FLEXIT

The high volume production line for Integrated Photonics

Photonic integrated circuits (PICs) play an essential role in finding and developing solutions to many of the world's critical problems, such as reducing energy consumption, improving healthcare, fighting food waste and meeting our continuous hunger for information. However, a generic solution for the assembly and packaging of photonic chips does not currently exist. The FLEXIT project, which runs from January 2022 to December 2023, therefore sees an opportunity to unite high-tech companies in the Netherlands and push forward this highly promising domain.

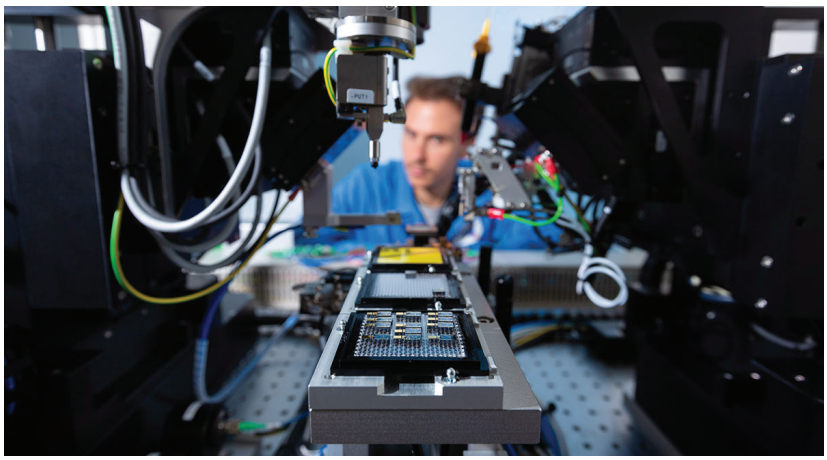
The FLEXIT project will enable this through the further development of the FLEXIT method to process photonic chips at an industrial level. Through a design tool for product development and the mapping of the entire digital chain, the project will also optimise all production processes in the supply chain. Ultimately, two demo products will be selected to test the supply chain according to a new FLEXIT product standard for mass production, through which manufacturing yield will rise, costs will be reduced and delivery reliability can be maintained for the foreseeable future.

EUROPEAN UNION
European Regional Development Fund.
Funded as part of the Union's response to the COVID-19 pandemic

OPoost
operationeel programma oost
European Regional Development Fund

PHIX: expanding the boundaries of knowledge within the FLEXIT project

Within FLEXIT's Dutch ecosystem for integrated photonics, PHIX leads the hybrid integration and assembly of PICs, providing scalable packaging solutions for a suite of applications to address various societal and technological challenges. Leveraging years of experience in product design, assembly development and equipment management in different industries, PHIX is contributing to FLEXIT by developing industrial processes for the high-speed, automated, robust and reliable assembly of modules based on InP and TriPleX PICs and their seamless integration with electronic ICs in scalable volumes. This will reduce production costs and accelerate the adoption of this new technology.



A long and complex process

Integrated photonics has emerged as the technology of the future. At the moment, there is no single material platform that can efficiently generate, guide, manipulate and detect light at a low cost while also being compatible with standard processes used in the semiconductor industry. Hybrid photonic packaging and the integration of photonic and electronic ICs is therefore necessary to satiate consumer demand. This activity is challenging for various reasons and can take up to 80% of a product's costs. For example, different material platforms have different optical, electrical, thermal and mechanical properties. Once they are assembled on the common substrate, each of these hybrid chip materials will react differently to moisture, mechanical and temperature stresses, particularly at the interface region between two chips, causing potential delamination. Meanwhile, the lack of standardisation makes it difficult for different modules and systems to be efficiently assembled to communicate together seamlessly in a package.

The commercial introduction of emerging technologies requires long and complex multi-layer product development, industrialisation and qualification cycles at all levels of the value chain, from initial product design, material sourcing, component-system-module manufacturing and testing to the marketing and delivery of new products to the market. Fortunately for FLEXIT, PHIX brings the wealth of experience in different industries needed to develop new assembly processes that will enable the complex hybrid integration of TriPleX and InP photonic integrated modules with electronic ICs in the same package. Their added value is anchored in packaging expertise and the development

of automated, accurate and reliable assembly processes, including for the placement and fixation of modules, the implementation of a cooling system if necessary and the bridging of the gap between photonics and electronics ICs by making them compatible with the current manufacturing processes at PHIX.

Promising performance

PHIX's photonics packaging solutions range from single manufacturing steps to complete joint development and manufacturing scale-up. They also possess state-of-the-art facilities, machines and assembly processes for pick-and-place complex hybrid integration of PIC-based modules, which are essential to the delivery of hybrid photonic modules within FLEXIT. Specialisation in optical coupling to fibre arrays and interfacing of direct current (DC) and radio frequency (RF) electrical signals also grants them a unique position within the photonics ecosystem, allowing them to seamlessly integrate photonic integrated modules and interface them with control electronics. This enables FLEXIT to cover the entire value chain of product manufacturing. PHIX's in-depth knowledge of photonics, front-end manufacturing processes, back-end manufacturing processes and chip-to-chip and fibre-to-chip coupling, as well as their ability to further contribute to the development of various applications beyond this project, represents a one-stop-shop for photonic assembly within FLEXIT – from design to volume manufacturing, perfectly tailored to customer needs.

Within the project, a selection of suitable demo products, system specification definitions and use cases have so far been created, including the product and chip design and interfacing electronics. Alternative design configurations have also been proposed as a back-up solution for the chip interface technology in order to minimise risks. PHIX is working closely with 11 members of the FLEXIT consortia – including VTEC, SMART Photonics, Workfloor, Chillas and LioniX – to provide packaging design guidelines and integration process flow that will be used in the FLEXIT manufacturing value chain. At the moment, PHIX is working on process development for the unique coupling technology developed in the FLEXIT project. Preliminary results have been obtained, revealing promising performance.

The global forefront

Together with their partners, PHIX is expanding the boundaries of knowledge to improve the world. However, this would not be possible without an excellent team and a company culture that promotes knowledge sharing, equality, diversity and inclusion. The project is headed by Joost van Kerkhof (PHIX COO) and Milan Milosevic (PHIX R&I Manager) and is being executed by PHIX's engineering team with the help of the operations team. Marketing and communication specialist Gijs van Ouwerkerk is responsible for showcasing the success stories and disseminating the results from PHIX's side.

PHIX's ambition is to be a world-leading foundry for the assembly and packaging of advanced PICs with medium and high production volumes. Thanks to its unique position within FLEXIT, PHIX is strengthening its own position in the integrated photonics ecosystem, covering different application areas and emerging markets for photonics assembly. Through the results of this project, they expect to expand their product and service portfolio with the unique coupling technology which is being developed and industrialised. Furthermore, by combining the strengths of the partners within FLEXIT, PHIX is accelerating innovation and reducing time to market and production costs, thereby placing them, their partners and the Netherlands at the global forefront of photonics high-volume manufacturing in response to global challenges and the complex geo-political situation.

FLEXIT project partners

Chilas
Development and production of semiconductor lasers based on several materials with high power in combination with integrated technology.

IMS
Development of production and assembly lines for hybrid microsystems with added value like lenses for smart phones, medical implants and microsystems.

LioniX International
Develops and commercialises on silicium-nitride (SiN)-based waveguide technology (TriPlex) for a variety of applications and is leading the photonic sector.

PHIX
World-leading packaging and assembly foundry for Photonic Integrated Circuits (PICs), building optoelectronic modules based on all major PIC technology platforms in scalable manufacturing volumes.

Salland Engineering
World-leading in test technology and engineering, specialised in solutions and services to improve efficiency and quality testing at semiconductor manufacturers.

SMART Photonics
The first "pure-play foundry" in the area of InP PIC production and on the verge of scale up.

Synopsys
Supports the project with design software and tools for the development of photonic ICs.

VTEC
Development and realisation of lasers and sensors for various photonic platforms. Assembly and packaging is taken care of including fibre connections.

Workfloor
Supplier of factory data collection systems.

High Tech NL
The national branch association for the Dutch high-tech industry. Its Semiconductors cluster is fully focused on the vast and strong semicon industry, operating as a 'single point of contact' in all steps of the value chain, driving and stimulating (international) cooperation, and initiating and facilitating (international) innovation and crossover projects.

Berenschot
A consultancy company that supports High Tech NL with grant proposal writing and project management and facilitates cooperation between companies and the growth of ecosystems.