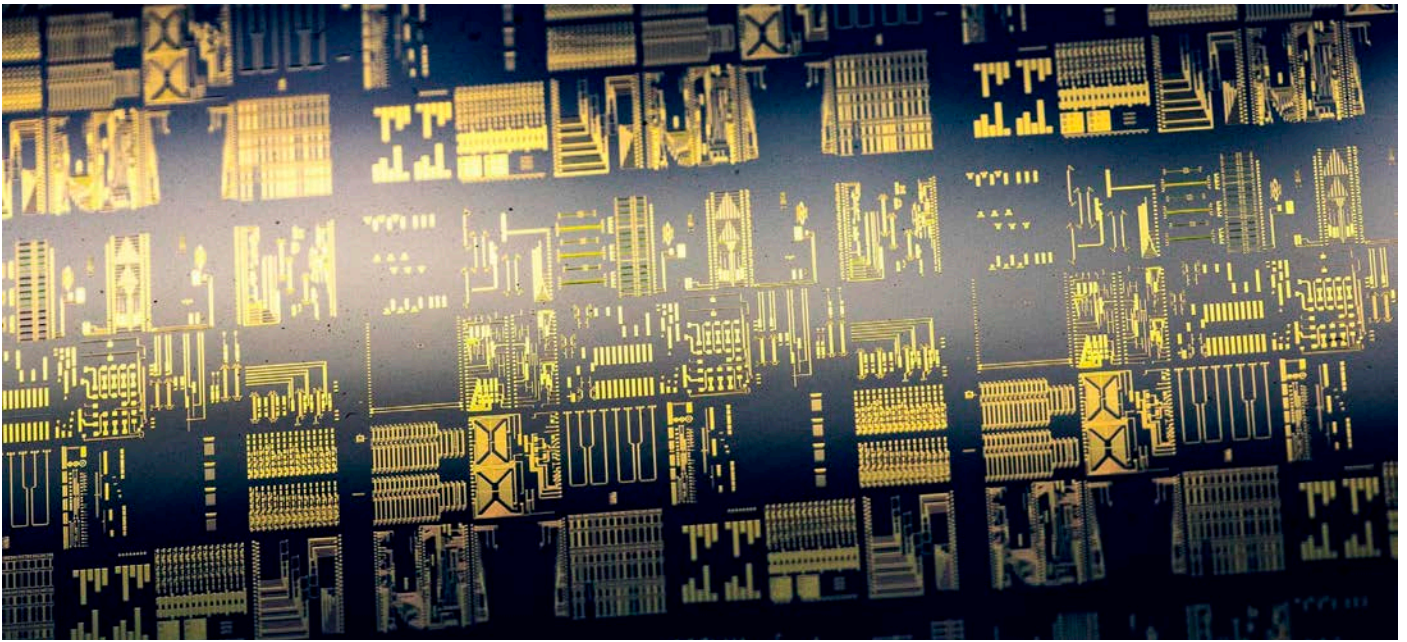


Integrated Photonics: The Dutch Ecosystem Building the Future of Chips

Introduction



Technology has become an important part of almost every aspect of modern life, transforming the way we communicate, access information, entertain ourselves and even manage our homes.

With the advent of smartphones, smart devices, artificial intelligence (AI) and the Internet of Things (IoT), this reliance on technology is only going to grow, especially with quantum computing on the horizon. Yet the current rate of tech expansion raises serious questions over long-term sustainability.

By 2030, tech growth is expected to result in the global semiconductor market reaching a value of more than \$1trn, according to research by management consultancy McKinsey. More than two-thirds of this growth is expected to come from greater demand for semiconductors in computing and data storage, wireless communications, and automotive electronics.

The recent global scarcity of semiconductors exposed flaws in current supply chains. Global automotive production has declined by more than a quarter (26%), while lead times for the manufacturing of new computers were extended to 120 days in some cases as a consequence of the shortage.

Although there are signs that the impact is on the wane, with many affected industries returning to normal levels of production, the shortage highlighted the importance of securing alternative sources of supply and new technologies to meet future requirements.

Within the world of microchips and semiconductors, one of the most critical developments is photonic integrated circuit (PIC) technology, which transmits information via light. It enables higher volumes of data to be processed at significantly faster speeds, but with lower energy consumption, significantly lessening the environmental impact.

In the Dutch province of Brabant, leading companies and researchers are working together on PICs and other technologies to ensure the future requirements for Industry 5.0 can be met. This new phase, known as the Fifth Industrial Revolution, envisages people working alongside AI, other advanced technology, and robots to enhance workplace processes, with an emphasis on a human-centric approach, resilience, and sustainability.

The key players in Brabant and stats

ECOSYSTEM



DESIGN



FABRICATION



APPLICATIONS



RESEARCH PARTNERS



TECH PARTNERS



VENTURE BUILDING



Key stats

85%

Of all the integrated circuits in all electronic devices worldwide are made on machines designed and manufactured in the Netherlands

300

The number of world-class semiconductor companies in the Netherlands, and Brabant is home to many of them, including global leaders AMSL and NXP

3

Main integrated photonics technology platforms are present, including the complete value chain. Brabant has a strong focus on indium phosphide

15

Research institutes and competence centres in the Netherlands have a strong focus on integrated photonics

€1.1bn

The value of the growth fund managed by PhotonDelta to enable ecosystem development

50,000

Number of wafers with photonic chips that will be produced in the Netherlands by 2025

50%

Of all Dutch EU patents are generated in Brabant

33%

Of all private R&D spending in the Netherlands is from Brabant

7th

Eindhoven's ranking in terms of 'most promising global science hub'

Why Brabant is a key location for integrated photonics development

As one of Europe's top locations for R&D spending, Brabant has emerged as a main player in the development of PIC technology, which is revolutionising the field of optics by integrating multiple functions on to a single chip. This enables the production of faster, more efficient and compact devices for various applications.

Brabant's importance in this field can be attributed to its strong technological ecosystem, collaborative industry efforts and supportive innovation infrastructure. The Netherlands is one of three countries in the world with the complete value chain for integrated photonics within its borders, with Brabant a strong contributor.

Brabant boasts a thriving industry tech ecosystem, with numerous companies specialising in photonics and semiconductors. ASML is the global leader in EUV lithography equipment used for manufacturing the latest generation of microchips. The company collaborates closely with a large network of equipment makers that deliver cutting-edge technology machines, modules and components in the field of semiconductors.

Brabant's commitment to the development of PICs is reflected in its investment in state-of-the-art infrastructure. A joint investment by parties that include AMSL, VDL and NXP in SMART Photonics – a Brabant-based pureplay foundry for indium phosphide – stresses the importance of integrated photonics for the next generation of microchips.



ASML has recently announced that it will build on its existing relationship with Eindhoven University of Technology by launching a new research programme and on-campus ASML research facility, which will feature a state-of-the-art clean room.

Collaboration is further encouraged through initiatives such as PhotonDelta, a public-private partnership aimed at accelerating the development and adoption of photonics through its €1.1bn growth fund. PhotonDelta brings together industry, academia and government organisations to facilitate knowledge sharing, provide funding opportunities and support the growth of photonic businesses.

The region actively engages in international partnerships to further technological development. Sharing of expertise and joint research projects enable collaborations with other photonics hubs in Europe, for example, comprising the Dutch Photonics Innovation Hub in Twente and four research associations in Germany, including the Fraunhofer Institute.

Showcase: PhotonDelta

PhotonDelta is a pioneering public-private partnership aimed at accelerating the development and adoption of photonic technologies in the Netherlands. It brings together industry, academia, and government organisations to foster collaboration, drive innovation and create a thriving ecosystem for photonics.

“We are creating this community of integrated photonics organisations that want to work together,” says Jorn Smeets, chief marketing officer and board member of PhotonDelta.

“When we started, we were 12 companies that were part of the PhotonDelta ecosystem. Now it’s around 66. Together, they form a supply chain that can design, develop and manufacture these photonic integrated circuits, and also solutions.”

PhotonDelta offers extensive support to companies with something to offer the photonics ecosystem in Brabant, notably start-ups, by providing access to funding, expertise and infrastructure.

The organisation co-funds selected start-ups and scale-ups, as well as projects dedicated to solving a particular issue affecting the industry. Examples could include developing a piece of equipment to make back-end processes more efficient, a start-up seeking to use indium phosphide from SMART Photonics, or a knowledge institute helping to integrate indium phosphide on higher-volume, complementary, metal-oxide semiconductor (CMOS) platforms.

“Whenever a company has something to add to the ecosystem, we want to open a discussion,” says Smeets.

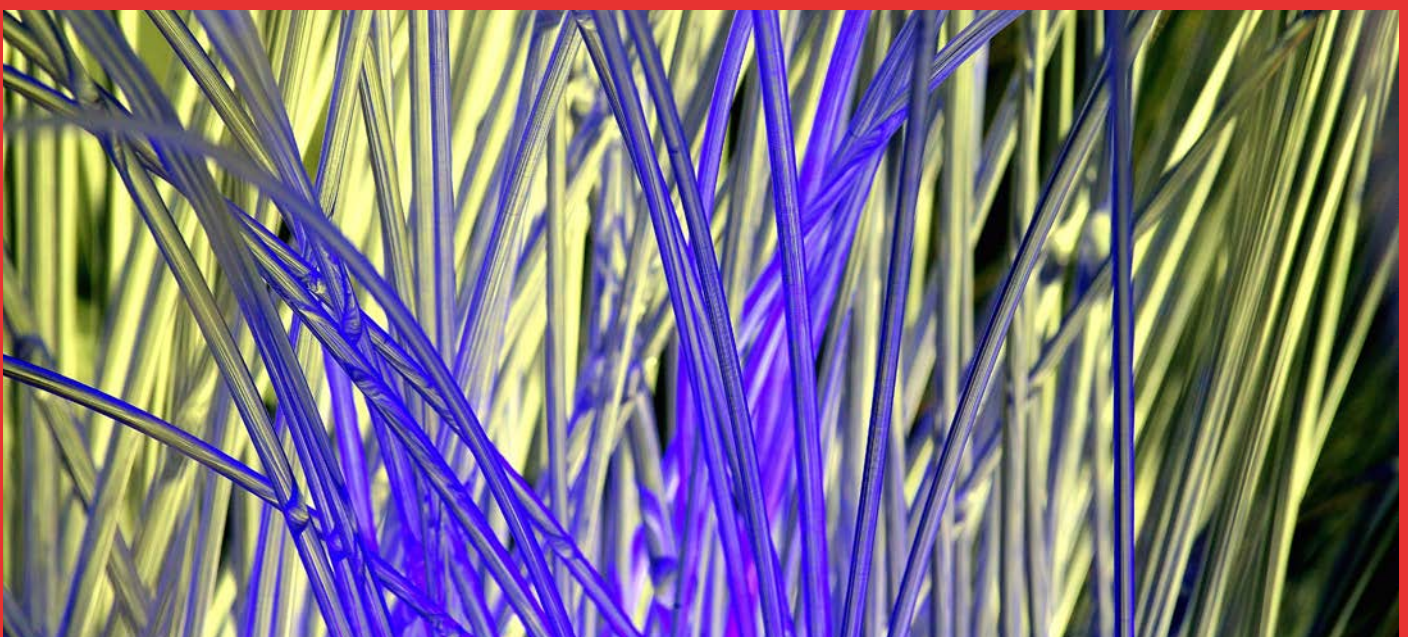
PhotonDelta facilitates knowledge sharing, networking opportunities and joint research projects among its members. By connecting businesses with research institutes and universities, the initiative promotes the exchange of ideas and the translation of research into fully operational products and services.

One of the initiative’s key strengths is its comprehensive approach to supporting the entire value chain of photonics – advancing core technologies and the development of application-specific solutions to ensure everything is driven by real-world needs.

By bringing together diverse stakeholders, such as chipmakers, system integrators, end-users and investors, the initiative creates a vibrant ecosystem where ideas can flourish, and partnerships thrive. Many photonics companies in Brabant are spinouts from universities.

PhotonDelta builds upon Brabant’s strengths in chip manufacturing, photonics research and high-tech innovation to position the Netherlands as a global leader in photonics. The success of this approach is evidenced by the fact that PhotonDelta has secured more than €1.1bn in funding for the industry, with €470m invested in technology development, and €600m being poured into companies, businesses, and other related parties.

“In the coming years, hopefully new tech giants will emerge out of the ecosystem,” says Smeets. “And that will continue the legacy of Brabant.”



Value chain for integrated photonics: showcases



The Netherlands is in a unique position to offer the complete value chain within its borders, alongside close collaboration with nearby ecosystems in Belgium and Germany.

From research and design, all the way to final applications, the value chain ensures companies can focus on their core expertise and activities while collaborating with partners in the ecosystem on other topics.

Value chain for integrated photonics: showcases



Showcase: Research | TU/e – Eindhoven University of Technology

For fundamental research, TU/e has research projects in photonics stretching back decades. There is also a dedicated group called Photonics Integration (PhI), which performs leading-edge research into indium phosphide, semiconductor-based technology for photonic integration and its applications.

TU/e is also home to the Eindhoven Hendrik Casimir Institute (EHCI), which is an authority in the field of integrated photonics. EHCI brings together two notable research fields: photonics and quantum technology. Working from an engineering science perspective, the EHCI is uniquely able to transfer research into real-world sustainable applications.

With a focus on societal needs, the EHCI drives the roadmap for these exponential technologies in computing, communications, and sensing, as the

TU/e has already proved in integrated photonics. The institute has a strong infrastructure, both internally and externally. The EHCI is strongly positioned in the local Brainport ecosystem, connected to world-class industry and knowledge partners, and its state-of-the-art facilities enable internal and external users to perform cutting-edge research.

The EHCI meets challenges through the unique synergy of two eminent research fields that it excels in: the precision and speed of photonics, and the immense power of quantum technology. By bringing these technologies together and working from an engineering science perspective, the EHCI is ideally placed to transfer research into real-world, sustainable applications. Partners include companies and research institutes involved in the integrated photonics ecosystem.

Value chain for integrated photonics: showcases

Showcase: Design | BRIGHT Photonics

BRIGHT Photonics is an independent design house for PICs made from silicon, III-V, SiN, silica and polymers. The company supports companies and researchers in PIC development from the application idea to prototypes and design for volume production. BRIGHT also commercially supports PIC design platform Nazca-Design for lowering barriers to the use of photonic technologies.

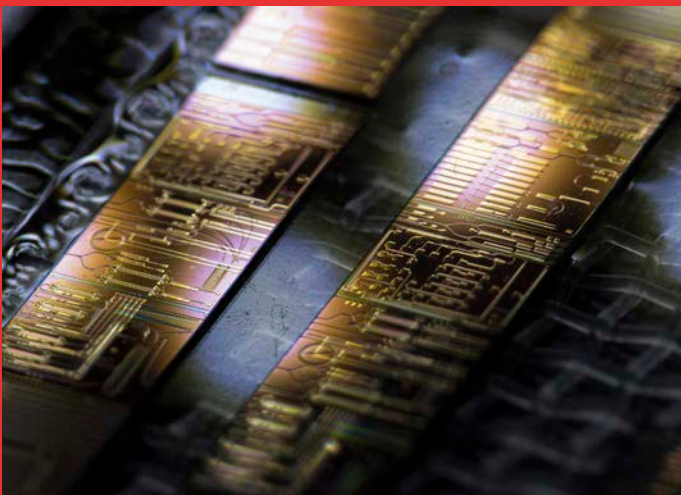
Showcase: Fabrication | SMART Photonics

As a foundry for integrated photonic circuits, SMART Photonics offers solutions for data and telecommunications, as well as for sensing – such as Lidar – and medical applications.

SMART Photonics is a pureplay indium phosphide foundry, producing only photonic components (discrete and integrated circuits) for its customers, based on precise designs. As it is an independent foundry, clients gain several important advantages, including:

- The product's intellectual property stays with the customer
- The cost benefits of using one expensive infrastructure for multiple customers
- Operational excellence, resulting in high-quality products with a short time to market

SMART Photonics recently secured an additional round of funding of €100m from a group of strategic industry and financial Dutch players. The foundry will use these funds to extend its manufacturing capabilities and accelerate the development of its photonic integrated-chip technology platforms and process design kits (PDKs).



Value chain for integrated photonics: showcases

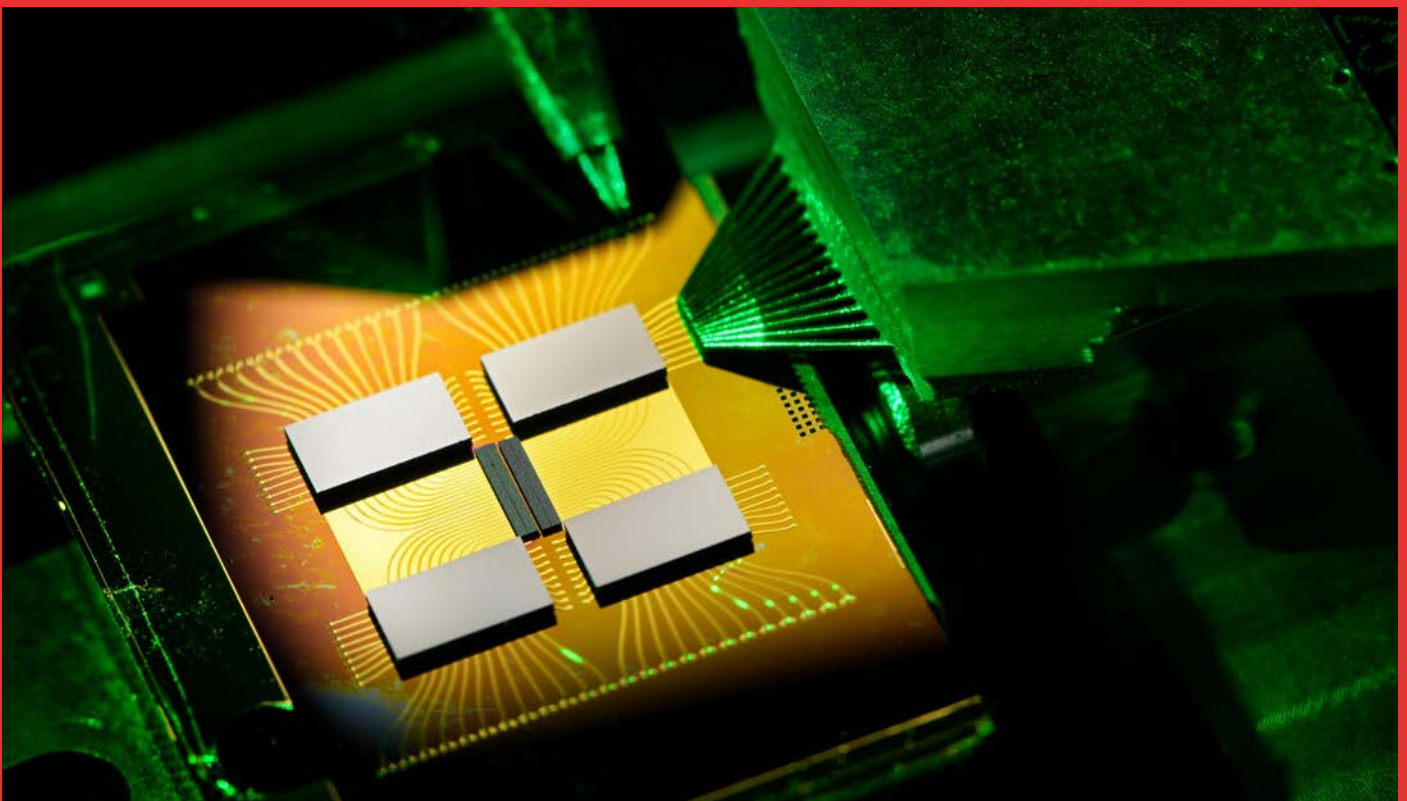
Showcase: Medical applications | MantiSpectra

MantiSpectra is a spinoff of the TU/e, providing spectral sensors capable of classifying and/or quantifying material composition just by using light. The company is working towards integrating spectroscopy at wafer level, as this will open up new applications where volume is key – ranging from quality measurements in agriculture and raw material identification in recycling to mobile healthcare and chemical analysis for consumer devices.

By using integrated photonics, MantiSpectra has significantly reduced the size of material sensors while lowering costs. Traditional devices can cost an average of €50,000, but MantiSpectra is committed to eventually reducing the cost of a sensor to less than €10, enabling mass application in the consumer market.

Showcase: Mobility applications | NXP

With infrastructure and transport being focus applications for sensing using integrated photonics, Eindhoven-headquartered NXP is an essential player. The semiconductor company works closely with major automotive OEMs, and it is a leading, global supplier of high-performance, mixed-signal products. NXP designs semiconductors and software for mobile communications, consumer electronics, security applications, in-car entertainment and networks. The company offers its products to the automotive, identification, wireless infrastructure, lighting, mobile and computing markets.



Value chain for integrated photonics: showcases

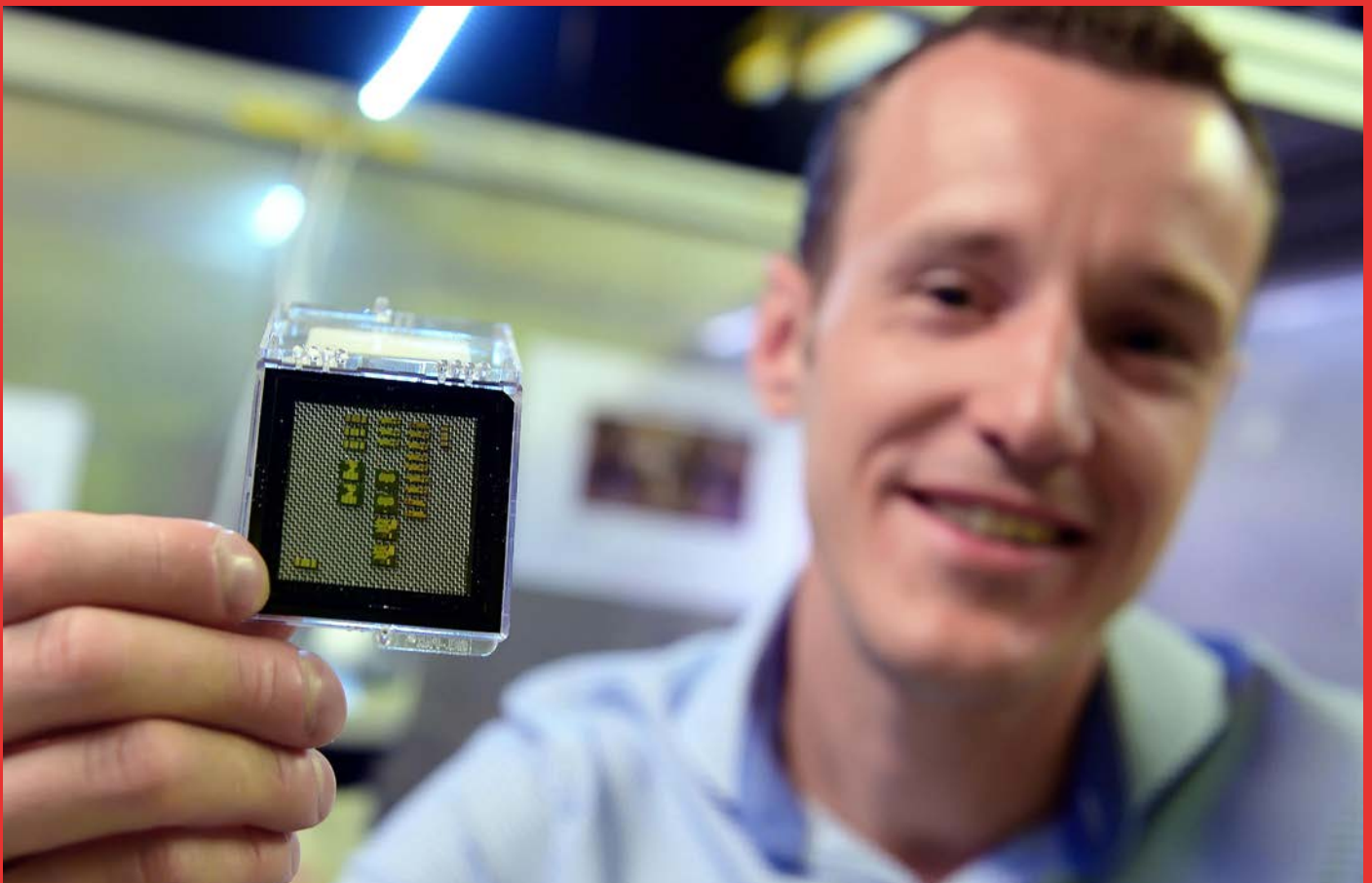
Showcase: Datacom applications | EFFECT Photonics

EFFECT Photonics is a highly vertically integrated, independent, photonic semiconductor company, which develops integrated systems for optical communications intended to bring core network performance to network providers. The company addresses the growing need for high-performance, affordable solutions that is being driven by the ever-increasing demand for greater bandwidth and faster data-transfer capabilities.

Headquartered in Eindhoven, EFFECT Photonics has additional facilities in the UK, the US and Taiwan, and it has a worldwide network of sales partners.

The firm's proprietary digital signal processing and forward error correction technology, as well as ultra-pure light sources offer compact form factors with seamless integration, cost efficiency, low power and security of supply.

By leveraging its established microelectronics industry partners, EFFECT Photonics provides manufacturing at scale and security of supply while embracing hybrid business model transceivers and sub-assemblies, enabling the disaggregation of key building blocks in 5G and beyond, in addition to access-ready coherent solutions and cloud-based services.





The next generation of faster chips

The next generation of PICs holds immense potential for advancing various fields, from telecommunications and data centres to mobility and healthcare.

Brabant's significance in the development of PICs is partly due to the presence of renowned research institutes and universities in the region, which contribute to cutting-edge studies and provide a skilled pool of talent, with TU/e at the forefront.

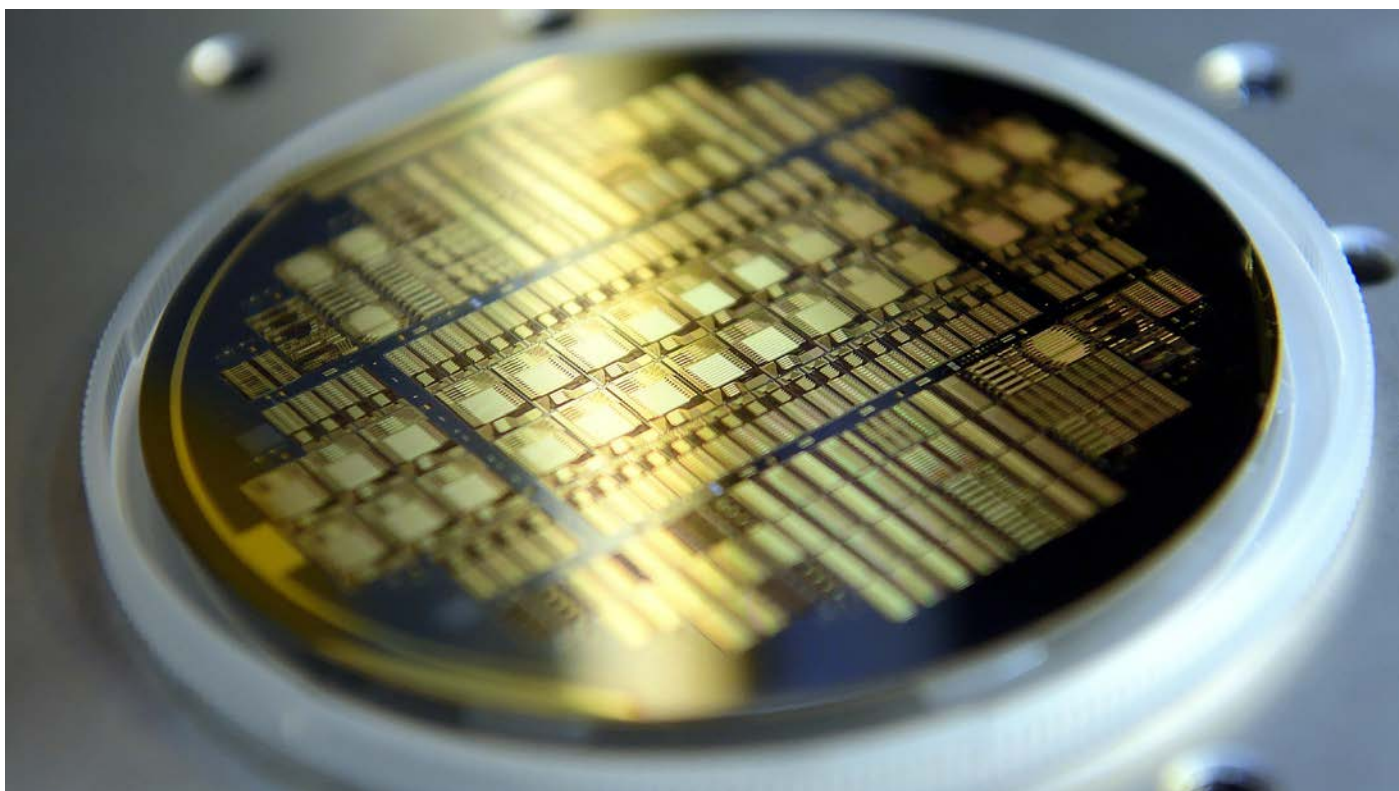
TU/e's Department of Electrical Engineering has been contributing to the advancement of photonics research and education. With a dedicated photonics and semiconductor nanophysics group, the university focuses on the development of novel PIC technologies. Researchers are exploring innovative materials, fabrication techniques and device designs to enhance performance and functionality.

The EHCI at TU/e is renowned for bringing together photonics, electronics, and quantum tech. The institute drives exponential computing, communications, and sensing technologies to enable a sustainable information society.

Other research institutions in the region, such as the Institute for Photonic Integration (IPI) and the PITC contribute significantly to developing next-generation PICs. IPI, like many organisations in Brabant, uses the triple helix model of innovation, which brings together experts from academia, research institutes and industry. The PITC offers services and facilities where companies and researchers can access advanced equipment and resources to design and prototype PICs.

With the growing importance of heterogenous integration and advanced packaging methods, collaboration will become even more important – from chip design to fabrication, testing and application. Research and testing facilities, as well as industry partners in Brabant and other semiconductor clusters in the Netherlands, are working closely together to ensure the next generation of chips are not only technically feasible but commercially feasible too.

Offering a deep and rich semiconductor ecosystem, complete value chains for the three main integrated photonic platforms, and a strongly developing habitat for quantum computing and communications, Brabant is at the centre of development for the next generation of faster chips.



Lightspeed: What is the future for chips?

Offering several advantages over traditional electronic circuits, PICs have the potential to revolutionise numerous industries and applications, from enabling driverless cars in the automotive sector to optimising food production and minimising waste in agritech.

One of the primary advantages of data transfer by light is the high speed at which information can be transmitted. Photons can travel at the speed of light, resulting in dramatically faster processing speeds compared with traditional electronic circuits, which could transform telecommunications, data centres and high-performance computing. In data centres, for example, where a massive amount of data is processed and transmitted, the use of PICs could reduce latency significantly and improve efficiency.

With the ability to integrate various optical components, such as lasers, modulators, and detectors on to a single chip, PICs can achieve complex functionalities in a much smaller footprint compared with traditional electronic circuits. This miniaturisation paves the way for applications in areas such as healthcare, where portable and wearable devices could benefit from smaller, more power-efficient PICs.

Emerging fields such as quantum computing and lidar technology could also benefit. Quantum computing relies on the manipulation of quantum states, and the use of photonic components in PICs can enable efficient control and transmission of quantum information. Lidar, which stands for light detection and ranging, is an essential technology for autonomous vehicles and environmental monitoring, which PICs could boost significantly by providing precise and rapid light detection and modulation.



Collaborating to create combined value

Brabant is known for its expertise in building complex machines and its high-tech heritage. The emergence of PIC technology has positioned the province as a highly attractive market for international investors seeking promising opportunities.

Over a relatively small area, globally renowned research institutions, specialist universities and cutting-edge technology centres can interact seamlessly. This dynamic interchange of knowledge propels breakthroughs, fosters pioneering research, and ultimately results in the development of state-of-the-art technologies.

Such an environment offers a unique opportunity for companies to establish their presence, access exceptional talent and capitalise on the ongoing frontiers of photonics innovation.

The Brabant Development Agency (BOM) offers support to companies that want to create value and collaborate in the photonics sector. BOM possesses deep industry knowledge and extensive networks. It can connect companies with specialists and facilitate partnerships, enabling the exchange of ideas and expertise that are crucial for project success.

Contact

To find out more about the services available, get in touch using the contact details below:

Email:

info@brabantisbright.nl

Website:

www.brabantisbright.nl