MEKOPP

Metrology Equipment for critical scale up of PIC Production

Photonic integrated circuits (PICs), combining photonics with chips, are a technology for which the Netherlands enjoys a leading position. With chips that use light instead of electricity, many new and improved applications can be realised in healthcare, energy, automotive, agrifood and IT. PICs also drive the global internet infrastructure and are highly suitable for the large amounts of data collected and combined in the Internet of Things. The MEKOPP project will therefore facilitate sustainable economic growth by preparing metrology equipment for the efficient production of PICs and reduction of production defects.

In doing so, MEKOPP brings together ten expert partners and focuses on two machines: a Photonics Test Prober and a Photonics Visual Inspection Tool. These will enhance PIC production sustainability, potentially reducing material, energy and water usage by 50%. Indirectly, the project will contribute to PIC market adoption and scaling, which are vital for digital communication infrastructure efficiency. And with an expected 21-31% year-on-year market growth for PICs, the consortium expects to achieve an annual revenue of over €100 million by 2030 and create ~400 jobs in the eastern Netherlands.

EUROPEAN UNION
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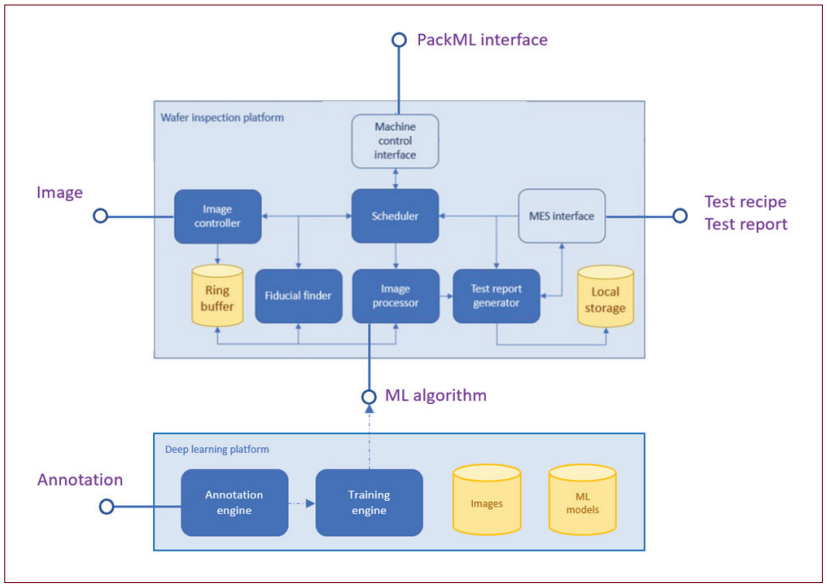
OPoost
operationeel programma oost
European Regional Development Fund

Nobleo brings intelligent deep learning solutions to MEKOPP

Founded in 2011, Nobleo Technology has since grown to over 75 employees and offers expertise on the development of mechatronics design solutions, autonomous robotics and machine learning algorithms for high-tech applications. The latter brought them to the MEKOPP project, where they are responsible for the software that detects wafer defects on photonic wafers (PICs) with a step-and-scan microscope. The tool can process a 20-megapixel image in 100 milliseconds, targeting a throughput rate of 10 wafers per second (4 inch). The microscope generates PIC images with an image resolution of 0.3 µm and/or 0.1 µm.



For anybody, anywhere

PICs are inspected manually by process experts. Within MEKOPP, Nobleo developed a machine learning suite that facilitates automation of the visual inspection task. The operator can categorise the defects found according to company-specific categories in order to build up a database of defect images. The tool is fully web-based, thereby allowing anybody anywhere to assess the images taken. Once a consistent definition of a defect category is established, a machine learning algorithm is trained to automate the inspection task. Machine learning algorithms process a 20-megapixel image within 100 milliseconds on a GPU, targeting a throughput of more than 10 wafers per hour (4-inch wafers). By applying machine learning, a fast and cost-efficient inspection tool has been realised that can be easily adapted to high-tech products produced in small series.

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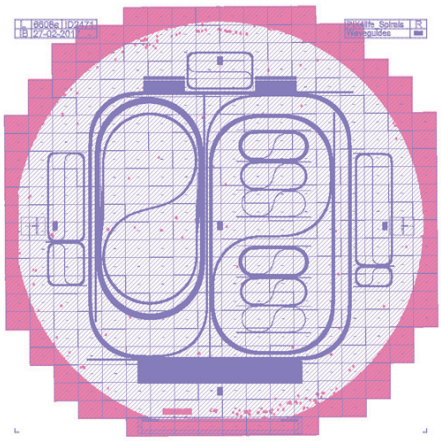

This figure shows a typical visualization of a design in combination with defects found on the wafer.

The edge of feasibility

Nobleo's involvement in the project is executed by their Intelligent Solutions team consisting of Yanick Douven, Birgit Plantinga, Paul Verhoeckx, Ali Moayyedi, Rinus Hoogesteeger, Rik Wetzels, Wouter Houtman and Stefan van der Palen – all of whom bring in-depth knowledge of deep learning algorithms and significant experience in applying state-of-the-art technology so that customers can get a solution right at the edge of what is feasible. The team is actively involved in the image acquisition process to make sure that image quality is not compromised by the step-and-scan action, the image acquisition and the real-time autofocus sensor. This is vital to MEKOPP as high-resolution image intake at a high speed requires the system as a whole to be properly aligned and calibrated and operating within dynamic stability requirements.

As for the added value for Nobleo itself, their work in MEKOPP has helped them to develop a software suite to manage the entire deep learning lifecycle, from the annotation of data to the training and deployment of algorithms. This will assist Nobleo in their continuous efforts to apply complicated technology in a user-friendly manner.

Keeping up the good work

Going forward, Nobleo is targeting the deployment of their deep learning framework in a high-tech environment for microscopy applications, allowing it to be used to develop custom deep learning solutions for high-tech applications in close cooperation with domain experts. The primary focus is to generate business in the photonics industry and for high-speed (microscopy) applications in general.

In addition, a demonstrator was built in 2023 that is able to execute the key functions of a commercial proposition by Helios. This is capable of performing a full wafer scan at a speed of over 10 wafers per hour, looking for particles and waveguide interrupts. The next step is to turn the prototype into a commercial product. The usability of the proposition will be tested with process engineers and the existing demonstrator will be used to scan as many wafers as possible to improve the stability of the software stack – just one of many ways that MEKOPP's impact will continue to grow after the project's formal conclusion.

MEKOPP project partners

IMS
Development of equipment for high-precision positioning of Photonic Integrated Circuits (PICs), enabling the optimisation of back-end processes and cost reduction.

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

Nobleo Technology
Realisation of software for the automatic inspection of photonic chips (PICs).

Photonic Integration Technology Center (PITC)
Shortening the path to the commercial application of integrated photonics through application-driven technology programs and by offering access to shared infrastructure.

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

Settels Savenije
Total solution supplier for high-tech equipment, systems, modules and critical components, including engineering and prototyping.

Technolution
Advanced electronics and embedded systems for complex instruments: specialist in the (combined) development of software, programmable logic and electronics for embedded and technical information systems.

TNO
One of the focus areas in the TNO expertise centre for semicon and quantum is optical metrology. TNO 's goal is to bridge low TRL developments and businesses.

Workfloor
Development of software modules that interact with manufacturing execution systems.

High Tech NL Semiconductors
Fully focused on the vast and strong semicon industry and operates as a 'single point of contact' in all steps of the value chain. Drives and stimulates (international) cooperation and initiates and facilitates (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.