

# CMOS Biochip for Rapid Assessment of New Chemicals

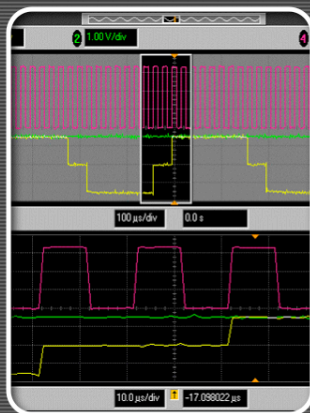
## Cell-Based Biosensors for Toxicity Testing of New Chemicals



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Lee Ann Mathine: Optical Sciences, UA  
Gabriel Gray: Optical Engineering, UA  
Lynn LaRussa: Electrical and Computer Engineering, UA  
Daniel J. O'Connell: Sarver Heart Center, UA  
Joseph J. Bahl: Sarver Heart Center, UA  
Matt Scholz: Cell Biology and Anatomy, UA  
Raymond B. Runyan: Cell Biology and Anatomy, UA

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## Outline



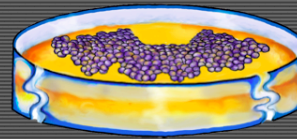
- 1 Motivation
- 2 Environmental Control
- 3 Multi-Sensor Integration
- 4 Cell Attachment

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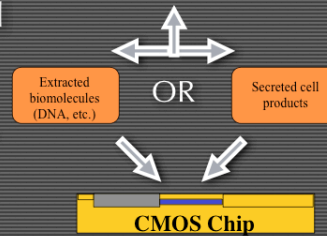
## Project Objectives and Impact



- Rapid Assessment of Chemicals and Process Chemistries
- Important for both Chemical and Equipment Suppliers
- A First Step Towards an On-Line ESH Monitor



Reporter cells treated with chemicals of interest



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## Other Applications



09-11-01  
NOT STOP US.  
O THIS ANTHRAX.  
NOW.  
ARE YOU APPAID?  
DEATH TO AMERICA.  
DEATH TO ISRAEL.  
ILLAH IS GREAT.



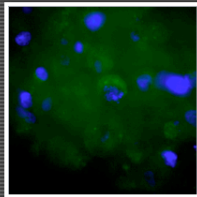
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## Biosystems of Interest

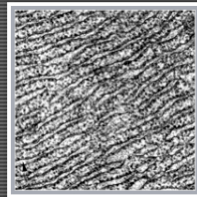
DNA



Cell



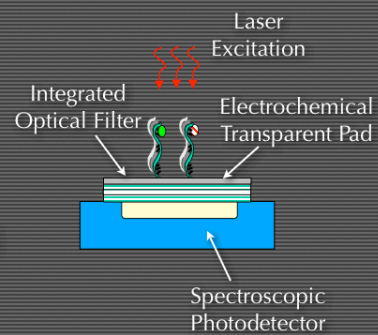
Tissue



5

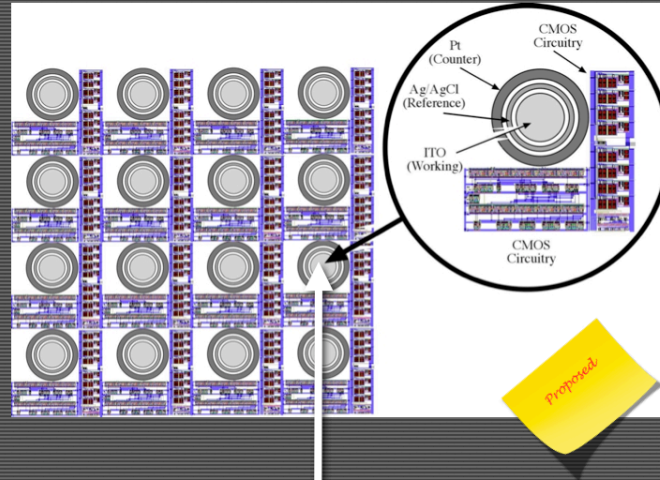
## Biosensor Fusion

- 1 Optical Sensing
- 2 Capacitance Sensing
- 3 Electrochemical Sensing
- 4 Electrical Sensors



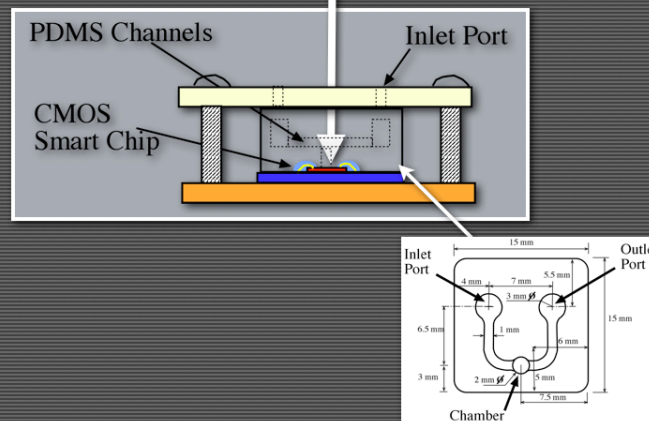
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## Biochip Array

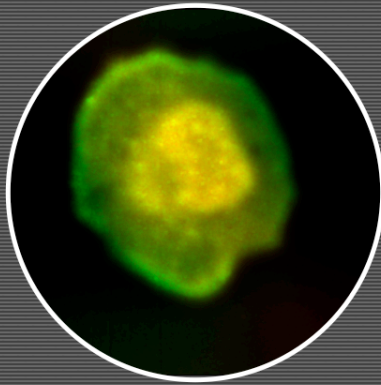


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## Biochamber Design



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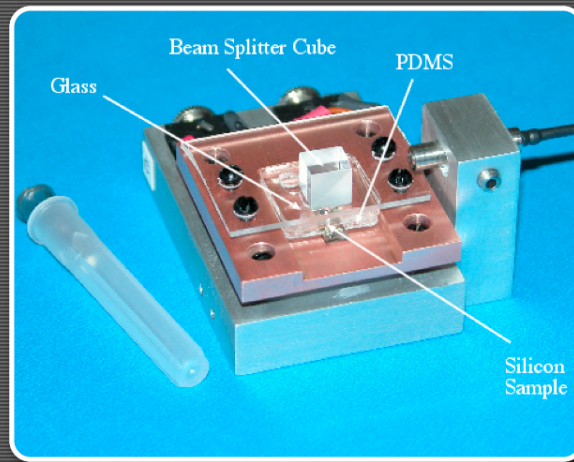


Chamber Supports Cell Health

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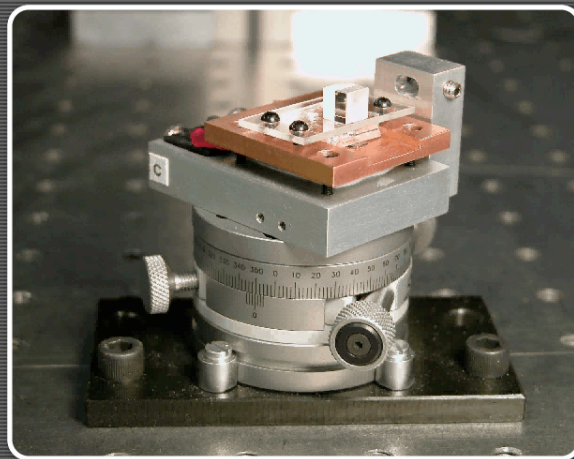
Cell-Based Biosensing

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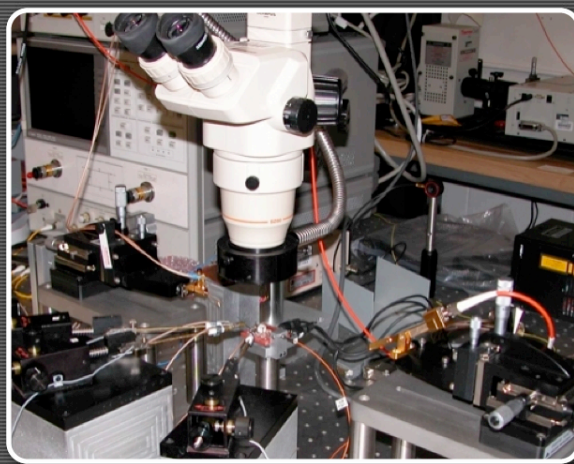
Cell Based Biochamber

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Biochamber

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Biochamber Test

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## CMOS Prototyping

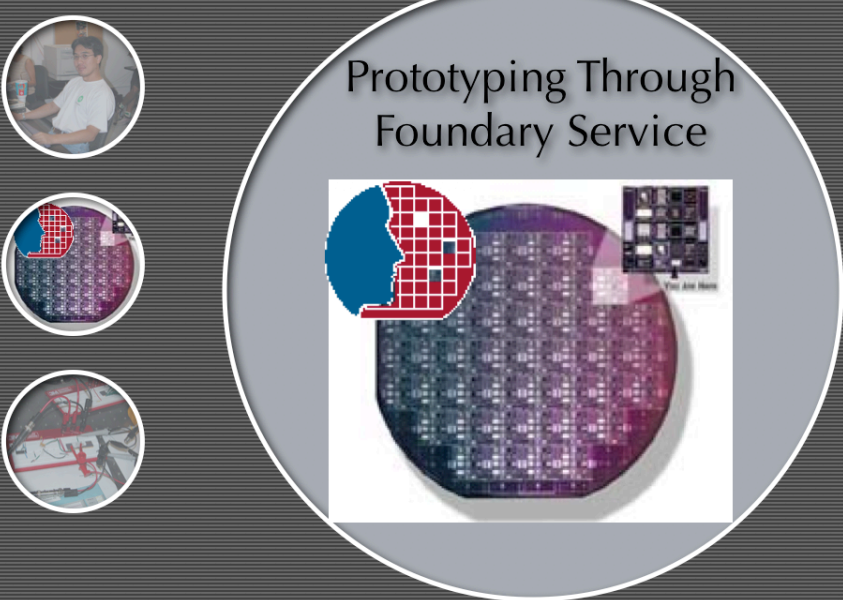
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Circuit Design

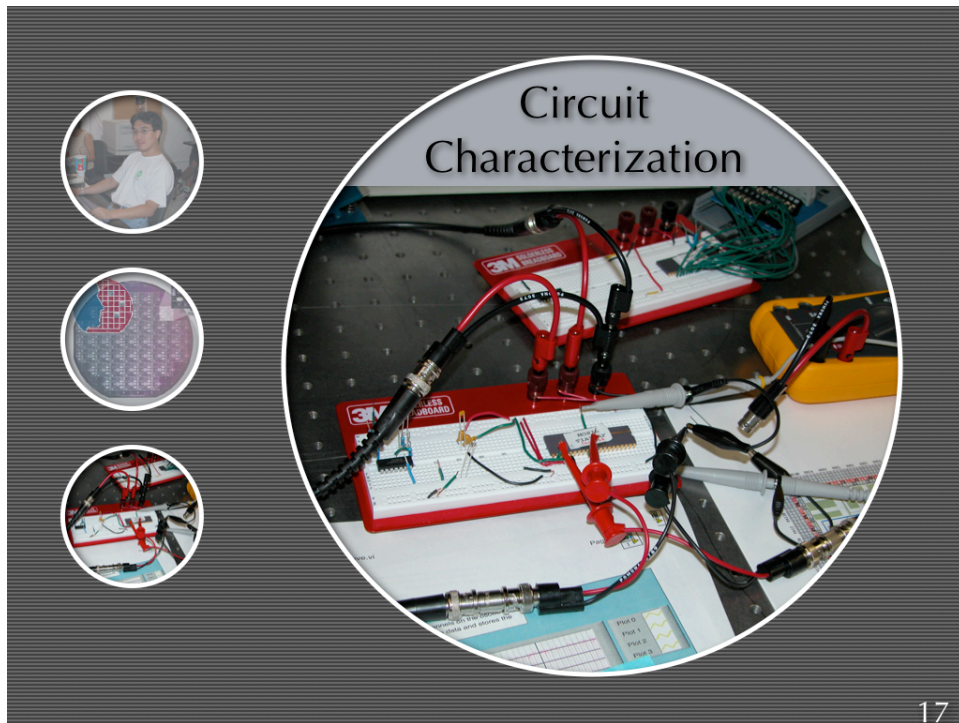
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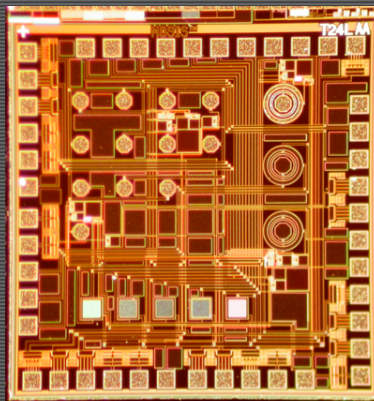
Prototyping Through Foundary Service

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## CMOS Biochip



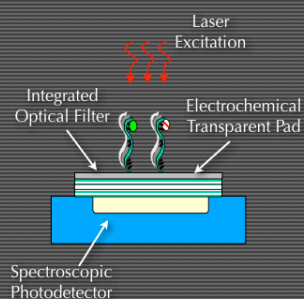
- Nucleic Acid Binding
- Photodetectors
- Cyclic Voltammetry
- Capacitance

## MultiSensor Fusion

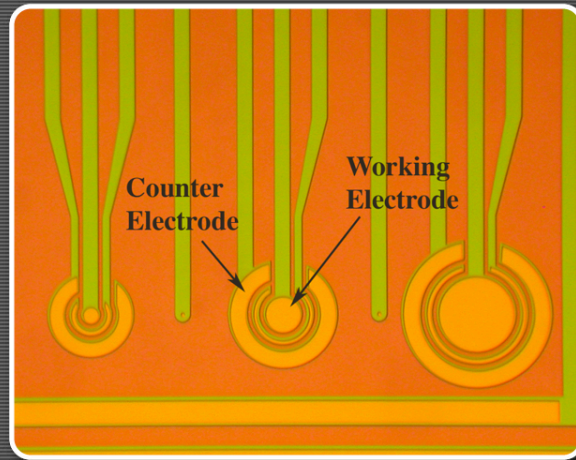
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## MultiSensor Fusion

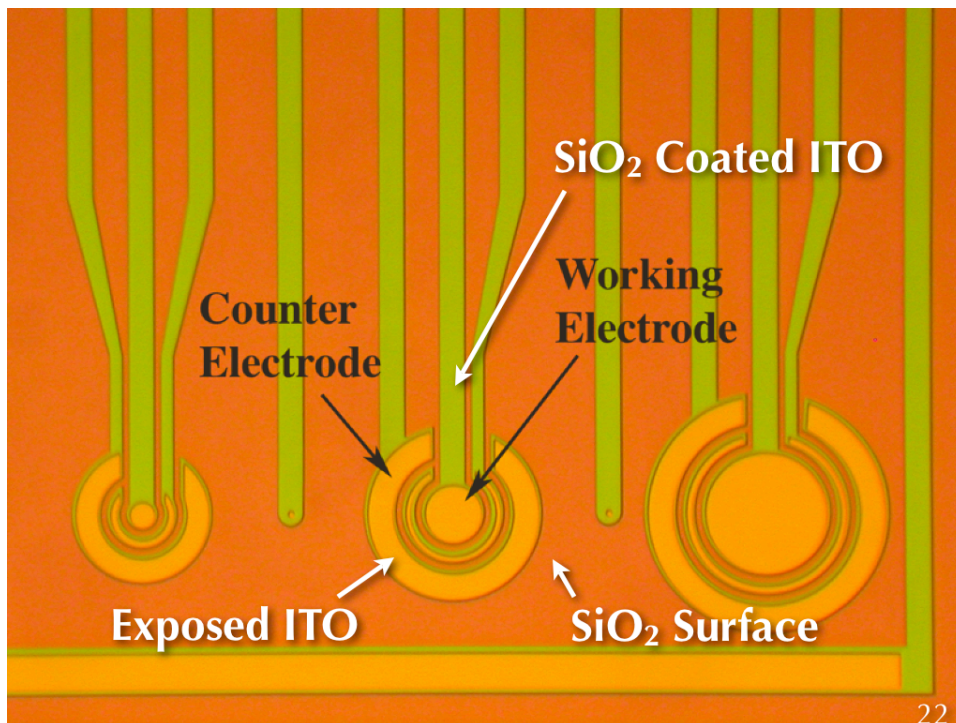
- 1 Electric Field Directed Binding
- 2 Hybridization Site Monitored with Capacitance
- 3 Electrochemical Analysis at Each Pad
- 4 On Chip Photodetectors
- 5 Data transfer from Chip to Bioinformatics



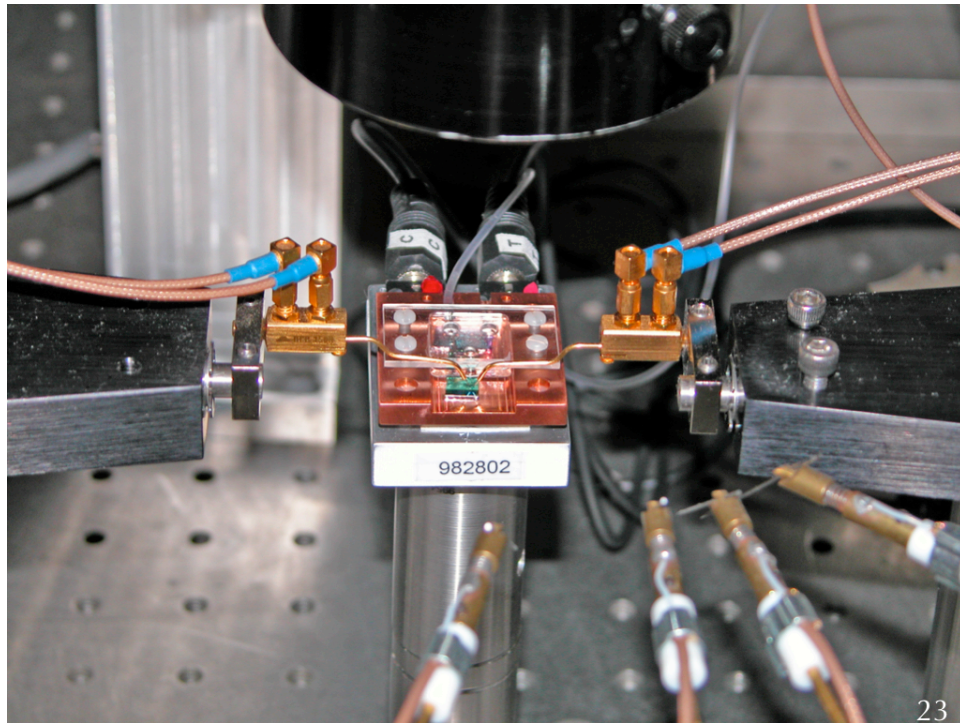
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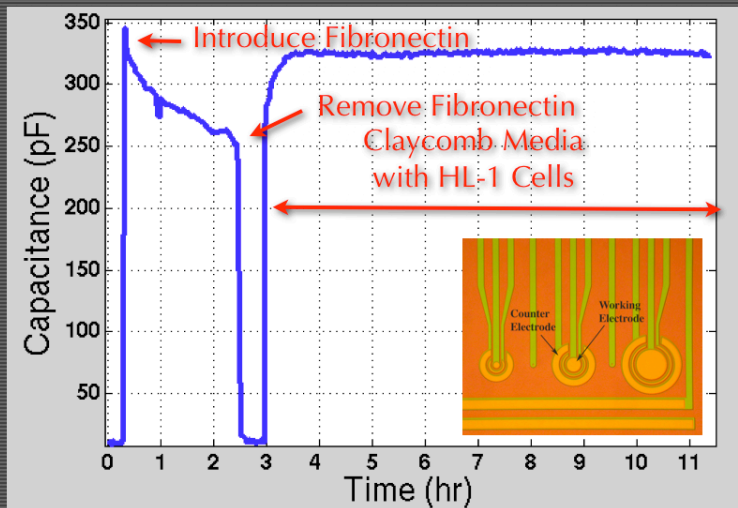
ITO Test Chip



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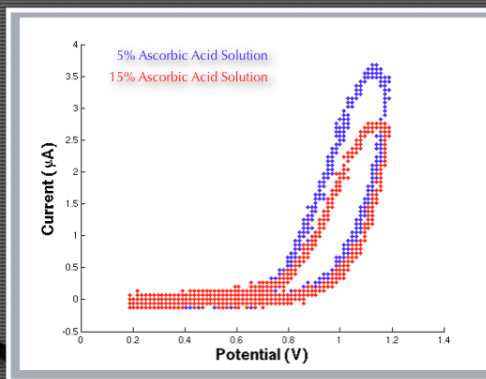
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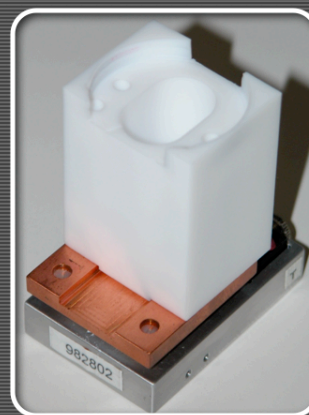
## Pad Characterization

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## Ascorbic Acid Detection



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## Small Biochamber

March 16, 2005

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## CMOS Photodetector

Lambert's Law

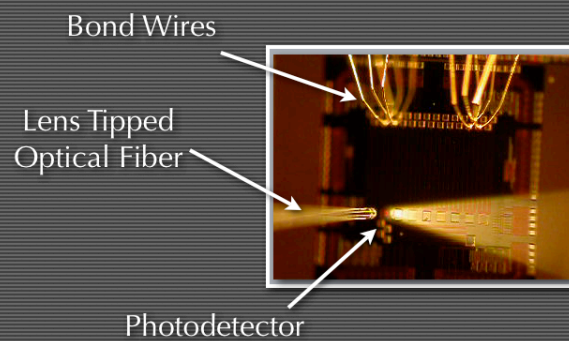
$$I = I_0 e^{-\alpha x}$$



See Class Notes  
OPTI580 Microphotonics  
Instructor: D. L. Mathine

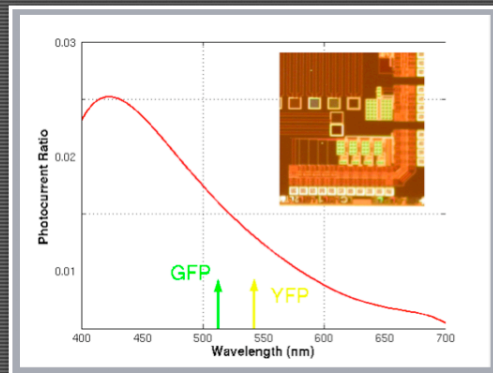
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## Spectroscopic Photodetectors



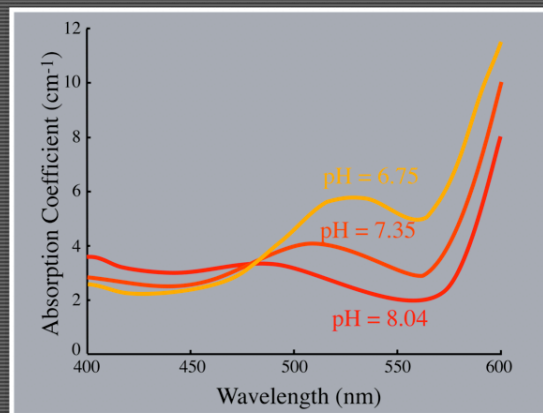
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## Spectroscopic Photodetectors



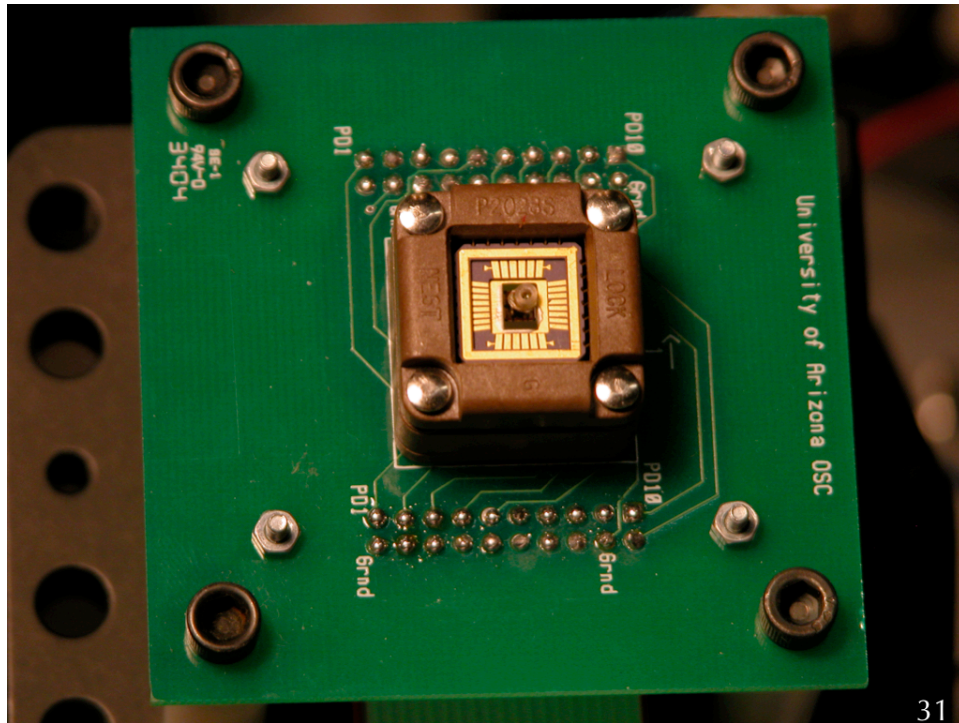
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## Phenol Red



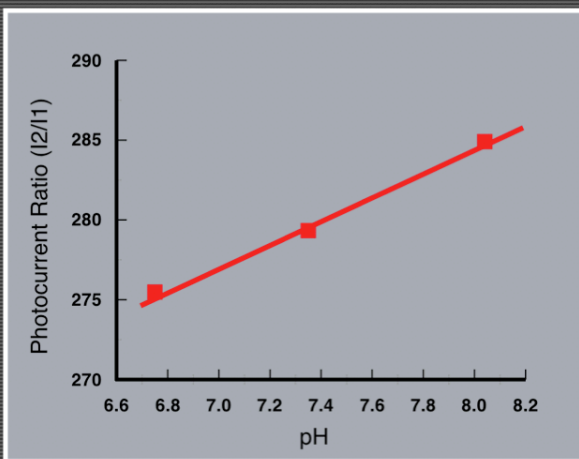
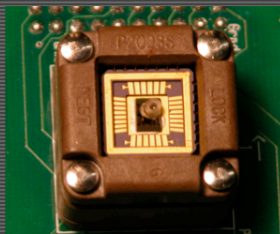
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# CMOS Biochip for Rapid Assessment of New Chemicals



## Measured Current Ratio

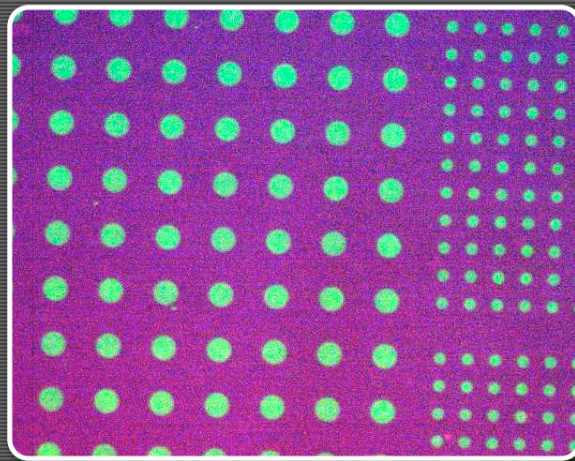
Spectroscopic  
Photodetector





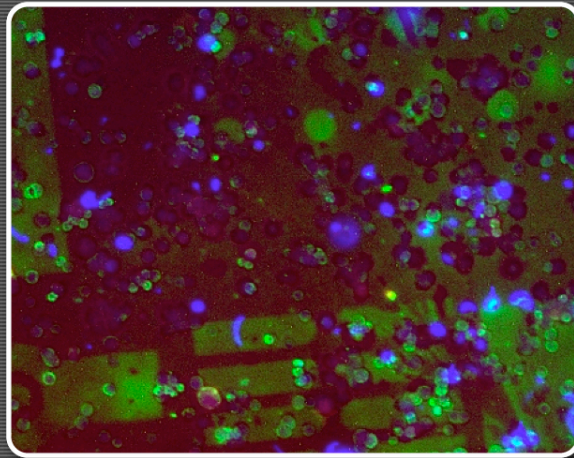
## Cell Attachment

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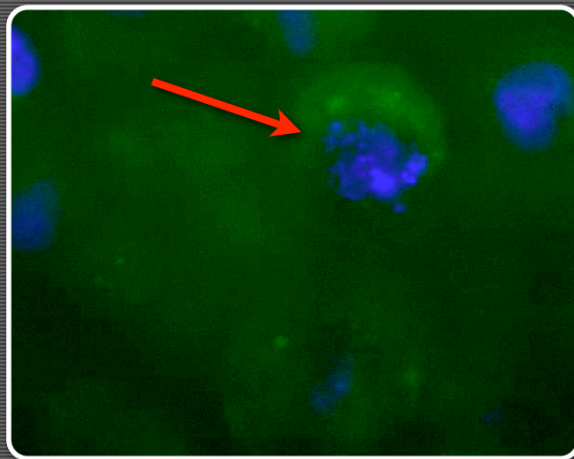
Poly-L-lysine Patterning

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DU145 Cells on  
Poly-L-lysine Patterned SiO<sub>2</sub>

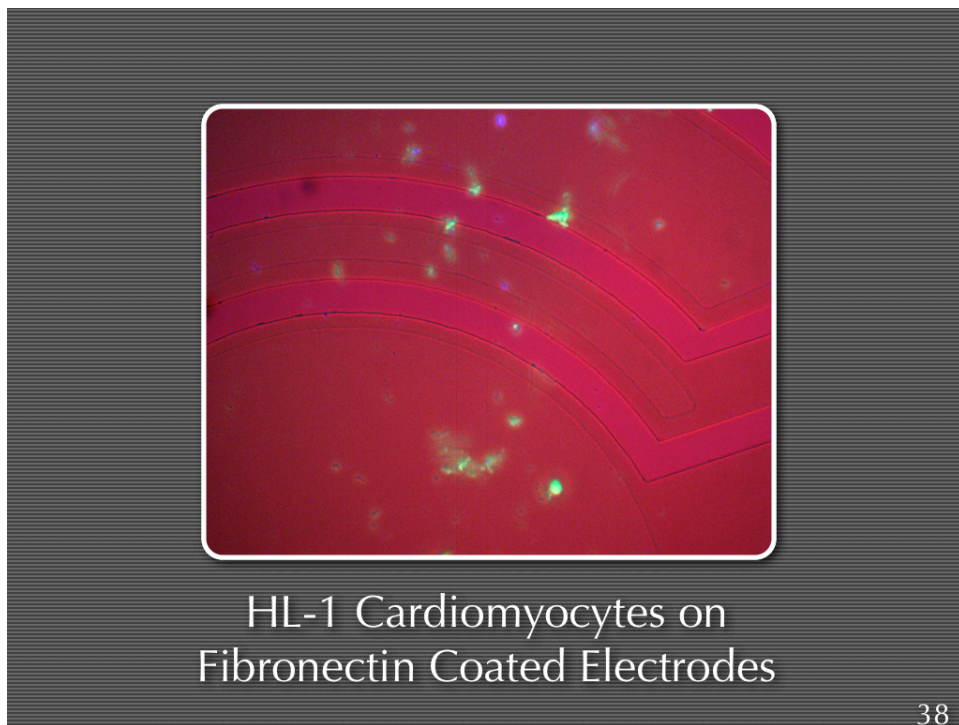
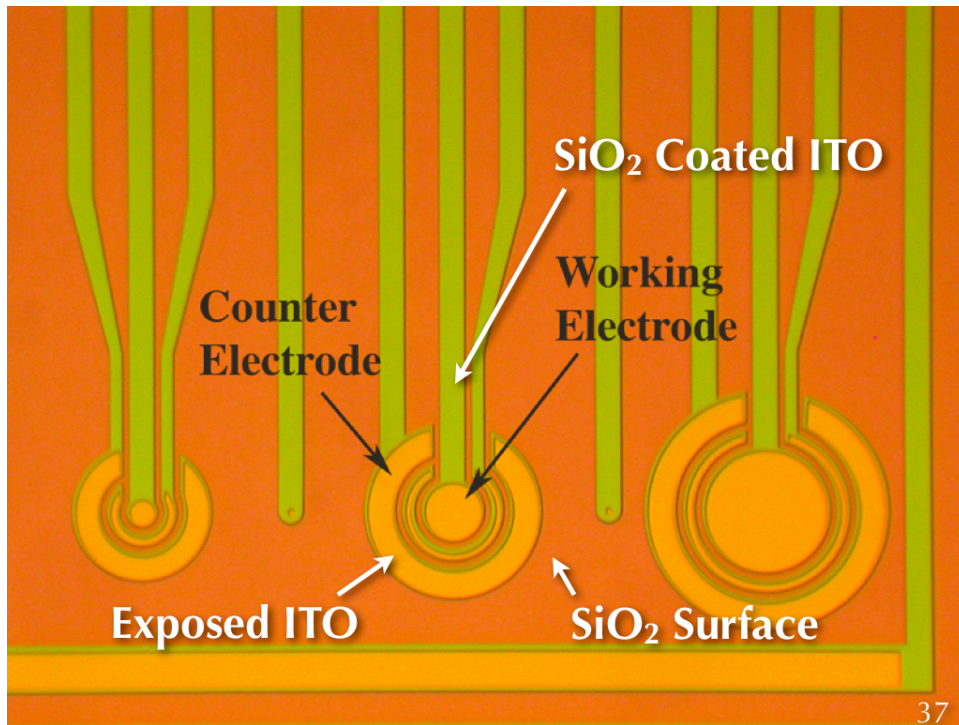
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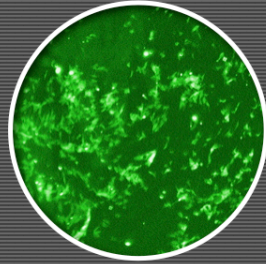
Cell Splitting

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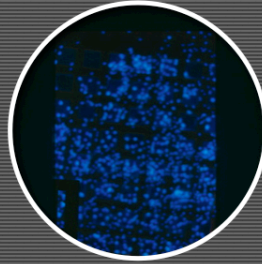
## CMOS Biochip for Rapid Assessment of New Chemicals



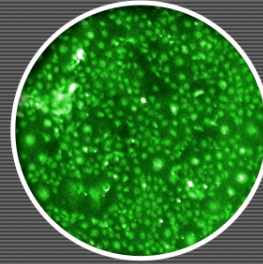
## Cell Attachment



Fibroblasts on  
ITO Coated  
Substrate

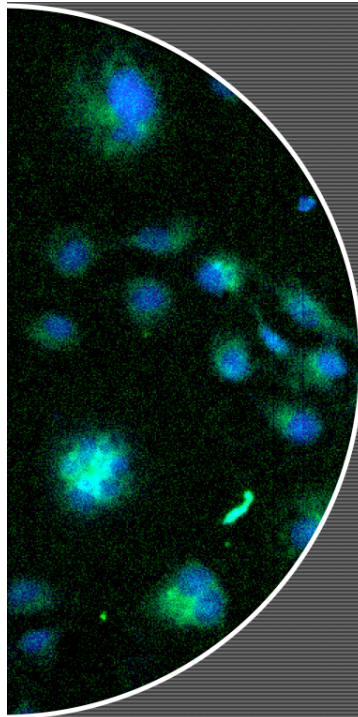


COS-7 Cells on  
CMOS Substrate

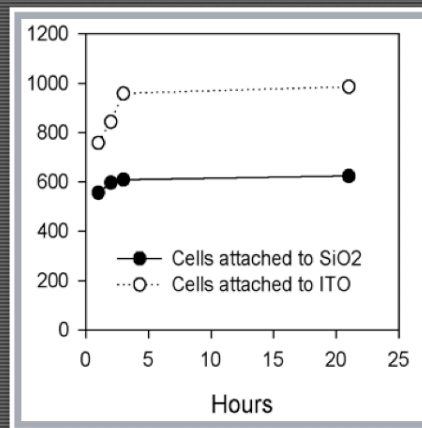


COS-7 Cells on  
ITO Coated  
Substrate

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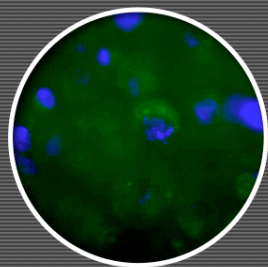


## COS-7 Attachment

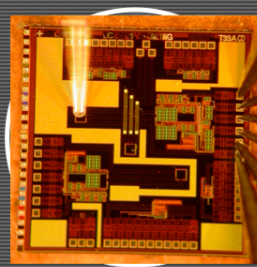


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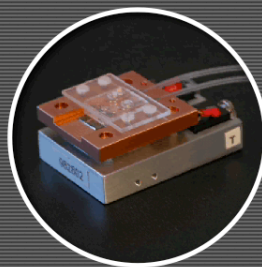
## Summary



Cell-Based  
Biosensor



CMOS  
Sensor



Biochamber

That's All Folks!

