NanoFrazor Technology - Enabling Unique Semiconductor Device Fabrication with 2D Materials

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Combining thermal scanning probe lithography (t-SPL) and direct laser sublimation (DLS), the NanoFrazor allows fabrication of devices with nano- and microstructures on arbitrary substrates [1-4]. t-SPL is carried out using a heated, ultrasharp probe tip to remove a thermal resist to create patterns at the nanoscale. The integrated DLS module allows sublimation of the same thermal resists to conveniently write micron-scale patterns within the same lithography session. The NanoFrazor technology has shown its advantage, as a low-damage method, for fabricating devices for nanoelectronics, quantum electronics, bio-nano-devices, photonics, spintronics, and nanofluidics.

Automated markerless overlay capabilities using the integrated topography sensor of the NanoFrazor allows for streamlined workflows and facile processing for device fabrication. It enables the detection of buried flakes of 2D materials, nanowires, or pre-existing structures immediately before patterning. Examples include nanopillars on micro-posts and defined channels between FinFET sources. The NanoFrazor has also been used in the direct manipulation of materials, such as cutting or straining 2D materials with a thermosensitive polymer at ambient environments. Such manipulation has been shown to locally modulate the bandgap of strained 2D materials at the nanoscale with patterning resolution down to 20 nm [5].

The background and principles of t-SPL will be briefly introduced, nanostructuring on nanowires will be discussed along with electrical and optical device performance for nanowire-based devices fabricated using t-SPL. Finally, the first multi-tip version of the NanoFrazor, the Decapede, will be presented. The tip parallelization approach scales up t-SPL by allowing uninterrupted patterning of large-area without compromising pattern resolution.