Innovative etching method for silicon: Higher precision through interlayer

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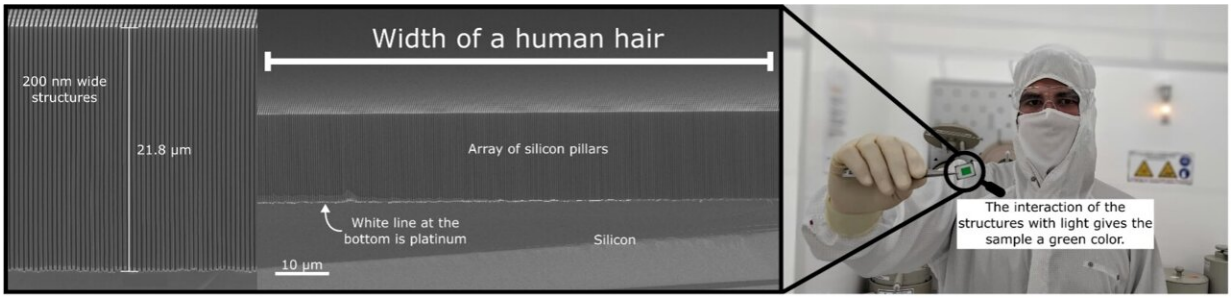

The new method enables the production of dense nanostructures that cover up to 50% of the surface area and are 250 times taller than they are wide. Credit: B. Benz, PSI and University of Basel

In micro- and nanotechnology, highly precise components with tall, narrow structures (high aspect ratios) made from semiconductor materials like silicon are important. A promising fabrication method is gas-phase metal-assisted chemical etching (MacEtch). In this plasma-free process, a thin metal layer defines the pattern on the silicon substrate. The etching step takes place in a chemical environment, where the reaction occurs only at the interface between the metal and silicon. The metal catalyst gradually sinks into the silicon, directing the etching deeper.

For precise results, the catalyst must maintain its shape and activity

throughout the process. Problems arise when the catalyst is contaminated or locally pinned, leading to irregular structures, defects or unwanted porosity.

Dr. Lucia Romano and the research team at Paul Scherrer Institute (PSI) developed a process that overcomes pattern instabilities and enables higher fidelity by introducing a thin interlayer of chromium, aluminum oxide and/or silicon dioxide between the photoresist and the metal catalyst. This layer separates the two materials and allows thorough cleaning of the surface before the catalyst is applied, keeping it clean and ensuring more uniform etching.

"With this method, we have succeeded in producing dense nanostructures that cover up to 50% of the area and are 250 times taller than they are wide," said Bryan Benz, first author of the study and a doctoral student at the SNI Doctoral School.

The researchers recently published their findings in the journal *Small Methods*. They demonstrated that various interlayer materials and patterning methods work effectively. Applications such as X-ray optics could benefit from this precise technology in the future.

More information: Bryan Peter Jost Benz et al, Interlayer-Catalyst Method for Metal-Assisted Chemical Etching of Ultra-High Aspect Ratio Silicon Nanostructures, *Small Methods* (2026). DOI: 10.1002/smtd.70833

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