Scientists harness light to speed up computers

Canadian team's silicon breakthrough overcomes key flaw in today's microchips

LAWRENCE SURTEES
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Super-fast computers that use light to calculate and communicate are a big step closer to reality with a major breakthrough from Canadian and Spanish scientists.

Sajeev John, a theoretical physicist at the University of Toronto, heads the 13-person international research team that includes key Canadian members Geoffrey. Ozin, a professor of materials chemistry at U of T, and his PhD student, Emmanuel Chomski. The team has succeeded in building a three-dimensional silicon structure that traps light, called a silicon photonic chip.

The discovery might sound obscure, but it is a crucial step in creating a computer chip that uses light to process and store information, rather than electrical pulses, as is the case today.

When that kind of computer chip arrives on the scene (the researchers say it's at least five years away), it will represent a major advance over current machines, which are hobbled by the heat that electricity creates in tiny circuitry.

And that could create a huge leap forward in computing power comparable to the arrival, decades ago, of electronics, Prof. Ozin said. "It could be as disruptive for electronics as transistors [were] for vacuum tubes."

Much of the world's information is now pulsed by tiny lasers at the speed of light along hair-thin glass strands of fibre-optic lines. But all that information must be converted to electrons to be processed and stored by chips used in today's computers.

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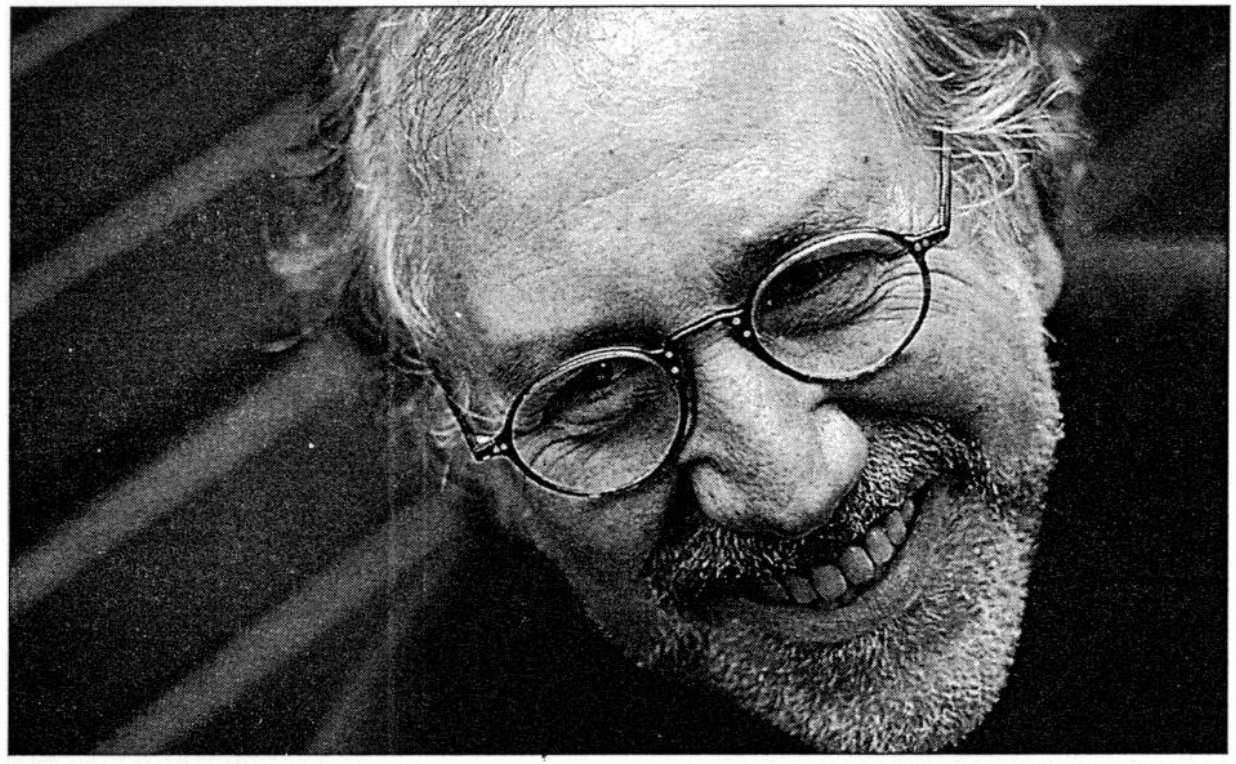
That conversion is inefficient because electron-based chips can not keep up with the capacity and speed of light-based signals. And researchers are limited in how much further they can improve the current generation of microprocessors because of the tremendous heat electrons produce.

"This process removes a fundamental bottleneck for manipulating light waves directly in electronic devices," Prof. John said.



Geoffrey Ozin helped make a breakthrough in the use of light to transmit information. TARAS KOVALIV/The Globe and Mail

The photonic chip is a Holy Grail' for legions of university and corporate researchers throughout the world because it promises faster and more efficient communications networks and computers.

"This is the first time that someone has been able to grow silicon at a desired size to control light," said Mohamed Zaid, a senior manager at Nortel Networks Corp.'s labs in Ottawa.

"It's a breakthrough that could have tremendous potential," he said, adding that it could lead to the development of new chips that route, store and process light waves directly.

The next step, which requires the development of a demonstration photonic microchip, is about two to three years away, Prof. Ozin said.

Prof. John first developed a theory for trapping light with silicon crystals in his PhD thesis at Harvard University in 1984. He returned to U of T in 1989, but only began collaborating with fellow researcher Prof. Ozin last year.

Unlike current silicon chips, which are made in two-dimensional layers, Prof. Ozin's group has had to make a three-dimensional structure in order to trap light. They have also had to arrange and order the silicon atoms to the precise size to block a light wave, in this case, 1.5 microns or one one-100th of a millimetre.

The group collaborated with researchers in Spain to use tiny opal crystals as templates to grow silicon crystals from the inside out, and to develop chemical techniques to fill the voids and dissolve the template.

The resulting structure, called a bandgap, should block wavelengths of light at the same frequency used in fibre-optic communications, the researchers state.

Yet they say that microchip makers will not have to scrap their manufacturing techniques to make the photonic bandgap because it uses the same material in the same size range as current chips.

A spokesman for the Canadian Institute of Advance Research, with which the team is affiliated, said Profs.

John and Ozin and Mr. Chomski hold the intellectual-property rights to the development.