

Masters for micro- and nanostructure replication by



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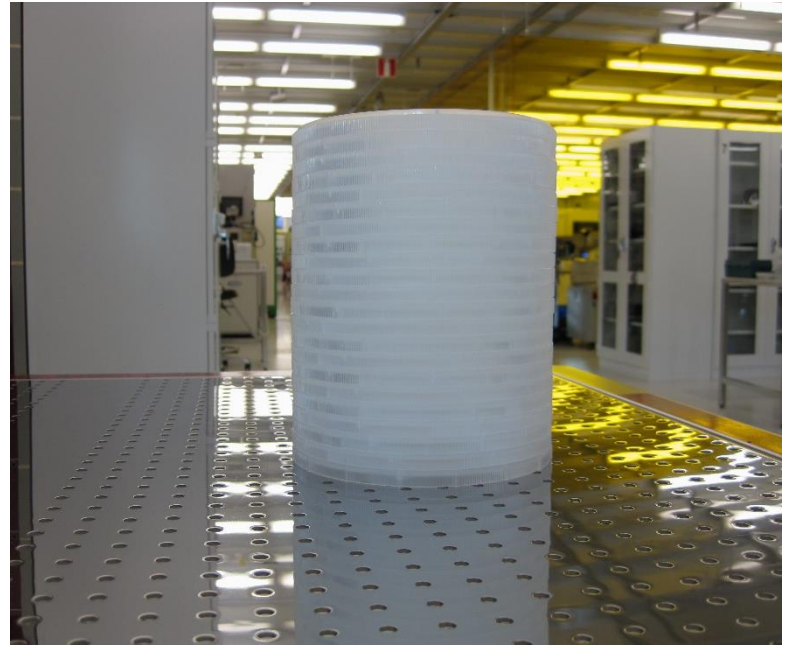
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Background

- More than 8 years of experience in providing stamps to the imprint community
- 12 Full time employees
- More than 250 clients across the more than 30 countries
- Delivering products to meet technical and economical expectations from clients
- Striving to achieve the highest possible quality of stamps
- Working in state-of-the-art silicon processing cleanrooms, class 10/100, in Denmark and Sweden

Added value by NILT

- Reduced prices if more than one stamp is ordered
- Repeat orders are subject to discounts
- High focus on delivered stamps fulfilling specs
- Close interaction with client already in design phase of the stamp
- High degree of production status to client



Stamps/molds by NILT

Products

- Silicon stamps
- Quartz stamps (including 65 Templates)
- Nickel shims
- Steel tools

Technologies where master/stamps/molds are used

- Nanoimprint
- Hot embossing
- Roll-2-Roll printing
- Injection molding

Silicon stamps/molds

Available sizes:

- Round: 2-inch, 4-inch round, 6-inch round, 8-inch round
- Any square format cut from wafers.

Stamp thickness

- In general the stamp thickness will follow the standard wafer thickness, i.e. 525 μm (2-inch and 4-inch), 675 μm (6-inch), and 725 μm (8-inch)

Anti-sticking and stamp cleaning

- We can apply anti-sticking coating (FDTS, 1H,1H,2H,2H-perfluorodecyltrichlorosilane) onto all silicon stamps upon request
- Cleaning service is available upon request

Patterns

- We can prepare silicon stamps with features from below 20 nm
- Structures with lateral size of below 20 nm to 300 nm will be patterned with EBL
- Structures with lateral size of 300 nm to 2 μm will be patterned with DUV
- Structures with lateral size larger than 2 μm will be patterned with UVL

Pattern depth/height

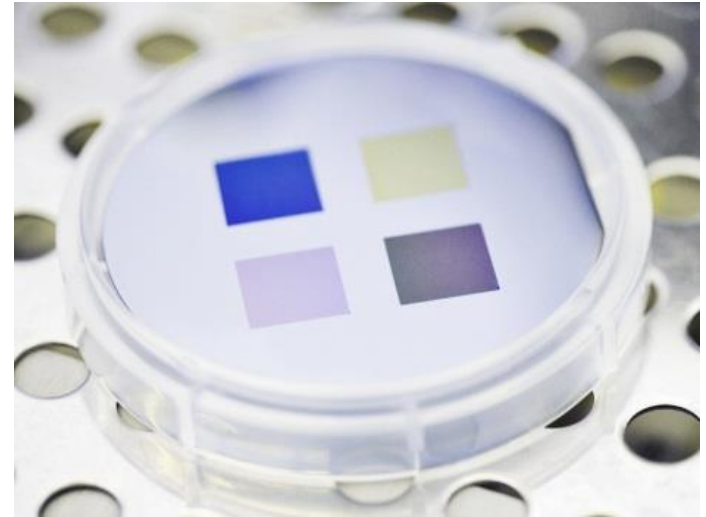
- The pattern depth/height depends on the lateral feature size

Side wall

- Regular specification: 85-90°
- Other angles available upon request

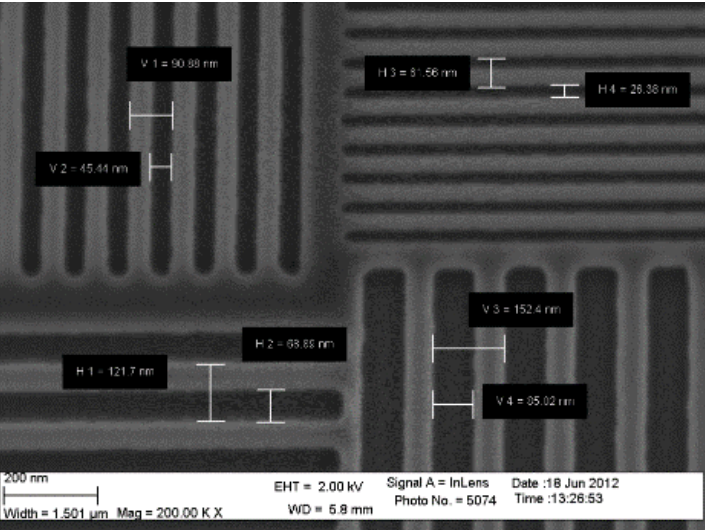
Line Edge Roughness

- Depends on etch depth and lateral and vertical dimensions

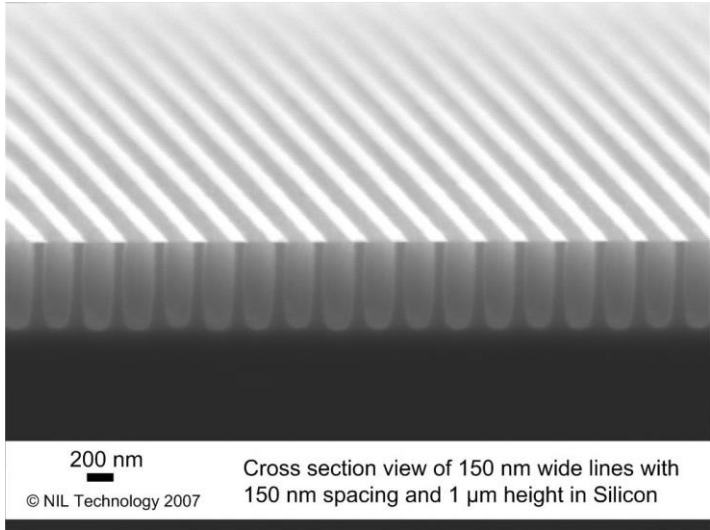


2-inch silicon NIL stamp with photonic crystal structures

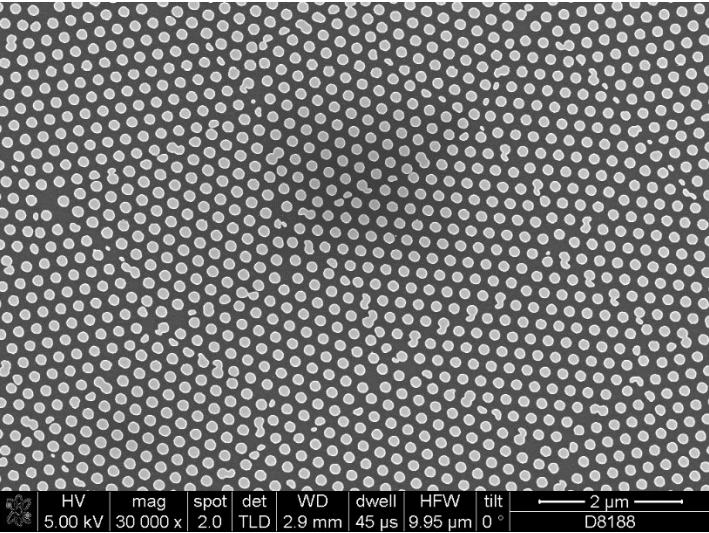
Silicon stamps - examples



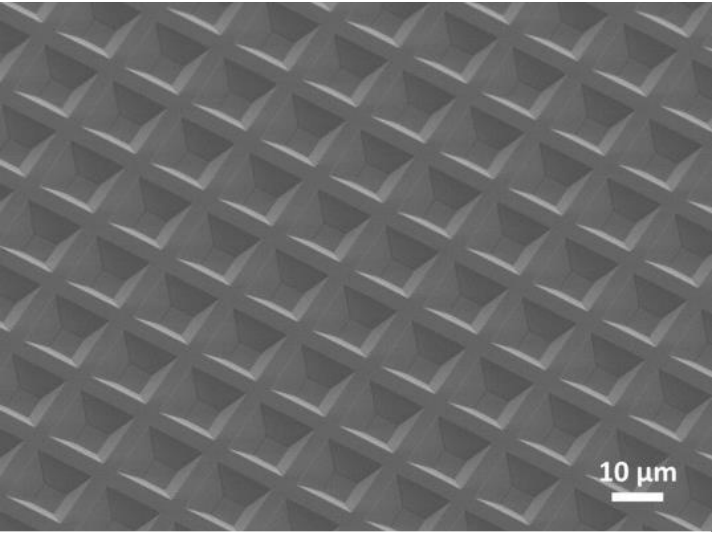
Silicon grooves with widths from 153 nm to 26 nm



Cross section of 150 nm wide and 1 μ m high lines

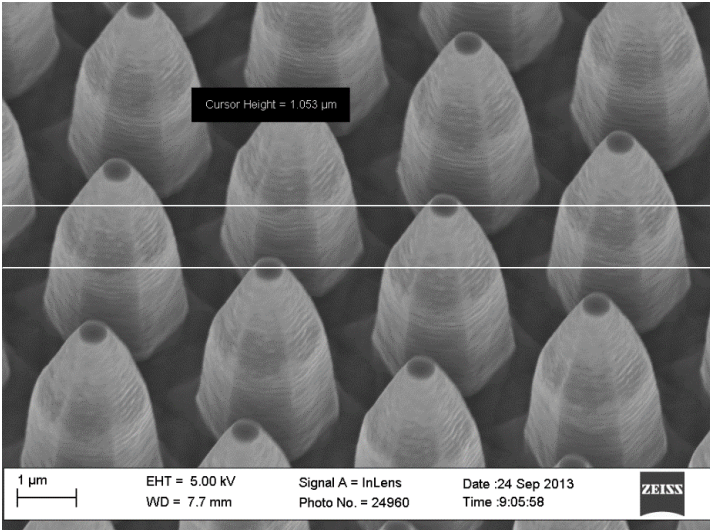


Pillars in fields with different lattice orientation

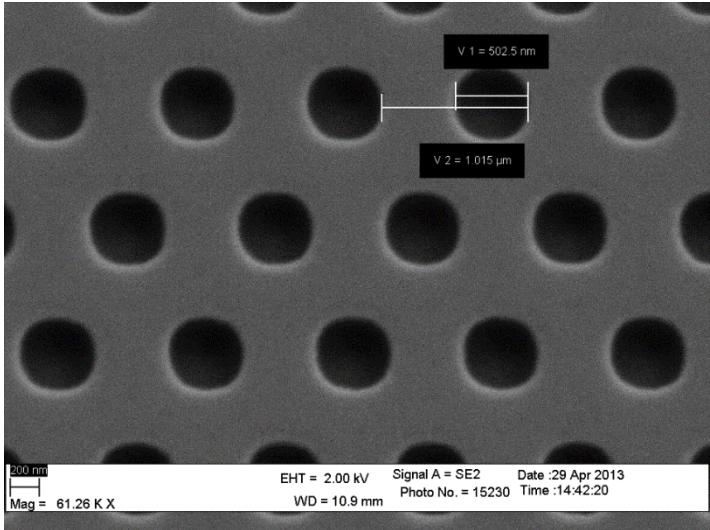


Truncated pyramids

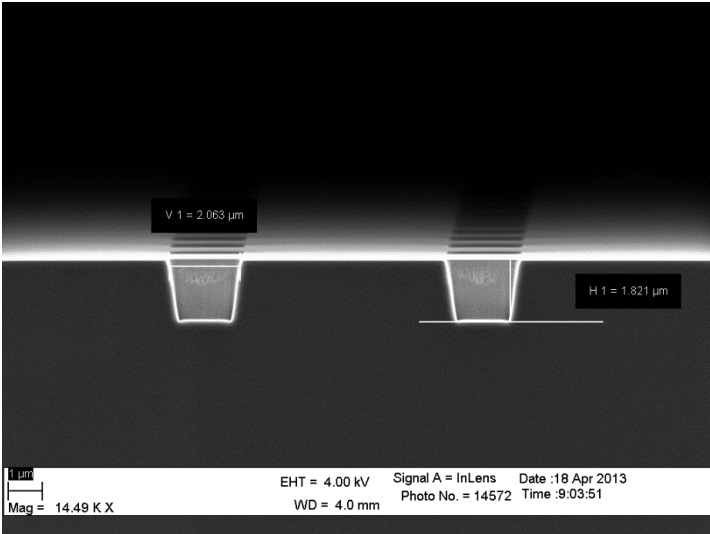
Silicon stamps - examples



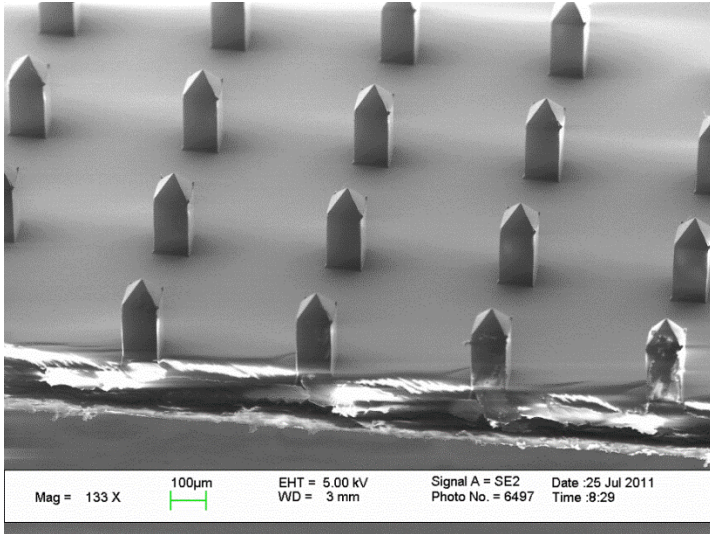
Shaping of silicon structures. Here pencil type protrusions



500 nm diameter holes in silicon



2 μm wide and 2 μm deep square holes



Polymer micro needles hot embossed from silicon master

Quartz stamps

Materials

- Quartz, Fused silica, glass

Available sizes:

- Round: 2-inch, 4-inch round, 6-inch round, 8-inch round
- Any square format cut from wafers
- 65 mm X 65 mm x 6.35 mm (cut from 6026 mask blanks)

Stamp thickness

- Stamp thickness from 200 μm

Stamp cleaning

- Cleaning service is available upon request

Patterns

- We can prepare quartz stamps with features from 20 nm
- Structures with lateral size of 20 nm to 300 nm will be patterned with EBL
- Structures with lateral size of 300 nm to 2 μm will be patterned with DUV
- Structures with lateral size larger than 2 μm will be patterned with UVL

Pattern depth/height

- The pattern depth/height depends on the lateral feature size

Side walls

- Regular specification: 80-85°

Line Edge Roughness

- Depends on etch depth and lateral and vertical dimensions

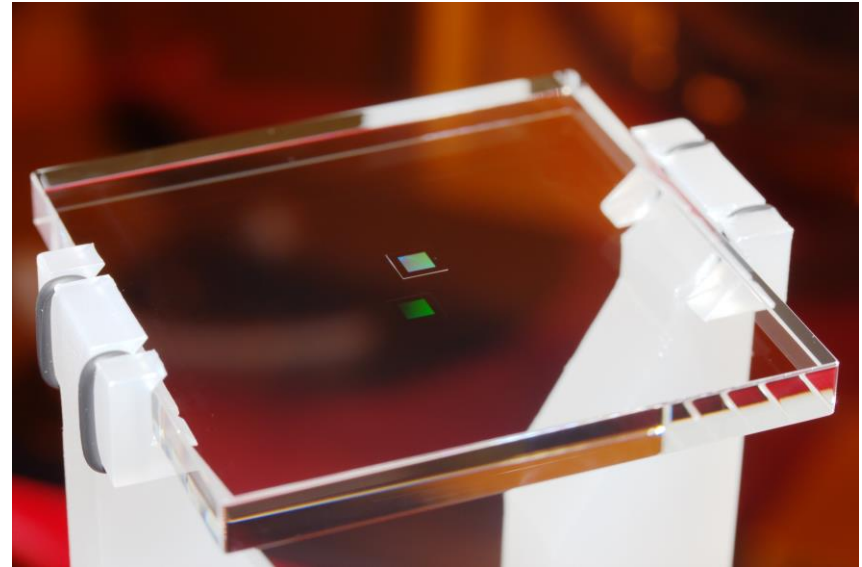
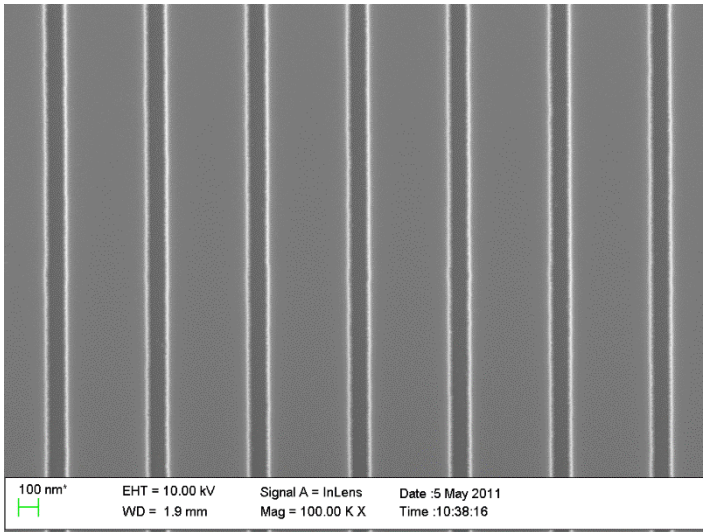
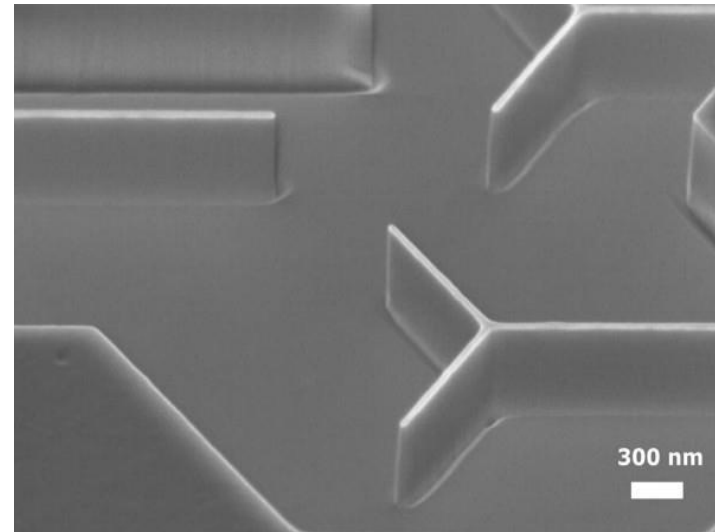


Image of 65 Template, cut from a 6025 Photomask. Pattern is located on central mesa

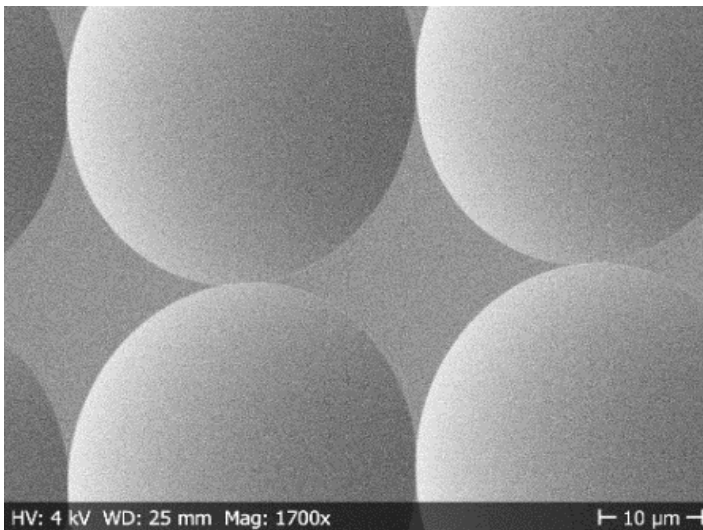
Quartz stamps - examples



100 nm wide grooves



30 nm wide lines etched to a depth of 1 μm



50 μm diameter concave lenses

Nickel shims

Nickel shims for nanoimprint lithography, hot embossing, Roll-2-Roll printing and injection moulding.

Available sizes:

- Any shape/size cut from $\varnothing 140$ mm diameter
- Up to 500 mm x 500 mm upon request and with certain limitation regarding structures

Shim thickness according to specification. Regular thickness is 300 μm (thickness from tens of μm to several mm can be made)

Anti-sticking and stamp cleaning

- We can apply anti-sticking coating (FDTS, 1H,1H,2H,2H-perfluorodecyltrichlorosilane) onto all silicon stamps upon request
- Cleaning service is available upon request

Patterns

- The Nickel shims are made from a resist pattern or a Silicon or Quartz master. Dimensions are available from 30 nm.

Pattern depth/height

- The pattern depth/height depends on the lateral feature size
- Regular aspect ratio up to 1:2 as standard (higher upon request)

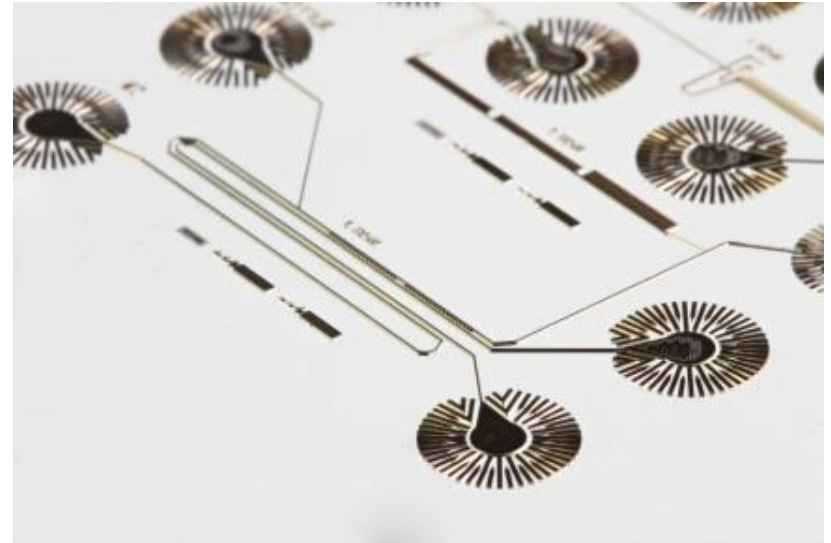
Side walls

- Regular specification: 80-85°

Line Edge Roughness

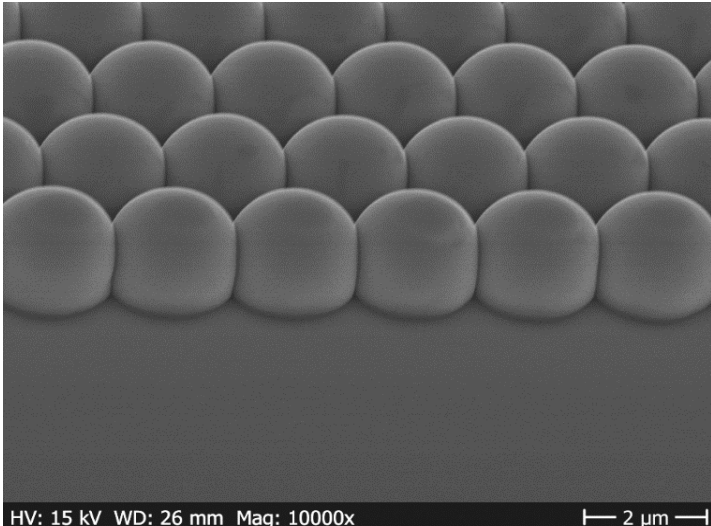
- Depends on etch depth and lateral and vertical dimensions

Various types of nickel (different hardness) can be provided upon request

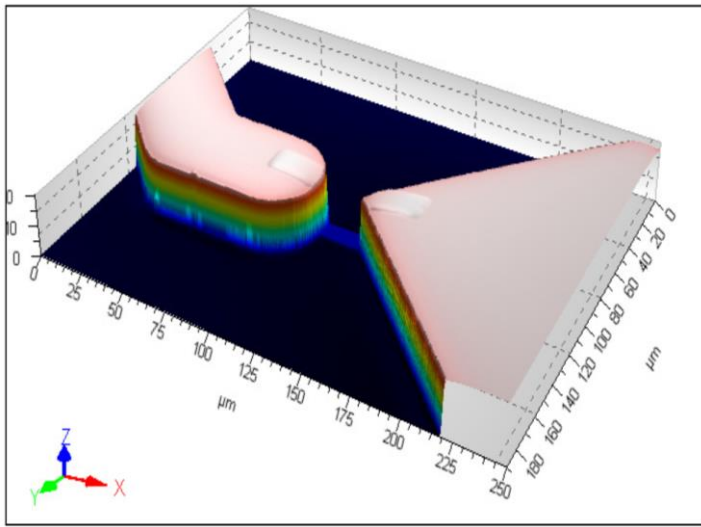


- Developed technology for shim fabrication for microfluidics and lab-on-a-chip purposes.
- Combining micro- and nanostructures
- Several layers
- Contact NILT to learn more

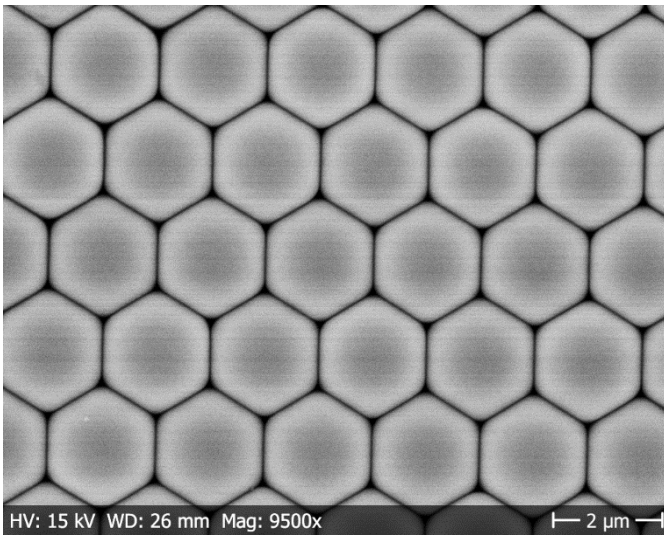
Nickel shims - examples



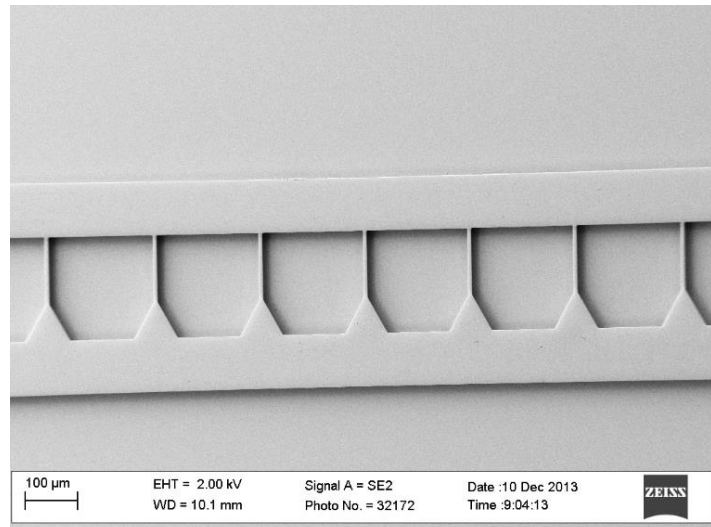
Moth-eye structures with 2 μm pitch



Confocal microscopy image of a dual layer Ni shim with 20 μm depth and 1 μm tall structures

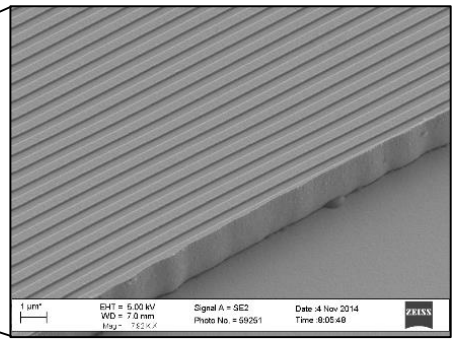
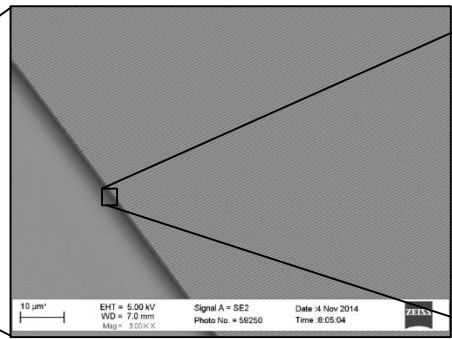
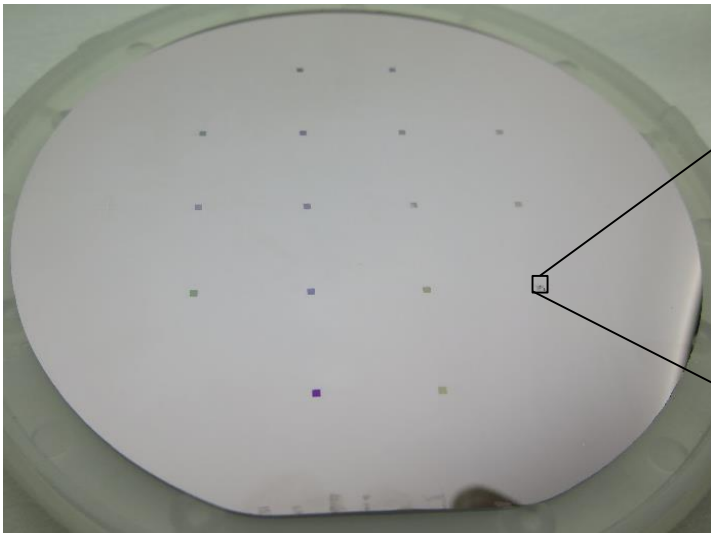


Moth-eye structures with 2 μm pitch (top view)

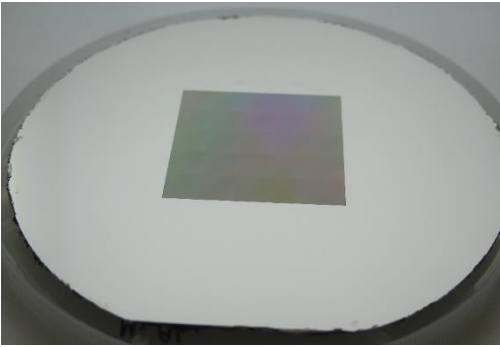


Ni shim for μ-fluidic applications. Structures are 30 μm tall.

Nickel shims - examples

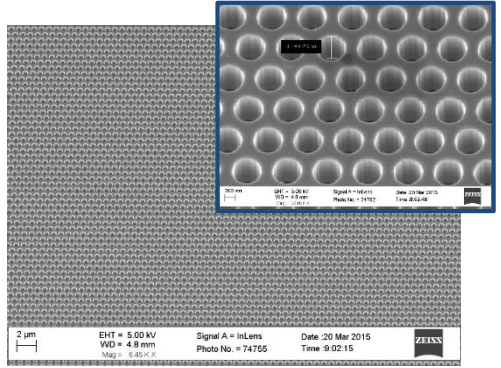
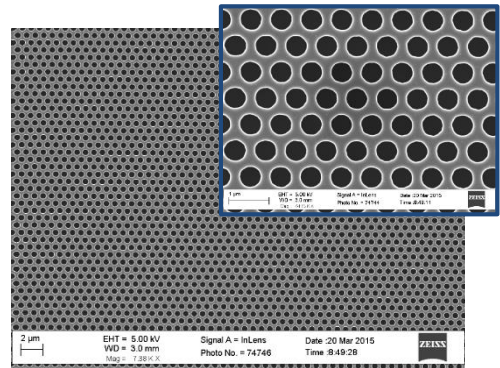


Nickel shim with isolated mesas, each having diffraction grating on top.

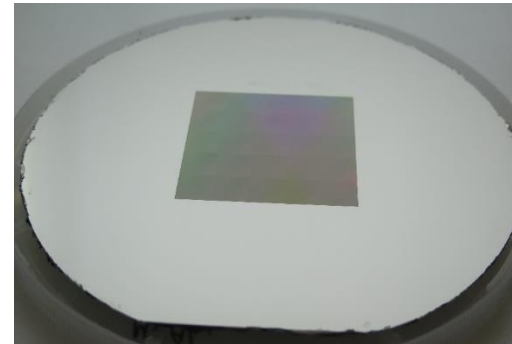
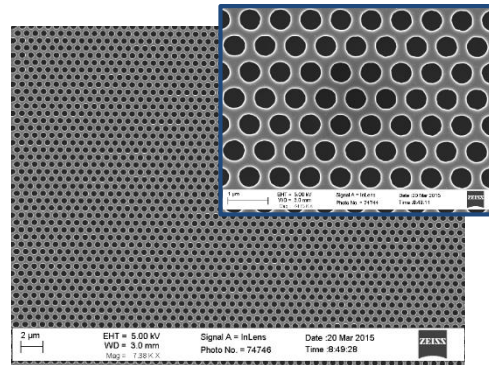
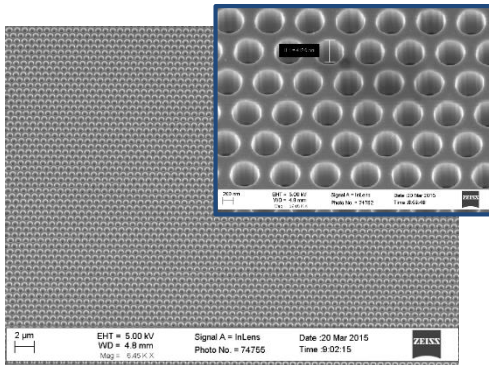


Nickel shim ready for replication by injection moulding.

Pattern consist of holes placed in hexagonal lattice, having diameter of 500 nm and depth of 825 nm.



NICKEL SHIM WITH 500 NM DIAMETER HOLES



Nickel shim ready for replication by injection moulding.

Pattern consist of holes placed in hexagonal lattice, having diameter of 500 nm, period of 750 nm and depth of 825 nm.

Advanced processing by NILT

Multilevel structures

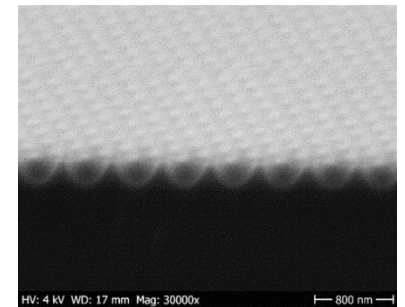
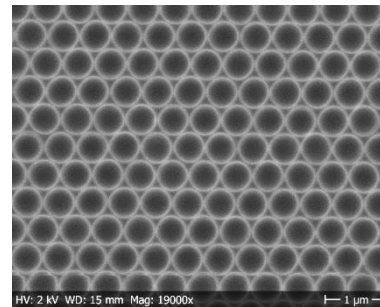
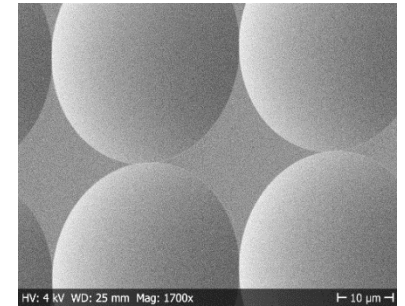
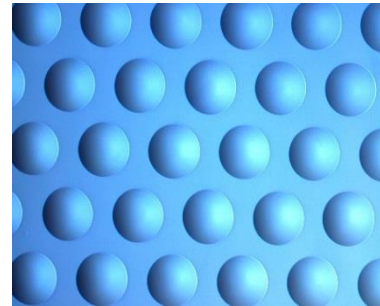
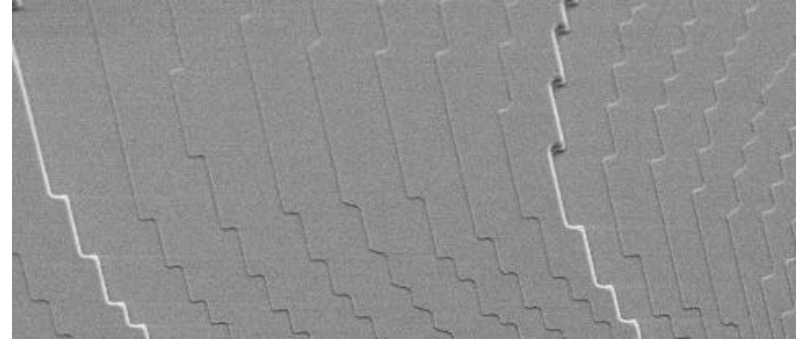
- Alignment accuracy between layers
 - <30 nm with EBL
 - <100 nm with DUV
 - <4 μm with UVL

3D structures

- Arbitrary continuous functions $f(x,y)$ can be made with 3D EBL and transferred both to Silicon and Quartz. However due to scattering effects there is a limit to how sharp transitions between different heights can be achieved.

Micro Lenses

- Concave lens shapes can be done in quartz
- $\text{SAG} < 2D$ where D =diameter of lens



Steel tools

We are developing technology for patterning injection molding steel tools with micro- and nanostructures. The patterns are made in a hard coating on top of the steel which ensures long life time of the structures.

The developments are on-going and is mainly performed in the two projects NanoPlast (Danish National Advanced Technology Foundation) and Plast-4-Future (EU FP7). We gain new results on a daily basis, so you are welcome to contact us to discuss current and future solutions relevant to you.

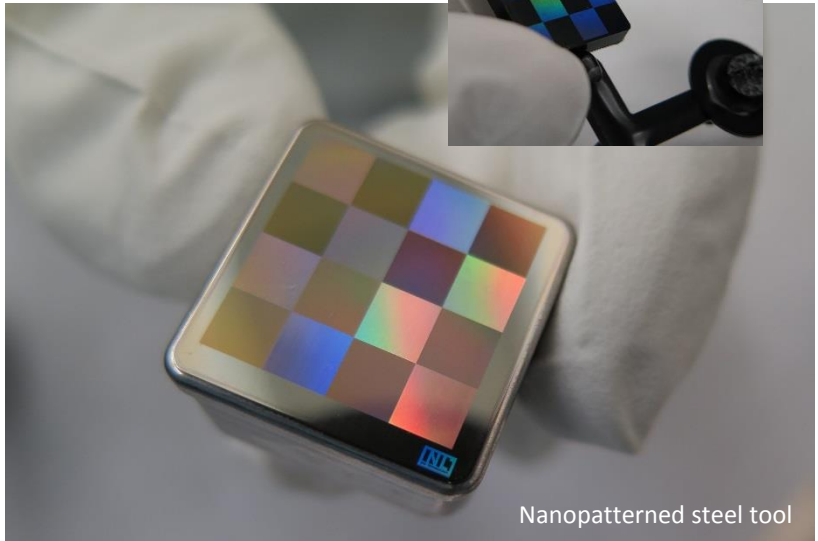
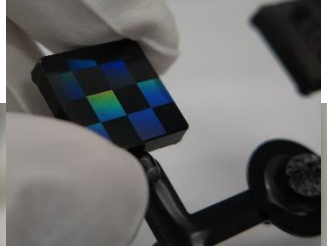
Our focus is to create the most advanced high precision injection moulding tools in the market.

Target is to provide our clients with the capability to make very fine structures in plastics directly in the injection moulding process AND to provide injection moulding steel tools with engineered surfaces to provide specific functionalities in the plastic products.

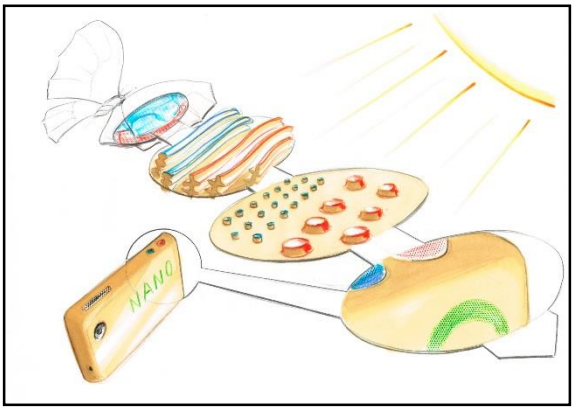
We are currently studying the following applicaton areas:

- Decoration (including colours)
- Anti-counterfeiting
- Labelling
- Water/substance repelling
- Anti-reflection
- Anti-fog/ice
- Anti-biofouling/bacteria

Nanopatterned plastics produced by injection moulding



Nanopatterned steel tool



Artist impression of self-cleaning and colour properties that can be created through injection moulding in polymer surfaces. Functionalities are inspired from nature, but the structures are designed for manufacturing.



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