

HoLiSTEP Demonstrates 500 nm Holographic Lithography and High-Topography Patterning

The HoLiSTEP project has reached two important milestones in holographic lithography: 500 nm patterning and patterning on high-topography wafers in photoresist

SWITZERLAND, June 24, 2026 /EINPresswire.com/ -- The breakthrough results were achieved using Sub-Wavelength Holographic Lithography (SWHL), a patterning approach being developed as a cost-effective alternative to conventional projection photolithography. Unlike standard lithography methods, which are largely optimised for planar wafer surfaces, holographic lithography uses holographic masks to reconstruct the target image at the wafer plane. This enables tailored optical fields and creates the potential for both 2D and 3D high-resolution patterning in a single exposure.

The HoLiSTEP 388nm test-bench demonstration showed that holographically generated aerial images can be transferred into photoresist for 500 nm patterning on flat silicon wafers. It also demonstrated two-level image generation across surfaces separated by 100 µm in a single exposure, highlighting the potential of holographic lithography for applications involving complex topographies such as stepped surfaces, sidewall slopes, or vertically separated device layers.

Further experimental results focused on single-exposure patterning in spray-coated resist on structured silicon wafers with 100 µm deep etched cavities. These wafers were designed to assess whether holographic lithography could expose both the top wafer surface and the cavity surface in one exposure. The results confirmed that structured wafers with deep cavities can be exposed in a single holographic step, with comparable pattern quality on both surfaces.

For industry, the significance of this result extends beyond the 500 nm feature size itself. Together, these milestones demonstrate a patterning approach that combines sub-micron resolution with increased flexibility for structured, non-flat and multi-level substrates: areas where conventional single-plane exposure methods can become technically demanding or process-intensive. This capability is directly relevant to industrial sectors where substrate complexity is increasing, including MEMS, integrated photonics, advanced packaging, sensors and micro-optics. In these applications, final pattern quality can be affected by resist coating uniformity, substrate height variation, surface roughness and focus control. Holographic lithography offers an alternative route by enabling the exposure field to be designed for more complex surface geometries.

Holographic masks may also offer manufacturing advantages. Their structures can be based on relatively simple elements, while image correction and resolution enhancement are embedded during the mask synthesis stage. This means that increasingly complex image-generation requirements do not necessarily translate into proportionally more complex physical mask structures.

The next step for HoLiSTEP is to adapt the verified 388 nm test-bench capability toward a 345 nm industrial platform, moving closer to the wavelength, resolution and system architecture required for future industrial deployment. This marks an important stage in translating the current 500 nm validation into a more advanced holographic stepper concept for sub-micron manufacturing applications.

INDUSTRY ENGAGEMENT OPPORTUNITY

HoLiSTEP is now entering an important phase of industry engagement and welcomes discussions with companies working in MEMS, photonics, advanced packaging, sensors, micro-optics, semiconductor equipment, materials and high-value microfabrication. These organisations would be well placed to help define relevant use cases, process requirements, substrate formats and performance targets for future industrial deployment.

ABOUT HoLiSTEP.

HoLiSTEP (Sub-Wavelength Holographic Lithography Stepper for Integrated Circuit Production) is a Horizon Europe project developing sub-wavelength holographic lithography as a disruptive approach for high-resolution 2D and 3D semiconductor and micro-component manufacturing. The project aims to overcome key limitations of conventional projection lithography by enabling high-resolution patterning on complex structures, reducing equipment and mask-related costs, and advancing toward an industrial prototype holographic stepper operating at 345 nm.

The project brings together an international consortium of academic and industrial research partners including SWHL GmbH, Flexible Optical B.V., Tampere University, AMPLICONYX OY, Mimotec SA, EKSPLA, MODUS Research and Innovation, Capgemini, Fraunhofer ENAS and the University of Eastern Finland.

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