MEMS Process Examples using tousimis® CPD Process

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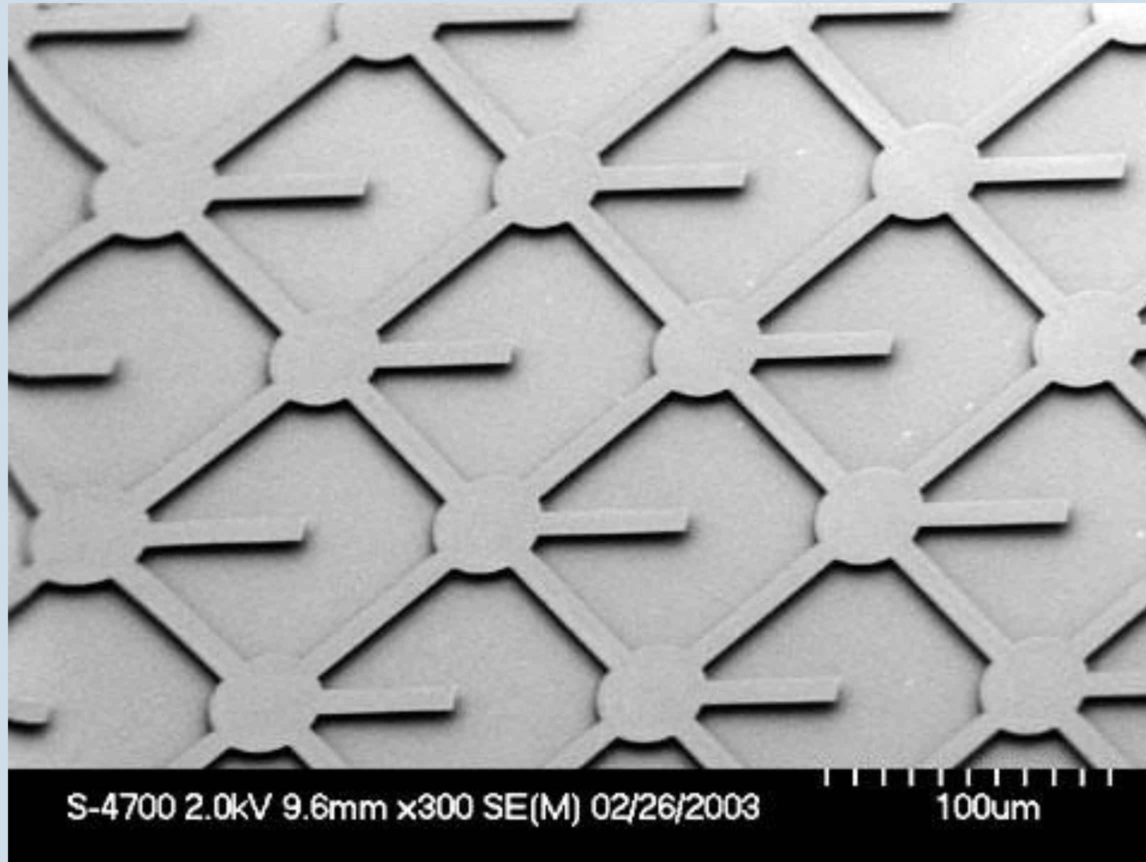
SEM View of Coupled Oscillators Made of Low Stress Silicon Nitride. 300x



Cornell Nanoscale Facility and Department of Applied Physics, USA
Rob Ilic and H.G. Craighead (Craighead Group)

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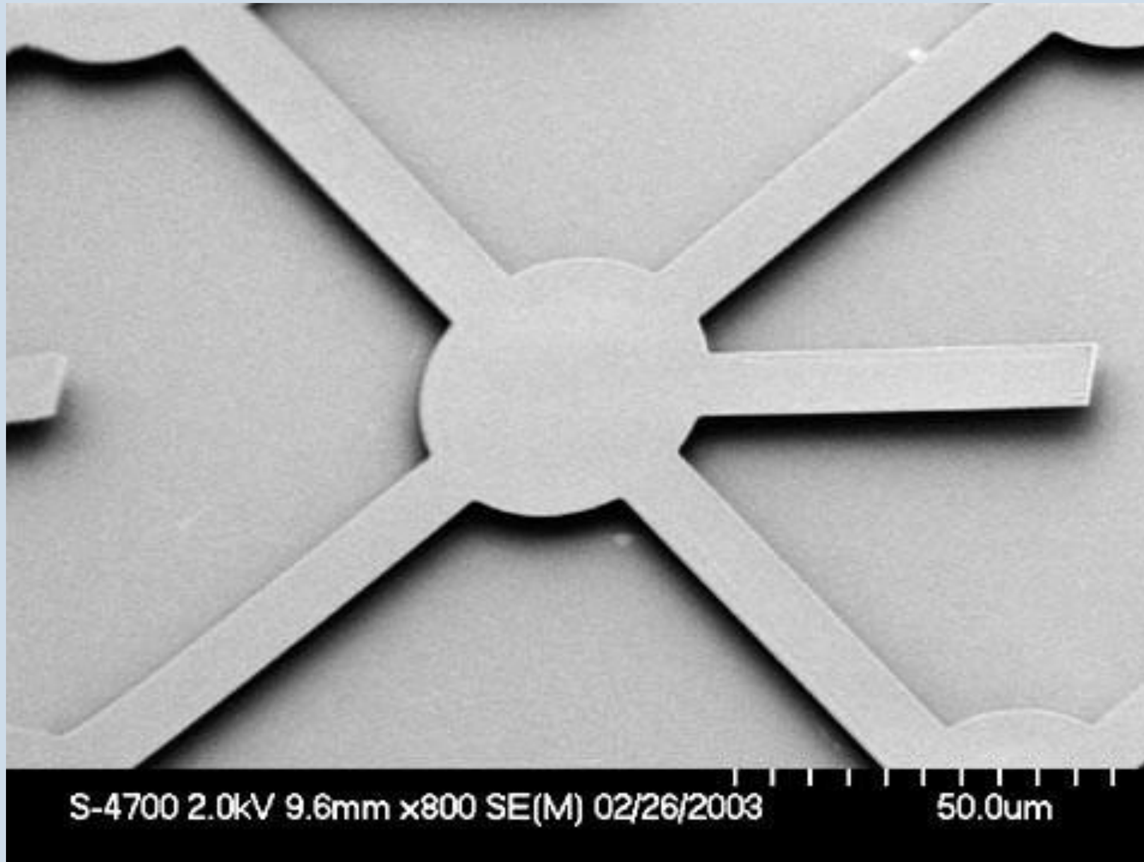
Single Coupled Oscillator Made Out of Low Stress Silicon Nitride. Mag = 800x



1µm distance between silicon substrate and device

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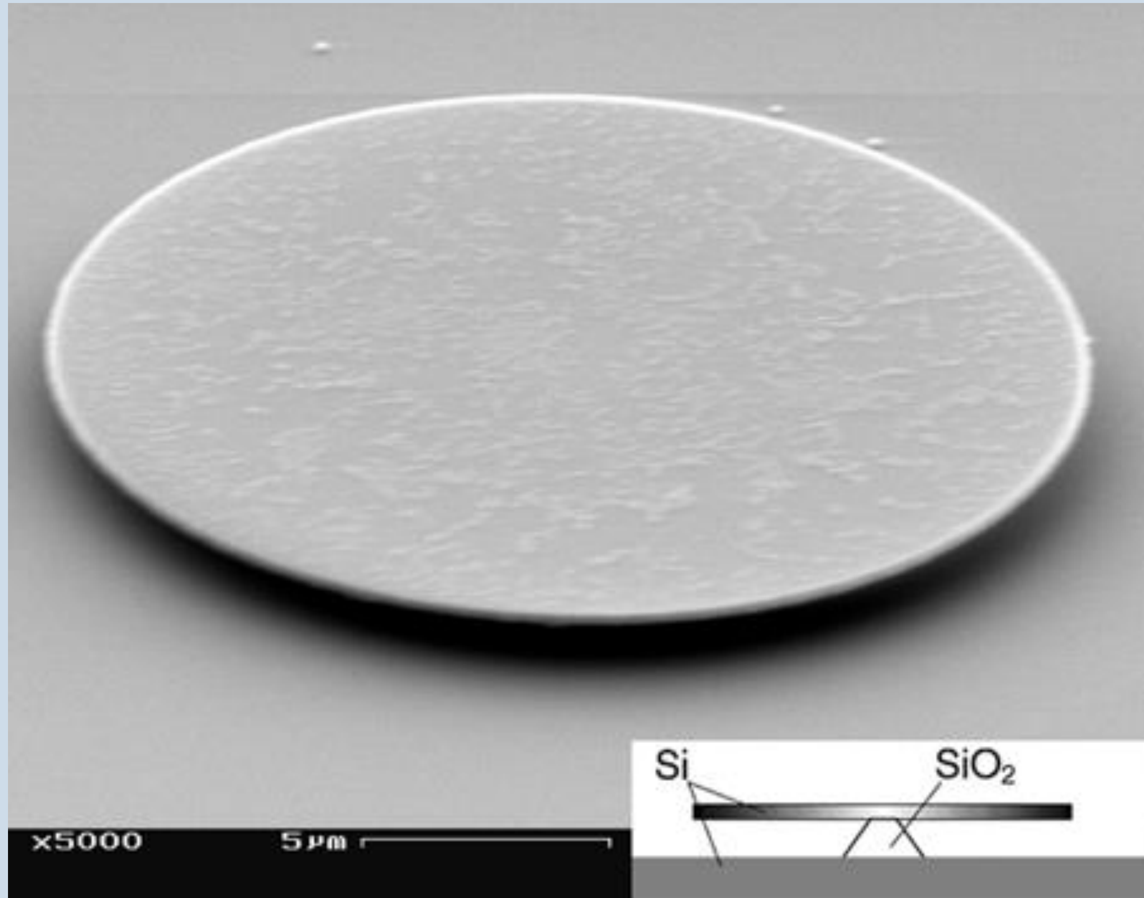
MEMS Based Resonant Device



250nm Si Thickness
1μm Gap from
Si Substrate
~20μm in Diameter

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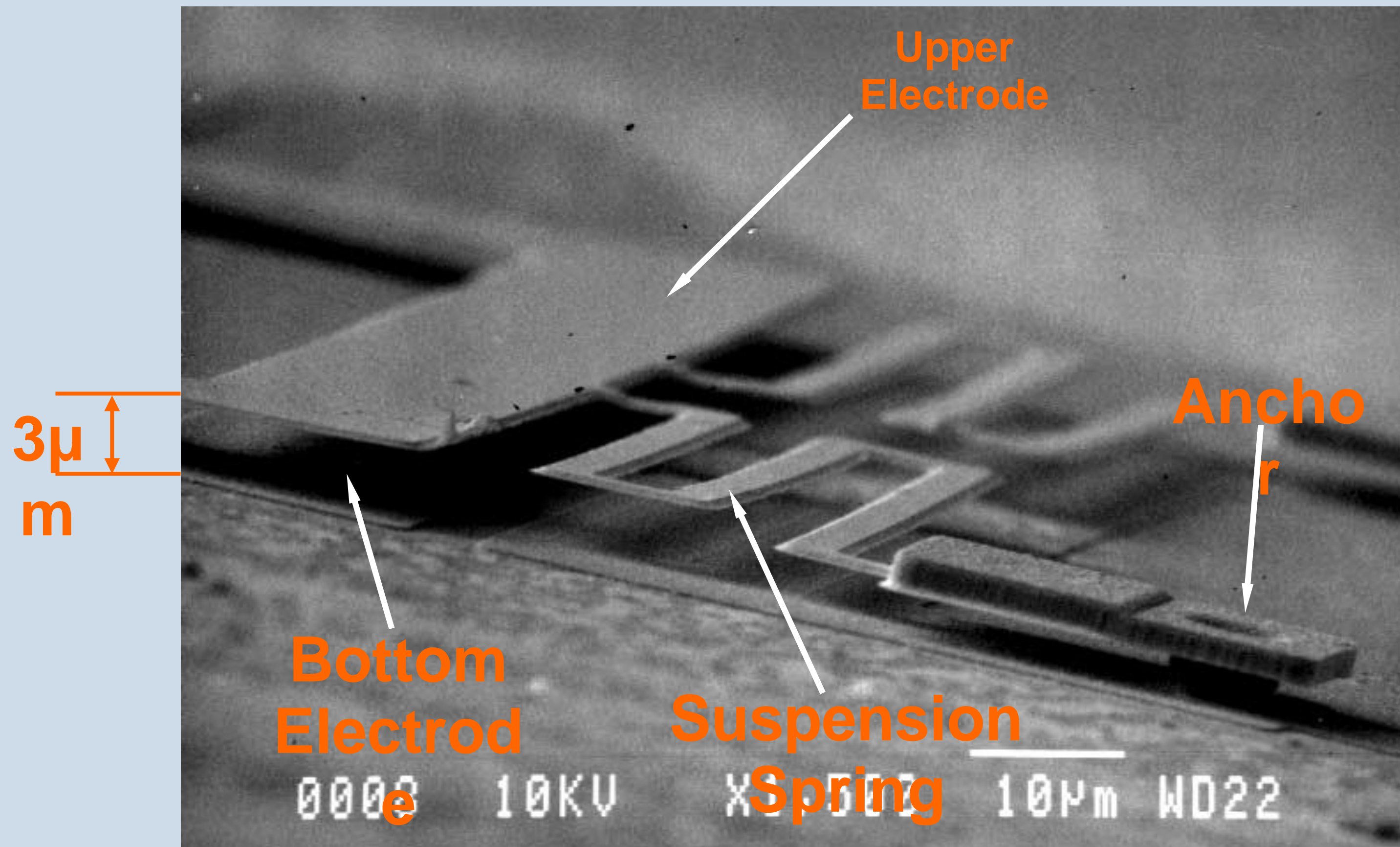
Tiltable Microplatform



University of Michigan at Ann Arbor, Dept. of Engineering, USA
Yuan Xie, Ph.D.

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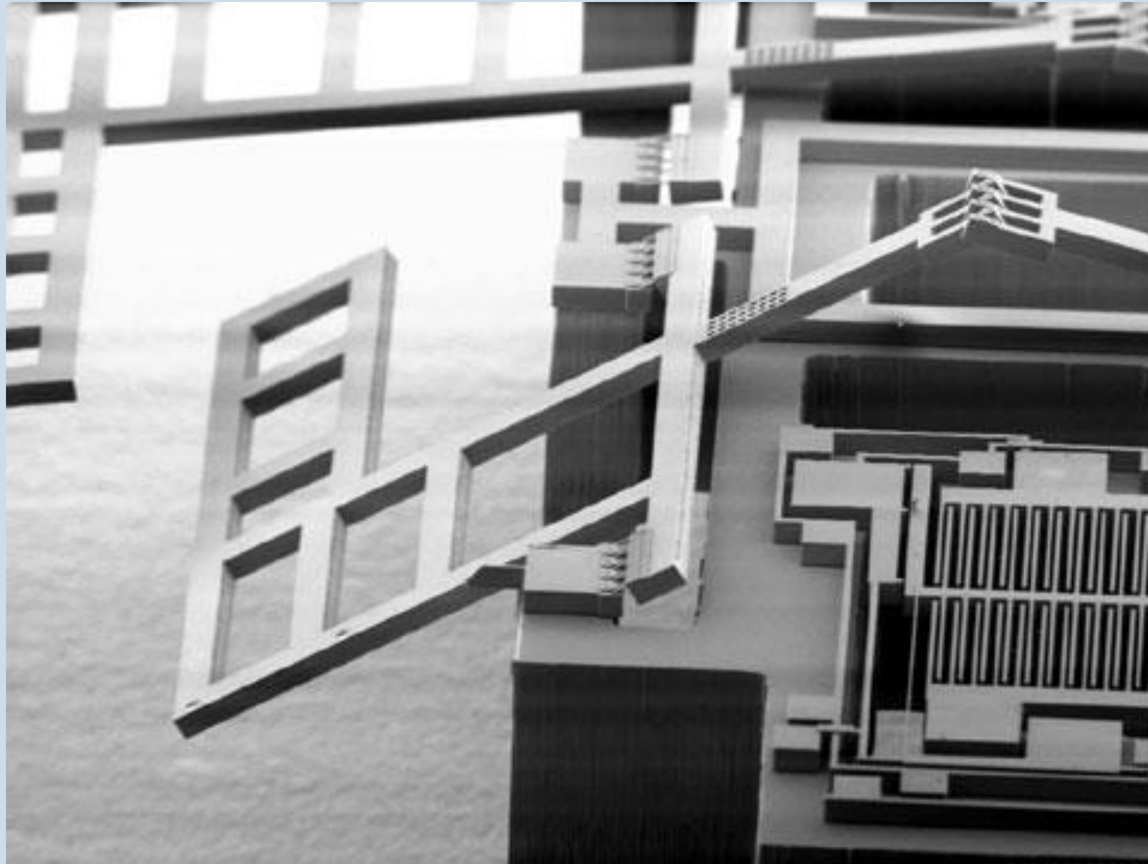
Silicon MicroRobots



University of California at Berkeley & Micropropulsion Corp. USA
Seth Hollar and Anita Flynn

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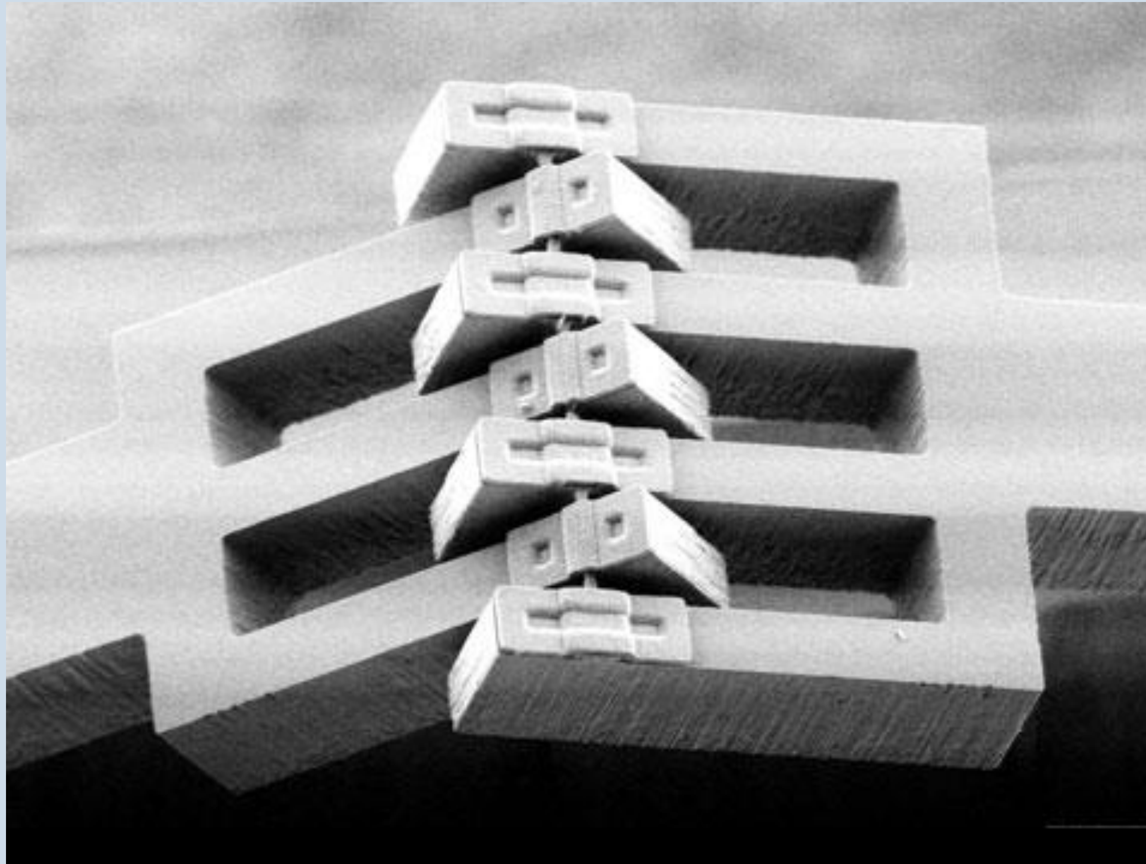
Silicon MicroRobots
- Elbow hinge - full view



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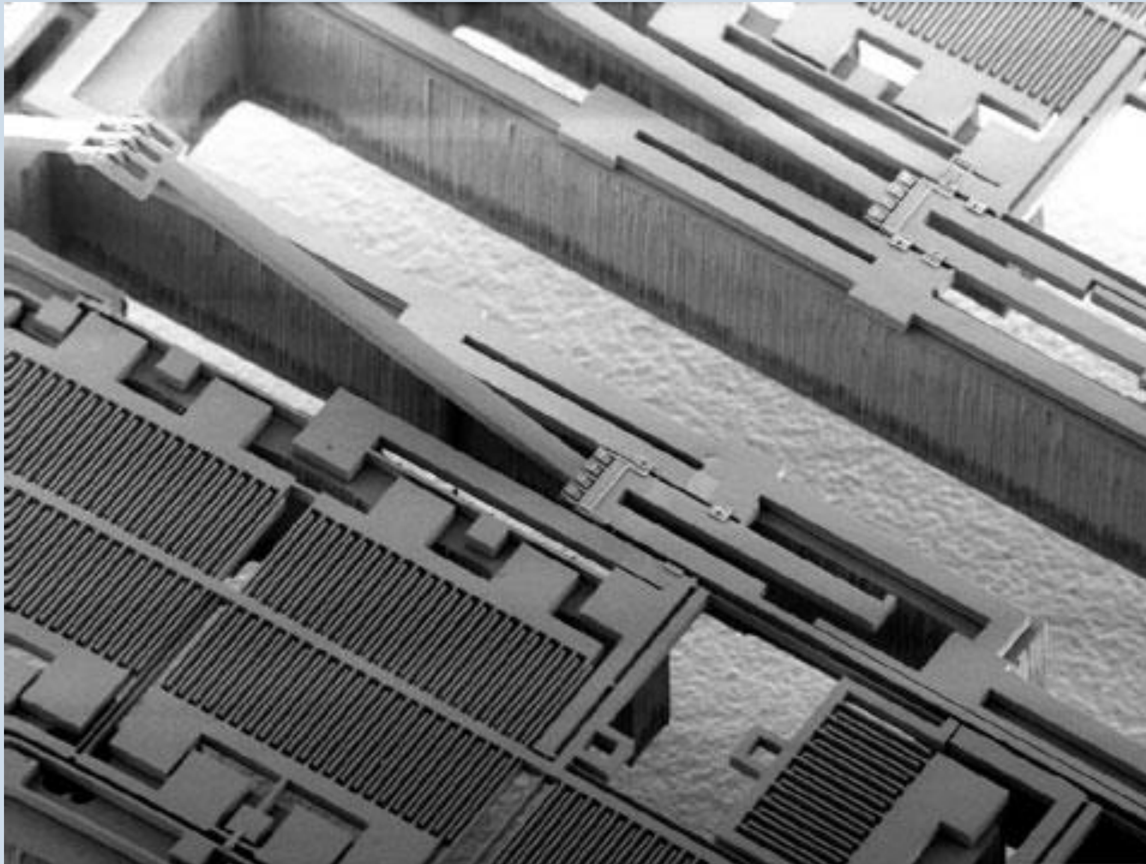
Silicon Microrobots
- Leg and motor linkage near the shuttle



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RF MEMS Device

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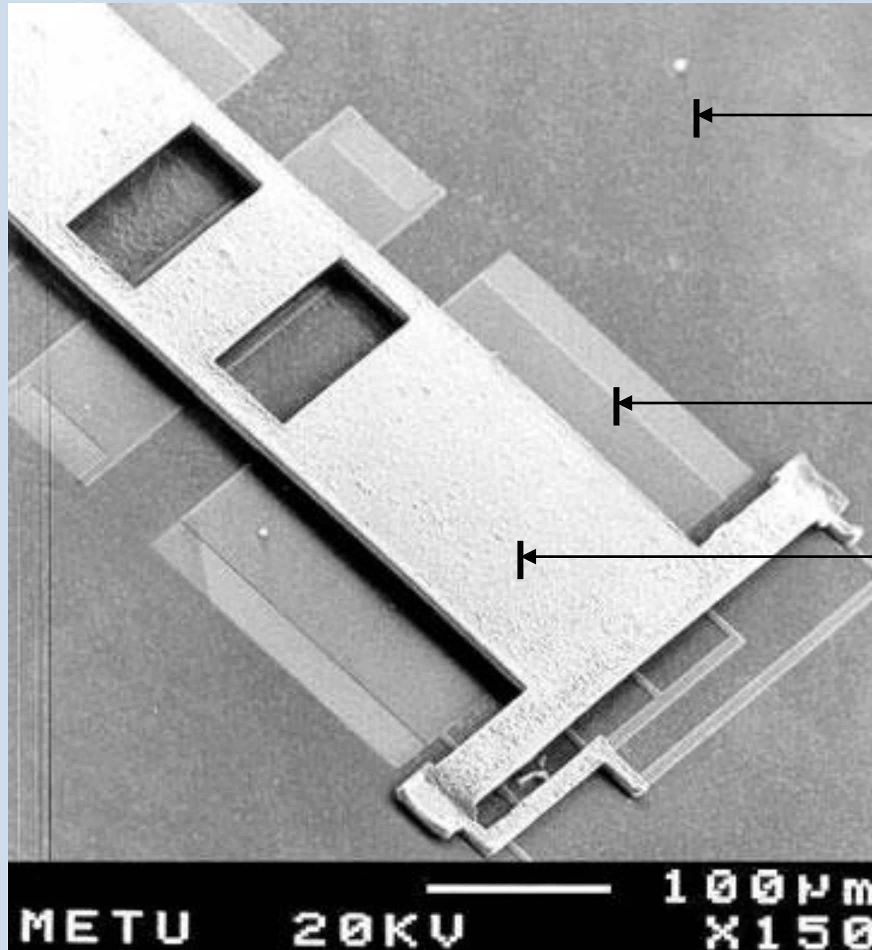

Substrate: Pyrex 7740 Glass

Base Metal: Sputtered AL

Suspended Metal Layer:
Electroplated Ni

Sacrificial Layer: Photo Resist
Beam Length: 600µm
Gap Size: 5µm

Middle East Technical University (METU), Turkey
Tayfun Akin

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RF MEMS Capacitive Switch

BEAM Length Vary Between 800µm - 1000µm

NASA - Glenn Research Center Technology Division, USA
Nicholas C. Varaljay

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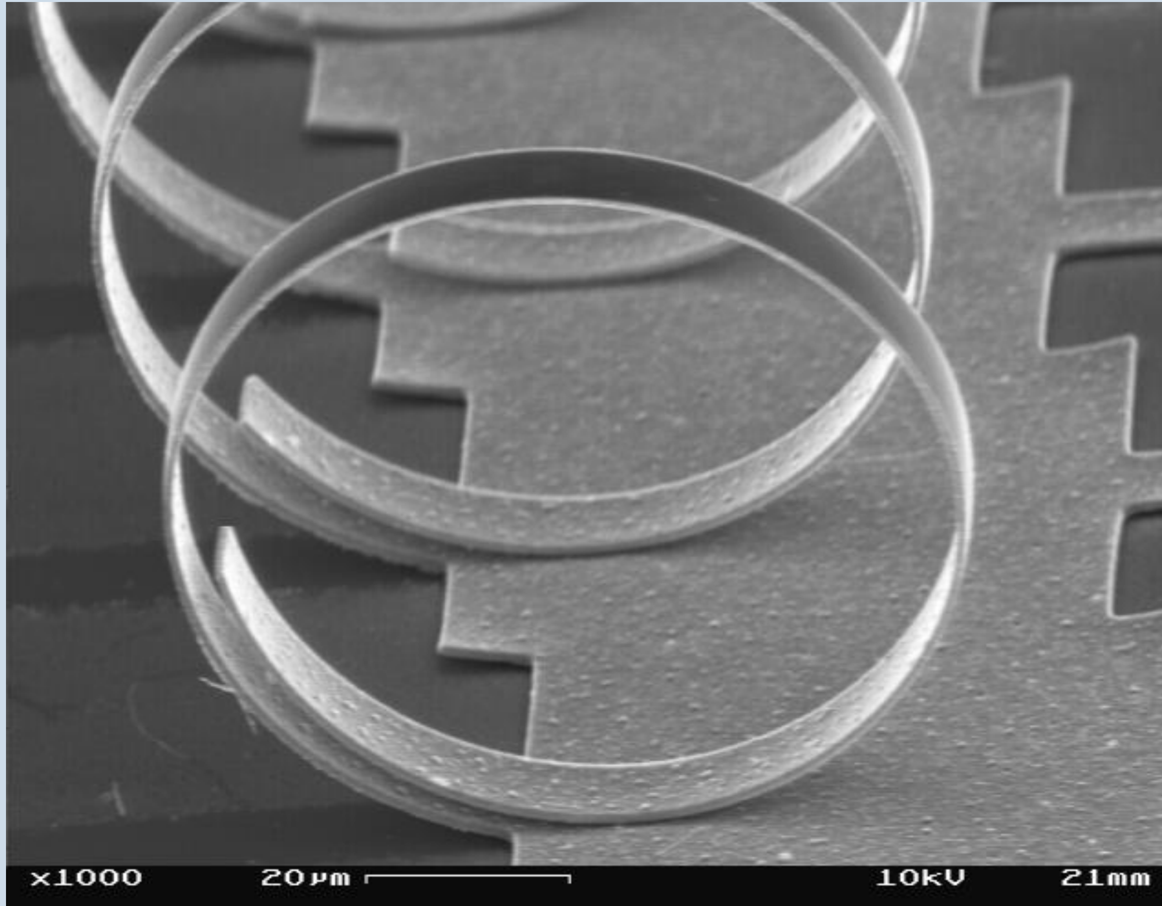
Released Cantilevers post thermal annealing



Université Catholique de Louvain, Belgium
Nicolas André

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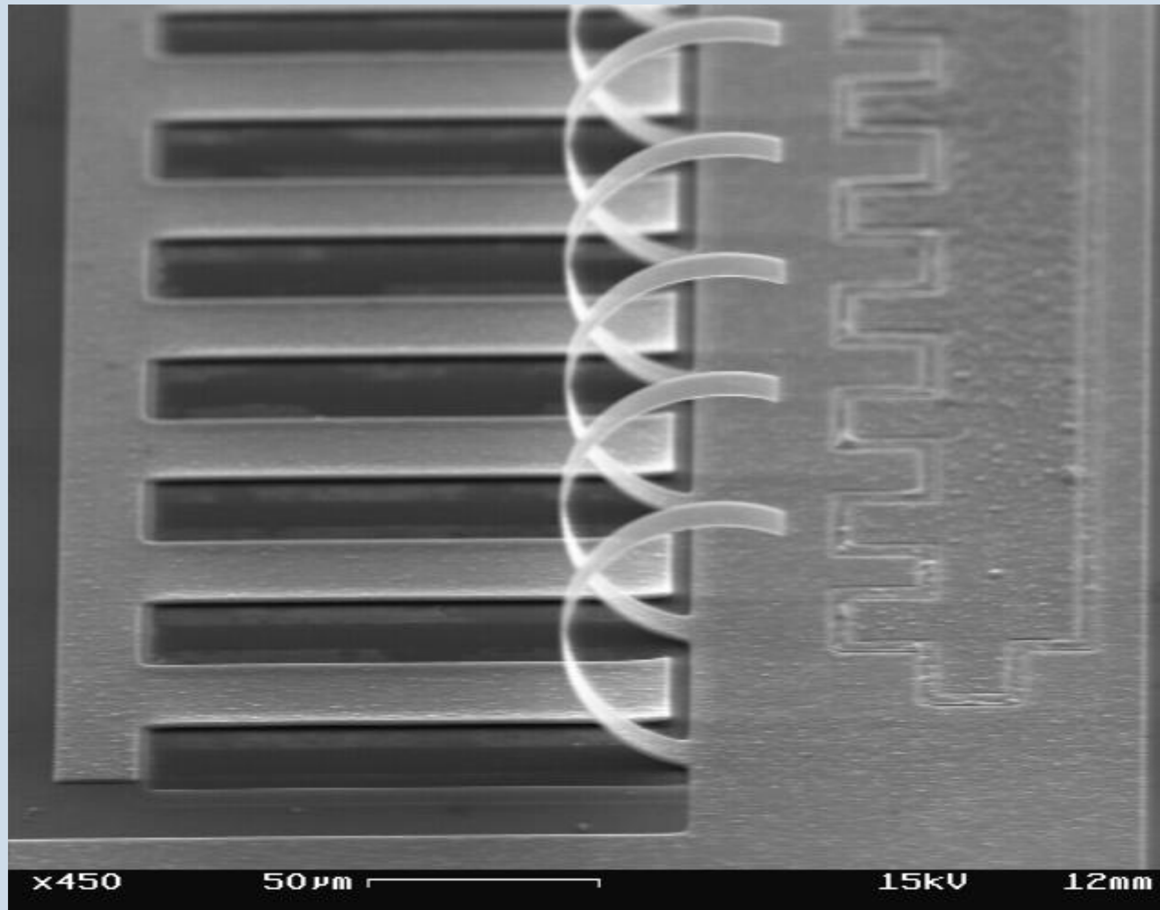
Thermal Actuated Actuators



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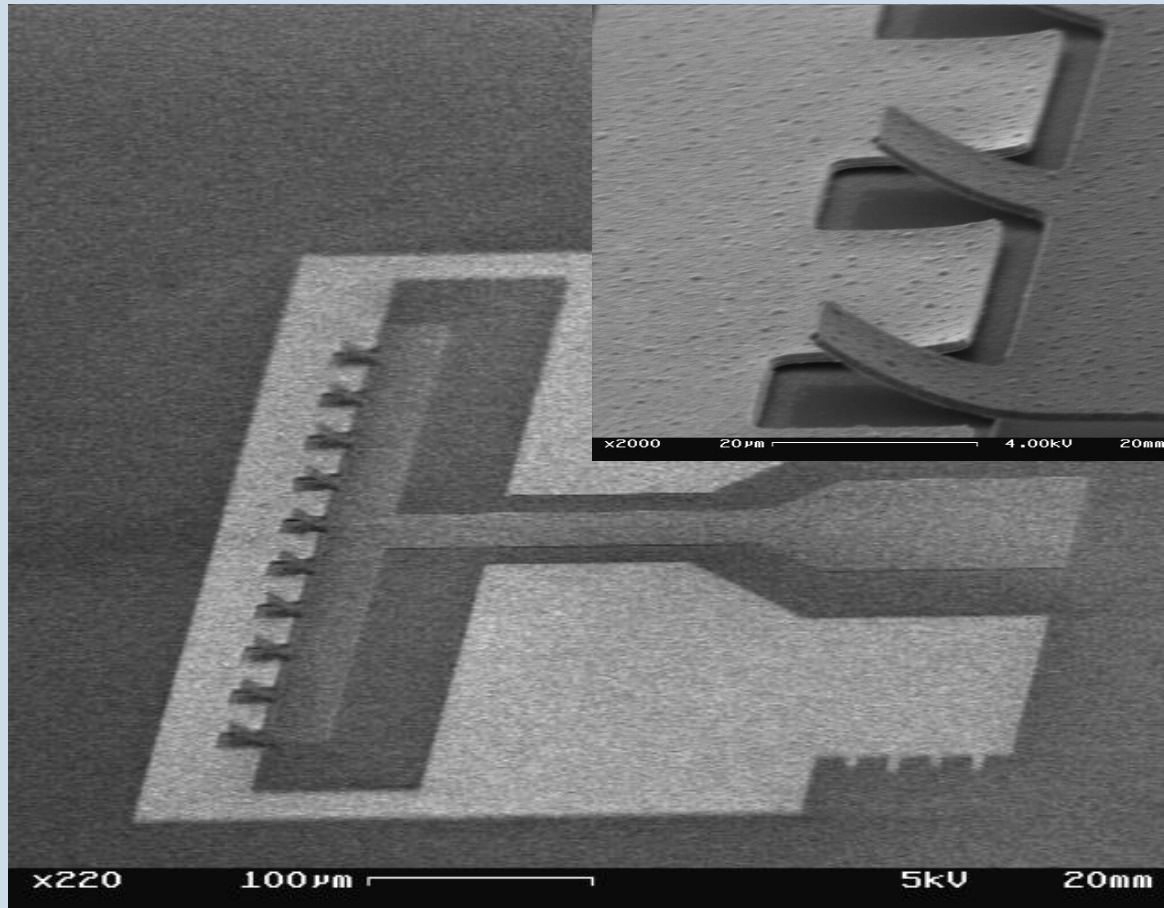
A flow sensor fabricated using the process flow



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Nicolas André

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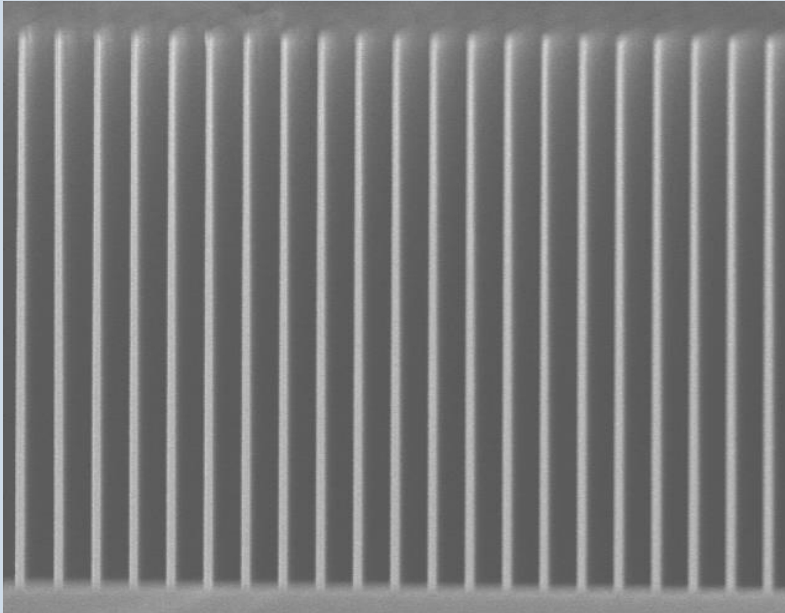
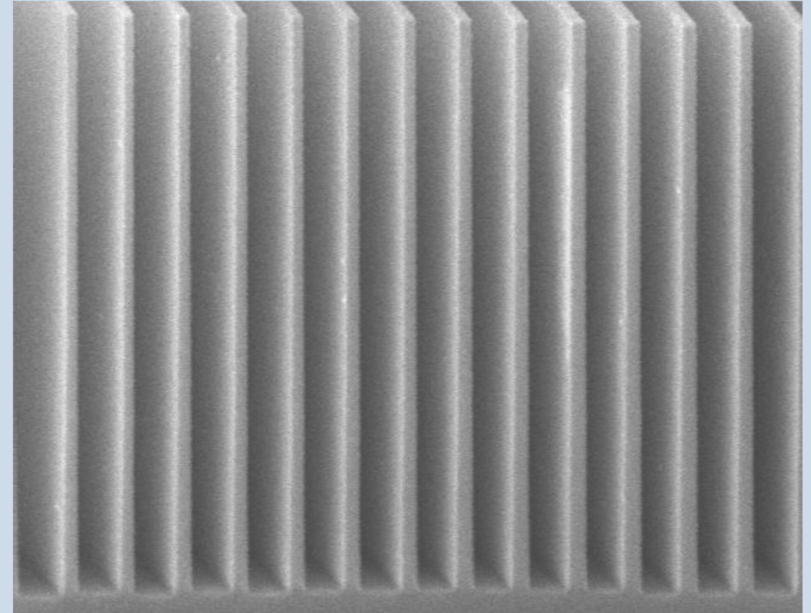
High aspect ratio silicon gratings Autosamdri®-815B, Series B Processed



SEM: 5kV, 10,000x
Pitch: 574 nm, Height: 8 μm, Depth 40 μm
Aspect ratio: ~ 100



SEM: 5kV, 40,000x
Pitch: 200 nm, Height: 2.5 μm, Depth: 20 μm
Aspect ratio: ~50

Massachusetts Institute of Technology
Minseung Ahn

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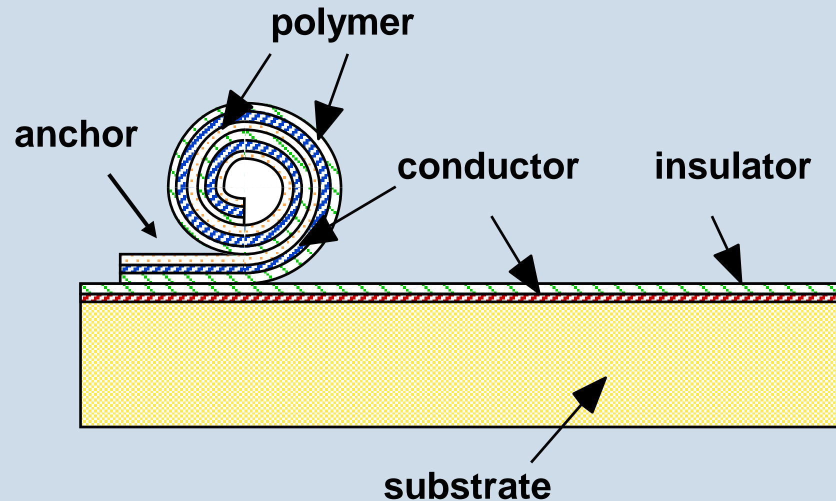
ARTIFICIAL EYELID ACTUATOR
- Flexible film electrostatic actuator-



- ***Polymer/metal thin film stack is fabricated and released from the substrate***
- ***Thermal and mechanical stress causes curling of the actuator when released***
- ***Electrostatic force uncurls film; recoils when voltage removed***
- ***Large electrostatic displacement, high operating frequency (>1 kHz)***

MCNC Research & Development Institute, USA
David Dausch, PhD

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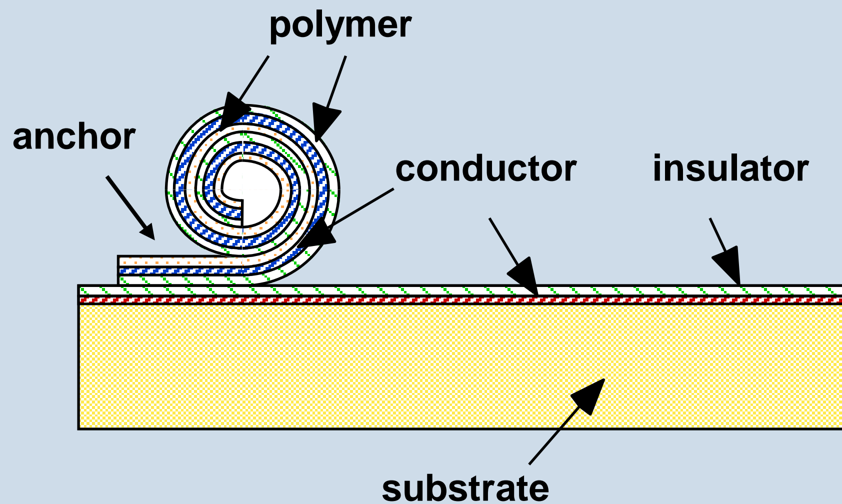
ARTIFICIAL EYELID ACTUATOR

- Flexible film electrostatic actuator



Potential Applications

- ***Optical Shutters***
- ***Electrical Relays***
- ***Microvalves***

MCNC Research & Development Institute, USA
David Dausch, PhD

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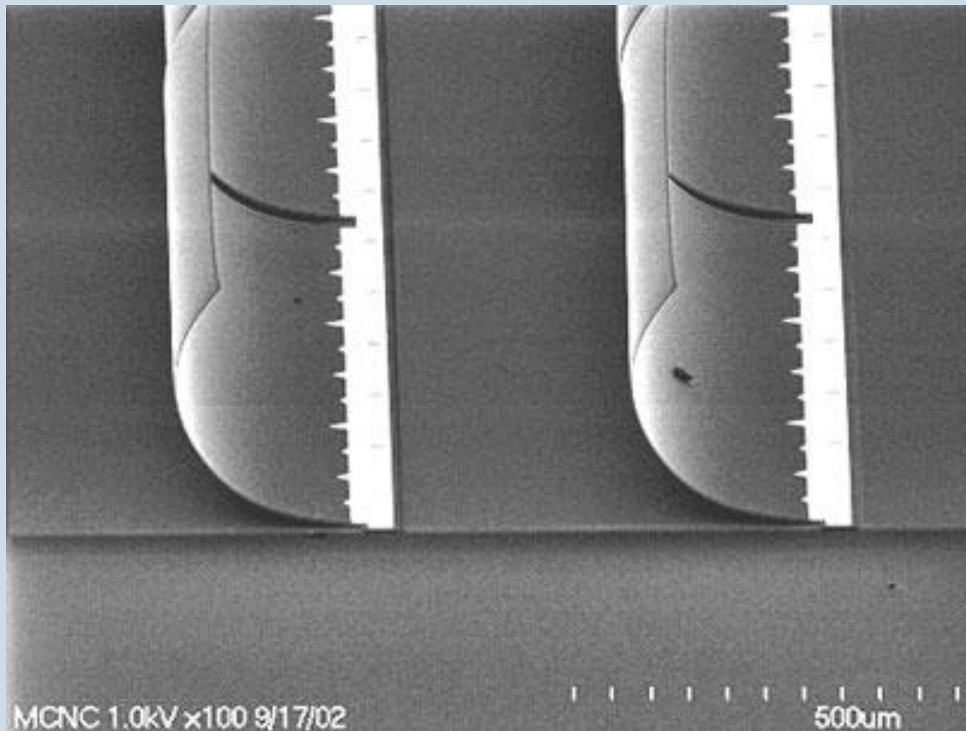
ARTIFICIAL EYELID ACTUATOR

- Arrays of 500μm width actuators; curl is tailored based on thicknesses of layers



Large curl devices

- *800nm Au film in flexible electrode*
- *120° curl, 250μm radius*
- *50-90V operating voltage*
- *40% open area*

MCNC Research & Development Institute, USA

David Dausch, PhD

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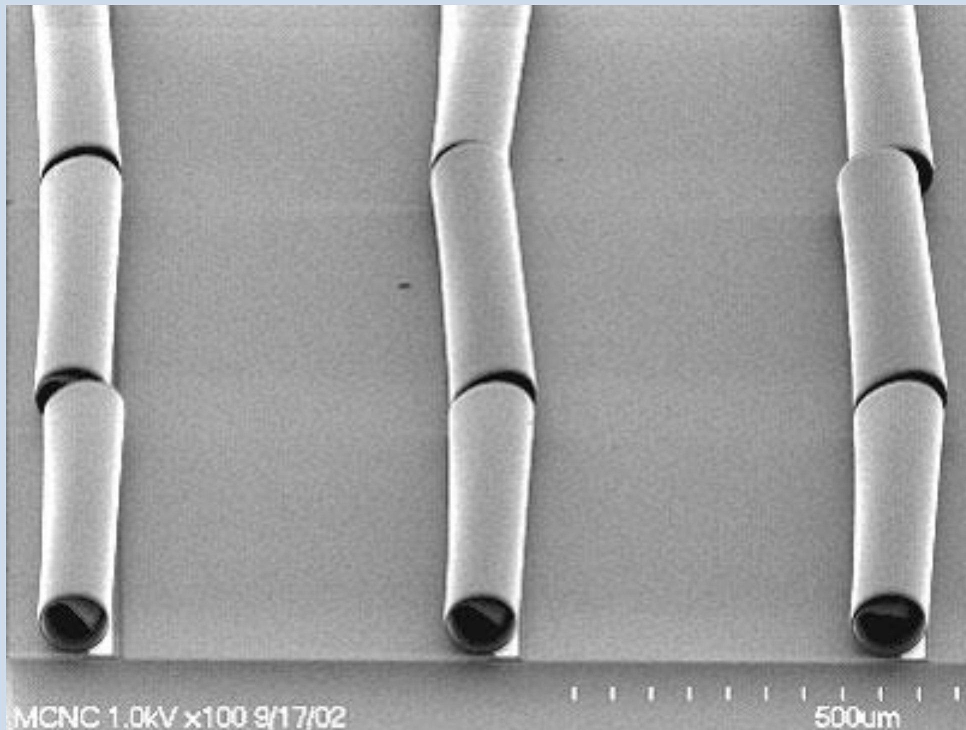
ARTIFICIAL EYELID ACTUATOR

- Arrays of 500μm width actuators; curl is tailored based on thicknesses of layers



Tight curl devices

– 50nm Au film in flexible electrode

– 640° curl, 45μm radius

– 220-340V operating voltage

– 80% open area

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David Dausch, PhD

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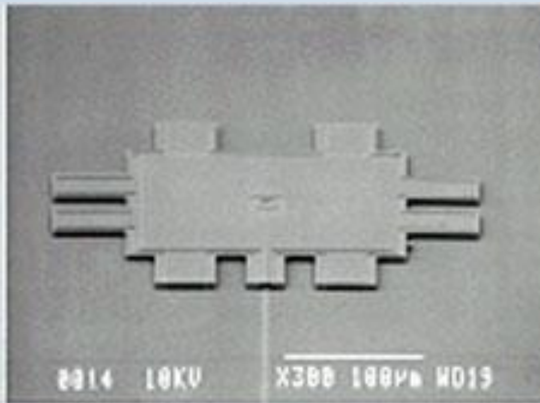
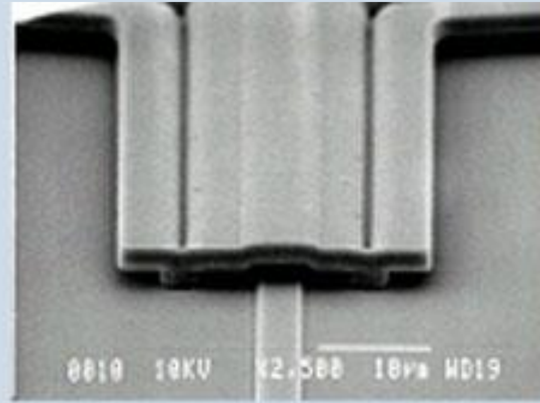
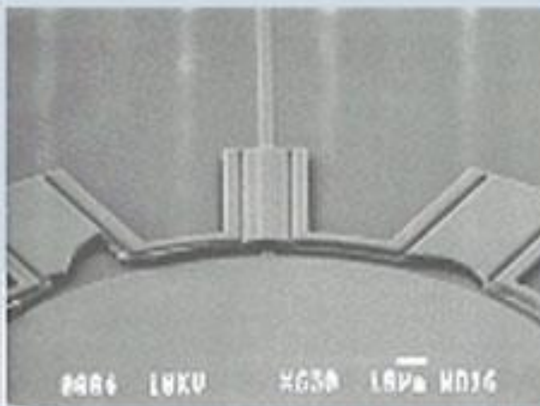
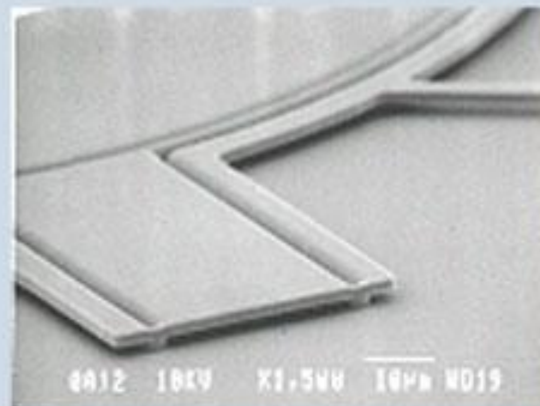
MEMSJet Drop Ejector









XEROX CORPORATION, USA

Joel A. Kubby

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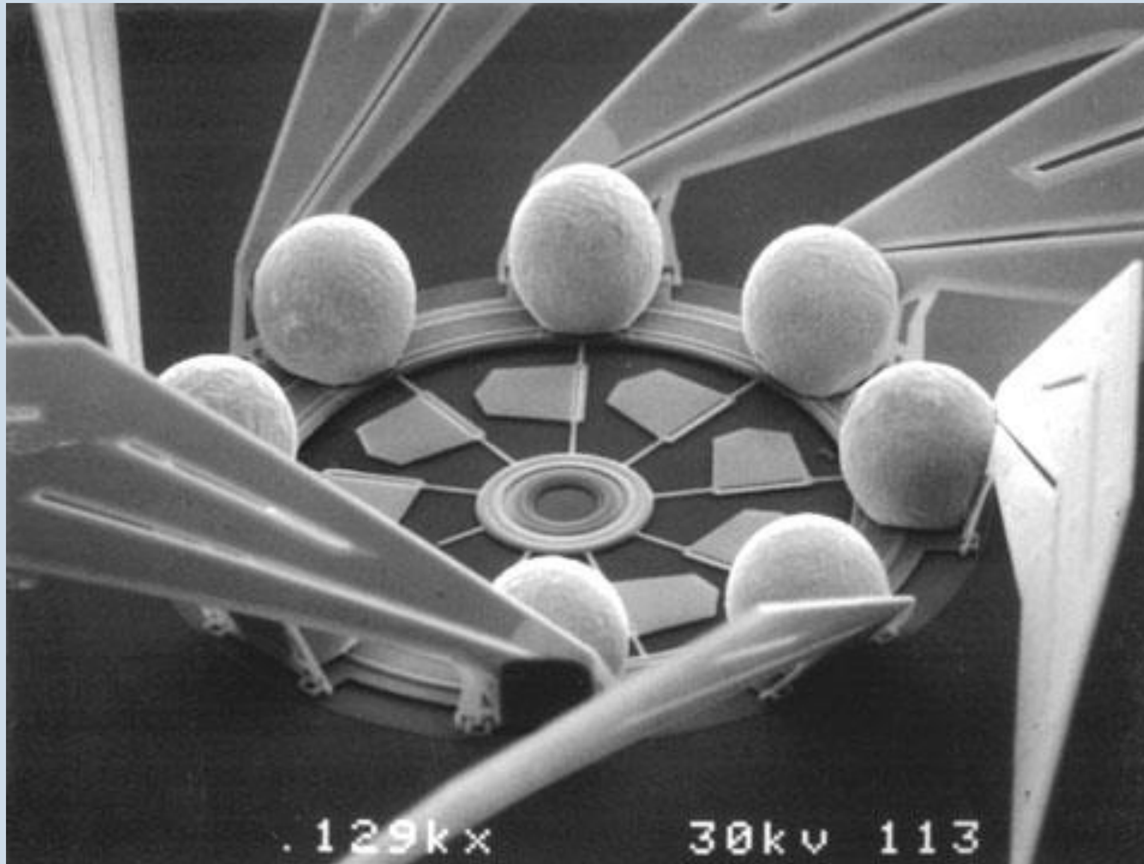
Solderfan



ETH, Switzerland

Ryan Linderman

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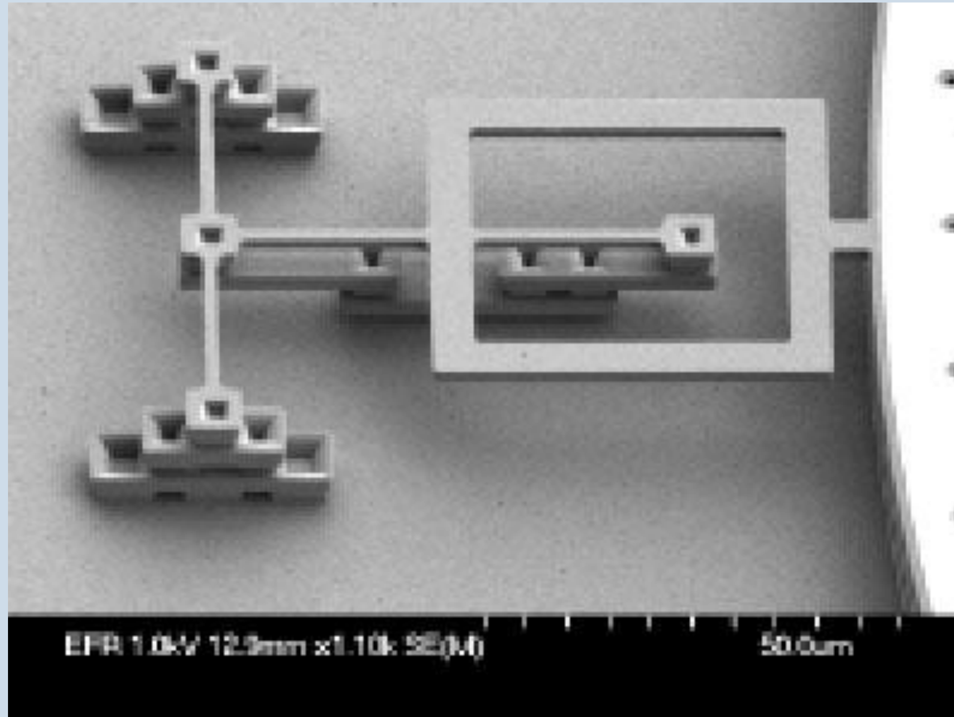
Unique MEMS Hinge



MEMX
New Mexico, USA

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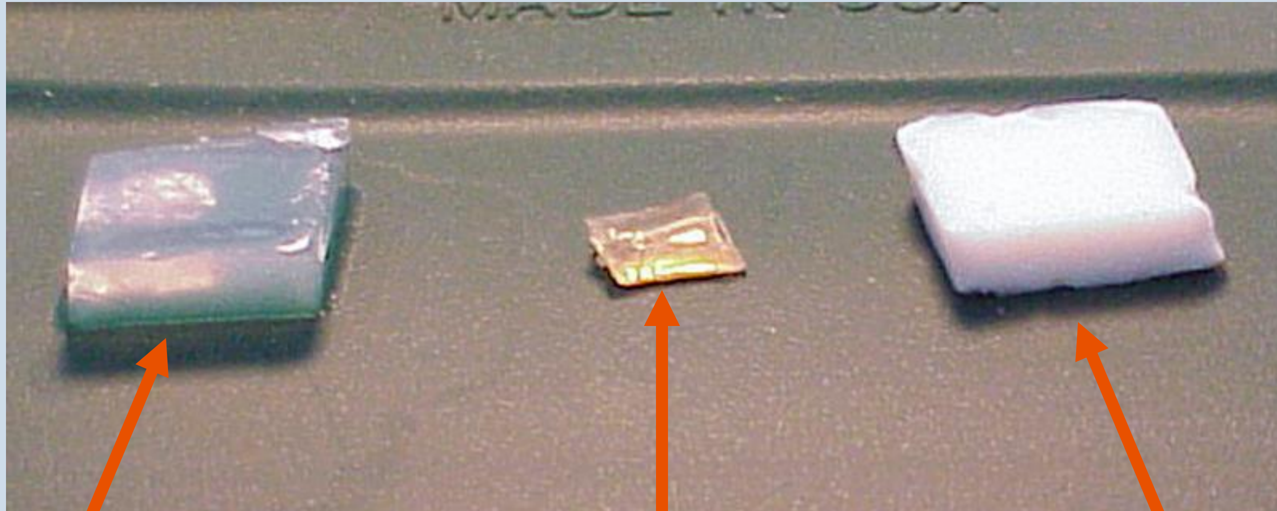
SAMDRIED™ vs. AIRDRIED Sol-Gel



SOL-GEL
0.1% solids in H_2O
Alcohol Dehydration

SAMDRIED™

SOL-GEL
1.0% solids in H_2O
Alcohol Dehydration

AIRDRIED

SOL-GEL
1.0% solids in H_2O
Alcohol Dehydration

SAMDRIED™

Tousimis Research Corporation
Rockville, MD

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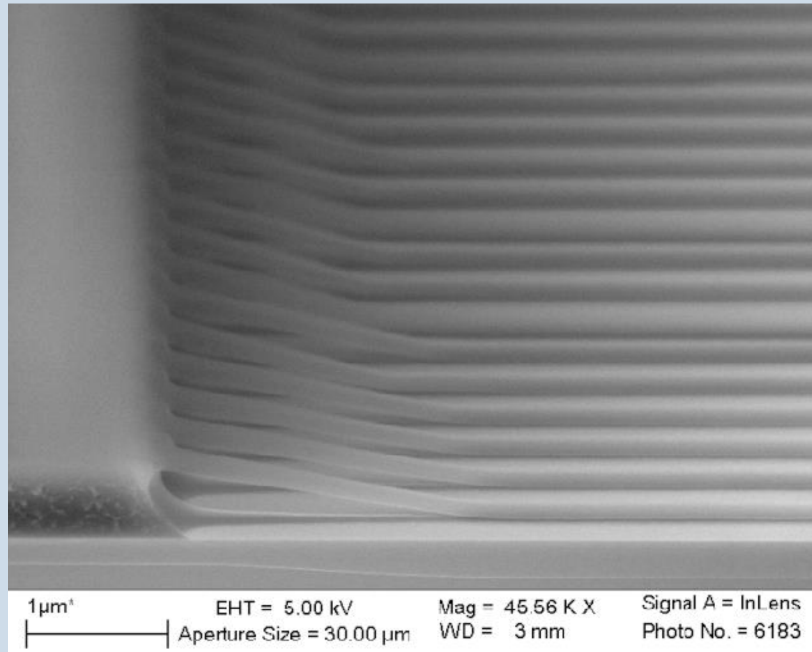
Failed attempts to get thick (~200 nm) and high repetitive(~ 500 nm) film

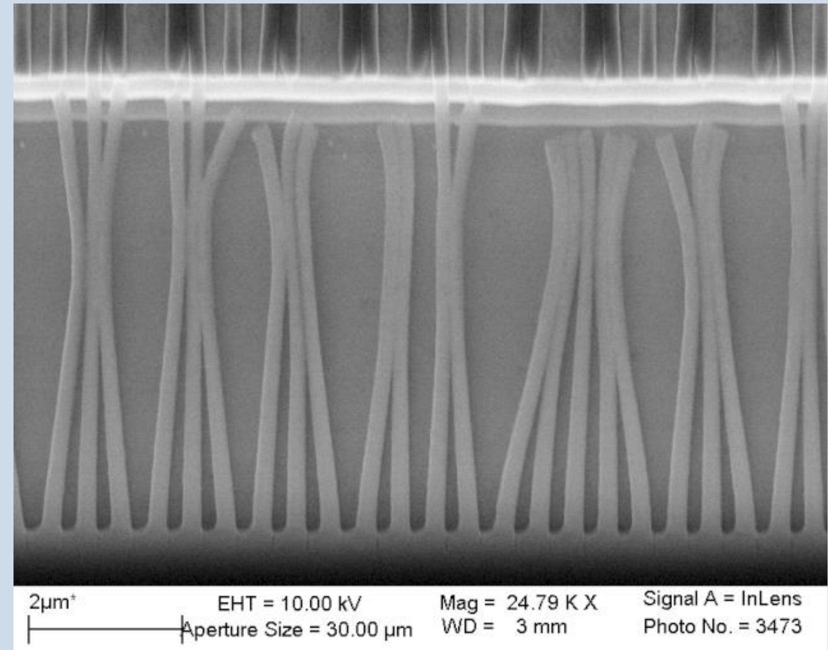


❶ Bi-layer e-beam resist

- top resist pattern couldn't sustain and collapsed down.

❷ Single thick e-beam resist

- Resist pattern collapsed each other during drying process.



NRL NanoFab - Washingtopn, DC
Chul-Soo Kim

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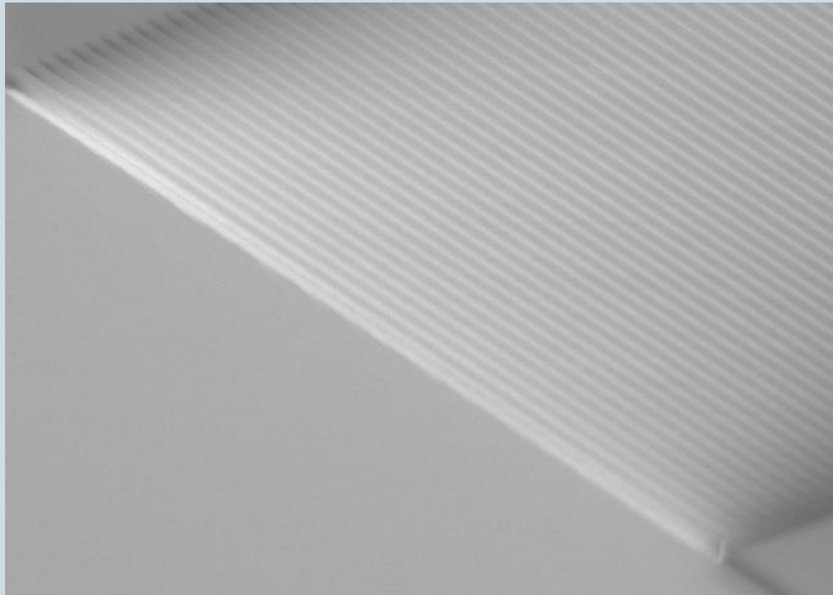
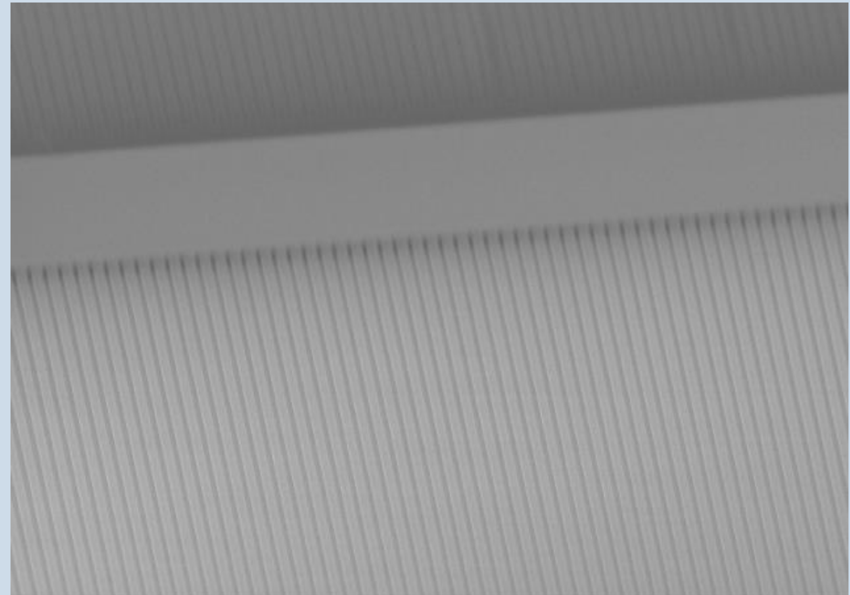
E-beam resist pattern quality after CPD Process





The same repetitive pattern was fabricated using 450 nm thick e-beam resist. Patterned, developed, and transferred to IPA prior to CPD Process.

Patterns are all coherent and no defects were found.

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