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Technological revolution is in the works at a UW lab

Scientists using the energy of light to transform electronic world

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By TOM PAULSON
SEATTLE POST-INTELLIGENCER REPORTER

Larry Dalton can get a little excited when talking about his latest polymeric electro-optic modulator.

Well, who wouldn't?

The little gadgets promise a technological revolution, Dalton says, that will help transform today's largely electronic world into a new era of telecommunications and computing operating mostly on the energy of light.

"This is the technology that will dominate the 21st century," he said, describing a report in today's Science magazine on his research team's latest achievement in the field.

Dalton, a chemist with appointments at the University of Washington and the University of Southern California, is one of a number of scientists who have been struggling to improve the speed and efficiency of translating from the electrical realm into the optical realm, such as fiber optics.

Electro-optic modulators are the translators. But the devices in use today are largely restrained in bandwidth, by energy demand and in speed of transmission according to the limits imposed by electronics.

In today's report, Dalton and his colleagues describe how they were able to craft an experimental kind of polymer-based modulator that capitalizes on the low energy needs and high bandwidth capacity of optical systems. In

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this case, the polymers used are high-strength plastics.

Using their modulator, also known as an "opto-chip," they were able to transmit 100 gigabytes of information per second using less than one volt. One example of what this would mean, Dalton said yesterday, is it would virtually eliminate any delay in downloading even the biggest files off the Internet.

"Bandwidth is critically important to the future of telecommunications," he said. "This is a technology with bandwidth to burn."

Working with Tacan Corp. of Carlsbad, Calif., funded by the National Science Foundation and the U.S. Air Force Office of Research, the UW-USC team used organic molecules known as chromophores to manage the optical signals.

While electrons are the basic units of electricity, photons are the basic units of light. Chromophores are large organic molecules with an electrical charge that allows them to capture and direct the behavior of photons.

Five years ago, Dalton asked UW chemist Bruce Robinson to help him figure out why their first shot at a polymeric assembly of chromophores wasn't working. The problem was the chromophores wouldn't remain aligned in the polymer.

Robinson proposed they attach "ballast" molecules around the linear chromophores to give them a spherical shape. Using an electrical field to line them up while being embedded in the polymer, the spherical shapes helped keep them in line.

With the improved alignment, the team was able to achieve the high speed and low voltage they wanted.

A remaining potential problem is the stability of the polymer, said Dr. Cheng Zhang, Dalton's research associate at USC.

"We need to get a longer lifetime," Zhang said. After awhile, the polymer -- like any plastic -- can deform ever so slightly and the chromophores get out of alignment again. One of the tasks ahead is to improve the long-term stability of the opto-chip.

"This isn't going to happen overnight," said Susan Ermer,

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program manager of photonic materials for Lockheed Martin in Palo Alto, Calif., and someone who is interested in making use of the opto-chips.

But Dalton's team has demonstrated that you can translate from the electrical to the optical realms using very low voltage with very high efficiency, Ermer said.

Most modulators today are made of crystal, she said, while Dalton's polymeric approach should make manufacturing easier and allow for much wider use of this technology in many market applications.

Dalton, who along with the UW and USC holds a patent on the opto-chip technology, believes his approach will be a key to ushering in the new age of optics. The U.S. Department of Defense has already agreed to help fund a demonstration project, he said, and he expects more commercial projects within the next several years.

It may be awhile before we can announce an end to today's maddening downloading experience -- those annoying pages floating out of the file folder on the screen as the timer lies to us about how long it will take.

But there's light at the end of the tunnel, Dalton says.

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