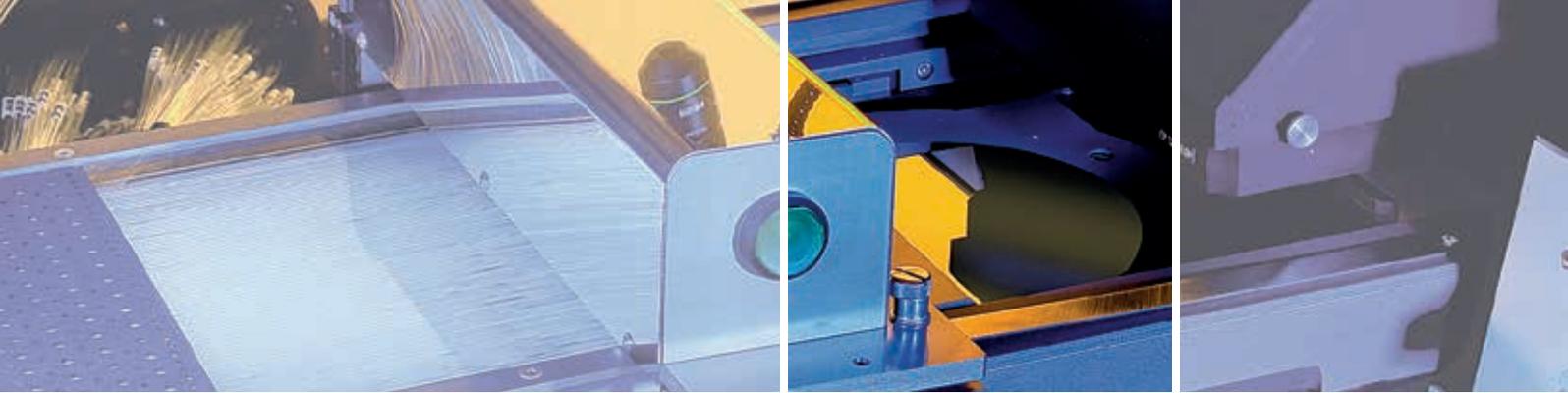


IMPRINT LITHOGRAPHY

MICRO- AND NANO-IMPRINT SOLUTIONS
FOR SUSS MASK ALIGNERS



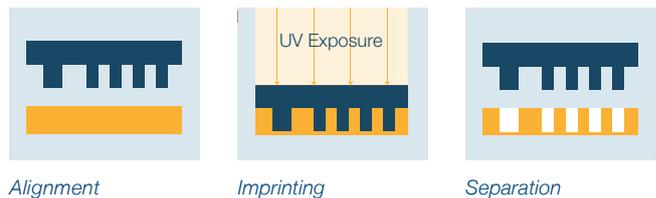
SUSS MicroTec IMPRINT TECHNOLOGIES

ADDRESSING THE CHALLENGES

Imprint lithography has proven itself to be a cost-effective and highly reliable technology for transferring sub-micrometric 3D patterns to a large variety of substrates. The process consists of the following steps:

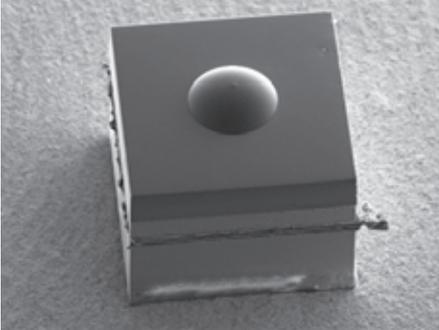
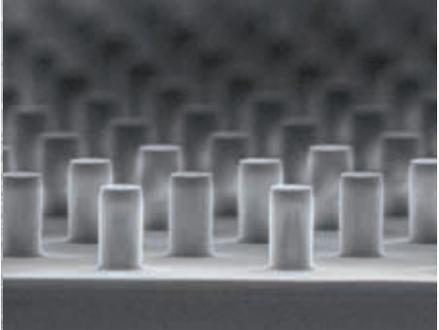
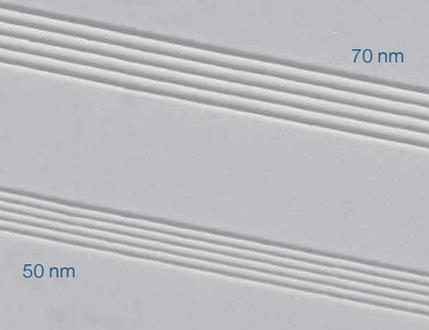
- + The substrate is precisely aligned to the stamp.
- + When the substrate coated with liquid resist is brought into contact with the stamp the resist fills in the cavities of the stamp via capillary forces. The resist typically solidifies by UV cross-linking.
- + Once the stamp is removed, the 3D patterned resist is used either as etching mask or as functional layer on the substrate.

SUSS MicroTec offers various approaches to the imprint technology, tailored to the specific process requirements of different applications.



All imprint solutions are based on SUSS MicroTec's highly regarded semi-automated mask aligner suite and support multiple substrate materials and sizes from small pieces up to 200mm wafers. The mask aligner platform not only allows for accurate alignment of stamp to substrate but also provides valuable functionalities such as precise stamp-to-substrate levelling and contact pressure control. Process recipes are conveniently edited, offering a high degree of tunability for all relevant parameters. SUSS mask aligners already in the field are easily upgraded with imprint tooling.

SUSS MicroTec IMPRINT TECHNOLOGIES

SMILE SUSS MicroTec Imprint Lithography Equipment	SCIL Substrate Conformal Imprint Lithography	UV-NIL UV Nanoimprint Lithography
		
MEMS, optical lenses	LED, photovoltaics, optical elements, MEMS/NEMS	MOEMS/optoelectronics



APPLICATIONS

WIDE FIELD OF OPERATION

Special substrate conditions such as uneven or warped wafers, materials like glass, sapphire, III-V compounds and challenging structure properties such as high aspect ratios, small feature sizes or non-periodic

structures, place high demands on imprint equipment. SUSS MicroTec's imprint solution portfolio offers the flexibility to cover a wide range of applications.

LED

The demand for high performing LED is leading manufacturing towards PSS/nPSS technology. The cost-effectiveness and high yield of SUSS imprint technologies optimally address the challenges of this competitive market.

MEMS/NEMS

MEMS typically pose manufacturing challenges with their high topography and non-periodic structures. SUSS MicroTec not only offers a wide range of specific functions especially adapted for MEMS, but also delivers highly accurate alignment as needed for optical gratings.

MICROOPTICS

Imprint lithography ideally implements the manufacture of optical devices such as wafer-level cameras and image sensors into well-established semiconductor processes. SUSS MicroTec provides reliable imprint solutions specially for patterning optical elements.

OPTOELECTRONIC SENSORS

Optical nano-gratings are key components for the communication market worldwide. SUSS MicroTec provides a full-field solution that reproduces with the highest fidelity the grating patterns.

STRONG PARTNERS

COUNTING ON EXPERTISE

SUSS MicroTec works hand-in-hand with material suppliers along the supply chain and with research partners to support the integration of imprint technologies in the field. A highly qualified network of experts leads users through the customization of processes in order to successfully address specific applications. An experienced SUSS team functioning as main customer contact responds to all technology-related queries. Together with its cooperation partners, SUSS MicroTec is able to conveniently offer turn-key solutions for imprint applications – from the development of processes and materials to the setup of pilot productions.



Supply Chain Resist suppliers Stamp material suppliers Master supplier	Research Partners Process development Application support Pilot production
SUSS MicroTec Imprint equipment Demonstrations Application support	



SMILE

WHEN FLEXIBILITY IS NEEDED

Imprint lithography is essential to fabricate the micro-optical devices needed in the production of wafer-level cameras and image sensors. Control over accuracy and uniformity of the optical devices is critical to precisely target the specific optical properties of the final product.

With SMILE (SUSS MicroTec imprint lithography equipment), SUSS MicroTec provides a highly flexible technology for large-area patterning on its mask aligner platform. By adapting to the particular applications, the tooling presents different procedure possibilities:

MICRO-PATTERNING

An optically tailored resist is dispensed as a puddle on the substrate surface. By moving the substrate in contact with the stamp, the resist spreads radially between the substrate and stamp stack, filling the 3D patterning of the stamp.

NANO-PATTERNING

A flexible stamp is bent at the center and brought into contact with the substrate coated with resist. The contact wave extends radially to the substrate's outer edge. As a final step the resist solidifies (for example via UV illumination). The stack is then separated and the negative of the pattern features remains in the resist on the substrate.

Accurate wedge error compensation and gap setting are therefore crucial factors for imprint lithography. The SUSS mask aligner platform provides an active wedge error compensation system that employs piezo-electric linear actuators, a highly accurate gap measurement system and a force detector. This accomplishes exact lateral and axial alignment of the stamp to the substrate.

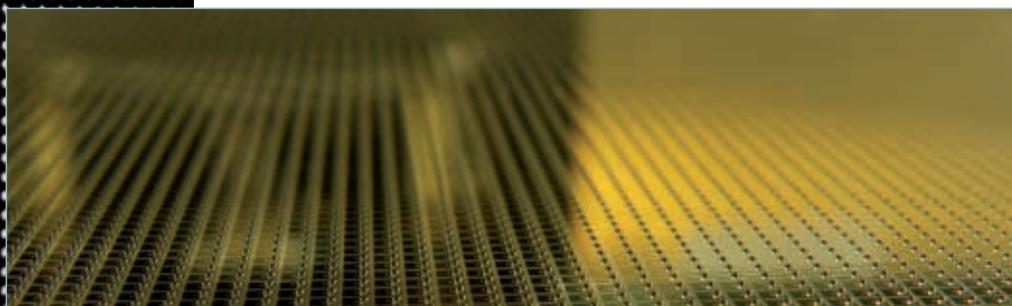
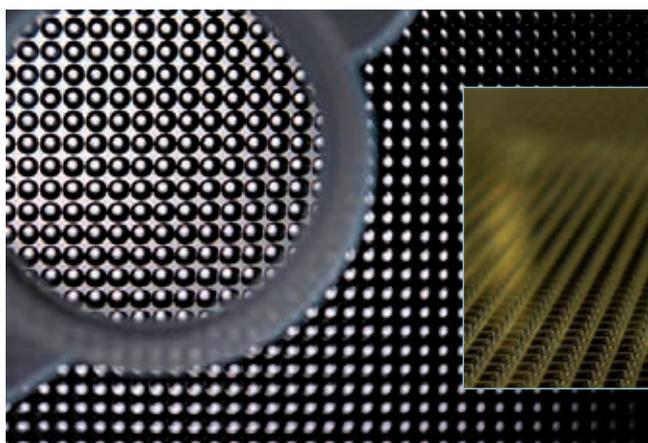


HIGHLIGHTS

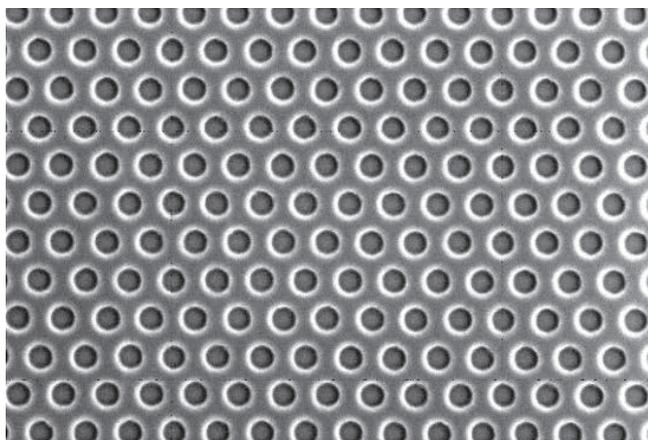
- + Precise control over resist thickness and uniformity
- + Arbitrary substrate materials
- + Double-sided patterning capability
- + High alignment accuracy
- + Edge handling or buffer wafers to avoid lens contact
- + Warped wafer handling



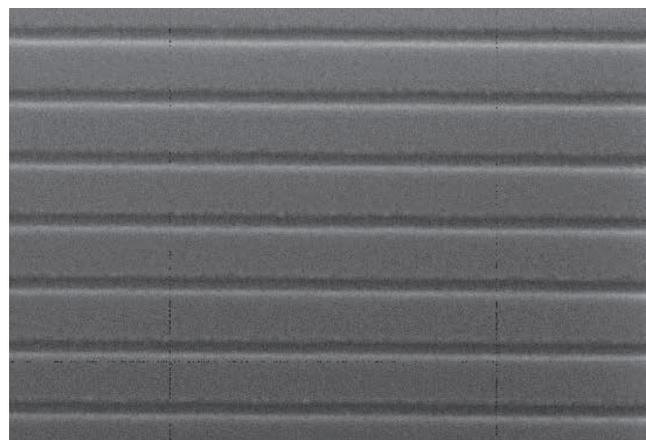
Illustrations of Imprinted Features



Microlenses formed with DELO resist



D: 100 nm; pitch: 190



W: 50 nm; pitch: 550

Combinations of lines and spaces and dots patterns fabricated with SMILE technology

Source: SUSS MicroTec

Process Specifications*

	<i>Micro-imprint</i>	<i>Nano-imprint</i>
Wafer sizes	Up to 200 mm	Up to 200 mm
Imprinted area	Up to 200 mm	Up to 200 mm
Resolution of imprinted structure	From mm to < 100 nm	From mm to < 100 nm

* Achievable specifications depend on wafer flatness, resist and stamp type, and cleanroom class

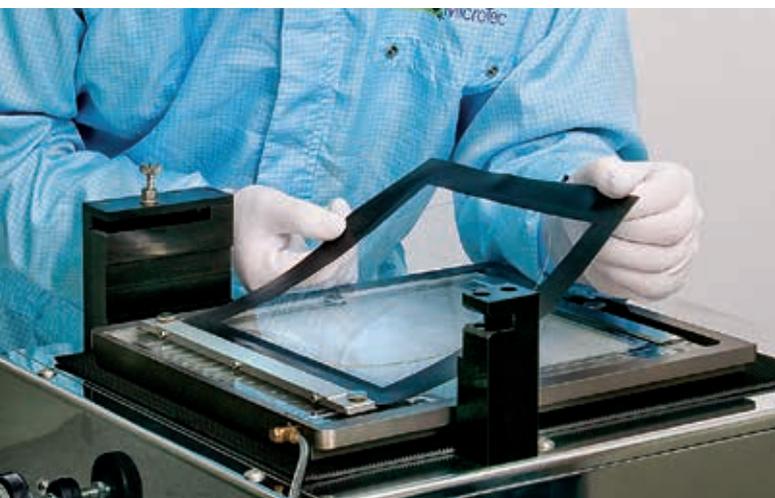


SCIL

FOR HIGH DEMANDS ON PROCESS CONTROL

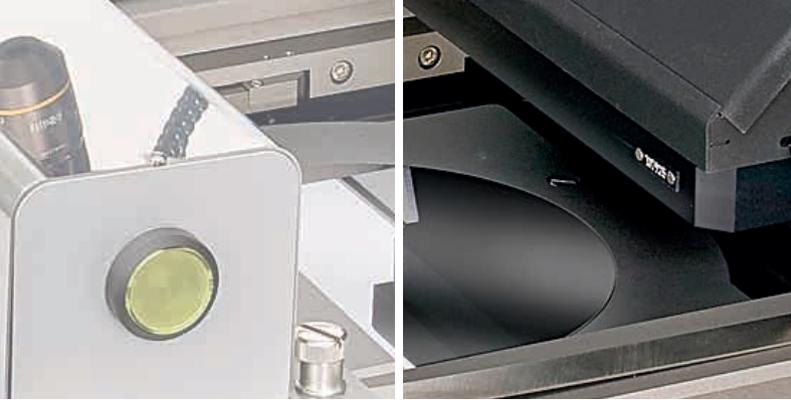
For highly demanding imprint processes SUSS MicroTec offers SCIL (substrate conformal imprint lithography) technology as best-in-class residual layer control for optimal definition of etching masks. The method combines a soft composite working stamp with a rigid glass carrier to achieve low pattern deformation.

In the SCIL process, the nano-imprint resist fills pattern features via capillary forces, employing very low pressure and therefore minimizing pattern distortion and residual layer-thickness variation. The stamp is brought into contact with the substrate and is separated in a sequential movement, allowing for a fully automatic handling and avoiding forces that may damage substrate and generated structures. This proprietary method, developed in collaboration with Philips Research, results in a reduction of air inclusions even in large-area printing, thus improving the uniformity of imprinted structures. Its excellent substrate conformality and pattern fidelity over large areas make SCIL a powerful tool for applications like LED/VCSEL, optical gratings and MEMS/NEMS.



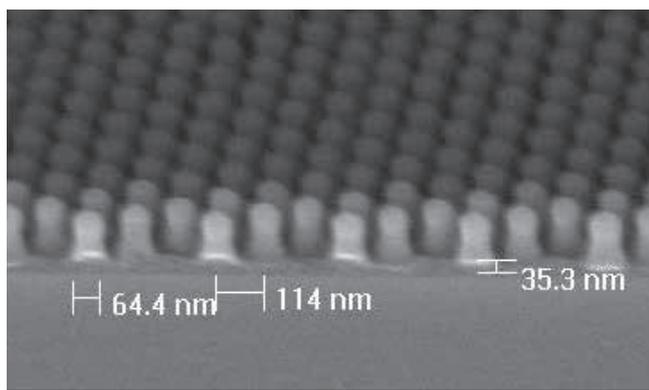
HIGHLIGHTS

- + Full-field imprints
- + High resolution
- + Multiple stamps from one single master and high number of imprints with every stamp
- + High alignment accuracy
- + Flexible composite stamp to avoid lateral deformation and to accommodate substrate unevenness
- + Accurate feature replication due to low stress sequential stamp application and separation



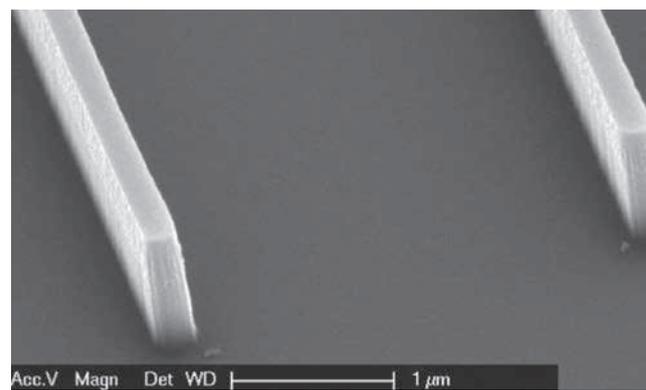
Illustrations of Imprinted Features

HIGH DENSITY



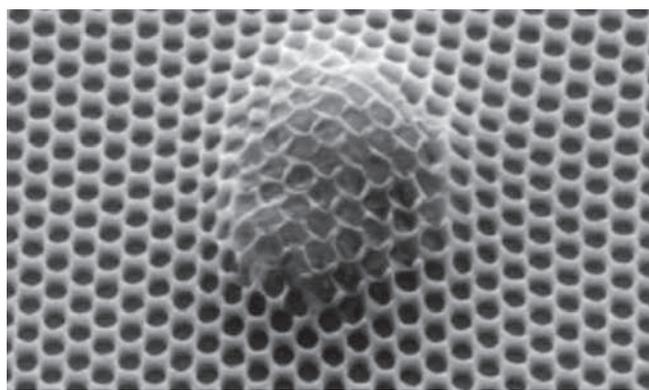
Posts in sol-gel \varnothing 65 nm
Aspect ratio 1:2
Residual layer thickness 25-35 nm

HIGH ASPECT RATIO



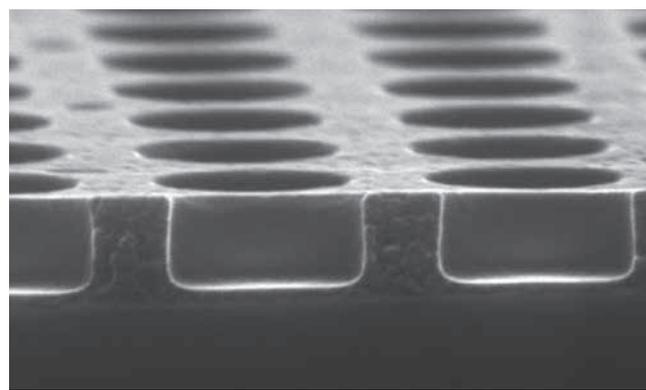
200 nm gratings imprinted in sol-gel.
Aspect ratio: 1:3

HIGH SUBSTRATE CONFORMALITY



Pattern imprinted over a particle contaminant which was present on the substrate, demonstrating substrate conformal imprinting.
Source: Philips

HIGH UNIFORMITY



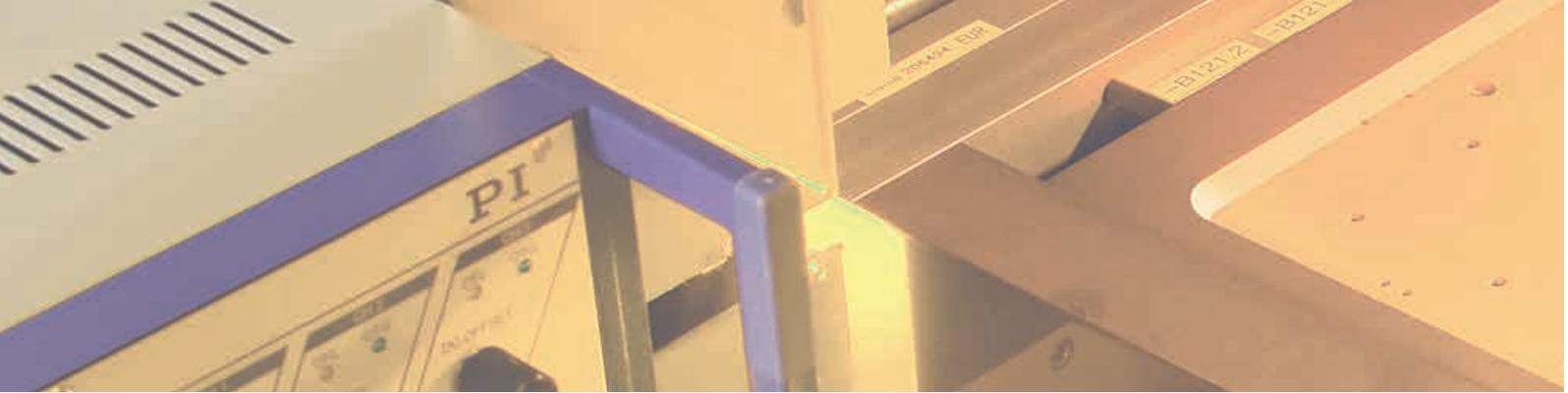
Residual layer: 5 % at 37 nm
Structure depth 2 % at 169 nm
Pitch: 0.2 % at 514 nm

Process Specifications*

Wafer sizes	Up to 200 mm
Imprinted area	Up to 200 mm
Resolution of imprinted structure	70 nm
Residual layer thickness uniformity	5 %

Courtesy: Philips Innovation Services

* Achievable specifications depend on wafer flatness, resist and stamp type, and cleanroom class



UV-NIL

COST-EFFICIENCY AND HIGH RESOLUTION



UV-NIL (ultraviolet nano-imprint lithography) is a low-cost solution for replicating structures in small areas with resolution as low as a few nanometers. With UV-NIL technology, a rigid quartz stamp transfers structures onto a UV-sensitive resist coating on the substrate. Afterwards the material cures under exposure to UV light. The mask aligner platform comprehensively supports the printing process with wedge error compensation that enables precise levelling of the substrate to the stamp, which is fundamental to imprint uniformity. Stamp and substrate can also be accurately aligned. The setup allows for precise control of all crucial process parameters such as pressure, distance and speed making the tool extremely versatile and ideal for research and development. Additional tooling is also suited to producing in-house low-cost test stamps with sub-micrometric resolution. UV-NIL technology by SUSS MicroTec delivers a valuable solution for developing of next-generation semiconductor, MEMS/NEMS and opto-electronic technology and is the ideal starter kit for Research.

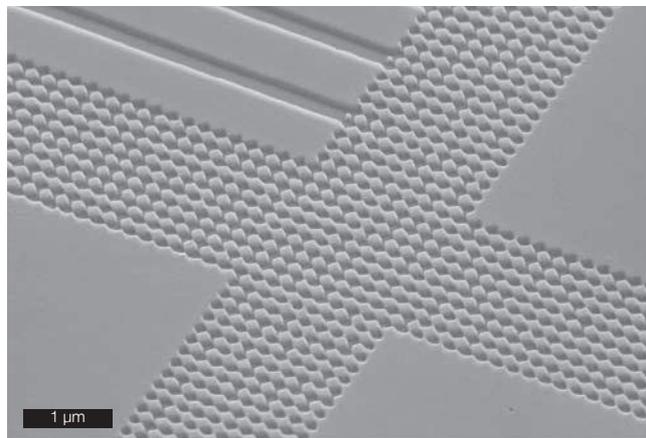
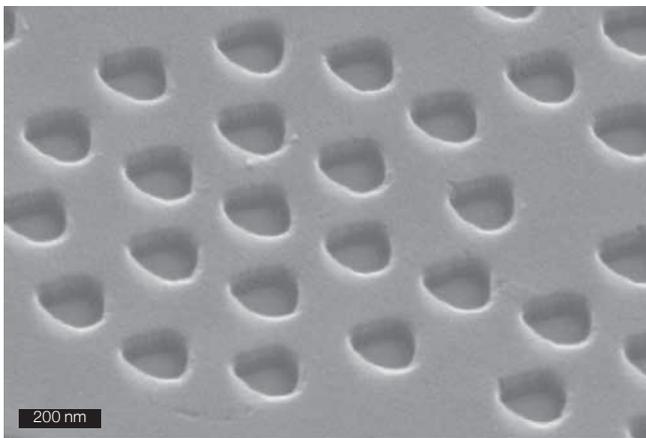
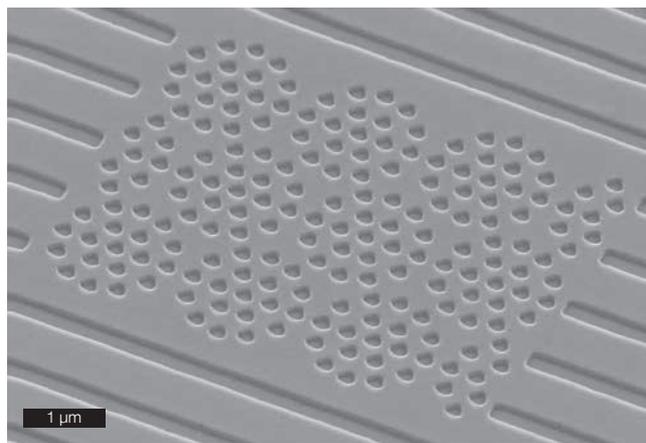
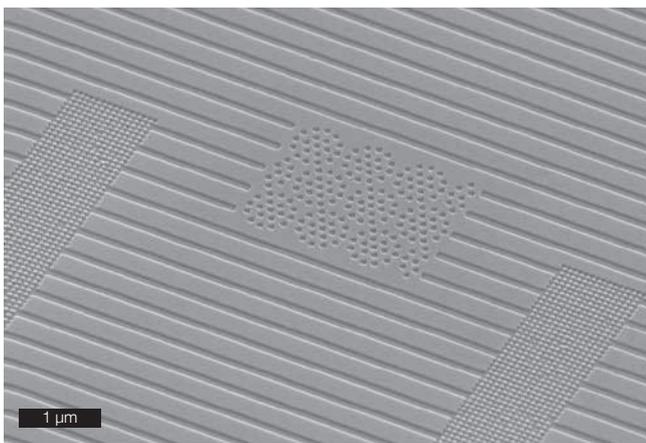
HIGHLIGHTS

- + Easy handling, especially suited to university environment
- + Alignment in submicron resolution
- + High leveling precision for good residual layer uniformity
- + Control of printing parameters via recipe editor
- + Long-life quartz stamp provides high resolution



Illustrations of Imprinted Features

HIGH RESOLUTION STRUCTURES



Combinations of lines and spaces and dots patterns realized with UV-NIL technology Imprint in Amonil (AMO GmbH)
Source: SUSS MicroTec

Process Specifications*

Wafer sizes	Up to 100 mm
Imprinted area	1"x1"
Resolution of imprinted structure	< 50 nm

* Achievable specifications depend on wafer flatness, resist and stamp type, and cleanroom class



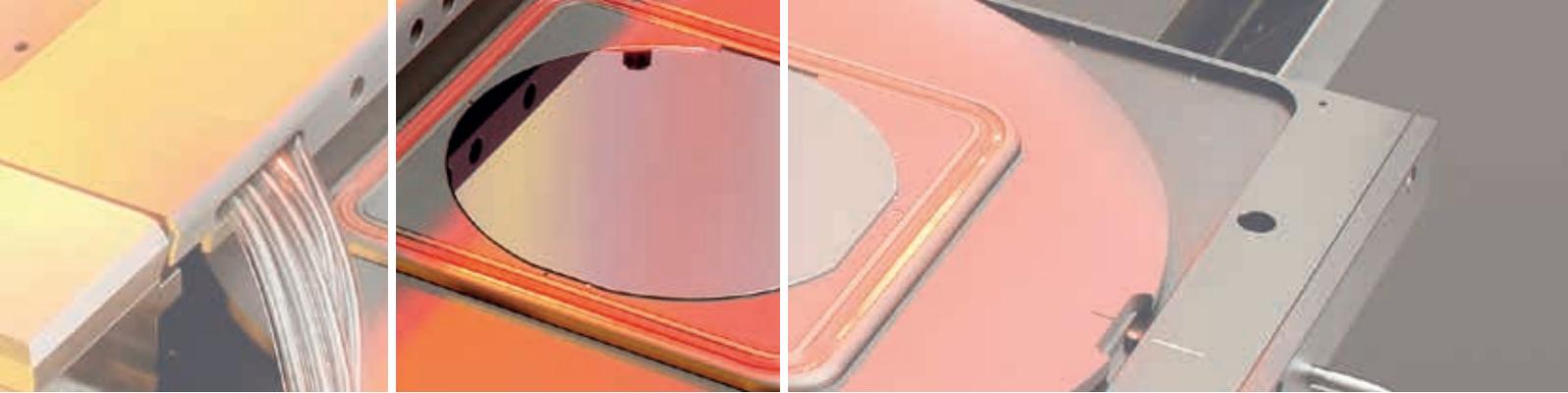
SUSS MicroTec IMPRINT TECHNOLOGIES

SOLUTIONS THAT FIT MANY NEEDS

SUSS manual and semi-automated mask aligners are designed for maximum versatility. Fast and easy switching between all options and wafer/substrate sizes is at the core of SUSS MicroTec's imprint technologies.

Different options in one tool save cleanroom space as well as investment costs, thus providing a high degree of flexibility in process and device development.

SMILE	SCIL	UV-NIL
		
<p>High process flexibility: from micro to nano</p>	<p>Best residual layer for optimal definition of etching masks</p>	<p>Highest resolution and ease-of-use</p>
<ul style="list-style-type: none"> + Soft stamp on glass carrier + Flexible and/or rigid stamp + Full-field imprint up to 200 mm + Tunable pressure imprint + From mm to < 100 nm 	<ul style="list-style-type: none"> + Soft stamp on glass carrier + Flexible stamp + Full-field imprint up to 200 mm + Low-pressure imprint + 70 nm 	<ul style="list-style-type: none"> + Hard quartz stamp (soft stamp on quartz carrier optional) + Rigid stamp + Small imprint area 1"x1" + High-pressure imprint + < 50 nm
<p>MA/BA Gen4 Pro Series</p>	<p>MA/BA Gen4 Pro Series MA/BA6</p>	<p>MA/BA Gen4 Pro Series MA/BA6 MJB4</p>



SUSS MicroTec IMPRINT LITHOGRAPHY PLATFORMS

WHERE ACCURACY MATTERS

SUSS MicroTec's imprint solutions are designed as an add-on to its manual and semi-automated mask aligner suite, which supports multiple substrate materials and sizes ranging from small pieces up to 200 mm wafers. The mask aligner platform not only allows for an accurate alignment of the substrate to the stamp but

also offers valuable functions such as precise substrate-to-stamp levelling and contact-pressure control. Editable process recipes provide for a high degree of tunability for all relevant parameters. SUSS mask aligners already in the field are easily upgraded with imprint options and tooling.

MA/BA Gen4 Pro Series

With its superior solutions the fourth generation of SUSS MicroTec's mask and bond aligner platforms meets the demands of challenging research and development environments as well as of semi-automated production.



Features

- + Up to 200 mm substrate size
- + Top- and bottom-side alignment, IR alignment
- + Automated alignment with image processing
- + Mask-to-wafer and wafer-to-wafer alignment
- + Contact and proximity exposure
- + Diffraction-reducing optics
- + MO Exposure Optics for unmatched light uniformity
- + Full-surface plasma activation
- + Selective plasma activation (MA/BA8 Gen4 Pro only)

MA/BA6

The MA/BA6 mask aligner offers high precision and reliability solutions for mask aligner and imprint lithography in R&D and operator-assisted production.



Features

- + Up to 150 mm substrate size
- + Top- and bottom-side alignment, IR alignment
- + Mask-to-wafer and wafer-to-wafer alignment
- + Contact and proximity exposure
- + Diffraction-reducing optics
- + MO Exposure Optics for unmatched light uniformity

MJB4

Owing to its ease of handling and compact size the MJB4 mask aligner is an ideal system for research and development.



Features

- + Up to 4" substrate size
- + Top-side and IR alignment
- + Contact exposure
- + Diffraction reducing optics
- + Multiple language GUI

NORTH AMERICA

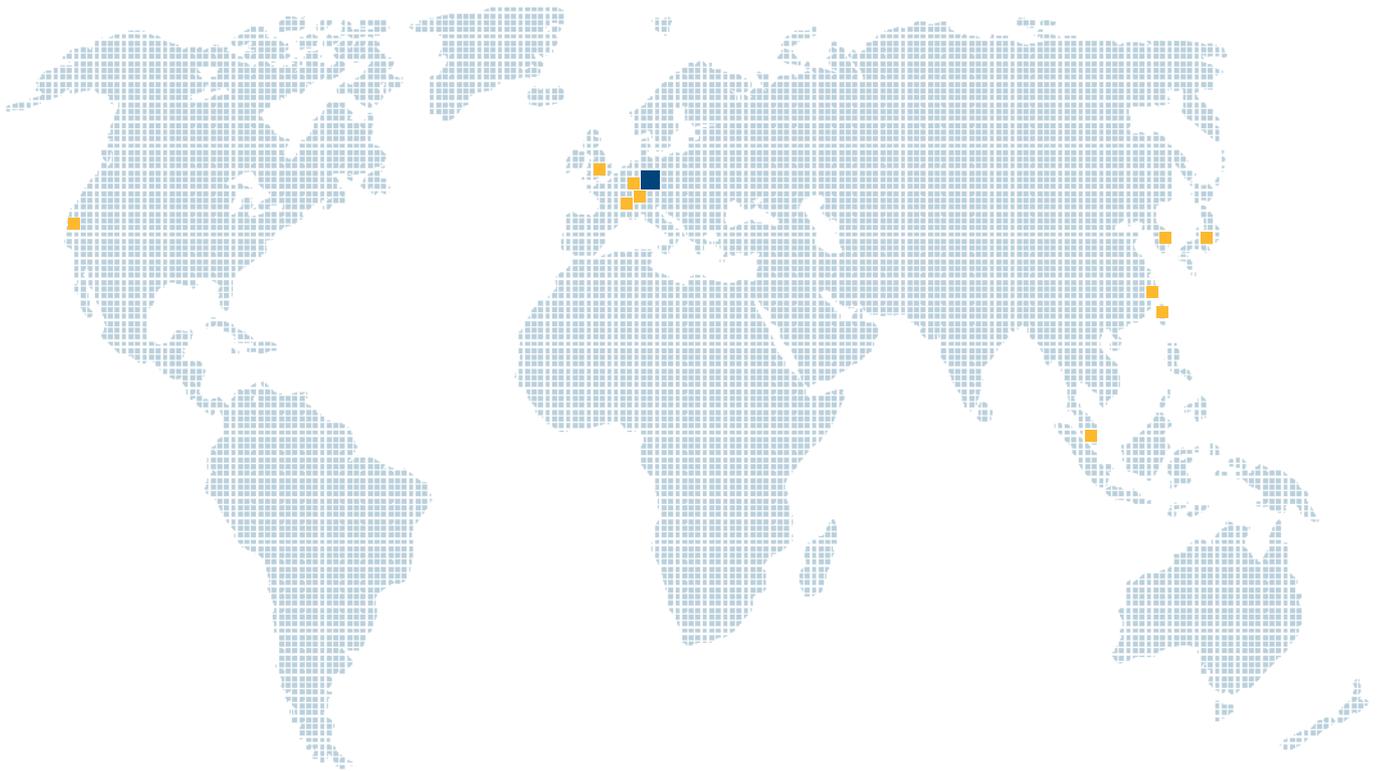
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