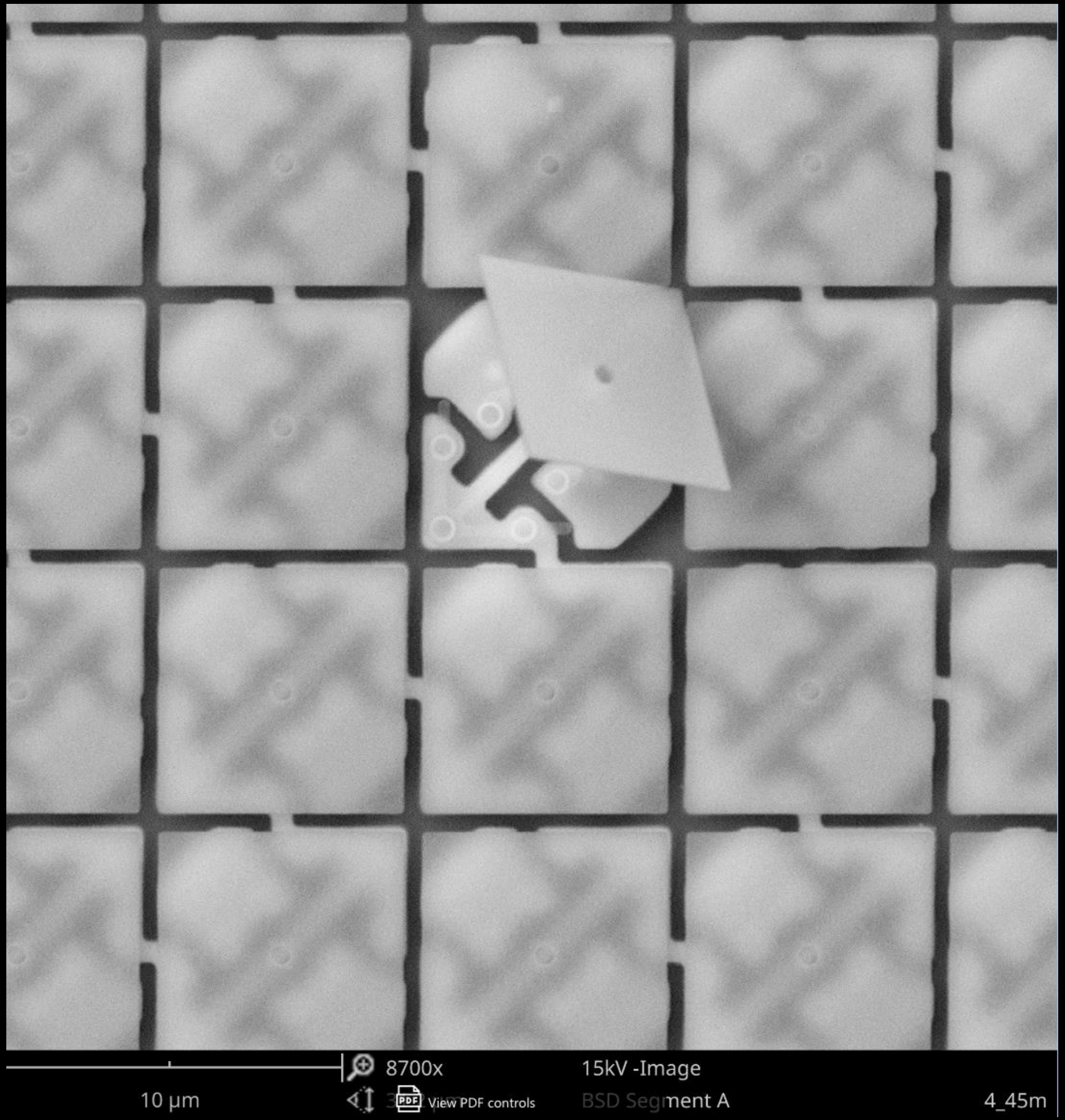
BIOMEMS DEVICES
WEARABLE ELECTRONICS
SURFACE ACOUSTIC WAVE
ENERGY HARVESTERS
MICRO FLUIDICS





METROLOGY TOPICS

SEM
THIN FILM MEASUREMENT
PROFILOMETER
PROBE STATION



PROCESS CHARACTERIZATION EXAMPLES

ETCH – WET, DRY, DRIE

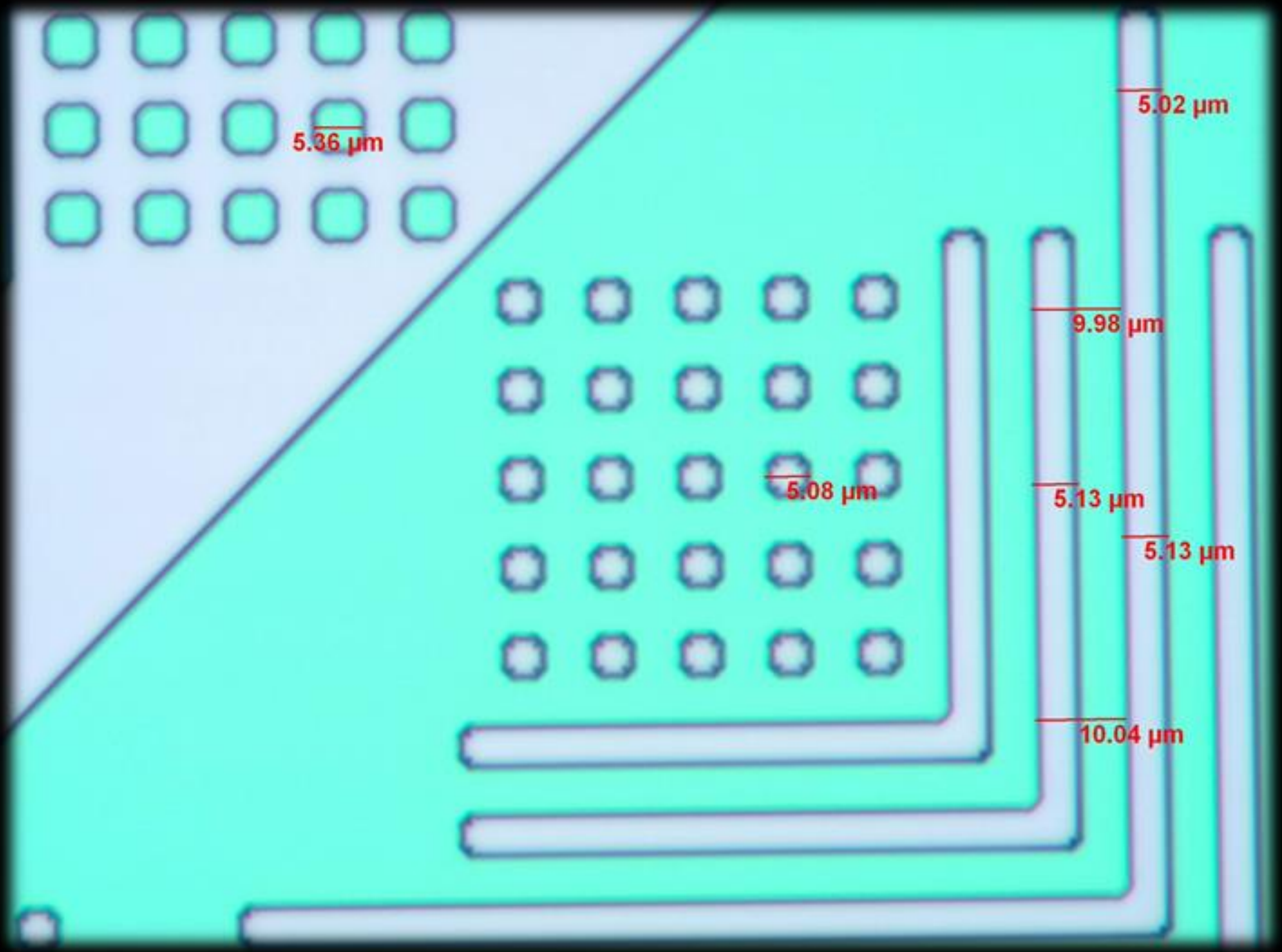
- RATES
- SELECTIVITY
- PROFILES

LITHOGRAPHY

- DOSE TO CLEAR
- CD VS MASK (BIAS)
- SOFT BAKE VS PHOTOSPEED
- SPIN SPEED CURVES
- POST EXPOSURE BAKE VS RESIST PROFILES

DEPOSITION

- OXIDE GROWTH
- SPUTTER



ADDITIONAL OPPORTUNITIES
GET INVOLVED!

- MNTeSIG – Micro Nano Technology Education Special Interest Group

Our Mission

Foster collaboration between educators at all levels, industry, and agencies for relentless improvement of the micro and nano technology workforce.

www.MNTeSIG.net

MNTeSIG
MICRO NANO TECHNOLOGY
education
SPECIAL INTEREST GROUP

MORE OPPORTUNITIES

ATMAE

- ATMAE – Association of Technology, Management and Applied Engineering
  - MNT Focus Group
  - Virtual Conference Nov. 4th-6th in conjunction with IAJC, International Association of Journals and Conferences

ATMAE
LEAD • INNOVATE • COLLABORATE
The Association of Technology, Management, and Applied Engineering

COMS 2020 Virtual Conference

THEME: CONVERGENCE OF TECHNOLOGIES

HTTPS://COMSWORLD2020.COM/

OCTOBER 19-OCTOBER 22

MANCEF
COMSWORLD 2020

QUESTIONS?

mpleil@unm.edu

MNT^eSIG
MICRO NANO TECHNOLOGY education SPECIAL INTEREST GROUP

NSF

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