Wafer-scale Nano- & Micro-optics for Lasers and Integrated Photonics Applications

SCIL
Nanoimprint solutions

Jeroen Visser
QA & BD Manager
12-Nov-2024

Contents

- Who we are
- Our production tools
- Imprint resists
- Nano Imprint Lithography – NIL
- Substrate Conformal Imprint Lithography – SCIL
- Current applications
- New applications
- Future applications
- Conclusions

Who we are

SCIL Nanoimprint solutions

Start-up with strong financial partners

Solutions for volume production

Proven world-class technology

Building customer success - Together

imec xpand

RSBG VENTURES

Deep Tech

BOM Catalyzing Change

intel ignite

TRUMPF

MOXTEK

Teramount

Our imprint machines

SCIL Nanoimprint solutions

LabSCIL

- R&D
- 100, 150 and 200mm wafers

AutoSCIL

- Integrated tool
- 100, 150 and 200mm wafers

FabSCIL

- Cluster design, freely confinable
- 150, 200 and 300mm wafers

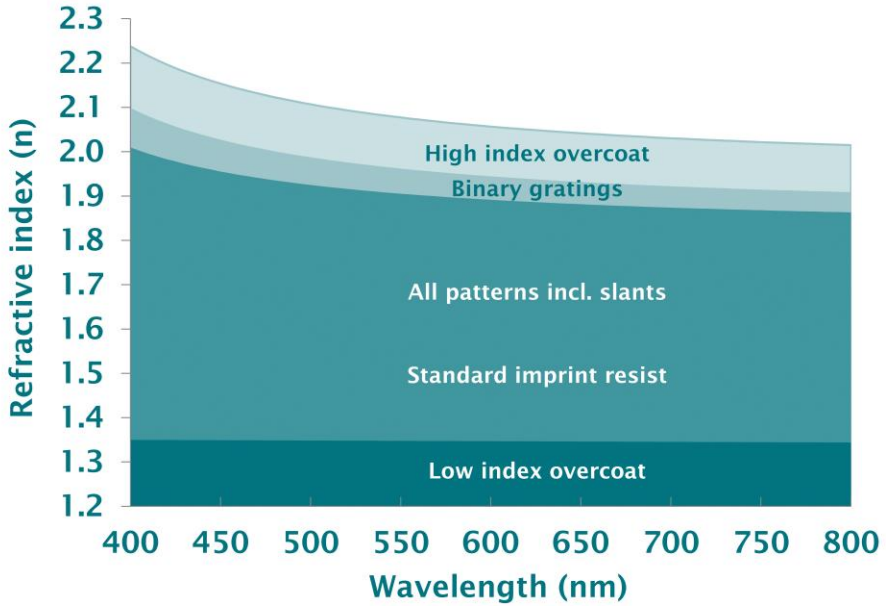
All tools are capable of:

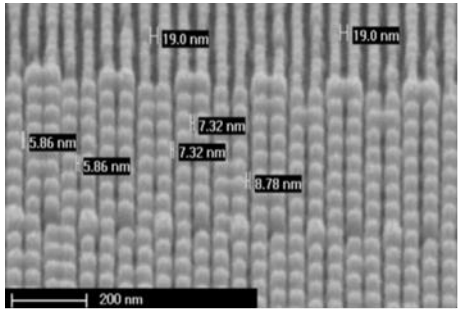
- Automatic (double side) overlay alignment
- Proprietary SCIL imprint process (seamless scaling)

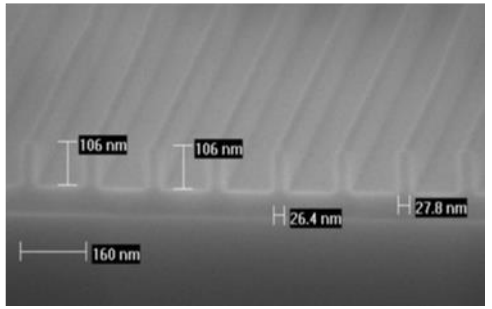
Our imprint resists

- **Proprietary imprint resist properties**

- Fully inorganic solgel based room temperature curing
- Low-shrinkage → < 10%
- Refractive index of 1.15 up to 2.2
- Feature sizes → Tens of microns down to 6 nm
- High aspect ratios
- Non-yellowing, no haze
- High temperature stability when cured → > 400 °C
- Insensitive to humidity UV when cured





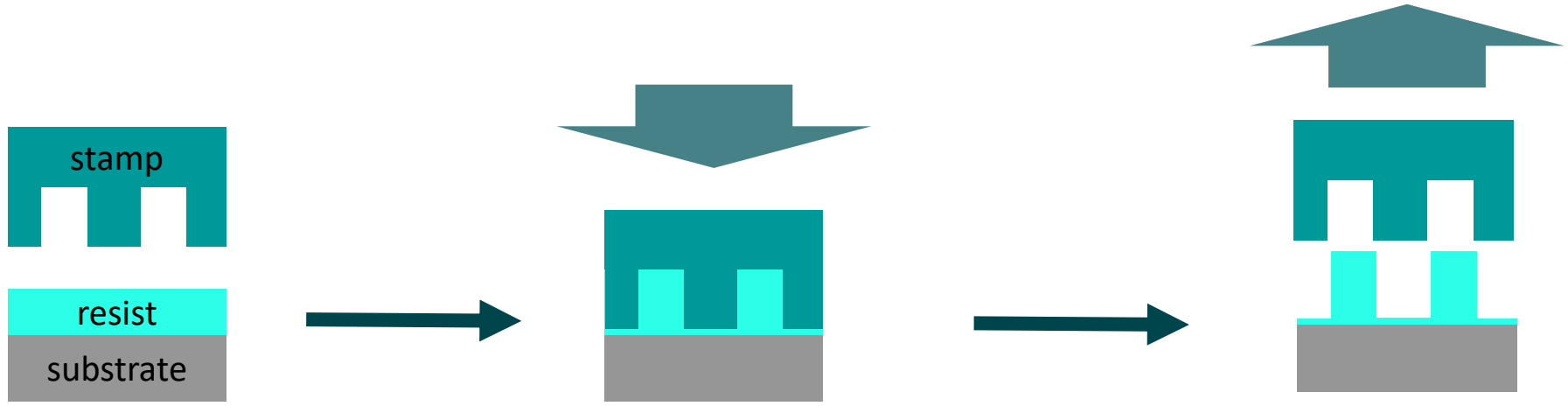


Etched quartz: 6 nm gaps

Nano Imprint Lithography - NIL

SCIL Nanoimprint solutions

- Conventional NIL

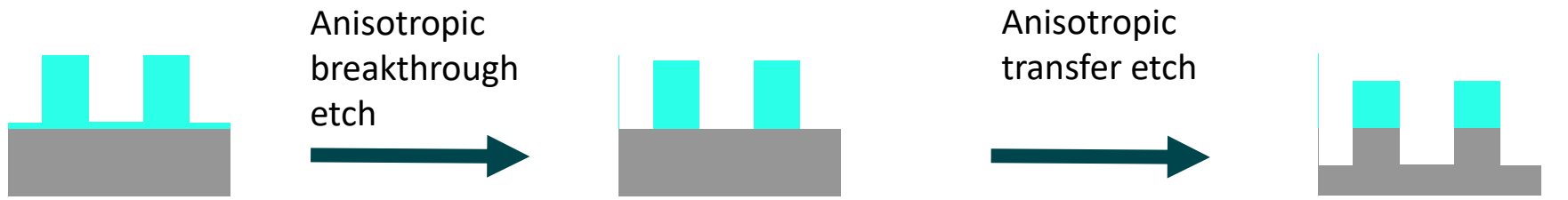


Imprint resist applied to substrate

Force stamp into resist and cure

Release stamp

- NIL process for etch hard mask



Functional layer + residual layer

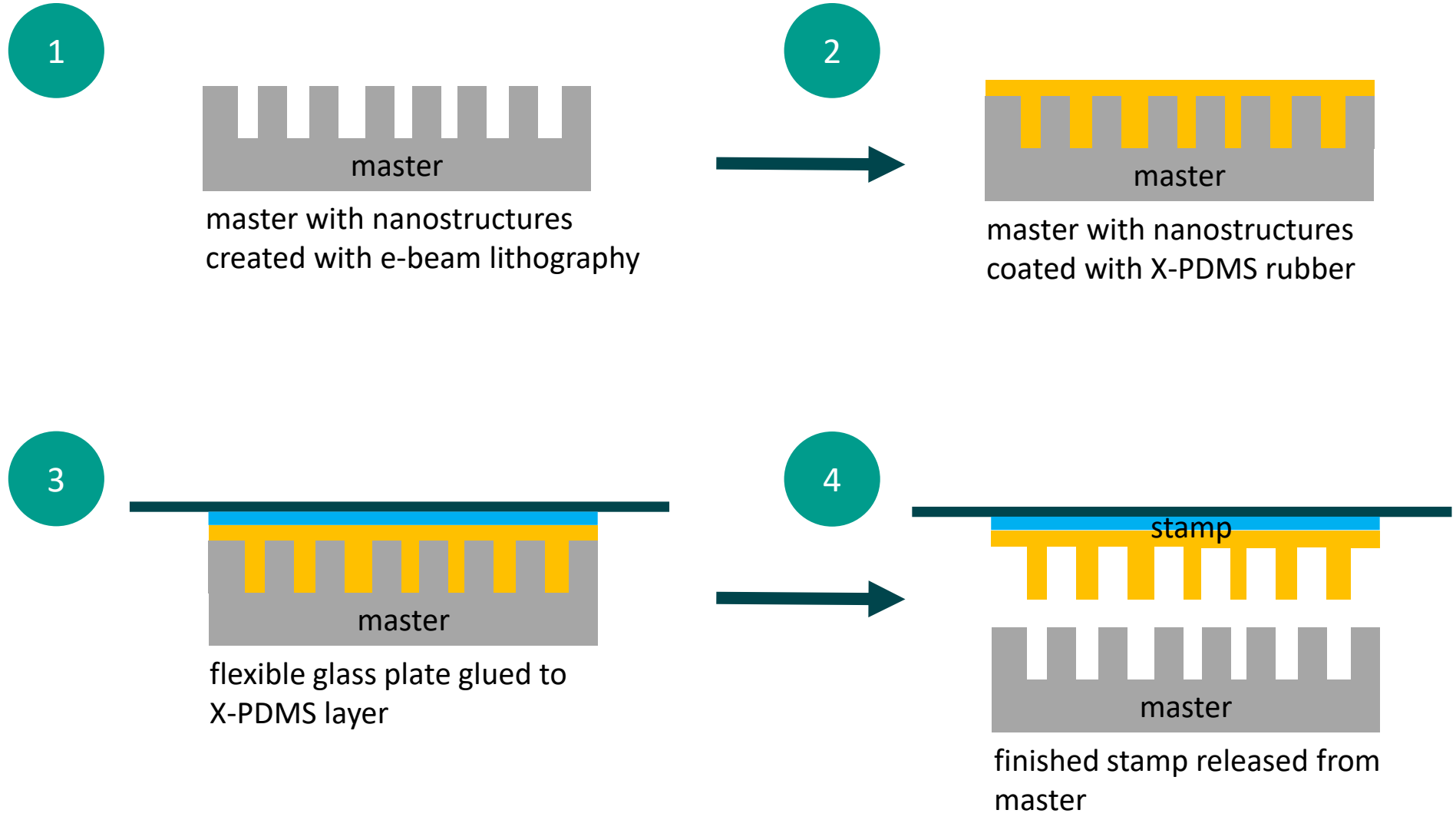
Functional layer as etch mask

Functional layer transferred

Substrate Conformal Imprint Lithography - SCIL

SCIL Nanoimprint solutions

- Stamp or mold creation
- 250+ stamps from 1 master
- 500+ imprints from 1 stamp
- 125k+ imprints from 1 master



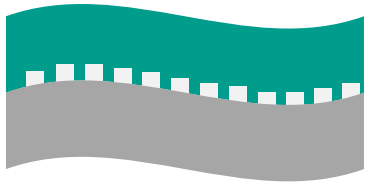
Substrate Conformal Imprint Lithography - SCIL

SCIL Nanoimprint solutions

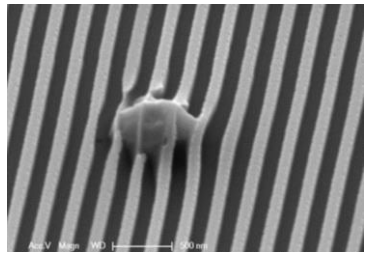
- Rigid quartz stamp

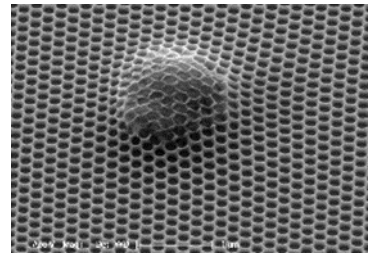
+ resolution
+ low pattern deformation
- low throughput
- need for release layer
- small contact area
- only organic resists
- sensitive to particles
- expensive stamps

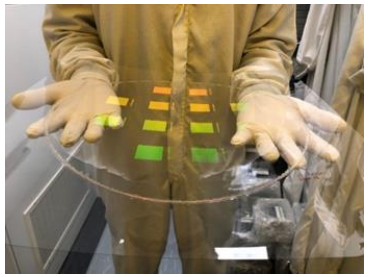
- Soft rubber stamp



- resolution →X-PDMS: + resolution
- pattern deformation → SCIL: + low pattern deformation
+ high throughput
+ intrinsic non-sticking
+ wafer-scale conformal contact
+ organic + inorganic resists
+ insensitive to particles
+ low cost rubber stamps



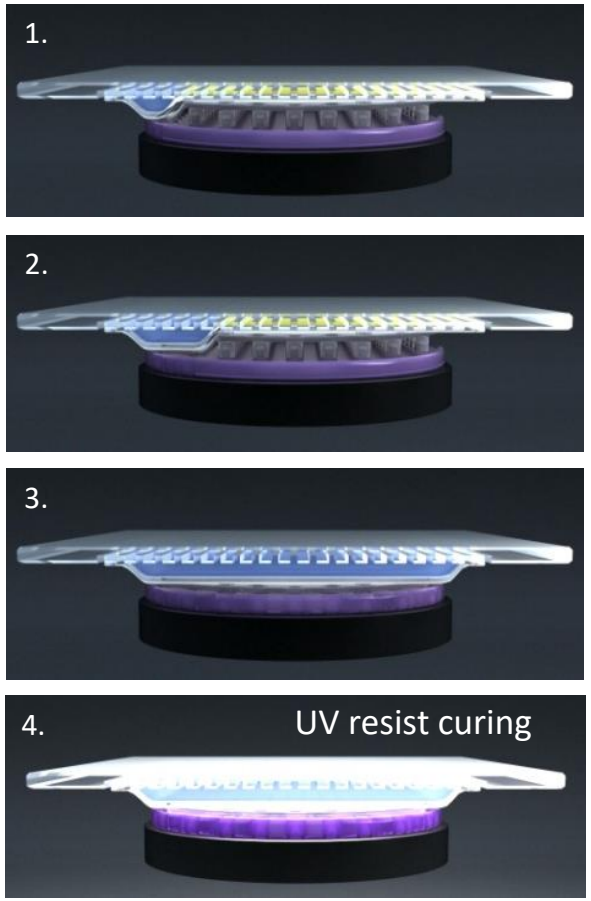




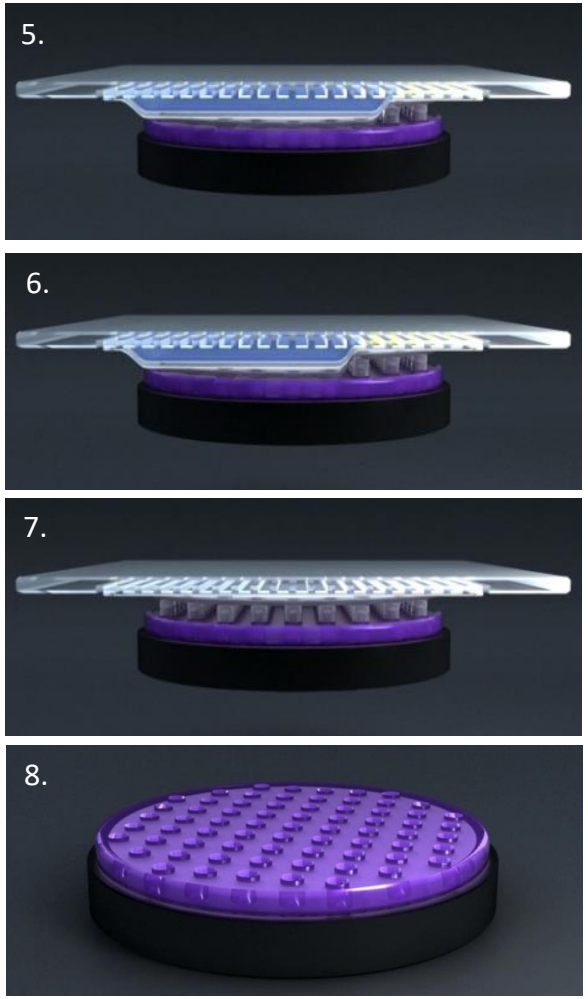
Substrate Conformal Imprint Lithography - SCIL

SCIL Nanoimprint solutions

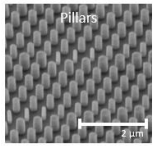
Sequential low pressure imprint cycle.
Capillary force driven.



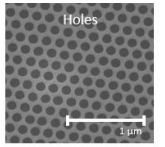
Sequential low force stamp release



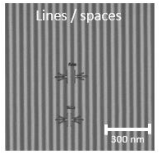
- Scalable technique
- Ultra-low pressure
- 3”-12” wafers demonstrated
- Scalable to larger areas
- Full automatic system
  - Imprint
  - Stamp release
- Low cost soft stamps
- Freedom of resist
  - Organic
  - Hybrid
  - Inorganic



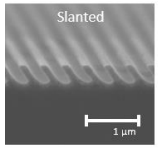
Ø 20 nm
↕ 1500 nm
↔30 nm pitch
aspect ratio: 10



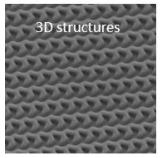
Ø 20 nm
↕ 1500 nm
↔ 50 nm pitch
aspect ratio: 3



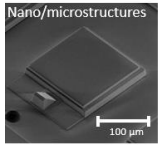
↔ 50 nm pitch
0.1 - 0.9 DC
↕ 1300 nm



∠45°
↕ 350 nm
↔ 300 nm period
0.33-0.66 DC



↕ 0-2000 nm
↔ 100nm – 20 microns
Multiple and continuous height levels



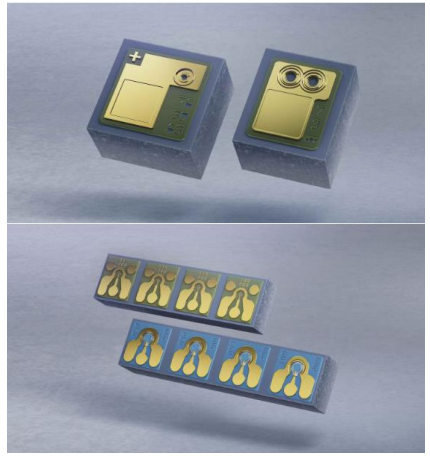
↕ up to 60 µm
Nano / micro patterns combination

Current applications

TRUMPF

❑ Vertical cavity surface emitting laser (VCSEL)

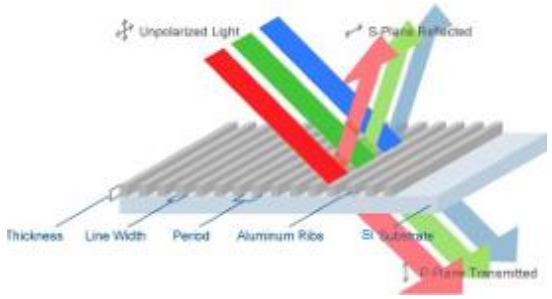
- III-V materials have inherent defects limiting optical litho
- SCIL is used for single-mode VCSELs since 2008 – present
- TRUMPF VCSEL and photodiodes: key components in data communication



MOXTEK

❑ Wiregrid polarizers

- 50/50 nm line/space
- Pixelated polarizers

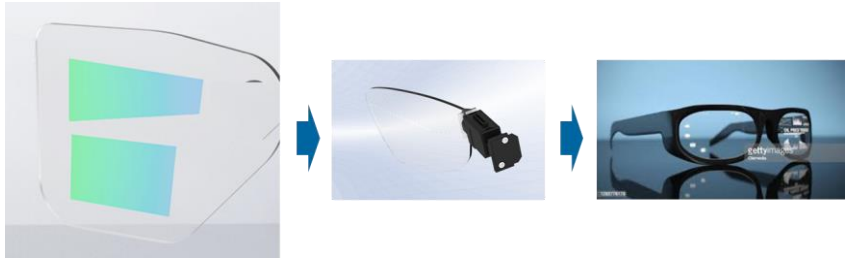


Current applications

undisclosed

❑ Waveguides for AR smartglass

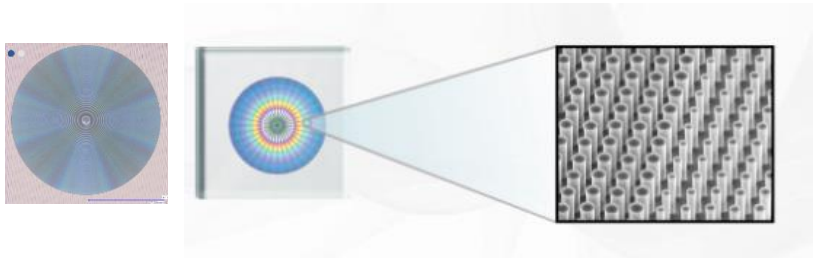
- (Slanted) grating in high refractive material ~ n=2
- Double sided patterning with 500 nm overlay alignment accuracy

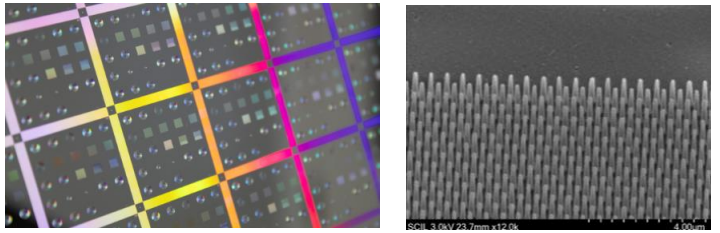


MOXTEK

❑ Metalens

- High-performance metalenses for visible and IR wavelengths
- Full solution, including design, fabrication, measurement, and packaging capabilities at Moxtek



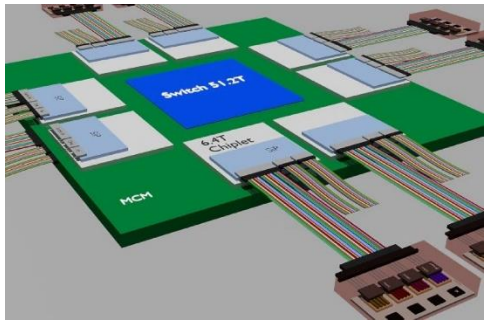


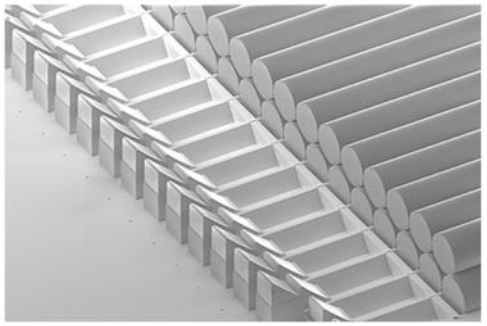
New Applications

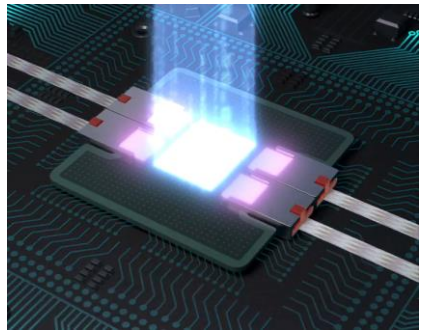
❑ Photonics Integrated Circuits

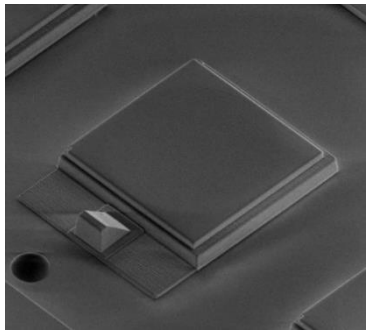
Teramount

- The I/O bottleneck → Data transfer is limited by copper I/O's
- The connection between optics and silicon has not been reliable enough. Until now.
- SCIL is used to produce waveguides for the detachable glassfiber connection to silicon photonics chips, designed by Teramount







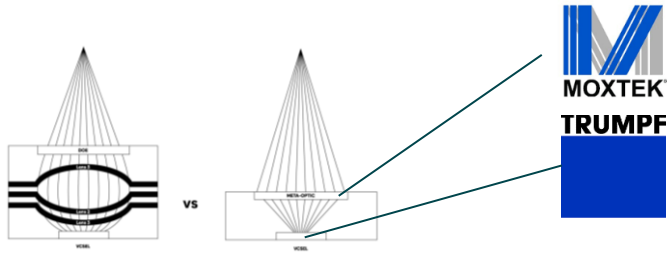


Future Applications

SCIL Nanoimprint solutions

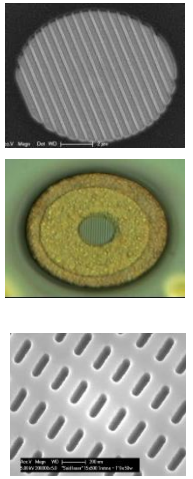
3D sensor for mobile phone

- Replacement of conventional lens with flat metalens single mode
- Polarizing grating to improve light efficiency of VCSEL laser



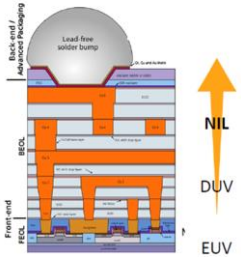
Photonic crystal surface emitting laser (PCSEL)

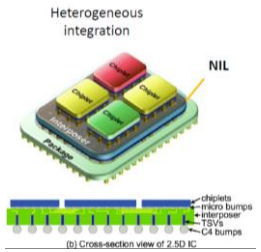
- scaling power output without sacrificing beam coherence
- single-mode operation over larger emission area



Added functionality on:

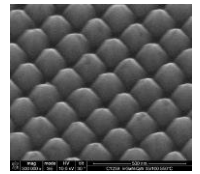
- semicon devices (color filters, polarizers, sensors)
- Chiplets/CPO (single- and multi-mode waveguides, through glass vias, high density interconnects)

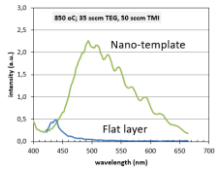


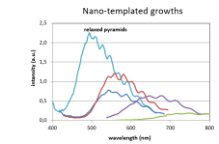


Direct growth of RGB LEDs on wafer

- Nano-templated InGaN growth → full nitride RGB system
- High temperature growth – better quality







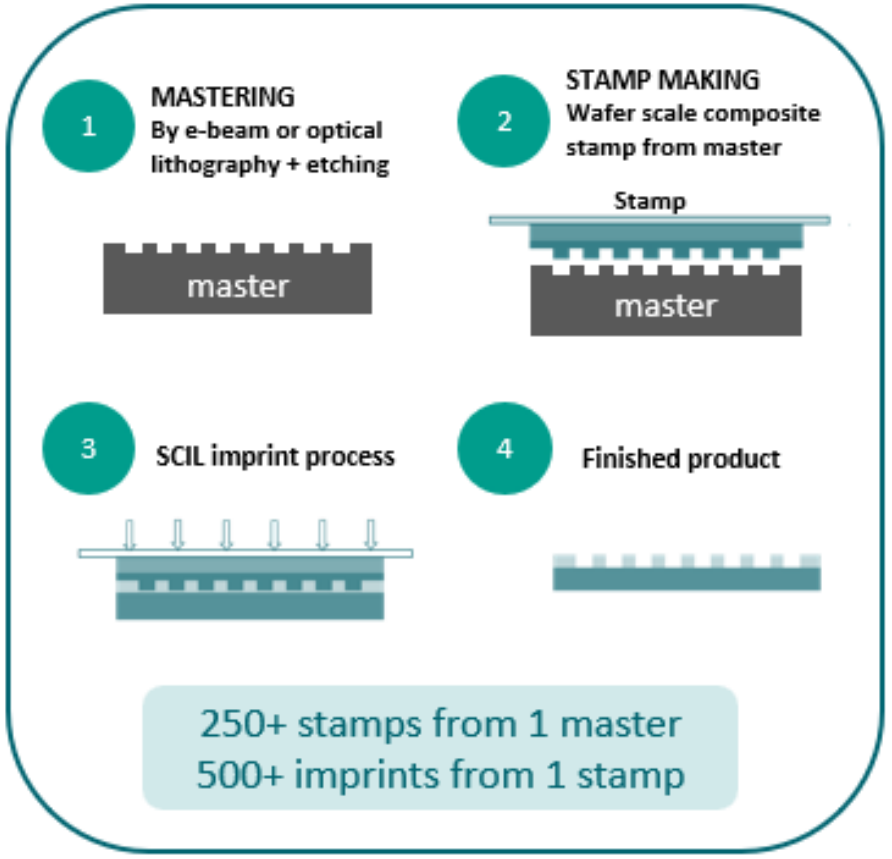
Conclusions

SCIL Nanoimprint solutions

Substrate Conformal Imprint Lithography

- Wafer scale nanoimprinting
- Sub-10 nm resolution
- Wafer scale overlay accuracy ~500nm
- High throughput, high yield
- Low costs
- For use as **hard etch mask** or

  direct patterning functional materials
  - Saving deposition and etch process steps
  - Creating new opportunities in a wide range of applications



> 2.5 Million AR waveguides from one master
> 1 Billion VCSEL lasers from one master
> 300 Million Metalenses from one master

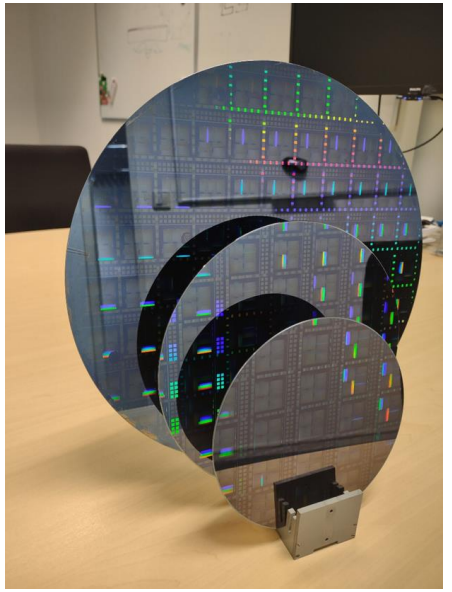
Interested in cooperating with SCIL?

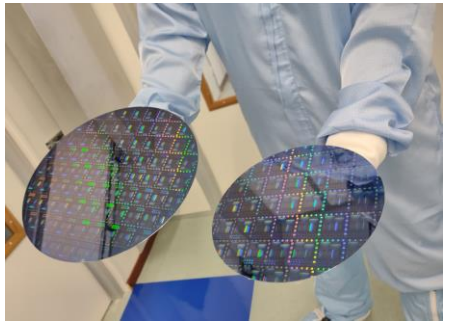
SCIL Nanoimprint solutions

www.scil-nano.com

jeroen.visser@scil-nano.com

+31 6 48449027





SCIL

Nanoimprint solutions

www.scil-nano.com