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.

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OPoost
operationeel programma oost
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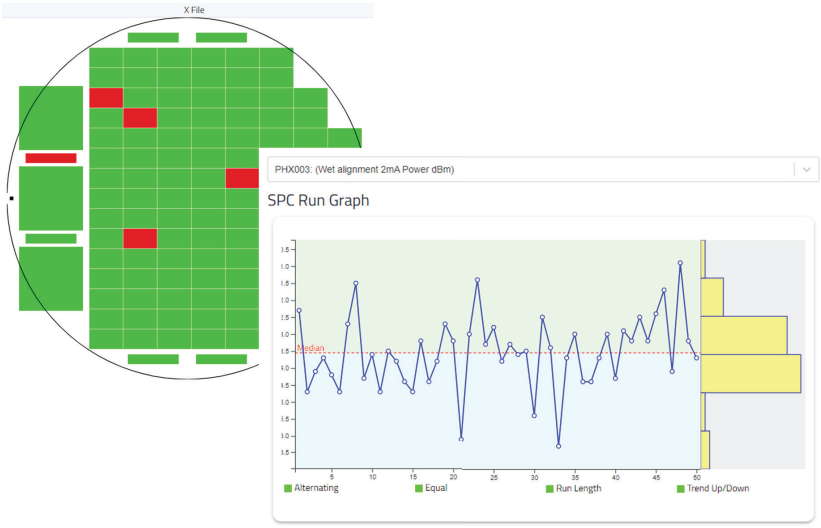
Managing the complete FLEXIT production line with Workfloor

With a unique combination of extensive photonic integrated chip (PIC) knowledge and many years of experience in managing manufacturing automation, Workfloor provides the digital connection to FLEXIT and takes care of the flow of information for the complete production line. This enables strong collaboration across an ecosystem of Dutch photonics players via a platform for quick data analysis and product improvements.

The FLEXIT FactoryTool

This platform is Workfloor's FLEXIT FactoryTool, used to collect, manage and analyse data along the production chain. As a cloud-based manufacturing execution system (MES), it enables the various partners to upload and access data from the start to the end of their processes. Chilas, for example, serves as one of the demonstrators within the project; their laser design consists of a bill of materials and the process flows needed to create this laser. With the FLEXIT FactoryTool and its built-in, configurable approval flows, any changes to the laser design can be managed so that all revisions of the product are controlled.



The actual execution of these process flows happens at different locations, resulting in many kinds of data that are usually hard to correlate. The Chilas laser has two PICs that are connected using special flexible fingers, providing a simple way to connect these chips while maintaining optimal coupling efficiency. The gain block is an indium phosphide (InP) PIC provided by SMART Photonics while FLEXIT's silicon nitride (SiN) wafers are processed at LioniX – but, with the FLEXIT FactoryTool, the complete process flow of these PICs can be managed across company borders.

An important part of the PIC production process is specialised equipment for PIC inspection and PIC testing, for which ten partners of the EFRO project MEKOPP have been developing a Photonic Visual Inspection Tool and a Photonic Test Prober. Workfloor provides SECS/GEM-compatible interfaces that allow these to communicate directly

with the FLEXIT FactoryTool, which manages the recipes needed to run these machines. The tool can therefore provide a real-time overview of the state of the different machines on the production floor.

Configurable and traceable

For the FLEXIT FactoryTool, EZ-Connectors are also being developed through which specific folders on the equipment can be monitored for new test results. Once summary test files are written to these folders, the content is analysed and stored on that specific test step of the process flow. These different datapoints are used to perform statistical process control (SPC) checks and the SPC graphs are shown on a real-time, web-based dashboard. In this way, the FLEXIT FactoryTool provides a powerful way to analyse and improve any of the processes.

Based on this summary test data, web interfaces can easily be configured for operations later in the production flow. For instance, operators that need to pick the wafers for further processing can now select them with the best test parameters for specific devices. After dicing the collected wafer maps, the Photonic Test Prober can be used to skip any dies that fail the test. These wafer maps, based on semiconductor standards, can be displayed in the FLEXIT FactoryTool. Once the best PICs are identified for further processing, these dies are placed in gel packs. To maintain full traceability, the tool uses E142 transfer maps for tracking which PICs of which wafer are in which location in the gel pack.

The digital glue

At PHIX, the FLEXIT FactoryTool's inventory receive process maintains an up-to-date overview of the PICs received from LioniX and SMART Photonics. PHIX's assembly machines are connected to the tool with EZ-Connectors that collect different process parameters. Examples of the data collected include the alignment tolerances of the various steps and the coupling losses between the fibre arrays that are connected to the LioniX PIC. This coupling loss is measured before and after curing the glue, providing valuable insights by analysing the correlation and performance as a function of other process parameters.

Once PHIX completes the assembly, the lasers are sent to Chilas, where incoming inspection measurements are performed. The summary data of these measurements are uploaded to the FLEXIT FactoryTool, providing Chilas' engineers with a treasure trove of data to improve the design of the next version of the product. Extensive access management keeps this data secure: by defining user groups and assigning individual users to these groups, access to pieces of information can be managed at many different levels, from product designs to steps in different process flows.

This protection of intellectual property makes it the ideal tool for in-depth collaboration such as FLEXIT. For example, the project has connected Workfloor with leading suppliers of PIC design software, like Synopsys and their process design kits (PDK) for LioniX and SMART Photonics' PICs. As a platform to make the measurement data available to Synopys engineers, the FLEXIT FactoryTool provides direct feedback for the improvement of these PDKs. The improved PDK building blocks can then be managed in the FLEXIT FactoryTool's revision-controlled design of the Chilas laser, creating a virtuous cycle. All in all, Workfloor's digital connections serve as the glue that holds FLEXIT together, allowing the partners to achieve better defined inputs that are available in a centralised system for quick and easy control, traceability and analysis.

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.