Advanced 2D Materials Devices Fabrication with NanoFrazor

Andrea Ubezio
Simon Bonanni, Emine Cagin
Heidelberg Instruments, Bändliweg 30, 8048 Zürich, Switzerland
andrea.ubezio@himt.ch

Thermal scanning probe lithography (t-SPL) is the core of the NanoFrazor technology. An ultra-sharp heated tip locally sublimates a thermally sensitive resist, enabling high-resolution, grayscale, and damage-free patterning. Thermal nanolithography thus leads to high quality electronic devices and superior contacts on 1D and 2D materials. Furthermore, the NanoFrazor's in-situ reading capabilities allow for markerless overlay on arbitrarily positioned features like nanowires and flakes. The NanoFrazor can be equipped with a direct laser sublimation (DLS) module, which can pattern microstructures using a 405 nm laser. These capabilities make the NanoFrazor ideally suited for research and fabrication involving sensitive materials like nanowires and 2D semiconductors, combining naonstructuring with the heated tip and microstructuring via DLS.
This talk will introduce the NanoFrazor technology with a focus on advanced device fabrication strategies for graphene and other two-dimensional materials. Central to the discussion is the NanoFrazor’s markerless overlay capability, which allows alignment of devices directly onto randomly positioned flakes and heterostructures with nanometer precision. This approach has been shown to be particularly effective for graphene and TMDC field-effect transistors, where precise contact placement and clean interfaces are essential for achieving high device performance [1,2]. The talk will further present the use of grayscale t-SPL for three-dimensional nanoscale patterning, enabling controlled topography and strain engineering in 2D materials [3–5]. Finally, emerging approaches combining t-SPL with interfacial cleaning, defect engineering and nanoimprint lithography will be briefly introduced, pointing toward scalable fabrication routes for next-generation graphene-based devices [6–8].

References

[1] Liu et al., APL Materials 9.1 (2021).
[2] Zheng et al., Nature Electronics 2.1 (2019): 17-25.
[3] Liu et al., Nature Communications 15.1 (2024): 6934.
[4] Zambito et al., Small Science (2026): e202500404.
[5] Wang et al., ACS Nano 19.21 (2025): 20237-20246.
[6] Zhao et al., Advanced Materials (2025): e17425.
[7] Talha-Dean et al., ACS Applied Materials & Interfaces 16.24 (2024): 31738-31746.
[8] Erbas et al., Microsystems & nanoengineering 10.1 (2024): 28.
[9] Shani et al., Nanotechnology 35 (2024): 255302.

Figures

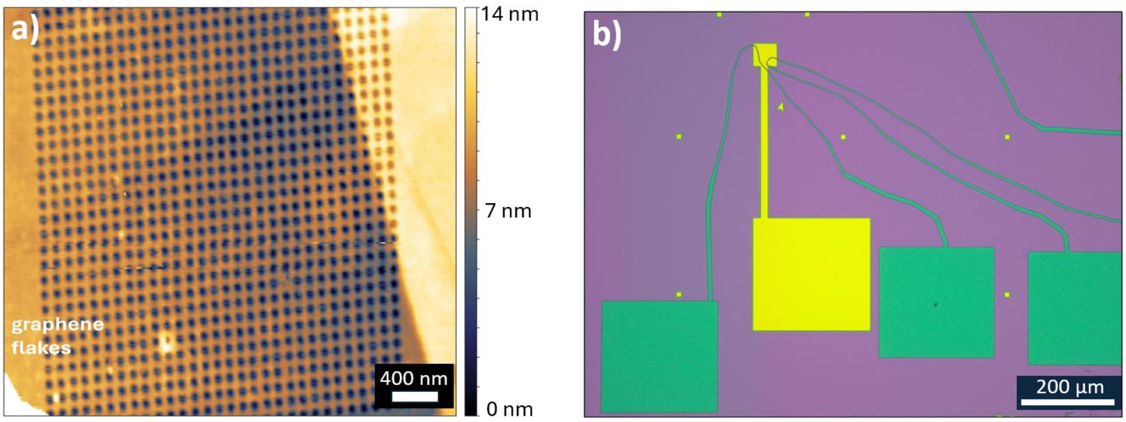

Figure 1: a) AFM image of array of dots etched in graphene with the NanoFrazor, b) optical microscope image of a low dimensional material device fabricated with the NanoFrazor [9].