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Microsystems Sensors: Forces Pushing Technology into the Future

Keith Ortiz
Sandia National Laboratories
NASA Tech Briefs: SENSORS Tech Forum
Boston, MA
October 12, 2011

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Sandia National Laboratories

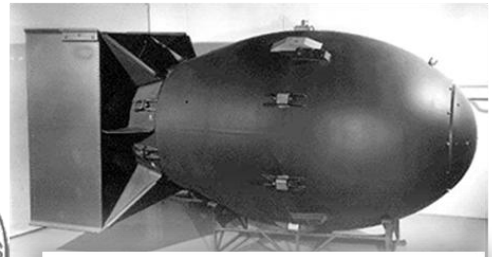
Another revolution has begun:

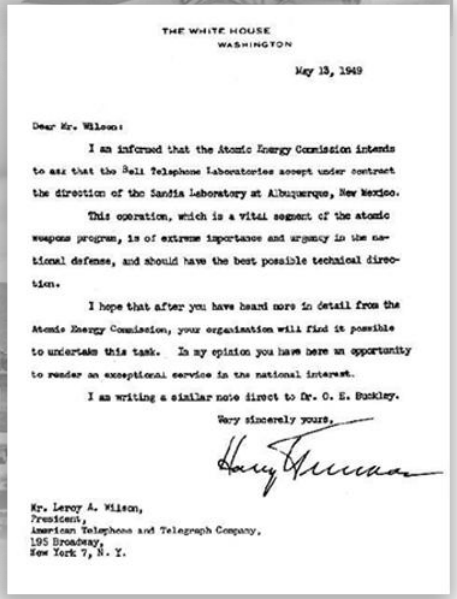
a Revolution in Sensing...

“The Forces Pushing the Revolution”

Sandia National Laboratories

"Exceptional service in the national interest" **since 1945**





THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. C. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.

Government-Owned Contractor-Operated (GOCO) Federally Funded Research & Development Center (FFRDC)
AT&T: 1949–1993; Martin Marietta: 1993–1995; Lockheed Martin: 1995–Present

Sandia National Laboratories

Microelectronics and Microsystems

MESA: Microsystems Engineering Sciences and Applications

Radiation-hard CMOS

Compound Semiconductors

Photonics

MicroElectroMechanical Systems (MEMS)

Sandia National Laboratories

MicroElectroMechanical Systems

Creating options for national security

Research and Development

Fabrication Capabilities

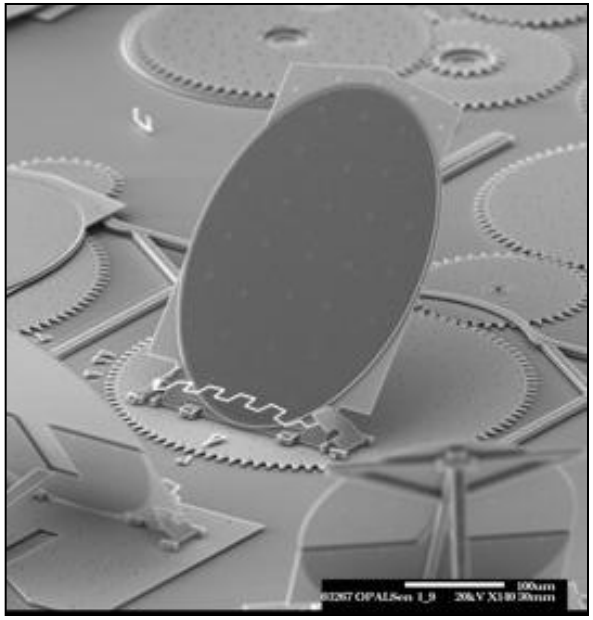
SUMMiT V™, Shared Wafers

Other, e.g., Aluminum Nitride

Prototyping and Small Volume Production

Working with Industry

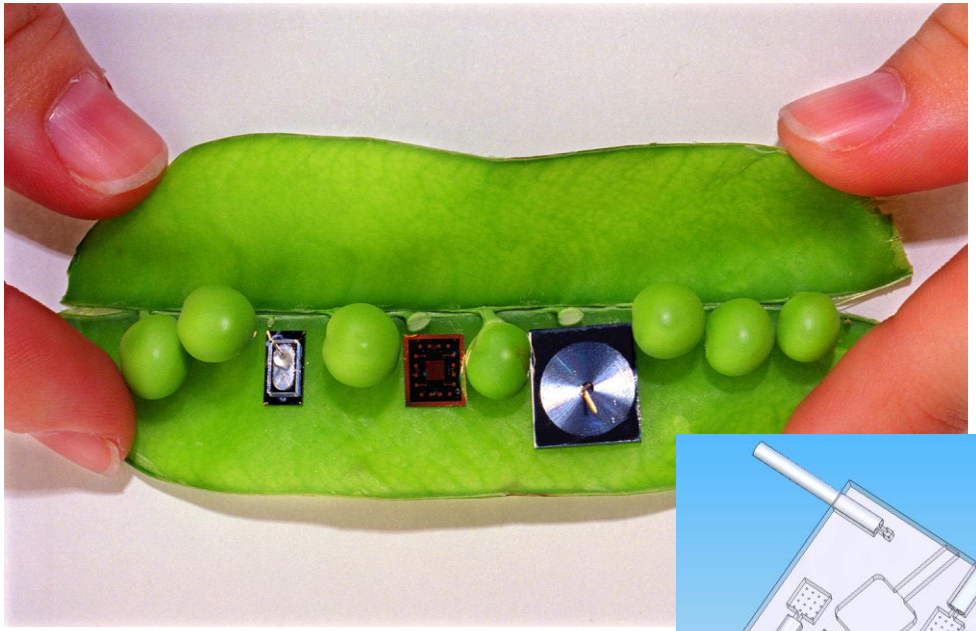
Joint Sponsored R&D, CRADA, WFO

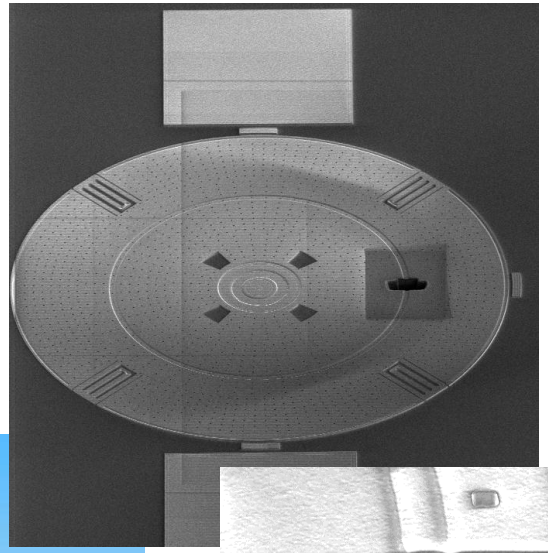


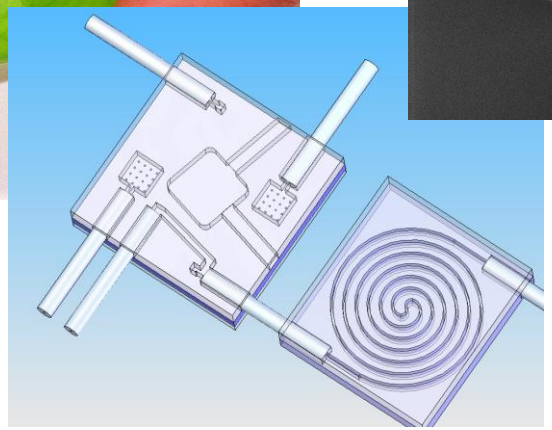
Five Forces Push to:

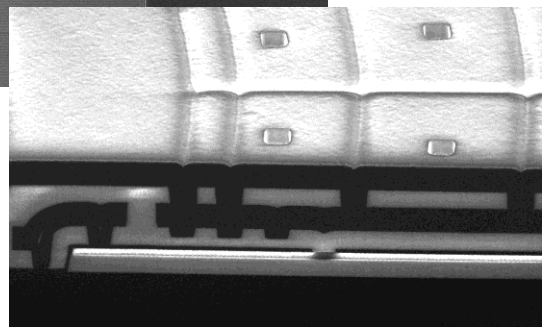
Make Things Smaller
Lower Cost
Work at the Micro Scale
Create Arrays
Integrate

Make Things Smaller



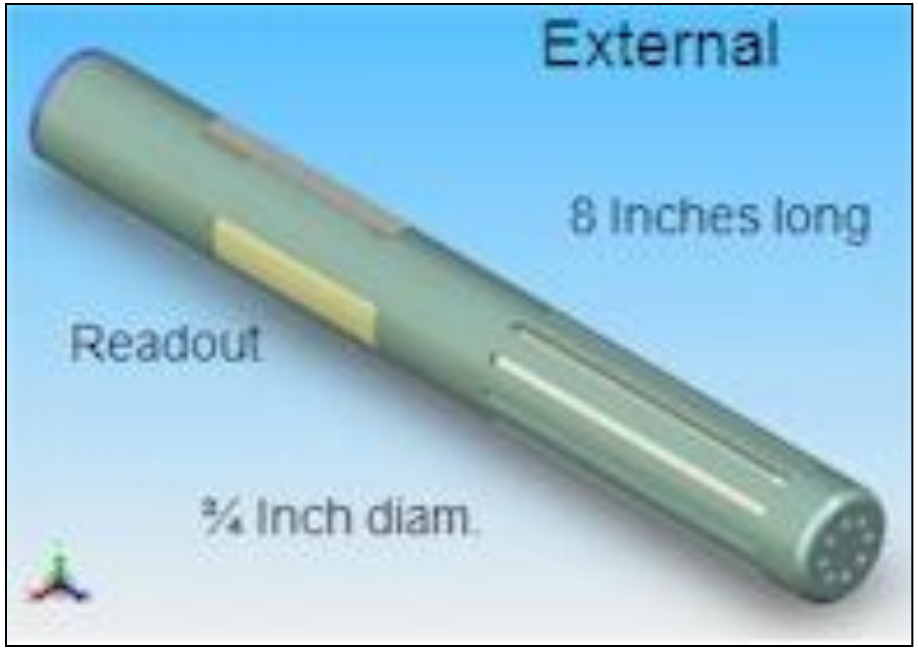


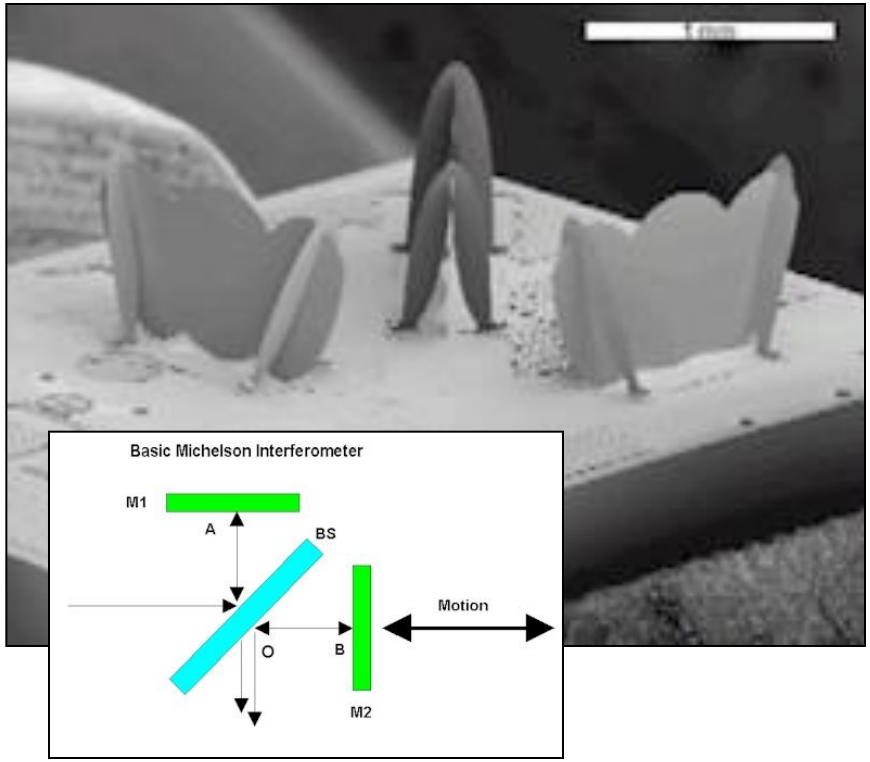




Micro Chem Lab, MGA

Make Things Smaller





Block MEMS ChemPen™

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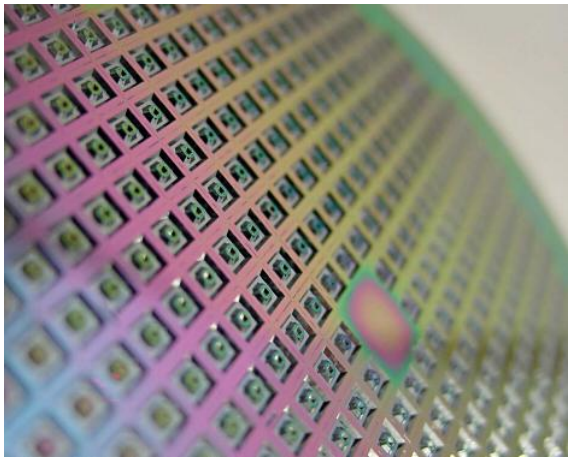
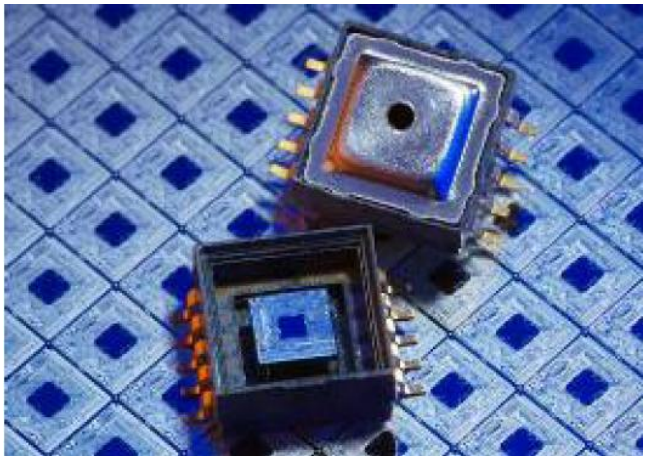
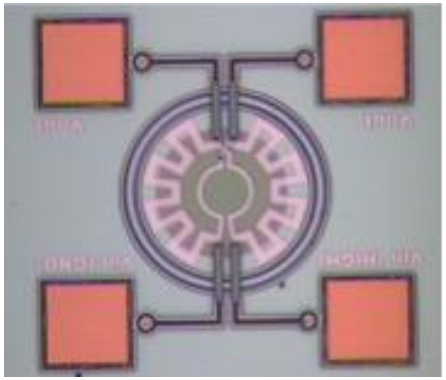
Lower Cost

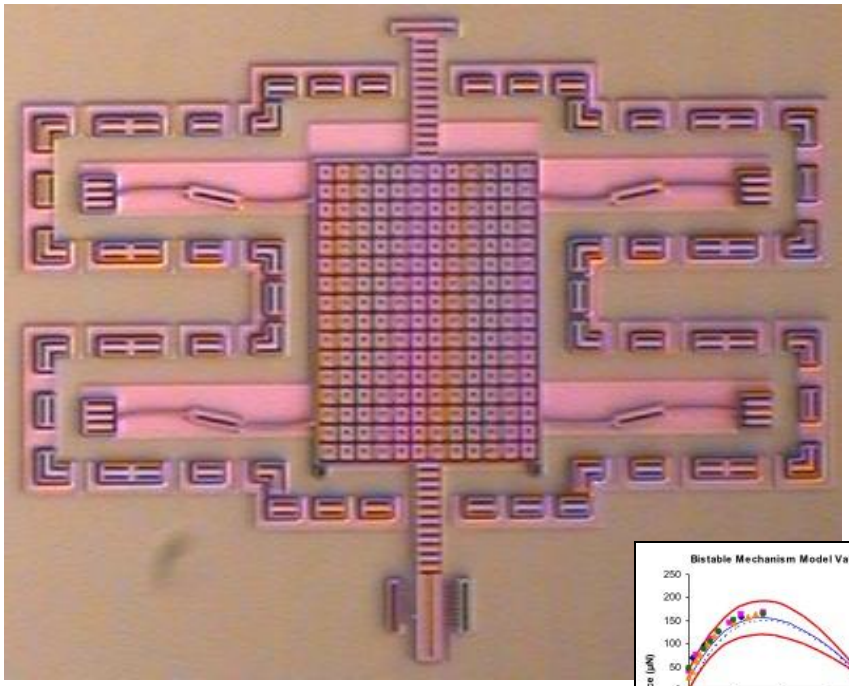


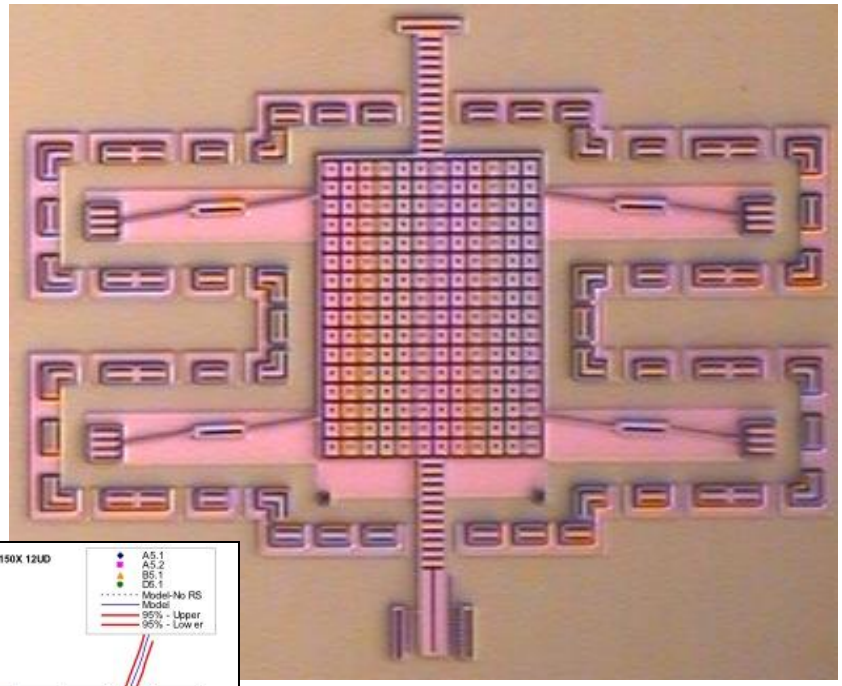


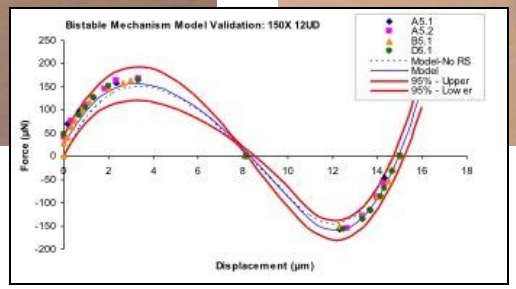


Pressure Sensors

Lower Cost







Passive Shock Sensor

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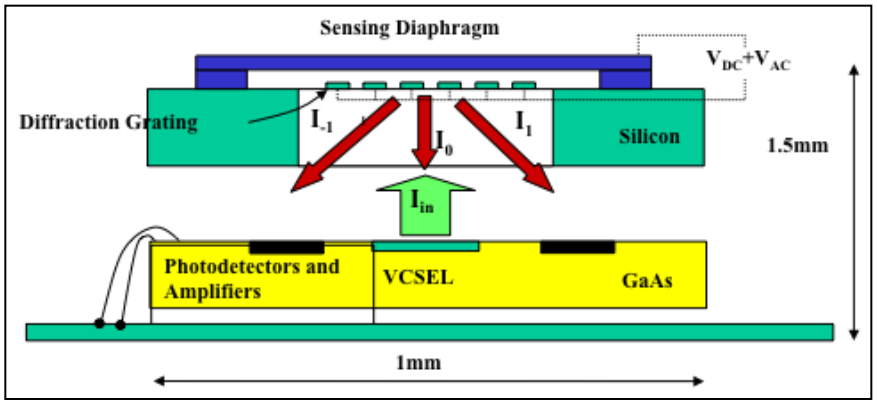
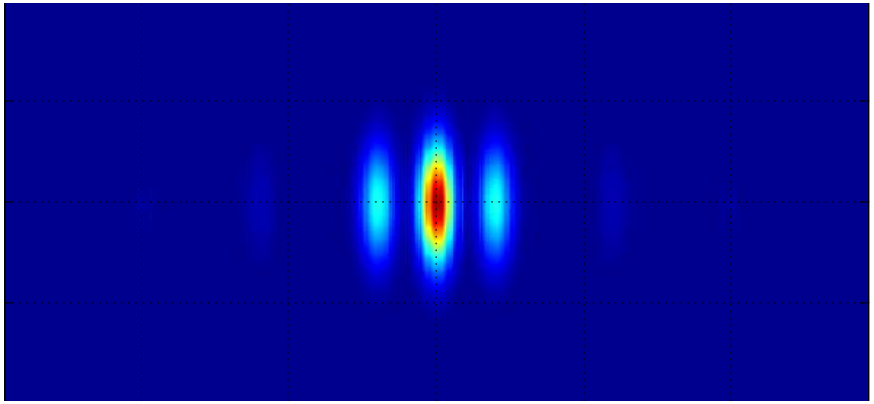
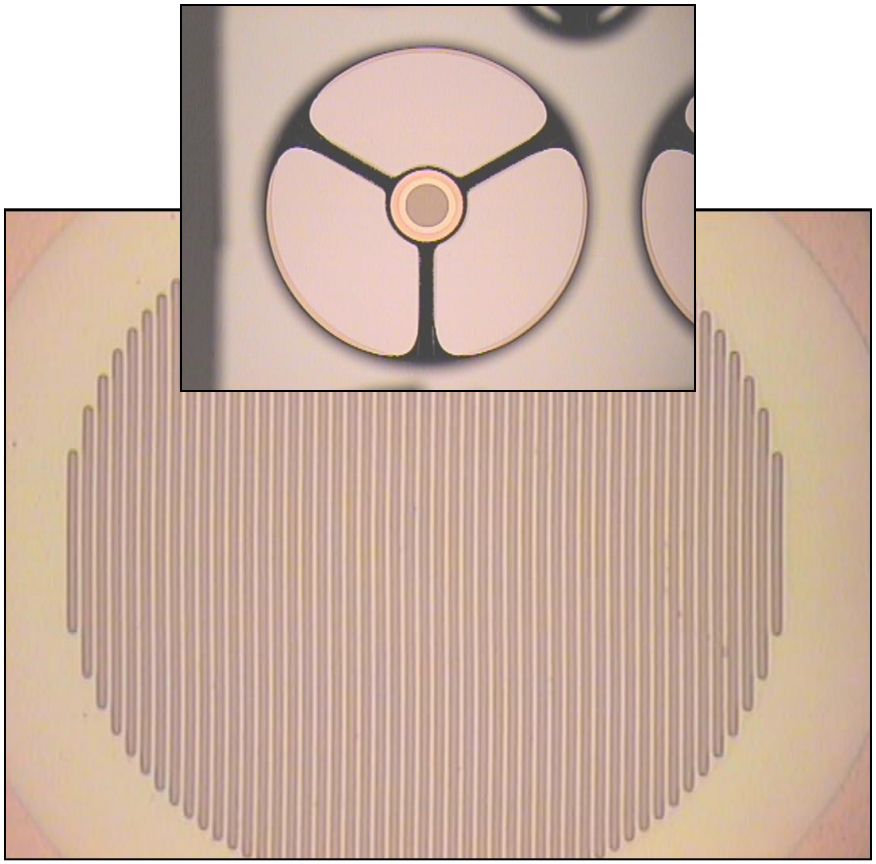
Work at the Micro-Scale







Optical Measurement of Displacement

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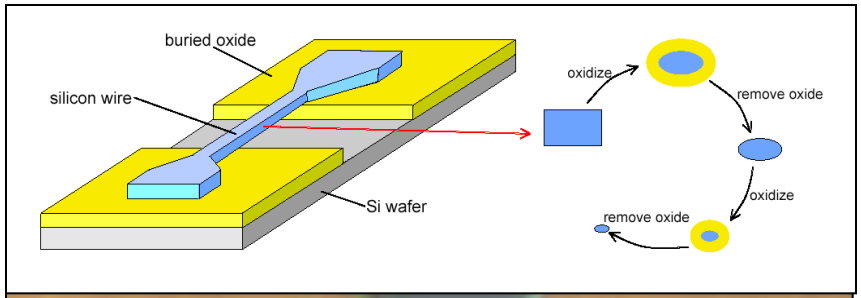
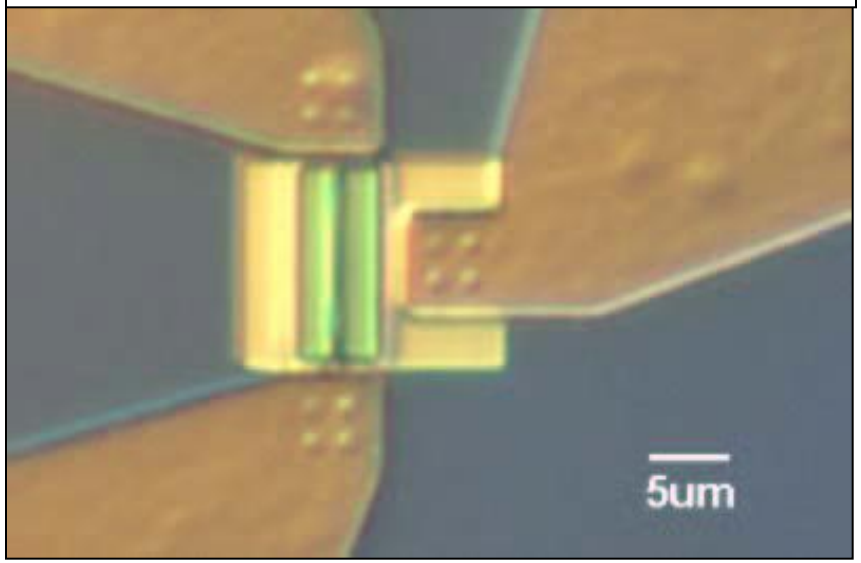
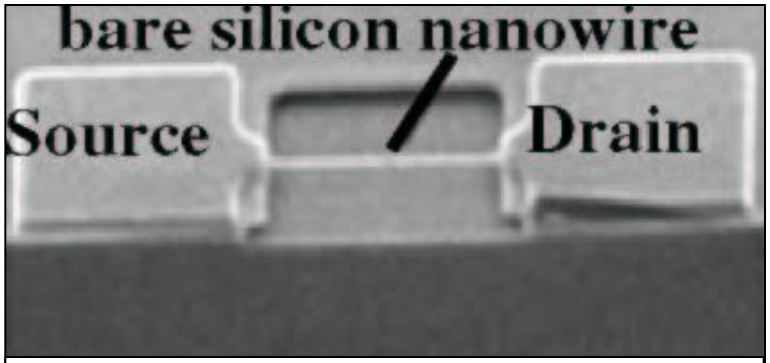
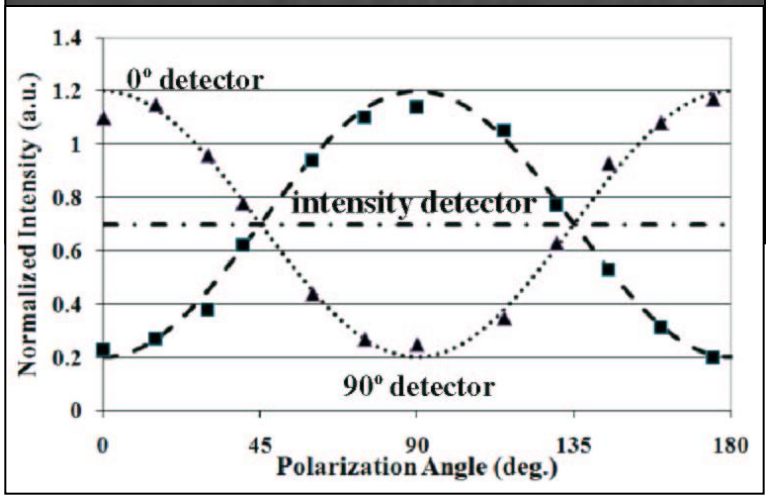
Work at the Micro-Scale









Silicon Nanowires

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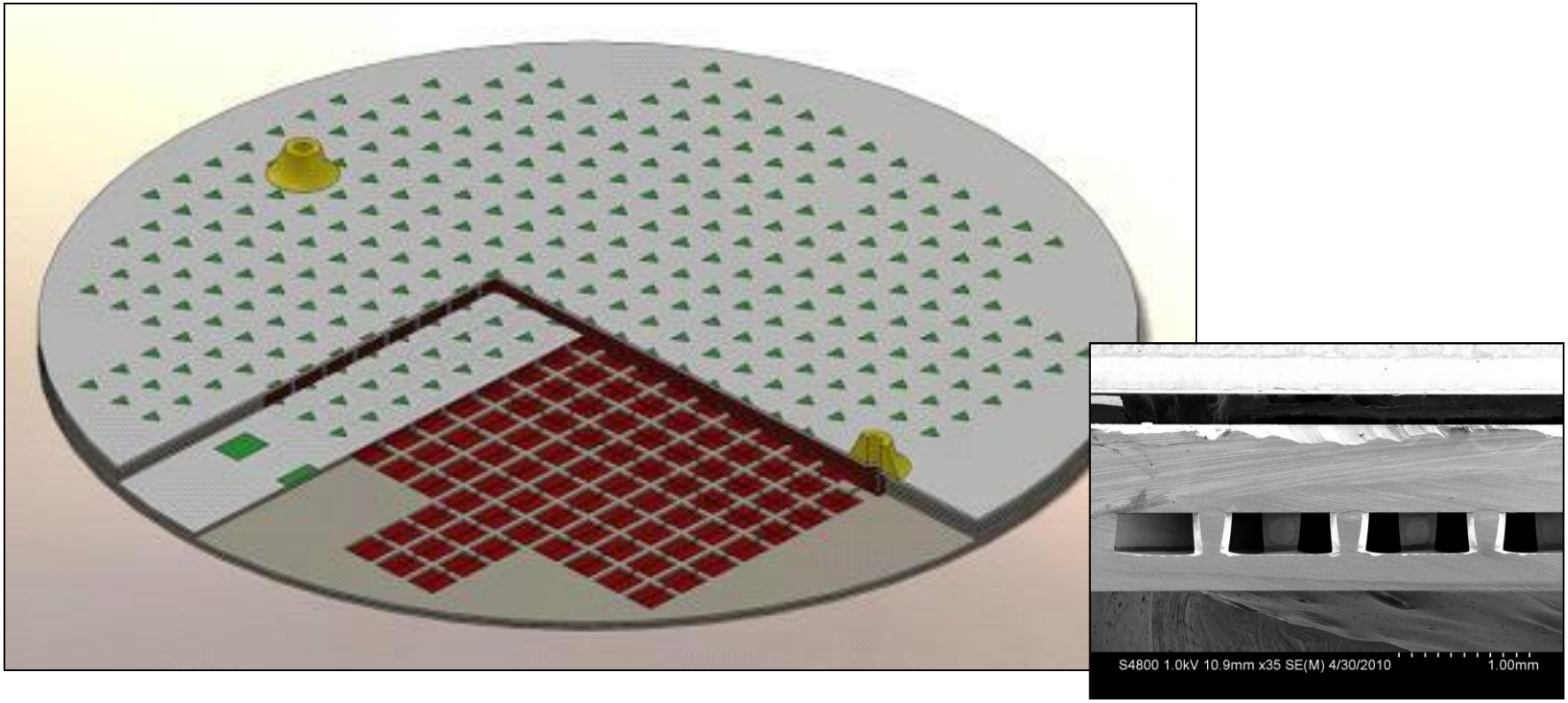
Create Arrays



Radiation Sensors

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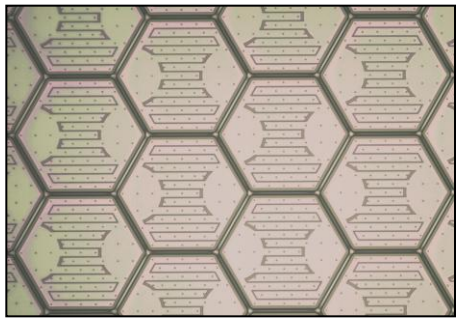
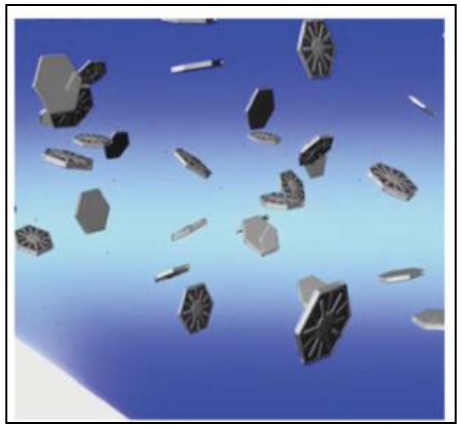
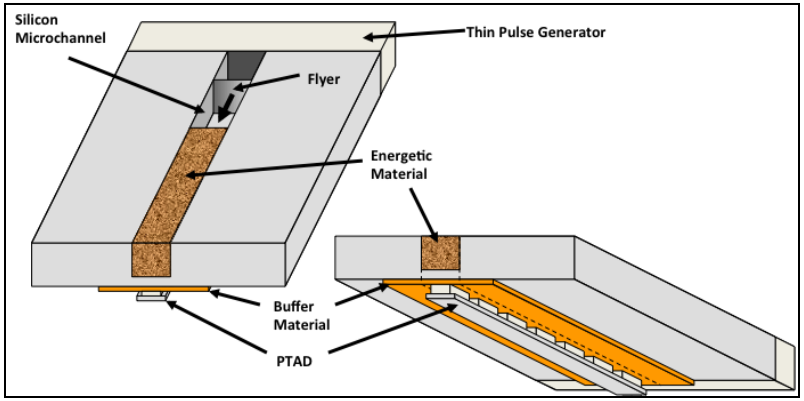
Create Arrays

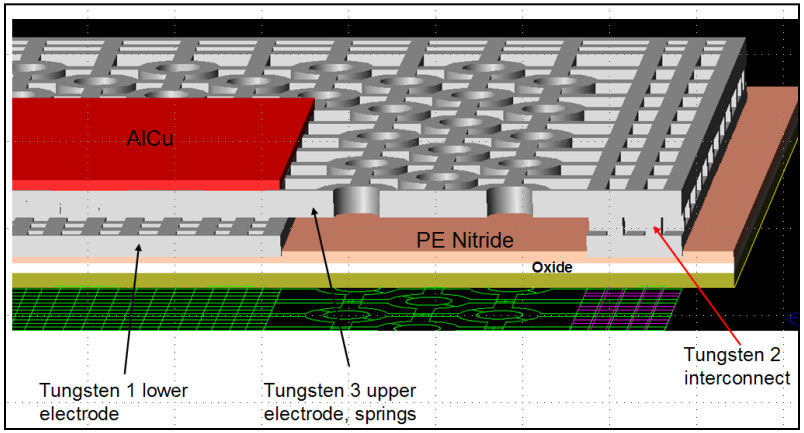


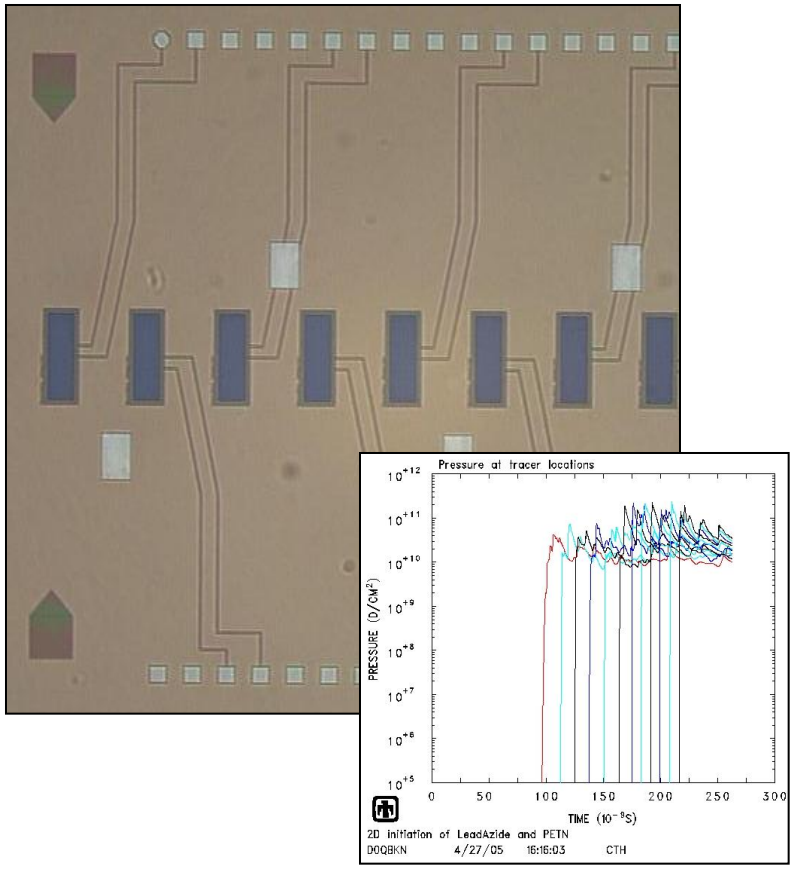


Microsystems Enabled PhotoVoltaics

Integrate







Integrated Tungsten Sensor-CMOS Pressure Transducer Array

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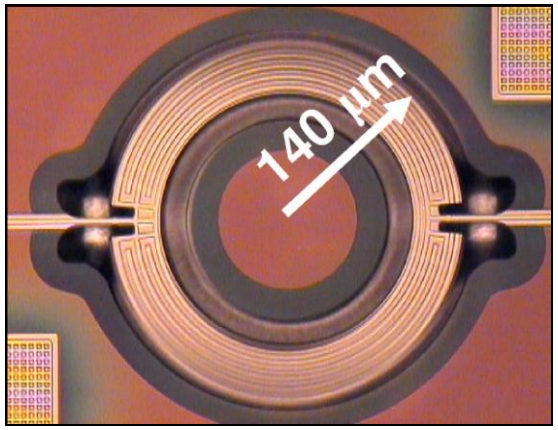
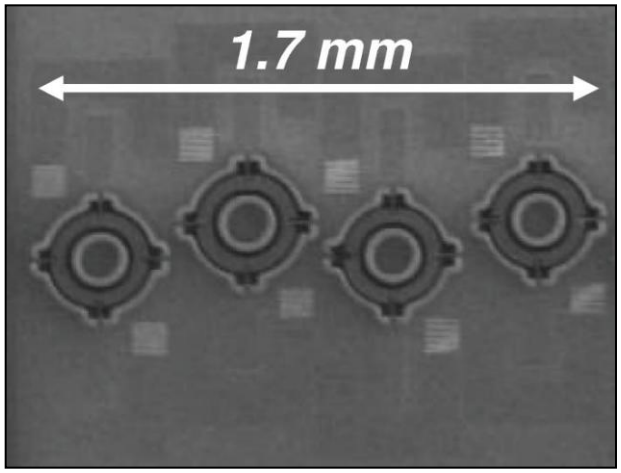
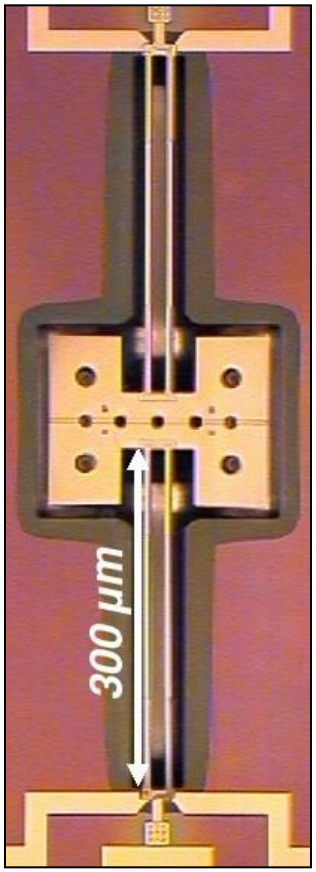
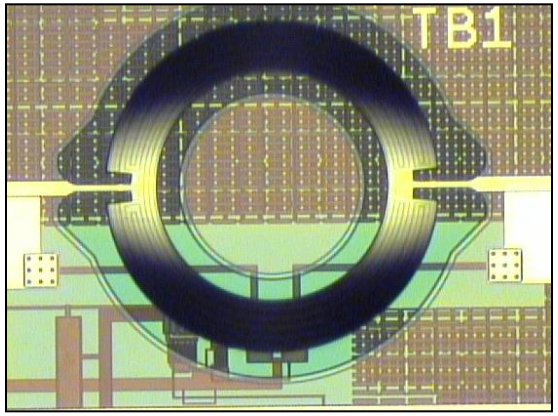
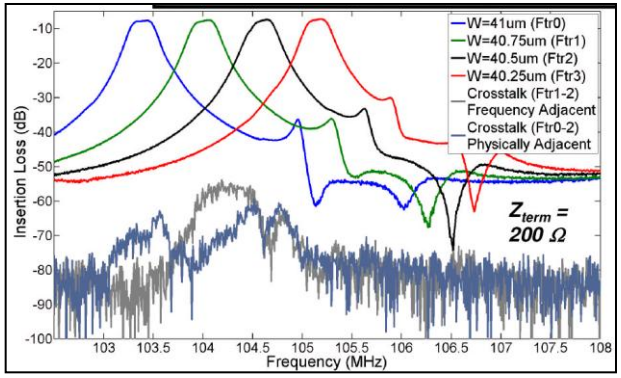
Integrate











Aluminum Nitride (Piezoelectric) Resonators

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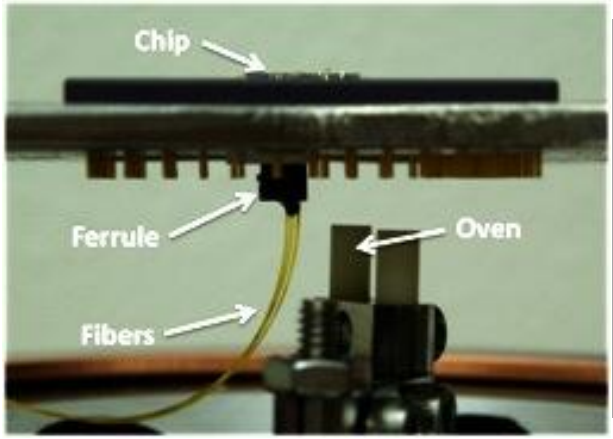
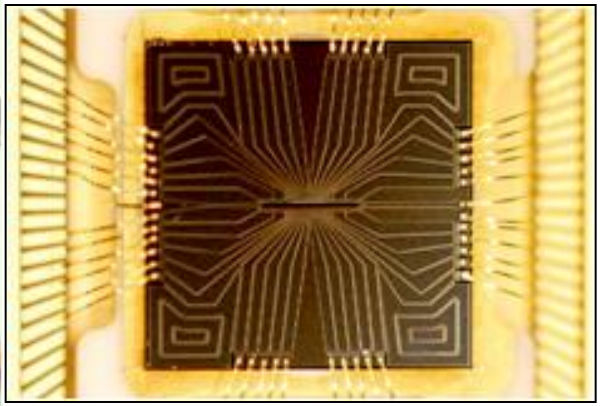
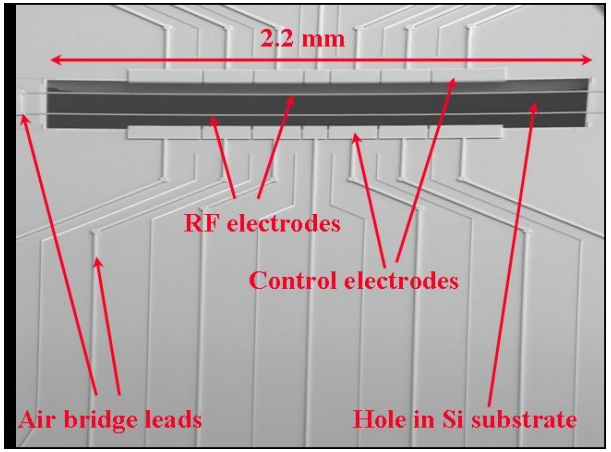
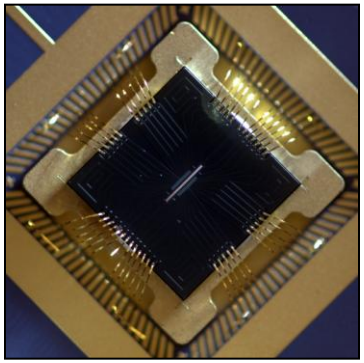
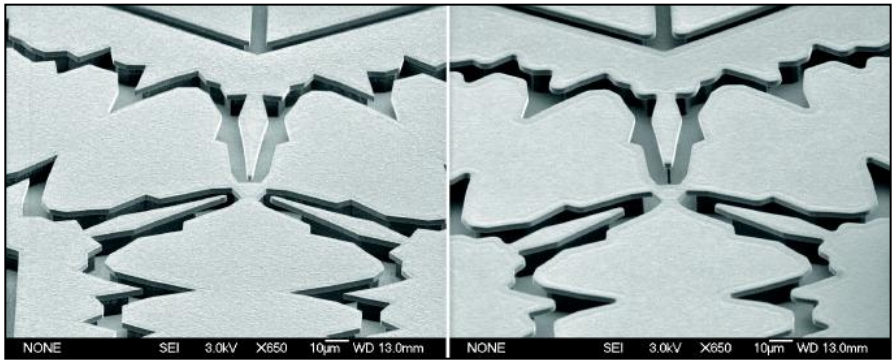
Convergence!

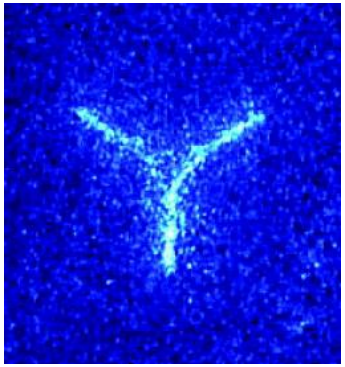












Ion Traps for Quantum Computing

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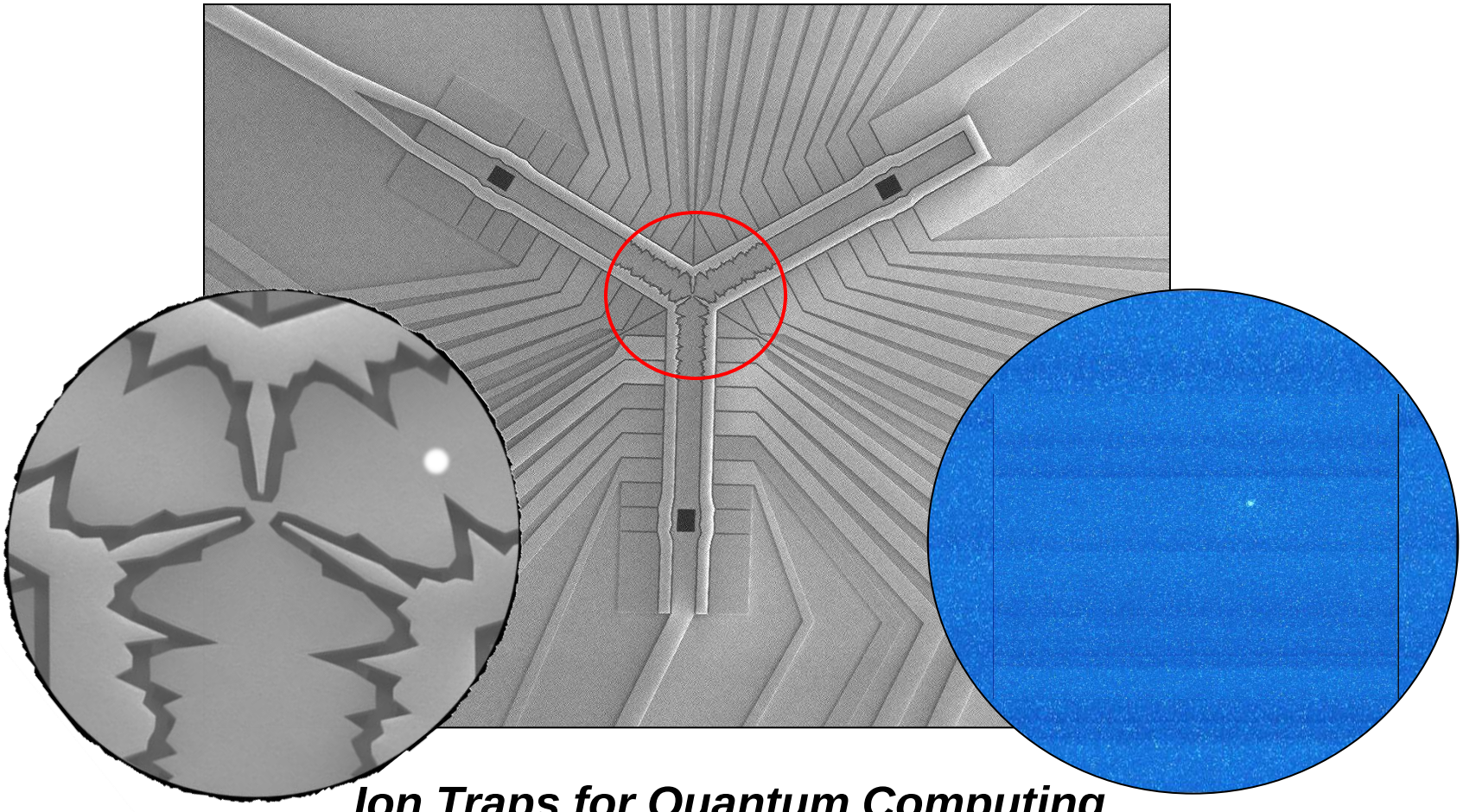
Convergence!

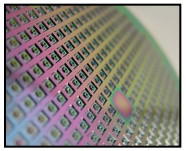


Ion Traps for Quantum Computing

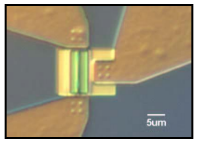
Five Forces Push Technology

Act alone or in combination

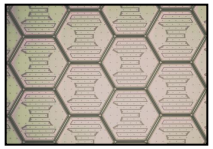
To Make Things Smaller
Especially portable or hand-held



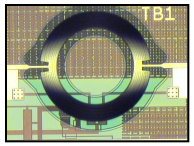
To Lower Cost
By using mass fabrication and economies of scale



To Work at the Micro Scale
Sense and manipulate inherently micro-sized things



To Create Arrays
To increase signal-noise; scale size/power; multiplex



To Integrate
Thus achieving novel functionality

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The Sensor Revolution

Will be as profound as The Computer Revolution

Sensors will become:

Embedded and Ubiquitous

Integrated with Computation and Communication

The Markets that will Pull:

Consumers and Industry

Healthcare and Medicine

Energy and Environment

and more...

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Contact Information

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(505) 844-2072

www.mems.sandia.gov

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“Obstacles”

or “Opportunities for Innovation”

- **Technical**
  - Power, Communication, Data Management, ...
  - Development Cost and Time: Fabrication, Packaging, ...
- **Business**
  - Small or Unknown Market Size, Comparative Value Proposition, ...