Improved design of lasers on optoelectronic chips will advance optical communications

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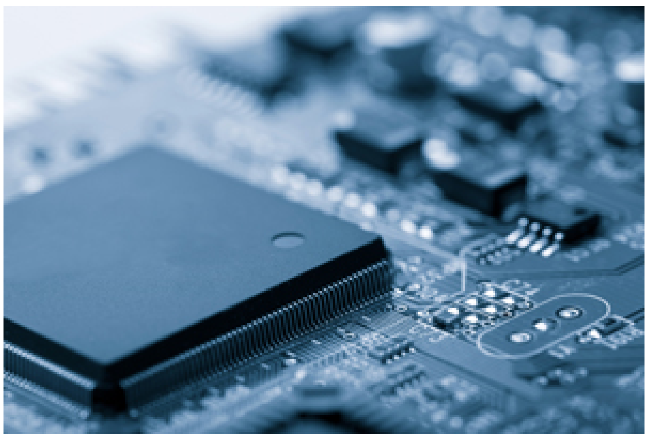

Current computer technology uses electronics, but a new laser design based on a thin-layered silicon chip may help increase data processing capabilities. Credit: Olga Miltsova/Hemera/Thinkstock

When it comes to data transmission, light is superior to electronics. An ability to transmit data in parallel by utilizing multiple light wavelengths allows optical fibers to carry more information than electrical cables. Computers are currently based on electronics, but they would benefit from employing optical signals. However, for this to become a reality, it needs to be implemented on a small scale and result in low power consumption.

Now, Vivek Krishnamurthy from the A*STAR Data Storage Institute in Singapore and his colleagues have designed a laser on a microelectronic chip that has a lower power consumption and a higher efficiency.

"By developing lasers on silicon, we can combine the electronic data processing capability of the microelectronic chip with the high energy efficiency of optical communications over distances ranging from a few micrometers within a chip to hundreds of meters in data centers," says Krishnamurthy.

The processing speed of the microelectronic chip is limited by its power consumption; most of the power is consumed by the connecting electrical wires and links. Optical links, on the other hand, consume practically no energy but are limited by the power consumption of the light source, which is often a laser. For optical links to be feasible on a small scale, the electrical power consumption of lasers must be reduced, yet still be able to generate sufficient optical energy for transmission.

Lasers cannot be made from silicon as it is a poor light emitter. Instead, lasers are fabricated by bonding an active material based on indium phosphide—a good light emitter—to a thin silicon film. However, because silicon is better for carrying optical signals, the light from the laser needs to be routed through the silicon chip via optical channels. This requires fabricating optical channels in silicon outside the laser region.

Generating light efficiently in the active medium and efficiently routing it via the silicon layer simultaneously reduces the electrical current required and increases the power generated. Calculations show that this silicon-based design will have a three to four times higher light generation efficiency than competing schemes.

This high efficiency makes the silicon-based laser design promising for making optical chips, which, says Krishnamurthy, is the next step for the project team. "We have begun the experimental demonstration of the laser," he says. "Our plan is to integrate this laser onto our silicon platform and develop a fully functional photonic system for applications, for example, in data communications and storage."

More information: Krishnamurthy, V., Wang, Q., Pu, J., Loh, T.-H. & Ho, S. T. "Optical design of distributed feedback lasers-on-thin-film-silicon." *IEEE Photonics Technology Letters* 25, 944–947 (2013). dx.doi.org/10.1109/LPT.2013.2257719

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