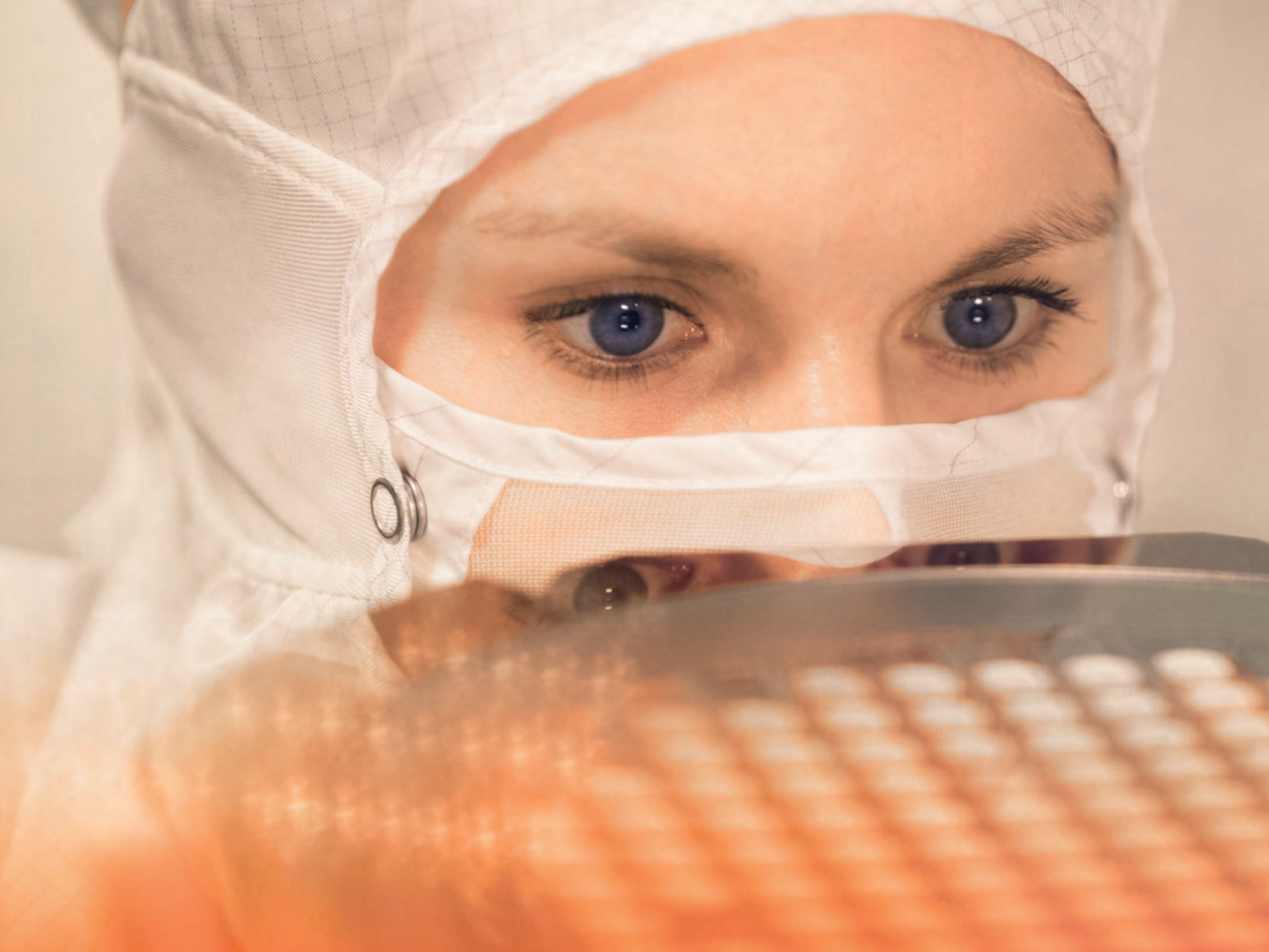
SÜSS MicroOptics



CONTENTS

OVER TWO DECADES OF SWISS MICRO-OPTICS EXPERIENCE

SUSS MicroOptics SA was founded in 1999 with the remit to supply its parent **SUSS MicroTec AG** with micro-optical elements for their lithography equipment. As the market for micro-optics grew, **SUSS MicroOptics** expanded to meet the new and diverse requirements, developing its product portfolio and expertise to become one of the leading producers of precision refractive and diffractive micro-optics in the world.

SUSS MicroOptics is recognized by Carl Zeiss SMT GmbH as a preferred supplier and first became ISO 9001 and IATF16949 certified in 2008. SUSS MicroOptics is a major supplier for datacom, telecom and automotive lighting.

In 2013 it moved to its current premises, complete with state-of-the-art cleanroom, from where it continues to deliver excellence to its international customer base.

SUSS MicroOptics is a wholly owned subsidiary of **SÜSS MicroTec SE**, a leading supplier of products and solutions for backend lithography, wafer bonding and photomask processing.

OUR QUALITY POLICY

SUSS MicroOptics is committed to providing the highest quality products and services.

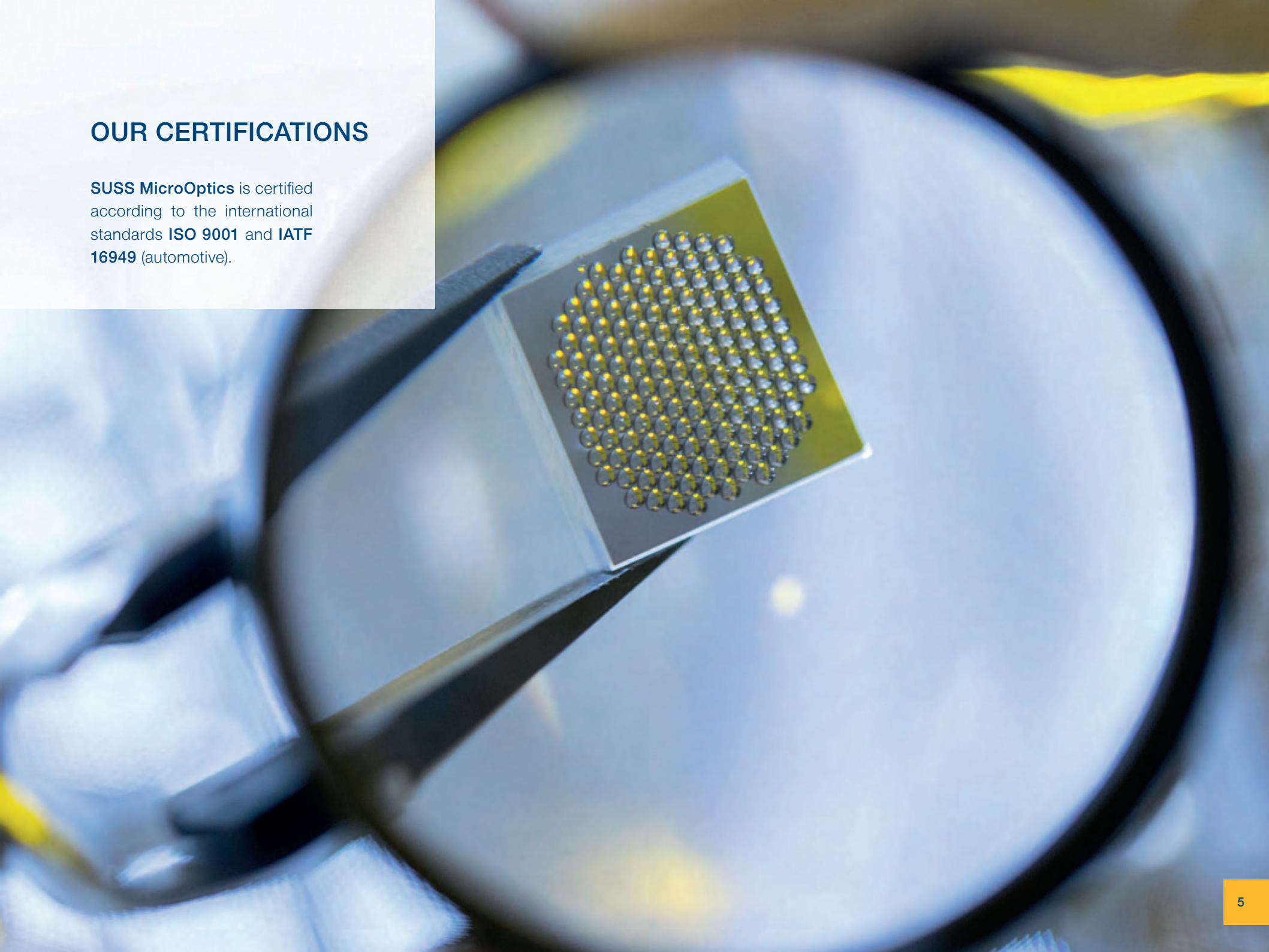
We value our customers and aim for the total satisfaction of their needs through enjoyable, efficient and effective interactions.

Our goal is zero defects through preventive actions. We strive to do the right thing the first time. If a problem does arise, we take immediate action to resolve it in an efficient and effective manner.

For more information please visit **suss-microoptics.com**

OUR CERTIFICATIONS

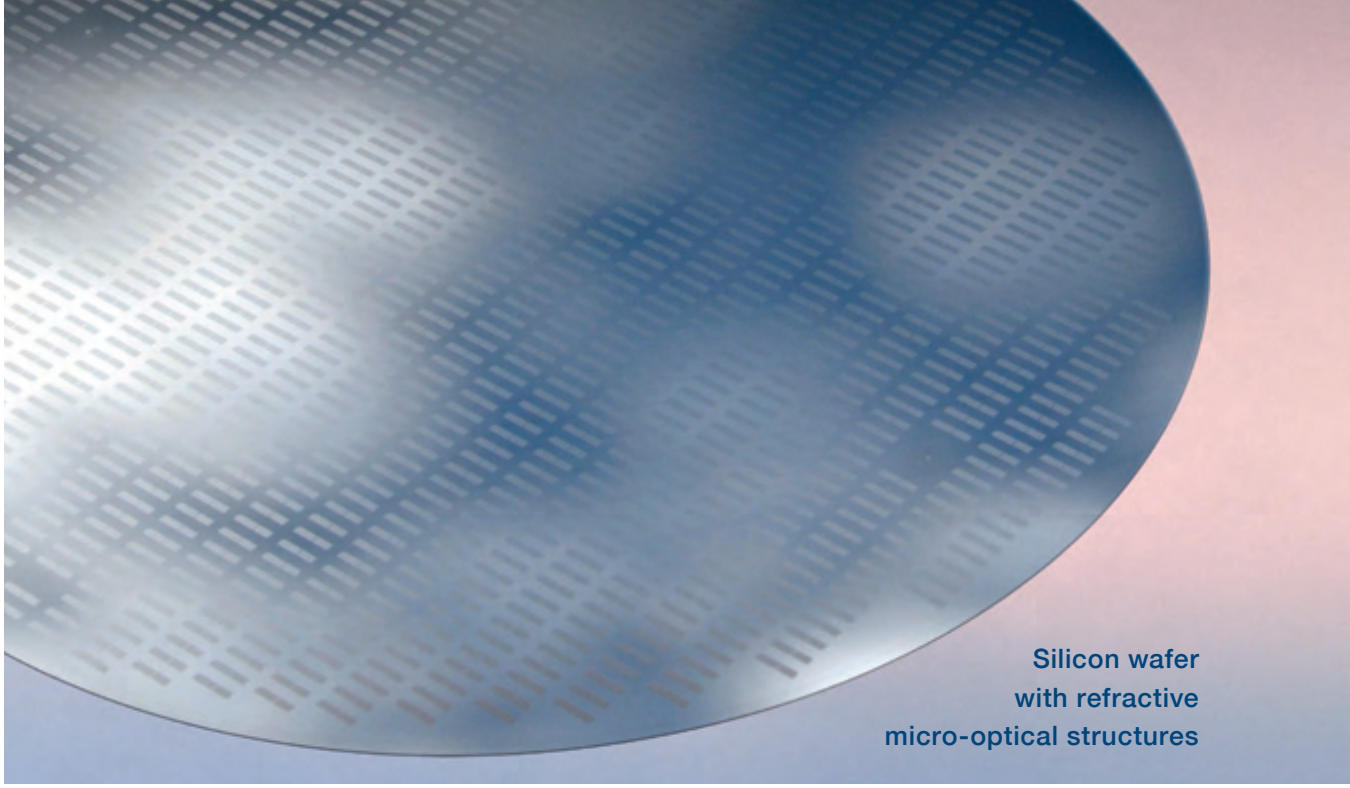
SUSS MicroOptics is certified according to the international standards **ISO 9001** and **IATF 16949** (automotive).



OUR MICRO-OPTICS SET THE STANDARDS

SUSS MicroOptics is committed to providing the highest quality components underpinned by cutting edge manufacturing techniques.

Combined with a unique blend of people skills, its innovative advances in technology make SUSS MicroOptics a leader in its product offerings.



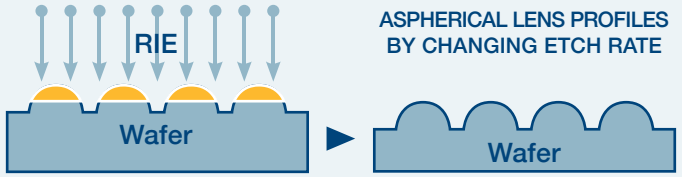
Silicon wafer with refractive micro-optical structures

PHOTOLITHOGRAPHY

Thick film photoresists are optimized for mask aligner lithography. **Exposed areas become transparent and guide the exposure light linearly into deeper resist regions.** After development, the resist structure is melted to obtain a rounded shape.

REACTIVE ION-ETCHING

In the next step the micro-optical structures are transferred into the bulk wafer material. **The etching process removes atoms from the resist and wafer surface at different etch rates.** Surface areas covered by resist structures are protected until the covering resist layer is removed.



PROTOTYPING TO VOLUME PRODUCTION

SIMULATION

DESIGN REVIEW

MANUFACTURING REVIEW

PROPOSAL

PROTOTYPE MANUFACTURING

REVIEW & ACCEPTANCE WITH THE CUSTOMER

PRE-SERIES & VOLUME PRODUCTION

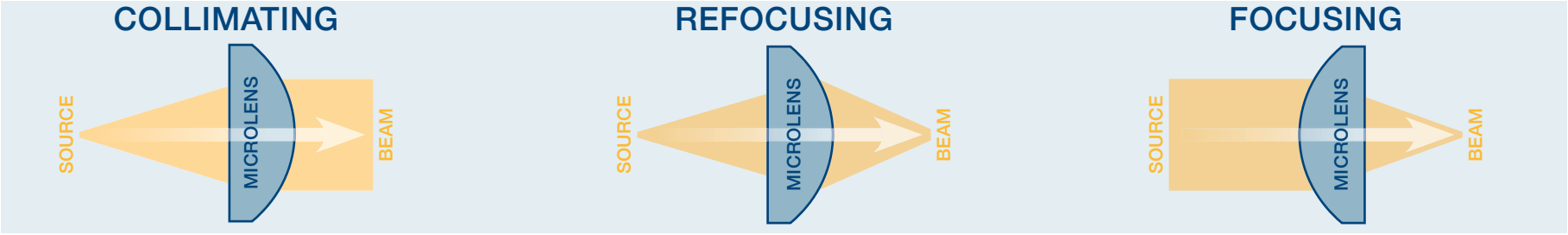
SUSS MicroOptics SA currently has class 100, 1,000 **and** 10,000 cleanrooms, **along with** fully operational production lines for 8" wafers.

FIBER COUPLERS AND PIC COLLIMATORS

IT´S ALL ABOUT EFFICIENCY

SUSS MicroOptics provides a broad range of customized microlenses for efficient collimation and light coupling for fiber optics, as well as Si-Photonics, PIC, WSS, laser diodes, VCSEL, CWDM, DWDM and more. These MLA's can be used for the visible and infrared applications.

SPECIFICATIONS	
Materials	Fused silica (various grades), silicon
Numerical aperture (NA)	Typically 0.09 to 0.6 (fast and slow axis collimation)
Mode Field Diameter (MFD)	0.6 µm to 50 µm
Beam Diameter/Output	50 to 400 µm, others on request
Fiber/Waveguide types	SMF, MMF, LD, PIC, Si-Photonics
Back focal distance	Typically 0 to 300 µm
Pitch	82 µm, 125 µm, 250 µm, 500 µm, 750 µm, and custom pitch
Lens type	Circular, cylindrical
Lens profile	Spherical, aspheres, DOEs
Arrays	Linear, quadratic, hexagonal, custom
Number of lenses per array	According to customer requirements
AR coating	UV, VIS, NIR – front-side, back-side, against air or glue



TYPICAL APPLICATIONS

TELECOM/DATACOM	3D SENSING	MEDICAL

KEY FEATURES

+ 1D & 2D microlens arrays
+ Highest quality and precision
+ Bulk material: fused silica, silicon, borofloat
+ Wavelength range: DUV to Mid-IR
+ Lens profile: sphere, asphere
+ Sub-micron position accuracy

ADDITIONAL FEATURES

+ Trenches for glue stops and glue pockets, pupils, pinholes, alignment marks, mounting posts
+ Double-sided lens arrays with precise front-to-back alignment
+ AR coating, metallization, wafer-level packaging
+ Wafer thinning

LARGE SELECTION OF STANDARD ARRAYS AVAILABLE OFF-THE-SHELF

+ Pitches 127 µm, 250 µm, 500 µm, 750 µm, 1000 µm, 1250 µm in stock
+ Array sizes available up to 120 x 120 mm²

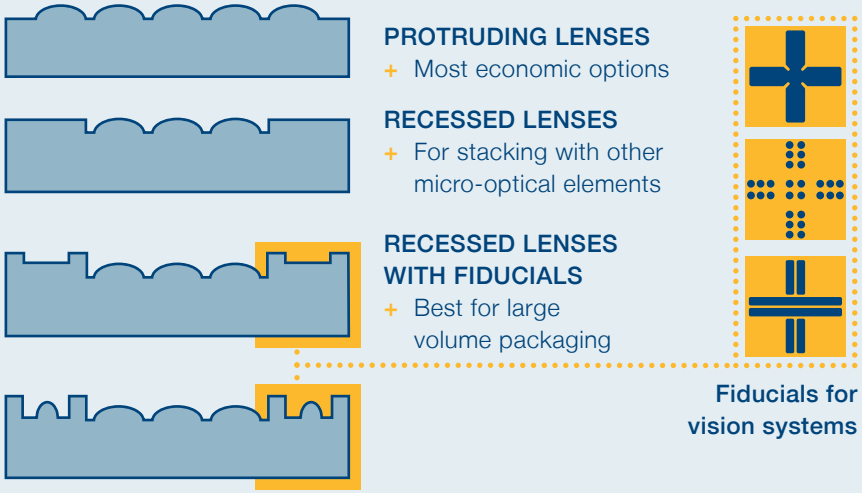
TAILOR-MADE CUSTOMIZED ARRAYS

Customized microlens arrays along with all important measurement data (ROC, conic, uniformity, coating) can be supplied if requested.

FORM FACTORS & PACKAGING FEATURES

SUSS MicroOptics offers innovative solutions for packaging to ensure the most efficient integration into customers' systems. Packaging options include recessed lenses, cavities, integrated microprisms and fiducial markers.

MICROLENS ARRAYS – DESIGN OPTIONS



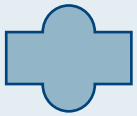
PROTRUDING LENSES
+ Most economic options

RECESSED LENSES
+ For stacking with other micro-optical elements

RECESSED LENSES WITH FIDUCIALS
+ Best for large volume packaging

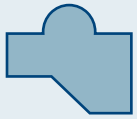
Fiducials for vision systems

Microlens with recess underneath: Recess from 2 to 20 µm used as a glue stop, a glue pocket, or well-defined air gap



Double-sided microlenses: alignment between top and bottom lenses < 3 µm

Recessed microlens: recess depth from 5 to 10 µm



Microlens with 45° prism underneath in silicon

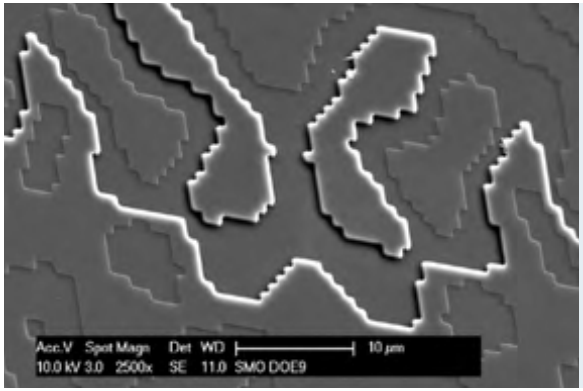
… AND ANY COMBINATION OF THE ABOVE

DIFFRACTIVE OPTICAL ELEMENTS (DOEs)

HIGH-END

SUSS MicroOptics is a premium supplier of high-end diffractive optical elements. They are suitable for very demanding applications such as DOE-based spot generators, DUV wafer stepper illumination systems, high-power laser beam shaping, vortex lenses for fiber interconnects, random DOE and diffusers for beam smoothing, metrology, medical devices and masters for imprint or replication.

SPECIFICATIONS	
Materials	Fused silica (various grades) and silicon
Composition	2 (binary) to 16 levels
Precision	Typically overlay error < 70 nm
Minimum feature size	500 nm to 1 µm depending on step height and / or etch depths
Efficiency	Up to 96 %

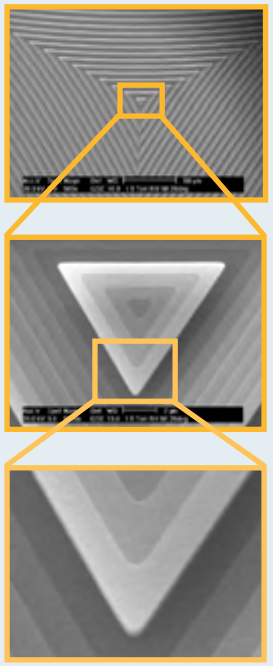


Diffractive optical elements (DOEs) can be used instead of microlenses where size in an application is a concern.

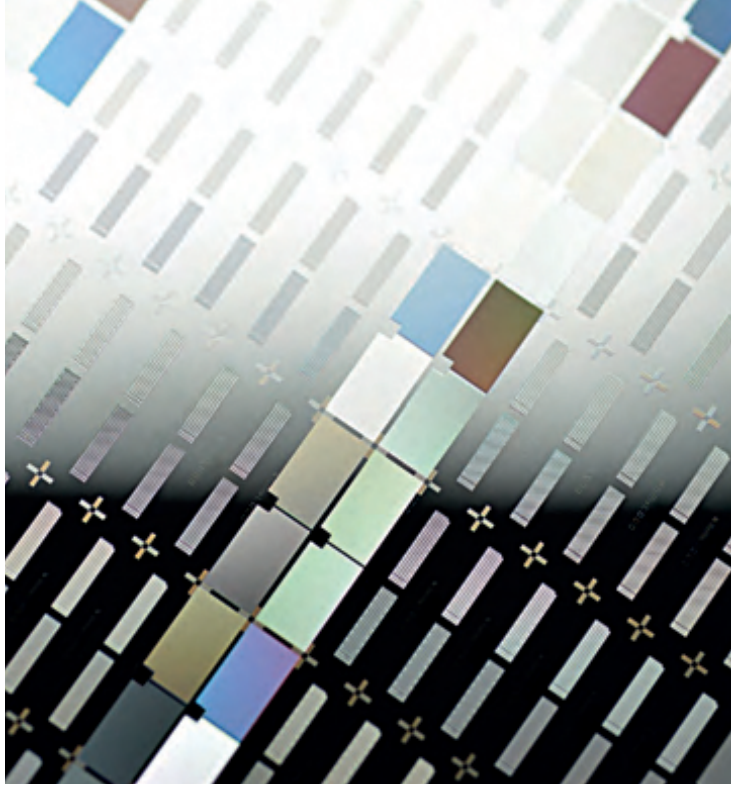
They are also excellent beam homogenizers and shapers and – unlike their microlens counterparts – have no shape constraint for the illumination they produce.

8-LEVEL DIFFRACTIVE OPTICAL ELEMENTS DESIGNED FOR A FRESNEL LENS

Our wafer-based technology (8" wafer scale) allows large scale manufacturing of diffractive optical elements for very competitive prices.



In the images above you can see an example of 8-level diffractive optical element (Fresnel design) for excimer laser beam shaping (193 nm).



TYPICAL APPLICATIONS		
BEAM SHAPING	LASER	HOMOGENIZERS/ DIFFUSERS
PHASE PLATES	3D SENSING	SPOT GENERATOR

KEY FEATURES

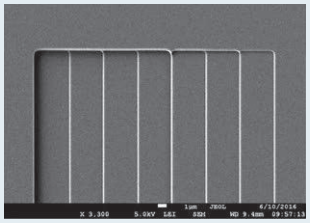
+ Fused silica, silicon
+ 8" wafer scale
+ Binary, 8-level, 16-level
+ 0.5 µm Minimum feature size
+ < 70 nm overlay accuracy
+ Diffraction efficiency up to 98 %
+ 190 nm to 5 µm wavelength range

ADDITIONAL FEATURES

+ MLAs and DOEs on one element
+ Custom designs
+ Fiducials, ID marks
+ Pedestals & trenches
+ AR coating & metallization
+ Delivery options

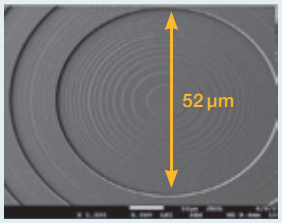
DESIGN CAPABILITIES - CUSTOM SOLUTIONS

Our optical engineers understand the critical nature of your requirements and the need to produce them in a cost effective way. SUSS MicroOptics helps to bring your vision to life with our custom lens design solutions both in prototyping and volume production.



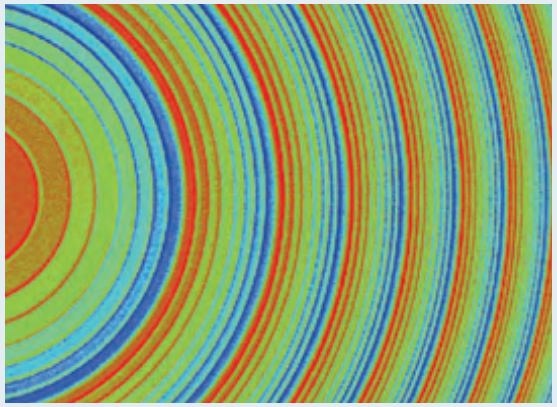
+ 8-LEVEL GRATING

+ 16-LEVEL GRATING



+ 16-LEVEL DOE LENSES
+ STEPPER TECHNOLOGY
+ DOUBLE-SIDE AR COATING

> 96 % DIFFRACTION EFFICIENCY



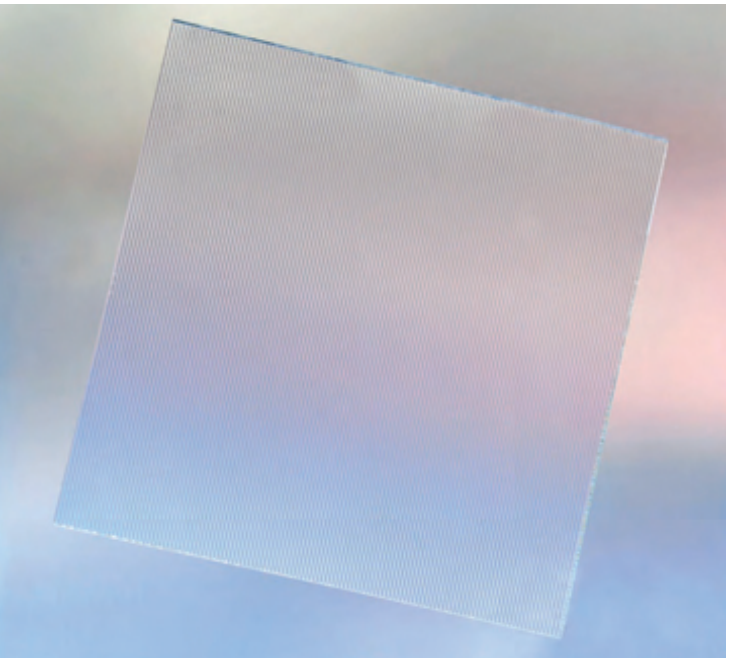
Key advantages of the DOE – possibility to produce elements with different “ROCs” across an element, off-axis lenses, no gaps between lenses, etc.

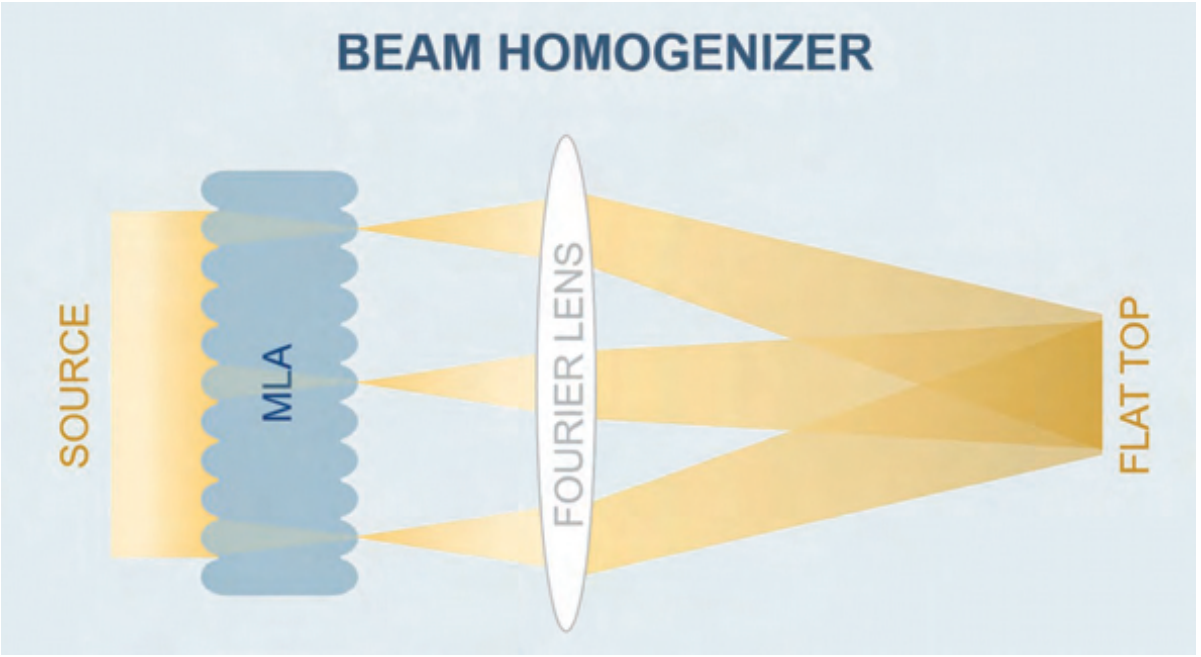
BEAM HOMOGENIZERS – UNIFORM LIGHT DISTRIBUTION

HOMOGENIZE YOUR LIGHT SOURCE

Most applications such as UV curing, laser machining/processing, gluing and illumination require a uniform light distribution in order to achieve the best possible results. With SUSS MicroOptics homogenization components, you will have an easy solution even for very demanding applications.

SPECIFICATIONS	
Materials	Fused silica (various grades) and silicon
Angular spectrum	Typically < 1° to 20°
Area of illumination	Linear, circular, rectangular, square
Source-workplane distance	Typically 30 to 1000 mm
AR coating	UV, VIS, NIR – front-side, back-side, to air, to glue
Lens array dimensions	According to customer requirements





TYPICAL APPLICATIONS

SEMICONDUCTOR	LASER MACHINING	OPTICAL INSTRUMENTS	DISPLAYS

KEY FEATURES

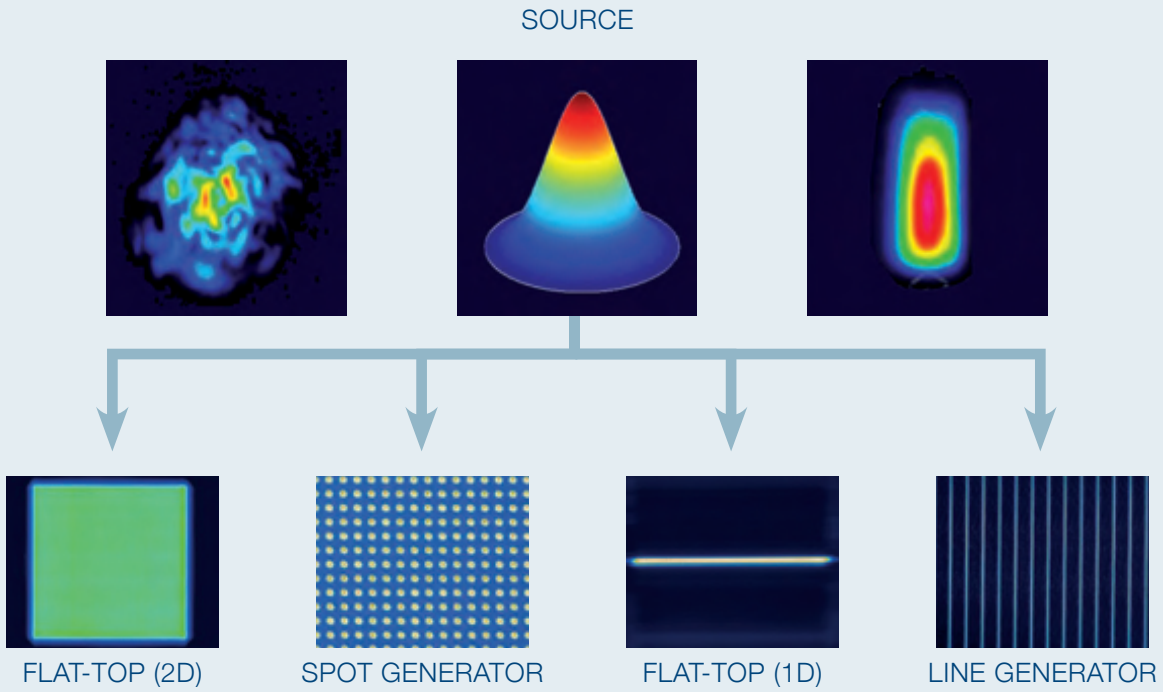
+ Perfect uniformity in working plane (flat-top profile)
+ Flat-top shapes: square, rectangular, circular, line
+ Compact design
+ Easy to use
+ UV grade fused silica: very high power
+ Fused silica grade for high power applications available
+ Suitable for all light sources (mercury arc lamps, excimer laser, UV LED)
+ AR coating for UV broad band or specific wavelengths available
+ AR coating with a high Laser-induced Damage Threshold (LIDT)
+ High power is available for all wavelength from DUV to NIR, i.e. DUV, UV, VIS, NIR

A LARGE SELECTION OF MODULES

+ Standard off-the-shelf solutions
+ Tailor-made specific modules

OFF-THE-SHELF PRODUCTS AND SIMULATIONS

Our micro-optical elements offer near-perfect decoupling of output illumination from the properties of the incoming beam. Generate 2-dimensional rectangular or square areas of uniform illumination, as well as lines and spot patterns with our refractive microlenses, or create the shape of your choice with uniform illumination using a diffractive optical element. We can create any shape you need and do simulation tests of the desired effect.

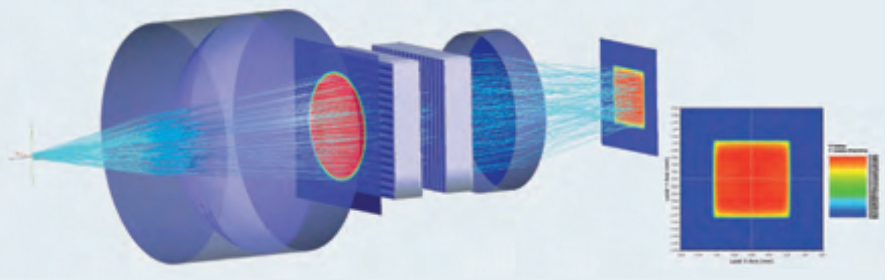


SIMULATION AND OPTICAL MODELING

The experienced team of SUSS MicroOptics has extensive advanced optical modeling capabilities. We support customers with simulations across many applications. A few examples of our work includes simulation and optical modeling for beam homogenizing, fiber and PIC coupling, MLA-based projectors for automotive lighting, ray tracing and physical optics for diffractive and hybrid 3D sensing.

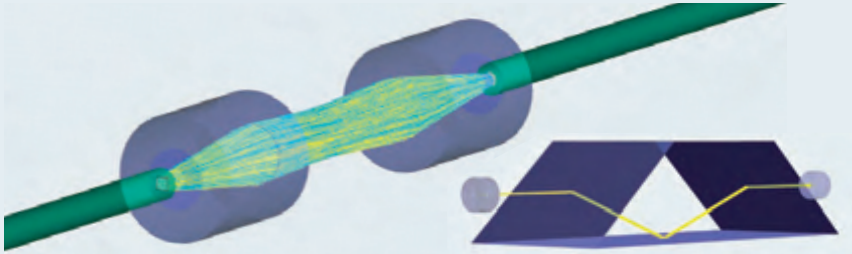
Beam Homogenizers

Using optical modeling techniques we can help you design high performance beam homogenizers and spot generators. We can optimize the far field of arbitrary input fields, optimize the output uniformity and account for diffraction effects.



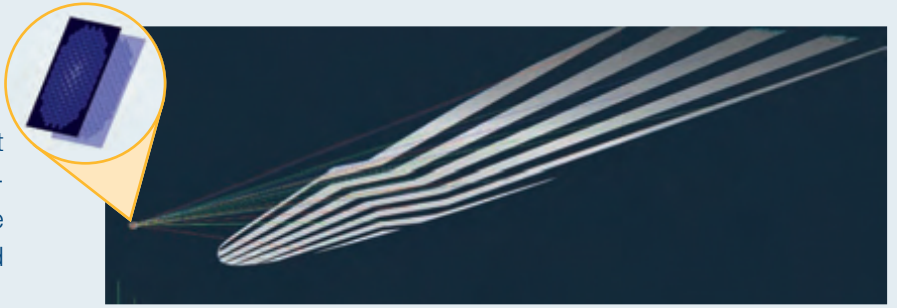
Fiber Optics and PIC Optics

Fiber optics, silicon photonics (PIC), CWDM, LDs and VCSELs require high coupling efficiencies and perfect collimation. This can be achieved by using the correct microlens array. Our physical optics simulations can optimize for low wavefront errors and reduced diffraction effects. We can handle various types of MFDs and waveguide modes as inputs.



Mini- and Micro-Projectors (MLA-based) for Lighting Systems

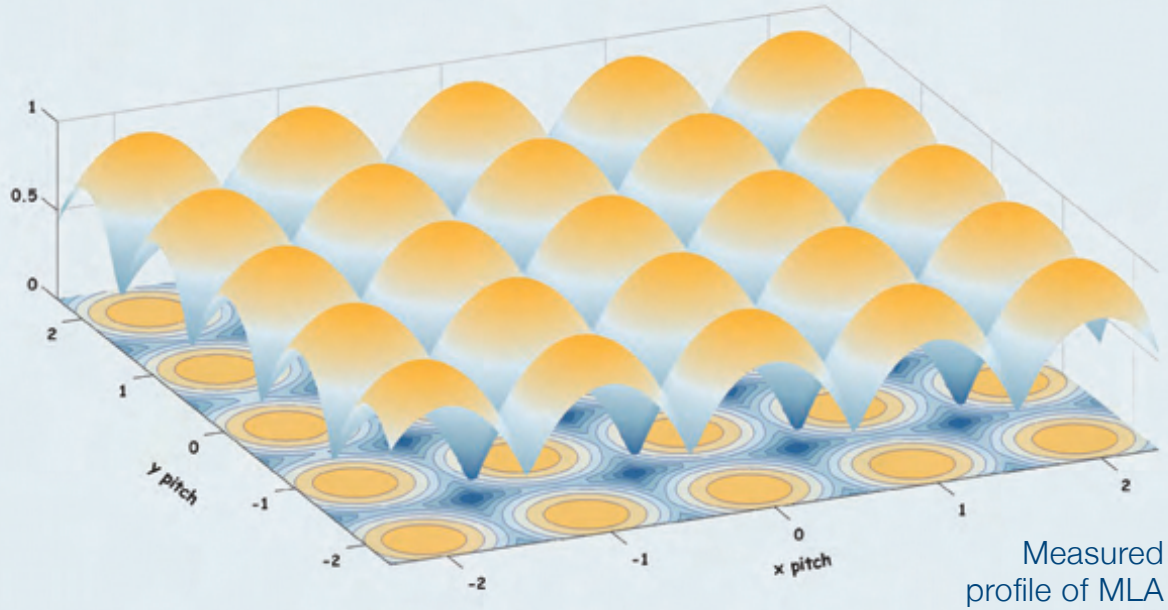
We offer full optical design of MLA-based projectors from the target pattern to the embedded chromium "slide". Our simulations can reduce aberration effects in the final construction and optimize for the best-possible illumination area and large field of view. We can design MLAs for low and large volume production, while keeping the system size extremely small.



METROLOGY

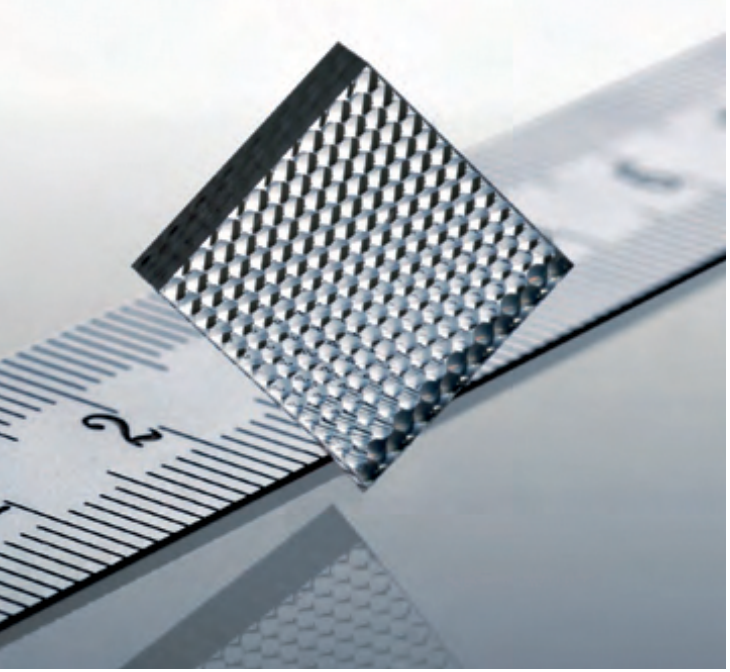
SUSS MicroOptics has a large variety of state-of-the-art metrology tools for inspection and quality control of wafer-level optics. We perform testing at component level using interferometric tools such as confocal scanning microscopy, white light interferometry and mechanical stylus techniques.

Photometric measurement
of the light distribution
of a light carpet.



Measured
profile of MLA

These tools allow precise characterization of the microlenses which can be measured with nanometer precision across their whole surface. Fully automated analyses enable critical lens parameters to be extracted and shared with clients. These data are used by our production teams to optimize manufacturing.



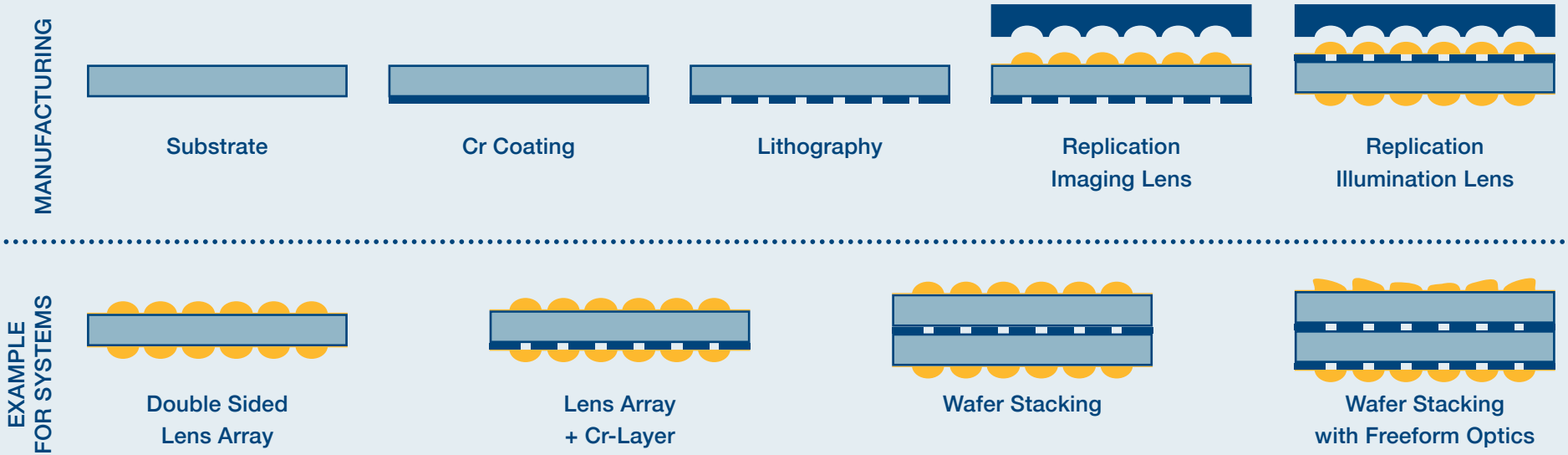
IMPRINT SOLUTIONS

SUSS MicroOptics imprint capabilities give customers the flexibility they need to design demanding structures for their applications, including freeform micro-optics, high fill factors (up to 100 %) and mixes of concave and convex shapes. This technology has been deployed in high volume manufacturing for the automotive industry, making it a good solution for cost-sensitive markets while benefiting from stable processes.

Using the latest equipment developed by our parent company SUSS MicroTec, we can replicate even the most demanding lens shapes at cost competitive prices.

TYPICAL APPLICATIONS		
AUTOMOTIVE	MEDICAL	3D SENSING

IMPRINT - PRODUCTION OF POLYMER-ON-GLASS-LENSES



SUSS IMPRINT EXCELLENCE CENTER

Imprint lithography is a key technology for many emerging applications such as LED, MEMS/NEMS, micro-optics, augmented reality and optoelectronic sensors. SUSS MicroTec and SUSS MicroOptics share decades of imprint technology expertise and manufacturing experience. At the SUSS Imprint Excellence Center customers can draw on this expertise and access a broad range of SUSS imprint technologies together with our deep knowledge of process applications. We work under the rigorous requirements of recognized automotive standards and support our customers from the design stage to HV production.

TYPICAL APPLICATIONS

AUTOMOTIVE	MEDICAL	3D SENSING

SUSS MicroTec Lithography
+ **Imprint Equipment**
+ Demonstrations
+ Application support

Supply chain
+ Resist supplier
+ Stamp material supplier
+ Master supplier

SUSS Imprint Excellence Center
Services for:
+ Design & Prototyping
+ Mastering
+ Process development
+ Transfer to HV production

SUSS MicroOptics
+ **Wafer-level imprint volume production**
+ Design & Prototyping
+ WLO metrology
+ Automotive qualification

For more information please visit
www.suss.com/en/suss-imprint-excellence-center

SUSS MicroOptics – A SUCCESS STORY

We started SUSS MicroOptics SA to answer a growing demand for micro-optical components and within 20 years the company has grown **from 3 to more than 100 employees**.

In 2012, we moved to our current premises in Hauterive, Switzerland, and built a new 6"/8" wafer cleanroom fab. **In 2017**, we launched a new production line for Wafer-Level Optics (WLO) dedicated to automotive lighting applications and **in 2018**, we successfully passed IATF 16949:2016 automotive qualification. We are currently building a second cleanroom fab in Neuchâtel, Switzerland, which will be fully operational in **2021**.

Over the years, we have constantly evolved and found new ways to improve our production processes while following our main principles:

Working with Integrity: we build trust and commitment through our daily actions. Interactions with our customers, our suppliers, and our co-workers occur within a code of moral and ethical conduct that is above reproach.

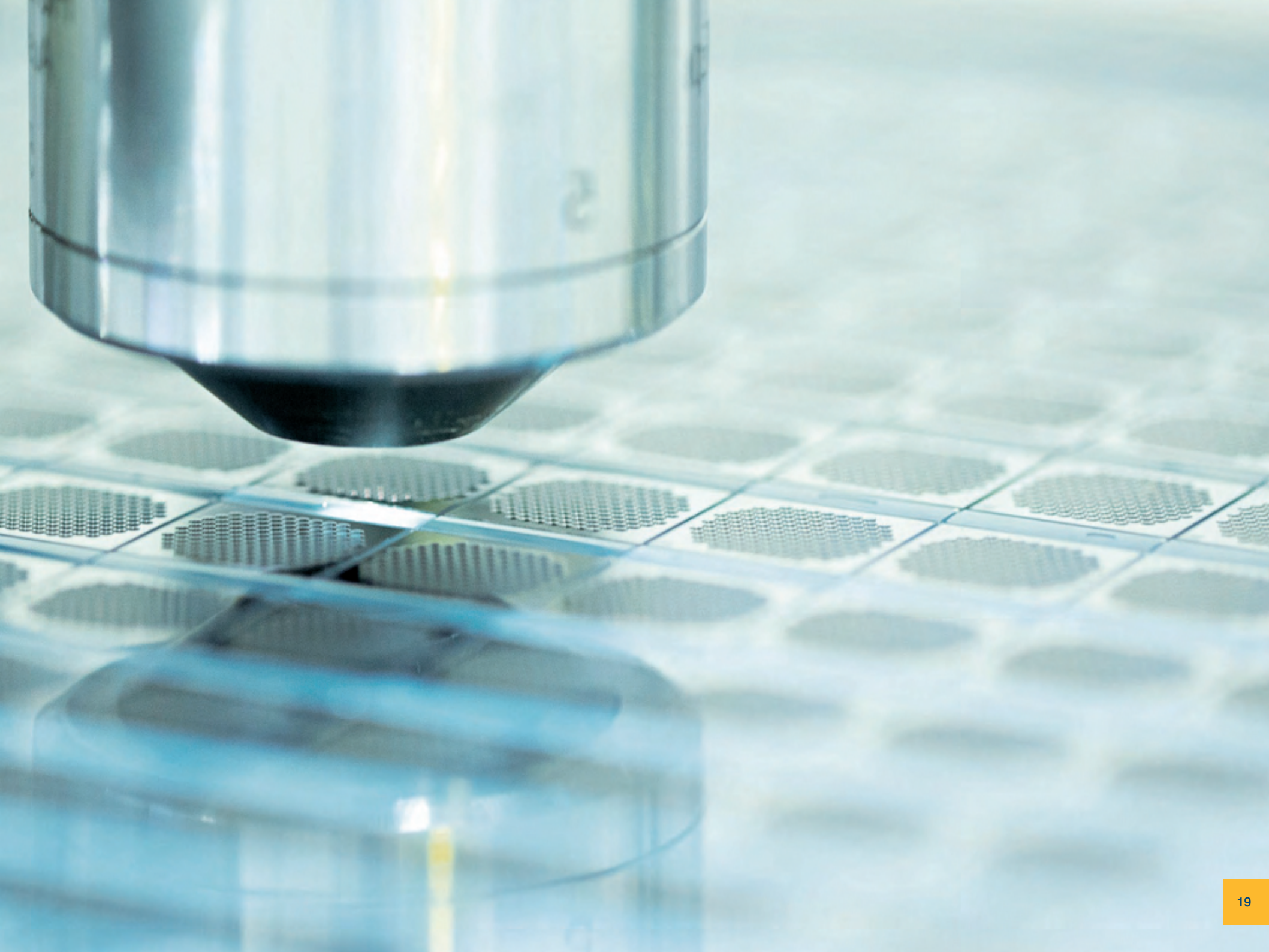
Technology: we stay at the cutting edge of technology in the development, production, testing and application of our products. Our investment in technology ensures the quality and reliability of our micro-optics. We motivate and train our co-workers. Our investment in technology will ensure quality and reliability of our micro-optics. We motivate and train our collaborators.

Advocating for our Customer: we value our customers and do whatever it takes to satisfy their needs. We ensure that customer interactions are enjoyable, efficient, and effective.

Delivering Quality: we strive to do the right thing the first time. If a problem does arise, we take immediate action to resolve it. The quality of our people, our products, and our services will ensure the long-term viability of our company.

Today, we deliver high-quality micro-optics to more than 200 customers across the globe and we are recognized as preferred and leading supplier to major companies in optics, telecom, metrology, semiconductor and automotive industry.

Dr. Reinhard Völkel
SUSS MicroOptics CEO



Visit **www.suss-microoptics.com**
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