ME 411 / ME 511

Biological Frameworks for Engineers

Gical Frameworks for Engineers



Class Organization

- Lab 2
 - Report due Friday
- Exam 1

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- Available online on Friday
- Take home (honor code)
- Due Friday Nov 1
- Tiny Workhorses
 - Solo project
 - No partnerships





Micro and Nano Fabrication

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In the beginning...

Vacuum Tube



- Gate electron flow
- Warm up

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- Glowed! Bugs!

• Solid State Transistor



Bardeen & Brattain, Phys Rev, 74, 230 (1948)



Integrated Circuits

• Circa 1960



Intel 133 MHz Pentium 3.3 million transistors 0.35 micron Litho 4 layer metalization • Circa 1990



Moore's Law



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Gordon Moore, "Cramming more components onto integrated circuits", Electronics, April 19, 1965





Microelectronic Processes

- Czochralski Process
- Oxide Growth
- Lithography
- Ion Implantation
- Thin Film Deposition
 - Physical Vapor Dep. (PVD)
 - Chemical Vapor Dep. (CVD)
- Chemical Etching
 - Wet Chemical Etching
 - Dry Plasma Etching
- Chemical-Mechanical Polishing (CMP)

Richard C. Jaeger "Introduction to Microelectronic Fabrication, 2nd Ed." Stephen A. Campbell "The Science and Engineering of Microelectronic Fabrication"



Microfabrication

Bulk Micromachining

- Wet Chemical Etching
- Plasma Etching

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- Inductively Coupled Plasma
 Reactive Ion Etching (ICP-RIE)
- Deep Reactive Ion Etching (DRIE)
- Surface Micromachining
 - MEMSCAP's MUMPs Process
 - Sandia's SUMMiT Process
 - ADI's optical iMEMS Process
 - LIGA process

Marc Madou "Fundamental of Microfabrication" Nadim Maluf "An Introduction to MEMS Engineering"



Lithography



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- Patterning
 - Photoresist
 - Expose
 - Develop
 - Etch!
- Positive Resist
 - Light makes it soluble in developer
 - Negative Resist
 - Light causes it to polymerize and resist developer



Soft Lithography

- SU-8
 - Epoxy-like negative photoresist
- PDMS
 - Glass-like silicone rubber
- Applications
 - Microcontact printing
 - Microfluidics
 - Cell-based assays

a) Fabricate master mold.







c) Cure PDMS and remove.



d) Punch-out reservoirs and seal onto bottom wafer.







cal Frameworks for Engineers Duffy et al., "Rapid Prototyping of Microfluidic Systems in PDMS," Anal Chem 1998 70:4974

Tools for Cells



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WASHINGTON





Sniadecki & Chen (2007) In *Methods in Cell Biology - Cell Mechanics, Vol.*83. Chapter 13:313

* (tridecafluoro-1,1,2,2-tetrahyrooctyl)-1-trichlorosilane

Micro-contact Printing





Sniadecki, N.J., Chen, C.S. (2007) In Methods in Cell Biology - Cell Mechanics, Volume 83. Chapter 13:313-328

Block and Post Technology



A Rapid Measurement of Clot Characteristics





Block and Post Technology



A Rapid Measurement of Clot Characteristics







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Nanotechnology

- Nanolithography
 - E-beam lithography
 - Nanoimprint lithography
 - Tip-based lithography
- Molecular Assembly
 - DNA orgami

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- Alkanethiol monolayers
- Supermolecular assembly
- Nanomaterials
 - Carbon nanotubes
 - Nanoparticles





Nanopost Arrays



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Diameter: 790 nm Height: 3.4 µm Gap: 1 µm

Diameter: 790 nm Height: 2.5 µm Gap: 1 µm



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Nanopost Arrays







Questions?

