Latest Raith Innovations Driving Advanced Nano- and Microfabrication, Process Control, and Correlative Analysis

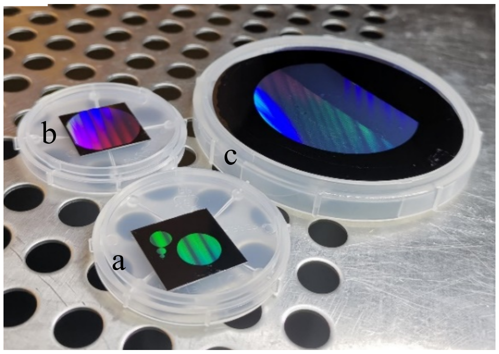
F. Nouvertné, M. Kahl, A. Wscieklica, T. Richter, and K. Keskinbora

Raith GmbH, Konrad-Adenauer-Allee 8, Dortmund, 44263, Germany
frank.nouvertne@raith.com

Metasurfaces have strong potential to transform sensing and imaging in consumer electronics, medicine, autonomous vehicles, and AR/VR. Their highly complex designs, however, pose major nanofabrication challenges, as GDSII files can reach hundreds of gigabytes, exceeding the efficient processing limits of conventional EBL systems.
We present a lean and highly efficient algorithmic EBL workflow that eliminates the need for flat GDSII layouts by using formula-based metalens descriptions. This approach enables reliable upscaling of metalens fabrication from typical 1 mm dimensions to diameters of up to 50 mm.

Raith has further expanded its portfolio with laser-based nano- and microfabrication systems. Single-beam laser writers enable deep SU-8 structures up to 600 µm with excellent sidewall verticality, achieved through advanced optics with adjustable spot sizes and depth of focus. This capability is particularly valuable for microfluidics and micromechanical applications requiring deep, high-aspect-ratio features.

Finally, ensuring device quality requires thorough verification and analysis of lithography and process results. Raith VECTOR and IONMASTER support this through automated large-area SEM imaging, metrology, and SIMS-based correlative analysis, helping bridge the gap from laboratory research to industrial fabrication.



Diameter	Number of circles	Exposure time
0.2 mm	0.13×10^6	2 s
1 mm	3.14×10^6	1 min 4 s
2 mm	12.57×10^6	4 min 20 s
5 mm	78.54×10^6	26 min 35 s
10 mm	314.16×10^6	1 h 46 min
20 mm	$1{,}257\times10^6$	7 h 5 min
50 mm	$7{,}853\times10^6$	44 h 12 min

Figure 1: Metasurfaces with different diameters, exposed in PMMA resist with algorithmic patterning (Raith VOYAGER) at 13.4 nA: a) 0.2 - 10 mm, b) 20 mm (both on 20 mm large silicon samples), c) 50 mm (3" silicon wafer)
Table 1: Exposure Times for various metalens diameters

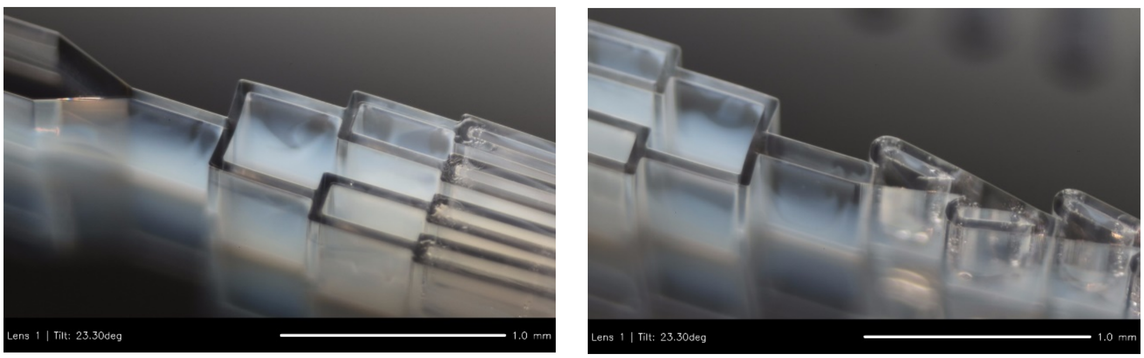


Figure 2. Cascaded mixers (left) and Tesla valves (right) exposed in 600 µm deep SU-8 using PicoMaster 200 with 375nm i-line optical module with 5-µm-wide extra-large spot size.

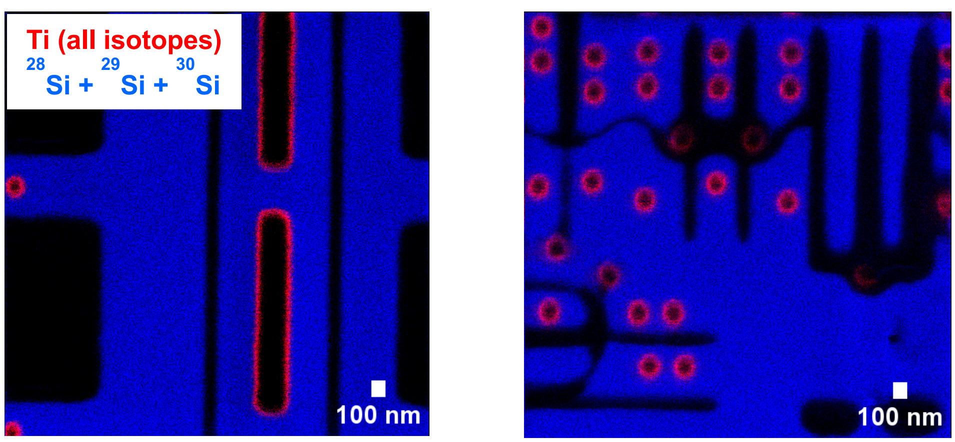


Figure 3: High resolution SIMS mapping of a microchip sample