PHOTOGENIC

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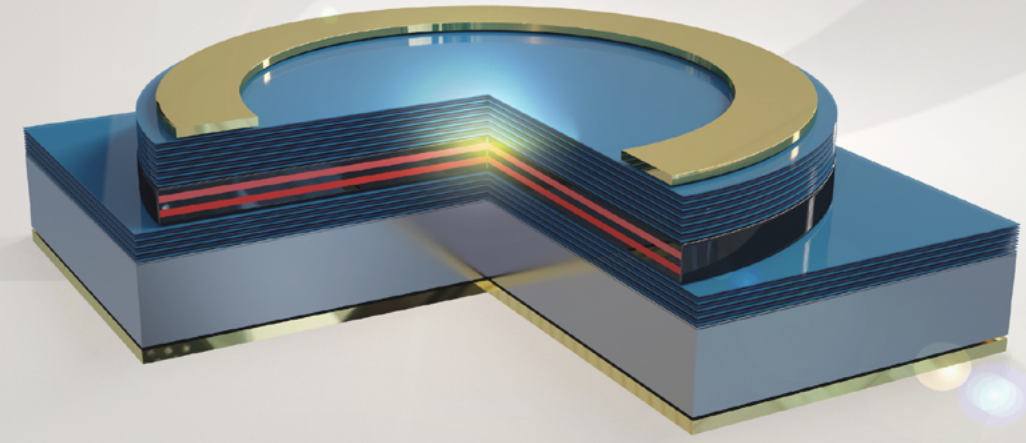
A GAME CHANGER FOR THE PHOTONICS INDUSTRY

NOVEL LASER TECHNOLOGY



Message from the Coordinator

The intension of this newsletter is to provide news on the project's progress and to discuss ongoing topics relevant to PhotoGeNIC. It is intended for internal and external project partners, stakeholders, and all other interested bodies. For more detailed information about the project, we invite you to visit our **Website**, which is constantly updated with the latest project-related news.

After the first project period the consortium felt it was necessary to request an extension to the project timeline in order to achieve all of the planned deliverables and milestones. The project extension of 12 months was granted to PhotoGeNIC by the European Commission in September 2025, which means that it is now going to run until September 2026 (M48).

The PhotoGeNIC project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101069490.

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Budget

€ 4.8 Million
100% EU-funded

Consortium

8 Partners
5 countries

Duration

48 Months
10/2022 - 09/2026

Technical Update:

The PhotoGeNIC Project involves advanced photonics and concerns semiconductor vertical-cavity surface-emitting lasers (VCSEL), widely used in the photonics industry, including short-distance communication systems, LIDARs, time-of-flight sensors, autonomous vehicles, robots, and drones. The goal is to meet the demand of the constantly growing photonics market by providing a novel solution that will increase production yield, reduce defectivity, and introduce reduced environmental impact. Moreover, the project findings can be developed into usable tools, bringing innovative change across various end-user industries.
Here's a glimpse into the latest status of the project objectives.

Objective 1: Mastering epitaxial growth technology of Ge-VCSEL structures and device fabrication

Significant progress has been made in achieving this objective. Key accomplishments include the successful development of epitaxy processes for VCSEL epi-stack on 4-inch diameter GaAs and Ge substrates. The design parameters were carefully optimized to achieve the required spectral properties and, identical VCSEL heterostructures were produced on both substrate materials, demonstrating a high degree of compatibility.
The characterization results of material and device performance are now available as a valuable database for further optimization. Additionally, the template wafers for MBE growth have been fabricated. A monolithically integrated 940nm VCSELs grown on Ge substrates by MBE was demonstrated.
Despite these significant achievements, several challenges remain. In particular, scaling up the epi-stack design using InGaAs quantum wells and GaAsP quantum barriers - developed through theoretical simulations by project partner TUL - requires additional optimization work. This optimization will be carried out in tight integration with epitaxy, coupling experimental findings with theoretical modelling.

Objective 2: Improving VCSEL's spectral quality, optical power and reliability

Significant progress has been made in improving the spectral quality, optical power, and reliability of VCSELs. Key achievements include the development and optimization of the growth of GaAs/AlGaAs on Ge substrates, with particular attention paid to the surface morphology of the GaAs nucleation layer.
Additionally, the growth of an Al0.5GaAs buffer layer with good morphology, lattice-matched to the Ge substrate, was confirmed by XRD measurements.
A device processing technology was also developed, enabling the fabrication of the first Ge-VCSEL lasers using a batch of several epi-wafers.
New epi-wafers were grown with optimized buffer layers and improved optical region of MQW, and additional works were performed on strain analysis introduced by cladding and waveguide layers influencing spectral features of light emission from MQWs. The results were used for design modifications performed by partner TUL.
Challenges remain, such as further optimization of the epitaxy on Ge wafers and improvement of device processing technology to minimize laser degradation.

Objective 3: Lowering VCSELs' environmental impact to meet the market growing requirements.

The successful growth of VCSEL structures on Ge wafers has proven the concept of replacing GaAs substrates with recycled safe Germanium (Ge) wafers, thus eliminating the use of toxic materials. Additionally, the reduced need for arsenic-containing process gases (arsine) was demonstrated, as heating of Ge substrates prior to epitaxial growth does not require protection against As sublimation.
The first devices fabricated using this technology, Ge-VCSELs, have validated the concept and shown promise. However, further optimization of the entire technology is necessary to fully realize its potential for environmental impact reduction.
While the final optimization of epi-stack design and epi-growth technology will be crucial in minimizing environmental impact, preliminary results indicate that a significant reduction in toxic As-components can already be achieved through this approach.

Objective 4: Integration with CMOS and miniaturization of technologies

Epi-stacks for VCSELs were grown on both GaAs and Ge wafers, with a notable reduction in bowing (a measure of warping) on Ge substrates compared to GaAs ones.
The first full VCSEL structures were deposited on 4-inch diameter Ge substrates, paving the way for further optimization and scaling up to larger wafer sizes.
Preliminary experiments were conducted on 6-inch Ge wafers to examine uniformity of AlGaAs chemical composition over large areas. While some challenges remain, this experience will be valuable in implementing optimized epi-technology on 6-inch Ge substrates.
To prepare for the transition to larger wafer sizes, researchers performed extensive experiments with epi-growth on 6-inch GaAs and InP wafers to gain essential experience that can now be applied to 6-inch Ge substrates.

Publications:

Absolute In situ measurement of Al x Ga 1-x As growth rate and composition by magnification inferred curvature method

Karim Ben Saddik, Guilhem Almuneau, Benjamin Reig, Pierre Gadras, Léo Bourdon, Alexandre Arnoult

Published 21 May 2025
Link | DOI: 10.1063/5.0268846

Optical refractive index measurements of AlGaAs at high temperature for fully automated molecular beam epitaxy growth of Bragg mirrors

Pierre Gadras, Léo Bourdon, Antoine Fées, Karim Ben Saddik, Guilhem Almuneau and Alexandre Arnoult
Published 26 November 2025
Link | DOI 10.1088/1361-6463/ae172c

The PhotoGeNIC Consortium

The PhotoGeNIC consortium comprises eight partners from 5 countries (AT, BE, DE, FR, PL). It consists of a well-balanced mixture of academic and industrial players, from large to small semiconductor companies.

PHOTOGENIC

Past Events

PhotoGeNIC Technical Meeting
18. Nov 2024
@Olen, Belgium

SPIE Photonics West
25.-31. Jan 2025
@San Francisco, US

CS International 2025
8.-9. April 2025
@Brussels, Belgium

VCEL Day
19. Sep 2025
@Lodz Poland

Make sure you follow PhotoGeNIC on **LinkedIn** and **X**, where all events and important information are published.