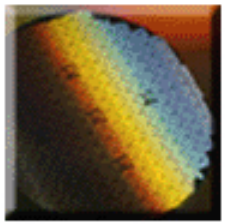
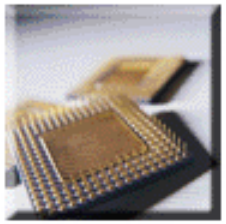
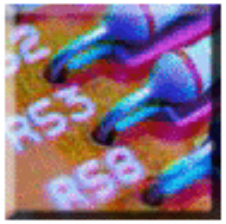
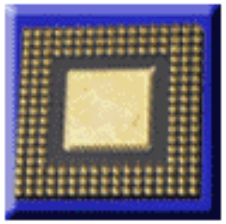
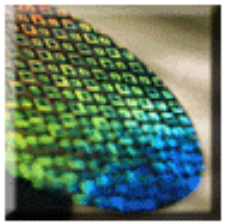




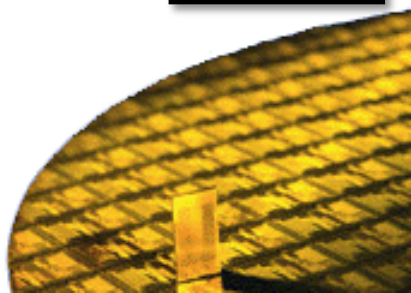
Azrieli College of Engineering Jerusalem

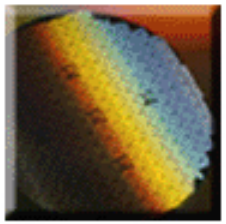
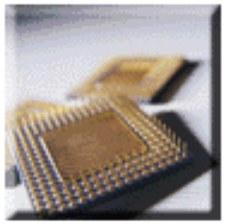
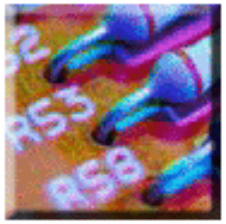
עזריאלי מכללה אקדמית להנדסה ירושלים

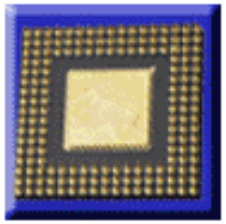
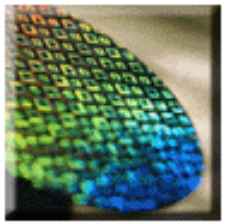



The Department of Advanced Materials Engineering

Materials and Processes in Polymeric Microelectronics

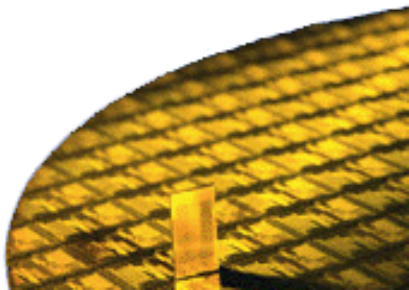


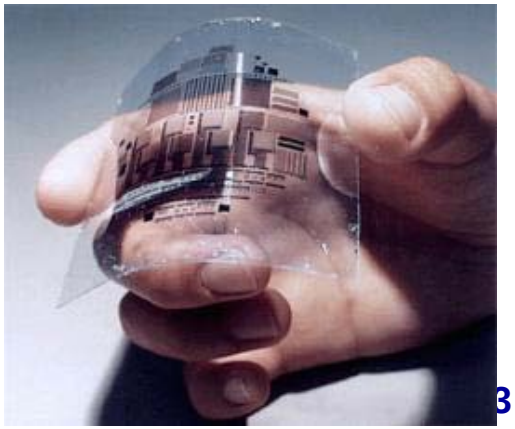
Outline

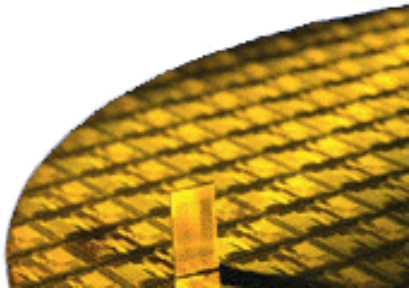
- Materials and Processes in Polymeric Microelectronics
  - Polymeric Microelectronics
  - Process
  - Results
  - Applications
- The Department of Advanced Materials Engineering-Specialization in Materials for Microelectronics
  - Materials and Processes in Microelectronics
  - Learning Objectives
    - the “why”
    - the “how”



Introduction

- Recently, a great deal of research was concerned with polymers for device applications:
  - Molecular electronics,
  - Optical devices,
  - Etch resists,
  - Biosensors
  - Scaffolds for tissue engineering and fundamental studies in cell biology





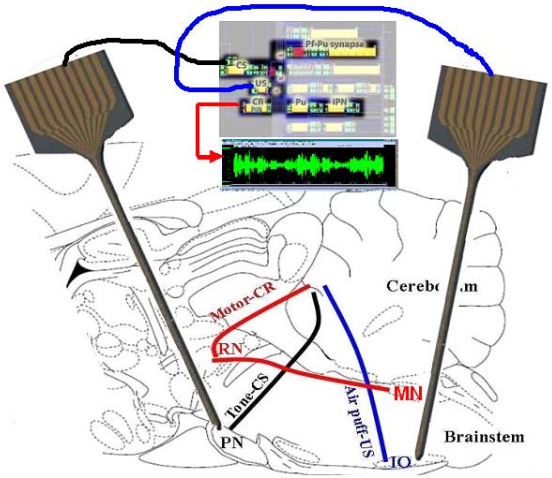
Polymeric Microelectronics

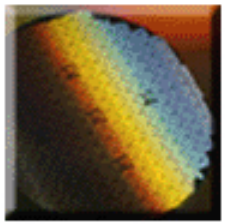
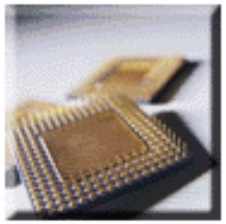
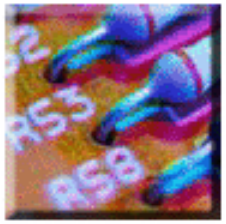
- Flexible devices
- E.g. Implanted flexible electrodes:

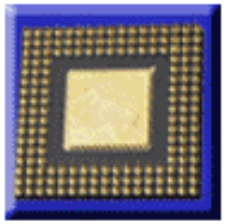
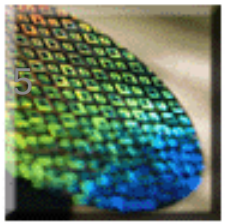
microelectrode toughness

≈ tissue toughness

- To avoid acute damage caused by conventional rigid electrodes

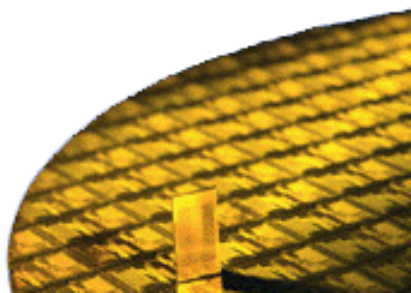


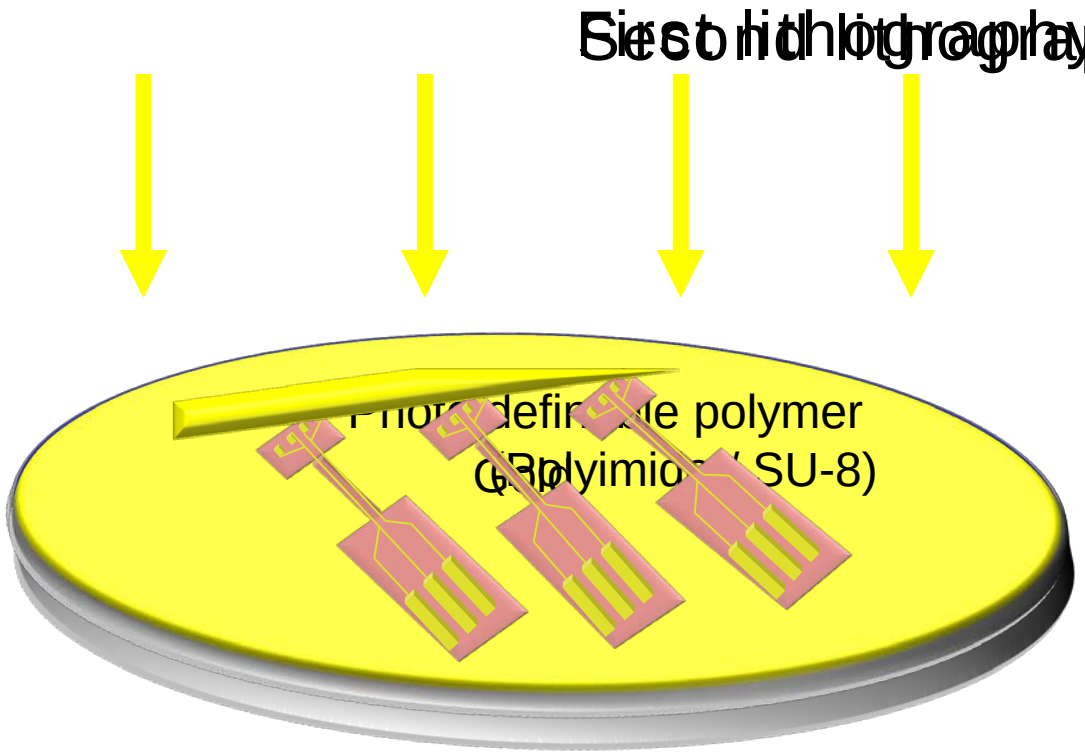



Research Goals and Motivation

- Development of polymeric based microelectronic technologies for medical and healthcare applications:
- Integration of conductive organic conductors on polymeric substrates for
  - Polymeric biosensors
  - Polymeric implanted electrodes
- Optimization of the electrical and mechanical properties of the integrated films



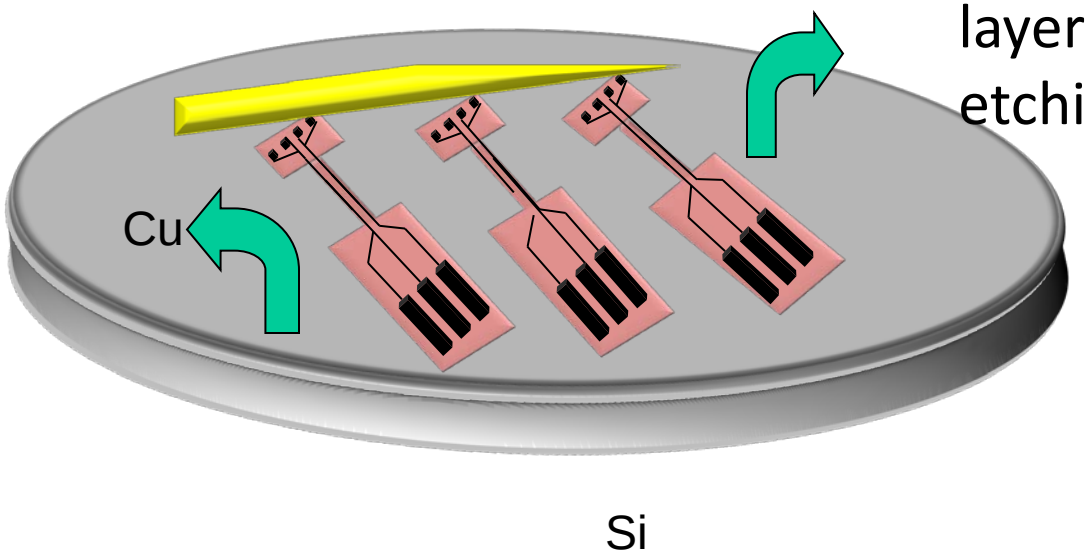
Process: Photolithography



Process : Final Steps

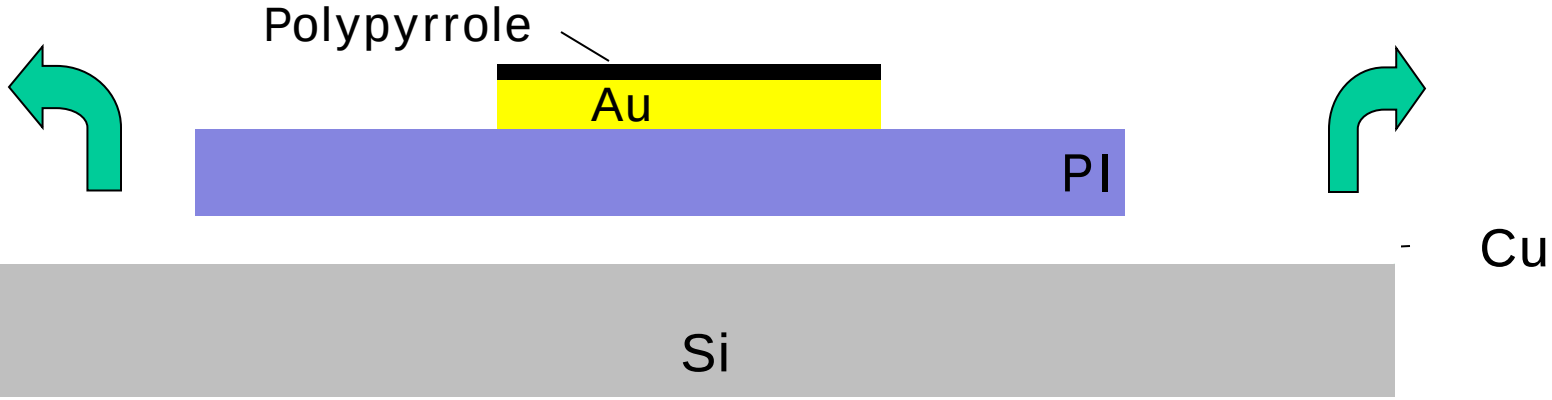
Electropolimerization of PPy on Au

Cu under-layer etching:

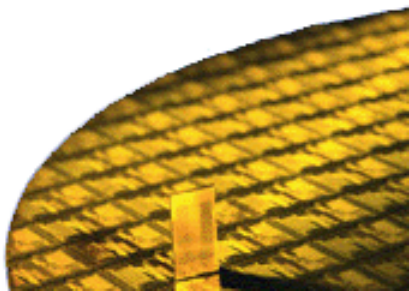


Process : Final Steps (Cross Section)

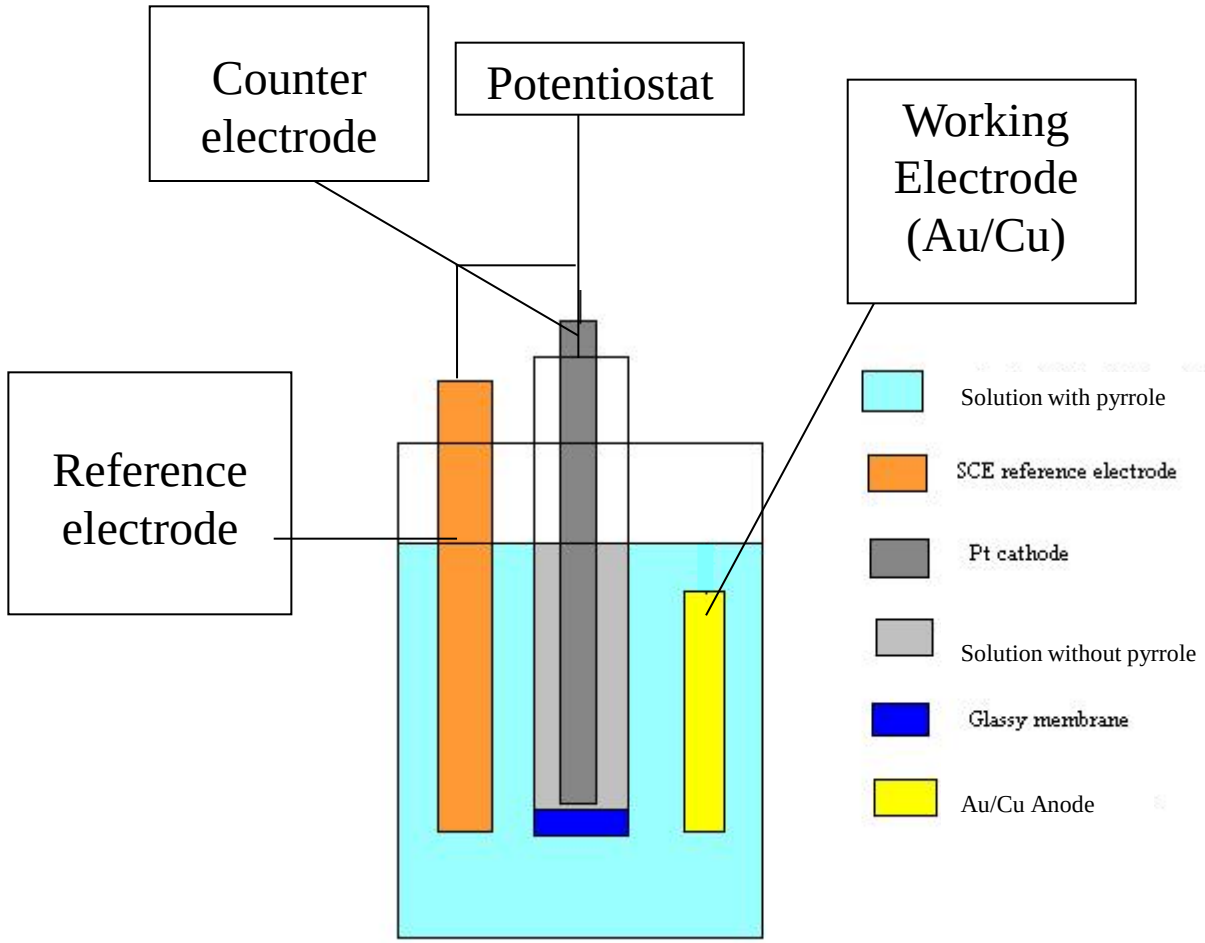
- Cu under-layer is pre-etched in $FeCl_3$ solution
- then completely etched-out electrochemically



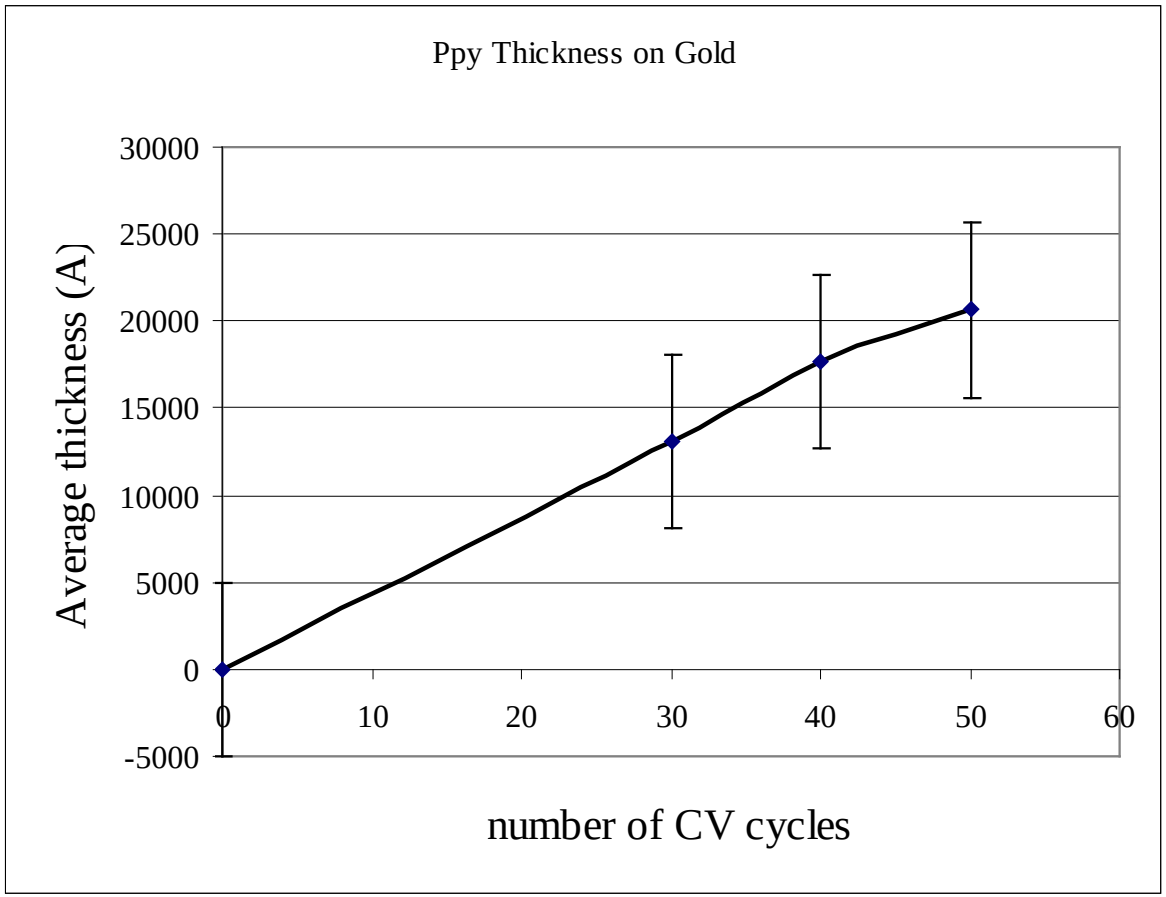
The device on PI support is released



Polypyrrole microfabrication



Thickness of PPy films deposited on Au-seed from acetonitrile electrolyte

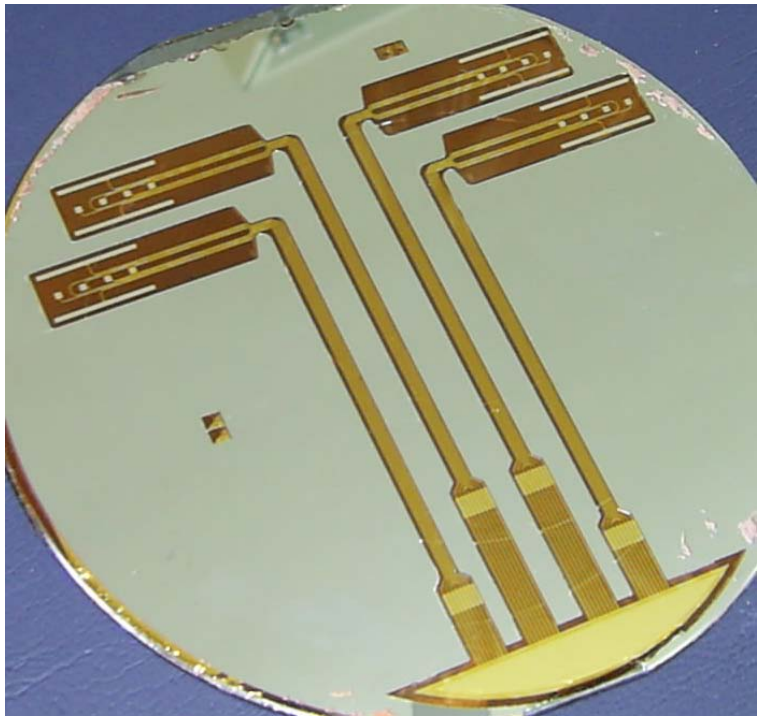


2 microns/50 cycles= 40 nm per cycle

One cycle is about 1 minute

Applications

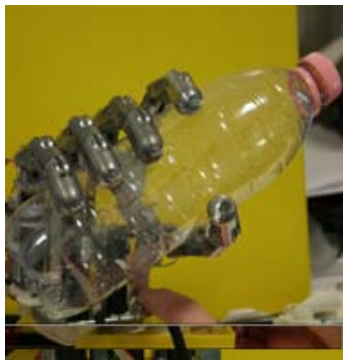
- Flexible Folded Cuff Electrode
- Bio-sensors on a polymeric chip
- Implantable Penetrating Electrode

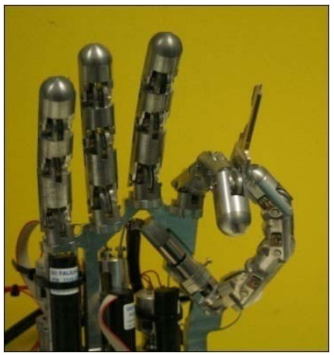


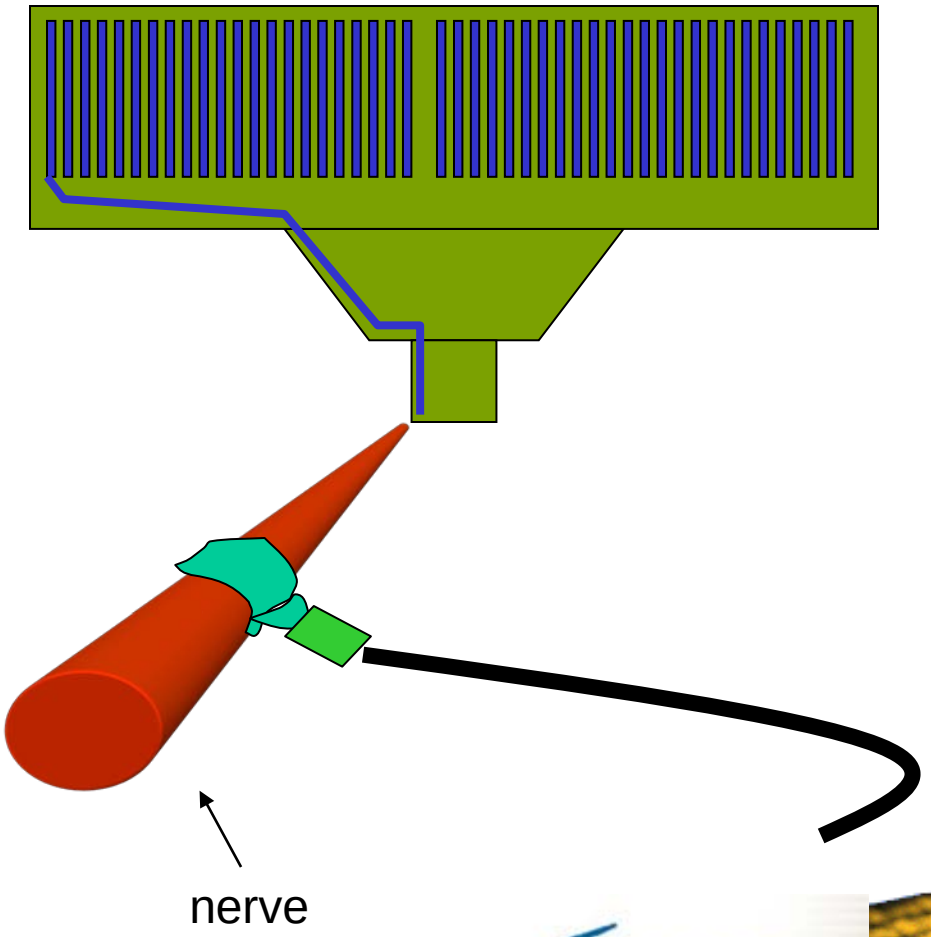
Flexible Folded Cuff Electrode

https://www.youtube.com/watch?v=X85Lpuczy3E

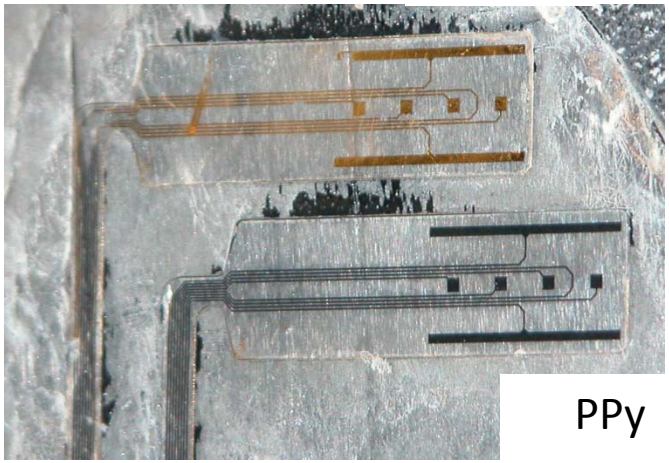
Flexible Folded Cuff Electrode

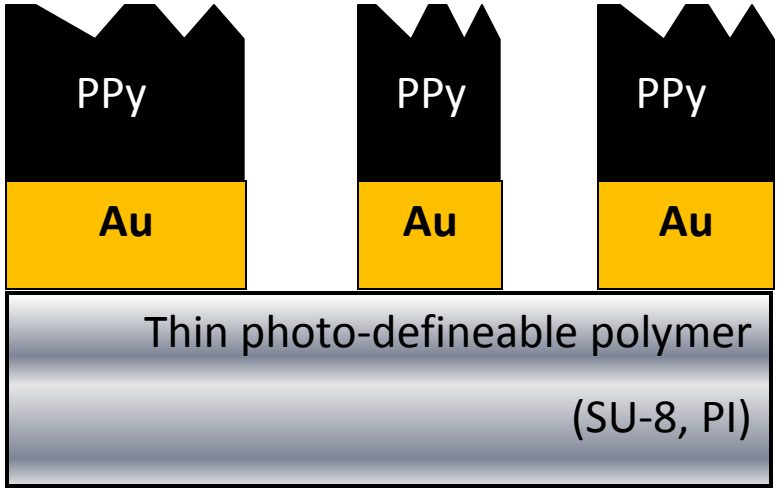






Flexible Cuff Electrodes With Polypyrrole

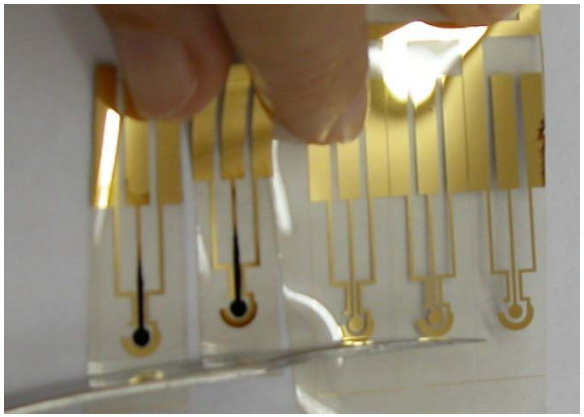




Flexible electrodes using polypyrrole (PPy) electro-polymerization on Au on flexible substrate (PI or SU-8)

Applications

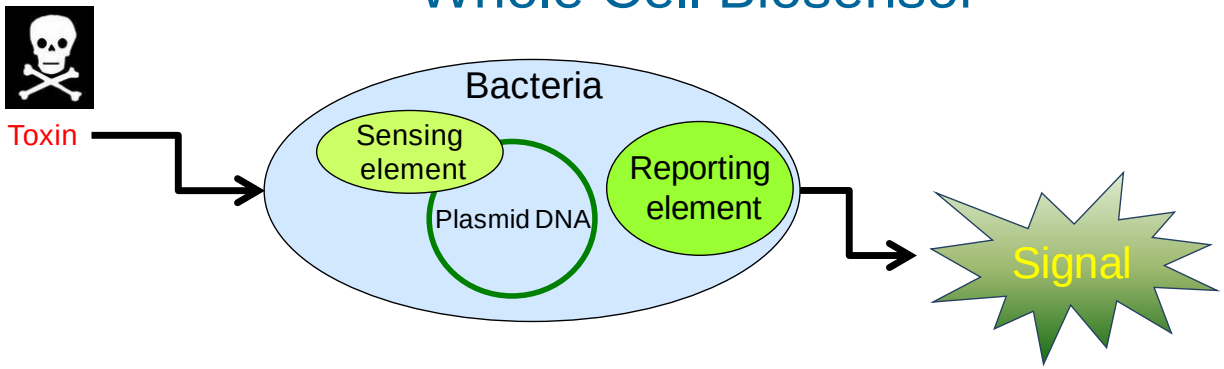
- Flexible Folded Cuff Electrode
- Bio-sensors on a polymeric chip
- Implantable Penetrating Electrode



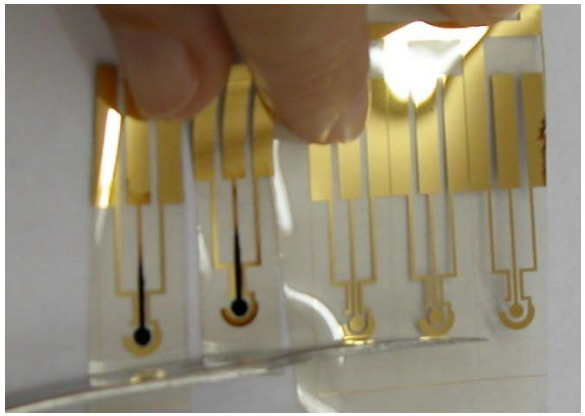
Bio-Sensors on a Polymeric Chip

Environmental: Water Toxicity Detection

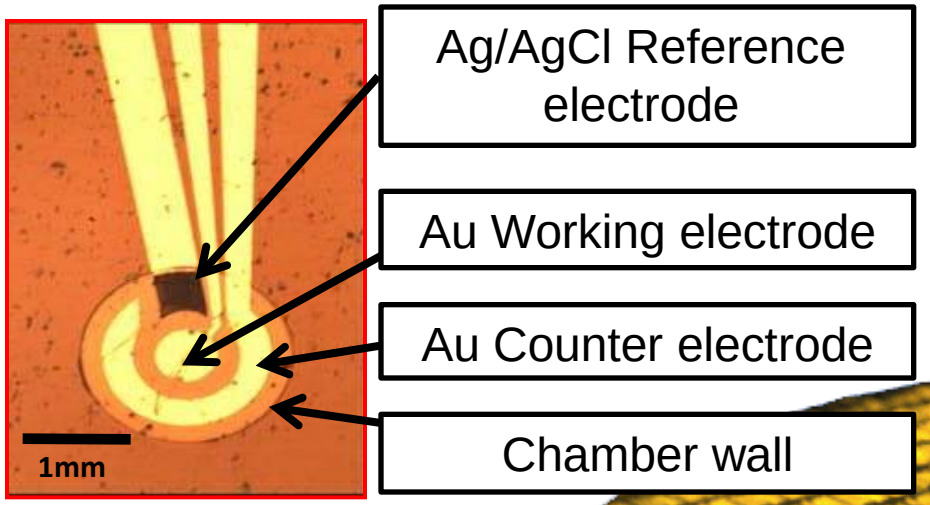
Whole Cell Biosensor



Electrochemical bio-chips



PPy on Gold, SU8 chip

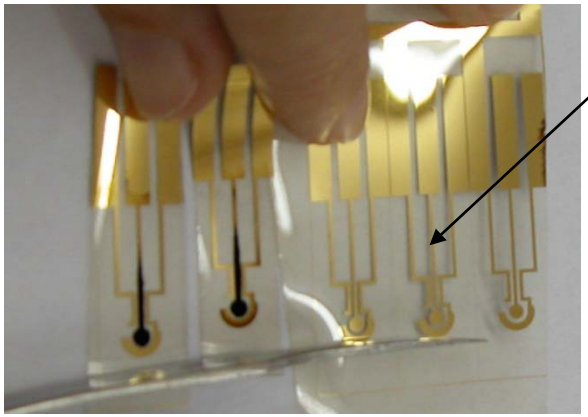


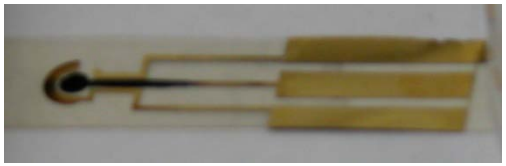
Bio-Sensors on a Polymeric Chip

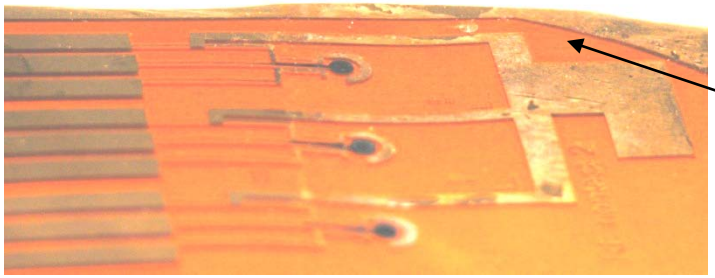
for Electrochemical Measurements of Biological Species

Bio-sensors: Electrodeposition of PPy on Gold, SU8 and Polyimide chip

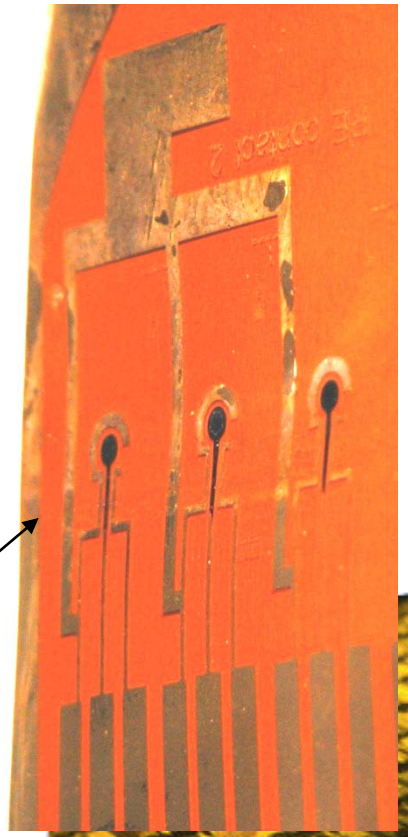
SU8 chip





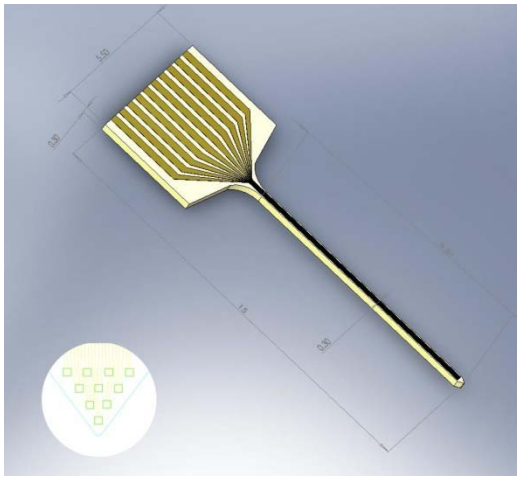


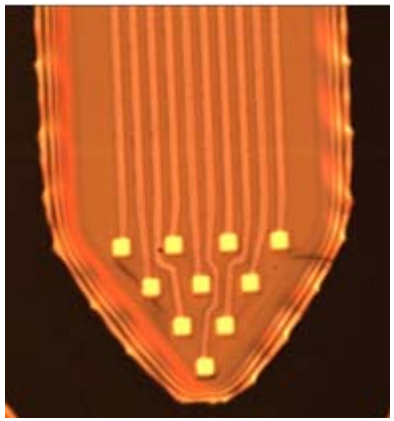
Polyimide chip

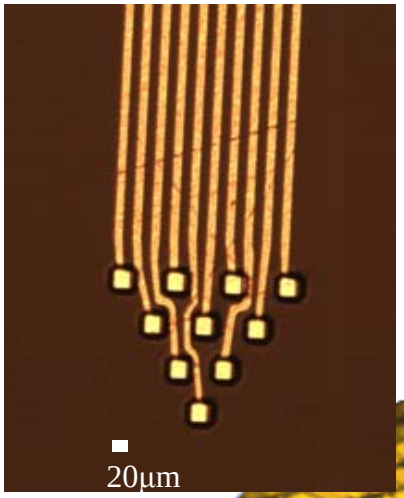


Applications

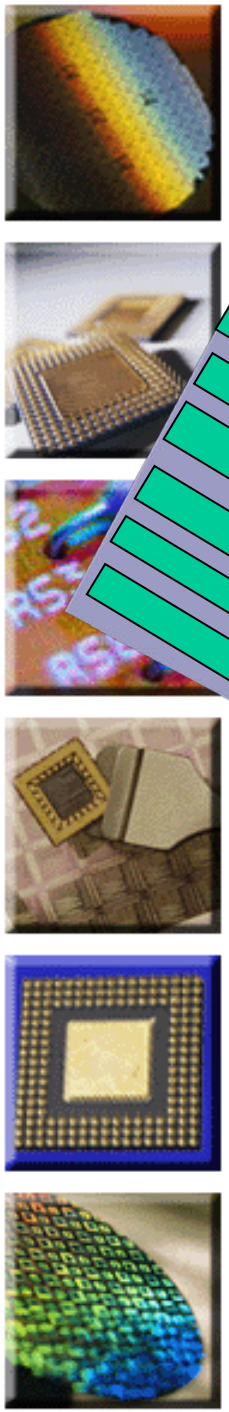
- Flexible Folded Cuff Electrode
- Bio-sensors on a polymeric chip
- Implantable Penetrating Electrode

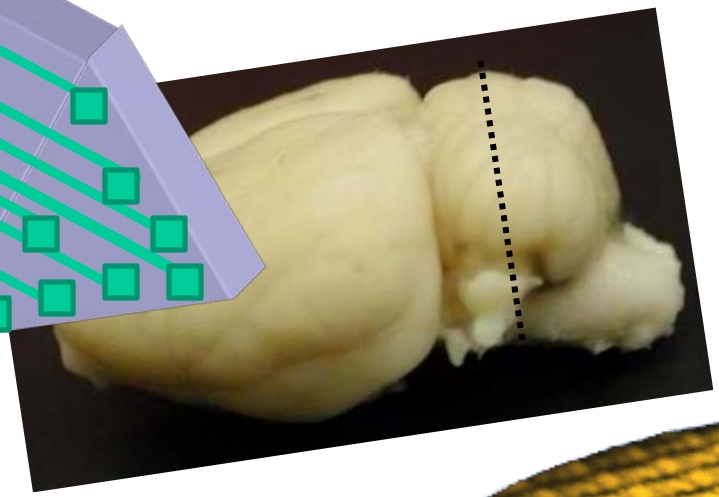


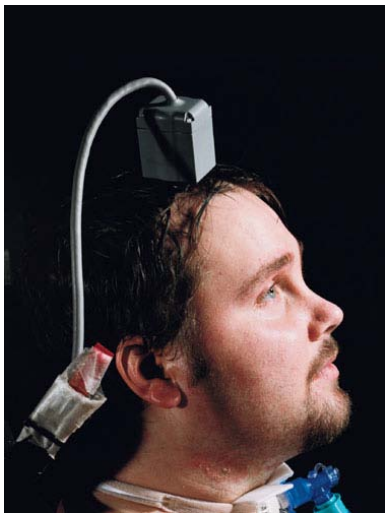


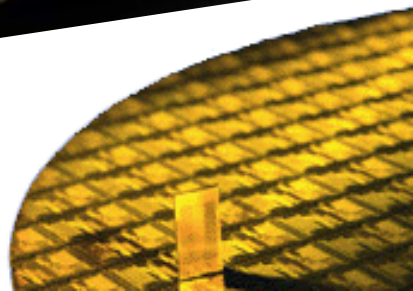


Implantable Penetrating Electrode

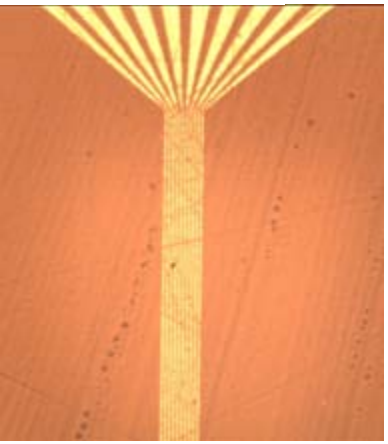




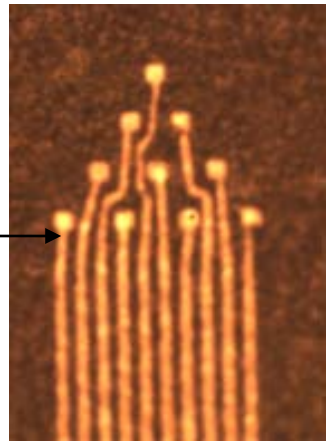


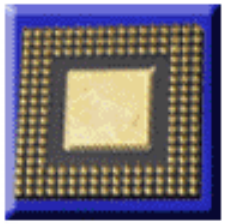


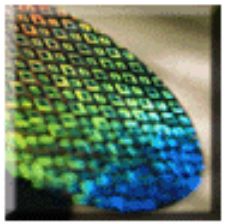
Implantable Penetrating Electrode



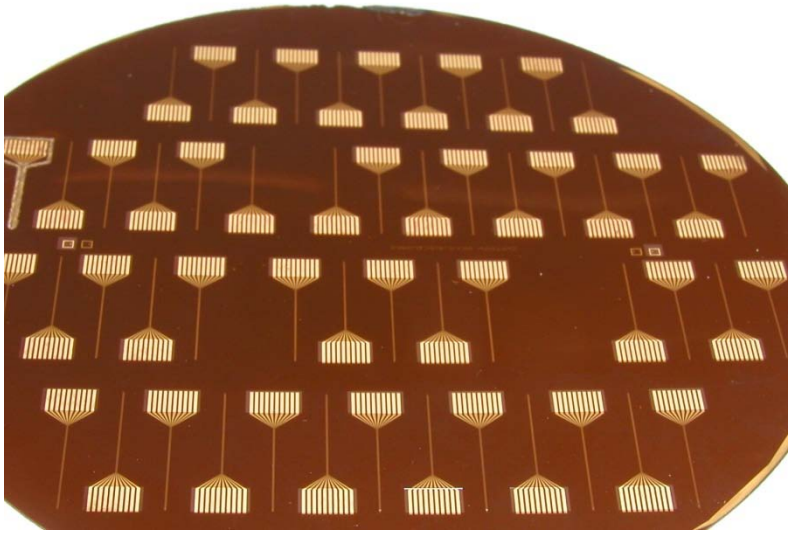
Microscope pictures of PI wafer with Au layout after 1st lithography





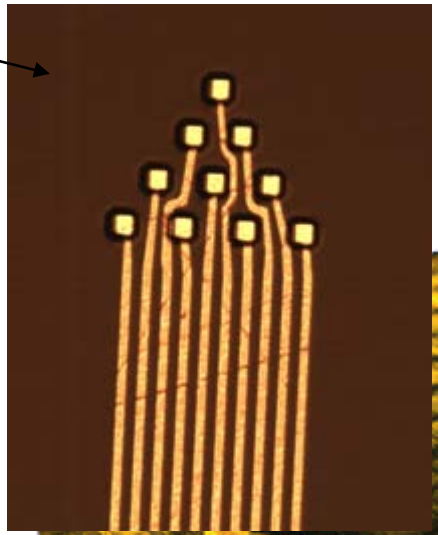


PI wafer after 2nd lithography



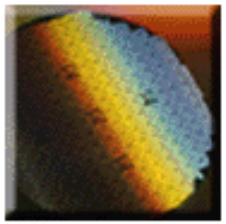
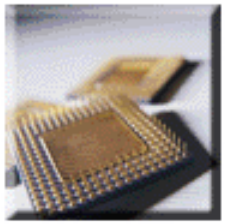
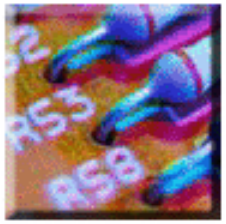
100mm

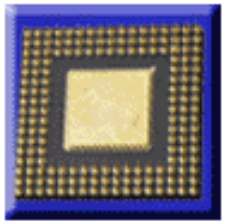
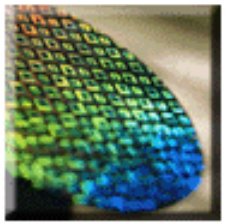
after 2nd lithography



Summary and Conclusions

- A polymeric device was fabricated
- The device was integrated with PPy conductive polymer
- The integrated device applications -
  - Implantable electrodes-
    - flexible cuff
    - penetrating
  - Bio-sensors on a polymeric chip
- Future extension of the research may be far reaching by its application to medical and healthcare investigations and treatment.

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עזריאלי מכללה אקדמית להנדסה ירושלים

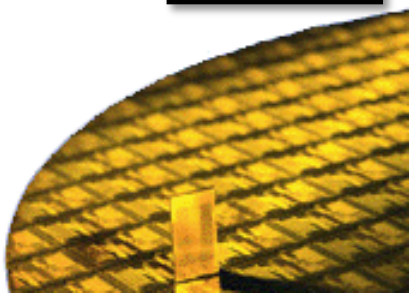



The Department of Advanced Materials Engineering

"Classical" Materials Laboratories and

Specialization in

Materials for Microelectronics

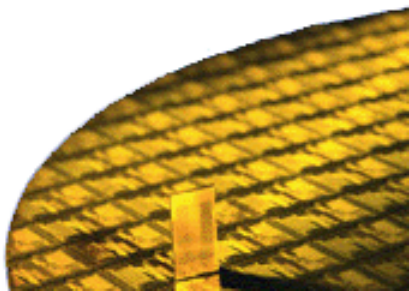





Learning Outcomes

Students will...

- Become familiar with basic materials characterization techniques through hands-on experience;
- Be able to perform measurements of mechanical properties, analyze the results and compare with values expected from theory or known technical data.

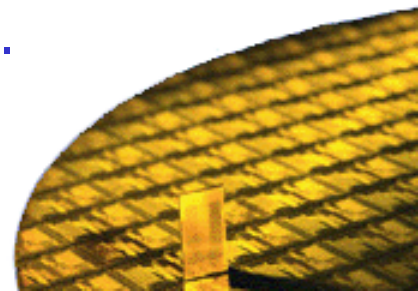





Learning Outcomes

Laboratories are also designed to...

- Enhance the understanding of selected subjects of the theoretical courses:
  - Materials Science and Engineering
  - Processing and Manufacturing Technology
  - Advanced Processing, Manufacturing and NDT Methods
  - Ceramic Materials
  - Polymeric Materials
  - Composite Materials
- Demonstrate the usage of a variety of techniques; Emphasize processing – microstructure - property relationships.



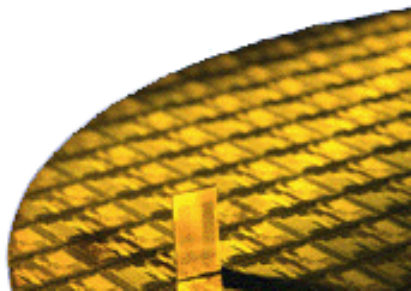
Materials Characterization Laboratory 1 & 2

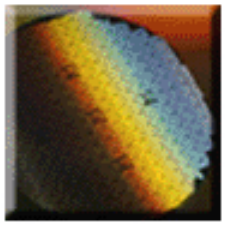
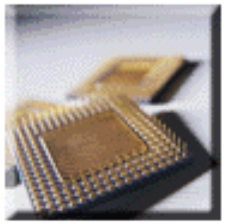
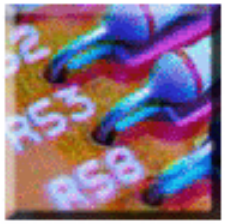
Materials Processing

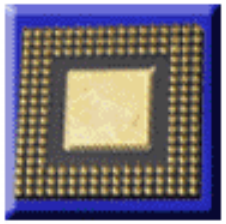
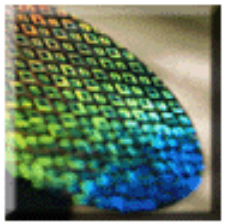
- Casting & Solidification
- Powder Metallurgy
- Steel Heat Treatment
- Aluminum Alloys Heat Treatment
- Welding

Materials Characterization

- The Tensile Test
- The Impact Test (mainly on heat-treated steel; ductile-brittle transition)
- The Fatigue Test
- Hardness Testing (used in steel & Al alloys experiments)
- Metallography (includes steel microstructures)
- Thermal Analysis (TGA, DTA, DSC)
- NDT Techniques



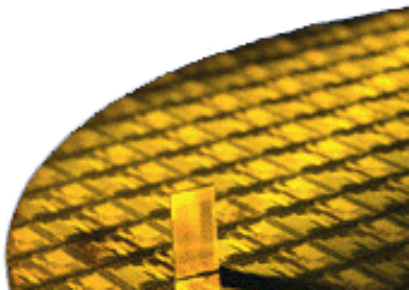




Materials for Microelectronics:
Courses and Labs

Learning Outcomes

- At the end their studied, students will have a broad conceptual understanding of:
- the principles of micro-electronic devices -
  - the "why"
- The technological means of manufacturing them
- A good sense of how the manufacturing looks like from a practical point of view
  - the "how"



Specialization in Materials for Microelectronics

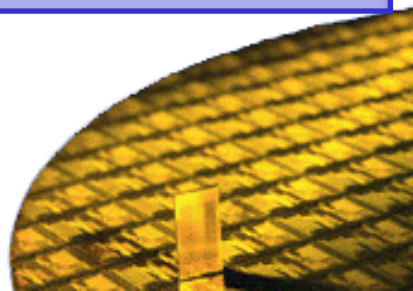
Microelectronics Physics

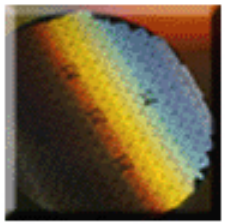
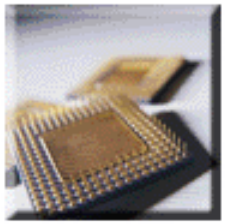
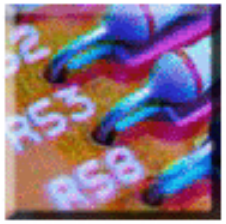
- Semiconductor Physics
- Semiconductor Devices
- Physical Methods for Materials Characterization
- Materials for Electro-Optic Devices

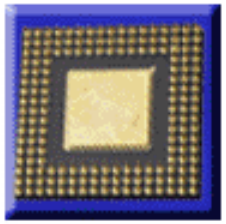
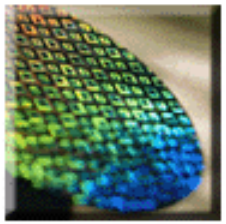
Microelectronics Technology

- Technological Background
- Microelectronics 1
- Microelectronics 2
- Microelectronics 3

- Practical
- Semiconductor Manufacturing Lab
- Materials Characterization – Advanced Lab



Microelectronics Theory

- Semiconductor devices- physical principles and operational characteristics
- Electro-optic devices
- Advanced device issues
- Failure analysis
- Nanotechnology and nanoelectronics
- Materials characterization
- State-of-the-art integrated-circuit technologies.

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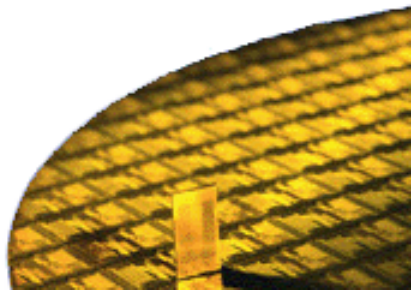
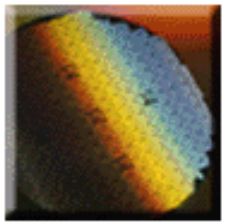
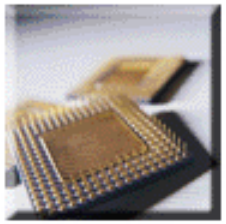
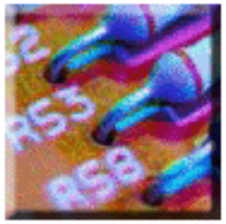
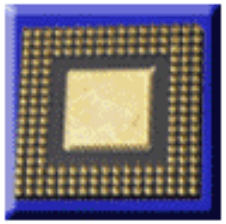
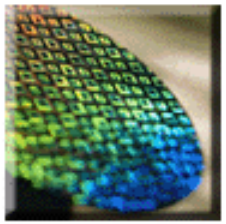
ירושלים



Materials Characterization Laboratory

course # 20017

- Microfabrication:
  - Working in the clean room
  - Photo-lithography
  - Wet etching and dry etching (reactive ion etch)
  - PVD (physical vapor deposition)
  - Metal plating (electroplating of silicon, electroplating of polymers)
- Nanofabrication
  - Electron beam lithography

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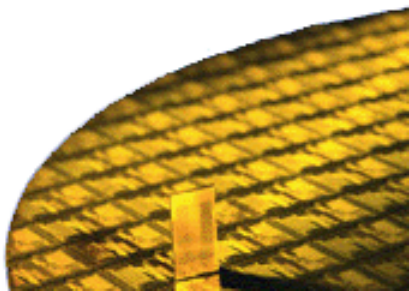


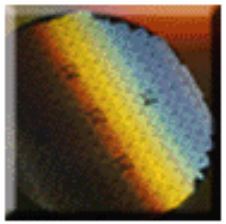
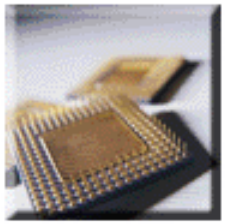
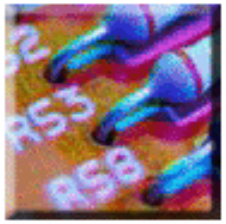
Materials Characterization Laboratory
course # 20017

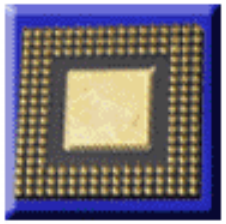
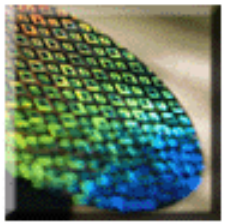
- Nanofabrication- Electron beam lithography

Dr. Shimon Eliav- Head of the Nanofabrication Unit, the Hebrew University

Azrieli College of Engineering Jerusalem

עזריאלי מכללה אקדמית להנדסה ירושלים

Materials Characterization – Advanced Laboratory - course # 20016

- Optical measurements of thin films
- Electrical measurements of semiconductors
- Hall effect measurement
- Haines Shockley experiment
- Plasma Etch

- Materials Characterization using SEM and XRD
  - Dr. Inna Popov, Head of the Unit for nano Characterization, the Hebrew university

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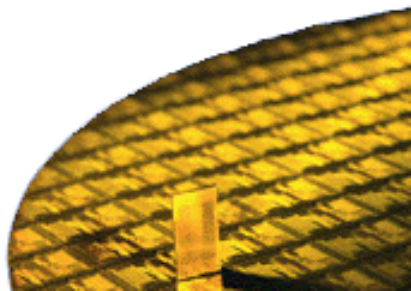
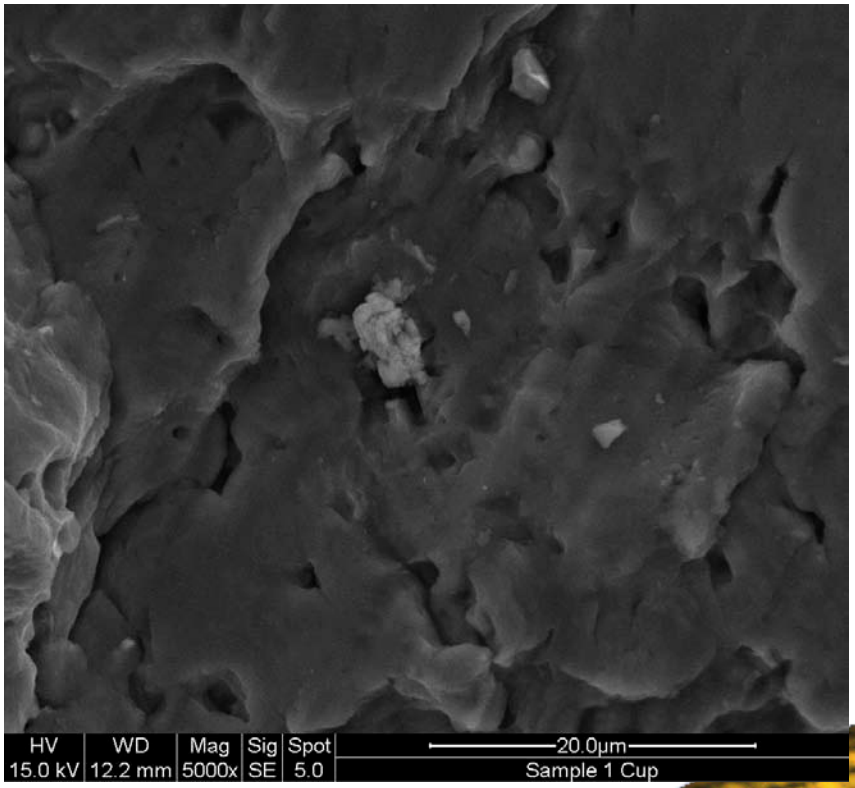
עזריאלי מכללה אקדמית להנדסה ירושלים

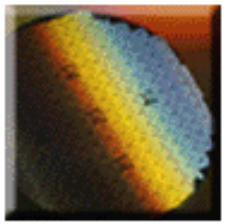
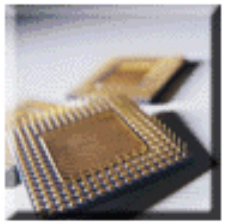
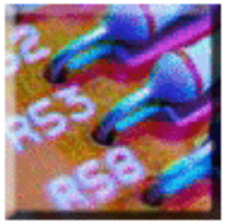


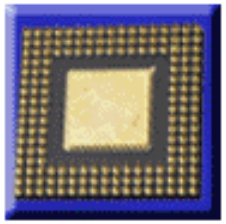
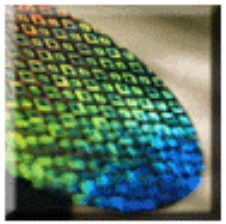
Materials Characterization – Advanced Laboratory-course no 20016

- Materials Characterization using SEM



Courtesy of Dr. Inna Popov, Head of the Unit for Nano Characterization, the Hebrew University

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Thank you!

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