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Stretchable silicon camera next step to artificial retina

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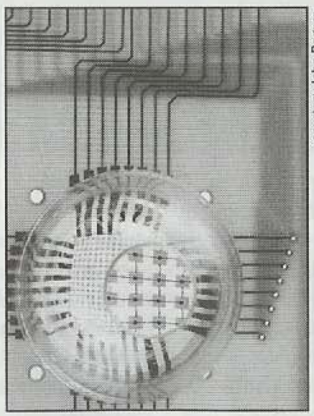
By combining stretchable optoelectronics and biologically inspired design, scientists have created a remarkable imaging device, with a layout based on the human eye.

As reported in the Aug. 7 issue of the journal Nature, researchers at the UI and Northwestern University have developed a high-performance, hemispherical "eye" camera using an array of single-crystalline silicon detectors and electronics, configured in a stretchable, interconnected mesh.



courtesy John Rogers

The work opens new possibilities for advanced camera design. It also foreshadows artificial retinas for bionic eyes similar in concept to those in the movie "Terminator" and other popular science fiction.

"Conformally wrapping surfaces with stretchable sheets of optoelectronics provides a practical route for integrating well-developed planar device technologies onto complex curvilinear objects," said John Rogers, the Flory-Founder Chair Professor of Materials Science and Engineering at Illinois, and corresponding author of the paper.

tronics in places where we couldn't before," Rogers said. "We can now, for the first time, move device design beyond the flatland constraints of conventional wafer-based systems."

The camera's design is based on that of the human eye, which has a simple, single-element lens and a hemispherical detector. The camera integrates such a detector with a hemispherical cap and imaging lens, to yield a system with the overall size, shape and layout of the human eye.

To make the camera, the researchers begin by molding a thin rubber membrane in the shape of a hemisphere. The rubber membrane is then stretched with a specialized mechanical stage to form a flat drumhead.

Next, a prefabricated focal plane array and associated electronics – created by conventional planar processing – are transferred from a silicon wafer to the tensioned, drumhead membrane.

When the tension is released, the membrane returns to its original shape. This process compresses the focal plane array, causing specially designed electrical interconnects to delaminate from the rubber surface and form arcs, pinned on the ends by detector pixels. These deformations accom-

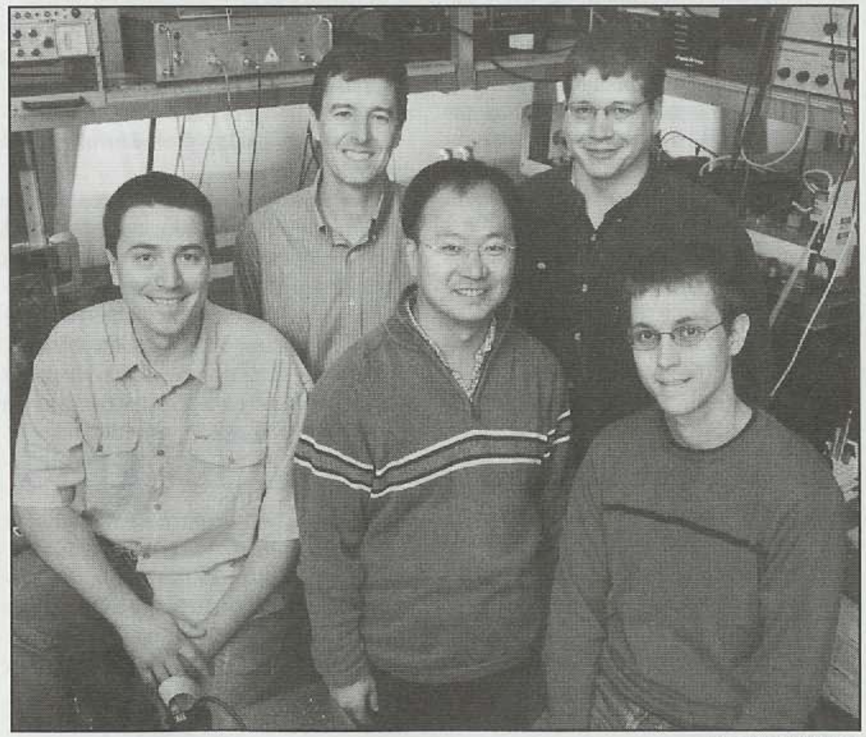


photo by L. Brian Stauffer

Copy cat *At left, a close-up photograph of the completed electronic eye camera. Above, the camera was designed by John Rogers (back left), the Flory-Founder Chair Professor of Materials Science and Engineering, and his research group: (clockwise from back right) Joe Geddes, Mark Stoykovich, Heung Cho Ko and Viktor Malyarchuk, all postdoctoral researchers.*

to hemispherical transformation, without stressing the silicon, as confirmed by mechanics modeling performed by researchers at Northwestern.

to a matching hemispherical glass substrate. Attaching a lens and connecting the camera to external electronics completes the assembly. The camera has the size and shape of a