THE UNIVERSITY of NEW MEXICO

Parylene Deposition

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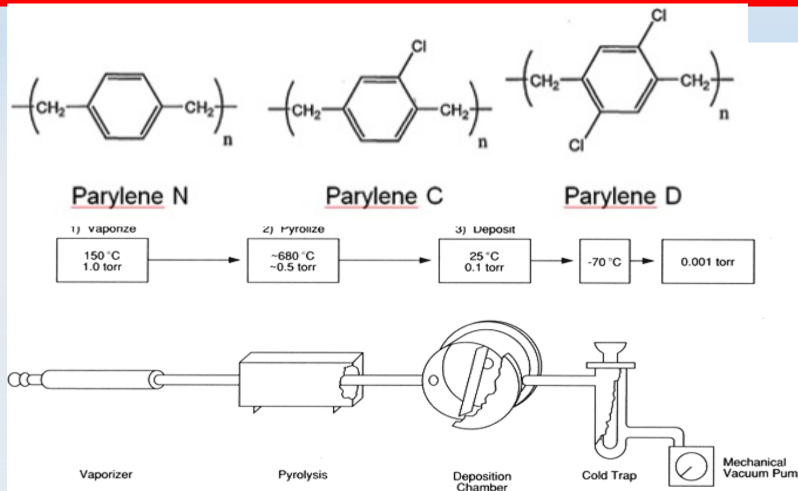
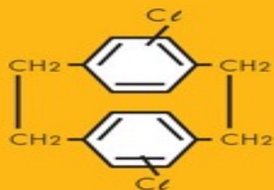
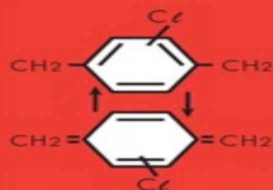
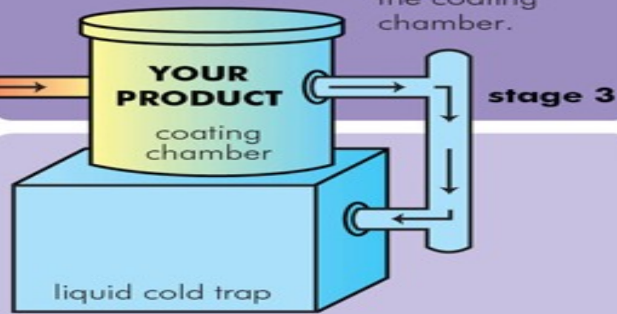
April 2026

Parylene (deposition (polymer CVD))

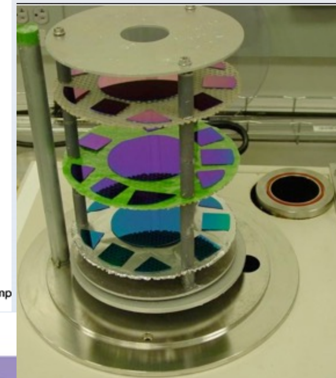








- Polymer deposited by CVD
- Pin hole free deposition (200nm-40um)



Parylene Applications

- Stent Coatings
- PCB or IC coating (moisture barrier)
- Biocompatible Coating
- MEMS
- Microfluidics
- Corrosion or Abrasion Protection
- Reduce Friction for catheters/needles
- Syringe coating
- Stretchable or Flexible Circuits
- Photonics Packaging (transparent properties)
- Organic LED's
- Fab process (shadow mask, acid/solvent protection layer, etc..)
- Coating for any Biomedical device
- ETC…

Parylene Properties

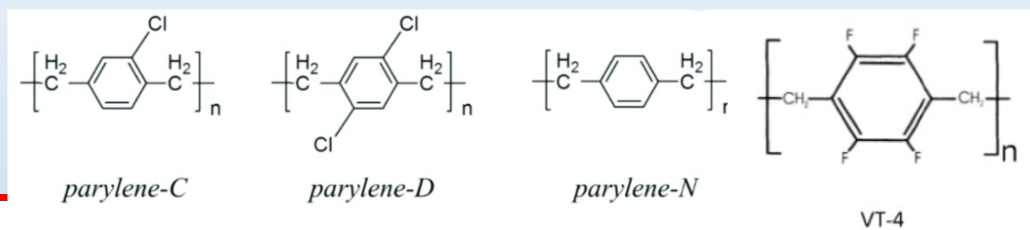


TABLE 5: Parylene Physical and Mechanical Properties

	Method	Parylene N	Parylene C	Parylene D	Parylene HT	Acrylic (AR)[a,b]	Epoxy (ER)[a,b]	Polyurethane (UR)[a,b]	Silicone (SR)[a,b]
Secant (Young's) Modulus (psi)	1, 2	350,000	400,000	380,000	370,000	2,000 – 10,000	350,000	1,000 – 100,000	900
Tensile Strength (psi)	3	7,000	10,000	11,000	7,500	7,000 – 11,000	4,000 – 13,000	175 – 10,000	350 – 1,000
Yield Strength (psi)	3	6,100	8,000	9,000	5,000	–	–	–	–
Elongation to Break (%)	3	Up to 250	Up to 200	Up to 200	Up to 200	2 – 5.5	3 – 6	>14	100 – 210
Yield Elongation (%)	3	2.5	2.9	3.0	2.0	–	–	–	–
Density (g/cm^3)	4	1.10 – 1.12	1.289	1.418	1.32	1.19	1.11 – 1.40	1.10 – 2.50	1.05 – 1.23
Index of Refraction (n_D^{23})	5, 6	1.661	1.639	1.669	1.559	1.48	1.55 – 1.61	1.50 – 1.60	1.43
Water Absorption (% after 24 hrs)	7	Less than 0.1	Less than 0.1	Less than 0.1	Less than 0.01	0.3	0.05 – 0.10	0.6 – 0.8	0.1

TABLE 4: Parylene Thermal Properties

	Method	Parylene N	Parylene C	Parylene D	Parylene HT	Acrylic (AR)	Epoxy (ER)	Polyurethane (UR)	Silicone (SR)
Melting Point (°C)[a]	1	420	290	380	>500	85 – 105[b]	NA	~170[b]	NA
T5 Point (°C) (modulus = 690 MPa)	2, 3	160	125	125	377	–	110	~30	~125
T4 Point (°C) (modulus = 70 MPa)	2, 3	>300	240	240	>450	–	120	–	~80
Continuous Service Temperature (°C)	–	60	80	100	350	82[b]	177[b]	121[b]	260[b]
Short-Term Service Temperature (°C)	–	80	100	120	450	–	–	–	–
Linear Coefficient of Thermal Expansion at 25°C (ppm)	4	69	35	38	36	55 – 205[b,c]	45 – 65[b,c]	100 – 200[b,c]	250 – 300[b,c]
Thermal Conductivity at 25°C (W/(m•K))	5, 6	0.126	0.084	–	0.096	0.167 – 0.21[c,d]	0.125 – 0.25[c,d]	0.11[c,d]	0.15 – 0.31[c,d]

Very good Gas Barrier properties about 10,000x better than silicone

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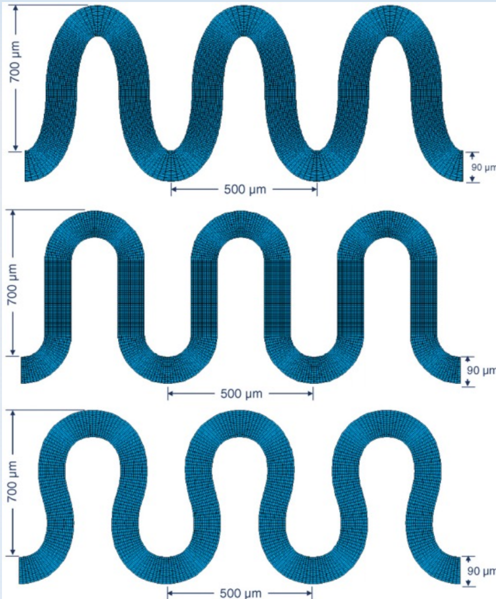
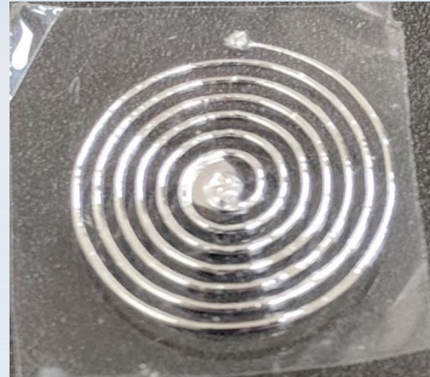
Stretchable and Flexible Electronics

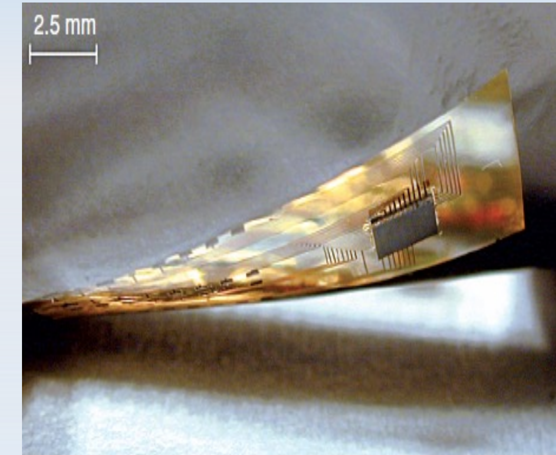
Interconnect design





Jackson et al 2018

Embedded Electronics



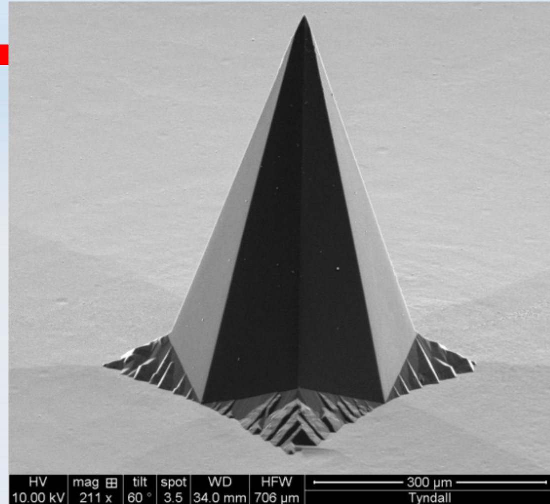
Cal tech 2007

Parylene balloon for MEMS actuation

Cal tech 2006

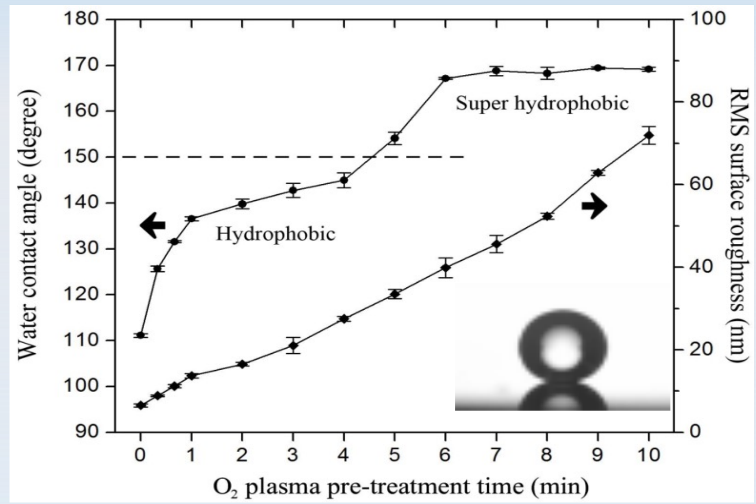
Coatings

Coating of Micro-Needles

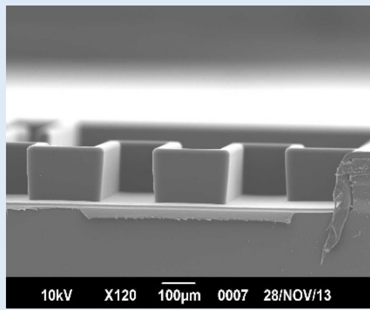


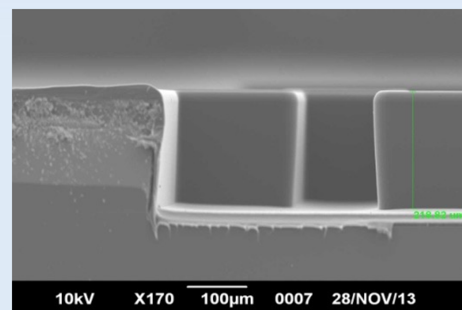
Jackson et al.

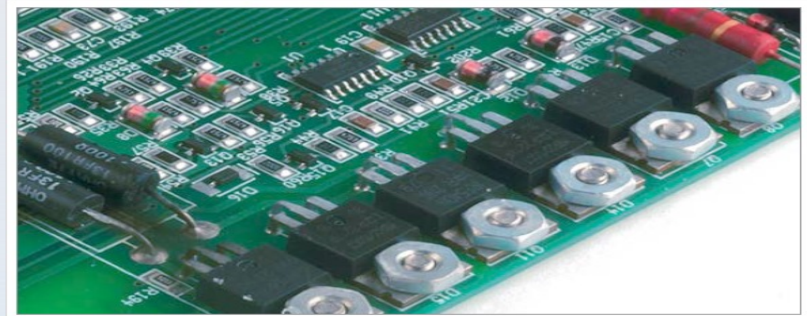
Parylene- into Super Hydrophobic Coating



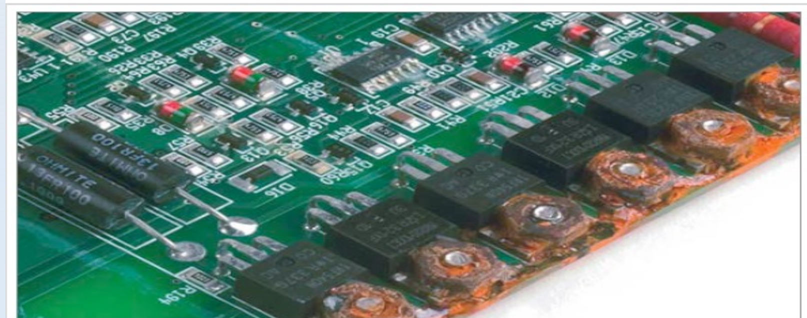
Transparent Polymer coating for 3D Micro structures







Coated with SCS Parylene HT

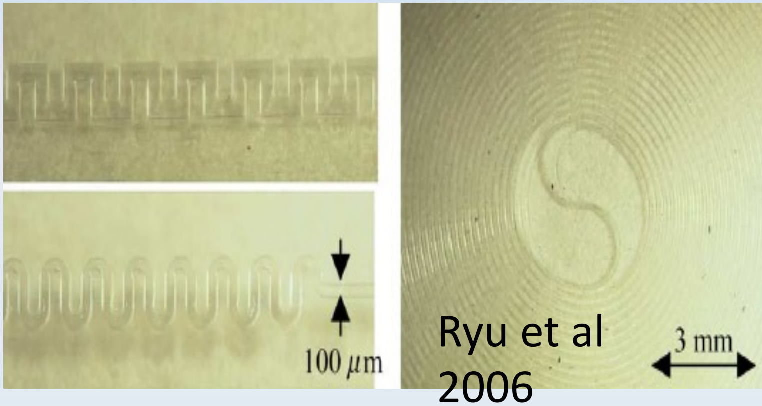


Uncoated

Coating of PCB as moisture barrier

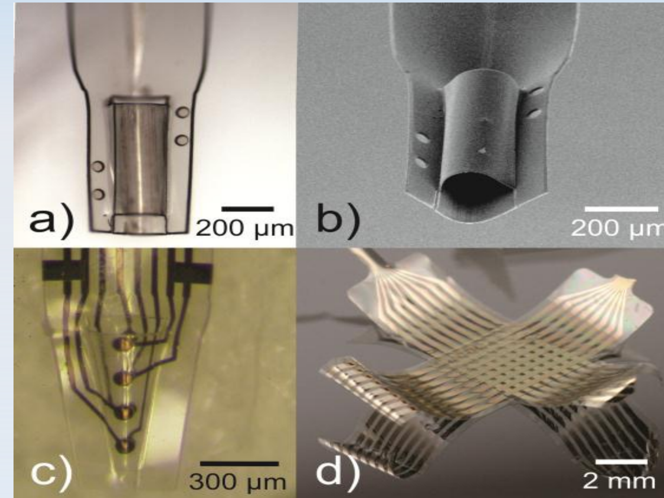
Parylene Structures

3D Microfluidic Channels



Ryu et al 2006

Thermoforming Neural Electrodes

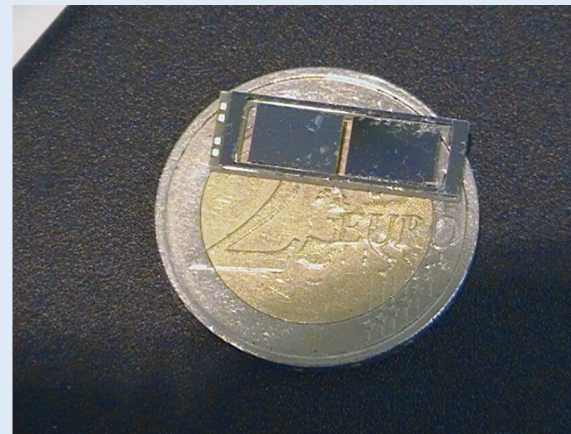


Jonathan et al. 2013

Shadow Mask Layer for Microfabrication

Selvarasah et al. 2008

MEMS Cantilever for Energy Harvester



Jackson et al.)

Parylene Summary

- Parylene is a polymer that is deposited using CVD (resulting in conformal pin hole free films)
  - Excellent moisture barrier, gas barrier, FDA compatible, transparent, flexible, somewhat stretchable, can handle elevated temperatures, and deposited at Room Temperature.

- If you have an application or want more information contact Dr. Jackson (njack@unm.edu)

Sputtering Deposition

MTTC Sputtering Capabilities

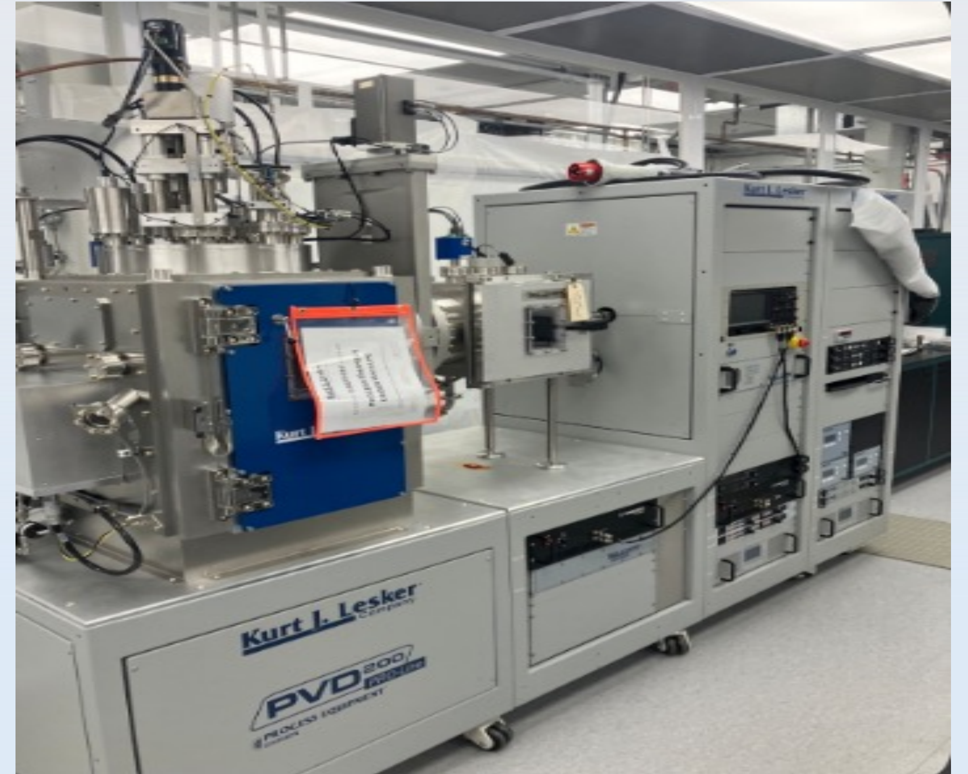
AJA 5 target Sputtering System (workhorse)
Good for most applications

AJA Multi-gun Sputter system MTTC Plaza Photo 2021

Capabilities:

- 5 targets/guns
- Power source: DC, RF, Pulsed DC
- Substrate Temperature Control
- Reactive and Co-sputtering technology
- Materials
  - Single metals, dielectrics, some ternary materials (Al_2O_3, ZnO etc…)

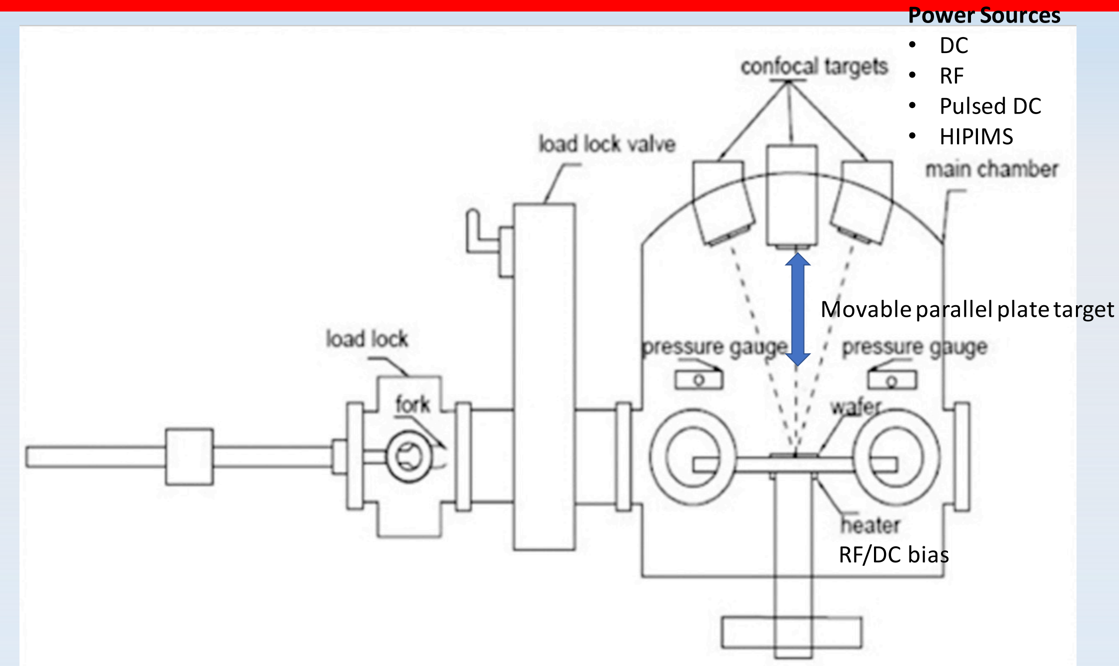
New SOA Custom Designed Sputter



- ❑ Tool was designed for Ternary or Quaternary Nitride Films
- ❑ Currently used for AlN and alloys

New Sputtering Tool Capabilities

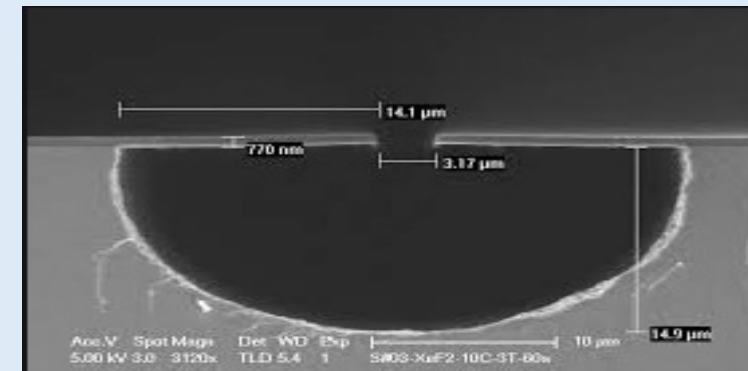
- ❑ Features of the New Sputter
  - ❑ Can handle up to 8” wafers
  - ❑ 4 confocal targets and 1 central target
    - ❑ Central target can alter target to substrate distance (to alter mean free path)
  - ❑ Power sources (2- DC, 2 RF, 2 Pulsed DC, and 2 HIPIMS (high power impulse magnetron)
- ❑ Temperature control (up to 800°C)
- ❑ RF Substrate Bias
- ❑ Ion Beam Etching (for pre-clean of wafer)
- ❑ Ultra high vacuum (base pressure <1 x10^{-7} Torr)
- ❑ Integrated Ellipsometer (thickness measurements)
- ❑ Reactive Co-sputtering



XeF_2 for Silicon Etching

XeF_2 Etching Basics

- XeF_2 is a non-plasma Gas etching process for performing Isotropic Etching of Silicon
- Etches:
  - Silicon, polysilicon, Ge and Mo (~ 1-10 µm/min)
  - Can also etch W, Ti, TiN, TiW (process not developed at MTTC yet)
- Excellent Selectivity
  - SiO_2 ~10,000:1
  - Does not etch photoresist, Al, Cr, AlN, Al_2O_3, PDMS, etc…



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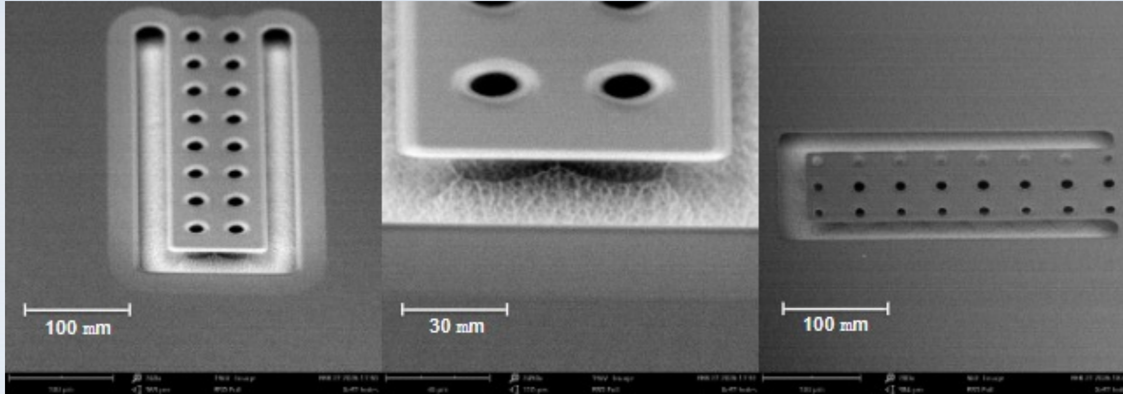
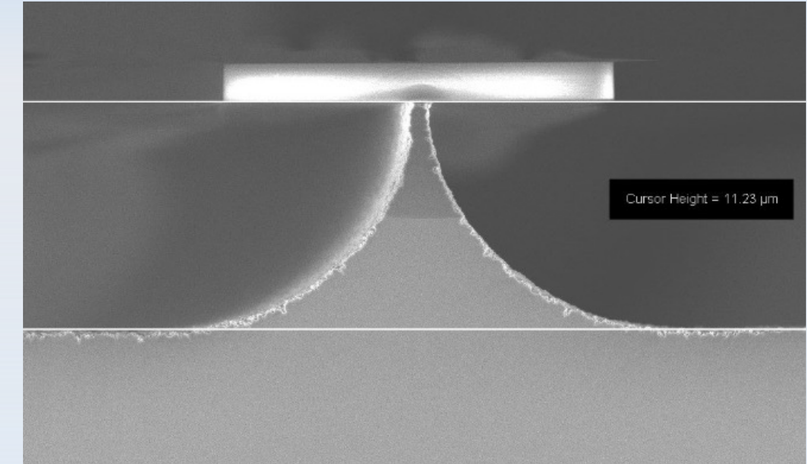
Cantilever Release

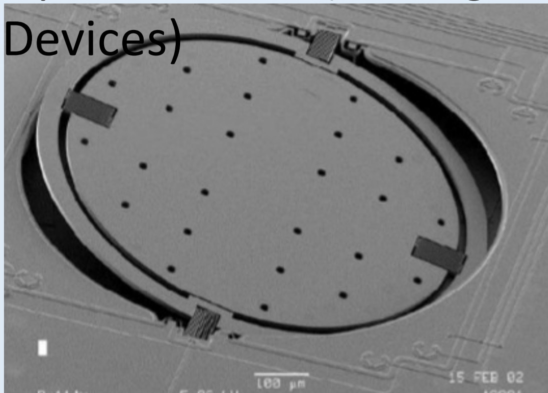


Trung et al 2026 (UNM)

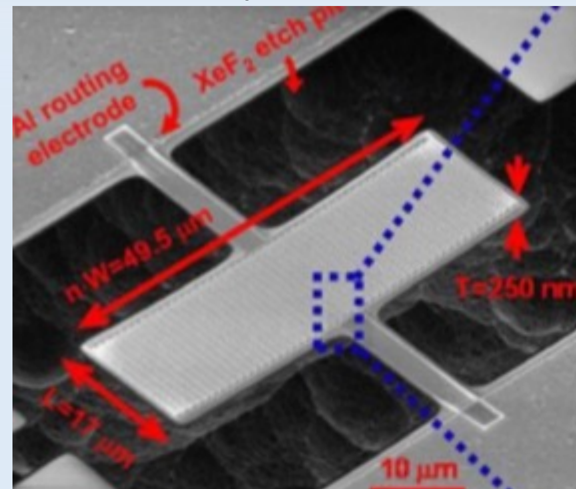
Needles or AFM Tips



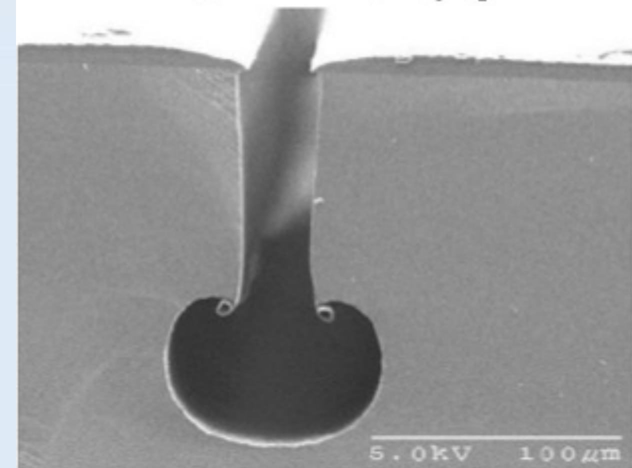
Optical Mirror (Analog Devices)



RF MEMS (Gianluca U. Penn)



Cooling Tubes, C_4F_8 Mask



Carnegie Mellon University

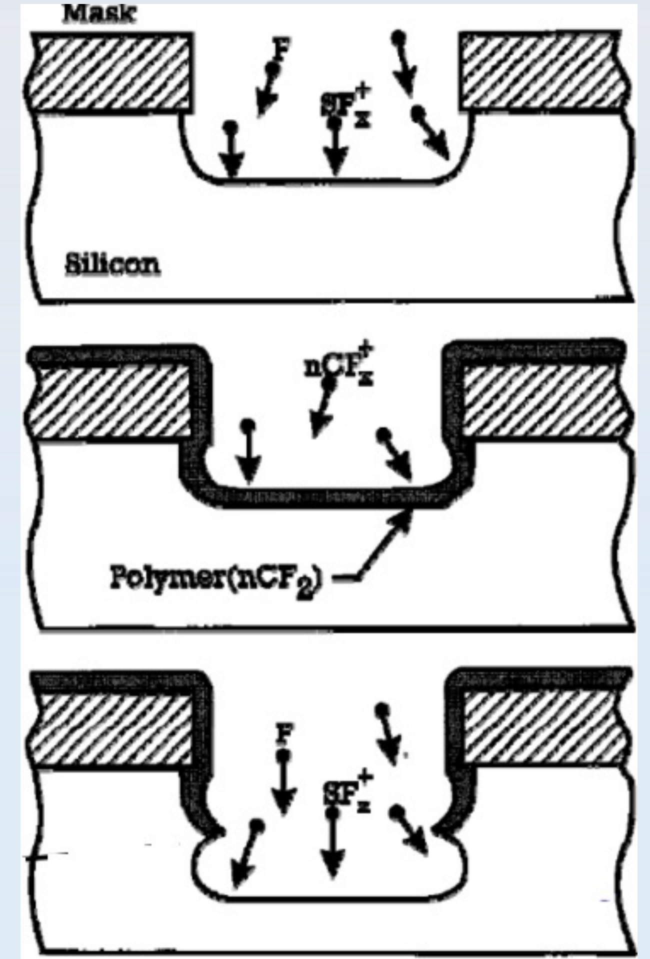
Deep Reactive Ion Etching (DRIE) aka Bosch Process for Silicon Etching

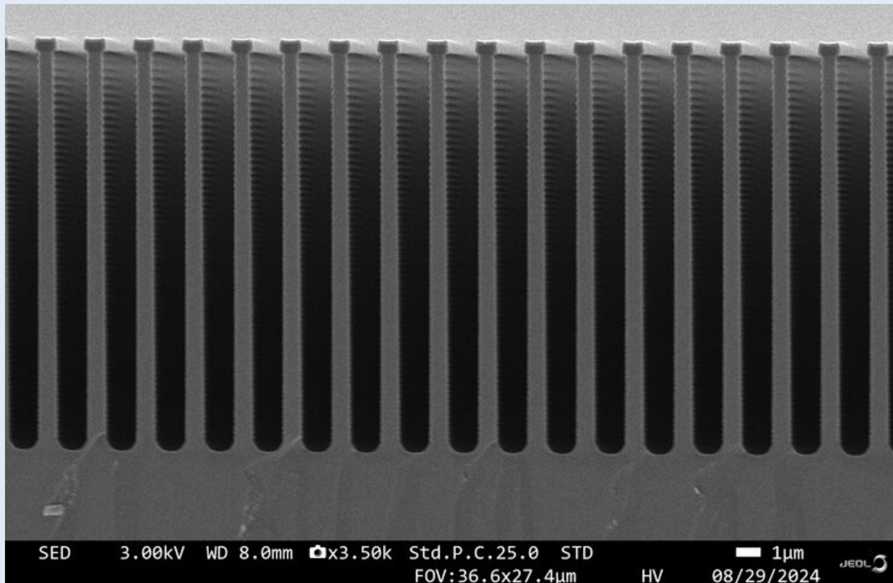
DRIE Etching Basics

- Invented in Mid 90's for etching thick films of Si (Anisotropic near 90° side wall)

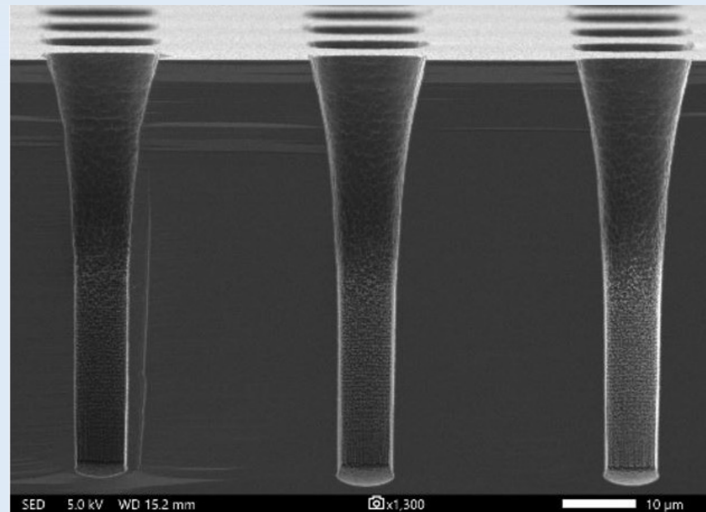
- Uses High Density Plasma
- Alternates between etch cycle and depositions cycle
  - SF_6 (etching) and C_4F_8 (passivation)

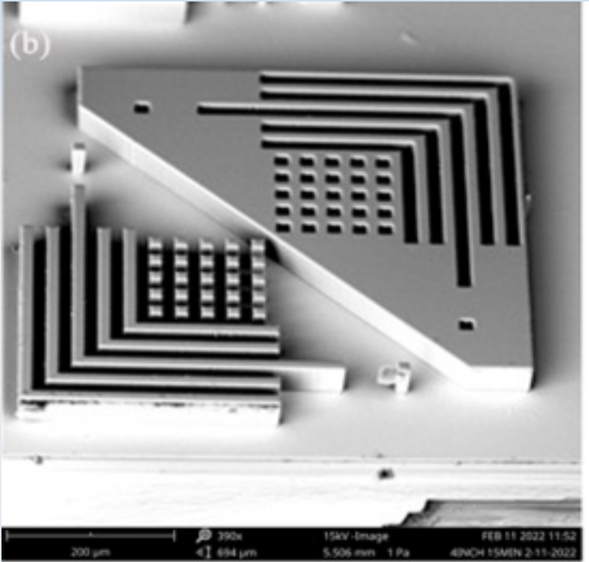
- Good selectivity to SiO_2, Nitride, or Photoresist (100:1)

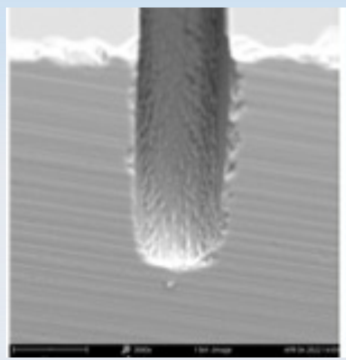




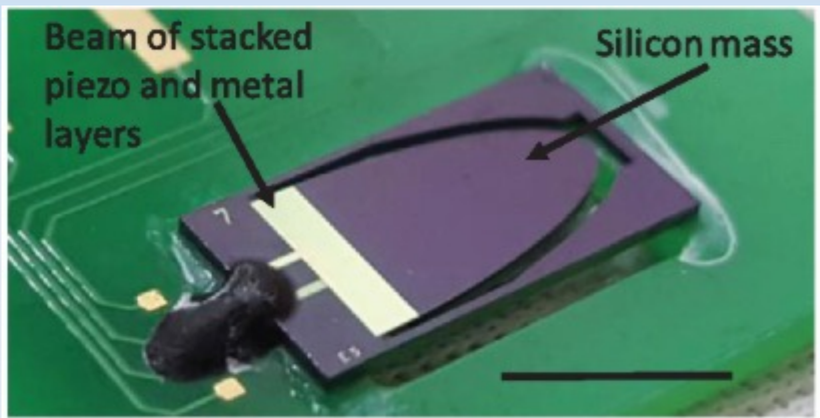
Through Silicon Vias channel formation

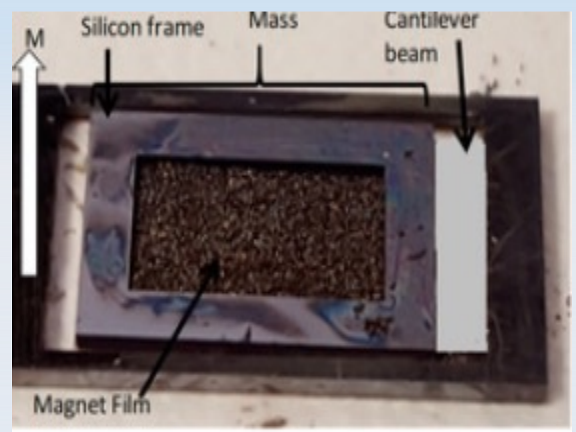






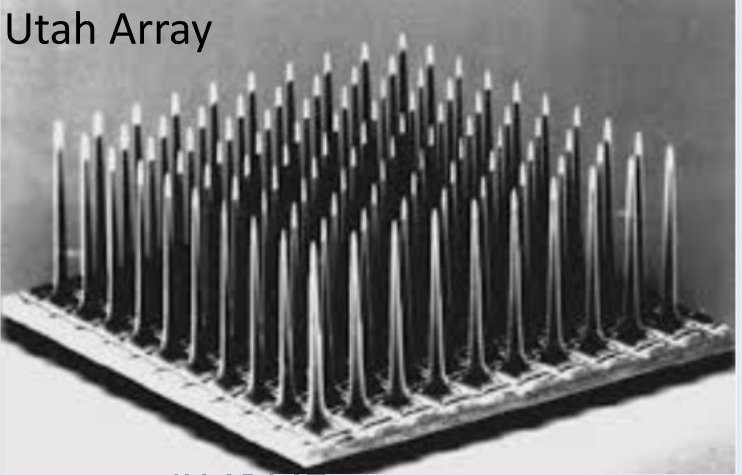
Pallavi et al 2022 (UNM)



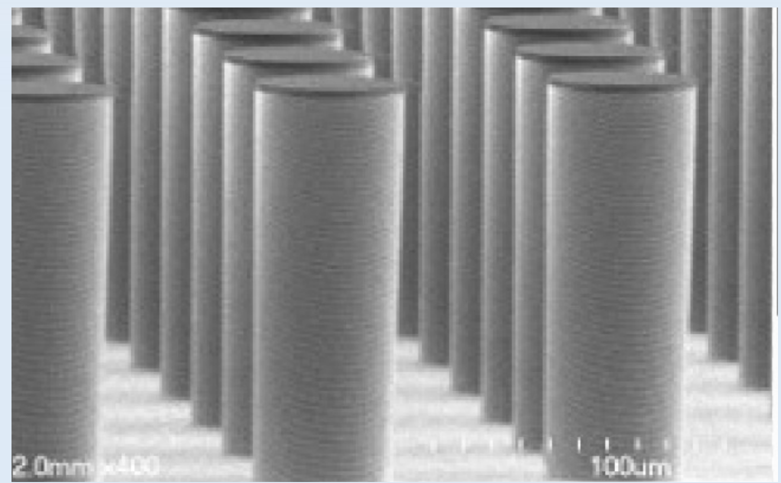


Jackson et al (2018) Energy harvester (Pacemaker)

Implantable Neural Electrodes
Utah Array



Pillars and Phononic Crystal Waveguides



Resonators