Simultaneously simulating electrical and optical input achieves unprecedented performance in electro-optical interfaces

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A key interface component between electronic and light-based circuits receives a boost in performance through A*STAR research that combines previously independent simulations of the two systems. This research highlights the scope to improve electro-optical circuits as critical components in modern communications systems.

Light offers particular advantages over conventional electronics—it can be transmitted with high fidelity over long distances, and can carry much more information. Optical fiber networks exploit these advantages for fast and efficient data communications. The devices at each end of an optical fiber, however, are usually built on conventional electronics, and the performance of this electro-optical interface is a factor that limits the rate of data transmission.

Much research has focused on the development of faster and smaller electro-optical components that can be integrated into conventional silicon-based electronic circuits and microchips. But progress has been hindered by the complexity of simulating both electronic and optical effects in the same device.

Soon Thor Lim and colleagues from the A*STAR Institute of High Performance Computing found a way to combine electronic and optical effects into a single numerical simulation model. They now demonstrate that it can significantly increase the performance of a silicon optical modulator.

"Optical modulators are electro-optical devices that modify the propagating light by applying electrical pulses," says Lim. "They are used in optical communication systems to encode electronic information into laser beams."

While there are many fabrication parameters for silicon modulators, there are also many fabrication constraints, and so finding the optimal set of parameters requires painstaking computation.

"The problem is that two types of simulation must usually be performed for such research work – electrical followed by optical simulation using two different types of software. This is computationally expensive in terms of simulation time and resources," explains Lim. "Our in-house code performs both electrical and optical simulation in one single platform with no loss in data fidelity."

The team's method allows the electrical-optical interaction inside the modulator to be visualized by showing the light intensity as an overlay on the modulator's distribution of electronic properties. The exact position of the nano-scale features and electronic properties can then be fine-tuned to achieve the best optical performance.

"With modeling and optimization using our in-house code, we can design a silicon modulator with best-in-class performance," says Lim, "which will facilitate the development of low-loss, high-speed optical data transmission systems."

More information: Ching Eng Png et al. Numerical Modeling and Analysis for High-Efficiency Carrier-Depletion Silicon Rib-Waveguide Phase Shifters, *IEEE Journal of Selected Topics in Quantum Electronics* (2016). DOI: 10.1109/JSTQE.2016.2564648

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