MEMS

A BSAC Introduction

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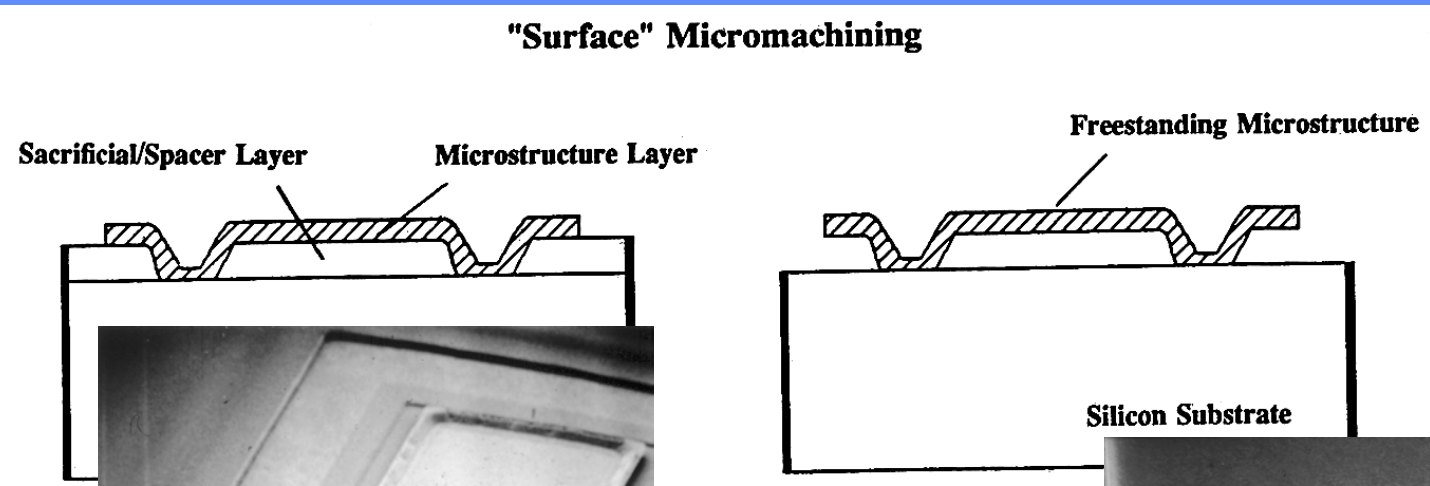
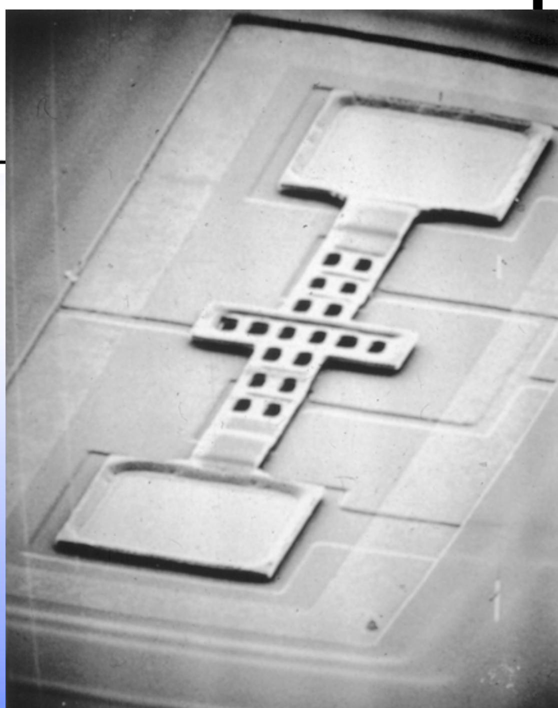
Shaping Deposited Surface Films





Howe – 1982

Resonant

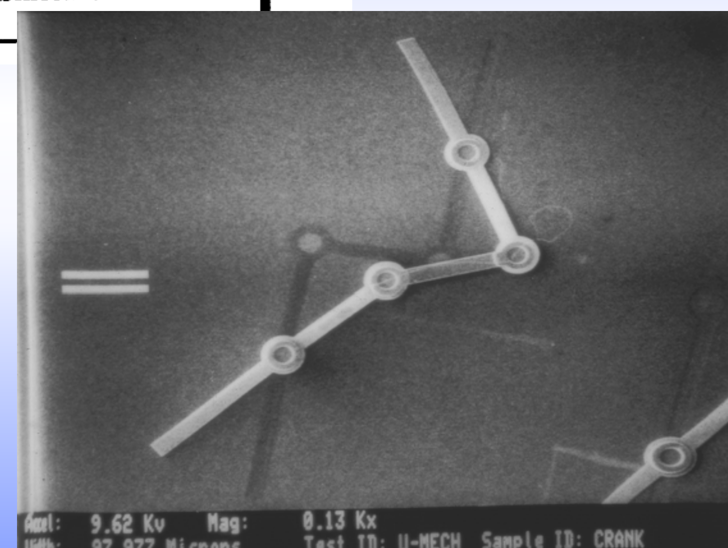
Beam

Fan, Tai 1987

Cranks

Springs

Pin Joints



The Berkeley Sensor & Actuator Center

BSAC

- ***Founded 1986 as an NSF Industry-University-Cooperative Research Center with the mission:***

to develop science, engineering, and technology for microsensors, microactuators, and microelectromechanical systems

MEMS

BSAC

BSAC Research Impact

❖ Polysilicon Surface Micromachining

- ***Initial process development 1981-88***
- ***Exported to MCNC - 1992***
- ***Tech transfer to BSAC member Analog Devices Inc. - 1990***

In 1998, honored by
IEEE Cledo Brunetti Award

To: Roger T. Howe and Richard S. Muller

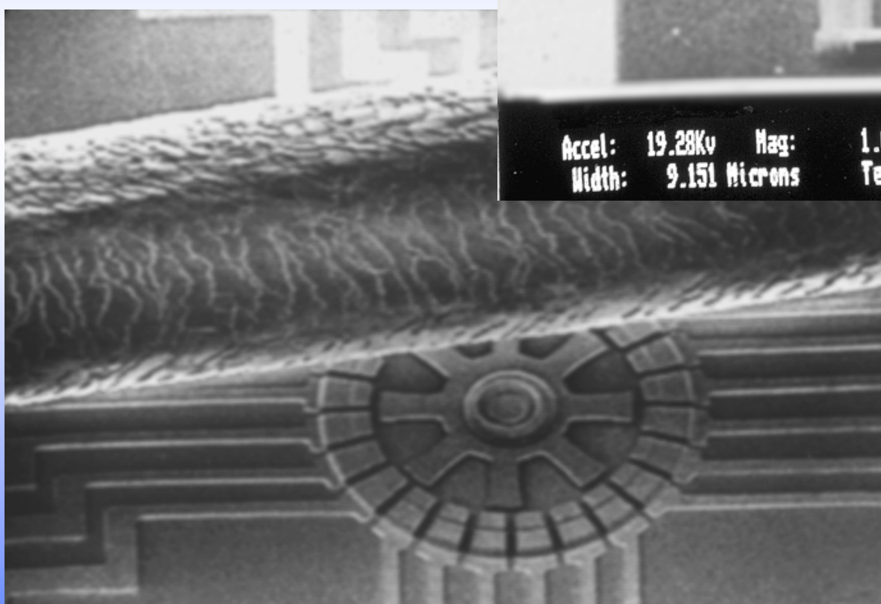
BSAC

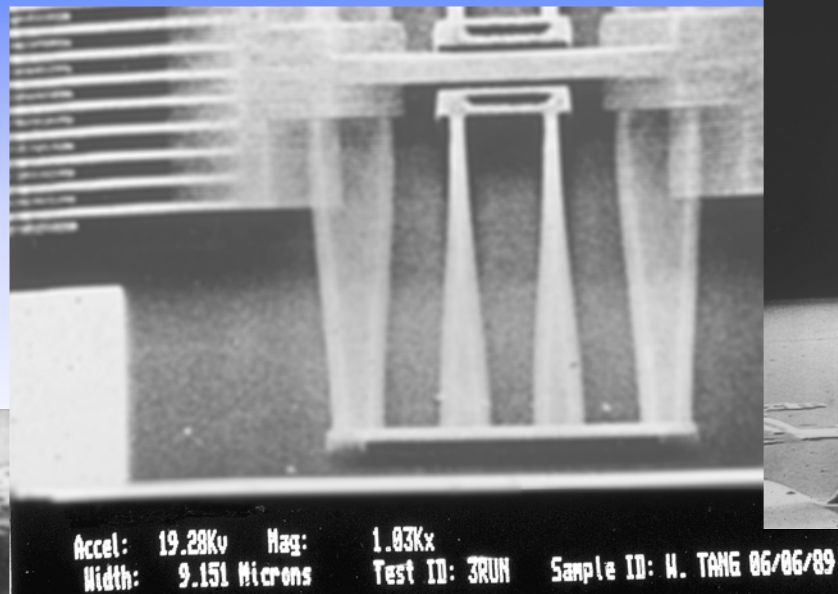
Surface Micromachining

Fan, Tai 1988

Micromotor

Gears

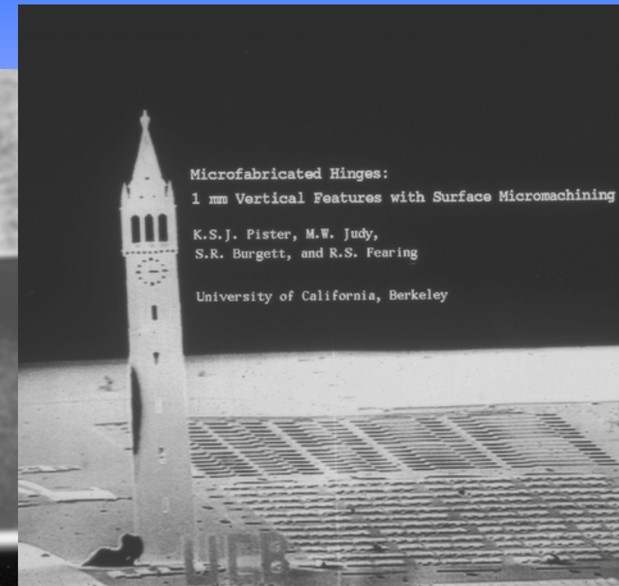




Tang 1987

Combdrive

Resonators



Pister 1991

Fold-up

Structures

Surface Micromachining

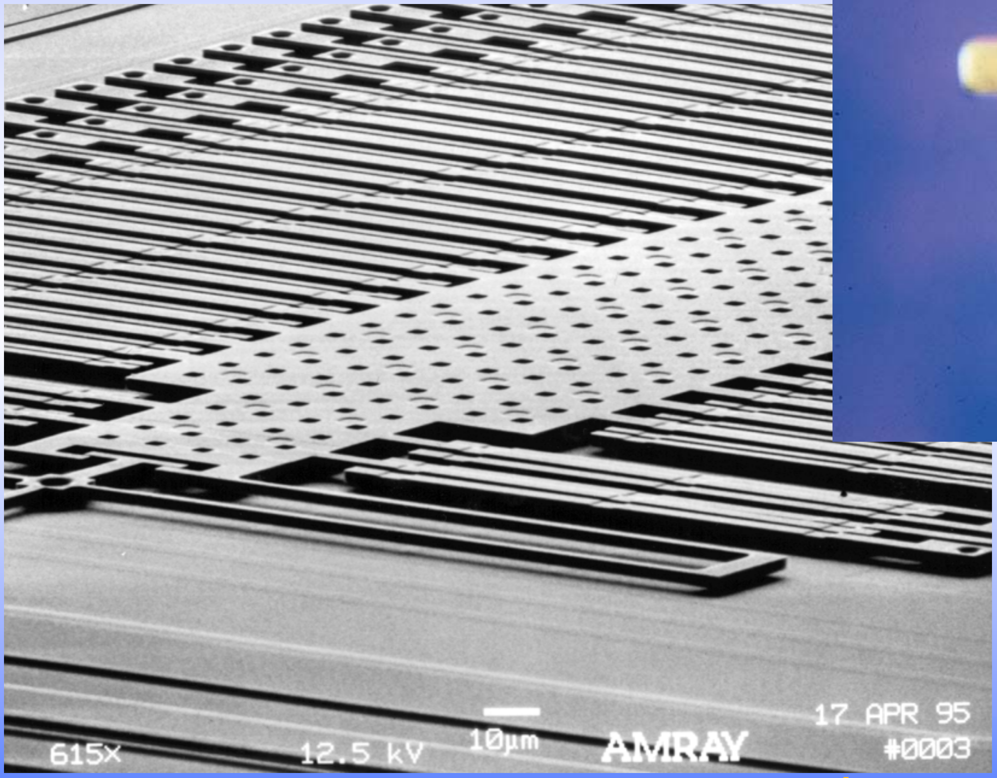
- **1988 – BSAC** produces world's first operating micromotor

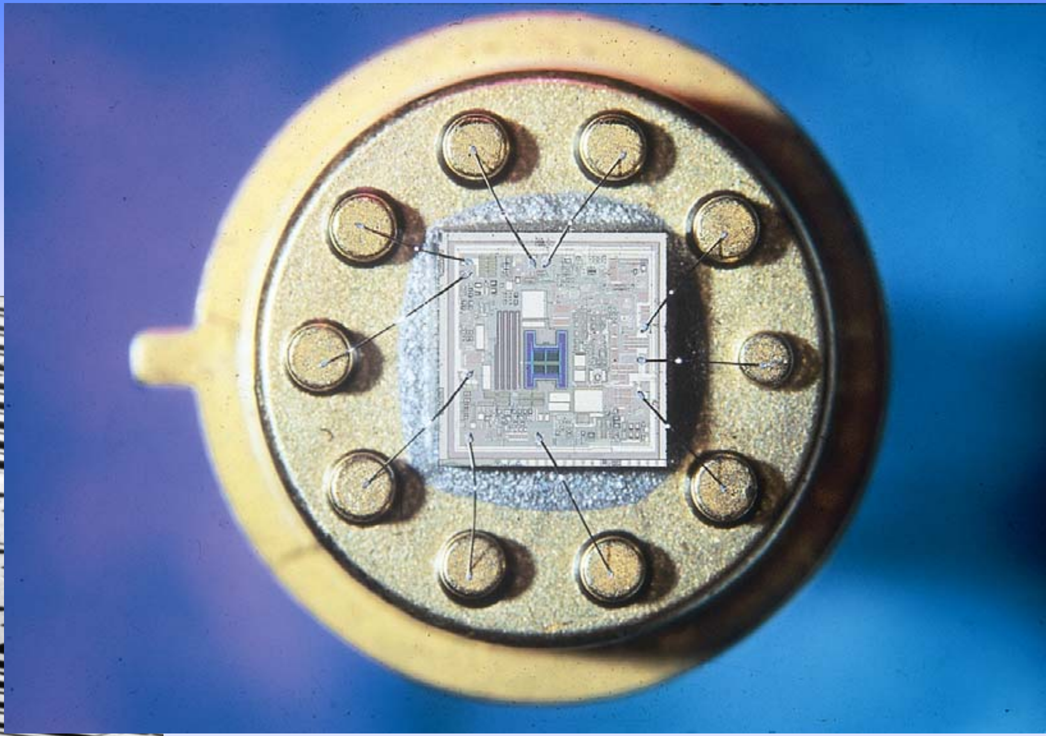
L.-S. Fan
Y.-C. Tai
R.S. Muller

***IEEE* SPECTRUM**
Cover, July 1990

Surface Micromachining

ADI Surface Micromachining
K. Chau (1995)



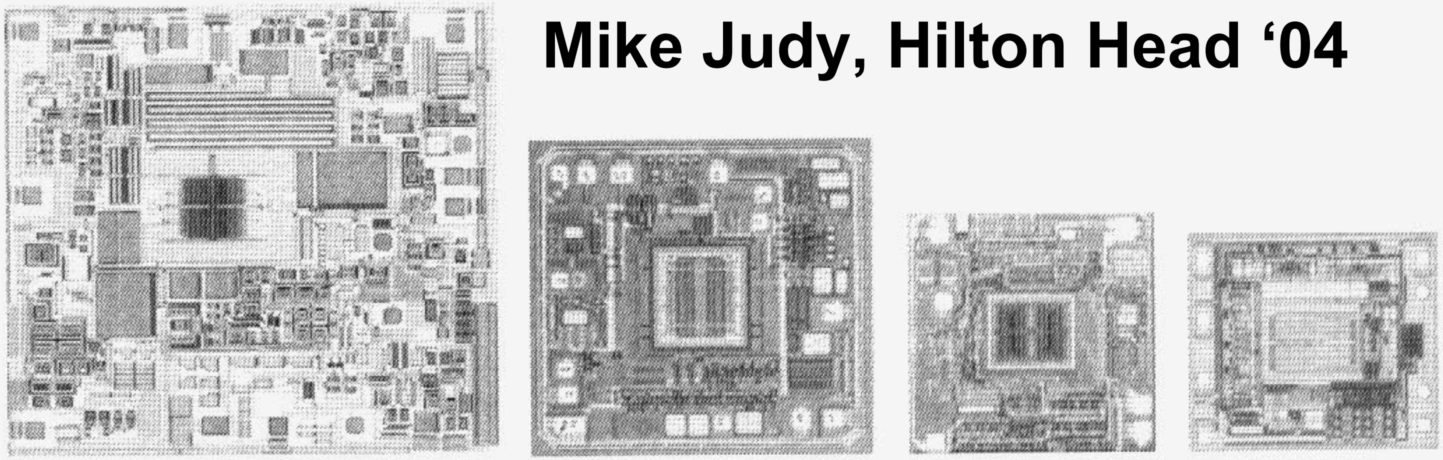


ADXL50 - 1991

Tech Transfer – BSAC to Analog Devices

BSAC

Mike Judy, Hilton Head '04



	ADXL50 (1994)	ADXL76 (1996)	ADXL78 (2001)	ADXL40 (2004)	
Die Area	10.8	5.4	2.7	2.5	mm^2
MEMS Area	0.43	0.38	0.27	0.22	mm^2
% MEMS	4.0%	7.0%	10%	8.8%	
Cs	100	100	40	160	fF
fo	25.0	24.5	24.5	12.5	kHz
Noise	6.0	1.0	1.0	1.0	mgee/ rt.hz
Offset	3.0	1.0	0.5	0.5	gee

Figure 5: *The airbag crash sensor family of ADI – from the original ADXL50 (1991) to the 4th-generation accelerometer using the new SOIMEMS process technology.*

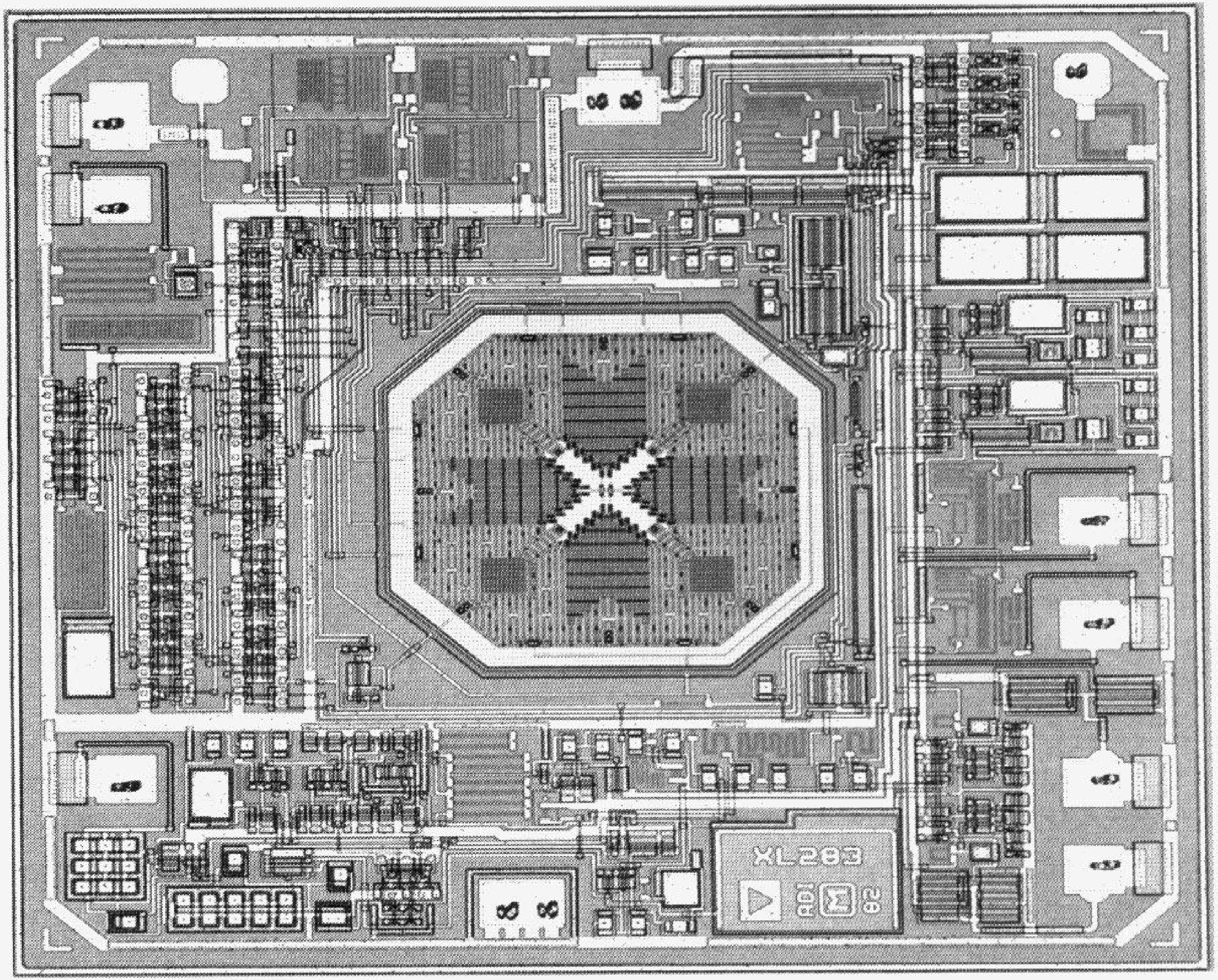
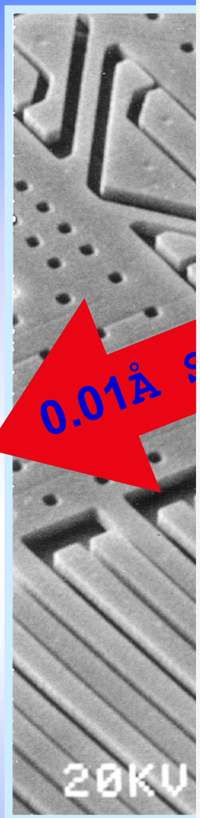


Figure 6: *ADXL203: a 2-axis accelerometer with ±50 mgee null bias stability and 110 µgee/rt.hz noise.*

MEMS Gyroscope



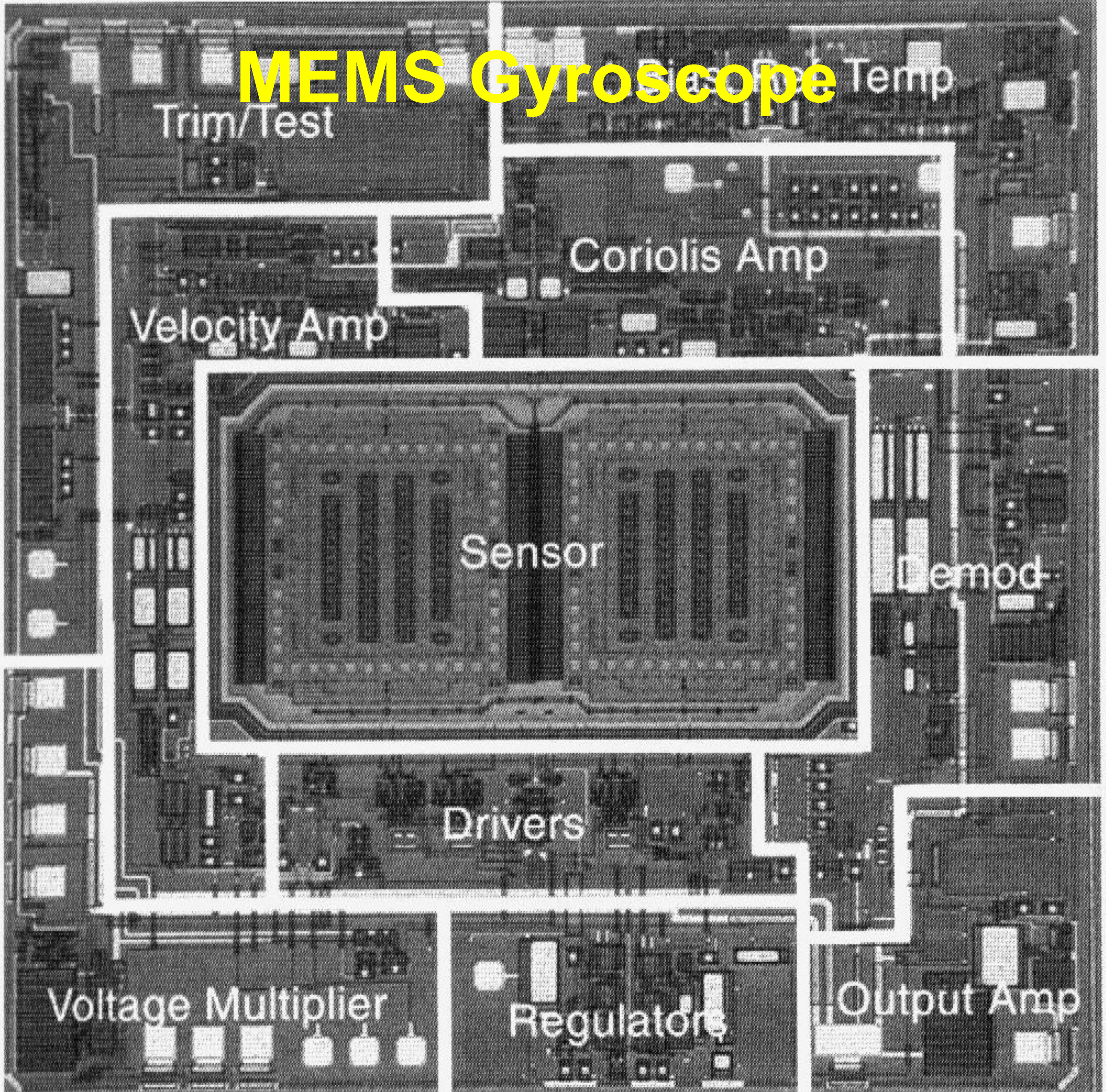
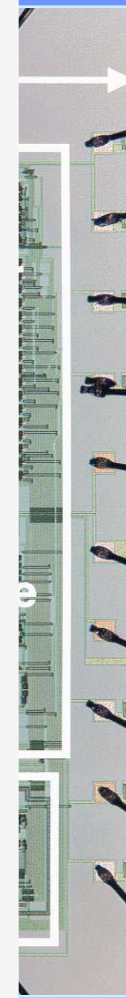


Figure 7: ADXRS150: a z-axis gyroscope with 0.05 deg/rt.sec noise integrated on a 3x3 mm die.

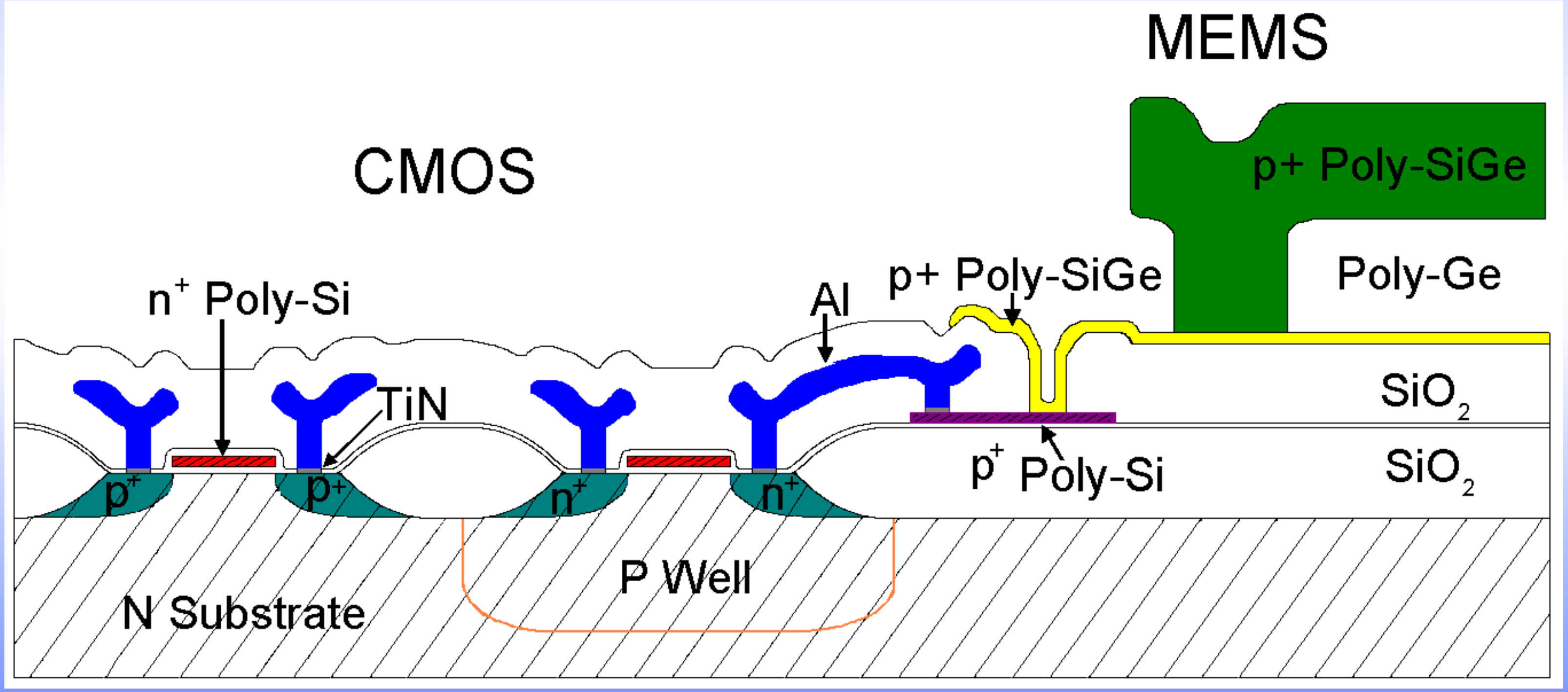


J. Seeger, X. Jiang, and B. Boser - Hilton Head 2000

Surface Micromachining

LPCVD Polysilicon/germanium

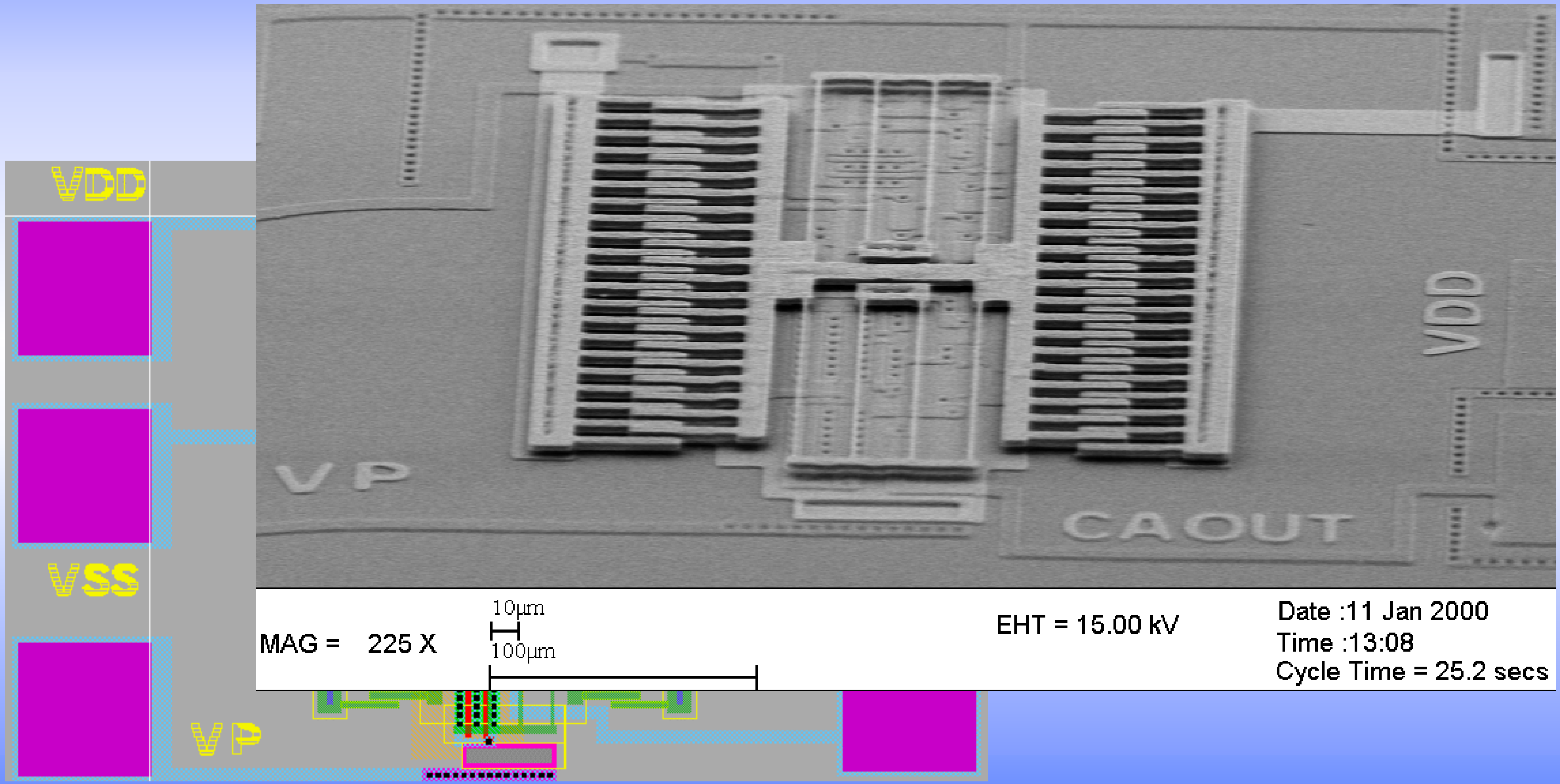
Lower temperature process – Better IC compatibility



A. Franke, T. J. King, R. Howe – Hilton Head 2000

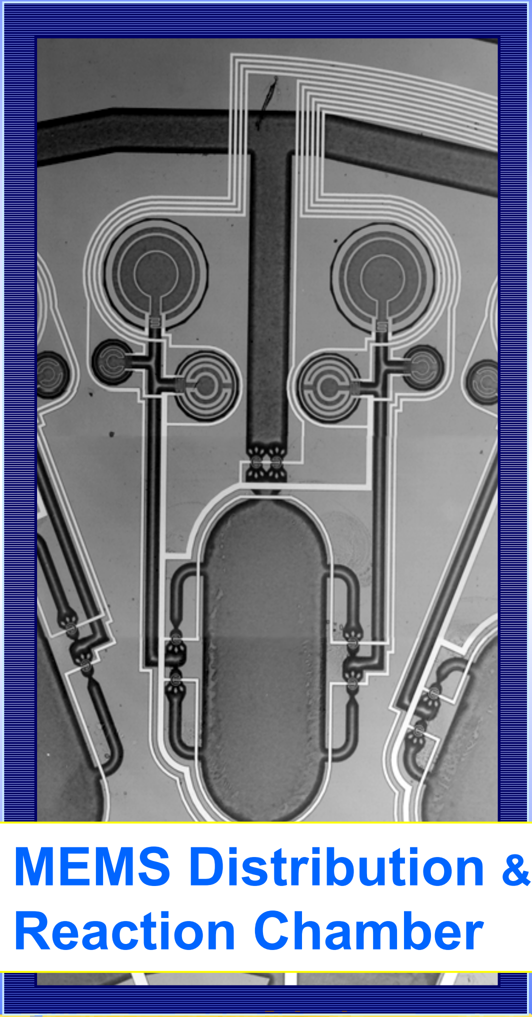
Surface Micromachining

- with LPCVD polysilicon/germanium



The CHEMLAB on a CHIP

MEMS for the Amazing Shrinking Laboratory



MEMS Distribution & Reaction Chamber

Specimen Sizes

- DNA Helix - 1nm
- Proteins - 2 to 10nm
- Virus - 10 to 100nm
- Bacterium - 1 μm
- Human sperm - 3 μm
- Animal cell - 10-30 μm
- Plant cell - 50-100 μm
- Human egg - 100 μm

D. Liepmann, L. Lee, R. S. Muller

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The MEMS Opportunity

- **Small, portable, lightweight, batch-processed engineering systems –**
  MEMS are here
- **Potential applications are very broad**
- **Much work is yet to be done…but**
  - **"MEMS have the capacity to rival, and even to surpass, the impact on society of the integrated circuit.*"**

*** US National Academy of Engineering Report-- 1997**

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