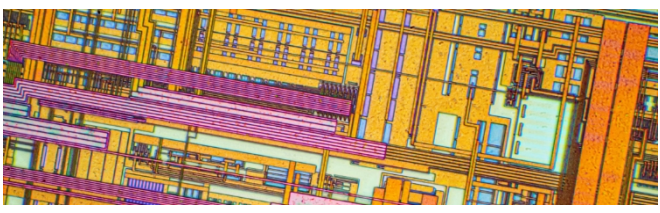
Does the Netherlands have an asset with new super-fast computer chips?

In Mexico they have tortilla chips and in Las Vegas poker chips are indispensable, in Eindhoven they are busy working on the new Dutch pride: Photonic chips. The upcoming efficiency revolution in the world of computers.



Source: Wikimedia Commons - Alexander Klepnev, Silicon chip

Interview: Dr. Yuqing Jiao & Pavel Goor

The purpose of a computer chip is to send data signals from one place to another. Faster computers can send and receive more signals, which often comes with a higher number of transistors on the chip. These transistors are tiny switches that control the flow of these signals. In recent years, the art of chip companies has been to cram as many of these transistors on a chip as possible. What made for a significant increase in computing power
of computers. These developments allow us to create new, faster technological products every year.

Today's computer chips are produced on a scale that covers only a few nanometers. These chips are now so small that the chip industry faces a natural barrier. Electric chips in a computer not only generate electrical signals, but also a lot of heat. This heat poses a problem; it leads to unnecessary energy loss
hindering the ability to make chips work even faster. The search for solutions has led researchers to a radically different technological approach: photonics.

Light chip

Unlike electric computer chips, a photonic chip works through photons (light). These photonic chips are being integrated into various technological applications. In the entire universe, there is nothing faster than light, making it the ideal choice for transmitting information. These chips can use light instead of electricity to transmit data signals, which is promising for creating smaller, faster and more energy-efficient devices.

> "It's a sorting machine that can exchange information as many as 100 billion times a second." - Pavel Goor

Photons have several properties that make them more suitable for signal transmission than electrons. They have no charge or mass, so they have fewer interactions with the chip and cause less resistance. Which means less energy is lost in the form of heat. In addition, the light in these photonic chips can carry much more information thanks to the wide frequency spectrum. This allows us to convey more than just simple ones and zeros. These advantages of light have long been known in the world of data communications. Especially in the use of fiber optic cables for high-speed Internet.

Source: Wikimedia Commons - Stephane Gaudry, Eindhoven University of Technology

Outlook

Before we see photonic computer chips on the market, it will probably take another 10 to 20 years. Pavel Goor notes, "If you look purely at time, we can see that we have been making electric computers for 100 years, but only a few decades with photonic chips."

While photonics may not currently be available to consumers, it is already in wide use in the world of
telecommunications and data centers. Master's student Pavel Goor sees in this the greatest technological advances, both now and in the future. For example, an experiment at the Technical University of Denmark in Copenhagen has shown that a photonic chip can send 1.84 petabits per second of data through a fiber optic cable over a distance of 8 km. So at this speed, you can download 1840 Terabytes per second. These are Internet speeds that we cannot currently imagine. Still, to paint a picture, you could download all the movies ever made, even at the highest resolution, in just one second. This leap in efficiency paints a powerful picture of the immense capacity and speed of data transmission possible with photonic chips. Which will lead to new innovations that can take advantage of this.

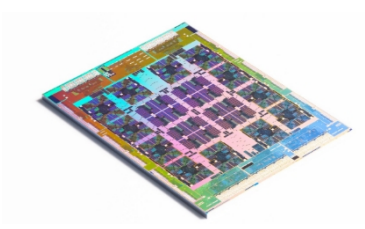
Assistant Professor Yuqing Jiao discusses what we can expect in the near future, applications such as Solid-State LIDAR, a technology that uses light to measure distances, which is used in self-driving cars, for example. He also mentions Neuromorphic computing, which attempts to make connections (neurons) in a human brain
mimic as accurately as possible on a chip. This enables systems to p e r f o r m certain tasks more efficiently and adaptively.

> "Neuromorphic computing is, like you design a processor which mimics the human brain. You have neurons, which when activated spike to the next 100 neurons, then spike to the next. You can do the same on the chip, and technology of photonics is a perfect candidate and to some extent even better than the electronics." - Yuqing Jiao

These photonic chip technologies are going to play a particularly important role in industries such as: data communications, healthcare, transportation and
agriculture. There are around three hundred companies in the Netherlands active in the field of photonics. "Moreover, the Netherlands leads the way in research and education in this field. At Eindhoven University of Technology, there is intensive cooperation with companies around the world," Yuqing Jiao said.

Fabrication

Mainly, Yuqing Jiao conducts research on the production of photonic chips, aiming to bring them to the same level as current computer chips. Making photonic chips uses the same basic principles as electric chips. These chips are produced in EUV machines, mainly by the Dutch company ASML, in which patterns are etched into a wafer. However, the similarities end there, as a photonic chip involves replacing the aforementioned transistor with new components.



Source: Wikimedia Commons - Alexander Klepnev, Silicon chip

These new components are considerably more complex and are the biggest reason why photonic chips are not yet at the same level as electric computer chips. Yet Dutch companies such as Smart Photonics are actively working to manufacture these tricky chips smaller and smaller. Unique to Yuqing Jiao's research is his take on the integration of making photonic chips. He states that "in replacing current chips with photonics is not the future; photonics is more powerful when combined with electrical chips." Jiao explains that by combining the strengths of current chips with those of photonics, you can achieve the very best results.

> "why don't we let photonics and electronics in the future play into their best role?" - Yuqing Jiao

Investments

Has the Netherlands seen the light? In terms of investment, it seems so. Indeed, the government and investors are making hundreds of millions of euros available in the coming years to stimulate this industry. Moreover, there is a huge initiative from the EU to expand the European chip sector, for which as much as €43 billion has been set aside.
A promising future prospect is for the Netherlands to take a leading position in the production of photonic chips. This idea is not at all far-fetched, as we have all the necessary facilities here: from design, production and testing to companies making products with photonic chips. This is what PhotonDelta director Ewit Roos told King Willem-Alexander.

But the question is whether the Netherlands will succeed in cashing in on this position.
Indeed, other countries, both inside and outside Europe, also smell opportunities in this industry. Huge sums of money are being invested in the development of the photonic chip industry, led by the superpowers China and the United States.

The upcoming revolution in chip technology, thanks to the introduction of photonics, presents a huge opportunity to continue to support our tireless quest for acceleration. The Netherlands is conducting intensive research and working hard to potentially become a market leader. With sufficient investment and a favorable business climate, promising opportunities lie ahead.

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