A New Generation in Thermal Scanning Probe Lithography

E. Çağın
Heidelberg Instruments Nano AG, Bändliweg 30, 8048 Zürich, Switzerland
emine.cagin@himt.ch

Thermal scanning probe lithography, possible with the NanoFrazor from Heidelberg Instruments, makes it possible to create nanostructures with real-time inspection and correction, in grayscale as well as in high resolution. These capabilities, combined with accurate, markerless second layer alignment and automation features, provide a versatile and unique nanofabrication tool to pave the way for new ideas and advances in nanophotonics, nanobiosystems, nanoelectronics and emerging materials research[1].

Building on the high-impact research carried out by NanoFrazor users in high-quality contacts to 2D materials[2,3], phase engineering[4], biomimicry[5], and arbitrary structures for optical surfaces[6], a new generation of the tool will make it possible to expand to larger areas and automate significant portions of the user operations. Further applications to exploit optical effects on unexpected materials, as well as ever larger number of devices created in each lithography session, are expected as a result of the new developments.

The breakthroughs in throughput and maximum lithography area are possible due to the long-awaited parallelization of thermal scanning probe lithography, and smart handling of large designs in software implementation. Full parallel operation of the NanoFrazor will be demonstrated to enable the simultaneous and independent patterning of a set of ten designs on the same surface. Further developments in automation are enabled through increased lifetime of each scanning probe and optimization of resist stacks. The interplay between the heated probes and the integrated direct laser sublimation system will allow users a practical solution to create microscale bridges to nano-devices via electrical contacts or optical waveguides. Implementation details, application examples and use cases will be discussed in this talk, along with a demonstration of the new generation of the NanoFrazor.

[1] N. Lassaline, J. Phys. **7**, 1 (2023)
[2] K. He, *et. al.* Front. Phys. **18**, 6 (2023)
[3] M. C. Giordano, *et. al.* Adv. Mater. Interfaces, **10**, 5 (2023)
[4] V. Levati, *et. al.* Adv. Mater. Technol., **8**, 16 (2023)
[5] X. Liu, *et. al.* Ad. Func. Mater., **31**, 19 (2021)
[6] N. Marcucci, *et. al.* Nanophotonics, **12**, 6 (2023)

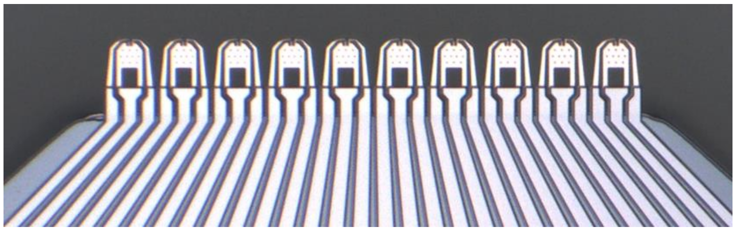

Figure 1: Array of thermal cantilevers on an integrated Silicon MEMS chip, ready for implementation on the NanoFrazor, micrograph with 20x magnification

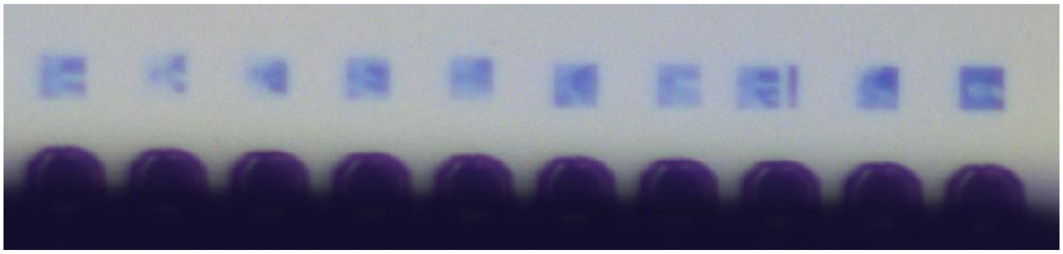

Figure 2: Same array of thermal cantilevers as Figure 1 under the NanoFrazor microscope, with different designs written by each 50microns away from the tip for demonstration purposes, micrograph with 20x magnification

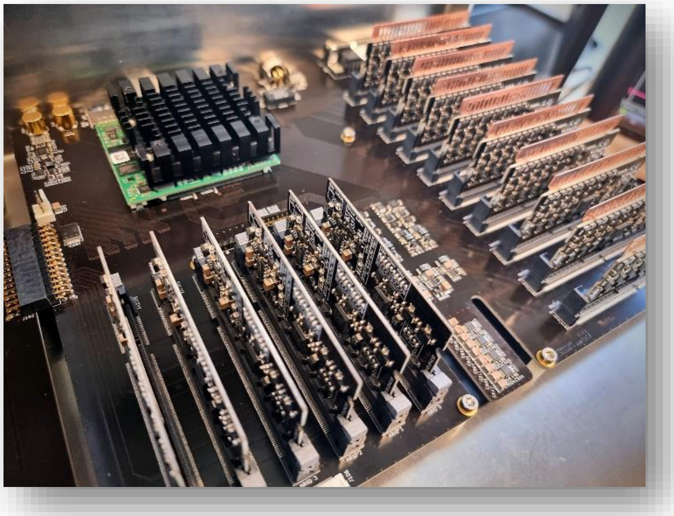

Figure 3: New analog electronics with ultra-low noise and 20x higher data rates were implemented for the new generation of the NanoFrazor