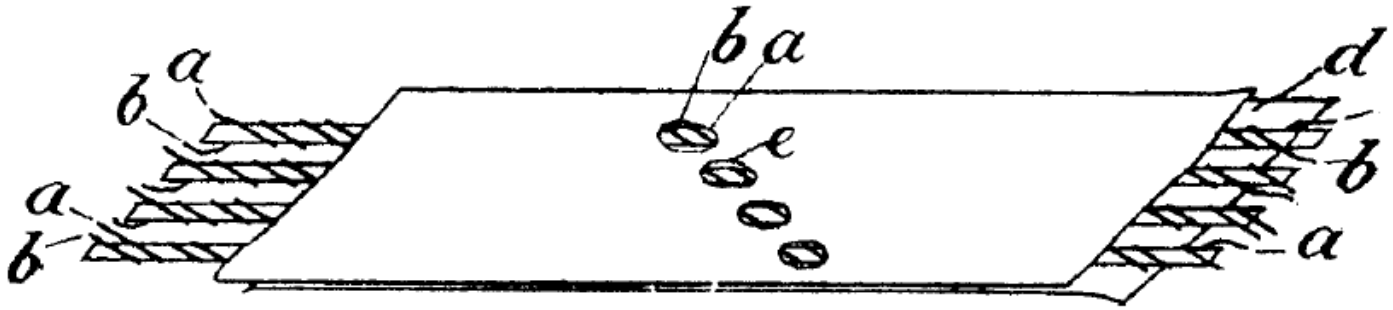
# Ever-Smaller Circuit Boards Enable Most Compact, Capable Medical Devices

Originally Presented by Randal Chinnock
at MDM East 2011 Innovation Briefs

# About Optimum Technologies

- We are not a flex manufacturer
- We are a product development company specializing in biomedical optics
- We use flex technology to develop smaller, more capable optics-based medical devices
- I will mention some flex manufacturers in my talk, but I am not offering any endorsements

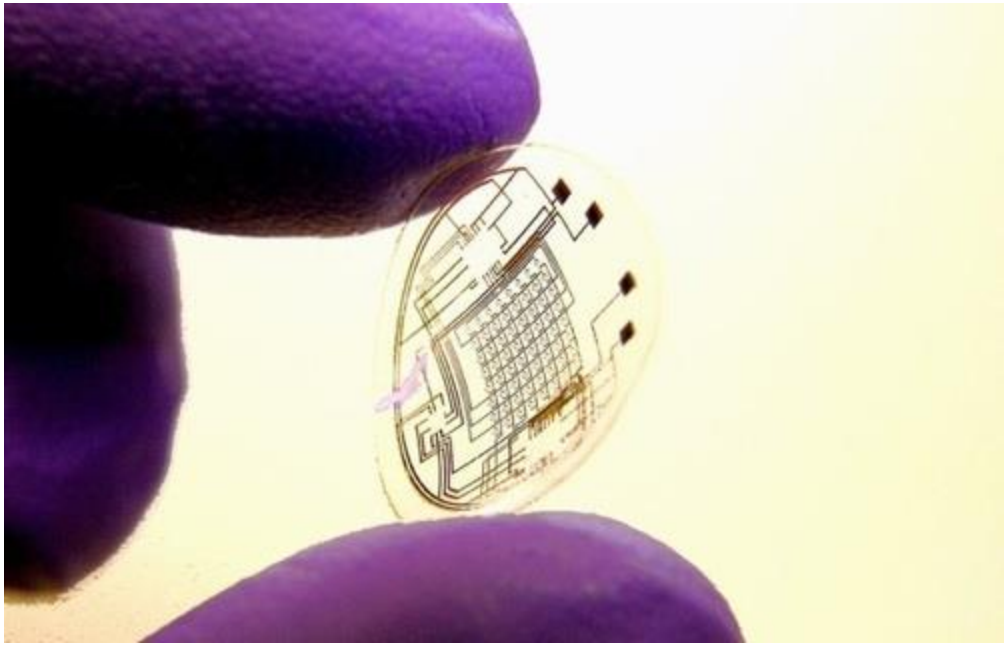
# 1903(1)




- Albert Hanson filed his "printed" wire patent in England
- Aimed at solving the telephone exchange need

(1) **The Circuit Centennial,** Ken Gilleo, Ph.D. , ET-Trends, gilleo@ieee.org

# 2011[2]



Flexible circuit on a contact lens

(2) Babak Parviz, University of Washington

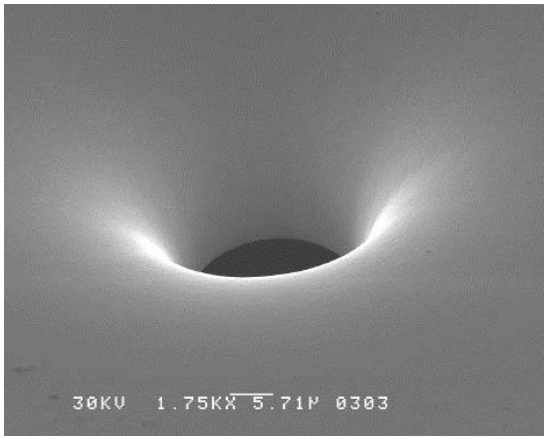
# Why Use Flex Circuits?

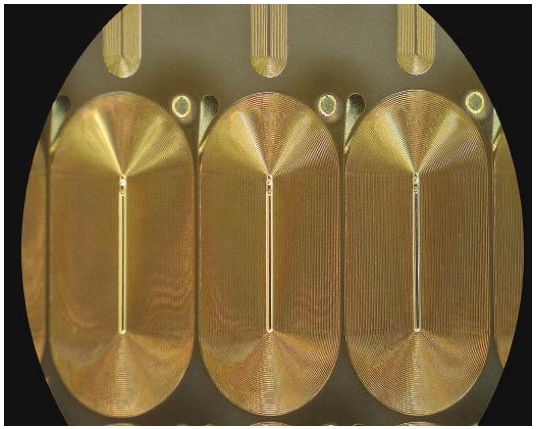
- Lighter/more rugged than rigid PCBs
- Can be bent & folded (Oragami)
- Can articulate (e.g., through hinges)
- Mounting features easily integrated
- Unique connectivity capabilities, including replacement for wires & harnesses
- Can have flexible & rigid sections

*Courtesy: Cybersensors*

# Capabilities

| | Commercial | High Resolution |
|---|---|---|
| Processes | Wet-Etch | Photolithography, Electrochemical Deposition |
| Minimum Trace/Space | .004” | .0001” |
| Minimum Drill Hole Size | .005” | .0019” |

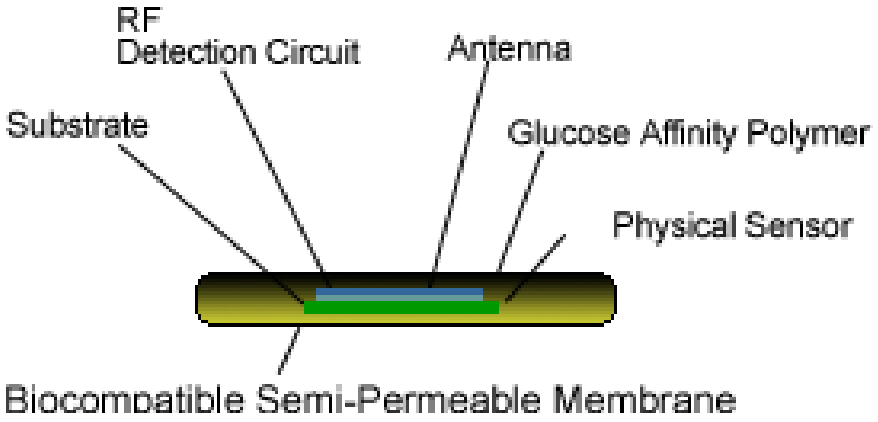


*ERMF images, courtesy Metrigraphics*

# Current Applications

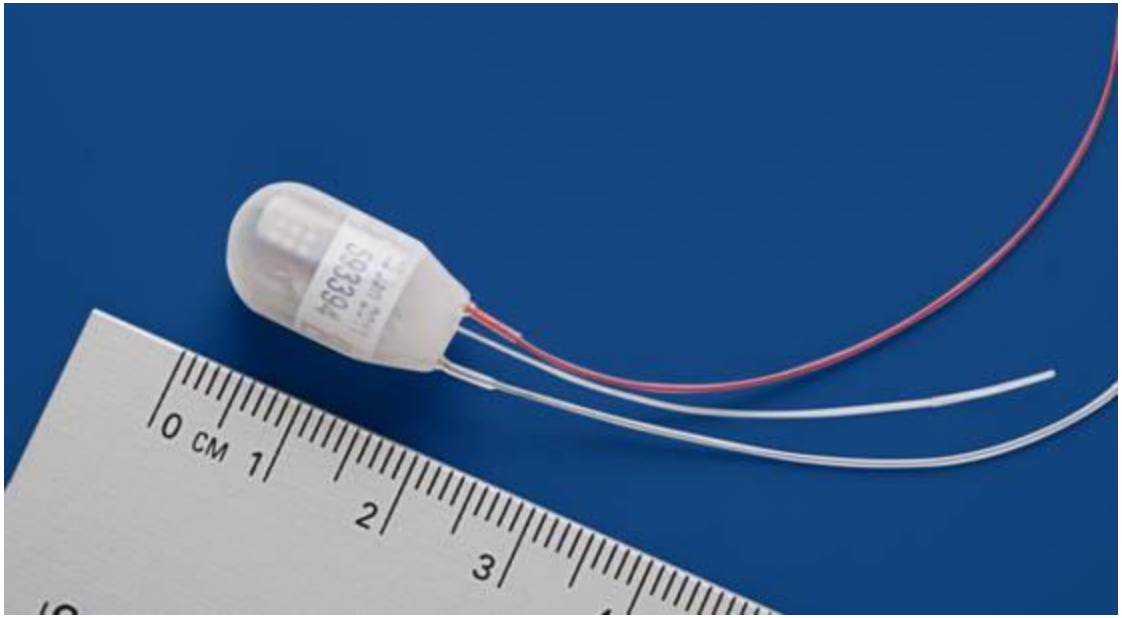
## Implantable Glucose Sensor




*Courtesy: Cybersensors*

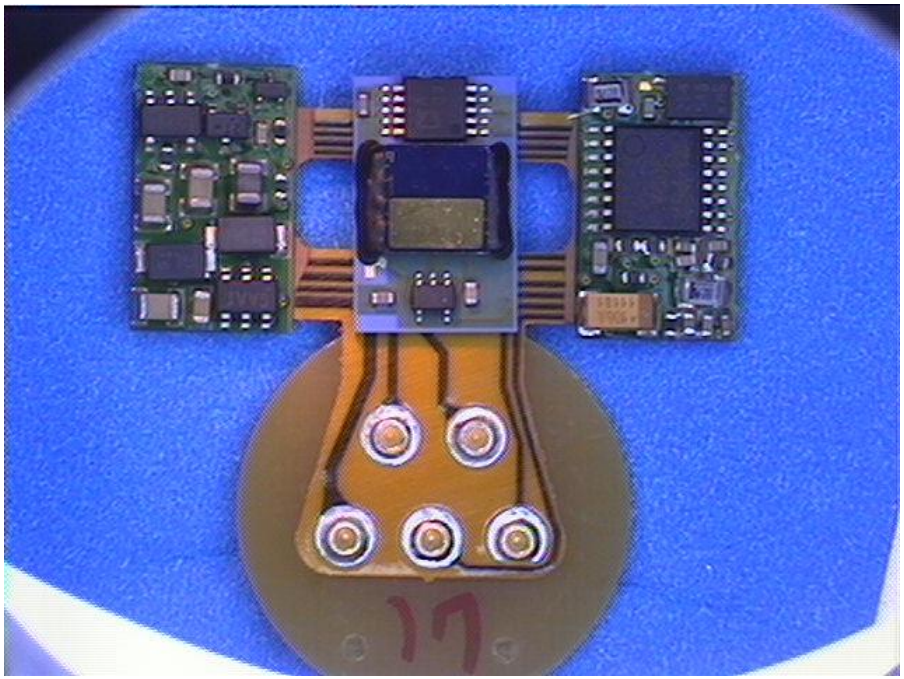
# Airway Device

# Implantable Sensor



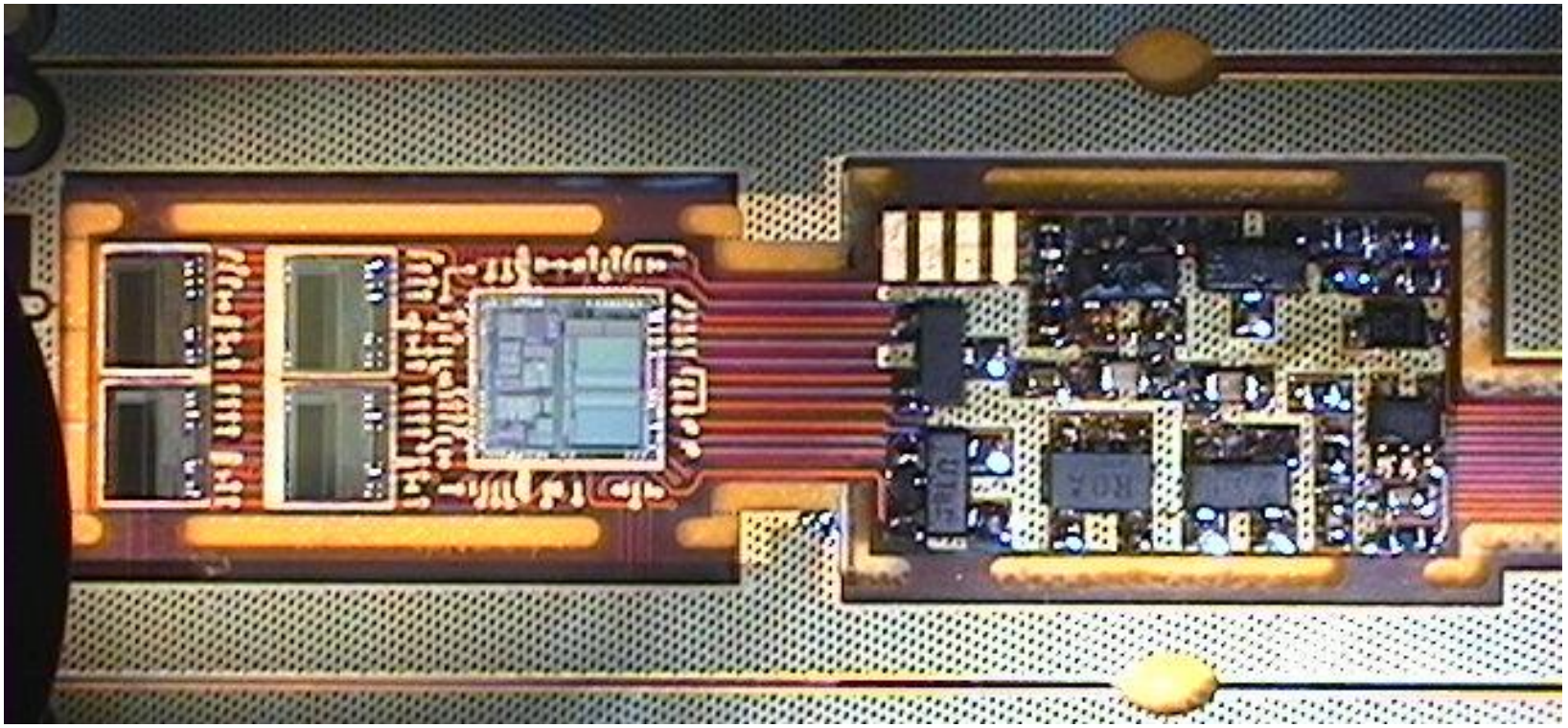

*Courtesy Data Sciences International*

# Gas Sensor



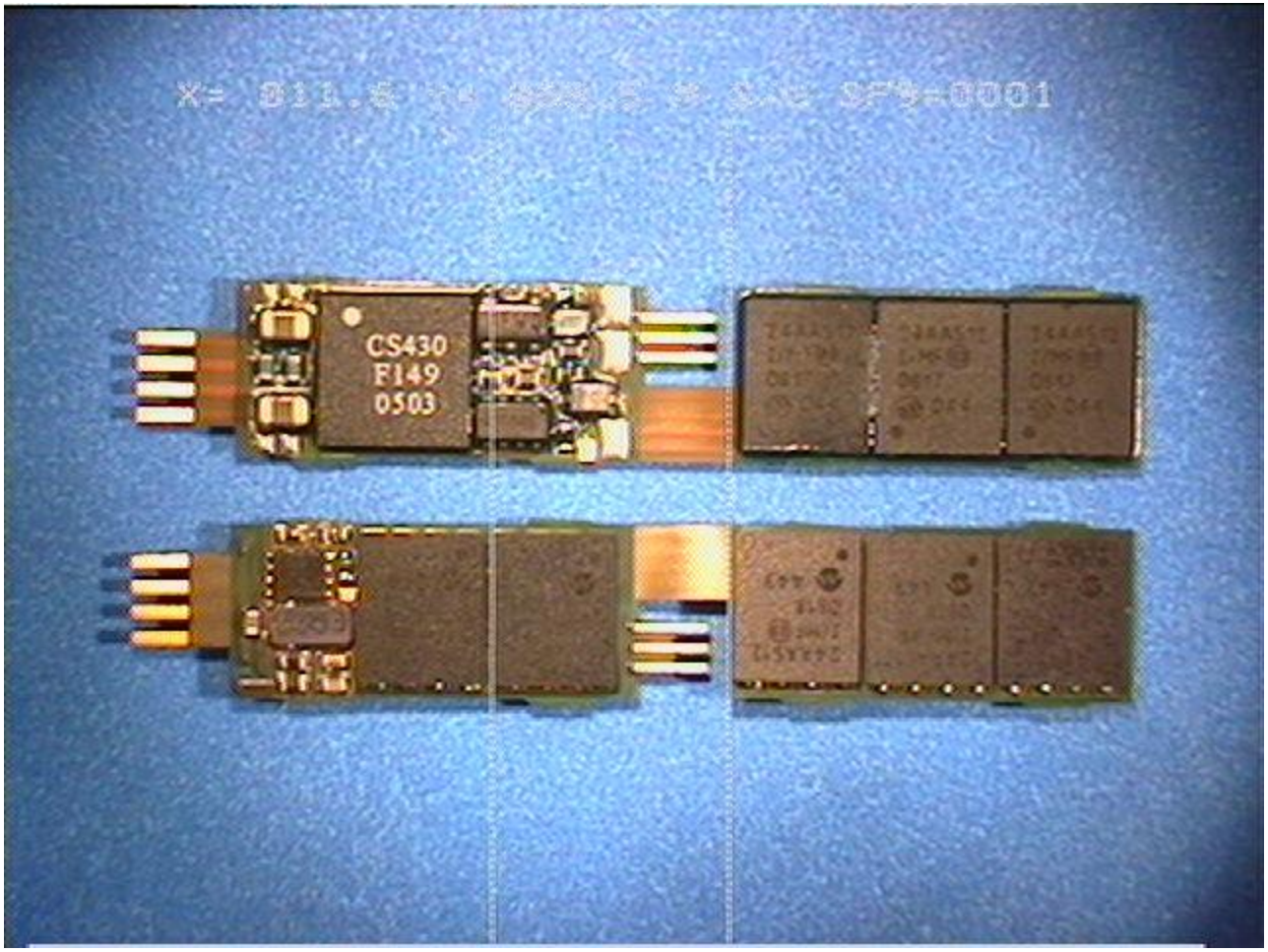
*Courtesy TASK Microelectronics*

# Archival Fish Tag



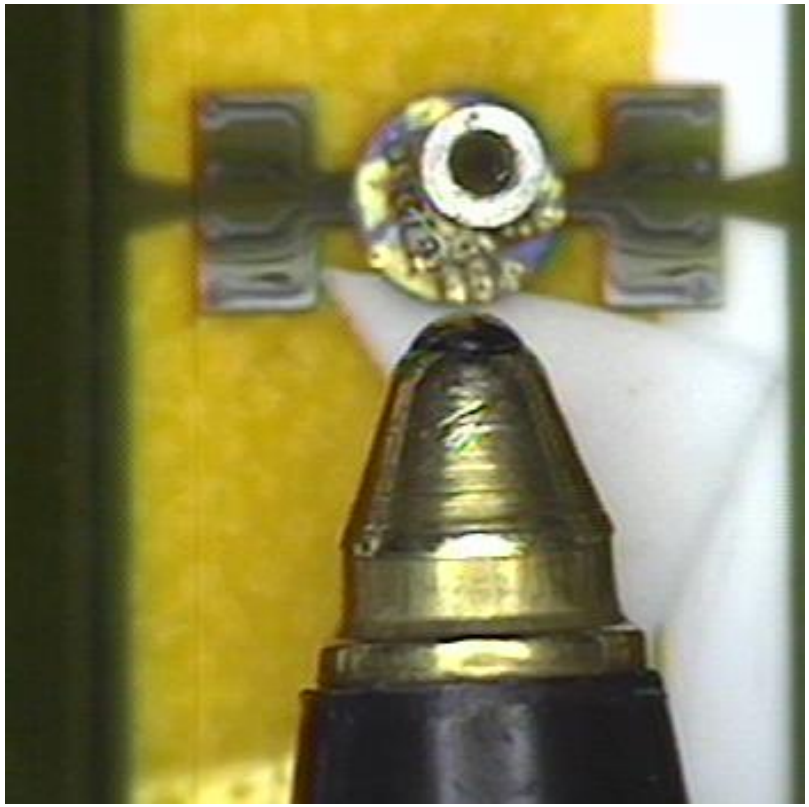
*Courtesy TASK Microelectronics*

# Wildlife Tracker




*Courtesy TASK Microelectronics*

# Endoscopic Camera



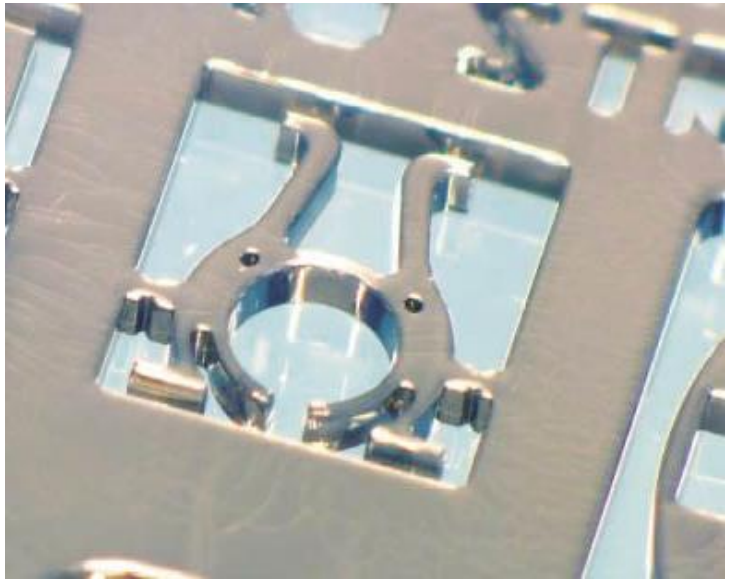

*Courtesy TASK Microelectronics*

# Other Applications

- Ultrasound angioplasty devices
- Blood chemistry sampling devices
- Retinal implants
- Remote transmitters for data transfer in and out of the human body
- Magnetic sensing and analysis devices
- Lab-on-a-pill, smart pill
- pH monitoring
- Fall sensors

# Challenges

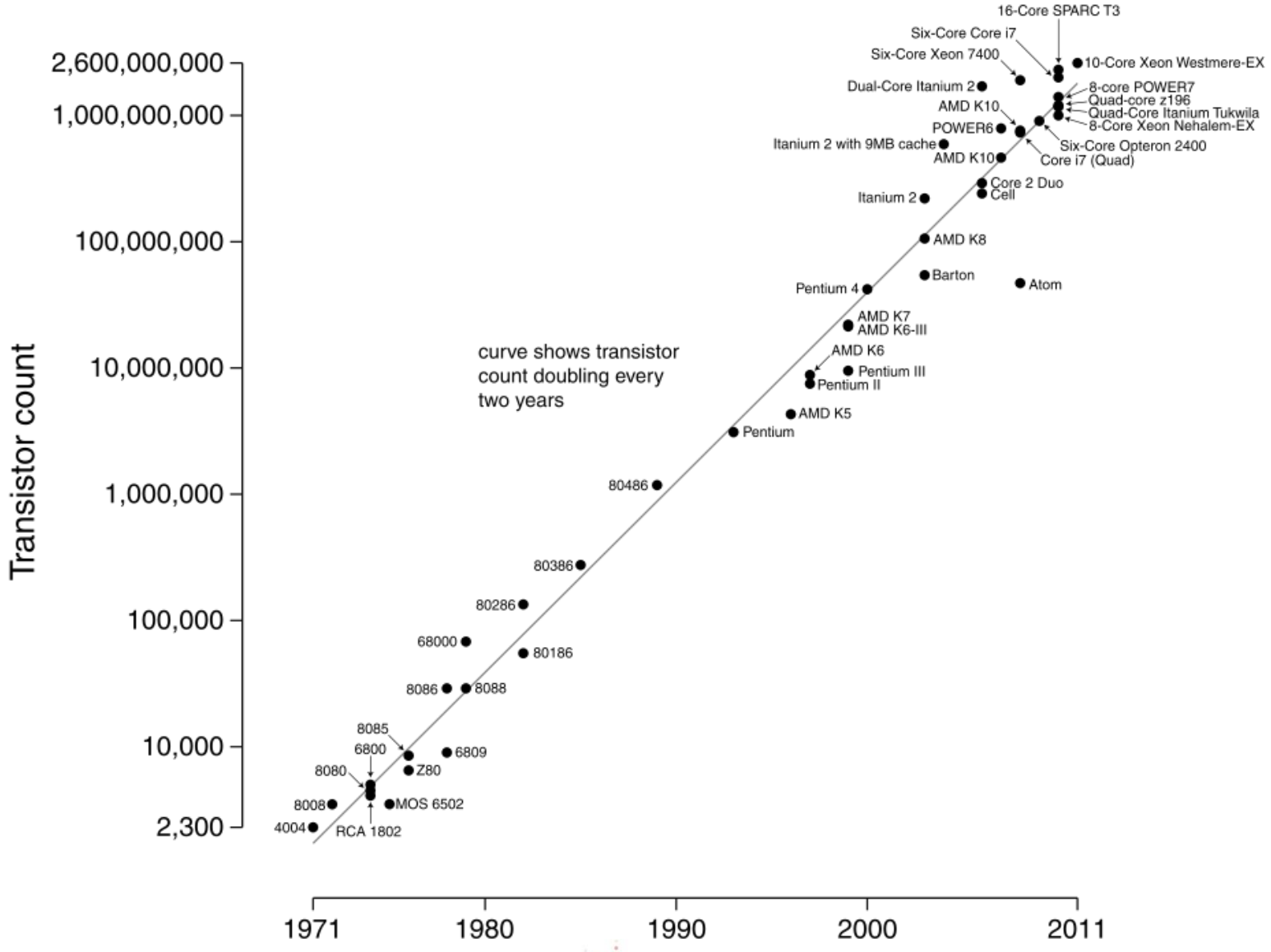
- Biocompatibility
- Material quality as features shrink
- Overlap with MEMS & nano technologies



Microlens Holder
*Courtesy Metrigraphics*

# What's Coming Next?

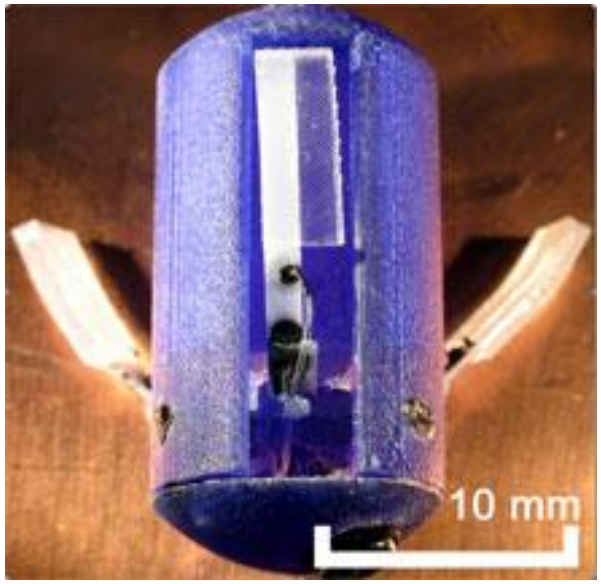
# Microprocessor Transistor Counts 1971-2011 & Moore's Law



# Forecast

- Ever-denser circuits and systems
- New functionalities enabled by smaller and more specialized ICs
- Manufacturing processes based on self-assembly
- Micron-scale metal interconnects incorporated onto thin flexible plastic substrates
- Biocompatible polymer encapsulation

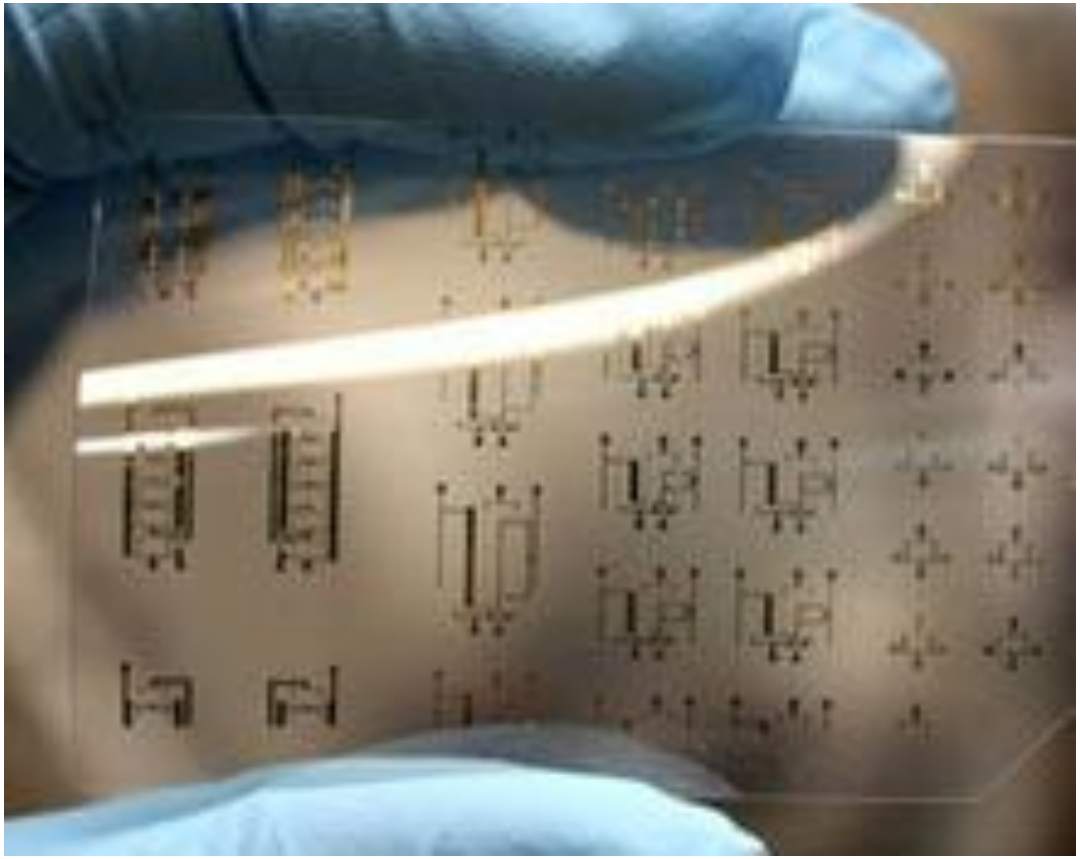
# Devices in Development




Anchorable pillcam
*Courtesy: Carnegie Mellon University*

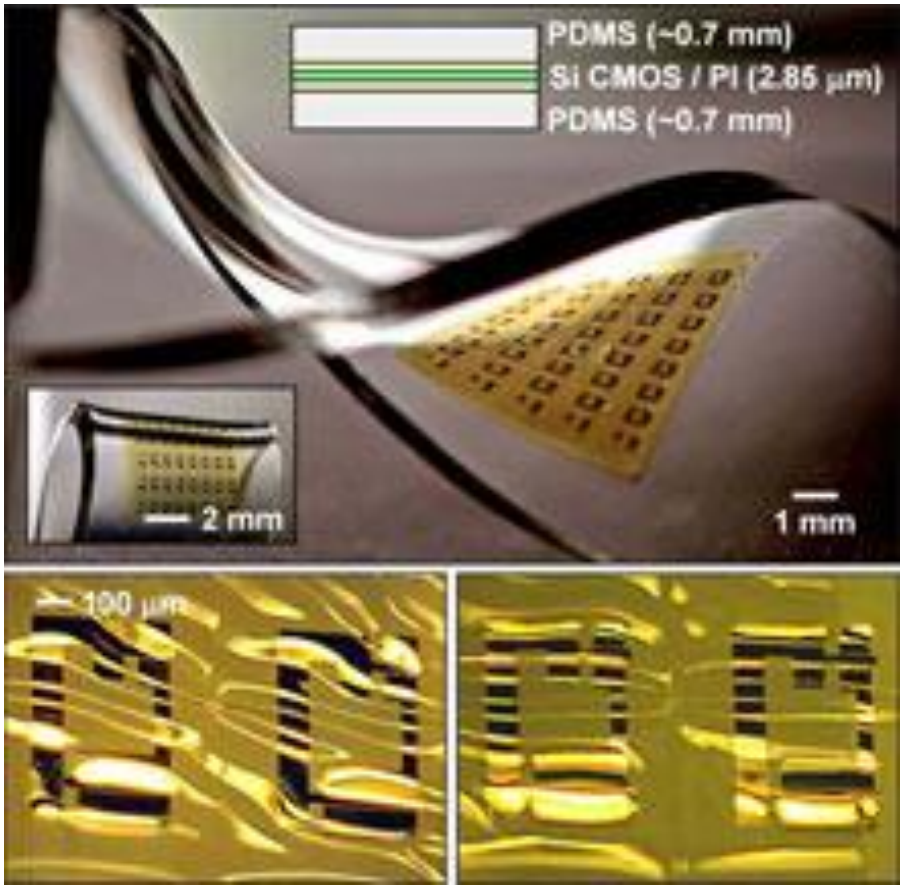
Self-assembling robot
*Courtesy: MIT*

# Impact of Nanotechnologies

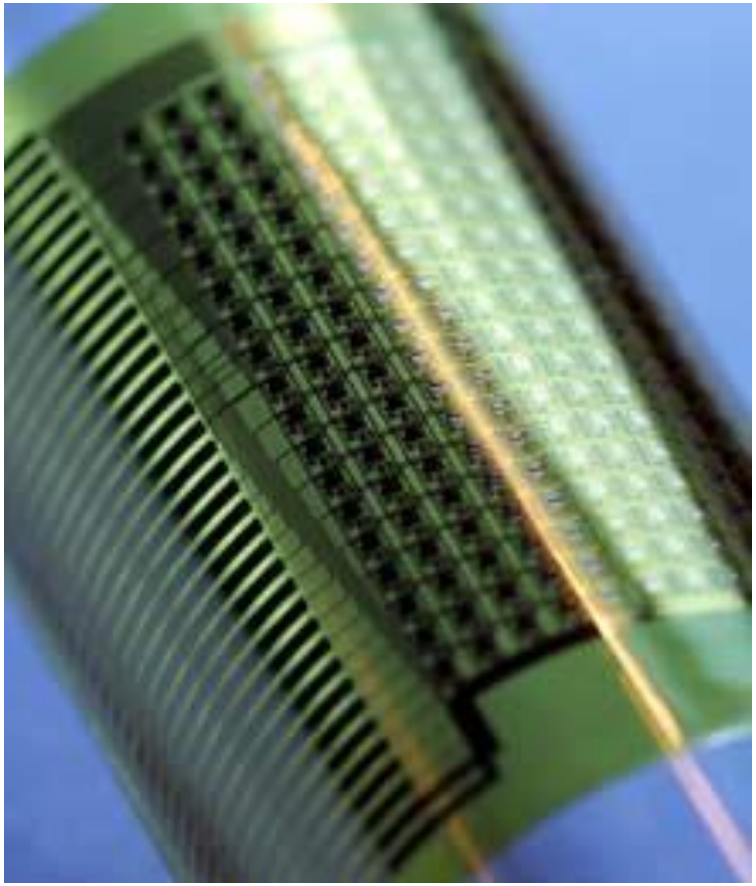


Circuits made from printed carbon nanotubes.
*Courtesy Northwestern University*

# Impact of Flexible Single Crystal Silicon



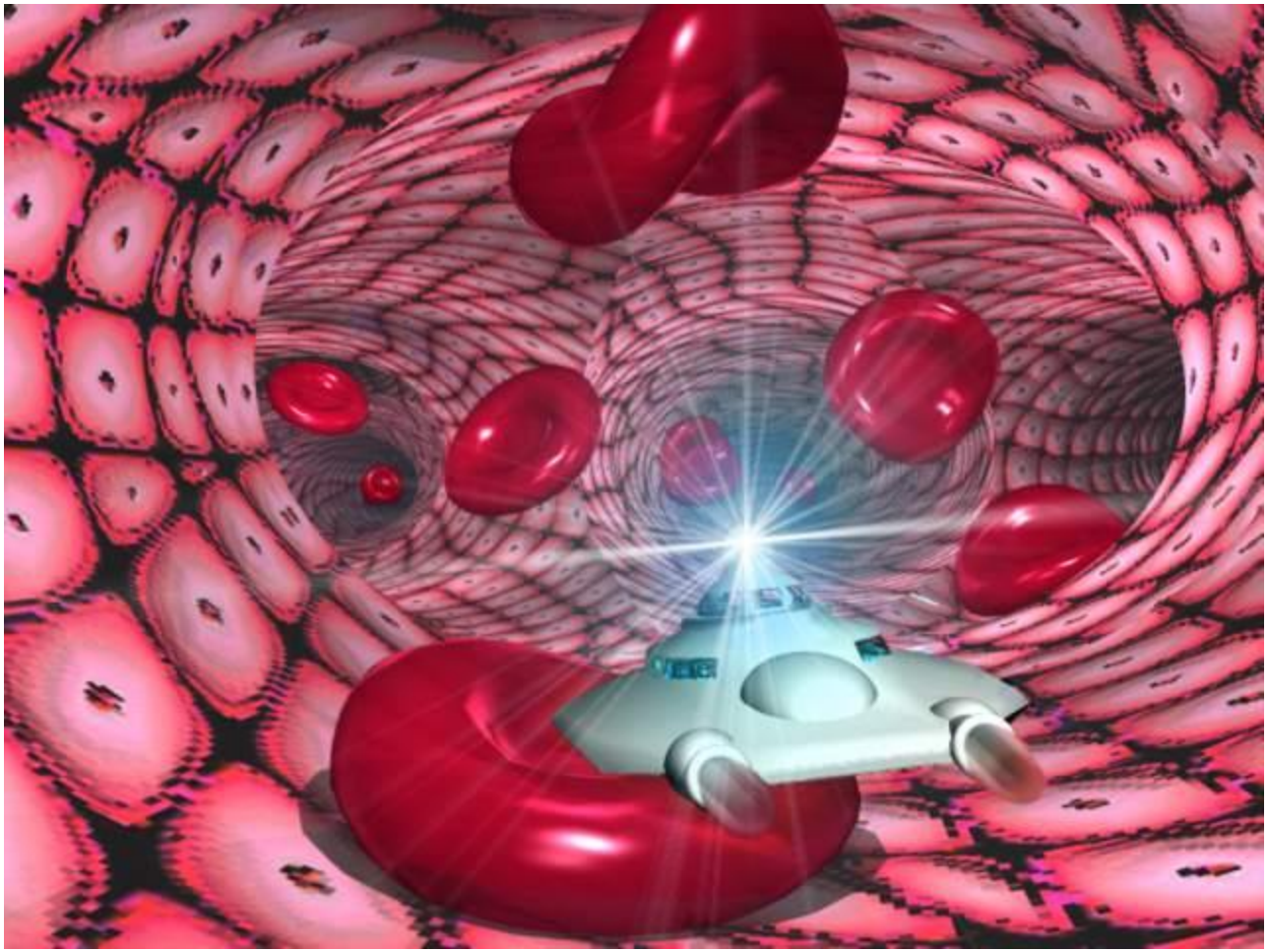

Circuits made from single crystal silicon.



Electrophysiology sensor.

*Courtesy University of Illinois*

# “Fantastic Voyage” to Nanomedicine



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