'Opto-chip' breaks speed records

Scientist Larry Dalton holds a circuit containing an opto-chip. The device itself is far too small to be seen by the naked eye.

From Seattle's KING-TV: Glenn Farley reports on the new electro-optic modulator.

By Alan Boyle
MSNBC

SEATTLE, April 7 — Imagine downloading digital movies in the blink of an eye ... driving a "smart car" equipped with radar to ward off fender-benders ... chatting over a pocket videophone ... or watching 3-D holographic displays in high fidelity. Researchers say they have developed a low-voltage device known as an "opto-chip" that could start turning those high-bandwidth dreams into realities over the next few years.

COMPLETE STORY

MSNBC
Alan Boyle
SCIENCE EDITOR

THE EXPERIMENTAL DEVICE is the result of nine years of research into new ways to convert light transmitted by fiber-optic lines into electrical signals, said Larry Dalton, a chemist at the University of Washington and the University of Southern California.

Dalton said the new type of modulator, described in Friday's issue of the journal Science, already has been demonstrated in commercial applications and will be used by the U.S. Army and Air Force as early as this summer. They would likely come into wide commercial use within the next two to five years, he said.

Modulators are devices that convert one type of signal into another. For example, your modem — an abbreviation for "modulator-demodulator" — translates between computer data and transmission data for phone, cable or wireless systems. This new type of electro-optic modulator is designed to link up with high-speed fiber-optic lines or satellites.

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The key breakthrough behind the opto-chip involved engineering organic molecules called chromophores to convert light into electrical current at high efficiency. During previous attempts, the molecules tended to get in each other's way, slowing down the conversion rate — but researchers altered the chemical structure of the material to provide a kind of plastic insulation around each chromophore.

A 'HOLY GRAIL'

The researchers claimed in Science that the result represented the achievement of a "Holy Grail" in the field: a modulator capable of switching signals at rates of up to 100 gigabits per second, at a fraction of a volt. A single particle of the opto-chip material, just a hundredth as wide as a human hair, could handle all of a major corporation's telephone, computer, television and satellite traffic, the researchers said.

Put another way, the opto-chip would require less than a half-second to download a two-hour movie in digital format.

The devices could lead to quantum leaps in cable TV transmission capacity, satellite communications, optical network switching and fiber-optic medical sensors, Dalton said. Opto-chip material also could be spray-painted onto a surface to form the basis of a phased-array radar system with no moving parts. That would open the way for cheaper and better navigation systems for aircraft, missiles and ships — which explains the Pentagon's interest — or even an anti-collision radar system for your car.

In a further flight of fancy, Dalton said the opto-chips' bandwidth is large enough to allow for a future generation of hand-held television/telephone/computer devices linked via satellites, or for the transfer of flicker-free 3-D holographic images — all standard fare on "Star Trek."

"This is a technology that has bandwidth to burn," Dalton told reporters gathered at the University of Washington.

A FEW CATCHES

There are a few catches, of course. Connie Chang-Hasnain, a professor at the University of California at Berkeley who does research in optoelectronics, said the results represented "pioneering work," but added that "it will take some time to know whether this is real or not." After reviewing the Science paper, she said she wanted to see more data about frequency response and the long-term stability of the material.

The opto-chips underwent testing at Tacan Corp. as well as at Lockheed Martin in California. Susan Ermer, a program manager for photonic material at the Lockheed Martin Advanced Technology Center in Palo Alto, said the polymers used in the material were "fairly soft," and she wasn't yet satisfied with their thermal stability.

"There would be some engineering that needs to be done," she said. "However, that doesn't negate the proof of principle there."

Then you have to consider the economics of the electronics industry. The organic material can be sprayed onto a computer chip or another type of surface like paint, at a marginal cost of

mere pennies, Dalton said: "You can build it cheaper than microprocessors, and there are no toxic chemicals."

But manufacturers have invested millions of dollars in existing technologies, and would need a powerful incentive to switch over to a new fabrication method. The researchers argued that the opto-chip material had a powerful edge, not only because of the higher speeds and lower voltage, but also because of lower signal loss and lower heat levels.

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Dalton said he is in discussions with many of the major players in the field.

"They have to keep an eye on this," said University of Washington chemist Bruce Robinson, another co-author of the Science paper.

Even if the material is perfected and mass-produced, other factors still could delay that high-bandwidth nirvana. For example, you'd need a direct connection right to a fiber-optic line to get the full benefit. Electrical wiring most likely couldn't handle electrons as fast as the fiber-optic flow.

"If you want to do things fast, you don't want to transmit that electrical signal through wire," Dalton said. But he voiced confidence that engineers would eventually find a way to speed up processors to take advantage of the opto-chips.

In addition to Dalton and Robinson, other co-authors of the Science paper include Yongqiang Shi, now working at Lucent Technologies; Cheng Zhang, Hua Zhang and William Steier of USC; and James Bechtel of Tacan Corp. The intellectual property behind the opto-chip was developed by the University of Washington and the University of Southern California, which jointly license the technology to small businesses for applications, Dalton said.

Support for the research was provided by the Air Force Research Laboratory, the Air Force Office for Scientific Research, the Ballistic Missile Defense Organization, the

National Science Foundation and the Office of Naval Research.

A previous version of this story mischaracterized the transfer rate for the opto-chip, based on publicity information, and inaccurately described the concept of voltage.

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