New center aims to dramatically lower barrier to making silicon photonic chips

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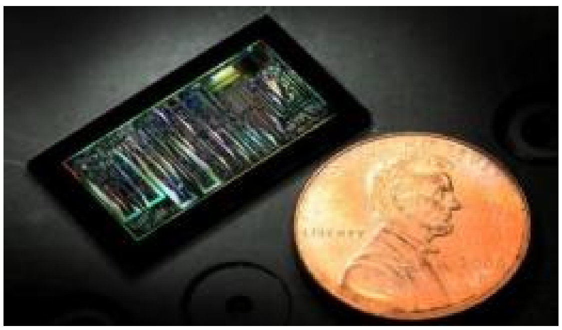


A completed photonic circuit measures less than an inch across. Credit: University of Washington

The University of Washington today announced the launch of a new program, co-funded by Intel Corp., that aims to make it dramatically easier and cheaper to manufacture silicon chips that combine light and electronics, enabling the next generation of computer chips. This program will provide access to high-end semiconductor manufacturing, enabling any researcher in the world to build integrated electronic-photonic circuits in silicon.

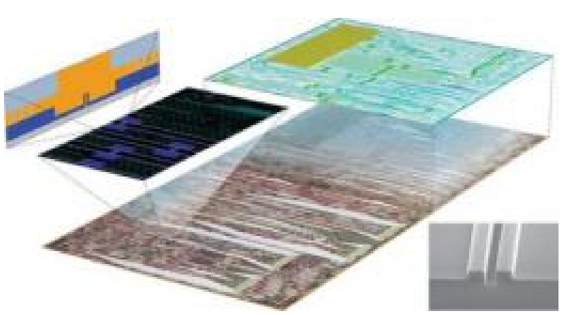
In a ceremony today on the UW campus, Michael Hochberg, a UW assistant professor of electrical engineering; Justin Rattner, chief technology officer at Intel Corp.; Carver Mead, professor emeritus at the California Institute of Technology; and Matt O'Donnell, dean of the UW College of Engineering, kicked off the initiative to support startups and academic researchers.

"We would like the photonics industry, 10 years from now, to function in a way that's very similar to the electronics industry today," Hochberg said. "People building optoelectronic systems will send designs out to an inexpensive, reliable third party for manufacturing, so they can focus on being creative about the design."

The new center aims to create for silicon photonics what Mead and colleague Lynn Conway did for silicon electronics in the 1970s. The "Mead and Conway Revolution" is widely credited with ushering in the current era of integrated circuit computing technology.

Optoelectronics Systems Integration in Silicon, or OpSIS, will offer a service similar to the Metal Oxide Semiconductor Implementation Service, or MOSIS, an organization based at the University of Southern California that helped combine many different circuits, based on Mead and Conway's design principles, onto a single silicon wafer.

"More than 15 years ago, we had a collaboration that allowed my group to design custom integrated circuits that would have been totally impossible for us to do from scratch," said O'Donnell, who then worked at the University of Michigan. "It's now clear that silicon photonics is becoming an integral part of the electronics world, and so it's critical to have that type of capability."



This is a graphic of a recently built silicon photonic chip measuring 1 cm by 2 cm. At the bottom is a photograph of the chip. Above it, in green, is the original chip design. The rectangle on the upper left shows how layers of silicon (blue), metal (gray) and electrical insulator (orange) combine to create channels, or waveguides, for light to pass through. Credit: A. Spott, University of Washington

The OpSIS project will permit "shuttle runs" in which researchers cut costs by sharing silicon wafers between multiple projects. A single circuit design might use only a few square millimeters. Enabling shuttle runs, Hochberg said, can reduce costs by more than 100 times.

In developing the rules and protocols, Hochberg aims to create a system analogous to Mead and Conway's so that even non-specialists can begin to design and build functioning chips that integrate photonics and electronics.

Creating these rules requires striking a fine balance.

"You want a minimum of rules because people are going to use the technology in ways that you never imagined," Mead said. "You want people to use it in ways that seem crazy."

The emerging field of photonics uses photons, or light, rather than electrons to carry information. Using photons provides a faster, lower-power means for moving data around; a single optical fiber or waveguide can carry many terabits per second of data, tens of thousands of times more than a copper cable does today. Using silicon as the base for the technology eases integration with existing devices and builds on the mature silicon chip manufacturing industry.

Combining photonics and electronics promises to improve radar and sensing technology, and the U.S. Air Force Office of Scientific Research funds Hochberg's UW research. There are also a number of emerging applications for silicon photonics: In the future, Hochberg said, chips that combine electronics and photonics could allow for biological sensors that can test hundreds of blood samples on a single inexpensive chip that combines lasers, sensors and electronics.

"OpSIS will enhance the education of U.S. engineering students, giving them the opportunity to learn the new optical design paradigm," Intel's Rattner said. "The ability to produce such low-cost silicon chips that manipulate photons, instead of electrons, will lead to new inventions and new industries beyond just data communications, including low-cost sensors, new biomedical devices and ultra-fast signal processors."

In August, Hochberg and Tom Baehr-Jones, a UW research scientist in electrical engineering, published a *Nature Photonics* article calling for a foundry for silicon photonics.

"With such an organization in place, we predict that designing and building photonic-electronic silicon chips will constitute a multibillion-dollar industry within the next ten years," they wrote.

The OPSIS organization already has a half-dozen early users who are participating in so-called "risk runs" that test the protocols now under development.

One early user is John Bowers, a professor of electrical and computer engineering at the University of California, Santa Barbara who has designed a circuit for the first run. While Bowers can build photonics circuits elsewhere, he sees himself as a potential user of the foundry.

"By focusing research of many different groups in one process line, that allows you to advance a library of components and processes faster than any one group could do on its own," Bowers said. "It enables a faster evolution of photonic devices."

Eventually, the UW center plans to offer three runs per year, each of which could accommodate 30 to 40 users. The chips will be built by BAE Systems Inc.

OpSIS will be based at the UW's new Institute for Photonic Integration.

"I'm just rooting for it," Mead said. "It's a wonderful thing and it needs to happen. I might even use it for some of my own research."

More information: Hochberg's article in *Nature Photonics* is at www.nature.com/nphoton/journal … photon.2010.172.html

Provided by University of Washington