Grayscale nanopatterning and nanoimprint lithography

Semester project / Master project

(Section: Microengineering – Materials Science)

We aim to fabricate high aspect ratio grayscale nanostructures with **thermal scanning probe lithography** (T-SPL). T-SPL is a non-conventional nanolithography technique to create 2.5D (grayscale) shapes with sub-2 nm vertical precision and 10 nm lateral resolution [1]. Grayscale nanostructures with depth up to 100 nm are patterned on thermosensitive resist, then there are transferred to substrates with vertical depth amplification. However, the **repeatability** and **scalability** of scanning probe-based fabrication at a reasonable cost for high-volume mass production are the main bottlenecks. **Nanoimprint lithography** (NIL) is the most widely used way to overcome these issues in the industry. We aim to fabricate thermal NIL stamp with resolution down to the **single-digit nanometer** by combining **T-SPL** and **dry etch transfer techniques**.

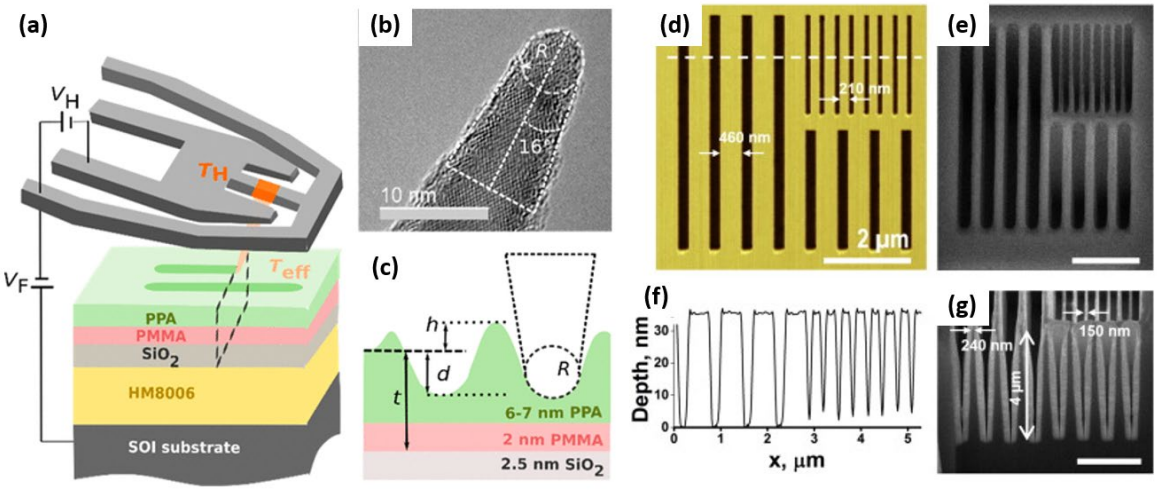

Figure 1 (a) Scheme of electrostatically actuated T-SPL patterning (b) TEM image of the scanning probe tip. (c) Scheme T-SPL patterning on thermosensitive resist PPA [2]. (d-g) High-aspect ratio T-SPL nanopatterns fabricated in silicon substrate [3]

The main tasks in the project will be:

- T-SPL patterning and dry etch transfer from polymer to substrate
- Nanoimprint lithography
- Metrology characterization

Desired Skills:

- Autonomy
- Knowledge in cleanroom processes is a plus

References:

[1] Howell, Samuel Tobias, et al. "Thermal scanning probe lithography—A review." *Microsystems & nanoengineering* 6.1 (2020): 1-24.

[2] Ryu Cho, Yu Kyoung, et al. "Sub-10 nanometer feature size in silicon using thermal scanning probe lithography." *ACS nano* 11.12 (2017): 11890-11897.

[3] Lisunova, Yuliya, et al. "High-aspect ratio nanopatterning via combined thermal scanning probe lithography and dry etching." *Microelectronic Engineering* 180 (2017): 20-24.

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