



Sensing and Awareness in Microsystems

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Stretchable Electronics – From Hemispherical Imagers to Neural Monitors

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Summary

The Problem:

Conventional electronics are rigid, brittle and planar, thereby restricting application possibilities

The Solution:

New ways to use old materials enable soft, elastomeric and curvilinear electronics, with performance equal to conventional systems

The Opportunity:

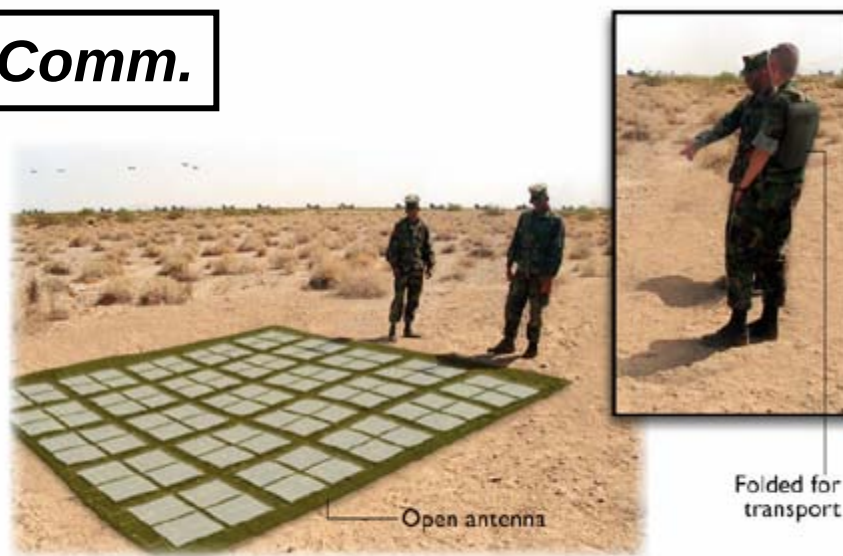
Stretchable electronics can be used for many new classes of application, with important military implications

Stretchable, Curvilinear, Large Area, Rugged *and* High Perf.

Imagers



Comm.



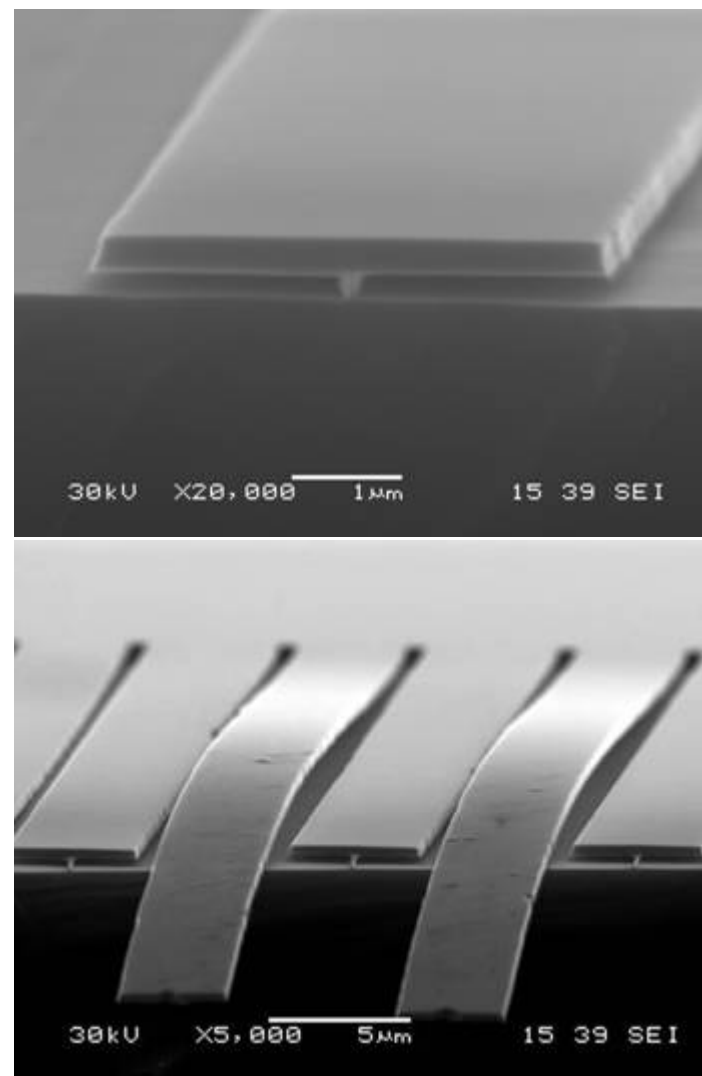
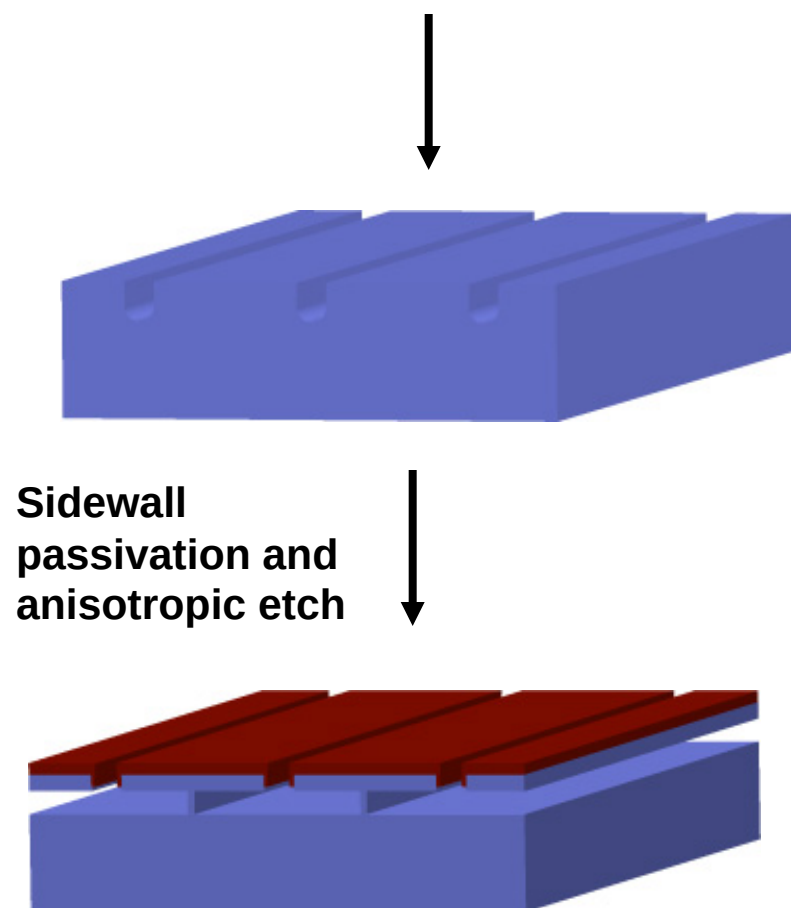
Control



Struct. Health

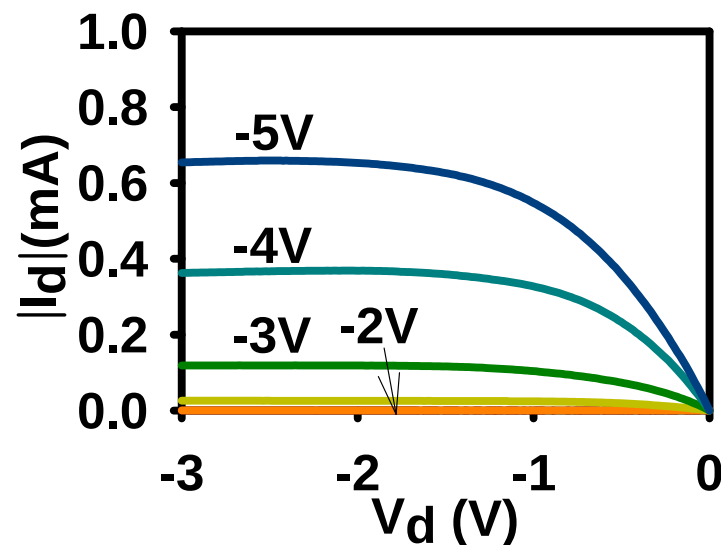
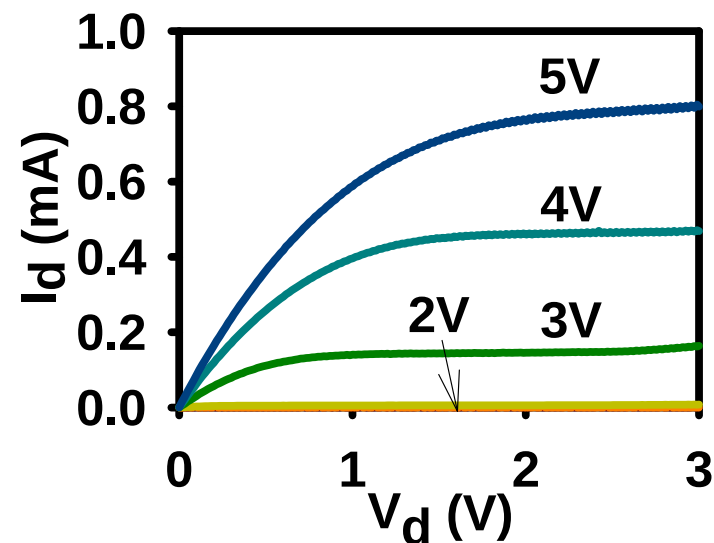
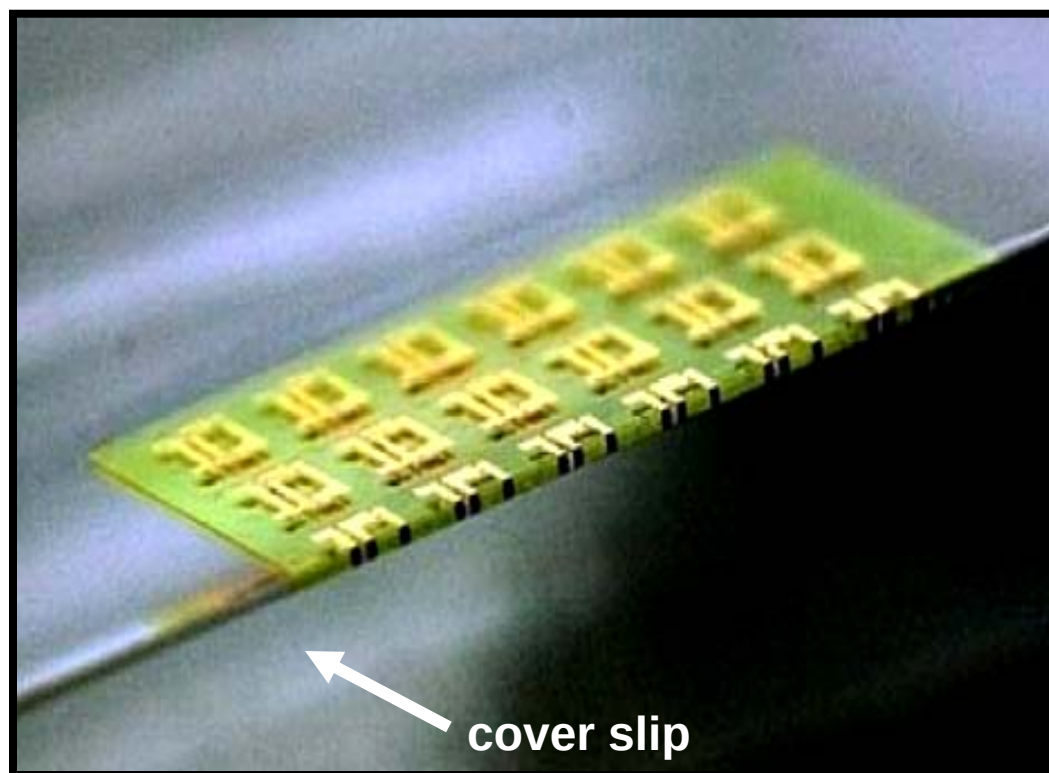


Si Nanoribbons from Bulk Wafers



Appl. Phys. Lett. **88**, 213101 (2006).

Si CMOS and Extreme Bendability

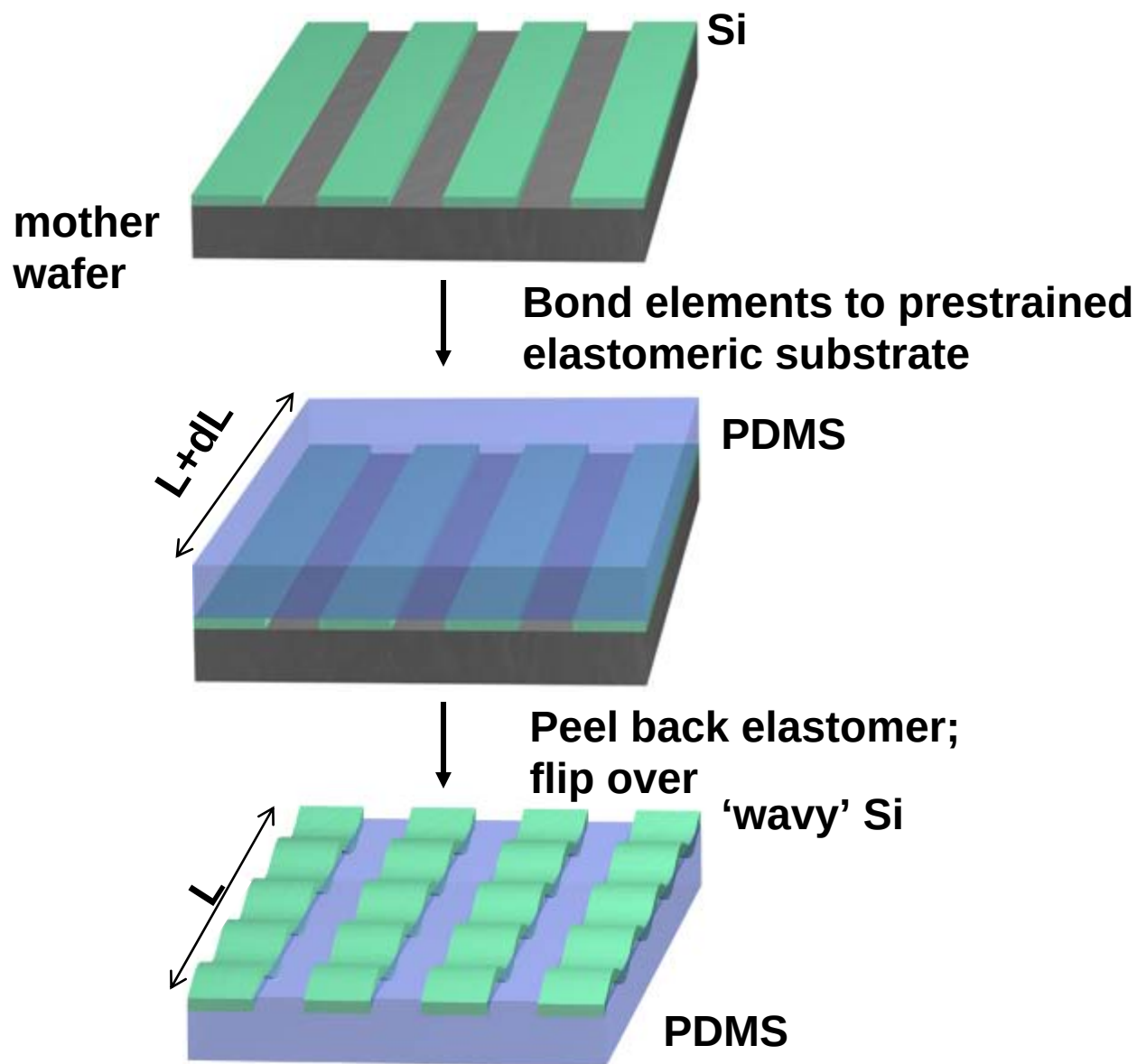


Adv. Func. Mater. **18**, 2673 (2008). *IEEE EDL* **29**, 73 (2008).

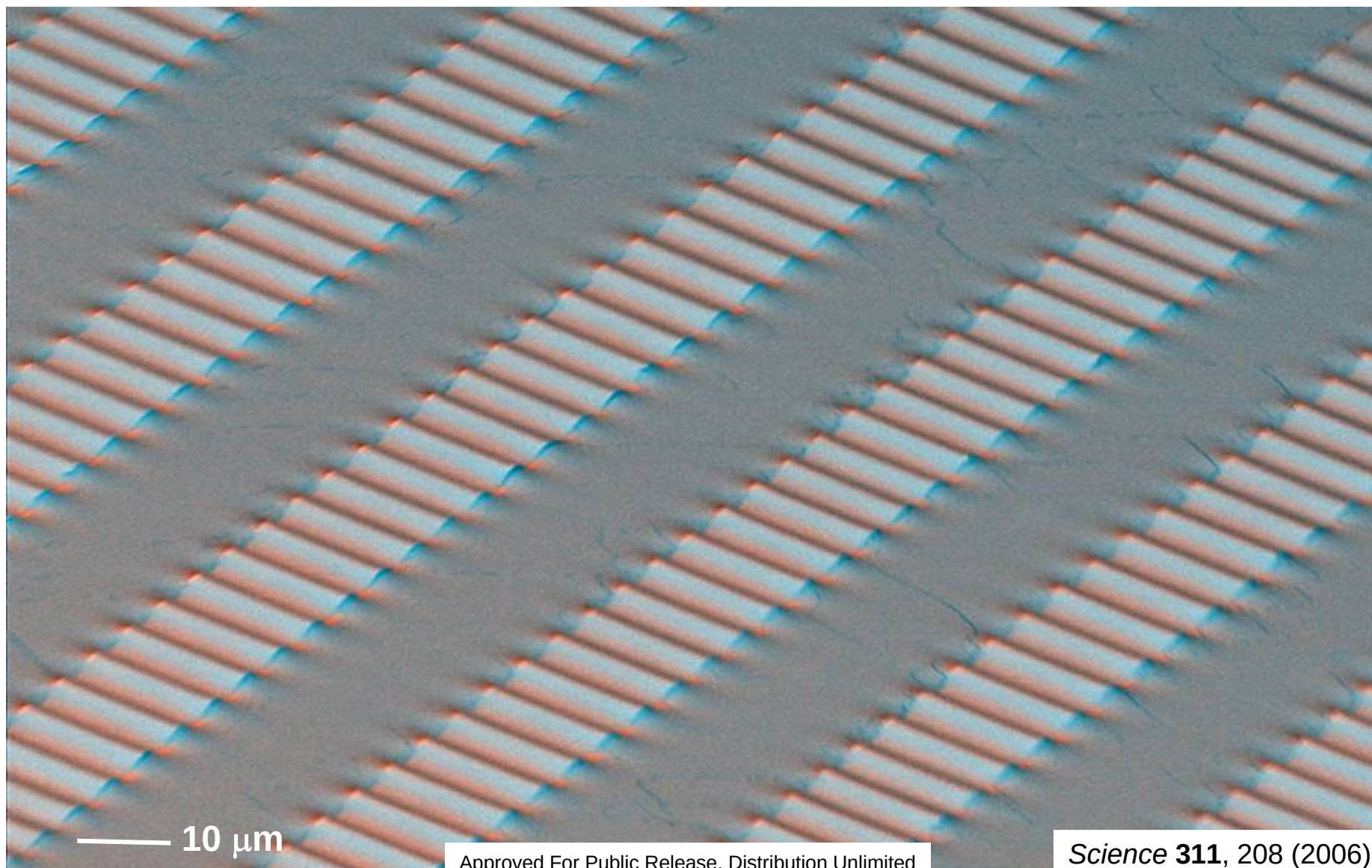
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Science **320**, 507 (2008).

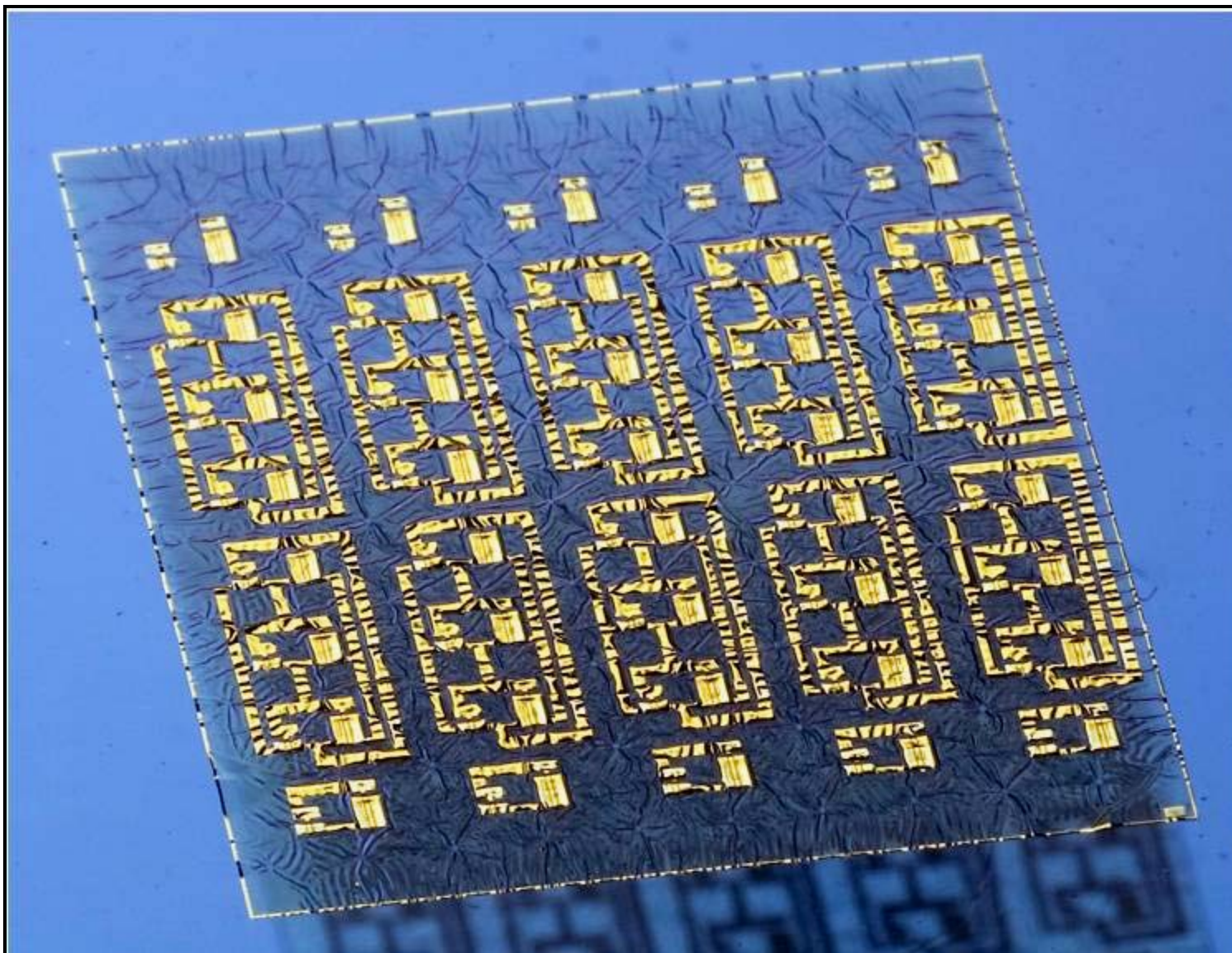
A Stretchable Form of Single Crystal Silicon



Stretchable Single Crystal Silicon – ‘Wavy’ Si on Rubber



Stretchable Silicon Integrated Circuits

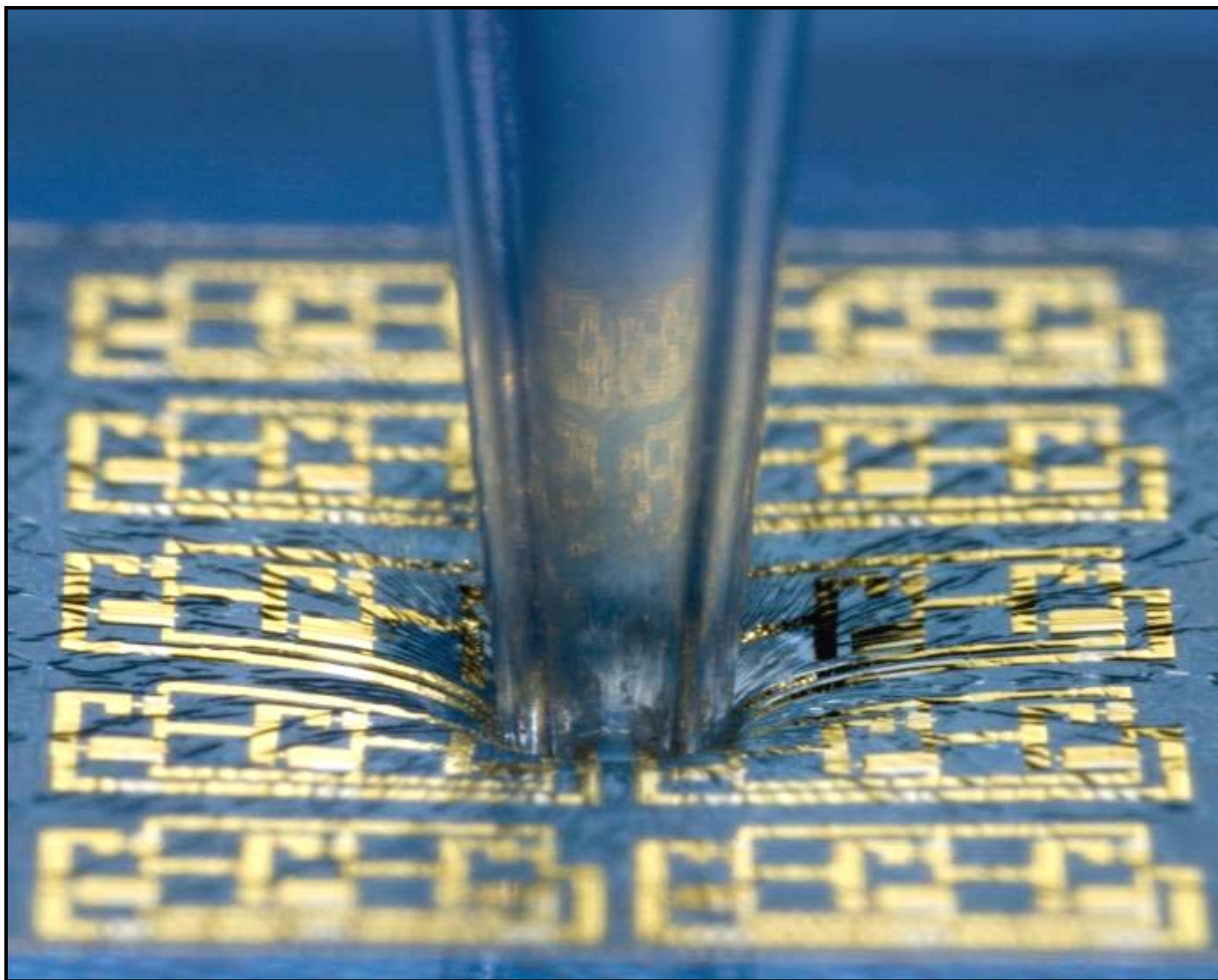


— 0.5 mm

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Stretchable Silicon Integrated Circuits

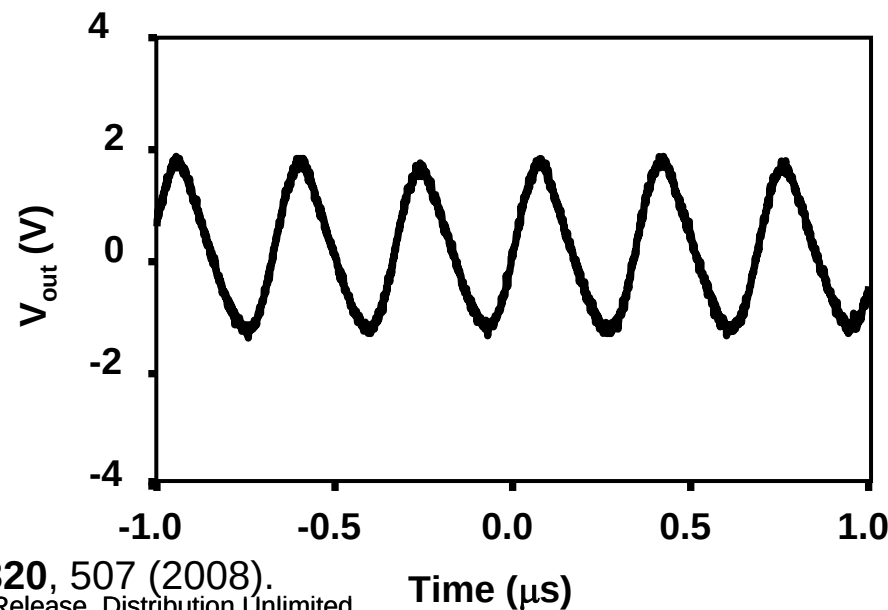
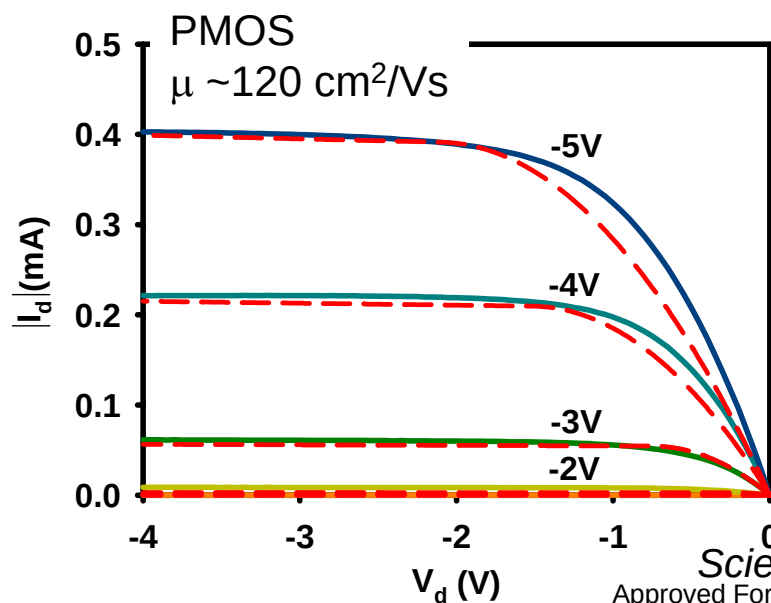
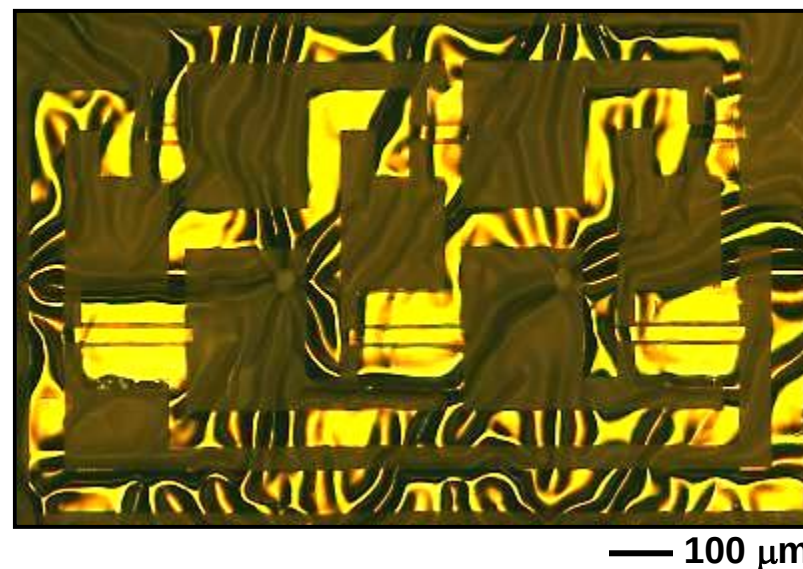
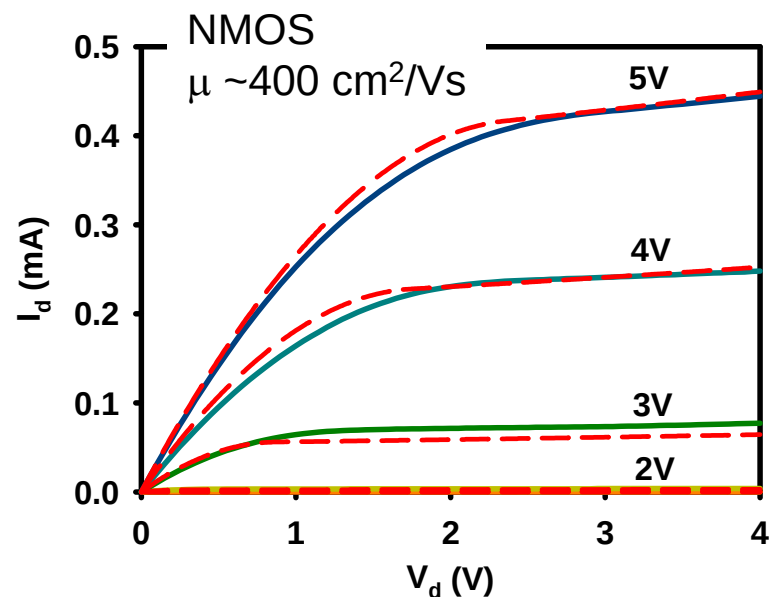


— 0.5 mm

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Science **320**, 507 (2008).

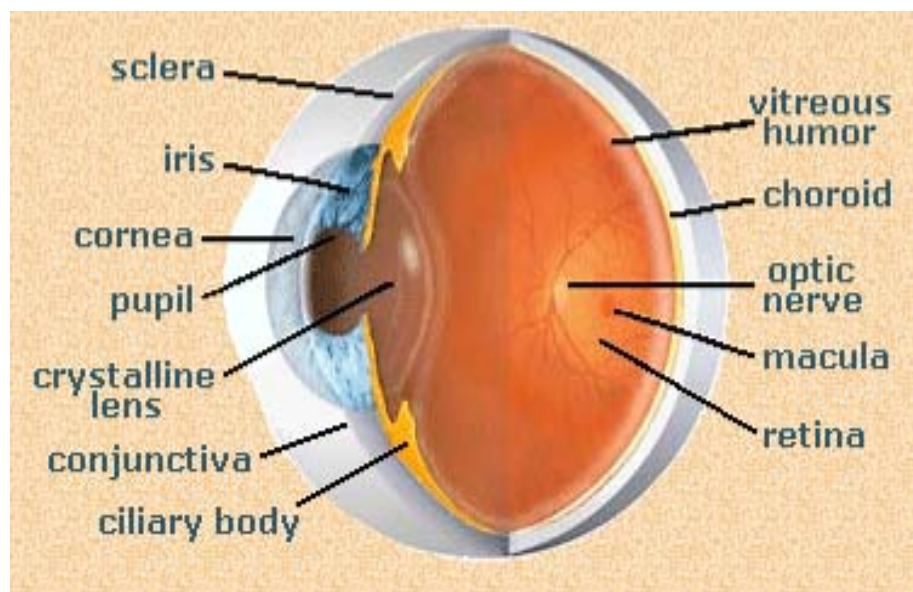
Stretchable Silicon Integrated Circuits



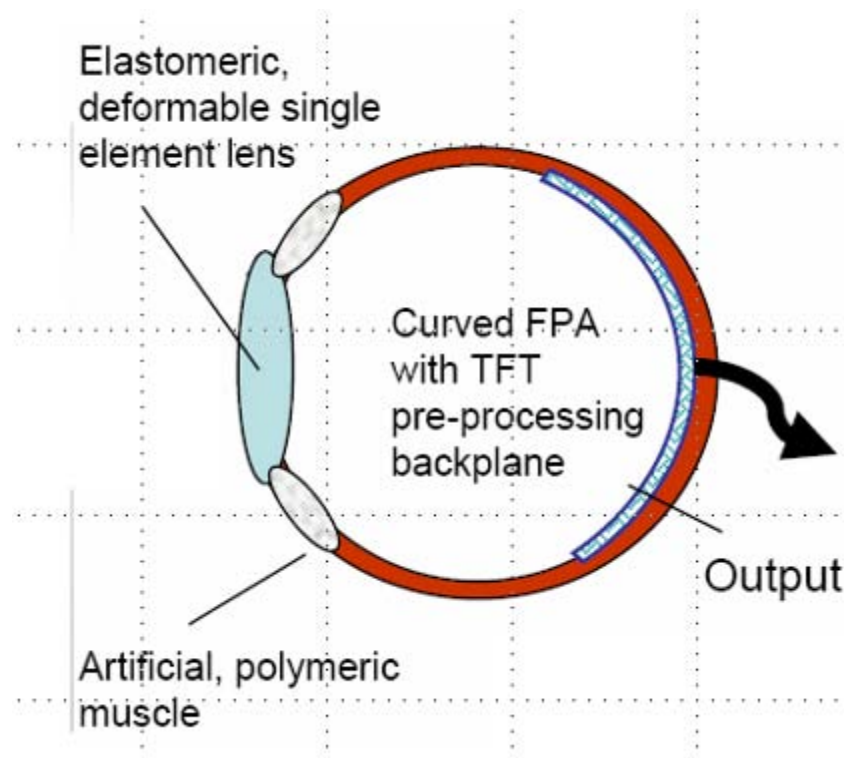
Science 320, 507 (2008).
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Curved Focal Plane Arrays for Wide FOV Imagers

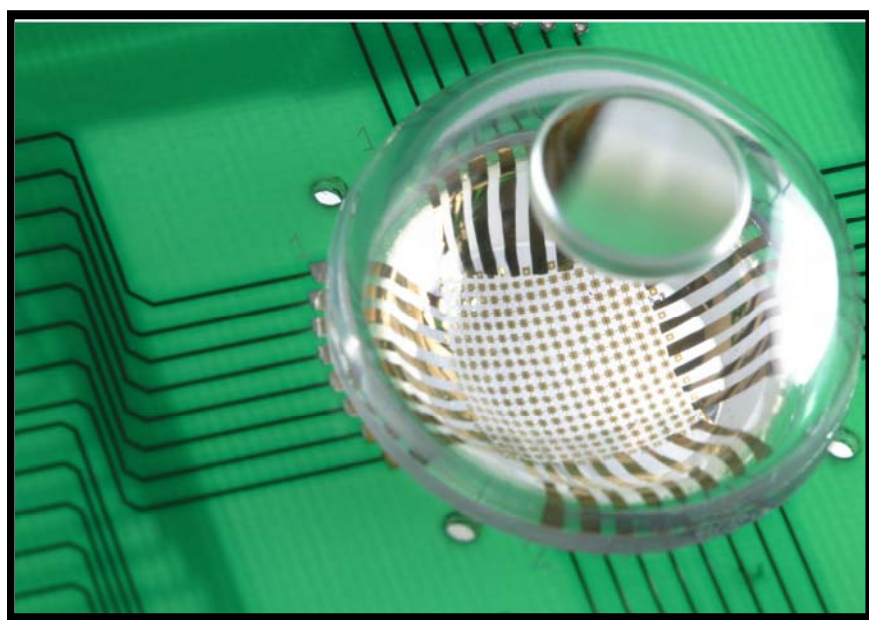
Human Eye



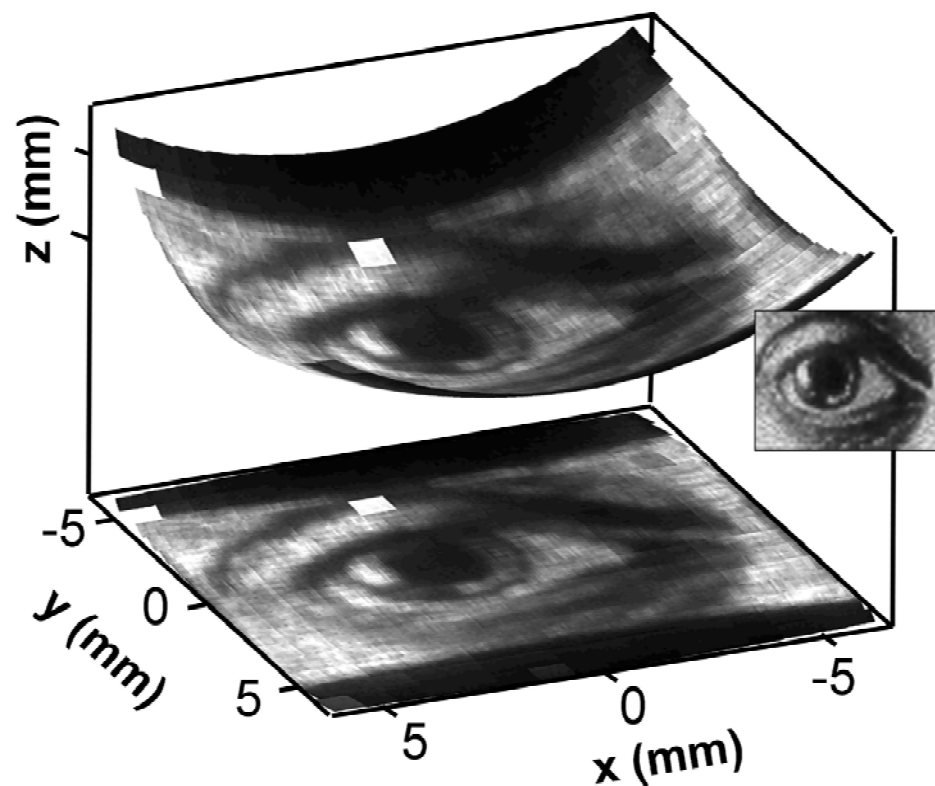
Electronic Eye



Electronic Eye via Stretchable Electronics

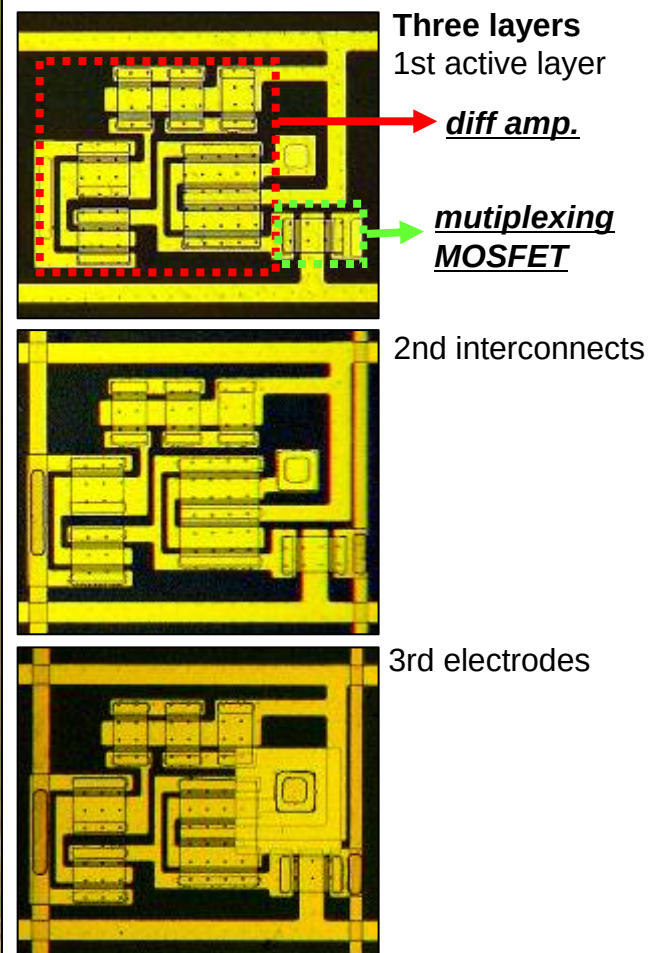
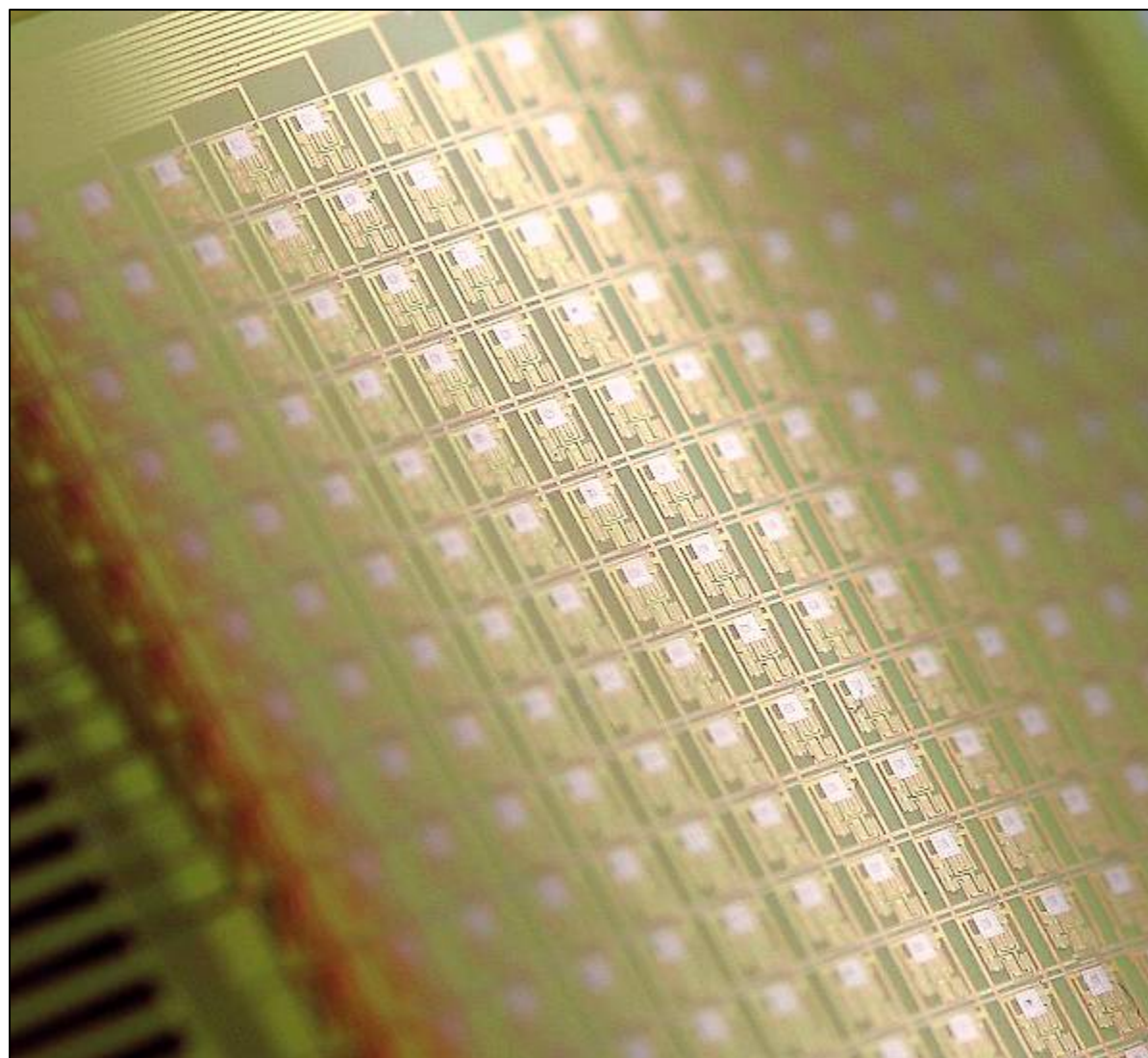


2 cm



Active Neural Sensors – ECoG Tapes (w/ Litt)

- 288 (16×18) Sensor Array
- Multiplexing Capability
- $288 \times 7 = 2016$ transistors



unpublished

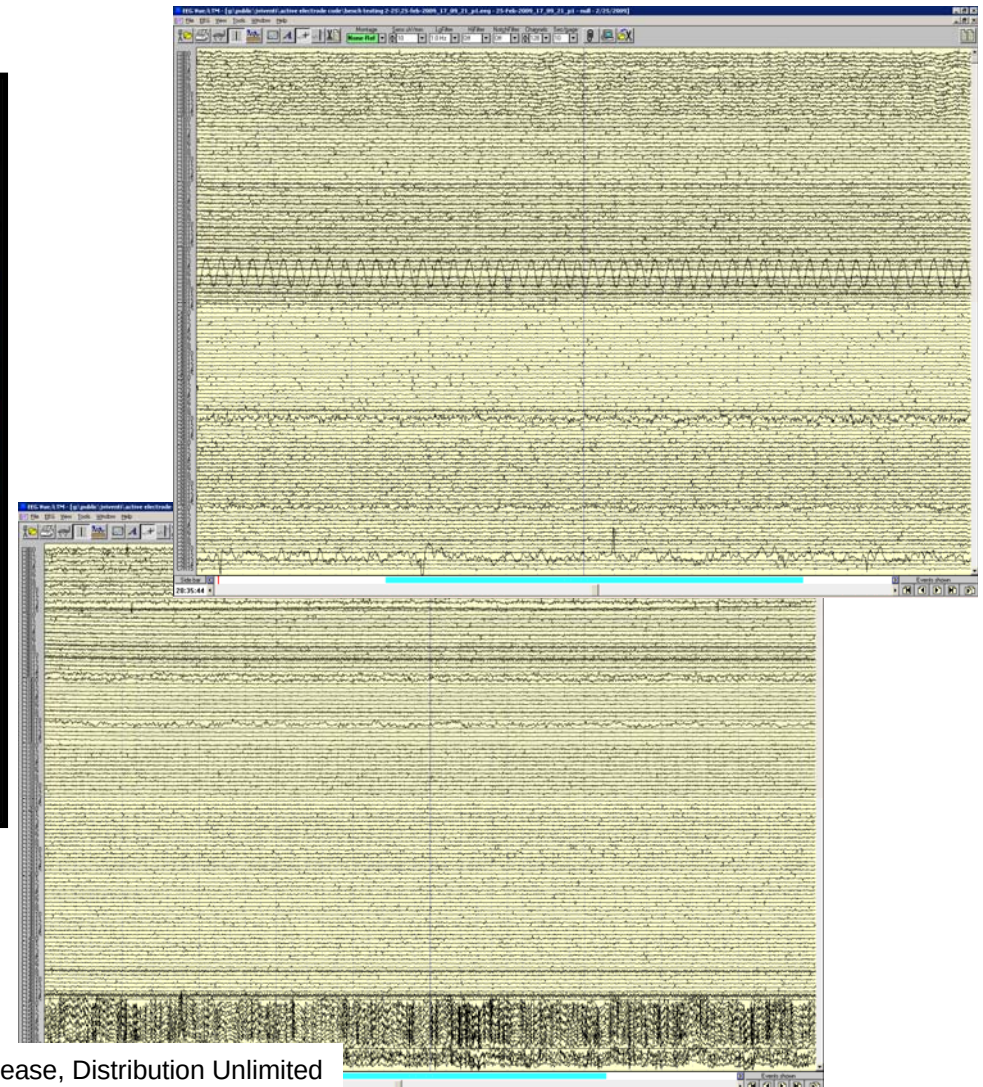
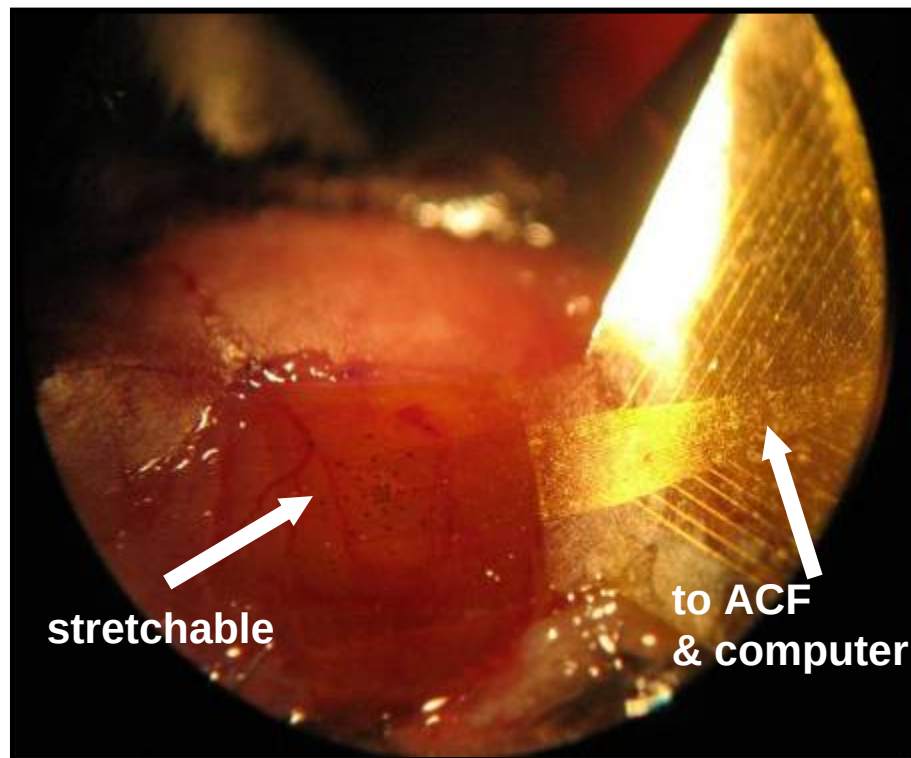
1 mm
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200 μ m

Stretchable Electronics for Brain Monitoring (w/ Litt)

256 channels; 500 Hz sampling

Barrel Cortex in a Rat



unpublished

Stretchable Electronics – From Hemispherical Imagers to Neural Monitors

**Semiconductor ribbons, membranes represent promising
materials for unusual format electronics**

**‘Wavy’ versions of these materials enable stretchable
electronics: bio-inspired designs and biomedical devices**

Electronic eye cameras and neural monitors provide examples

Senior Collaborators

Prof. Y. Huang (Northwestern) – mechanics theory

Prof. P. Ferreira (UIUC) – printer manufacturing systems

Prof. B. Litt (U. Penn) – cardiac, neural testing

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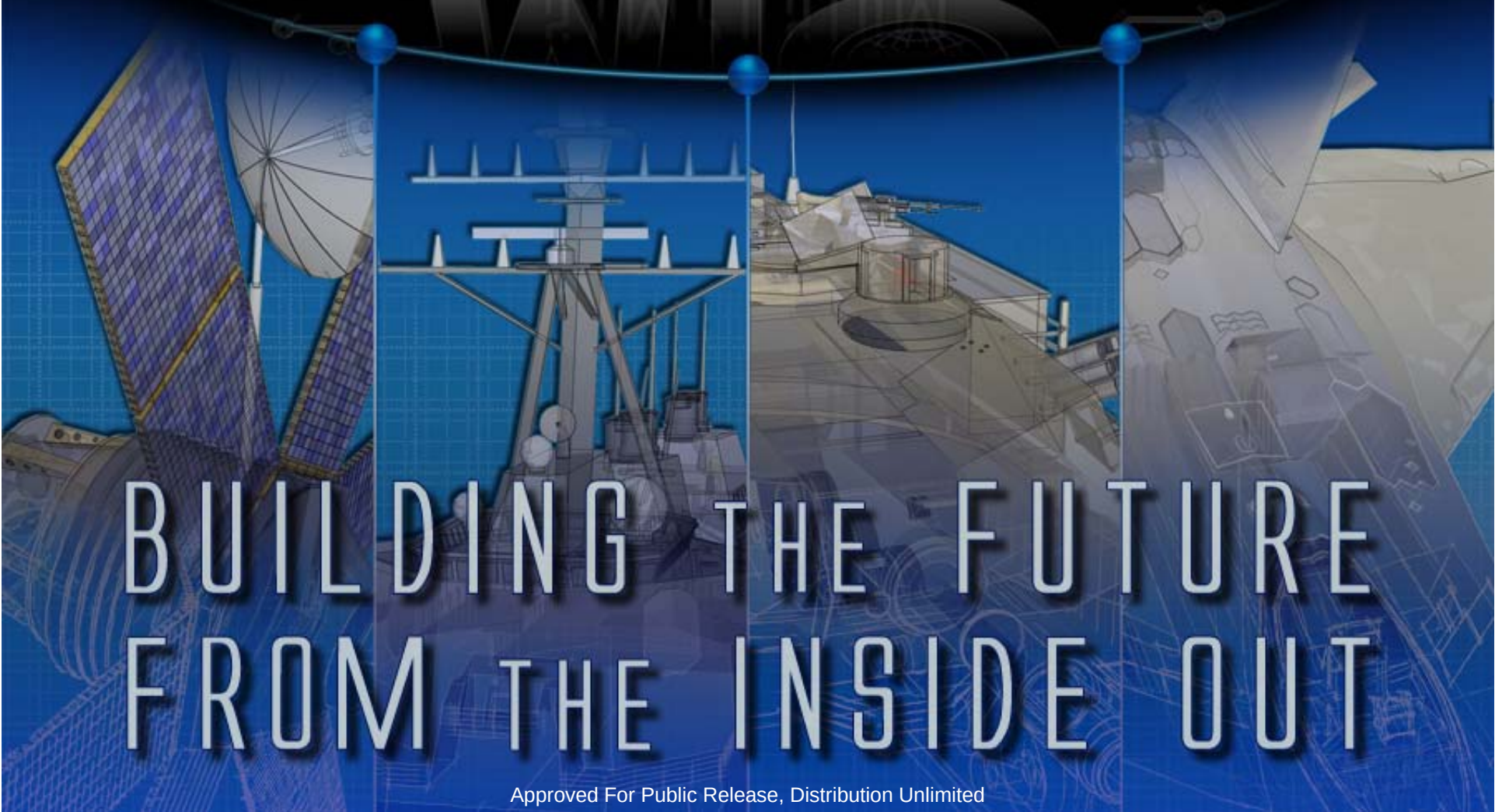


MICROSYSTEMS TECHNOLOGY OFFICE

MTO SYMPOSIUM

The logo for the Microsystems Technology Office (MTO) Symposium. It features the letters "MTO" in a large, bold, metallic font. The "O" is a circle containing a globe with the word "DARPA" on it. Circuit traces extend from the "M" and "O". Below "MTO" is the word "SYMPOSIUM" in a smaller, white, sans-serif font. The entire logo is set against a dark background with a reflection effect below it.

BUILDING THE FUTURE
FROM THE INSIDE OUT

The background of the poster is a collage of various technological and infrastructure elements. On the left, there's a large satellite dish and a solar panel array. In the center, a complex antenna structure is visible. On the right, there's a large, modern building with a glass facade. The entire background is in shades of blue and white, with a grid pattern overlaid. A thin blue line with three blue spheres runs horizontally across the middle of the image.

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