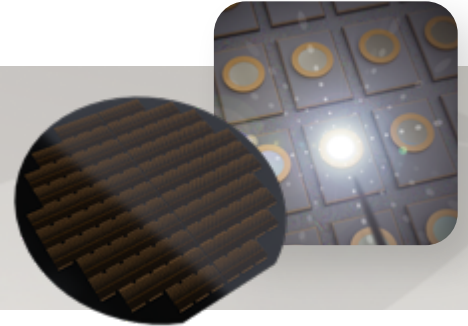
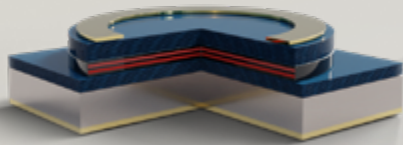


## PhotoGeNIC concludes with pioneering advances in germanium-based VCSEL technology

October 2026



After 48 months of research and innovation, PhotoGeNIC has concluded its work on a new approach to VCSEL manufacturing: growing 940 nm laser structures on germanium substrates instead of conventional gallium arsenide.

The Horizon Europe project brought together complementary expertise in materials, epitaxy, device processing, modelling, characterization and system integration. Its goal was to establish germanium as a viable platform for next-generation VCSELs and explore a path toward larger wafer diameters, cleaner production and future integration with silicon technologies. The project began on 1 October 2022 and was later extended to 48 months.

### From material concept to laser action

PhotoGeNIC successfully produced several 940 nm Ge-VCSEL wafers. Three were evaluated using fast commercial processing, and all demonstrated laser action at a low threshold current of approximately 1 mA.

The consortium developed complete Ge-VCSEL structures using both metal-organic chemical vapour deposition, MOCVD, and molecular beam epitaxy, MBE. This required careful management of strain, thermal and lattice mismatch, wafer bow, surface morphology, defect formation and micro-cracking when growing complex III-V semiconductor structures on group IV substrates.

These results advance the scientific understanding of Ge-based VCSELs and demonstrate that germanium is a credible alternative substrate for high-performance laser structures.

### Three major areas of impact

**New photonic devices:** PhotoGeNIC advanced Ge-based VCSEL technology and explored its potential for photonic integrated circuits, 3D sensing and LiDAR systems.

**Cleaner manufacturing:** Replacing conventional GaAs substrates with recyclable, non-toxic germanium can reduce

reliance on toxic substrate materials. The developed approach can also lower the use of arsine and avoid phosphine-related buffer-processing steps.

**Scalable integration:** Germanium supports larger, mechanically stable wafers and provides a potential bridge between III-V lasers and silicon-compatible manufacturing, opening future routes toward wafer-scale CMOS and photonic integration.

**Increased production yield for lasers:** Larger Ge wafers, up to 8" vs 6" GaAs, and the elimination of bowing from post-epitaxy stress (a common issue with GaAs) substantially cut production waste.

### Lasting impact for European photonics

PhotoGeNIC has created new knowledge, processes and experimental evidence for connecting III-V laser technology with group IV semiconductor platforms. Its results provide a foundation for continued research into more scalable and environmentally responsible VCSEL technologies for advanced sensing, LiDAR, imaging and future integrated photonic systems.

By bringing together European research organizations, universities, materials specialists, device manufacturers and technology users, PhotoGeNIC has strengthened Europe's capabilities across the Ge-VCSEL value chain and opened new directions for scientific research and industrial development.

**For more information about the PhotoGeNIC project, contact the coordinator directly:**

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