Particle Beam Induced Fabrication of Nanoimprint Lithography Templates

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Nanoimprint lithography (NIL) has been established as high-throughput technique to fabricate sub-25nm patterns at a low cost. The potential of NIL for production of 3-dimensional structured surfaces has not been unleashed yet. One of the reasons is, that the fabrication of NIL templates with features in the sub-nm range currently still relies on the same resist-based technology used for producing alternating aperture phase-shift photomask. The fabrication of 3-dimensional templates (stamps) is one of the technological obstacles with nanoimprint technology. The use of a focused ion beam system for fabrication and modification of nanoimprint templates (stamps) has been investigated. By maskless direct patterning with a focused beam the fabrication of 3-dimensional NIL-structures has been demonstrated without the need for a resist.

Arbitrary structures were milled into the stamp thus providing a rapid prototyping approach for NIL stamps. Also 3-dimensional structures not accessible by other fabrication methods have been demonstrated. Fabrication of stamp structures, a Zeiss Neon 40 ESB focused ion beam system was employed. It was found that in all scenarios investigated, the highest resolution and throughput is achieved at an acceleration-voltage of 30kV, thus all further processes were optimized for operation with an acceleration-voltage of 30kV. The effect of scan parameters such as scan speed, pixel spacing and the effect of different geometries were investigated. Depending on the application recommendations for the balance between speed and throughput have been corroborated. Higher throughput is achieved at higher beam-currents, while high-resolution is only possible at low beam-currents. Examples of different structures as well as their imprints will be processed.

From all fabricated stamps individual imprints were fabricated and compared to the stamp itself. A good structural conformity was observed.

[1] M. Muehlberger, I. Bergmair, A. Klukowska, A. Kolander, H. Leichtfried, E. Platzgummer, H. Loeschner, C. Ebm, G. Gruetzner, and R. Schoeftner, Microelectronic Engineering 86, 691 (2009).

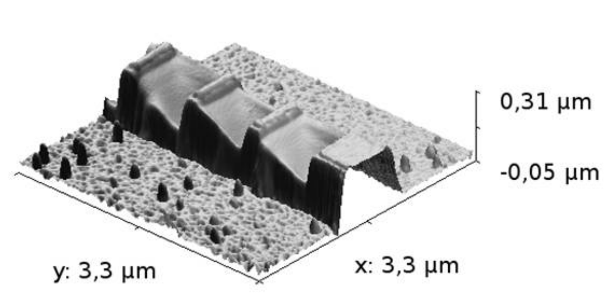

Fig. 1 AFM-image after FIB-fabricated ramp structure

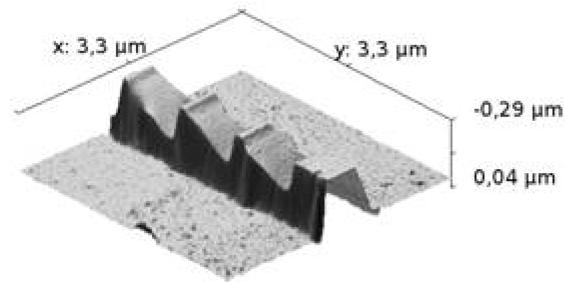

Fig. 2 AFM-image of imprint of the structure in Ormostamp on glass

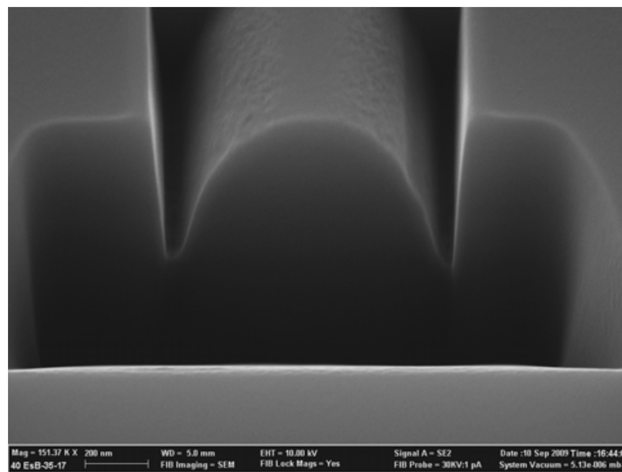

Fig. 3. A 3-dimensional structure fabricated by FIB