Foundry service aids silicon photonic chips

A new foundry service for silicon photonics will reduce costs and allow new lines of research on computer chips.

OpSIS Director Michael Hochberg

About OpSIS

OpSIS is a new foundry service for silicon photonics in Seattle in which the community shares the cost of fabricating complex chip-scale systems across many projects.

Multiproject-wafer (or shuttle) runs will aggregate the designs of many users into a single complementary metal–oxide–semiconductor (CMOS) process, with designs fabricated together on the same wafers.

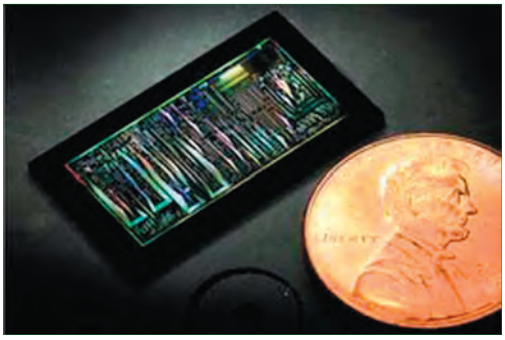
Each user will pay only for the cost associated with the wafer area they use, which might be as small as a few square millimeters.

OpSIS Director Michael Hochberg is a founder of Luxtera and a 2009 recipient of a Presidential Early Career Awards for Scientists and Engineers, the highest honor bestowed by the U.S. government on young professionals in the early stages of their independent research careers.

The opening of a new foundry service for silicon photonic chips in Seattle, WA (USA) earlier this year signals a "new age" for optical integrated circuits, one that could revolutionize the computing industry as well as communications, biomedicine, and imaging.

The University of Washington (UW) launched the new Optoelectronic Systems Integration in Silicon (OpSIS) lab in February to allow engineers and researchers working on different projects anywhere in the world to share the cost of prototyping and fabricating chip-scale systems in silicon.

The lab, partly supported by Intel Corp., BAE Systems, and the U.S. Air Force Office of Scientific Research, is modeled on the Metal Oxide Silicon Implementation Service (MOSIS) developed at the University of Southern California in 1981. MOSIS has been widely credited with ushering in the current era of integrated circuit computing technology.



A photonic circuit is about the size of a U.S. penny.

The multi-project wafer service for silicon photonics at UW's new Institute for Photonic Integration aims to make it radically easier and cheaper to design and manufacture the next generation of computer chips that move information with light as well as electricity. OpSIS will bring prototyping capability within reach of startups and academic research groups by coordinating "shuttle runs" that spread the cost of processing across many users of a single mask set.

BAE Systems, the Institute of Microelectronics in Singapore, and other foundry partners will produce the prototype chips for multiple users.

Creating an ecosystem

The complexity of silicon photonic systems on chips has exploded over the past several years, and the processes needed to build these circuits are usually too expensive or too risky for the research community to access. This, in turn, has hampered progress in low-cost, volume manufacturing.

To solve this problem, OpSIS will provide the shuttle runs as well as design rules, device design support, and assistance with design-flow development so that even non-specialists can design and build functioning chips that integrate photonics and electronics. By developing standard rules and protocols, SPIE member Michael Hochberg, OpSIS director and assistant professor of electrical engineering at UW, says the overhead connected to dozens of different formats will be eliminated.

"Our goal is to create an ecosystem for fabless silicon photonics to really take off, much like the fabless semiconductor industry did over the past 30 years," Hochberg says.

Because a single circuit design might use only a few square millimeters of a wafer, shuttle runs at OpSIS can result in a 100-fold reduction in costs, says Hochberg, a founder of Luxtera, a fabless semiconductor company commercializing silicon CMOS photonics.

"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 says. "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."

Hochberg notes that ePIXfab, a European effort to build silicon photonic chips in shared processes, has produced many wafers for device researchers. It offers shuttle services for passive devices but not yet for processes that include modulators and detectors, or transistors.

"ePIXfab has provided a fantastic service for device research, allowing users to customize

Intel's Mario Paniccia; Carver Mead, the CalTech professor emeritus who is one of the inventors of VLSI circuits; and SPIE Executive Director Eugene Arthurs celebrate the launch of OpSIS.

processes individually," Hochberg says. "Our focus at OpSIS is on standardization of a few processes, to enable a transition from devices to full electronic-photonic systems."

Ushering a new age

Combining photonics and electronics promises to improve radar and sensing technology and could allow for biological sensors that can test hundreds of blood samples on a single inexpensive chip. Biomedical sensing devices that now cost hundreds of thousands of dollars and are the size of copy machines, for instance, could be replaced one day with handheld devices with tiny optical chips that cost $1 or less, Hochberg says.

A fingernail-size chip loaded with optical integrated circuits could download an entire movie or 150 albums worth of music in a second. OpSIS is seen as a means of making all that happen cost-effectively, to serve the estimated 15 billion connected devices in use by 2015. Hochberg also predicts speeds of terabits per second in the future, downloading the entire contents of a modern hard disk in a second or less.

"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," says Justin Rattner, CTO at Intel.

"Together, we usher in a new age of optical integrated circuits," Rattner says.

SPIE CEO Eugene Arthurs has congratulated Hochberg and UW on the establishment of OpSIS. "The visionary work and energy provided by Intel, BAE Systems, the Air Force, and future partners will do much to move science forward and enable applications that help improve lives through more robust communications, improved medical technologies, and other advances," he says.

The center plans to offer three or four runs per year, with the first one expected this summer. Each run could accommodate 30 to 40 users. ■

Leveraging CMOS fabs

OpSIS Director Michael Hochberg says that silicon photonic devices can be built using commercial CMOS chip fabrication facilities if academic groups, startup companies, and large semiconductor manufacturers collaborate on shared CMOS foundry infrastructure.

"It is possible to integrate devices that use silicon waveguides into CMOS electronics flows," Hochberg says. "Practical challenges exist," he adds, but "Luxtera, where I was a founder, has done this already; Luxtera has run electronics and optics through a CMOS fab on the same chip. And they're not the only ones who have done it."